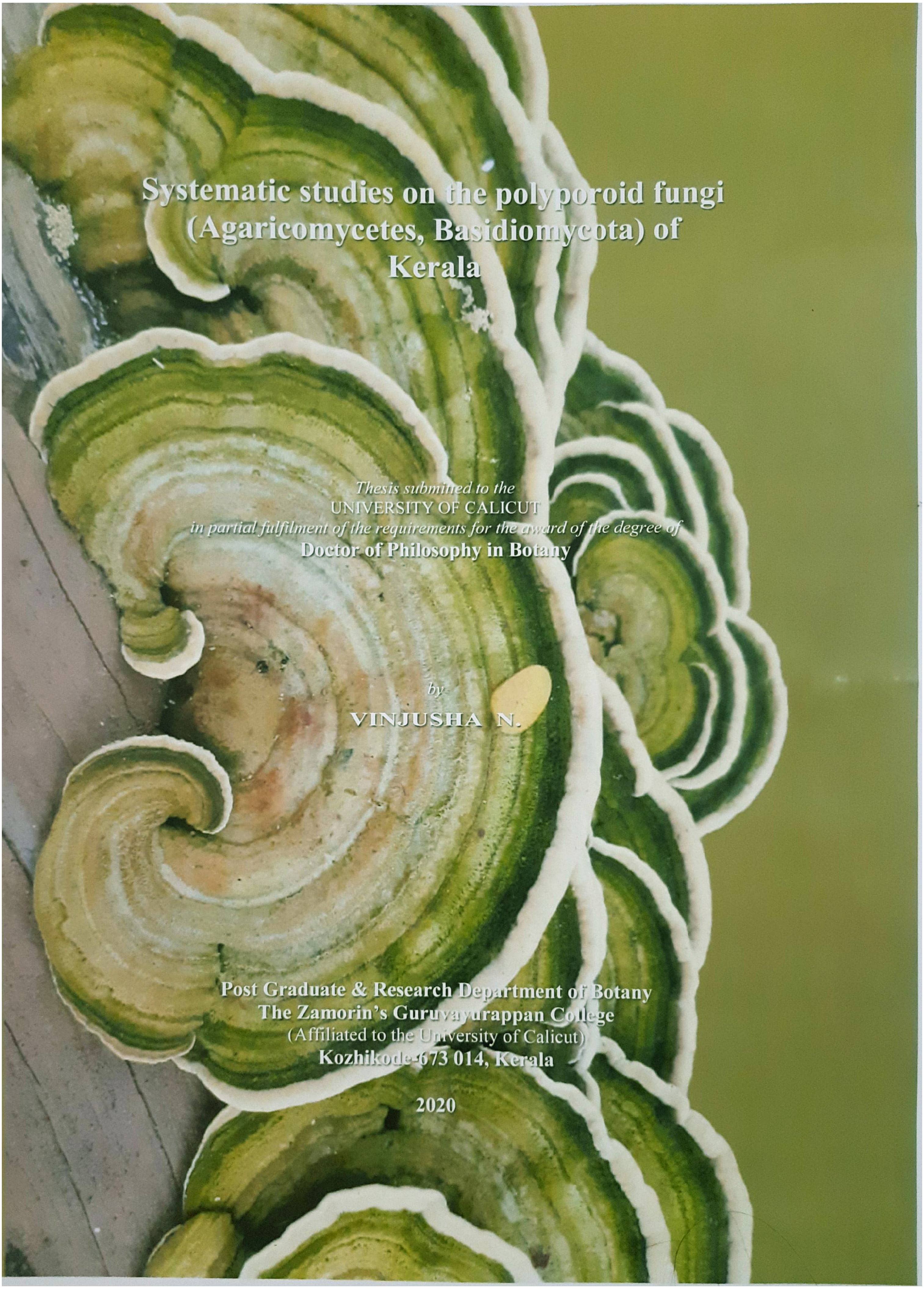


Systematic studies on the polyporoid fungi (Agaricomycetes, Basidiomycota) of Kerala

Thesis submitted to the
UNIVERSITY OF CALICUT
in partial fulfilment of the requirements for the award of the degree of
Doctor of Philosophy in Botany

by

VINJUSHA N.

Post Graduate & Research Department of Botany
The Zamorin's Guruvayurappan College
(Affiliated to the University of Calicut)
Kozhikode-673 014, Kerala

2020

Systematic studies on the polyporoid fungi (Agaricomycetes, Basidiomycota) of Kerala

Thesis submitted to the
UNIVERSITY OF CALICUT
in partial fulfillment of the requirements for the award of the degree of
Doctor of Philosophy in Botany

by

VINJUSHA N.
(U.O. No. 7128/2015/Admn., dated 06/07/2015)

Post Graduate & Research Department of Botany
The Zamorin's Guruvayurappan College
(Affiliated to the University of Calicut)
Kozhikode-673 014, Kerala

2020

THE ZAMORIN'S GURUVAYURAPPAN COLLEGE
(Established in 1877, Affiliated to the University of Calicut. Re-accredited by NAAC with A Grade)
Guruvayurappan College P.O., Kozhikode-673014, Kerala
Website: www.zgcollege.org, Phone: 0495-2331516, Email: zgckozhikode@gmail.com

December 2020

CERTIFICATE

This is to certify that the thesis entitled "**Systematic studies on the polyporoid fungi (Agaricomycetes, Basidiomycota) of Kerala**", submitted to the University of Calicut by Ms. Vinjusha N., for the award of PhD. Degree in Botany is a record of Bonafide research work carried out by her under the supervision and guidance of Dr. Arun Kumar T. K., Assistant Professor, Post Graduate and Research Department of Botany of this College during the period 2015–2020.

PRINCIPAL

POST GRADUATE & RESEARCH DEPARTMENT OF BOTANY
THE ZAMORIN'S GURUVAYURAPPAN COLLEGE
(Established in 1877, Affiliated to the University of Calicut. Re-accredited by NAAC with A Grade)
Guruvayurappan College P.O., Kozhikode-673014, Kerala
Website: www.zgcollege.org, Phone: 0495-2331516, Email: zgckozhikode@gmail.com

Dr. Arun Kumar T. K.
Assistant Professor of Botany

December 2020

CERTIFICATE

This is to certify that the thesis entitled "**Systematic studies on the polyporoid fungi (Agaricomycetes, Basidiomycota) of Kerala**" submitted to the University of Calicut by Ms. Vinjusha N. in partial fulfillment of the requirements for the award of the degree of Doctor of Philosophy in Botany, has been carried out by her under my supervision and guidance, and that no part of this thesis has formed the basis for the award of any degree or diploma or other similar title or recognition.

Dr. Arun Kumar T. K.

POST GRADUATE & RESEARCH DEPARTMENT OF BOTANY
THE ZAMORIN'S GURUVAYURAPPAN COLLEGE
(Established in 1877, Affiliated to the University of Calicut. Re-accredited by NAAC with A Grade)
Guruvayurappan College P.O., Kozhikode-673014, Kerala
Website: www.zgcollege.org, Phone 0495-2331516, Email: zgckozhikode@gmail.com

December 2020

CERTIFICATE

This is to certify that the thesis entitled “**Systematic studies on the polyporoid fungi (Agaricomycetes, Basidiomycota) of Kerala**” submitted to the University of Calicut by Ms. Vinjusha N. in partial fulfillment of the requirements for the award of the degree of Doctor of Philosophy in Botany, has been carried out by her under the supervision and guidance of Dr. Arun Kumar T. K., Assistant Professor of this department, and that no part of this thesis has formed the basis for the award of any degree or diploma or other similar title or recognition.

Dr. Rajan P. P.
Head of the Department,
P.G. & Research Department of Botany

DECLARATION

I hereby declare that the thesis entitled “**Systematic studies on the polyporoid fungi (Agaricomycetes, Basidiomycota) of Kerala**” submitted to the University of Calicut in partial fulfillment of the requirements for the award of the degree of Doctor of Philosophy in Botany, has been carried out by me under the supervision and guidance of Dr. Arun Kumar T. K., Assistant Professor, Post Graduate and Research Department of Botany, and that no part of this thesis has formed the basis for the award of any degree or diploma or other similar title or recognition.

Vinjusha N.

Place: Kozhikode
Date:

ACKNOWLEDGEMENTS

I express my sincere gratitude to Dr. Arun Kumar T. K. (Assistant Professor, P. G. & Research Department of Botany, The Zamorin's Guruvayurappan College, Kozhikode) for introducing me to fungal taxonomy, for his excellent guidance, inspiring comments, consistent supervision, and encouragement extended throughout my work.

I am grateful to the Management of the Zamorin's Guruvayurappan College, Principal of the College, Dr. P. T. Malini, former Principals, Dr. M. Madhavikutty, Dr. T. Ramachandran and Dr. G. Indiradevi, for providing all facilities, and whole hearted support for carrying out my PhD. studies.

I record my sincere thanks to the Kerala State Council for Science, Technology, and Environment (KSCSTE), Thiruvananthapuram, for the support given to me in the form of a Research Fellowship.

I am grateful to the Principal Chief Conservator of Forests, and Chief Wildlife Warden, Kerala for granting me permission for fieldwork in the forest areas of Kerala. I also thank staff members of the Kerala Forest Department for giving facilities during the field trips to various forest areas of Kerala.

Thanks are due to my Research Advisory Committee members, Dr. R. V. M. Divakaran, Dr. M. Sathyan, Dr. A. K. Pradeep, Professor (Dr). P. Manimohan, Dr. P. P. Rajan, and Dr. K. P. Rajesh, for critically evaluating the progress of my research work periodically, and for proving suggestions for improvement. I record my special gratitude to Prof. (Dr.) P. Manimohan (Department of Botany, University of Calicut) for his invaluable advice and suggestions.

I am thankful to Dr. P.P. Rajan, Head of the Department of Botany, and Dr. M. Jayasree (former HoD) for giving all the facilities and support during my studies. I am thankful to the faculty members, Dr. P. Indulekha, Dr. K. P. Rajesh, Dr. Manju C. Nair, Dr. Sanoj E., Dr. Anoop K. and Dr. Sreejith P. E. for their support.

I am grateful to Prof. (Dr.) Leif Ryvarden (University of Oslo, Oslo, Norway, Europe) for his valuable help and encouragement. I express my sincere thanks to Dr. Manoj Emanuel Hembrom (AJCB Indian Botanic Garden, Howrah, Kolkata, India) for his expert suggestions, help, and support.

I am thankful to all teaching and non teaching staff of the College for their help and support. I express my sincere thanks to Mr. T. M. Mohanakrishnan (IT Administrator of the College), and to Mr. Subeesh K. (Librarian of the College) for their valuable help and support.

I have great pleasure to record the valuable help and constant encouragement extended to me by the Research Scholars of the Department of Botany, Ms. Krishnapriya K., Ms. Salna N., Ms. Anjitha Thomas, Ms. Chandini V. K., Ms. Vijisha P., Ms. Manju A. C., Mr. Mufeed B., Ms. Thulasi R., Ms. Vafa A. Latheef, Ms. Anju John V., Ms. Nishida P. P., Ms. Sajitha Menon S., Dr. Manjula K. M. and Dr. Deepa K. M. I record my sincere thanks to the former students of the College, Ms. Athira C. K. and Mr. Abhijith S., for their generous help and whole hearted support. I also thank Research Scholars of other Departments of the college for their support.

I thank my family members and friends for their valuable help, encouragement, cooperation and support to bring this work to a successful end.

Above all, I thank the almighty God for the grace and blessings showered on me throughout my work, and for giving me strength for the successful completion of my work.

Vinjusha N.

CONTENTS

1. INTRODUCTION

Polyporoid fungi are a group of wood inhabiting fungi, coming under the class Agaricomycetes, Basidiomycota. They are one of the largest and well noticeable fungal groups in all forests of the world (Rajchenberg 2011). Polyporoid fungi develop sexual fruit bodies called as basidiocarps, which produce spores within the tubes that open to outside as pores. Most members of the group possess a poroid hymenial surface, and are collectively called as polypores or polyporoid fungi. However, the group is also represented by members with smooth, tuberculate, lamellate, daedaleoid to irpicoid hymenophore. Most species are found growing on live trees or dead wood. But there are also species growing on soil. Fruit bodies of polypores vary from resupinate, pileate and stipitate forms. They are found either solitary or in clusters. Polyporoid species show much variation in consistency, size, colour and surface features of basidiocarps. Consistency of basidiocarps varies from soft coriaceous to hard and woody. They produce fertile structures like holobasidia, and ballistospores, and sterile structures such as cystidia and hyphal pegs in the continuous layer of hymenium (Gibertoni 2008). Hyphal system of polyporoid fungi are monomitic (only generative hyphae present), dimitic (generative hyphae and skeletal hyphae present, sometimes with skeleto ligative hyphae instead of skeletal hyphae) or trimitic (all three types of hyphae present) (Ryvarden 1991). Many species of the group have a cosmopolitan distribution whereas others are climate dependant (tropical, temperate, or boreal) (Ryvarden 1991).

Polyporoid fungi play significant role in forest ecosystems as symbionts and parasites (Swift 1982). Basidiocarps of many polypore species host various insect communities (e.g., *Fomes fomentarius* (L.) Fr., *Fomitopsis pinicola* (Sw.) P. Karst.) (Thunes 1994; Schigel 2011). Thirty three species of beetles have been reported from species like *Fomes fomentarius*, *Fomitopsis pinicola* and *Trametes pubescens* (Schumach.) Pilát (Selonen *et al*. 2005). Species of *Coltricia* Gray and *Coltriciella* Murrill are known to form ectomycorrizhae with plants (Tedersoo *et al*. 2007; Hibbett *et al.* 2014). Many polyporoid species are known as parasites and pathogens of different palms or trees (*Ganoderma* P. Karst., *Inonotus* P. Karst, *Phellinus* Quél.). *Ganoderma* species are pathogenic on plantation crops like oil palm, coconut, rubber, betel nut, and tea. *Ganoderma* species also cause considerable yield loss on many forest tress (Naidu *et al.* 1966). Some of the major plant diseases caused by polypores are root rot by *Amauroderma* species (Glen *et al.* 2009), white pocket rot on broad leaved hard wood trees and conifers caused by *Fuscoporia torulosa* (Pers.) T. Wagner & M. Fisch (Motta *et al*. 1996; Wagner & Fischer 2001), butt rot of coconut by *Ganoderma* species (Harrison & Jones 2003), heart rot disease and cankers on living trees by *Phellinus* species (Hansen *et al.* 2000; Wagner & Fischer 2002) and white spongy rot by *Trametes* species (Hickman *et al*. 2011).

Fruit bodies of polyporoid fungi like *Ganoderma lucidum* (Curtis) P. Karst, *Polyporus umbellatus* (Pers.) Fr., and *Fomitopsis betulina* (Bull.) B.K. Cui, M.L. Han & Y.C. Dai are edible (Boa 2006; Grienke *et al.* 2014; Bandara *et al.* 2015). Many polypore species have potential medicinal value. *Ganoderma lucidum* popularly known as “mushroom of immortality”, “ten thousand year mushroom”, “mushroom of spiritual potency” and “spirit plant” in China (Huang 1993; Liu & Bau 1994) is a medicinal mushroom that possesses anti tumour, anti inflammatory, anti chronic bronchitis, immunoenhancing, cardiovascular regulating and hepato protectant properties (Chen *et al*. 2006; Upton 2006). The polypore *Grifola frondosa* (Dicks.) Gray is reported to have anti tumour, immuno regulating, anti hypertensive, anti hyperlipidemia, anti radiation activity and liver protecting properties (He *et al.* 2018). *Wolfiporia extensa* (Peck) Ginns nourishes and replenishes spleen system and improve immune status (Yance 2013). Presence of polysaccharide K in *Trametes versicolor* (L.) Lloyd gives them anticancer, antitumour and immune enhancing properties (Fritz *et al.* 2015). Species of polypores also have many ethnobotanical uses (Rogers 2012). Some other medicinally important polypores are *Lentinus edodes, Lenzites betulina, Inonotus obliquus,* (Zhang *et al.* 2016), *Laetiporus sulphureus, Fomes fomentarius, Fomitopsis pinicola, Piptoporus betulinus* and *Laricifomes officinalis* (Grienke *et al.* 2014). Some polypores such as *Bjerkandera adusta* and *Perenniporia* species cause pulmonary infection in humans (Buzina *et al*. 2005; Chowdhary *et al*. 2012; Liu *et al.* 2014).

Polyporoid fungi are considered as one of the major wood decomposers and they play an important role in nutrient cycling. This group includes both white rot and brown rot fungi. White rot fungi degrade both cellulose and lignin of the wood leaving a white powdery mass. Enzymes like quinone oxidoreductase, lignin peroxidase, and laccases perform wood decay. Examples for white rot fungi are species of *Ganoderma, Trametes* Fr. and *Microporus* P. Beauv. Brown rot fungi are capable of degrading only cellulose and hemicellulose, thus breaking the wood into cubical fragments. As a result of the decay process, the wood shows a brown discoloration. Examples of brown rot fungi are species of *Antrodia* P. Karst., *Fomitopsis* P. Karst. and *Postia* Fr. (Ryvarden & Melo 2014). Mycelium of the rot causing species initially gets ramified in the woody tissues and later develops characteristic fruiting structures, which indicates the infection (Leelavathy & Ganesh 2000).

The presence of cellulolytic and lignolytic enzymes in polyporoid fungi makes them useful in bioremediation processes like, clearing various industrial effluents, oil containing crop wastes, degradation of polycyclic aromatic hydrocarbons and decolourization of synthetic dyes (Peláez *et al*. 1995; Balan & Monteiro 2001; Hmd 2011; Choi *et al.* 2013; Krastanov *et al.* 2013; Singh *et al*. 2019). The white rot fungi *Abortiporus biennis* Murrill is used in pilot scale bioreactors for large scale production of laccase enzyme (Erden *et al*. 2009). Willow sawdust after pretreatment with *A. biennis* is reported to have increased biogas production (Alexandropoulou *et al*. 2015). Another white rot species *Flavadon flavus* (Klotzsch) Ryvarden is used in the dye industry for the extraction of yellow pigments. (http://indiasendangered.com/researchers-find-thousands-of-fungi-species-insinghadforests/). *Pycnoporus sanguineus* (L.) Murrill is capable of degrading plastic (Cesarino *et al*. 2019).

Polyporoid fungi have been documented worldwide (Berkeley & Cooke 1876; Cunningham 1965; Ryvarden & Johansen 1980; Gilbertson & Ryvarden 1986; Corner 1989, 1989a, 1989b, 1991; David & Rajchenberg 1992; Gulaid & Ryvarden 1998; Núñez & Ryvarden 1999, 2000, 2001; Decock & Ryvarden 2003; Gibertoni *et* *al.* 2004; Ryvarden & Iturriaga 2004; Bernicchia 2005; Hattori 2005; Spirin 2007; Gomes-Silva & Gibertoni 2009; Wang *et al.* 2009; Dai 2010; Cao *et al*. 2012; Bolhassan *et al.* 2012; Lee *et al.* 2012; Dai 2012; Salvador-Montoya *et al*. 2012; Zhou *et al.* 2016; Xing *et al*. 2018; Cui *et al*. 2019).

Some of the major Indian records on polypores are that of Berkeley (1850, 1851, 1854, 1855, 1866, 1872), Bose (1918, 1919, 1919a, 1920, 1920a, 1921, 1921a, 1921b, 1922, 1922a, 1922b, 1923, 1923a, 1924, 1925, 1928, 1928a, 1934, 1937, 1944, 1946), Butler & Bisbi (1931), Mitter & Tandon (1932, 1938), Banerjee & Chakravarthy (1945), Banerjee & Chatterjee (1945), Bagchee (1951, 1954, 1957, 1958, 1960, 1961), Thind & Adlakha (1956), Vasudeva (1960), Roy (1968, 1968a, 1969, 1970, 1971), Thind & Rattan (1968, 1970, 1971, 1971a, 1971b, 1971c, 1972, 1973, 1973a, 1976), Natarajan (1978), Natarajan & Manjula (1978), Sharma (2000), Arya (2004), Bhosle *et al*. (2005), Dhingra & Singla (2005), Natarajan *et al*. (2005), Prasher & Chander (2006, 2007), Arya *et al.* (2008), Sehgal *et al*. (2008), Swapna *et al.* (2008), Bhosle *et al.* (2010), Tiwari *et al*. (2010), Sharma *et al*. (2013), Nagadesi *et al.* (2014), Senthilarasu (2014), Usha & Janardhana (2014), Singh *et al*. (2014), Lyngdoh & Dkhar (2014), Ranadive (2014), and Hembrom *et al*. (2015).

Major published documentary works on the polyporoid fungi of Kerala are that of Rangaswamy *et al.* (1970), Ganesh & Leelavathy (1986), Ganesh *et al.* (1988), Sankaran & Florence (1995), Roy & De (1996), Leelavathy & Ganesh (2000), Florence & Yesodharan (2000), Florence (2004), Manimohan *et al.* (2004), Kumar & Manimohan (2005), Pradeep & Vrinda (2007), Mohanan (2011), Farook *et. al*. (2013) and Adarsh *et al.* (2019). Leelavathy & Ganesh (2000) have recorded 79 species belonging to 32 genera, placed in 3 families (Polyporaceae, Ganodermataceae and Hymenochaetaceae). Mohanan (2011) gave an account of 91 species of polypores of 46 genera, belonging to six families (Polyporaceae, Hymenochaetaceae, Meruliaceae, Meripilaceae, Fomitopsidaceae and Ganodermataceae). Adarsh *et al.* (2018) published a checklist which compiled 145 species of polypores previously reported from Kerala. Recently, Adarsh *et al.* (2019)

reported three polypores, and Kiran *et al.* (2020) reported two polypores, which were new records to the State.

All the previous documentary studies on polyporoid fungi from Kerala are based on identifications using morphological characters alone. Molecular characterization has not been carried out in any of the previous studies on polypores from the state. Also, these earlier works do not treat taxa according to the latest phylogenetic concepts in polyporoid taxonomy. There exists much taxonomic confusion among different species concepts in polyporoid fungi of Kerala, especially in economically important genus like *Ganoderma*. Thus, studies that supplements morphology with molecular data are essential for resolving these taxonomic problems, and getting a better phylogeny of the group in Kerala.

Objectives of the study are to:

1) To prepare a comprehensive mycobiota of the polyporoid fungi (Agaricomycetes, Basidiomycota) of Kerala State.
2) To elucidate the phylogenetic relationships of the documented taxa.

2. REVIEW OF LITERATURE

2. 1. POLYPOROID FUNGI

Polyporoid fungi are basidiomycota members that produce holobasidia and ballistosporic basidiospores within pore tubes in the hymenial region (Gibertoni 2008). They are represented in different orders (Amylocorticiales K.H. Larss, Corticiales K.H. Larss., Gloeophyllales Thorn, Hymenochaetales Oberw., Jaapiales Manfr. Binder, K.H. Larss & Hibbett, Polyporales Gäum., Trechisporales K.H. Larss., and Russulales Kreisel *ex* P.M. Kirk, P.F. Cannon & J.C. David) of the class Agaricomycetes (Hibbett *et al*. 2014). Although, most members of the group generally exhibit poroid hymenial configuration, they are a polyphyletic group of organisms with much distinct microscopic characters, cultural characters and biology (Rajchenberg 2011).

Polyporoid fungi show variation in size, colour, surface features, and consistency of basidiocarps (Donk 1964; Ryvarden 1991; Bernicchia 2005). The hymenium in the polyporoid fungi is mostly tubular, that opens as pores on the underside of the basidiocarps (Leelavathy & Ganesh 2000). Apart from this, polypores also exhibit elongated poroid, daedaleoid, sinuous or lamellate hymenium (Núñez & Ryvarden 2001; Ryvarden & Melo 2014). Members of the group produce fertile structures such as holobasidia and ballistospores, and sterile structures like cystidia and hyphal pegs in the continuous layer of hymenium (Gibertoni 2008). Hyphal system of polyporoid fungi are monomitic, dimitic, or trimitic (Ryvarden 1991).

Species of polyporoid fungi are mainly wood inhabiting, whereas, some are terrestrial. Most species are saprotrophic on dead wood, whereas many are serious parasites on different tree species. This group of fungi is also well known to form different insect associations (Thunes 1994; Komonen *et al*. 2003; Schigel *et al*. 2006; Schigel 2011). As wood decomposers, they play a major role in the nutrient recycling. Most wood degrading species of the group causes white rot, whereas, others cause brown rot (Ryvarden & Melo 2014). According to Ryvarden & Johansen (1980), 75 percentage of the fungal species involved in wood decay belong to the family Polyporaceae. Since most polyporoid fungi occur in less disturbed regions than in human interfered areas, they are used as indicators of disturbance in a forest ecosystem (Sverdrup-Thygeson *et al*. 2003; Gibertoni *et al.* 2007). Some species of polypores (eg. *Hapalopilus croceus* (Pers.) Donk, *Neolentiporus squamosellus* (Bernicchia & Ryvarden) Bernicchia & Ryvarden, *Picipes melanopus* (Pers.) Zmitr. & Kovalenko (as *Polyporus melanopus* (Pers.) Fr.) are listed in the IUCN Red List of Threatened Species 2019 (Dahlberg 2019; Bernicchia *et al*. 2019).

Polyporoid fungi are used in biodegradation of toxic dyes, polycyclic aromatic hydrocarbons, olive oil mill effluents and other industrial waste waters (Jaouani *et al*. 2003; Papinutti *et al.* 2006; Champagne 2009; Zeng *et al.* 2011; Selvakumar *et al.* 2012; Vantamuri 2017). A large number of polypore species possess anti cancer, anti bacterial, anti fungal and anti oxidative properties (Cui & Chisti 2003; Hobbs 2004; Radwan *et al.* 2011; Oyetayo 2011; Chiu *et al.* 2015; Onar *et al.* 2016).

The study and documentation of polyporoid fungi was initiated by Micheli in 1729 by introducing the genus name *Polyporus* for placing 14 species with centrally stipitate basidiocarps and poroid hymenial surface. In *Species Plantarum* (1753), Linnaeus placed all species bearing pores or tubes within two genera, *Agaricus* L. and *Boletus* L. Among the list of 93 species of fungi recognized by Linnaeus (1764), nine species in the genera *Agaricus* and *Boletus* belonged to polyporoid fungi. Linnaeus (1780) defined *Boletus* as '*subtus porosus*', which formed the base of the family Polyporaceae. Schaeffer (1762–1774) categorized the genera described by Linnaeus into separate tribes and all poroid species were placed under the tribe '*Boleti*'. Persoon in his work '*Synopsis Methodica Fungorum*' (1801) treated 96 species of polyporoid fungi in *Boletus* under the class *Gymnocarpii* and the order *Hymenothecii.* Fries (1821) classified members of Polyporaceae into three genera, *Daedalea* Pers., *Merulius* Fr. and *Polyporus* P. Micheli (*ex*) Adans. and divided *Polyporus* into three sub genera such as *Favolus*, *Microporus* and *Polystictus*.

Persoon (1825) categorized poroid fungi into a separate section, ‘*Porodermei*’, and placed all species having poroid hymenium, and basidia inside the pore tubes, under this section. Sub genus *Favolus* was elevated to genus rank by Fries (1828). Later in 1830, Kuntze erected another genus *Cyclomyce*s Kunze *ex* Fr. for including sessile species with concentrically elongated pores. Fries (1836) accepted *Cyclomyces* and established the poroid genera *Hexagonia* Fr. and *Trametes* Fr. Based on the presence of setae and cystidia, Léveillé (1846) established the genus *Hymenochaete* Lév that possessed smooth hymenium. In “*Novae Symbolae Mycologici*” (1855), Fries recognized three sub genera for *Polyporus*; *Eupolyporus* for annual, fleshy and hard species, *Fomes* for perennial, woody species having stratified tube layers and *Poria* for resupinate species (Prasher 2015). Later in 1874, Fries distinguished eight genera of polypores such as the lamellate genus *Lenzites* Fr., and genera like *Polyporus, Trametes, Daedalea, Cyclomyces, Hexagonia, Favolus* Fr. and *Merulius* Fr. This was based on the Berkeley’s (1839, 1845, 1847, 1851, 1851a, 1851b, 1851c, 1852, 1852a, 1854, 1854a, 1854b, 1854c, 1855, 1856, 1866, 1867), Tulasne’s (1853,1872) and Masse’s (1889–1912) concepts which gave emphasis on the significance of hymenial configuration and internal characters of basidiocarps in the taxonomic classification of Basidiomycetes (Adarsh *et al*. 2015). Following Friesian classification, Gillet (1876–1878) established a genus *Merisma* for placing *Polyporus* species having a branched stipe, and transferred all resupinate species and perennial sessile forms to the genera *Physisporus* P. Karst. and *Fomes* (Fr.) Fr. respectively (Sharma 2000). Another significant contribution to knowledge of polypores were made by Karsten (1879, 1881, 1882, 1883, 1887, 1889). Karsten took in to account other characters such as basidiocarp shapes, pileus surface features, colour of context and spores, and presence or absence of setae for classifying polypores. Based on this concept, more genera were established (Sharma 2000). He divided the Friesian genera into several genera in his series of publications (Karsten 1879, 1881, 1882, 1883, 1887, 1889). Karsten (1889) treated the genus *Lenzites* Fr. under Polyporaceae which placed under Agaricaceae in the Friesian systems. Cooke (1884–1886) elevated Fries’ sub genus *Poria* to generic level. Quelet (1886) separted Friesian *Polyporus* into 11 genera such as *Caloporus*

P. Karst (currently *Rhodonia* Niemelä), *Leucoporus* Quél. (*Polyporus*), *Pelloporus* Quél. (*Coltricia* Gray), *Cerioporus* Quél., *Cladomeris* Quél (*Grifola*) Gray, *Placodes* Quél (*Fomes* (Fr.) Fr.), *Phellinus* Quél, *Inodermis*, *Coriolus* Quél. (*Trametes* Fr.), *Leptoporus* Quél. and *Poria* based on form, texture and surface features of the pileus (Prasher 2015). Saccardo & Sydow (1899) transferred all resupinate poroid and non poroid fungi under families Polyporaceae and Thelephoraceae of the group *Gymnocarpi* (Adarsh *et al*. 2015).

Patouillard (1900) based on microscopic characters, divided the class Basidiomycetes in to “Basidiomycetes Homobasidies” and “Basidiomycetes Heterobasidies”. The “Basidiomycetes Homobasidies” was classified in to four families such as Exobasidiaces, Aphyllophoraces, Agaricaces, and Gasteromycetes. Majority of the resupinate members of polypores were included under Aphyllophoraces. Murrill (1907) in his “North American Flora (Polyporaceae)” followed Karsten’s system of classification and divided Polyporaceae into 4 sub families such as *Porieae* (included resupinate species), *Polyporeae*, *Fomiteae* and *Daedaleae*. Murrill (1907) described 74 genera of polypores in his floristic work (1907). The family Polyporaceae was included under Hymenomycetes, by Smith in “British Basidiomycetes” (1908). Smith (1908) considered 231 species belonging to 11 genera under the family. He kept the resupinate members of Polyporales under families Agaricaceae Chevall., Polyporaceae and Thelephoraceae Chevall. Later, Ames (1913) described 16 genera and 130 species within Polyporaceae from Eastern North America. Cunningham (1927) recognized five genera, under the sub family *Polyporeae* of Polyporaceae. Microscopic characters like hyphal arrangement, presence or absence of clamps and sterile structures in the basidiocarps, nature of basidia, and amyloid reaction of spore wall were given importance in the classification of Hymenomycetes by Bourdot & Galzin (1928). The concept of different types of hyphal system in polyporoid fungi was introduced by Corner (1932, 1932a, 1932b). Three successive lists of polypore genera were given by Cooke (1940, 1953, 1959) with discussions on their typification and nomenclature. Bondartsew and Singer (1941) classified 60 poroid genera in 6 suborders and 8 families. Later, Bondartsev (1953) recognized 54 genera in the family Polyporaceae, classified Polyporaceae in to five sub families and ten tribes. Cunningham (1965) separated the family Polyporaceae, in to two subfamilies such as *Polyporoideae* (having hyaline hyphae in context without any reaction in KOH) and *Fomitoideae* (having coloured hyphae that darkens in KOH). Cunningham (1965) divided sub family *Polyporoideae* in to four tribes (*Polyporeae*, *Flaviporae*, *Trametoideae*, and *Ganodermae*) and the sub family Fomitoideae was divided in to three tribes (*Coltriceae*, *Phellineae* and *Fomiteae*), describing a total of 32 genera of polyporoid fungi (Prasher 2015). Donk (1964) placed all poroid fungi among ten families within Aphyllophorales, and his system was widely accepted. Several Floras were published by different workers based on Donk's concept (Domanski 1972; Domanski *et al*. 1967, Ryvarden 1976, 1977, 1978, Gibertson & Ryvarden 1986, 1987, Ryvarden & Gilbertson 1993, 1994, Bernicchia 1991). Leif Ryvarden has greatly contributed to the current knowledge on polyporaceous fungi. Some of his major works on polypores alone or with other coworkers are; Ryvarden 1972, 1973, 1974, 1975, 1976, 1977, 1991; Ryvarden & Johansen 1980; Gilbertson & Ryvarden 1986, 1987; Ryvarden & Gilbertson 1993, 1994; Ryvarden & Melo 2014. Another mycologist who made significant contributions to the present knowledge of polyporoid fungi is Corner (Corner 1981, 1983, 1984, 1989, 1991).

With the advent of molecular techniques, more refined and natural grouping of polyporoid fungi and related groups in Homobasidiomycetes was initiated (Hibbett & Vilgalys 1991, 1993; Hibbett & Thorn 2001; Binder *et al.* 2005; Rajchenberg 2011; Binder *et al.* 2013). Hibbett & Vilgalys (1991) studied the evolutionary relationships of the agricoid genus *Lentinus* to members of *Polyporaceae* using restriction analysis of enzymatically amplified ribosomal DNA. Based on the this study (Hibbett & Vilgalys 1991), it was proved that the gilled fungi *Lentinus*, at least in part, shows closer affinity to polypores, than to certain agarics. A molecular phylogenetic study by Hibbett & Vilgalys (1993) confirmed that the agaricoid genus, *Lentinus sensu stricto* was derived from *Polyporaceae*. In a study on the higher level relationships of Homobasidiomycetes (Hibbett & Thorn 2001), the polyporoid clade settled as a well supported clade among the other seven clades (bolete clade, cantherelloid clade, euagarics clade, gomphoid-phalloid clade, hymenochaetoid clade, polyporoid clade, russuloid clade and thelephoroid clade) of Homobasidiomycetes. Hibbett & Thorn (2001), considered the poroid nature of the hymenium as the primitive form, from which lamellate, toothed, or smooth hymenium was derived. The study by Binder *et al.* (2005) divided the polyporoid clade into three major sub clades like *Antrodia* clade, core polyporoid clade and phlebioid clade. Those species that could not be properly placed under these three sub clades of polyporoid clade were placed in a fouth category as the residual polyporoid clade by Binder *et al.* (2005). Rajchenberg (2011) studied the nuclear behavior of mycelium, and phylogeny of many polyporoid genera. Based on this study (Rajchenberg 2011), nuclear behavior was found as a distinct and consistent character in polypores at the generic level. According to Rajchenberg (2011), the combination of type of wood rot, type of nuclear behavior and mating system has a significant role in revealing the phylogeny of most polypores. The study (Rajchenberg 2011) also proved the polyporoid fungi to be heterogenouos and polyphyletic. Binder *et al*. (2013) re-evaluated the position of the sub clades (*Antrodia* clade, core polyporoid clade, phlebioid clade, residual polyporoid clade) recognized within large polyporoid clades based on six gene regions (nuclear ribosomal LSU, 5.8S, nuclear ribosomal SSU, RNA polymerase II subunits rpb1 and rpb2, tef1). According to Binder *et al*. (2013), except the residual polyporoid clade, the other three lineages of polyporoid clade were well supported in all datasets.

A revised family level classification for the order Polyporales Gäum. was recently published by Justo *et al.* (2017), based on both morphology and molecular phylogenetic data. The study divided the order into two main clades; one including phlebioid, residual and *Candelabrochaete africana* Boidin and, the other including core polyporoid, *Antrodia* and other satellite lineages. In this study, 18 families and 167 genera have been recognized under Polyporales. According to the study (Justo *et al*. 2017), some taxa such as *Candelabrochaete africana*, *Mycoleptodonoides vassiljevae* Nikol., *Auriporia aurea*, (Peck) Ryvarden and *Tyromyces merulinus* (Berk.) G. Cunn. were not positioned with certainty in any of the families recognized under Polyporales. Another recent systematic study on Polyporales based on molphology and molecular phylogenetic data, by Zmitrovich (2018) recognized seven families and 204 genera under the order. The study (Zmitrovich 2018) provided a detailed systematic account on the history of polyporoid fungi and taxonomic characters of the group. Ten new genera were described and 85 new combinations were made in this study (Zmitrovich 2018).

2.1.1. TAXONOMIC CHARACTERS

Macroscopic fruit body characters

Polyporoid fungi include annuals, biennials and perennials (Ryvarden & Gilbertson 1980; Bernicchia 2005). Based on the life cycle, Schigel *et al*. (2006) divided polyporoid fungi into four categories, such as ephemeral, annual sturdy, annual hibernating and perennial. Ephemerals are fast growing but lasts only for a short period of time and produce small fruit bodies in selective seasons (e.g., *Leptoporus mollis* (Pers.) Quél.). Annual sturdy species produces larger and robust basidiocarps and their sporulating period persist for long time. In this group, the basidiocarps after spore dispersal and death, survives in the host for few seasons (*Climacocystis borealis* (Fr.) Kotl. & Pouzar). Annual hibernating species are more persistant and long lasting than annual sturdy species (*Trichaptum abietinum* (Pers. *ex* J.F. Gmel.) Ryvarden). Perennial polypores are capable of producing spores repeatedly at any time of the year and survive for many years. The basidiocarps of perennials usually have distinctly stratified pore tube layers (*Fomitopsis pinicola* (Sw.) P. Karst.).

Basidiocarps of polyporoid fungi are mainly divided in to three forms such as pileate (*Ganoderma lucidum* (Curtis) P. Karst., *Trametes gibbosa* (Pers.) Fr.), resupinate (*Terana coerulea* (Lam.) Kuntze, *Fuscoporia contigua* (Pers.) G. Cunn.) and stipitate (*Coltricia cinnamomea* (Jacq.) Murrill, *Podoscypha mellissii* (Berk. *ex* Sacc.) Bres.) (Ryvarden1991). Apart from these, many species form effused reflexed basidiocarps where they are partly resupinate and partly pileate (*Coriolopsis telfairii* (Klotzsch) Ryvarden, *Trametes villosa* (Sw.) Kreisel). Basidiocarps grow either solitary or in clusters. Adjacent pilei of certain species overlap and get fused to form imbricate fruit bodies (*Bjerkandera adusta* (Fr.) Karst). The type of attachment of basidicarps also show variations such as, broadly sessile and semi circular (*Trametes* *polyzona* (Pers.) Justo), dimidiate (*Cerioporus squamosus* (Huds.) Quél.), flabelliform (*Microporus affinis* (Blume & T. Nees) Kuntze) and spathulate (*Microporellus obovatus* (Jungh.) Ryvarden). Basidiocarps with different types of pileus shapes such as, applanate (*Ganoderma applanatum* (Pers.) Pat.), convex (*Fomitopsis betulina* (Bull.) B.K. Cui, M.L. Han & Y.C. Dai), ungulate (*Phellinus igniarius* (L.) Quél.), and triquetrous (e.g., *Fomes extensus* (Lév.) Cooke) are found. In some, pileus surface is umbonate near the attachment (*Fomes fomentarius* (L.) Fr.). In the case of stipitate species, positon of the stipe is either central (*Lentinus tricholoma* (Mont.) Zmitr.), or eccentric to lateral (*Podoscypha petalodes* (Berk.) Boidin, *Neofavolus alveolaris* (DC.) Sotome & T. Hatt.).

The consistancy of fruit body varies from soft, spongy and coriaceous to corky. Many polypore species having a monomitic hyphal system (having only generative hyphae) produce soft or sappy fruit bodies which may get shrinked hard on drying (Núñez & Ryvarden 2000). Examples are *Spongipellis africana* Ipulet & Ryvarden, *Tyromyces leucomallus* Berk. & M.A. Curtis) Murrill. Some species of polyporoid fungi produce coriaceous basidiocarps which usually turn hard on drying (e.g. *Coriolopsis telfairii* (Klotzsch) Ryvarden, *Microporus xanthopus* (Fr.) Kuntze). *Podoscypha petalodes* is a species that have a thin and papery texture. Perennial fruit bodies having thick walled skeletal hyphae are usually woody and those fruitbodies with a trimitic hyphal system (having generative, skeletal and skeleto ligative hyphae) are tough and rigid in nature (Ryvarden 1991). Examples for woody and tough basidiocarps are that of *Ganoderma adspersum* (Schulzer) Donk, *Daedalea dochmia* (Berk. & Broome) T. Hatt. and *Phellinus tremulae* (Bondartsev) Bondartsev & P.N. Borisov.

In large number of polyporoid fungi, pileus surface possesses distinct concentric zonations and sulcations (e.g., *Ganoderma zonatum* Murrill, *Trametes meyenii* (Klotzsch) Lloyd, *Rigidoporus lineatus* (Pers.) Ryvarden, *Phellinus igniarius* (L.) Quél.). Many other species lack concentric zonations or sulcations on pileus surface and remain smooth or with minute tubercles or ridges (*Favolus tenuiculus* P. Beauv., *Fomitopsis palustris* (Berk. & M.A. Curtis) Gilb. & Ryvarden, *Tyromyces chioneus* (Fr.) P. Karst). Pileus surface of some species possesses radial line or grooves (*Favolus grammocephalus* (Berk.) Imazeki, *Panus simils* (Berk. & Broome) T.W. May & A.E. Wood). In polyporoid fungi, pileus are either glabrous (*Pycnoporus sanguineus* (L.) Murrill) or covered with different types of hairs. The major forms of pileal hairs among the group are hispid (*Inonotus hispidus* (Bull.) P. Karst.), hirsute (*Trametes hirsuta* (Wulfen) Lloyd, villose (*T. villosa* (Sw.) Kreisel), strigose (*T. apiaria* (Pers.) Zmitr.) tomentose (*Onnia tomentosa* (Fr.) P. Karst.) and velutinate (*Inonotus sideroides* (Lév.) Ryvarden). In certain species, pileus surface possesses distinct scales, or may possesses fibrillose to pointed squamules (*Cerioporus squamosus* (Huds.) Quél., *Lentinus zeyheri* Berk., *L. swartzii* Berk). In many members of the family Hymenochaetaceae, pileus is covered by brownish black to black, thin to thick "crust" (*Phellinus conchatus* (Pers.) Quél., S*anghuangporus baumii* (Pilát) L.W. Zhou & Y.C. Dai). In certain species of *Phellinus*, pileus surface gets cracked and becomes "rimose" with age ((Berk.) Pilát). Members of genera like *Ganoderma* and *Amauroderma* produce basidiocarps with "varnished" pileus surface, termed as "laccate", which makes the surface smooth and shiny. Pileal margin of the members may be even, wavy or lobed. Some species of polyporoid fungi have dense cilia along the margin (*Lentinus arcularius* (Batsch) Zmitr., *L. tricholoma* (Mont.) Zmitr.).

Basidiocarps of polyporoid fungi show great variation in colour from white, cream, tan, buff or other paler shades (e.g., *Favolus tenuiculus* P. Beauv., *Neoantrodia serialis* (Fr.) Audet, *Trametes pubescens* (Fr.) Pil.) to dark blue (*Terana coerulea* (Lam.) Kuntze), deep reddish brown (*Polyporus dictyopus* Mont.) to almost black (*Inonotus obliquus* (Fr.) Pilát). Basidiocarps with white and lighter shades usually become darker with brownish shades on maturity (Núñez & Ryvarden 2000). The pigmentation of fruit bodies ranges from bright yellow (*Flavodon flavus* (Klotzsch) Ryvarden), bright yellowish orange (*Pycnoporus cinnabarinus* (Jacq.) P. Karst), dark blue (*Terana coerulea*), pinkish brown (*Rhodofomitopsis lilacinogilva* (Berk.) B.K. Cui, M.L. Han & Y.C. Dai) reddish brown (*Ganoderma lucidum*), brownish black to black (*Sanguinoderma rugosum*). Some chemical constituents are responsible for the various pigmentation of polypores (Ryvarden 1991). For example, the bright reddish orange or yellowish orange colour of the polypore *Pycnoporus cinnabarinus* is due to the presence of a chemical “cinnabaric acid”. Similarly, the bluish colour of the fungus *Terana coerulea* is due to the presence of benzobisbenzofurans named corticins (Briggs *et al*. 1976). The yellow to deep brown colouration of the members of family Hymenochaetaceae is given by another group of compound “styrylpyrones” (Fiasson 1982; Ryvarden 1991). Most members of Hymenochaetaceae show xanthochroic reaction, where basidiocarps turn black in KOH. The species, *Hapalopilus nidulans* (Fr.) P. Karst shows a violet colour change in KOH (Ryvarden & Johansen 1980).

Most species of the polyporoid fungi have a poroid hymenophore, with single (annuals) or stratified tube layers (Perennials) (Zmitrovich 2018). Shape of pores may be round (*Microporus xanthopus*), angular (*Trametes maxima* (Mont.) A. David & Rajchenb.), hexagonal (*Hexagonia tenuis* (Fr.) Fr) or radially elongated (*Neofavolus alveolaris*). Apart from the poroid nature, other hymenophore configurations exhibited by members of the group are smooth (*Phlebia unica* (H.S. Jacks. & Dearden) Ginns), deadaleoid (*Cellulariella acuta* (Berk.) Zmitr. & Malysheva), lamellate (*Panus neostrigosus* Drechsler-Santos & Wartchow), labyrinthine (*Daedalea quercina* (L.) Pers.), and irpicoid (*Irpex lacteus* (Fr.) Fr.). Some species show partly poroid, and partly lamellate hymenium in a single basidiocarp (*Gloeophyllum sepiarium* (Wulfen) P. Karst.) (Ryvarden & Melo 2014). In species of *Hymenochaete*, protruding hymenial setae are visible on hymenial surface when viewed under a lens (Ainsworth 2004). In polypores, pore surface varies in colour as in pileus from white, cream, yellow, orange, pink, purplish brown, to cinnamon brown or dark brown. Pore tubes in most species are concolorous with pore surface, however sometimes may becomer lighter with age (Núñez & Ryvarden 2001).

Context of the basidiocarps differ in type, colour and consistency (Ryvarden & Johansen 1980, Ryvarden & Gilberson 1993). Most species of polyporoid fungi have a homogenous context, whereas, in some species, context is heterogenous or duplex (e.g.'s, *Piloporia sajanensis* (Parmasto) Niemelä, *Spongipellis spumeus* (Sowerby: Fr.) Pat.,) with soft and fibrous upper part and dense lower part. Certain members possess black zones or lines in the context below the tomentum (*Cerrena unicolor* (Bull.) Murrill, *Datronia mollis* (Sommerf.) Donk, *Phylloporia* species). The consistency of context can be tough fleshy to fibrous coriaceous to hard and woody. Presence of mycelia cores is reported in few species like *Fomes fomentarius* (L.) Fr. and *Inocutis rheades* (Pers.) Fiasson & Niemelä (Núñez & Ryvarden 2000). Many *Ganoderma* species (*G. curtisii* (Berk.) Murrill, *G. flexipes* Pat.) possess distinct melanoid bands in the context (Zhou *et al*. 2014). In fresh condition, consistency of context varies from coriaceous (*Podoscypha* species), soft, spongy to moderately tough (*Favolus tenuiculus*, *Leucophellinus hobsonii* (Berk. *ex* Cooke) Ryvarden) to hard and woody (*Phellinus* species). Colour of context may be white (*Abortiporus* (Bull.) Singer), cream (*Leiotrametes lactinea* (Berk.) Welti & Courtec.), pale to dark brown (*Ganoderma zonatum* Murrill) or vinaceous brown (*Nigroporus vinosus* (Berk.) Murrill).

Stipe may be centrally, eccentrically or laterally attached with the pileus. Commonly a single pileus arises from a single stipe, but in *Polyporus umbellatus* (Pers.) Fr., many pilei are formed on a single stipe (Núñez & Ryvarden 1995). In most polyporoid species colour of the stipe is same as that of pileus. However, in species like *Cerioporus varius* (Pers.) Zmitr. & Kovalenko and *Picipes melanopus* (Pers.) Zmitr. & Kovalenko, the colour of the stipe is darker than that of the pileus (Ryvarden & Melo 2014). Pores in the hymenium are usually deccurent (Núñez & Ryvarden 2000). Surface of stipe are glabrous (e.g., *Microporus xanthopus*) or hairy (*Panus neostrigosus*). In few species of polypores, stipe arises from a well developed underground scerotium (*Lignosus rhinocerus* (Cooke) Ryvarden, *Polyporus tuberaster* (Jacq. *ex* Pers.) Fr.).

Most of the polyporoid fungi do not produce distinct odour or taste. However, few species like *Gloeophyllum odoratum* (Wulfen) Imazeki and *Haploporus odorus* (Sommerf.) Bondartsev & Singer produce strong scent of anise seed (Niemelä 1971, Ryvarden & Gilbertson 1993). Although most polypores have a bitter taste, there are no polyporoid species reported as poisonous, except *Hapalopilus nidulans* (Fr.) P. Karst (Núñez & Ryvarden 2000). Some of the edible polyporoid fungi are *Meripilus giganteus* (Pers.) P. Karst., *Grifola frondosa* (Dicks.) Gray and species of *Albatrellus* Gray.

Microscopic fruit body characters

Hyphal system

The concept of monomitic, dimitic and trimitic hyphal system among polyporoid fungi was introduced by Corner (1932, 1932a, 1932b). Hyphal arrangement is an important character that can be used in delimitation of genera in Polyporaceae (Ryvarden 1991). There are mainly three kinds of hyphae found among polypores, such as generative hyphae, skeletal hyphae and skeleto ligative or binding hyphae. Based on the occurrence of different types of hyphae in the fruit bodies, hyphal system of polyporoid species are classified mainly into three groups like monomitic, dimitic and trimitic (Leelavathy & Ganesh 2000). Basidiocarps of monomitic species consists of only generative hyphae that are moderately to highly branched, either thin walled (*Perenniporia ochroleuca* (Berk.) Ryvarden, *Polyporus dictyopus* Mont.) or thick walled (*Osteina obducta* (Berk.) Donk, *Rigidoporus eminens* Y.C. Dai, hyaline (*Earliella scabrosa* (Pers.) Gilb. & Ryvarden, *Trametes vernicipes* (Berk.) Zmitr., Wasser & Ezhov) or pale yellow to yellowish brown (*Coltricia minor* Y.C. Dai., *Pseudoinonotus dryadeus* (Pers.) T. Wagner & M. Fisch.), with (*Bresadolia uda* (Jungh.) Audet, *Lentinus tricholoma*) or without clamp connections (*Irpex lacteus* (Fr.) Fr., *Phlebiopsis crassa* (Lév.) Floudas & Hibbett). The generative hyphae of *Terana coerulea* is pale to dark bluish in colour and are usually encrusted (Maekawa 1994). Another term ‘sclerified generative hyphae’ was coined by Donk (1964) for the clamped hyphae or hyphal segments with thickened walls (*Trichaptum byssogenum* (Jungh.) Ryvarden). In many species, fruit bodies possess hyphal pegs which are fascicles of hyphae projecting from the hymenium (*Epithele ceracea* Nakasone, *Lentinus badius* (Berk). Berk).

In dimitic species, hyphal system has both generative and skeletal hyphae. Skeletal hyphae are often unbranched, thick walled to solid and without septations

(Núñez & Ryvarden 2000), but in certain species they are weakly branched (*Fomitopsis palustris*, *Microporus affinis*) and sparsely septate (*Phellinus igniarius* (L.) Quél.). Skeletal hyphae may be hyaline (*Trametes* species) or may be yellowish brown (*Coriolopsis* species, *Phellinus* species) to fuliginous brown (*Nigroporus* species). In *Pycnoporus* species, skeletal hyphae are encrusted with orange crystals (Ryvarden & Johansen 1980). Skeletal hyphae are usually inamyloid in Melzer's reagent, but in some species they are dextrinoid (*Perenniporia* Murrill, *Microporellus* Murrill) or amyloid (*Diplomitoporus* Domanski). Certain species posssess pseudo dimitic hyphal system (intermediate form between generative and skeletal hyphae; *Antrodiella fissiliformis* (Pilát) Gilb. & Ryvarden, *Rigidoporus aurantiacus* Ryvarden & Iturriaga) where septate hyphae are clearly distinguished from generative hyphae by their increased width, thicker walls and pigmentation (Zmitrovich 2018). Teixera (1956) used the term 'arboriform skeletal hyphae' for the skeletal hyphae found in "Ganodermataceae" (currently synonymized under the family Polyporaceae, *Index Fungorum* database (www.indexfungorum.org, accessed on 16 October 2020)), possessing long unbranched lower segments with tree like branching in the apex.

Species of *Polyporus* Fr. possesses a dimitic hyphal system, but they have skeleto ligative hyphae instead of skeletal hyphae (Sharma 2000). Skeleto ligative hyphae are branched, thick walled, and usually dichotomously branched in acute angles (Ryvarden 1991). Skeleto ligative hyphae in polypores often form arboriform branches with tapering ends (*Perenniporia cremeopora* Decock & Ryvarden, Decock & Ryvarden 2000) and may be hyaline (*Trametes* species) or coloured (*Ganoderma applanatum*). Corner (1932) called the skeleto ligative hyphae as 'binding hyphae of *Bovista* type', characterized as highly branched and twisted with tapering side branches. Trimitic species consists of all the three types of hyphae (generative, skeletal and skeleto ligative) in their fruit bodies (species of *Microporus*, *Trametes*) (Mohanan 2011). Because of the difficulty in morphological separation, binding and skeletal hyphae were collectively called as 'vegetative hyphae' by Pouzar (1966). Pegler & Hills (1996) used the term "amphimitic" hyphal system for species having generative hyphae and either of skeletal or skeleto ligative hyphae.

Some polyporoid fungi develop thin walled, often yellow coloured hyphae with refractive contents (either homogenous or grainy), and appear as distinct from normal generative hyphae and are called as “gloeopherous hyphae” (*Oligoporus subpendulus* (G.F. Atk.) Gilb. & Ryvarden, *Tyromyces leucomallus*) (Ryvarden 1991). The hymenium and dissepiments of some species possess another modified hyphae termed as “dendrohyphidia”, that are usually thin walled, weakly or strongly branched and smooth or encrusted (e.g., *Datronia mollis* (Sommerf.) Donk, *Perenniporia dendrohyphidia* Ryvarden, *Terana coerulea*). In some members of Hymenochaetaceae (*Inonotus pachyphloeus* (Pat.) T. Wagner & M. Fisch., *I. rickii* (Pat.) D.A. Reid). Another modified hyphae called “setal hyphae”, characterized by yellow brown to dark umber brown, thick walled and with obtuse to acute tips are present in pore tubes and trama, and are (Dai 2010).

Basidiospores

Basidiospores are small to medium, mostly thin walled, hyaline, inamyloid and smooth (Ryvarden 1991). Thick walled, coloured, ornamented and amyloid or dextrinoid spores are also present in many species of polyporoid fungi. Spore shapes range from sub globose to globose (e.g.’s, *Rigidoporus* Murrill, *Phylloporia* Murrill), ellipsoid, broadly ellipsoid, ovoid (*Ganoderma* P. Karst., *Perenniporia*) to cylindric to allantoid (*Trametes* Fr., *Trichptum* Murrill). Most species of the order Polyporales have hyaline basidiospores. However, basidiospores of some species develop pale yellow to golden colour (*Perenniporia ochroleuca* (Berk.) Ryvarden) (Ryvarden & Melo 2014). Basidiospores are smooth (*Meripilus* P. Karst., *Microporellus* Murrill) to ornamented (*Haploporus* Singer, *Heterobasidion* bref.), usually are thin walled or sometimes thick walled (*Ganoderma*, *Leucophellinus* Bondartsev & Singer). Species belonging to Hymenochaetales produce hyaline (*Phellinus* Quél. (*sensu stricto*), *Fomitiporia* Murrill) or yellowish brown to brown basidiospores (*Coltricia* Gray, *Fulvifomes* Murrill) and they are fairly thick walled (Dai 2010). In this group, most genera have smooth basidiospores and are seldom ornamented (*Coltriciella* Murrill) (Ryvarden 2004). Basidiospores of majority of the polyporoid fungi are inamyloid in Melzer’s reagent, but some genera have dextrinoid to amyloid basidiospores (*Vanderbylia* Reid and *Anomoporia* Pouzar respectively) (Núñez & Ryvarden 2001).

In Polyporales, certain genera such as *Amauroderma*, *Ganoderma* and *Sanguinoderma* shows a distinct set of spore characters where the spores are coloured, double walled with inter wall pillars and truncate at the apex (Leelavathy & Ganesh 2000). The double wall of the spores constitutes a brownish coloured, ornamented endosporium covered by a hyaline, smooth, thin walled exosporium (Núñez & Ryvarden 2000). The ornamentation vary from rugose to warted (e.g., *Sanguinoderma rugosum* Blume & T. Nees) Torrend) or coarsely echinulate (*Ganoderma curtisii* (Berk.) Murrill) to finely echinulate (*G. boninense* Pat.). The inter wall pillars may be thin (*Ganoderma zonatum* Murrill, intermediate thick (*Ganoderma corrugatum* Steyaert) to thick (*Ganoderma colossus* (Fr.) C.F. Baker). Spores of this group contain four different pillar dispositions such as free (*Ganoderma perzonatum* Murrill), subfree (*G. elegantum* Ryvarden), partially anastomosed (*G. concinnum* Ryvarden) and reticulate (*G. colossus* (Fr.) C.F. Baker) (Torres-Torres & Guzmán-Dávalos 2012).

Among polyporoid species, ellipsoid and globose basidiospores are commonly found in tropical areas than in temperate and boreal areas (Ryvarden 1991). Most species in temperate countries possess cylindric to allantoid spores. In this group of fungi, higher number of genera is with ellipsoid and cylindric spores and they are considered as more advanced than polypores with globose spores (Ryvarden 1991). According to Corner (1984), a correlation between spore size and pore size is shown by *Amauroderma* and *Ganoderma*, where larger the pores, larger are the spores. Ornamentations, and amyloid reaction of spores in Melzer’s reagent are considered as a primitive character in the family *Polyporaceae*.

Asexual spores

Although not common, some polypores produce asexual spores in the margin of the pileus or context of the fruit bodies (Núñez & Ryvarden 2000). The species

Echinoporia aculeifera (Berk. & M.A. Curtis) Ryvarden) develop conidia on the hyphae of hairs of pileus or pileal margin (Gilbertson & Ryvarden 1986). Apart from conidia, some species have chlamydospores in the fruit bodies (mainly in the context) (*Abortiporus biennis*, *Postia ptychogaster* (F. Ludw.) Vesterh. (Bernicchia 2005). In *Postia ptychogaster*, the imperfect stage is sometimes present without the production of basidiocarps (Ryvarden & Gilbertson 1994).

Cystidia and setae

These are sterile elements found in many *Hymenomycetes* which act as organs for excretion of metabolites or as a defence system against small insects, animals and other fungi (Ryvarden 1991). Both hymenial and tramal cystidia are present in polypores. They vary in shape, wall thickness and other surface features. Shape of cystidia may be cylindrical (*Emmia* Zmitr., Spirin & Malysheva) or tubular (*Hyphodontia* J. Erikss., subulate (*Phanerina* Miettinen), ventricose (*Auriporia* Ryvarden), clavate (e.g. *Junghuhnia* Corda), to pyriform (*Perenniporia piceicola* Y.C. Dai) (Maekkawa 1994, Núñez & Ryvarden 2001, Dai *et al.* 2002, Miettinen *et al*. 2016). Some species possess thin walled cystidia (*Ceriporia cystidiata* Ryvarden & Iturriaga, *Kneiffiella abdita* Riebesehl & Langer), whereas many others produce thick walled cystidia (*Phlebiopsis* Jülich, *Leucophellinus hobsonii* (Berk. *ex* Cooke) Ryvarden. Surface of cystidia of polypores may by smooth (*Antrodiella globospora* Nunez and Ryvarden, *Ceriporia cystidiata*) (Núñez & Ryvarden 1999; Ryvarden & Iturriaga 2003) or encrusted (*Microporellus violaceocinerascens*, *Phlebiopsis crassa* (Lév.) Floudas & Hibbett) (Yang 2000; Bernicchia & Gorjón 2010). Cystidia of the genus *Amylocystis* Bondartsev & Singer shows amyloid reaction on treatment with Melzer's reagent (Ryvarden & Gilbertson 1993).

There are various types of cystidia found in different species of polypores such as gloeocystidia, hyphoid cystidia, lagenocystidia, leptocystidia, metuloids (or lamprocystidia) and skeletocystidia. Gloeocystidia are thin to thick walled, tubular, smooth, hyaline to yellow with grainy or oily contents (Ryvarden & Melo 2014) (*Podoscypha, Junghuhnia japonica* Nufiez and Ryvarden). Hyphoid cystidia are similar to gloeocystidia, but instead of grainy contents as in the latter, hyphoid cystidia are filled with some transparent liquids (Ryvarden 1991) (*Rigidoporus eminens* Y.C. Dai). Lagenocystidia are small sized, thin to thick walled cystidia present in hymenium, smooth or weakly encrusted at the apex (*Hyphodontia* species; Larsson *et al.* 2006; Gorjón 2012). Leptocystidia are thin walled cystidia, also reffered as 'basidioles' or 'cystidioles' (Donk 1967). According to Prasher (2015), leptocystidia are usually fusoid to conical in shape, encrusted, and sometimes with constrictions (moniliform cystidia). Some examples of polypores having leptocystidia are species of *Amyloporia* Singer, Skeletocutis Kotl. & Pouzar, *Schizopora* Velen. (Donk 1967)*, Phanerochaete cystidiata* Sheng H. Wu, C.C. Chen & C.L Wei, *P. fusca* Sheng H. Wu, C.C. Chen & C.L. Wei (Wu *et al.* 2018). Metuloids, also called as lamprocystidia are thick walled, encrusted elements seen in subhymenium, at most times projecting above the hymenium (*Panus neostrigosus* Drechsler-Santos & Wartchow (Pegler 1983), *Podoscypha mellissii* (Berk. *ex* Sacc.) Bres. (Reid 1965). The apical part of skeletal hyphae forms skeletocystidia which may be smooth or encrusted. They are formed in the subhymenium or in the trama (Núñez & Ryvarden 2000). (*Flaviporus brownii* (Humb.) Donk (Núñez & Ryvarden 1999).

The presence of hymenial or tramal setae (a characteristic type of cystidia) is a unique character of the family *Hymenochaetaceae* (*Cyclomyces* Kunze *ex* Fr., *Phellinus*, *Phellinopsis* Y.C. Dai, *Inonotus* P. Karst.) (Larsson *et al*. 2006). Setae present in Hymenochaetaceae members may be straight (*Inonotus*), ventricose (*Pseudoinonotus dryadeus* (Pers.) T. Wagner & M. Fisch.), hooked (*Phellinus ellipsoideus* (B.K. Cui & Y.C. Dai) B.K. Cui, Y.C. Dai & Decock), branched (*Inonotopsis subiculosa* (Peck) Parmasto), and are yellowish to brownish in colour and often thick walled (Dai 2010). Genus *Asteron* Pat is characterized by star shaped setae called as "asterosetae" (Bernicchia & Gorjón 2010). The genus *Echinochaete* Ryvarden of the family *Polyporaceae* possesses sterile structures which are brown in colour and acute with short side branches, similar to true setae of *Hymenochaetaceae*. These are referred to as pseudosetae (Ryvarden 1991).

Molecular characters

Advanced molecular approaches reveal the occurrence of multiple morphological convergence among polyporoid fungi (Ko & Jung 1999). Different gene regions like internal transcribed spacer (ITS), 5.8 S, nuclear ribosomal LSU (nrLSU), Mitochondrial SSU (mtSSU rDNA), RNA polymerase II subunits rpb1 and rpb2, and tef1 are sequenced for molecular identification of polypores at species level (Hibbett & Vilgalys 1991; Hibbett & Vilgalys 1993; Hibbett & Donoghue 1995; Moncalvo *et al.* 1995, 1995a; Ko & Jung 1999; Hong *et al.* 2002; Kim *et al*. 2003; Larsson *et al.* 2006; Moncalvo & Buchanan 2008; Binder *et al.* 2013; Hapuarachchi *et al.* 2015; Justo *et al.* 2017; Xing *et al*. 2018; Luangharn *et al.* 2019). However, in certain taxa, some gene regions carry more information than other gene regions. For example, in the genus *Ganoderma*, mtSSU rDNA sequences are found to be more effective in the phylogenetic reconstruction than the nrITS gene region (Hong *et al.* 2002). In *Ganoderma*, there are specific segments in the ITS regions which shows greater variability than other segments (Moncalvo *et al.* 1995a). According to this study (Moncalvo *et al.* 1995a), variations were mostly located in the central region of ITS1 and near to the terminal region of ITS2, and the nucleotide divergence between newly diverged taxa occurred in the ITS2 region. Gottlieb *et al.* (2000) also opined that ITS1 gene region possessed lower level of resolution of internal phylogenetic branches in species of *Ganoderma*. Generally, rpb1 is considered as the most informative gene region for elucidating the phylogeny of Polyporales (Justo *et al*. 2017). Phylogenetic relationships of many genera of polyporoid fungi has been inferred from other molecular tools like restriction analysis of ribosomal DNA, PCR coupled to restriction digestions, single strand conformational polymorphism (SSCP), random amplified polymorphic DNA-PCR analysis, random amplified microsatellite (RAMS), Restriction fragment length polymorphisms (RFLP) (Hibbett & Vilgalys 1991; Hseu *et al*. 1996; Gottlieb *et al.* 2000; Zakaria *et al.* 2005; Fischer & Wagner 2008).

2.1.2. ECOLOGICAL AND ECONOMIC IMPORTANCE

Polyporoid fungi are economically important due to their edibility, medicinal properties, industrial applications and pathogenicity. Among members of Polyporales, species of *Ganoderma*, especially *G. lucidum* is one of the major medicinal mushrooms. As per Upton (2006), thay are the most significant of all Japanese medicinal polypores. In China, it is variously known as “mushroom of immortality”, “ten thousand year mushroom”, “mushroom of spiritual potency” and “spirit plant” (Huang 1993; Liu & Bau 1994). Apart from *G. lucidum, G. applanatum, G. japonicum*, and *G. tsugae* are used as medicine, and are traded as *reishi* mushroom in United States of America (Upton 2006). According to Chen *et al*. (2006), presence of various bioactive compounds in fruitbodies of *Ganoderma* provides them anti tumour, anti inflammatory, anti chronic bronchitis, immunoenhancing, cardiovascular regulating and hepato protectant properties. They are used in treatment of different types of cancers (Zhang *et al.* 2010; Hapuarachchi *et al*. 2016), Type 2 diabetes mellitus (Seto *et al*. 2009), gastric ulcers (Rony *et al.* 2011), hepatitis (Li & Wang 2006), hyperlipidemia (Chen *et al.* 2005) and hypertension (Morigiwa *et al.* 1986). The anticancer activity of *G. lucidum* is due to the presence of methanol soluble triterpenoid extracts, called as ganoderic acids (GAs) in their fruit body (Radwan *et al.* 2011). This fungus is also known to have anti HIV activity (EL-Mekkawy *et al.* 1998). Because of the immense medicinal properties, a large number of *G. lucidum* products are commercially available as nutraceuticals in the form of tonics, pills or powders (Bishop *et al*. 2015). A similar genus *Amauroderma* also has potential medicinal value and has been traditionally used by the Chinese to cure inflammation, indigestion and cancer (Dai & Yang 2008). This fungus possesses good anti oxidant and anti inflammatory properties, and has been used by some native people of Malaysia for preventing epilepsy in children (Chang & Lee 2004; Azliza *et al.* 2012; Chan *et al*. 2013). *Sanguinoderma rude* is well known for its anti cancer (Jiao *et al*. 2013; Pan *et al*. 2015; Hapuarachchi *et al*. 2018) and anti oxidant activities (Wang & Qi 2016). This species is reported to be more efficient than the medicinal fungus, *Ganoderma lucidum* in curing various types of cancers (Jiao *et al*. 2013). Mycelia of

Sanguinoderma rugosum is a source of carbohydrates, proteins, dietary fibre, phosphorus, potassium and sodium (Chan *et al*. 2013). *S. rugosum* also shows antimicrobial activity against *Staphylococcus aureus*, *S. pyogenes*, *Pseudomonas aeruginos*, *Escherichia coli* and *Clostridium difficile* (Liew *et al*. 2015). Laccase from *Abortiporus biennis* species is also known to possess anti cancer and anti tumour activities (Zhang *et al.* 2011; Ivanova *et al.* 2014; Jaya lakshmi *et al.* 2015).

The polypore *Bjerkandera adusta* contains good amount of unsaturated fatty acids, ergosterols of medicinal value, and phenolic organic compounds and is highly recommended as a supplementary food or nutraceutical (Küçükaydi & Duru 2017). *Bjerkandera adusta* also has anti bacterial, anti radical and pro oxidant properties (Shintani *et al*. 2002; Korneichik & Kapich 2011; Sugawara *et al.* 2019). Fruit bodies of another polypore, *Fomitopsis pinicola* are dried and applied on wounds to stop bleeding (Rogers 2012). The species *Trametes versicolor* is reported to have good immunomodulating activities (Hobbs 2004). According to Kobayashi *et al*. (1994), presence of *T. versicolor* polysaccharopeptides increases *in vitro* anti cancer activity of the chemotherapy drug, cisplatin. Many members in the genus *Lentinus* are edible (Burkill 1966; Chin 1981; Karunaratha *et al.* 2011; Seelan *et al.* 2015). The species *Lentinus squarrosulus* Mont. is widely consumed in Central Africa as a food source (Watling 1993). Some *Polyporus* species have good anti inflammatory and immune enhancing properties and are used in curing various ailments (Ying *et al.* 1987; Yuan *et al.* 2004; Liu & Liu 2009; Kawashima *et al.* 2012). Species of *Polyporus* such as *P. tenuiculus* (P. Beauv.) Fr., *P. squamosus* (Huds.) Fr. and *P. umbellatus* (Pers.) Fr. are edible (Gomes-Silva *et al*. 2012; Ergönül *et al.* 2013; Bandara *et al.* 2015). The sclerotia of *P. umbellatus* possess rich medicinal properties (Ying *et al*. 1987; Xing *et al.* 2013). The polypore *Earliella scabrosa* is reported to have *in vitro* antifungal activity (Peng & Don 2013). *Irpex lacteus* has been used as a medicine for many years in China against inflammation, bacterial and fungal infections and urinary problems (Dong *et al.* 2017; Chen *et al.* 2018). Various kinds of terpenoids and biologically active metabolites have been reported from *I. lacteus* (Silberborth *et al.* 2000; Tang *et al*. 2018). Sclerotia of *Lignosus rhinocerus* (Cooke) possess anti oxidative, anti tumour and immunomodulatory effects (Lai *et al.* 2008; Wong *et al.* 2011). This species is consumed as a traditional medicine for treating various illnesses like asthma, breast cancer, cough, fever and food poisoning (Lee *et al*. 2012a). Because of the presence of various macro and micro nutrients, the species *M. xanthopus* is recommended as a protein supplementary diet (Meghalatha *et al.* 2014). Some of the other species of order Polyporales having medicinal properties are *Cellulariella warnieri* (Durieu & Mont.) Zmitr. & Malysheva (Savino *et al.* 2014, 2016), *Coriolopsis gallica* (Fr.) Ryvarden (Fakoya & Oloketuyi 2012; Doskocil *et al.* 2016), *D. quercina* (L.) Pers. (Bal *et al.* 2017), *Flavodon flavus* (Fernando *et al.* 2016), *Panus* (Smith *et al.* 2002; Boa 2006), *Perenniporia fraxinea* (Bull.) Ryvarden (Kim *et al.* 2008), *Podoscypha petalodes* (Fernando *et al.* 2015), *Postia ptychogaster* (F. Ludw.) (Doskocil *et al.* 2016), *Pycnoporus* (Correa *et al*. 2006; Viecelli *et al.* 2009; Jena & Thatoi 2019) and *Rigidoporus ulmarius* (Sowerby) Imazeki (Chao *et al.* 2011).

Most of the white rot members of Polyporales are able to decolourize toxic industrial effluents and artificial dyes and have been used in bioremediation processes (Abadulla *et al.* 2000; Jarosz-Wilkołazka *et al.* 2002; Murugesan & Kalaichelvan 2003; Jaouani *et al*. 2005; Champagne 2009; Lyra *et al.* 2009; Selvakumar *et al.* 2012; Si *et al.* 2011, 2012, 2014; Sharma *et al.* 2015; Vantamuri *et al.* 2017; Yamuna *et al.* 2017). *Bjerkandera adusta* is reported to degrade kraft pulp lignin, polycyclic aromatic hydrocarbons, and effluents containing heavy metals (Heinfling *et al.* 1998; Haritash & Kaushik 2009; Heinfling *et al.* 2011). The white rot fungi *Abortiporus biennis* Murrill is used in pilot scale bioreactors for production of laccase enzyme in large scale (Erden *et al*. 2009). It has been reported that willow sawdust after pretreatment with *A. biennis* shows enhanced biogas production (Alexandropoulou *et al.* 2015). *Flavodon flavus* (Klotzsch) Ryvarden from marine habitat is found effective in decolorizing brown colored pigments from the effluents of molasses-based alcohol distilleries and for removal of their toxicity (Raghukumar *et al.* 2001, 2004). This species is used in the dye industry for large scale extraction of the yellow pigments (http://indiasendangered.com/researchers-find-thousands-of-fungi-species-insinghadforests/). *Pycnoporus sanguineus* (L.) Murrill is able to degrade plastic (Cesarino *et al.* 2019). *Pycnoporus* species also have many industrial and biotechnological applications, which include large scale degradation of biomass by the activity of laccase enzyme, degradation and decolourization of various dyes, clarification of waste water from oil mills and production of colured pigments (Schliephake *et al.* 1993; Alexopoulos *et al.* 1996; Falconnier *et al.* 1994; Oddou *et al*. 1999; Schliephake *et al* 2000; Eugenio *et al.* 2009; Lomascolo *et al*. 2011; Göçenoğlu & Pazarlioglu 2014; Zimbardi *et al.* 2016; Wang *et al.* 2019). *Nigroporus* species are also capable of degrading organic wastes (Kondo 2005) and polyaromatic hydrocarbons (PAHs) and polychlorinated biphenyls (PCBs) in culture media (Siripong *et al.* 2009).

Species of Polyporales play a major role in decomposing wood and recycling of nutrients in a forest ecosystem. Members of the group cause both white rot (*Ganoderma*, *Trametes*) and brown rot (*Postia*, *Rubellofomes*) on wood. Most species are saprobic, but many are serious pathogens on the host. *Ganoderma* species are considered as one of the serious plant/tree pathogens as they affect plantation crops like oil palm, coconut, rubber, betelnut, tea and other forest trees and result in considerable yield loss (Naidu *et al*. 1966). According to Naidu *et al.* (1966), 48 plant species belonging to 36 genera and 19 families are known to be infected by species of *Ganoderma*. *Ganoderma* rot or basal stem rot is one of the serious diseases affecting coconut palms (Harrison & Jones 2003). Different species of *Ganoderma* P. Karst. such as *G. applanatum* (Pers.) Pat., *G. boninense* Pat., *G. lucidum* (Curtis) P.Karst., and *G. zonatum* Murrill have been treated as the pathogens of the disease (Bhaskaran 2000; Karthikeyan & Bhaskaran 2001; Elliot & Broschat 2001; Harrison & Jones 2003; Kandan *et al*. 2010; Sankaran *et al*. 2005; Snehalatharani *et al*. 2016; Thamban *et al*. 2016). The polypore *Amauroderma parasiticum* corner and *A. rude* (Berk.) Torrend is known to cause root rot disease on *Acacia mangium* plantations (Glen *et al.* 2009). Genus *Bjerkandera* is known to cause timber damage and negatively affects cultivation of edible mushrooms (Bak *et al.* 2011; Jung *et al.* 2014). *Trametes hirsuta* and *T. versicolor* cause white spongy rot on different landscape trees (Hickman *et al*. 2011). *Rigidoporus microporus* (Sw.) Overeem is considered as a serious pathogen of *Hevea brasiliensis* Muell. Arg. (Peries 1969; Jayasinghe *et al.* 1995; Jayasuriya 1996; Jayasuriya & Deacon

1996). *Perenniporia fraxinea* (Bull.: Fr.) Ryv and *P. robiniophila* (Murrill) Ryvarden are economically important species which causes white rot on different hard wood trees, either as a parasite or as a saprotroph (Szczepkowski 2004; Kuo 2016).

Hymenochaetaceae members are also well known forest pathogens and medicinal group of fungi (Dai *et al*. 2007; Dai *et al*. 2010a). Species of *Phellinus* are serious pathogens causing heart rot disease and cankers on living trees (Sunhede & Vasiliauskas 2002; Wagner & Fischer 2002; Miklašēvičs 2019; Ranadive *et al.* 2012). According to Larsen & Cobb-Poulle (1990), *Phellinus* species causes more timber loss than other groups of wood destroying fungi, thereby causing huge economic loss to wood industry. Species of *Inonotus* are also considered as important primary decayers of forest ecosystem, as well as serious pathogens of forest trees, and urban landscapes (Lindner *et al*. 2006; Robles *et al.* 2011). *Fuscoporia torulosa* (Pers.) T. Wagner & M. Fisch is considered as a serious pathogen that causes white pocket rot on broad leaved hard wood trees and conifers (Motta *et al*. 1996; Wagner & Fischer 2001; Tomšovský & Jankovský 2007; Campanile *et al*. 2008; Tzean *et al.* 2016). Similarly, *Phylloporia* species are also reported as serious forest pathogens having host specificity (Esquivel & Carranza-Morse 1996; Wagner & Ryvarden 2002; Dai 2010; Rajchenberg & Robledo 2013; Yombiyeni *et al.* 2015; Zhou 2016; Chen *et al.* 2017). *Phellinus igniarius* is consumed as a tonic and laxative, and externally applied to stop bleeding (Chopra *et al*. 1956). Species of *Phellinus* possess potential medicinal properties and has been used in folk medicines (Saar 1991; Vaidya & Rabba 1993; Hobbs 1995; Han *et al.* 1999; Vaidya & Lamrood 2001; Shon *et al*. 2003; Ajith & Janardhanan 2007; Guo *et al*. 2010; Jaszek *et al*. 2014; Rony *et al.* 2013; Dong *et al.* 2016; Sułkowska-Ziaja *et al.* 2017; Sunthudlakhar *et al.* 2018; Wang *et al.* 2018; Li *et al*. 2019). This mushroom is also used in many commercial ayurvedic preparations. In Indian folk medicine, many species of *Phellinus* are commercially available in the name ‘Phansomba’ (Vaidya & Lamrood 2001; Vaidya *et al.* 2001; Vaidya *et al*. 2010; Sonawane *et al.* 2013). Polysaccharides and terpenoids present in *Coltricia perennis* is shown to exhibit anti carcinogenic (Ohtsuka *et al.* 1973; Magdalene & Temitope

2019) and anti bacterial activity (Ghosh 2013). This species is also known to have antimicrobial, antioxidant, anticholineestarase, and xanthine oxidase inhibitory activities (Kovács *et al.* 2017; Duru *et al.* 2019). Aqueous extracts of *F. rhabarbarina* (Berk.) Groposo, Log.-Leite & Góes-Neto shows anti-HIV-1 activity on lymphocytic cells without toxicity (Walder *et al.* 1995). Potential pharmacological activity has been reported in *Hymenochaete rheicolor* (Mont.) Lév. (Silva *et al.* 2009). The species *Hymenochaete rubiginosa* (Dicks.) Lév possesses strong radical scavenging properties (Fernando *et al*. 2015). Species of *Phylloporia* also possess some beneficiary properties. The polysaccharides present in *P. ribis* (Schumach.) Ryvarden show good antioxidant activity (Zhiqing *et al.* 2017; Zhao *et al.* 2018). Many species of *Inonotus* are utilized in Asian folk medicine for treatment of various ailments (Lindner *et al.* 2006). *Inonotus obliquus* (Fr.) Pilát, commonly called as "chaga mushroom" possesses potential medicinal and nutraceutical value (Pliz 2004; Spinosa 2006; Park *et al.* 2004, 2008; Moon & Lee 2009)

Because of the presence of lignolytic enzymes, species of *Phellinus* are also used in biodemediation processes such as clearing various industrial effluents, oil containing crop wastes and decolorization of artificial dyes (Peláez *et al*. 1995; Dombrovská & Kostyshyn 1998; Balan & Monteiro 2001; Hmd 2011; Sweety 2018). An unidentified *Fuscoporia* species is also reported in detoxifying waste water and decolourizing synthetic dyes (Choi *et al.* 2013a). Laccase present in *Inonotus hispidus* (Bull.) P. Karst. is known to decolourize various industrial dyes (Jebapriya & Gnanadoss 2013; Krastanov *et al.* 2013; Singh *et al*. 2019a).

Polyporoid fungi are well known for various insect associations. Basidiocarps of many polypore species host various insect communities (e.g., *Fomes fomentarius* (L.) Fr., *Fomitopsis pinicola* (Sw.) P. Karst.) (Thunes 1994; Jonsell & Nordlander 1995; Nilsson 1997; Fossli & Andersen 1998; Jonsell 1998; Rukke & Midtgaard 1998; Hågvar 1999; Jonsell *et al.* 1999, 2001 2003; Jonsell & Nordlander 2002, 2004; Jonsson 2003; Komonen 2003; Komonen *et al.* 2003; Schigel 2011). Thirty three species of beetles have been recorded from species like *Fomes fomentarius, Fomitopsis pinicola* and *Trametes pubescens* (Schumach.) Pilát

(Selonen *et al*. 2005). In this study by Schigel (2011), 176 species of *Coleoptera* were recorded from 116 species of polypores belonging to both Polyporales (*Ganoderma applanatum*), and Hymenochaetales (*Phellinus igniarius*, *Phellinus populicola* Niemelä). A symbiotic association between ambrosia beetles and basidiomycotan fungi was reported first in *Flavadon ambrosias* (Li *et al.* 2015a; Simmons *et al.* 2016). According to Li *et al.* (2017), *F. ambrosias* was associated with two genera of ambrosia beetles. Ectomycorrizal associations are reported in some species of polyporoid fungi (*Coltricia* Gray and *Coltriciella* Murrill) (Tedersoo *et al*. 2007; Hibbett *et al.* 2014).

2.1.3. DISTRIBUTION

Distribution of polyporoid fungi is associated with latitude, altitude, rainfall and diversity of habitats (Lodge & Cantrell 1995). There are cosmopolitan as well as climate dependent genera among polyporoid fungi. *Abortiporus, Antrodiella, Bjerkandera, Ceriporia, Daedalea, Datronia, Dichomitus, Ganoderma, Gloeophyllum, Phellinus, Polyporus, Phylloporia*, *Trametes,* and *Tyromyces* are some of the polypore genera which are cosmopolitan in distribution. Climate dependant genera among polyporoid fungi include both tropical (e.g., *Amauroderma, Cyclomyces, Earliella, Hexagona, Leucophellinus, Microporellus, Microporus, Grammothelopsis, Theleporus, Paratrichaptum* and *Echinopora*) and boreal or temperate genera (*Albatrellus, Anomoporia, Cerrena, Fistulina, Fomes, Meripilus, Perenniporia, Phaeolus, Podofomes, Pycnoporellus,* and *Spongipellis*) (Ryvarden 1991).

Polyporoid fungi have been reported from different parts of the world. AFRICA: Barundi (Gulaid & Ryvarden 1998), Cameroon (Ryvarden & Johansen 1980; Decock & Mossebo 2002; Roberts & Ryvarden 2006; Douanla-Meli *et al.* 2007; Njouonkou *et al*. 2013, 2013a), Kenya (Otieno 1968; Ryvarden 1972; Ryvarden & Johansen 1980), Malavi, Rwanda (Ryvarden & Johansen 1980), Tanzania (Mtui & Nakamura 2008; Ryvarden & Johansen 1980), Uganda (David & Rajchenberg 1992; Ipulet & Ryvarden 2005), Zimbabwe (Masuka & Ryvarden 1992). NORTH AMERICA: Carolina (Grand & Vernia 2007), Costa Rica

(Carranza-Morse 1982, 1992; Carranza-Morse & Ryvarden 1998; Carranza-Morse & Ruiz-Boyer 2005; Decock & Ryvarden 2013), Cuba (Kotlaba 1984; Decock & Herrera-Figueroa 2000; Decock & Ryvarden 2003), Dominican Republic (Decock & Ryvarden 2000), Great Lakes (Baxter 1940), Jamaica (Murrill 1910; Ryvarden 2000), Mexico (Brusis 1972; Palacios-Pacheco *et al.* 2010; Valenzuela *et al*. 2008; Valenzuela *et al*. 2013; Torress-Torress *et al*. 2015), New York (Gilbertson & Ryvarden 1986), Southern Florida (Vlasák *et al.* 2011), United States of America (Burt 1920; Lentz 1955; Reid 1965; Lowe 1966; Bishop & McGrath 1978; Ryvarden 2010; Cao *et al*. 2012; Brazee *et al.* 2012, 2014; Zhou *et al.* 2016). SOUTH AMERICA: Andes-Amazon (Salvador-Montoya *et al*. 2012), Argentinian Yungas (Robledo & Rajchenberg 2007), Brazil (Berkeley & Cooke 1876; Loguercio-Leite & Wright 1991; Silveira & Guerrero 1991; Gugliotta & Capelari 1995; Gerber & Loguercio-Leite 1997; Gerber *et al.* 1999; Hattori & Lee 1999; Gibertoni *et al.* 2004, 2004a; Gomes-Silva & Gibertoni 2009; Nogueira-Melo *et al.* 2012; Torress-Torress *et al.* 2012; Drechsler-Santos *et al*. 2013), Colombia (López-Quintero *et al.* 2012), Ecuador (Patouillard & Lagerheim 1892; Læssøe & Ryvarden 2010), Guyana (Decock & Ryvarden 2000; Aime *et al*. 2003; 2007), Peru (Decock & Ryvarden 2003), Venezuela (Dennis 1970; Ryvarden & Iturriaga 2003). ASIA: Armenia (Ghobad-Nejhad 2011), China (Patouillard 1907; Hou 1950; Zhao *et al.* 1983; Zhao & Zhang 1986; Zhao 1989; Núñez & Ryvarden 2000, 2001; Hong & Jung 2004; Wang *et al.* 2005; Dai *et al.* 2007; Wang & Wu 2008; Dai *et al.* 2009; Wang *et al.* 2009; Dai 2010; Cao *et al*. 2012; Dai 2012; Dai 2012a; Yang & Feng 2013; Zhou *et al*. 2014; Hapuarachchi *et al.* 2018; Xing *et al.* 2018; Cui *et al.* 2019), Indonesia (Jülich 1974; Corner 1989; Corner 1991; Núñez *et al*. 2001), Israel (Țura *et al.* 2010), Japan (Aoshima & Abe 1983; Hattori & Ryvarden 1996; Núñez & Ryvarden 1999, 2000, 2001; Hattori 1999; Hattori 2005), Korea (Lim & Kim 1972; Jung 1975; Lee 1975; Lee 1988; Lee 1990; Jung 1994; Lee *et al.* 2010; Kim *et al.* 2009; Park *et al.* 2014), Malaysia (Newsam *et al.* 1967; Lim 1972; Corner 1981; Pegler 1983; Oldridge *et al.* 1986; Lee *et al.* 1995; Salmiah & Thillainathan 1998; Núñez & Ryvarden 2000; Salmiah & Jones 2001; Noorlidah *et al*. 2005; Sumaiyah *et al.* 2007; Zakaria *et al.* 2009; Bolhassan *et al.* 2012; Lee *et al.* 2012; Peng & Don

2013; Rakib *et al.* 2014; Urbizu *et al.* 2014), Mesapotamia (Wright & Deschamps 1975), Pakistan (Razaq & Shahzad 2016; Khan *et al.* 2016), Philippines (Steyaert 1975; Ryvarden & Johansen 1980), Singapore (Corner 1983, 1991), Sri Lanka (Berkeley 1872; Berkeley & Broome 1873; Ediriweera *et al*. 2014), Sumatra (Suhirman & Núñez 1998), Taiwan (Chang & Chou 1998, 1999; Núñez & Ryvarden 2000; 2001), Thailand (Ryvarden 1976; Le *et al*. 2007; Kerekes & Desjardin 2009; Choeyklin *et al.* 2009; Somchai 2012; Sysouphanthong *et al.* 2010; Choeyklin *et al.* 2011; Karunarathna *et al*. 2011; Thawthong *et al*. 2017; Luangharn *et al.* 2019), Turkey (Asan *et al.* 2002), Uzbekistan (Gafforov *et al.* 2014), Valenzuela (Corner 1983; Ryvarden & Iturriaga 2004; Lee *et al.* 2012). AUSTRALIA (Lowe 1966; Wright & Deschamps 1975; Carranza-Morse 1986; Smith & Sivasithamparam 2000, 2003; Cui *et al*. 2019), New Zealand (Cunningham 1948, 1965; Buchanan & Hood 1992); Papua New Guinea (Corner 1984; Quanten 1997; Decock 2007). EUROPE: Byelorussia, Czechoslovakia, France, Germany, Georgia (Ryvarden & Gilbertson 1986); Crimea (Isikov & Kuznetzov 1990); Czech Republic (Kotlaba 1975, 1984; Antonín *et al.* 2000; Vlasák *et al*. 2011), Finland (Niemelä & Kotiranta 1982; Niemelä *et al.* 1992), Hungary (Bresadola 1897), Italy (Berniccchia 2001, 2005; Bernicchia *et al.* 2007; Bernicchia & Gorjön 2010; Niemelä & Miettinen 2008; Cao & Yuan 2013; Ryvarden & Melo 2014), Norway (Bendiksen *et al.* 1998), Paris (Torrend 1920), Poland (Piątek 1999), Rome (Bernicchia *et al.* 2006), Russia (Spirin 2007; Ghobad-Nejhad *et al*. 2009; Spirin *et al.* 2014; Zmitrovich *et al.* 2016), Siberia (Filippova & Zmitrovich 2013), Slovakia (Lizoň 2001), Switzerland (Senn-Irlet *et al*. 2007), Sweden (Josefsson & Spirin 2010; Vesterholt 2012); Yugoslavia (Ryvarden & Gilbertson 1993).

The earliest available records of polyporoid fungi from India are those of Kotzch (1832, 1833). Berkeley (1850, 1851, 1851a, 1851b, 1851c, 1854, 1854a, 1854b, 1854c, 1855, 1866, 1872) reported many polypores based on his studies on the collections made by Dr. Hooker from Sikkim Himalayan regions of India. Bose in his series of publications (1918, 1919, 1919a, 1920, 1920a, 1921, 1921a, 1921b, 1922, 1922a, 1922b, 1923, 1923a, 1924, 1925, 1928, 1928a, 1934, 1937, 1944, 1946) provided a comprehensive record of 143 polyporoid fungi mostly from

Bengal regions. Eleven species of polypores were reported from Madras by Sundararaman & Marudarajan (1925). Butler & Bisbi (1931) documented 300 polyporoid species belonging to 15 genera in their “Fungi of India”. Mitter & Tandon (1932, 1938) reported 30 species and 2 forms of polypores from Uttarakand. Apart from Bose, polyporoid fungi of Bengal were recorded by Banerjee (1935, 1935a), Banerjee & Chakravarthy (1945), Banerjee & Chatterjee (1945, 1945a, 1945b), Banerjee & Ghosh (1945) and Banerjee & Bakshi (1954). Polyporoid fungi were recorded from Sikkim Himalayas and Kolkata by Banerjee (1946) and Banerjee (1947) repectively. Taxonomy, pathology and cultural characters of 14 polypore species from India were studied by Bagchee & Bakshi (1950) and Bakshi & Bagchee (1950). Thind & Adlakha (1956) and Reid *et al*. (1958) reported 12 polypores from Mussoorie hills of Uttarakand. In the revised edition of Butler & Bisbi’s “Fungi of India” by Vasudeva (1960), 400 polyporoid species belonging to 21 genera were reported.

Many works have been carried mainly on the pathological aspects of polyporoid fungi from the Forest Research Institute, Deharadun, and these include Banerjee (1946, 1947), Bagchee (1950, 1951, 1954, 1957, 1958, 1960, 1961), Bagchee & Bakshi (1951), Bagchee *et al*. (1954), Bakshi (1955, 1956, 1957, 1958), Banerjee & Anjali (1956), Puri (1956), Bakshi & Boyce (1959), Bagchee & Singh (1960), Thind & Chatrath (1960), Bakshi & Choudhary (1961), Balwant (1961), Balwant & Bakshi (1961), Balwant (1966, 1966a), Singh (1961), Singh & Bakshi (1961), Singh *et al*. (1961, 1961a), Rehill & Bakshi (1965, 1966), Bakshi *et al*. (1966), Sehgal *et al*. (1966), Singh (1966, 1966a) and Bakshi & Singh (1970). Other major works on the systematics of polyporoid fungi from India are Pegler (1967), Bakshi (1971), Roy (1968, 1968a, 1969, 1970, 1971), Rangaswami *et al*. (1970), Thind & Rattan (1968, 1970, 1971, 1971a, 1971b, 1971c, 1972, 1973, 1973a, 1976), Ryvarden & Dhanda (1975), Rattan (1977), Natarajan (1978), Natarajan & Manjula (1978), Bilgrami *et al*. (1979), Thind & Dhanda (1979, 1979a, 1980, 1980a), Sathe & Daniel (1980), Sathe & Deshpande (1980), Sathe & Kulkarni (1980), De & Roy (1981), Natarajan & Raman (1981), Manjula (1983), Natarajan and Kolandavelu (1985), Sharma *et al*. (1985), Roy (1989), Bilgrami *et al*. (1991), Rabba (1994), Roy

& De (1996), Rattan (1997), Prasher (1999), Sharma (2000), Deshpande (2003), Arya (2004), Lamrood (2004), Bhosle *et al*. (2005), Dhingra & Singla (2005), Natarajan *et al*. (2005), Prasher & Chander (2006, 2007), Forutan (2006), Arya *et al.* (2008), Hakimi (2008), Sehgal *et al*. (2008), Swapna *et al.* (2008), Bhosle *et al.* (2010), Tiwari *et al*. (2010), Dhingra & Priyanka (2011), Prasher *et al*. (2011), Ranadive *et al.* (2011), Tiwari *et al*. (2011), Prasher *et al*. (2012), Senthilarasu & Singh (2012), Hembrom *et al.* (2013), Prasher & Ashok (2013), Prasher & Lalitha (2013), Ranadive *et al*. (2013), Sharma *et al*. (2013), Nagadesi *et al.* (2014), Senthilarasu (2014), Usha & Janardhana (2014), Singh *et al*. (2014), Lyngdoh & Dkhar (2014), Ranadive (2014), Hembrom *et al*. (2015), Prasher (2015), Senthilarasu (2015), Sharma & Atri (2015), Ranadive & Jagtap (2016), Hembrom *et al.* (2017), Chakraborty *et al*. (2018), Pongen *et al.* (2018), and Singh *et al.* (2019).

Published systematic works on the polyporoid fungi of Kerala include those of Rangaswamy *et al.* (1970), Ganesh & Leelavathy (1986), Ganesh *et al.* (1988), Sankaran & Florence 1995, Roy & De (1996), Leelavathy & Ganesh (2000), Florence & Yesodharan (2000), Florence (2004), Manimohan *et al.* (2004), Kumar & Manimohan (2005), Pradeep & Vrinda (2007), Mohanan (2011), Farook *et. al*. (2013), Iqbal *et al*. (2016), Adarsh *et al.* (2019). Two major documentary works on polyporoid fungi of Kerala are those of Leelavathy & Ganesh (2000), Florence (2004), and Mohanan (2011). Leelavathy & Ganesh (2000) described 79 species belonging to 32 genera, placed in 3 families; Polyporaceae, Ganodermataceae and Hymenochaetaceae. Florence (2004) listed 93 species of polyporoid fungi from the State. Mohanan (2011) gave an account of 91 species of polypores of 46 genera, belonging to six families (Polyporaceae, Hymenochaetaceae, Meruliaceae, Meripilaceae, Fomitopsidaceae and Ganodermataceae). Farook *et. al*. (2013), in their checklist listed 14 species of polyporoid fungi, which possessed gilled hymenium. Adarsh *et al.* (2018) published a checklist which compiled 145 species of polypores previously reported from Kerala. Recently, Adarsh *et al.* (2019) documented three polypores, and Kiran *et al*. (2020) reported two polypores, which were new records to Kerala.

2.1.4. ORDER POLYPORALES GÄUMANN

Polyporales, established by Gäumann (1926), is one of the major groups of Agaricomycetes, comprising about 1800 species (Binder *et al.* 2013). Most members of the group are saprotrophic, whereas some are pathogenic on plants (e.g.'s species of *Ganoderma* P.Karst., *Fomitopsis* P. Karst) (Binder *et al.* 2013). The order includes species with varying basidiocarp morphology such as bracket shaped pileate forms (eg's. *Ganoderma*, *Trametes* Fr.), perennial conks (*Fomes* Fr.), corticioid forms (*Dentocorticium* (Parmasto) M.J. Larsen & Gilb., *Dendrodontia* Hjortstam & Ryvarden), resupinate polypores (*Phanerochaete* P. Karst., *Phlebia* Fr.), stipitate with poroid (*Polyporus* P. Micheli *ex* Adans.), lamellate (*Lentinus* Fr.) or smooth hymenium (*Podoscypha* Pat.), hydnoid fungi (*Steccherinum* Gray, *Trulla* Miettinen & Ryvarden) and highly folded forms (*Sparassis* Fr.) (Binder *et al.* 2005, 2013; Hibbett *et al.* 2014; Justo *et al.* 2017). Species belonging to the order are characterized by monomitic, dimitic or trimitic hyphal systems, simple septate or clamped generative hyphae which are sometimes inflated, fibrous, thick walled, branched or unbranched skeletal hyphae that are inamyloid to rarely dextrinoid or weakly amyloid in Melzer's reagent, cyanophilic or acyanophilic in cotton blue and thin to thick walled, smooth to ornamented, inamyloid to dextrninoid basidiospores that are usually cyanophilic (Zmitrovich 2018). Binder *et al.* (2005) states that there is no morphological synapomorphy common among members of Polyporales. According to Hibbett & Thorn (2001), poroid nature of the hymenium in Polyporales is primitive, from which lamellate, toothed, or smooth hymenium has been derived. All the members of the order possess genes of laccases and peroxidases in their active or inactive form and are capable of causing either brown rot or white rot on the host (Ryvarden & Melo 2014). They are a major wood decomposing group, and play important role in nutrient recycling in the biosphere (Floudas *et al.* 2012).

Polyporales has been considered as polyphletic or paraphyletic in origin (Hibbett & Donoghue 1995; Hibbett 1996; Hibbett & Vilgalys 1993; Kim & Jung 2000; Langer 2002; Larsson *et al*. 2004). The order was weakly supported as monophyletic in the studies carried out by Binder *et al.* (2005). Whereas, in other studies such as that of Binder & Hibbett (2002), Binder *et al.* (2005), Larsson (2007), Garcia-Sandoval *et al.* (2011), Justo & Hibbett (2011), Matheny *et al.* (2007), Miettinen *et al*. (2012), Sjökvist *et al.* (2012), Binder *et al.* (2013), Floudas *et al.* (2012) the order is well resolved as monophyletic. Binder *et al.* (2005) recognized four sub clades for Polyporales such as the *Antrodia* clade, the core polyporoid clade, the phlebioid clade and the residual clade, with different support levels. The position of these sub clades was also supported in a later study by Binder *et al*. (2013) based on six gene regions (nuclear ribosomal LSU, 5.8S, nuclear ribosomal SSU, RNA polymerase II subunits rpb1 and rpb2, tef1). Polyporales has been treated as a strongly supported clade of Agaricomycetes. The other orders of Agaricomycetes such as Corticiales, Gloeophyllales, Russulales, and Thelephorales are recognized as closely related to Polyporales (Hibbett *et al.* 2014). Currently 46 genome sequences of Polyporales are available at the Joint Genome Institute MycoCosm portal (Grigoriev *et al*. 2013).

Recently, Justo *et al.* (2017) published a revised family level classification for the order Polyporales based on both morphology and molecular phylogenetic data. They divided the order into two main clades; one clade including phlebioid, residual and *Candelabrochaete africana* Boidin and the other clade including core polyporoid, *Antrodia* and other satellite lineages. In this study, 18 families (Cerrenaceae Miettinen, Justo & Hibbett, Gelatoporiaceae Miettinen, Justo & Hibbett, Dacryobolaceae Jülich, Fomitopsidaceae Jülich, Grifolaceae Jülich, Hyphodermataceae Jülich, Incrustoporiaceae Jülich, Irpicaceae Spirin & Zmitr., Ischnodermataceae Jülich, Laetiporaceae Jülich, Meripilaceae Jülich, Meruliaceae Rea, Panaceae Miettinen, Justo & Hibbett, Phanerochaetaceae Jülich, Podoscyphaceae D.A. Reid, Polyporaceae Fr. *ex* Corda, Sparassidaceae Herter and Steccherinaceae Parmasto) and 167 genera have been recognized under Polyporales. According to the study (Justo *et al*. 2017), some taxa such as *Candelabrochaete africana* Boidin, *Mycoleptodonoides vassiljevae* Nikol., *Auriporia aurea*, (Peck) Ryvarden and *Tyromyces merulinus* (Berk.) G. Cunn. were not positioned with certainty in any of the families recognized under Polyporales. Another recent systematic study on Polyporales by Zmitrovich (2018) recognizes seven families (Fomitopsidaceae, Gelatoporiaceae, Polyporaceae, Incrustoporiaceae, Ischnodermataceae, Meruliaceae, Grifolaceae) and 204 genera under the order. Families such as Dacryobolaceae, Laetiporaceae and Sparassidaceae, recognized under Polyporales by Justo *et al*. (2017) have been considered as synonyms of Fomitopsidaceae by Zmitrovich (2018). Families recognized under polyporoid group in some of the major classification systems are provided below (Table 1).

Table 1: Major family level classification systems of polypores

Family names	**References**
Caloporaceae Bondartseva, Polyporaceae Fr. *ex* Corda, Ganodermataceae Donk, Hymenochaetaceae Donk	Bondartseva 1983a, 1983b
Albatrellaceae Nuss, Aporpiaceae Bondartsev & Bondartseva, Boletopsidaceae Bondartsev & Singer *ex* Jülich, Bondarzewiaceae Kotl. & Pouzar, Corticiaceae Herter, Fistulinaceae Lotsy, Ganodermataceae, Lachnocladiaceae D.A. Reid, Phaeolaceae Jülich, Polyporaceae, Poriaceae Locq., Rigidoporaceae Jülich	Bondartseva 1998
Albatrellaceae, Bondarzewiaceae, Coniophoraceae Ulbrich, Corticiaceae Herter, Cyphellaceae Maire, Echinodontiaceae Gross, Fistulinaceae, Ganodermataceae, Hericiaceae Donk, Hymenochaetaceae, Thelephoraceae Chevall, Polyporaceae	Ryvarden 1991
Cerrenaceae Miettinen, Justo & Hibbett, Dacryobolaceae Jülich, Fomitopsidaceae Jülich, Gelatoporiaceae Miettinen, Justo & Hibbett, Grifolaceae Jülich, Hyphodermataceae Jülich, Incrustoporiaceae Jülich, Irpicaceae Spirin & Zmitr., Ischnodermataceae Jülich, Laetiporaceae Jülich, Meripilaceae Jülich, Meruliaceae Rea, Panaceae Miettinen, Justo & Hibbett, Phanerochaetaceae Jülich, Podoscyphaceae D.A. Reid, Polyporaceae, Sparassidaceae Herter, Steccherinaceae Parmasto	Justo *et al.* 2017
Fomitopsidaceae, Gelatoporiaceae, Grifolaceae, Incrustoporiaceae, Ischnodermataceae, Meruliaceae, Polyporaceae	Zmitrovich 2018

Sub groups of Polyporales

Ryvarden (1991), classified polypores into 11 groups based on morphological characters and type of wood decay. Ryvarden (1991) recognized the following groups: *Polyporus* group, *Trametes* group, *Daedalea* group, *Laetiporus* group, *Rigidoporus* group, *Tyromyces* group, *Junghuhnia* group, *Perenniporia* group, *Fomes* group, *Nigroporus* group and *Grammothele* group. Some genera which had uncertain affinity were included under a separate group (*Australoporus* P.K. Buchanan & Ryvarden, *Diacanthodes* Singer, *Echinoporia* Ryvarden, *Lenzitella* Ryvarden, *Murrilloporus* Ryvarden, *Navisporus* Ryvarden, *Pachykytospora* Kotl. & Pouzar, *Paratrichaptum* Corner, *Pseudopiptoporus* Ryvarden, *Polyporoletus* Snell). The characters of major groups recognized by Ryvarden (1991) are as below (Table 2).

Table 2: Groups of polyporoid fungi recognized by Ryvarden (1991)

Sl. No.	Name of the group	Major characters
1	*Polyporus* group (=Polyporaceae *sensu stricto*)	Dimitic hyphal system, clamped generative hyphae, "*Bovista type*" skeleto ligative hyphae, absence of cystidia, cylindrical to ellipsoid, thin walled, smooth, inamyloid basidiospores and causing white rot.
2	*Trametes* group	Trimitic hyphal system, clamped generative hyphae, torturous skeleto ligative hyphae, absence of cystidia, hyaline, thin walled, smooth, inamyloid basidiospores, white rot type of decay.
3	*Daedalea* group	Dimitic to trimitic hyphal system, generative hyphae with clamp connections, absence of cystidia, oblong ellipsoid to cylindrical basidiospores, hyaline, thin walled, smooth, inamyloid basidiospores, causing brown rot on wood.
4	*Laetiporus* group	Monomitic to dimitic hyphal system, generative hyphae without clamp connections, skeleto ligative hyphae without torturous branches, absence of cystidia, mostly ellipsoid basidiospores, that are thin walled, smooth and inamyloid in Melzer's reagent. Members of the group mostly occur on gymnosperms.
5	*Rigidoporus* group	Monomitic to dimitic hyphal system, generative hyphae without clamp connections, absence of skeleto ligative hyphae, mostly globose to subglobose basidiospores,

		causing white rot wood decay.
6	*Tyromyces* group	Monomitic hyphal system, generative hyphae without clamp connections, ellipsoid to allantoid basidiospores, causing white rot on wood.
7	*Junghuhnia* group	Dimitic hyphal system with dense consistency, presence of cystidia, smaller basidiospores that are often less than 5 µm long, causing white rot.
8	*Perenniporia* group	Dimitic to trimitic hyphal system, generative hyphae without clamp connections, thick walled, truncate, usually smooth basidispores, showing dextrinoid reaction in Melzer's reagent.
9	*Fomes* group	Pileal surface with hard smooth crust, trimitic hyphal system, generative hyphae with clamp connections, brown coloured skeletal hyphae, large, cylindrical, smooth basidiospores.
10	*Nigroporus* group	Basidiocarps with deep vinaceous to black colour, dimitic to trimitic hyphal system, generative hyphae with clamp connections, dark coloured skeletal hyphae, causing white rot on wood.
11	*Grammothele* group	Resupinate adnate basidiocarps, absence of cystidia, monomitic to dimitic hyphal system, generative hyphae with clamp connections, absence of skeleto ligative hyphae, causing white rot on wood.

Based on the molecular phylogenetic studies by Binder *et al.* (2005, 2013), Polyporales were divided into four major clades as follows:

i. *Core polyporoid clade*

The term core polyporoid clade was proposed by Binder *et al.* (2005) and corresponds to the previously recognized "*Trametes* group" (Lim 2001), ‘‘polyporoid clade’’ (Larsson *et al.* 2004) and "Polyporaceae" (Kim & Jung 2000). This clade consists of species belonging to the families Ganodermataceae and Polyporaceae (in the sense of Ryvarden 1991), having a dimitic or trimitic hyphal system, tetrapolar mating system, and capable of causing white rot (Binder *et al.* 2005). However, exceptions from above characters are seen in some species, *Diplomitoporus lindbladii* (Berk.) Gilb. & Ryvarden which possesses bipolar mating system and *Wolfiporia cocos* (Schwein.) Ryvarden & Gilb., which causes brown rot on wood (Gilbertson & Ryvarden 1986, 1987). But the placement of the latter in core polyporoid clade is doubted (Kim & Jung 2000). The clade includes pileate and resupinate polypores, corticioid forms, as well as the gilled mushroom *Lentinus* (Hibbett *et al.* 2014). The core polyporoid clade was again classified into three by Justo & Hibbett (2011), as the *Polyporus* clade, the trametoid clade and the *Dentocorticium* clade. Genomes of 16 taxa belonging to the core polyporoid clade (*Dichomitus squalens* (P. Karst.) D.A. Reid, *Ganoderma* species, *Leiotrametes* species, *Lentinus arcularius* (Batsch) Zmitr. (as *Polyporus arcularius*), *Lentinus brumalis* (Pers.) Zmitr. (as *Polyporus brumalis* (Pers.) Fr.), *Lentinus tigrinus* (Bull.) Fr., *Pycnoporus cinnabarinus, Pycnoporus puniceus* (Fr.) Ryvarden, *Pycnoporus sanguineus* (L.) Murrill, *Trametes cingulata* Berk., *Trametes coccinea* (Fr.) Hai J. Li & S.H. He (as *Pycnoporus coccineus* (Fr.) Bondartsev & Singer), *Trametes elegans* (Spreng.) Fr., *Trametes gibbosa* (Pers.) Fr., *Pilatotrama ljubarskyi* (Pilát) Zmitrovich (as *Trametes ljubarskyi* Pilát, *Trametes pubescens* (Schumach.) Pilát, *Trametes versicolor* (L.) Lloyd) have been sequenced so far (Justo *et al*. 2017).

ii. *Antrodia clade*

Antrodia clade was recognized as a subgroup of polyporoid clade by Hibbett & Donoghue (2001) and included 11 genera (*Antrodia* P. Karst., *Auriporia* Ryvarden, *Daedalea* Pers., *Fomitopsis* P. Karst., *Laetiporus* Murrill, *Oligoporus* Bref., *Postia* Fr., *Neolentiporus* Rajchenberg, *Phaeolus* (Pat.) Pat., *Piptoporus* P. Karst., *Sparassis* Fr.) that are characterized by brown rot type of wood decay (Binder *et al*. 2005; Ortiz-Santana *et al*. 2013). Exceptionally, the clade also includes few white rot species such as *Climacocystis* species, *Grifola frondosa* (Dicks.) Gray and *Ischnoderma benzoinum* (Wahlenb.) P. Karst. (Binder *et al.* 2005; Garcia-Sandoval *et al*. 2011). However, the position of these species in *Antrodia* clade is not supported in the phylogenetic study of Binder *et al.* (2013). According to Wu *et al.* (2004), Binder *et al.* (2005), Dai *et al.* (2006), Yu *et al.* (2010) and Garcia-Sandoval *et al.* (2011), genus *Grifolia* Gray is unrelated to the species of *Antrodia* clade. *Antrodia* clade comprises many groups that were earlier recognized under the Fomitopsidaceae and Laetiporaceae *sensu* Kim & Jung (2000), Fomitopsidales and Phaeolales *sensu* Boidin *et al*. (1998), clade "Brown rot group" of Lim (2001) and few unnamed groups in the studies of Hibbett & Donoghue (1995) and Langer (2002). Most of the species of the clade possessed bipolar mating systems. Whereas, six species are reported to be tetrapolar (Binder *et al.* 2005). Based on the phylogenetic study by Ortiz-Santana *et al.* (2013), *Antrodia* clade has been divided into five sub groups with moderate support such as the *Fibroporia* group, *Laetiporus* group, *Laricifomes* group, *Postia* group and the core *Antrodia* group.

iii. *Phlebioid clade*

The term phlebioid clade was put forward by Larsson *et al.* (2004) for placing most corticioid genera such as *Phlebia* Fr., *Mycoacia* Donk, *Mycoaciella* J. Erikss. & Ryvarden, *Hyphoderma* Wallr. (later transferred to residual polyporoid clade by Binder *et al.* 2005), *Ceriporia* Donk., *Gloeoporus* Mont., *Ceraceomyces* Jülich and *Byssomerulius* Parmasto. According to Larsson *et al.* (2004), phlebioid clade has been divided into three sub clades, which were also distinct based on morphology. Larsson (2007) called these clades as the *Byssomerulius* family, Phanerochaetaceae, and Meruliaceae, which is in line with subsequent works (Floudas & Hibbett 2015; Miettinen *et al.* 2016). Some of the most studied genera within the clade are *Bjerkandera*, *Phlebia*, *Phanerochaete* and *Irpex* (Hibbett *et al*. 2014). Members of the clade are characterized by monomitic hyphal system, bipolar mating system and by the capability to cause white rot wood decay, with an exception of *Leptoporus mollis* (Pers.) Quél. that produce a brown rot (Binder *et al.* 2005, 2013). However species exhibiting tetrapolar mating sytem and dimitic hyphal system also occur in the phlebioid clade (Kim & Jung 2000; Eriksson & Ryvarden 1976; Gilbertson & Ryvarden 1987).

iv. *Residual polyporoid clade*

This clade is a highly heterogenous group consisting of species that could not be satisfactorily placed in other three clades (Core polyporoid, *Antrodia*, and phlebioid) of Polyporales (Binder *et al.* 2005, 2013). The members of the clade may be poroid (eg. *Xanthoporus* Audet), gilled (*Panus* Fr.), corticioid (*Hyphoderma* Wallr.), resupinate-hydnoid (*Steccherinum* Gray), and stipitate sterioid types

(*Podoscypha* Pat.) (Hibbett *et al.* 2014). Microscopic features also differ among the members of the clade, from monomitic to dimitic or trimitic hyphal system, presence or absence of clamp connections and cystidia. The common character shared among all species of the clade is the white rot type of wood decay (Bernicchia 2005; Binder *et al.* 2013). Monophyly of this clade is doubtful (Hibbett *et al.* 2014). According to Binder *et al.* (2013), it is essential to resolve the phylogenetic relationships within this clade for the comprehensive study of evolution of characters in Polyporales. A detailed discussion on the phylogeny of various genera belonging to different clades of Polyporales has been provided by Rajchenberg (2011).

2.1.4.1. MAJOR FAMILIES OF POLYPORALES

2.1.4.1.1. **Dacryobolaceae** Jülich

The family includes a group of brown rot causing fungi belonging to the *Antrodia* clade of Polyporales. They include polyporoid and corticioid species. Members of the family are characterized by monomitic, rarely dimitic or trimitic; generative hyphae with clamp connections, absence of cystidia and hyaline, smooth or exceptionally ornamented, thin to thick walled basidiospores. The family consists of six genera such as *Amylocystis* Bondartsev & Singer *ex* Singer, *Dacryobolus* Fr., *Jahnoporus* Nuss, *Oligoporus* Bref., *Postia* Fr., and *Spongiporus* Murrill (Justo *et al.* 2017). Based on the molecular phylogenetic studies by Ortiz-Santana *et al.* (2013) and Binder *et al.* (2013), other poroid genera, *Auriporia* Ryvarden, *Sarcoporia* P. Karst., and *Taiwanofungus* Sheng H. Wu, Z.H. Yu, Y.C. Dai & C.H. Su, also appears as related to the members of Dacryobolaceae. However, according to Justo *et al.* (2017), *Auriporia* clustered outside the *Antrodia* clade, *Sarcoporia* were distantly related to Dacryobolaceae.

GENUS *POSTIA* FRIES

The genus was established by Fries in 1874 with *Postia lactea* (Fr.) P. Karst. as the type species. Most species of *Postia* were earlier placed under another polypore genus *Tyromyces* P. Karst. However, the two genera were later separated based on the type of wood decay, white rot in *Tyromyces* species (Gilbertson &

Ryvarden 1987; Ryvarden 1991; Ryvarden & Gilbertson 1994), and brown rot in *Postia* species (Jülich 1982; Niemelä 2005) (Shen *et al.* 2014). David (1980) treated brown rot species under *Spongiporus* Murrill, while Jülich (1982) and Gilbertson & Ryvarden (1985) transferred all brown rot species to *Postia* and *Oligoporus* Bref. respectively (Papp 2014). Based on morphology and molecular characterization, *Oligoporus* was treated as a synonym of *Postia* (Yao *et al.* 1999; Papp 2014). The name *Postia* was widely accepted by many workers (Karsten 1879, 1881; Donk 1960; Jülich 1982; Larsen & Lombard 1986; Renvall 1992; Walker 1996; Pieri & Rivoire 1998; Buchanan & Ryvarden 2000; Hattori *et al.* 2011; Dai 2012). However, Ryvarden (1991) and Ryvarden & Gilbertson (1994) used the name *Oilgoporus* for accommodating brown rot species, instead of *Postia*. According to Erkkilä & Niemelä (1986) and Renvall (1992), genus *Postia* produces thin walled basidiospores, whereas, *Oligoporus* produces thick walled basidiospores with cyanophilous walls. *Oligoporus* species sometimes may produce chlamydospores.

Molecular studies place *Postia* under the *Antrodia* clade of Polyporalres (Hibbett & Donoghue 2001; Binder *et al.* 2013). In the phylogenetic study of Pildain & Rajchenberg (2013), species of *Postia sensu lato* settled in a separate clade, called as '*Postia* clade' which was mainly characterized by tetrapolar mating system, normal nuclear behavior, generative hyphae that are metachromatic in cresyl blue, and by the lack of thick walled hyphae in culture. Recent molecular studies (Binder *et al*. 2013; Ortiz-Santana *et al.* 2013; Cui *et al*. 2014; Justo *et al.* 2017; Zmitrovich 2018) treat *Oligoporus*, *Postia*, and *Spongiporus* as distinct genera. Currently, 47 species are recognized under *Postia* (*Index Fungorum*, accessed on 30 September 2020).

Based on recent concepts (Hattori *et al.* 2011; Cui & Li 2012; Pildain & Rajchenberg 2013; Shen *et al.* 2019), *Postia* is defined by annual, mostly soft to corky fruit bodies, monomitic to dimitic hyphal system with clamped, metachromatic generative hyphae, absence of cystidia, and thin walled, allantoid to cylindrical or ellipsoid basidiospores that are acyanophilous in cotton blue and inamyloid to weakly amyloid in Melzer’s reagent. Genus produces brown rot on wood.

Infrageneric classification

According to Ţura *et al.* (2008), a distinct morphological group called “*Postia caesia* complex” exist within the genus *Postia*. The position of this complex within *Postia* is also supported in the studies by Pildain & Rajchenberg (2013), Ortiz-Santana *et al.* (2013) and Miettinen *et al*. (2018). *Postia Caesia* complex is characterized by annual, spongy whitish fruit bodies which change blue-grey in colour on bruising or with age, and small cylindrical to allantoid, cyanophilous basidiospores (Niemelä 2013). Papp (2014) established a sub genus for *Postia*, called *Cyanosporus* (McGinty) V. Papp, for placing species belonging to *Postia caesia* complex.

Economic importance

Immunomodulatory and cytotoxic activities have been reported in *Postia ptychogaster* (F. Ludw.) Vesterh and *Postia stiptica* (Pers.) Julich by Doskocil *et al.* (2016). *Postia stiptica* also posseses antioxidant activity (Kalyoncua *et al.* 2010).

Distribution

Genus *Postia* is cosmopolitan in distribution (Ryvarden 1991). AFRICA (Ryvarden & Johansen 1980), Cameroon (Roberts & Ryvarden 2006). NORTH AMERICA (Murrill 1907; Lowe 1975; United States of America (Atkinson 1908; Brazee *et al.* 2012). SOUTH AMERICA: Argentina (Pildain & Rajchenberg 2013), Brazil (Loguercio-Leite *et al*. 2008; Pires *et al*. 2017), Costa Rica (Carranza-Morse 1982), Ecuador (Patouillard & Lagerheim 1892). ASIA: China (Wei & Dai 2006; Dai *et al.* 2007; Dai *et al*. 2009; Wei & Qin 2010; Yuan *et al.* 2010; Dai *et al*. 2011; Dai 2012; Shen *et al*. 2014), Far East Russia (Núñez & Ryvarden 2001), Japan (Dai & Hattori 2007; Hattori *et al.* 2010), North Thailand, Taiwan (Núñez & Ryvarden 2001), Malaysia (Corner 1984; Lee *et al.* 2012), West Siberia (Flippova & Zmitrovich 2013), Sri Lanka (Ediriweera *et al.* 2014). AUSTRALIA (Rajchenberg & Buchanan 1996), New Zealand (Buchanan & Ryvarden 2000; Niemelä *et al.*

2001). EUROPE (David 1974, 1980; Jülich 1982; Ryvarden & Gilbertson 1994; Pieri & Rivoire 1998, 2005; Ryvarden & Melo 2014), Finland (Kotiranta *et al*. 2009), Germany (Schrader 1794), Italy (Bernicchia 2005), Lapland (Renvall 1992).

Species of *Postia* such as *P. balsamea* (Peck) Jülich, *Postia caesia* (Schrad.) P. Karst., *P. grata* (Berk.) Rajchenb., *P. sericeomollis* (Romell) Jülich and *P. tephroleuca* (Fr.) Jülich have been from India (Sharma 2000; Florence 2004; Ranadive *et al.* 2011; Prasher & Lalita 2013; Ranadive 2013; Lalita & Prasher 2014, 2014a).

GENUS ***SPONGIPORUS*** MURRILL

Genus *Spongiporus* belongs to the family Dacryobolaceae of Polyporales. The genus was erected by Murrill in 1905 with *Spongiporus leucospongia* (Cooke & Harkn.) Murrill as the type species. The genus accommodated all brown rot species that possessed a monomitic hyphal system (David 1980). *Spongiporus* has been considered as the synonym of other two brown rot polypore genera, *Oligoporus* Bref. and *Postia* Fr., by different workers (Gilbertson & Ryvarden 1985; Ryvarden & Gilbertson 1994; Pildain & Rajchenberg 2013). Recent molecular phylogenetic studies by Ortiz-Santana *et al.* (2013), Binder *et al*. (2013), Cui *et al*. (2014), Justo *et al.* (2017) treats *Oligoporus*, *Postia* and *Spongiporus* as independent genera under the *Antrodia* clade of Polyporales. Based on the phylogenetic study carried out by Shen *et al*. (2019), five species of *Spongiporus* formed a separate lineage from other *Oligoporus* or *Postia* species under the *Antrodia* clade of Polyporales. According to Shen *et al*. (2019), basidiocarps of *Oligoporus sensu stricto* are resupinate where as members of the genus *Spongiporus sensu stricto* prooduce effused reflexed to pileate basidiocarps. Species of *Postia* differ from that of *Spongiporus* by having fruit bodies that are always solitary, and with narrower basidiospores (Shen *et al*. 2019). Zmitrovich (2018) places the genus under the "*Postia* group" of Fomitopsidaceae. Currently, seven species (*Spongiporus altocedronensis* Murrill, *S. floriformis* (Quél.) Zmitr., *S. gloeoporus* (L.L. Shen, B.K. Cui & Y.C. Dai) B.K. Cui, L.L. Shen & Y.C. Dai, *S. lateralis* Ryvarden & Gilb., *S. perdelicatus* (Murrill) Zmitr., *S. rhodophilus* Spirin & Zmitr. and *S. zebra* (Y.L. Wei & W.M. Qin) B.K.

Cui, L.L. Shen & Y.C. Dai) have been recognized under the genus *Spongiporus* (*Index Fungorum,* accessed on 30 September 2020).

The major characteristics of the genus are annual growth habit, effused reflexed to pileate basidiomata that are usually imbricate, a monomitic hyphal system with clamped generative hyphae and allantoid to cylindrical basidiospores that are hyaline, smooth, thin walled, acyanophilous in cotton blue and inamyloid in Melzer's reagent (Shen *et al.* 2019). However, amyloid nature of hyphae is reported in one species of *Spongiporus, S. rhodophilus* Spirin & Zmitr. (Spirin *et al*. 2006).

Distribution

The genus has been reported from the following regions of the world: NORTH AMERICA (Murrill 1907; Zhou *et al*. 2016). ASIA: Russia (Spirin & Shirokov 2002). EUROPE (Ryvarden & Gilbertson 1994; Spirin *et al*. 2006; Ryvarden & Melo 2014).

2.1.4.1.2. **Fomitopsidaceae** Jülich

The family was erected by Jülich in 1982. Corner (1990) grouped together some species in Fomitopsidaceae with members of *Trametes* (Polyporaceae) based on the similarity in the microscopic characters of both genera. The key character that distinguishes this family from Polyporaceae is the brown rot type of wood decay.

Based on the phlyogenetic study of Homobasidiomycetes by Binder *et al.* (2005), Fomitopsidaceae was positioned in the *Antrodia* clade of Polyporales. The position of this family under the *Antrodia* clade was also supported in their later studies (Binder *et al.* 2013). According to the phylogenetic study of Kim *et al.* (2005), type genus *Fomitopsis* was heterogenous and was divided into three subgroups such as *Fomitopsis* core group (included *Piptoporus betulinus* (Bull.) P. Karst. and *Daedalea quercina* (L.) Pers), *F. rosea* group, and *F. cajanderi* group, which includes some *Antrodia* species. Ortiz-Santana *et al*. (2013) also recognized the genus as polyphyletic. Han *et al.* (2016) divided *Fomitopsis* in to six genera such as *Fragifomes* B.K. Cui, M.L. Han & Y.C. Dai, *Niveoporofome*s B.K. Cui, M.L.

Han & Y.C. Dai, *Rhodofomitopsis* B.K. Cui, M.L. Han & Y.C. Dai, *Rubellofomes* B.K. Cui, M.L. Han & Y.C. Dai, *Ungulidaedalea* B.K. Cui, M.L. Han & Y.C. Dai and *Piptoporellus* B.K. Cui M.L. Han & Y.C. Dai based on morphological and molecular evidences. Phylogeny of *Antrodia* and related genera in Fomitopsidaceae was studied by many workers (Rajchenberg *et al*. 2011; Ortiz-Santana *et al*. 2013; Spirin *et al.* 2013; Chen & Cui 2015; Chen *et al.* 2015; Han *et al*. 2016). *Antrodia sensu lato* was segregated into three genera *Antrodia sensu stricto, Amyloporia* Singer, and *Fibroporia* Parmasto (Rajchenberg 2011, Spirin *et al.* 2013). Ortiz-Santana *et al.* (2013) accepted *Antrodia sensu stricto* and *Fibroporia*. However, monophily of *Amyloporia* was not supported. The distinctiveness of *Fibroporia* in *Antrodia sensu lato* was also confirmed in the studies by Chen *et al.* (2015a) and (Park *et al.* 2014).

Fomitopsidaceae is mainly characterized by annual to perennial basidiomata, poroid to daedaleoid hymenium, white, apricot, cream, tan to cinnamon or yellowish brown context, dimitic to trimitic or rarely monomitic hyphal system, hyaline to golden brown coloured generative hyphae with clamp connections, hyaline or brown skeletal hyphae, sometimes with presence of leptocystidia and pseudocystidia. Basidiospores vary in shape from ellipsoid to subglobose or cylindrical to allantoid, hyaline, thin to thick walled, smooth, inamyloid in Melzer's reagent (Núñez & Ryvarden 2001; Justo *et al*. 2017). Currently 24 genera and 197 species are recognized under the family (Soares *et al.* 2017).

Species of Fomitopsidaceae has been classified in to several groups by Zmitrovich (2018) as follows:

a) *Daedalea* group (*Brunneoporus* Audet, *Daedalea* Pers., *Neoantrodia* Audet, *Niveoporofomes* B. K. Cui, M. L. Han *et* Y. C. Dai)

b) *Fomitopsis* group (*Antrodiopsis* Audet, *Buglossoporus* Kotl. *et* Pouzar, *Cartilosoma* Kotl. *et* Pouzar, *Flavidoporia* Audet, *Fomitopsis* P. Karst.)

c) *Antrodia* group (*Antrodia* P. Karst., *Dentiporus* Audet, *Lentoporia* Audet)

d) *Amyloporia* group (*Amyloporia* Singer, *Resinoporia* Audet, *Rhodonia* Niemelä)

e) *Postia* group (*Amylocystis* Bondartsev *et.* Singer, *Dacryobolus* Fr., *Oligoporus* Bref.)

f) *Ryvardenia* group (*Gilbertsonia* Parmasto)

g) *Phaeolaceae* group (*Laetiporus* Murrill, *Phaeolus* (Pat.) Pat.)

h) Sparassidaceae/Crustoderma/Pycnoporellus clade (eg. *Pycnoporellus* Murrill)

GENUS *ANTRODIA* P. KARSTEN

Antrodia was erected by Karsten (1879). Donk (1960) designated the type of the genus as *Antrodia serpens* (Fr.) P. Karst. In 1974, Donk transferred some species of *Daedalea* (*A. albida* (Fr.) Donk, *A. heteromorpha* (Fr.) Donk) to *Antrodia*. Bondartseva (1998) placed the genus in *Corioleae*, sub family *Corioloideae* of Polyporaceae, and this was later transferred to the family Poriaceae by (Zmitrovich 2018). *Antrodia* includes brown rot polyporoid species having coriaceous to corky basidiomes, dimitic hyphal system and smooth, cylindrical to ellipsoid and inamyloid basidiospores (Ryvarden 1991; Park *et al*. 2014; Spirin *et al*. 2013a). *Antrodia* shows similarities with *Antrodiella* Ryvarden & Johans. and *Diplomitoporus* Domański, but has been separated by the type of wood decay (Park *et al.* 2014). The type species, *Antrodia serpens* has been considered in a separate complex named *Antrodia heteromorpha* species complex (currently *Antrodia sensu stricto*, Spirin *et al*. 2017) which is mainly characterized by persistent fruit bodies and large pores (Spirin *et al.* 2013). According to Spirin *et al*. (2013), taxonomic confusions existed in this complex mainly due to the erroneous usage of old species names of *Antrodia* in the earlier works especially by Fries (1815, 1818, 1821). *Antrodia sensu lato* was later segregated into three genera, *Antrodia sensu stricto, Amyloporia* Singer, and *Fibroporia* Parmasto (Rajchenberg 2011; Kim *et al.* 2001; Chiu 2007; Yu *et al*. 2010; Spirin *et al.* 2013; Spirin *et al*. 2013a).

The presence of rhizomorphic margin, generative hyphae without thickened walls (in nature or culture), uninucleate, elliposoid, slightly thick walled basidiospores, and tetrapolar mating system with normal nuclear behavior characterize *Fibroporia* (David 1988; Parmasto 1968; Rajchenberg 2011). The distinctivness of *Fibroporia* in *Antrodia sensu lato* also was supported in the molecular study by Park *et al.* (2014). Similarly, *Amyloporia* is distinguished by perennial basidiomata having a chalky consistency, generative hyphae with irregularly thickened walls, skeletal hyphae either enlarging in KOH, or becoming amyloid and heterocytic nuclear behavior (Rajchenberg 2011). The genus resolved as paraphyletic in Yu *et al*. (2010). According to Rajchenberg (2011), *Antrodia sensu stricto* consists of homothallic or bipolar species that produce generative hyphae with irregularly thickened walls, and uni to binucleate basidiospores. Based on Spirin *et al.* (2017), *Antrodia serialis* and related species that form *Antrodia serialis* group falls outside the *Antrodia sensu stricto* (represented by *A. heteromorpha* group). Cultural studies of some *Antrodia* species have been carried out by David & Dequatre (1985) and Lombard (1990).

Recent phylogenetic works treat *Antrodia* as a polyphyletic genus, usually clustered together with other brown rot genera like *Fomitopsis* P. Karst. and *Daedalea* Pers., (Kim *et al*. 2003; Yu *et al*. 2010; Rajchenberg *et al.* 2011; Bernicchia *et al*. 2012; Ortiz-Santana *et al.* 2013; Spirin *et al*. 2013, 2013a). Ortiz-Santana *et al.* (2013), accepts *Antrodia sensu stricto* and *Fibroporia,* but according to their study, monophyly of *Amyloporia* was not confirmed. In their study, *Antrodia* species nested under distinct groups such as *Antrodia sensu stricto* clade, *Antrodia serialis* group, *Antrodia malicola* group, *Antrodia pulvinascens* clade with moderate to strong support. According to Spirin *et al.* (2013), *Antrodia sensu stricto* represents a small, distinct clade of brown rot polypores in the *Antrodia* clade of Polyporales recognized by Binder *et al.* (2005). Currently, the genus is accepted under Fomitopsidaceae (Justo *et al.* 2017; Zmitrovich 2018) and 48 species are recognized (*Index Fungorum*, accessed on 30 September 2020).

` Based on the current concepts (Ryvarden & Johansen 1980; Ryvarden & Gilbertson 1993; Spirin *et al*. 2013; Audet 2017) the genus is mainly distinguished by annual to perennial, mostly resupinate to effused reflexed, hard to tough basidiomata that are more rarely pileate, white, cream to tan in colour, dimitic hyphal system, generative hyphae with clamp connections, skeletal hyphae with in amyloid or with variable amyloid reaction, that are weakly to strongly metachromatic in cresyl blue, absence of cystidia and cylindrical, allantoid to oblong ellipsoid, hyaline, thinwalled, smooth basidiospores that are inamyloid in Melzer's reagent. They occur mostly on conifers, and are less frequently on deciduous wood.

Distribution

Antrodia species have a cosmopolitan distribution. AFRICA: Cameroon (Roberts & Ryvarden 2006), Ethiopia (Ryvarden 2019), Tanzania, Usambara (Ryvarden & Johansen 1980), NORTH AMERICA: Widespread in North America (Gilbertson & Ryvarden 1987), Canada (Lowe 1966; Vlasák *et al.* 2012), Dominic Republic (Lodge *et al.* 2001), Mexico (Lowe 1966; Valenzuela *et al.* 2008), United States of America (Bishop & McGrath 1978; Kout & Vlasák 2009; Spirin *et al*. 2017). SOUTH AMERICA: Brazil (Meijer 2006; Drechsler-Santos *et al.* 2008; Reck & Silveira 2008; Leal & Gugliotta 2008; Baltazar & Gibertoni 2009; Motato-Vásquez & Gugliota 2013; Kaipper-Figueiró *et al*. 2016). ASIA: China (Núñez & Ryvarden 2001; Dai & Niemelä 2002; Dai & Penttilä 2006; Cui *et al*. 2011a; Dai 2012; Cui 2013; Chen & Wu 2017; Cui *et al.* 2019), Japan (Núñez & Ryvarden 2001; Hattori 2005), Korea (Kim *et al.* 2009; Park *et al*. 2014), Malaysia (Yamashita *et al.* 2009; Lee *et al*. 2012), Taiwan (Chang & Chou 1998, 1999) Far East Russia (Núñez & Ryvarden 2001), Russia (Spirin 2007, Spirin *et al*. 2013a). AUSTRALIA: New Zealand (Buchanan & Ryvarden 2000). EUROPE: England (Henrici & Ryvarden 1997), Fennoscandia (Ryvarden & Gilbertson 1993), Italy (Bernicchia 2001; Bernicchia & Ryvarden 2001; Bernicchia *et al.* 2007; Gorjón & Bernicchia 2009), Finland (Renvall & Niemelä 1992, Spirin *et al*. 2013, 2013a), Norway (Renvall & Niemelä 1992), Siberia (Filippova & Zmitrovich 2013), Sweden (Renvall & Niemelä 1992).

Species of *Antrodia* such as *A. albida* (Fr.) Donk, *A. gossypium* (Speg.) Ryv., *A. rhizomorpha* (Bagchee) J.R. Sharma and *A. xantha* (Fr.) Ryvarden have been reported from India (Sharma 2000; Verma *et al*. 2008; Ranadive *et al.* 2011; Prasher & Lalita 2013; Ranadive 2013; Lyngdoh & Dkhar 2014). *Antrodia albida* has been reported from Kerala by Mohanan (2011).

GENUS *DAEDALEA* PERSOON

Daedalea was established by Persoon (1801), with *Daedalea quercina* (L.) Pers as the type species. However, the genus was validly published by Fries in 1821. The genus name was used for accommodating all species that possessed sinuous, labyrinthine or daedaleoid hymenophore (Han *et al.* 2015). Following this genus concept, many taxa with analogous hymenium were described or transferred to the genus (Lindner *et al*. 2011). Generative hyphae with irregularly thickened walls, and tramal cystidia forming a distinct catahymenium characterized *Daedalea* according to Rajchenberg (1986). *Lenzites* is closely related to *Daedalea*, but the former produces moderately ephemeral basidiocarps and hyaline skeletal hyphae (Ryvarden & Johansen 1980). Similarly, distinct catahymenium and thicker dissepiments separated *Daedalea* from morphologically similar trametoid genera like *Cerrena*, *Lenzites* and *Trametes* (Ryvarden & Gilbertson 1993). Based on the molecular phylogenetic studies (Hibbett & Donoghue 1995; Binder & Hibbett 2002; Hibbett & Binder 2002), nature of hymenium was given limited taxonomic significance in distinguishing taxa among Homobasidiomycetes (Lindner *et al.* 2011). As a result and because of the availability of more morphological and chemical characters, many species which were earlier placed in *Daedalea* were transferred to other genera (Singer 1944; Donk 1966; Ryvarden 1984; Binder *et al.* 2005; Binder *et al.* 2013; Han *et al.* 2015). In most of the phylogenetic studies (Hibbett & Binder 2002; Kim *et al.* 2003; Binder *et al.* 2005; Rajchenberg 2011), the genus is positioned under the *Antrodia* clade of Polyporales. According to Binder *et al*. (2005), species with daedaleoid hymenium settled in the core polyporoid clade (*Daedaleopsis*). In the phylogentic study of Lindner *et al.* (2011), the type species of *Daedalea* settled in the *Antrodia* clade, close to other brown rot genera *Fomitopsis* and *Piptoporus.* This clade was recognized as *Antrodia sensu stricto.* Taxonomic identity of many *Daedalea* species remain unresolved (Lindner *et al*. 2011). Currently the genus is positioned under the family Fomitopsidaceae of Polyporales (Justo *et al.* 2017, Zmitrovich 2018). *Index Fungorum* database recognizes 115 species in *Daedalea* (*Index Fungorum,* accessed on 03 August 2020).

Based on the concept forwarded by Ryvarden & Johansen (1980), Gilbertson & Ryvarden (1986), Núñez & Ryvarden (2001), Lindner *et al.* (2011), Li & Cui (2013), Ryvarden & Melo (2014), Lindner *et al.* (2011), species of *Daedalea* are described by the perennial, sessile and broadly attached basidiomata, smooth to velutinate pileus surface with concentric sulcations, poroid, sinuous labyrinthine or daedaleoid or lamellate hymenium, ochraceous hymenial surface, trimitic hyphal system, thin walled generative hyphae with clamp connections, tortuous, hyaline to light yellowish brown binding hyphae with short and stout branches, skeletal hyphae forming distinct catahymenium, presence or absence of cystidia, and oblong ellipsoid to cylindrical, hyaline, thin walled basidiospores. Some tropical species produce chlamydospores. *Daedalea* species occur on hardwoods, causing brown rot.

Economic importance

The presence of a compound named quercinol in *D. quercina* provides the fungus antioxidant and anti inflammatory properties (Gebhardt *et al.* 2007; Bal *et al.* 2017). This species is also known for their *in vitro* cytotoxic and immunomodulatory activities (Doskocil *et al.* 2016). Antioxidant property is also reported in *D. dickinsii* Yasuda (Lee *et al*. 2013; Mao *et al*. 2013) and *D. dochmia* (Berk. & Broome) T. Hatt. (Ravikumar *et al.* 2016). Because of the presence of laccase enzyme, both *D. dickinsii* and *D. quercina* play a major role in biodegradation processes, and decolourization of various harmful dyes and pigments (Baldrian 2004; Rizqi & Purnomo 2017; Purnomo *et al*. 2019).

Distribution

Daedalea is a cosmopolitan genus. AFRICA: Kenya (Ryvarden & Johansen 1980). NORTH AMERICA: United States of America (Bishop & McGrath 1978; Lindner *et al.* 2011). SOUTH AMERICA: Argentina (Robledo & Rajchenberg 2007), Brazil (Drechsler-Santos *et al*. 2012; Santos *et al*. 2018) ASIA: China (Dai *et al*. 2011; Dai 2012; Li & Cui 2013; Han *et al*. 2015; Zhou *et al.* 2016), Israel (Ţura *et al*. 2010), Japan (Hattori 2005), Malaysia (Lee *et al.* 2012; Bolhassan *et al.* 2012), Sri Lanka (Berkeley & Broome 1873). AUSTRALIA: South Australia (Berkeley 1873). EUROPE: (Ryvarden & Gilbertson 1993), Italy (Bernicchia 2001).

From India, species such as *Daedalea africana* I. Johans. & Ryvarden, *D. bosei* Lloyd, D. *dickinsii* Yasuda, *D. dochmia* (Berk. & Broome) T. Hatt., *D. hobsonii* Berk., *D. quercina* (L.) Pers., *D. roseola* Lloyd and *D. subsulcata* Berk. & Broome have been recorded (Roy 1970; Bakshi 1971; Florence & Yesodharan 2000; Florence 2000; Sharma 2000; Verma *et al*. 2008; Mohanan 2011; Ranadive *et al*. 2011; Rathod 2011; Prasher & Lalita 2013; Ranadive 2013).

GENUS ***FOMITOPSIS*** P. KARSTEN

Fomitopsis P. Karst. erected by Karsten (1881), with *F. pinicola* (Sw.) P. Karst. as the type species. The genus belongs to Fomitopsidaceae of Polyporales (Jülich 1981), and includes poroid, brown rot species having a dimitic hyphal system (Gilbertson & Ryvarden 1986; Núñez & Ryvarden 2001; Ryvarden & Melo 2014; Han *et al.* 2016). Earlier classifications by Bondartsev & Singer (Bondarzew & Singer 1941; Singer 1944; Bondartsev 1953) treated the genus under tribe Fomiteae, sub family Fomitoideae of Polyporaceae, while Bondartseva (1998) considered *Fomitopsis* under Poriaceae (Zmitrovich 2018). Species of *Fomitopsis* shows similarities with *Daedalea* Pers., *Piptoporus* P. Karst. and certain species of *Antrodia* P. Karst (Han *et al*. 2016). *Daedalea sensu stricto* is distinguished from *Fomitopsis sensu stricto* in having irregularly poroid to labyrinthine/daedaleoid or sometimes lamellate to hydnoid hymenium and catahymenium made of skeletal hyphae penetrating into the hymenia. *Fomitopsis* species grow on both angiosperm and gymnosperm wood, whereas species of *Daedalea* occur only on angiosperm wood (Ryvarden & Johansen 1980; Gilbertson & Ryvarden 1986; Núñez & Ryvarden 2001; Ryvarden & Melo 2014). *Fomitopsis rosea* (Alb. & Schwein.) P. Karst and *F. cajanderi* (P. Karst.) Kotl. & Pouzar showed high similarity with species of *Daedalea sensu stricto* (Nobles 1971; Donk 1974). This was treated as a complex "*Fomitopsis rosea* complex" and its taxonomy has been studied in detail by Carranza-Morse & Gilbertson (1986).

According to the phylogenetic study carried out by Kim *et al*. (2005), the genus *Fomitopsis* proved to be heterogenous, and three sub groups, *Fomitopsis* core group, *F. rosea* group and *F. cajanderi* group are recognized. Of these, *Fomitopsis* core group included *P. betulinus* (Bull.) P. Karst. and *Daedalea quercina* (L.) Pers., *F. rosea* group, and *F. cajanderi* group included some *Antrodia* species. In the phylogenetic study by Han *et al.* (2016), *Daedalea sensu stricto* formed a clade distant from *Fomitopsis sensu stricto.* Based on morphological similarities as well as with the support of molecular data, Han *et al*. (2016) treated *Piptoporus* as a synonym of *Fomitopsis.* The study (Han *et al*. 2016) supported the placement of *P. betulina* (type species of *Piptoporus*) in *Fomitopsis sensu stricto*, which was also in accordance with the previous studies (Hibbett & Binder 2002; Binder *et al.* 2005; Garcia-Sandoval *et al*. 2011; Ortiz-Santana *et al.* 2013). According to the Han *et al.* (2016), *Fomitopsis sensu lato* was split into six genera, such as *Fragifomes* B.K. Cui, M.L. Han & Y.C. Dai, *Niveoporofome*s B.K. Cui, M.L. Han & Y.C. Dai, *Rhodofomitopsis* B.K. Cui, M.L. Han & Y.C. Dai, *Rubellofomes* B.K. Cui, M.L. Han & Y.C. Dai, *Ungulidaedalea* B.K. Cui, M.L. Han & Y.C. Dai and *Piptoporellus* B.K. Cui, M.L. Han & Y.C. Dai based on morphological and molecular evidence. Currently, *Fomitopsis sensu stricto* belongs to *Antrodia* clade of Polyporales (Binder *et al.* 2005; Rajchenberg 2011; Binder *et al*. 2013; Han *et al.* 2014; Han *et al*. 2016). At present, 31 species are recognized in the genus (*Index Fungorum,* accessed on 30 September 2020).

Based on the current concepts (Núñez & Ryvarden 2001; Ryvarden & Melo 2014; Han & Cui 2015), *Fomitopsis* is distinguished by often perennial, or annual, sessile, effused reflexed to pileate basidiomata that are tough, hymenophore mostly with small regular pores, white to tan or pink coloured pore surface, dimitic to trimitic hyphal system, generative hyphae with clamp connections, mostly without cystidia, often with thin walled cystidioles, and subglobose to cylindrical, hyaline, thin to thick walled, smooth basidiospores that are inamyloid in Melzer’s reagent. Members produce brown rot on both angiosperm and gymnosperm wood.

Economic importance

Species of *Fomitopsis* possess potential anti inflammatory, anti oxidant, anti toxic, and anti tumour effects (Choi *et al.* 2007; Onar *et al.* 2016; Gao *et al*. 2017; Gaylan *et al.* 2018; Ravikumar *et al.* 2016; Sułkowska-Ziaja *et al.* 2018). Fruit bodies of *F. pinicola* are dried and applied on wounds to stop bleeding (Rogers 2012). Some *Fomitopsis* species are used for decolourizing synthetic dyes (Freitag & Morrell 2011; Machado *et al.* 2005; Buthelezi *et al.* 2012; Sharma *et al.* 2013a; Hartikainen *et al.* 2015; Adebajo *et al.* 2017).

Distribution

Fomitopsis has a cosmopolitan distribution. AFRICA: East Africa (Ryvarden & Johansen 1980). NORTH AMERICA: United States of America (Bishop & McGrath 1978; Gilbertson & Ryvarden 1986; Lindner *et al.* 2006; Brazee *et al*. 2012). SOUTH AMERICA: Argentina (Rajchenberg 1995), Brazil (Gibertoni *et al*. 2004, 2007; Gugliotta *et al.* 2014; Gomes-Silva *et al.* 2015), Chile (Sandoval & Rajchenberg 2011). ASIA: China (Núñez & Ryvarden 2001; Dai *et al*. 2011; Dai 2012; Zhou & Wei 2012; Li *et al.* 2013; Han *et al.* 2014; Han & Cui 2015; Han *et al*. 2016), Japan (Núñez & Ryvarden 2001; Hattori 2005; Hattori 2003; Hattori & Sotome 2013), Korea (Kim *et al*. 2007), Thailand, Nepal (Ryvarden & Gilbertson 1993), West Siberia (Filippova & Zmitrovich 2013). AUSTRALIA (Carranza-Morse & Gilbertson 1986; Wright & Deschamps 1975): New Zealand (Cunningham 1948). EUROPE: Italy (Bernicchia *et al.* 2007; Bernicchia & Gorjón 2010; Ryvarden & Melo 2014), North Cape (Ryvarden & Gilbertson 1993).

Species of *Fomitopsis* such as *F. palustris* (Berk. & M.A. Curtis) Gilb. & Ryvarden, *F. officinalis* (Vill.) Bondartsev & Singer, *F. pinicola* (Sw.) P. Karst., *F. rubida* (Berk.) A. Roy & A.B.De have been reported from India (Bakshi 1971; Bose 1946, 1937; Roy 1969; Rangaswami *et al*. 1970; Florence & Yesodharan 2000; Leelavathy & Ganesh 2000; Mohanan 2011; Prasher & Lalita 2013; Ranadive 2013; Lyngdoh & Dkhar 2014).

GENUS *NEOANTRODIA* AUDET

Neoantrodia is a genus recently erected by Audet (2017), with *Neoantrodia serialis* (Fr.) as the type species. The genus was introduced to represent the *Antrodia serialis* group (*A. serialis* (Fr.) Donk, *A. serialiformis* Kout & Vlasák, *A. leucaena* Y.C. Dai & Niemelä, *A. infirma* Renvall & Niemelä, *A. primaeva* Renvall &

Niemelä and *A. variiformis* (Peck) Donk), that formed a separate clade among *Antrodia sensu lato* (Ortiz-Santana *et al.* 2013; Spirin *et al*. 2013). In the phylogenetic study conducted by Han *et al.* (2016) and Spirin *et al.* (2017), *A. serialis* group formed a lineage distinct from the *Antrodia sensu stricto* clade (represented by *A. heteromorpha* group). The genus *Neoantrodia* accommodated all the species belonging to this group and some related *Antrodia* species. Currently, the genus holds 13 species (*Index Fungorum*, accessed on 30 September 2020).

According to Audet (2017), *Neoantrodia* is distinguished from *Antrodia sensu stricto* by non metachromatic reaction of hyphae, smaller, long living pedunculate basidia, often with cystidioles having encrustations at its apex, and uninucleated basidiospores. The species occur both on angiosperm and gymnosperm wood, causing brown rot.

Distribution

The genus has a wide distribution. AFRICA: Kenya, Nigeria (Ryvarden & Johansen 1980. NORTH AMERICA (Zhou *et al.* 2016), United States of America (Lowe 1966; Bishop & McGrath 1978, Brazee *et al.* 2012). SOUTH AMERICA: Argentina (Robledo & Rajchenberg 2007). ASIA: China (Dai 2012; Núñez & Ryvarden 2001), Japan, Korea (Núñez & Ryvarden 2001), Malaysia (Urbizu *et al.* 2014), West Siberia (Filippova & Zmitrovich 2013). EUROPE (Ryvarden & Gilbertson 1993), Italy (Bernicchia 2001).

Neoantrodia serialis has been reported from India (Bakshi *et al*. 1970; Bakshi 1971; Mohanan 2011; Ranadive 2013; Prasher & Lalita 2013).

GENUS ***PILATOPORUS*** KOTLABA & POUZAR

Pilatoporus was described by Koltlaba and Pouzar in 1990, with *F. palustris* (Berk. & M.A. Curtis) Kotl. & Pouzar as the type species. The genus was erected for accommodating some *Fomitopsis* species that produced thin walled basidiospores, in contrast to the thick walled spores of the type species of *Fomitopsis* (Kotlaba & Pouzar 1990). According to Kotlaba & Pouzar (1990), closely related *Laricifomes* Kotl. & Pouzar differs from *Pilatoporus* in having typically inflated skeletal hyphae.

Based on Kotlaba & Pouzar (1990), the genus is characterized by annual, sessile to dimidiate, tough to hard basidiomata, fibrous or rough pileus surface, poroid hymenium with round pores, white context, trimitic hyphal system with clamped generative hyphae, absence of cystidia, and cylindrical, hyaline, thin walled, smooth basidiospores that are inamyloid and acyanophilous.

However, recent phylogenetic studies do not treat *Pilatoporus* as an independent genus (Kim *et al.* 2005, 2007; Han *et al.* 2016), since the type species of *Pilatoporus* settled under *Fomitopsis sensu stricto.* At present, genera *Pilatoporus* and *Laricifomes* have been synonymised under *Fomitopsis* (*Index Fungorum*, accessed on 30 September 2020). However, currently, six species are listed under *Pilatoporus*, according to *Index Fungorum* database (accessed on 30 September 2020).

Distribution

Pilatoporus species have been recorded from different parts of the world. AFRICA: North Africa (Kotlába & Pouzar 1993). NORTH AMERICA (Lowe 1975; Overholts 1941; Gilbertson & Ryvarden 1986). ASIA: China (Li *et al.* 2013), Philippines (Berkeley 1877), Thailand (Rungjindamai *et al.* 2008). AUSTRALIA: New Zealand (Hooker 1855; Cunningham 1965). EUROPE: France (Welti *et al*. 2012).

Pilatoporus ostreiformis (Berk.) Zmitr. has been reported from India by Florence & Yesodharan (2000), Ranadive (2013) (as *Polyporus ostreiformis* Berk.).

GENUS ***RHODOFOMITOPSIS*** B.K. CUI, M.L. HAN & Y.C. DAI

Rhodofomitopsis B.K. Cui, M.L. Han & Y.C. Dai is a genus recently established by Cui, Han and Dai (Han *et al.* 2016), with *R. feei* (Fr.) as the type species. The genus differs from *Fomitopisis sensu stricto* in having hymenophore with circular to angular, labyrinthiform, daedaleoid to sinuous daedaleoid pores, pink, viole or pinkish brown pore surface and context, and by the absence of cystidia and cystidioles (Han *et al.* 2016; Soares *et al*. 2017). Molecular phylogenetic studies by Kim *et al*. (2001, 2003) and Li *et al*. (2013) also had previously supported the placement of species belonging to this genus as distinct from *Fomitopsis sensu stricto*. The latest classifications (Justo *et al*. 2017; Zmitrovich 2018) also accept *Rhodofomitopsis* a distinct genus from *Fomitopsis*. At present, *Rhodofomitopsis* consists of five species, *Rhodofomitopsis africana* (Mossebo & Ryvarden) B.K. Cui, M.L. Han & Y.C. Dai, *R. cupreorosea* (Berk.) B.K. Cui, M.L. Han & Y.C. Dai, *R. feei* (Fr.) B.K. Cui, M.L. Han & Y.C. Dai, *R. lilacinogilva* (Berk.) B.K. Cui, M.L. Han & Y.C. Dai and *R. roseomagna* Nogueira-Melo, A.M.S. Soares & Gibertoni (*Index Fungorum*, accessed on 30 September 2020).

According to Han *et al.* (2016), members belonging to the genus are mainly characterized by annual to perennial, often sessile, leathery to woody hard basidiocarps, velutinate to glabrous pileus with straw, tan, brownish pink, rosy brown to blackish brown colours, mostly sulcate, poroid to weakly labyrinthiform, sub daedaleoid to sinuous daedaleoid hymenium that are rose, lilac, violaceous, pinkish-brown or dirty brown in colour, rose to pinkish brown context, dimitic hyphal system with clamped generative hyphae, absence of cystidia or cystidioles, and cylindrical to ellipsoid or navicular, hyaline, thin walled, smooth, basidiospores that are acyanophilous and negative in Melzer's reagent. Species occur on angiosperm wood and cause a brown rot.

Economic importance

Rhodofomitopsis feei can be considered as a potential medicinal mushroom since they shows anti bacterial, anti fungal, antioxidant and enzymatic activities (Rashid 2010; Nidadavolu *et al.* 2013; Nidadavolu & Charya 2017). Polyscaccharide present in *Rhodofomitopsis feei* is capable of decolourizing synthetic dyes (Nidadavolu *et al.* 2013).

Distribution

Rhodofomitopsis species have widespread distribution. AFRICA: Cameroon (Mossebo & Ryvarden 1997), East Africa (Ryvarden & Johansen 1980), NORTH AMERICA (Gilbertson & Ryvarden 1986; Zhou *et al.* 2016), Cuba (Carranza-Morse

& Gilbertson 1986). SOUTH AMERICA: Argentinean Yunags (Robledo & Rajchenberg 2007), Brazil (Drechsler-Santos *et al.* 2008; Salvador-Montoya *et al.* 2012; Soares *et al*. 2017). ASIA: China (Núñez & Ryvarden 2001, Dai *et al.* 2011; Dai 2012; Lee *et al.* 2012; Han *et al.* 2016), Japan (Núñez & Ryvarden 2001), Malay Peninsula (Corner 1989), Malaysia (Yamashita *et al.* 2009), Thailand (Carranza-Morse & Gilbertson 1986), Vietnam (Núñez & Ryvarden 2001). AUSTRALIA (Carranza-Morse & Gilbertson 1986). EUROPE: Finland (Ryvarden & Gilbertson 1993; Ryvarden & Melo 2014), Italy (Bernicchia 2005), Norway (Ryvarden & Gilbertson 1993).

Rhodofomitopsis feei (Fr.) B.K. Cui, M.L. Han & Y.C. Dai has been reported from India by Bose (1937), Bakshi (1971), Leelavathy & Ganesh (2000), Florence (2004), Mohanan (2011), Nagadesi & Arya (2012), Nagadesi *et al.* (2014), Nidadavolu *et al.* (2013), Ranadive *et al*. (2013), Krishna *et al.* (2015).

GENUS ***RUBELLOFOMES*** B.K. CUI, M.L. HAN & Y.C. DAI

Rubellofomes B.K. Cui, M.L. Han & Y.C. Dai is a genus recently erected by Cui, Han & Dai (2016) for accommodating two polypore species which were previously included in the genus *Fomitopsis* P. Karst. The distinguishing feature of this genus (from *Fomitopsis sensu stricto*), is the purple pink to light pinkish brown context. *Fomitopsis sensu stricto* always produced white to greyish or straw coloured context (Han *et al.* 2016). According to the phylogenetic study conducted by Han *et al*. (2016), species such as *F. cystidiata* and *F. minutispora*, together formed a moderately supported lineage, which was distinct from *Fomitopsis sensu sricto*. Genus *Rubellofomes* was raised to accommodate these two species. Species of *Antrodia serialis* group and *Niveoporofomes* B.K. Cui, M.L. Han & Y.C. Dai are related to *Rubellofomes* (Han *et al.* 2016). The closely related *Niveoporofomes* is distinguished by white to light ochraceous pileal surface and context, and broadly ellipsoid to ovoid basidiospores. *Rubellofomes* produces orange brown to dark brown pileal surface, purple pink to light pinkish brown context and cylindrical to ellipsoid basidiospores. Members of *Antrodia serialis* group generally produces resupinate to effused reflexed basidiomata, white to brown colored context, and mostly grows on gymnosperm wood (Núñez & Ryvarden 2001; Ryvarden & Melo 2014). *Rubellofomes* species never grow on gymnosperm wood. *Ungulidaedalea* B.K. Cui, M.L. Han & Y.C. Dai is also similar to *Rubellofomes*, however, *Unguidaedalea* produces ungulate, fragile fruit bodies and highly septate skeletal hyphae, characters which are absent in the latter. The genus has been currently accepted under Fomitopsodaceae of Polyporales (Zmitrovich 2018). To date, the genus *Rubellofomes* contains only two species, *R. cystidiatus* and *R. minutisporus* (*Index Fungorum*, accessed on 30 September 2020).

The genus is characterised by annual to perennial, resupinate to pileate fruit bodies, orange brown to dark brown, glabrous, often concentrically strongly zonate and sulcate pileus, purple pink to light pinkish brown context, poroid, white to cream or purple pink hymenophore that turn straw yellow to cinnamon brown on drying, dimitic hyphal system with clamped generative hyphae, colourless to pale brown skeletal hyphae, presence or absence of cystidia and cylindrical to ellipsoid, hyaline, thin walled, inamyloid basidiospores. Species cause brown rot on angiosperm wood (Han *et al.* 2014, 2016)

Economic importance

Being a brown rot fungi, *Rubellofomes* is capable of causing considerable harm to living trees (Rajchenberg 1995, 2006; Sandoval & Rajchenberg 2011). So far there are no reports on any kind of medicinal importance or other commercial applications of the genus.

Distribution

So far, *Rubellofomes* species have only been reported from China and South America (Sandoval & Rajchenberg 2011; Han *et al.* 2014).

2.1.4.1.3. **Gelatoporiaceae** Miettinen, Justo & Hibbett

Gelatoporiaceae is a family recently established by Justo *et al.* (2017), for representing the "*Cinereomyces* clade" which was introduced by Miettinen & Rajchenberg (2012), for accommodating those white rot species, whose position under Polyporales were uncertain. The study by Binder *et al.* (2013) also recognized this as a clade, distinct from Polyporaceae. *Gelatoporia* Niemelä is accepted as the type of the family (Justo *et al.* 2017).

Gelatoporiaceae is characterized by resupinate basidiomata, poroid hymenium, monomitc to rarely dimitic hyphal system, hyphae with clamp connections, absence of cystidia, sometimes with characteristic cystidioles and, cylindrical to allantoid, hyaline, thin walled or slightly thick walled basidiospores. The group exhibits heterothallic, bipolar or tetrapolar mating system and astatocoenocytic nuclear behavior.

Justo *et al.* (2017) accepts four genera under the family. They are *Cinereomyces* Jülich, *Gelatoporia* Niemelä, *Obba* Miettinen & Rajchenb. and *Sebipora* Miettinen. In addition to these, Zmitrovich (2018) included the genera *Auriporia* Ryvarden, *Cinereomycetella* Zmitr. and *Mycoleptodonoides* Nikol. under Gelatoporiaceae. However, *Cinereomycetella* is currently positioned under the family Polyporaceae, and family level of *Auriporia* and *Mycoleptodonoides* are uncertain (*Index Fungorum*, accessed on 04 August 2020).

GENUS *SEBIPORA* MIETTINEN

Genus *Sebipora* was established recently by Miettinan (Miettinan & Rajchenberg 2012), with *S. aquosa* Miettinen as the type species. Major characteristics of the genus are annual, mostly watery, resupinate to pileate basidiomata, with a rubber like consistency, glabrous, azonate pileus that are white in colour when fresh and cream, grey to brownish when dry, poroid hymenium with round to angular pores, white, homogenous context, monomitic hyphal system with clamped generative hyphae, either encrusted or not and cylindrical, slightly bent, hyaline, thin walled basidiospores that are usually guttulate and inamyloid in Melzer's reagent (Miettinan & Rajchenberg 2012). The genus is closely related with *T. chioneus*, the type of the genus *Tyromyces sensu stricto* (T. (Fr.) P. Karst.) by having infrequently enrusted hyphae that are metachromatic in cresyl blue, inamyloid in Melzer's reagent and cylindrical, guttulate basidiospores. However, the former produces a dimitic hyphal system in mature fruitbodies and their contextual hyphae possess thick walled, finger like projections, characters that are absent in *Sebipora*.

Phylogenetically, *Sebipora* belongs to the *Cinereomyces* clade of Polyporales. Currently, the genus consists of single species, *S. aquosa* (*Index Fungorum*, accessed on 30 September 2020).

Distribution

Sebipora has been described from Indonesia, New Guinea and China (Miettinen & Rajchenberg 2012; Glen *et al.* 2014; Zhao *et al.* 2017).

2.1.4.1.4. **Incrustoporiaceae** Jülich

The family consists of annual, wood inhabiting, polyporoid species with white context. They are mainly characterized dimitic, more rarely monomitic hyphal system, clamped generative hyphae, deliquescent skeletal hyphae and pseudoskeletal hyphae, absent of cystidia, but sometimes generative hyphae at pore tubes with thorn like encrustation, and cylindrical to allantoid, thinwalled, smooth, inamyloid basidiospores. Members of the group cause white rot on wood (Justo *et al.* 2017; Zmitrovich 2018). The group consists of genera such as *Gloeoporellus* Zmitr., *Incrustoporia* Domański, *Piloporia* Niemelä, *Skeletocutis* Kotl. & Pouzar, *Tyromyces* P. Karst.

GENUS *TYROMYCES* P. KARTSEN

Tyromyces was erected by Karsten in 1881. Murrill (1903) considered *Polyporus chioneus* Fr. as the lectotype of the genus. Bondartseva (1998) treated the genus under the sub family *Tyromycetoideae* of family Poriaceae. Later, *Tyromyces* was placed in the family Corioloaceae, and included pileate, short lived, brightly coloured basidiocarps, having white context and monomitic hyphal system with clamped generative hyphae (Yao *et al.* 1999; Spirin 2001). The genus was accepted by many workers (Donk 1960, 1974; Cunningham 1965, Domanski *et al*. 1967, Pegler 1973, 1973a; Ryvarden & Johansen 1980). The type of *Tyromyces* was a white rot causing species, whereas, most of the other species earlier placed under the genus (*sensu lato*) caused brown rot on the host. Based on the view of Gilbertson (1980, 1981), type of the wood decay had a significant taxonomic value in species delimitation of all fungi, *Tyromyces sensu lato* was split into different genera (Yao *et al.* 1999). As a result, *Tyromyces sensu stricto* contained only white rot species and the rest of the brown rot species were transferred to *Postia*, *Oligoporus* or *Spongiporus*. According to Teston (1953), generative hyphae of most *Tyromyces* species showed metachromatic reaction in cresyl blue. Genus *Ceriporiopsis* Domański is closely related to *Tyromyces* in having similar morphological characters, and was separated mainly based on the resupinate nature of basidioarps of the former (Ryvarden & Gilbertson 1994).

Based on the molecular phylogenetic study of Yao *et al.* (1999), *Tyromyces sensu lato* was found as an artificial genus consisting of many distantly related species. In the phylogenetic study of Binder *et al*. (2013), species in the *Tyromyces* clade were intermixed among species in the *Phlebioid* clade (white rot members) and *Antrodia* clade (brown rot members). Currently, *Tyromyces* is positioned under family Incrustoporiaceae in the *Index Fungorum* database, with 143 species (*Index Fungorum*, accessed on 29 July 2020).

Based on the current concept (Ryvarden & Johansen 1980; Ryvarden & Gilbertson 1994; Núñez & Ryvarden 2001; Spirin 2001), *Tyromyces* is characterized by annual, resupinate to pileate short lived basidiomata, which are usually sappy when fresh, shrinking when dry, tomentose to smooth, often white or brightly coloured pileus, white to light brown context that are soft in consistency when fresh, hard on drying, round to angular pores, monomitic to dimitic hyphal system, clamped generative hyphae, sometimes with few binding hyphae, presence or absence of cystidia and allantoid, cylindrical to ellipsoid, hyaline, smooth, basidiospores that are thin walled, and inamyloid to weakly amyloid in Melzer’s reagent. Some species posseses gloeopherous hyphae. Members cause white rot on wood.

Economic importance

A sesquiterpene isolated from *T. chioneus* posseses anti HIV activity (Liu *et al*. 2007; Pathania & Chander 2018). Cytotoxicity and antimicrobial activity have been reported from the secondary metabolites of *Tyromyces leucomallus* Murrill (Ziegenbein *et al.* 2006).

Distribution

Tyromyces species have a cosmopolitan distribution. AFRICA (Ryvarden & Johansen 1980), Cameroon (Robertz & Ryvarden 2006). NORTH AMERICA (Gilbertson & Ryvarden 1987). SOUTH AMERICA: Brazil (Drechsler-Santos *et al*. 2008; Westalphen *et al*. 2010a; Westphalen & Silveira 2013), Guyana (Aime *et al*. 2003). ASIA: China, Far East Russia, Japan, North Thailand (Núñez & Ryvarden 2001; Dai *et al*. 2011; Dai 2012), Malaysia (Lee *et al*. 2012), Singapore (Corner 1992). AUSTRALIA (Ryvarden *et al*. 2006). EUROPE: Italy (Bernicchia 1991; 2005).

Tyromyces chioneus (Fr.) P. Karst., *T. lacteus* (Fr.) Murrill and *T. leucospongius* (Cooke & Harkn.) Bondartsev & Singer have been reported from India (Ranadive 2013; Pathian & Chander 2018).

2.1.4.1.5. **Irpicaceae** Spirin & Zmitr.

Irpicaceae was established by Spirin & Zmitrovich (in Spirin 2003), with *Irpex* Fr. as the type genus. The family consists of both corticioid and polyporoid species, characterized by monomitic to rarely dimitic hyphal system, mostly without clamp connections, often without cystidia, and ellipsoid to cylindrical, hyaline, smooth, thin walled basidiospores. The family consists of 12 genera, *Byssomerulius* Parmasto, *Ceriporia* Donk, *Cytidiella* Pouzar, *Efibula* Sheng H. Wu, *Emmia* Zmitr., Spirin & Malysheva, *Flavodon* Ryvarden, *Gloeoporus* Mont., *Hydnopolyporus* D.A. Reid, *Irpex* Fr., *Leptoporus* Quél, *Meruliopsis* Bondartseva, and *Trametopsis* Tomšovský.

In the phylogenetic study of Justo *et al.* (2017), Irpicaceae formed a distinct lineage in Polyporales.

GENUS *FLAVODON* RYVARDEN

Flavodon was established by Ryvarden in 1973, with *Flavodon flavus* (Klotzsch) Ryvarden (=*Irpex flavus* Klotzsch), as the type species. *Flavodon* was separated from *Irpex* Fr. by the yellowish colour of the fruit bodies, and the reddish to brownish colour change in KOH (Maas Geesteranus 1967; Ryvarden & Johansen 1980). The genus was characterized by resupinate to pileate basidiomata, poroid hymenium in effused forms which becomes hydnoid with age, dimitic hyphal system and slightly ellipsoid, hyaline basidiospores (Maas Geesteranus 1967). Corner (1987) transferred a monomitic species, *Polyporus cervinogilvus* Jungh. to *Flavodon*, and proposed the name "*Flavodon cervinogilvus*" (Jungh.) Corner. However, the latter name was invalidated because, the basionym of the same was not referred (Kirk *et al*. 2008; Simmons *et al*. 2016). Ryvarden & Johansen (1980) considered *Flavodon* as a tropical complement of the temperate boreal genus *Irpex sensu stricto.* The genus consisted of only a single species *F. flavus* until the recent publication of another species *Flavodon ambrosius* D.R. Simmons, You Li, C.C. Bateman & Hulcr, a mycosymbiont of Ambrosia beetles that produced arthroconidia (Li *et al.* 2015a; Simmons *et al.* 2016). In the opinion of Simmons *et al.* (2016), another arthroconidia producing species *Emmia latemarginata* (Durieu & Mont.) Zmitr., Spirin & Malysheva that formed a monophyletic clade with *F. flavus* (Zmitrovich & Malysheva 2014) could also be transferred to the genus *Flavodon*. In the phylogenetic analysis of Polyporales using ribosomal and protein coding DNA, *Flavodon flavus* settled in a lineage with *Irpex lacteus* Fr. (Miettinen *et al.* 2012). Currently, the genus contains only two species, such as *F. flavus* and *F. ambrosius* (*Index Fungorum,* accessed on 01 October 2020).

Major features of the genus are annual, resupinate to pileate basidiomata that turns reddish to brown in KOH, adpressed tomentose pileus, yellowish to ochraceous grey coloured pileus surface, poroid to hydnoid or irpicoid hymenium, bright sulphurous yellow context, dimitic hyphal system with simple septate generative hyphae, presence of smooth or encrusted cystidia arising from the ends of skeletal hyphae and broadly ellipsoid, smooth, hyaline and inamyloid basidiospores. Members grow on deciduous wood. The genus cause white rot on wood (Ryvarden & Johansen 1980; Simmons *et al.* 2016).

Economic importance

Based on the study by Fernando *et al.* (2016), *F. flavus* possesses strong antioxidant activity against radical mediated toxicity. According to Fernando *et al.* (2016), polyphenolic metabolites present in *F. flavus* has potential free radical scavenging effect. Presence of compounds such as flavodonfuran with tremulinolide in *F. flavus* provides the fungus antibacterial and antifungal activities against *Staphylococcus aureus* and *Cryptococcus neoformans* respectively (Klaiklay *et al.* 2013). Lignolytic and lignocellulosic enzymes isolated from *F. flavus* are used in the degradation of aromatic pollutants and decolorization of synthetic dyes (Padhiar *et al*. 2010; Mtui & Nakamura 2008; Raghukumar 2000). *Flavodon flavus* from marine habitat is reported to be effective in decolorizing brown colored pigments from the effluents of molasses based alcohol distilleries and remove their toxicity (Raghukumar & Rivonkar 2001; Raghukumar *et al.* 2004). Dye industry also uses this species for the extraction of yellow pigments. (http://indiasendangered.com/researchers-find-thousands-of-fungi-species-insinghadforests/).

Distribution

Flavadon has a tropical to subtropical distribution. AFRICA: Tropical Africa to south Africa (Ryvarden & Johansen 1980), Tanzania (Mtui & Nakamura 2008). NORTH AMERICA (Klotzsch 1833), Florida (Simmons *et al*. 2016). ASIA: China (Dai *et al.* 2011; Dai 2012), Pakistan, Philippines (Ryvarden & Johansen 1982), Thailand (Choeyklin *et al.* 2009), Malaysia (Corner 1987; Lee *et al.* 2012): EUROPE: Italy (Bernicchia 2005). AUSTRALIA: Ryvarden & Johansen (1980), New Zealand (Cunningham 1965).

Flavodon flavus has been reported from India by Bakshi (1971), Roy (1981), Sankaran & Florence (1995), Florence & Yesodharan (1997, 2000), Florence (2000), Verma *et al.* (2008), Ranadive (2013), Raghukumar *et al.* (1999), Sharma (2000), Ranadive *et al*. (2011), Prasher & Lalita (2013), Padhiar *et al.* (2010) and Saha *et al.* (2018).

GENUS ***IRPEX*** FRIES

The genus *Irpex* Fr., typified by *Irpex lacteus* Fr. was established by Fries (1825) for placing all basidiomycetes having a hydnoid hymenium with effused reflexed basidiome (Ryvarden & Gilbertson 1993). Bondartsev and Singer in their classifications on polyporaceous fungi (Bondarzew & Singer 1941; Singer 1944; Bondartsev 1953) placed the genus under tribe *Oxyporeae*, sub family *Corioloideae* of Polyporaceae (Zmitrovich 2018). Parmasto (1968) treated this genus together with closely related *Steccherinum* Gray and *Chaetoporus* P. Karst. (currently synonymised under *Junghuhnia* Corda, Kirk *et al.* 2008) under sub family *Steccherinoideae* of family Steccherinaceae. Generic delimitation and taxonomy of *Irpex* and *Steccherinum* was studied in detail by Mass-Geesteranus (1974). In this work, *Irpex* was considered as a monotypic genus and many species were excluded. Ryvarden (1991) and Niemelä (2005) later included few species in the genus (Miettinen *et al*. 2007). However, more species were considered in the genus by different workers (Kotiranta & Saarenoksa 2002; Lim & Jung 2003; Miettinen *et al*. 2007; Lee *et al.* 2008). Kotiranta & Saarenoksa (2002) placed a majority of *Steccherinum* species and *Junghuhn*ia species in *Irpex*. According to Bernnichia & Gorjón (2010), *Irpex* species produce fruitbodies often with irregularly irpicoid hymenium, whereas in species of *Steccherinum*, hymenium is distinctly dentate. Another feature that distinguishes *Irpex* and *Steccherinum* is the presence of clamped generative hyphae in most *Steccherinum* species, and its absence in the former (Ryvarden & Gilbertson 1993; Bernicchia & Gorjón (2010).

In the phylogenetic analysis by Larsson (2007), species of *Irpex* and *Steccherinum* were positioned under two different clades of Polyporaceae. According to Binder *et al*. (2005, 2013), Hibbett *et al.* (2014) and Justo *et al*. (2017), *Irpex* belongs to the phlebioid clade of Polyporales. Phylogenetic study by Justo *et al.* (2017) placed *Irpex* in the family Irpicaceae. However, Kirk *et al*. (2008) and Zmitrovich (2018) treats this genus in a separate "*Byssomerulius* group" under the family Meruliaceae. Currently, *Irpex* holds 101 species (*Index Fungorum*, accessed on 30 September 2020).

According to the current concept (Corner 1987; Ryvarden & Gilbertson 1993; Núñez & Ryvarden 2001; Bernnicchia 2005; Bernnicchia & Gorjón 2010), species of *Irpex* are characterized by annual, sessile, effused reflexed, or resupinate, poroid to hydnoid basidiomata, mostly with irpicoid hymenium, tomentose to hirsute, light coloured pileus, dimitic hyphal system with simple septate generative hyhae, presence of thick-walled, encrusted cystidia and smooth, cylindric, thin walled basidiospores. Members cause white rot on angiosperm wood, rarely found on conifers.

Infrageneric classification

Fries (1828) treated species of *Irpex* under two tribes, Tribe I. *Apus* and Tribe II. *Resupinatus*. The tribe *Apus* was characterized by sessile to dimidiate basidiocarps with definite margins, and hydnoid hymenium, with parallelly arranged spines, that are seldom sinuous. The Tribe *Resupinatus* consisted of resupinate basidiocarps with indefinite margin, and hymenium with reticulately arranged spines.

Economic importance

Irpex lacteus has been consumed as medicine for many years in China against inflammation, bacterial and fungal infections and urinary problems (Chen *et al.* 2018). Varoius kinds of terpinoids and biologically active metabolites have been extracted from *I. lacteus* (Silberborth *et al.* 2000; Chaudhary & Tripathy 2015; Chen *et al.* 2018; Tang *et al*. 2018). Another species, *I. hydnoides* Y.W. Lim & H.S. Jung also possesses cytotoxic effects (Bhimba *et al*. 2011). According to Hayashi *et al.* (1981), *I. lacteus* has the ability to produce nematocidal metabolites. *Irpex lacteus* has industrial applications in proteinase and cellulase production, lignin degradation and decolourization of synthetic dyes of textile effluents (Kanda *et al*. 1978; Norris 1980; Kobayashi *et al*. 1992; Capelari & Zadrazil 1997; Tanaka 1999; Novotný *et al.* 2000, 2001; Kasinath *et al.* 2003; Novotný *et al.* 2004; Shin 2004; Shin *et al*. 2005; Tavčar *et al.* 2006; Casieri *et al*. 2008; Malachová *et al.* 2006; Choi *et al*. 2013; Qin *et al*. 2014; Yang *et al.* 2016a). *Irpex lacteus* can increase sugar revival from wheat straw, which is a good substrate for worldwide ethanol production (Salvachúa *et al.* 2012) and also reported to increase saccharification of corn stover (Xu *et al.* 2010; Brethauer *et al*. 2017). This species is also used in bioremediation of water, soil and other organic pollutants (Leštan & Lamar 1996; Lee *et al.* 2009; Novotný *et al.* 2000, 2009). Since *I. lacteus* has the ability to produce white rot on wood, this species has been suggested for checking the quality of chemical and biological wood preservatives (Eberhardt *et al.* 1994; Nzokou *et al.* 2005; Yang *et al.* 2004a, 2007). *I. lacteus* is also known to cause pulmonary fungal infection in humans (Buzina *et al*. 2005).

Distribution

Species of *Irpex* has a cosmopolitan distribution (Ryvarden 1991). AFRICA. NORTH AMERICA (Overholts 1953; Gilbertson & Ryvarden 1986; Murrill 1905; Nakasone 1990; Zhou *et al.* 2016), Canada (Buzina *et al.* 2005), Mexico (Mass-Geesteranus 1974), United States of America (Lindner *et al.* 2006, Brazee *et al.* 2012). SOUTH AMERICA: Argentinean Yungas (Robledo & Rajchenberg 2007), Brazil (Rick 1959; Gibertoni *et al.* 2004; Westphalen & Silveira 2013). ASIA: China (Núñez & Ryvarden 2001; Dai *et al*. 2011; Dai 2012), Japan (Núñez & Ryvarden 2001; Hattori 2005), Korea (Lim & Jung 2003; Kim *et al*. 2009), Malaysia (Lee *et al*. 2012), Sri Lanka (Petch 1909), Taiwan (Núñez & Ryvarden 2001), Thailand (Choeyklin *et al*. 2009). EUROPE: Austria (Buzina *et al.* 2005), Italy (Bernicchia 2001; Bernnicchia 2005, Bernicchia & Gorjón 2010), Finland (Ahti *et al.* 1968), Norway (Miettinen *et al*. 2007), Sweden (Ryvarden & Gilbertson 1993).

Species such as *Irpex canescens* Fr., *I. consors* Berk., *I. destruens* Petch, *I. lacteus* (Fr.) Fr. and *I. vellereus* Berk. & Broome have been reported from India

(Bakshi 1971; Roy 1981; Sharma 2000; Florence 2004; Mohanan 2011; Prasher *et al.* 2012; Prasher & Lalitha 2013; Ranadive 2013; Lyngdoh & Dkhar 2014).

2.1.4.1.6. **Meripilaceae** Jülich

Family Meripilaceae was erected by Jülich in 1981 with *Meripilus* P. Karst. as the type species. The family is characterized by monomitic, rarely dimitic hyphal system, hyphae lacking clamp connections, mostly with presence of cystidia, and subglobose, hyaline, smooth, thin walled to slightly thick walled basidiospores. Members of the group cause white rot on host. Family Rigidoporaceae Murrill has been considered as a synonym of Meripilaceae. Meripilaceae holds two genera, *Physisporinus* P. Karst. and *Rigidoporus* Murrill (Justo *et al*. 2017).

The family belongs to the residual polyporoid clade of Polyporales (Binder *et al*. 2013; Justo *et al*. 2017).

GENUS *RIGIDOPORUS* MURRILL

Genus *Rigidoporus* was erected by Murrill in 1905 under the family Polyporaceae with *Rigidoporus micromegas* (Mont.) Murrill as the type species. Bondartseva (1983) treated this genus under the family Caloporaceae, and Bondartseva (1998) placed the genus under Rigidoporaceae Jülich. According to Ryvarden (1991), presence of mammillate cystidioles is a major distinguishing feature of the genus. Genus *Oxyporus* (Bourdot & Galzin) Donk. is very close to *Rigidoporus* in many microscopic characters, but is separated by the presence of soft, white to cream basidiocarps, and absence of mammillate cystidioles (Westphalen & Silveira 2012). *Physisporinus* P. Karst. is also closely related to *Rigidoporus*, but the annual, thin and soft basidiomata, and absence of cystidia differentiate *Physisporinus* from the latter (Gilbertson & Ryvarden 1987; Dai 1998; Niemelä 2005; Ryvarden & Melo 2014; Wu *et al*. 2017a). Similar genus *Leucophellinus* Bondartsev & Singer is distinguished from *Rigidoporus* by the presence of thick walled basidiospores.

Based on the phylogenetic studies carried out by Wagner & Fischer (2002), Larsson *et al.* (2006) and Miettinen *et al.* (2012), some species of *Rigidoporus* and *Oxyporus* clustered in the order *Hymenochaetales*, while majority of *Rigidoporus* species settled in the order *Polyporales*. According to the phylogenetic study of *Rigidoporus* and related genera conducted by Wu *et al.* (2017a), *Rigidoporus* is polyphyletic in origin. Wu *et al.* (2017a) treated *Rigidoporus* and *Oxyporus* as synonyms, because the type species of both the genera belonged to a single clade in *Hymenochaetales,* and therefore majority of *Oxyporus* species were transferred to *Rigidoporus.* Polyphyletic nature of the genus *Rigidoporus* has been confirmed by the latest phylogenetic study on *Polyporales* (Justo *et al.* 2017). Justo *et al.* (2017) treats *R. lineatus* (Pers.) Ryvarden and related species in the family *Meripilaceae* and *R. vinctus* (Berk.) Ryvarden and related taxa in the family *Cerrenaceae* under Polyporales. Currently 51 species are recognized in the genus (*Index Fungorum*, accessed on 01 October 2020).

Based on the current concepts (Ryvarden & Johansen 1980; Gilbertson & Ryvarden 1987; Silveira & Guerrero 1989; Ryvarden 1991; Ryvarden & Gilbertson 1994; Dai 1998; Nuñez & Ryvarden 2001; Cui *et al.* 2009; Westphalen & Silveira 2012; Gomes-Silva *et al.* 2014), the genus *Rigidoporus* is distinguished by annual or perennial, resupinate to pileate basidiomata with reddish orange to pinkish or pale ochraceous colour, monomitic to pseudodimitic hyphal system, presence or absence of cystidia, or mammilliform cystidioles, and inamyloid, ellipsoid to globose basidiospores, which are hyaline and thin walled. They cause white rot on wood on angiosperm wood, sometimes parasitic, and exceptionally occur on coniferous wood.

Economic importance

Rigidoporus ulmarius have been used as a medicinal mushroom in Asia (Cheng *et al.* 2009). This fungus is known for their edibility and medicinal value (Chao *et al.* 2011), including anti inflammatory properties (Cheng *et al.* 2009), and regulation of angiogenesis (Ganesan & Xu 2000; Chen *et al.* 2005a). Cheng *et al.* (2009) suggested the use of *R. ulmarius* as a potential food supplement as well as medicine. *Rigidoporus* species also have industrial applications in the decolourization of synthetic dyes (Nicole *et al.* 1992; Cambria *et al.* 2008; Li *et al*. 2009; Sudha *et al*. 2014; Cheng *et al.* 2016; Munir *et al.* 2017). *Rigidoporus microporus* (Sw.) Overeem is considered as a serious pathogen of *Hevea brasiliensis* Muell. Arg. (Peries 1969; Jayasinghe *et al.* 1995; Jayasuriya & Deacon 1995; Jayasuriya 1996; Jayasuriya & Deacon 1996; Jayasuriya *et al.* 1996, 1996a; Jayasuriya & Thennakoon 2007; Kaewchai & Soytong 2010; Fernando *et al.* 2012; Zaini & Halimoon 2013; Oghenekaro *et al*. 2014; Oghenekaro *et al.* 2015) and *Artocarpus nobilis* (Madushani *et al.* 2013) causing white rot. *Rigidoporus populinus* (Schumach.) Pouzar is also reported as a forest pathogen on angiosperm trees (Wu *et al.* 2017a).

Distribution

Species of *Rigidoporus* have a cosmopolitan distribution (Ryvarden 1991): AFRICA (Patouillard 1894; Ryvarden & Johansen 1980. NORTH AMERICA (Murrill 1905; Gilbertson & Ryvarden 1986; Gilbertson & Ryvarden 1987), Jamaica (Swartz 1788). SOUTH AMERICA: Argentina (Rajchenberg 2006), Brazil (Silveira & Guerrero 1989; Góes-Neto 1999; Sotão *et al.* 2009; Gomes-Silva & Gibertoni 2009; Westphalen & Silveira 2012; Gugliotta *et al*. 2013; Gomes-Silva *et al*. 2014), Venezuela (Ryvarden & Iturriaga 2001). ASIA: China (Dai 1998; Zhao & Zhang 1992; Cui *et al*. 2009; Dai *et al*. 2009; Dai 2012; Wu *et al*. 2017a), Japan (Hattori 2001; Núñez & Ryvarden 1999, 2001), Taiwan, Thailand, Vietnam (Núñez & Ryvarden 2001). EUROPE: Czech Republic, Finland, Norway, Slovakia, Ukraine (Vampola & Vlasák 2012; Ryvarden & Melo 2014).

From India, four species of *Rigidoporus* (*R. lineatus* (Pers.) Ryvarden, *R. microporus* (Sw.) Overeem, *R. ulmarius* (Sowerby) Imazeki, *R. vinctus* (Berk.) Ryvarden) have been reported so far (Bose 1938; Bakshi *et al.* 1963; Bakshi 1971; Thind & Rattan 1972; Sankaran & Florence 1995; Florence & Yesodharan 1997, 2000; Leelavathy & Ganesh 2000; Florence 2004; Verma *et al*. 2008; Ranadive *et al*. 2011; Mohanan 2011; Prasher & Lalita 2013; Ranadive *et al*. 2013, 2013a).

2.1.4.1.7. **Meruliaceae** Rea

The family was established by Rea in 1922 and is one of the large families within Polyporales. The group consists of both corticioid and poroid species that often have a waxy texture on drying (Justo *et al.* 2017). Major taxonomic characters of the species belonging to the family are monomitic, rarely pseudo dimitic or dimitic hyphal system, with clamp connections, usually with cystidia, and thin walled, smooth, hyaline basidiospores. Species causes white rot on wood.

According to Zmitrovich (2018), Meruliceae has evolved parallelly with Polyporaceae and hence both families show similar morphotypes, and distinctions between them are quite difficult. Justo *et al.* (2017) recognized 13 genera under the family; *Aurantiopileus* Ginns, D.L. Lindner & T.J. Baroni, *Aurantiporus*, Murrill, *Climacodon* P. Karst., *Crustodontia* Hjortstam & Ryvarden, *Hydnophlebia* Parmasto, *Lilaceophlebia* (Parmasto) Spirin & Zmitr., *Luteoporia* F. Wu, Jia J. Chen & S.H. He, *Mycoacia* Donk, *Mycoaciella* J. Erikss. & Ryvarden, *Phlebia* Fr., *Phlebiporia*, Jia J. Chen, B.K. Cui & Y.C. Dai, *Sarcodontia* Schulzer, *Scopuloides* (Massee) Höhn. & Litsch.

GENUS *PAPPIA* ZMITROVICH

Genus *Pappia* was established recently by Zmitrovich (2018) for accommodating *Tyromyces fissilis* (Berk. & M.A. Curtis) Donk. The genus is characterized by large, tyromycetoid basidiomata, soft, fibrous context that are white when fresh, pinkish to light umber brown when dry, thick tube layer, initially honey brown in colour, turning umber brown and glazing when dry, monomitic hyphal system, clamped generative hyphae that are thin walled in trama and nearly thick in upper context, presence of chalmydospores in the context, absence of cystidia and ellipsoid to subglobose, thin walled, inamyloid basidiospores. Species cause white rot on host. The similar genus *Odoria* V. Papp *et* Dima is distinguished from *Pappia* by having context with red colour change in KOH, presence of thick walled basidiospores, and by the absence of chlamydospores (Zmitrovich 2018).

Currently, the genus consists of only two species; *P. fissilis* and *P. longitubus* (Lespiault) Maffert (*Index Fungorum*, accessed on 30 September 2020)

Distribution

NORTH AMERICA: United States of America (Berkeley & Curtis 1849). ASIA: China (Núñez & Ryvarden 2001; Dai 2012; Zhou *et al.* 2016), Japan (Núñez & Ryvarden 1999, 2001), Far East Russia, Taiwan, Thailand, Vietnam (Núñez & Ryvarden 2001). EUROPE: Southern part of Fennoscandia south to Central Europe (Ryvarden & Gilbertson 1994).

Economic importance

Pappia fissilis is reported to cause lung infection in a lung transplanted patient (Chrenkova *et al*. 2014, as *T. fissilis*). *T. fissilis* is also a source of different terpinoids (Quang *et al*. 2004).

GENUS ***PHLEBIA*** FRIES

Phlebia was erected by Fries (1821) and typified by *Phlebia radiata* Fr. This corticioid genus mainly differs from other similar genera in having hymenium with warts, ridges or some tooth like protuberances (Cooke 1956). Since *Phlebia* showed resemblance with some hydnaceous taxa (*Radulum* Fr. and *Hydnum* L. *sensu lato*), they were initially included in the family Hydnaceae (Cooke 1956). According to Patouillard (1900), *Phlebia* showed similarities with certain resupinate species of *Merulius* Fr. in having hyaline basidiospores. Therefore, these two genera were treated together by Patouillard (1900), which was also followed later by Nakasone & Burdsall (1984). In the opinion of Nakasone & Sytsma (1993), the simple nature of the fruit bodies of this genus have resulted in species complexes of morphologically similar but genetically dissimilar species. According to Maekawa (1993), *Phlebia* is a heterogenous genus with variable appearance. However, most species produce basidiocarps with ceraceous to gelatinous consistency and are with a dense layer of narrowly clavate basidia. Later, small genera were segregated from the large genus *Phlebia*. They are, *Amethicium* Hjortstam (1983), for including *Phlebia* species that consisted of highly branched and aseptate hyphae in the subiculum and *Efibula* Wu

(1990) for species of *Phlebia* that lacked clamps (Maekawa 1993). In 1992, Wu & shifted the *P. cretacea* group (which included *P. cretacea* (Romell *ex* Bourdot & Galzin) J. Erikss. & Hjortstam and related species with taxonomic confusions, Eriksson *et al.* 1981) to *Jacksonomyces* Jülich. All these changes made the concept of *Phlebia* narrower (Maekawa 1993). But Parmasto & Hallenberg (2000) was not in agrrement with splitting of *Phlebia sensu lato.* (Bernicchia & Gorjón 2010). Corticioid genera such as *Cytidiella* Pouzar, *Mycoacia* Donk and *Mycoaciella* J. Erikss. & Ryvarden were synonymised with *Phlebia* by Nakasone (1996, 1997, 2002).

In the phylogentic study of Hibbett & Thorn (2001), many species of *Phlebia* were treated in the polyporoid clade. Based on the molecular study of Larsson *et al.* (2004), this genus is highly similar to *Phlebiella*, *Mycoacia* and *Mycoaciella* in having common characters such as the almost gelatinous basiodiomata, hymenium made of a palisade of narrowly clavate basidia, and small inamyloid basidiospores. Larsson *et al*. (2004) introduced “Phlebioid clade” for including these three genera and *Hyphoderma* Wallr., *Ceriporia* Donk., *Gloeoporus* Mont., *Ceraceomyces* Jülich and *Byssomerulius* Parmasto. According to the classification of corticioid fungi by Larsson (2007), the genus *Phlebia* has been resolved as polypohyletic even after the separation of many dissimilar taxa. Larrson (2007a) placed the type species of the genus *P. radiata* Fr. in Meruliaceae. In the phylogenetic analysis of European *Ceriporiopsis* Domański, based on nLSU and mtSSU gene data (Tomšovský *et al*. 2010), the type of the genus clustered with the type of Phlebia. According to Binder *et al.* (2013), type of *Phlebia* nested in the phlebioid clade under Phlebiaceae Jülich along with *Ceraceomyces* Jülich, *Ceriporia* and *Ceriporiopsis.* In the latest studies of Polyporales (Justo *et al.* 2017; Zmitrovich 2018), *Phlebia* is placed in the family Meruliaceae. *Phlebia* includes 91 species (*Index Fungorum,* accessed on 30 September 2020).

Based on current descriptions (Eriksson *et al.* 1981; Maekawa 1993; Bernicchia & Gorjón 2010; Shen *et al*. 2018), *Phlebia* is characterized by resupinate, effused reflexed, exceptionally pileate basidiomata having subceraceous to subgelatinous texture when fresh, membranaceous to coriaceous when dry, smooth, tuberculate, phlebioid, odontioid, merulioid or poroid hymenium, monomitic hyphal system, but rarely dimitic, hyphae with or without clamp connections, presence or absence of cystidia, when present, with or without encrustation, palisade of narrowly clavate basidia and ellipsoid to allantoid, hyaline, smooth, thin walled, basidiospores that are acyanophilous in cotton blue, and inamyloid in Melzer's reagent. Members are saprophytes and cause white rot on wood.

Infrageneric classification

Three sub genera (*Lilaceophlebia* Parmasto, *Phanerophlebia* Parmasto, *Phlebia* Fr.), seven sections (*Flavophlebia* Parmasto, *Hyalophlebia* Parmasto, *Leptocystidiophlebia* Parmasto *Lilaceophlebia* Parmasto, *Pallidophlebia* Parmasto, Phlebia, *Purpureophlebia* Parmasto) and two sub sections (*Pallidae* Parmasto, *Phlebia*) are known for *Phlebia* (Kirk *et al.* 2008). Of these, section *Flavophlebia* is currently recognized as a distinct genus, *Radulomyces* M.P. Christ (characterized by resupinate basidiomata, smooth to tuberculate or raduloid hymenium, monomitic hyphal system, absence of cystidia and globose to ellipsoid, slightly thick walled, guttulate basidiospores; Eriksson *et al.* 1981; Maekawa 1994) (*Index Fungorum*, accessed on 20 February 2020). Section *Lilaceophlebia* (Parmasto) has been elevated to the genus rank by Spirin & Zmitrovich (2004). Genus *Lilaceophlebia* (Parmasto) Spirin & Zmitr. has been distinguished by resupinate basidiomata, merulioid, granuloid, or irregularly tuberculate hymenium, monomitic hyphal system, presence of leptocystidia and cylindrical to allantoid basidiospores (Spirin & Zmitrovich 2004).

Economic importance

Being white rot fungi, species of *Phlebia* are used for the production of laccase and lignin peroxide that can be applied for various biotechnological processes (Kantelinen *et al.* 1989; Niku-Paavola *et al.* 1990; D'souza *et al.* 1996; Arora & Rampal 2002; Gill *et al.* 2002; Arora & Gill 2000; Arora & Gill 2005; Arora & Sharma 2009; Mäkelä 2009; Shraddha *et al.* 2011; Gowri *et al.* 2014;

Kumar *et al.* 2018a). Some species of *Phlebia* are also known to possess antioxidant and anti antimicrobial properties (Vieira *et al*. 2012; Ranadive *et al.* 2013a, Bang *et al.* 2014; Chandra *et al*. 2019).

Distribution

Genus has a wide spread distribution. AFRICA: Cameroon (Roberts 2000). NORTH AMERICA (Nakasone *et al.* 1982; Nakasone & Sytsma 1993), Canada (Cooke 1956), United States of America (Lindner *et al.* 2006; Nakasone & Bursdall 1995). ASIA: Japan (Maekawa 1993), China (Cooke 1956; Shen *et al*. 2018), Malaysia (Yamashita *et al*. 2009; Lee *et al.* 2012; Urbizu *et al.* 2014), West Siberia (Filippova & Zmitrovich 2013), EUROPE: Italy (Bernicchia 2001; Bernicchia *et al*. 2007; Bernicchia & Gorjón 2010), France (Duhem 2013), Norway, Scandinavia (Eriksson *et al.* 1981).

From India, *Phlebia griseolivens* (Bourdot & Galzin) Parmasto, *P. radiata* Fr., *P. rufa* (Pers.) M.P. Christ., *P. segregata* (Bourdot & Galzin) Parmasto *P. subceracea* (Wakef.) Nakasone and *P. subserialis* (Bourdot & Galzin) Donk have been recorded by different workers; Dhingra (1989a), Verma *et al.* (2008), Ranadive *et al.* (2011), Prasher & Lalita (2013), Ranadive (2013), Lalita & Prasher (2014).

2.1.4.1.8. **Panaceae** Miettinen, Justo & Hibbett

Panaceae is a family recently established by Justo *et al.* (2017), with *Panus* Fr. as the type genus. The family is characterized by pileate to stipitate basidiomata, lamellate to smooth hymenophore, dimitic hyphal system, generative hyphae with clamp connections, presence of cystidia as either gloeocystidia or thickwalled metuloids, and hyaline, smooth, thin walled, basidiospores. Members of the family cause white rot on wood (Justo *et al.* 2017). According to (Justo *et al.* 2017) the family consists of two genera, *Panus* and *Cymatoderma* Jungh. Zmitrovich (2018) considered Panaceae as a synonym of Meruliaceae. However, as per the *Index Fungorum* database (accessed on 08 September 2020), Panaceae has been recognized as an independent family of the order Polyporales.

GENUS *PANUS* FRIES

Panus was introduced by Fries in 1838. *Panus conchatus* (Bull.) Fr. is the type species. The genus was considered as closely related to genera like *Lentinus*, *Neolentinus* Redhead & Ginns, *Heliocybe* Redhead & Ginns and *Pleurotus* (Fr.) P. Kumm), and their relationships have been studied by many workers (Kühner 1980; Corner 1981; Redhead & Ginns 1985; Singer 1975, 1986; Hibbett & Vilgalys 1991, 1993; Rune 1994; Thorn *et al.* 2000; Garcia-Sandoval *et al.* 2011). Based on similarities with certain *Polyporus* species, *Panus, Lentinus, Pleurotus* and some other poroid genera were placed in Polyporaceae by Singer (1951), who transferred the family to Agaricales (Zmitrovich 2018). Based on the type of hyphal system, Corner (1981) treated *Lentinus* and *Panus* as independent genera. However, Pegler (1983) considered *Panus* as a sub genus of *Lentinus* and also placed many *Pleurotus* species (*sensu* Singer 1975) in *Panus* (Senthilarasu 2015). According to Pegler (1983), the sub genus *Lentinus* consists of species with skeleto ligative hyphae and hyphal pegs while, sub genus *Panus* includes only species with skeletal hyphae, and are without hyphal pegs. Pegler (1983) suggested a polyporoid ancestory for *Panus* and related genera, while Corner (1981), considered these genera (positioned in his tribe *Lentinulae*) as paraphyletic groups from which Agaricales and Polyporaceae emerged (Hibbett & Vilgalys 1991). According to Pegler (1983), *Panus* is distinguished by dimitic hyphal system and radiate arrangement of hymenial trama. Grand (2004) provided a detailed discussion on the species concepts in *Panus*. The study (Grand 2004) also made a discussion on the *Panus lecomtei* complex, that included *P. lectomei* (Fr.) Corner, which shared many morphological characters with the type of *Panus*, and with those species considered by Pegler as *L. strigosus* (Schw.) Fr.). Members of the genus possess enzymatic complexes that include cellulases, laccases, tyrosinases and peroxidases capable of causing white rot on wood (Hibbett & Vilgalys 1993; Douanla-Meli & Langer 2010; Njouonkou *et al.* 2013).

In a phylogenetic study on Polyporales by Binder *et al.* (2013), *Panus* nested in a residual polyporoid clade, whereas, *Lentinus* was positioned in the core polyporoid clade. The position of *Panus* outside the core polyporoid clade was also confirmed in a study by Zmitrovich & Kovalenko (2016). Justo *et al.* (2017) introduced the family Panaceae Miettinen, Justo & Hibbett with *Panus* as the type genus. According to Justo *et al.* (2020), the genus *Panus* has an independent origin of agaricoid habit in the order Polyporales. Zmitrovich (2018) considered Panaceae as a synonym of Meruliaceae. Currently, *Panus* is positioned under the family Panaceae, and holds 80 species (*Index Fungorum*, accessed on 08 September 2020).

Species of *Panus* are characterized by annual, stipitate, infundibuliform basidiomata, glabrous to strigose or radially striated pilei, lamellate hymenium, dimitic hyphal system, presence or absence of pleurocystidia (as either gloeocystidia or skeletocystidia), absence of hyphal pegs, and sub cylindrical to cylindrical, hyaline, smooth, thin walled basidiospores that are inamyloid in Melzer's reagent, causing white rot on wood (Corner 1981; Pegler 1983; Njouonkou *et al.* 2013; Senthilarasu 2015; Seelan *et al.* 2015).

Infrageneric classification

Subgenus *Panus* of *Lentinus* was divided by Pegler (1983) in to nine sections, as follows:

Section *Pulverulenti* Fr.

Members of this group are characterized by the presence of convex, umbonate to applanate pileus, well distinguished stipe, hymenial trama of descending construction, non inflated generative hyphae, unbranched to branched skeletal hyphae, conspicuous pleurocystidia often with oily contents, which may be thick walled.

Section *Panus* (Fr.) Pegler

The section is distinguished by hirsute strigose pileus, squamulose or glabrous, umbonate to applanate pileus, hymenial trama of radiate construction, non inflated generative hyphae, unbranched skeletal hyphae, either with gloeocystidia or with thick walled metuloids.

Section *Cirrhosi* Pegler

Small basidiomata, presence of sclerotium below the stipe, denticulate lamellae edge, hymenial trama of descending construction, absence of cystidia, and cylindrical basidiospores characterize this section.

Section *Velutini* Pegler

The section is defined by velutinate to strigose pileus, entire lamellae edge, sometimes with pseudosclerotium, hymenial trama of radiate construction, non inflated generative hyphae, un branched skeletal hyphae, often with skeletocystidia, absence of metuloids and gloeocystidia and short cylindrical basidiospores.

Section *Gigantopanus* (Corner) Pegler

The section is distinguished by large and fleshy basidiomata, radicant and tapering stipe, thick context, presence of partial veil, entire lamellae edge, hymenial trama of radiate construction, inflated generative hyphae, sparsely branched skeletal hyphae, absence of cystidia, and ovoid to ellipsoid basidiospores.

Section *Squamosi* Fr.

Members of this section are characterized by fibrillose squamulose to glabrous pileal surface, sometimes with partial veil, denticulate to serrate lamellae edge, hymenial trama of descending construction, non inflated generative hyphae, unbranched skeletal hyphae, absence of cystidia and large cylindric basidiospores.

Section *Tuberregium* (Singer) Pegler

The section is distinguished by large and robust basidiomata, often with sclerotuim or pseudosclerotium, entire lamellae edge, hymenial trama of radiate construction, consisting of skeletal hyphae and non inflated generative hyphae, absence of cystidia, and cylindrical basidiospores.

Section *Prolifer* Pegler

Members belonging to this section are characterized by pleurotoid basidiomata, reduced stipe, entire lamellae edge, hymenial trama of radiate construction, consisting of skeletal hyphae and non inflated generative hyphae, absence of cystidia, and short cylindric basidiospores.

Section *Tenebrosi* Pegler

Rigid, dark coloured basidiomata, reduced hymenium, sterile lamellae edge, hymenial trama of radiate construction, pileipellis made of a crust with coralloid elements, non inflated generative hyphae, skeletal hyphae with few branches, absence of cystidia, and small, ellipsoid basidiospores characterizes the group.

Economic importance

Edibility and medicinal properties of *Panus* species have been reported in different works (Smith *et al.* 2002; Boa 2006; Wasser 2014; Hussein *et al.* 2015; Zmitrovich & Kovalenko 2016; Parveen *et al.* 2017). Presence of laccase in species of *Panus* is known to decolourize various artificial dyes (Zhang *et al.* 2006a; Cardoso *et al.* 2018). According to Mossebo (2002), enzymes produced by *Panus* species has biotechnological application.

Distribution

Panus have a worldwide distribution. AFRICA: Cameroon (Douanla-Meli *et al.* 2007; Njouonkou *et al*. 2013). SOUTH AMERICA: Brazil (Drechsler-Santos *et al.* 2012). ASIA: Malaysia (Corner 1981; Pegler 1983; Bolhassan *et al.* 2012; Lee *et al.* 2012). AUSTRALIA (Berkeley 1881).

From India, species of *Panus* such as *Panus alpacus* (Senthil. & S.K. Singh) Senthil., *P. caespiticola* var. *asiaticus* Manim. & Leelav., *P. conchatus* (Bull.) Fr., *P. hookerianus* (Berk.) T. W. May & A. E. Wood, *P. indicus* Sathe & J. T. Daniel, *P. natarajanus* Senthil., *P. neostrigosus* Drechsler-Santos & Wartchow, *P. rudis* Fr., *P. similis* (Berk. & Broome) T. W. May & A. E. Wood, and *Panus velutinus* (Fr.) Sacc. have been reported by different workers (Berkeley 1851, 1876; Natarajan

1978, Natarajan & Manjula 1978, Watling & Gregory 1980; Natarajan & Raman 1981; Sathe & Daniel 1980; Manjula 1983; Pegler 1983; Manimohan & Leelavathy 1995; Florence 2004; Manimohan *et al.* 2004; Atri *et al.* 2010; Sharma & Atri 2015; Senthilarasu & Singh 2012; Usha & Janardhana 2014; Senthilarasu 2015; Vrinda & Pradeep 2014; Parveen *et al.* 2017).

2.1.4.1.9. **Phanerochaetaceae** Jülich

Phanerochaetaceae was erected by Jülich in 1981, under the order Phanerochatales Jülich, for placing the resupinate genus *Phanerochaete* P. Karst. and other associated taxa. Later, Boidin *et al.* (1998) transferred species of genera *Candelabrochaete, Ceriporia, Hyphodermella* J. Erikss. & Ryvarden, and *Phlebiopsis* Jülich under Phanerochaetales. Another genus *Rhizochaete* was established under Phanerochaetaceae by Greslebin *et al*. (2004) for placing coloured *Phanerochaete* like taxa. In the phylogenetic study of Binder *et al*. (2005), most of these genera settled under the phlebioid clade of Polyporales. According to Binder *et al.* (2013), Phanerochaetaceae forms a strongly supported sub clade within phlebioid clade of Polyporales. This group is composed of corticioid species, and a few poroid species, and is mainly characterized by monomitic hyphal system, absence of clamp connections, presence of cystidia, thin walled, smooth, hyaline basidiospores and white rot type of wood decay (Justo *et al.* 2017).

A detailed overview on the family has been provided by Floudas & Hibbett (2015) based on morphology and molecular data. According to the molecular analysis of Miettinen *et al*. (2016), Phanerochaetaceae has been split in to four clades, "*Bjerkandera* clade", "*Phanerochaete* clade", "*Donkia* clade" and "*Phlebiopsis* clade". The *Bjerkandera* clade was characterized by effused, corticioid members (e.g., *Terana coerulea* (Lam.) Kuntze) to pileate polypores (*Bjerkandera adusta* (Willd.) P. Karst), having generative hyphae always with clamp connections. The *Phanerochaete* clade consisted mostly of corticioid species and few poroid species, lacking clamp connection on hyphae (*Oxychaete cervinogilva* (Jungh.) Miettinen). The *Donkia* clade was characterized by species with effused to pileate basidiomata, smooth to hydnoid hymenium, and generative hyphae often with clamp connections (*Donkia pulcherrima* (Berk. & M.A. Curtis) Pilát). The *Phlebiopsis* clade consisted of species with variety of fruiting body types, like pileate polypores with clamped generative hyphae (*Hapalopilus africanus* Ryvarden), resupinate members lacking clamp connections on hyphae (*Phlebiopsis castanea* (Lloyd) Miettinen & Spirin), resupinate members with encrusted cystidia (*Phlebiopsis crassa* (Lév.) Floudas & Hibbett), and fruit bodies with rhizomorphs (*Rhizochaete violascens* (Fr.) K.H. Larss). Miettinen *et al*. (2016) recognized 14 genera under the family Phanerochaetaceae.

GENUS *BJERKANDERA* P. KARSTEN

Bjerkandera was introduced by Karsten in 1879, with *Bjerkandera adusta* (Willd.) P. Karst. as the type species. The genus was raised for accomodating annual, tyromycetoid species with coloured pore layer, distinguished from the context by a dense zone. Members of the genus are mainly characterized by pileate basidiomata, monomitic hyphal system and hyaline basidiospores (Westphalen *et al.* 2015). Ames (1913) and Donk (1974) considered the dense layer below the tomentum as an important character for the genus (Zmitrovich *et al*. 2016). The genus was placed in the sub family Tyromycetoideae of Polyporaceae in the earlier classifications of Bondartsew & Singer (1941). Bondartseva (1998) transferred the genus to the family Poriaceae. The type of the genus, *B. adusta* was included under other polypore genera such as *Gloeoporus* Mont. (Pilát 1937), *Tyromyces* P. Karst. (Pouzar 1966) or *Grifola* Gray (Zmitrovich *et al.* 2006). According to Zmitrovich *et al*. (2016), *Bjerkandera* type was shifted to *Gloeoporus* because of the presence of two layered nature of the basidiomes, and gelatinization in the hymenial tissues. However, Corner (1981) concluded that the extent of gelatinization in *G. adustus* (Willd.) Pilát and *G. fumosus* (Pers.) Pilát was poor when compared to some species of *Gloeoporus*. The molecular phylogenetic study of polypore genera by Floudas & Hibbett (2015) confirmed the monophyly of *Bjerkandera* (represented by *B. adusta*, *B. fumosa* (Pers.) P. Karst.). According to the study, *Bjerkandera* settled as the sister lineage of the corticioid fungus *Terana coerulea* (Lam.) Kuntze.

Based on the phylogenetic works (Binder *et al*. 2005, Binder *et al.* 2013), *Bjerkandera* settled under the phlebioid clade of Polyporales. Latest classifications by Justo *et al.* (2017) and Zmitrovich (2018) recognized the genus under family Phanerochaetaceae and Phanerochaete group of Meruliaceae of Polyporales. Currently, 12 species (*B. adusta*, *B. acidula* (Fr.) P. Karst., *B. alba* (Huds.) P. Karst., *B. atroalba* (Rick) Westph. & Tomšovský, *B. centroamericana* Kout, Westph. & Tomšovský, *B. diffusa* (Fr.) P. Karst., *B. fumosa*, *B. irregularis* (Sowerby) P. Karst., *B. mikrofumosa* Ryvarden, *B. pura* P. Karst., *B. subsimulans* Murrill, *B. terebrans* (Berk. & M.A. Curtis) Murrill) are recognized under the genus (*Index Fungorum*, accessed on 30 September 2020).

According to recent concepts (Ryvarden & Johansen 1980, Bernicchia 2005, Zmitrovich *et al.* 2016), the genus is defined by annual, usually soft, resupinate to pileate fruitbodies, finely velutinate to pubescent, light coloured pileus, two layered context with almost loosely arranged tomentum and dense layer below, poroid hymenium with blackish to brown pore surface, distinctly restricted with white to pale cream context, monomitic hyphal system with clamped, thin to thick walled hyphae, absence of cystidia and oblong ellipsoid, hyaline, smooth, thin walled and inamyloid basidiospores.

Economic importance

Bjerkandera adusta is reported as an endophytic fungus from some medicinal plants, and is known to possess anti microbial activity (Dar *et al.* 2017). Because of rich contents of unsaturated fatty acids, ergosterols of medicinal value, and phenolic organic compounds, *B. adusta* is highly recommended as a supplementary food or nutraceutical (Küçükaydi & Duru 2017). *Bjerkandera adusta* shows anti bacterial, anti radical and pro oxidant properties (Shintani *et al*. 2002; Korneichik & Kapich 2011; Nowacka *et al.* 2015; Sugawara *et al.* 2019). This fungus is reported to degrade kraft pulp lignin, polycyclic aromatic hydrocarbons, effluents containing heavy metals and synthetic dyes (Heinfling *et al.* 1998; Haritash & Kaushik 2009; Adenipekun & Lawal 2012; Tripathi *et al.* 2012; Rhodes 2014). *Bjerkandera* is known to cause timber damage, and negatively affects cultivation of edible mushrooms (Bak *et al.* 2011). As an adverse effect in human, *B. adusta* act as a fungal aeroallergen that causes allergic cough in humans (Ogawa *et al.* 2009; Ogawa *et al.* 2011, 2014). According to Liu *et al.* (2014), *B. adusta* isolated from Asian sand dust aerosol is capable of causing lung eosinophilic lung disease.

Distribution

Genus has a worldwide distribution. AFRICA: Ethiopia, Malawi (Ryvarden & Johansen 1980, Ţura *et al.* 2010). NORTH AMERICA: Murrill 1905, Gilbertson & Ryvarden 1986, Zhou *et al.* 2016, Cuba (Lowe 1966), Mexico, Montepío, Veracruz, Tabasco (Westphalen *et al.* 2015), United States of America (Bishop & McGrath 1978; Lindner *et al*. 2006; Brazee *et al.* 2012). SOUTH AMERICA: Argentinian Yungas (Robledo & Rajchenberg 2007), Brazil (Rick 1935; Groposo & Loguercio-Leite 2005; Silveira *et al*. 2008; Baltazar & Gibertoni 2009; Pires *et al.* 2017). ASIA: Armenia, Azerbaijan (Zmitrovich *et al.* 2016), China (Núñez & Ryvaden 2001; Dai 2012), Georgia (Zmitrovich *et al.* 2016), Japan (Hattori 2005; Nuñez & Ryvarden 2001), Iran, Israel (Zmitrovich *et al.* 2016), Turkey, Far East Russia (Nuñez & Ryvarden 2001), Korea (Jung 1994; Kim *et al*. 2009; Lim *et al.* 2010), Malaysia (Lee *et al.* 2012), Mongolia (Zmitovich *et al*. 2016), Nepal (Zmitrovich *et al.* 2016), Pakistan (Razaq & Shahzad 2016), Russia, Sri Lanka (Zmitrovich *et al.* 2016), Taiwan, Thailand (Nuñez & Ryvarden 2001), West Siberia (Filippova & Zmitrovich 2013). AUSTRALIA: New Zealand (Cunningham 1965), Papua New Guinea (Zmitrovich *et al.* 2016), EUROPE: Austria, Belarus, Belgium, Bulgaria, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary (Zmitrovich *et al.* 2016; Ryvarden & Gilbertson 1993), Italy (Bernicchia 2001; Bernicchia 2005; Bernicchia *et al.* 2007), Slavia, Lithuania, Netherlands, Norway, Poland, Portugal, Romania, Slovenia, Spain, Sweden, Switzerland, Ukraine, United Kingdom (Zmitovich *et al.* 2016).

In India, *Bjerkandera adusta* and *B. fumosa* have been recorded by Bakshi (1971), Sharma (2000), Mohanan (2011), Prasher & Lalita (2013), Ranadive (2013), Lyngdoh & Dkhar (2014) and Chuzho *et al*. (2017).

GENUS *OXYCHAETE* MIETTINEN

Oxychaete is a genus established recently in Phanerochaetaceae by Miettinen *et al.* (2016), with *Oxychaete cervinogilva* (Jungh.) Miettinen (=*Oxyporus cervinogilvus* (Jungh.) Ryvarden) as the type species. The type species was earlier treated among different polypore genera such as, *Polyporus* (Bakshi *et al.* 1969), *Flavodon* (Corner 1987; Gilbertson & Adaskaveg 1993) and *Oxyporus* (Schizoporaceae, Hymenochaetales, Ryvarden & Johansen 1980). According to the phylogenetic study by Miettinen *et al.* (2016), *Oxychaete cervinogilva* formed a distinct lineage among the members of the large Phanerochaetaceae clade of Polyporales. Based on the original description (Miettinen *et al.* 2016), the genus is characterized by effused reflexed, yellow to brown coloured basidiomata, with a light "cardboard" like texture, poroid hymenium with large shallow pores, monomitic hyphal system, hyphae slightly thick walled without clamp connections, presence of subulate, thick walled cystidia arising from subhymenial region, and large, cylindrical, slightly curved basidiospores. Currently, the genus includes only a single species, *O. cervinogilva* (*Index Fungorum*, 30 September 2020).

Distribution

Oxychaete cervinogilva is found mainly in the tropics. AFRICA: East Africa (Ryvarden & Johansen 1980). NORTH AMERICA: United States of America (Gilbertson & Adaskaveg 1993). ASIA: Borneo (Corner 1987), China (Dai 2012), Malaysia (Corner 1987; Lee *et al*. 2012), Sumbava (Watling *et al*. 2002). AUSTARLIA: New Zealand (Cunningham 1965).

From India, *Oxychaete cervinogilva* has been reported by Bakshi *et al.* (1969), Ranadive *et al*. (2011), Prasher & Lalita (2013) and Ranadive (2013).

GENUS *PHLEBIOPSIS* JÜLICH

Phlebiopsis Jülich is a corticioid fungus, erected by Jülich in 1978 with *Phlebiopsis gigantea* (Fr.) Jülich as the type species. The genus accommodated species having resupinate and adnate basidiomata, smooth to odontoid hymenium, compact subiculum, monomitic hyphal system without clamp connections, and thick walled encrusted cystidia (Jülich 1978). *Phlebiopsis* was distinguished from the similar corticioid genus *Phanerochaete* by the compact subiculum made of parallelly arranged agglutinated hyphae (Eriksson *et al.* 1981; Maekawa 1993). According to Eriksson *et al.* (1981), basidial cluster of *Phanerochaete* species get easily separated in microscopic preparations, while in *Phlebiopsis* species, basidia remain usually agglutinated and are difficult to separate. Burdsall (1985) considered the character of subiculum not to be significant enough to differentiate it from *Phanerochaete*. Hence, Burdsall (1985) treated *Phlebiopsis* as a synonym of *Phanerochaete*. *Phaeophlebiopsis* Floudas & Hibbett was erected by Floudas & Hibbett (2015) in the *Phlebiospis* clade (of large *Phanerochaete* clade) for the species which resembled *Phlebiopsis* in morphology, but separated by the grey-brown colour of the basidiocarps. Another corticioid species, *Hjortstamia crassa* (Lév.) Boidin & Gilles was regarded close to *Phlebiopsis,* and was transferred to the latter (Floudas & Hibbett 2015). *Hjortstamia* Boidin & Gilles differed from *Phlebiopsis* in having effused reflexed to pileate fruit bodies, and loosely arranged subiculum (Miettinen *et al.* 2016). However, according to Miettinen *et al.* (2016), these differences were not distinct enough to separate *Hjortstamia* from *Phlebiopsis*, since the characters were intermixed in species of both genera. Miettinen *et al.* (2016) considered *Hjortstamia* as a synonym of *Phlebiospsis*. Miettinen *et al.* (2016), based on their phylogenetic study, expanded the genus *Phlebiopsis* by including *Dentocorticium pilatii* (Parmasto) Duhem & H. Michel, some species of *Hjortstamia*, and the monotypic poroid genus *Castanoporus* Ryvarden. Thus, based on their concept, *Phlebiopsis* includes basidiocarps with diverse morphology (like smooth and effused, poroid and effused, stereoid and pileate taxa with smooth hymenium). According to Miettinen *et al.* (2016), encrusted cystidia (also called as lamprocystidia) and compactly arranged subiculum can be considered as delimiting characters in *Phlebiopsis,* which keeps it apart from other close genera of Phanerochaetaceae. Currently, the genus includes 19 species (*Index Fungorum*, accessed on 30 September 2020).

According to the current concept (Eriksson *et al.* 1981; Maekawa 1993; Bernicchia & Gorjón 2010; Miettinen *et al.* 2016), *Phlebiopsis* species are mainly characterized by ceraceous, resupinate, effused reflexed to pileate fruitbodies with smooth, tuberculate or odontoid to poroid hymenium, compact subiculum with parallelly arranged, usually agglutinated hyphae, monomitic hyphal system without clamp connections, presence of conical thick walled cystidia which are densely encrusted at the tip, and narrowly ellipsoid to subcylindrical, thin walled, smooth, basidiospores that are inamyloid in Melzer's reagent.

Economic importance

Phlebiopsis gigantea (Fr.) Jülich is a well known biocontrol agent used against species of *Heterobasidion* Bref. which are serious root rot pathogens on forest trees (Pratt *et al*. 2010; Sun *et al*. 2011; Menkis *et al*. 2012; Terhonen *et al.* 2013; Hyder *et al*. 2013; Sierota *et al*. 2015; Oliva *et al*. 2017; Vainio *et al.* 2001; Zaluma *et al.* 2019). *P. gigantia*, as a biocontrol agent is commercially available in the trade name Rotstop® (Oliva *et al*. 2017). This species is capable of producing different secondary metabolites of which some possesed anti fungal property (Kälvö *et al.* 2018).

Distribution

Species of *Phlebiopis* have been recorded from different parts of the world. AFRICA: Cameroon (Roberts 2000). ASIA: Japan (Maekawa 1993), West Siberia (Filippova & Zmitrovich 2013). EUROPE (Eriksson *et al.* 1981; Bernicchia *et al*. 2007; Bernicchia & Gorjón 2010).

Phlebiopsis gigantea (Fr.) Jülich, *P. crassa* (Lév.) Floudas & Hibbett and *P. flavidoalba* (Cooke) Hjortstam have been reported from India by Ranadive *et al.* (2011), Prasher & Lalita (2013), Ranadive (2013) and Lalita & Prasher (2014).

GENUS ***TERANA*** ADANSON

Terana Adans. was established by Adanson (1763) and typified by *Terana coerulea* (Lam.) Kuntze. The genus is mainly characterized by its luminescent bluish basidiocarps (Larsson 2007a). Because of the bluish colour, the type species, *Terana coerulea* is commonly called as "cobalt crust" (Thomas 2011). According to

Velíšek & Cejpek (2011), oxidation of the colourless quinhydrones impart bluish colour to the hymenium of this taxa. *Terana* has been widely accepted as a corticioid fungus, belonging to Phanerochaetaceae of Polyporales (De Koker *et al.* 2003; Hallenberg *et al.* 2008; Miettinen *et al.* 2016; Justo *et al.* 2017).

Based on the recent molecular studies of *Phanerochaete* and allied genera (Floudas & Hibbett 2015; Miettinen *et al.* 2016; Zmitrovich 2018), *Terana* belongs to "*Bjerkandera* clade" of Phanerochaetaceae. Currently 61 species are known under the genus *Terana* (*Index Fungorum*, accessed on 30 September 2020).

Major characteristics of the genus are resupinate basidiomata, smooth to slightly tuberculate bluish hymenium, monomitic hyphal system with clamps, presence of dendrohyphidia, absence of cystidia, 4 spored basidia often with dendritical branches and basal clamps, and ellipsoid, hyaline, smooth, thin walled, inamyloid basidiospores (Bernicchia & Gorjón 2010). They occur on dead wood of different angiosperm trees.

Economic Importance

Terana coerula possesses antibiotic activity (Maisterra *et al.* 2012).

Distribution

Terana coerulea has been recorded from the following regions: ASIA: China (Tai 1979), Indonesia (Jülich 1974) Iran (Hallenberg 1981), Japan (Maekawa 1994), Thailand (Hjortstam & Ryvarden 1982). EUROPE: Italy (Bernicchia & Gorjón 2010), Norway, Scandinavia (Eriksson *et al.* 1981).

From India, *Terana coerulea* was recorded by Rattan (1977). This species has not been reported from Kerala so far.

2.1.4.1.10. **Podoscyphaceae** D.A. Reid

The family was erected by Reid in 1965, with *Podoscypha* Pat as the type genus. *Podoscypha* Pat. Members are mainly characterized by pileate basidiomata, with smooth, ridged, or poroid hymenophore, dimitic or trimitic hyphal system, generative hyphae with clamp connections, presence of cystidia and/or gloeocystidia, and subglobose to ellipsoid, smooth, hyaline, thinwalled basidiospores. Members cause white rot on wood. The genus rarely consists of corticioid species, and exceptionally possesses monomitic hyphal system, hyphae without clamp connections, and with thick walled, ornamented basidiospores (Vesterholt 1997; Justo *et al.* 2017).

Based on the molecular phylogenetic analyses, Justo *et al.* (2017) suggested that the Podoscyphaceae is well supported to accommodate all families in the residual polyoroid clade (e.g Steccherinaceae, Meripilaceae). However, in the opinion of Justo *et al.* (2017), adoption of the Podoscyphaceae to represent all families of the residual clade, would make the morphological characterization of the group more problematical. According to Justo *et al.* (2017), further studies are needed to resolve the limits of Podoscyphaceae. Genera *Abortiporus* Murrill, *Podoscypha* Pat., and *Pouzaroporia* Vampola are recognized under Podoscyphaceae (Justo *et al.* 2017).

GENUS *ABORTIPORUS* MURRILL

Genus *Abortiporus* was proposed by Murrill (1904) under the tribe Polyporeae of Polyporaceae, with *Abortiporus biennis* (Bull.) Singer as the type species. The genus name is referred to the usually aborted appearance of the type species, which prematurely develops tubes and rich contents before the complete development of pileus (Murrill 1904). Singer (1944) kept this genus under the tribe *Oxyporeae*, sub family Corioloideae of Polyporaceae. In 1998, Bondartsev transferred this genus to another family Poriaceae. According to the phylogenetic study of Binder *et al.* (2005) and He *et al.* (2014), *Podoscypha* Pat. is the closely related genus of *Abortiporus*. Recent studies on Polyporales by Justo *et al.* (2017) and Zmitrovich (2018) places this genus under Podoscyphaceae and “Podoscyphaceae group”of the family Meruliaceae respectively. Currently the genus consists of four species (*Index Fungorum*, accessed on 02 October 2020).

Abortiporus is defined by annual, sessile to dimidiate, substipitate or infundibuliform basidiomata, white to pale buff, duplex context with soft and spongy upper layer and rigid lower layer, angular to daedaloid pores, monomitic to dimitic, generative hyphae with clamp connections, presence or absence of cystidia, gloeocystidia and chlamydospores, and subglobose to ellipsoid, hyaline, smooth basidiospores that are inamyloid in Melzer's reagent. Species cause white rot on wood (Ryvarden & Gilbertson 1993; Núñez & Ryvarden 2001). *Abortiporus biennis* is reported as a parasite on fruit shrubs (Piątek 1999).

Economic importance

Being a white rot fungi, *Abortiporus biennis* is used in pilot scale bioreactors or fermenters for large scale production of laccase (Erden *et al*. 2009; He *et al.* 2014). It has been reported that willow sawdust after pretreatment with *A. biennis* results in increased biogas production (Alexandropoulou *et al.* 2015). According to Yin *et al.* (2017), laccase from *A. biennis* was thermo and pH stable and was used to reduce the phenolic contents of litchi juice, suggesting the application of the enzyme from *A. biennis* in juice processing. This fungus is able to decolourize different types of synthetic dyes (Jarosz-Wilkołazka *et al.* 2002). Laccase from this species is also known to possess potential anti cancer and anti tumour activity (Zhang *et al.* 2011; Ivanova *et al.* 2014, Jaya lakshmi *et al* 2015). *A. biennis* is a rich source of beta glucans and phenols and also possesss good immunomodulatory, cytotoxic and antibacterial properties (Doskocil *et al.* 2016; Tamrakar *et al.* 2017).

Distribution

Species of *Abortiporus* has a cosmopolitan distribution. AFRICA: Kenya, Nigeria, (Ryvarden & Johansen 1980), Zimbabwe (Masuka & Ryvarden 1992). NORTH AMERICA: Jamaica (Murrill 1910), North Carolina (Grand & Vernia 2007), United States of America (Bishop & McGrath 1978). SOUTH AMERICA: Ecuador (Læssøe & Ryvarden 2010; Zhou *et al.* 2016), Argentinean Yungas (Robledo & Rajchenberg 2007). ASIA: China (Núñez & Ryvarden 2001; Dai *et al.* 2011; Dai 2012), Japan (Núñez & Ryvarden 2001), Malaysia (Corner 1987; Lee *et al.* 2012), Pakistan (Razaq & Shahzad 2016; Khan *et al.* 2016), Taiwan (Núñez & Ryvarden 2001). EUROPE: Byelorussia (Ryvarden & Gilbertson 1993), Czechoslovakia (Ryvarden & Gilbertson 1993), Italy (Berniccchia 2001; Bernicchia *et al.* 2007), France (Ryvarden & Gilbertson 1993), Poland (Piątek 1999), Southern Norway, Sweden (Ryvarden & Gilbertson 1993), Yugoslavia (Ryvarden & Gilbertson 1993).

Abortiporus biennis have been reported from India: Bakshi (1971), Thind & Rattan (1971), Leelavathy & Ganesh (2000), Florence (2004), Mohanan 2011, Prasher & Lalita (2013), Ranadive (2013), Lyngdoh & Dkhar (2014).

GENUS *PODOSCYPHA* PATOUILLARD

Genus *Podoscypha* was established by Patouillard in 1900, with *Podoscypha surinamensis* (Lév.) Pat. (currently *Podoscypha nitidula* (Berk.) Pat.) as the type species. Patouillard (1900) placed the genus along with other stereoid forms. Reid (1965), in his monograph on stipitate stereoid fungi erected a separate family "Podoscyphaceae", and *Podoscypha* was reserved as its type genus. *Stereogloeocystidium* Rick has been considered as the synonym of genus *Podoscypha* (Kirk *et al.* 2008). According to Drechsler-Santos *et al.* (2007), there has not been much change in the nomenclatural concept of the genus after Reid (1965). Major features of the genus are stipitate and flabellate basidiomata, dimitic hyphal system, and the occurrence of gloeocystidia in all the members (Bernicchia & Gorjón 2010; Ryvarden 2010). Athough another stipitate genus, *Cymatoderma* Jungh. also shares these characters, the latter can be distinguished from the former by their large sized and robust basidiomata, folded hymenial surface, tomentum made of undifferentiated hyphae with clamp connections (Drechsler-Santos *et al.* 2007). Family Podoscyphaceae was weakly supported in the phylogenetic study of Aphyllophorales by Kim & Jung (2000). Based on the phylogenetic analysis of Binder *et al*. (2005), *Abortiporus biennis* is the closest genus of *Podoscypha*. According to studies (Binder *et al.* 2005, 2013; Hibbett *et al.* 2014), *Podoscypha* nested in the residual polyporoid clade, which included taxa of uncertain affinity. In Larsson (2007a), the genus was placed in the Polyporales, and it clustered with other corticioid forms of the family Meruliaceae. In the study of Sjökvist *et al.* (2012), species of *Podoscypha* along with other stereoid genera (*Cotylidia* P. Karst., *Cymatoderma* Jungh. *Muscinupta* Redhead, Lücking & Lawrey, *Stereopsis* D.A.

Reid) clustered under Meruliaceae. Binder *et al*. (2013) suggested Podoscyphaceae as the oldest name available for the residual polyporoid clade. According to recent study of Justo *et al.* (2017), *Podoscypha* is placed in the family Podoscyphaceae. Zmitrovich (2018) treats the genus under Meruliaceae. The monograph on "Stereoid fungi of America" published by Ryvarden (2010), describes and illustrates many *Podoscypha* species. At present, 46 species are recognized in the genus (*Index fungorum*, accessed on 01 October 2020).

Based on the current concepts (Bernicchia & Gorjón 2010; Ryvarden 2010; Wu *et al*. 2019), *Podoscypha* is mostly characterized by flabelliform to infundibuliform, often stipitate basidiomata, more or less imbricate pilei, smooth to more or less rugose hymenium, dimitic hyphal system, generative hyphae with clamp connections, presence of gloeocystidia, basidia with basal clamp connections and ellipsoid to cylindrical, hyaline, smooth, thin walled basidiospores that are inamyloid in Melzer's reagent. *Podoscypha* species cause white rot on wood.

Economic importance

Podoscypha petalodes is known to possess antioxidant properties (Fernando *et al.* 2015). Dye decolourizing ability is reported in *P. elegans* (G. Mey.) Pat. (Agrawal *et al.* 2017; Pramanik & Chaudhuri 2018).

Distribution

Genus has a wide spread distribution. AFRICA (Ryvarden 1997), Cameroon (Douanla-Meli & Langer 2004). NORTH AMERICA (Berkeley 1852b; Welden 1993), United States of America (Burt 1920; Lentz 1955; Reid 1965; Ryvarden 2010). SOUTH AMERICA: Brazil (Drechsler-Santos *et al*. 2007). ASIA: China (Ryvarden 1997; Wu *et al.* 2019), Malaysia (Lee *et al.* 2012; Ryvarden 1997), Pakistan (Ryvarden 1997), Philippines (Boidin 1966), SriLanka (Fernando *et al.* 2015), Thailand (Rungjindamai *et al*. 2008). EUROPE (Bernicchia & Gorjón 2010), Italy (Bernicchia 2001).

Podoscypha petalodes (Berk.) Boidin and *P. venustula* (Speg.) D.A. Reid have been reported from India by Dhingra (1987), Ryvarden (1997), Florence

(2004), Prasher & Lalita (2013), Ranadive *et al*. (2013), Lyngdoh & Dkhar (2014), Ranadive (2014), Akash *et al*. (2017), and Tarafder *et al.* (2017).

2.1.4.1.11. **Polyporaceae** Fries *ex* Corda

Polyporaceae was erected by Fries in 1938 under the order Aphyllophorales for including all fungi that possessed a poroid hymenium (Cui *et al.* 2019). Thereafter, concept of the family kept changing (Karsten 1879; 1881, 1892, Patouilliard 1900; Donk 1960, 1964; Ryvarden 1976, 1978, 1983, 1984; Ryvarden & Gilbertson 1993, 1994; Jülich 1981; Ryvarden 1991; Zhao 1998; Kirk *et al.* 2008). In the earlier classifications (Bondarzew & Singer 1941; Singer 1944; Bondartsev 1953), species of Polyporaceae were placed under five sub families (Porioideae, Tyromycetoideae, Fomitoideae, Polyporoideae, Corioloideae) and ten tribes (Piptoporeae, Ischnodermateae, Fomiteae, Phaeoleae, Inonoteae, Ganodermateae, Corioleae, Oxyporeae, Hirschioporeae, Daedaleae). Among the sub families, Ganodermateae was later erected as family Ganodermataceae by Donk (1948). Species included in the subfamily Inonoteae were later confirmed as belonging to another distinct clade of the Homobasidiomycetes, "Hymenochaetales" (Larsson *et al.* 2006; Hibbett *et al*. 2014). The agaricoid genera *Lentinus* and *Panus* were recognized as closely related with Polyporaceae (Singer 1951, 1975; Hibbett & Vilgalys 1991; Seelan *et al.* 2015). The recent classifications by Justo *et al.* (2017) and Zmitrovich (2018) treats Ganodermataceae as a synonym of Polyporaceae. At present, this is the largest group of Polyporales consisting mostly of poroid species and a few corticioid members (Justo *et al.* 2017). According to Kirk *et al.* (2008), Polyporaceae consists of 92 genera and 636 species (Cui *et al.* 2019). Justo *et al.* (2017) accepts 45 genera and Zmitrovich (2018) accepts 57 genera under the family Polyporaceae. Family names considered as synonyms of Polyporaceae are Coriolaceae Singer, Cryptoporaceae Jülich, Echinochaetaceae Jülich, Fomitaceae Jülich, Ganodermataceae (Donk) Donk, Grammotheleaceae Jülich, Haddowiaceae Jülich, Microporaceae Jülich, Pachykytosporaceae Jülich, Perenniporiaceae Jülich, Sparsitubaceae Jülich, Lophariaceae Boidin, Mugnier & Canales and Trametaceae Boidin, Mugnier & Canales (Cui *et al*. 2019).

Based on the molecular phylogenetic studies of Hibbett & Vilgalys (1991, 1993), the agaricoid genus *Lentinus* Fr. was found closely related to the poroid genus *Polyporus*. In the phylogenetic study of family *Polyporaceae* by Hibbett & Donoghue (1995) species belonging to *Polyporus sensu stricto* were claded together with species *Lentinus* which again indicated the close relation between these two genera. The molecular phylogenetic studies by Hibbett & Thorn (2001), Binder & Hibbett (2002), Ko & Jung (2002), Krüger & Gargas (2004), Sotome *et al.* (2008), Seelan *et al*. (2015) also confirm the closeness of the gilled genus *Lentinus* with members of Polyporaceae. *Lentinus*, along with *Polyporellus* P. Karst. (one of the infrageneric group of *Polyporus*) formed sister clades with *Amauroderma* Murrill, *Ganoderma* P Karst. and *Perenniporia* Murrill (Sotome *et al.* 2008). In the phylogenetic study of Binder *et al.* (2013) and Zmitrovich & Kovalenko (2016), *Lentinus* was clustered in the core polyporoid clade, and *Panus* was settled in the residual polyporoid clade of the family Polyporaceae. Molecular phylogenetic study of the genus *Trametes* of Polyporaceae, using ITS, LSU and RPB2 sequence data by Welti *et al*. (2012), distinguished four distinct genera in the *Trametes* group. They are i) *Trametes* (species with pubescent to hirsute pileus surface, including *Lenzites betulinus* (L.) Fr. and *Coriolopsis polyzona* (Pers.) Ryvarden), ii) *Pycnoporus* (species with red basidiocarps which blackens in KOH) iii) *Artolenzites* Falck (tropical *Lenzites elegans*) and iv) *Leiotrametes* gen. nov. (tropical *Trametes menziesii*, *T. lactinea*, and *Leiotrametes* species). Tomšovský *et al.* (2006) studied the phylogeny of all European and one American species of the genus *Trametes* and related genera. The study confirmed the monophyly of the genus *Pycnoporus* inside the *Trametes* clade. Tomšovský (2008) and Justo & Hibbett (2011) considers *Pycnoporus* as a synonym of *Trametes*, because both genera were settled together in their studies.

According to the latest taxonomic concepts of Ryvarden (1991), Bernicchia (2005) and Justo *et al.* (2017), the major diagnostic characters of Polyporaceae members are: basidiomata that are resupinate, effused reflexed to pileate, hymenium smooth, poroid, daedaleoid, labyrinthine to lamellate hymenium, hyphal system dimitic to trimitic or sometimes monomitic, with clamp connections, rarely simple septate, with or without dendroid hyphal elements in the hymenium, absence of cystidia, and basidiospores that are smooth to ornamented, hyaline to brown, thin to thick walled. Members cause white rot type of wood decay.

Zmitrovich (2018) classifies Polyporaceae into three sub families, and four tribes:

1. Sub family *Polyporoideae* Fr.

The group includes species with diverse morphotypes, sometimes with melanized context and branched skeletal hyphae with distinct axial elements. Polporoideae has been divided into into 4 tribes:

i. *Polyporeae* Fr.–This group consists of species with polyporoid, trametoid, or fibroporioid basidiomata, and weakly melanized, hyaline sclerohyphae. *Atroporus* Ryvarden, *Cerioporus* Quél., *Echinochaete* D.A. Reid, *Favolus* Fr., *Polyporus* Micheli *ex* Adans. are some of the taxa recognized under this tribe.

ii. *Epitheleae* Zmitr.–This tribe mainly includes the crust fungi having resupinate to effused reflexed habit, and reduced sclerohyphae that are often fibrous in consistency. Some of the taxa treated in this group are *Epithele* (Pat.) Pat., *Grammothele* Berk. and *Porogramme* (Pat.) Pat.).

iii. *Lentineae* Fayod–This tribe is mainly characterized by melanized sclerohyphae and often thin walled basidiospores. *Daedaleopsis* J. Schröt., *Earliella* Murrill, *Fomes* (Fr.) Fr., *Hexagonia* Fr. and *Lentinus* Fr. are some of the genera belonging to this tribe.

iv. *Ganodermateae* Bondartsev et Singer –Mostly melanized sclerohyphae and thick walled basidiospores are the major features of this tribe. Some of the taxa placed in this tribe are *Amauroderma* Murrill, *Dichomitus* D. A. Reid, *Donkioporia* Kotl. *et* Pouzar, *Ganoderma* P. Karst. and *Perenniporia* Murrill.

2. Sub family *Trametoideae* Pinto-Lopes

This sub family is characterized by trametoid habit, white, cream, or carmine red context and sympodially branched skeletal hyphae with indistinguishable axial elements. Taxa such as *Coriolopsis* Murrill, *Lenzites* Fr., *Trametes* Fr belong to this group.

3. Sub family *Lopharioideae* Zmitr.

Members of this sub family are distinguished by stereoid or corticioid habit, coloured or uncoloured context, poroid to hydnoid, uneven hymenium and fibrous skeletal hyphae. *Dentocorticium* (Parmasto) M. J. Larsen *et* Gilb., *Dextrinoporus* H. S. Yuan in Yuan *et* Qin and *Lopharia* Kalchbr. are included under this sub family.

GENUS *AMAURODERMA* MURRILL

The genus *Amauroderma* was proposed by Murrill in 1905, with *Fomes regulicolor* Berk. *ex* Cooke (=*Amauroderma schomburgkii* (Mont. & Berk.) Torrend) as the type species (Santana & Leite 2013). *Amauroderma* was earlier placed as a section of genus *Ganoderma* P. Karst. by Patouillard (1889a). The key character used to differentiate species of *Amauroderma* was the nature of basidiospores (Lloyd 1912). A work on the genus in South America was carried out by Torrend (1920) who recorded 28 species, placed in 3 sections, mainly characterized by stipitate basidiomata with globose or oblong, non truncate basidiospores. However, Cunningham (1965) recognized only 18 species under *Amauroderma*, from tropical and subtropical regions of the world. An infundibuliform, umbonate pileus with concentric zonations, and stipe with bulbous base were also considered as important characters for species recognition in *Amauroderma* by Otieno (1968). Furtado (1981) modified the genus concept of *Amauroderma*, and characterized the genus by the stipitate basidiomata, double walled, globose to subglobose basidiospores, and with tropical distribution. Pileus surface characters were also considered as important in the genus by Furtado (1981). Some of the other earlier studies in taxonomy of the genus were by Ryvarden & Johansen (1980), Corner (1983), and Moncalvo & Ryvarden (1997). According to

Nuñez & Ryvarden (2000) and Ryvarden (2004), basidiospores of *Amauroderma* are round to oblong ellipsoid, double walled, with a smooth, exosporium and a columnar endosporium. Zhao & Zhang (2000) reported 20 species of *Amauroderma* from China. But according to Hapuarachchi *et al*. (2018), only six species of these have been properly recognized under *Amauroderma* based on both morphological and phylogenetic studies. Twenty one species of *Amauroderma* were reported from the neotropics by Ryvarden (2004). According to Ryvarden (2004), species of *Amauroderma* can be distinguished from closely related *Ganoderma* by their non truncate basidiospores, and by their occurrence on buried roots/woods, while most *Ganoderma* species grow on dead wood.

Amauroderma was placed as a sister genus of *Ganoderma* based on the combined nLSU and mtSSU-rDNA sequence data analysis by Moncalvo (2000). However, from the study (Moncalvo 2000), it was not clear whether the genus was monophyletic (Gomes-Silva *et al.* 2015). According to a molecular phylogenetic study by Gomes-Silva *et al.* (2015), *Amauroderma* is polyphyletic and is segregated into different clades. The clade which included the type species of the genus, and other Brazilian *Amauroderma* species used in the study were defined as *Amauroderma sensu stricto*, and the remaining clades were assumed as new genera. Polyphyletic and heterogenous nature of the genus was also proven in the subsequent molecular phylogenetic studies (Costa-Rezende *et al.* 2016, 2017). Based on Costa-Rezende *et al* (2017), two new genera were segregated from *Amauroderma, Furtadoa* Costa-Rezende, Robledo & Drechsler-Santos, characterized by monomitic hyphal system, and *Foraminispora* Robledo, Costa-Rezende & Drechsler-Santos, characterized by hollow columnar endospore ornamentation. Recently another new genus, *Sanguinoderma* Y.F. Sun, D.H. Costa & B.K. Cui has been distinguished from *Amauroderma* by Sun *et al.* (2020). According to Sun *et al.* (2020), *Sanguinoderma* is morphologically differentiated from *Amauroderma sensu stricto* by its noticeable reaction in the pore surface, which easily turns blood red on bruising (Sun *et al.* 2020). The genus *Amauroderma* was treated under the Ganodermataceae by most workers (Bondartseva 1983a, 1983b; Bondartseva 1998; Ryvarden 1991; Hapuarachchi *et al.* 2018, 2018a, 2019).

However, according to the recent molecular phylogenetic works by Justo *et al.* (2017) and Zmitrovich (2018), *Amauroderma*, and related genera like *Ganoderma* and *Haddowia* (Steyaert) Zmitr. are considered as belonging to the family Polyporaceae. Justo *et al.* (2017) and Zmitrovich (2018) recognize the family Ganodermataceae as a synonym of the family Polyporaceae. The *Index Fungorum* database also accepts the genus *Amauroderma* under the family Polyporaceae (database accessed on 03 November 2020). Currently, the genus holds 74 species (*Index Fungorum*, accessed on 03 November 2020).

According to the latest concept (Ryvarden 2004; Gomes-Silva *et al.* 2010), *Amauroderma* is distinguished by the generally stipitate fruitbodies, globose to ellipsoid, hyaline to pale yellow, non truncated, double walled basidiospores with smooth to ornamented inner layer, and by the absence of cystidia. Species occurr on fallen dead wood, or roots of living or dead trees, in soil mixed with remains of decayed wood. Members have tropical and subtropical distribution. The genus causes white rot on wood.

Infrageneric classification

Species of *Amauroderma* were classified into three sections, by Torrend (1920) as follows:

Section *Polyporoídes a spores lisses ou legerement échinulées*

The group consisted of species with robust habit, and smooth, sparsely echinulate basidiospores.

Section *Polyporoides a spores reticules verruqueuses ou echinulees*

This section included species with robust habit, and warty or echinutate basidiospores.

Section *Polystictoíoes*

The group consisted of species with thinner and quite membraneous pileus.

Economic importance

Species of *Amauroderma* possess potential nutritional and therapeutic properties. *Amauroderma* species are commonly known as “epileptic child mushroom”, “*cendawan budak sawan*” (Malay language) or “*Jiazhi*” (China) (Chan *et al.* 2013; Hapuarachchi *et al*. 2018). This fungus possess good anti oxidant and anti inflammatory properties, and has been used by some natives of Malaysia for preventing epilepsy in Children (Chang & Lee 2004; Azliza *et al.* 2012; Chan *et al*. 2013). Presence of volatile constituents in *Amauroderma* species is thought to be responsible for their useful effects (Chan *et al.* 2015). Amauroamoienin, (l7R)-17-methylincisterol and jacareubin compounds present in *Amauroderma amoiense* J.D. Zhao & L.W. Hsu provides this fungus acetyl cholinesterase inhibitory activity (Zhang *et al.* 2013). A purified protein, amaurocine from *A. camerarium* (Berk.) J.S. Furtado fermentations were found to be effective against the sexually transmitted disease Trichomoniasis (Hapuarachchi *et al*. 2018). Amaurocine has anti toxic effects against parasites and pathogens, thereby improving immune system (Duarte *et al.* 2016).

Amauroderma species are well known for its pathogenicity. Members of the genus are generally parasitic on the roots of living or dead trees, and cause white rot (Hapuarachchi *et al*. 2018). *Amauroderma parasiticum* corner and *A. rude* (Berk.) Torrend is known to cause root rot disease on *Acacia mangium* plantations (Glen *et al.* 2009).

Distribution

The genus has a tropical and subtropical distribution: AFRICA: Kampala, Kenya, Rhodesia, Uganda (Otieno 1968), Liberia (Ryvarden 2004). NORTH AMERICA: Florida (Dollinger & Vlasák 2016). SOUTH AMERICA: Guyana (Aime *et al.* 2003), Brazil (Torrend 1920; Gulaid & Ryvarden 1998; Ryvarden & Meijer 2002; Groposo & Loguercio-Leite 2005; Coelho *et al.* 2007; Gibertoni *et al.* 2008; Campacci & Gugliotta 2009; Gomes-Silva *et al.* 2010; Gibertoni & Drechsler-Santos 2010; Gugliotta *et al.* 2010; Abrahão *et al.* 2012; Gomes-Silva & Gibertoni 2012; Campos-Santana & Loguercio-Leite 2012; Gomes-Silva *et al* 2015; Gugliotta *et al.* 2015; Costa-Rezende *et al*. 2016), Tropical America (Ryvarden 2004; Decock & Herrera-Figueroa 2006). ASIA: China (Teng 1936; Zhao *et al.* 1979, 1983; Zhao & Zhang 1987; Zhao & Zhang 2000), North Thailand (Núñez & Ryvarden 2000), Japan (Núñez & Ryvarden 2000), Malaysia (Lee *et al.* 2012), Philippines (Murrill 1908), Singapore (Corner 1983), Taiwan (Núñez & Ryvarden 2000), Valenzuela (Corner 1983; Ryvarden & Iturriaga 2004; Ryvarden 2004).

Species of *Amauroderma* such as *A. camerarium* (Berk.) J.Furtado, *A. fuscoporia* Wakef. *A. leptopus* (Pers.) J. Furtado, and *A. pudens* (Berk.) Ryv. have been reported from India (Mohanan 2011; Ranadive 2013).

GENUS *BRESADOLIA* SPEGAZZINI

Genus *Bresadolia* was erected by Spegazzini in 1883, with *B. paradoxa* as the type species. The genus was considered as a synonym of *Polyporus* Micheli *ex* Adans by Cunningham (1927). *Bresadolia* is differentiated from *Polyporus sensu lato* in having fleshy to watery basidiomata, papery and wrinkled pileus surface, absence of scales, inflated generative hyphae, and presence of skeletal hyphae (Motato-Vásquez *et al.* 2018).

Phylogenetically, *Bresadolia* belongs to the core polyporoid clade of Polyporales (Binder *et al.* 2013). In the recent study of Motato-Vásquez *et al.* (2018), the genus settled as a sister taxon to *Polyporus sensu stricto*. Currently, the genus is accepted under the family Polyporaceae, and holds five species according to *Index Fungorum* (accessed on 30 September 2020).

Major features of the genus are annual, laterally to centrally or eccentrically stipitate basidiomata, that are fleshy and watery when fresh, turning papery and easily broken when dry, flabelliform to infundibuliform pileus, pale yellow to ochraceous, azonate pileus that have a wrinkled and papery cuticle or with dark radial lines or pink to purplish spots, white to cream, fleshy context, round to angular pores that are decurrent on stipe, white to cream pore surface and cylindrical, fleshy to hard stipe. Microscopically, the genus is characterized by dimitic hyphal system, with inflated and clamped generative hyphae, fewer clamp connections in more inflated hyphae, absence of cystidia and cylindrical to subellipsoid, hyaline to slightly yellowish, thin walled, smooth, basidiospores, usually with large guttules, and inamylod in Melzer's reagent. Members cause white rot on wood (Motato-Vásquez *et al.* 2018).

Distribution

The genus is distributed in tropical and warm climatic regions. AFRICA: Kenya, Malawi, Tanzania (Ryvarden & Johansen 1980). NORTH AMERICA: Amazonia forests, Argentina, Cuba (Motato-Vásquez *et al.* 2018). SOUTH AMERICA: Bolivia, Brazil, Paraguay, Peru (Corner 1984; Silveira & Wright 2005). ASIA: China (Si & Dai 2016), Japan (Núñez & Ryvarden 1995), Java (Junghuhn 1840), Taiwan, Vietnam (Núñez & Ryvarden 2001).

From India, *B. uda* (Jungh.) Audet (as *Polyporus udus* Jungh) has been reported (Núñez & Ryvarden 1995; Ranadive 2013).

GENUS *CELLULARIELLA* ZMITROVICH & MALYSHEVA

Genus *Cellulariella* was established by Zmitrovich and Malysheva in 2014, with *Cellulariella acuta* (Berk.) Zmitr. & Malysheva as the type species. The genus was erected for accommodating two species of *Lenzites* Fr. (*L. acuta* Berk. and *L. warnieri* Durieu *et* Mont.), belonging in the *Trametes* group (Ryvarden 1991; Tomšovský 2008; Rajchenberg 2011; Welti *et al.* 2012; Carlson *et al*. 2014). In the molecular phylogenetic study of Welti *et al.* (2012), *Lenzites acuta* and *L. warnieri* were found to be distinct from other species of *Lenzites*. Zmitrovich & Malysheva (2013) proposed the name *Cellulariella* (as a substitution for the name *Cellularia nom. ambig*) for accommodating these two species. However, this was invalidly published. Later, the name *Cellulariella* was validly published by Zmitrovich & Malysheva (2014).

Cellulariella is characterized by annual to perennial, trametoid or scenidioid basidiocarps, poroid, large favoloid or daedaloid to lamellate hymenium, suberose, white to tan coloured context, dimitic hyphal system, generative hyphae with clamp connections, presence of pseudocystidia formed from the ends of skeletal hyphae and cylindrical, thin walled basidiospores that are acyanophilous and inamyloid in Melzer's reagent (Zmitrovich & Malysheva 2013; Zmitrovich 2018). Members of the genus cause white rot on wood.

Economic importance

The species *C. warnieri* is considered as an important medicinal mushroom mainly because of their antioxidant property (Savino *et al.* 2014, 2016; Knežević *et al.* 2017). According to Badyalan *et al.* (2019), *C. warnieri* could be used by humans food and medicine.

Distribution

Cellulariella has a wide distribution. AFRICA: Algeria (Donk 1974), Cameroon (Ambit & Mossebo 2015), East Africa (Ryvarden & Johansen 1980), Morocco (Pilát 1936–1942). NORTH AMERICA (Ryvarden & Gilbertson 1993), Costa Rica (González-Ball *et al.* 2004). ASIA: China (Dai *et al.* 2011; Dai 2012; Cui *et al.* 2019), Japan (Núñez & Ryvarden 2001), Kazakhstan (Švarcman 1964), Malaysia (Lee *et al.* 2012), Pakistan, Thailand (Núñez & Ryvarden 2001), Turkmenistan (Bondarsev 1953). AUSTRALIA: (Núñez & Ryvarden 2001). EUROPE: Armenia (Melik-Hacatryan & Martirosyan 1971), Austria (Passauer 1976), Bulgaria (Pilát 1936–1942), Caucasus (Bondarsev 1953), Czechoslovakia (Pilát 1936–1942), France (David 1967, Marchand 1975), Georgia (Bondarsev 1953), Hungary (Igmándy 1962), Italy (Bernicchia 2001).

Cellulariella acuta and *C. warnieri* has been reported from India by Bakshi (1971), Sankaran & Florence (1995), Florence & Yesodharan (1997), Florence & Yesodharan (2000), Sharma (2000), Leelavathy & Ganesh (2000), Florence (2004), Mohanan (2011), Ranadive (2013), Lyngdoh & Dkhar (2014), Rathod & Bendre (2015), and Pathania & Chander (2018).

GENUS *CORIOLOPSIS* MURRILL

Coriolopsis was established by Murrill in 1905, with *C. occidentalis* (Klotzsch) Murrill as the type. Recent mycologists consider *Coriolopsis polyzona*

(Pers.) Ryvarden as the type species (Niemelä *et al* 1992; Justo & Hibbett 2011; Li *et al*. 2016). *Coriolopsis* was placed in Polyporaceae by Bondartseva (1983), and in Poriaceae by Bondartseva (1998). The genus had been considered as a synonym of *Trametes* Fr., and many *Coriolopsis* species have been treated in the latter genus (Corner 1989; Tomšovský 2008; Justo & Hibbett 2011). According to Ryvarden (1991), and Justo & Hibbett (2011), brown context and coloured hyphae distinguish *Coriolopsis* from *Trametes. Funalia* Pat. also resembles *Coriolopsis*, but they possess white context and hyaline hyphae (Ryvarden & Johansen 1980; Li *et al*. 2016). Species of *Hexagonia* Fr. also show similarity with *Coriolopsis* in having coloured hyphae, but the former can be separated from the latter by their cyanophilous skeletal hyphae, and absence of a distinct sharp line above the context as present in *Trametes* (Ryvarden & Gilbertson 1993). Based on the phylogenetic study by Ko & Jung (1999), the genus *Coriolopsis* belonged to the *Trametes* group. In the study based on SSU rDNA and ITS sequence data (Ko 2000), four genera such as *Coriolopsis* (*C. polyzona* (Pers.) Ryvarden), *Lenzites* Fr., *Pycnoporus* P. Karst. and *Trametes* were grouped together under the core Polyporaceae clade. Morphological and cytological support for *Lenzites*-*Coriolopsis*-*Pycnoporus*-*Trametes* group was put forward by Rajchenberg (2011). Currently the genus is considered as polyphyletic with two lineages in the *Polyporus* clade that are distantly related with each other and the generic type (*C. polyzona*) in *Trametes* (Justo & Hibbett 2011). According to Zmitrovich & Malysheva (2013), *Coriolopsis sensu stricto* evolved through the trametoid subradiation of Polyporaceae. In the opinion of Justo *et al.* (2017), species of *Coriolopsis* warrants a new name since the type of the genus has been transferred to *Trametes*. Zmitrovich (2018) treats *Coriolopsis* as an independent genus. Currently 27 species are accepted in the genus (*Index Fungorum,* accessed on 30 September 2020).

Based on the current concepts (Ryvarden & Johansen 1980; Ryvarden & Gilbertson 1993; Justo & Hibbett 2011), *Coriolopsis* species are characterized by annual, resupinate to pileate basidiomata, velutinate to hirsute or sometimes glabrous, zonate or azonate pileus, yellowish to umber brown, hymenium poroid, pore surface concolorous with pileus, golden to umber brown context, trimitic hyphal system with clamped generative hyphae, hyaline to golden brownish skeletal hyphae, absence of cystidia, hyaline, cylindrical to oblong ellipsoid, smooth, thin walled basidiospores that are negative in Melzer's reagent. Members cause white rot on hardwoods.

Economic importance

Coriolopsis gallica (Fr.) Ryvarden is known to possess antimicrobial, immunomodulatory and cytotoxic activities (Fakoya & Oloketuyi 2012; Ranadive *et al.* 2013a; Doskocil *et al.* 2016). Presence of laccase provides *Coriolopsis* species the ability to decolourize industrial and textile waste waters and synthetic dyes (Murugesan & Kalaichelvan 2003; Jaouani *et al*. 2006; Xu *et al*. 2016; Champagne 2009; Nandal *et al*. 2013; Chen & Ting 2015; Daâssi *et al.* 2014; Cheng *et al*. 2016).

Distribution

Coriolopsis species has a cosmopolitan distribution: AFRICA: Angola (Ryvarden & Johansen 1980), Cameroon (David & Rajchenberg 1992; Roberts & Ryvarden 2006; Douanla-Meli *et al.* 2007), Ethiopia, Malawi, Sierra Leone, Zambia (Ryvarden & Johansen 1980). NORTH AMERICA (Gilbertson & Ryvarden 1986; Zhou *et al*. 2016). SOUTH AMERICA: Argentina (Robledo & Rajchenberg 2007), Brazil (Ryvarden 1988; Drechsler-Santos *et al.* 2008; Nogueira-Melo *et al.* 2012), Andes-Amazon (Salvador-Montoya *et al*. 2012), United States of America (Bishop & McGrath 1978). ASIA: (Núñez & Ryvarden 2001), China (Dai 2011; Dai *et al*. 2011; Dai 2012; Li *et al*. 2016; Cui *et al.* 2019), Israel (Ţura *et al.* 2010), Malaysia (Corner 1989a; Yamashita *et al.* 2009; Bolhassan *et al.* 2012; Lee *et al.* 2012), Singapore (Corner 1989a), Thailand (Choeyklin *et al.* 2011). EUROPE: Central Sweden (Ryvarden & Gilbertson 1993; Ryvarden & Melo 2014), Italy (Bernicchia 2001; Bernicchia *et al.* 2007).

Species of *Coriolopsis* reported from India are *C. brunneo-leuca* (Berk.) Ryvarden, *C. gallica* (Fr.) Ryvarden, *C. occidentalis* (Klotzsch) Murrill and *C. telfairii* (Klotzsch) Ryvarden (Bakshi 1971; Sankaran & Florence 1995; Roy & De 1996; Florence & Yeshodharan 1997; Florence & Yeshodharan 2000; Leelavathy &

Ganesh 2000; Prasher & Lalita 2013; Ranadive 2013; Nagadesi *et al.* 2014; Verma *et al.* 2008; Mohanan 2011).

GENUS ***EARLIELLA*** MURRILL

Earliella is a monotypic genus established by Murrill in 1905, with *Earliella cubensis* Murrill (currently *E. scabrosa* (Pers.) Gilb. & Ryvarden) recognized as the type species. Corner (1990) considered *Earliella* under *Trametes* Fr. (Zmitrovich 2018), and Ryvarden (1991) treated the genus in the *Trametes* group. The genus consists of only a single species, *E. scabrosa*. In the molecular phylogenetic work on *Trametes* by Justo & Hibbett (2011), *Earliella* formed a clade along with *Daedaleopsis* J. Schröt., in the trametoid group of the large polyporoid clade. Based on Binder *et al.* (2013), *Earliella* is positioned in the core polyporoid clade of Polyporales. Justo *et al.* (2017), and Zmitrovich (2018) accept the genus under Polyporaceae.

According to Nuñez & Ryvarden (2001), Bernicchia (2005) and Zmitrovich (2018), the genus is described by annual to perennial, effused relaxed to pileate basidiomata, often with a broad decurrent base, suberose, white to cream context, dimitic hyphal system with clamped generative hyphae, skeletal hyphae with dendroid branchings, absence of cystidia, usually with a dense agglutinated layer in the crust region made of yellowish brown clavate, thick walled cells, basidia with basal clamp connections, and ellipsoid to cylindrical basidiospores that are acyanophilous and inamyloid. Members of the genus cause white rot on wood.

Economic importance

Earliella scabrosa has many pharmaceutical applications since they are reported to have anticancerous, antimicrobial, antioxidant and free radical scavenging properties (Liew *et al.* 2015, Zmitrovich *et al.* 2017). According to Peng & Don (2013), *in vitro* grown *E. scabrosa* possessed antifungal activity. *Earliella sacbrosa* is also able to decolourize various artificial dyes that are serious environmental pollutants (Erkut 2010; Lyra *et al.* 2009; Moreira-Neto *et al*. 2013).

Distribution

Earliella has a pantropical distribution (Ryvarden 1991). AFRICA: Cameroon (Roberts & Ryvarden 2006), East Africa (Ryvarden & Johansen 1980). NORTH AMERICA (Murrill 1905; Gilbertson & Ryvarden 1986; Zhou *et al.* 2016). SOUTH AMERICA: Brazil (Groposo & Loguercio-Leite 2005; Salvador-Montoya *et al.* 2012), Guyana (Aime *et al.* 2003). ASIA: Malaysia (Corner 1989a, Lyra *et al*. 2009; Yamashita *et al.* 2009; Bolhassan *et al.* 2012; Lee *et al.* 2012; Peng & Don 2013), China (Dai *et al*. 2011; Dai 2012; Cui *et al.* 2019), Japan, Taiwan, Far East Russia, Northern Thailand, Vietnam (Nuñez & Ryvarden 2001): EUROPE: Italy (Bernicchia 2005).

Earliella scabrosa has been reported from India by Ramakrishnan (1959), Rangaswamy *et al.* (1970), Bilgrami *et al*. (1991), Mohanan (1994), Sankaran & Florence (1995), Hosagoudar *et al*. (1996), Roy & De (1996), Florence & Yesodharan (1997), Florence & Yesodharan (2000), Thind & Chatrath (1960), Bakshi (1971), Leelavathy & Ganesh (2000), Sharma (2000), Verma *et al.* 2008, Mohanan (2011), Ranadive *et al*. (2011), Prasher & Lalita (2013), Ranadive (2013) and Saha *et al.* (2018).

GENUS *ECHINOCHAETE* REID

Echinochaete was erected by Reid in 1963, with *Echinochaete megalopora* (Bres.) D.A. Reid (currently *E. brachypora* (Mont.) Ryvarden) as the type species. Bondartseva (1983a, 1983b) placed the genus under a separate family Echinochaetaceae Jülich. According to Sotome *et al.* (2009), the genus *Asterochaete* Bondartsev & Singer, earlier established by Bondartsew & Singer (1941) resembled *Echinochaete*, but the former genus was illegitimate, since the name was used for a genus of the Cyperaceae. A similar genus *Dendrochaete* G. Cunn. typified by *D. russiceps* (Berk. & Broome) G. Cunn. was erected by Cunningham (1965), but was treated as a synonym of *Echinochaete* by many workers (Ryvarden & Johansen 1980; Corner 1984; Núñez & Ryvarden 1995, 2001; Sotome *et al.* 2008). Presence of setal elements on the pileal surface, as well as in the hymenium, and the strong dextrinoid reaction in Melzer’s reagent of hyphae in the context are considered as the important distinguishing characters of the genus by Ryvarden & Johansen (1980). According to Ryvarden & Johansen (1980), species in the genus are mainly distinguished by differences in the form of basidiocarps and shape of setal elements rather than the differences in the hyphal characters and size of basidiospores. The genus has been subjected to many studies along with species of *Polyporus*, because of the closeness of two genera (Corner 1984; Núñez & Ryvarden 1995; Silveira & Wright 2005; Sotome *et al*. 2008; Coelho & Silveira 2014; Palacio *et al.* 2017). The presence of distinct setal elements distinguishes it from *Polyporus* (Sotome *et al*. 2008; Coelho & Silveira 2014). Based on Binder *et al.* (2013), *Echinochaete* belongs to the core polyporoid clade, under the family Echinochaetaceae, closely related with *Polyporus*. However, Justo *et al*. (2017) & Cui *et al.* (2019) consider Echinochaetaceae as a synonym of Polyporaceae. At present, the genus consists of five species, *E. brachypora*, *E. cinnamomeosquamulosa* (Henn.) D.A. Reid, *E. maximipora* Sotome & T. Hatt, *E. ruficeps* (Berk. & Broome) Ryvarden, and *E. russiceps* (Berk. & Broome) D.A. Reid (*Index fungorum*, accessed on 30 September 2020).

Species of this genus are distinguished by annual, short, laterally stipitate basidiomata, dimitic hyphal system, generative hyphae with clamp connections, arboriform skeleto ligative hyphae that are dextrinoid in Melzer's reagent, spinulose setae like structures on the pileipellis region and hymenium, and ellipsoid to cylindrical, hyaline, smooth, thin walled basidiospores that are inamyloid in Melzer's reagent (Ryvarden & Johansen 1980; Corner 1984; Núñez & Ryvarden 1995, 2001; Silveira & Wright 2005; Sotome *et al*. 2008; Zmitrovich 2018). Species of *Echinochaete* cause white rot on wood.

Economic importance

The secondary metabolites in *E. brachypora* (Mont.) Ryvarden is known to possess antimicrobial activity (Chemutai *et al.* 2018; Sum *et al*. 2019).

Distribution

The genus has pantropical distribution (Ryvarden 1991): AFRICA: Kenya, Burundi, Malawi, Tanzania, Uganda (Ryvarden & Johansen 1980), Cameroon (Roberts & Ryvarden 2006). NORTH AMERICA: Mexico (Welden *et al.* 1989). SOUTH AMERICA: Brazil (Coelho & Silveira 2014), Cayenne (Saccardo 1888), Quintana Roo (Welden *et al.* 1989). ASIA: China (Dai 2012, Cui *et al*. 2019), Ceylon (Berkeley & Broome 1873), Japan (Aoshima & Abe 1983; Núñez & Ryvarden 1995, 2001; Sotome *et al*. 2009), Malaysia (Lee *et al*. 2012; Bolhassan *et al*. 2012), Singapore (Corner 1984), Vietnam (Núñez & Ryvarden 2001), Sri Lanka (Reid 1976). AUSTRALIA: New South Wales, New Zealand (Cunningham 1965), Papua New Guinea (Corner 1984). EUROPE: New Caledonia (Reid 1976).

From Kerala, one species (*E. ruficeps*) has been reported (Mohanan 2011).

GENUS ***FAVOLUS*** FRIES

Genus *Favolus* was established by Fries in 1828, with *F. brasiliensis* (Fr.) Fr. as the type species. The genus was erected for accommodating species having fleshy basidiocarps and radially arranged pores. However, most of the mycologists (Corner 1984; Ryvarden 1991; Núñez & Ryvarden 1995, 2001; Ryvarden & Iturriaga 2003; Silveira & Wright 2005; Drechshler-Santos *et al*. 2008; Kirk *et al*. 2008) treated *Favolus* as a synonym of genus *Polyporus* P. Micheli *ex* Adans., because of the macro and micromorphological similarities between these two genera. Ryvarden & Johansen (1980) recognized *Favolus* as a distinct genus. According to Ryvarden (1991), acceptance of *Favolus* as a separate genus by Johansen & Ryvarden (1980) was because of a wrong supposition that *F. brasiliensis* possessed simple septate generative hyphae. Núñez & Ryvarden (1995) treated *Favolus* as one of the six infrgeneric groups of *Polyporus,* and defined the group by the flabelliform to dimidiate pileus and a short lateral stipe without a dark crust. In the phylogenetic study of Sotome *et al.* (2013) the infrageneric group *Favolus* was separated into two major clades, *Favolus* and *Neofavolus* Sotome & T. Hatt., which according to them was distinguishable at the generic level. According to Sotome *et al.* (2013), genus *Favolus* was characterized by basidiomata with radially striate pileus surface, often undifferentiated pileipellis, composed of non agglutinated, interwoven hyphae (with *F. pseudobetulinus* as an exception), whereas the genus *Neofavolus* was was distinguished by glabrous pileus with or without scales, and pileipellis composed of parallel and agglutinated hyphae. Currently 77 species are listed under *Favolus* (*Index Fungorum*, accessed on 30 September 2020).

The genus is characterised by annual, dimidiate, flabelliform to spathulate basidiomata, which are usually thin and soft in consistency, turning brittle and light weighted on drying, glabrous to weakly tomentose pileus that are smooth or radially striated, white to cream coloured when fresh, hexagonal to radially elongated hymenium, thin context, dimitic hyphal system with generative hyphae, with or without clamp connections, sparsely branched skeletal hyphae, absence of cystidia and cylindrical to weakly navicular, smooth, thin walled basidiospores that are inamyloid in Melzer's reagent. *Favolus* species occur on angiosperms and cause white rot (Ryvarden & Johansen 1980; Papp & Dima 2017; Zhou & Cui 2017).

Economic importance

Favolus tenuiculus P. Beauv. is a well known edible (Ruán-Soto *et al.* 2006; Salmones *et al*. 2005; Gamboa-Trujillo *et al.* 2019), and is available in the markets of the Gulf of Mexico (Omarini *et al*. 2009).

Distribution

Favolus has a pantropical distribution (Ryvarden & Johansen 1980). AFRICA: Cameroon (Roberts & Ryvarden 2006), Kenya, Malawi (Ryvarden & Johansen 1980), Tanzania (Juma *et al*. 2016); NORTH AMERICA: Costa Rica, Jamaica (Murrill 1905), United States of America (Overholts 1953; Bishop & McGrath 1978). SOUTH AMERICA: Argentina (Robledo & Rajchenberg 2007), Brazil (Borges Da Silveira & Wright 2002; Gibertoni *et al.* 2004; Groposo & Loguercio-leite 2005, Sotome *et al*. 2011), French Antilles and Guiana (David & Rajchenberg 1985. ASIA: China (Dai 2012; Zhou *et al*. 2016; Zhou & Cui 2017; Cui *et al*. 2019), Japan (Núñez & Ryvarden 2001; Sotome *et al.* 2011), Malaysia (Lee *et al*. 2012), Singapore (Llyod 1920, Sotome *et al.* 2013), South Korea

(Tibpromma *et al.* 2017), Thailand, Vietnam (Núñez & Ryvarden 2001). EUROPE: Hungary (Papp & Dima 2017), Sweden (Ryvarden & Melo 2014).

From India, species of *Favolus* such as *F. bengala* Bose, *F. brasiliensis* (Fr.) Fr., *F. jacobaeus* Sacc. & Berl., *F. tenuiculus* P. Beauv., *F. grammocephalus* (Berk.) Imazeki and *F. tessellatulus* (Murrill) Sacc. & D. Sacc. have been reported (Bose 1919, 1927, 1937; Thind & Chatrath 1957, Bakshi 1971; Leelavathy & Ganesh 2000; Mohanan 2011; Prasher & Lalita 2013; Ranadive 2013; Saha *et al.* 2018).

GENUS *GANODERMA* P. KARSTEN

The genus *Ganoderma* was erected by Karsten in 1881 for placing laccate and stipitate white rot polypore *Polyporus lucidus* W. Curt (Murrill 1902). Later, 1887, Patouillard included all members of polyporaceae with coloured spores, adhering tubes, and shining crusted pilei under the genus *Ganoderma*. He also published a partial monograph on the genus in 1889 which represented forty eight species (Murrill 1902). In 1889a, Patouillard classified the genus into two sections, section *Ganoderma*, and section *Amauroderma*. Karsten (1889) created another genus *Elfvingia* Karst. for including non laccate *Ganoderma* species with *Polyporus applanatus* (Pers.) Wallr. as the type species. Genus *Tomophagus* Murrill was erected by Murrill (1905b) for placing *Polyporus colossus* Fr. which was later considered as a synonym of *Ganoderma* by Furtado (1965), Steyaert (1972) and Ryvarden (1991). Steyaert (1980) believed that *G. colossus* (Fr.) C.F. Baker could be a tropical variant of the temperate western North American species, *G. oregonense* Murrill, which also possesses soft and pale context as *G. colossus*. Coleman (1927) studied the structure of the spore wall in *Ganoderma* and suggested that all species having basidiospores which are usually truncate, with hyaline outer wall separated from brown spiny inner wall by inter wall pillars should be placed under the genus *Ganoderma*. Members of the genus are treated under several complexes such as *G. lucidum* complex (Adaskaveg & Gilbertson 1988; Hapuarachchi *et al* 2015), *G. parvulum* complex, *G. resinaceum* complex (Steyaert 1980), *G. valesiacum* complex (Monocalvo *et al*. 1995a), and *G. applanatum-australe* species complex (Adaskaveg & Gilbertson 1988; Moncalvo & Buchanan

2008). *Ganoderma lucidum* complex includes *G. lucidum* and its allied species (Monocalvo *et al*. 1995a). According to Hapuarachchi *et al*. (2015), this complex is represented by seventeen species such as *G. ahmadii*, *G. boninense*, *G. carnosum*, *G. flexipes*, *G. lingzhi* , *G. lucidum*, *G. multipileum*, *G. oerstidii*, *G. oregonense*, *G.pfeifferi*, *G. resinaceum*, *G. sessile, G. sichuanense*, *G. tropicum*, *G. tsugae, G. valesiacum* and *G. zonatum.* Taxa such as *G. bibadiostriatum*, *G. stipitatum* and *G. parvulum* belong to *Ganoderma parvulum* complex (Steyaert 1980). According to Steyaert (1980), *G. resinaceum* complex consists of *G. lucidum* and *G. resinaceum*. *G. valesiacum,* G. *tsugae,* G. *oregonense* and *G. carnosum* forms *G. valesiacum* complex (Monocalvo *et al*. 1995a). The non laccate species *of Ganoderma* such as *G. adspersum*, *G. applanatum*, *G. australe*, *G. gibbosum*, *G. lobatum*, *G. philippii* constitutes *G. applanatum-australe* species complex (Moncalvo & Buchanan 2008). In 1988, Adaskaveg & Gilbertson studied and compared basidiospores, pileocystidia and other basidiocarp characters of some species of *Ganoderma lucidum* complex (*G. tsugae*, *G. zonatum*, *G. colossus*, *G. meredithae* and *G. oregonense*), which showed affinities with *G. lucidum.* A world list of *Ganoderma* species has been published by Moncalvo & Ryvarden (1997). The variations in micromorphological characters such as thickness of inter walled pillars of basidiospores, pillar disposition and pileipellis structure shown by different species under sub genus *Ganoderma*, has been described by the authors in detail and they consider these as valuable characters for species recognition of the genus. According to Moncalvo (2000), high morphological variability, misinterpretations of different taxonomic characters like, colour and consistency of fruit bodies of *Ganoderma*, have greatly contributed to the erection of unwanted synonyms, and to the lack of proper identification keys. The detailed morphology of *Ganoderma* species with laccate surface was described by Torress-Torress & Guzmán-Devalos (2012a). Taxonomy of *Ganoderma* is always in a state of confusion and one-third of the species placed in this genus are synonyms (Wang *et al*. 2014).

Molecular phylogenetic studies on hymenomycetous fungi using sequences from nuclear small subunit were conducted by Hibbett & Donoghue (1995), and Hibbett *et al.* (1997). According to these works, *Ganoderma* belonged to a group of white rot fungi that included *Trametes*, *Fomes*, *Polyporus*, *Lentinus*, *Datronia*, *Pycnoporus*, and many other polypore genera. Hseu *et al*. (1996) used RAPD – Polymerase chain reaction, and internal transcribed spacer sequences to differentiate the isolates of *G. lucidum* complex. Park *et al*. (1994), Gottlieb *et al*. (1995, 1998), and Gottlieb & Wright (1999a) carried out isoenzyme analysis for discriminating species of *Ganoderma*. Moncalvo *et al*. (1995) used nrDNA ITS sequences to differentiate species of *Ganoderma*. Based on Moncalvo *et al.* (1995), *Ganoderma* was distinct from *Amauroderma*, and the sub genus *Elfvingia* formed a monophyletic clade with good support. Their study does not support the categorization of *Ganoderma* to different sections based on pileocystidia shape as proposed by Steyaert (1980). Moncalvo *et al.* (1995) considered *Ganoderma* as a recently derived genus because of their low sequence difference observed in the 28S ribosomal gene. The taxonomy of the *G. lucidum* complex was revised in their study (Moncalvo *et al.* 1995a), and according to the authors, extensive convergence or parallelism of morphological characters has occurred during *Ganoderma* evolution, and also, remarkable morphological difference may occur with less divergence time. Based on the phylogenetic study conducted by Moncalvo *et al.* (1995a), laccate species of *Ganoderma* has a tropical origin, and there is less correlation between rDNA gene phylogeny and morphology in the *G. lucidum* complex. Literature also suggests that culture characters are less polymorphic than morphological characters between recently diverged taxa and therefore not useful in distinguishing monophyletic groups. The genus *Amauroderma* was placed as a sister genus of *Ganoderma* based on the combined nLSU and mtSSU-rDNA sequence data (Moncalvo 2000). Moncalvo *et al.* (1995), Moncalvo (2000) and Hong & Jung (2004) supports the recognition of *Tomophagus* as a distinct genus, and not as a synonym of *Ganoderma,* as previously considered by Furtado (1965), Steyaert (1972), Steyaert (1980) and Ryvarden (1991). The nrDNA ITS sequences were used by different workers in identifying species of *Ganoderma* (Gottlieb *et al*. 2000; Smith & Sivasithamparam 2000; Wang *et al*. 2014).

Molecular phylogenetic study on *Ganoderma* based on nearly complete mitochondrial small subunit ribosomal DNA (mtDNA SSU) was conducted by Hong *et al.* (2002) and according to their study, mtDNA SSU carried 3.3 times more information than nrDNA ITS sequences between the studied *Ganoderma* species. As per Hong & Jung (2004), the variable domains of mt SSU rDNA form a useful marker for delineation of phylogenetic groups within *Ganoderma*. The strains of *Ganoderma* used in the study (Hong & Jung 2004) were divided into six monophyletic groups and *Ganoderma lucidum,* the most cosmopolitan member of *Ganoderma,* was polyphyletic according to geographical origins. A study on global diversity of *Ganoderma lucidum* complex based on morphology and multilocus phylogeny was carried out by Zhou *et al.* (2014). As per the study (Zhou *et al.* 2014), *Ganoderma* species did not cluster in a single monophyletic clade, instead were grouped into different lineages with species from different geographical regions. The genus *Ganoderma* was treated under the separate family Ganodermataceae until recently. According to the latest works (Justo *et al.* 2017; Zmitrovich 2018), the genus is positioned under the family Polyporaceae. The *Index Fungorum* database also accepts *Ganoderma* under the family Polyporaceae (database accessed on 22 October 2020). Currently 234 species have been recognized under the genus (*Index Fungorum*, accessed on 03 November 2020).

According to the concepts of Bazzalo & Wright (1982), Ryvarden & Gilbertson (1993) and Hapuarachchi *et al*. (2015), genus *Ganoderma* is characterized as follows:

Fruit body annual or perennial, terrestrial or lignicolous, stipitate or sessile. Pileus suface either dull or shiny and laccate. Fruit bodies with laccate surface possess clavate end cells. Hymenophore cream coloured, turns brown on bruising, pores regular, tube layers single or stratified. Stipe central to lateral. Context cream coloured to dark purplish brown, soft and spongy to fibrous. Hyphal system dimitic to trimitic. Generative hyphae possess clamp connections. Skeletal hyphae hyaline to brown, non septate, with long tapering branches. Basidia clavate, hyaline. Cystidia present or absent. Basidiospores narrowly to broadly ellipsoid, non amyloid, apex truncate, apical germ pore visible. Spore wall is two layered, with brown endosporium which is separated from a hyaline exosporium by inter wall pillars. Members of the genus cause uniform or mottled white rot of dead and living hardwoods and conifers. They grow as a facultative parasite that can also live as saprobes on stumps and roots (Hapuarachchi *et al*. 2015).

Infrageneric classification

Ganoderma was initially grouped in to two sections by Patouillard (1889a), section *Ganoderma* and section *Amauroderma*. Shiny pileal surface and characteristically double walled, truncate basidiospores characterized section *Ganoderma*, and subspherical or spherical, uniformly thickened basidiospores characterized section *Amauroderma*. The section *Amauroderma* Pat. was later elevated to the genus level by Murrill (1905a). The genus *Elfvingia* P. Karst. created by Karsten (1889), for placing non laccate *Ganoderma* species was revised later to include all species that lacked pileocystidia, and was treated as a sub genus of *Ganoderma* (Imazeki 1939; Steyaert 1980). *Elfvingia* possessed a trichodermal type of cutis anatomy (Lohwag 1941). Murrill (1908), Imazeki (1943), Kotlaba & Pouzar (1957), Pegler (1973a) and Cunningham (1965) accepted *Elfvingia* at the genus level, while it was reduced to synonym of *Ganoderma* by Furtado (1965). Zhao *et al.* (1981) treated *Elfvingia* Karst. at the subsectional level under the genus *Ganoderma*. Incorporation of *Elfvingia* into sub genus of *Ganoderma* automatically resulted in creation of sub genus *Ganoderma* (Steyaert 1980). Pileipellis type was described as "trichoderm" in *Elfvingia* and as "*hymenioderm*" in sub genus *Ganoderma* (Steyaert 1980). Clémençon (2004) defined pileipellis type in sub genus *Ganoderma* as "crustohymeniderm" and similarly, *Elfvingia* pileipellis was later called as "crustotrichoderm". Gottlieb & Wright (1999, 1999a) studied the macro and micromorphology of the two sub genera. According to Moncalvo (2000), the presence of thick walled pileocystidia in members of the sub genus *Ganoderma*, gives them a laccate appearance. Sub genus *Ganoderma* comprised of species having glossy pileus with hymenodermic pileipellis (Torress-Torress *et al.* 2015). Sub genus *Ganoderma* was again divided into two sections; section *Ganoderma* and section *Characoderma*. Former included those species with swollen, almost cylindrical hymenioderm elements, and the latter with non swollen hymenioderm elements, but sometimes with spheroid inflation. Later, based on cutis anatomy, two more sub genera were recognized under the genus *Ganoderma*; sub genus *Anamixoderma*, which include species with cutis composed of hyaline or brown loosely intermixed hyphae covered by melanoid substances, and sub genus *Plecoderma* in which members have cutis, which form a distinct layer from context, composed of hyaline hyphae that are densely interwoven and encrusted with melanoid substances (Steyaert 1980; Moncalvo & Ryvarden 1997). Based on the concepts of Zhao & Zhang (2000), the genus *Ganoderma* consists of the sub genus *Ganoderma*, sub genus *Eflvingia* and sub genus *Trachyderma* Imazeki. However, as per Richter *et al*. (2014), *Trachyderma* is an illegitimate name because there is a lichenised genus called *Trachyderma* Norman, and hence this sub genus is treated as a synonym of *Ganoderma*.

Zmitrovich (2018) recognizes four sub genera under the genus *Ganoderma*; sub genus *Ganoderma* (characterized by annual basidiomata, pilepellis comprised of hymenoderm, and echinulate exosporium), sub genus *Humphreya* (annual basidiomata, pileipellis comprised of hymenoderm or anamixoderm, and reticulate exosporium) sub genus *Haddowia* (annual basidiomata, pileipellis comprised of hymenoderm, and costate exosporium, and sub genus *Elfvingia* (perennial basidiomata, pileipellis comprised of anamixoderm, and echinulate exosporium. However, *Humphreya* and *Haddowia* are currently treated as independent genera under the family Polyporaceae (*Index Fungorum*, accessed on 18 October 2020). Subdivision of the genus in to two sub genera (*Ganoderma* and *Elfvingia*) based on pileal surface features, has been recently questioned in the molecular phylogenetic study by Tchoumi *et al.* (2019). Tchoumi *et al.* (2019) opined that, the laccate and non laccate species may not always form two distinct groups in the phylogenetic tree, and hence, separation of *Ganoderma* species at the sub generic level does not always indicate exact phylogenetic relationships.

Economic importance

Species of *Ganoderma*, especially *G. lucidum* possess potential medicinal properties. This species is commonly called as *reishi* mushroom (United States), *Ling zhi*, *Chi–zhi*, *Rui–zhi*, (China), *reishi*, *mannentake*, *sachitake* (Japan) and *youngzhi* in Korea (Upton 2006). As per Upton (2006), *reishi* mushroom is the most significant of all Japanese medicinal polypores. In China, it is variously known as "mushroom of immortality", "ten thousand year mushroom", "mushroom of spiritual potency" and "spirit plant" (Huang 1993; Liu & Bau 1994). Apart from *G. lucidum*, *G. applanatum*, *G. japonicum*, and *G. tsugae* are used as medicine and traded as reishi mushroom in United States (Upton 2006). According to Chang & Miles (2004), the presence of various bioactive compounds in fruitbodies of *Ganoderma*, like polysaccharides, triterpenes, fattyacids, nucleotides, proteins, sterols, minerals and vitamins are responsible for the medicinal property of this mushroom. *Ganoderma lucidum* has anti tumour, anti inflammatory, anti chronic bronchitis, immunoenhancing, cardiovascular regulating and hepato protectant properties (Upton 2006). They are used in the treatment of different types of cancers (Zhang *et al.* 2010; Hapuarachchi *et al.* 2016), Type 2 diabetes mellitus (Seto *et al.* 2009), gastric ulcers (Rony *et al.* 2011), hepatitis (Li & Wang 2006), hyperlipidemia (Chen *et al.* 2005) and hypertension (Morigiwa *et al.* 1986). The anticancer activity of *G. lucidum* is due to the presence of methanol soluble triterpenoid extracts, called as ganoderic acids (GAs) in their fruit body (Radwan *et al.* 2011).

Ganoderma lucidum is effective against muscular dystrophy, arteriosclerosis, hypercholesterolemia, leucopenia (Nahata 2013) and posseses anti aging (Saltarelli *et al.* 2009 and anti microbial properties (Wang & Ng 2006). This fungus is also known to have anti Human Immuno Deficiency Virus (HIV) activity (EL-Mekkawy *et al.* 1998). According to Bishop *et al.* (2015), a large number of *G. lucidum* products are commercially available as nutraceuticals in the form of tonics, pills or powders. Another species, *Ganoderma subresinosum* is known to possesses anti acetyl cholinesterase activity (Wang *et al.* 2016). Some of the studies on the medicinal properties of *Ganoderma* are by Liu (1974), Morigiwa *et al.* (1986), Komoda *et al.* (1989), Jong & Birmingham (1991), Mizuno (1995), Bisko & Mitropolskaya (1999), Chang & Buswell (1999), Eo *et al.* (1999, 2000), Gao *et al.* (2003, 2005), Shiao (2003), Chang & Miles (2004), Shao *et al.* (2004), Zhao *et al.* (2005), Kuo *et al.* (2006), Li *et al.* (2005), Lin (2005), Peng *et al.* (2005), Li &

Wang (2006), Ajith & Janardhanan (2007), Boh *et al.* (2007), Dai & Bau (2007), Chen *et al*. (2008), Ajith *et al.* (2009), Cherian *et al*. (2009), El Dine *et al*. (2009), Ferreira *et al.* (2009), Wu & Wang (2009), Huang & Ning (2010), Jung *et al.* (2011), Rony *et al.* (2011), De Silva *et al.* (2012), Liang *et al.* (2012), Xiao *et al.* (2012), Ansor *et al.* (2013), Zhu *et al.* (2013), Singh *et al*. (2014) and Hapuarachchi *et al.* (2016, 2017, 2018a, 2018b).

According to Selvakumar *et al.* (2012), Vantamuri (2017) and Sudiana *et al.* (2018), *Ganoderma* species have the ability to degrade and decolourize synthetic dyes which is one of the major toxic pollutants present in textile Industrial waste water. Similar studies were conducted by Murugesan *et al.* (2007) and Pratiwi *et al.* (2017) and proved the potential of *G. lucidum* in biodegradation of the toxic synthetic dyes. As per Al-Ghamdi (2016), vegetative mycelium of *G. applanatum* can be used for the treatment of azo dyes and other textile dye industry waste matter. Again, *Ganoderma lucidum* is capable of degrading polycycic aromatic hydrocarbons (phenanthrene and pyrene), one of the major toxic environmental pollutant by their laccase activity (Punnapayak *et al*. 2009; Agrawal *et al*. 2018).

Species of *Ganoderma* are economically important since they are capable of causing white rot disease on the wood they attack (Adaskaveg *et al.* 1991; Dai *et al.* 2007). They affect plantation crops like oil palm, coconut, rubber, betelnut, tea and other forest trees and result in considerable yield loss (Naidu *et al*. 1966). According to Naidu *et al.* (1966), 48 plant species belonging to 36 genera and 19 families have been infected by species of *Ganoderma*. *Ganoderma* rot or basal stem rot is one of the severe diseases affecting coconut palms (Harrison & Jones 2003). Different species of *Ganoderma* P. Karst. such as *G. applanatum* (Pers.) Pat., *G. boninense* Pat., *G. lucidum* (Curtis) P.Karst., and *G. zonatum* Murrill act as the causal agents of *Ganoderma* rot of coconut (Bhaskaran 2000; Elliot & Broschat 2001; Harrison & Jones 2003; Pilotti *et al.* 2003; Sankaran *et al*. 2005; Snehalatharani *et al*. 2016; Thamban *et al*. 2016). According to a recent study (Loyd *et al.* 2018), some species of *Ganoderma* (especially *G. curtisii*) are pathogenic on landscape trees such as

Pinus elliottii var. *elliottii*, *P. taeda*, *Quercus shumardii*, *Q. virginiana*, and *Butia odorata*.

Distribution

Ganoderma has a worldwide distribution, both in tropical and temperate geographical regions. According to Pilotti *et al.* (2004), they are generally found in subtropical and tropical regions since they are able to tolerate hot and humid conditions. *Ganoderma* species have been studied and documented from various parts of the world. AFRICA: Cameroon (Kinge & Mih 2011; 2014), Ghana, Kenya, Tanzania (Ryvarden & Johansen 1980), South Africa (Coetzee *et al*. 2015). NORTH AMERICA: Canada (Nobles 1948; Gilbertson & Ryvarden 1986), Costa Rica (Torres-Toress *et al.* 2012), Florida (Elliott & Broschat 2001), Jamaica (Ryvarden 2000), Tropical America (Ryvarden 2000, 2004), United States of America (Murrill 1902; Overholts 1953; Adaskaveg & Gilbertson 1988; Cao *et al*. 2012; Zhou *et al.* 2014). SOUTH AMERICA: Amazon (Weir 1926), Argentina (Bazzalo & Wright 1982), Brazil (Torrend 1920; Furtado 1967; Bononi *et al*. 1981; Rajchenberg & Meijer 1990; Loguercio-Leite & Wright 1991; Da Silva & Minter 1995; Gottlieb *et al.* 1998; Góes-Neto 1999; Gottlieb & Wright 1999; Meijer 2001; Gibertoni & Cavalcanti 2003; Góes-Neto *et al.* 2003; Groposo & Loguercio-Leite 2005; Loguercio-Leite *et al.* 2005; Moncalvo & Buchanan 2008; Drechsler-Santos *et al.* 2008, 2009; Baltazar & Gibertoni 2009; Gomes-Silva & Gibertoni 2009; Gibertoni & Drechsler-Santos 2010; Westphalen *et al.* 2010; Gomes-Silva *et al.* 2011; Torres-Torres *et al.* 2012). ASIA: China (Patouillard 1907; Hou 1950; Zhao *et al.* 1983; Zhao & Zhang 1986, 1987; Zhao 1989; Hong & Jung 2004; Wang *et al.* 2005; Dai *et al.* 2007; Wang & Wu 2008; Dai *et al.* 2009; Wang *et al.* 2009; Cao *et al*. 2012; Yang & Feng 2013; Zhou *et al*. 2014; Hapuarachchi *et al.* 2018a; Xing *et al.* 2018; Cui *et al.* 2019), Japan (Imazeki 1939), Malaysia (Steyaert 1975; Corner 1983; Rakib *et al.* 2014), Peninsular Malaysia (Zakaria *et al.* 2009), Philippines (Murrill 1907a), Thailand (Thawthong *et al*. 2017; Luangharn *et al.* 2019), Taiwan, Vietnam (Núñez & Ryvarden 2000). AUSTRALIA (Smith & Sivasithamparam 2000, 2003). EUROPE: Patouillard (1889, 1889a), Niemelä & Miettinen (2008), Finland

(Ryvarden & Melo 2014), Italy (Ryvarden & Melo 2014; Hapuarachchi *et al.* 2015), Norway (Ryvarden & Gilbertson 1993), Paris (Torrend 1920), United Kingdom (Moncalvo *et al.* 1994).

Forty eight species of *Ganoderma* has been reported from India till date (Ranadive 2016). Some of the major records are those of Bagchee *et al*. (1954), Banerjee & Sarkar (1956), Sarkar & Anjali (1969), Thind *et al.* (1957), Rangaswami *et al*. (1970), Bakshi (1971), Bilgrami *et al*. (1991), Bhaskaran (2000), Naik (2001), Sankaran *et al*. (2005), Kaliyaperumal & Kalaichelvan (2008), Verma *et al.* (2008), Bhosle *et al*. (2010), Ranadive *et al.* (2011), Mohanty *et al.* (2012), Arulpandi & Kalaichelvan (2013), Kaliyaperumal (2013), Prasher & Lalita (2013), Ranadive (2013), Singh *et al.* (2014), Ranadive & Jagtap (2016), and Crous *et al*. (2017).

From Kerala, four species have been documented. They are *Ganoderma applanatum* (Pers.) Pat. (Mohanan 1994a; Florence & Yesodharan 2000; Florence 2004; Mohanan 2011), *Ganoderma australe* (Fr.) Pat. (Florence & Yesodharan 2000; Leelavathy & Ganesh 2000; Florence 2004), *Ganoderma colossus* (Fr.) C. F. Baker (Mohanan 2011) and *Ganoderma lucidum* (Curtis) P. Karst (Mohanan 1994; 1994a; Florence & Yesodharan 1997, 2000; Leelavathy & Ganesh 2000; Sheena *et al*. 2003; Florence 2004; Mohanan 2011).

GENUS *LEIOTRAMETES* WELTI & COURTECUISSE

Leiotrametes was established recently by Welti & Courtecuisse in Welti *et al.* (2012), with *Leiotrametes lactinea* (Berk.) Welti & Courtec as the type species. The genus was introduced for accommodating three tropical species of *Trametes* Fr., which settled in a separate clade from the *Trametes* group (Welti *et al.* 2012). A glabrous pileus surface, absence of a black line under the pileipellis, presence of brown resinous material in the lumen of the skeletal hyphae of pileipellis, and the absence of parietal crystals in context and hymenium, are the major characters that distinguishes *Leiotrametes* from *Trametes* and related genus, *Pycnoporus* P. Karst. Currently the genus hold two species, *Leiotrametes lactinea* and *L. menziesii* (Berk.) Welti & Courtec (*Index Fungorum*, accessed on 30 September 2020).

Leiotrametes is characterized by annual to perennial, often coriaceous basidiomata, pseuodostipitate, sometimes with discoid base, buff coloured homogenous context, poroid to labyrinthine hymenophore, trimitic hyphal system, generative hyphae with clamp connections, hyaline to pale yellow skeletal hyphae, absence of cystidia, and cylindrical, hyaline, smooth, thin walled basidiospores, that are acyanophilous in cotton blue and inamyloid in Melzer's reagent. Species cause white rot on angiosperm and gymnosperm wood (Welti *et al.* 2012).

Economic importance

Phenolic compounds and linoleic acids extracted from from *Leiotrametes lactinea*, have antimicrobial, antioxidant and genoprotective properties (Ferreira *et al.* 2009; Alves *et al.* 2013; Sheikh *et al*. 2014). Extracts of *L. lactinea* are reported to inhibit the activities of enzymes, hyaluronidase, lipoxygenase and xanthine oxidase *in vitro*, thereby preventing various diseases like asthma, edema, gout, psoriasis, rheumatoid arthritis and colitis ulcerosa in humans (Yahaya & Don 2012). *Leiotrametes lactinea* is known to possess antibacterial activity against gram negative bacteria (Awala & Oyetayo 2015). It has also been reported that willow sawdust after pretreatment with *L. menziesii* results in increased biogas production (Alexandropoulou *et al.* 2015).

This species also possesses free radical scavenging properties (Awala & Oyetayo 2016). According to Razarinah *et al.* (2011), *Trametes menziesii* (=*L. menziesii* (Berk.) Welti & Courtec. can be used in the biodegradation of leachates. Laccases present in *L. lactinea* has the ability to decolourize and degrade synthetic dyes (Goh *et al.* 2016).

Distribution

Leiotrametes has a pantropical distribution. AFRICA: Cameroon (Robertz & Ryvarden 2006), Burundi, Ethiopia, Kenya, Tanzania, Zaire (Ryvarden & Johansen 1980), Nigeria (Awala & Oyetayo 2015). NORTH AMERICA: Jamaica (Ryvarden 2000), Southern Florida (Vlasák *et al.* 2011), United States of America (Vlasák & Kout 2011). SOUTH AMERICA: Guyana (Aime *et al.* 2003; Ryvarden 2000), ASIA: China (Núñez & Ryvarden 2001; Dai 2012), Indonesia, Malaysia (Corner 1989; Yamashita *et al.* 2009; Hattori *et al.* 2012; Lee *et al.* 2012); Pakistan, Philippines (Zmitrovich *et al.* 2012), Singapore (Corner 1989), Sri Lanka (Zmitrovich *et al.* 2012). AUSTRALIA: New Guinea (Zmitrovich *et al.* 2012). EUROPE (Ryvarden & Gilbertson 1993; Ryvarden & Melo 2014), Italy (Bernicchia 2001; Bernicchia 2005).

From India, *T. lactinea* and *T. menziesii* have been reported by Roy & De (1996), Rangaswamy *et al.* (1970), Bakshi (1971), Mohanan (1994), Sankaran & Florence (1995), Leelavathy & Ganesh (2000), Florence (2004), Ranadive *et al*. (2011), Prasher & Lalitha (2013), and Ranadive (2013).

GENUS *LENTINUS* FRIES

Genus *Lentinus* was established by Fries in 1825, and he designated *Lentinus crinitus* (L.) Fr. as the type species. The genus was introduced for placing species belonging to *Omphalina* tribe of the gilled genus *Agaricus* L., which showed similarity with the genus *Polyporus* P. Micheli *ex* Adans. Kühner (1928) gave a discussion on relationship of *Lentinus variabilis* Schulzer *ex* Quél. and *Polyporus squamosus* group. Based on the similarities with certain *Polyporus* species, *Lentinus* along with *Panus* Fr., *Pseudovafolus* Pat., *Mycobonia* Pat., *Phyllotopsis* E.J. Gilbert & Donk *ex* Singer, and *Pleurotus* (Fr.) P. Kumm. were placed in Polyporaceae (Singer 1951). Singer (1951) transferred Polyporaceae to Agaricales. Donk (1962) accepted *L. crinitus* as the type of the genus, whereas Clements & Shear (1931) and Singer (1975) considered the type to be *L. tigrinus* Fr. and *L. lepideus* Fr. respectively (Grand 2004). Since *Lentinus* produced lamellate hymenium and white spore prints, it was positioned under the family Tricholomataceae R. Heim *ex* Pouzar of Agaricales Underw. by Miller & Manning (1976). But, because of the presence of dimitic hyphal system, which is the characteristic feature of poroid speces in the order Aphyllophorales, *Lentinus* was treated in Polyporaceae in the subsequent works (Moser 1978; Pegler 1983; Singer 1986; Hibbett & Vilgalys 1991, 1993). It should be noted that these authors while using the term dimitic, was reffering to a system where all the three types of hyphae (generative, skeletal, skeleto ligative) were present. Moreover, some *Lentinus* species possess hyphal pegs, which is a common feature in many genera (ten) of polyporoid fungi (Corner 1981; Gilbertson & Ryvarden 1986, 1987; Pegler 1983; Hibbett & Vilgalys 1991, 1993). In the monograph on *Lentinus* by Pegler (1983), *Lentinus* was limited to include only species with generative hyphae, skeletal hyphae, and skeleto ligative hyphae. Monomitic species (*L. edodes* (Berk.) Singer) was transferred to another genus *Lentinula* Earle of Agaricales.

According to Corner (1981), tribe *Lentinulae* (which includes *Lentinus*, *Panus*, and *Pleurotus*) form paraphyletic groups from which Agaricales and Polyporaceae emerged (Hibbett & Vilgalys 1991). Pegler (1983) treated *Panus* Fr. as one of the sub genera of *Lentinus*, and also suggested the possibility of a polyporoid ancestory for *Lentinus* collectively with *Pleurotus* (Fr.) Kummer and *Panus*. According to Corner (1981) and (Pegler 1983), the sub genus *Lentinus* consisted of species with skeleto ligative hyphae, and sub genus *Panus* includes species with only skeletal hyphae. In 1985, genera *Heliocybe* Redhead & Ginns and *Neolentinus* Redhead & Ginns were segregated from *Lentinus* (Redhead & Ginns 1985), for including those species in the genus that possessed bipolar mating system and lacked laccase activity, since all *Lentinus* species were white rot causing members. Singer (1986) also discussed the polyporoid ancestry for *Lentinus*, based on of microscopic characters, and basidiocarp development patterns. Grand (2004) treats *L. tigrinus* as the type species of *Lentinus*. Seelan *et al.* (2015) considerd the type of the genus as *L. crinitus* (based on Pegler 1983) as, in their opinion, choosing *L. tigrinus* as type would make *Lentinus* sect. *Tigrini* invalid, and a new sectional name would be required for *Lentinus* sect. *Lentinus sensu* Pegler.

In the molecular phylogenetic study of family *Polyporaceae* and its relation to *Lentinus* (Hibbett & Vilgalys 1991, 1993; Hibbett & Donoghue 1995), *Lentinus* clustered with *Polyporus sensu stricto*, indicating close relation between these two genera. Hibbett & Vilgalys (1991) stated that *Lentinus* was more closely related to polypores than agarics. According to Hibbett & Vilgalys (1993), *Lentinus sensu stricto* was derived from Polyporaceae, suggesting gills as the products of convergent evolution. Other molecular phylogenetic studies that specify the closeness of these two genera are that of Hibbett & Thorn (2001), Binder & Hibbett (2002), Ko & Jung (2002), Krüger & Gargas (2004) and Sotome *et al.* (2008). In Sotome *et al.* (2008), *Lentinus* along with *Polyporellus* P. Karst. formed sister clades with *Amauroderma* Murrill, *Ganoderma* P Karst. and *Perenniporia* Murrill. In the phylogenetic study of Binder *et al.* (2013) and Zmitrovich & Kovalenko (2016), *Lentinus* clustered in the core polyporoid clade (Polyporaceae), and *Panus* settled outside this clade. Based on the study on *Lentinus* and related genera using data from ITS, 28S nuc rDNA, RPB1 and RPB2 (Seelan *et al*. 2015), *Polyporellus* formed a clade with *Lentinus* section *Tigrini*. In their opinion, parallel transformations would have occurred between angular pores and sub poroid lamellae in the *Lentinus/Polyporellus* clade and the *Neofavolus* Sotome & T. Hatt. clade. They also opined that the sub poroid lamellae of *Neofavolus* clade would have been derived from angular pores. Currently, *Polyporellus* has been treated as a synonym of *Lentinus* (Kirk *et al.* 2008). The latest concepts by Justo *et al*. (2017) & Zmitrovich (2018) accepts *Lentinus* under the family Polyporaceae. Currently, the genus holds 228 species (*Index Fungorum*, accessed on 30 September 2020).

The genus is mainly characterized by annual, mostly infundibuliform basidiomata, fibrous to suberose pileus, white to tan context, poroid to lamellate hymenium, presence of hyphal pegs, generative, skeletal, skeleto ligative hyphae, generative hyphae are with clamp connections, dendroid skeletal hyphae hyaline to rusty brown, and inamyloid or amyloid in Melzer's reagent, presence or absence of cystidia and ellipsoid to cylindrical, hyaline, smooth, thin walled basidiospores, that are acyanophilous and inamyloid in Melzer's reagent (Pegler 1983; Seelan *et al* 2015; Zmitrovich 2018).

Infrageneric classification

Based on hyphal characters, and anatomy of hymenophoral trama, the genus *Lentinus* has been divided into two sub genera, *Lentinus* and *Panus* (Pegler 1983).

The Sub genus *Lentinus* includes species with branched skeleto ligative hyphae, hyphal pegs, hymenial trama made of descending, radiate or intermediate construction, and without metuloids and gloecystidia. Sub genus *Panus* included species with unbranched skeletal hyphae, without hyphal pegs, hymenophoral trama mainly of radiate construction, and presence of metuloids and gloecystidia.

Sub genus *Lentinus* was divided in to six sections as follows (Pegler 1983).

Section *Lentinus* Fr.

The section is characterized by pilose strigose pileal surface, ciliate margin, hymenial trama of radiate construction, and irregular, non inflated generative hyphae, skeleto ligative hyphae with filiform branching, presence of hyphal pegs, and cylindrical basidiospores.

Section *Tigrini* Pegler

The group includes species having appressed squamules, without fibrillose hairs on pileus, hymenial trama of descending construction, inflated generative hyphae, presence of hyphal pegs and cylindrical basidiospores.

Section *Dicholamellatae* Pegler

The section is characterized by species having verrucose squamose pileus surface, dichotomously branched lamellae, hymenial trama of radiate construction, non inflated generative hyphae, with or without hyphal pegs and ellipsoid to narrowly cylindrical basidiospores.

Section *Rigidi* Pegler

Species belonging to this section are defined by squamose or glabrous pileus, lamellae without furcations, hymenial trama of radiate construction, non inflated generative hyphae, presence of hyphal pegs and small, narrowly cylindric basidiospores.

Section *Lentodiellum* (Murr.) Pegler

The section is characterized by white pileal surface, without squamules or with minute dark squamules, hymenium with lamellae lacking dichotomous branching, presence of non inflated generative hyphae, and skeleto ligative hyphae with less branchings, with or without hyphal pegs, and cylindrical basidiospores.

Section *Pleuroti* Sacc.

The group is distinguished by smooth and glabrous pileus, short stipe, lamellae without furcations, finely denticulate lamella edges, hymenial trama of radiate construction, non inflated generative hyphae, skeletal hyphae with rounded tips, presence of hyphal pegs, and cylindrical basidiospores.

According to Pegler (1983), sub genus *Panus* comprises nine Sections such as Section *Pulverulenti*, Section *Panus*, Section *Cirrhosi*, Section *Velutini*, Section *Gigantopanus*, Section *Squamosi*, Section *Tuberregium*, Section *Prolifer*, and Section *Tenebrosi*.

Economic importance

Lentinus species are popular as food and medicine (Burkill 1966; Chin 1981; Karunarathna *et al.* 2011; Seelan *et al.* 2015; Zmitovich & Kovalenko 2016). The species *Lentinus squarrosulus* Mont. is widely consumed in Central Africa as a food source (Watling 1993). Commercial cultivation of *Lentinus* species is a source of income, mainly in Southeastern Asia and southern Africa (Chin 1981; Watling 1993; Mossebo 2002; Bayramoglu *et al.* 2006; Sysouphanthong *et al*. 2010). *Lentinus sajor-caju* (Fr.) Fr. is also locally available in markets in Thailand and species of the genus possess good anti oxidant activity (Karunarathna *et al.* 2011; Rich *et al.* 2015; Pattanayak *et al.* 2018). Many species of *Lentinus* have medicinal value and therapeutical applications (Zmitrovich & Kovalenko 2016). According to Ghate & Sridhar (2017), *L. squarrosulus* contains various bioactive compounds that can be used as neutraceuticals. Peptide derived from *Lentinus squarrosulus* exhibited anti cancer activity by causing apoptosis in human lung cancer cells (Prateep *et al.* (2017). Anti cancer activity of this species is also reported by Sumkhemthong *et al.* (2016) and Kothari *et al.* (2018). *Lentinus squarrosulus* also has anti microbial, antinociceptive and anti oxidant properties (Ugbogu *et al.* 2019). *Lentinus polychrous* Lév. is also reported to show anti cancerous effects (Sharif *et al.* 2018).

The former species possess anti thrombotic, anti tyrosinase, and anti αglucosidase activities (Sharif *et al.* 2018). Many *Lentinus* species have been used for lignolytic enzyme production (Maltseva *et al.* 1989; Leontievsky *et al.* 1994). Species of *Lentinus* are known to decolorize various textile dyes (Moreira *et al*. 2000; Hsu *et al.* 2012; Ratanapongleka & Phetsom 2014; Mustafa *et al*. 2017; Khammuang & Sarnthima 2007; Almeida *et al.* 2018; Isanapong & Mataraj 2018).

Distribution

Lentinus species have a widespread distribution: AFRICA: Cameroon (Njouonkou *et al*. 2013, 2013a), Congo-Kinhasa (Pegler 1971). SOUTH AMERICA: Brazil (Groposo & Loguercio-Leite 2005; Drechsler-Santos & Loguercio-Leite 2008, 2012; Nogueira-Melo *et al*. 2014), Guyana (Aime *et al*. 2003), ASIA: China (Huang 1998), South China (Nazura *et al*. 2010), Malaysia (Chipp 1921; Newsam *et al.* 1967; Lim 1972; Corner 1981; Pegler 1983; Oldridge *et al.* 1986; Lee *et al*. 1995; Salmiah & Thillainathan 1998; Salmiah & Jones 2001; Noorlidah *et al*. 2005; Lee *et al.* 2012; Bolhassan *et al.* 2012), Thailand (Karunarathna *et al.* 2011; Somchai 2012; Sysouphanthong *et al.* 2010). EUROPE (Bernicchia & Gorjón 2010).

Species of *Lentinus* such as *Lentinus alopecinus Fr.*, *L. arcularius* (Batsch) Zmitr, *L. badius* (Berk.) Berk., *L. bambusinus* T. K. A. Kumar & Manim., *L. begurensis* Mohan., *L. candidus* P.W. Graff, *L. cladopus* Lév, *L. coadunatus* Hook. f., *L. connatus* Berk., *L. crinitus* (L.) Fr., *L. dicholamellatus* Manim., *L. exilis* Klotzsch, *L. glabratus* Mont., *L. patulus* Lév., *L. polychrous* Lév., *L. prolifer* (Pat. & Har.) D.A. Reid, *L. sajor-caju* Fr., *L. squarrosulus* Mont., *L. subdulcis* Berk., *L. tigrinus* (Bull.) Fr., *L. villosus* Klotzsch, and *L. tricholoma* (Mont.) Zmitr. have been documented from India by different workers (Léveille 1846; Berkeley 1851; Berkeley 1854; Berkeley 1856; Currey 1874; Cooke 1881; Lloyd 1898–1925; Lloyd 1904–1919; Theissen 1911; Petch 1916; Bose 1920a; Banerjee 1943; Banerjee 1947; Petrak 1950; Bakshi 1955; Butler & Bisby 1960; Vasudeva 1960; Natarajan 1978; Natarajan & Manjula 1978; Bilgrami *et al.* 1979, 1991; Sathe & Daniel 1980; Sathe & Deshpande 1980; Sathe & Kulkarni 1980; Watling & Gregory 1980; Natarajan &

Raman 1980, 1981; Manjula 1983; Pegler 1983; Purkayastha & Chandra 1985; Sharma *et al.* 1985; Hennings 1900; Manimohan & Leelavathy 1995; Sarbhoy *et al*. 1996; Florence & Yesodharan 2000; Florence 2004; Jamaluddin *et al.* 2004; Manimohan *et al.* 2004; Kumar & Manimohan 2005; Natarajan *et al.* 2005; Pradeep & Vrinda 2007; Varghese *et al.* 2010; Mohanan 2011; Senthilarasu & Singh 2012; Farook *et al.* 2013; Prasher & Lalita 2013; Ranadive 2013; Senthilarasu 2014; Usha & Janardhana 2014; Sharma & Atri 2015; Senthilarasu 2015; Kaur *et al.* 2016).

GENUS ***LIGNOSUS*** LLOYD *EX* TORREND

Lignosus was validly established by Torrend (1920), with *Lignosus sacer* (Afzel. *ex* Fr.) Torrend 1920 as the type species. The genus was placed in the Tribe *Trameteae*, sub family *Trametoideae* of family Polyporaceae in the earlier classifications of Bondartseva (1983) (Zmitrovich 2018). According to Ryvarden & Johansen (1980), *Lignosus* shows similarity with *Microporus* in some macroscopic and microscopic features, but the latter can be separated from *Lignosus* by the absence of sclerotia, occurrence on wood, presence of dichophytic elements, and cylindrical to allantoid basidiospores. Currently, eight species have been accepted in the genus (*Index Fungorum*, accessed on 30 September 2020); *L. dimiticus* Ryvarden, *L. ekombitii* Douanla-Meli, *L. goetzii* (Henn.) Ryvarden, *L. hainanensis* B.K. Cui, *L. rhinocerus* (Cooke) Ryvarden, *L. sacer* (Afzel. *ex* Fr.) Ryvarden, *L. tigris* Chon S. Tan and *L. cameronensis* Chon S. Tan.

The genus is mainly characterised by annual, centrally stipitate basidiomata, white to brownish pileus surface that are smooth or finely tomentose, poroid hymenium, stipe always arising from an underground sclerotium, dimitic to trimitic hyphal system with clamped generative hyphae, absence of cystidia, and smooth, globose, isodiametric to ellipsoid, hyaline and inamyloid basidiospores. Members mostly grow on the ground (Ryvarden & Johansen 1980; Tan *et al.* 2013), but sometimes grow in highly rotten wood (Núñez & Ryvarden 2001).

Economic importance

Lignosus rhinocerus (Cooke) Ryvarden, commonly known as ‘tiger milk mushroom’ possesses rich medicinal properties (Eik *et al*. 2012; Lee *et al.* 2012a; Lai *et al*. 2011, 2013; Lau *et al*. 2014; Yap *et al.* 2014, 2015; Nallathamby *et al.* 2018; Yap *et al.* 2018). Sclerotia of this species are known to possess anti oxidative, anti tumour and immunomodulatory effects (Lai *et al.* 2008; Wong *et al.* 2011; Lau *et al.* 2014). Various bioactive components are known to be present in the sclerotia of *L. rhinocerus*. Among the different bioactive components, polysaccharide protein complexes, and b-glucans possess anti tumour (Lai *et al.* 2008), and immunomodulatory activities (Wong *et al*. 2011). *Lentinus rhinocerus* is consumed as a traditional medicine for treating various illnesses like treat asthma, breast cancer, cough, fever and food poisoning (Lee *et al*. 2012a). According to Lee *et al*. (2009b), *L. rhinocerus* is the most accepted and widely used medicinal mushroom by indigenous people in Malaysia. Chinese physicians use the sclerotia of the species to treat liver cancer, chronic hepatitis, and gastric ulcers (Wong & Cheung 2008). The species is also known to possess anti coagulant, anti inflammatory, anti microbial, anti diabetic, anti viral, anti obesity, fibrinolytic, hepatoprotective, and neuroprotective effects (Mohanarji *et al.* 2011; Nallathamby *et al.* 2018; Yap *et al.* 2018).

Distribution

The genus has paleotropic distribution (Tan *et al.* 2013). AFRICA: Cameroon (Douanla-Meli & Langer 2003), Malay Peninsula (Ryvarden & Johansen 1980). ASIA: Borneo (Ryvarden & Johansen 1980), Ceylon (Corner 1989), China (Nuñéz & Ryvarden 2001; Cui *et al.* 2011b; Dai 2012; Cui *et al.* 2019), Malaysia (Lai *et al*. 2011; Tan *et al*. 2013), Philippines, Sri Lanka (Ryvarden & Johansen 1980), Sumatra (Cunningham 1965). AUSTRALIA: New Zealand (Cunningham 1965).

Lignosus sacer has been reported from India (Ranadive 2013).

GENUS *MICROPORELLUS* MURRILL

The genus *Microporellus* was established by Murrill (1905), with *Polyporus dealbatus* Berk. & M.A. Curtis as the type species. The genus was erected for placing stipitate polypores (Decock & Ryvarden 2002). In 1985, David & Rajchenberg introduced an emended description of the type species, with a combination of characters such as a stipitate basidiocarp, a dimitic hyphal system with dextrinoid skeletal hyphae, thick walled, occasionally encrusted cystidia, and subglobose, slightly thick walled basidiospores. Those species exhibiting these combinations of characters, were earlier placed in another genus *Cystostiptoporus* Dhanda & Ryvarden (Dhanda & Ryvarden 1975). However, David & Rajchenberg (1985) treated both the names as synonyms. Later, Corner (1987) included some trimitic and some acystidiate species in the genus. Again, the genus concept was made wider by Decock (2001) by introducing two sessile species within the genus.

Recently a study on *Microporellus* in neotropics was carried out by Motato-Vásquez & Gugliotta (2016), and according to them, *Microporellus* is a genus segregate from *Microporus* P. Beauv., the latter being separated from the former by the presence of trimitic hyphal system and coralloid dichophytic elements along the dissepiments. *Navisporus* Ryvarden is a close relative of *Microporellus*, because both genera share similar hyphal system, similar basidiospores, similar cystidia and cause white rot (Decock 2007). The difference lies only in the basidiome habit, where *Navisporus floccosus* produce large sessile, spongy basidiomes (Decock 2007). According to the description of Santos *et al*. (2007), basidiospores of *Navisporus* are navicular to fusiform. However, such basidiospores are not found in any species of *Microporellus*. *Perenniporia* Murrill is another genus that shows similarity with *Microporellus*. However, *Perenniporia* has been separated from *Microporellus* by having truncate basidiospores (Zhao & Cui 2012a). A molecular study on *Perenniporia* by Zhao *et al.* (2013) proved that *Microporellus* was distinct from *Perenniporia sensu stricto*. *Neolentiporus* Rajchenb. is another stipitate polypore characterized by a dimitic hyphal system, and cylindric basidiospores (Rajchenberg 1995). The skeletal hyphae present in *Neolentiporus* is metachromatic in cresyl blue and acyanophilous in cotton blue, whereas, that of *Microporellus* is non meatchromatic and cyanophilous (Decock 2007).

Comprehensive phylogenetic works on the genus *Microporellus* does not exist. However, based on phylogenetic studies on the closely related genus *Perenniporia* (Zhao & Cui 2013; Robledo *et al.* 2009; Zhao *et al.* 2013), *Microporellus* can be treated as distinct genus. In all these studies, *Microporellus* was distantly related from the type species of *Perenniporia*. Currently, the genus holds 24 species (*Index Fungorum*, accessed on 30 September 2020).

According to the latest concepts (Ryvarden & Gilberson 1994; Decock 2001; Decock & Stalpers 2006; Decock 2007; Motato-Vásquez & Gugliotta 2016), *Microporellus* is characterized by pileate basidiomata, sessile to stipitate, white to pale cream context, a dimitic hyphal system with unbranched, thick walled, hyaline, inamyloid to strongly dextrinoid and cyanophilous skeletal hyphae, hymenial cystidia are either apically smooth or light to coarsely encrusted and hyaline to faintly yellowish, and basidiospores occasionally slightly dextrinoid, and with cyanophilous walls and without germ pore. As per Motato-Vásquez & Gugliotta (2016), members of this genus possess slightly thick walled, subglobose to often lacrymoid basidiospores. They cause white rot on wood.

Economic importance

Although not reported as a pathogen so far, the genus is economically important since the members have the ability to cause white rot on wood and timbers. No data on medicinal or industrial applications of *Microporellus* are available.

Distribution

The genus has a pantropical distribution (Ryvarden 1991). AFRICA: East Africa (Ryvarden & Johansen 1980), West Africa (Decock & Ryvarden 2002). NORTH AMERICA (Gilbertson & Ryvarden 1986), Costa Rica (Carranza-Morse & Ruiz-Boyer 2005), United States of America (Murrill 1907). SOUTH AMERICA: Argentina (Rajchenberg 1987; Medeiros & Ryvarden 2011), Brazil (Rajchenberg &

Meijer 1990; Loguercio-Leite & Wright 1991; Gugliotta & Bononi 1999; Decock & Ryvarden 2002; Meijer 2006; Gibertoni *et al*. 2004; Dreschler-Santos *et al.* 2008; Medeiros & Ryvarden 2011; Reck *et al*. 2011; Westphalen & Borges Da Silveira 2013; Motato-Vásquez & Gugliotta 2016), French Antilles and Guiana (David & Rajchenberg 1985), Guyana (Aime *et al*. 2003). ASIA: China (Yang 2000; Cui *et al.* 2019), Indonesia (Suhirman & Núñez 1998), Malaysia (Corner 1987), Pakistan (Hattori & Murakami 1993), Singapore (Corner 1987), Sri Lanka (Ryvarden & Johansen 1980), Sumatra (Suhirman & Núñez 1998) EUROPE: Italy (Bernicchia 2005). AUSTRALIA: Papua New Guinea (Decock 2007).

From India, *Microporellus obovatus* (Jungh.) Ryvarden and *M. violaceocinerescens* (Petch) A. David & Rajchenb. have been reported by Bakshi (1971), Ryvarden & Dhanda (1975), Leelavathy & Ganesh (2000), Sharma (2000), Mohanan (2011), and Farooq *et al.* (2013).

GENUS *MICROPORUS* P. BEAUVOIS

Genus *Microporus* was erected by Beauvois in 1805, under the family *Polyporaceae*, with *M. perula* P. Beauv., as the type species. He included other three species, *M. perennis* (L.), *M. fuligineus* (Fr.), and *M. nummularius* (Fr.) M. in the genus (Murrill 1903). Fries (1821) treated *Microporus* as a sub genus of *Polyporus*. Corner (1989) treated the genus as the synonym of *Trametes*, and acccording to Ryvarden (1991), this placement by Corner is a violation of nomenclatural rules because *Microporus* was older than *Trametes.* Ryvarden (1991) considers genus *Tomentoporus* Ryvarden as the synonym of *Microporus* and *Polyporus sensu stricto* as the closely related genus. However, *Tomentoporus* is currently accepted as a synonym of *Trametes* Fr. (*Index Fungorum*, accessed on 18 February 2020). According to Ryvarden (1991), restriction of *Microporus* species in the paleotropical areas of the world indicate its recent origin. Bondartseva (1998) placed the genus in the family Poriaceae. A literature survey indicates that, not much work has been carried out on the morphological and molecular aspects of this genus. To date, there are no monographic studies on the genus *Microporus*. Based on the phylogenetic study carried out by Binder *et al.* (2013), genus *Microporus* has been placed in the core polyporoid clade of Polyporales. The most recent phylogenetic work on *Polyporales* by Justo *et al.* (2017), and the latest classification on polyporaceous fungi (Zmitrovich 2018) also confirm the position of the genus in the family *Polyporaceae*. Currently 132 species are recognized in the genus *Microporus* (*Index Fungorum*, accessed on 19 February 2020).

According to Ryvarden & Johansen (1980) and Zmitrovich (2018), the genus is characterized by annual, centrally or laterally attached, stipitate basidiomata, circular, flabelliform or spathulate, concentrically zoned, smooth to hirsute pileus, hymenium with minute pores, pseudo dimitic to trimitic hyphal system, presence of coralloid dichophytic elements in dissepiments, sometimes with hyphal pegs or cystidia like structures, and smooth, hyaline, allantoid to elliptical basidiospores. *Microporus* causes white rot on wood.

Infrageneric classification

Microporus was split into five tribes such as *Mesopus, Pleuropus, Merisma, Apus* and *Resupinatus* by Fries (1821). The first two tribes consisted of centrally and laterally stiptate species respectively. Species with branches and multiple pilei were placed in the tribe *Merisma* and sessile species were placed in the tribe *Apus*. The last tribe included all dorsally attached species (Zmitrovich 2018).

Economic importance

Microporenic acids A-G present in *Microporus* species show anti microbial and biofilm inhibitory activity (Chepkirui *et al*. 2018). Anti oxidant and anti angiogenic properties are reported in *Microporus xanthopus* (Ornely *et al.* 2018). Being a rich source of macro and micro nutrients, *M. xanthopus* may be consumed as a protein supplementary diet (Meghalatha *et al.* 2014). *Microporus* species also have industrial applications in the production of lignolytic enzymes (Risna & Suhirman 2002; Shri *et al.* 2013), and in synthetic dye decolourization and degradation (Kang *et al.* 2014).

Distribution

Microporus is a paleotropical genus (Ryvarden 1991). AFRICA: Cameroon (Roberts & Ryvarden), West Africa (Ryvarden & Johansen 1980). ASIA: China (Dai *et al*. 2011, Dai 2012, Cui *et al.* 2019), Japan (Núñez & Ryvarden 2001; Hattori 2005), Korea (Kim *et al.* 2009), Malaysia (Corner 1989a; Lee *et al.* 2012), Thailand, Taiwan, Vietnam (Núñez & Ryvarden 2001). EUROPE: Italy (Bernicchia 2005).

Microporus species have been recorded from India by Bose (1946), Bakshi (1971), Sharma *et al.* (1985), Leelavathy & Ganesh (2000), Sharma (2000), Verma *et al.* (2008), Mohanan (2011), Prasher & Lalita (2013), Ranadive (2013), Ranadive & Jagtap (2013), Ranadive *et al*. (2013), Lyngdoh & Dkhar (2014), Nagadesi *et al*. (2014), Rajput *et al*. (2015), Iqbal *et al.* (2016). According to Ranadive (2013), the genus is represented by 3 species in India such as *M. affinis* (Blume & Nees: Fr., *M. scopulosus* (Berk.) Ryv., and *M. xanthopus* (Fr.) Kunt. Among these, *M. scopulosus* has now been transferred to genus *Amauroderma* as *A. scopulosum* (Berk.) Imazeki (*Index Fungorum*, accessed on 19 February 2020).

GENUS *NAVISPORUS* RYVARDEN

Navisporus Ryvarden was established by Ryvarden (Ryvarden & Johansen 1980), with *Navisporus floccosus* (Bres.) Ryvarden (*Trametes floccosa* Bres.) as the type species. According to the original description (Ryvarden & Johansen 1980), the genus was mainly distinguished by dextrinoid skeletal hyphae and navicular to fusiform, non dextrinoid basidiospores. Later, Ryvarden (1983) emended the genus concept by describing basidiospores as non dextrinoid to weakly dextrinoid and included one more species (*N. sulcatus* (Lloyd) Ryvarden) in the genus. Later, more species were described under the genus, of which some of them were by Bondartseva & Herrera (1989), Ryvarden & Iturriaga (2003), Ryvarden (2018) and Spirin & Ryvarden (2019). *Navisporus* is closely related to the genus, *Pseudopiptoporus* Ryvarden, but the latter possesses gloeopleurous hyphae and skeletal hyphae are not dextrinoid (Ryvarden & Johansen 1980). According to Decock (2007), *Navisporus* is very much closer to the genus *Microporellus,* sharing similar hyphal system, basidiospores and type of rot. Hence, Decock (2007) preferred to keep *Navisporus* as a synonym of genus *Microporellus*. According to Decock (2007), *Navisporus* is morphologically heterogenous and polyphyletic. Species of this genus are poorly studied, and are in need of revision (Torress-Torress *et al.* 2007; Decock *et al.* 2007). Currently 12 species have been recognized under the genus (*Index Fungorum*, accessed on 30 September 2020).

Based on the widely accepted concepts (Ryvarden & Johansen 1980; Roy & De 1980; Decock & Herrera-Figueroa 2000; Decock 2007; Torress-Torress *et al.* 2007), *Navisporus* is characterized by pileate basidioamata, poroid hymenium with round to angular pores, or radially elongated, cinnamon, pale brown to brown coloured context, dimitic hyphal system, generative hyphae with clamp connections, unbranched, dextrinoid skeletal hyphae, presence or absence of cystidia, and ellipsoid, Basidiospores ellipsoid to weakly amygdaliform, navicular, with distinct apicule, hyaline, smooth, thick walled, variably dextrinoid in Melzer's reagent. Members cause white rot on wood.

Economic importance

Navisporus floccosus is considered as a serious heart rot pathogen on tropical trees in India (Nagadesi & Arya 2013; Verma *et al.* 2020). Biomass of *N. floccosus* possesses antifungal activity against *Phytophthora nicotianae* Breda de Haan and *Curvularia clavata* B. L. Jain (Jorge *et al.* 2011). This species is also known to have *in vitro* anti inflammatory activities (Leliebre-Lara *et al.* 2015). In addition, *N. floccosus* is reported to have high cellulose degrading ability, which has applications in various industries like textile industries, detergents and chemical industries (Parihar *et al.* 2012).

Distribution

Navisporus has pantropical distribution. AFRICA: Cameroon, Central African Republic (Ryvarden 2018), Democratic Republic of the Congo (Ryvarden 2000a), Eastern Africa (Ryvarden & Johansen 1980), Gabon (Decock 2007), Kenya (Ryvarden 1983), Uganada (Spirin & Ryvarden 2019), Somalia (Ryvarden 1983), Zimbabwe (Sharp & Ryvarden 2020). NORTH AMERICA: Cuba (Bondartseva &

Herrera- Figueroa 1989; Decock & Herrera-Figueroa 2000), French Antilles (David & Rajchenberg 1985), Mexico (Torres-Torres *et al.* 2007), United States of America (Gilbertson & Ryvarden 1986). SOUTH AMERICA: Brazil (Rajchenberg & Meijer 1990; Ryvarden & Meijer 2002; Gibertoni *et al.* 2004; Torres-Torres *et al.* 2007), Venezuela (Ryvarden & Iturriaga 2003), Brazil (Drechsler-Santos *et al.* 2007a), Paraguay (Popoff & Wright 1998). ASIA: Malaysia, Papua New Guinea (Decock 2007).

From India, *Navisporus floccosus* has been reported by different workers (Roy & De 1980; Roy & De 1996; Mohanan 2011; Nagadesi & Arya 2013a; Ranadive 2013; Prasher 2015; Verma *et al.* 2020).

GENUS *NEOFOMITELLA* Y.C. DAI, HAI J. LI & VLASÁK

Neofomitella is a recently established genus under Polyporaceae (Li *et al.* 2014). *Neofomitella* was segregated from *Fomitella* Murrill based on a distinct crust on its pileus, with cuticle extending from base to margin (Li *et al.* 2014). This is a character which is absent in the type species of *Fomitella* (*F. supina* (Sw.) Murrill). According to the phylogenetic study by Li *et al*. (2014), *Fomitella sensu stricto* was divided in to two distinct clades under the core polyporoid clade; one contained the type species of *Fomitella* and the second consisted of *F. fumosipora* (Corner) T. Hatt., *F. rhodophaea* (Lév.) T. Hatt. and an undescribed species (proposed as *N. polyzonata* Y.C. Dai, Hai J. Li & Vlasák in their study). *Neofomitella* was erected for accommodating species in the second sub clade, as *Neofomitella fumosipora* and *N. rhodophaea*. Based on the molecular phylogenetic study by Li *et al* (2014), *Neofomitella* formed a closely related clade, with the genus *Microporus*. However, *Microporus* included species with stipitate or infundibuliform basidiomata, and white to cream coloured context, whereas *Neofomitella* consisted of sessile to effused reflexed fruit bodies with yellowish brown or grey brown to brown context. *Coriolopsis* Murrill also shares some macro and microscopic characters with *Neofomitella*, in having a brown context, trimitic hyphal system, generative hyphae with clamp connections, hyaline basidiospores, and white rot type of wood decay (Gilbertson & Ryvarden 1986; Núñez & Ryvarden 2001; Hattori 2005). But in the phylogenetic analysis of Li *et al.* (2014), *Coriolopsis* appeared as polyphyletic as its type species (*Coriolopsis occidentalis* (Klotzsch) Murrill) settled in *Trametes* clade, which is distinct from *Neofomitella.* Genus *Hexagonia* Fr. also shows some similarities with *Neofomitella* species, but was separated from the latter by having larger hexagonal pores and basidiospores (Gilbertson & Ryvarden 1986; Núñez & Ryvarden 2001; Li *et al.* 2014). Currently five species have been recognized in the genus (*Index Fungorum*, accessed on 30 September 2020).

Neofomitella is mainly characterized by annual to perennial, pileate, sessile to effused reflexed basidiomata, glabrous to velutinate, yellowish brown, fuscous to almost black pileus surface, often with concentric zonations or sulcations, buff to yellowish brown or pale grey, context with a dark crust extending from base to margin, having agglutinations, poroid hymenium, white, creamish to light beige hymenial surface, trimitic type of hyphal system, generative hyphae with clamp connections, absence of cystidia, oblong ellipsoid to cylindrical, hyaline, thin walled, smooth basidiospores that are acyanophilous and inamyloid. Species cause white rot on angiosperm wood (Li *et al.* 2014).

Distribution

Members of the genus have a tropical to subtropical distribution. AFRICA: Rwanda (Ryvarden & Johansen 1980). ASIA: China (Dai *et al*. 2011; Dai 2012; Li *et al.* 2014), Japan (Núñez & Ryvarden 2001), Malaysia (Yamashita *et al*. 2009; Hattori *et al*. 2012; Lee *et al.* 2012), Peninsular Malaysia (Corner 1989), Thailand (Choeyklin *et al.* 2011), Vietnam (Núñez & Ryvarden 2001). AUSTRALIA: Victoria (Cui *et al.* 2019).

Neofomitella rhodophaea has been recorded from India by Bakshi (1971), Leelavathy & Ganesh (2000), Sharma (2000) and Ranadive (2013).

GENUS *PERENNIPORIA* MURRILL

Perenniporia is a genus established by Murrill in 1942, for placing two perennial species of *Poria* P. Browne (a genus characterized by annual basidiocarps), but without designating a type species (Decock & Stalpers 2006).

Later, in 1953, Cooke designated the type species of *Perenniporia* as '*Polyporus medulla-panis* (Jacq.) Fr.' (Gerber *et al.* 1999). Corner (1989) defined the genus by combining characters such as dimitic hyphal system with arboriform skeletal hyphae, and thick walled basidiospores. He separated the genus in to two sub genera: *Perenniporia* and *Brachymeria* based on the branching nature of hyphae (Decock 2001). The classification on polyporaceous fungi by Bondartseva (1998) placed *Perenniporia* under family Poriaceae Locquin. According to Robledo *et al*. (2009) and Zhao *et al*. (2013), *Perenniporia sensu lato* includes white rot genera such as *Abundisporus* Ryvarden, *Hornodermoporus* Teixeira, *Perenniporia sensu stricto, Perenniporiella* Decock & Ryvarden, *Truncospora* Pilát, and *Vanderbylia* D. A. Reid. As per Costa-Rezende *et al.* (2015), *Abundisporus* can be distinguished from *Perenniporia* by its pale yellow coloured, non dextrinoid basidiospores. Similarly, *Hornodermoporus* is separated from *Perenniporia* by their amygdaliform shaped basidiospores (Costa-Rezende *et al.* 2015). Genus *Perenniporiella* was segregated from *Perenniporia* by having sublobose to globose, non truncate basidiospores that lacked apical germ pore (Decock & Ryvarden 2003). *Truncospora* differs from *Perenniporia* by having skeletal hyphae that are non arboriform and variably branched (Decock 2011). Presence of amygdaliform, non truncate and strongly dextrinoid basidiospores in species of *Vanderbylia* D. A. Reid distinguishes them from *Perenniporia* (Zhao *et al*. 2013). According to Cui & Zhao (2012), *Loweporus* J.E. Wright is also a closely related genus of *Perenniporia,* but separated from the latter by having brownish basidiomata. Ryvarden (1991) treated *Vanderbylia* Reid and *Truncospora* Pilát as synonyms of *Perenniporia,* while Corner (1987, 1989) considered these two as distinct genera (Decock 2001). In 2013, a genus named *Yuchengia* B.K. Cui & K.T. Steffen was segregated from *Perenniporia sensu stricto,* which differed from the latter by having acyanophilous, amyloid skeletal hyphae, and non dextrinoid basidiospores (Zhao *et al*. 2013a). Recently, another new genus *Perenniporiopsis* C.L. Zhao, has also been erected from *Perenniporia sensu stricto* by Wu *et al.* (2017), based on morphological and molecular data. According to Wu *et al.* (2017b), the consistency of basidiomata (waxy when fresh, hard on dying), and larger basidiospores distinguishes this genus from *Perenniporia sensu stricto.*

Based on molecular studies (Robledo *et al.* 2009; Zhao *et al.* 2013), *Perenniporia* can be confirmed as a polyphyletic group. A molecular study on *Perenniporiella* and its relation with *Perenniporia* was conducted by Robledo *et al.* (2009). According to this work (Robledo *et al.* (2009), *Perenniporia sensu stricto* formed a well supported monophyletic clade, distinct from *Perenniporiella*. This study (Robledo *et al.* 2009) also revealed the existence of some deviating taxa within *Perenniporia*, such as *P. ochroleuca* and *P. vicina* species complexes, that could be erected as separate genera. Phylogeny of *Perenniporia* was studied in detail by Zhao *et al.* (2013), based on ITS and LSU sequence data. According to Zhao *et al.* (2013), sampled species of *Perenniporia sensu lato* formed seven sub clades and species of *Perenniporia sensu stricto* were grouped in a separate clade. Species of *Perenniporia ochroleuca* complex, as mentioned by Robdelo *et al.* (2009) were recognized as belonging to a separate genus *Truncospora* by Zhao *et al*. (2013). Thus, According to Zhao *et al.* (2013), *Perenniporia sensu stricto* is distinct from other genera such as *Abundisporus*, *Hornodermoporus* (represented by *P. martia complex*), *Perenniporiella* and *Vanderbylia* in forming a well supported monophyletic clade. Binder *et al.* (2013) placed *Perenniporia* in the family Perenniporiaceae of core polyporoid clade. However, the family Perenniporaceae has not been recognized in the latest classifications of *Polyporlales* (Justo *et al.* 2017; Zmitrovich 2018), and *Perenniporia* is placed under the family Polyporaceae of the order Polyporales. Currently the genus holds 145 species (*Index Fungorum*, accessed on 30 September 2020).

As per the current concepts (Decock & Stalpers 2006; Zhao *et al.* 2013; Zmitrovich 2018), *Perenniporia sensu stricto* is characterized by a dimitic to trimitic hyphal system, cyanophilic vegetative hyphae with varying dextrinoid reaction in Melzer’s reagent, and hyaline, ellipsoid to apically truncate, thick walled, cyanophilic and variably dextrinoid, having a distinct apical germ pore.

Economic importance

There are forest pathogens as well as medicinal species among *Perenniporia* (Dai *et al*. 2007; Dai & Yang 2008; Dai *et al.* 2009a; Dai 2012). Anti oxidant activity is reported in *Perenniporia fraxinea*, *P. robiniophila* and *P. subacida* (Peck) Donk (Li *et al.* 2017a). Presence of fibrinolytic protease in the mycelia of *P. fraxinea* has the ability to treat thrombosis (Kim *et al.* 2008). Species of *Perenniporia* such as *P. subacida* and *P. tephropora* (Mont.) Ryvarden have industrial applications since they are able to degrade synthetic dyes (Younes *et al*. 2007; Si *et al*. 2011; Si *et al.* 2014; Singh *et al.* 2014a; Singh 2017). Recently, an unknown species of *Perenniporia* was reported to cause pulmonary fungal ball in humans (Chowdhary *et al*. 2012). *Perenniporia fraxinea* (Bull.) Ryvarden and *P. robiniophila* (Murrill) Ryvarden cause white rot on different hard wood trees, either as a parasite or saprotroph (Szczepkowski 2004; Kuo 2016).

Distribution

The genus has a worldwide distribution (Ryvarden 1991). AFRICA (Decock & Bitew 2012), East Africa (Ryvarden 1972; Ryvarden & Johansen 1980), Uganda (Ipulet & Ryvarden 2005). NORTH AMERICA (Lowe 1966; Ryvarden & Gilbertson 1984; Gilbertson & Ryvarden 1987; Decock & Ryvarden 1999, 1999a; Decock & Ryvarden 2000; Decock & Ryvarden 2003), Costa Rica (Carranza-Morse & Ryvarden 1998; Decock & Ryvarden 2013), Great Lakes (Baxter 1940), Cuba (Kotlaba 1984; Decock *et al*. 2001), Mexico (Spirin & Ryvarden 2016). SOUTH AMERICA: Argentina (Rajchenberg & Wright 1998), Brazil (Berkeley & Cooke 1876; Loguercio-Leite & Wright 1991; Borges Da Silveira & Guerrero 1991; Gugliotta & Capelari 1995; Gerber *et al.* 1999; Hattori & Lee 1999; Gibertoni *et al.* 2004; Gomes-Silva & Gibertoni 2009; Drechsler-Santos *et al*. 2013), Southern Andea (Rajchenberg 1987), Venezuela (Patouillard & Gaillard 1888). ASIA: China (Chang 1994; Dai *et al.* 2002, 2003, 2004; Cui *et al*. 2006; Dai & Penttilä 2006; Cui *et al.* 2007; Dai *et al.* 2007; Xiong *et al.* 2008; Cui *et al*. 2010; Dai 2010; Dai *et al.* 2011; Zhao & Cui 2013; Dai 2012; Cui *et al.* 2019), Far east Russia (Núñez & Ryvarden 2001), Japan (Hattori & Ryvarden 1994; Núñez & Ryvarden 2001), Mesopotamia (Wright & Deschamps 1975), Pakistan (Ryvarden 1983), Thailand (Choeyklin *et al.* 2009; Ji *et al.* 2017), Vietnam (Núñez & Ryvarden 2001). AUSTRALIA (Decock *et al*. 2000), New Zealand (Cunningham 1965; Buchanan & Hood 1992). EUROPE (Donk 1967, 1974; Ryvarden 1978; Bernicchia 1990; Ryvarden & Gilbertson 1994; Bernicchia 2005; Ryvarden & Melo 2014), Finland (Niemelä *et al.* 1992), Hungary (Bresadola 1897), Poland (Szczepkowski 2004).

Perenniporia species such as *P. piperis* (Rick) Rajchenb., *P. ellipsospora* Ryvarden & Gilb., *P. fulviseda* (Bres.) Dhanda, *P. gomezii* Rajchenb. & J.E. Wright, *P. martia* (Berk.) Ryvarden, *P. medulla-panis* (Jacq.) Donk, *P. ochroleuca* (Berk.) Ryvarden, *P. subacida* (Peck) Donk, *P. tenuis* (Schwein.) Ryvarden and *P. voeltzkowii* (Henn.) Ryvarden have been reported from India (Roy & De 1996; Bakshi 1971; Leelavathy & Ganesh 2000; Mohanan 2011; Ranadive *et al.* 2011; Ranadive 2013).

GENUS *PILATOTRAMA* ZMITROVICH

Pilatotrama Zmitr. is a newly established monotypic genus of Polyporaceae. *Pilatotrama ljubarskyi* was placed as the type species of the genus (Zmitrovich 2018), which was until recently treated under genus *Trametes* (Ryvarden & Gilbertson 1994). Based on the descriptions (Ryvarden & Gilbertson 1994; Zmitrovich 2018), the genus is characterized by annual to perennial, effused reflexed to pileate basidiomata, sessile pileus with brown pigments and resinous deposits, and poroid hymenium with angular pores. Microscopically the genus possesses dimitic hyphal system, hyaline, clamped generative hyphae, cyanophilous skeletal hyphae, basidia with basal clamp connections, and lacrymoid hyaline, thin walled, basidiospores that are cyanophilous and inamyloid in Melzer's reagent. Member's causes white rot on wood. *Cubamyces* is the closely related genus, and differs from *Pilatotrama* by acyanophilous basidiospores, and by the lack of resinous deposits on pileus surface.

To date, the genus contains only the type species, *P. ljubarskyi* (*Index Fungorum*, 30 September 2020).

Ecological importance

P. ljubarskyi has been used in the biosynthesis of silver nanoparticles. The synthesized silver nanoparticles from the species are known to possess anti bacterial activity against different pathogenic bacteria (Gudikandula *et al.* 2017). *P. ljubarskyi* is also reported to be highly effective in degradation of toxic dyes (Kumar *et al.* 2019).

Distribution

The genus has distribution in Asia and Europe. Asia: China, North Thailand (Núñez & Ryvarden 2001; Dai 2012; Cui *et al.* 2019); Philippines (Guerrero *et al*. 2018). EUROPE: France (Welti *et al.* 2012), Portugal, Yugoslavia, Russia (Ryvarden & Gilbertson 1994).

From India *P. ljubarskyi* has been reported by Rajput *et al.* (2015) and Gudikandula *et al.* (2017). There are no reports of this species from Kerala so far.

GENUS ***POLYPORUS*** P. MICHELI *EX* ADANSON

Polyporus the type genus of family *Polyporaceae* was proposed by Micheli (1729) for placing 14 poroid species. However, the genus was validly published by Adanson in 1763. Fries (1821) emended the genus by including all the polypore species that produced stipitate, pileate or resupinate fruit bodies without referring to a type species (Krüger & Gargas 2004). Later, *Polyporus tuberaster* (Jacq.) Fr. was selected as the lectotype for the genus by Donk (1933). *Polyporus tuberaster* was characterized by stipitate basidiomata with or without a sclerotium and a dimitic hyphal system having arboriform vegetative hyphae (Sotome *et al.* 2008). However, Krüger & Gargas (2004) defines *P. brumalis* as the proper lectotype of *Polyporus*. The most recent monograph on *Polyporus* is that of Núñez & Ryvarden (1995), which describes 32 species in the genus (Krüger 2002; Sotome *et al*. 2008; Coelho & Borges Da Silveira 2014; Vlasenko & Vlasenko 2015). Records of polypore species from the neotropics was updated later by different workers (Gibertoni *et al*. 2004; Ryvarden & Iturriaga 2003, 2004). *Echinochaete* D.A. Reid and *Pseudofavolus* Pat. resembled *Polyporus* by having stipitate fruit bodies, and similar hyphal system. However, *Echinochaete* is separated from *Polyporus* in having setae like cystidia and *Pseudofavolus* by the presence of dendrohyphidia and larger basidiospores (Sotome *et al*. 2008). Genera such as *Microporus* P. Beauv. and *Lignosus* Lloyd *ex* Torrend produce stipitate basidiocarps which are similar to these produced by *Polyporus* (Ryvarden & Johansen 1980; Núñez & Ryvarden 1995). But the presence of trimitic hyphal system with proper skeletal and binding hyphae distinguishes them from *Polyporus*.

In the phylogenetic study of family *Polyporaceae* by Hibbett & Donoghue (1995), species of *Polyporus sensu stricto* clustered along with species of *Lentinus* Fr., indicating close relation between these two genera. Singer (1986) had previously opined that *Lentinus* species had a polyporoid ancestry, on the basis of microscopic characters and basidiocarp development patterns. The close relationship between *Polyporus* and *Lentinus* was also suggested by Hibbett & Vilgalys (1993), based on a phylogenetic study of *Lentinus*. Other molecular phylogenetic studies that specify the closeness of these two genera are those by Hibbett & Thorn (2001), Binder & Hibbett (2002), Ko & Jung (2002), Krüger & Gargas (2004) and Sotome *et al.* (2008). In the study carried out by Ko & Jung (2002), species of *Polyporus* formed clades with *Datronia* Donk, *Lentinus* Fr. and *Fomes* (Fr.) Fr. (*F. fomentarius* (L.) Fr.), indicating the polyphyletic nature of the genus. The study by Sotome *et al.* (2008) proved that many *Polyporus* species were closely related to the polyporoid genera *Pseudofavolus* Pat., *Lentinus* and *Datronia*, than to other species of *Polyporus*. Ryvarden & Johansen (1980), Singer (1986) and Núñez & Ryvarden (1995) differentiated *Pseudofavolus* from *Polyporus* by the presence of a gelatinous subhymenium, larger basidiospores (more than 10 µm long), and presence of dendrohyphidia in the dissepiments (Sotome *et al.* 2008). According to the study by Sotome *et al*. (2008), specialized basidiospore morphology of the family Ganodermataceae (currently synonymized under Polyporaceae, *Index Fungorum* accessed on 18 October 2020), and *Perenniporia* must have been derived from the smooth and cylindrical spores of *Polyporus sensu lato*.

Polyporus belongs to the core polyporoid clade of Polyporales (Binder *et al*. 2005, 2013; and Justo & Hibbett 2011; Justo *et al*. 2017). The genus holds 26 species (Gomes-Silva *et al*. 2012).

Based on different concepts (Ryvarden & Johansen 1980; Gilbertson & Ryvarden 1987; Núñez & Ryvarden 1995; Borges Da Silveira & Wright 2005; Sotome *et al.* 2008; Gomes-Silva *et al*. 2012), *Polyporus* is characterized by annual, centrally to laterally stipitate basidiocarps, smooth to scaly, squamulose or finely tomentose pileus, that are light to dark brown or purplish in colour, hymenium with round to angular, small to large pores, white to cream pore surface, white context, glabrous to finely tomentose stipe, that are cream, light to deep brown or even blackish, with smooth or longitudinally wrinkled surface, with or without a cuticle, or crusted at the base. Microscopically, *Polyporus* species consist of a hyphal system, with hyaline, thin walled and clamped generative hyphae, and arboriform skeleto ligative hyphae, absence of cystidia, and cylindrical spores that are straight to slightly curved, thin walled, hyaline, smooth and inamyloid. Members of the genus cause white rot on hardwoods, and are rarely parasitic on conifers. Some species are found to arise from a sclerotium buried in the ground, or immersed in wood.

Infrageneric classification

Fries (1821) divided *Polyporus* into three sub genera (*Favolus, Microporus, Polysticta*). Of these, sub genus *Microporus* was categorized into five sections (*Mesopus, Pleuropus, Merisma*, *Apus, Resupinatus*). Ryvarden & Johansen (1980) classified *Polyporus* into four sub groups such as *P. squamosus* group, *P. arcularius* group, *P. dictyopus* group and *P. mori* group. *Polyporus squamosus* group included species with large and fleshy basidiocarps, pileus with squamules, hymenium with large pores and spores (*P. squamosus* (Huds.) Fr., *P. retirugus* (Bres.) Ryvarden, *P. udus* Jungh., *P. lentus* Berk.). Species of *Polyporus* having centrally stipitate fruitbodies, tan to umber brown pileus, cilia along margin, and smooth, whitish to dirty brown stipe were placed in the *P. arcularius* group (*P. arcularius* (Batsch) Fr., *P. tricholoma* Mont., *P. brumalis* (Pers.) Fr., *P. ciliatus* Fr., *P. rhizophilus* Pat., *P.*

meridionalis (A. David) H. Jahn). According to Ryvarden & Johansen (1980), *P. arcularius* group also contained some intermediate taxa that showed variation from common characters of the group. *Polyporus dictyopus* group contained species with a dark brown to black stipe which becomes wrinkled on drying, with a distinct cuticle composed of short, thick walled, dark coloured generative hyphae (*P. badius* (Pers.) Schwein., *P. dictyopus* Mont., *P. melanopus* (Pers.) Fr., *P. varius* (Pers.) Fr., *P. hemicapnodes* Berk. & Broome, *P. guianensis* Mont., *P. leprieuri* Mont., *P. blanchetianus* Berk. & Mont., *P. diabolicus* Berk., *P. infernalis* Berk., *P. virgatus* Berk. & M.A. Curtis and *P. doidgeae* Wakef.). *Polyporus mori* group included species which produced sessile fruitbodies, or with short tapering base (*P. philippinensis* Berk., *P. grammocephalus* Berk and *P. mori* (Pollini) Fr.).

Based on macroscopic characters, *Polyporu*s was split into six infrageneric groups by Núñez & Ryvarden (1995), such as ‘*Polyporus sensu stricto*’, ‘*Admirabilis*’, ‘*Dendropolyporus*’, ‘*Melanopus*’, ‘*Polyporellus*’ and ‘*Favolus*’. The group *Polyporellus* included three species (*P. arcularius* (Batsch) Fr., *P. brumalis* (Pers.) Fr., and *P. ciliatus* Fr.) that were common in the northern hemisphere (Krüger 2002). *Favolus* Fr. was erected earlier as a distinct genus by Fries in 1828, with *F. brasiliensis* (Fr.) Fr as the type species. Ryvarden & Johansen (1980) recognized *Favolus* as a distinct genus. Núñez & Ryvarden (1995) treated *Favolus* as one of the groups of *Polyporus*, and defined the group by flabelliform to dimidiate pileus and a short lateral stipe without a dark crust. Most of the modern mycologists treat *Favolus* as a synonym of *Polyporus* (Corner 1984; Ryvarden 1991; Núñez & Ryvarden 1995a; 2001; Ryvarden & Iturriaga 2004; Borges Da Silveira & Wright 2005; Drechshler-Santos *et al.* 2008; Kirk *et al.* 2008; Sotome *et al.* 2013). According to Núñez & Ryvarden (1995), the group *Melanopus* was characterized by coriaceous basidiocarps which become tough on drying, thin context, black solid coloured stipe, and thin skeleto ligative hyphae, and cylindrical basidiospores. Núñez & Ryvarden (1995) accepted 11 species in the group (Zhou *et al.* 2016b). According to Krüger (2002), Krüger *et al*. (2006) and Zhou *et al.* (2016b), the group *Melanopus* was polyphyletic. Species of the group settled in two distinct clades such as the *Picipes* clade and the *Squamosus* clade (Zhou *et al.*

2016b). Two groups, *Dendropolyporus* and *Admirabilis*, were recognized for placing *Polyporus umbellatus* (Pers.) Fr. and *Polyporus pseudobetulinus* (Murashk. *ex* Pilát) Thorn, Kotir. & Niemelä respectively (Krüger 2002; Sotome *et al.* 2013). At present, all the infrageneric groups of *Polyporus*, except *Admirabilis* are treated as sub genera of *Polyporus* (Pauzar 1972; Singer 1986; Ryvarden & Iturriaga 2004; Borges Da Silveria & Wright 2005; Kirk *et al*. 2008; Sotome *et al.* 2008).

Sotome *et al.* (2008) distinguished another distinct clade among the *Polyporus sensu lato* named "*Neofavolus* clade", which was distinct from *Favolus*. However, they could not identify the differentiating morphological characters of this clade. Later, Sotome *et al.* (2013) established the genus *Neofavolus* Sotome & T. Hatt, for accommodating the species belonging to *Neofavolus* clade. The genus was characterized by glabrous pileus, with or without scales, and pileipellis a cutis composed of parallel and agglutinated generative hyphae. According to Sotome *et al.* (2013), majority of *Favolus* species possess radially striate pileal surface and undifferentiated pileipellis made of non agglutinated, hyphae. Sotome *et al*. (2013) divided the *Polyporus grammocephalus* complex into two subsidiary groups, and *P. tricholoma* complex into three subsidiary groups. Currently, *P. tricholoma* complex is treated under *Polyporellus* (Krüger 2002), which is a synonym of genus *Lentinus* (*Index Fungorum*, accessed on 19 February 2020).

A recent molecular phylogenetic work by Palacio *et al.* (2017) revealed the *Polyporus dictyopus* complex as polyphyletic. This study (Palacio *et al.* 2017) resulted in the segregation of another genus *Neodictyopus* Palacio, Robledo, Reck & Drechsler-Santos. The study also re established the genus *Atroporus* Ryvarden which has been treated as a synonym of *Polyporus* by different mycologists (Gugliotta *et al.* 1996; Núñez & Ryvarden 2001; Borges Da Silveira & Wright 2005; Louza & Gugliotta 2006; Gomes-Silva *et al*. 2012). Latest classification on Polyporales (Zmitrovich 2018) accepts *Atroporus* as an independant genus. However, *Atroporus* is considered as a synonym of *Polyporus* (*Index Fungorum*, accessed on 30 September 2020).

Economic importance

Polyporus umbellatus (Pers.) Fr. is a well known edible mushroom (Ying *et al.* 1987; Gomes-Silva *et al*. 2012; Bandara *et al.* 2015). The species has been widely used in traditional Chinese medicine (Huang & Liu 2007; Zhao 2009). The fruitbody of *P. umbellatus* is edible, while its sclerotia that is found below ground posesses potential medicinal properties (Ying *et al*. 1987; Xing *et al*. 2013). The sclerotia of this species contain various bioactive compounds, including amino acids, polysaccharides, crude proteins, fats, fiber, mineral compounds and stereoids (Lee *et al.* 2002; Chen & Deng 2003; Lee *et al.* 2004; Zhao 2009). They have anti inflammatory and immune enhancing properties and are used for curing diseases like acute nephritis, systemic dropsy, thirst, difficulty in urination, oliguria, leucorrhea, edema, sunstroke, watery diarrhea, jaundice, cirrhosis and ascites (Ying *et al.* 1987; Yuan *et al.* 2004; Liu & Liu 2009). According to Sun & Yasukawa (2008) and Ueno *et al.* (1980), *P. umbellatus* posseses *in vitro* cytotoxic, *in vivo* anti tumour, anti cancer and anti oxidant activities. They are also used in enhancing immune system (Ying *et al.* 1987; Zhang *et al*. 1991; Yang *et al.* 2004; Li *et al.* 2007). Sclerotia of this species are used in Choreito Japanese traditional medicine for treatment of renal problems (Kawashima *et al.* 2012). This fungus also holds good anti viral, anti bacterial and anti protozoal activity (Xiong 1993; Liu *et al.* 2001; Peng *et al.* 2012; Hao *et al.* 2011). Apart from *P. umbellatus,* species such as *P. badius* (Pers.) Schwein., *P. squamosus* also have potential medicinal properties (Lindequist *et al*. 2005; Ergönül *et al.* 2013). Species of *Polyporus* also have industrial applications. They are used for decolarization of synthetic dyes, and for treating textile waste water (Hadibarata *et al.* 2011; Hadibarata *et al*. 2012; Yogita *et al.* 2011; Marimuthu *et al.* 2013; Munir *et al.* 2017; Przystaś *et al.* 2018; Singh 2017).

Many species of *Polyporus* are economically important due to their edibility, medicinal properties and pathogenicity. The fungus *Polyporus shoreae* Wakef. is a serious pathogen on Sal trees and caues root rot disease (Bagchee 1957).

Distribution

Polyporus has a worldwide distribution. AFRICA: East Africa (Ryvarden & Johansen 1980). NORTH AMERICA (Murrill 1915; Gilbertson & Ryvarden 1986; Gilbertson & Ryvarden 1987; Zhou *et al.* 2016), Costa Rica (Carranza-Morse & Ruiz-Boyer 2005), Tropical America (Ryvarden & Meijer 2002). SOUTH AMERICA: Argentina (Robledo & Rajchenberg 2007), Brazil (Rajchenberg & Meijer 1990; Gugliotta & Bononi 1999; Borges Da Silveira & Wright 2002; Gibertoni *et al.* 2004; Borges Da Silveira & Wright 2005; Drechsler-Santos *et al.* 2008; Gomes-Silva *et al.* 2012; Coelho & Borges Da Silveira 2014), Guyana (Gibertoni *et al*. 2004), Paraguay (Popoff & Wright 1998), United States of America (Lowe 1942; Overholts 1953; Martin & Gilbertson 1976), Venezuela (Dennis 1970; Ryvarden & Iturriaga 2003). ASIA: China (Dai 1996; Dai 1999; Dai 2000; Dai 2012; Dai *et al.* 2014; Xue & Zhou 2014; Cui *et al*. 2019), Japan (Núñez & Ryvarden 1995a, 2001), Korea (Lim & Kim 1972; Jung 1975; Lee 1975; Jung 1994; Lee *et al.* 2010), Russia (Barsukova 1998; Thorn 2000; Vlasenko 2010, 2011), Siberia (Zhukov 1980; Vlasenko & Vlasenko 2015). EUROPE (Ryvarden & Gilbertson 1993; Ryvarden & Gilbertson 1994; Núñez & Ryvarden 1995; Ryvarden & Melo 2014), Italy (Bernicchia 2005), Finland (Niemelä *et al.* 2001). AUSTRALIA: New Zealand (Cunningham 1965; Horak & Ryvarden 1984; Buchanan & Ryvarden 1998).

From India, *Polyporus rugulosus Lév.*, *P. calcuttensis* Bose, *P. dictyopus* Mont., *P. friabilis* Bose, *P. fumoso-olivaceus* Lloyd, *P. leprieurii* Mont., *P. medullaris* Berk., *P. nigrocristatus* E. Horak & Ryvarden, *P. nodipes* Berk., *P. philippinensis* Berk., *P. picipes* Fr., *P. plorans* (Pat.) Sacc. & D. Sacc., *P. sarbadhikarii* (Bose) B.K. Bakshi, *P. steinheilianus* Berk. & Lév., *P. suboccidentalis* (Sacc. & P. Syd.) B.K. Bakshi, *P. subvirgatus* Lloyd and *P. umbellatus* (Pers.) Fr., have been reported by Bose (1920, 1921, 1921a, 1928, 1937, 1946), Thind & Chatrath (1957), Rangaswami *et al.* (1970), Bakshi (1971), Roy & De (1977), De & Roy (1981), Leelavathy & Ganesh (2000), Sharma (2000), Florence (2004), Verma *et al.* (2008), Mohanan (2011), Prasher & Lalita (2013), Ranadive (2013, 2013a), Lalitha & Prasher (2014), Lyngdoh & Dkhar (2014).

GENUS ***PSEUDOFAVOLUS*** PATOUILLARD

Pseudofavolus was established by Patouillard in 1900, with *Pseudofavolus miquelii* (Mont.) Pat. as the type species. The genus was characterized by annual basidiomata, sometimes reviving for a second season, flabelliform to spathulate pileus, sessile to laterally stipitate, thin context, hymenium poroid with angular to hexagonal pores, short pore tubes, dimitic hyphal system, with clamped generative hyphae and arboriform sheleto ligative hyphae, skeleto ligative hyphae showing variable dextrinoid reaction, absence of cystidia, sometimes with cystidioles and dendrohyphidia, and cylindrical, hyaline, smooth basidiospores, that are inamyloid in Melzer's reagent. Members of the genus cause white rot on wood (Núñez & Ryvarden 1995; Ryvarden & Johansen 1980).

In the opinion of Ryvarden & Johansen (1980), *Pseudofavolus* occupies an intermediate position between genera *Grammothele* Berk. & M.A. Curtis and *Polyporus sensu stricto*. In *Pseudofavolus*, basidia line the tubes completely, whereas in the majority of *Grammothele* species, basidia are found lining only near the bottom (Ryvarden & Johansen 1980). According to Núñez & Ryvarden (1995), *Pseudofavolus* is closely related with *Polyporus sensu stricto*, in having cylindrical basidiospores and arboriform skeleto ligative hyphae. However, the presence of dendrohyphidia seperates *Pseudofavolus* from *Polyporus* (Núñez & Ryvarden 1995). Moreover, *Pseudofavolus* generally produces smaller basidiomata and shallow pores than *Polyporus* species (Núñez & Ryvarden 2001).

Justo *et al.* (2017) accepts *Pseudofavolus* as a distinct genus, under Polyporaceae. However, Zmitrovich (2018) considers the genus as a synonym of *Favolus*. Currently, eight species have been accepted in the genus (*Index Fungorum*, accessed on 30 September 2020).

Economic importance

Pseudofavolus tenuis species has the ability to degrade artificial dyes and textile industrial effluents (Sánchez-López *et al.* 2008). Terpenoids and stereoids present in this species are known to have cytotoxic effects, against tumour cell lines (Hung *et al.* 2019). The cytotoxic effect of this species has also been reported by Aneesh & Thoppil (2019).

Distribution

Pseudofavolus has a pantropical distribution. AFRICA: Kenya, Ghana, Sierra Leone, Uganda, Tanzania (Ryvarden & Johansen 1980). SOUTH AMERICA: Brazil (Loguercio-Leite 1994; Drechsler-Santos *et al.* 2008), Venezuela (Núñez & Ryvarden 1995). ASIA: China (Dai 2011; Dai 2012), Japan (Núñez & Ryvarden 2001), Malaysia (Corner 1984, 1989; Lee *et al.* 2012). AUSTRALIA: Papua New Guinea (Quanten 1997). EUROPE (Ryvarden & Gilbertson 1993).

From India, *P. miquelii* (Mont.) Pat., *P. polygrammus* (Mont.) G. Cunn., *P. pulchellus* (Lév.) G. Cunn. and *P. tenuis* (Fr.) G. Cunn. have been documented by Bakshi (1971), Roy & De (1979), Parmasto (1983a), Leelavathy & Ganesh (2000), Mohanan (2011), Ranadive *et al*. (2011), Prasher *et al*. (2012), Prasher & Lalita (2013) and De (2018).

GENUS ***PYCNOPORUS*** P. KARSTEN

Pycnoporus was established by Karsten (1881), with *Pycnoporus cinnabarinus* (Jacq.) P. Karst as the type species. According to Nobles & Frew (1962), *Pycnoporus* fungi belong to heterothallic homobasidiomycetes, having tetrapolar mating system. The presence of various pigments such as cinnabarin, tramesanguin and cinnabarinic acid are responsible for the characteristic colour of the basidiocarps of *Pycnoporus* species (Sullivan & Henry 1971, Téllez-Téllez *et al.* 2016). The genus was placed in the tribe Corioleae, subfamily Corioloideae of Polyporaceae in the classifications of Bondartseva & Singer during 1940’s (Zmitrovich 2018). Bondartseva (1998) treated the genus in the family Poriaceae Locq. The genus is separated from the closely related *Trametes* by the noticeable bright reddish orange colour of the basidiocarps (Ryvarden 1991, Ryvarden & Gilbertson 1994; Lomascolo *et al.* 2002). *Pycnoporus* grouped together with *Coriolopsis polyzona* (Pers.) Ryvarden), *Lenzites* and *Trametes* under the core Polyporaceae clade based on SSU rDNA and ITS sequence data based study (Ko 2000). Monophyly of the genus *Pycnoporus* within the *Trametes* clade was confirmed by Tomsovsky *et al.* (2006). Tomšovský (2008) and Justo & Hibbett (2011) preffered to treat *Pycnoporus* as a synonym of *Trametes,* because both genera clustered together in their studies. Morphological and cytological evidence for *Lenzites-Coriolopsis-Pycnoporus-Trametes* group was provided by Rajchenberg (2011). According to Lesage-Meessen *et al.* (2011), there is much difficulty in identifying wild or cultivated *Pycnoporus* species, although they are morphologically similar. *Pycnoporus* has been included in the trametoid genera (*Coriolopsis, Lenzites, Trametes*) of Polyporaceae (Welti *et al.* 2012; Zmitrovich & Malysheva 2013). Cui *et al.* (2019) considers *Pycnoporus* as a synonym of *Trametes*. However, currently *Pycnoporus* is considered as an independent genus under Polyporaceae (Justo *et al.* 2017; Zmitrovich 2018). Currently the genus consists of four species (*P. cinnabarinus, P. palibini* P. Karst., *P. puniceus* (Fr.) Ryvarden and *P. sanguineus* (L.) Murrill) (*Index Fungorum*, accessed on 30 September 2020).

Based on the current concept (Ryvarden & Johansen 1980; Cifuentes *et al.* 1986; Gilbertson & Ryvarden 1986; Ryvarden & Gilbertson 1994; Zmitrovich 2018), the genus is characterized by mostly annual, sessile, coriaceous, dimidiate to flabelliform basidiomata, soft and velvety to glabrous pileus surface, cinnabar to reddish orange colour, corky to cottony floccose, reddish orange context, poroid hymenium, trimitic hyphal system with clamped generative hyphae, inamyloid to dextrinoid skeletal hyphae, presence of orange crystals on hyphae in context and hymenium, absence of cystidia and short cylindric, hyaline, smooth basidiospores that are negative in Melzer’s reagent. Basidiocarps turn brownish on treatment with KOH. Members cause white rot on wood.

Economic importance

Species of *Pycnoporus* possess anti cancerous, anti oxiadant, anti fungal, free radical scavenging and immunomodulatory activities properties (Smânia *et al*. 1995, 2003; Estrada *et al.* 2003; Correa *et al*. 2006; Borderes *et al.* 2011; Juliette-Ornely *et al*. 2019). *Pycnoporus* species also have various industrial and biotechnological applications, mainly in large scale degradation of biomass by the activity of laccase enzyme, degradation and decolourization of various dyes, clarification of waste water from oil mills and in pigment production (Schliephake *et al.* 2000; Alexopoulos *et al.* 1996; Falconnier *et al.* 1994; Eggert *et al*. 1996; Larking *et al.* 1999; Jaouani *et al.* 2005; Garcia *et al*. 2006; Vikineswary *et al.* 2006; Lomascolo *et al*. 2011; Thongkred *et al.* 2011; Lalitha & Prasher 2015; Onofre *et al.* 2015; Azmi *et al*. 2016). *P. sanguineus* is reported to degrade plastic (Cesarino *et al.* 2019).

Distribution

The genus has a cosmopolitan distribution (Ryvarden 1991). AFRICA: Cameroon (Roberts & Ryvarden 2006), East Africa (Ryvarden & Johansen 1980). NORTH AMERICA (Murrill 1904, 1905, Gilbertson & Ryvarden 1986, Zhou *et al.* 2016). SOUTH AMERICA: Argentina (Bobadilla *et al*. 2007; Robledo & Rajchenberg 2007), Brazil (Groposo & Loguercio-Leite 2005; Borges Da Silveira *et al.* 2008; Salvador-Montoya *et al.* 2012; Westphalen & Borges Da Silveira 2013; Nogueira-Melo *et al.* 2014; Pires *et al*. 2017), Guyana (Aime *et al*. 2003), United States of America (Bishop & McGrath 1978). ASIA: China (Dai 2012; Cui *et al*. 2019), Malaysia (Yamashita *et al*. 2009; Lee *et al.* 2012), Peninsular Malaysia (Bolhassan *et al.* 2012), Japan (Hattori 2005), Kenya (Núñez & Ryvarden 2001), Sri Lanka (Ediriweera *et al*. 2014), Taiwan, Thailand (Núñez & Ryvarden 2001; Choeyklin *et al.* 2011). EUROPE: Britain, Norway (Ryvarden & Gilbertson 1994), Italy (Bernicchia 2001).

Pycnoporus cinnabarinus (Jacq.) P. Karst. and *P. sanguineus* (L.) Murrill have been reported from India by Bakshi *et al.* (1969), Bakshi (1971), Sankaran & Florence (1995), Florence & Yesodharan (1997, 2000), Leelavathy & Ganesh

(2000), Mohanan (2011), Prasher & Lalita (2013), Ranadive (2013), Lyngdoh & Dkhar (2014), Iqbal *et al.* (2016).

GENUS *SANGUINODERMA* Y.F. SUN, D.H. COSTA & B.K. CUI

Sanguinoderma is a segregate genus of *Amauroderma*, established recently by Sun *et al.* (2020), with *Sanguinoderma rude* (Berk.) Y.F. Sun, D.H. Costa & B.K. Cui as the type species. The genus was morphologically separated from *Amauroderma sensu stricto* by its rapid reaction of the pore surface, which changes colour to blood red colour when bruised (Sun *et al.* 2020). *Sanguinoderma* was also well supported as a distinct lineage from *Amauroderma sensu stricto*, in the multigene phylogenetic analysis (Sun *et al.* 2020). Currently, ten species are recognized in the genus (*Index Fungorum*, accessed on 30 September 2020).

Sanguinoderma is morphologically characterized by annual, central or lateral stipitate to sessile, woody hard, basidiomata, suborbicular to reniform pileus, dark brown to almost black, concentrically zonate or furrowed, radially rugose, tomentose to glabrous pileus surface, poroid hymenium, greyish white to dark grey pore surface, which turns blood red when bruised, and pale brown to dark brown context. Microscopically, the genus possesses trimitic hyphal system, hyaline, clamped generative hyphae, hyaline to yellowish brown, thick walled skeletal hyphae, hyaline to pale yellow, arboriformly branched skeleto ligative hyphae, and subglobose, ellipsoid to reniform, pale yellow, double walled, sparsely to distinctly thick walled, inamyloid basidiospores, with semi reticulate or vermiculate to verrucose exosporium and, solid, columnar to coniform endosporium. Members cause white rot on wood (Sun *et al.* 2020).

Economic importance

Sanguinoderma rude (Berk.) Y.F. Sun, D.H. Costa & B.K. Cui and *S. rugosum* (Blume & T. Nees) Y.F. Sun, D.H. Costa & B.K. Cui have potential medicinal value, and have been traditionally used by the Chinese to cure inflammation, indigestion and cancer (Dai & Yang 2008). *S. rude* is well known for their anti cancer (Jiao *et al*. 2013; Li *et al.* 2015; Pan *et al*. 2015; Hapuarachchi *et al.*

2018) and anti oxidant activities (Wang & Qi 2016). *S. rude* is reported to be more effective than the medicinal fungus, *Ganoderma lucidum* in suppressing various types of cancers (Jiao *et al*. 2013). It was found out that the presence of ergosterol in *S. rude* is responsible for its anti cancer activity (Li *et al.* 2015). The cytotoxic effect of *S. rude* was studied by Chen *et al.* (2016). Mycelia of *S. rugosum* (Blume & T. Nees) Y.F. Sun, D.H. Costa & B.K. Cui are a source of carbohydrates, proteins, dietary fibre, phosphorus, potassium and sodium (Chan *et al*. 2013). This species is reported to possess high anti oxidant and anti inflammatory properties (Chan *et al*. 2013). *S. rugosum* also exhibits anti microbial activity against *Staphylococcus aureus*, *S. pyogenes*, *Pseudomonas aeruginos*, *Escherichia coli* and *Clostridium difficile* (Liew *et al*. 2015) and has been found effective against dyslipidemia (Seng *et al*. 2017). The phenolic compounds present in *S. rugosum* can be used to treat atherosclerosis and cardiovascular problems (Seng *et al*. 2017a).

Distribution

Sanguinoderma has mainly a paleotropical distribution (Sun *et al.* 2020). AFRICA: East Africa (Ryvarden & Johansen 1980), Kenya, Rhodesia (Otieno 1968), Zambia (Sun *et al.* 2020). SOUTH AMERICA: Brazil (Campacci & Gugliotta 2009; Costa-Rezende *et al.* 2016). ASIA: China (Zhao *et al.* 1979, 1983; Zhao & Zhang 1987; Moncalvo & Ryvarden 1997; Li & Yuan 2015; Song *et al*. 2016; Sun *et al.* 2020), Japan (Moncalvo & Ryvarden 1997), Laos (Hapuarachchi *et al.* 2018), Malaysia (Corner 1983), Philippines (Murrill 1907a, 1908), Thailand (Hapuarachchi *et al.* 2018), Singapore (Corner 1983), Taiwan (Núñez & Ryvarden 2000). AUSTRALIA: Queensland (Sun *et al.* 2020).

Sanguinoderma rude (Berk.) Torrend and *S. rugosum* (Nees.) *Bose.* have been reported from India (Bose 1937; Banerjee 1947; Bakshi 1971; Leelavthy & Ganesh 2000; Sharma 2000; Mohanan 2011; Ranadive *et al.* 2013, Chuzho *et al.* 2017).

GENUS *THELEPORUS* FRIES

Theleporus was describred by Fries in 1847, under Polyporaceae with *Theleporus cretaceus* Fr. as the type species. Major characteristics of the genus are resupinate, adnate, basidiomata, irregularly poroid to semilabyrinthine hymenium, light cream to ochraceous pore surface, dimitic to trimitic hyphal system with clamped generative hyphae, presence of arboriform skeleto ligative hyphae, inamyloid hyphae, presence or absence of dendrohyphidia, broadly ellipsoid, thin walled, smooth and inamyloid basidiospores. Members grow on deciduous wood (Ryvarden & Johansen 1980).

The genus is closely related with *Grammothele* Berk. & M.A. Curtis in morphology, but can be distinguished by some microscopic features (Ryvarden & Johansen 1980; Zhou & Dai 2012; Yuan 2015; Wu *et al.* 2016). Species of *Theleporus* possess a dendroid skeletal hyphae or skeleto ligative hyphae. Branched hyphae are absent in *Grammothele.* In *Grammothele*, skeletal hyphae are dextrinoid and darkens with age (which imparts dark colouration on their fruit bodies), while species of *Theleporus* do not exhibit such a character. Fruit bodies are always white to grey in colour, and hyphae are inamyloid (Ryvarden & Johansen 1980). According to Ryvarden (2014), *Theleporus* possesses mostly poroid hymenium, but *Grammothele* species consists of hydnoid to poroid hymenium. Both genera resemble corticioid fungi in having hymenium limited to the horizontal plane of the fruit bodies (Ryvarden & Johansen 1980). Molecular studies place *Theleporus* in the core polyporoid clade of Polyporales (Binder *et al.* 2013; Zhou & Dai 2012; Wu *et al.* 2016). Currently, ten species are accepted in the genus (*Index Funforum*, accessed on 30 September 2020).

Distribution

The genus has a tropical distribution (Ryvarden 1991): AFRICA: Cameroon (Roberts & Ryvarden 2006), Malawi, Tanzania (Ryvarden & Johansen 1980). NORTH AMERICA (Zhou *et al.* 2016; Ryvarden 2014). SOUTH AMERICA: Venezuela (Ryvarden & Iturriaga 2003). ASIA: China (Dai *et al.* 2011; Dai 2012;

Zhou & Dai 2012; Yuan 2015), Malaysia (Lee *et al.* 2012), Sri Lanka (Ryvarden & Johansen 1980), Tanzania (Nuñéz & Ryvarden 2001).

From India, *Theleporus calcicolor* (Sacc. & P. Syd.) Ryvarden has been listed in the checklist of Ranadive (2013).

GENUS *TRAMETES* FRIES

Genus *Trametes* was established by Fries (1836) in the tribe *Polyporei* to place coriaceous polyporoid species, having their context descending into the trama of hymenium (Welti *et al.* 2012). Kavina & Pilát (1936) gave less importance to the pore characters and according to them, the genus *Trametes sensu* Pilát included poroid, daedaleoid as well as lamelloid genera such as *Lenzites* Fr. or *Daedalea* Pers., (e.g., *T. betulina* (L.) Fr.) Pilát; *T. quercina* (L.) Fr.) Pilát). Based on the colour of the context, two new genera, *Coriolopsis* Murrill (basionym *Trametes occidentalis* (Klotzsch) Murrill) and *Pycnoporus* P. Karst. (*Trametes cinnabarina* (Jacq.) Fr.) were established for trametoid specimens with fruit bodies possessing brown or cinnabarin red colours respectively (Welti *et al.* 2012). Later, Patouillard (1900) in his *"série des Trametes"* included all genera with poroid, daedaleoid and lamelloid hymenium. The same concept was followed by Kotlaba & Pouzar (1957), who kept all genera with dimitic or trimitic hyphal system, and colourless, smooth and inamyloid spores in the "*Trametes* group". The white rot type of wood decay was considered as a significant character for defining *Trametes* group by Nobles (1958), and thus the genus *Daedalea* Pers. was excluded from the group as they caused brown rot decay of wood. Singer (1961) described *Trametes* as a member of family *Coriolaceae* which included other related genera like *Coriolopsis* Murrill, *Lenzites* Fr.*, Cerrena* Gray and *Pycnoporus* P. Karst. Later, *Trametes* was restricted to species with trimitic hyphal system (Ryvarden & Johansen 1980). Corner (1989) synonymized 15 other genera of polypores having trimitic hyphal systems excluding three genera (*Daedalea, Lenzites* and *Trichaptum* Murrill, which possessed hymenial skeleto ligative hyphae with cystidiform ends) under *Trametes*. However, Ryvarden (1991) placed all white rot genera including those with coloured hyphal pigments and pointed cystidiform hyphal ends under the *Trametes* group.

Morphological and cytological support for *Lenzites-Coriolopsis-Pycnoporus-Trametes* group was put forward by Rajchenberg (2011). The white rot type of wood decay, di-trimitic hyphal system, clamped generative hyphae, absence of true hymenial cystidia, hyaline, thin walled, often cylindrical, smooth and inamyloid basidiospores are the characteristics of the members of *Trametes* group (Welti *et al.* 2012).

Molecular characterization of the genus *Trametes* based on mitochondrial small subunit ribosomal DNA was initiated by Hibbett & Donoghue (1995). According to their study, *Trametes* settled along with other genera (*Cryptoporus* (Peck) Shear, *Daedaleopsis* J. Schröt., *Datronia* Donk, *Fomes* (Fr.) Fr., *Ganoderma* P. Karst., *Lenzites*, *Polyporus*, *Pycnoporus*), having a dimitic to trimitic hyphal system and white rot type of wood decay. Phylogenetic study conducted by Ko & Jung (1999) confirmed that the genus *Coriolopsis* belonged to the *Trametes* clade. The genus *Cerrena* was excluded from the *Trametes* group based on the same study (Ko & Jung 1999). *Coriolopsis* (*C. polyzona* (Pers.) Ryvarden), *Lenzites, Pycnoporus* and *Trametes* grouped together under the core Polyporaceae clade based on SSU rDNA and ITS sequence data (Ko 2000). Again, *Trametes* and *Pycnoporus* were placed in a single clade in the study based on mitochondrial ribosomal DNA (Klonowska *et al*. 2003; Lutzoni *et al*. 2004). These studies (Klonowska *et al*. 2003; Lutzoni *et al*. 2004) also proved that some species, previously classified in *Trametes* by Corner (1989), Gilbertson & Ryvarden (1987) and Ryvarden & Gilbertson (1994), were not really belonging to *Trametes*. Tomšovský *et al.* (2006) studied the phylogeny of all European and one American species of the genus *Trametes*, and allied genera using the sequence of LSU and ITS regions of nuclear ribosomal DNA. In their study, ITS sequence of *Trametes cervina* (Schwein.) Bres. settled in the the phlebioid clade. The study (Tomšovský *et al.* 2006) confirmed the monophyly of the genus *Pycnoporus* inside the *Trametes* clade. Later, Tomšovský (2008) erected genus *Trametopsis* Tomšovský for placing *Trametes cervina*.

The phylogenetic classification of genus *Trametes* by Justo & Hibbett (2011), placed *Trametopsis cervina* (Schwein.) Tomšovský in the phlebioid clade, *Trametes trogii* in the *Polyporus* clade and rest all *Trametes* species in the trametoid clade. Trametoid clade included *Lenzites betulinus*, *Coriolopsis polyzona*, and the genus *Pycnoporus* (Justo & Hibbett 2011). Six genera such as *Cryptoporus* (Peck) Shear, *Daedaleopsis* J. Schröt., *Datronia* Donk, *Earliella* Murrill, *Megasporoporia* Ryvarden & Wright and *Microporus* P. Beauv. which were kept in *Trametes* group by Ryvarden (1991) were positioned in the *Polyporus* clade in the study. Based on phylogenetic classification of *Trametes* by Justo & Hibbett (2011), genera *Artolenzites*, *Coriolopsis*, *Coriolus* Quél., *Cubamyces* Murrill, *Cyclomycetella* Murrill, *Lenzites, Poronidulus* Murrill, *Pseudotrametes* Bondartsev & Singer and *Pycnoporus* were considered as synonyms of *Trametes*. According to the molecular phylogenetic study by Cui *et al.* (2011c), the genus *Cerrena* was found to be distinct from the genus *Trametes*. Molecular phylogenetic study of *Trametes* using ITS, LSU and RPB2 sequence data by Welti *et al*. (2012), differentiated four distinct genera in the *Trametes* group such as i) *Trametes* (species with pubescent to hirsute pileus surface, including *Lenzites betulinus* and *Coriolopsis polyzona*), ii) *Pycnoporus* (species with red basidiocarps which blackens in KOH) iii) *Artolenzites* Falck (for placing tropical *Lenzites elegans* (Spreng.) Pat., characterized by large, spathulate to reniform basidiomata, white to cream coloured, glabrous pileus, narrowly daedaleoid to lamellate hymenium) and iv) *Leiotrametes* (included tropical *Trametes menziesii* (Berk.) Ryvarden, *T. lactinea* (Berk.) Sacc., and *Leiotrametes* sp., distinguished by glabrous pileal surface and presence of a brown resinous substance in the lumen of the skeletal hyphae of pileipellis). Of these, the genus *Artolenzites* has been currently treated as synonym of *Trametes* (*Index Fungorum*, accessed on 20 February 2020). Currently, 230 species have been recognized under *Trametes* in the *Index Fungorum* database (accessed on 20 February 2020).

Trametes species are characterized by annual to biennial basidiomata, dimidiate to flabelliform pileus, hispid, hirsute, tomenose to glabrous pileal surface, poroid hymenium, homogenous context that are white to cream colour, trimitic hyphal system, absence of cystidia and ellipsoid to allantoid, smooth, thin walled basidiospores that are inamyloid in Melzer's reagent. *Trametes* cause white rot on wood (Ryvarden & Johansem 1980; Gilbertson & Ryvarden 1987; Núñez & Ryvarden 2001; Zmitrovich *et al.* 2012).

Economic importance

According to Kobayashi *et al.* (1994), presence of *T. versicolor* polysaccharopeptides increases *in vitro* anti cancer activity of the chemotherapy drug, cisplatin. Polysaccharopeptides of *T. versicolor* ranked 19th position in the list of the world's most commercially successful medicine (Yang *et al.* 1992). *Trametes versicolor* is known to possesss immunomodulating activity (Hobbs 2004). *Trametes versicolor* has been used for counteraction of immunosupression due to chemotherapy, radiotherapy and tumours (Mayer *et al*. 1980; Lin *et al.* 1996; Mao *et al.* 1996; Wang *et al.* 1996; Cheng *et al.* 1998; Chu *et al.* 2002; Cui & Chisti 2003; Ng *et al.* 2006; Brown & Reetz 2012; Standish *et al*. 2008; Cruz *et al.* 2016). Extracts of *T. versicolor* also possess good anti oxidant and anti inflammatory properties (Kamiyama *et al.* 2013; Oyetayo 2014). *Trametes versicolor* also possesses good anti viral (Teplyakova *et al.* 2012; Kamiyama *et al.* 2013; Cruz *et al.* 2016), antimicrobial (Özgör *et al.* 2016), prebiotic (Zhuo-Teng *et al.* 2013; Cruz *et al.* 2016) and anti diabetic activities (Shokrzadeh *et al.* 2017). Tea prepared from *T. versicolor* proved to have healing properties, and is consumed by the Chinese and the Japanese as part of their traditional medicinal practices (Cui & Chisti 2003). Species of *Trametes* (*T. zonata* Wettst., *T. hirsuta* (Wulfen) Lloyd and *T. gibbosa* (Pers.) Fr. also have anti bacterial, anti oxidant, immune-modulating, anti virus and hypoglycaemic properties (Rashid 2010; Barros *et al*. 2016; Shahbazyan 2017). *Trametes apiaria* (Pers.) Zmitr., Wasser & Ezhov possess anti inflammatory properties (Thang *et al.* 2015).

Trametes versicolor also has application in biodegradation of toxic pharmaceutically active compounds (PhACs) (Morató-Cruz *et al.* 2013), and in degradation of recalcitrant organic contaminants like pentachlorophenol (PCP) (Tuomela *et al.* 1998). According to Rameshaiah & Reddy (2015), laccases present in *T. versicolor* are capable of degrading variety of environmental contaminants such as phenolic and non phenolic compounds and also has role in decolourization of azo dyes, dye and textile industry sewages (Archibald *et al.* 1997; Amaral *et al.* 2004; Selvam & Shanmuga 2012; Sudha *et al*. 2014; Chenaux *et al*. 2014; Munir *et al.* 2017). Laccases from *Trametes hirsuta* also has application in decolorization and detoxification of textile dyes (Abadulla *et al.* 2000).

Trametes hirsuta and *T. versicolor* are known to cause white spongy rot on different landscape trees (Hickman & Perry 1997; Hickman *et al.* 2011). *Trametes versicolor* is considered as a wound pathogen on broad leaved trees and conifers (Smith 2018).

Distribution

Genus *Trametes* has a cosmopolitan distribution. AFRICA (Ryvarden 1972; Ryvarden & Johansen 1980; Zmitrovich & Malysheva 2014; Ueitele *et al.* 2018). NORTH AMERICA (Murrill 1905a, 1905b; Gilbertson & Ryvarden 1986; Gilbertson & Ryvarden 1987; Gardes & Bruns 1993; Ryvarden 2000, Ryvarden *et al.* 2009; Læssøe & Ryvarden 2010), United States of America (Grand & Vernia 2002; Vlasák & Kout 2011). SOUTH AMERICA: Argentina (Rajchenberg 1982), Brazil (Gomes-Silva *et al*. 2012). ASIA: China (Dai 1996; Dai *et al.* 2011; Dai 2012; Li *et al.* 2011; Cui *et al.* 2019), Japan, Korea (Núñez & Ryvarden 2001; Lee & Lim 2010), Malaysia (Watling 1994; Salmiah 1997; Lee *et. al.* 1995), Philippines (Murrill 1907a), Taiwan, Tailand (Núñez & Ryvarden 2001). AUSTRALIA: Papua New Guinea (Quanten 1997). EUROPE (Kotlaba & Pouzar 1957; Ryvarden & Gilbertson 1993; Ryvarden & Gilbertson 1994; Bernicchia 2005; Tomšovský *et al*. 2006).

Species of *Trametes* such as *T. apiaria* (Pers.) Zmitr., Wasser & Ezhov, *T. strumosa* (Fr.) Zmitr., *T. cincta* Bose, *T. cingulata* Berk., *T. cotonea* (Pat. & Har.) Ryvarden, *T. gibbosa* (Pers.) Fr., *T. cubensis* (Mont.) Sacc., *T. flavida* (Lév.) Zmitr., Wasser & Ezhov, *T.hirsuta* (Wulfen) Lloyd, *T. hololeuca* (Cooke) G. Cunn., *T. incana* Berk., *T. karii* Bose, *T. manilaensis* (Lloyd) Teng, *T. meyenii* (Klotzsch) Lloyd, *T. marianna* (Pers.) Ryvarden, *T. ochracea* (Pers.) Gilb. & Ryvarden, *T. pubescens* (Schumach.) Pilát, *T. roseola* Pat. & Har., *T. suaveolens* (L.) Fr., *T. sycomori* Henn., *T. tephroleuca* Berk., *T. trogii* Berk., *T. varians* Van der Byl, *T.*

vernicipes (Berk.) Zmitr., *T. versicolor* (L.) Lloyd and *T. villosa* (Sw.) Kreisel have been recorded from India by Butler & Bisby (1931), Bose (1934, 1937), Berkeley (1854), Butler & Bisby (1960), Rangaswamy *et al*. (1970), Bakshi (1971), Roy & De (1996), Leelavathy & Ganesh (2000), Verma *et al.* (2008), Ranadive *et al*. (2011), Prasher & Lalita (2013), Gautam (2013), Ranadive (2013) and Saha *et al.* (2018).

2.1.4.1.12. **Steccherinaceae** Parmasto

Family Steccherinaceae was erected by Parmasto in 1968. According to Maas Geesteranus (1971), the family is characterized by resupinate, effused reflexed or pileate basidiomata with white, yellow to brownish shades, smooth, granular, hydnoid, or poroid hymenium and coriaceous to corky context having whitish to pallid colours. Microscopically, members of the family are distinguished by dimitic hyphal system, clamped generative hyphae, subglobose, ellipsoid, cylindrical, hyaline, smooth, basidiospores that are inamyloid in Melzer's reagent. Species of the group usually possess cystidia, that are thin to thick walled, smooth or with encrustations. Species belonging to the family cause white rot on the host.

According to Binder *et al.* (2013) and Justo *et al.* (2017), Steccherinaceae belongs to the residual polyporoid clade of Polyporales. Currently, genera such as *Antella* Miettinen, *Austeria* Miettinen, *Butyrea* Miettinen, and *Trulla* Miettinen & Ryvarden have been recognized under the family (*Index Fungorum*, accessed on 02 October 2020).

GENUS *BUTYREA* MIETTINEN

Butyrea is a genus recently established by Miettinen & Ryvarden (2016), with *Butyrea luteoalba* (P. Karst.) as the type species. The genus was introduced for placing two species of *Junghuhnia* Corda having gloeocystidia. *Butyrea* is mainly characterized by annual, resupinate basidiocarps with cream to yellowish shades, small pores (4–8 per mm), dimitic hyphal system, clamped generative hyphae, moderately cyanophilous skeletal hyphae, presence of thin walled gloeocystidia and thick walled encrusted cystidia, and cylindrical, straight, thin walled, basidiospores that are inamyloid in Melzer's reagent (Núñez & Ryvarden 2001; Miettinen & Ryvarden 2016). The genus causes white rot on wood (Núñez & Ryvarden 2001). *Butyrea* is closely related to the genus *Antrodiella* Ryvarden & I. Johans. However, the latter lacks cystidia (Ryvarden & Melo 2014). According to Miettinen & Ryvarden (2016), genus *Metuloidea* G. Cunn. shows similarity with *Butyrea* in having encrusted cystidia, and differs by producing pileate basidiocarps. Genus *Steccherinum* Gray produces resupinate basidiocarps, and encrusted cystidia as *Butyrea*. However, *Steccherinum* lacks gloeocystidia (Miettinen & Ryvarden 2016).

Currently, two species are recognized in the genus, such as *B. japonica* (Núñez & Ryvarden) Miettinen & Ryvarden, and *B. luteoalba* (P. Karst.) Miettinen (*Index Fungorum*, accessed on 30 September 2020).

Distribution

NORTH AMERICA (Lowe 1966; Vampola 2009; Zhou *et al.* 2016). ASIA: China (Dai 2012), Korea, Japan (Núñez & Ryvarden 1999, 2001). EUROPE: Checzh Republic, Estonia, Finland, Lithuania, Norway, Poland, Sweden, Switzerland (Ryvarden & Glbertson 1993; Vampola 2009).

Butyrea luteoalba (P. Karst.) Miettinen has been recorded (as *Junghuhnia luteoalba* (P. Karst.) Ryvarden) from India (Ranadive 2013).

GENUS *NIGROPORUS* MURRILL

Nigroporus is a genus established by Murrill (1905) under Polyporaceae with *Nigroporus vinosus* (Berk.) Murrill as the type species. The genus was introduced for placing annual poroid species that possessed dark brown context and black coloured pore tubes (Murrill 1905). The genus was treated under the family Poriaceae by Bonsartseva (1998). According to Ryvarden & Johansen (1980), pinkish, violet to dark bluish grey coloured basidiocarps and dimitic hyphal system made of fuliginous skeletal hyphae characterizes the genus *Nigroporus*. Based on the phylogenetic study by Binder *et al.* (2013), the genus belongs to the residual polyporoid clade of Polyporales. Recent studies on Polyporales place *Nigroporus* under family Steccherinaceae Parmasto (Justo *et al.* 2017), and in the

Steccherinaceae group of family Meruliaceae (Zmitrovich 2018). Currently six species have been recognized under the genus (*Index Fungorum*, accessed on 30 September 2020).

Based on concepts by Ryvarden & Johansen (1980), Núñez & Ryvarden (2001) and Ryvarden & Melo (2014), *Nigroporus* species are characterized by annual to perennial, pileate to resupinate basidiocarps, scrupose to glabrous pileus surface with or without zonations, vinaceous brown to pink or violet in colour, vinaceous brown to pink or purple coloured context, poroid hymenium and concolourous with pileus surface, dimitic hyphal system with clamped generative hyphae, fuliginous brown skeletal hyphae, absence of cystidia and allantoids to broadly ellipsoid, hyaline, smooth and thin walled basidiospores that are inamyloid in Melzer’s reagent. Species cause white rot on wood.

Economic importance

Nigroporus vinosus has been used for large scale lignolytic enzyme production (Risna & Suhirman 2002). *Nigroporus* species are also capable of degrading organic wastes (Kondo 2005) and poly aromatic hydrocarbons (PAHs) and polychlorinated biphenyls (PCBs) in culture media (Siripong *et al.* 2009).

Distribution

The genus has a Pantropical distribution (Ryvarden 1991). AFRICA: Cameroon (Roberts & Ryvarden 2006; Douanla-Meli *et al.* 2007), Ethiopia, Ghana, Kenya, Malawi, Nigeria, Rwanda, Sierra Leone, Tanzania, Zaire, Zambia (Ryvarden & Johansen 1980). NORTH AMERICA: United States of America (Berkeley 1845; Lowe 1966; Bishop & McGrath 1978), Tropical America (Ryvarden 2015). SOUTH AMERICA: Argentinean Yungas (Robledo & Rajchenberg 2007), Brazil (Drechsler-Santos *et al.* 2008), Guyana (Aime *et al.* 2003), Venezuela (Ryvarden & Iturriaga 2003). ASIA: China (Dai *et al.* 2011; Dai 2012), Japan, Korea (Núñez & Ryvarden 2001), Malaysia (Yamshita *et al.* 2009; Lee *et al.* 2012), Mesapotamia (Wright & Deschamps 1975), Peninsular Malaysia (Bolhassan 2013), Vietnam (Núñez & Ryvarden 2001). AUSTRALIA: New Zealand (Cunningham 1965).

Nigroporus durus (Jungh.) Murrill, and *N. vinosus* (Berk.) Murrill have been reported from India by Bose (1934, 1937), Bakshi (1971), Sankaran & Florence (1995), Florence & Yesodharan (1997), Leelavathy & Ganesh (2000), Verma *et al*. (2008), Mohanan (2011), Prasher & Lalita (2013), Ranadive (2013), Lyngdoh & Dkhar (2014).

2.1.5. ORDER HYMENOCHAETALES OBERWINKLER

Hymenochaetaceous fungi were first described in *Serie des Igniaires* of Patouillard (1900) as family Hymenochaetaceae of the order Aphyllophorales. Although, there were variations in the morphology of basidiomes and hymenophore configurations, most of the species possessed setae as a common character (Fiasson & Niemelä 1984). The golden to brown coloured basidiocarps, and their xanthochroic reaction in KOH solution were the major distinguishing features of all the members of the group, and these characters were accepted by Corner (1950) and Donk (1948). In 1977, Oberwinkler elevated the group to the rank of order. Hymenochaetales was accepted as a natural group by Jahn (1963, 1981), Domanski *et al.* (1973), Oberwinkler (1977), Jülich (1984), Corner (1991), Ryvarden (1991), Hibbett & Donoghue (1995) (Wagner & Fischer 2001). Donk (1964) placed the brown rot species *Phaeolus schweinitzii* (Fr.) Pat. in Hymenochaetaceae. Parmasto & Parmasto (1979) opined that the pigment responsible for brownish colouration of *Phaeolus* basidiocarps is distinct from that of other Hymenochaetaceae members, and also stated that the xanthochroic reaction of basidiocarps was also found in groups other than Hymenochaetaceae (Larsson *et al*. 2006). Fiasson & Niemelä (1984) characterized the order as homobasidiomycetes with xanthochroic basidiocarps, poroid, smooth or hydnoid hymenium, hyaline or golden to brown coloured hyphae, constantly without clamp connections, mostly with the presence of setae, imperforate septa, and ability to produce white rot on host. The study (Fiasson & Niemelä 1984) recognized two sub orders for Hymenochaetales, such as Hymenochaetinae Fiasson & Niemela and Phaeolinae Fiasson & Niemelä. The sub order Hymenochaetinae included three families such as, Hymenochaetaceae Donk (typified by *Hymenochaeate* Lév), Inonotaceae Fiasson & Niemela (typified by

Inonotus P Karst. and Phellinaceae Jiilich (typified by *Phellinus* Quél). The sub order Phaeolinae contained single family, Phaeolaceae Jiilich (typified by *Phaeolus* Pat.). According to Fiasson & Niemelä (1984), the sub order Hymenochaetinae, typified by Hymenochaetaceae is characterized by poroid, smooth or hydnoid hymenium, mostly with the presence of setae, consistently imperforate paranthesomes, capable of synthetizing hispidin, leucohymenoquinone, hypho1omin B, 3,14'-bishispidinyl and causing white rot. The sub order Phaolinae, typified by Phaeolaceae contained species having poroid hymenium, absence of setae, perforate paranthesomes, ability to synthetize only hispidin, and causing white rot or imperfect brown rot.

In the molecular study of homobasidiomycetes (Hibbett & Donoghue 1995), Hymenochaetales (=hymenochaetoid clade) was moderately supported, and genera *Oxyporus* (Bourdot & Galzin) Donk and *Trichaptum* Murrill which lacked xanthochroic reaction, setae, and brownish hyphae were found to be closely related. These genera, along with some corticioid species that possessed imperforate parenthesomes (*Hyphodontia* species, *Basidioradulum radula* (Fr.) Nobles and *Schizopora paradoxa* (Schrad.) Donk, Langer & Oberwinkler 1993) clustered under Hymenochaetales. Hymenochaetoid clade was well supported in the phylogenetic study of Hibbett & Thorn (2001). Based on the phylogenetic study by Wagner & Fischer (2001), the genera *Phellinus sensu lato* and *Inonotus sensu lato* was found to be polyphyletic. Accordingly, *Phellinus sensu lato* was divided into different genera such as *Phellinus sensu stricto*, *Porodaedalea* Murrill, *Fomitiporia*, *Fuscoporia*, *Phellinidium*, and *Phylloporia*. *Inonotus sensu lato* was divided into genera *Inonotus sensu stricto, Inocutis*, *Pseudoinonotus* and *Inonotopsis*. In the study of Moncalvo *et al*. (2002), stipitate stereoid genus *Cotylidia* and agaricoid genera, *Cantharellopsis* Kuyper, *Omphalina* Quél. and *Rickenella* Raithelh, associated with mosses (Redhead 1981), were also positioned in or near to Hymenochaetales. These latter three genera were then transferred to Hymenochaetales by Redhead *et al*. (2002). The concept of Hymenochaetales has also been discussed in Larsson *et al*. (2004) and Binder *et al*. (2005). Currently, Hymenochaetales is considered as one of the largest orders of basidiomycetous fungi comprising more than 900 species (Hibbett *et al.* 2014). The order also includes some clavarioid fungi (eg's. *Alloclavaria* Dentinger & D.J. McLaughlin, *Clavariachaete* Corner). According to Hibbett *et al.* (2014), *Peniophorella praetermissa* P. Karst is the only species reported to have perforate parenthesomes in the order Hymenochaetales. Hymenochaetales are dominant wood rotting groups that includes parasites and pathogens (species of *Inonotus, Phellinus sensu lato*) as well as ectomycorrizae forming *Coltricia* and *Coltriciella* Murrill (Tedersoo *et al.* 2007; Hibbett *et al.* 2014). In the phylogenetic study of Larsson *et al*. (2006), Hymenochaetales has been divided into six clades, such as *Oxyporus* clade, *Rickenella* clade, *Kneiffiella* clade, *Hyphodontia* clade, *Coltricia* clade and Hymenochaetaceae clade.

Based on the recent concept (Wagner & Fischer 2001; Larsson *et al.* 2006; Hibbett *et al.* 2014), the order comprises species with annual to perennial, resupinate, effused reflexed, pileate and bracket shaped, agaricoid, clavarioid, spathulate to rosette basidiomata, with smooth, poroid, lamellate or hydnoid hymenium, monomitic to dimitic hyphal system, large globose to narrow or curved, hyaline to yellow brown basidiospores, with or without setae, when present, setae of varying shapes and surface features, mostly saprotrophic causing white rot (brown rot in *Bridgeoporus nobilissimus* (W.B. Cooke) T.J. Volk, Burds. & Ammirati, Redberg *et al*. 2003). Some species of the group are pathogenic on different plants (e.g., species of *Phellinus, Inonotus*) (Larsson *et al.* 2006). Few members form ectomycorrizae (*Coltricia* and *Coltriciella* Murrill) (Tedersoo *et al.* 2007). In Hymenochaetales, some agaricoid species often are associated with mosses (e.g. *Rickenella, Cantharellopsis* Kuyper, *Cotylidia* P. Karst.), whereas others are soil inhabiting, or associated with leaf litter, or dead wood (*Hymenochaete* species). Nematode traping ability is reported in *Hyphoderma* species. (Larsson *et al.* 2006).

Some of the major works providing taxonomic descriptions and keys to species of Hymenochaetales are those of Léger (1998), Gilbertson & Ryvarden (1986, 1987), Larsen & Cobb-Poulle (1990), Núñez & Ryvarden (2000), Parmasto (2001a, 2001b), Ryvarden (2004) and Parmasto (2005).

2.1.5.1. MAJOR FAMILIES OF HYMENOCHAETALES

2.1.5.1.1. **Hymenochaetaceae** Donk

The family was erected by Donk in 1948, with *Hymenochaete* Lév. as the type species. Members of the group have a cosmopolitan distribution (Malgaonkar *et al.* 2015). Hymenochataceae consists of 28 genera and 400 species (Malgaonkar *et al.* 2015). Dai (2010) recognizes more than 450 species in the group. According to Hibbett *et al.* (2014), the family comprises 60% of the described Hymenochaetales species, including poroid, stereoid and some hydnoid forms.

Hymenochaetaceae is characterized by the xanthochroic reaction of basidiocarps, simple septate hyphae, many species are with setae and imperforate parenthesomes (Hibbett & Thorn 2001). However, according to Hibbett & Thorn (2001), the settlement of certain corticioid and polyporoid taxa which lack these characters in the Hymenochaetoid clade disagrees with the widely accepted rule of Hymenochaetaceae. Species concepts in Hymenochaetaceae have been discussed in detail by Parmasto (1985). Hymenochaetaceae members produce compound named styrilpyrones, as part of defence mechanism, and its distribution has been used in classifying species by Fiasson (1982) and Fiasson & Bernillon (1983) (Larsson *et al*. 2006). Species of the group mainly grow on wood, while some act as parasites on living trees and bushes (Hibbett *et al.* 2014). Many species in the family are serious forest pathogens, whereas, many other species possess medicinal properties (Jo *et al*. 2007; Dai *et al*. 2010). *Phellinus* sensu lato, *Hymenochaete* Lév. and *Inonotus sensu lato* are considered as the three largest genera in the family Hymenochaetaceae. Based on phylogenetic studies (Wagner & Fischer 2001, 2002, 2002a), Hymenochaetaceae is recognized as polyphyletic, with corticioid species and polyporoid genera (*Trichaptum* and *Schizopora*) intermixed among the true hymenochaetoid forms.

GENUS *COLTRICIA* GRAY

Coltricia typified by *C. perennis* (L.) Murrill, is a genus belonging to Hymenochaetales, mainly distinguished from other species of the order by its occurrence on the ground (Larsson *et al*. 2006), and rarely on dead wood (Baltazar *et al.* 2010, Zhou & Tedersoo 2012). Few species of *Coltricia* are reported to have ectomycorrhizal association (Danielson 1984; Tedersoo *et al*. 2007). Earlier classifications (Bondartsew & Singer 1941) had treated the genus under sub family *Fomitoideae* of Polyporaceae (Zmitrovich 2018). The genus shows similarity with *Coltriciella* Murrill in growth form and hyphal characters, but the latter produces ornamented basidiospores (Ryvarden 1991; Dai 2010; Zhou & Tedersoo 2012; Bian & Dai 2017). *Coltricia* and *Coltriciella* appeared either monophyletic or paraphyletic (Wagner & Fischer 2002; Larsson *et al.* 2006; Tedersoo *et al.* 2007). *Coltricia* also shows resemblance with *Inonotus* P. Karst. *sensu lato* and *Phylloporia* Murrill (Baltazar *et al*. 2010). *Phylloporia* Murrill can be separated from *Coltricia* in having a distinct black line in the context, below the tomentum (Gomes-Silva *et al*. 2012a). It is interesting to note that some *Coltricia* species clustered within the *Phylloporia* clade in a study by Valenzuela *et al.* (2011).

Most authors accept *Coltricia* as a monophyletic genus (Baltazar *et al.* 2010). *Coltricia* together with *Coltriciella,* and some corticioid members formed a separate clade called as "*Coltricia* clade" in the molecular phylogenetic study by Larsson *et al.* (2006). Dai (2010) called this clade as "*Coltricia*/*Coltriciella* clade". According to Larsson *et al.* (2006), although *Coltricia* and *Coltriciella* could be morphologically separated, their distinctness was not supported in the phylogenetic analysis. Currently, the genus holds 58 species (*Index Fungorum*, 30 September 2020).

According to the current concept (Ryvarden & Johansen 1980; Ryvarden & Gilbertson 1993; Léger 1998; Nunez & Ryvarden 2000; Ryvarden 2004; Ryvarden & Melo 2014; Dai 2010), *Coltricia* is characterized by terrestrial, centrally to laterally stipitate, soft and tough basidiomata that turn hard and brittle on drying, with tomentose to silky pileus which are yellowish to rusty brown in colour, homogenous and cinnamon to deep brown context, poroid, brown to rusty brown hymenium, monomitic hyphal system without clamp connections, mostly without setae and ellipsoid to cylindrical, smooth, golden yellow to rusty brown, variably dextrinoid basidiospores. According to Ryvarden & Gilbertson (1993), setae are present in some tropical *Coltricia* species. Members cause white rot on dead wood.

Economic importance

Polysaccharides and terpenonoids present in *Coltricia perennis* has anti carcinogenic (Ohtsuka *et al.* 1973; Magdalene & Temitope 2019) and anti bacterial activity (Ghosh 2013).

Distribution

Species of *Coltricia* shows cosmopolitan distribution. AFRICA (Hjortstam *et al.* 1993; Ryvarden & Johansen 1980; Ryvarden *et al*. 2006, Tedersoo *et al.* 2007). NORTH AMERICA (Murrill 1904, 1908, 1920; Gilbertson & Ryvarden 1986; Ryvarden & Meijer 2002; Ryvarden 2004), Canada (Corner 1991; Hutchison 1991), United States of America (Overholts 1953; Burdsall 1969; Grand & Vernia 2005). SOUTH AMERICA: Argentina (Rajchenberg & Wright 1998), Brazil (Rajchenberg & Meijer 1990; Gomes-Silva *et al*. 2008, 2009; Baltazar & Gibertoni 2009; Gomes-Silva & Gibertoni 2009; Baltazar *et al*. 2010; Baltazar & Borges Da Silveira 2012; Gomes-Silva *et al*. 2012a; Westphalen & Borges Da Silveira 2013), Guyana (Aime *et al.* 2003). ASIA: China (Dai & Cui 2005; Dai & Niemelä 2006; Dai 2010; Dai *et al*. 2010; Dai 2012; Dai & Li 2012; Bian & Dai 2017), Japan, (Núñez & Ryvarden 2000), Malaysia (Masuka & Ryvarden 1993; Lee *et al*. 2012, Taiwan, Thailand, Vietnam (Núñez & Ryvarden 2000). AUSTRALIA (Zhou & Tedersoo 2012), New Zealand (Cunningham 1948). EUROPE (Ryvarden & Gilbertson 1993; Ryvarden & Melo 2014), Italy (Bernicchia 2001; Bernicchia *et al*. 2007), Norway (Núñez & Ryvarden 2000).

Coltricia bambusicola (Henn.) D.A. Reid, *C. cinnamomea* (Jacq.) Murrill, *C. focicola* (Berk. & M.A. Curtis) Murrill, *C. montagnei* (Fr.) Murrill, *C. perennis* (L.) Murrill and *C. pyrophila* (Wakef.) Ryvarden have been reported from India by Thind & Chatrath (1960), Sexena (1961), Rangaswamy *et al.* (1970), Bakshi (1971), Sharma (1989, 2000, 2012), Ranadive *et al.* (2013), Lyngdoh & Dkhar (2014), Prasher & Lalita (2013), Nagadesi *et al*. (2014).

GENUS *CYCLOMYCES* FRIES

Cyclomyces was established by Fries (1830) and typified by *C. fuscus* Fr. The genus was treated in the sub family *Fomitoideae* of Polyporaceae in the earlier classifications of Bondartsew & Singer (1941) (Zmitrovich 2018). The major characteristics of the genus are annual basidiomata, monomitic hyphal system, presence of setae, and cylindrical to ellipsoid, hyaline to pale yellowish, thin walled basidiospores (Ryvarden & Johansen 1980; Núñez & Ryvarden 2000). The genus shows resemblance with *Inonotus* P. Karst., but can be separated from the latter by the thin and flexible basidiocarps with a distinct duplex context (Ryvarden & Johansen 1980). *Onnia* P. Karst. also shows similarity with *Cyclomyces* in having the duplex context, setae and hyaline spores, but can be distinguished by thicker fruit bodies and distinctly thick walled contextual hyphae of the former (Dai 2010). Similarly, morphologically similar genus *Phylloporia* Murrill is distinguished from *Cyclomyces* by thick walled, coloured spores and absence of setae (Dai 2010). Based on the phylogenetic analysis by Wagner & Fischer (2001, 2002), *Cyclomyces* clustered in the *Hymenochaete sensu lato* clade, along with *Hydnochaete* Bres. In the phylogenetic study of Larsson *et al.* (2006), *Cyclomyces* was found to be inseparable from *Hymenochaete* Lév. *Cyclomyces* has the priority over *Hymenochaete* and *Hydnochaete*, since the former name was published earlier, However, transfer of all *Hymenochaete* and *Hydnochaete* species to *Cyclomyces* was not favoured, since the former two genera consisted more number of species than the latter (Dai 2010). According to *Index Fungorum* database (accessed on 30 September 2020), *Cyclomyces* consists of eight species.

Current genus concept (Ryvarden & Johansen 1980; Núñez & Ryvarden 2000; Dai 2010) defines *Cyclomyces* by annual to perennial, effused reflexed to pileate or centrally to laterally stipitate basidiomata that are mostly imbricate, semicircular to flabelliform or dimidiate pilei, tomentose to finely pubescent, rust brown to reddish brown pileus surface, distinctly duplex context with black line separating upper tomentum and lower dense layer, poroid to rarely lamellate hymenium, monomitic hyphal system, presence of subulate, dark brown, thick walled setae arising from tramal hyphae, and ellipsoid to cylindrical, hyaline, thin walled basidiospores that are acyanophilous to weakly cyanophilous in cotton blue and inamyloid in Melzer's reagent. Members cause white rot on wood.

Distribution

Cyclomyces has a pantropical distribution (Ryvarden 1991). AFRICA (Ryvarden & Johansen 1980). NORTH AMERICA (Zhou *et al.* 2016). ASIA: China (Núñez & Ryvarden 2000; (Dai 2010; Dai *et al.* 2011; Dai 2012), Japan (Hattori 2005), Malaysia (Lee *et al.* 2012), Sri Lanka (Berkeley 1847), Taiwan (Núñez & Ryvarden 2000), Thailand (Choeyklin *et al.* 2011). AUSTRALIA (Cunningham 1965; Ryvarden & Johansen 1980).

Cyclomyces setiporus have been reported from India by Ranadive (2013), Sharma (2000), Leelavathy & Ganesh (2000) and Mohanan (2011).

GENUS *FULVIFOMES* MURRILL

Fulvifomes was established by Murrill in 1914, with *Fulvifomes robiniae* (Murrill) Murrill as the type species. Murrill (1914) characterized the genus by perennial and sessile basidiocarps, brown and woody context, colored basidiospores, and absence of setae. However, many mycologists considered *Fulvifomes* as a synonym of *Phellinus* Quél. (Ryvarden & Johansen 1980; Gilbertson & Ryvarden 1987; Larsen & Cobb-Poule 1990; Ryvarden 1991; Núñez & Ryvarden 2000). Kotlaba & Pouzar (1978) treated the genus under *Phellinus rimosus* (Berk.) Pilát complex. *Fulvifomes* was recognized in the genus rank by Fiasson & Niemelä (1984), whereas, Dai (1999) treated *Fulvifomes* as a sub genus of *Phellinus*. Later, based on molecular phylogenetic studies by Wagner & Fischer (2002, 2002a) and Larsson *et al.* (2006), *Fulvifomes* was accepted as an independent genus under Hymenochaetaceae. In the study by Larsson *et al.* (2006), *Fulvifomes* was proved to be closely related to genera *Aurificaria* D.A. Reid and *Phylloporia*. The latter two genera are morphologically distinguished by having a monomitic hyphal system (Dai 2010). However, according to Dai (2010), a proper demarcation between these three genera is difficult, since they shares similar morphological features. Currently, *Fulvifomes* consists of 27 species (*Index Fungorum*, accessed on 30 September 2020).

According to the widely accepted concepts (Fiasson & Niemelä 1984; Dai 2010), *Fulvifomes* is characterized by mostly perennial, resupinate, effused reflexed, or pileate basidiomata, which are that corky to woody hard, with tomentose or crust covered pileus, homogeneous to duplex context, dimitic hyphal system, hyaline to pale yellowish generative hyphae, brown skeletal hyphae, often without setae, and subglobose to ellipsoid, yellowish or brown, fairly thick to thick walled basidiospores that are inamyloid in Melzer's reagent. Members of the genus cause white rot on angiosperms and gymnosperms.

Distribution

Fulvifomes has cosmopolitan distribution. AFRICA: Benin (Olou *et al.* 2019), Cameroon, Kenya (Ryvarden & Johansen 1980). NORTH AMERICA (Zhou *et al.* 2016), Brazil (Groposo & Loguercio-Leite 2005; Drechsler-Santos *et al.* 2008; Salvador-Montoya *et al*. 2012; Nogueira-Melo *et al.* 2014), United States of America (Lindner *et al.* 2006; Ji *et al*. 2017a), Costa Rica (Ji *et al*. 2017a). SOUTH AMERICA: Argentina (Robledo & Rajchenberg 2007). ASIA: Cambodia (Zhou & Zhang 2012), China (Dai 2010; Dai *et al.* 2011; 2012; Zhou 2014), Iran (Amoopour *et al*. 2016), Malaysia (Yamashita *et al*. 2009; Lee *et al.* 2012), Taiwan (Núñez & Ryvarden 2000), Thailand (Choeyklin *et al.* 2011; Sakayaroj *et al.* 2012; Hattori *et al*. 2014; Zhou 2015). EUROPE (Bernicchia 2005; Ryvarden & Melo 2014), Fennoscandia (Fiasson & Niemelä 1984).

Species of *Fulvifomes* such as *F. cesatii* (Bres.) Y.C. Dai, *F. durissimus* (Lloyd) Bondartseva & S. Herrera, *F. glaucescens* (Petch) Y.C. Dai, *F. inermis* (Ellis & Everh.) Y.C. Dai, *F. johnsonianus* (Murrill) Y.C. Dai, *F. mcgregorii* (Bres.) Y.C. Dai, *F. melleoporus* (Murrill) Baltazar & Gibertoni, *F. merrillii* (Murrill) Baltazar & Gibertoni, *F. membranaceus* (J.E. Wright & Blumenf.) Baltazar & Gibertoni, *F. sanjanii* (Lloyd) Bondartseva & S. Herrera and *F. umbrinellus* (Bres.) Y.C. Dai have been reported from India (Leelavathy & Ganesh 2000; Foroutan &

Vaidhya 2007; Ranadive *et al.* 2011; Prasher & Lalitha 2013, Ranadive 2013, Singh *et al.* 2014).

GENUS *FUSCOPORIA* MURRILL

Fuscoporia was established by Murrill (1907), with *F. ferruginosa* (Schrad.) Murrill as the type species. The genus was introduced for accommodating annual, resupinate, effused reflexed species with globose to ovoid, hyaline, smooth basidiospores and setae. Murrill (1907) treated nine species within the genus. *Fuscoporia* was considered as a synonym of *Phellinus* Quél. in most works (Overholts 1953; Lowe 1966; Ryvarden & Johansen 1980; Larsen & Cobb-Poulle 1990; Ryvarden & Gilbertson 1994). Cunningham (1965) used *Fuscoporia* for including resupinate *Phellinus* species (Baltazar *et al.* 2009). Dai (1999) treated *Fuscoporia* as a sub genus of *Phellinus,* and defined *Fuscoporia* by hyaline spores and encrusted generative hyphae in the dissepiments. The genus is closely related to *Fomitiporia* Murrill and *Fomitiporella* Murrill. However, *Fomitiporia* is separated from *Fuscoporia* by having strongly dextrinoid basidiospores (Dai 2010). Similarly, the presence of coloured basidiospores in *Fomitiporella*, distinguishes it from *Fuscoporia*. Based on Fiasson & Niemelä (1984), *Fuscoporia* is recognized as a monophyletic genus that contains annual to perennial, resupinate to pileate basidiomata, dimitic type of hyphal system, generative hyphae with encrustations, occurrence of hymenial setae, and basidiospores that are hyaline, thin walled and smooth. Wagner & Fischer (2001, 2002) also confirmed monophyly of the genus. Based on Wagner & Fischer (2002), *Fuscoporia* represents a small, sub group of a large heterogenous genus, *Phellinu*s *sensu lato*. In the molecular phylogenetic study by Larsson *et al.* (2006), *Fuscoporia* formed a distinct clade from *Phellinus sensu stricto.* According to Dai (2010), in species of *Fuscoporia*, setae arise from tramal hyphae, whereas, in *Phellinus sensu stricto*, they originate from the subhymenium (Dai 2010). Currently, 46 species are recognized in the genus (*Index Fungorum*, accessed on 30 September 2020).

According to the current concept (Fiasson & Niemelä 1984; Dai 2010), the genus is described by mostly perennial, rarely annual, resupinate, pileate or laterally stipitate basidiomata that are usually corky to woody hard, tomentose to velutinate, with non crusted pileus, homogeneous context, hymenium with small pores, dimitic hyphal system, generative hyphae encrusted at dissepiment edge, but dissolving in KOH, presence of subulate, straight or hooked hymenial setae, usually originating from tramal hyphae, sometimes with fusoid cystidioles, and cylindric, oblong ellipsoid, broadly ellipsoid or subglobose, hyaline, smooth, thin walled basidiospores that are acyanophilous to weakly cyanophilous in cotton blue, and inamyloid in Melzer's reagent. Species occur on both angiosperm wood and conifers as parasites or saprobes.

Economic importance

Fuscoporia torulosa (Pers.) T. Wagner & M. Fisch is also known to have anti microbial, anti oxidant, anti cholineestarase, and xanthine oxidase inhibitory activities (Kovács *et al.* 2017; Duru *et al.* 2019). Aqueous extracts of *F. rhabarbarina* (Berk.) Groposo, Log.-Leite & Góes-Neto shows anti HIV-1 activity on lymphocytic cells without toxicity (Walder *et al.* 1995). An unidentified *Fuscoporia* species is also reported to be useful in detoxifying waste water and decolourizing synthetic dyes (Choi *et al.* 2013a). *F. torulosa* is considered as a serious pathogen that causes white pocket rot on broad leaved hard wood trees and conifers (Motta *et al*. 1996; Wagner & Fischer 2001; Tomšovský & Jankovský 2007; Campanile *et al*. 2008; Tzean *et al.* 2016).

Distribution

Fuscoporia species have a world wide distribution. AFRICA: Canary Islands (Fischer & Bresinsky 1992), North Africa (Parmasto 1985). NORTH AMERICA (Murrill 1907; Gilbertson & Burdsall 1972; Gilbertson 1979; Zhou *et al.* 2016), United States of America (Brazee *et al.* 2012). SOUTH AMERICA: Argentina (Coelho *et al.* 2009), Ansdes Amazon (Salvador-Montoya *et al*. 2012), Brazil (Baltazar *et al*. 2009; Baltazar & Gibertoni 2010; Baltazar *et al*. 2012; Westphalen & Borges Da Silveira 2013; Nogueira-Melo *et al*. 2014; Motato-Vásquez *et al*. 2015), Mexico (Raymundo *et al.* 2013), Southern Brazil (Groposo *et al.* 2007). ASIA: China (Dai 2010; Dai 2012; Chen & Yuan 2017), Japan (Núñez & Ryvarden

2000), Iran (Ghobad-Nejhad & Dai 2007), Malaysia (Lee *et al*. 2012; Urbizu *et al*. 2014), Russia (Spirin *et al*. 2014). AUSTRALIA: New Zealand (Cunningham 1965). EUROPE (Ryvarden & Gilbertson 1994; Tomšovský & Jankovský 2007), Czech Republic (Kotlaba 1975, 1984; Antonín *et al*. 2000; Vlasák *et al*. 2011), Crimea (Isikov & Kuznetzov 1990), Italy (Panconesi *et al*. 1994; Campanile *et al*. 2004), Slovakia (Kotlaba 1962).

From India, *Fuscoporia* species such as *F. callimorpha* (Lév.) Groposo, Log.-Leite & Góes-Neto, *F. chrysea* (Lév.) Baltazar & Gibertoni, *F. contigua* (Pers.) G. Cunn., *F. discipes* (Berk.) Y.C. Dai & Ghob.-Nejh., *F. ferrea* (Pers.) G. Cunn., *F. ferruginosa* (Schrad.) Murrill, *F. rhabarbarina* (Berk.) Groposo, Log.-Leite & Góes-Neto, *F. senex* (Nees & Mont.) Ghob.-Nejh., *F. torulosa* (Pers.) T. Wagner & M. Fisch.and *F. wahlbergii* (Fr.) T. Wagner & M. Fisch. have been reported (Bose 1919, 1928, 1937; Banerjee 1947; Bagchee *et al*. 1954; Thind & Rattan 1957; Bakshi 1971; Leelavathy & Ganesh 2000; Verma *et al*. 2008; Mohanan 2011; Prasher & Lalita 2013; Ranadive 2013).

GENUS ***HYDNOPORIA*** MURRILL

Hydnoporia Murrill was established by Murrill (1907), with *Sistotrema fuscescens* Schwein., as the type species. Murrill (1907) characterized the genus as annual, epixylous, resupinate, basisiomata with thin brown context, irpiciform or hydnoid hymenium, brown coloured hyphae, presence of cystidia, and hyaline, smooth basidiospores. Cooke (1959) listed *Hydnum squalidum* Fr. as the genus type, considering it as a synonym of *Sistotrema fuscescens*. However, according to Donk (1962a), *Hydnum squalidum* Fr was an entirely different species from *S. fuscescens*. A species of *Hydnochaete*, *H. olivacea* (Schwein.) Banker was considered as the synonym of *Sistotrema fuscescens* by Ryvarden (1982a). Based on molecular phylogenetic studies by Parmasto *et al.* (2014) and Yang *et al.* (2016), *H. olivacea* was found to be closely related to *Hymenochaete tabacina* (Sowerby) Lév., a species which was distantly related to other *Hymenochaete* species according to Wagner & Fisher (2001, 2002a).

For placing *H. tabacina* and related species, initially the name *Pseudochaete* T. Wagner & M. Fisch. was proposed (Wagner & Fisher 2002a). However, *Pseudochaete* was found as illegitimate, since the name had been used for algae since 1903 (Nie *et al.* 2017). Later, *Hymenochaetopsis* was proposed by Yang *et al.* (2016) for replacing *Pseudochaete* and was widely accepted. However, according to Miettinen *et al.* (2019), the genus *Hydnoporia* had priority over *Hymenochaetopsis* and *Pseudochaete*, since the former was published earlier. Therefore, *Hydnoporia* was established for including all species belonging to *Hymenochaete tabacina* clade (Miettinen *et al.* 2019). Currently, 14 species are recognized in the genus (*Index Fungorum*, accessed on 30 September 2020).

According to the latest concept (Miettinen *et al.* 2019), *Hydnoporia* is characterized by resupinate to effused reflexed basidiomata, brownish pileus, smooth to hydnoid hymenium, monomitic to dimitic hyphal system with intermediary hyphae or setal hyphae, pointed setae, narrowly clavate basidia, and small to medium sized, curved cylindrical or allantoid, basidiospores. Basidiomes of some species possess mycelia mats for infecting living branches. Members of the genus cause white rot on the wood.

Economic importance

Hydnoporia tabacina (as *Hymenochaetopsis tabacina*) is reported to degrade condensed tannins present in plants (Kimura *et al*. 2009).

Distribution

Species of *Hydnoporia* have cosmopolitan distribution. AFRICA: South Africa (Job 1990). NORTH AMERICA: Murrill 1907; Zhou *et al.* 2016, Mexico (Job 1990; Parmasto 2001a), United States of America (Lindner *et al*. 2006). SOUTH AMERICA: Argetina (Escobar 1978; Job 1990), Brazil (Groposo & Loguercio-Leite 2005; Gomes-Silva *et al*. 2012a). ASIA: China (Dai 2010; He & Li 2013; Yang *et al.* 2016), Malaysia (Lee *et al.* 2012), Russia (Ghobad-Nejhad *et al*. 2009, Siberia (Kotiranta & Penzina 1998), West Siberia (Filippova & Zmitrovich 2013). EUROPE: Austria (Gerhold 2000), Belgium (Breitenbach & Kränzlin 1986), Denmark (Christiansen 1960), England (Job 1990), Italy (Bernicchia 2001), Corfixen & Parmasto 2017), Germany (Krieglsteiner 2000), Spain (Telleria 1990), Republic of Macedonia (Karadelev & Rusevska 2004).

Hydnoporia corrugata (Fr.) K.H. Larss. & Spirin and *H. tabacina* (Sowerby) Spirin, Miettinen & K.H. Larss. have been reported from India (as *Hymenochaetopsis corrugata* (Fr.) S.H. He & Jiao Yang and *H. tabacina* (Sowerby) S.H. He & Jiao Yang respectively) by Mohanan (2011), Ranadive (2013) and Lyngdoh & Dkhar (2014).

GENUS *HYMENOCHAETE* LÉVEILLE

Hymenochaete, typified by *Hymenochaete rubiginosa* (Dicks.) Lév., was established by Léveillé (1846) for placing species with effused to effused reflexed basidiocarps having a smooth hymenophore. *Hymenochaete* is considered as the second largest genus in the family Hymenochaetaceae (He & Li 2014; Parmasto *et al*. 2009; 2014). The species placed in *Hymenochaeate* by Léveillé (1846), were previously treated under *Thelephora* Ehrh. *ex* Willd. (Parmasto *et al*. 2014). In the opinion of Léveillé (1846), genus *Hymenochaete* is "a most natural group of Théléphorées" (Parmasto *et al.* 2014). The genus is morphologically heterogeneous and include stereoid, hydnoid, concentric lamellate and poroid species (Dai 2010). Genus *Hymenochaetella* P. Karst. erected by Karsten (1889) has been treated as a synonym of *Hymenochaete*. Ryvarden in 1985, established a new genus *Stipitochaete* Ryvarden for placing two stipitate pileate species of *Hymenochaete*. However, the genus was not supported in the cladistic study carried out by Parmasto (1995). Later molecular phylogenetic studies (Larsson *et al.* 2006; Parmasto *et al.* 2014) also do not support the position of *Stipitochaete* as an independent genus.

In the molecular studies of Boidin *et al.* (1998), and Wagner & Fisher (2002), *Hymenochaete* resolved as a monophyletic clade. According Wagner & Fisher (2001, 2002), all *Hymenochaete* species together with two *Hydnochaete* Bres. and two *Cyclomyces* species formed a monophyletic group, except *H. tabacina* (Sowerby) Lév. In order to place *H. tabacina*, a new genus *Pseudochaete* T. Wagner & M. Fisch. was established by Wagner & Fischer (2002). However, the name

Pseudochaete was later substituted by the name *Hymenochaetopsis* S.H.He & Jiao Yang by Yang *et al.* (2016), because the former had been used for algae since 1903 (Nie *et al.* 2017). However, *Hymenochaetopsis* has been recently replaced by *Hydnoporia* Murrill (Miettinen *et al.* 2019), since the latter name was published earlier, and had priority over *Hymenochaetopsis* and *Pseudochaete*. According to Larsson *et al.* (2006), genera *Cyclomyces* and *Hydnochaete* were indivisible from the genus *Hymenochaete*. *Cyclomyces* has priority over *Hymenochaete* and *Hydnochaete* since it was published earlier. However, transferring all *Hymenochaete* and *Hydnochaete* species to *Cyclomyces* was not appropriate, as *Hydnochaete* and *Hymenochaete* consist of more number of species than *Cyclomyces* (Dai 2010). Based on the phylogenetic studies on Hymenochaetales (Dai 2012; Baltazar *et al.* 2014; Parmasto *et al.* 2014; Yang *et al.* 2016), it was found that *Hymenochaete* forms a monophyletic clade, sister to closely related *Hymenochaetopsis*. Currently, genera *Cyclomyces*, *Hymenochaete*, *Hydnoporia* have been treated as independent genera, whereas, species of *Hydnochaete* has been synonymised under *Hymenochaete* (*Index Fungorum,* accessed on 24 October 2020). Currently, the genus holds 234 species (*Index Fungorum*, accessed on 20 February 2020).

Hymenochaete is characterized by annual to perennial, resupinate, effused reflexed, pileate to stipitate basidiomes that are usually thin and membraneous, with smooth to tuberculate hymenium, monomitic hyphal system with hyaline or golden yellow to rusty brown hyphae without clamp connections, subulate dark brown setae, and cylindrical, ellipsoid, allantoid to subglobose, smooth and thin walled basidiospores, causing white rot on dead angiosperm and gymnosperm wood (Dai 2010; Gomes-Silva *et al.* 2012a).

Infrageneric classification

Cooke (1880) recognized one sub genus, "*Veluticeps*" for *Hymenochaete* species having velvety hymenium, with persistent, pigmented flexuous hairs formed in tufts. Although *Veluticeps* was proposed as a sub genus, Cooke (1880) had mentioned their preference for establishing it in a genus rank. Cooke (1880) treated species of *Hymenochaete* under three sections, *Mesopus, Apus* and *Resupintus*.

Presently, *Veliticeps* Cooke is considered as a separate genus under the order Gloeophyllales Thorn (*Index Fungorum*, accessed on 30 September 2020).

Based on the presence or lack of various layers (cortex, hyphal layers and thickening layer of setae) in the context of the basidiomata, the genus was classified into four sections or groups by Burt (1918), Cunningham (1957), Escobar (1978) and Léger (1998) such as *Hymenochaete, Fultochaete, Gymnochaete* and *Paragymnochaete*. However, this classification of genus into sections was not supported in the molecular study of Boidin *et al.* (1998).

Economic importance

Potential pharmacological activity has been reported in *Hymenochaete rheicolor* (Mont.) Lév. (Gomes-Silva *et al.* 2009). The species *Hymenochaete rubiginosa* (Dicks.) Lév possesses strong radical scavenging properties (Fernando *et al*. 2015).

Distribution

Most members of the genus have a tropical or subtropical distribution, while some have their occurrence in the northern temperate regions (Parmasto *et al.* 2014). AFRICA (Ryvarden 1998), Natal, Zululand (Job 1987). NORTH AMERICA (Murrill 1907; Zhou *et al.* 2016), United States of America (Lindner *et al.* 2006). SOUTH AMERICA: Brazil (Groposo & Loguercio-Leite 2005; Drechsler-Santos & Loguercio-Leite 2008; Gibertoni *et al.* 2012; Gomes-Silva *et al.* 2012a). ASIA: China (He & Li 2011, 2011a; He & Dai 2012; He & Li 2014; He *et al.* 2017; Wu *et al*. 2017), Korea (Kim *et al.* 2009), Malaysia (Lee *et al*. 2012), Thailand (Choeyklin *et al.* 2011). AUSTRALIA: New Zealand (Cunningham 1957). EUROPE: Italy (Bernicchia 2001), Germany (Krieglsteiner 2000), Hungary (Papp 2013), Spain (Telleria 1980), Switzerland (Breitenbach & Kränzlin 1986).

Species of *Hymenochaete* such as *H. attenuata* (Lév.) Lév., *H. cacao* (Berk.) Berk. & M.A. Curtis, *H. cinnamomea* (Pers.) Bres., *H. cruenta* (Pers.) Donk, *H. floridea* Berk. & Broome, *H. fuliginosa* (Fr.) Lév., *H. fuscobadia* K.S. Thind & Adlakha, *H. gladiola* G. Cunn., *H. innexa* G. Cunn., *H. leonina* Berk. & M.A.

Curtis, *H. luteobadia* (Fr.) Höhn. & Litsch., *H. mougeotii* (Fr.) Cooke, *H. patelliformis* G. Cunn., *H. plurimaesetae* G. Cunn., *H. rubiginosa* (Dicks.) Lév., *H. semistupposa* and *H. sharmae* Hembrom, K. Das & A. Parihar, have been reported from India (Reeves & Welden 1967; Rangaswami *et al.* 1970; Rattan 1977; Leelavathy & Ganesh 2000; Verma *et al.* 2008; Mohanan 2011; Sharma 2012; Ranadive 2011; Ranadive 2013; Kaur *et al.* 2015; Dhingra *et al*. 2014 and Hembrom *et al*. 2017).

GENUS *INONOTUS* P. KARSTEN

Inonotus was described by Karsten (1879) for including pileate polypores with coloured basidiospores (Gottlieb *et al.* 2002). Later, Donk (1933) placed in *Inonotus* those species which possessed coloured spores as well as fibrous, brown context, and elaborated the genus concept. *Polyporus cuticularis* (Bull.) Fr. (=*Inonotus cuticularis* (Bull.: Fr.) P. Karst.) was considered as the type of the genus by Murrill (1904), Donk (1933), Imazeki (1943), Cunningham (1948), Teixeira (1989) & Ryvarden (1991). Pegler (1964), Wright & Deschamps (1975), Corner (1991) and Donk (1960) treated *Polyporus hispidus* (Bull) Fr. (=*Inonotus hispidus* (Bull.) P. Karst.) as the generic type (Gottlieb *et al.* 2002). Later, the concept of *Inonotus* was made wider by accommodating species that showed large differences in basidiocarp morphology, form and colour of the basidiospores, colour of spore wall, and presence or absence of setae (Sharma *et al.* 2013). Brown fibrous context, xanthochroic reaction of basidiomes in KOH, and monomitic hyphal system without clamp connections were taken as the major distinguishing features of the genus by many workers (Pegler 1964; Gilbertson 1976; Gilbertson & Ryvarden 1986; Ryvarden & Gilbertson 1993; Sharma 1995). However, some also possessed a dimitic to trimitic hyphal system (Domanski *et al*. 1973; Jahn 1981; Corner 1991). Colour of basidiospores of *Inonotus* species varied from hyaline to rusty brown (Gottlieb *et al.* 2002). Xanthochroic reaction of basidiocarps was not considered as a distinguishing character of the genus by Parmasto & Parmasto (1979), since, according to them, this character was common in many groups of fungi. Kühner (1980) had reported xanthochroic reaction in species of Agaricales. Corner (1991) gave less importance to the colour and consistency of context as it was highly variable (Gottlieb *et al.* 2002). The related genus *Phellinus* was separated from *Inonotus* by perennial basidiomes, and usually by dimitic, narrower hyphae (Ryvarden & Gilbertson 1993). According to Fischer *et al.* (2001), presence of setal elements cannot be used for species delimitation in *Inonotus* because the character was also found in distantly related lineages (Donk 1971). Uncertainity still exists in the systematics of the genus and their natural relationships (Gottlieb *et al.* 2002). *Inonotus* has been considered as heterogenous based on morphology, microscopic features, sexuality, nuclear behavior and ecology (Fiasson 1982; Fiasson & Niemela 1984; Dai 1995, 1995a, 1999, Fischer 1996; Sharma *et al*. 2013). A monograph on *Inonotus sensu lato* has been published by Ryvarden (2005).

Based on the recent study by Dai (2010), *Inonotus sensu lato* has been divided into five genera such as *Inonotopsis* Parmasto *Onnia* P. Karst., *Mensularia* Lázaro Ibiza, *Inonotus sensu stricto* and *Inocutis* Fiasson & Niemelä. Presence of hyaline and thin walled basidiospores separated *Inonotopsis* from *Inonotus sensu stricto* (Dai 2010). Although *Onnia* species resembled *Inonotus* in some microscopic characters, they formed a distinct clade and were not related with *Inonotus* in the phylogenetic studies (Wagner & Fischer 2001, 2002; Larsson *et al*. 2006). Presence of granular core and absence of setae are the distinguishing features of *Inocutis* that separate them from *Inonotus* (Dai 2010). Similarly, genus *Mensularia* (currently *Xanthoporia* Murrill) is characterized by deeply cyanophilous basidiospores, a character absent in *Inonotus sensu stricto* (Dai 2010). According to Sharma *et al.* (2013), *Inonotus sensu lato* consisted of many natural homogeneous sub groups. Sharma *et al.* (2013) recognized all genera segregated from *Inonotus sensu lato* (accordance with Dai 2010), except *Onnia*. Sharma *et al.* (2013) also distinguished genus *Pseudoinonotus* T. Wagner & M. Fisch. within *Inonotus sensu lato*. According to Sharma *et al.* (2013), *Pseudoinonotus* is differentiated from *Inonotus* by having hyaline basidiospores (*Inonotus* species produce coloured spores). Currently, 138 species have been recognized in *Inonotus* (*Index Fungorum*, accessed on 30 September 2020).

Based on the current concept (Ryvarden & Johansen 1980; Ryvarden & Gilbertson 1993; Dai 2010), *Inonotus* species are characterized by annual to perennial, resupinate, effused reflexed to pileate basidiocarps, hispid, velutinate to glabrous pileus surface, homogenous brown context, poroid hymenium with brownish pore surface, usually monomitic hyphal system, or dimitic, presence or absence of hymenial setae and hyaline to yellow to brown, thick walled, smooth basidiospores which are inamyloid in Melzer's reagent. Species cause white rot on angiosperms and gymnosperms.

Economic importance

Many species of *Inonotus* are utilized in asian folk medicine for treatment of various ailments (Lindner *et al.* 2006). *Inonotus obliquus* (Fr.) Pilát, commonly called as "chaga mushroom" possesses potential medicinal and nutraceutical values (Pliz 2004; Spinosa 2006; Nakajima *et al.* 2007; Zheng *et al.* 2007; Park *et al.* 2008; Moon & Lee 2009; Wolfe 2011; Balandaykin & Zmitrovich 2015; Arata *et al.* 2016; Staniszewska *et al*. 2017; Wold *et al.* 2017; Ibrahim & Altuwajiri 2018; Géry *et al.* 2018, https://www.verywellhealth.com/what-can-chaga-do-for-you-89553). Laccase present in *Inonotus hispidus* (Bull.) P. Karst. is known to decolourize various industrial dyes (Jebapriya & Gnanadoss 2013; Krastanov *et al.* 2013; Singh *et al*. 2019a). Species of *Inonotus* are important primary decayers of forest ecosystem as well as serious pathogens on forest trees and urban landscapes (Lindner *et al*. 2006).

Distribution

Members have a cosmopolitan distribution (Ryvarden 1991). AFRICA: East Africa (Ryvarden & Johansen 1980). NORTH AMERICA: Ryvarden 2004; Zhou *et al.* 2016, Arizona (Gilbertson 1976), New York (Murrill 1920), Southern Florida (Vlasák *et al*. 2011), United States of America (Lindner *et al*. 2006; Brazee *et al.* 2012). SOUTH AMERICA: Argentina (Robledo & Rajchenberg 2007), Brazil (Gottlieb *et al*. 2002; Drechsler-Santos & Loguercio-Leite 2008; Borges Da Silveira *et al*. 2008; Baltazar *et al*. 2012; Westphalen & Borges Da Silveira 2013). ASIA: China (Dai & Zhang 2001; Wu *et al*. 2000; Dai & Wu 2002; Dai 2010; Dai *et al.* 2011; Dai 2012; Cui *et al.* 2011), Malaysia (Corner 1991; Yamashita *et al.* 2009;

Lee *et al*. 2012; Urbizu *et al*. 2014), Iran (Ghobad-Nejhad & Kotiranta 2008), Japan (Hattori 2005), Taiwan (Núñez & Ryvarden 2001), Thailand (Choeyklin *et al.* 2011). EUROPE: Italy (Ryvarden & Gilbertson 1993; Bernicchia 2001).

Inonotus brevisporus (K.S. Thind & Chatr.) J.R. Sharma, *I. cuticularis* (Bull.) P. Karst., *I. diverticuloseta* Pegler (Bull.) P. Karst., *I. glomeratus* (Peck) Murrill, *I. hamusetulus* Ryvarden, *Inonotus hispidus* (Bull.) P. Karst., *I. juniperinus* Murrill, I. *luteoumbrinus* (Romell) Ryvarden, *I. obliquus* (Fr.) Pilát, *I. ochroporus* (Van der Byl) Pegler, *I. patouillardii* (Rick) Imazeki, *I. polymorphus* (Rostk.) Pilát, *I. rickii* (Pat.) D.A. Reid, *I. ryvardenii* J.R. Sharma & D. Mishra, *I. subhispidus* Pegler & D.A. Reid and *I. tenuicarnis* Pegler & D.A. Reid have been recorded from India (Pegler 1967; Bakshi 1971; Leelavathy & Ganesh 2000; Mohanan 2011; Ranadive *et al.* 2011; Prasher & Lalita 2013; Ranadive 2013; Sharma *et al*. 2013; Nagadesi *et al.* 2014; Singh *et al*. 2019).

GENUS *PHELLINUS* QUÉLET

Phellinus was established by Quélet in 1886 and typified by *Phellinus igniarius* (L.) Quél. The genus has been considered as the largest genus of all polyporoid fungi (Ryvarden & Johansen 1980). Donk (1960) accepted *P. torulosus* (Pers.) Bourdot & Galzin as the generic type. The genus is mainly characterized by perennial basidiomata and dimitic hyphal system (Larsen & Cobb-Poulle 1990). *Inonotus sensu lato* is closely related to *Phellinus sensu lato*, but mainly differentiated by the annual basidiocarps and monomitic hyphal system in the former (Fisher 1996, Wagner & Fischer 2001). According to Wagner & Fischer (2001), some *Inonotus* species produce dimitic hyphal system as in *Phellinus*. Similarly, certain *Phellinus* species produce annual basidiocarps and monomitic hyphal system as in *Inonotus* (Domanski *et al*. 1973; Jahn 1981; Fiasson & Niemelä 1984; Corner 1991; Dai 1995, 1999; Hansen & Knudsen 1997). *Phellinus ribis* (Schumach.) Quél., has a monomitic hyphal system (Ryvarden 1978; Jülich 1984; Ryvarden & Gilbertson 1993,1994), and has been often treated in another genus *Phylloporia* Murrill (Wagner & Fischer 2001). Other features including shape and size of basidiospores, setae, nuclear behavior, and the pattern of sexuality were also conflicting among *Phellinus* and *Inonotus* species (Wagner & Fischer 2001). Based on morphological characters, *Phellinus* was divided into different genera by Fiasson & Niemelä (1984), such as *Fomitiporia* Murrill, *Porodaedalea* Murrill, *Ochroporus* J. Schröt., *Phellinidium* (Kotl.) Fiasson & Niemelä, *Phellinus sensu stricto*, *Fuscoporia* Murrill, *Fulvifomes* Murrill and *Phylloporia* Murrill.

Molecular phylogenetic works (Niemelä *et al*. 2001; Wagner & Fischer 2001, 2002; Larsson *et al.* 2006) also supported the sub division of *Phellinus* in to different genera. *Phellinus sensu lato* is regarded as polyphyletic, and many species were shifted from the genus (Dai *et al.* 2001; Niemelä *et al.* 2001; Wagner & Fischer 2001, 2002; Ghobad-Nejhad & Dai 2007; Groposo *et al.* 2007; Coelho *et al.* 2009; Baltazar & Gibertoni 2010; Dai 2010). In Wagner & Fischer (2001), *P. igniarius* group that included the type (*P. igniarius*) and related species formed a monophyletic clade that included *Phellinus*. Features of setae were considered as one of the most distinguishing character of *Phellinus* and related genera (Jin *et al.* 2005). Recent works (Dai 2010; Zhou *et al.* 2016a) also consider *P. igniarius* group as the *Phellinus sensu stricto*. *Phellinus* shows similarity with *Phellinopsis* Dai, but the latter is distinguished by the pale yellowish colour of spores, and by the presence of hymenial setae of tramal origin. In *Phellinus*, colour of the basidispores is consistenty hyaline, and setae are of subhymenial origin (Dai 2010). Currently, *Phellinus* includes 155 species (*Index Fungorum*, accessed on 20 February 2020). A world monograph of *Phellinus* is by Larsen & Cobb-Poulle (1990).

According to the current concept (Wagner & Fischer 2001; Dai 2010), *Phellinus sensu stricto* is characterized by perennial, sometimes annual, solitary or imbricate, resupinate, effused reflexed or pileate basidiomata, crusted pileus surface, that becomes usually rimose with age, homogenous context, poroid hymenium, usually stratified pore tubes, dimitic hyphal system, brownish skeletal hyphae, presence of setae originating from the subhymenium, and subglobose to broadly ellipsoid or ovoid, hyaline, almost thick walled basidiospores that are usually slightly cyanophilic in cotton blue, and inamyloid in Melzer's reagent. Members are parasitic or saprobic, causing white rot on living trees or dead wood.

Infrageneric classification

Fiasson & Niemelä (1984) divided *Phellinus sensu lato* in to many sub groups, *Phellinus igniarius* group, the *P. pini* group, the *P. robustus* group, the *P. rimosus* group, *P. ferruginosus* group, and *P. ferrugineofuscus* group. Fiasson & Niemelä (1984) accepted these groups as separate genera, such as *Fomitiporia* Murrill (*P. robustus* group), *Porodaedalea* Murrill 1905 (*P. pini* group), *Ochroporus* J. Schröt. (*P. igniarius* group), *Phellinidium* (Kotl.) Fiasson & Niemelä (*P. ferrugineofuscus* (P. Karst.) Bourdot & Galzin and related species), *Phellinus sensu stricto* (*P. torulosus* (Pers.) Bourdot & Galzin), *Fuscoporia* Murrill (*P. ferruginosus* group), *Fulvifomes* Murrill (*P. rimosus* group), and *Phylloporia* Murrill (*P. ribis* (Schumach.) Ryvarden).

According to Fiasson & Niemelä (1984), *Fomitiporia* was characterized by brass coloured context, pseudo dimitic hyphal system, infrequent hymenial setae, often with ampullaceous cystidioles and subglobose basidiospores that are cyanophilous in cotton blue, and dextrinoid in Melzer's reagent. The group *Porodeadalea* is characterized by hirsute to pubescent pileus surface, which develops in to a crust with age, round to labyrinthine pores, and ellipsoid, thick walled basidiospores, that are weakly cyanophilous in cotton blue. Presence of a dimitic hyphal system with encrusted hyphae, subulate setae, and thick walled, inamyloid, weakly cyanophilous basidiospores, distinguish the *Ochroporus* group. The distinguishing characters of the group *Phellinidium* are the presence of setal hyphae in hymenial trama and context, and ellipsoid to cylindrical, thin walled basidiospores (Fiasson & Niemelä 1984). According to this classification, *Phellinus sensu stricto* has been characterized by absence of setal hyphae, and presence of hyaline, ellipsoid, thin walled basidiospores that are acyanophilous in cotton blue and inamyloid in Melzer's reagent. Similarly, *Fuscoporia* group has been distinguished by its soft corky basidiocraps, non crusted pileal surface, presence of encrusted hyphae and allantoid, thin walled basidiospores. Absence of hymenial setae, and presence of large, coloured basidiospores characterizes the group

Fulvifomes. The epiphyllous nature of basidiocarps has been considered as the unique feature of the group *Phylloporia* (Fiasson & Niemelä 1984).

The generic sub division was accepted by Jahn & Jahn (1986), Hansen & Knudsen (1997). However, it was rejected by Gilbertson & Ryvarden (1987), Parmasto (1988), Larsen & Cobb-Poulle (1990) mainly because the segregation was based solely on European species (Fischer 1996; Wagner & Fischer 2001). Detailed information on species complexes/groups of *Phellinus* has been provided in Fiasson & Niemelä (1984), Zhou *et al*. (2016a), Fischer (1995, 1996), Wagner & Fischer (2001) and Sell (2008).

Economic importance

Phellinus is commonly known as *Sang-Hwang* (Korea), *Song Gen* or *sanghuang* (China) and *Meshimakobu* (Japan) (Wu *et al.* 2012). *Phellinus igniarius* is consumed as a tonic and laxative, and externally applied to stop bleeding (https://www.ukessays.com/essays/biology/identification-phellinus-sl-3129.php). Species of *Phellinus* possess medicinal properties and has been used in the folk medicine of different countries (Vaidya & Bhor 1990; Vaidya *et al.* 1991; Hobbs 1995; Han *et al.* 1999; Vaidya & Lamrood 2001; Jeong *et al*. 2004; Ajith & Janardhanan 2007; Guo *et al*. 2010; Jaszek *et al*. 2014; Ajith & Janardhanan 2015; Rony *et al.* 2013; Dong *et al.* 2016; Yan *et al*. 2017; Sułkowska-Ziaja *et al.* 2017; Sunthudlakhar *et al*. 2018; Wang *et al.* 2018; Kim *et al.* 2019; Liu *et al*. 2019a). *Phellinus* is also used in many commercial ayurvedic preparations. In Indian folk medicine, many species of *Phellinus* are commercially available in the name ‘*Phansomba*’ (Vaidya & Lamrood 2001; Vaidya *et al*. 2010; Sonawane *et al.* 2013). Because of the presence of lignolytic enzymes, species of *Phellinus* are also used in biodemediation processes such as clearing various industrial effluents, oil containing crop wastes and decolorization of artificial dyes (Peláez *et al*. 1995; Balan & Monteiro 2001; Hmd 2011; Sweety 2018).

Species of *Phellinus* are serious pathogens causing heart rot disease and cankers on living trees (Dombrovská & Kostyshyn 1998; Hansen & Goheen 2000; Wagner & Fischer 2002; Miklašēvičs 2009; Ranadive *et al.* 2012). According to

Larsen & Cobb-Poulle (1990), *Phellinus* species cause more timber loss than other groups of wood destroying fungi, thereby causing a huge economic loss to wood industry.

Distribution

Phellinus has a cosmopolitan distribution. AFRICA: Cameroon (Roberts & Ryvarden 2006), East Africa (Ryvarden & Johansen 1980). NORTH AMERICA (Gilbertson 1979, Gilbertson & Ryvarden 1987, Zhou *et al.* 2016), United States of America (Lindner *et al.* 2006; Brazee *et al.* 2012), Southern Florida (Vlasák *et al.* 2011). SOUTH AMERICA: Brazil (Groposo & Loguercio-Leite 2005; Coelho *et al.* 2009; Drechsler-Santos & Loguercio-Leite 2008; Westphalen & Borges Da Silveira 2013; Nogueira-Melo *et al.* 2014; Salvador-Montoya *et al*. 2015), Guyana (Aime *et al*. 2003). ASIA: China (Dai & Yang 2008; Dai 2010; Dai 2012), Israel (Ţura *et al.* 2010), Japan (Núñez & Ryvarden 2000; Hattori 1999; Hattori 2005), Korea (Kim *et al*. 2009), Malaysia (Yamashita *et al.* 2009; Lee *et al*. 2012; Urbizu *et al*. 2014), Singapore (Corner 1991), Thailand (Choeyklin *et al.* 2011), Vietnam (Núñez & Ryvarden 2000). EUROPE (Fiasson & Niemela 1984, Fischer 1995), Fennoscandia (Niemelä 1974, 1975), Finland (Niemelä & Kotiranta 1982), Italy (Bernicchia 2001, Bernicchia *et al*. 2007).

From India, *P. acontextus* Ryvarden, *P. adamantinus* (Berk.) Ryvarden, *P. allardii* (Bres.) S. Ahmad, *P. aureobrunneus* J.E. Wright & Blumenf., *P. badius* (Cooke) G. Cunn, *P. carteri* (Berk. *ex* Cooke) Ryvarden, *P. caryophylli* (Racib.) G. Cunn., *cinchonensis* (Murrill) Ryvarden, *P. coffeatoporus* Kotl. & Pouzar, *P. crocatus* (Fr.) Ryvarden, *P. fastuosus* (Lév.) S. Ahmad, *P. ferrugineovelutinus* (Henn.) Ryvarden, *P. gilvus* (Schwein.) Pat., *P. grenadensis* (Murrill) Ryvarden, *P. griseoporus* D.A. Reid, *P. hoehnelii* (Bres.) Ryvarden, *P. igniarius* (L.) Quél., *P. incrustaticeps* Corner, *P. laevigatus* (P. Karst.) Bourdot & Galzin, *P. luctuosus* (Ces.) Ryvarden, *P. melanodermus* (Pat.) M. Fidalgo, *P. minimus* N. Walters, *P. minutiporus* Bondartseva & S. Herrera, *P. nigricans* (Fr.) P. Karst., *nilgheriensis* (Mont.) G. Cunn., *P. pini* (Brot.) Pilát, *P. purpureogilvus* (Petch) Ryvarden, *P. ralunensis* Adask., Gilb. & Blanchette, *P. rechingeri* (Bres.) Ryvarden, *P. resinaceus* Kotl. & Pouzar, *P. rickii* Teixeira, *P. rimosus* (Berk.) Pilát, *P. robiniae* (Murrill) A. Ames, *P. sancti-georgii* (Pat.) Ryvarden, *P. sanfordii* (Lloyd) Ryvarden, *P. setulosus* (Lloyd) Imazeki, *P. shaferi* (Murrill) Ryvarden, *P. sonorae* Gilb., *P. stratosus*, *P. swieteniae* (Murrill) S. Herrera & Bondartseva, *P. syringeus* X.L. Zeng have been reported (Bose 1922; Bagchee *et al.* 1954; Bakshi 1971; Thind & Rattan 1971a, 1971b; Rattan 1977; Thind & Dhanda 1980, 1980a; Roy 1989; Rabba 1994; Sharma 1995; Natarajan & Kolandavelu 1998; Sharma 2000; Leelavathy & Ganesh 2000; Deshpande 2003; Lamrood 2004; Forutan 2006; Foroutan & Vaidya 2007; Hakimi 2008; Mohanan 2011; Prasher *et al*. 2012; Ranadive 2012; Ranadive *et al.* 2012; Prasher & Lalita 2013; Ranadive 2013; Ranadive *et al.* 2013; Lyngdoh & Dkhar 2014; Paul *et al.* 2014; Ranadive 2014).

GENUS ***PHYLLOPORIA*** MURRILL

Phylloporia was introduced by Murrill (1904) and typified by *P. parasitica* Murrill, a resupinate polypore parasitic on leaves (Valenzuela *et al.* 2011; Zhou & Dai 2012a). The most remarkable character of this genus is their parasitism on growing leaves or branches (Ryvarden 1991). However, some species occur on litter or buried wood (Corner 1991; Ryvarden 1991; Ipulet & Ryvarden 2005; Wagner & Ryvarden 2002). The genus consisted of only a single resupinate species till Ryvarden (1972) elaborated the genus concept by adding some pileate forms (Valenzuela *et al.* 2011). Presence of a thick tomentum over pileus as an adaptation in species growing in drought sensitive areas, and a duplex context are also considered as distinguishing characters of the genus (Wagner & Ryvarden 2002; Valenzuela *et al*. 2011; Zhou & Dai 2012a). According to Valenzuela *et al.* (2011), *Phylloporia* is a morphologically heterogenous genus, since it includes species with either annual or perennial, resupinate or pileate, sessile or stipitate basidiomata, monomitic to dimitic hyphal system and varying nutritional modes (such as parasitic on living leaves and branches, saprophytic on dead wood or terrestrial associated with living or dead underground wood or root). The genus differs from related *Inonotus* P. Karst. by their thick tomentum, dark zone in the context, smaller basidiospores, and absence of setae (Ryvarden & Gilberstson 1994; Wagner &

Ryvarden 2002). Genus *Fulvifomes* Murrill is closely related with *Phylloporia* by the presence of ellipsoid, thick walled, yellow basidiospores, and absence of setae, but distinguished from the latter by having a crust on pileus instead of tomentum, and by larger basidiospores (Wagner & Ryvarden 2002). In addition, *Fulvifomes* species always produce dimitic hyphal system, while species of *Phylloporia* are monomitic, except *P. pectinata* (Klotzsch) Ryvarden (Wagner & Ryvarden 2002). However, the distinctions between these genera are not evident in the European species (Dai 2010). *Phylloporia* also shows similarity with *Cyclomyces* Kunze *ex* Fr., but in the latter genus, the dark zone in the context is thinner and they produce long and subulate setae and hyaline spores (Ryvarden & Johansen 1980; Wagner & Ryvarden 2002). Similarly, *Phylloporia* and related *Inocutis* species are differentiated based on mitism and texture of basidiomes (Wagner & Ryvarden 2002).

Phylloporia formed a well supported monophyletic clade in the order Hymenochaetales, with *Fulvifomes* as the sister group, based on the phylogenetic studies (Wagner & Ryvarden 2002; Wagner & Fischer 2002; Zhou & Dai 2012a). Currently, the genus holds 60 species (*Index Fungorum*, accessed on 30 September 2020).

Based on the current concept (Ryvarden & Johansen 1980; Ryvarden & Gilberstson 1994; Wagner & Ryvarden 2002; Dai 2010; Zhou & Dai 2012a; Gafforov *et al.* 2014), *Phylloporia* species are characterized by annual to perennial, resupinate, effused reflexed or pileate, sessile to stipitate basidiomata, distinct thick tomentum on pileus, usually duplex context with a darker line or zone below tomentum or sometimes homogenous monomitic to dimitic hyphal system, hyaline to rusty brown simple hyphae, absence of setae, and and ellipsoid, yellow colored, thickwalled basidiospores that are always less than 6 µm long, and inamyloid in Melzer’s reagent. Species are either saprobic or parasitic.

Economic importance

The polysaccharides present in *Phylloporia ribis* (Schumach.) Ryvarden are known to have good anti oxidant activity (Zhiqing *et al.* 2017; Zhao *et al.* 2018).

Phylloporia fontanesiae L.W. Zhou & Y.C. Dai could be used in preparation of medicines, healthcare products, food, drink or tea against tumour, and for improving the immune system (https://patents.google.com/patent/WO2017152834A1/en). Polysaccharides from *Phylloporia ribis* (Schumach.) Ryvarden possesses nueroprotective properties (Yang *et al.* 2019).

Phylloporia species are reported as serious forest pathogens having host specificity (Esquivel & Carranza-Morse 1996; Wagner & Ryvarden 2002; Dai 2010; Rajchenberg & Robledo 2013; Liu *et al.* 2015; Yombiyeni *et al.* 2015; Lopes *et al.* 2016; Zhou 2016; Chen *et al.* 2017).

Distribution

The genus has a tropical distribution (Ryvarden 1991). AFRICA: Cameroon (Roberts & Ryvarden 2006, Douanla-Meli *et al*. 2007), East Africa (Ryvarden & Johansen 1980), Guineo-congolia (Decock *et al*. 2015; Yombiyeni & Decock 2017; Jerusalem *et al.* 2019), Uganda (Ipulet & Ryvarden 2005). NORTH AMERICA: California (Berkeley 1856). SOUTH AMERICA: Argentina (Robledo & Rajchenberg 2007), Atlantic forest (Bittencourt *et al.* (2018), Guyana (Aime *et al.* 2003), Brazil (Groposo & Loguercio-Leite 2005; Drechsler-Santos & Loguercio-Leite 2008; Borges Da Silveira *et al.* 2008; Baltazar *et al.* 2012; Salvador-Montoya *et al*. 2012; Westphalen & Borges Da Silveira 2013). ASIA: China (Dai *et al.* 2004; Dai *et al.* 2007; Li *et al.* 2007a; Cui *et al.* 2010a; Dai 2010; Dai *et al*. 2011; Dai 2012; Chen *et al.* 2017; Ren & Wu 2017), Israel (Țura *et al.* 2010), Japan (Núñez & Ryvarden 1999; Qin *et al.* 2018), Malaysia (Yamashita *et al.* 2009; Lee *et al*. 2012), Uzbekistan (Gafforov *et al.* 2014, Armenia (Ghobad-Nejhad 2011). EUROPE: Cambridge (Corner 1991), Fennoscandia, Norway (Ryvarden & Gilberstson 1994), Italy (Bernicchia 2001), Thailand (Choeyklin *et al.* 2011), Turkey (Asan *et al.* 2002).

Phylloporia chrysites (Berk.) Ryvarden, *P. pectinata* (Klotzsch) Ryvarden, *P. ribis* (Schumach.) Ryvarden and *P. weberiana* (Bres. & Henn. *ex* Sacc.) Ryvarden have been reported from India (Leelavathy & Ganesh 2000; Farooq *et al.* 2013a; Prasher & Lalita 2013; Ranadive 2013; Adarsh *et al.* 2019).

GENUS *TROPICOPORUS* L.W. ZHOU, Y.C. DAI & SHENG H. WU

Tropicoporus was established by Zhou *et al.* (2015) with *T. excentrodendri* L.W. Zhou & Y.C. Dai as the type species. The genus was erected for accommodating some species belonging to *Inonotus linteus* complex, which was mainly distinguished in having annual to perennial, resupinate, effused reflexed to pileate basidiomata, homogeneous to duplex context, dimitic hyphal system, but monomitic in context, presence of hymenial setae and ellipsoid to subglobose, yellowish, slightly thick to thickwalled basidiospores (Salvador-Montoya *et al*. 2018). As the name indicates, members of this genus occur exclusively in the tropical zones of the world (Zhou *et al.* 2015).

Tropicoporus shows similar with *Sanghuangporus* Sheng H. Wu, L.W. Zhou & Y.C. Dai, another genus segregated from the *Inonotus linteus* complex. *Sanghuangporus* differs from the former characterized by exclusively pileate species (Wu *et al.* 2015). These two genera settled in two different clades in the phylogenetic studies of *Tropicoporus*, and related genera by Wu *et al.* (2015) and Coelho *et al*. (2016). Currently, the genus contains 11 species (*Index Fungorum*, accessed on 30 September 2020).

Economic importance

Tropicoporus linteus is a popular medicinal mushroom with immunomodulatory and anti tumour effects and has been suggested as an alternative medicine in cancer therapy (Sliva 2010). The Polysaccarides in *T. linteus* enhances the mitochondrial membrane potential and induces death of cancerous cells (Griensven & Verhoeven 2013). This species also have anti inflammatory, immunomodulatory, anti oxidative, and anti fungal, anti diabetic, hepatoprotective and neuroprotective properties and has been widely used as medicine in China, Japan and other Asian countries (Kim *et al.* 2004; Chen *et al.* 2019). Medicinal activity of this fungus is due to the presence of β-glucans, phenols and terpenes (Moradali *et al*. 2007; Rop *et al.* 2009).

Distribution

Species of *Tropicoporus* occur in the tropical zones of the world. AFRICA: Niger, Tanzania (Patouillard 1907; Zhou *et al*. 2016): NORTH AMERICA: Cuba (Coelho *et al*. 2016); Northern Argentina (Salvador-Montoya *et al*. 2018). SOUTH AMERICA (Ryvarden & Meijer 2002, Drechsler-Santos *et al*. 2008, Rajchenberg & Robledo 2013), Brazil (Campos-Santana *et al*. 2015; Coelho *et al*. 2016), Caribbean (Tian *et al*. 2013). ASIA: China (Zhou *et al.* 2016; Zhou *et al*. 2016a), Thailand (Wu *et al*. 2015).

Tropicoporus dependens (Murrill) L.W. Zhou, Y.C. Dai & Vlasák and *T. linteus* (Berk. & M.A. Curtis) L.W. Zhou & Y.C. Dai have been reported from India (as *Phellinus dependens* (Murrill) Ryvarden, and *P. linteus* (Berk. & M.A. Curtis) Teng, respectively) by Leelavathy & Ganesh (2000), (Ranadive *et al.* 2011), Uttarakand (Prasher & Lalitha 2013) and Ranadive (2013).

2.1.5.1.2. **Oxyporaceae** Zmitr. & Malysheva

Oxyporaceae is a family recently described in Hymenochaetales by Zmitrovich & Malysheva (2014a), with *Oxyporus* (Bourdot & Galzin) Donk as the type genus. The family is characterized by annual or perennial, resupinate to pileate basidiomata with tubular hymenium. Microscopically, the members possess monomitic to pseudodimitic hyphal system, thin to thick walled hyphae lacking clamp connections, presence or absence of pseudocystidia, if present, cylindrical, thick walled, with or without apical incrustations, presence of hyphoid to fusoid, leptocystidia, with apical encrustations, and subglobose to ovoid basidiospores, that are acyanophilous to cyanophilous in cotton blue. Members cause white rot on wood.

According to Zmitrovich & Malysheva (2014a), Oxyporaceae shows similarity with Schizoporaceae in many morphological characters. However, basidiocarps with a trametoid habit, elongated pore tubes, and absence of clamp connections on hyphae distinguish Oxyporaceae from Schizoporaceae (Zmitrovich

& Malysheva 2014a). The family includes only a single genus, *Oxyporus* (Zmitrovich & Malysheva 2014a).

GENUS *OXYPORUS* (BOURDOT & GALZIN) DONK

Oxyporus was established by Bourdot & Galzin (1925), as a section of another polypore genus *Coriolus* Quél. Bourdot & Galzin (1925) recognized *Polyporus connatus* Weinm. as the type of *Oxyporus*. Donk (1933) elevated *Oxyporus* to genus rank, and defined the genus by members having homogenous context, stratified pore tubes, simple septate hyphae, ovoid to subglobose basidiospores and presence of encrusted cystidia (Zmitrovich & Malysheva 2014a). Donk (1974) recognized *P. connatus* as identical to *Boletus populinus* Schumach (*P. populinus*), and the latter was then treated as the type species of the genus (Ryvarden 1991; Ryvarden & Gilbertson 1994; Bondartseva 1998). Pouzar (1966) synonymised species of *Oxyporus* under genus *Rigidoporus*. *Oxyporus* (Bourdot & Galzin) Donk. showed high similarity with *Rigidoporus* in many microscopic characters, but was separated by the presence of soft, white to cream basidiocarps and absence of mammillate cystidioles (Westphalen & Borges Da Silveira 2012). According to Zmitrovich & Malysheva (2014a), *Oxyporus* produces fibrous coriaceous basidiocarps with interwoven hyphae that are usually monomitic, but sometimes weakly dimitic. Whereas, *Rigidoporus* species produces cheesy coriaceous to waxy basidiocarps and more or less distinctly dimitic hyphae system, with radially arranged skeletal hyphae in many pileate species. In addition, *Oxyporus* lacks the palisade like hymenioderm of pileus, and agglutinated dissepiments, which are common features of many *Rigidoporus* species (Zmitrovich & Malysheva 2014a). Wu *et al*. (2017a) treated *Rigidoporus* and *Oxyporus* as synonyms, because the type species of both the genera belonged to a single clade in *Hymenochaetales* in their study, and transferred most of *Oxyporus* species to *Rigidoporus.*

Based on the molecular phylogenetic works (Wagner & Fischer 2002; Larsson *et al.* 2006; Miettinen *et al.* 2012), some species of *Oxyporus* nested under the order Hymenochaetales, and most species of *Rigidoporus* settled under the order

Polyporales. Larsson *et al.* (2006) treated *Oxyporus* under a separate clade "*Oxyporus* clade" in Hymenochaetales. Hibbett *et al.* (2014) also recognized the *Oxyporus* clade under Hymenochaetales, and opined that the extent of the genus, and its separation from related *Rigidoporus* was uncertain. Currently, the genus consists of 38 species (accessed on 30 September 2020).

Based on the genus concept (Ryvarden & Johansen 1980; Ryvarden & Gilbertson 1994), *Oxyporus* is characterized by annual to perennial, pileate to resupinate, broadly attached basidiomata, poroid hymenium with white, cream to straw coloured pore surface, stratified or non stratified pore tubes, monomitic hyphal system, thin to thick walled hyphae, lacking clamp connections, presence of ventricose to tubular cystidia, that are either smooth or apically encrusted, and globose to broadly ellipsoid basidiospores. Members of the genus cause white rot on wood.

Economic importance

Oxyporus corticola (Fr.) Ryvarden is reported to possess medicinal properties (Wu *et al.* 2017a). An antifungal volatile compound isolated from the cultures of *O. latemarginatus* (Durieu & Mont.) Donk is known to possess *in vitro* antifungal activity in mycofumigation assays against some hyphomycetous fungi (e.g.'s *Alternaria alternata*, *Colletotrichum gloeosporioides*, *Fusarium oxysporum*), which are responsible for causing various diseases on crop plants (Lee *et al.* 2009a).

Oxyporus populinus and *O. sinensis* X.L. Zeng are considered as serious forest pathogens on angiosperm trees (Dai *et al.* 2007; Rajchenberg & Robledo 2013). *Oxyporus corticola* has been reported to cause lymphatic infections in dogs (Brockus *et al.* 2012; Miller *et al.* 2012). Recently, *Oxyporus ginkgonis* Y.C. Dai and *O. latemarginatus* has been reported as potential emerging human pathogens in chronic granulomatous disease patients (Wunschel *et al.* 2018).

Distribution

Oxyporus has worldwide distribution. AFRICA: Kenya, Tanzania, Uganda (Ryvarden & Johansen 1980), Morocco (Kotlaba & Pouzar 1988). NORTH

AMERICA: British Colombia (Montagni 1856), Costa Rica (Carranza-Morse 1992), Canada, Cuba, Dominica, Jamaica, Mexico (Lowe 1966), Canada, United States of America (Lindner *et al*. 2006; Gilbertson & Ryvarden 1987). SOUTH AMERICA: Argentina (Robledo & Rajchenberg 2007; Rajchenberg & Robledo 2013), Brazil (Góes-Neto 1999; Loguercio-Leite *et al.* 2008; Brazee *et al.* 2012; Westphalen *et al*. 2010a; Westphalen & Borges Da Silveira 2013), Paraguay (Popoff & Wright 1998), Jamaica (Ryvarden 2000), ASIA: China (Dai 2000; Dai *et al.* 2011; Dai 2012), Japan, Thailand (Núñez & Ryvarden 1999, 2001; Hattori 2005), Iran (Hallenberg 1981), Kazakhstan (Kotlaba 1984), Japan (Corner 1987), Malaysia (Lee *et al.* 2012), Pakistan (Kotlaba 1984), Siberia (Lowe 1966). EUROPE: Austria, Belarus, Belgium, Bulgaria, Croatia, the Czech Republic, England, Estonia, France, Germany, Italy, Latvia, Lithuania, the Netherlands, Poland, Portugal, Romania, Russia, Slovakia, Spain, Switzerland, Ukraine, Yugoslavia (Bernicchia 1990, 2001; Bernicchia *et al.* 2007; Bontea 1985; Järva & Parmasto 1980; Jülich 1984; Kotlaba 1984, 1997; Kreisel 1987; Krieglsteiner 1991; Ryvarden & Gilbertson 1994; Vampola 1989, Piątek 2003), Norway (Ryvarden & Gilbertson 1994), St. Petersburg (Zmitrovich & Malysheva 2014).

Oxyporus ravidus (Fr.) Bondartsev & Singer, *O. corticola*, *O. latemarginatus*, *O. pellicula* (Jungh.) Ryvarden, *O. populinus*, and *O. spiculifer* (G. Cunn.) P.K. Buchanan & Ryvarden have been reported from India (Bakshi 1971; Ranadive *et al.* 2011; Prasher & Lalita 2013; Ranadive 2013; Bala *et al*. 2020).

2.1.5.1.3. **Rickenellaceae** Vizzini

This family comprises of species showing much variations in basidiocarp morphology and habitats, including moss associated agaricoid genera (e.g. *Rickenella*), stereoid (*Cotylidia*), clavarioid (*Alloclavaria*), poroid (*Sidera*), and many corticioid (*Peniophorella, Resinicium*) forms. All species possess inamyloid basidiospores (Vizzini 2010). Larsson *et al.* (2006) had previously recognized the group as "*Rickenella* clade''. According to Larsson *et al.* (2006), there are no distinguishing characters common to all the species in the group. However, nutritional modes of the members of the group always include different types of interactions like association with bryophytes, and green algae, and predation on nematodes (Larsson *et al.* 2006). In Larsson (2007a) and Miettinen & Larsson (2010), *Rickenella* clade was resolved as paraphyletic. According to Hibbett *et al*. (2014), clear multigene data sets are required for the proper resolution of this clade.

GENUS *COTYLIDIA* P. KARSTEN

Genus *Cotylidia* P. Karst. was erected by Karsten (1881), with *Cotylidia undulata* (Fr.) P. Karst as the type species. Ried (1965) in his monograph on stipitate stereoid fungi, treated *Cotylidia* in the family Podoscyphaceae because of its resemblances with stereoid genera *Podoscypha* Pat. and *Stereopsis* D.A. Reid. (Kout & Zíbarová 2013). Eriksson & Ryvarden (1975) also accepted this genus under Podoscyphaceae. *Cotylidia* species produces monomitic hyphal system with clampless hyphae, whereas, species of *Podoscypha* always possess dimitic hyphal system with clamped generative hyphae (Kout & Zíbarová 2013). Similarly, *Cotylidia* is distinguished from *Stereopsis* by having cystidia. According to Moncalvo *et al*. (2002), *Cotylidia* along with agaricoid genera such as *Cantharellopsis* Kuyper, *Omphalina* Quél and *Rickenella* Raithelh. were positioned in or near to the order Hymenochaetales. A bryophilous habitat was the common character connecting these morphologically different genera (Larsson *et al.* 2006; Redhead *et al.* 2002). *Podoscypha* was distantly related with *Cotylidia* (Kim & Jung 2000) and was treated in the polyporoid sub clade of Polyporales (Hibbett & Thorn 2001). Binder *et al*. (2005) also placed *Cotylidia* under Hymenochaetales. This placement was confirmed by Larsson *et al*. (2006). In the phylogenetic study of Sjökvist *et al*. (2012), *Podoscypha* and *Stereopsis* were found as unrelated to *Cotylidia*. Currently 13 species are recognized in the genus (*Index Fungorum*, accessed on 30 September 2020) of which, many species are red listed (Kout & Zíbarová 2013).

Major characteristics of the genus are pileate, spathulate to infundibuliform, centrally or laterally stipitate basidiomata, light coloured pileus, hymenium appearing smooth, setulose under a lens, pale coloured context, monomitic hyphal system without clamp connections, presence of pseudocystidia in the hymenium, cylindrical with obtuse tips, presence of pileocystidia and caulocystidia and ellipsoid, smooth, thin walled basidiospores that are inamyloid in Melzer's reagent, and white rot type of wood deacay. Species are terrestrial or associated with mosses (Eriksson & Ryvarden 1975; Larsson *et al.* 2006; Bernicchia & Gorjón 2010; Kout & Zíbarová 2013).

Economic importance

Cotylidia aurantiaca (Pat.) A.L. Welden is recorded in the list of wild edible fungi (http://www.fao.org/3/y5489e/y5489e14.htm). This species is reported to have medicinal properties and used in the curing of conjunctivitis (Kamalebo *et al.* 2018). Laccase present in *C. pannosa* (Sowerby) D.A. Reid is known to have dye decolorizing ability (Sharma *et al*. 2015).

Distribution

According to Kout & Zíbarová (2013), species of *Cotylidia* are predominant in the tropics AMERICA: Ryvarden (2010). EUROPE (Moreau *et al*. 2008), Britain (Evans *et al*. 2006), Czech Republic (Holec & Beran 2006), Denmark (Wind & Pihl 2010), Finland (Rassi *et al.* 2010), Italy (Lonati 2000; Bernicchia 2001; Bernicchia & Gorjón 2010), North Europe (Eriksson & Ryvarden 1975), Norway (Bendiksen *et al.* 1998), Slovakia (Lizoň 2001), Switzerland (Senn-Irlet *et al*. 2007), Sweden (Vesterholt 2012).

From India, *Cotylidia pannosa* has been reported by Sharma *et al.* (2015).

2.1.5.1.4. **Schizoporaceae** Jülich

Schizoporaceae was established by Jülich (1982), with *Schizopora* Velen as the type species. This family contains most species of corticioid genera *Hyphodontia* (currently recognized under *Xylodon* (Pers.) Gray) and poroid *Schizopora* (Hibbett *et al*. 2014). Phylogeny of *Schizopora* was studied by Paulus *et al*. (2000). Larsson *et al.* (2006) included the genus *Coltricia* in this group and called it as the "*Coltricia* clade". The clade is relatively homogenous based on micromorphology (Hibbett *et al.* 2014).

GENUS *LEUCOPHELLINUS* BONDARTSEV & SINGER

Leucophellinus was established in 1941 by Bondartsew & Singer, but the name was invalidated because of the lack of a latin diagnosis. The name was later revalidated by Singer (1944) with *L. irpicoides* (Bondartsev *ex* Pilát) Bondartsev & Singer as the type species, under the sub family Fomitoideae, family Polyporaceae of Polyporales (Zmitrovich 2018). Later the genus was transferred to the family Rigidoporaceae of Polyporales (Bondartseva 1998). *Leucophellinus* is closely related with *Oxyporus* (Bourdot & Galzin) Donk in most microscopic characters (Parmasto 1983; Dai 1998; Núñez and Ryvarden 2001). However, the presence of thick walled and cyanophilous basidiospores distinguish *Leucophellinus* from *Oxyporus* and other closely related genera such as *Rigidoporus* Murrill and *Physisporinus* P. Karst (Wu *et al.* 2017a).

According to the molecular phylogenetic study of Wu *et al*. (2017a), *Leucophellinus*, and most of the *Oxyporus* species belonged to Hymenochaetales, while *Rigidoporus* and *Physisporinus* were nested under Polyporales. The study (Wu *et al.* 2017a) accepts *Leucophellinus* as an independant genus under *Hymenochaetales*. The genus consists of two species; *Leucophellinus hobsonii* (Berk. *ex* Cooke) Ryvarden & *L. irpicoides* (Bondartsev *ex* Pilát) Bondartsev & Singer (*Index Fungorum,* accessed on 30 September 2020).

Based on the concepts of Ryvarden & Gilbertson (1980), Corner (1987), Dai & Niemelä (1995), Bondartseva (1998) and Wu *et al.* (2017a), the genus is characterized by effused reflexed to pileate sessile basidiomata, highly tomentose to hispid, light coloured pileus which turns yellow brown to ochraceous on drying, often sulcate zonate, irregularly poroid to sub irpicoid hymenium which are concolourus with pileus, monomitic hyphal system with simple septate generative hyphae, presence of cylindrical to ventricose cystidia, that are either thin or thick walled, with or without encrustations, and mostly broadly ellipsoid to globose, hyaline, thick walled and cyanophilous basidiospores. Members of the genus cause white rot on wood.

Distribution

Species belonging to the genus occurs in tropical climatic conditions (Ryvarden 1991). AFRICA: Lang Nhôi (Parmasto 1983), Zambia, Zaire (Ryvarden & Johansen 1980). ASIA: Borneo (Corner 1987), China (Dai & Niemela 1995; Dai *et al.* 2011; Dai 2012; Malaysia (Lee *et al.* 2012), North East Asia, North Thailand, Taiwan, Vietnam (Núñez & Ryvarden 2001). EUROPE (Ryvarden & Gilbertson 1993).

Leucophellinus hobsonii has been reported from India (as *Oxyporus mollissimus* (Pat.) D.A. Reid) (Bakshi 1971; Leelavathy & Ganesh 2000; Sharma 2000; Ranadive 2013).

GENUS ***SCHIZOPORA*** VELENOVSKÝ

Schizopora. is a genus placed in Schizoporacae of Hymenochaetales by Velenovský (1922), with *Schizopora laciniata Velen*. (currently *S. paradoxa* (Schrad.) Donk) as the type species. According to Ryvarden & Johansen (1980), species of *Hyphodontia* J. Erikss. showed similarities with *Schizopora* in many microscopic characters, such as the slightly thickened generative hyphae with abundant clamp connections, and presence of cystidioles that are bottle shaped to ventricose, clavate, slightly vermicular or hyphoid, with a globose head (Ryvarden & Johansen 1980). In the opinion of Ryvarden & Johansen (1980), *Schizopora* can be considered as one of the major connecting genera between families Corticiaceae and Polyporaceae in a broad sense. *Schizopora* in Europe was studied by Hallenberg (1983) and he revealed two incompatibility groups in *S. paradoxa* complex which were also morphologically dissimilar. The closeness of *Schizopora* and *Hyphodontia* has been mentioned in many works (Hassan & David 1983; Eriksson *et al*. 1984; Langer & Oberwinkler 1993). In the monograph on *Hyphodontia* by Langer (1994), three species of *Schizopora* clustered among the major clades of *Hyphodontia*. Because of the microscopic similarities, *Schizopora* and *Hyphodontia* were treated together, and the latter name was preferred for conservation against *Schizopora* by Langer (1994). In the molecular phylogenetic study by Langer (1998), the type of *Schizopora* settled under the *Hyphodontia* clade, which confirmed the previous study (Langer 1994). According to Paulus *et al.* (2000), species of *Schizopora* published till that period was treated in the genus *Hyphodontia*. However, *Schizopora* resolved as a monophyletic group, distinct from both *Hyophodontia* and *Xylodon* by Fernández-López *et al.* (2015). The corticioid genus *Xylodon* (Pers.) Gray shows high similarity with *Schizopora* in many characters and these two genera could not be separated based on morphology as well as molecular data (Riebesehl & Langer 2017). Riebesehl & Langer (2017) placed species of both genera under a single name, *Xylodon* being the earliest. Currently, only two species are accepted in the genus (*Index Fungorum*, accessed on 30 September 2020).

The genus is characterized by annual, resupinate to effused reflexed basidiomata, usually imbricate with decurrent pore layer, poroid or daedaleoid to irregularly hydnoid or irpicoid hymenium, cream to light buff hymenial surface that darkens with age, monomitic to dimitic, with clamped generative hyphae, often encrusted at the dissepiments, presence of cystidia or fusiform to capitate hyphal ends covered with resinous materials or crystals, ellipsoid to subglobose, hyaline basidiospores that are negative in Melzer' s reagent. *Schizopora* species cause white rot on angiosperm wood, sometimes on conifers (Ryvarden & Johansen 1980; Eriksson *et al.* 1984; Ryvarden & Gilbertson 1994).

Economic importance

Schizopora paradoxa helps in bioremediation process by degrading heavy metals, polycyclic aeromatic hydrocarbons and decolourizing industrial dyes and other pollutants in waste waters (Pinedo-Rivilla *et al.* 2009; Lee *et al*. 2014; Min *et al*. 2015). Anti oxidant property is also reported in *S. paradoxa* (Colombo & Bianco 2007; Lee *et al.* 2013).

Distribution

Members of the genus have a worldwide distribution. AFRICA: Sierra Leone, Kenya, Tanzania (Ryvarden & Johansen 1980). NORTH AMERICA (Zhou *et al.* 2016). SOUTH AMERICA: Brazil (Drechsler-Santos & Loguercio-Leite 2008). EUROPE (Hallenberg 1983; Eriksson *et al.* 1984; Ryvarden & Gilbertson

1994), Italy (Bernicchia 2001; Bernicchia *et al.* 2007), Japan (Hattori 2005), Korea (Kim *et al*. 2009), Malaysia (Lee *et al*. 2012), Malaysia (Urbizu *et al.* 2014).

Schizopora paradoxa has been reported from India by Verma *et al.* (2008), Ranadive *et al.* (2011), Prasher & Lalita (2013), Ranadive *et al.* (2013).

2.1.5.1.5. Family *insertae sedis*

GENUS *TRICHAPTUM* MURRILL

Trichaptum was established by Murrill in 1904, with *Trichaptum trichomallum* (Berk. & Mont.) Murrill as the type species. According to Murrill (1904), although the type species of *Trichaptum* shows similarity with some species of genus *Funalia* (Polyporales), the former can be easily separated from the latter by their darker context and daedaleoid hymenium. Ryvarden & Johansen (1980) accepted *Trichaptum* for species in *Hirschioporus* Donk, a genus established by Donk (1933) based on *Boletus abietinus* Pers. *ex* J.F. Gmel. According to Traquiar & McKeen (1978) and Moore (1985), species in *Trichaptum* possess hyphae with imperforate dolipore septa, characteristic of the species in Hymenochaetaceae (Gilbertson & Ryvarden 1987; Ryvarden 1991; Ryvarden & Gilbertson 1994). Based on the study by Ko *et al.* (1997), *Trichaptum* species showed more similarity with *Inonotus* P. Karst. of Hymenochaetaceae than with members of Polyporaceae (except *T. abietinum*) which formed many polyphyletic sub clades. However, *T. abietinum* and species of Hymenochaetaceae were reported as closely related taking to consideration the septal ultrastructure (imperforate paranthesomes) as a conservative character (Hibbett 1996; Hibbett & Donoghue 1995). Based on recent molecular studies (Hibbett & Binder 2002; Larsson *et al.* 2006), *Trichaptum* settled in Hymenochaetales near to *Hyphodontia* J. Erikss. According to a recent study by Vlasák & Vlasák (2017), *Trichaptum laricinum* (P. Karst.) Ryvarden formed sister clade to *Nigrofomes melanoporus* (Mont.) Murrill, a species belonging to Nigrofomitaceae, Hymenochaetales. *Nigrofomes* resembles *Trichaptum* in having basidiocarps with blackish violet shades. However, the presence of distinct crust on the pileus and lack of clamp connection in *Nigrofomes* separates it from *Trichaptum*

(Vlasák & Vlasák 2017). The family level classification of the genus remains uncertain (*Index Fungorum* website, accessed on 05 August 2020). Currently, 34 species are recognized in the genus (*Index Fungorum*, accessed on 30 September 2020).

Trichaptum is characterized by annual, resupinate, effused to pileate basidiomata, usually imbricate with a decurrent pore layer, hispid to adpressed tomentose pileus surface, blackish, grey or dirty white, duplex context, irpicoid, lamellate to poroid hymenium, usually pale brownish to light violet in colour, brownish pore tubes, dimitic to trimitic hyphal system, with clamped generative hyphae, skeletal hyphae usually predominant, presence of cystidia that are thin to thick walled, subulate to clavate, smooth or apically encrusted and cylindrical, slightly bent, smooth, hyaline thin walled basidiospores that are inamyloid in Melzer’s reagent. Species cause white rot on conifers and hard wood. (Ryvarden & Johansen 1980; Gilbertson & Ryvarden 1987; Ryvarden & Gilbertson 1994).

Economic importance

Being white rot fungi, *Trichaptum* species play a vital role in decomposing hard woods and coniferous woods in various habitats (Magasi 1976; Arora 1986; Jung 1991). Some species of *Trichaptum* are well known for their medicinal and nutraceutical values and are rarely edible (Choi *et al*. 1999; Saparrat *et al*. 2000; Ranadive *et al.* 2013a; Breuil 2008; Lee *et al.* 2013; Tetianec *et al*. 2014; Udu-Ibiam *et al.* 2014; Nowacka *et al*. 2015; Lawal *et al.* 2016; Bal *et al.* 2017; Mali *et al.* 2017; Smith *et al*. 2017; Tamrakar *et al*. 2017; Upadhyaya *et al*. 2017; Adhikari *et al*. 2019). *Trichaptum* species also play a major role in biodegradation process by decolorizing various synthetic dyes (Machado *et al*. 2005; Eshghia *et al*. 2011; Singh 2017).

Distribution

The genus has cosmopolitan distribution (Ryvarden 1991). AFRICA: Ethiopia, Liberia, Tanzania (Ryvarden & Johansen 1980). NORTH AMERICA (Gilbertson & Ryvarden 1987; Zhou *et al*. 2016; Ryvarden 2016), United States of

America (Lindner *et al.* 2006; Grand *et al.* 2009; Brazee *et al*. 2012). SOUTH AMERICA: Argentina (Robledo & Rajchenberg 2007), Brazil (Groposo & Loguercio-Leite 2005; Borges Da Silveira *et al.* 2008; Baltazar & Gibertoni 2009; Drechsler-Santos *et al*. 2009; Gomes-Silva & Gibertoni 2009; Gibertoni & Drechsler-Santos 2010; Gibertoni *et al.* 2011; Westphalen & Borges Da Silveira 2013), Guyana (Aime *et al*. 2003), Venezuela (Ryvarden & Iturriaga 2003). ASIA: Borneo (Corner 1987), China (Dai *et al.* 2009; Dai *et al.* 2011; Dai 2012), Israel (Nogueira-Melo *et al*. 2014), Japan (Hattori 2005; Núñez & Ryvarden 2001), Korea (Kim *et al.* 2009), Malaysia (Corner 1987; Lee *et al*. 2012; Vlasák & Vlasák 2017). AUSTRALIA: New Zealand (Cunningham 1965). EUROPE: Finland (Ryvarden & Gilbertson 1994), Italy (Bernicchia 2001; Bernicchia *et al.* 2007), North Sweden (Josefsson & Spirin 2010).

Trichaptum abietinum (Pers. *ex* J.F. Gmel.) Ryvarden, *T. biforme* (Fr.) Ryvarden, byssogenum (Jungh.) Ryvarden, *T. fuscoviolaceum* (Ehrenb.) Ryvarden, *T. sector* (Ehrenb.) Kreisel and *T. versatile* (Berk.) G. Cunn. have been reported from India (Bose 1937; Bakshi 1971; Leelavathy & Ganesh 2000; Ranadive *et al*. 2011; Prasher & Lalita 2013; Ranadive 2013; Lyngdoh & Dkhar 2014).

3. MATERIALS AND METHODS

3.1. STUDY AREA- KERALA

Physiography

Kerala State lies in the south west coast of Indian Peninsula with area coordinates 8°18′–12°48′ N 74°52′–77°22′ E (Kumar *et al.* 2019). The total area of the state is 39,000 km^2 and is bordered by the Arabian Sea of the Indian Ocean on the west and the mountains of Western Ghats on the east (Balasubramanian 2017). Kerala covers 1.18% of total land area of India (Thomas 2000). The state is comprised of three different geographical regions such as highlands (600-1800 m high), midlands (300-600 m high) and lowlands or coastal area (6-300 m high) (Aravindakshan & Manimohan 2015). Highlands, midlands and lowlands constitutes 48%, 42% and 10% of the total land area of Kerala respectively (Shijitha *et al.* 2020). The highlands extend as a slope from the Western Ghats and consist of numerous peaks, having dense evergreen forests cover. The midlands are composed of undulating hills and valleys (Thomas 2000). The lowlands or coastal area of Kerala stretch out to 590 kms with 44 rivers, 34 lakes and 11 backwaters (Joshi 2012). Forests, marshes, mangroves, ponds, seashores and deltas are the five different geophysical areas of Kerala (Sreedharan 2004). Different types of soils are found in Kerala, such as coastal alluvium, acid saline, acid sulphate, laterite, red soil, hill soil, black cotton soil, and forest soil (Nayar 2010).

Vegetation

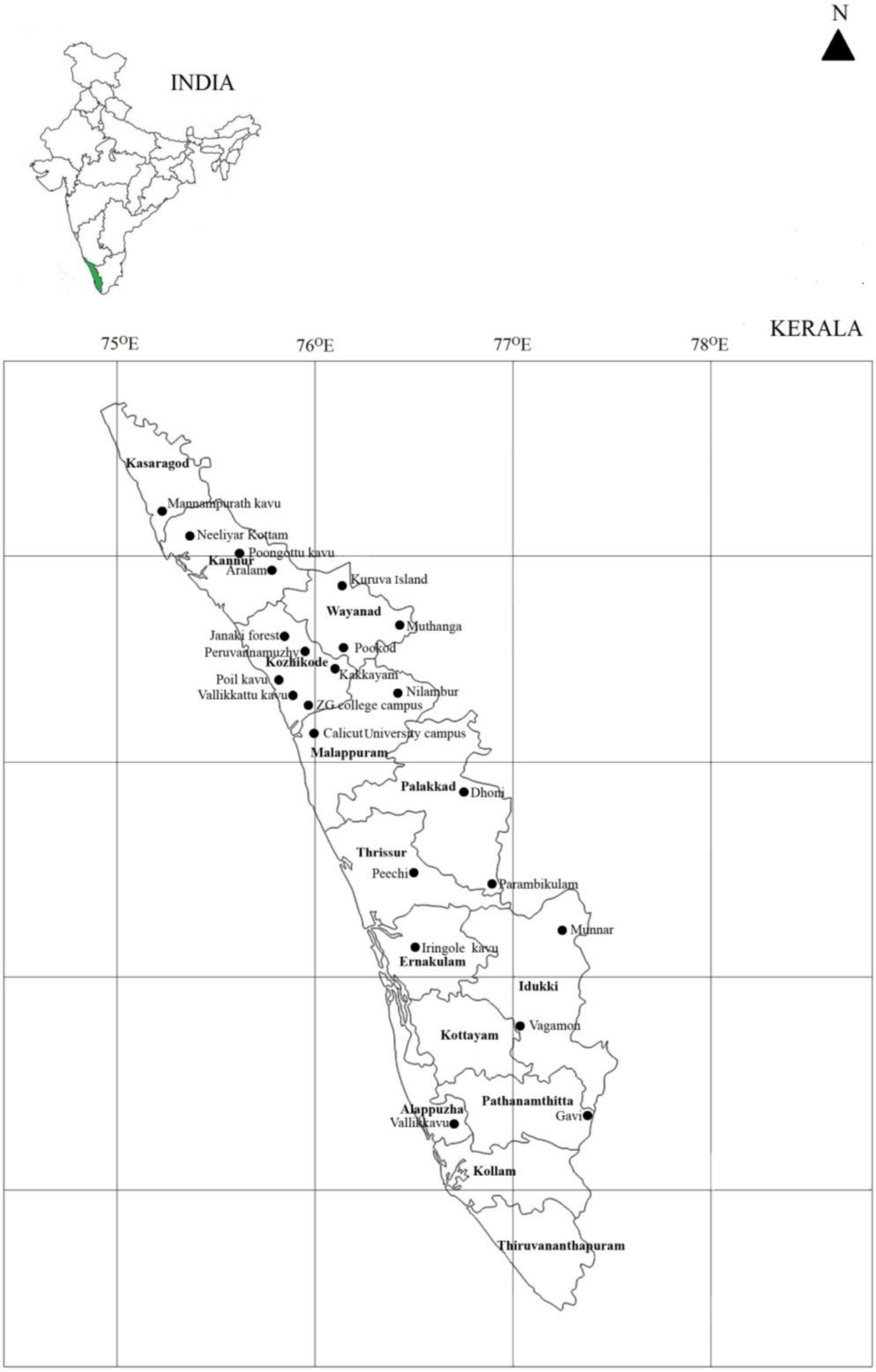
Kerala has abundant forest cover stretching out to 11,125.59 km^2, which encompasses 28.88% of its total geographic area (Aravindakshan & Manimohan 2015). Of the total forest areas of the state, 51% forest cover occurs in southern districts and rest 49% is distributed in central and northern districts (Balasubramanian 2017). The peculiar physiographic conditions contribute to the increased biodiversity of Kerala (Mohanan 2011, Nayar 2010). Western Ghats, one of the biodiversity hotspots of the world, cover 72.08% (28,008 km^2) of the total geographical area of Kerala (Arisdason & Lakshminarasimhan 2014). The mountain ranges of Western Ghats averages a height of 900 mm (Thomas 2000) and the highest peak, Anamudi reaches to an elevation of 2694 m (Raj 2015). The main forest types of Kerala are evergreen, semi evergreen, moist deciduous, dry deciduous, Shola grassland complex, plantations, wetlands and sacred groves (Champion & Seth 1968; Chandrasekharan 1997; Kumar *et al.* 2019). About 25% of Indian plant species occur in Kerala, including many rare and endangered species (Raj 2015). According to Sasidharan (2012), 5094 flowering plant taxa belonging to 1537 genera are found in the state. Of these, 344 taxa (175 genera) are endemic to the state (Reddy *et al*. 2007), and 1709 taxa are endemic to peninsular India (Arisdason & Lakshminarasimhan 2014). Some of the major tree species of the evergreen forests of Kerala are *Actinodaphne hookeri, Aglaia barberi, Antiaris toxicaria, Aporusa lindleyana, Artocarpus heterophyllus, Artocarpus hirsutus, Bischofia javanica, Bombax ceiba, Cinnamomum zeylanicum, Cynometra travancorica, Dipterocarpus indicus, Elaeocarpus tuberculatus, Ficus nervosa, Hopea parviflora, Hydnocarpus macrocarpus, Litsea bourdillonii, Mallotus tetracoccus, Mangifera indica, Pterospermum reticulatum, Syzygium gardneri, Terminalia bellirica, Terminalia travancorensis* and *Vateria indica*. Trees such as *Strychnos nuxvomica, Tabernamontana haeyneana, Tectona grandis, Terminalia bellirica, Terminalia paniculata and Xylia xylocarpa* occur in tropical moist deciduous forests. *Actinodaphne bourdillonii, Cinnamomum sulphuratum, Elaeocarpus recurvatus, Euonymus indicus, Fagraea ceylanica, Mahonia leschenaultii, Michelia champaca, Pittosporum neelgherrense, Symplocos cochinchinensis and Syzygium densiflorum* are some of the trees commonly observed in the Shola forests of Kerala (Sasidharan 2006). Many sacred groves in Kerala are well known for luxuriant flora and fauna (Balasubramanyan & Induchoodan 1996; Chandrashekara & Sankar 1998; Rajendraprasad *et al.* 2000). Sacred groves are small forest segments conserved in the name of religion and culture (Sing *et al*. 2017a). Sacred groves of Kerala are considered as the finest means of traditional conservatory system (Gadgil & Chandran 1992). Some of the trees commonly found in sacred groves of Kerala are *Antiaris toxicaria, Artocarpus* *hirsutus*, *Caryota urens*, *Celtis timorensis*, *Cinnamomum malabathrum*, *Ficus mysorensis*, *F. virens*, *Flocourtia montana*, *Garcinia gummi-gutta*, *Ixora brachiata*, and *Macaranga peltata* (Chandrashekara & Sankar 1998).

As part of conservation of the biodiversity, there are two Biosphere Reserves (Nilgiri Biosphere Reserve, Agasthyamalai Biosphere Reserve), five National Parks (Anamudi Shola National Park, Eravikulam National Park, Silent Valley National Park, Mathikettan Shola National Park and Pampadum Shola National Park) and 17 Wild life Sanctuaries (Aralam Wildlife Sanctuary, Chinnar Wildlife Sanctuary, Chimmony Wildlife Sanctuary, Choolannur Pea Fowl Sanctuary, Idukki Wildlife Sanctuary, Karimpuzha Wildlife Sanctuary, Kottiyoor Wildlife Sanctuary, Kurinjimala Sanctuary, Malabar Sanctuary, Mangalvanam Bird Sanctuary, Neyyar Wildlife Sanctuary, Parambikulam Wildlife Sanctuary, Peechi-Vazhani Wildlife Sanctuary, Peppara Wildlife Sanctuary, Periyar Wildlife Sanctuary, Shendurney Wildlife Sanctuary, Thattekkaad Bird Sanctuary and Wayanad Wildlife Sanctuary) and one Community Reserve (Kadalundi-Vallikunnu Community Reserve) in Kerala(http://forest.kerala.gov.in/index.php?option=com_content&view= article&id= 205&Itemid, accessed on 09 September 2020).

Climate

The climate of Kerala is maritime and monsoonal. Southwest (June-August) and northeast (October-December) monsoons are the two principal rainy seasons during the year, that provides alternating dry and wet climatic conditions in Kerala (Kumar *et al.* 2019). Kerala receives about 65% of rainfall during the south west monsoon (Shirin & Thomas 2016). North east monsoon brings less rain in Kerala when compared to the south west monsoon (Leelavathy & Ganesh 2000). The annual rainfall of the state is 3000 mm (Adarsh *et al.* 2018). The average monthly temperature varies from 22–33 ^{0}C (during December to January) to 24–39 ^{0}C (during rest months) (Kumar *et al.* 2019). Kerala State has high humidity with an average of 70 % (Sreedharan 2004).

Figure 1: Map of Kerala State, India, showing major collection localities



*ZG College- The Zamorin's Guruvayurappan College, Kozhikode, Kerala

3.2. FIELD STUDY AND SPECIMEN COLLECTION

Polypore specimens for the study were collected during the years June 2015–June 2020 from different regions of Kerala. Major collections were made during the south west monsoons (June to September) and north east monsoon seasons (October to December) of these years. Collections of polypores were also obtained during the summer seasons. The collection areas included various forest and non forest areas, National Parks, sacred groves, botanical gardens and private owned lands. Peruvannamuzhy forest, Janaki forest and Kakkayam forest of Kozhikode district were the frequently visited areas for the field studies. Field collections were also carried out in sacred groves like Poyil kavu, Thurayil kavu and Vallikkattu kavu of Kozhikode district, Neeliyar Kottam and Poongottu kavu of Kannur district, Edayilakkad kavu, Mannampurath kavu of Kasaragod district, and Iringole kavu of Ernakulam district. Major collection areas are shown in FIGURE 1. Most fruit body collections were from either live trees or dead and decayed logs or branches, whereas some fruit bodies were obtained from soil, often attached to small roots and leaf litters of nearby trees or plants. In the field, fruit bodies of different stages were collected whenever possible. Care was taken to collect the fruit bodies from the base along with the supporting wood. The host trees were taxonomically identified from the field as far as possible.

Herbaria of University of Calicut (CALI), Forest Research Institute (FRI) and Kerala Forest Research Institute (KFRI), were consulted for studying preserved polypore specimens previously collected and recorded from Kerala.

3.3. MORPHOLOGICAL CHARACTERIZATION

Colour photographs of fresh fruit bodies were taken from the field as far as possible. Macro photographs of fruit bodies were taken using SONY CYBERSHOT DSE-HX400V camera and mobile cameras of MICROMAX CANVAS NITRO E455 and REDMI YI. Field notes and collection data indicating habit, habitat, collection date, localities of collection, associated trees/plants and the type of rot on the host were prepared for each specimen. Macroscopic characters of the fruit bodies like size, shape, colour, colour changes on bruising, odour and surface features were noted. A LABOMED CXM2 stereomicroscope was used to examine the macroscopic features of the basidiocarps. Features of the pileus surface of collected fruit bodies such as glabrous or hairy, type of hairs (hispid, pruinose, pubescent, velutinous, villose, hirsute, tomentose, strigose), presence or absence of concentric zonations, sulcations and protuberances or tubercles were recorded. Other characters of fruit bodies like texture and colour of context region, presence or absence of distinct zonations or melanoid bands in the context, colour changes on handling (if present), type of hymenium (smooth, poroid, daedaleoid, lamellate, meruloid), shape of pores (round, angular, radially elongated), colour of hymenium, length and colour of pore tubes were also noted. Macrochemical tests using 5% KOH and Melzer's reagent were carried out on fresh fruit bodies and colour changes were recorded.

Microscopic examination of the fruit bodies was done using fresh samples, whenever possible. When fresh specimens were not available, dried specimens were used. For microscopy, thin sections from different regions of the fruit bodies such as pileus, context and hymenium were taken using razor blades and placed on microscopic slides. The sections were stained using an aqueous mixture made of 1% phloxine and 1% congo red. Five percentage aqueous solution of KOH was used for removing excess stains on the tissues, and stained specimens were mounted in KOH. For noting characters like colour and surface features of cells and hyphae, these specimens were also mounted and observed in tap water. Reaction of the basidiospores on treatment with Melzer's reagent, and 1% lactophenol cotton blue was noted. A caliberated LABOMED Lx400 compound light microscope was used for observing the microscopic preparations, and for taking measurements of the fungal structures. Arrangement of hyphae of pileus trama, hymenial trama, pileipellis, stipitipellis (for stipitate species), colour, size, wall features of hyphae and characters of sterile structures like cystidia, setae, setal hyphae or hyphidia (when present) were noted. Twenty basidiospores from each specimen were measured, and the spore range (minimum size to maximum size), spore quotient (Q, spore length divided by spore width), range of spore quotient and its mean value (Q_m) were recorded for each species. Microscopic photographs of the observed fruit bodies were taken using AMSCOPE digital microscopic camera attached to the compound microscope. Microscopic photographs were captured using TOUP VIEW 3.7 software. Based on macroscopic and microscopic characterization, taxonomic description sheets were prepared for all taxa examined and the descriptions of multiple collections of each species were compiled. Photographic plates showing the macro photographs and images of major microscopic characters were prepared for each species using Adobe Photoshop CS3.

All collections were dried in hot air oven at 65^0C and transferred to paper packets labelled with the species name and collection details. For preservation, these packets were then processed using vacuum seal method modified from Pradhan *et al.* (2015). For this, moderately thick polypropylene bags were taken, and their sealed bases were once more sealed using THEJUS plastic impulse hand sealer. One to five grams of silica crystals were put inside the plastic bag and sealed again leaving 1.5–2 cm open at either edge. Then packed specimens were transferred to the plastic bags and air was completely drawn out from the bags (for 10–15 minutes per bag) using EUROCLEAN vacuum cleaner. Finally, the bags were sealed using the hand sealer. All the specimens examined were packed by above method and deposited at the ZGC herbarium, with collection information recorded. A part of the collections were also deposited in the Central National Herbarium (CAL), Botanical Survey of India, Kolkata.

3.4. PURE CULTURE ESTABLISHMENT

Attempts were made to isolate pure cultures from basidiocarps of many polypore collections. Potato Dextrose Agar (PDA) Medium (composition: Potato-200 g, Dextrose-18 g, Agar-20 g, Tap water-1 L) was used for developing cultures from the fruit bodies. For culturing, the medium was dispensed into sterile Petri plates under aseptic conditions. To avoid bacterial contamination, a pinch of antibiotic streptomycin or chloramphenicol was added to the medium, before pouring it into the Petri plates. The medium dispensed in the Petri plates was allowed to solidify. Then small pieces mainly from the hymenial region of the fresh fruit bodies of polypores were sliced using sterile blades. In some cases, tissues from the contextual region of fruit bodies were also taken for isolation of pure cultures.

These slices were placed in the sterile Petri plates containing the PDA media, and were allowed to grow. Mycelial growth from the tissues of fruit bodies was observed after 1–2 days. After getting proper mycelia growths in the Petri plates, they were sub cultured. For sub culturing, PDA media was allowed to solidify in a slanting manner in sterile test tubes and 1.5 ml Eppendorf tubes. Then, mycelia were transferred from the Petri plates to the test tubes or Eppendorf tubes containing the media. All culture works were carried out under aseptic conditions. The sub cultured tubes were labelled with collection numbers, and dates of sub culturing. These pure cultures growing on suitable growth media are maintained according to short-term low temperature storage method. Further sub culturing of obtained mycelia growths in all tubes were carried out at an interval of 2–4 months. All the pure cultures obtained have been catalogued and maintained in refrigerator, in the Mycology laboratory of the Zamorin's Guruvayurappan College.

3.5. Terminology, classification systems, and taxonomic concepts followed

Several books on polyporoid fungi such as, "Polypores of Kerala" (Leelavathy & Ganesh 2000), "Genera of polypores, nomenclature and taxonomy" (Ryvarden 1991). East Asian polypores-Vol 1" (Núñez & Ryvarden 2000), Fungi Europaei, Polyporaceae *s.l.*" (Bernicchia 2005 and "Poroid fungi of Europe" (Ryvarden & Melo 2014) were were referred for getting the technical terms (basidiocarp, pileus, cuticle, cortex, pores, pore tubes, dissepiments, context, hyphae) and methodologies for describing macroscopic and microscopic structures of polyporoid fungi. This study follows the usage of the terms, monomitic, dimitic, trimitic to refer to the three types of hyphae seen in polypores. Those species which possess only generative hyphae are termed monomitic, with generative and skeletal hyphae are referred to as dimitic, and those with generative, skeletal, and skeleto ligative hyphae are considered as trimitic. In the present work, identification of species was mainly done with the help of the taxonomic keys provided in the books "East Asian polypores-Vol 1" (Núñez & Ryvarden 2000), "Polyporaceae of India" (Roy & De 1996), "Indian polypores" (Sharma 2000), "East Asian polypores-Vol 2" (Núñez & Ryvarden 2001), "Fungi Europaei, Polyporaceae *s.l.*" (Bernicchia 2005), and “Poroid fungi of Europe” (Ryvarden & Melo 2014). For current information on taxonomy and systematic position, the online resource *Index Fungorum* (www.indexfungorum.org). was followed.

The higher level classification and taxonomic concept of polyporoid fungi adapted here is based on the recent work on Polyporales by Justo *et al.* (2017), and also based on the latest classification of *Polyporaceae* by Zmitrovich (2018). Along with the order Polyporales, order Hymenochaetales are also included in the present work on polyporoid fungi because Hymenochaetales contains a large number of poroid species and also they represents a major part of collected specimens during the study period. The concept of order Hymenochaetales followed here is essentially that of Leelavathy & Ganesh (2000), Núñez & Ryvarden (2000) and Dai (2010). Thus, polyporoid fungi described in this study are represented by two orders, Polyporales and Hymenochaetales.

Major books, floras and monographs referred here for the identification of species are: The polypores (Pegler 1973a), The genus *Lentinus*-A world monograph (Pegler 1983), Genera of Polypores, nomenclature and taxonomy (Ryvarden 1991), Polyporaceae of India (Roy & De 1996), A Nomenclatural study of the Ganodermataceae Donk (Moncalvo & Ryvarden 1997), East Asian polypores-Vol 1 (Núñez & Ryvarden 2000), East Asian polypores-Vol 2 (Núñez & Ryvarden 2001), Polypores of Kerala (Leelavathy & Ganesh 2000), Indian polypores (Sharma 2000), Fungi Europaei, Polyporaceae *s.l.* (Bernicchia 2005), Stereoid fungi of America (Ryvarden 2010), Macrofungi of Kerala (Mohanan 2011), Poroid fungi of Europe (Ryvarden & Melo 2014), Wood-rotting non-gilled Agaricomycetes of Himalayas (Prasher 2015). Apart from these, many international, national and regional papers on polypores were also referred for getting data on distribution of polyporoid fungi and identification of the studied specimens.

3.6. MOLECULAR CHARACTERIZATION

Molecular characterization was done for all species of *Ganoderma* collected and identified (10 species) during the present study, and some other selected taxa (17 species) which could not be properly identified to species level due to taxonomic confusions. For DNA extraction, small tissues from the hymenial region of the fruit bodies were taken. NucleoSpin® Plant II kit (Macherey-Nagel 2014) and CHROMOUS bacterial genomic DNA isolation kit (www.chromous.com) were used for DNA extraction from the tissues of fruit bodies. For some collections, DNA was extracted according to the protocol described in Izumitsu *et al.* (2012). For this, small pieces taken from the fruit bodies were transferred to a 1.5 ml microfuge tube, containing 100 µl TE buffer. The tubes containing the tissues were microwaved for 1 min at 600W. Then the tubes were stored at room temperature for 30 seconds. This was again microwaved for another 1 min at 600W. After that, the tubes were cooled at -20^{0}C for 10 minutes. Finally, the tubes were centrifuged at 10,000 rpm for 5 minutes, and the supernatants were used for PCR.

Three gene regions such as ITS, LSU, and RPB2 of selected specimens were amplified using GeneAmp PCR System. PCR amplification of the ITS gene region was carried out using the primers ITS1F (5' TCCGTAGGTGAACCTGCGG 3') and ITS4R (5' TCCTCCGCTTATTGATATGC 3') (Gardes & Bruns 1993; White *et al.* 1990), LSU gene region using the primers LROR (5' ACCCGCTGAACTTAAGC 3') and LR5 (5' TCCTGAGGGAAACTTCG 3') (Binder & Hibbett 2003), and RPB2 gene region using the primers fRPB2-5F (GAYGAYMGWGATCAYTTYGG) and bRPB2-7R2 (ACYTGRTTRTGRTCNGGRAANGG) (Matheny 2006). PCR amplification profile of ITS and LSU regions consisted of 30 sec at 98 °C; 40 times cycle of 5 sec at 98 °C, 10 sec at 60 °C, 50 sec at 72 °C, and a final extension step of 60 sec at 72 °C. PCR amplification profile of RPB2 consisted of 5 min at 95 ^{o}C, followed by 35 cycles of 30 sec at 94 ^{o}C, 30 sec at 52 ^{o}C, 2 min at 72 ^{o}C, and 7 min at 72 ^{o}C. Sequencing was done using BigDye Terminator v3.1 Cycle sequencing Kit (Applied Biosystems, USA), in ABI 3500 Genetic Analyzer. The primers used for PCR amplification was also used for sequencing. The sequencing PCR temperature profile of ITS and LSU regions consisted of 2 minutes at 96 ^{o}C, followed by 30 cycles of 30 sec at 96 ^{o}C, 40 sec of 50 ^{o}C, 4 minutes of 60 ^{o}C. The sequencing temperature profile of RPB2 consisted of 5 min at 96 ^{o}C, 35 times cycle of 30 sec at 96 °C, 30 sec at 50 °C, 45 sec at 60 ^{o}C. DNA amplification and sequencing were done from the DNA sequencing service centres, Rajiv Gandhi Centre for

Biotechnology (RGCB), Thiruvanathapuram, Kerala, AgriGenome Labs., Ernakulam, Kerala, and CHROMOUS BIOTECH PVT. LTD., Bangalore. Quality of the obtained DNA sequences were checked using Sequence Scanner Software v1 (Applied Biosystems). Alignment and editing of obtained DNA sequences were carried out using Geneious Pro v5.1 (Drummond *et al.* 2010) and BioEdit Sequence Alignment Editor. The newly generated sequences were deposited in the GenBank database (www.ncbi.nlm.nih.gov) and EMBL-EBI database (www.ebi.ac.uk), and accession numbers were obtained (Table 7). Sequence similarity assessments were conducted using BLAST search in NCBI's GenBank nucleotide database (https://blast.ncbi.nlm.nih.gov/). BLAST search results with an identity of ≥90 %, with Zero Error value were considered for the phylogenetic analysis.

3.7. Phylogenetic analyses

3.7.1. Phylogenetic analysis of *Ganoderma* species of Kerala

The newly generated sequences of *Ganoderma* species of Kerala and those retrieved from GenBank (Table 3) were aligned using MEGA X64 (Kumar *et al.* 2018). The dataset consisted of 185 taxa. Sequences of the laccate *Ganoderma* species in the datasets were selected from Hapuarachchi *et al.* (2015), Xing *et al.* (2018), Luangharn *et al.* (2019), Sun *et al.* (2020) and selection of the non laccate *Ganoderma* taxa included in the analyses follows Moncalvo & Buchanan (2008). *Trametes trogii* Berk. was selected as the outgroup taxon. Selection of the outgroup follows Hapuarachchi *et al.* (2018). Maximum Likelihood (ML) analysis was conducted using MEGA X 64 using Tamura-Nei model (Tamura & Nei 1993). Phylogeny tests were carried out using boot bootstrap method and the number of bootstrap replicates was set to 1000 for each test. All sites were given uniform rates and gaps were treated as missing data. The aligned sequence data matrices have been deposited in TreeBase software (Submission ID: 26790). In the phylogenetic tree, bootstrap support values above 50% alone are shown (Figure 133).

3.7.2. PHYLOGENETIC ANALYSIS OF *GANODERMA* SPECIES ASSOCIATED WITH STEM ROT DISEASE OF COCONUT IN KERALA

The newly generated ITS, LSU, and RPB2 sequences, and those retrieved from GenBank (TABLE 3) were aligned using MEGA X64 (Kumar *et al.* 2018). A combined dataset alignment contained 120 taxa. Sequences of the laccate species in the datasets were selected from Hapuarachchi *et al.* (2015), Xing *et al*. (2018), Luangharn *et al.* (2019), Sun *et al.* (2020) and selection of the non laccate *Ganoderma* taxa included in the analyses follows Moncalvo & Buchanan (2008). *Trametes trogii* Berk. was selected as the outgroup taxon. Selection of the outgroup follows Hapuarachchi *et al.* (2018). Phylogenetic analyses were conducted using Maximum Parsimony (MP) method in PAUP 4.0d90 (Swofford 2002), Maximum Likelihood (ML) method using MEGA X64 and Bayesian analysis (Ronquist & Huelsenbeck 2003) with MrBayes 3.1.2. MP analyses were performed with parameters as described in Kumar *et al.* (2007). ML analyses were done using Tamura-Nei model (Tamura & Nei 1993). Phylogeny test was carried out using bootstrap method and the number of bootstrap replicates was set to 1000. All sites were given uniform rates and gaps were treated as missing data. Bayesian phylogenetic inference was done with a Kimura 2-parameter (K2) model, including a fraction of invariable sites and discrete gamma distributed substitution rates at the remaining sites. The best-fit likelihood model of evolution was estimated using MEGA X64. Two independent analyses were run from random starting trees for 1.5 M generations, with trees saved every 100 generations, using four chains and a burnin fraction of 0.25. Posterior probability values above or equal to 0.95 were considered significant. The aligned sequence data matrices have been deposited in TreeBase (Submission ID: 26386). In the phylogenetic tree, bootstrap support values above 50% alone are shown (FIGURE 134).

Table 3: List of *Ganoderma* species, voucher numbers, locality and GenBank/EMBL accession numbers of sequences (ITS, LSU and RPB2) used in the phylogenetic analysis. Sequence accessions generated during this study are highlighted in bold.

Taxa	**Voucher numbers**	**Locality**	**DNA sequence accession numbers**		
			ITS	**LSU**	**RPB2**
G. adspersum	SFC20141001-22	South Korea	KY364252	-	KY393271
G. adspersum	KM 44264	United Kingdom	AJ006685	-	-
G. adspersum	CBS351.74	Belgium	X78742/ X78763	-	-
G. angustisporum	BJFCCui 13817	China	NR158431	-	-
G. angustisporum	Cui 13817	China	MG279170	-	MG367507
G. angustisporum	Cui 14578	China	MG279171	-	-
G. angustisporum	Cui 16340	China	MG279172	-	-
G. annulare	KCTC16803	Korea	JQ520160	-	-
G. applanatum	UOCBIBMB 13	Sri Lanka	KR867655	-	-
G. applanatum	SFC20150930-02	South Korea	KY364258	-	KY393274
G. applanatum	7411	China	MG279158	-	MG367493
G. applanatum	HMAS60686	China	AF255191/AF 255192	-	-
G. applanatum	CBS187.31	Germany	AF255093	-	-
G. applanatum	K(M)120829	Britain	AY884179	-	-
G. applanatum	GYONGYI0150	Hungary	AF255092	-	-
G. applanatum	NIAST824	South Korea	AF255114	-	-
G. applanatum-australe complex	**CAL1547**	**India**	**MF072395**	**-**	**-**
G. applanatum complex	JM97/3	United States of America	AF255094	-	-
G. applanatum complex	JM98/2	South Africa	AF255149	-	-
G. applanatum complex	JM98/233	China	AF255116	-	-
G. applanatum complex	MUCL40412	Ecuador	AF255140	-	-
G. applanatum complex	JM97/2	United States of America	AF255095	-	-
G. applanatum complex	JMCR.41	Costa Rica	AF255135	-	-
G. aridicola	Dai 12588	South Africa	KU572491	-	-
G. australe	DHCR411	Australia	MF436675	MF436672	-
G. australe	Moncalvo0705	United States of America	-	X78780	AY218485
G. australe	K(M)120828	Britain	AY884183	-	-
G. australe	RSH1206	Taiwan	AF255106/7		
G. australe	30-2	Malaysia	LC084748	-	-
G. australe	FA-CNn1	Malaysia	AF255143	-	-

G. australe	**VN85**	**India**	**MT364483**	**-**	**-**
G. australe complex	PKB96/346	Australia	AF255157	-	-
G. australe complex	JFMA414	Chile	AF255174/ AF255175	-	-
G. australe complex	MUCL41812	Cambodia	AF255118	-	-
G. australe complex	PKB96/332	Japan	AF255104	-	-
G. australe complex	CP333	Papua New Guinea	AF255128	-	-
G. australe complex	PKB96/270	Singapore	AF255123/AF 255124	-	-
G. australe complex	PKB93/035	Taiwan	AF255108/ AF255109	-	-
G. australe complex	PKB96/303	Japan	AF255102/AF 255103	-	-
G. australe complex	JM95/6	Thailand	AF255121	-	-
G. austroafricanum	CMW41454	South Africa	KM507324	-	-
G. boninense	WD 2028	Japan	KJ143905	KU220015	KJ143964
G. boninense	WD 2085	Japan	KJ143906	-	-
G. brownii	365739	United States of America	MK883702	-	-
G. carocalcareum	DMC 322	Cameroon	EU089969	-	-
G. casuarinicola	HKAS 104639	Thailand	MK817650	MK817654	MK840868
G. casuarinicola	Dai 16336	China	MG279173	-	MG367508
G. casuarinicola	Dai 16337	China	MG279174	-	MG367509
G. casuarinicola	Dai 16338	China	MG279175	-	MG367510
G. casuarinicola	Dai 16339	China	MG279176	-	MG367511
G. chalceum	URM80457	Brazil	JX310812	-	-
G. cupreum	GanoTK7	Cameroon	JN105702	-	-
G. curtisii	CBS 100131	United States of America	JQ781848	-	KJ143966
G. curtisii	CBS 100132	United States of America	JQ781849	-	KJ143967
G. destructans	CBS 139793	South Africa	NR132919	NG058157	-
G. destructans	Dai 16431	South Africa	MG279177	-	MG367512
G. destructans	CMW 43670	South Africa	KR183856	-	-
G. dunense	CMW42150	South Africa	MG020249	-	-
G. dunense	CMW42157	South Africa	MG020255	-	-
G. dunense	CMW42149	South Africa	MG020248	-	-
G. ecuadoriense	PMC126	Ecuador	KU128525	-	-
G. eickeri	CMW49692	South Africa	MH571690	-	-
G. ellipsoideum	JFL 14080968	China	MH106868	-	-
G. enigmaticum	CBS 139792	South Africa	NR132918	-	-
G. enigmaticum	Dai 15970	South Africa	KU572486	-	MG367513
G. enigmaticum	Dai 15971	South Africa	KU572487	-	MG367514
G. enigmaticum	**VN731**	**India**	**MT364486**	**-**	**-**

G. enigmaticum	**VN73**	**India**	**MT364487**	**-**	**-**
G. flexipes	MFLU 19-2198	China	MN398340	-	-
G. formosanum	0109	Taiwan	X78752/X78773	-	-
G. gibossum	ACCC5.151	China	X78741/ X78762	-	-
G. gibbosum	SFC20150630-23	South Korea	KY364264	-	KY393276
G. hoehnelianum	Dai 11995	China	KU219988	-	MG367497
G. hoehnelianum	Yuan 6337	China	MG279160	-	MG367498
G. hoehnelianum	Cui 13982	China	MG279178	-	MG367515
Ganoderma keralense sp. nov.	**CAL1543**	**India**	**MT449082**	**MT449228**	**-**
Ganodermakeralense sp. nov.	**ZGCVN733**	**India**	**-**	**-**	**PRJEB36109**
G. knysnamense	CMW 47755	South Africa	NR1655231	-	-
G. leucocontextum	GDGM44303	China	KJ027607	-	-
G. leucocontextum	GDGM 44489	China	KM396271	-	-
G. leucocontextum	GDGM 44490	China	KM396272	-	-
G. leucocontextum	Dai 15601	China	KU572485	-	MG367516
G. lipsiensis	NOR_53-1143/2	Finland	EF060005	-	-
G. lingzhi	Cui 14342	China	MG279179	-	MG367517
G. lingzhi	Wu 1006-38	China	JQ781858	-	JX029980
G. lingzhi	Cui 14375	China	MG279180	-	MG367518
G. lingzhi	HKAS 76642	China	KC222318		
G. lobatum	JV 1008/32	United States of America	KF605670	-	MG367500
G. lobatum	JV 1008/31	United States of America	KF605671	-	MG367499
G. lobatum	BAFC651	Argentina	AH008100	-	-
G. lobatum	CBS222.48	United States of America	X78740/ X78761	-	-
G. lobatum	JV 1008/39	United States of America	KF605672	-	-
G. lucidum	K 175217	United Kingdom	KJ143911	-	KJ143971
G. lucidum	RYV 33217	Norway	Z37096/ Z37073	-	-
G. lucidum	HMAS86597	England	AY884176	-	-
G. lucidum	Cui 14404	China	MG279181	-	MG367519
G. lucidum	Cui 14405	China	MG279182	-	MG367520
G. lucidum	HKAS71088	China	KC222321	-	-
G. lucidum	FRI816	India	X87351/ X87361	-	-
G. lucidum	BCRC36123	India	EU021459	-	-
G. martinicense	LIP SW-Mart08-44	Martinica	KF963257	-	-
G. martinicense	LIP SW-Mart08-55	Martinica	KF963256	-	-
G. martinicense	He 2240	United States	MG279163	-	MG367503

		of America			
G. mbrekobenum	MIN 850481	Ghana	NR147647	-	-
G. meredithae	UMNFL50	United States of America	MG654103	-	-
G. mexicanum	XAL D.Jarvio	Mexico	MK531823		
G. miniatocinctum	337036	Malaysia	MN490056	-	-
G. mizoramense	UMN-MZ5	India	KY643751	-	-
G. mizoramense	UMN-MZ4	India	KY643750	-	-
G. multicornum	**VN308**	**India**	MT772000	**-**	**-**
G. multipileum	CWN 04670	China	KJ143913	-	KJ143972
G. multipileum	Dai 9447	China	KJ143914	-	KJ143973
G. multipileum	Cui 14373	China	MG279184	-	MG367521
G. multipileum	G82	China	KX055556	-	-
G. multipileum	Dai9521	China	JQ781874	-	-
G. multipileum	LQ	China	MG739453	-	-
G. multipileum	TWS31Auf-a	Taiwan	MN533795	-	-
G. multipileum	SSP:4	India	KY865255	-	-
G. multipileum	**VN402**	**India**	**MT765061**	**-**	**-**
G. multipileum	**VN481**	**India**	**MT765065**	**-**	**-**
G. multipileum	**VN534**	**India**	**MT765063**	**-**	**-**
G. multiplicatum	SPC9	Brazil	KU569553	-	-
G. multiplicatum	60119011	Brazil	MG279185	-	-
G. multiplicatum	URM 83346	Brazil	JX310823	-	-
G. multiplicatum	**VN529**	**India**	**MT396669**	**-**	**-**
G. mutabile	CLZhao 982	China	MG231527	-	-
G. mutabile	Yuan2289	China	JN383977	-	-
G. nasalanense	LPDR17060212	Laos	MK345442	-	-
G. neojaponicum	ASI 7032	Korea	JQ520193	-	-
G. oerstedii	GO138	China	DQ425011	-	-
G. orbiforme	Cui 13918	China	MG279186	-	MG367522
G. orbiforme	Cui 13880	China	MG279187	-	MG367523
G. orbiforme	BCC22325	Malaysia	KX421867	-	-
G. orbiforme	BCC22324	Malaysia	JX997990	-	-
G. orbiforme	**VN577**	**India**	-	-	-
G. oregonense	JZB2114013	China	MH294309	-	-
G. oregonense	CBS 265.88	United States of America	JQ781875	-	-
G. parvulum	CRGF:719	Cuba	MK554782	-	-
G. pfeifferi	K(M)120818	England	AY884185	-	-
G. philippii	Cui 14443	China	MG279188	-	MG367524
G. philippii	Cui 14444	China	MG279189	-	MG367525
G. philippii	LXT.6	Vietnam	AF255189	-	-
G. podocarpense	QCAM6422	Ecuador	MF796661	-	-
G. resinaceum	Rivoire 4150	France	KJ143915	-	-
G. resinaceum	CBS 194.76	Netherlands	KJ143916	-	-
G. resinaceum	HMAS86599	Britain	AY884177	-	JF915435
G. ryvardenii	HKAS 58053	Cameroon	HM138671	-	-
G. ryvardenii	HKAS 58054	Cameroon	HM138672	-	-

G. ryvardenii	HKAS 58055	Cameroon	HM138670	-	-
G. sandunense	GACP 18012501	China	NR164049	-	-
G. sessile	MUCL38061	United States of America	MK554778	-	-
G. sessiliforme	BAFC2580	Brazil	AH008108	-	-
G. shandongense	Dai 15785	China	MG279190	-	MG367526
G. shandongense	Dai 15787	China	MG279191	-	MG367527
G. shandongense	Dai 15791	China	MG279192	MG367582	MG367528
G. sinense	Wei 5327	China	KF494998	KF495008	MG367529
G. sinense	Cui 13835	China	MG279193	-	MG367530
Ganoderma species	BAFC2531	Chile	AF255176	-	-
Ganoderma species	MUCL27886	India	AF255190	-	-
Ganoderma species	GPS 047	Iran	MK050593	-	-
G. stipitatum	THC 16	Colombia	KC884264	-	-
G. subfornicatum	BRFM 1024	French Guiana	JX082352	-	-
G. subresinosum	MFLU 19-2218	Thailand	MN398322	-	-
G. subresinosum	HNCM004	China	MH537850	-	-
G. subresinosum	**VN826**	**India**	**MT364489**	**-**	**-**
G. steyaertanum	MEL238273	Australia	KP012964	-	-
G. steyaertanum	36-11-58	Indonesia	KJ654424	-	-
G. steyaertanum	8-1-115	Indonesia	KJ654419	-	-
G. steyaertanum	II-121-1	Indonesia	KJ654427	-	-
G. steyaertanum	6-WN-14(M)-A	Indonesia	KJ654458	-	-
G. thailandicum	HKAS 104641a	Thailand	MK848682	-	-
G. tornatum	URM82776	Brazil	JQ514110	-	-
G. tornatum	BAFC1172	Argentina	AH008096	-	-
G. tropicum	Yuan 3490	China	JQ781880	-	-
G. tropicum	Dai 16434	China	MG279194	-	MG367532
G.tropicum	He 1232	China	KF495000	-	MG367531
G. tropicum	**VN429**	**India**	**MT364499**	**-**	**-**
G. tropicum	**VN873**	**India**	**MT364498**	**-**	**-**
G. tsugae	AFTOL ID 771	United States of America	DQ206985	AY684163	-
G. tsugae	Dai 12751b	United States of America	KJ143919	-	KJ143977
G. tsugae	Cui 14110	China	MG279195	-	MG367533
G. tsugae	Cui 14112	China	MG279196	-	MG367534
G. valesiacum	CBS 428.84	Korea	JQ520218	-	-
G. weberianum	CBS 219.36	Philippines	JQ520219	-	-
G. williamsianum	Wei 5032	Thailand	KU219994	KU220024	-
G. williamsianum	Dai 16809	Thailand	MG279183	-	MG367535
G. wiiroense	MIN 938704	Ghana	NR158480	-	-
G. zonatum	FL-02	United States of America	KJ143921	-	KJ143979
G. zonatum	FL-03	United States of America	KJ143922	KJ143942	KJ143980
Trametes trogii	RLG4286sp	United States of America	JN164993	-	JN164867

3.7.3. PHYLOGENETIC ANALYSIS OF *NEOFOMITELLA GUANGXIENSIS*, *SEBIPORA AQUOSA* AND RELATED TAXA

The newly generated sequences and those taken from GenBank (TABLE 4) were aligned using MEGA X64 (Kumar *et al*. 2018). Sequences used in the dataset were selected from Miettinen & Rajchenberg (2012), Cui *et al.* (2019) and Ji *et al.* (2019). The dataset included 74 taxa. *Laetiporus sulphureus* (Bull.) Murrill was selected as the outgroup taxon for the dataset. Maximum Likelihood (ML) analysis was conducted with MEGA X64 using Tamura-Nei model (Tamura & Nei 1993). Phylogeny test was carried out using boot bootstrap method, based on 1000 bootstrap replicates. The aligned sequence data matrix was deposited in TreeBase (Submission ID: 26538). In the phylogenetic tree, bootstrap support values above 50% alone are shown (FIGURE 135).

TABLE 4- List of some selected species in the order Polyporales, voucher numbers, locality and GenBank accession numbers for ITS sequences used in the study. Sequence accessions generated during this study are highlighted in bold.

Taxa	Voucher numbers	Locality	DNA sequence accession numbers
Cereporiopsis subvermispora	Juha Kinnunen 1052	Finland	HQ659225
C. subvermispora	Yu-Cheng Dai 3120 (H)	China	HQ659226
C. subvermispora	Tuomo Niemela 5978 (H)	Poland	HQ659227
Cinereomyces linbaldii	FBCC 117	China	HQ659223
Coriolopsis dendriformis	Yuan 6316	China	KC867409
C. retropicta	Dai 13074	China	KX832055
Daedaleopsis confragosa	Cui 6892	China	KU892428
D. purpurea	Dai 8060	Japan	KU892442
D. tricolor	Dai 8349	China	KU892432
Datronia mollis	Dai 11456	China	JX559253
Datroniella melanocarpa	Cui 10646	China	KC415186
D. scutellata	Cui 7265	China	JX559263
D. subtropica	Dai 12883	China	KC415184
Dichomitus squalens	Cui 9725	China	JQ780408
D. kirkii	Yuan 1237	China	JQ780406
Earliella scabrosa	Cui 6236	China	KC867366
Echinochaete ruficeps	BJFC007373	China	KX832052
E. russiceps	BJFC017598	China	KX832051

Favolus acervatus	Dai 10749b	China	KX548979
F. grammocephalus	Cui 10926	China	KU189776
Fomes fomentarius	Cui 8020	China	JX290073
Fomitopsis hemitephra	NZFS 2774	New Zealand	MN007024
F. palustris	Dollinger 782	Florida	KY264029
Funalia cystidiata	Dai 12093	China	KC867394
F. subgallica	Dai 10814	China	KC867382
Hexagonia glabra	Dai 12993	China	KX900637
Lignosus hainanensis	Dai 10670	China	GU580883
Megasporia cystidiolophora	Cui2688	China	JQ780389
M. ellipsoidea	Cui 5222	China	JQ314367
Megasporoporia bannaensis	Cui 13967	China	MG847212
M. setulosa	Dai 13673	China	KX900655
Megasporoporiella pseudocavernulosa	Yuan 1270	China	JQ314360
Microporus affinis	Cui 7714	China	JX569739
M. subaffinis	Dai 11712	China	KX880616
Neodatronia gaoligongensis	Cui 8055	China	JX559269
N. sinensis	Dai 11921	China	JX559272
N. mikawai	Dai 12361	China	KX548975
Neofomitella australiensis	Cui 16542	Australia	MK192438
N. australiensis	Cui 16558	Australia	MK192440
N. fumosipora	Dai 10777	China	JX569735
N. fumosipora	Cui 16759	Australia	MK192433
N. fumosipora	Cui 8816	China	JX569734
N. guanxiensis	Cui 14029	China	MK192437
N. guangxiensis	Cui 13968	China	MK192434
N. guangxiensis	**ZGCVN689**	**India**	**MT365177**
N. polyzonata	Dai 10816	China	KX900665
N. polyzonata	Dai 10419	China	JX569738
N. polyzonata	Dai 10420	China	JX569736
N. rhodophaea	TFRI 414	Taiwan	EU232216
Obba rivulosa	FBCC 938	Finland	HQ659233
O. rivulosa	Otto Miettinen X59	Finland	HQ659234
O. valdiviana	FF503 (CIEFAP)	Australia	HQ659235
Perenniporia martia	Cui 4055	China	KX900641
P. medulla-panis	MUCL 43250	Norway	FJ411087
Picipes badius	Cui10501	China	KC572015
P. subtropicus	Cui 2662	China	KU189759
Polyporus umbellatus	Pen 13513	China	KU189772
Pyrofomes demidoffii	MUCL 41034	Russia	FJ411105
Sebipora aquosa	Otto Miettinen 8680	Indonesia	HQ659240
S. aquosa	Otto Miettinen 12032	Indonesia	HQ659241
S. aquosa	Otto Miettinen 8868	Indonesia	HQ659242
S. aquosa	Otto Miettinen 9265	Indonesia	HQ659243
S. aquosa	Dai 13592	China	KU376422

S. aquosa	Dai 13268	China	KX161648
S. aquosa	**ZGCVN775**	**India**	**MT649883**
Trametes apiaria	Cui 6447	China	KC867362
Trametes cotonea	CBS 352.80	India	MH861271
Trametes elegans	Dai 9546	China	KC848265
Trametes gibbosa	Cui 7390	China	KC848302
Truncospora fuscopurpureus	Cui 10950	China	KC456254
Truncospora macrospora	Cui 8106	China	JX941573
Truncospora mollissima	Cui 6257	China	JX141451
Yuchengia narymica	Dai 7050	China	JN048776
Laetiporus sulphureus	Cui 12388	China	KR187105

3.7.4. Phylogenetic analysis of *Hymenochaete boddingii*

Sequence similarity assessments were conducted using BLAST search in NCBI's GenBank nucleotide database. The newly generated ITS sequence was deposited in the GenBank database. The newly generated ITS sequence and those downloaded from GenBank (Table 5) were aligned using MEGA X (Kumar *et al.* 2018). Selection of taxa was based on Nie *et al.* (2017). A total of 48 taxa were aligned. *Fomitiporia punctata* (P. Karst.) Murrill was selected as the outgroup taxon for the dataset. Maximum Likelihood (ML) analysis was conducted using MEGA X using Tamura-Nei model (Tamura & Nei 1993). Phylogeny test was carried out using boot bootstrap method and the number of bootstrap replicates was set to 1000. All sites were given uniform rates and gaps were treated as missing data. The aligned sequence data matrix was deposited in TreeBase (Submission ID: 26790). In the phylogenetic tree, bootstrap support values above 50% alone are shown (Figure 136).

Table 5- List of *Hymenochaete* species, voucher numbers, locality and GenBank accession numbers for ITS sequences used in the study. Sequence accessions generated during this study are highlighted in bold.

Taxa	Voucher numbers	Locality	GenBank numbers
Hymenochaete adusta	He207	China	JQ279523
H. anomala	He135	China	JQ279567
H. attenuata	He15	China	JQ279525
H. boddingii	MEH-69996	India	MN030341
H. boddingii	MEH-66068	India	MN030343
H. boddingii	MEH-66150	India	MN030344
H. boddingii	**VN869**	**India**	**MT361095**

H. corrugata	He761	China	JQ279606
H. damicornis	URM 84261	Brazil	KC348466
H. denticulata	He1271	China	KF438171
H. duportii	AFTOL-ID 666	United States of America	DQ404386
H. epichlora	He525	China	JQ279549
H. floridea	He529	China	JQ279598
H. fuliginosa	He785	China	JQ279545
H. fulva	He640	China	JQ279565
H. hydnoides	He245	China	JQ279590
H. huangshanensis	He432	China	JQ279533
H. innexa	He446	China	JQ279585
H. intricata	He412	China	JQ279608
H. legeri	He 960	China	KU975469
H. longispora	He101	China	JQ279536
H. luteobadia	He8	China	JQ279569
H. megaspora	He302	China	JQ279553
H. minuscula	He253	China	JQ279546
H. minor	He933	China	JQ279555
H. murina	He569	China	JQ716406
H. muroiana	He405	China	JQ279542
H. nanospora	He475	China	JQ279531
H. ochromarginata	Cui8197	China	JQ279578
H. quercicola	He 373	China	KU975474
H. rheicolor	Cui8317	China	JQ279529
H. rhododendricola	He389	China	JQ279577
H. rigidula	He343	China	JQ279612
H. rubiginosa	He458	China	JQ279580
H. rufomarginata	He1489	China	KU975477
H. separabilis	He267	China	JQ279573
H. spathulata	He685	China	JQ279591
H. sharmae	KD-2017a-66088	India	MK588753
H. subferruginea	CLZhao 3325	China	MK269013
H. tasmanica	He449	China	JQ279582
H. tropica	He98	China	JQ279586
H. ulmicola	He864	China	JQ780065
H. unicolor	He450	China	JQ279552
H. verruculosa	Dai17052	China	MF370594
H. villosa	He537	China	JQ279528
H. xerantica	CLZhao 8356	China	MK404369
H. yasudai	He273	China	JQ279614
Fomitiporia punctata	MUCL 47629	Japan	GU461950

4. RESULTS

4.1. *Taxonomy*

4.1.1. TAXONOMIC KEYS TO THE POLYPOROID FUNGI OF KERALA

Key to the orders

1a. Basidiocarps not showing xanthochroic reaction in KOH; setae or setal hyphae absent.. Polyporales

1b. Basidiocarps generally showing xanthochroic reaction in KOH; setae or setal hyphae present in most species ....Hymenochaetales

Key to the families of Polyporales

1a. Hyphal system monomitic, rarely pseudodimitic 2

1b. Hyphal system dimitic to trimitic 3

2a. Generative hyphae with clamp connections 4

2b. Generative hyphae without clamp connections 5

3a. Metuloids or skeleto cystidia present in hymenium or context 6

3b. Metuloids or skeleto cystidia absent in hymeniuim or context 7

4a. Members causing white rot on wood 8

4b. Members causing brown rot on wood .... Dacryobolaceae

5a. Hymenophore hydnoid to irpicoid ....Irpicaceae

5b. Hymenophore smooth to poroid 9

6a. Basidiomata pileate to stipitate, hymenium smooth, poroid to lamellate 10

6b. Basidiomata effused to effused reflexed, never stipitate, hymenium poroid . ...Steccherinaceae

7a. Hyphal system dimitic, rarely monomitic, but never trimitic; tips of generative hyphae spinulose at pore mouths, with encrustation .... Incrustoporiaceae (*Tyromyces leucomallus*)

7b. Basidiomata dimitic to trimitic, tips of generative hyphae not spinulose at pore mouths.. 11

8a. Basidiomata with a waxy appearance when dry, cystidia often present.................. .... Meruliaceae

8b. Basidiomata without a waxy appearance when dry, cystidia absent........... ....Gelatoporiaceae (*Sebipora aquosa*)

9a. Basidiospores globose, subglobose to ovoid, poroid species ....Meripilaceae (*Rigidoporus*)

9b. Basidiospores cylindrical to cylindrical ellipsoid, mostly corticioid species.......... . ...Phanerochaetaceae

10a. Hymenium lamellate...Panaceae (*Panus*)

10b. Hymenium smooth..Podoscyphaceae

11a. Members causing white rot on wood, annual to perennial, species do not develop crust on pileus with age...Polyporaceae

11b. Members causing brown rot on wood, mostly perennial, species usually develops crust on pileus with age .... Fomitopsidaceae

Key to the genera of Dacrybolaceae

1a. Basidiomata solitary, hyphae metachromatic in cresyl blue, basidiospores 1–2 µm wide ....*Postia* (*P. tephroleuca*)

1b. Basidiomata in imbricate clusters, hyphae non metachromatic in cresyl blue, basidiospores 2–3 µm wide .... *Spongiporus* (*S. floriformis*)

Key to the genera of Irpicaceae

1a. Pileus and hymenophore bright sulphurous yellow, basidiospores broadly ellipsoid; 5–6 × 3–4 µm .... *Flavodon* (*F. flavus*)

1b. Pileus and hymenophore ochraceous brown to brown, basidiospores subcylindrical to cylindrical; 5–7 × 2–3 µm .... *Irpex* (*I. lacteus*)

Key to the genera of Steccherinaceae

1a. Basidiomata resupinate, skeletal hyphae hyaline................ *Butyrea* (*B. luteoalba*)

1b. Basidiomata pileate, skeletal hyphae fuliginous brown ....*Nigroporus*

Key to the species of *Nigroporus*

1a. Pores 10–11 per mm, basidiospores cylindrical ....*N. vinosus*

1b. Pores 7–8 per mm, basidiospores ellipsoid... *N. durus*

Key to the genera of Meruliaceae

1a. Basidiomata pileate, cystidia absent .... *Pappia* (*P. fissilis*)

1b. Basidiomata resupinate to effused reflexed, cystidia often present, encrusted at apex...*Phlebia*

Key to the species of *Phlebia*

1a. Basidiomata bright yellow when fresh 2

1b. Basidiomata white when fresh...*P. unica*

2a. Hymenophore with white mycelia near to the attachment region, cystidia smooth, basidiospores 3–4 µm long ....*P. acerina*

2b. Hymenophore lacking white mycelia, cystidia encrusted, basidiospores 4–6 µm long ....*P. ludoviciana*

Meripilaceae

Key to the species of *Rigidoporus*

1a. Basidiomata resupinate and widely effused, at some part slightly reflexed............ .. .. *R.vinctus*

1b. Basidiomata mostly pileate, sometimes with effused part...................... *R. lineatus*

Key to the genera of Phanerochaetaceae

1a. Blue coloured dendrohyphidia present ....*Terana* (*T. coerulea*)

1b. Blue coloured dendrohyphidia absent 2

2a. Subiculum with parallely arranged agglutinated hyphae....*Phlebiopsis* (*P. crassa*)

2b. Subiculum interwoven, agglutinated hyphae absent……....................... 3

3a. Pore surface and pore tubes brownish black, cystidia absent ....

.... *Bjerkandera* (*B. adusta*)

3b. Pore surface and pore tubes cream to ochraceous, cystidia present ....*Oxychaete* (*O. cervinogilva*)

Panaceae

Key to the species of *Panus*

1a. Gloeocystidia present...*Panus bambusinus*

1b. Gloeocystidia absent.. 2

2a. Basidiomata arising from a pseudosclerotium, pileus surface with radial striations... *P. similis*

2b. Basidiomata not arising from a pseudosclerotium, pileus surface without radial striations... 3

3a. Pileus surface azonate, skeletocystidia present, with wall thickness 4–6 µm, metuloids absent ....*P. neostrigosus*

3b. Pileus surface with concentric zonations, skeletocystidia absent, metuloids present, with wall thickness of 1–1.5 µm 4

4a. Basidiospores 4–6 × 2–3 µm...*P. hookerianus*

4b. Basidiospores 7–9 × 3–5 µm .... *P. velutinus*

Key to the genera of Podoscyphaceae

1a. Hymenophore smooth..*Podoscypha*

1b. Hymenophore poroid to daedaleoid.................................*Abortiporus (A. biennis)*

Key to species of *Podoscypha*

1a. Metuloid cystidia present 2

1b. Metuloid cystidia absent .... *P. thozetii*

2a. Skeletocystidia present .... *P. venustula*

2b. Skeletocystidia absent 3

3a. Basidiomata stipitate 4

3b. Basidiomata sessile .... *P. involuta*

4a. Basidiospores 4–6 × 2–3.5 µm .... *P. petaloides*

4b. Basidiospores 2–3.7 × 1.6–2 µm .... *P. mellissii*

Key to the genera of Polyporaceae

1a. Hymenium gilled .... *Lentinus*

1b. Hymenium poroid to daedaleoid 2

2a. Basidiospores double walled with ornamented inner endosporium covered by smooth outer exosporium, thick walled, with inter wall pillars 3

2b. Basidiospores simple walled, walls thin to thick, without inter wall pillars 4

3a. Basidiospores oblong to ellipsoid, apex truncate .... *Ganoderma*

3b. Basidiospores subglobose to globose, apex non truncate 5

4a. Basidiomata laterally to centrally stipitate 6

4b. Basidiomata resupinate, effused reflexed to pileate 7

5a. Pore surface turning blood red in colour on bruising .... *Sanguinoderma* (*S. rugosum*)

5b. Pore surface not turning blood red in colour on bruising .... *Amauroderma* (*A. fuscoporia*)

6a. Stipe arising from underground sclerotium .... *Lignosus* (*L. rhinocerus*)

6b. Stipe not arising from underground sclerotium 8

7a. Basidiomata completely resupinate .... *Theleporus*

7b. Basidiomata effused reflexed to pileate 9

8a. Setoid elements present on pileus surface, hymenium or dissepiments edges ....

.... *Echinochaete* (*E. ruficeps*)

8b. Setoid elements absent... 10

9a. Basidiospores variably dextrinoid in Melzer's reagent 11

9b. Basidiospores inamyloid in Melzer's reagent.. 12

10a. Skeletal hyphae always present, dextrinoid in Melzer's reagent, hymenial cystidia present .... *Microporellus*

10b. Skeletal hyphae present or absent, if present, not dextrinoid in Melzer's reagent, hymenial cystidia absent 13

11a. Basidiospores truncate .... *Perenniporia*

11b. Basidiospores not truncate.. *Navisporus* (*N. floccosus*)

12a. Hymenophore turning black in KOH; pores hexagonal ....

.... *Pseudofavolus* (*P. tenuis*)

12b. Hymenophore not turning black in KOH; pores round, angular to daedaleoid.....

.... 14

13a. Coralloid dichophytic elements present along dissepiments .... *Microporus*

13b. Coralloid dichophytic elements absent along dissepiments 15

14a. Pileus and hymenophore orange red to cinnabar red .... *Pycnoporus*

14b. Pileus and hymenophore white, cream to straw coloured or light to dark brown .

.... 16

15a. Pileus surface glabrous, with membraneous and wrinkled cuticle, generative hyphae inflated.. *Bresadolia* (*B. uda*)

15b. Pileus surface hairy or with scales, without membraneous cuticle, generative hyphae not inflated 17

16a. Hymenium tubular to daedaleoid...................................... *Cellulariella* (*C. acuta*)

16b. Hymenium poroid, or becoming dentate with age.. 18

17a. Pileus spathulate to dimidiate; surface with small hairs .... *Favolus*

17b. Pileus circular to semi circular; surface squamulose or glabrous.......... *Polyporus*

18a. Reddish or purplish cuticle present on pileus .... *Earliella* (*E. scabrosa*)

18b. Reddish or purplish cuticle absent on pileus 19

19a. Skeletal hyphae subhyaline, ochraceous yellow, yellowish brown to deep golden brown .... *Coriolopsis*

19b. Skeletal hyphae hyaline .... *Pilatotrama* (*P. ljubarskyi*)

20b. Hyphal system trimitic 21

21a. Pileus surface developing an agglutinated crust with age .... *Neofomitella*

21b. Pileus surface not developing an agglutinated crust with age 22

22a. Brown resinous material present in the lumen of skeletal hyphae at pileipellis, parietal crystals absent in the context and hymenium ....

.... *Leiotrametes* (*L. menziesii*)

22b. Brown resinous material absent in the lumen of skeletal hyphae at pileipellis, parietal crystals present or absent in the context and hymenium .... *Trametes*

Key to the species of *Lentinus*

1a. Hymenophore poroid 2

1b. Hymenophore lamellate 3

2a. Pores large, 1–2 per mm, radially elongated .... *L. arcularius*

2b. Pores small, 4–6 per mm, angular .... *L. tricholoma*

3a. Lamellae dichotomously branched 4

3b. Lamellae not dichotomously branched 5

4a. Metuloid cystidia present .... *L. badius*

4b. Metuloid cystidia absent .... *L. dicholamellatus*

5a. Pileus surface without erect squamules, basidiospores 5–7.5 × 2–2.5 µm .... *L. sajor-caju*

5a. Pileus surface squamose-squarrose 6

6a. Basidiomata pale yellowish brown to greyish, basidiospores 7–9 × 2–3 µm......... . ... *L. polychrous*

6b. Basidiomata white, basidiospores subcylindrical, 4.5–6.5 × 1.5–3 µm .... *L. squarrosulus*

Key to the species of *Ganoderma*

1a. Pileus surface laccate 2

1b. Pileus surface non laccate 3

2a. Context cream .... *G. subresinosum*

2b. Context brown, dark brown or umber brown 4

3a. Basidiospores 6–9 µm long.............. Species of *G. applanatum-australe* complex

3b. Basidiospores 9–11 µm long .... *G. australe*

4a. Pileal end cells branched, antler shaped ....*G. multicornum*

4b. Pileal end cells branched or unbranched, when branched not antler shaped......... 5

5a. Pileal end cells regular without lobes and protuberances 6

5b. Pileal end cells irregular with lobes and protuberances.. 7

6a. Encrustations present on pileus end cells... *G. multipileum*

6b. Encrustations absent on pileus end cells..*G. enigmaticum*

7a. Basidiomata substipitate to stipitate, context without melanoid bands 8

7b. Basidiomata sessile to dimidiate, context with melanoid band.......... *G. orbiforme*

8a. Encrustations present on pileus end cells...............................*G. keralense sp. nov.*

8b. Encrustations absent on pileus end cells... 9

9a. Pileal end cells almost regularly clavate, with infrequent lobes or branches ....
. ...*G. tropicum*

9b. Pileal end cells versiform, with many lobes and protuberances.............................
. ...*G. multiplicatum*

Key to the species of *Theleporus*

1a. Dendrohyphidia present, basidiospores subglobose to broadly ellipsoid, 3.5–4 × 2–3 µm.. *T. minisporus*

1b. Dendrohyphidia absent, basidiospores cylindrical, 2.5–4 × 1–1.5 µm....................

....*T. venezuelicus*

Key to the species of *Microporellus*

1a. Basidiomata violaceous grey, with alternating greyish brown to brownish black concentric zones; encrusted cystidia present .... *M. violaceocinerascens*

1b. Basidiomata cream to butter yellow, with greyish brown to black concentric zones; cystidia absent .... *M. obovatus*

Key to the species of *Perenniporia*

1a. Basidiomata usually resupinate to sometimes effused reflexed ...*P. medulla-panis*

1b. Basidiomata pileate.. 2

2a. Basidiospores large, 10–16 × 5–8 µm ....*P. ochroleuca*

2b. Basidiospores comparatively small, 3–4.5 × 1.5–3 µm.......................*P. decurrata*

Key to the species of *Microporus*

1a. Basidiomata infundibuliform; basidiospores 5–7 × 1.5–2 µm .... *M. xanthopus*

1b. Basidiomata flabelliform; basidiospores 3–5 × 1.5–2 µm........................*M. affinis*

Key to the species of *Pycnoporus*

1a. Basidiomata bright orange red, basidiospores 4–5 × 2–2.5 µm.........*P. sanguineus*

1b. Basidiomata cinnabar yellow to apricot orange, basidiospores 5–7.5 × 2–3 µm ....

....*P. cinnabarinus*

Key to the species of *Favolus*

1a. Basidiocarps white, soft and delicate; basidiospores 7–11 × 2–2.5 µm ....

.... *F. tenuiculus*

1b. Basidiocarps ochraceous yellow to orange; basidiospores 6–8 × 2–3 µm ....

. ... *F. grammocephalus*

Key to the species of *Polyporus*

1a. Pileus reddish brown to brownish black; pores 8–11 per mm............ *P. dictyopus*

1b. Pileus ochraceous yellow, black towards attachment part; pores 4–6 per mm ....

.. ..*P. leprieurii*

Key to the species of *Coriolopsis*

1a. Basidiomata cinnamon brown to dark brown; context with distinct black line below tomentum; dendroid hyphae present .... *C. caperata*

1b. Basidiomata ochraceous; context without black line below tomentum, dendroid hyphae absent 2

2a. Skeletal hyphae hyaline..*C. telfarii*

2b. Skeletal hyphae brown .... *C. occidentalis*

Key to the species of *Neofomitella*

1a. Basidiomata soft and coriaceous when fresh, pileus surface creamish white.......... . ...*N. guangxiensis*

1a. Basidiomata hard and woody when fresh, pileus surface yellowish brown to brown 2

2a. Basidiospores 2.5–3 × 1.5–2 µm, ovoid to broadly ellipsoid .... *N. fumosipora*

2b. Basidiospores 3.5–5 × 2–3 µm, ellipsoid .... *N. rhodophaea*

Key to the species of *Trametes*

1a. Pores hexagonal .... *T. apiaria*

1b. Pores round to angular 2

2a. Basidiomata centrally to laterally stipitate or substipitate 3

2b. Basidiomata sessile to dimidiate.. 4

3a. Pores angular to radially elongated... *T. gibbosa*

3b. Pores round ....*T. vernicipes*

4a. Context and pore surface yellowish... *T. ochracea*

4b. Context and pore surface white to cream 5

5a. Pileus glabrous.. 6

5b. Pileus pubescent to hirsute, villose or tomentose 7

6a. Hymenium daedaleoid ....*T. flavida*

6b. Hymenium poroid.. 8

7a. Pores large, 2–4 per mm 9

7b. Pores small, 5–7 per mm 10

8a. Basidiospores ellipsoid, 4.5–5.5 × 2.5–3 µm; pores 5–8 per mm............ *T. varians*

8b. Basidiospores cylindrical to subcylindrical, 3.5–6 × 2–2.5 µm, pores 3–4 per mm
. ... *T. marianna*

9a. Basidiospores cylindrical, 1.5–2 µm wide..*T. pubescens*

9b. Basidiospores ovoid-ellipsoid, 2–4 µm wide ....*T. meyenii*

10a. Pileus surface white to cream, basidiospores broadly ellipsoid to ellipsoid..........
. ... *T. villosa*

10b. Pileus surface golden yellow to yellow brown, basidiospores cylindrical ....

....*T. hirsuta*

Key to the genera of Fomitopsidaceae

1a. Hymenophore irregular, partly poroid, sinuous, labyrinthine to daedaleoid 2

1b. Hymenophore regular, poroid.. 3

2a. Context brown...*Daedalea*

2b. Context rose, lilac, pinkish brown .... *Rhodofomitopsis* (*R. feei*)

3a. Sclerified generative hyphae present ....*Pilatoporus* (*P. ostreiformis*)

3b. Sclerified generative hyphae absent 4

4a. Context purplish brown, greyish brown to dark brown*Rubellofomes* (*R. cystidiatus*)

4b. Context white, cream, straw coloured to pale brown 5

5a. Basidia with basal clamp connections .... *Fomitopsis*

5b. Basidia without basal clamp connections... 6

6a. Skeletal hyphae weakly to strongly metachromatic in cresyl blue, cystidioles absent..*Antrodia* (*A. albida*)

6b. Skeletal hyphae non metachromatic in cresyl blue, cystidioles often present, with apical encrustation ....*Neoantrodia* (*N. serialis*)

Key to the species of *Daedalea*

1a. Pileus with distinct crust, surface glabrous................................*Daedalea dochmia*

2a. Pileus without crust, surface hispid to hirsute ....*Daedalea radiata*

Key to the species of *Fomitopsis*

1a. Pores 2–4 per mm, hyphal system trimitic...*F. palustris*

1b. Pores 7–10 per mm, hyphal system dimitic....................................... *F. caribensis*

Key to the families of Hymenochaetales

1a. Basidiocarps turning black in KOH; setae present in many species; cystidia absent... Hymenochaetaceae

1b. Basidiocarps not turning black in KOH; setae absent; cystidia present or absent .

.... 2

2a. Basidiocarps growing on ground, basidiospores thin walled............................. .. ..Rickenellaceae (*Cotylidia pannosa*)

2b. Basidiocarps growing on wood, basidiospores thin to thick walled.................... 16

3a. Species with trametoid habit, generative hyphae without clamp connections......... ....Oxyporaceae (*O. ravidus*)

3b. Species effused reflexed, not trametoid, generative hyphae with clamp connections.. Schizoporaceae

Key to the genera of Hymenochaetaceae

1a. Hymenium smooth... 2

1b. Hymenium poroid... 3

2a. Hymenial setae encrusted .... *Hydnoporia* (*H. tabacina*)

2b. Hymenial setae not encrusted .... *Hymenochaete*

3a. Hyphal system monomitic 4

3b. Hyphal system dimitic 5

4a. Basidiocarps centrally stipitate, growing mostly on soil ....*Coltricia*

4b. Basidiocarps pileate to effused reflexed, growing on live trees or dead wood 6

5a. Pileus covered with crust, basidiospores fairly thick walled, setae present or absent, when present, arising from subhymenium... 7

5b. Pileus not covered with crust, basidiospores thin walled, setae present, arising from tramal hyphae..*Fuscoporia* (*F. rhabarbarina*)

6a. Setae and setal hyphae absent, context with a distinct black line, occur mostly on live trees..*Phylloporia*

6b. Setae or setal hyphae present, context without distinct black line, occur on both live trees and dead woods 8

7a. Hymenial setae absent...*Fulvifomes* (*F. cesatii*)

7b. Hymenial setae present 9

8a. Basidiomata always pileate; context possesses distinct black zone; basidiospores less than 4 µm long..*Cyclomyces* (*C. setiporus*)

8b. Basidiomata resupinate to pileate; context without black zones; basidiospores up to 12 µm long...*Inonotus*

9a. Hymenial setae 5–8 µm wide, basidiospores subglobose to ellipsoid, hyaline to yellowish brown..*Phellinus*

9b. Hymenial setae 4–5 µm wide, basidiospores globose, yellowish to light brown....

....*Tropicoporus* (*T. dependens*)

Key to the species of *Hymenochaete*

1a. Basidiomata stipitate; hymenial setae 30–72 long..............................*H. boddingii*

1b. Basidiomata effused reflexed; hymenial setae 20–56 long.......*H. ochromarginata*

Key to the species of *Coltricia*

1a. Pileus 15–45 mm diameter, up to 3 mm thick, velutinate, shiny, basidiospores 5–8 × 4–5 µm..*C. cinnamomea*)

1b. Pileus 40–70 mm diameter, up to 1 cm thick, weakly pubescent, not shiny, basidiospores 5–6 × 3–4 µm..*C. pyrophila*

Key to the species of *Phylloporia*

1a. Basidiocarps solitary..*P. weberiana*

1b. Basidiocarps usually in imbricate clusters.. 2

2a. Basidiomata perennial; many pilei get fused to form compound fruit bodies......... . ...*P. pectinata*

2b. Basidiomata annual; pilei not fused to form compound fruit bodies..................... 3

3a. Pileus often flabelliform, attached with a discoid base, basidiospores 3–4.5 × 2–2.5 µm, ellipsoid to ovoid..*P. gabonensis*

3b. Pileus mostly semicircular, laterally attached with a distinct region, but not with discoid base, basidiospores 2.5–3 × 2–2.5 µm, subglobose ....*P. chrysites*

Key to the species of *Inonotus*

1a. Species with setal hyphae 2

1b. Species without setal hyphae 3

2a. Basidiomata perennial, large and robust...*I. pachyphloeus*

2b. Basidiomata annual, medium sized ....*I. patouillardii*

3a. Basidiospores yellowish brown 4

3b. Basidiospores hyaline .... *I. tabacinus*

4a. Pileus surface glabrous ....*I. luteoumbrinus*

4b. Pileus surface with tuft of fasciculate hairs ....*I. subhispidus*

Key to the species of *Phellinus*

1a. Basidiomata resupinate to effused reflexed 2

1b. Basidiomata pileate.. 3

2a. Hymenial setae present ....*P. ferrugineo-velutinus*

2b. Hymenial setae absent 4

3a. Pileus covered with distinct crust 5

3b. Pileus without crust... 6

4a. Basidiospores 5–6.5 × 4–5 µm, weakly dextrinoid ....*P. allardii*

4b. Basidiospores 3–4 × 2.5–3 µm, inamyloid.....................................*P. caryophylli*

5a. Pores small, 7–11 per mm..7

5b. Pores comparatively large, 4–6 per mm ....*P. rimosus*

6a. Hymenial setae present .... *P. gilvus*

6b. Hymenial setae absent ....*P. fastuosus*

7a. Setal hyphae present ....*P. hoehnelii*

8a. Setal hyphae absent..*P. nilgheriensis*

Key to the genera of Schizoporaceae

1a. Generative hyphae possesses clamp connections; basidiospores thin walled ....
. ... *Schizopora* (*S. paradoxa*)

1b. Generative hyphae lacking clamp connections; basidiospores thick walled...........
. ... *Leucophellinus* (*L. hobsonii*)

Family- *Insertae sedis*

Key to the species of *Trichaptum*

1a. Basidiospores cylindrical to weakly allantoid ....*T. biforme*

1b. Basidiospores ellipsoid to broadly ellipsoid.................................... *T. byssogenum*

4.2. TAXONOMIC DESCRIPTIONS

Postia Fr.

Basidiomata annual, mostly soft to corky, pileate. Hymenophore poroid, pores angular to oblique. Hyphal system monomitic to dimitic, generative hyphae hyaline, metachromatic or non metachromatic in cresyl blue, thin to thick walled, with clamp connections. Basidia clavate, 4 sterigmate. Basidiospores ellipsoid or allantoid to cylindrical, inamyloid to weakly amyloid in Melzer’s reagent. Genus produces brown rot on wood.

Postia tephroleuca (Fr.) Jülich, Persoonia 11 (4): 424 (1982)

Basionym: *Polyporus tephroleucus* Fr., Syst. mycol. (Lundae) 1: 360 (1821)
Synonyms:
Boletus tephroleucus (Fr.) Spreng., Syst. veg., Edn 16 4 (1): 278 (1827)
Polyporus elatinus Berk., Hooker's J. Bot. Kew Gard. Misc. 6: 140 (1854)
Bjerkandera tephroleuca (Fr.) P. Karst., Bidr. Känn. Finl. Nat. Folk 37: 35 (1882)

Leptoporus tephroleucus (Fr.) Quél., Enchir. fung. (Paris): 176 (1886)
Bjerkandera melina P. Karst., Meddn Soc. Fauna Flora fenn. 14: 80 (1887)
Polyporus tokyoensis Lloyd [as '*tokyvensis*'], Mycol. Writ. 4 (Syn. Apus): 302 (1915)
Polyporus tephroleucus var. *scruposus* Lloyd, Mycol. Writ. 6 (Letter 61): 885 (1919)
Polyporus linearisporus Velen., České Houby 4-5: 654 (1922)
Piptoporus elatinus (Berk.) Teng, Chung-kuo Ti Chen-chun, [Fungi of China]: 762 (1963)
Tyromyces elatinus (Berk.) S. Ahmad, Basidiomyc. W. Pakist.: 97 (1972)
Spongiporus tephroleucus (Fr.) A. David, Bull. mens. Soc. linn. Lyon 49 (1): 37 (1980)
Oligoporus tephroleucus (Fr.) Gilb. & Ryvarden, Mycotaxon 22 (2): 365 (1985)

FIGURE 2

Basidiomata annual, small sized, soft when fresh, light in weight, slightly hard and brittle on drying, pileate. **Pileus** 25–35 mm long, 45–80 mm thick, sessile, weakly convex, semicircular to circular, zonations absent, fibrillar hairs present, mainly towards the attachment porion, surface dull white when fresh, pale brown to grayish brown on bruising. **Hymenophore** poroid. **Pores** 3–5 per mm, angular, mostly oblique, lacerate, surface dull white, pore tube 4–5 mm long, non stratified, grayish white. **Context** 1–2 mm thick, white, homogenous. **Odour** not distinctive. **Spore print** not observed.

Basidiospores 4–5 × 1–2 µm, Q=2.3–5.3, Q_m=3.4, allantoid, hyaline, guttulate, usually with two large guttules at either ends, thin walled, smooth, inamyloid in Melzer's reagent. **Basidia** 10–14 × 4–5 µm, clavate, 4 sterigmate, with basal clamp connections. **Cystidia** absent. **Hymenial trama** interwoven and monomitic. Generative hyphae 2–4 µm wide, hyaline, branched, thin to mostly thick walled (1–2 µm), nodose-septate at some regions, with frequent clamp connections, weakly metachromatic in cresyl blue. Skeletal hyphae and skeleto ligative hyphae not observed. **Pileal trama** interwoven and monomitic. Generative hyphae 2–5 µm wide, hyaline, branched, thin to mostly thick walled (1–2 µm), weakly metachromatic in cresyl blue. Skeletal hyphae and skeleto ligative hyphae not observed. **Pileipellis** loosely interwoven and agglutinated made of thin walled, hyaline hyphae which are 2–4 µm wide.

Specimen examined: India. Kerala State: Idukki district, Munnar, on dead branch (unidentified), 26 October 2015, Vinjusha N., ZGCVN252, ZGCVN253; Wayanad district, Chembra Peak, on fallen tree log (*Cinnamomum verum*), 16 November 2018, Vinjusha N., ZGCVN756.

Comments: *Postia* is a genus closely related to *Oligoporus* and *Tyromyces*. The metachromatic reaction of hyphae in cresyl blue separate it from *Oligoporus* and *Tyromyces* (Pildain & Rajchenberg 2013). Generative hyphae of present collections are weakly metachromatic.

As per the description given by Núñez & Ryvarden (2001), *P. tephroleuca* (treated as *Oligoporus tephroleucus* (Fr.) Gilb. & Ryvarden) produce annual, sessile or effused reflexed fruit bodies with lacerate to finely lacerate, angular pores. The present specimen also produces annual, sessile fruit bodies, and the pores appear lacerate in most regions. According to Núñez & Ryvarden (2001), hyphal system of *P. tephroleuca* is monomitic, with thin to moderately thick walled generative hyphae having abundant nodose septa. Some thin walled hyphae of the species are brightly stained in phloxine. Present collections also have monomitic hyphal system with nodose septate generative hyphae and as in the description, some hyphae were brightly stained in phloxine. Thus all these features correctly place the species within the available descriptions of *P. tephroleuca*. The specimen shows some similarities with *Tyromyces chioneus*. According to Ryvarden & Johansen (1980), *T. chioneus* possess a dimitic hyphal system with unbranched skeletal hyphae. However, in the present specimen, hyphal system is monomitic.

Postia tephroleuca has occurrence in Asia and Europe (Ryvarden & Gilbertson 1994; Núñez & Ryvarden 2001). This species has not been reported from Kerala so far.

Spongiporus Murrill

Basidiomata annual, mostly imbricate, coriaceous to hard, effused reflexed to pileate. Pileus sessile to dimidiate, semicircular or flabellifom, zonations present or absent, cream, tan, ochraceous to brown. Hymenophore poroid. Context white, cream to light brown. Hyphal system monomitic, generative hyphae hyaline, thin to thick walled, with clamp connections. Cystidia absent. Basidiospores cylindrical to allantoid, hyaline, smooth, thin walled, inamyloid or rarely amyloid in Melzer’s reagent. Members cause brown rot on wood.

Spongiporus floriformis (Quél.) Zmitr., Folia Cryptogamica Petropolitana (Sankt-Peterburg) 6: 90 (2018)

Basionym: *Polyporus floriformis* Quél., in Bresadola, Fung. trident. 1 (1): 61 (1884)
Synonyms:
Bjerkandera subsericella P. Karst., Meddn Soc. Fauna Flora fenn. 11: 136 (1884)
Polyporus subsericellus (P. Karst.) Sacc., Syll. fung. (Abellini) 6: 122 (1888)
Coriolus floriformis (Quél.) Quél., Fl. mycol. France (Paris): 390 (1888)
Tyromyces cinchonensis Murrill, Mycologia 2 (4): 192 (1910)
Polyporus cinchonensis (Murrill) Sacc. & Trotter, Syll. fung. (Abellini) 21: 281 (1912)
Polystictus floriformis (Quél.) Bigeard & H. Guill., Fl. Champ. Supér. France (Chalon-sur-Saône) 2: 369 (1913)
Cladomeris floriformis (Quél.) Lázaro Ibiza, Revta R. Acad. Cienc. exact. fis. nat. Madr. 14 (12): 862 (1916)
Polyporus tabulosus Velen., České Houby 4-5: 650 (1922)
Leptoporus albellus subsp. *floriformis* (Quél.) Bourdot & Galzin, Bull. trimest. Soc. mycol. Fr. 41 (1): 127 (1925)
Agaricus floriformis (Quél.) E.H.L. Krause, Basidiomycetum Rostochiensium, Suppl. 5: 164 (1933)
Leptoporus floriformis f. subterranea Pilát, in Kavina & Pilát, Atlas Champ. l'Europe, III, Polyporaceae (Praha) 1: 209 (1938)
Tyromyces floriformis (Quél.) Bondartsev & Singer, Annls mycol. 39 (1): 52 (1941)
Tyromyces zonatulus (Lloyd) Imazeki, Mycol. Fl. Japan, Basidiomycetes 2 (4): 280 (1955)
Postia floriformis (Quél.) Jülich, Persoonia 11 (4): 423 (1982)
Oligoporus floriformis (Quél.) Gilb. & Ryvarden, Mycotaxon 22 (2): 365 (1985)

FIGURE 3

Basidiomata annual, small to medium, found in clusters, slightly coriaceous and spongy when fresh, becoming hard on drying, pileate. **Pileus 1**5–30 mm long, 3–6 mm thick, laterally attached with a distinct region of attachment, few fruit bodies sessile, applanate, semicircular to flabelliform, incurved on drying, many fruit bodies fused at the attachment part, glabrous, minutely pubescent at some region, creamish white with pale brown zones when fresh, more brownish when mature, surface appear as concentrically zoned due to the colour patterns, margin even to slightly wavy. **Hymenophore** poroid, pores minute, 6–8 per mm, absent near margin, angular to irregular, creamish white, pale brown on bruising, pore tubes 2–3 mm long, non stratified, white when fresh, cream on bruising. **Context** 1–2 mm thick, white, homogenous. **Odour** not distinctive. **Spore print** not observed.

Basidiospores 3–4 × 2–2.5 µm, Q=1.5–1.6, Q_m=1.83, ellipsoid to broadly ellipsoid, hyaline, guttulate, usually with one or two large guttules, thin walled, smooth, inamyloid in Melzer's reagent. **Basidia** 12–30 × 4–5 µm, clavate, four sterigmate, with basal clamp connections. **Cystidia** and other sterile structures absent. **Hymenial trama** loosely intertwined and monomitic. Generative hyphae 2–4 µm wide, hyaline, branched, thin to mostly thick walled (1–2 µm), with frequent clamp connections. Skeletal hyphae and skeleto ligative hyphae not observed. **Pileal trama** interwoven and monomitic. Generative hyphae 2–5 µm wide, hyaline, branched, thin to mostly thick walled (1–2 µm), with clamp connections. Skeletal hyphae and skeleto ligative hyphae not observed. **Pileipellis** an irregular cutis with scattered short erect agglutinated hyphal patches that are hyaline, up to 20 µm long, each hyphae 2–5 µm wide, hyaline, thin to thick walled .

Specimen examined: India. Kerala State: Kottayam district, Vagamon, Pine valley, on rotten wood of *Pinus* species, 25 October 15, Vinjusha N, ZGCVN258.

Comments: Present specimen shows some resemblances with *Postia tephroleuca* (Fr.) Jülich in morphology. Fruit bodies of *P. tephroleuca* are always sessile or effused reflexed (Núñez & Ryvarden 2001). However, fruit bodies of present collection have a distinct point of attachment. Moreover, basidiospores of *P. tephroleuca* are longer and narrower (4.5–6 × 1–1.5 µm) than that of our collection (3–4 × 2–2.5 µm). According to the description from the isotype (Lowe 1975), *S. floriformis* produces conchate to often spathulate pileus with a central stem like point of attachment. Ryvarden & Melo (2014) describes the species as petal like, sessile or effused reflexed. According to Lowe (1975), trama of the fruit body contains some gloeopherous hyphae, however such hyphae were not observed in the present collection.

The species has distribution in Asia, Northern to Southern Europe, circumpolar in the boreal conifer zone. So far, there are no reports of this species from India.

Flavodon Ryvarden

Basidiomata annual, often foung in clusters, effused reflexed to pileate. Pileus sessile, semicircular, concentrically zonate, adpressed tomentose, yellowish to ochraceous-grey, brown in KOH. Hymenophore poroid to hydnoid or irpicoid, pores mostly angular, surface bright sulphurous yellow, pore tube concolorous with pore surface. Context cream, homogenous. Hyphal system dimitic, generative hyphae hyaline, thin walled, without clamp connections. Skeletal hyphae hyaline to yellowish, thick walled. Cystidia present, arising from ends of skeletal hyphae, narrowly to broadly cylindrical, hyaline to pale coloured, thick walled, encrusted at the tip. Basidia narrowly clavate, 2–4 sterigmate. Basidiospores broadly ellipsoid, hyaline, smooth, inamyloid in Melzer's reagent. The genus cause white rot on wood.

Flavodon flavus (Klotzsch) Ryvarden, Norw. Jl Bot. 20 (1): 3 (1973)

Basionym: *Irpex flavus* Klotzsch, Linnaea 8 (4): 488 (1833)
Synonyms:
Xylodon flavus (Klotzsch) Kuntze, Revis. gen. pl. (Leipzig) 3 (3): 541 (1898)
Polyporus crenatoporus Rostr., Bot. Tidsskr. 24: 360 (1902)
Coriolopsis melleoflava Murrill, Bull. Torrey bot. Club 35: 393 (1908)
Polystictus melleoflavus (Murrill) Sacc. & Trotter, Syll. fung. (Abellini) 21: 324 (1912)
Daedalea rhodesica Van der Byl, S. Afr. J. Sci. 22: 167 (1925)
Hirschioporus flavus (Klotzsch) Teng, Chung-kuo Ti Chen-chun, [Fungi of China]: 761 (1963)

FIGURE 4

Basidiomata annual, medium sized coriaceous, becoming harder on drying, light in weight, initially appressed on the substratum, then turning effused reflexed, to distintly pileate. **Pileus** 15–35 mm wide, 3–7 mm thick, sessile, applanate, semicircular, greyish brown near the attachment region, greyish to sulphur yellow towards the margin, brown in KOH, with sulcate concentric rings, velvety to touch, velutinous, highly tomentose at the region of attachment and near sulcations, decreases towards margin, margin even, thick, with small irregular yellowish outgrowths. **Hymenophore** poroid to irpicoid. Pores when present large, initially 0.3–1 mm wide, later becoming irpicoid, less toothed towards margin, surface sulphur yellow, yellow colour fades and turns brownish on drying, dark brown in KOH, pore tubes 1–3 mm long, concolourous with pore surface, homogenous.

Context 2–6 mm, cream to light brown, turning darker on bruising. **Odour** not distinctive. **Spore print** not observed.

Basidiospores 5–6 × 3–4 µm, Q=1.5–1.6, Q_m=1.2, ellipsoid, smooth, thin walled, with guttulate contents, inamyloid in Melzer's reagent. **Basidia** 25–35 × 4–5 µm, narrowly clavate, 2–4 sterigmate. **Cystidia** present in the hymenophore, 20–70 × 4–6 µm, elongated, cylindical to flexuous, hyaline, encrusted at the tip, thick walled (1–1.5 µm). **Hymenial trama** highly interwoven. Generative hyphae 2–4 µm, hyaline, smooth, thin to slightly thick walled (up to 1 µm), highly branched, without clamp connections. Skeletal hyphae 2–5 µm wide, mostly light sulphur yellow, some hyaline, thick walled (1 µm), branched, septations not observed. Skeleto ligative hyphae not observed. **Pileal trama** interwoven. Generative hyphae 2–4 µm, hyaline, thin to slightly thick walled, highly branched, without clamp connections. Skeletal hyphae 2–5 µm wide, sulphur yellow to hyaline, thick walled (1 µm), branched, septations not observed. Skeleto ligative hyphae not observed. **Pileipellis** composed of hyphae that are interwoven at the base and aggregating to short erect trichodermial patches with obtuse apex, hyphae 2–4 µm wide, hyaline to yellow, slightly thick walled (up to 1 µm).

Specimens examined: India. Kerala State: Kozhikode district, Eranjipalam, on dead wood stump (unidentified), 20 July 2015, Vinjusha N., ZGCVN61; Chelapram, 15 September 2015, on *Erythrina variegata*, Vinjusha N., ZGCVN184; Pokkunnu, ZGC campus, on dead branches of *Ficus religiosa*, 27 september 2019, Vinjusha N., ZGCVN907; Palakkad district, Pattambi, on dead branch of *Anacardium occidentale*, 01 October 2018, Vinjusha N., ZGCVN730.

Comments: Morphological characters of the present collection properly match with the descriptions of *Flavodon flavus* such as Ryvarden & Johansen (1980), Ryvarden & Gilbertson (1993) and Núñez & Ryvarden (2001). The bright sulphur yellow coloured hymenium is a peculiar character of this species. The specimen resembles *Irpex lacteus* (Fr.) Fr., in having irpicoid hymenium, and encrusted cystidia. However, hymenial surface of *Irpex lacteus* is white cream or tan, and never yellowish (Ryvarden & Gilbertson 1993; Bernicchia & Gorjón 2010). Moreover, *I.*

lacteus produces oblong to cylindrical basidiospores (Ryvarden & Gilbertson 1993), whereas, present collection produces ellipsoid basidiospores. The dried collections of the specimen also show similarity with *Oxychaete cervinogilva* (Jungh.) Miettinen. However, the latter species produces monomitic hyphal system.

Flavodon flavus has a distribution in Australia, tropical Africa, India, Philippines, New Zealand and Pakistan (Leelavathy & Ganesh 2000). From Kerala, this species has been documented by Sankaran & Florence (1995), Florence & Yesodharan (1997, 2000), Leelavathy & Ganesh (2000) and Mohanan (2011).

Irpex Fr.

Basidiomata annual, coriaceous to hard, resupinate, effused-reflexed to pileate. Pileus when present, sessile, semicircular to flabelliform, applanate, concentrically zonate, tomentose to hirsute, ochre to light brown. Hymenophore poroid to hydnoid, mostly irpicoid, surface light coloured. Hyphal system dimitic, generative hyphae hyaline, thin to slightly thick walled, without clamp connections. Skeletal hyphae hyaline, thick walled. Cystidia present, clavate to cylindrical, hyaline, thick walled, smooth to encrusted. Basidiospores cylindrical, hyaline, thin walled, inamyloid in Melzer's reagent. Members cause white rot on wood.

Irpex lacteus (Fr.) Fr., Elench. fung. (Greifswald) 1: 142 (1828)

Basionym*: Sistotrema lacteum* Fr., Observ. mycol. (Havniae) 2: 266 (1818)
Synonyms:
Boletus cinerascens Schwein., Schr. naturf. Ges. Leipzig 1: 99 [73 of repr.] (1822)
Hydnum lacteum (Fr.) Fr., Syst. mycol. (Lundae) 2 (2): 412 (1823)
Irpex cinerascens (Schwein.) Schwein., Trans. Am. phil. Soc., New Series 4 (2): 164 (1832)
Irpex hirsutus Kalchbr., Értek. termész. Köréb. Magy. tudom. Akad. 8: 17 (1878)
Irpex bresadolae Schulzer, Hedwigia 24 (4): 146 (1885)
Polystictus cinerascens (Schwein.) Cooke, Grevillea 14 (no. 71): 86 (1886)
Poria cincinnati Berk. ex Cooke, Grevillea 15 (no. 73): 27 (1886)
Polystictus bresadolae (Schulzer) Sacc., Syll. fung. (Abellini) 6: 257 (1888)
Daedalea diabolica Speg., Boln Acad. nac. Cienc. Córdoba 11 (4): 441 (1889)
Xylodon hirsutus (Kalchbr.) Kuntze, Revis. gen. pl. (Leipzig) 3 (3): 541 (1898)
Xylodon lacteus (Fr.) Kuntze, Revis. gen. pl. (Leipzig) 3 (3): 541 (1898)
Xylodon bresadolae (Schulzer) Kuntze, Revis. gen. pl. (Leipzig) 3 (3): 541 (1898)
*Coriolus lacteus (*Fr.) Pat., Essai Tax. Hyménomyc. (Lons-le-Saunier): 94 (1900)
Irpiciporus lacteus (Fr.) Murrill, N. Amer. Fl. (New York) 9 (1): 15 (1907)
Irpex diabolicus (Speg.) Bres., in Spegazzini, Boln Acad. nac. Cienc. Córdoba 23 (3-4): 428 (1918)
Trametes lactea (Fr.) Pilát, Atlas Champ. l'Europe, III, Polyporaceae (Praha) 1: 322 (1940)
Steccherinum lacteum (Fr.) Krieglst., Beitr. Kenntn. Pilze Mitteleur. 12: 45 (1999)

FIGURE 5

Basidiomata annual, medium sized, coriaceous when fresh, hard on drying, most part appressed on the substratum, forming small to large patches up to 110 mm long and 2–4 mm thick, but edges of the fruit body slightly extending outwards as flaps from the region of attachment forming small pilei. **Pileus** sessile, semicircular, concentrically zontate, applanate, adpressed velutinous to villose, lesser towards margin, ochraceous to brown, margin sharp, even to slightly wavy, incurved on drying. **Hymenophore** irpicoid, less toothed towards margin, where it is replaced by minute hairs, light yellowish brown to brown, margin paler. **Context** light yellow, thin, up to 1 mm, homogenous. **Odour** not distinctive. **Spore prints** not observed.

Basidiospores 5–7 × 2–3 µm, Q=2–3, Q_m=2.5, cylindrical to subcylindrical, hyaline, smooth, thin walled, with guttulate contents, inamyloid in Melzer's reagent. **Basidia** 25–30 × 4–5 µm, narrowly clavate, 2–4 sterigmate. **Cystidia** 28–84 × 4–6 µm, elongtaed, cylindical to flexuous, hyaline, thick walled (1–1.5 µm), encrusted at the tip. **Hymenial trama** highly interwoven and dimitic. Generative hyphae 2–4 µm, hyaline, smooth, thin to thick walled (up to 1 µm), highly branched, without clamp connections. Skeletal hyphae 2–5 µm wide, hyaline, smooth, thick walled (1µm), branched. Skeleto ligative hyphae not observed. **Pileal trama** interwoven. Generative hyphae 2–4 µm, hyaline, smooth, thin to thick walled (up to 1 µm), highly branched, without clamp connections. Skeletal hyphae 2–5 µm wide, hyaline, smooth, thick walled (1µm), branched. Skeleto ligative hyphae not observed. **Pileipellis** composed of hyphae that are interwoven at the base and aggregating to short trichodermal patches, each hyphae 2–5 µm wide, slightly thick to thick walled, with obtuse apex.

Specimen examined: India. Kerala State: Kozhikode district, location unknown, on dead branch, collecter and collection date unknown, ZGCVN2; Pokkunnu, on dead branch of *Polyalthia longifolia*, 06 April 2015, Arun Kumar T. K., ZGCVN319; Kannur district, Aralam, on dead branch (unidentified), 09 January 2016, Vijisha P., ZGCVN293; Neeliyarkottam, on dead branch (unidentified), Vinjusha N., 15 July 2016, ZGCVN365; Malappuram district, Nilambur, KRFI campus, on dead branch (unidentified), 17 November 2016, Vinjusha N., ZGCVN478.

Comments: Morphology of the present collections agrees well with the descriptions of *I. lacteus* by Ryvarden & Gilbertson (1993), Núñez & Ryvarden (2001), and Bernicchia & Gorjón **(**2010). The collections show resemblance with species of *Steccherinum* Gray by having irpicoid to hydnoid hymenium and encrusted cystidia. However, species of *Steccherinum* are separated from the present collection in having clamp connections on hyphae (according to the description by Maas Geesteranus 1974).

The species has a cosmopolitan distribution, and occurs on dead woods of different hardwood genera (Ryvarden & Gilbertson 1993). *Irpex lacteus* has been reported from Kerala by Leelavathy & Ganesh (2000) and Mohanan (2011).

Butyrea Miettinen

Basidiocarps annual, resupinate, adpressed on the substratum, cream to pale orange, pileus and context not distinct. Hymenophore poroid, pores angular, pore surface creamish white to pinkisk cream. Hyphal system dimitic, generative hyphae hyaline, thin walled, with clamp connections. Skeletal hyphae hyaline, thick walled. Cystidia present, clavate to ventricose, hyaline, thick walled, encrusted, encrustations easily dissolved in KOH. Gloeocystidia present, of various shapes like narrowly clavate, flexuose, cylindrical elongated, narrowly utriform to catenulate like, hyaline, smooth, thin walled. Basidia broadly clavate to clavate, 4 sterigmate. Basidiospores cylindrical, hyaline, smooth, thin walled, inamyloid in Melzer's reagent. Genus causes white rot on wood.

Butyrea luteoalba (P. Karst.) Miettinen, in Miettinen & Ryvarden, Ann. bot. fenn. 53 (3-4): 161 (2016)

Basionym: *Physisporus luteoalbus* P. Karst., Revue mycol., Toulouse 9 (no. 33): 10 (1887)
Synonyms:
Poria luteoalba (P. Karst.) Sacc., Syll. fung. (Abellini) 6: 299 (1888)
Poria calcea f. *luteoalba* (P. Karst.) Bourdot & Galzin, Bull. trimest. Soc. mycol. Fr. 41 (2): 233 (1925)
Chaetoporellus luteoalbus (P. Karst.) Bondartsev [as *'luteo-albus'*], Trut. Grib Evrop. Chasti SSSR Kavkaza [Bracket Fungi Europ. U.S.S.R. Caucasus] (Moscow-Leningrad): 37 (1953)
Chaetoporus luteoalbus (P. Karst.) M.P. Christ., Dansk bot. Ark. 19 (no. 2): 353 (1960)
Junghuhnia luteoalba (P. Karst.) Ryvarden, Persoonia 7 (1): 18 (1972)
Steccherinum luteoalbum (P. Karst.) Vesterh., in Knudsen & Hansen, Nordic Jl Bot. 16 (2): 216 (1996)
Irpex luteoalbus (P. Karst.) Kotir. & Saaren., Polish Bot. J. 47 (2): 105 (2002)

FIGURE 6

Basidiomata annual, resupinate, initially as small irregular patches on the host, getting coalesced and becoming larger basidiomata, up to 120 mm long, 2 mm thick, margin irregular. **Hymenophore** poroid. **Pores** 7–9 per mm, angular, irregular, not prominent along the margin, surface creamish white when fresh, later turning very pale pinkish cream, drying to light brown. **Context** indistinct. **Odour** not distinctive. **Spore print** not observed.

Basidiospores 4–5 × 1.5–2 µm, Q=2.5–2.6, Q_m=2.55, cylindrical, hyaline, smooth, thin walled, inamyloid in Melzer's reagent. **Basidia** 15–23 × 7–11 µm, broadly clavate to clavate, 4-sterigmate. **Hymenial cystidia** 25–42 × 5–8 µm, clavate to ventricose, hyaline, thick walled, weakly encrusted, encrustations easily dissolved in KOH. **Gloeocystidia** abundant in hymenial trama; 24–144 × 6–17 µm, of various shapes; narrowly clavate, flexous, cylindrical elongated, narrowly utriform to catenulate like, hyaline, smooth, thin walled. **Hymenial trama** interwoven and dimitic. Generative hyphae 2–5 µm, hyaline, smooth, thin walled, branched, with clamp connections. Skeletal hyphae 2–7 µm wide, hyaline, smooth, thick walled (1–2 µm), branched, septations not observed. Skeleto ligative hyphae not observed.

Specimen examined: India. Kerala State: Kozhikode district, Pokkunnu, on *Polyalthia longifolia*, 01 July 2015, Vinjusha N., ZGCVN5.

Comments: Genus *Butyrea* consists of only two species, *B. japonica* Núñez & Ryvarden and *B. luteoalba*. According to Núñez & Ryvarden (2001), *B. japonica* is differentiated from *B. luteoalba* by the presence of gloeocystidia. However, presence of gloeocystidia was reported in *B. luteoalba* later, by Vampola (2009) and Miettinen & Ryvarden (2016). Based on Miettinen & Ryvarden (2016), the only available character for separating both species is the width of basidiospores. Basidiospores of *B. luteoalba* are always less than or up to 2 µm wide, whereas, those of *B. japonica* are greater than 2 µm (Núñez & Ryvarden 2001; Miettinen & Ryvarden 2016). Therefore, the present specimen is placed as *B. luteoalba*. However, according to the above descriptions, *B. luteoalba* usually occurs on conifers and has not been reported from angiosperms. Whereas, the present collection was obtained from trunk of *Polyalthia longifolia.* Hence, present study forms the first report of the species on an angiosperm tree.

Butyrea luteoalba has been documented from China, Japan, and Korea (Núñez & Ryvarden 2001), India (Ranadive 2013), Finland (Miettinen & Ryvarden 2016). This species has not been reported from Kerala till date.

Nigroporus Murrill

Basidiomata annual to perennial, coriaceous to hard and woody, resupinate, effused reflexed to pileate. Pileus semicircular to flabelliform, with or without zonations, scrupose to glabrous, vinaceous brown to pink or violet. Hymenophore poroid, pores round to angular, pore surface vinaceous vinaceous brown to brown, pore tubes concolorous with pore surface. Context pink or purple coloured. Hyphal system dimitic, generative hyphae hyaline, thin to thick walled, with clamp connections. Skeletal hyphae fuliginous brown, thick walled. Cystidia absent. Basidiospores broadly ellipsoid to allantoid, hyaline, smooth, thin walled, inamyloid in Melzer's reagent. *Nigroporus* species cause white rot on wood.

Nigroporus vinosus (Berk.) Murrill, Bull. Torrey bot. Club 32 (7): 361 (1905)

Basionym: *Polyporus vinosus* Berk., Ann. Mag. nat. Hist., Ser. 2 9: 195 (1852)
Synonyms:
Polyporus tristis Lév., Annls Sci. Nat., Bot., sér. 3 5: 126 (1846)
Polyporus xerophyllaceus Berk., Hooker's J. Bot. Kew Gard. Misc. 8: 200 (1856)
Polystictus xerophyllaceus (Berk.) Cooke, Grevillea 14 (no. 71): 86 (1886)
Polystictus vinosus (Berk.) Sacc., Syll. fung. (Abellini) 6: 273 (1888)
Trametes tristis Sacc., Syll. fung. (Abellini) 6: 336 (1888)
Polystictus nigrescens Cooke, Grevillea 20 (no. 95): 90 (1892)
Microporus vinosus (Berk.) Kuntze, Revis. gen. pl. (Leipzig) 3 (3): 497 (1898)
Microporus xerophyllaceus (Berk.) Kuntze, Revis. gen. pl. (Leipzig) 3 (3): 497 (1898)
Microporus nigrescens (Cooke) Kuntze, Revis. gen. pl. (Leipzig) 3 (3): 496 (1898)
Coriolus vinosus (Berk.) Pat., Essai Tax. Hyménomyc. (Lons-le-Saunier): 94 (1900)
Coriolus tristis Pat., Essai Tax. Hyménomyc. (Lons-le-Saunier): 94 (1900)
Fomes xerophyllaceus (Berk.) Sacc., Boln Acad. nac. Cienc. Córdoba 19: 360 (1926)
Fomes sclerophyllaceus Speg., Boln Soc. Cienc. Córdoba 28: 360 (1926)
Fomitopsis vinosa (Berk.) Imazeki, Bull. Gov. Forest Exp. Stn Tokyo 57: 111 (1952)

FIGURE 7

Basidiomata annual, medium sized, usually found in clusters, almost coriaceous when fresh, hard when mature, light in weight, pileate. **Pileus** 20–80 mm long, 2–3 mm thick, broadly attached to dimidiate, imbricate, applanate, semicircular, concentrically zonate, zonations closely arranged, almost glabrous, slightly hispid at some regions, vinaceous grey to purplish brown or brown, white along margin, margin even. **Hymenophore** poroid. Pores 10–11 per mm, round to angular, absent along margin, pale vinaceous brown to brown, pore tubes 1 mm long, concolorous with pore surface, non stratified. **Context** up to 2 mm thick, pale purplish brown. **Odour** not distinctive. **Spore print** not observed.

Basidiospores 3–4 × 1–2 µm, Q=1.5–2.6, Q_m=2.17, cylindrical, smooth, thin walled, inamyloid in Melzer's reagent. **Basidia** not observed. **Cystidia** absent. **Hymenial trama** interwoven and dimitic. Generative hyphae 2–4 µm wide, hyaline, smooth, thin to slightly thick walled (up to 1 µm), branched, with clamp connections. Skeletal hyphae 2–6 µm wide, hyaline, thick walled (1) µm, weakly branched, septations not observed. Skeleto ligative hyphae not observed. **Pileal trama** interwoven. Generative hyphae 2–4 µm wide, hyaline, smooth, thin to slightly thick walled (up to 1µm), branched, clamp connections frequent. Skeletal hyphae 2–5 µm wide, hyaline, thick walled (1 µm), unbranched to very weakly branched, Skeleto ligative hyphae not observed. **Pileipellis** interwoven at the base to form irregularly arranged, agglutinated trichodermal patches which are 10–18 long, with obtuse tips.

Specimens examined: India. Kerala State: Kozhikode district, Peruvannamuzhy forest, on dead branch (unidentified), 11 August 2016, Vinjusha N., ZGCVN433; Kuttyadi, Janaki forest, on dead branch (unidentified), Vinjusha N., ZGCVN589; Ernakulam district, Iringole Kavu, on dead log (unidentified), 08 July 2017, Vinjusha N., ZGCVN558; Kottayam district, Vagamon, Pine Valley, on base of *Pinus* species, 24 October 2015, Vinjusha N, ZGCVN247; Wayanad district, Kuruva Island, on fallen *Swietenia mahagoni*, Vinjusha N., ZGCVN784.

Comments: Vinaceous brown pileus, fuliginous brown skeletal hyphae, and small basidiospores, easily distinguishes *N. vinosus* from other polypores. *Nigroporus ussuriensis* (Bondartsev & Ljub.) Y.C. Dai & Niemelä has a rosy brown basidiomata and similar hyphae as in *N. vinosus*, but is separated by wider spores (2–2.5 µm; as per the description of Núñez & Ryvarden 2001).

Nigroporus vinosus has a pantropical distribution (Ryvarden & Johansen 1980). From Kerala, this species has been reported by Leelavathy & Ganesh (2000), Mohanan (2011) and Iqbal *et al.* (2016).

Nigroporus durus (Jungh.) Murrill, Bull. Torrey bot. Club 34: 471 (1907)

Basionym: *Polyporus durus* Jungh., Verh. Batav. Genootsch. Kunst. Wet. 17 (2): 62 (1838)
Synonyms:
Polyporus cartilagineus Berk. & Broome, J. Linn. Soc., Bot. 14 (no. 73): 49 (1873)
Polyporus testudo Berk. & Broome, Trans. Linn. Soc. London, Bot. 2 (3): 59 (1883)
Fomes durus (Jungh.) G. Cunn., Proc. Linn. Soc. N.S.W. 75 (3–4): 224 (1950)
Rigidoporus durus (Jungh.) Imazeki, Bull. Gov. Forest Exp. Stn Tokyo 57: 117 (1952)
Osmoporus durus (Jungh.) G. Cunn., Bull. N.Z. Dept. Sci. Industr. Res. 164: 245 (1965)
Trichaptum durum (Jungh.) Corner, Beih. Nova Hedwigia 86: 219 (1987)
Rigidoporus cartilagineus (Berk. & Broome) Ginns, Can. J. Bot. 58 (14): 1589 (1980)

FIGURE 8

Basidiomata perennial, small to medium sized, solitary or imbricate, hard and woody, light in weight, pileate. **Pileus** 40–140 mm long, 2–10 mm thick, sessile, broadly attached, solitary or imbricate, semicircular, applanate, sometimes weakly convex, young specimens azonate, weakly zonate in mature and large fruit bodies, slightly hispid in young fruit bodies, becoming glabrous, pale brown to dirty grey, often turning greyish black when mature, margin remaining creamish white, then to light brown, often radially ridged, sometimes with minute tubercles, margin, even to undulate or lobed. **Hymenophore** poroid. Pores 7–10 per mm, angular, absent along margin, pore tubes 2–4 mm long, no stratified, brown to brownish black, often with a violet tint. Context 2–8 mm thick, vinaceous brown, lighter than pore surface. Odour not distinctive. Spore print not observed.

Basidiospores 4–4.5 × 2–3 µm, Q=1.5–2.5–4, Q_m=2.15, ellipsoid, smooth, thin walled, eguttulate, inamyloid in Melzer's reagent. **Basidia** not observed. **Cystidia** absent. **Hymenial trama** interwoven and dimitic. Generative hyphae 2–3 µm wide, hyaline, smooth, thin walled, branched, clamp connections frequent, some with multiple clamp connections. Skeletal hyphae 3–7 µm wide, fuliginous brown, thick walled (1–2 µm), unbranched, septations not observed. Skeleto ligative hyphae not observed. **Pileal trama** interwoven. Generative hyphae 2–3.5 µm wide, hyaline, smooth, thin walled, branched, with clamp connections. Skeletal hyphae 3–7 µm wide, fuliginous brown, but paler than those present in hymenium, some hyphae hyaline, thick walled (1–2 µm), unbranched, septations not observed. Skeleto ligative hyphae not observed. **Pileipellis** a cutis made of hyaline to pale brown hyphae, that are 2-5 µm wide, mostly brownish, slightly thick walled (less than 1 µm).

Specimens examined: India. Kerala State: Kozhikode district, Peruvannamuzhy forest, on *Swietenia mahagoni*, 11 Ausust 2016, Vinjusha N., ZGCVN415, ZGCVN422; Chelavoor, Thurayil Kavu, on live *Diospyros paniculata*, 11 August 2018, Vinjusha N., ZGCVN702; Kuttyadi, Janaki forest, on fallen tree (unidentified), 02 October 2018, Vinjusha N., ZGCVN722; Thrissur district, Peechi, on *Terminalia paniculata*, 20 September 2017, Vinjusha N, ZGCVN640; Kannur district, Poongottu Kavu, on live tree (unidentified), 02 July 2019, Vinjusha N., ZGCVN833; Idukki district, Vattavada, on dead wood, 28 July 2019, Vinjusha N., ZGCVN893.

Comments: Characters of the present collections match well with the taxonomic descriptions of *N. durus* by Ryvarden & Johansen (1980) and Mohanan (2011). However, present Kerala collection of *N. durus* produces much large fruit bodies than those collections described by Ryvarden & Johansen (1980) and Mohanan (2011). The specimen resembles *Melanoporia nigra* (Berk.) Murrill in having a purplish black to black hymenophore and fuliginous skeletal hyphae. However, the latter produces only resupinate basidiocarps and are never pileate (Berkeley 1845; Lowe 1966). BLAST search using the ITS sequences generated from the present collection showed 98% similarity with *N. dursus* (GenBank number: LC327032). BLAST result showed 93% identity *Trichaptum sector* (Ehrenb.) Kreisel (KP859296). However, presence of thin basidiomata (as per the description of Alexander *et al.* 1989), large, angular labyrinthiform to more or less irpicoid hymenium, and subclavate to subventricose cystidia (according to the description by Corner 1987) easily distinguish *T. sector* from the present collection.

Nigroporus durus has distribution in paleotropical regions (Asia, Africa and Oceania) of the world (Ryvarden & Johansen 1980). From Kerala, this species has been reported by Mohanan (2011).

Tyromyces P. Karst.

Basidiomata annual, often found in clusters, usually sappy when fresh, shrinking when dry, resupinate to pileate. Pileus sessile, tomentose to smooth, often white or brightly coloured. Hymenophore poroid, with round to angular pores, pore surface white to cream or pale brown. Context white to light brown, soft in consistency when fresh, hard on drying. Hyphal system monomitic to dimitic, generative hyphae hyaline, thin to thick walled, with clamp connections. sometimes with few skeleto ligative hyphae. Cystidia present or absent. Basidiospores cylindrical to ellipsoid, hyaline, smooth, thin walled, inamyloid to weakly amyloid in Melzer's reagent. Some species posseses gloeopherous hyphae. Members cause white rot on wood.

Tyromyces leucomallus (Berk. & M.A. Curtis) Murrill, N. Amer. Fl. (New York) 9 (1): 36 (1907)

Basionym: *Polyporus leucomallus* Berk. & M.A. Curtis 1868

FIGURE 9

Basidiomata, annual, small to medium to sized, found in clusters, soft and coriaceous when fresh, hard on drying, pileate. **Pileus** 15–65 mm long, up to 2 mm thick, sessile or attached with a distinct region of attachment, semicircular, applanate, weakly concentrically zonate, sulcations absent, pubescent, lesser towards margin, cream, bruising to pale brown, margin slightly wavy, rolled and incurved on drying. **Hymenophore** poroid. **Pores** 8–12 per mm, round to ovoid, absent near margin, cream, slightly glancing, pore tubes less than 1 mm long, non stratified, concolourous with pore surface. **Context** 1 mm thick, creamish white, homogenous. **Odour** not distinctive. **Spore print** not observed.

Basidiospores 3–4 × 1–1.5 µm, Q=1.2–2, Q_m=3.26, allantoid, easily detached from basidia and free floating, hyaline, some spores minutely guttulate, thin walled, smooth, inamyloid in Melzer's reagent. **Basidia** 7–15 × 2–3 µm, clavate, 4 sterigmate. **Cystidia** absent. **Gloeopherous hyphae** present in hymenial trama, mostly with a zig-zag appearance, 1.5–3 µm wide, with hyaline to pale yellowish contents, thin walled, septate, branched. **Hymenial trama** interwoven and monomitic. Generative hyphae 2–4 µm wide, hyaline, thin to mostly thick walled (1–2 µm), branched, with clamp connections. Skeletal hyphae and skeleto ligative hyphae not observed. **Pileal trama** interwoven and monomitic. Generative hyphae 2–5 µm wide, hyaline, thin to mostly thick walled (1–2 µm), branched, with clamp connections. Skeletal hyphae and skeleto ligative hyphae not observed. **Pileipellis** an irregular cutis with scattered short erect agglutinated trichodermial patches, up to 20 µm long, made of hyphae 2–4 µm wide, hyaline, thin to thick walled, with obtuse ends.

Specimen examined: India. Kerala State: Kannur district, Aralam, on dead branch (unidentified), 09 January 2016, Vijisha P., ZGCVN300; Kozhikode, Peruvannamuzhy forest, on dead wood of *Mallotus repandus*, 22 November 2018, Vinjusha N., ZGCVN766.

Comments: This species is easily recognized by the presence of gloeopherous hyphae and short allantoid basidiospores (Núñez & Ryvarden 2001). *Postia tephroleuca* is the closely related species, however, distinguished from the present collection by absence of gloeopherous hyphae, and presence of larger basidiospores (according to the description by Ryvarden & Gilbertson 1994).

Tyromyces leucomallus has subtropical distribution (Núñez & Ryvarden 2001). So far, this species has not been recorded from Kerala.

Pappia (Berk. & M.A. Curtis) Zmitr.

Badidiomata annual, large, hard and woody, pileate. Pileus sessile or with a distinct region of attachment, glabrous, cream to brown coloured. Hymeophore poroid, pores angular, pore surface cream to brown, pore tubes honey brown to umber brown. Context soft, fibrous context, white when fresh, cream, pinkish to light umber brown when dry. Hyphal system monomitic, generative hyphae hyaline, thin walled in trama and nearly thick in upper context, with clamp connections. Cystidia absent. Basidia clavate, 4 sterigmate. Basidiospores ellipsoid to subglobose, hyaline, thin walled, inamyloid in Melzer's reagent. Chalmydospores present or absent. Members cause white rot on wood.

Pappia fissilis (Berk. & M.A. Curtis) Zmitr., Folia Cryptogamica Petropolitana (Sankt-Peterburg) 6: 101 (2018)

Basionym: *Polyporus fissilis* Berk. & M.A. Curtis, Hooker's J. Bot. Kew Gard. Misc. 1: 234 (1849)
Synonyms:
Spongipellis fissilis (Berk. & M.A. Curtis) Murrill, N. Amer. Fl. (New York) 9 (1): 39 (1907)
Polyporus albosordescens Romell, Svensk bot. Tidskr. 6: 637 (1912)
Polyporus cavernosus Velen., České Houby 4-5: 640 (1922)
Polyporus fuscomutans Lloyd, Mycol. Writ. 7 (Letter 67): 1158 (1922)
Polyporus pomaceus Velen., České Houby 4-5: 645 (1922)
Phaeolus albosordescens (Romell) Bourdot & Galzin, Bull. trimest. Soc. mycol. Fr. 41 (1): 135 (1925)
Leptoporus albosordescens (Romell) Pilát, Bull. trimest. Soc. mycol. Fr. 48 (1): 8 (1932)
Tyromyces fissilis (Berk. & M.A. Curtis) Donk, Meded. Bot. Mus. Herb. Rijks Univ. Utrecht 9: 153 (1933)
Leptoporus fissilis (Berk. & M.A. Curtis) Pilát, in Kavina & Pilát, Atlas Champ. l'Europe, III, Polyporaceae (Praha) 1: 227 (1938)
Aurantiporus fissilis (Berk. & M.A. Curtis) H. Jahn, Westfälische Pilzbriefe 9: 134 (1973)

FIGURE 10

Basidiomata annual, medium to large sized, solitary or in clusters, soft and fleshy when fresh, bone hard and brittle on drying, light in weight, pileate. **Pileus** up to 185 mm long, 40 mm thick, sessile, centrally or laterally attached with a distinct region, applanate to convex, semicircular to irregularly circular, uneven with minute depressions and projections, concentric zonations absent, glabrous, cream, (surface turned greyish black on exposure to heavy rains and attack of many conidia forming fungi) margin undulate, obtuse, slightly incurved on drying. **Hymenophore** poroid. **Pores** 2–5 per mm, angular, oblique towards margin, yellowish cream, greyish to pale brown on exposure, pore tube 3–7 mm long, non stratified, cream. **Context** 7–25 mm thick, pale pinkish cream, homogenous. **Odour** not distinctive. **Spore print** not observed.

Basidiospores 3–5 × 2–3 µm, Q=2–2.5, Q_m=1.85, subcylindrical to ellipsoid, many curved at one end, hyaline, eguttulate, thin walled, smooth, inamyloid in Melzer’s reagent. **Basidia** 9–12 × 4–5 µm, clavate, 4 sterigmate, with basal clamp connections. **Cystidia** absent. **Hymenial trama** interwoven and monomitic. Generative hyphae 2–4 µm wide, smooth, hyaline, metachromatic in cresyl blue, thin to slightly thick walled (less than 1 µm), branched, with frequent clamp connections. Skeletal hyphae and skeleto ligative hyphae not observed. **Pileal trama** interwoven and monomitic, wider than those in hymenium (2–9 µm), hyaline, metachromatic in cresyl blue, thin to slightly thick walled (less than 1 µm), branched, with frequent clamp connections. **Pileipellis** an irregular and agglutinated cutis made of hypahe that are 2–4 µm wide, hyaline and thin walled.

Specimens examined: India. Kerala State: Kannur district, Aralam, dead wood (unidentified), 08 April 2016, Vijisha P., ZGCVN322.

Comments: The large size and overall morphology of the present collection has an appearance of species of genus *Albatrellus* Gray, (Russulales Kreisel *ex* P.M. Kirk, P.F. Cannon & J.C. David), however, the latter differs by having distinctly stipitate basidiocarps. Present Kerala collection also resembles *Osteina obducta* (Berk.) Donk in morphology. However, the latter produces laterally to centrally stipitate or substipitate basidiomata, and cylindrical basidiospores, that are slightly longer (5.5–6.3 µm long, Niemelä 1985; 5–6.5 µm long, Ryvarden & Gilbertson 1994) than those of present collection.

According to the descriptions (Ryvarden & Gilbertson 1994; Núñez & Ryvarden 2001), *Pappia fissilis* (treated as *Tyromyces fissilis* in above studies) produces sappy and partly waxy basidiospores in fresh condition and later shrinks on drying. This feature was not noticed in the present collection, since it was collected in an extremely dried form. As per the description (Ryvarden & Gilbertson 1994), *Pappia fissilis* possesses chlamydospores in the context region, whereas chlamydospores were not observed in the present collection.

Pappia fissilis is circumpolar in the temperate zones of the world (Núñez & Ryvarden 2001). In East Asia, this species has been reported from China. There are no records of *P. fissilis* from India so far.

Phlebia Fr.

Basidiocarps annual, resupinate, effused reflexed, exceptionally pileate, having subceraceous to subgelatinous texture when fresh, membranaceous to coriaceous or with a waxy appearance when dry. Hymenophore smooth, tuberculate, phlebioid, odontioid, merulioid or poroid. Hyphal system monomitic, rarely dimitic, Generative hyphae hyaline, thin to thick walled, with or without clamp connections. Cystidia present or absent, when present, with or without encrustations. Basidia narrowly cylindrical to narrowly clavate, 4 sterigmate. Basidiospores ellipsoid to allantoid, hyaline, smooth, thin walled, inamyloid in Melzer's reagent. Members cause white rot on wood.

Phlebia unica (H.S. Jacks. & Dearden) Ginns, Mycotaxon 21: 329 (1984)

Basionym: *Peniophora unica* H.S. Jacks. & Dearden, Canadian Journal of Research, Section C 27: 148 (1949)
Synonyms:
Metulodontia cremeoalutacea Parmasto, Consp. System. Corticiac. (Tartu): 216 (1968)
Metulodontia cremeoalutacea f. *crassa* Parmasto, Consp. System. Corticiac. (Tartu): 217 (1968)
Metulodontia cremeoalutacea var. *pulchra* Parmasto, Consp. System. Corticiac. (Tartu): 217 (1968)
Hyphoderma cremeoalutaceum (Parmasto) Jülich, Persoonia 8 (1): 80 (1974)
Phlebia cremeoalutacea (Parmasto) K.H. Larss. & Hjortstam, Mycotaxon 5 (2): 478 (1977)

FIGURE 11

Basidiomata annual, entirely resupinate, adnate, hard and tough, forming large patchy growth, margin irregular. **Pileus** absent. **Hymenophore** smooth, tuberculate to uneven, with many ridges and depressions, white when fresh, turning greyish white to light brown on drying. **Context** indistinct. **Odour** not distinct. **Spore print** not observed.

Basidiospores 3.5–4 × 2–3 µm, $Q=1.3–2$, $Q_m=1.65$, subglobose to ovoid, hyaline, smooth, thin walled, eguttulate, inamyloid in Melzer's reagent. **Basidia** 17–22 × 3–4.5 µm, clavate to cylindrical, 4 sterigmate. **Cystidia** frequent; 23–65 ×

8–15 µm, of various shapes such as, lageniform, utriform, obclavate, with golden yellow to brown wall, thick walled (up to 1 µm), smooth, slightly encrusted at apex. **Hymenium** interwoven and monomitic. Generative hyphae 1.5–2.5 µm wide, hyaline, smooth, thin to thick walled (1 µm), some hyphae solid, moderately branched to highly bifurcate and arboriform, septations not observed, with infrequent clamp connections.

Specimens examined: India. Kerala State: Kozhikode district, Palazhi, Bhayankavu, on *Ficus* species, 26 June 2016, Vinjusha N., ZGCVN338.

Comments: The ceraceous basidiomata with small pores and large cystidia and easily makes *P. unica* unique among other species in the genus (Jackson & Dearden 1949).

Phlebia unica has been recorded from British Colombia (Jackson & Dearden 1949) and South Korea (Kim *et al.* 2015). There are no reports of this species from India so far.

Phlebia acerina Peck, Ann. Rep. N.Y. St. Mus. 42: 123 (1889)

Synonyms:

Merulius acerinus (Peck) Spirin & Zmitr., Nov. sist. Niz. Rast. 37: 181 (2004)
Phlebia vassilkovii Parmasto, Notul. syst. Sect. cryptog. Inst. bot. Acad. Sci. U.S.S.R. 15: 130 (1962)
Phlebia radiata var. *vassilkovii* (Parmasto) Parmasto, Eesti NSV Tead. Akad. Toim., Biol. seer 16 (4): 393 (1967)

FIGURE 12

Basidiomata annual, effused, adnate, forming small to medium sized patches, waxy, central area with raised foldings, with a callus like appearance, margin irregular, 20–42 mm long, 2–3 mm thick. **Hymenophore** uneven, irregularly folded, foldings broad and coarse, bright yellow, with whitish mycelia frequent at the central region, lesser towards margin, margin even, easly detached. **Context** up to 2.5 mm thick, pale cream to creamish yellow, upper layer thinner, and more concolorous with the hymenium. **Odour** not distinct. **Spore print** not observed.

Basidiospores 3–4 × 2–3 µm, Q=1.5–2, Q_m=1.7, subcylindrical to ellipsoid, hyaline, smooth, thin walled, guttulate, inamyloid in Melzer's reagent. **Basidia**

42–72 × 6–7 µm, cylindrical to clavate, 4 sterigmate. **Hymenium** consist of closely packed **cystidia** and basidia. **Cystidia** 45–73 × 7–10 µm, cylindrical to clavate, hyaline, thin to slightly thick walled (up to 1 µm), smooth. **Contextual trama** monomitic, interwoven in marginal region; 3–7 µm wide, hyaline, smooth, thin to thick walled (1 µm), branched, with clamp connections. Hyphae towards central region parallelly arranged, thick walled (3 µm), more branched than in marginal region.

Specimens examined: India. Kerala State: Idukki district, Vattavada, on dead wood (unidentified), 28 July 2019, Anjitha Thomas., ZGCVN886.

Comments: Present collection shows similarity with *Phlebia rufa* (Pers.) M.P. Christ., in having irregularly folded hymenium, and similar basidiospores. However, *P. rufa* produces reddish brown coloured hymenium, that turn more darker in KOH (Nakasone & sytsma 1993). According to Nakasone & Sytsma (1993), *P. rufa* often produces narrowly folded hymenium with distinct circular pits. Present specimen possesses a coarsely folded hymenium and lacks circular pits. Nakasone & sytsma (1993), also opines that the hymenum interepted by white, felty to woolly mycelia is a typical character of *P. acerina,* and is absent in *P. rufa*. In the present specimen, white mycelia were clearly visible on the hymenial surface. *P. rufa* possesses fibrillose margin, whereas basidiocarps of present collection have entire margin. In addition, *P. rufa* lacks parallelly arranged hyphae, however, present specimen posseses parallel arranged hyphae in the context in the middle portion, which according to Nakasone & sytsma (1993), is a characteristic feature of *P. acerina*. Moreover, distribution of *P. rufa* is limited to Europe and the Pacific Northwest region of the United States. Present specimen also resembles *Phlebia radiata* Fr. in morphology, however the latter possesses radially folded hymenium with an orangish red to violaceous red colour, and narrower suballantoid basidiospores (1.5–2 µm) (Erikkson *et al.* 1981).

BLAST search using the newly generated ITS sequence resulted in 100% similarity with *P. acerina* (GenBank numbers: MK404455, MK404448, MK404444) and *P. rufa* (Pers.) M.P. Christ. (AY787679, KC414253).

Phlebia acerina has distribution in Asia, North America and Europe (Erikkson *et al.* 1981). According to Nakasone & sytsma (1993), this species has occurrence in all the continents except Antarctica. Recently, *Phlebia acerina* has been reported from India by Kumar *et al*. (2018a). There are no reports of this species from Kerala so far.

Phlebia ludoviciana (Burt) Nakasone & Burds., in Nakasone, Burdsall & Noll, Mycotaxon 14 (1): 3 (1982)

Basionym: *Peniophora ludoviciana* Burt, Ann. Mo. bot. Gdn 12: 244 (1926)
Synonym:
Hyphoderma ludovicianum (Burt) K.J. Martin & Gilb., Mycotaxon 6 (1): 62 (1977)

FIGURE 13

Basidiomata annual, entirely resupinate, adnate, thin, forming small to large patches, margin irregular, 220 mm long, 1 mm thick. **Pileus** absent. **Hymenophore** mostly tuberculate with projecting irregular outgrowths, smooth towards margin, bright yellow when fresh, dull white towards margin, turning greyish brown to brown on drying. **Context** indistinct. **Odour** not distinct. **Spore print** not observed.

Basidiospores 4–6 × 2–3 µm, Q=1.6–2.5, Q_m=2, subcylindrical to ellipsoid, hyaline, smooth, thin walled, guttulate, inamyloid in Melzer's reagent. **Basidia** 18–38 × 3–5 µm, cylindrical to narrowly clavate, 4 sterigmate. **Cystidia** 26–42 × 5–5.5 µm, broadly cylindrical to clavate, hyaline, thin to thick walled (1 µm), highly encrusted towards apex, dissolved in KOH. **Hymenium** interwoven and monomitic. Generative hyphae 2–3 µm wide, hyaline, smooth, thin to thick walled (1 µm), with frequent clamp connections.

Specimens examined: India. Kerala State: Kozhikode district, Chelavoor, Thurayil Kotta, on dead branch (unidentified), 20 June 2019, Vinjusha N., ZGCVN809.

Comments: Nakasone *et al.* (1982) describes the presence of two kinds of cystidia in *Phlebia ludoviciana*; 1) cylindrical, thick walled, highly encrusted and (2) narrowly obclavate or ventricose, thin walled and smooth. But only one type of cystidia, that are clavate to broadly cylindrical, thin to thick walled and encrusted, was observed in the present collection. However, encrustations on most of the cystidia were dissolved in KOH, making the surface smooth. Punugu *et al.* (1980) describes cystidia of the species as either encrusted or non encrusted. However, present collection produces smaller cystidia (26–42 µm long), when compared to above descriptions (30–70 µm long). *Phlebia subochracea* (Alb. & Schwein.) J. Erikss. & Ryvarden shares similar microscopic features as *P. ludoviciana*, however, are separated by cream to greyish ochraceous basidiomata, and slightly larger basidiospores (6–8 × 2.5–3.5 µm) (Eriksson *et al.* 1981; Bernicchia & Gorjón 2010).

Phlebia ludoviciana has been mostly recorded from North America (Burt 1925; Punugu *et al.* 1980; Nakasone & Sytsma 1993). The species also occurs in India (Ranadive 2013). There are no reports of this species from Kerala so far.

Sebipora Miettinen

Basidiomata annual, mostly soft and water soaked, with a rubber like consistency, resupinate to pileate. Pileus sessile, azonate, glabrous, pileus, white when fresh, cream, grey to brownish when dry. Hymenophore poroid with round to angular pores, surface white to pale brown. Context homogenous and white in colour. Hyphal system monomitic with hyaline, thin to thick walled generative hyphae, with clamp connections, with or without encrustations. Basidia clavate, 4 sterigmate. Basidiospores cylindrical, slightly bent, hyaline, usually guttulate, thin walled, namyloid in Melzer’s reagent.

Sebipora aquosa Miettinen, in Miettinen & Rajchenberg, Mycol. Progr. 11 (1): 144 (2012)

FIGURE 14

Basidiomata annual, small sized, found in large clusters and imbricate, soft, membraneous and coriaceous when fresh, almost hard on drying, light in weight, effused reflexed. **Pileus** 6–50 mm long, 2–3 mm thick, sessile, applanate to uneven, semicircular, concentric zonations absent, glabrous to hispid, white, pale brown on bruising, margin thin, undulate, lacerate, incurved on drying. **Hymenophore** poroid. **Pores** 4–5 per mm, angular, absent along margin, white, pale brown on bruising, pore tube 1–2 mm long, non stratified, concolourous with pore surface. **Context** 1 mm thick, white, homogenous. **Odour** not distinctive. **Spore print** not observed.

Basidiospores 5–7 × 2–3 µm, Q=2–3, Q_m=2.37, cylindrical, usually curved at one end, hyaline, often monoguttulate, thin walled, smooth, inamyloid in Melzer's reagent. **Basidia** 15–21 × 4–5 µm, clavate, 4 sterigmate, with basal clamp connections. **Cystidia** absent. **Hymenial trama** subparallel and monomitic. Generative hyphae 2–5 µm wide, hyaline, smooth, thin to slightly (up to 1 µm) thick walled, with frequent clamp connections. Skeletal hyphae and skeleto ligative hyphae not observed. **Pileal trama** subparallel. Generative hyphae 2–6 µm wide, hyaline, smooth, thin to slightly (up to 1 µm) thick walled, with frequent clamp connections. **Pileipellis** a regular cutis made of hyphae that are 2–3 µm wide, hyaline, thin to slightly thick walled.

Specimens examined: India. Kerala State: Palakkad district, Dhoni, on dead wood stump (unidentified), 26 November 2018, Vinjusha N., ZGCVN775.

Comments: This specimen resembles *Ceriporiopsis subvermispora* (Pilát) Gilb. & Ryvarden in some morphological characters. According to the descriptions (Lowe 1966; Niemelä 1985; Ryvarden & Gilbertson 1993), *C. subvermispora* always produces resupinate fruit bodies. However, the present collection produces effused reflexed basidiocarps. Microscopically, *C. subvermispora* produces allantoid basidiospores with a width of 1–1.2 µm, whereas our collection produces cylindrical basidiospores, that are 2–3 µm wide. In addition, *C. subvermispora* do not have oil droplets inside spores, whereas those of present collection are usually monoguttulate. *C. subvermispora* produces hyphae that swell in KOH (Miettinen & Rajchenberg 2012), whereas present collection shows no hyphal swellings in KOH. *Sebiporia aquosa* is a tropical species, whereas, *C. subvermispora* is typically a North American species (Miettinen & Rajchenberg 2012). According to Miettinen & Rajchenberg (2012), *C. subvermispora* collections from China and Thailand are that of another species.

BLAST search using the ITS sequence generated from the fruit body shows 100% similarity with the sequences of *Sebipora aquosa,* including that from the type material (GenBank number: KJ654615, HQ659243). Blast search also showed 99% similarity with sequence of *Ceriporiopsis subvermispora* (JN116698). However, this species can be separated morphologically. In the phylogene tree (Figure 136), Kerala collection of *S. aquosa* claded together with the four accessions of Indonesian *S. aquosa* (including the holotype), with 98% bootstrap support, in the *Cinereomyces* clade.

According to Miettinen & Rajchenberg (2012), substrates of *S. aquosa* were always a fallen angiosperm tree trunk. Zhao *et al.* (2017) also recorded the species from fallen angiosperm trunk. But, Glen *et al.* (2014) reported the species on root of *Acacia mangium*. From India, an ITS sequence of *S. aquosa* has been deposited in the GenBank database (GenBank number: JQ746682) by Abraham *et al.* (2012), however the data remains unpublished. The reliability of the sequence which they identify as "*S. aquosa*" is also doubted. In India, *S. aquosa* has been isolated from corneal scrapings of keratitis patients (Nithya & Bhaskar 2013). However the paper (Nithya & Bhaskar 2013) does not provide a systematic account of the species, and neither the voucher material nor its molecular data has been deposited or made available. Hence, the present study forms the first systematic record of *S. aquosa* from India based on a voucher deposit and molecular sequence.

Rigidoporus Murrill

Basidiomata annual to perennial, solitary or in clusters, hard and woody, resupinate, effused reflexed to pileate. Pileus semicircular, concentrically zonate, tomentose to glabrous, reddish orange to pinkish or pale ochraceous. Hymenophore poroid, pores small and isodiametric. Context white, cream to ochraceous. Hyphal system monomitic to pseudodimitic, generative hyphae hyaline, thin walled, without clamp connections. Cystidia present or absent, when present mostly mammilliform, thick walled and encrusted at tip. Basidiospores ellipsoid to globose basidiospores, hyaline, smooth, thin walled, inamyloid in Melzer's reagent. Members cause white rot on wood.

Rigidoporus vinctus (Berk.) Ryvarden, Norw. Jl Bot. 19 (2): 143 (1972)

Basionym: *Polyporus vinctus* Berk., Ann. Mag. nat. Hist., Ser. 2 9: 196 (1852)
Synonyms:
Polyporus acupunctatus Berk. & Broome, J. Linn. Soc., Bot. 14 (no. 73): 52 (1873)
Fomes acupunctatus (Berk. & Broome) Cooke, Grevillea 14 (no. 69): 21 (1885)
Poria vincta (Berk.) Cooke, Grevillea 14 (no. 72): 110 (1886)
Poria carneopallens f. *cinerea* Bres., Bull. Soc. mycol. Fr. 6 (1): XXXIV (1890)
Poria fulvobadia Pat. [as *'fulvo-badia'*], J. Bot., Paris 11: 340 (1897)
Scindalma acupunctatum (Berk. & Broome) Kuntze, Revis. gen. pl. (Leipzig) 3 (3): 518 (1898)
Scindalma bistratosum (Berk. & Cooke) Kuntze, Revis. gen. pl. (Leipzig) 3(3): 518 (1898)
Trametes vincta (Berk.) Pat., in Duss, Enum. Champ. Guadeloupe (Lons-le-Saunier): 30 (1903)
Physisporinus vinctus (Berk.) Murrill, Mycologia 34 (5): 595 (1942)
Chaetoporus vinctus (Berk.) J.E. Wright, Mycologia 56 (5): 786 (1964)
Poria vincta var. *cinerea* (Bres.) Setliff, Mycologia 64 (4): 695 (1972)
Rigidoporus albostygius (Berk. & M.A. Curtis) Rajchenb., Revta Investnes agrop., Sér. 5 19 (1): 72 (1984)
Junghuhnia vincta (Berk.) I.A. Hood & M.A. Dick, N.Z. Jl Bot. 26 (1): 114 (1988)
Poria fumosa Bres. & Pat., Mycol. Writ. 1: 49 (1901)
Poria porphyrophaea Bres., Hedwigia 56 (4, 5): 296 (1915)
Polyporus porphyrophaea Bres., Hedwigia 56 (4, 5): 296 (1915)

FIGURE 15

Basidiomata annual, resupinate**,** spread as adpressed long patches on the host, some portion slightly effused reflexed, tough when fresh, becoming harder and woody on drying. **Pileus** when present, small, up to 15 mm long, 9 mm thick, semicircular, applanate, concentrically zonate, glabrous, cream with a shade of orange, margin even to wavy, round. **Hymenophore** poroid. **Pores** 7–9 per mm, round, pale ochre, sometimes slightly cracked when dry. **Context** up to 3 mm thick, ochre, turning darker on handling. **Odour** not distinctive. **Spore print** not observed.

Basidiospores 4–6 × 3.5–5 µm, Q=1–1.2, Q_m=1.05, subglobose to globose, hyaline, smooth, thin walled, with guttulate contents, inamyloid in Melzer's reagent. **Basidia** not observed. **Cystidia** frequent, 30–92 × 6–14 µm, cylindric to clavate, thick walled (wall thickness up to 4 µm), heavily encrusted at the tip. **Hymenial trama** monomitic and highly interwoven. Generative hyphae 3–7 µm wide, hyaline, thick walled (1–2 µm), sparsely septate, branched, clamp connections absent. Skeletal hyphae and Skeleto ligative hyphae not observed.

Specimens examined: India. Kerala State: Kozhikode district, ZG college campus, on dead branch (unidentified), 22 September 2015, Vinjusha N., ZGCVN207;

Alappuzha district, Vallikavu, on live angiosperm tree (unidentified), 18 December 2018, Vinjusha N., ZGCVN802.

Comments: Microscopically, *R. vinctus* shows close similarity with *R. lineatus*, however, the latter produces mostly pileate basidiomata. Moreover, *R. lineatus* possesses narrower cystidia than *R. vinctus* (Leelavathy & Ganesh 2000; Núñez & Ryvarden 2001).

Rigidoporus vinctus has pantropical distribution, and also occurs on warmer temperate regions of the world (Ryvarden & Johansen 1980). From Kerala, this species has been recorded by Leelavathy & Ganesh (2000).

Rigidoporus lineatus (Pers.) Ryvarden, Norw. Jl Bot. 19: 236 (1972)

Basionym: *Polyporus lineatus* Pers., in Gaudichaud-Beaupré in Freycinet, Voy. Uranie., Bot. (Paris) 4: 174 (1827)
Synonyms:
Polyporus inconspicuus Miq., Bull. Sci. phys. nat. Néerl.: 456 (1839)
Polyporus surinamensis Miq., Bull. Sci. phys. nat. Néerl.: 454 (1839)
Polyporus micromegas Mont., Annls Sci. Nat., Bot., sér. 2 17: 128 (1842)
Polyporus zonalis Berk., Ann. Mag. nat. Hist., Ser. 1 10: 375 (1843)
Polystictus surinamensis (Miq.) Cooke, Grevillea 14 (no. 71): 83 (1886)
Polyporus rufopictus Berk. & M.A. Curtis, in Cooke, Grevillea 15 (no. 73): 23 (1886)
Polystictus inconspicuus (Miq.) Sacc., Syll. fung. (Abellini) 6: 228 (1888)
Polystictus lineatus (Pers.) Sacc., Syll. fung. (Abellini) 6: 283 (1888)
Microporus lineatus (Pers.) Kuntze, Revis. gen. pl. (Leipzig) 3 (3): 496 (1898)
Microporus surinamensis (Miq.) Kuntze, Revis. gen. pl. (Leipzig) 3 (3): 497 (1898)
Microporus rufopictus (Berk. & M.A. Curtis *ex* Cooke) Kuntze, Revis. gen. pl. (Leipzig) 3 (3): 497 (1898)
Microporus inconspicuus (Miq.) Kuntze, Revis. gen. pl. (Leipzig) 3 (3): 496 (1898)
Rigidoporus micromegas (Mont.) Murrill, Bull. Torrey bot. Club 32 (9): 478 (1905)
Rigidoporus surinamensis (Miq.) Murrill, Bull. Torrey bot. Club 34: 473 (1907)
Polyporus zonalis var. *resupinatus* Trotter, in Saccardo, (1925)
Rigidoporus surinamensis var. *subauberianus* Murrill, Lloydia 5: 156 (1942)
Rigidoporus micromegas var. *aurantiacus* Corner, Beih. Nova Hedwigia 86: 171 (1987)

FIGURE 16

Basidiomata annual, small to medium sized, tough when fresh, becoming harder and woody on drying, pileate. **Pileus** 15–140 mm long, 2–3 mm thick, laterally attached, dimidiate, semicircular, applanate, small irregular outgrowths present towards the region of attachment, concentrically zonate, faintly sulcate, glabrous, hispid hairs present at the margin and along the concentric rings, surface yellow with alternating cream bands, margin more yellowish, even, obtuse, many pilei fused together along the margin. **Hymenophore** poroid. **Pores** 5–9 per mm, round to irregular, pore tubes 1–4 mm long, absent at the margin, creamish white to very light yellow, turning pale brown on bruising. **Context** 1–2 mm thick, white, turning cream on handling. **Odour** not distinctive. **Spore print** not observed.

Basidiospores 5–6 × 4–5 µm, Q=1–1.2, Q_m=1.06, subglobose to globose, hyaline, smooth, thin walled, with guttulate contents, inamyloid in Melzer's reagent. **Basidia** 13–22 × 7–9 µm, clavate, hyaline, 4 sterigmate, guttulate. **Cystidia** present; 7–10 µm wide, clavate to setiform, some mamillate, thick walled (wall thickness up to 3 µm), encrusted at the tip. **Hymenial trama** highly interwoven and monomitic. Generative hyphae 3–8 µm wide, hyaline, smooth, thick walled (1–2 µm), sparsely septate, branched, clamp connections absent. Skeletal hyphae and skeleto ligative hyphae not observed. **Pileal trama** interwoven. Generative hyphae 3–10 µm wide, hyaline, thick walled (1–2 µm), sparsely septate, branched, flexuous, clamp connections absent. Skeletal hyphae and skeleto ligative hyphae not observed. **Pileipellis** composed of hyphae that are slightly interwoven at the base to form a trichodermium with obtuse tips; hyphae 4–7 µm wide, hyaline, slightly thick to thick walled (1–2 µm), with obtuse ends.

Specimens examined: India. Kerala State: Kozhikode district, Kannur road, on *Polyalthia longifolia*, 03 July 2015, Vinjusha N., ZGCVN8; Kakkodi, on dead wood of *Cocos nucifera*, Vinjusha N, VN11; Chungam, on dead logs (unidentified), 09 July 2015, Vinjusha N., ZGCVN31; Chungam, on dead logs (unidentified), 09 July 2015, Vinjusha N., ZGCVN32; Edakkara, Vallikkattukavu, on dead wood stump of *Knema attenuata*, 11 July 2015, Vinjusha N., ZGCVN38; Edakkara, Vallikkattukavu, on dead branches of *Knema attenuata*, 11 July 2015, Vinjusha N., ZGCVN39; Pokkunnu, ZG College campus, on dead stump of *Polyalthia longifolia*, 15 July 2015, Vinjusha N., ZGCVN55; Eranjipalam, on dead stump of *Cocos nucifera*, 20 July 2015, Vinjusha N., ZGCVN70; Eranjipalam, on dead stump of *Cocos nucifera*, 20 July 2015, Vinjusha N., ZGCVN71; Thiruvannur, on dead wood of *Cocos nucifera*, 20 July 2015, Vinjusha N., ZGCVN86; Kakkayam, on branches of unidentified tree, 29 August 2015, Vinjusha N., ZGCVN157, Kakkayam, dead logs (unidentified), 29 August 2015, Vinjusha N., ZGCVN158; Chelannur, Kalarimala, on dead wood stump of *Cocos nucifera*, 6 September 2015, Vinjusha N., ZGCVN181; Pokkunnu, ZG College Yoga Centre, on dead logs of unknown tree, 22 September 2015, Vinjusha N., VN208; Koyilandy, Kottayil kavu, on *Polyalthia longifolia*, 04 October 15, Vinjusha N., ZGCVN228; on dead logs (unidentified), 06 July 2016, Vinjusha N., ZGCVN368; Chungam, on dead logs (unidentified), 09 November 15, Vinjusha N., ZGCVN261; Peruvannamuzhy Forest, on dead log of *Swietenia macrophylla*, 11 September 18, Vinjusha N., ZGCVN405; Edakkara, Vallikkattukavu, on dead logs of *Knema attenuata*, 16 June 2017, Vinjusha N., ZGCVN498; Palakkad district, Aryambavu, on dead wood of *Cocos nucifera*, 21 July 2015, Abhijith S., ZGCVN79; Kottayam district, Vagamon, Mottakkunnu, on dead branch (unidentified), Vinjusha N., ZGCVN245; Wayanad district, Muthanga, on dead log (unidentified), 27 July 2016, Vinjusha N., ZGCVN388; Pattanamthitta district, Gavi, on dead branches (unidentified), 04 July 2017, Vinjusha N., ZGCVN601.

Comments: Present collection shows similarity with *Rigidoporus microporus* (Sw.) Overeem in morphology, however differs by having smaller basidiomata, absence of cystidia and slightly smaller basidiospores (3.5–5 × 3.5–4 µm) (Núñez & Ryvarden 2001).

Rigidoporus lineatus has widespread distribution in Africa, Asia, America (Ryvarden & Johansen 1980) and infrequent in Europe (Ryvarden & Gilbertson 1994). Sankaran & Florence (1995), Florence & Yesodharan (1997, 2000), Leelavathy & Ganesh (2000), Mohanan (2011) and Iqbal *et al*. (2016) reported the species from Kerala.

Terana Adans.

Basidiomata annual, resupinate. Hymenophore smooth to slightly tuberculate, bluish, with monomitic type of hyphal system. Hyphae hyaline to blue coloured, thin or thick walled, bearing clamp connections. Dendrohyphidia present. Cystidia absent, basidia often with dendritical branches, 4 sterigmate, with basal clamp connections. Basidiospores ellipsoid, hyaline, smooth, thin walled, inamyloid in Melzer's reagent. Members causes white rot on wood.

Terana coerulea (Lam.) Kuntze, Revis. gen. pl. (Leipzig) 2: 872 (1891)

Basionym: *Byssus coerulea* Lam. [as '*caerulea*'], Fl. franç. (Paris) 1: (103) (1779)
Synonyms:
Dematium violaceum Pers., Syn. meth. fung. (Göttingen) 2: 697 (1801)
Auricularia phosphorea Sowerby, Col. fig. Engl. Fung. Mushr. (London) 3 (no. 24): tab. 350 (1802)
Thelephora coerulea (Lam.) Schrad. *ex* DC., in Lamarck & de Candolle, Fl. franç., Edn 3 (Paris) 2: 107 (1805)
Thelephora indigo Schwein., Schr. naturf. Ges. Leipzig 1: 107 [81 of repr.] (1822)
Athelia coerulea (Lam.) Chevall., Fl. gén. env. Paris (Paris) 1: 85 (1826)
Thelephora violascens var. *coerulea* (Lam.) Fr., Elench. fung. (Greifswald) 1: 202 (1828)
Corticium coeruleum (Lam.) Fr., Epicr. syst. mycol. (Upsaliae): 562 (1838)
Pulcherricium coeruleum (Lam.) Parmasto, Consp. System. Corticiac. (Tartu): 132 (1968)

FIGURE 17

Basidiomata annual, membranous, entirely resupinate, adnate, thin and papery, forming large patchy growth, margin indefinite and irregular. **Hymenophore** smooth to slightly tuberculate, pores absent, intense cobalt blue when fresh, colour diminishing on drying and turning greyish blue. **Context** indistinct. **Odour** not distinct. **Spore print** not observed.

Basidiospores 7–8 × 5–6 µm, Q=1.3–1.4, Q_m=1.35, ellipsoid, hyaline, smooth, thin walled, eguttulate, inamyloid in Melzer's reagent. **Basidia** 27–38 × 4–5 µm, clavate, 4 sterigmate. **Cystidia** absent. **Dendrohyphidia** present in between basidia; 20–22 × 5–6 µm wide, hyaline to blue or sometimes violet, sometimes with lateral branches, smooth or encrusted at tip. **Hymenium** interwoven and monomitic. Generative hyphae 3–6 µm wide, blue, colour fades and disappears in KOH, encrusted, with bluish contents, thick walled (up to 2 µm), highly branched with frequent clamp connection. Hyphae usually swollen and becoming bulbous at tip, closely pseudoseptate towards the widened portion, often with a bluish cap like structure.

Specimens examined: India. Kerala State: Idukki district, Anamudi, on fallen tree log (unidentified), 08 February 2018, Manju A. C., ZGCVN677.

Comments: This fungus is easily distinguished by the resupinate, intense bluish coloured basidiocarps. Microscopically, the presence of blue coloured dendrohyphidia is a remarkable character of the species. Because of the bluish colour, the type species, *Terana coerulea* is commonly called as “cobalt crust” (Thomas 2011).

The species has wide distribution in Africa, Asia, Australasia, Europe and North America (Maekawa 1994). *Terana coerulea* has not been recorded from Kerala to date.

Phlebiopsis Jülich

Basidiomata ceraceous, resupinate, effused-reflexed to pileate. Hymenophore smooth, tuberculate or odontoid to poroid. Subiculum compact with parallelly arranged, usually agglutinated hyphae. Hyphal system monomitic, with hyaline to yellowish brown coloured hyphae, that are thin to thick walled, lacking clamp connections. Cystidia present, conical, hyaline to pale golden yellow or pale brown, thick walled, densely encrusted at the tip. Basidia clavate, 4 sterigmate. Basidiospores narrowly ellipsoid to subcylindrical, thin walled, smooth, inamyloid in Melzer’s reagent. Members cause white rot on wood.

Phlebiopsis crassa (Lév.) Floudas & Hibbett, Fungal Biology 119 (7): 710 (2015)

Basionym: *Thelephora crassa* Lév., Annls Sci. Nat., Bot., sér. 3 2: 209 (1844)
Synonyms:
Stereum crassum (Lév.) Fr., Nova Acta R. Soc. Scient. upsal., Ser. 3 1 (1): 111 (1851)
Stereum umbrinum Berk. & M.A. Curtis, Grevillea 1 (no. 11): 164 (1873)
Corticium murinum Kalchbr., in Thümen, Mycoth. Univ., cent. 16: no. 1504 (1880)
Hymenochaete crassa (Lév.) Berk., Grevillea 8 (no. 48): 148 (1880)
Hymenochaete umbrina Cooke, Grevillea 8 (no. 48): 148 (1880)
Hymenochaete multispinulosa Peck, Bot. Gaz. 7 (5): 54 (1882)
Hymenochaete purpurea Cooke & Morgan, in Cooke, Grevillea 11 (no. 59): 106 (1883)
Hymenochaete scabriseta Cooke, Grevillea 11 (no. 59): 106 (1883)
Thelephora vinosa (Berk.) Massee, J. Linn. Soc., Bot. 25 (no. 170): 145 (1889)
Peniophora intermedia Massee, J. Linn. Soc., Bot. 25 (no. 170): 143 (1889)
Lloydella scabriseta (Cooke) Höhn. & Litsch., Sber. Akad. Wiss. Wien, Math.-naturw. Kl., Abt. 1 115: 1580 (1906)
Hymenochaete kwangensis Henn., Ann. Mus. Congo Belge, Bot., Sér. 5 2 (2): 97 (1907)
Lloydella vinosa (Berk.) Bres., Annls mycol. 14 (3/4): 233 (1916)
Gloeocystidium intermedium (Massee) Rick, Brotéria, N.S. 3 (1): 44 (1934)
Laxitextum crassum (Lév.) Lentz, U.S. Dept. Agric. Monogr. 24: 20 (1955)
Lloydella umbrina (Cooke) S. Ito, Mycol. Fl. Japan 2(4): 146 (1955)
Lopharia vinosa (Berk.) G. Cunn., Trans. Roy. Soc. N.Z. 83 (4): 625 (1956)
Lopharia crassa (Lév.) Boidin, Bull. trimest. Soc. mycol. Fr. 74: 479 (1959)

FIGURE 18

Basidiomata annual, membranous, entirely resupinate, adnate, hard and difficult to separate from host, thin (up to 1 mm), forming large patchy growth, margin indefinite. **Hymenophore** smooth, weakly tuberculate, with a velvety appearance when fresh, especially towards margin, deep violet to purple, turning brownish from margin towards center, **Context** indistinct. **Odour** not distinct. **Spore print** not observed.

Basidiospores 7–8 × 3–3.5 µm, Q=2.3–2.4, Q_m=2.35, narrowly ellipsoid, hyaline, smooth, thinwalled, eguttulate, inamyloid in Melzer's reagent. **Basidia** 20–52 × 4–6 µm, clavate, slightly thick walled, 4 sterigmate. **Cystidia** frequent; 52–160 × 6–15 µm, elongated fusiform, cylindrical to narrowly clavate, yellowish brown, thick walled (up to 4 µm), heavily encrusted at tip. **Hymenium** interwoven and monomitic. Generative hyphae 2–5 µm wide, hyaline to light brown, smooth, thick walled (1 µm), highly branched, at some portions narrow and arboriform, resembling skeleto ligative hyphae, frequently septate without clamp connections.

Specimens examined: India. Kerala State: Kozhikode district, Puthiyangadi, on dead log (unidentified), 06 January 2018, Arun Kumar T. K., ZGCVN666.

Comments: This species is easily recognized by smooth to tuberculate, purple coloured hymenium, thick walled encrusted cystidia and large, narrowly ellipsoid basidiospores. *Phlebiopsis amethystea* (Hjortstam & Ryvarden) Chikowski & C.R.S also produces purple tinted smooth hymenium as in *P. crassa*. According to Lima *et al.* (2020), *P. amethystea* is a closely related species of *P. crassa*. However, the former is differentiated from *P. crassa* by the darker context, consistently purple hymenium, having three types of cystidia, that are dark brown in colour.

Phlebiopsis crassa has pantropical distribution (Bernicchia & Gorjón 2010). There are no reports of this species from Kerala till date.

Bjerkandera P. Karst.

Basidiomata annual, found in imbricate clusters, resupinate, usually soft, hard and light in weight on drying, effused reflexed to pileate. Pileus sessile, flabelliform to semicircular, concentrically zonate, finely velutinate to pubescent, greyish brown to yellowish brown. Hymenophore poroid, pore surface brownish black to black, pore tubes greyish black. Context white to cream, homogenous to duplex. Hyphal system monomitic, with hyaline to light brown coloured hyphae, that are thin to sparsely thick walled, bearing clamp connections. Cystidia absent. Basidia clavate to narrowly clavate, 4 sterigmate. Basidiospores oblong ellipsoid, hyaline, smooth, thin walled and inamyloid in Melzer's reagent. Members causes white rot on wood.

Bjerkandera adusta (Willd.) P. Karst., Meddn Soc. Fauna Flora fenn. 5: 38 (1879)

Basionym: *Boletus adustus* Willd. Fl. berol. prodr.: 392 (1787)
Synonyms:
Boletus fuscoporus J.J. Planer, Ind. Pl. erfurt. Fung. add.: 26 (1788)
Boletus pelleporus Bull., Hist. Champ. Fr. (Paris) 1 (2): 365 (1791)
Boletus carpineus Sowerby, Col. fig. Engl. Fung. Mushr. (London) 2 (no. 18): tab. 231 (1799)
Polyporus carpineus (Sowerby) Fr., Observ. mycol. (Havniae) 2: 257 (1818)
Polyporus adustus (Willd.) Fr., Syst. mycol. (Lundae) 1: 363 (1821)
Polyporus adustus var. *pelleporus* (Bull.) Pers., Mycol. eur. (Erlanga) 2: 64 (1825)
Leptoporus adustus (Willd.) Quél., Enchir. fung. (Paris): 177 (1886)
Polystictus adustus (Willd.) Gillot & Lucand, Bull. soc. Hist. nat. Autun 3: 173 (1890)
Gloeoporus adustus (Willd.) Pilát, in Kavina & Pilát, Atlas Champ. l'Europe (Praha) 3: 137 (1937)
Tyromyces adustus (Willd.) Pouzar, Folia geobot. phytotax. bohemoslov. 1: 370 (1966)
Grifola adusta (Willd.) Zmitr. & Malysheva, in Zmitrovich, Malysheva & Spirin, Mycena 6: 21 (2006)

FIGURE 19

Basidiomata annual, small sized, imbricate, in clusters, coriaceous when fresh, rigid when dry, light in weight, effused reflexed to pileate. **Pileus** 25–45 mm long, 2–5 mm thick, soft and pliable when fresh, becoming hard on drying, flabelliform to nearly semicircular, applanate to wavy, radial ridges present, concentrically zonate, adpressed velutinate, hairs lesser towards margin, greyish brown or yellowish brown to brown, white along margin when young, but soon whole fruit body turns dark brown or with a vinaceous brown tint on maturity, margin wavy and lobed, narrow. **Hymenophore** poroid. **Pores** 7–9 per mm, angular, absent towards margin, greyish black to black, pore tubes up to 2 mm long, greyish black, with a discontinuous, narrow black zone above. **Context** up to 1–1.5 mm thick, cream, homogenous. **Odour** not distinct. **Spore print** not observed.

Basidiospores 3.5–4.5 × 2–2.5 µm, Q=1.2–2, Q_m=1.6, ellipsoid, hyaline, smooth, thin walled, eguttulate, inamyloid in Melzer's reagent. **Basidia** not observed. **Cystidia** absent. **Hymenial trama** interwoven and monomitic. Generative hyphae 2–4 µm wide, mostly hyaline or rarely brown pigmented, thin to slightly (up to 1 µm) thick walled, branched, with clamp connections. Skeletal hyphae and skeleto ligative hyphae not observed. **Pileal trama** interwoven and monomitic. Generative hyphae wider (2.5–7µm) and thick walled (1–1.5 µm) than those present in hymenium, hyaline to light brown, branched, with prominent clamp connections. Skeletal hyphae and skeletoligative hyphae not observed. **Pileipellis** made of trichodermal patches that are 25–42 µm long, made of hyphae 2–4 µm wide, thin to slightly thick walled, with obtuse ends.

Specimen examined: India. Kerala State: Idukki district, Thekkadi, on dead tree (unidentified), 07 July 2017, Salna N., ZGCVN838.

Comments: Morphology of the present specimen fits properly with the descriptions of *B. adusta* by Ryvarden & Johansen (1980), and Ryvarden & Gilbertson (1993). The greyish black pore surface is a remarkable character of this species (Ryvarden & Gilbertson 1993). Present collection shows similarity with another species of *Bjerkandera*, *B. fumosa* (Pers.) P. Karst. However, pore surface of the latter species is buff to brownish in colour (Ryvarden & Gilbertson 1993). In addition, *B. fumosa* produces slightly larger basidiospores (5.5–7 × 2.5–3.5 µm; according to descriptions of Ryvarden & Gilbertson 1993) than the present specimen. The spore size of *B. adusta* is 4.5–5 × 2.5–3.5 µm (Ryvarden & Johansen 1980; Corner 1989a; Núñez & Ryvarden 2001). When compared to this, present collection has slightly smaller spores (3.5–4.5 × 2–2.5 µm). *Bjerkandera adusta* is reported to produce conidia, chlamydospores and oidia in culture (Nobles 1948). However, the present study could not generate pure cultures of the species, and hence the occurrence of conidia, chlamydospores or oidia in culture was not observed.

Bjerkandera adusta is a cosmopolitan species (Núñez & Ryvarden 2001; Bernicchia 2005; Ryvarden & Melo 2014). The species has been reported from Kerala by Mohanan (2011).

Oxychaete Miettinen

Basidiomata annual, coriaceous, resupinate to effused reflexed, yellow to brown coloured with a light cardboard like texture. Hymenophore poroid, pores angular, large and shallow. Context indistinct or very thin. Hyphal system monomitic, with hyaline to yellowish brown colored hyphae, that are thin to thick walled, and lacking clamp connections. Cystidia present, arising from subhymenial region, subulate, thick walled. Basidia clavate, 4 sterigmate. Basidiospores cylindrical, slightly curved, hyaline, thin walled, inamyloid in Melzer's reagent. *Oxychaete* species cause white rot on wood.

Oxychaete cervinogilva (Jungh.) Miettinen, in Miettinen, Spirin, Vlasák, Rivoire, Stenroos & Hibbett, MycoKeys 17: 20 (2016)

Basionym: *Polyporus cervinogilvus* Jungh., Verh. Batav. Genootsch. Kunst. Wet. 17 (2): 45 (1838)
Synonyms:
Polystictus cervinogilvus (Jungh.) Fr., Nova Acta R. Soc. Scient. upsal., Ser. 3 1 (1): 94 (1851)
Microporus cervinogilvus (Jungh.) Kuntze, Revis. gen. pl. (Leipzig) 3 (3): 495 (1898)
Trichaptum cervinogilvum (Jungh.) G. Cunn., Bull. N.Z. Dept. Sci. Industr. Res. 164: 96 (1965)
Oxyporus cervinogilvus (Jungh.) Ryvarden [as *'cervin-ogilvus'*], Norw. Jl Bot. 20: 3 (1973)
Flavodon cervinogilvus (Jungh.) Corner, Beih. Nova Hedwigia 86: 58 (1987)
Flabellophora cervinogilvum (Jungh.) Corner, Beih. Nova Hedwigia 86: 58 (1987)
Rigidoporus cervinogilvus (Jungh.) Teixeira [as *'cervino-gilvus'*], Revista Brasileira de Botânica 15(2): 126 (1992)
Trametes dermatodes Lév., Annls Sci. Nat., Bot., sér. 3 2: 196 (1844)
Coriolopsis dermatodes (Lév.) Murrill, Bull. Torrey bot. Club 34: 466 (1907)
Polystictus chrysoleucus (Kalchbr.) Cooke, Grevillea 14 (no. 71): 82 (1886)
Microporus chrysoleucus (Kalchbr.) Kuntze, Revis. gen. pl. (Leipzig) 3 (3): 495 (1898)
Trametes bombycina Pat., J. Bot., Paris 3: 166 (1889)

FIGURE 20

Basidiomata initially formed as small patches on the substratum, later coalesced and widely effused with well defined margins, sometimes becoming pileate from edges, almost coriaceous when fresh, thin and light in weight, harder on drying, up to 280 mm long. **Pileus** 14–98 mm long, up to 2 mm thick, applanate, surface tomentose, narrowly zonate, hairs more at zontations, dark ochre, pale yellow at margin, turning brownish black in KOH, margin even. **Hymenophore** poroid. **Pores** 1–2 per mm, angular, sometimes obliquely elongated, pale orangish brown when fresh, margin pale yellow or cream, turning light brown on drying.

Context less than 1 mm thick, pale ochre, turning brownish on bruising. **Odour** not distinctive. **Spore print** pale yellow.

Basidiospores 5–7.5 × 2–3 µm, Q=2.6–4, Q_m=3.51, subcylindrical to oblong ellipsoid, hyaline, smooth, thin walled, eguttulate, inamyloid in Melzer's reagent. Basidia 16–19 × 5.2 µm, clavate, 4 sterigmate. **Cystidia** 14–23 × 4–8 µm, ventricose, hyaline to brown, encrusted, thick walled, wall thickness up to 3 µm. **Hymenial trama** interwoven and monomitic. Generative hyphae 2–5 µm wide, hyaline to yellow brown, smooth to weakly encrusted, encrustations usually easily dissolved in KOH, thin to thick walled (1 µm), branched, without clamp connections. **Pileal trama** loosely interwoven than hymenial trama. Generative hyphae 2–6 µm wide, hyaline to yellow brown, smooth to weakly encrusted, encrustations usually easily dissolved in KOH, thin to thick walled (1 µm), branched, without clamp connections. **Pileipellis** interwoven at the base and aggregating to form trichodermium with obtuse ends; hyphae 2–5 µm wide, hyaline to pale brown, thick walled, with obtuse ends.

Specimens examined: India. Kerala State: Kozhikode district, Pokkunnu, ZG college campus, on dead branch of *Ficus religiosa*, Vinjusha N., ZGCVN202; Chelavoor, Thurayil kotta, on dead branch, Vinjusha N., ZGCVN209; Chelapram, on dead branch of *Acacia manjium*, 22 October 2015, Vinjusha N, ZGCVN239; Marad, on dead log (unidentified), 03 January 2015, Athira C. K., ZGCVN281, ZGCVN282; Kannur district, Poongottukavu, on branch (unidentified), 12 September 2018, Vinjusha N., VN717.

Comments: Basidiospores of *O. cervinogilva* show variations according to different descriptions such as, 6.5–8.5 × 3–3.8 µm (Corner 1987), 7–9.5 × 3.5–4 µm (Gilbertson & Adaskaveg 1993), 5.9–8.9 × 2.8–3.8 µm (Miettinen *et al.* 2016). BLAST search using the ITS sequences from the present collection showed 99% similarity with *O. cervinogilva* (GenBank numbers: MK269274, MK269143, MK269147). BLAST search also resulted in 99% similarity with *Phanerochaete chrysosporium* Burds. (KP771707), however is separated by having smooth hymenium and cylindrical cystidia (Bursdall 1985).

The species has distribution in tropical Asia and Australia (Ryvarden & Johansen 1980) and Unites States of America (Gilbertson & Adaskaveg 1993). Leelavathy & Ganesh (2000) and Mohanan (2011) had reported this species from Kerala (as *Oxyporus cervinogilvus* (Jungh.) Ryvarden).

Panus Fr.

Basidiomata annual, stipitate, infundibuliform. Pileus circular, concentrically zonate or azonate, glabrous to strigose or radially striated, brownish. Hymenophore lamellate, surface light to dark brown, hyphal pegs absent. Context thin, cream to brown, homogenous. Hyphal system dimitic, generative hyphae hyaline, with clamp connections. Skeletal hyphae hyaline to pale brown, thick walled. Pleurocystidia present as either gloeocystidia, metuloid cystidia or skeletocystidia. Basidia clavate, 4 sterigmate. Basidiospores subcylindrical to cylindrical, hyaline, smooth, thin walled, inamyloid in Melzer's reagent. Members cause white rot on wood.

Panus similis (Berk. & Broome) T.W. May & A.E. Wood, Mycotaxon 54: 148 (1995)

Basionym: *Lentinus similis* Berk. & Broome, J. Linn. Soc., Bot. 14 (no. 73): 43 (1873)
Synonyms:
Pocillaria similis (Berk. & Broome) Kuntze, Revis. gen. pl. (Leipzig) 2: 866 (1891)
Lentinus velutinus f. *similis* (Berk. & Broome) Pilát, Annls mycol. 34 (1/2): 130 (1936)
Panus fulvus var. *similis* (Berk. & Broome) Corner, Beih. Nova Hedwigia 69: 85 (1981)

FIGURE 21

Basidiomata annual, medium to large sized, solitary, coriaceous when young, tough and hard when mature, light in weight, stipitate, often deeply rooted on the host, up to 140 mm tall. **Pileus** 50–130 mm diameter, circular, plano-concave or infundibuliform, radially plicate sulcate with striations, velutinate to glabrous, dark ochre to brown, darker near center and becoming paler towards margin, margin ciliate, even to wavy, up curved on drying. **Hymenophore** lamellate, lamellae subdecurrent, not crowded, edge even, lamellulae few, dark brown. **Context** 1 mm or less thick, pale brown. **Stipe** 40–90 mm long, 4–8 mm thick, centrally to eccentrically attached, cylindrical, even, with irregular pseudosclerotium at the base, which are deeply inserted in the host, stipe surface densly villose to squamulose, dark brown, tissue solid, cream. **Odour** not distinct. **Spore print** not observed.

Basidiospores 5–6 × 2.5–3 µm, Q=1.6–2.4, Q_m=2, subcylindrical to ellipsoid, hyaline, smooth, thin walled, with a few guttules, inamyloid in Melzer’s reagent. **Basidia** 20–25 × 3–6 µm, narrowly clavate, 4 sterigmate. **Pleurocystidia** frequent; 21–35 × 5–7 µm, weakly lageniform, straight to flexuose, hyaline, thin to slightly thick walled, brightly stained in phloxine, with obtusely rounded apex. **Sclerocystidia** present; 17–30 × 4–7 µm, conical to subulate, hyaline, smooth, thick walled (1-1.5 µm), with acute tips. Hyphal pegs absent. **Hymenial trama** irregular and dimitic. Generative hyphae 2–3 µm wide, hyaline, smooth, thin walled, branched, with clamp connections. Skeletal hyphae dominant, 2–4 µm wide, hyaline to pale coloured, thick walled (1 µm), mostly unbranched, sometimes weakly branched, septations not observed. **Pileal trama** interwoven. Generative hyphae 2–3 µm wide, hyaline, smooth, thin walled, branched, with clamp connections. Skeletal hyphae dominant, 2–5 µm wide, hyaline to pale coloured, thick walled (1 µm), mostly unbranched, sometimes weakly branched, septations not observed. **Pileipellis** ascending to erect trichoderm, often forming trichodermal patches up to 62 µm long, made of hyphae that are 1.5–3 µm wide, hyaline to yellowish brown. **Stipe trama** interwoven. Generative hyphae 2–4 µm wide, hyaline, smooth, thin walled, branched, with clamp connections. Skeletal hyphae 2–5 µm wide, hyaline to pale brown, thick walled (1 µm), unbranched to weakly branched, septations not observed. **Stipitipellis** composed of erect, thick trichodermial patches, made of hyaline to yellowish brown, thin to slightly thick walled hyphae that are 2–4 µm wide.

Specimens examined: India. Kerala: Kozhikode district, Edakkara, Vallikkatukavu, on dead log (unidentified), 15 August 2015, Vinjusha N., ZGCAL15; Kotooli, on dead wood stump (unidentified), Vinjusha N., ZGCVN138; Chelannur, Kalarimala, on fallen log of *Anacardium occidentale,* Vinjusha N., ZGCVN177; Kuttyadi, Thottil palam, on dead log (uunidentified), Vinjusha N., ZGCVN718; Peruvannamuzhy forest, on dead log (unidentified), 22 November 2018, Vinjusha

N., ZGCVN764; Peruvannamuzhy forest, on dead log, 11 August 2016, Vinjusha N., ZGCVN430; Malappuram district, Idimuzhikkal, on dead log (unidentified), 01 September 2015; Vinjusha N., ZGCVN25; Idukki district, Vattavada, on dead wood (unidentified), 28 July 2019, Vinjusha N., ZGCVN892, ZGCVN895, ZGCVN896; Kasaragod district, Edayilakad Kavu, on dead wood (unidentified), 16 September 2019, Vinjusha N., ZGCVN911.

Comments: *Panus similis* is easily identified from the field by centrally to eccentrically stipitate, infundibuliform basidiomata arising from a pseudosclerotium, cinnamon brown to dark brown, plicate sulcate pileus and ciliate margin. Microscopically, this species is characterized by the presence of cheilocystidia, sclerocystidia and elliposoid to oblong cylindrical basidiospores. *Panus velutinus* is the closely related species, however, separated by densely velutinate, non striated pileus (Pegler 1983).

The species has a paleotropical distribution (Pegler 1983). From Kerala, *P. similis* has been reported by Manimohan *et al.* (2004, as *L. similis* Berk. & Broome) and Mohanan (2011).

Panus neostrigosus Drechsler-Santos & Wartchow, J. Torrey bot. Soc. 139 (4): 438 (2012)

Basionym: *Agaricus strigosus* Schwein., Schr. naturf. Ges. Leipzig 1: 89 [63 of repr.] (1822)
Synonyms:
Agaricus crinitus Schwein., Schr. naturf. Ges. Leipzig 1: 89 [63 of repr.] (1822)
Lentinus strigosus Fr., Syst. orb. veg. (Lundae) 1: 77 (1825)
Lentinus lecomtei Fr., Syst. orb. veg. (Lundae) 1: 77 (1825)
Lentinus strigosus var. *tenuipes* Berk. & Broome, J. Linn. Soc., Bot. 14 (no. 73): 43 (1873)
Pocillaria strigosa (Fr.) Kuntze, Revis. gen. pl. (Leipzig) 2: 866 (1891)
Pocillaria lecomtei (Fr.) Kuntze, Revis. gen. pl. (Leipzig) 2: 866 (1891)
Panus rudis f. *stipitata* Malk., Annls mycol. 30 (1/2): 40 (1932)
Panus semirudis Singer, Beih. Botan. Centralbl., Abt. B 56: 142 (1936)
Panus rudis var. *semirudis* (Singer) Singer, Lilloa 25: 275 (1952)
Panus lecomtei (Fr.) Corner, Beih. Nova Hedwigia 69: 90 (1981)
Panus lecomtei var. *stipitatus* (Malk.) Zmitr., Bondartseva, Perevedentseva, Myasnikov & Kovalenko, Turczaninowia 21 (3): 39 (2018)
Panus lecomtei var. *semirudis* (Singer) Zmitr., Bondartseva, Perevedentseva, Myasnikov & Kovalenko, Turczaninowia 21 (3): 38 (2018)

FIGURE 22

Basidiomata annual, small to medium sized, 42–75 mm tall, solitary, coriaceous when young, tough and hard when mature, light in weight, stipitate, almost deeply rooted on the host. Pileus 3–8 mm diameter, infundibuliform, concentric zonations absent, rough, densly villose to strigose through out, pinkish brown to brown, margin densely ciliate, even to wavy, in curved on drying. **Hymenophore** lamellate, lamellae crowded, flexuose, not decurrent, edge even, lamellulae present, brown. **Context** 1 mm or less wide, pale brown. **Stipe** 10–74 mm long, 5–10 mm thick, central, cylindrical, even, broader near base, surface strigose, dark brown, tissue solid, cream. **Odour** not distinct. **Spore print** not observed.

Basidiospores 4–6 × 1.5–2.5 µm, Q=1.6–3, Q_m=2.15, elliptical to ovoid, hyaline, smooth, thin walled, with a few guttules, inamyloid in Melzers reagent. **Basidia** 22–30 × 4–5 µm, clavate, 4 sterigmate. **Cheilocystidia** present, 27–38 × 5–6 µm, clavate to cylindrical, mostly swollen at the middle, hyaline, smooth, thin walled with obtuse tips. **Skeletocystidia** present, 40–84 × 8–14 µm, broadly clavate, hyaline, smooth, highly thick walled (4–6 µm), narrow at the apex, with basal clamp connections. **Hyphal pegs** absent. **Hymenial trama** radially arranged, and dimitic. Generative hyphae 2–3 µm wide, hyaline, smooth, thin to slightly thick walled (up to 1 µm), branched, with frequent clamp connections. Skeletal hyphae dominant, 2–4 µm wide, hyaline, thick walled (1 µm), mostly unbranched, sometimes weakly branched, septations not observed. Skeleto ligative hyphae not observed. **Pileal trama** interwoven, dimitic. Generative hyphae 2–4 µm wide, hyaline, smooth, thin to slightly thick walled (up to 1 µm), branched, with clamp connections. Skeletal hyphae 3–5 µm wide, hyaline, thick walled (1 µm), mostly unbranched to weakly branched, septations not observed. Skeleto ligative hyphae not observed. **Pileipellis** basically a cutis forming erect, ascending trichodermial patches; 40–100 µm long, made of hyphae that are 2–5 µm wide, hyaline to pale brown, thick walled with obtuse ends. **Stipe trama** interwoven. Generative hyphae 2–4 µm wide, hyaline, smooth, thin to slightly thick walled (up to 1 µm), branched, with clamp connections. Skeletal hyphae 3–5 µm wide, hyaline, thick walled (1 µm), mostly unbranched to weakly branched, septations not observed. **Stipitipellis** similar as pileipellis, but trichodermial patches more elongate, made of hyphae, 2–5 µm wide, hyaline to pale brown, thick walled, with obtuse ends.

Specimens examined: India. Kerala State: Malappuram district, Nilambur, KFRI campus, on dead wood (unidentified), 03 July 2018, Vinjusha N, ZGCVN687; Idukki district, Vattavada, on dead wood (unidentified), 28 July 2019, Vinjusha N., ZGCVN897.

Comments: Morphologically, the present collection is similar to *P. velutinus*, especially by having a thick, hairy pileus. However, the latter produces much longer stipe (2–25 cm tall), larger basidiospores (5–8 × 3–3.7 µm) (according to descriptions of Pegler 1983).

Panus neostrigosus has widespread distribution in Asia, Africa, North America, South America and is occasionally distributed in Europe (Pegler 1983). From Kerala, this species has been recorded by Maninohan *et al.* (2004) and Mohanan *et al.* (2011).

Panus bambusinus (T.K.A. Kumar & Manim.) N. Vinjusha & T.K.A. Kumar *comb. nov.*

Basionym: *Lentinus bambusinus* T.K.A. Kumar & Manim., Mycotaxon 92: 119 (2005)

FIGURE 23

Basidiomata annual, small to large, solitary or in caespitose clusters, centrally stipitate. **Pileus** 15–200 mm diameter, weakly depressed in the centre or infundibuliform, concentric zonations absent, squamulose when young, almost glabrous with age, wrinkled in dried specimens, margin entire, dentate or irregularly lobed. **Hymenophore** lamellate. Lamellae close, deccurent, sometimes dichotomously branched, edge finely fimbriate under a lens, lamellulae present in 3–4 tiers, yellowish white. **Context** up to 6 mm thick, white. **Stipe** 40–100 mm long, 5–25 mm thick, central, cylindrical, even in younger specimens, tapering towards the base in older specimens, surface glabrous to matted fibrillose or strigose, sometimes with sparse and scattered squamules, yellowish white to brown, tissue solid, cream. **Odour** not distinct. **Spore print** not observed.

Basidiospores 5–6.5 × 4–4.5 µm, Q=1.3–1.7, Q_m=1.32, ellipsoid to ovoid, hyaline, smooth, thin walled, with refractive guttules, inamyloid in Melzers reagent. **Basidia** 20–37 × 5–7 µm, clavate, 4 sterigmate. **Cheilocystidia** present, 22–68 × 3–5 µm, versiform, generally flexuose, branched towards apex, hyaline, smooth, thin walled with obtuse tips. **Gloeocystidia** frequent on edges and sides of lamellae, 24–48 × 6–15 µm, mostly fusoid with acuminate tips, or narrowly clavate, hyaline, smooth, thin walled. **Hyphal pegs** absent. **Hymenial trama** radially arranged, and dimitic. Generative hyphae 2–6 µm wide, hyaline, smooth, thin to slightly thick walled (up to 1 µm), branched, with clamp connections. Skeletal hyphae dominant, 2–4 µm wide, hyaline, thick walled (1 µm), mostly unbranched, rarely branched, septations not observed. Skeleto ligative hyphae not observed. **Pileal trama** radially arranged. Generative hyphae 2–6 µm wide, rarely inflated up to 10 µm, hyaline, smooth, thin to slightly thick walled (up to 1 µm), branched, with clamp connections. Skeletal hyphae dominant, 2–6 µm wide, hyaline, thick walled (1 µm), mostly unbranched, rarely branched, septations not observed. Skeleto ligative hyphae not observed. **Pileipelliis** with scattered trichodermial patches, up to 100 µm long, made of hyphae that are 2–4 µm wide, hyaline, thin to slightly thick walled (up to 1 µm), with obtuse ends. **Stipe trama** interwoven. Generative hyphae 2–5 µm wide, hyaline, smooth, thin to slightly thick walled (up to 1 µm), branched, with clamp connections. Skeletal hyphae 2–5 µm wide, hyaline, thick walled (1 µm), mostly unbranched, rarely branched, septations not observed. **Stipitipellis** similar as pileipellis, made of hyphae that are 2–4 µm wide, hyaline, mostly thin walled, with obtuse ends.

Specimens examined: India. Kerala State: Malappuram district, Thenjipalam, Calicut University Campus, On dead roots and rhizomes of *Bambusa bambos*, 26 October 2004, T. K. Arun Kumar, AK61d (deposited at CALI).

Comments: *Panus* was earlier considered as one of the two sub genera of *Lentinus* (Pegler 1983). According to Pegler (1983), sub genus *Panus* includes species without skeleto ligative hyphae and hyphal pegs, whereas, the other sub genus, *Lentinus* included species with skeleto ligative hyphae and hyphal pegs. In a recent phylogenetic study on Polyporales by Binder *et al.* (2013), *Panus* nested in a residual polyporoid clade, whereas, *Lentinus* was positioned in the core polyporoid clade. The position of *Panus* outside the core polyporoid clade was also confirmed in a later study by Zmitrovich & Kovalenko (2016). Recent taxonomic studies treat *Lentinus* and *panus* as independent genera of Polyporales (Njouonkou *et al.* 2013; Seelan *et al.* 2015, Senthilarasu 2015). Morphologically, the absence of hyphal pegs, presence of skeletal hyphae, without skeleto ligative hyphae, and presence of gloeocystidia or skeletocystidia are diagnostic features of *Panus sensu stricto*. Based on this combination of characters, some species of *Lentinus* (*L. caespiticola* Pat. & Har., *L. strigosus* Fr., *L. alpacus* Senthil. & S.K. Singh) has been recently transferred to *Panus* (*P. caespiticola* Pat. & Har., *P. neostrigosus* Drechsler-Santos & Wartchow, *P. alpacus* Senthil. respectively) (Drechsler-Santos *et al.* 2012; Senthilarasu 2015).

Lentinus bambusinus is species originally described from Kerala by Kumar & Manimohan (2005). According to Kumar & Manimohman (2005), *L. bambusinus* belonged to sub genus *Panus* of genus *Lentinus*. Although, this species was placed under the genus *Lentinus*, the authors (Kumar & Manimohan 2005), had also suggested the affinity of *L. bambusinus* to *Panus sensu stricto*. In a latest phylogenetic study on lentinoid and polyporoid genera, Seelan *et al.* (2015), had mentioned that the morphological features of *L. bambusinus* makes them closer to genus *Panus* than to the genus *Lentinus*.

The herbarium specimens of *L. bambusinus* (AK61c, AK61d, AK61e) collected and studied by Kumar & Manimohman (2005), were reexamined during the present study. The combination of characters such as presence of gloeocystidia, and absence of hyphal pegs and skeleto ligative hyphae fits this species within the genus *Panus*, than in the genus *Lentinus*. Thus, based on morphological evidence, the species is treated under the genus *Panus* in the present study. So far, nobody has formally changed the combination of *L. bambusinus* to *P. bambusinus*. Hence, *P. bambusinus comb.nov* is proposed here.

Panus hookerianus (Berk.) T.W. May & A.E. Wood**,** Mycotaxon 54: 148 (1995)

Basionym: *Lentinus hookerianus* Berk., Hooker's J. Bot. Kew Gard. Misc. 3: 44 (1851)
Synonym:
Pocillaria hookeriana (Berk.) Kuntze, Revis. gen. pl. (Leipzig) 2: 866 (1891)

FIGURE 24

Basidiomata annual, medium sized, solitary, coriaceous when young, hard on drying, light in weight, stipitate, 25–45 mm tall. **Pileus** 28–50 mm diameter, circular, plano concave or infundibuliform, hispid strigose, with almost erect fasciculate hairs, cinnamon brown, with few impressed concentric zones, radial striations absent, margin even, thin, ciliate, incurved on drying. **Hymenophore** lamellate, lamellae subdecurrent, crowded, edge even, lamellulae present, but not frequent, surface cream to pale ochre. **Context** 1 mm thick, cream. **Stipe** 15–45 mm long, 4–7 mm thick centrally to eccentrically attached, cylindrical, even, stipe surface densely strigose, brown, tissue solid to fistulose, white. **Odour** not distinct. **Spore print** not observed.

Basidiospores 5–6 × 2–3 μm, Q=2–2.5, Q_m=2.2, oblong ellipsoid, hyaline, smooth, thin walled, with a few guttules, inamyloid in Melzer's reagent. **Basidia** not observed. **Cheilocystidia** 18–35 × 4–7 μm, elongate cylindrical to fusoid, often with constrictions, thin walled, apex rounded. **Meluloid cystidia** also frequent, 18–36 × 6–8 μm, lageniform to ventricose, hyaline, smooth, thick walled (1–1.5 μm), with acute tips. **Hymenial trama** dimitic, with radial construction. Generative hyphae 1.5–3 μm wide, hyaline, smooth, thin walled, branched, with clamp connections. Skeletal hyphae dominant, 2–4 μm wide, hyaline, thick walled (1 μm), unbranched, septations not observed. **Pileal trama** interwoven. Generative hyphae 2–3 μm wide, hyaline, smooth, thin walled, branched, with clamp connections. Skeletal hyphae dominant, 2–5 μm wide, hyaline, thick walled (1 μm), unbranched, septations not observed. **Pileipellis** consists of trichodermal patches, 50–84 μm long, made of hyphae that are 2–5 μm wide, hyaline to pale yellow brown, thick walled (1 μm), with obtuse ends. **Stipe trama** parallel. Generative hyphae 2–4 μm wide, hyaline, smooth, thin walled, branched, with clamp connections. Skeletal hyphae 2–5 µm wide, hyaline to pale brown, thick walled (1 µm), unbranched, septations not observed. **Stipitipellis** composed of erect, thick trichodermial patches, more than 100 µm long, made of hyphae that are 2–4 µm wide, hyaline to yellowish brown, thick walled hyphae.

Specimen examined: India. Kerala State: Idukki district, Vattavada, on dead wood (unidentified), 28 July 2019, Vinjusha N., ZGCVN897.

Comments: According to Pegler (1983), the size of cheilocystidia of *P. hookerianus* is 14–19 × 3–4 µm. When compared to this, cheilocystidia of present Kerala collection is larger in size (18–35 × 4–7 µm). Present collection also shows high similarity with *Lentinus ciliatus* Lév. in morphology. According to Pegler (1983), stipe of *L. ciliatus* arise from a psedosclerotium. However, stipe of present collection do not arise from a psedosclerotium. Pileus surface of *L. ciliatus* is velutinate to short hispid, that may become squamulose towards the center (Pegler 1983). Whereas, pileus surface of present Kerala collection is hispid strigose, with almost erect fasciculate hairs. The present Kerala collection also shows similarity with *P. velutinus*, however, the latter lacks thin walled cheilocystidia, and produces slightly larger basidiospores (5–8 × 3–3.7 µm) (as per the description of Pegler 1983).

Panus velutinus **(**Fr.) Sacc., Syll. fung. (Abellini) 5: 618 (1887)

Basionym*: Lentinus velutinus* Fr. Linnaea 5: 510 (1830)
Synonyms:
Lentinus fulvus Berk., Ann. Mag. nat. Hist., Ser. 1 10: 369 (1843)
Lentinus blepharodes Berk. & M.A. Curtis, J. Linn. Soc., Bot. 10 (no. 45): 301 (1868)
Lentinus fastuosus Kalchbr. & MacOwan, in Kalchbrenner, Grevillea 9 (no. 52): 135 (1881)
Pocillaria velutina (Fr.) Kuntze, Revis. gen. pl. (Leipzig) 2: 866 (1891)
Pocillaria blepharodes (Berk. & M.A. Curtis) Kuntze, Revis. gen. pl. (Leipzig) 2: 865 (1891)
Pocillaria fastuosa (Kalchbr. & MacOwan) Kuntze, Revis. gen. pl. (Leipzig) 2: 866 (1891)
Lentinus velutinus var. *africanus* Henn., Bot. Jb. 17: 31 (1893)
Lentinus castaneus Ellis & T. Macbr., Bull. Lab. Nat. Hist. Iowa State Univ. 3 (4): 194 (1896)
Lentinus velutinus var. *blepharodes* (Berk. & M.A. Curtis) Pilát, Annls mycol. 34 (1/2): 130 (1936)
Lentinus pseudociliatus Raithelh., Hong. Arg. (Buenos Aires) 1: 146 (1974)
Panus fulvus var. *fenestratus* Corner, Beih. Nova Hedwigia 69: 83 (1981)
Panus fulvus var. *glabrior* Corner, Beih. Nova Hedwigia 69: 83 (1981)
Panus fulvus var. *nudicollum* Corner, Beih. Nova Hedwigia 69: 84 (1981)

FIGURE 25

Basidiomata annual, medium sized, 62–125 mm tall, solitary, more or less soft and coriaceous when young, hard and woody when mature, light in weight, stipitate. **Pileus** up to 65 mm diameter, circular, infundibuliform, radially grooved, covered with densly velutinous to strigose hairs, pink to purplish when young, pallid to earth brown when mature, margin incurved, wavy, densely ciliate. **Hymenophore** lamellate, lamellae not crowded, without dichotomous branches, lamellulae absent, decurrent on stipe, lamellae edge even, surface cream to light brown. **Context** cream, homogenous, 1–2 mm thick. **Stipe** central, up to 75 mm long, 3–5 mm thick, central or eccentric, cylindrical, even, earth brown, paler than pileus, velutinous, tissue solid, cream. **Odour** not distinct. **Spore print** not observed.

Basidiospores 7–9 × 3–5 µm, Q=1.7–3, Q_m=2.1, ellipsoid, hyaline, smooth, thin walled, guttulate, inamyloid in Melzers reagent. **Basidia** 16–32 × 5–7 µm, clavate, 4 sterigmate. **Cheilocystidia** frequent, 24–44 × 4–9 µm, fusiform to cylindrical, sometimes swollen at the middle, hyaline, smooth, thin walled. **Metuloid cystidia** present, 28–33 × 4–7 µm ventricose, narrowly utriform with mucronate tip, erect to slightly flexuose, hyaline, smooth, thick walled (1-3 µm). **Pleurocystidia** absent. **Hyphal pegs** not observed. **Hymenial trama** radially arranged. Generative hyphae 2–3 µm wide, hyaline, smooth, thin to slightly thick walled (up to 1 µm), branched, with clamp connections. Skeletal hyphae dominant, 2–4 µm wide, hyaline, thick walled (1 µm), unbranched, septations not observed, lumen narrow or absent. **Pileal trama** intertwined. Generative hyphae 2–4 µm wide, hyaline, smooth, thin to slightly thick walled (up to 1 µm), branched, with clamp connections. Skeletal hyphae dominant, 2–5 µm wide, hyaline, thick walled (1 µm), unbranched, septations not observed, lumen absent. **Pileipellis** composed of erect, ascending, elongate trichodermal patches, formed of hyphae that are 2–5 µm wide, hyaline to pale brown, thick walled with obtuse tips. **Stipe trama** interwoven. Generative hyphae similar as in pileus, 2–3 µm wide, hyaline, smooth, thin to slightly thick walled (up to 1 µm), branched, with clamp connections. Skeletal hyphae more wide (3–5 µm) and thick walled (up to 1.5 µm), hyaline, unbranched, without septations. **Stipitipellis** composed of long trichodermial patches same as pileipellis, made of 3–6 µm wide, hyaline to light brown, thick walled (up to 2 µm) hyphae.

Specimens examined: India. Kerala State: Kozhikode district, Peruvannamuzhy forest, on dead branch of *Abrus precatorius*, Vinjusha N., ZGCVN523; Kuttyadi, Janaki forest, on dead branch (unidentified), Vinjusha N., ZGCVN590; Palakkad district, Dhoni, on dead log (unidentified), 28 November 2018, Vinjusha N., ZGCVN777.

Comments: *Lentinus velutinus* Fr. is a species originally described by Fries in 1830. Later, the species was treated under the genus *Panus*, as *P. velutinus* (Fr.) Sacc. by Saccardo (1887). Pegler (1983) considered the species in the genus *Lentinus* as Fries. According to the Index Fungorum database (accessed on 21 September 2020), current name of the species is *L. velutinus*. However, basidiomata with absence of hyphal pegs, and presence of metuloid cystidia properly place the species within the genus *Panus,* than in the genus *Lentinus.* Recent taxonomic works on lentinoid fungi by Drechsler-Santos *et al*. (2012) and Senthilarasu (2015) also treats this species as *P. velutinus*. Hence, based on the morphological characters, the species is considered as *P. velutinus* in the present study.

Characters of the present specimens properly match with the description of *P. velutinus* by Pegler (1983, as *L. velutinus*). According to Pegler (1983), stipe of *P. velutinus* generally arises from a pseudosclerotium. However, pseudosclerotium was not observed in the present collections. Present collections show similarity with *Panus similis* (Berk. & Broome) T.W. May & A.E. Wood, and *Panus natarajanus* Senthil. *Panus similis* has radially plicate sulcate pileus (Pegler 1983), wheres, pileus surface of the present collection is not radially striate and strongly velutinous. In addition, *Panus simils* has smaller basidiospores (5–6.2 × 2.5–3.2 µm) than the present collection. *Panus natarajanus* differs from the present collection by having concentrically zonate pileus and smaller basidiospores (4.5–5 (–5.5) × 2.5–3 µm).

Panus velutinus has pantropical distribution. The species has been reported from Kerala by Vrinda & Pradeep (2014).

Podoscypha Pat.

Basidiomata annual, mostly thin and coriaceous, solitary or in imbricate clusters, pileate to stipitate, when stipitate, infundibuliform. Pileus semicircular to flabelliform, hirsute to glabrous, white, cream to brown, margin even to wavy. Hymenium smooth to more or less rugose, surface cream to light brown. Hyphal system dimitic, generative hyphae thin to thick walled, with clamp connections. Skeletal hyphae hyaline, thick walled. Skeletocystidia, metuloid cystidia present or absent. Gloeocystidia present with basal clamp connections. Basidia clavate, narrowly clavate to cylindrical. Basidiospores ellipsoid to cylindrical, hyaline, smooth, thin walled, inamyloid in Melzer's reagent. *Podoscypha* species cause white rot on wood.

Podoscypha thozetii (Berk.) Boidin, Revue Mycol., Paris 24: 208 (1959)

Basionym: *Stereum thozetii* Berk., J. Linn. Soc., Bot. 18: 385 (1881)
Synonym:
Stereum cyathoides Henn., Hedwigia 37: 284 (1898)

FIGURE 26

Basidiomata annual, small sized, 10–30 mm tall, usually solitary, infundibuliform, light in weight, coriaceous when fresh, slightly hard when dry, pileate. **Pileus** 9–30 mm in diameter, circular, moderately to deeply depressed in the centre, with narrow concentric zones, glabrous, creamy ochraceous to brown, more brownish towards center, margin whitish, margin distinctly, undulate thin and papery. **Hymenophore** smooth, pores absent, creamish white when fresh, very pale brown when dry. **Context** less than 1 mm thick, cream. **Stipe** 3–9 mm long, 2–4 mm thick, cylindrical, brown, glabrous to minutely pruinose, tissue solid, even. **Odour** not distinct. **Spore print** not observed.

Basidiospores 4–7 × 3–4 µm, $Q=1.1–2$, $Q_m=1.47$, oblong ellipsoid to subglobose, hyaline, smooth, thin walled, usually monguttulate, inamyloid in Melzer's reagent. **Basidia** 30–40 × 4–6 µm, narrowly clavate, 4 sterigmate. **Gloeocystidia** abundant, 55–85 × 7–10 µm, subcylindrical, slightly sinuous, often with constrictions, hyaline, thin walled. **Hymenial trama** interwoven and dimitic.

Generative hyphae 3–4 µm wide, hyaline, smooth, thin walled, branched, with clamp connections. Skeletal hyphae 2.5–5 µm wide, hyaline, thick walled (up to 2 µm), mostly solid, unbranched to sparsely branched, septations not observed. Skeleto ligative hyphae not observed. **Pileal trama** interwoven. Generative hyphae 3–4 µm wide, hyaline, smooth, thin walled, branched, with clamp connections. Skeletal hyphae 2–4 µm wide, hyaline, thick walled (up to 2 µm), mostly solid, unbranched, septations not observed. Skeleto ligative hyphae not observed. **Pileipellis** a cutis composed of hyphae that are 2–4 µm wide, hyaline to pale brown, slightly thick to thick walled. **Stipe** trama similar as pileus trama; generative hyphae 3–4 µm wide, hyaline, smooth, thin walled, branched, with clamp connections. Skeletal hyphae 2–4 µm wide, hyaline, thick walled (up to 2 µm), mostly solid, unbranched, septations not observed. **Stipitipellis** an irregular cutis composed of hyphae that are less parallel arranged, 2-4 µm wide, hyaline to light brown, mostly thick walled.

Specimen examined: India. Kerala State: Kozhikode district, Pokkunnu, ZG College campus, on soil, 12 June 2016, Vinjusha N., ZGCVN326.

Comments: Basidiomata, that are often associated with grasses, and the absence of hymenial cystidia, pileocystidia, caulocystidia, and oblong ellipsoid basidiospores easily distinguish *P. thozetii* from other *Podoscypha* species.

Podoscypha thozetii has occurrence in Africa, America, Asia and Australasia (Ryvarden 2010). This species has not been previously reported from India so far.

Podoscypha venustula (Speg.) D.A. Reid, Beih. Nova Hedwigia 18: 260 (1965)

Basionym: *Thelephora venustula* Speg., Anal. Soc. cient. argent. 17 (2): 76 (1884)
Synonyms:
Thelephora zollingeri Sacc., Syll. fung. (Abellini) 6: 530 (1888)
Stereum flabellatum Pat., Bull. Soc. mycol. Fr. 16 (4): 179 (1900)
Podoscypha flabellata (Pat.) Pat., in Duss, Enum. Champ. Guadeloupe (Lons-le-Saunier): 21 (1903)
Lloydella affinis (Lév.) Bres., Hedwigia 51 (4): 322 (1912)
Stereum venustulum (Speg.) Lloyd, Mycol. Writ. 4: 36 (1913)
Stereum malabarense Lloyd, Mycol. Writ. 4: 39 (1913)
Stereum translucens Lloyd, Mycol. Writ. 7 (Letter 74): 1334 (1925)
Podoscypha affinis (Lév.) Pat., Annals Cryptog. Exot. 1: 4 (1928)

Auricularia affinis (Lév.) J.M. Mend., Philipp. J. Sci., C, Bot. 65: 99 (1938)
Podoscypha venustula f. *malabarensis* (Lloyd) D.A. Reid, Beih. Nova Hedwigia 18: 272 (1965)
Podoscypha venustula subsp. *cuneata* D.A. Reid, Beih. Nova Hedwigia 18: 264 (1965)

FIGURE 27

Basidiomata medium sized, 19–38 mm high, light in weight, narrowly infundibuliform or pilei fused along the margin to form a closed structure, attached to the substratum with a distinct stipe like part. **Pileus** 24–43 mm in diameter, circular, circular, glabrous, almost shiny, concentrically zonate, creamish brown with alternating dark brown to brownish black, even to wavy concentric circles, margin even to slightly wavy, thin and papery. **Stipe** like portion 7–8 mm long, cylindrical to laterally compressed towards the base, hispid, solid, with a flat disc like base. **Hymenophore** smooth, pores absent, cream when fresh, greyish to light brown on bruising. **Context** less than 1 mm thick, creamish white. **Odour** not distinct. **Spore print** not observed.

Basidiospores 4.2–5.5 × 2–3.7 µm, Q=1.2–2.5, Q_m=1.66, ellipsoid to broadly ellipsoid, smooth, thin walled, guttulate, inamyloid in Melzer’s reagent. **Basidia** 30–32 × 4–4.7 µm, cylindrical to narrowly clavate, 4 sterigmate, with granular contents and basal clamp connections. **Gloeocystidia** abundant, 29–79 × 4–10 µm, cylindrical, sinuous, narrowly utriform to utriform or slightly moniliform, hyaline, thin walled. **Skeleto cystidia** 7–12.3 µm wide, clavate to cylindrical with rounded ends, hyaline, thick walled (2 µm). **Hymenial trama** highly interwoven and dimitic. Generative hyphae 2–5 µm wide, hyaline, thin to slightly thick walled (up to 1µm), branched, with frequent clamp connections. Skeletal hyphae 2–6 µm wide, hyaline, thick walled (up to 2 µm), unbranched, septations not observed. Skeleto ligative hyphae not observed. **Pileal trama** almost parallel. Generative hyphae 2–4 µm wide, hyaline, thin to slightly thick walled (up to 1µm), branched, with frequent clamp connections. Skeletal hyphae 2–6 µm wide, hyaline, thick walled (2 µm), unbranched, septations not observed. Skeleto ligative hyphae not observed. **Pileipellis** a cutis made of hyphae, that are 2–5 µm wide, hyaline to pale brown, encrusted, and thick walled (2 µm). **Pileocystidia** present, sparase, 5–10 µm wide, hyaline, thick walled, often with rouded ends. **Stipe** trama interwoven.

Generative hyphae 2–4 µm wide, hyaline, thin to slightly thick walled (up to 1 µm), branched, with frequent clamp connections. Skeletal hyphae 2–6 µm wide, hyaline, thick walled (2 µm), unbranched, septations not observed. Skeleto ligative hyphae not observed. **Stipitipellis** a cutis made of hyphae, that are 2–5 µm wide, hyaline to pale brown, thick walled. **Caulocystidia** present, 8–13 µm, clavate to cylindrical, many constricted at tip, encrusted, thick (2 µm).

Specimens examined: India. Kerala State: Wayanad district, Muthanga, on dead *Bambusa* species, 27 July 2016, Vinjusha N, ZGCVN390.

Comments: As per the description of *Podoscypha venustula*, the size of basidiospores are (3.2) 3.5–4.75 × 2.2–3.5 µm (Reid 1965). However the basidiospores of the present collection are slightly larger (4.2–5.55.8 × 2.1–3.7 µm).

Podoscypha venustula has been recorded from South America and New Zealand (Ried 1965). From Kerala, *P. venustula* have been documented by Mohanan (2011).

Podoscypha petalodes (Berk.) Boidin, Revue Mycol., Paris 24: 230 (1959)

Basionym: *Stereum petalodes* Berk., Ann. Mag. nat. Hist., Ser. 2 9: 198 (1852)
Synonyms:
Stereum elegans sensu Cunningham; fide NZfungi (2008)
Stereum sowerbyi sensu Berkeley; fide Reid (1965)
Thelephora sowerbyi sensu Berkeley; fide Reid (1965)
Stereum floriforme Lloyd, Mycol. Writ. 4: 24 (1913)

FIGURE 28

Basidiomata annual, medium sized, 25–60 mm tall, coriaceous and papery, light in weight, stipitate. **Pileus** 18–40 mm wide, up to 1 mm thick, flabelliform to circular, imbricate and clustered together, uneven with radial foldings, concentrically zonate, mostly glabrous, minutely pubescent at some regions, cream with alternating orangish brown to brown zones, margin wavy to lobed or uneven, thin and papery. **Hymenophore** smooth, pores absent, uneven with minute scattered tubercles, cream when young, turning to light brownish on maturity. **Context** not distinct, less than 1 mm thick, cream. **Stipe** 35–45 mm long, centrally or eccentrically arranged, cylindrical, bilaterally flattened at some regions, solid, pubescent to velutinate, brown, even, often branched at apex, generally fused at the base in clusterd fruitbodies. Stipe possesss thick white mycelial networks near the base. **Odour** not distinct. **Spore print** not observed.

Basidiospores 4–6 × 2–3.5 µm, Q=1–2 µm, Q_m=1.47 µm, ellipsoid to ovoid, smooth, thin walled, guttulate, usually with single guttule in the center, weakly cyanophilic, inamyloid in Melzer's reagent. **Basidia** narrowly clavate, 20–60 × 4–5 µm, 4 sterigmate. **Gloeocystidia** abundant projecting beyond basidia, elongate, 40 µm to more than 100 µm long, 3–8 µm wide, cylindrical with sinuous, narrowly utriform, utriform or moniliform to irregular with swollen base, hyaline, thin walled. **Metuloid cystidia** 5.3–7 µm wide, setiform to lanceolate, with acute or rounded ends, hyaline, smooth, thick walled (1–3 µm). **Hymenial trama** highly interwoven and dimitic. Generative hyphae 2–3 µm wide, hyaline, smooth, thin to slightly thick walled (up to 1 µm), branched, with frequent clamp connections. Skeletal hyphae 2–4 µm wide, hyaline, thick walled (up to 2 µm), unbranched or sparsely branched, septations not observed. Skeleto ligative hyphae not observed. **Pileal trama** interwoven. Generative hyphae 2–4 µm wide, hyaline, smooth, often thick walled (up to 1 µm), branched, with frequent clamp connections. Skeletal hyphae 2–7 µm wide, hyaline, thick walled (wall thickness 1 µm), unbranched, septations not observed. Skeleto ligative hyphae not observed. **Pileipellis** basically a cutis with interwoven skeletal hyphae, that are 2–4 µm wide, yellowish brown, and unbranched. Pileipellis consists of few scattered **pileocystidia**, 5–6 µm wide, subclavate, hyaline, thick walled. **Stipe** trama dimitic. Generative hyphae 2–4 µm wide, hyaline, smooth, often thick walled (up to 1 µm), branched, with frequent clamp connections. Skeletal hyphae 2–6 µm wide, hyaline, thick walled (wall thickness 1 µm), unbranched, septations not observed. **Stipitipellis** a cutis, made of hyphae that are 2–5 µm wide, yellowish brown, and unbranched. **Caulocystidia** 2–5 µm, clavate to cylindrical, moniliform or flexous, many constricted at tip, light brown, mostly septate, thick walled (1 µm).

Specimens examined: India. Kerala State: Wayanad district, Pookod, on dead log (unidentified), 30 June 2017, Vinjusha N., ZGCVN548; Kozhikode district, Thusharagiri, on soil, 14 September 2017, Vinjusha N., ZGCVN634; Kasaragod district, Neeleshwaram, Mannampurath Kavu, on soil, 03 September 2018, Vinjusha N., ZGCVN709.

Comments: Stipitate basidiomata with thin, coriaceous, cream to pale brown coloured, petal like pileus are remarkable characters for identification in the field. The species is usually found in clusters. The stipitate species, *P. mellissii*, differs from the present collection by smaller basidiospores (Reid 1965).

Podoscypha petalodes is frequently distributed in tropical America and Pacific Islands (Reid 1965). The species has been documented from India by Ranadive (2014). There are no reports of *P. petalodes* from Kerala till date.

Podoscypha involuta (Klotzsch *ex* Fr.) Imazeki, Bull. Gov. Forest Exp. Stn Tokyo 57: 98 (1952)

Basionym: *Stereum involutum* Klotzsch *ex* Fr., Epicr. syst. mycol. (Upsaliae): 546 (1838)
Synonyms:
Stereum prolificans Berk., J. Linn. Soc., Bot. 16 (no. 89): 41 (1878)
Stereum pulchellum Sacc. & Berl., Revue mycol., Toulouse 11 (no. 44): 203 (1889)
Stereum bresadolanum Lloyd [as *'bresadoleanum'*], Mycol. Writ. 4: 41 (1913)
Stereum hollandii Lloyd, Mycol. Writ. 4: 30 (1913)
Stereum proximum Lloyd, Mycol. Writ. 4: 40 (1913)
Lloydella involuta (Klotzsch *ex* Fr.) Bres., Hedwigia 56 (4, 5): 300 (1915)
Lloydella involuta var. *philippinensis* Bres., Hedwigia 56 (4, 5): 300 (1915)
Lloydella prolificans (Berk.) Bres., Hedwigia 56 (4,5): 300 (1915)
Stereum philippinense (Bres.) Lloyd, Mycol. Writ. 7 (Letter 66): 1115 (1922)
Stereum gossweileri Lloyd, Mycol. Writ. 7 (Letter 66): 1115 (1922)
Stereum nigrobasum Lloyd, Mycol. Writ. 7 (Letter 74): 1339 (1925)
Stereum maculatum Beeli, Bull. Soc. R. Bot. Belg. 58: 6 (1926)
Lopharia involuta (Klotzsch *ex* Fr.) G. Cunn., Bull. N.Z. Dept. Sci. Industr. Res. 145: 194 (1963)

FIGURE 29

Basidiomata small to medium sized, light in weight, sessile or attached to the substratum with a very short stipe like base or appear as effuse reflexed, sometimes adjascent fruit bodies get fused and become compound basidiomes, almost coriaceous when fresh, slightly hard when dry. **Pileus** 30–70 mm long, 1 mm thick, flabelliform to semicircular, matted tomentose, lesser towards margin, concentrically zonate, cream to pale ochre when fresh, white along margin, orangish brown with age, dark brown or grey on drying with brownish black concentric circles, margn even to lobed, thin and papery. **Hymenophore** smooth, pores absent, transluscent showing the zonations on the pileus, cream to pale orange when fresh, grayish brown to brown on bruising. **Context** less than 1 mm thick, cream. **Odour** not distinct. **Spore print** not observed.

Basidiospores 2–3 × 1.6–2 µm, Q=1.2–1.4 µm, Q_m=1.29 µm, ellipsoid to broadly ellipsoid, smooth, thin-walled, eguttulate, inamyloid in Melzer's reagent. **Basidia** 12–17 × 4–5 µm, narrowly clavate to cylindrical, 4 sterigmate, hyaline, smooth with basal clamp connections. **Gloeocystidia** 22–100 × 6–21 µm, elongated cylindrical, broadly lageniform to lageniform, sometimes inflated towards apex, hyaline, smooth or encrusted, thin walled. **Metuloid cystidia** 11–20 µm wide, mostly lageniform, many with apical protrution, hyaline, apically encrusted, encrustations easily washed away in KOH solution, thick walled (1–2 µm), more abundant than gloeocystidia. **Hymenial trama** highly interwoven and dimitic. Generative hyphae 2–3 µm wide, hyaline, smooth, thin to slightly thick walled (up to 1 µm), branched, with frequent clamp connections. Skeletal hyphae 3–6 µm wide, hyaline, thick walled (1–2 µm), unbranched or sparsely branched, septations not observed. Skeleto ligative hyphae not observed. **Pileal trama** interwoven. Generative hyphae 1.5–4 µm wide, septate, hyaline, smooth, often thick walled (up to 1 µm), branched, with frequent clamp connections. Skeletal hyphae 2–3 µm wide, hyaline, thick walled (1 µm), mostly unbranched, but more branched towards the lower portion of trama, septations not observed. Skeleto ligative hyphae not observed. **Pileipellis** forming a trichoderm, arising from the highly intervowen skeletal hyphae below the tomentum; each hyphae 2–5 µm wide, hyaline to light brown, thick walled, with obtuse ends.

Specimens examined: India. Kerala State: Kozhikode district, Edakkara, Vallikkattukavu, on dead branch (unidentified), 11 July 2015 Vinjusha N, ZGCVN42; Pokkunnu, ZG College Yoga Centre, on dead branch (unidentified), 29

July 2015, Vinjusha N., ZGCVN95; 22 September 2015, Vinjusha N., ZGCVN206; Koyilandy, Muchikunnu, Kottayil Kavu, on dead log (unidentified), Vinjusha N., ZGCVN227; Peruvannamuzhy, on dead logs (unidentified), Vinjusha N, 11 August 2016, ZGCVN436; Kasaragod district, Nileshwar, Kareem's forest, 30 July 2019, Vnjusha N., ZGCVN871; Wayanad district, Pookod, on dead branch (unidentified), 30 June 2017, Vinjusha N., ZGCVN543.

Comments: Our collections show similarity with *P. multizonata* (Berk. & Broome) Pat. by having flabelliform compound basidiomata and cylindrical gloeocystidia. However, the latter produces multi coloured basidiomata, that are pale orange brown, ochraceous buff to pale brown with dark chestnut brown zones, or blackish brown in colour, and lacks cystidia (Reid 1965). In addition, *P. multizonata* produces larger basidiospores than the present collection (4.75–6.2 × 3.75–4.75 µm).

P. involuta has occurrence in tropical Africa, Asia and Australasia and are absent in tropical America (Reid 1965). This species has been not been reported from India till date.

Podoscypha mellissii (Berk. *ex* Sacc.) Bres., Mém. Acad. malgache 6: 11 (1928)

Basionym: *Stereum mellissii* Berk. *ex* Sacc. [as '*mellisii*'], Syll. fung. (Abellini) 6: 553 (1888)
Synonyms:
Stereum mellissii Berk. [as *'mellisii'*], Grevillea 13 (no. 65): 3 (1884)
Lloydella mellissii (Berk. *ex* Sacc.) Bres., Hedwigia 56 (4, 5): 300 (1915)
Stereum nigropus Lloyd, Mycol. Writ. 6 (Letter 61): 886 (1919)
Stereum nigroporum J.A. Stev., Bull. Lloyd Libr. Bot. 32: 56 (1933)

FIGURE 30

Basidiomata annual, small sized, solitary, 10–25 mm tall, light in weight, infundibuliform, almost coriaceous when fresh, hard and tough when dry. **Pileus** 10–40 mm in diameter, circular, glabrous, almost shiny, laccate, dark brown to black with alternating brownish black concentric circles, cream near margin, margin even, thin and papery. **Stipe** 2–14 mm long, 2–4 mm thick, cylindrical, solid, pubescent to velutinate, black, with a flat disc like base. **Hymenophore** smooth, pores absent, slighlt hispid when viewed under a lens, cream when fresh, greyish to light brown on bruising. **Context** less than 1 mm thick, cream. **Odour** not distinct. **Spore print** not observed.

Basidiospores 2–3.7 × 1.6–2 µm, Q=1.2–1.9, Q_m=1.96, broadly ellipsoid to ellipsoid, smooth, thin walled, eguttulate, inamyloid in Melzer's reagent. **Basidia** not observed. Basidioles bear basal clamp connections **Gloeocystidia** abundant, 22.5–53 × 4–8 µm, sinuous, narrowly utriform, utriform or moniliform to irregular with swollen base, hyaline, thin walled, some with basal clamp connections. **Metuloid cystidia** 30–38 × 5–7 µm, fusiform or ventricose, with acute or rounded ends, hyaline, smooth, thick-walled; wall thickness 1–3 µm. **Hymenial trama** highly interwoven and dimitic. Generative hyphae 2–3 µm wide, hyaline, smooth, thin to slightly thick walled (up to 1µm), branched, with frequent clamp connections. Skeletal hyphae 2–4 µm wide, hyaline, thick walled (up to 2 µm), unbranched or sparsely branched, septations not observed. Skeleto ligative hyphae not observed. **Pileal trama** interwoven. Generative hyphae 2–4 µm wide, hyaline, thin to often thick walled (up to 1µm), branched, with frequent clamp connections. Skeletal hyphae 2–5 µm wide, hyaline, thick walled (1 µm), unbranched, septations not observed. Skeleto ligative hyphae not observed. **Pileipellis** basically a cutis with interwoven skeletal hyphae, 2–4 µm wide, yellowish brown, unbranched, septations not observed. **Stipe** trama consist of generative and skeletal hyphae, similar as in pileus portion. Generative hyphae 2–4 µm wide, septate, hyaline, smooth, thin to slightly thick walled (up to 1 µm), branched, with clamp connections. Skeletal hyphae 2–6 µm wide, hyaline, thick walled (2 µm), unbranched, septations not observed. **Stipitipellis** basically a cutis, composed of hyphae that are 2–4 µm wide, yellowish brown, unbranched, thin to thick walled. **Caulocystidia** 2–5 µm wide, clavate to cylindrical, moniliform or flexous, many constricted at tip, pale yellow to yellowish brown, thick walled (1 µm).

Specimens examined: India. Kerala State: Kannur district, Aralam, on dead log (unidentified), 16 September 2015, Vijisha P., ZGCVN197; Ernakulam district, Perumbavoor, Iringlole kavu, on dead branch (unidentified), Vinjusha N., ZGCVN567.

Comments: Characters of the present collections properly fit in the available descriptions of *P. mellissii* by Reid (1965) and Ryvarden (2010). The collections show some similarities with *Podoscypha venustula* (Speg.) D. A. Reid. As per the description of Reid (1965), the size of basidiospores of *P. venustula* are (3.2) 3.5–4.75 × 2.2–3.5 (3.75) µm. However, basidiospores of the present collection are smaller (2.6–3.7 × 1.6–2 µm). *P. bolleana* (Mont.) Boidin also shows some resemblances with our collection, but produce larger spores (4–6 × 2.7–3.5 µm).

Podoscypha mellissii has paleotropical distribution (Hjortstam *et al*. 1998). In Asia, this species was documented from Perak (Chipp 1921, as *Stereum mellisii*), Philippines (Teodoro 1937; Reid 1965), and Indonesia, Malaysia, Singapore (Reid 1965). The species has not been reported from India so far.

Abortiporus Murrill

Basidiomata annual, lignicolous, found in imbricate clusters, sometimes solitary, sessile to dimidiate, soft and fleshy when fresh, hard on drying, light in weight, pileate. Pileus semicircular to distorted in shape, tomentose, adpressed fibrillose towards margin, yellowish to golden brown, margin white, uneven and lacerate. Hymenophore poroid to daedaloid, when poroid, usually angular, pore surface white when fresh, brown on bruising, pore tubes concolorous with pore surface. Context white to pale buff, homogenous to weakly duplex with soft and spongy upper layer and rigid lower layer. Hyphal system monomitic to dimitic, generative hyphae hyaline, thin to thick walled, with clamp connections. Cystidia absent. Gloeocystidia present, cylindrical, erect to flexuose, thin walled. Chlamydospores common and frequent, subglobose to ellipsoid, hyaline, thick walled. Basidia and basidiospores not observed. The genus causes white rot on wood.

Abortiporus biennis (Bull.) Singer, Mycologia 36 (1): 68 (1944)

Basionym: *Boletus biennis* Bull., Herb. Fr. (Paris) 10: tab. 449 (1789)
Synonyms:
Agaricus coriaceus Scop., Fl. carniol., Edn 2 (Wien) 2: 446 (1772)
Sistotrema bienne (Bull.) Pers., Syn. meth. fung. (Göttingen) 2: 550 (1801)
Sistotrema rufescens Pers., Syn. meth. fung. (Göttingen) 2: 550 (1801)
Hydnum bienne (Bull.) Lam. & DC., Fl. franç., Edn 3 (Paris) 2: 112 (1805)
Daedalea biennis (Bull.) Fr., Syst. mycol. (Lundae) 1: 332 (1821)
Daedalea rufescens (Pers.) Secr., Mycogr. Suisse (1833)
Polyporus biennis (Bull.) Fr., Epicr. syst. mycol. (Upsaliae): 433 (1838)
Trametes rufescens (Pers.) G.H. Otth, in Secretan, (1861)
Polystictus rufescens (Pers.) P. Karst., Bidr. Känn. Finl. Nat. Folk 37: 69 (1882)
Heteroporus biennis (Bull.) Lázaro Ibiza, Revta R. Acad. Cienc. exact. fis. nat. Madr. 15 (1–3): 120 (1916)
Phaeolus biennis (Bull.) Pilát, Beih. bot. Zbl., Abt. 2 52: 69 (1934)
Grifola biennis (Bull.) Zmitr. & Malysheva, in Zmitrovich, Malysheva & Spirin, Mycena 6: 21 (2006)

FIGURE 31

Basidiomata annual, medium to large sized, usually found in imbricate clusters, sometimes solitary, soft and fleshy when fresh, hard on drying, light in weight, pileate. **Pileus** 50–70 mm long, 10–15 mm thick, sessile to laterally attached, semicircular to irregular in shape, applanate to wavy, faintly concentrically zonate, tomentose, adpressed fibrillose towards margin, yellowish to golden brown, more brownish on exposure, yellow tint completely disappears on drying, margin white, often weakly up curved, uneven and lacerate. **Hymenophore** irregularly poroid to daedaleoid, pores 1–2 per mm, surface white when fresh, dull brown on bruising, pore tube up to 7 mm long, white, concolorous with pore surface, non stratified. **Context** up to 20 mm thick, slightly duplex, with white, loosely arrange layer above, and slightly darker, more densely arranged layer below. **Odour** not distinctive. **Spore print** not observed.

Basidia and **basidiospores** not observed. **Chlamydospores** 4–8 × 5–7 µm, abundant on hyphae in the contextual region, subglobose to globose, some spores weakly angled, hyaline, thick walled (1 µm). **Gloeocystidia** 40–64 × 4–7 µm, mostly embedded, cylindrical, often flexuose and with constrictions, thin walled. **Hymenial trama** interwoven and monomitic. Generative hyphae 2–6 µm wide, hyaline, smooth, thin to thick walled (1.5 µm), branched, with clamp connections.

Skeletal hyphae and skeleto ligative hyphae not observed. **Pileal trama** interwoven, generative hyphae 3–5 µm wide, hyaline, smooth, thick walled (1–2.5 µm), branched, with clamp connections. **Pileipellis** composed of trichodermium, consisting of hyphae that are 2–5 µm wide, hyaline to golden brown, thin to thick walled, thick walled hyphae frequently septate.

Specimens examined: India. Kerala State: Wayanad district, 900 Kandi forest, on dead wood (unidentified), 16 July 2019, Vinjusha N., ZGCVN848.

Comments: Characters of the present collection properly fits with the taxonomic descriptions of *Abortiporus biennis* by Ryvarden & Johansen (1980) and Ryvarden & Gilbertson (1993). *Abortiporus zonatus* (Corner) T. Hatt. shows similarity with the present collection in morphology. However, *A. zonatus* is separated from the present collection by the absence of chlamydospores (Hattori 2001). According to Ryvarden & Gilbertson (1993), *A. biennis* is recognized by their distorted basidiomata with hymenium having unevenly oriented pores, and presence of chlamydospores in the upper portion of context.

Abortiporus biennis is distributed in North and South America, Europe, Asia and Australia (Ryvarden & Johansen 1980). *Abortiporus biennis* has been reported from Kerala by Leelavathy & Ganesh (2000).

Lentinus Fr.

Basidiomata annual, mostly infundibuliform, fibrous to suberose, stipitate. Pileus pubescent to densely velutinous, or squamulose, with or without radial lines, white to brown. Hymenophore poroid to lamellate, with or without hyphal pegs, surface white, cream to light brown. Context white to tan. Hyphal system consists of hyaline generative hyphae, with clamp connections, and hyaline to rusty brown skeletal and skeleto ligative hyphae. Cystidia present or absent. Basidiospores ellipsoid to cylindrical, hyaline, smooth, thin walled, inamyloid in Melzer’s reagent.

Lentinus arcularius (Batsch) Zmitr., International Journal of Medicinal Mushrooms (Redding) 12 (1): 88 (2010)

Basionym: *Boletus arcularius* Batsch, Elench. fung. (Halle): 97 (1783)
Synonyms:
Polyporus arcularius (Batsch) Fr., Syst. mycol. (Lundae) 1: 342 (1821)
Polyporus rhombiporus Pers., Mycol. eur. (Erlanga) 2: 211 (1825)
Polyporus arcularius subsp. *rhombiporus* Pers., Mycol. eur. (Erlanga) 2: 211 (1825)
Favolus ciliaris Mont., Annls Sci. Nat., Bot., sér. 2 20: 364 (1843)
Polyporus anisoporus Delastre & Mont., Annls Sci. Nat., Bot., sér. 3 4: 357 (1845)
Polyporus nanus Durieu & Mont., in Montagne, Syll. gen. sp. crypt. (Paris): 153 (1856)
Polyporellus arcularius (Batsch) Fr., Meddn Soc. Fauna Flora fenn. 5: 38 (1879)
Leucoporus arcularius (Batsch) Quél., Enchir. fung. (Paris): 165 (1886)
Hexagonia portoricensis Murrill, Bull. Torrey bot. Club 31 (6): 331 (1904)
Favolus portoricensis (Murrill) Sacc. & D. Sacc., Syll. fung. (Abellini) 17: 141 (1905)
Polyporus arcularius var. *arenosus* (Pat.) Sacc. & Trotter, Syll. fung. (Abellini) 21: 259 (1912)
Favolus arcularius (Batsch) Fr., Annls mycol. 11 (3): 241 (1913)
Leucoporus arcularius var. *scabellus* Bourdot & Galzin, Bull. trimest. Soc. mycol. Fr. 41 (1): 115 (1925)
Polyporellus arcularius f. *olivascens* Pilát, Bull. trimest. Soc. mycol. Fr. 51 (3-4): 352 (1936)
Polyporellus agariceus (Berk.) Pilát, Bull. trimest. Soc. mycol. Fr. 51 (3-4): 352 (1936)
Polyporus arcularius f. *fasciatus* Bondartsev, Nov. sist. Niz. Rast., 1964: 180 (1964)

FIGURE 32

Basidiomata annual, small to medium sized, infundibuliform, coriaceous when fresh, 15–25 mm tall, stipitate. **Pileus** 10–25 mm wide, 1–3 mm thick, circular, pubescent when young, almost glabrous when mature, concentrically zonations absent, pale brown to brown, margin even, more brownish, thin and papery, incurved on drying, densely ciliate. **Hymenophore** poroid. **Pores** large, 1–2 per mm, angular, often radially elongated, especially near the center, and becoming less elongated towards margin, pore surface white when fresh, light brown on drying. **Context** thin, less than 1 mm thick, white, homogenous. **Stipe** 15–20 mm long, up to 4–6 mm thick, centrally attached, cylindrical, almost even, slightly bulged towards base, pubescent to glabrous, surface cream to pale brown, tissue white, solid. **Odour** not distinctive. **Spore print** not observed.

Basidiospores 6.5–9 × 2–3 µm, Q=2–3.5, Q_m=2.66, cylindrical ellipsoid, thin walled, hyaline, smooth, weakly cyanophilic, often with 1–2 large guttules, inamyloid in Melzer's reagent. **Basidia** 9–16 × 4–6 µm, clavate, 4 sterigmate. **Cystidia** absent. **Hymenial trama** radially arranged. Generative hyphae 2–6 µm wide, hyaline, smooth, thin walled, branched, with clamp connections. Skeleto ligative hyphae 2–7 µm wide, hyaline, thick walled (1 µm), mostly with narrow lumen, branched, septations not observed. **Pileal trama** interwoven. Generative hyphae 2–6 µm wide, hyaline, thin walled, branched, with clamp connections. Skeleto ligative hyphae 2–9 µm wide, hyaline, thick walled (1 µm), branched, septations not observed. **Pileipellis** an irregular cutis composed of thin to slightly thick walled, hyaline, weakly septate hyphae; 2–3 µm wide. **Stipe trama** interwoven. Generative hyphae similar as in pileus region, 2–5 µm wide, hyaline, thin walled, branched, with clamp connections. Skeleto ligative hyphae not frequent as in pileus, 2–6 µm wide, hyaline, thick walled (up to 1 µm), branched. **Stipitipellis** more or less a cutis with scattered small trichodermal patches; hyphae 3–7 µm wide, hyaline to brown, slightly thick to thick walled.

Specimens examined: India. Kerala State: Thrissur district, Peechi Dam areas, on dead wood (unidentified), 02 November 2018, Vinjusha N., ZGCVN746; Kozhikode district, Kakkodi, Chelapram, on dead branch (unidentified), 04 July 2019, Vinjusha N., ZGCVN836.

Comments: Characters of the present collections properly match with the descriptions of *L. arcularius* (as *Polyporus arcularius*) by Corner (1984) and Núñez & Ryvarden (1995, 2001). Thind & Chatrath (1960) had reported sparse and minute hyphal pegs in the collections from India. However, in the Kerala collections, hyphal pegs were not observed. Bose (1918, 1919, 1919a 1920, 1920a, 1921, 1921a) reported ovate, and smaller basidiospores for the species. The present specimen highly resembles *Lentinus brumalis* (Pers.) Zmitr. in morphology. However, *L. brumalis* possesses angular pores (2–4 per mm), and are not radially elongated (According to description of Núñez & Ryvarden 2001). In addition basidiospores size of *L. brumalis* are always slightly smaller than those of *L. arcularius* (Núñez & Ryvarden 2001). *L. brumalis* produces more dark coloured basidisocarps than the present collection.

Lentinus arcularius has a cosmopolitan distribution except in the boreal regions of the world (Núñez & Ryvarden 1995). From Kerala, this species has been reported (as *Polyporus arcularius* (Batsch) Fr.) by Sankaran & Florence (1995), Florence & Yesodharan (1997, 2000), Leelavathy & Ganesh (2000), Mohanan (2011), and Iqbal *et al.* (2016).

Lentinus tricholoma (Mont.) Zmitr., International Journal of Medicinal Mushrooms (Redding) 12 (1): 88 (2010)

Basionym: *Polyporus tricholoma* Mont., Annls Sci. Nat., Bot., sér. 2 8: 365 (1837)
Synonyms:
Polyporus acicula Berk. & M.A. Curtis, J. Linn. Soc., Bot. 10 (no. 45): 304 (1868)
Polyporus stipitarius var. *poris-majoribus* Berk. & M.A. Curtis, J. Linn. Soc., Bot. 10 (no. 45): 304 (1868)
Polyporus armitii Kalchbr., Grevillea 10 (no. 55): 94 (1882)
Polyporus stipitarius subsp. *armitii* (Kalchbr.) Sacc., Syll. fung. (Abellini) 6: 72 (1888)
Polyporus stipitarius var. *meizoporus* Sacc. [as 'meizopora'], Syll. fung. (Abellini) 6: 72 (1888)
Polyporus stipitarius var. *pusillus* Speg., Anal. Mus. nac. Hist. nat. B. Aires 6: 162 (1898)
Leucoporus tricholoma (Mont.) Pat., in Duss, Enum. Champ. Guadeloupe (Lons-le-Saunier): 25 (1903)
Polyporus stipitarius var. *armitii* (Kalchbr.) Sacc. & Traverso, Syll. fung. (Abellini) 20: 494 (1911)
Leucoporus chaetoloma Pat., Bull. Soc. mycol. Fr. 39 (1): 49 (1923)
Leucoporus tricholoma var. *madagascariensis* Pat., Mém. Acad. malgache 6: 14 (1928)

FIGURE 33

Basidiomata annual**,** medium sized, solitary, coriaceous when fresh, slightly hard when mature, 45–55 mm tall, stipitate. **Pileus** 35–70 mm wide, 2–4 mm thick, circular, applanate, slightly depressed in the center, glabrous, radially striated, wrinkled on drying, slighlty shiny when fresh, concentrically zonations absent, pale yellowish brown to creamish brown, margin even, incurved on drying, ciliate. **Hymenophore** poroid. **Pores** 4–6 per mm, angular, slightly ovoid in some areas, absent towards margin, white when young, becoming cream, very pale brown on bruising, slightly glazing. **Stipe** 23–35 mm long, 2–5 mm thick, central, cylindrical, almost even, slightly bulged towards base, glabrous, radially striated, surface cream to pale brown, tissue white, solid. **Context** up to 1 mm thick, white, homogenous. **Odour** not distinctive. **Spore print** not observed.

Basidiospores 5–7 × 2.5–3.5 µm, Q=1.7–2.4, Q_m=2.1, cylindrical ellipsoid, thin walled, hyaline, smooth, inamyloid in Melzer’s reagent. **Basidia** not observed. **Basidioles** 7–15 × 4–5 µm, clavate, with basal clamp connections. **Cystidia** absent. **Hymenial trama** radially arranged. Generative hyphae 2–3 µm wide, sometimes inflated up to 8 µm, hyaline, smooth, thin walled, branched, with clamp connections. Skeleto ligative hyphae 2–4 µm wide, hyaline, smooth, thick walled (up to 1 µm), branched, septations not observed lumen narrow to almost absent. **Pileal trama** interwoven. Generative hyphae 2–3µm wide, hyaline, smooth, thin walled, branched, with clamp connections. Skeleto ligative hyphae 2–4 µm wide, hyaline, smooth, thick walled (up to 1 µm), branched, branches more at the hyphal endings, rarely septate. **Pileipellis** a cutis composed of hyaline, thin to slightly thick walled, septate hyphae; 2–3 µm wide. **Stipe** tissue interwoven. Generative hyphae rarely observed, 2–3 µm wide, hyaline, smooth, thin walled, branched, with clamp connections. Skeleto ligative hyphae dominant, 2–6 µm wide, hyaline, thick walled (up to 1 µm), branched, branches more frequent than in the pileus region. **Stipitipellis** similar as pileipellis, consisting of a cutis composed of hyaline, thin to slightly thick walled, septate hyphae that are 2–3 µm wide.

Specimens examined: India. Kerala State: Kozhikode district, Puthiyangadi, on dead wood (unidentified), 10 September 2017, Arun Kumar T. K., AK1004, AK1005; Idukki district, Vattavada, dead wood (unidentified), 28 July 2019, Vinjusha N., ZGCVN883.

Comments: Presence of cilia along the pileal margin is one of the major distinguishing characters of the species. The present collection shows resemblances with *Lentinus substrictus* (Bolton) Zmitr. & Kovalenko in having cilia and similar microscopic characters. However, the latter is separated by having more thick basidiocarps and narrower basidiospores (1.7–2.3 µm wide, Núñez & Ryvarden 1995; Corner 1983). The specimen also shows similarity with another ciliate polypore, *Lentinus arcularius*. According to Núñez & Ryvarden (2001), hymenium of *Lentinus arcularius* possesses larger pores (1–2 per mm), whereas, present collection has smaller pores (4–6 per mm). Corner (1983) had reported that, some collections of *L. tricholoma* produced larger pores and similar spore range as in *L. arcularius*, which were placed as different varieties of the species.

Lentinus tricholoma has widespread distribution in the tropical areas of South America and are infrequent in tropical Asia, Africa and Oceania (Núñez &

Ryvarden 1995). The species has been documented from Kerala by Leelavathy & Ganesh (2000).

Lentinus badius (Berk.) Berk., London J. Bot. 6: 491 bis (1847)

Basionym: *Panus badius* Berk., London J. Bot. 1 (3): 145 (1842)
Synonyms:
Agaricus verrucarius Berk., Hooker's J. Bot. Kew Gard. Misc. 2: 82 (1850)
Lentinus inquinans Berk., Hooker's J. Bot. Kew Gard. Misc. 6: 132 (1854)
Lentinus brevipes Cooke, Grevillea 14 (no. 69): 12 (1885)
Pleurotus verrucarius (Berk.) Sacc., Syll. fung. (Abellini) 5: 351 (1887)
Pocillaria badia (Berk.) Kuntze, Revis. gen. pl. (Leipzig) 2: 865 (1891)
Pocillaria inquinans (Berk.) Kuntze, Revis. gen. pl. (Leipzig) 2: 866 (1891)
Pocillaria brevipes (Cooke) Kuntze, Revis. gen. pl. (Leipzig) 2: 865 (1891)
Dendrosarcus verrucarius (Berk.) Kuntze, Revis. gen. pl. (Leipzig) 3 (3): 464 (1898)
Panus inquinans (Berk.) Singer, Sydowia 15 (1-6): 46 (1962)
Panus brevipes (Cooke) Singer, Sydowia 15 (1-6): 45 (1962)

FIGURE 34

Basidiomata annual, medium to large sized, 50–80 mm tall, solitary, almost coriaceous when fresh, hard and tough, light in weight, stipitate. **Pileus** 50–100 mm diameter, circular, infundibuliform, radially striate, squamulose, squamules distinct in a concentric pattern, prominent along margin and lesser towards centre, leaving small circular brownish spots, fuscous brown, purplish brown at some parts, margin acute, even, densely hairy. **Hymenophore** lamellate, lamellae almost crowded, with distinct dichotomous branches, lamellulae absent, decurrent on stipe, lamellae edge weakly fimbriate, ochre to light yellowish brown. **Context** thin, (less than 1 mm thick), pale ochre, homogenous. **Stipe** 12–32 mm long, 7–8 mm thick, central or eccentric, cylindrical, even, slightly broader towards base, covered with projecting sheath like scales, cream to pale brown with, tissue solid, cream. **Odour** not distinct. **Spore print** not observed.

Basidiospores 4–6 × 2–2.5 µm, Q=1.5–3, Q_m=2.25, cylindric ellipsoid, hyaline, smooth, thin walled, often monoguttulate, inamyloid in Melzers reagent. **Basidia** 18–25 × 4–5 µm, clavate, 4 sterigmate. **Hyphal pegs** present, 39–51 × 11–31 µm, projecting beyond hymenium, mostly composed of sclerified hyphae, that are 3–6 µm wide, setiform with bulbous base, widened up to 10 µm, hyaline, thick walled (1 µm), with obtuse ends. **Hymenial trama** radially arranged.

Generative hyphae rarely observed, 2–4 µm wide, hyaline, smooth, thin branched, branched, with clamp connections. Skeleto ligative hyphae dominant, 2–10 µm wide, hyaline, thick walled (1 µm), highly branched, septations not observed mostly without lumen. **Pileal trama** interwoven. Generative hyphae sparsely observed as in hymenium, 2–4 µm wide, hyaline, smooth, thin branched, branched, with clamp connections. Skeleto ligative hyphae more wide, 3–12 µm wide, hyaline, thick walled (1–2 µm), lumen narrow to wide or solid, septations not observed. **Pileipellis** composed of erect, ascending, metuloid like cells, 30–60 µm long, 3–11 µm wide, hyaline, thick walled (1–2 µm) with obtuse tips. **Stipe trama** interwoven. Generative hyphae 2–4 µm wide, hyaline, smooth, thin branched, with clamp connections. Skeleto ligative hyphae 3–10 µm wide, hyaline, thick walled (1–2 µm), septations not observed, lumen narrow to wide or solid. **Stipitipellis** a cutis at base forming pseudo metuloid like cells; 3-6 µm wide, cylindrical to narrowly clavate, hyaline, thick walled (1–2 µm) with acute to obtuse tips.

Specimens examined: India. Kerala State: Kozhikode district, Kuttyadi, Janaki forest, 02 October 2018, on decayed log (unidentified), Salna N., ZGCVN728.

Comments: The species belongs to the section *Dicholamellatae* of *Lentinus* Fr. The present collection shows resemblances with another species of the section, *L. araucariae* Har. & Pat., in having dichotomously branched lamellae and hyphal pegs made of thin to distinctly thick walled hyphae. However, the latter produces slightly larger basidiospores (5–7 × 3–3.5 µm, Pegler 1983). The present specimen also shows similarity with *L. brunneofloccosus* Pegler in basidiocarp morphology. But, the latter lacks hyphal pegs in their tissues and produces large basidiospores (5.5–8.5 × 2–3.2 µm, Pegler 1983). *Lentinus dicholamellatus* Manim. differs from the present collection by the absence of metuloid cystidia, presence of sinuous-cylindric cheilocystidia, and larger basidiospores (6–10 × 3–5 µm) (Manimohan *et al.* 2004).

Distribution of the species is limited to south east Asia (Pegler 1983). The species has been documented from India, Malaysia, Nepal, Philippines, Thailand and Vietnam. There are no records of this species from Kerala so far.

Lentinus dicholamellatus Manim., in Manimohan, Divya, Kumar, Vrinda & Pradeep. Mycotaxon 90: 311–318 (2004)

FIGURE 35

Basidiomata annual, medium to large sized, usually found in clusters, rarely solitary, soft and coriaceous when young, more hard when mature, light in weight, stipitate. **Pileus** 50–150 mm diameter, circular, infundibuliform, without concentric zonations, adpressed squamulose, squamules not observed in some collections, light yellow when young, becoming ochre or light to dark brown, margin incurved, entire to wavy, sometimes lobed. **Hymenophore** lamellate, lamellae crowded, often dichotomously branched, decurrent on stipe, lamellae edge fimbriate, lamellulae few, surface dull white to cream or with a very pale yellowish tint. **Context** cream to pale brown, 1 mm thick. **Stipe** 20–110 mm long, 4–22 mm thick, central or eccentric, cylindrical, even, slightly narrower towards base, greyish brown to brown, velutinous, tissue solid, cream. **Odour** not distinct. **Spore print** not observed.

Basidiospores 5.5–8 × 3–4 µm, Q=1.5–2, Q_m=1.86, ellipsoid to broadly ellipsoid, hyaline, smooth, thin walled, inamyloid in Melzer's reagent. **Basidia** 14–25 × 5–7 µm, clavate, 4 sterigmate. **Cheilocystidia** frequent, 11–40 × 5–7 µm, light brown, elongated, sinuous cylindric, thick walled, with basal clamp connections. **Pleurocystidia** absent. Hyphal pegs present, not frequent, 35–76 µm wide, projecting beyond the hymenial surface, conical, made of thin walled hyphae. **Hymenial trama** irregular. Generative hyphae 3–4 µm wide, hyaline, thin to slightly thick walled (up to 1 µm), branched, with clamp connections. Skeleto ligative hyphae dominant, 2.5–5 µm wide, hyaline to pale coloured, branched, thick walled (up to 1.5 µm), septations not observed. **Pileal trama** interwoven. Generative hyphae 2–4 µm wide, hyaline, thin to slightly thick walled (up to 1 µm), branched, with clamp connections. Skeleto ligative hyphae dominant, 2.5–7 µm wide, hyaline to pale coloured, branched, thick walled (up to 1.5 µm), septations not observed. **Pileipellis** an irregular cutis with inbetween erect trichodermal patches up to 100 µm and more long, made of hyphae that are 2–4 µm wide, hyaline to light brown. **Stipe trama** interwoven. Generative hyphae 2–3 µm wide, hyaline, thin walled, branched, with clamp connections. Skeleto ligative hyphae dominant, 2–5 µm wide, hyaline to pale brown, branched, thick walled (up to 1.5 µm), septations not observed. **Stipitipellis** a trichodermium made of 2–6 µm wide, thin to slightly thick walled, pale yellowish to yellow brown hyphae, often with clamp connections, squamules of the stipe surface composed of erect, more than 100 µm long hyphal patches; hyphae 1.5–4 µm wide, slightly thick walled, hyaline to brown.

Specimens examined: India. Kerala State: Kozhikode district, Chelannur, on dead logs (unidentified), 06 September 2015, Vinjusha N, ZGCVN171, ZGCVN178; on dead branch of *Anacardium occidentale*, Vinjusha N., ZGCVN179; Koyilandy, Muchikunnu Kavu, on dead wood stump (unidentified), Vinjusha N., ZGCVN222; Kuttyadi, Thottilpalam, on dead log of *Cocos nucifera*, Salna N., ZGCVN734, ZGCVN735; Ramanattukara, Kanangad Kavu, on dead log of *Adenanthera pavonina*, 10 December 2018, Vinjusha N., ZGCVN791.

Comments: *Lentinus dicholamellatus* belongs to section *Dicholamellatae* of genus *Lentinus***.** was originally described from Kerala by Manimohan *et al.* (2004). This species was later reported from Kerala by Mohanan (2011).

Lentinus sajor-caju (Fr.) Fr., Epicr. syst. mycol. (Upsaliae): 393 (1838)

Basionym*: Agaricus sajor-caju* Fr., Syst. mycol. (Lundae) 1: 175 (1821)
Synonyms:
Lentinus tanghiniae Lév., Annls Sci. Nat., Bot., sér. 3 5: 119 (1846)
Lentinus woodii Kalchbr., Grevillea 9 (no. 52): 136 (1881)
Lentinus tenuipes Sacc. & Paol., Atti Inst. Veneto Sci. lett., ed Arti, Sér. 6: 392 (1888)
Pocillaria sajor-caju (Fr.) Kuntze, Revis. gen. pl. (Leipzig) 2: 866 (1891)
Pocillaria tanghiniae (Lév.) Kuntze, Revis. gen. pl. (Leipzig) 2: 866 (1891)
Pocillaria murrayi (Kalchbr. & MacOwan) Kuntze, Revis. gen. pl. (Leipzig) 2: 866 (1891)
Pocillaria woodii (Kalchbr.) Kuntze, Revis. gen. pl. (Leipzig) 2: 866 (1891)
Lentinus sajor-caju var. *elegans* Pilát, Annls mycol. 34 (1/2): 128 (1936)
Lentinus sajor-caju var. *medius* Pilát, Annls mycol. 34 (1/2): 128 (1936)
Lentinus sajor-caju var. *velutinosquamulosus* Pilát, Annls mycol. 34 (1/2): 128 (1936)
Pleurotus sajor-caju (Fr.) Singer, Lilloa 22: 271 (1951)
Antromycopsis sajor-caju L.N. Nair & V.P. Kaul, Sydowia 33: 223 (1980)
Lentinus sajor-caju var. *subdistans* Corner, Beih. Nova Hedwigia 69: 45 (1981)

FIGURE 36

Basidiomata annual, small to medium sized, 25–40 mm tall, solitary, almost coriaceous when young, tough and hard when mature, light in weight, stipitate. **Pileus** 30–42 mm diameter, circular, narrowly infundibuliform, concentric zonations absent, with radial striations present, rough, more or less smooth, white to cream, light brown on bruising, margin thin, even, incurved on drying. **Hymenophore** lamellate, lamellae crowded, deeply decurrent, surface minutely hispidulous, edge even, lamellulae present, creamish white, brownish towards margin. **Context** thin, 1 mm or less wide, cream. **Stipe** with an inconspicuous annulus towards apex, up to 9 mm long, 4–9 mm thick, central, short cylindrical, even, pubescent, creamish white when fresh, light brown on bruising, tissue solid, cream. **Odour** not distinct. **Spore print** not observed.

Basidiospores 5–7.5 × 2–2.5 µm, Q=2.4–3, Q_m=2.98, cylindrical, hyaline, smooth, thin walled, inamyloid in Melzer's reagent. **Basidia** 20–36 × 4–5 µm, clavate, 4 sterigmate. **Cheilocystidia** 21–26 × 4–7 µm, rarely observed, similar as sterile basidia, clavate, hyaline, thin walled. **Hyphal pegs** not observed. **Hymenial trama** interwoven. Generative hyphae 2–3 µm wide, hyaline, smooth, thin to slightly thick walled (up to 1 µm), branched, with clamp connections. Skeleto ligative hyphae dominant, 2–6 µm wide, hyaline, thick walled (1 µm), moderately branched, septations not observed. **Pileal trama** interwoven and dimitic. Generative hyphae 2–5 µm wide, hyaline, thin to slightly thick walled (up to 1 µm), branched, with clamp connections. Skeleto ligative hyphae 2–6 µm wide, hyaline, thick walled (1 µm), branched, septations not observed. **Pileipellis** a cutis made of hyphae that are 2–5 µm wide, hyaline to brown, thick walled with obtuse ends. **Stipe trama** interwoven. Generative hyphae 2–4 µm wide, hyaline, thin to slightly thick walled (up to 1 µm), branched, with clamp connections. Skeleto ligative hyphae 2–6 µm wide, hyaline, thick walled (1 µm), branched, septations not observed. **Stipitipellis** basically a cutis forming erect, ascending trichodermial patches; 40–70 µm long, made of hyphae 2–5 µm wide, hyaline to brown, thick walled with obtuse ends.

Specimen examined: India. Kerala State: Kozhikode district, Pokkunnu, ZG College campus, on dead branch of *Peltophorum ferrugenium,* 20 December 2015, Vinjusha N, ZGCVN238.

Comments: Characters of the present collection agrees with the description of *L. sajor-caju* by Corner (1981) and Pegler (1983). *Lentinus squarrosulus* Mont. is the closely related species. *Lentinus squarrosulus* possesses concentric zones of squamules on its pileus surface (Pegler 1983), and radial striations are absent. However, pileus of the present specimen lacks concentrically arranged sqaumules and are radially striate. Moreover, *L. squarrosulus* produces slightly wider hyphae (Pegler 1983) than the present specimen. The presence of annulus on the stipe is also a distinguishing feature of *L. sajor-caju* (Pegler 1983).

Lentinus sajor-caju has distribution in Africa, South East Asia, Australia (Pegler 1983). From Kerala, this species has been reported by Sathe & Daniel (1980), Florence (2004), Manimohan *et al.* (2004), Pradeep & Vrinda (2007), Varghese *et al.* (2010), and Mohanan (2011). Geetha *et al.* (1989), Florence & Balasundaran (2000), Ouseph *et al*. (2001), Florence (2004) reported the species as *Pleurotus sajor-caju* (Fr.) Singer.

Lentinus polychrous Lév., Annls Sci. Nat., Bot., sér. 3 2: 175 (1844)

Synonyms:

Lentinus praerigidus Berk., Hooker's J. Bot. Kew Gard. Misc. 6: 132 (1854)
Lentinus estriatus Berk. & Broome, J. Linn. Soc., Bot. 14 (no. 73): 44 (1873)
Lentinus eximius Berk. & Broome, J. Linn. Soc., Bot. 14 (no. 73): 44 (1873)
Pocillaria eximia (Berk. & Broome) Kuntze, Revis. gen. pl. (Leipzig) 2: 866 (1891)
Pocillaria praerigida (Berk.) Kuntze, Revis. gen. pl. (Leipzig) 2: 866 (1891)
Pocillaria estriata (Berk. & Broome) Kuntze, Revis. gen. pl. (Leipzig) 2: 866 (1891)
Pocillaria polychroa (Lév.) Kuntze, Revis. gen. pl. (Leipzig) 2: 866 (1891)
Lentinus sajor-caju var. *polychrous* (Lév.) Pilát, Annls mycol. 34 (1/2): 128 (1936)
Panus polychrous (Lév.) Singer, Sydowia 15 (1-6): 46 (1962)
Panus polychrous (Lév.) Singer *ex* Balf.-Browne, Bull. Br. Mus. nat. Hist., Bot. 4 (3): 121 (1968)

FIGURE 37

Basidiomata annual, medium to large sized, 65–80 mm tall, solitary, gregarious, hard and woody, tough on drying, light in weight, stipitate. Pileus 65–120 mm diameter, circular, narrowly infundibuliform, radially grooved, villose with uniformly spaced squamules, squamules more crowded towards margin, pale yellowish brown to greyish brown, margin acute, wavy, upcurved and often radially split towards center when dry. **Hymenophore** lamellate, lamellae almost crowded, usually without dichotomous branches, but rarely bifurcate, lamellulae present, decurrent on stipe, lamellae edge minutely serrate, yellowish to purplish brown. **Context** cream to light brown, homogenous, 3–6 mm thick. **Stipe** 10–20 mm long, 7–13 mm thick, central or eccentric, cylindrical, even, slightly broader towards base, villose, cream to pale brown with brownish black scales at base, tissue solid, cream. **Odour** not distinct. **Spore print** not observed.

Basidiospores 7–9 × 2–3 µm, Q=2.6–4, Q_m=3.51, cylindrical, hyaline, smooth, thin walled, guttulate, inamyloid in Melzers reagent. **Basidia** 15–37 × 4–6 µm, clavate, 4 sterigmate. **Cystidia absent. Hyphal pegs** not observed. **Hymenial trama** radially arranged. Generative hyphae not frequent, 2–4 µm wide, hyaline, thin to slightly thick walled (1 µm), branched, with clamp connections. Skeleto ligative hyphae dominant, 2–7 µm wide, hyaline, thick walled (1–3 µm), with short tortuous branches, septations not observed, lumen narrow to wide. **Pileal trama** almost parallel. Generative hyphae 2–4 µm wide, hyaline, thin to slightly thick walled (up to 1 µm), branched, with clamp connections. Skeleto ligative hyphae 3–7 µm wide, hyaline to pale brown, thick walled (1–2 µm), sparsely branched than that of hymenium, septations not observed. **Pileipellis** a trichodermium composed of erect, ascending, elongate trichodermal patches, formed of hyphae that are 2–6 µm wide, hyaline to pale coloured, thick walled (2 µm) with obtuse tips, these hyphae interrupted by many clavate to fusiform or variously shaped skeletal cell bodies; more than 100 µm long and up to 20 µm thick, hyaline, pseudo septate, with obtuse tips. **Stipe trama** almost parallel. Generative hyphae 2–4 µm wide, hyaline, thin to thick walled (1 µm), branched, with clamp connections. Skeleto ligative hyphae 3–7 µm wide, hyaline to pale brown, thick walled (1–2 µm), sparsely branched, septations not observed. **Stipitipellis** consists of skeletal cell bodies as in pileipellis, up to 100 µm long and 17 µm wide, erect clavate to cylindrical, hyalne to dark brown, pseudoseptate, thick walled (1–3 µm) with obtuse tips.

Specimen examined: India. Kerala State: Wayanad district, Kuruva Island, on fallen tree log (unidentified), 07 December 2018, Vinjusha N, ZGCVN786.

Comments: The specimen looks similar to *Lentinus badius,* however, the latter produces distinctly bifurcate lamellae and smaller basidiospores (4.7–6.5 × 2 µm, according to description of Pegler 1980). As per the description of Pegler (1983), *L. polychrous* possesses scanty to numerous hyphal pegs. However, hyphal pegs were not observed in the present collections. Corner (1981) had reported this species without hyphal pegs.

Lentinus polychrous is a frequently encountered species in south east Asia (Pegler 1983). From Kerala, *L. polychrous* has been documented by Manimohan *et al.* (2004) and Mohanan (2011).

Lentinus squarrosulus Mont., Annls Sci. Nat., Bot., sér. 2 18: 21 (1842)

Synonyms:

Lentinus leucochrous Lév., Annls Sci. Nat., Bot., sér. 3 2: 174 (1844)
Lentinus wilkesii Berk. & M.A. Curtis, Amer. J. Sci. Arts, Ser. 2 11: 93 (1851)
Lentinus pergameneus subsp. *ochroleucus* Fr., Nova Acta R. Soc. Scient. upsal., Ser. 31 (1): 37 (1851)
Lentinus caespitosus Curr., Bull. N.J. Agric. Expt. Sta. 1 (3): 120 (1876)
Lentinus hygrometricus Berk., J. Linn. Soc., Bot. 16 (no. 89): 49 (1878)
Lentinus curreyanus Sacc. & Cub., Syll. fung. (Abellini) 5: 586 (1887)
Lentinus bavianus Pat., J. Bot., Paris 4: 15 (1890)
Pocillaria squarrosula (Mont.) Kuntze, Revis. gen. pl. (Leipzig) 2: 866 (1891)
Pocillaria wilkesii (Berk. & M.A. Curtis) Kuntze, Revis. gen. pl. (Leipzig) 2: 866 (1891)
Pocillaria hygrometrica (Berk.) Kuntze, Revis. gen. pl. (Leipzig) 2: 866 (1891)
Pocillaria curreyana (Sacc. & Cub.) Kuntze, Revis. gen. pl. (Leipzig) 2: 866 (1891)
Lentinus melanopus Pat., Bull. Soc. mycol. Fr. 8 (2): 47 (1892)
Lentinus tigrinus f. *squarrosulus* (Mont.) Pilát, Annls mycol. 34 (1/2): 130 (1936)
Pleurotus squarrosulus (Mont.) Singer, Sydowia 15 (1-6): 45 (1962)
Lentinus squarrosulus var. *mangiferae* Sapan, Atri & Gulati, in Sharma, Atri, Thakur & Gulati, International Journal of Medicinal Mushrooms (Redding) 16 (6): 594 (2014)

FIGURE 38

Basidiomata annual, small to medium sized, usually found in clusters, rarely solitary, soft and coriaceous, becoming hard on drying, light in weight, stipitate. **Pileus** 25-70 mm in diameter, 25 mm thick, circular, umblicate to infundibuliform, without concentric zonations, adpressed squamulose, squamules lesser when mature, white when fresh, cream to light brown on when mature, more brownish on exposure or drying, margin incurved, entire to wavy, sometimes lacerate. **Hymenophore** lamellate, lamellae crowded, thin, without dichotomous branches, decurrent on stipe, lamellae edge even, lamellulae present, surface white to cream or with a very pale yellowish tint. **Context** 1–2 mm thick, dull white to cream, homogenous. **Stipe** 16–20 mm long, 2–6 mm thick, central or eccentric, cylindrical, even, slightly expanded at base, pubescent, squamulose at some region, cream to light brown, base sometimes blackish, tissue solid, cream. **Odour** not distinct. **Spore print** not observed.

Basidiospores 4.5–6.5 × 1.5–3 µm, Q=1.6–3, Q_m=2.2, subcylindrical, hyaline, smooth, thin walled, inamyloid in Melzer's reagent. **Basidia** 15–25 × 4–6 µm, clavate, 4 sterigmate. **Cystidia** absent. **Hyphal pegs** present, infrequent to abundant, more than 100 µm long, up to 80 µm wide, projecting beyond the hymenial surface, conical, made of thin walled hyphae. **Hymenial trama** irregular. Generative hyphae 2–5 µm wide, hyaline, smooth, thin to slightly thick walled (up to1 µm), branched, with clamp connections. Skeleto ligative hyphae dominant, 2–6 µm wide, thick walled (1 µm), hyaline, branched, septations not observed. **Pileal trama** parallel. Generative hyphae infrequent, 2–7 µm wide, hyaline, smooth, thin to slightly thick walled (up to 1 µm), branched, with clamp connections. Skeleto ligative hyphae dominant, 2–8 µm wide, irregularly enlarged, sometimes becoming bulbous at some region, which appear brightly stained, hyaline, thick walled (1 µm), branched, septations not observed. **Pileipellis** a cutis forming segregated short patches of trichoderm, made of hyphae that are 2–7 µm wide, hyaline, septate, thin walled. **Stipe trama** loosely interwoven. Generative hyphae 2–6 µm wide, hyaline, thin walled, smooth, branched, with clamp connections. Skeleto ligative hyphae dominant and more branched than that of pileus, 2–7 µm wide, hyaline to pale brown, thick walled (up to 1.5 µm), branched, septations not observed. **Stipitipellis** a cutis, slightly irregular than pileipellis, hyphae 2–6 µm wide, hyaline, septate, thin to slightly thick walled.

Specimens examined: India. Kerala State: Kozhikode district, Karanthur, on dead stump of *Cocos nucifera,* 04 November 2018, Vinjusha N, ZGCVN744A; Kakkodi, Malikkadavu, on dead branch (unidentified), Vinjusha N., ZGCVN651; Kannur district, Mattanur, Poongottukavu, on fallen trunk of *Swietenia mahagoni,* 12 September 2018, Vinjusha N., ZGCVN714, ZGCVN715; Malappuram district, Thenjipalam, Calicut University Botanical Garden, on dead wood stump (unidentified), 15 September 2015, Vinjusha N., VN188.

Comments: *Lentinus squarrosulus* Mont. is closely related to *Lentinus sajor-caju*, however, the latter is differentiated by absence of concentric zones of squamules and presence of radial striations on the pileus (Pegler 1983). In addition, *L. sajor-caju* usually possesses annulus towards the upper region of stipe, whereas present collection lack annulus on stipe.

Lentinus squarrosulus has distribution in tropical regions of Asia, Africa and Europe (Corner 1981). The species was reported from Kerala by Sharma *et al.* (1985), Sankaran & Florence (1995), Florence & Yesodharan (2000), Florence (2004), Manimohan *et al*. (2004), Pradeep & Vrinda (2007), Varghese *et al.* (2010), Mohanan (2011).

Ganoderma P. Karst.

Basidiomata annual to perennial, terrestrial or lignicolous, hard and woody, stipitate to sessile. Pileus dull or shiny and laccate, pubescent to glabrous. Hymenophore poroid, pores round to angular, pore surface white to cream, often turns brown on bruising, tube layers single or stratified, either concolorous with pore surface or distinct, mostly with various shades of brown. Context cream coloured to dark purplish brown, soft and spongy to fibrous, homogenous to duplex, with distinct melanoid bands. Stipe central to lateral, surface dull to shiny and laccate. Hyphal system dimitic to trimitic, generative hyphae hyaline, thin walled, with clamp connections. Skeletal hyphae golden yellow to brown, shortly branched or arboriform, thick walled. Skeleto ligative hyphae hyaline, slightly thick to thick walled. Pileipellis of fruit bodies with laccate surface possess cylindrical, clavate to capitate end cells, yellowish brown, smooth or encrusted, weakly to strongly amyloid in Melzer’s reagent. Cystidia present or absent. Basidia clavate, 4 sterigmate. Basidiospores narrowly to broadly ellipsoid, yellowish brown, double walled, with brown endosporium, separated from a hyaline exosporium by inter wall pillars, smooth to distinctly echinulate, apex truncate or non truncate, inamyloid in Melzer’s reagent. Genus causes white rot on wood.

Ganoderma subresinosum (Murrill) C.J. Humphrey, Mycologia 30 (3): 332 (1938)

Basionym: *Fomes subresinosus* Murrill, Bull. Torrey bot. Club 35: 410 (1908)
Synonyms:
Polyporus mamelliporus Beeli, Bull. Soc. R. Bot. Belg. 62: 62 (1929)
Trachyderma subresinosum (Murrill) Imazeki, Bull. Gov. Forest Exp. Stn Tokyo 57: 119 (1952)
Magoderna subresinosum (Murrill) Steyaert, Persoonia 7 (1): 112 (1972)
Amauroderma subresinosum (Murrill) Corner, Beih. Nova Hedwigia 75: 93 (1983)

FIGURE 39

Basidiomata annual, medium to large sized and robust, tough when fresh, becoming harder and woody, light in weight, pileate. **Pileus** 40–240 mm long, up to 90 mm thick, sessile to dimidiate, semicircular to irregular in shape, applanate, or uneven with ridges and grooves, radially wrinkled, cuticle with a cracked appearance on drying, concentric zonations usually absent, sometimes weakly zonate, laccate, shiny, glabrous, reddish brown to brownish black, almost completely black when mature, margin obtuse, even. **Hymenophore** poroid. **Pores** 3−5 per mm, round, absent near margin, surface creamish white, pale brown on bruising, pore tubes up to 25–50 mm long, non stratified, cream. **Context** up to 30 mm thick, soft when fresh, creamish white, homogenous. **Odour** not distinctive. **Spore print** not observed.

Basidiospores 12–17 × 9–13 µm, Q=1.1–1.8, Q_m=1.3, ovoid, yellow, double walled, coarsely echinulate, interwall pillars thin, pillar disposition reticulate, sometimes monoguttulate, inamyloid in Melzer's reagent. **Cystidia** or cystidioles not observed. **Basidia** 17−21 × 5−7 µm, clavate, 4 sterigmate. Hymenial trama interwoven and trimitic. Generative hyphae 2–3 µm wide, hyaline, smooth, thin to slightly thick walled (up to 1 µm), branched, with frequent clamp connections. Skeletal hyphae 2–5 µm wide, hyaline to pale yellow, thick walled (1–1.5 µm), weakly branched to branched, septations not observed. Skeleto ligative hyphae 1–2 µm wide, hyaline to very pale yellow, thick walled (1 µm), highly branched, sometimes arboriform, septations not observed. **Pileal trama** interwoven. Generative hyphae 2–4 µm wide, hyaline, smooth, thin to slightly thick walled (up to 1 µm), branched, with clamp connections. Skeletal hyphae 2–6 µm wide, hyaline to pale yellow, thick walled (1–2 µm), weakly branched to branched, septations not observed. Skeleto ligative hyphae 1–2 µm wide, hyaline to very pale yellow, thick walled (up to 1 µm), highly branched, sometimes arboriform, septations not observed. **Pileipellis** a hymeniderm composed of clavate to broadly clavate cells, 5–11 µm wide, with minute protuberances, yellow to light brown, thick walled (1–3 µm), mostly solid, without granular encrustations, dextrinoid to weakly amyloid in Melzer's reagent.

Specimens examined: India. Kerala State: Malappuram district, Thenjipalam, Calicut University campus, on live *Macaranga peltata,* 20 November 2015, Vinjusha N., ZGCVN266; Kozhikode district, Chelannur, on live *Atrocarpus heterophillus*, 26 December 2015, Vinjusha N, ZGCVN275; Thottipalam, on dead *Cocos nucifera,* 26 June 2019, Vinjusha N., ZGCVN820, ZGCVN826; Kannur district, Poongottu kavu, on *Cocos nucifera*, 02 July 2019, Vinjusha N., ZGCVN832; Wayanad district, Pookod, on dead stump (unidentified), 30 June 2017, Vinjusha N., ZGCVN550.

Comments: Morphology of the present collections match with the description of *G. subresinosum* by Hapuarachchi *et al*. (2018a) and Hapuarachchi *et al*. (2019). Present collection resembles *G. colossus* (Fr.) C.F. Baker in having paler context and larger basidiospores. Pileus surface of *Ganoderma colossus* is yellow, yellowish orange, pale brown, to brownish orange (Ryvarden & Johansen 1980; Torres-Torres *et al.* 2015), whereas, the present collections possess dark brownish black to pure black coloured pileus. *Ganoderma colossus* possesses slightly longer basidiospores (14–19 µm long) than the present collection (according to descriptions of Ryvarden & Johansen 1980; Torres-Torres *et al.* 2015).

A taxon named "*G. colossus*" has been previously reported from Kerala by Mohanan (2011). Since the voucher material of this taxon was not available for study, the taxonomic description of Mohanan (2011) was compared with the morphological characters of present Kerala collection. On comparison, it was found that the morphological features of the species reported as "*G. colossus*" by Mohanan (2011) properly matched with those of present Kerala collection of *G. subresinosum*. Morphology of the species documented by Mohanan (2011) was different from that of true *G. colossus* (Based on the descriptions of Ryvarden & Johansen 1980; Torres-Torres *et al.* 2015). The macrophotograph of the species provided in Mohanan (2011) is also exactly same as that of present collections. So, it is believed that the previous record of *G. colossus* from Kerala by Mohanan (2011) is a misidentification, and in reality those collections belonged to *G. subresinosum*.

BLAST search using the ITS sequence generated from the specimen showed 99% (GenBank numbers: MH537850, JQ409358, KP965914, LC176785) to 100% (GenBank number KJ654406) similarity with *G. subresinosum*. BLAST result also resulted in 99% identity with *G. sichuanense* J.D. Zhao & X.Q. Zhang (KY244067. However, *G. sichuanense* produce smaller basidiospores (7–9.3 × 4.55–6.8 µm, Zhou *et al.* 2014).

In the phylogenetic tree (Figure 133), present collection settled with accession of *G. subresinosum* from China (voucher number: HNCM004, GenBank number: MH537850) with 99% bootstrap support.

So far, *G. subresinosum* has been reported from Africa, Borneo Island, India, Malaysia, Myanmar, Philippines and Sri Lanka (Hapuarachchi *et al*. 2018a). *G. subresinosum* was recently reported from Kerala by Kiran *et al*. (2020).

Ganoderma **species of** ***applanatum-australe*** **complex**

FIGURE 40

Basidiomata small to large sized, hard and woody, light in weight on drying, pileate. **Pileus** 20–180 mm long, 8–20 mm thick, sessile, laterally attached, semicircular, mostly applanate or with small crust like growths or furrows on the surface, concentrically zonate, not so prominent in some collections, finely sulcate, glabrous to hispid or pubescent at some part, surface easily cracked when dry, light brown to grayish brown with alternating zonations, yellowish brown towards margin in fresh collections, white along the margin, smooth, wavy, rounded. **Hymenophore** poroid. Pores 5–8 per mm, round to angular, usually becoming irregular towards margin, absent along the margin, initially white, turning pale to dark brown on handling, pore tubes 5–17 mm long, coffee brown. **Context** 3–13 mm thick, tough, light brown to cinnamon brown, concentric zonations visible. **Odour** not distinctive. **Spore print** not observed.

Basidiospores 6–10 × 4–7 µm, Q=1.2–2, Q_m=1.56, ellipsoid to broadly ellipsoid or ovoid, most spores truncate at the apex, hyaline, obtuse apical cap present instead of truncations in some spores, yellowish brown, smooth to minutely roughened, double walled, interwall pillars intermediate thick, pillar disposition free, guttulate or eguttulate, acyanophilic, inamyloid in Melzer's reagent. **Basidia** not observed. **Cystidia** absent. **Hymenial trama** interwoven. Generative hyphae 2–5 µm wide, hyaline, thin walled, branched, with clamp connections. Skeletal hyphae 2–8 µm wide, golden yellow to brown, thick walled (up to 2 µm), branched in an arboriform pattern, septations not observed. Skeleto ligative hyphae 1–3 µm wide, hyaline, slightly thick walled (up to 1 µm), highly branched, branchings of *Bovista* type, septations not observed. **Pileal trama** interwoven. Generative hyphae 2–3 µm wide, hyaline, smooth, thin walled, branched, with granular contents, with clamp connections. Skeletal hyphae 2–7 µm wide, golden yellow to brown, thick walled (1–2 µm), branched in an arboriform pattern, septations not observed. Skeleto ligative hyphae 1–3 µm wide, hyaline, slightly thick walled (up to 1µm), highly branched, septations not observed. **Pileipellis** composed of more or less agglutinated, thin walled, 2–5 µm wide hyphae with obtuse ends, ascending to form trichodermal patches.

Specimens examined: India. Kerala State: Kozhikode district, Pokkunnu, on decayed stem of *Cocos nucifera*, 2 July 2015, Vinjusha N, ZGC (CAL1549); Kakkodi, 7 July 2015, Vinjusha N, ZGCVN15 (CAL1550); Eranjipalam, 20 July 2015, Vinjusha N, ZGCVN75; 20 July 2015, Vinjusha N, ZGCVN77 (CAL1551); Thiruvannur, 22 July 2015, Vinjusha N, ZGCVN83 (CAL1552); Arikkulam, 10 January 2016, Vinjusha N, ZGCVN289 (CAL1548); Chelannur, 7 July 2016, Vinjusha N, ZGCVN352 (CAL1553); Thottilpalam, on dead trunk of *Cocos nucifera*, 26 June 2019, Salna N., ZGCVN824, ZGCVN825; Kollam district, Karunagapally, 12 December 2016, Arun Kumar T. K., ZGCVN484 (CAL1547); Wayanad district, 900 Kandi forest, on dead log (unidentified), 12 July 2019, Vinjusha N., ZGCVN851, ZGCVN852; Idukki district, Vattavada, on decayed tree log (unidentified), 28 July 2019, Vinjusha N., ZGCVN878, ZGCVN889.

Comments: Present specimen shows high similarity with *Ganoderma australe* (Fr.) Pat. However, basidiospore size of present collections are smaller (6–10 × 4–7 µm), when compared to that of *G. australe* (11–13 × 6–9 µm; (11–) 11.5–14 × 4–7 µm, as per the descriptions of Cunningham (1965) and Buchanan & Wilkie (1994). In most specimens of *G. australe*, one or several horizontal black resinous or melanoid bands are present in the context above the pore tubes, and basidiospores are echinulate (Ryvarden and Johanson 1980). However, melanoid bands are absent in our specimen and basidiospores are not echinulate. Present collection also resembles *G. adspersum* in morphology, however, the latter possesses slightly larger basidiospores (8.5–12 × 6.5–8.5, (7.8) 8.3–10.6 (11.3) × 5.1 (5.4) – 7.4 (7.8), according to descriptions of Schwarze & Ferner (2003) and Jargalmaa *et al.* (2017) respectively. Present collection is distinguished from similar *G. gibbosum* (Cooke) Pat. by sessile basidiocarps and smaller pores (5–8 per mm; 4–5 per mm in *G. gibbosum*, Jargalmaa *et al.* 2017). *Ganoderma lobatum* (Cooke) G.F. Atk. is another closely related species present in *Ganoderma applanatum-australe* complex. Present collection differs from *Ganoderma lobatum* by having smaller basidiospores (10–12.5 × 7–8 µm in *G. lobatum*, according to Gilbertson & Ryvarden 1986). Present specimen also shows resemblances with *G. applanatum* without much disparity, based on the available descriptions (Steyaert 1975a; Torres-Torres *et al.* 2012; Ryvarden & Melo 2014).

BLAST search using ITS sequence of the specimen resulted in 99% similarity with a *Ganoderma applanatum* strain (KR867655). This search result also showed 99% identity with *G. australe* (Fr.) Pat., *G. adspersum* and *G. gibbosum* (Cooke) Pat. (LC084749, MK345425 and KJ654404 respectively).

In the phylogenetic tree (Figure 135), present collection clustered along with a taxa named as “*G. applanatum*” from Sri Lanka (voucher number-UOC BIB MB13, GenBank number: KR867655). However, our collection and the Sri Lankan material settled as distinct phylogenetic lineage from the *G. applanatum* accessions from Europe, which is the type locality of *G. applanatum* (Niemelä & Miettinen 2008). In the phylogenetic tree, present collection (CAL1547) settled in a one of the Asian clades of Moncalvo and Buchanan (2008), that includes other accessions of *G. applanatum* complex and *G. australe* complex from tropical countries (Cambodia, China, Thailand, and Singapore), and was phylogenetically distinct. This indicates a possible existence of an undescribed non laccate species in Asian countries like Sri Lanka and India, which is close to *G. applanatum* and *G. australe*. This species would have been misidentified as "*G. applanatum*" for long, because of the morphological semblance with the latter. Thus, the present collection from Kerala is discovered as a hitherto undescribed species belonging to *G. applanatum-australe* complex. However, since our collection needs additional morphological study and phylogenetic characterization based on multilocus data and broad sampling of similar species, for the time being considers the species from Kerala.

A taxa named as "*G. applanatum*" has been recorded from Kerala by Mohanan (2011). However, the microscopic features (especially the size of basidiospores) provided in the taxonomic description by Mohanan (2011) makes the species more closer to *G. australe* than *G. applanatum*. Unfortunately, the voucher material of the species described by Mohanan (2011) is not available for a restudy. Hence the identity of the taxa described as *G. applanatum* by Mohanan (2011) is highly doubted.

Ganoderma australe (Fr.) Pat., Bull. Soc. mycol. Fr. 5 (2, 3): 65 (1889)

Basionym: *Polyporus australis* Fr., Elench. fung. (Greifswald) 1: 108 (1828)
Synonyms:
Polyporus tornatus Pers., in Gaudichaud-Beaupré in Freycinet, Voy. Uranie., Bot. (Paris) 4: 173 (1827)
Polyporus scansilis Berk., J. Linn. Soc., Bot. 16 (no. 89): 53 (1878)
Fomes scansilis (Berk.) Cooke, Grevillea 13 (no. 68): 119 (1885)
Fomes australis (Fr.) Cooke, Grevillea 14 (no. 69): 18 (1885)
Placodes australis (Fr.) Quél., Enchir. fung. (Paris): 171 (1886)
Ganoderma australe f. *arculatum* Bres., Malpighia 4: 293 (1890)
Fomes australis subsp. *arculatus* (Bres.) Sacc., Syll. fung. (Abellini) 9: 180 (1891)
Scindalma tornatum (Pers.) Kuntze, Revis. gen. pl. (Leipzig) 3 (3): 517 (1898)
Scindalma scansile (Berk.) Kuntze, Revis. gen. pl. (Leipzig) 3 (3): 519 (1898)
Scindalma arculatum (Bres.) Kuntze, Revis. gen. pl. (Leipzig) 3 (3): 518 (1898)
Ganoderma arcuatum (Bres.) Mussat, in Saccardo, Syll. fung. (Abellini) 15: 147 (1901)
Elfvingia tornata (Pers.) Murrill, Bull. Torrey bot. Club 30 (5): 301 (1903)
Ganoderma tornatum (Pers.) Bres., Hedwigia 53 (1-2): 55 (1912)

Fomes applanatus var. *australis* (Fr.) Cleland & Cheel, J. Proc. R. Soc. N.S.W. 51: 518 (1917)
Ganoderma applanatum f. *australe* (Fr.) Bourdot & Galzin, Bull. trimest. Soc. mycol. Fr. 41 (2): 184 (1925)
Elfvingia australis (Fr.) G. Cunn., Bull. N.Z. Dept. Sci. Industr. Res. 164: 256 (1965)
Fomes nigrolaccatus sensu Lloyd; fide Buchanan & Ryvarden (2000)

FIGURE 41

Basidiomata tough when fresh, becoming corky to woody on drying, pileate. **Pileus** 70–135 mm long, 12–25 mm thick, sessile, laterally attached, dimidiate, semicircular, applanate, surface rough crust like growths, concentrically zonate, glabrous, hispid at the concentric zonations, varying shades of dark and light brown, margin even to wavy, smooth, rounded and entire. **Hymenophore** poroid. **Pores** 5–6 per mm, almost regular, round, absent at the margin, surface dull white, turning pale brown on handling, pore tubes up to 10 mm long, greyish brown. **Context** 6 mm thick, tough, dark brown. **Odour** not distinctive. **Spore print** not observed.

Basidiospores 9–11 × 6–7 µm, Q=1.2–1.8, Q_m=1.5, ellipsoid, yellowish brown, double walled, inter wall pillars intermediate thick, spores mostly truncate, with lens cap like covering, inamyloid in Melzer's reagent. **Basidia** not observed. **Cystidia** absent**. Hymenial trama** interwoven and trimitic. Generative hyphae 1–5 µm wide, hyaline, smooth, thin walled, branched, with clamp connections. Skeletal hyphae 2–7 µm wide, yellowish brown to brown, smooth, thick walled (up to 2 µm), branched, septations not observed. Skeleto ligative hyphae 2–3 µm wide, hyaline, slightly thick walled (up to 1 µm), highly branched, branchings of *Bovista* type. **Pileal trama** loosely interwoven and trimitic. Generative hyphae not observed. Skeletal hyphae 3–6 µm wide, hyaline, thick walled (up to 2 µm), moderately branched. Skeleto ligative 2–4 µm wide, hyaline, thick walled (up to 1 µm), branchings of *Bovista* type, septations not observed. **Pileipellis** composed of short, highly branched trichoderm hyphae 2–5 µm wide, hyaline, with obtuse ends.

Specimens examined: India. Kerala State: Palakkad district, Aryambavu, on dead wood stump of *Cocos nucifera*, 20 July 2015, Abhijith S., ZGCVN81, ZGCVN85;

Idukki, Pooppara, on dead wood, 30 July 2019, Vinjusha N., ZGCVN874, ZGCVN885.

Comments: The present specimen is very much similar to *G. applanatum* in most morphological characters. The major difference separating present specimen from *G. applanatum* is the size of basidiospores. *Ganoderma applanatum* possesses smaller basidiospores (7–9.6 × 5.6–6.4 µm, according to Torres-Torres *et al.* 2012), than the present collections. According to Leonard (1998), Torres-Torres *et al.* (2012), and Ryvarden & Melo (2014), larger basidiospores, thicker crust on pileus, thicker and darker context and are reliable characters that separates *G. australe* from *G. applanatum*. Reffering to these descriptions, present collection is placed as *G. australe*.

The BLAST search using the newly generated ITS sequence, shows 98% similarity with *G. australe* strains (LC084748, LC084738, LC084733, LC084702, LC084676). The BLAST result also showed 98% identity with one *G. fornicatum* (Fr). Pat. strain (JX840347). However, *G. fornicatum* is separated from present collection by its smaller basidiospores (6.9–10.3 × 3.6–5.7 µm, Hapuarachchi *et al.* 2018a) and having distinct echinulae on spore walls.

In the phylogenetic tree (Figure 133), present collection settled along with an accession of *G. australe* (Voucher number: 30-2, GenBank number: LC084748) from Malaysia, with 78% bootstrap support.

Ganoderma australe has pantropical distribution (Ryvarden & Johansen 1980; Steyaert 1975). Occurrence of this species in South India was confirmed by Kaliyaperumal & Kalaichelvan (2008), based on morphology and molecular phylogeny. From Kerala, the species has been reported by Leelavathy & Ganesh (2000), Iqbal *et al.* (2016), and Adarsh *et al.* (2018).

Ganoderma multicornum Ryvarden, Mycologia 92 (1): 184 (2000)

FIGURE 42

Basidiomata annual, small sized, tough when fresh, becoming harder, woody and light in weight on drying, pileate. **Pileus** 45–85 mm long, up to 25 mm thick, laterally attached, sessile, dimidiate, irregular with a slight convex surface when young, shiny, laccate, glabrous, concentrically zonate, reddish brown with shade of yellow, dull white towards margin, turning light brown on bruising, round, smooth and even. **Hymenophore** poroid. **Pores** 5–8 per mm, round to slightly angular, absent near margin, creamish white, turning light to dark brown on bruising, pore tubes 3–16 mm long, non- stratified, brown. **Context** 2–15 mm thick, tough, yellowish brown. **Odour** not distinctive. **Spore print** not observed.

Basidiospores 10–13 × 6–8 µm, Q=1.4–1.8, Q_m=1.48, ellipsoid to ovoid, dark brown, double walled, smooth, inamyloid in melzers reagent. **Basidia** and basidioles not observed. **Cystidia** absent. **Hymenial trama** interwoven and trimitic. Generative hyphae 2–3 µm wide, hyaline, smooth, thin walled, branched, with clamp connections. Skeletal hyphae 3–5 µm wide, golden brown, thick walled (1–2 µm), branched, sometimes arboriform, septations not observed. Skeleto ligative hyphae 2–3 µm wide, hyaline to pale brown, thick walled (1 µm), highly branched, sepatations not observed. **Pileal trama interwoven**. Generative hyphae 2–3 µm wide, hyaline, smooth, thin walled, branched, with clamp connections. Skeletal hyphae 3–7 µm wide, golden brown, thick walled (1–2 µm), branched, branchings arboriform, septations not observed. Skeleto ligative hyphae 1.5–3 µm wide, hyaline to pale brown, thick walled (1 µm), highly branched, sepatations not observed. **Pileipellis** composed of irregular, cylindrical to narrowly clavate end cells, mostly antler like, 35–98 × 4–11 µm, with many lobes and branches, straight to flexuose, golden brown to dark brown, thick walled (1–4 µm), without granulations in the apex, sometimes with very weak granulations, amyloid in Melzer's reagent, at some region hyphae interwined and highly agglutinated.

Specimens examined: India. Kerala State: Kozhikode, Eranjipalam, near Sarovaram Biopark, on *Polyalthia longifolia*, 20 July 2015, Vinjusha N., ZGCVN76; Marad, on dead *Cocos nucifera*, 16 January 2016, Athira C. K., ZGCVN308.

Comments: The typical antler like branching of the pileipellis cells of this species easily distinguishes it from other *Ganoderma* species present in the laccate complex. According to Ryvarden (2000b), *G. orbiforme* (Fr.) Ryvarden is the closely related species of *G. multicornum*, however, separated from the former by having less branched pileipellis cells and slightly smaller basidiospores.

So far, no DNA sequences of *G. multicornum* are available in the GenBank database. BLAST search using the ITS sequence generated from the present collection resulted in 93% with *G. orbiforme* (GenBank numbers: MK345448, MK345446).

In the phylogenetic tree, *G. multicornum* of the present study settled near to *G. australe* accession from Malaysia. However, the non laccate pileus surface, lacking palisade end cells easily distinguishes *G. australe* from present collection. Morphologically, *G. orbiforme* is the closest relative of *G. multicornum* (Ryvarden 2000b). However, *G. orbiforme* accessions used in the analysis settled in a separate clade from *G. multicornum*. Additional sampling and sequencing are required to resolve the phylogenetic relationship of this taxa.

There are no much records available for this species since its original description from South America (Ryvarden 2000b, on unidentified dead hardwood). In India, *G. multicornum* has been reported from Pune on *Azadiracta indica* and *Delonix regia* (Ranadive & Jagtap 2016). There are no reports of this species from Kerala till date.

Ganoderma multipileum Ding Hou [as '*multipilea*'], Quarterly Journal of the Taiwan Museum 3: 101 (1950)

FIGURE 43

Basidiomata annual, small to large sized, solitary, tough when fresh, becomes harder and woody on maturity, light in weight on drying, usually stipitate, sometimes sessile to dimidiate. **Pileus** 60–300 mm long, 10–50 mm thick, irregular in shape when young, becoming semicircular to circular, applanate or uneven with lobes in stipitate fruit bodies, sometimes get highly lobed and form large compound fruit bodies, surface concentrically zonate or not, sometimes sulcate, smooth, shiny, laccate, glabrous, reddish brown to wood brown, margin round, smooth and entire. **Hymenophore** poroid. **Pores** 5–6 per mm, round to ovoid, irregular at some parts, absent near margin, white, turning light to dark brown on bruising, pore tubes 3–4 cm long, non- stratified, coffee brown, dissepiments 72–123 µm wide. **Contex**t 1–4 cm, tough, corky, brown. **Stipe** 4–12 cm long, cylindrical, single or highly branched towards apex in large compoung fruitbodies, woody, smooth, shiny, laccate, glabrous, dark brown. Stipe tissue light to dark brown, fibrous, solid. **Odour** not distinctive. **Spore print** not observed.

Basidiospores 6–11 × 5–7 µm, Q=1.2–2, Q_m=1.5, ellipsoid to broadly ellipsoid, yellowish brown, distintly echinulate, double walled, interwall pillars intermediate thick, truncate to frequently ovoid at the apex, pillar disposition free, eguttulate, inamyloid in melzer’s reagent. **Basidia** not observed. **Cystidia** absent. **Hymenial trama** interwoven, trimitic and compactly arranged. Generative hyphae up to 2–3 µm wide, hyaline, smooth, thin to thick walled (1 µm), branched, with clamp connections. Skeletal hyphae 4–5 µm wide, light to dark brown, thick walled (up to 3 µm), branched, septations not observed. Skeleto ligative hyphae up to 3 µm wide, hyaline to pale brown, thick walled (1 µm), highly branched, septations not observed. **Pileal trama** interwoven. Generative hyphae 3–5 µm wide, hyaline, thin walled, branched, with clamp connections. Skeletal hyphae 4–7 µm wide, brown, thick walled (1–2 µm), branched, septations not observed. Skeleto ligative hyphae 1–2 µm wide, hyaline to pale brown, thick walled (1 µm), highly branched, sepatations not observed. **Pileipellis** hyphae composed of cylindrical to clavate end cells; 4–13 µm wide, regularly arranged, without lobes and protuberances, golden brown to yellowish brown, smooth to mostly encrusted at tip, encrustations easily dissolved in KOH, thick walled (2–4 µm), strongly amyloid in Melzer’s reagent.

Specimens examined: India. Kerala State: Kozhikode district, Francis road, on live tree of *Delonix regia*, 04 July 2015, Vinjusha N., ZGCVN13; Chelapram, on *Cocos nucifera*, 29 August 2017, Vinjusha N., ZGCVN325; Kariyathan Kavu, on dead wood stump (unidentified), 12 September 2016, Vinjusha N., ZGCVN348; Wayanad district, Muthanga, on dead wood stump of unknown tree (unidentified), 27 July 2016, Vinjusha N., ZGCVN395; Kannur district, Aralam, on dead wood (unidentified), 24 September 2016, Vijisha P., ZGCVN462; Kozhikode district, Ramanattukara, on dead wood stump (unidentified), 05 February 2017, Vinjusha N., ZGCVN481; Peruvannamuzhy, on *Terminalia arjuna*, 24 June 2017, Vinjusha N., ZGCVN524; Thrissur district, Peechi, on dead wood (unidentified), 25 June 2017, Vinjusha N., ZGCVN534; Kasaragod, Trikaripur, Edayilakkad kavu, on dead wood (unidentified), 01 September 2017, Vinjusha N., ZGCVN626; Malappuram district, Calicut University campus, on live *Acacia* species, 19 September 2017, Vinjusha N., ZGCVN637; on soil (near base of *Acacia* species) 20 July 2018, Vinjusha N., ZGCVN682.

Comments: Present collections show high morphological similarity with *G. lucidum* (Curtis) P. Karst., however can be differentiated from the latter based on surface feature of basidiospores. Basidiospores of *G. lucidum* are mostly defined as rugose, coarsely echinulate, with sinuous ridges or shallow depressions (Bazzalo & Wright 1982; Ryvarden & Gilbertson 1993; Zhou *et al.* 2014). Whereas, present collections possesses finely echinulate basidiospores.

BLAST search using ITS sequences from the present collections resulted in 99% similarity with *G. multipileum* accessions (MG279184, LC149613) and *G. lucidum* accessions (MK940282, HM053463, GU726932, GQ249884)

G. lucidum and *G. multipileum* are two widely misidentified taxa of the genus (Wang *et al.* 2009). Based on a molecular phylogenetic study, Wang *et al.* (2009) proved that the species reported as *G. lucidum* from Asian countries like India actually belongs to *G. multiplieum*. According to Wang *et al.* (2009), two Indian accessions (voucher numbers: FRI816, BCRC36123; GenBank numbers: X87351/X87361 and EU021459 respectively) labeled as "*G. lucidum*" settled together with *G. multipileum,* and were also distinct from the typical *G. lucidum* of European countries. In the phylogenetic tree (FIGURE 133) generated here, accessions of present collections settled near to *G. multipileum,* and was distinct from the *G. lucidum* accessions.

Ganoderma enigmaticum M.P.A. Coetzee, Marinc. & M.J. Wingf., in Coetzee, Marincowitz, Muthelo & Wingfield, Mycosphere 6 (1): 251 (2015)

FIGURE 44

Basidiomata annual to perennial, medium sized, solitary, tough when fresh, becoming harder and woody, light in weight on drying, lateral, with a stipe like region of attachment, pileate. Pileus 55–135 mm long, 18–20 mm thick, semicircular, applanate, shiny, laccate, glabrous, reddish brown, more brown on drying, margin round, with a yellowish colour on underside, smooth and entire. **Hymenophore** poroid. **Pores** 4–6 per mm, round, regular, absent near margin, off white, turning light to dark brown on bruising, pore tubes 5–15 mm long, non stratified to stratified, brown. **Contex**t 2–10 mm thick, tough, corky, coffee brown, with a narrow black distinct line. **Odour** not distinctive. **Spore print** not observed.

Basidiospores 8–11 × 4.5–7 µm, Q=1.2–1.8, Q_m=1.5, ellipsoid, yellowish brown, double walled, interwall pillars intermediate thick, inner wall verrucose, outer wall almost rough, truncate inamyloid in Melzers reagent. **Basidia** not observed. **Cystidia** absent. **Hymenial trama** interwoven, trimitic and compactly arranged. Generative hyphae 1.5–3 µm wide, hyaline, smooth, thin to thick walled (1µm), branched, with clamp connections. Skeletal hyphae 3–5 µm wide, golden brown, thick walled (1 µm), branched, with more branches near the hyphal endings, septations not observed. Skeleto ligative hyphae 1–2 µm wide, hyaline, thick walled (1 µm), highly branched, septations not observed. **Pileal trama** interwoven. Generative hyphae 2–3.5 µm, hyaline, smooth, thin to thick walled (1µm), branched, with clamp connections. Skeletal hyphae 3–7 µm wide, golden brown, thick walled (1 µm), branched with more branches near the hyphal endings, septations not observed. Skeleto ligative hyphae 1–3 µm wide, hyaline, thick walled (1 µm), highly branched, sepatations not observed. **Pileipellis** composed of clavate to irregularly swollen pileal end cells that are 31–62 × 4–10 µm, hyaline to yellowish brown, slightly encrusted, weakly amyloid in Melzer's reagent.

Specimens examined: India. Kerala State: Kozhikode district, Eranjipalam, on dead stump of *Cocos nucifera*, 20 July 2015, Vinjusha N., ZGCVN73; Pattambi, on *Cocos nucifera*, 01 October 2018, Vinjusha N., ZGCVN731.

Comments: Morphological characterization of the specimen properly matches with the description of *Ganoderma enigmaticum*. According to the description (Coetzee *et al.* 2015), size of basidiospores of *G. enigmaticum* is 8–11 × 3.5–6 µm. However, the present collection has slightly wider basidiospores (8–11 × 4.5–7 µm).

BLAST search using the newly generated ITS sequence of the specimens (GenBank numbers) showed 99% similarity with *G. enigmaticum* (KR150678). *Ganoderma enigmaticum* was described from South Africa by Coetzee *et al.* (2015), which was associated with root rot of *Jacaranda mimosifolia*.

In the phylogenetic tree (Figure 133), Kerala collection of *G. enigmaticum* recorded during the present study clustered along with *G. enigmaticum* from South Africa, with 95% bootstrap support. In the tree, *G. thailandicum* settled near to present collection of *G. enigmaticum* as a sister lineage. However, morphologically, the former is separted from the latter in having smaller basidiospores ((5.8) 6.5–7.33 (7.7) × (6.8.) 8.4–9.7 (10.2) µm, according to the description of Luangharn *et al.* 2019). The clustering of *G. enigmaticum* and *G. thailandicum* as sister clades agrees with the previous molecular study on *Ganoderma* species by Luangharn *et al.* (2019).

Ganoderma enigmaticum has been reported from India by Gudikandula *et al.* (2017). There are no records of the species from Kerala so far.

Ganoderma orbiforme (Fr.) Ryvarden [as '*orbiformum*'], Mycologia 92 (1): 187 (2000)

Basionym: *Polyporus orbiformis* Fr., Epicr. syst. mycol. (Upsaliae): 463 (1838) [1836-1838]
Synonyms:
Polyporus mastoporus Lév., Annls Sci. Nat., Bot., sér. 3 2: 182 (1844)
Polyporus cupreus Fr., Nova Acta R. Soc. Scient. upsal., Ser. 3 1 (1): 64 (1851)

Fomes mastoporus (Lév.) Cooke, Grevillea 13 (no. 68): 119 (1885)
Fomes orbiformis (Fr.) Cooke, Grevillea 14 (no. 69): 18 (1885)
Fomes cupreus Cooke, Grevillea 14 (no. 69): 17 (1885)
Fomes lucidus f. *noukahivensis* Sacc., Syll. fung. (Abellini) 6: 157 (1888)
Ganoderma noukahivense Pat., Bull. Soc. mycol. Fr. 5 (2, 3): 72 (1889)
Ganoderma mastoporum (Lév.) Pat. [as '*malosporum*'], Bull. Soc. mycol. Fr. 5 (2, 3): 75 (1889)
Scindalma orbiforme (Fr.) Kuntze, Revis. gen. pl. (Leipzig) 3 (3): 519 (1898)
Scindalma mastoporum (Lév.) Kuntze, Revis. gen. pl. (Leipzig) 3 (3): 519 (1898)
Scindalma cupreum (Cooke) Kuntze, Revis. gen. pl. (Leipzig) 3 (3): 518 (1898)
Ganoderma cupreum (Cooke) Bres., Annls mycol. 9 (3): 268 (1911)
Elfvingia mastopora (Lév.) Imazeki, Bull. Gov. Forest Exp. Stn Tokyo 57: 104 (1952)
Ganoderma lucidum var. *orbiformis* (Fr.) Rick, in Rambo (Ed.), Iheringia, Sér. Bot. 7: 201 (1960)

FIGURE 45

Basidiomata annual, medium sized, solitary, hard and woody, heavy when fresh, light in weight on drying, pileate. Pileus 110 mm long, 17 mm thick, semicircular, applanate, with radial ridges and grooves, smooth, shiny, laccate, concentrically zonate, not sulcate, glabrous, reddish brown, cuticle peeled off on exposure leaving a pale brownish surface, at some region, margin even, incurved on drying. **Hymenophore** poroid. **Pores** 4–5 per mm, round, regular, absent along margin, white when fresh, pale to dark brown on bruising, pore tubes 13 mm long, non stratified, brown. **Context** up to 3 mm thick, coffee brown, yellowish brown towards pileus, with a discontinuous black band, without concentric zonations. **Spore print** not observed.

Basidiospores 9–13 × 5–6 µm, Q=1.5–2.1, Q_m=1.65, elongated ellipsoid to ellipsoid, apex sub acute with a hyaline cap, truncate or not, brown, double walled, inter wall pillars intermediate thick, pillar disposition free, surface warty to slightly echinulate, eguttulate, inamyloid in melzers reagent. **Basidia** not observed. **Cystidia** absent. **Hymenial trama** interwoven and trimitic. Generative hyphae very rarely observed, 1–3 µm wide, hyaline, smooth, thin walled, branched with clamp connections. Skeletal hyphae 3–7 µm wide, light brown, darker in KOH, smooth, thick walled (1–3 µm), unbranched, septations not observed, lumen narrow. Skeleto ligative hyphae 1–3 µm wide, hyaline, thick walled (1 µm), highly branched, septations not observed, mostly without lumen. **Pileal trama** interwoven. Generative hyphae getting inflated up to 11 µm wide, hyaline, smooth, thin walled, branched with clamp connections. Skeletal hyphae 3–8 µm wide, light brown, darker in KOH, smooth, thick walled (1–3 µm), unbranched, septations not observed. Skeleto ligative hyphae 1–3 µm wide, hyaline, thick walled (1 µm), highly branched, septations not observed, mostly without lumen. **Pileipellis** hyphae composed of cylindrical to narrowly clavate end cells, 4–9 µm wide, even to irregular with many lobes or protuberances, straight to flexuose, pale yellowish brown, dark brown in KOH, thick walled (1–2) µm, smooth to slightly encrusted, weakly amyloid in Melzer's reagent.

Specimen examined: India. Kerala State: Kozhikode district, Kakkad, on live tree (unidentified), 13 July 2017, Vinjusha N., ZGCVN577.

Comments: Characters of the present collection fits well with the descriptions of *G. orbiforme* by Ryvarden (2004), Torres-Torres *et al*. (2012), and Zhou *et al.* (2014). The collection is very much similar with *G. boninense.*. According to Zhou *et al.* (2014), pore surface of *G. boninense* is straw yellow when fresh, whereas, the present collection possesses white pore surface in fresh condition. Based on the description of Ryvarden (2004), *Ganoderma boninense* produces slightly wider basidiospores (7–8 µm) than the present collection (5–6 µm). However, narrower spores have been reported in *G. boninense* (4–7 µm wide, according to descriptions of Steyaert 1975b; Zhou *et al.* 2014). Ryvarden (2000) and Hapuarachchi *et al.* (2018a) considered *G. orbiforme* and *G. boninense* as synonyms because of the morphological similarities between these two species. However, currently, *G. boninense* and *G. orbiforme* are retained as independent species (Index Fungorum, accessed on 27 March 2020). Present collection also resembles *G. stipitatum* in morphology. However, the latter produces smaller basidiospores (8–9 × 6–6.8 µm, Torres-Torres *et al*. 2012).

BlAST search using the ITS sequences generated from the present collection resulted in 97% identity with *G. orbiforme* (GenBank numbers: KX421867, JX997990) and 96% identity with *G. boninense* strains (MK713555, KF164430, MN148580, MK713561). Thus, based on morphology and molecular data, present collection shows slightly more affinity towards *G. orbiforme*.

In the phylogenetic tree (Figure 133), present collection claded together with accessions of *G. orbiforme* from Malaysia (voucher numbers: BCC22325, BCC22324; GenBank numbers: KX421867, JX997990) with 93% bootstrap support.

Ganoderma orbiforme has tropical distribution (Ryvarden 2000). This species has not been reported from Kerala so far.

Ganoderma keralense N. Vinjusha & T.K.A Kumar *sp. nov.*

Figure 46

Basidiomata small to medium sized, tough when fresh, becoming harder, woody and light in weight on drying, laterally stipitate and somewhat descending when young, becoming sessile to broadly attached on maturity. **Pileus** 48–160 mm long, 10–40 mm thick, semicircular, applanate, shiny, laccate, glabrous, concentrically sulcate zonate, sulcate zonations more prominent in larger fruit bodies, reddish brown,whitish at the margin when young,whole fruit body turning brownish black on maturity; margin round, smooth and even to slightly wavy. **Hymenophore** poroid. **Pores** 5–6 per mm, round to ovoid, absent near margin, dull white, turning light brown to dark brown on bruising, pore tubes 6–28 mm long, non stratified, wood brown to coffee brown. **Context** up to 13 mm thick near the region of attachment, 1.5–3 mm thick towards margin, tough, yellowish brown to light brown, slightly darker near the pore tubes in some collections, concentric circles visible in large fruit bodies. **Stipe** 10-20 mm long, lateral, hard, smooth and shiny, laccate, glabrous, reddish brown to brownish black, solid, inner tissue cream to light brown. **Odour** not distinctive. **Spore print** not observed.

Basidiospores 8–13 × 5–8, Q=1.5–2.2, Q_m=1.76, oblong ellipsoid, mostly truncate, brown, semi rugose, double walled, inter wall pillars thin, pillar disposition free, guttulate or eguttulate, acyanophilic, inamyloid in Melzer's reagent. **Basidia** and basidioles not observed. **Cystidia** absent. **Hymenial trama** interwoven. Generative hyphae 2–4 µm wide, hyaline, smooth, thin walled, branched, with clamp connections. Skeletal hyphae 3–8 µm wide, golden brown to brown, thick walled (wall thickness up to 3 µm), branched in an arboriform pattern, septations not observed. Skeleto ligative hyphae 2–4 µm wide, hyaline to very pale brown, thick walled (1 µm), highly branched, branchings of "*Bovista* type" (skeletal hyphae may branch freely, with branches arising from a relatively short main stem), septations not observed. **Pileal trama** interwoven. Generative hyphae 2–3 µm wide, hyaline, thin walled, branched, with clamp connections. Skeletal hyphae 3–8 µm wide, golden brown to brown, thick walled (1–2 µm), branched in arboriform pattern as in hymenophore, septations not observed. Skeleto ligative hyphae 2–4 µm wide, hyaline, thick walled (1 µm), highly branched, branchings of *Bovista* type, septations not observed. **Pileipellis** a hymeniderm composed of irregularly lobed, capitate to clavate end cells; end cells 5–15 µm wide, yellowish brown to brown, thick walled (1–4 µm) with granular encrustations, strongly amyloid in Melzer's reagent. **Stipe trama** interwoven. Generative hyphae sparsely observed, up to 3 µm wide, hyaline, thin walled, branched, with clamp connections. Skeletal hyphae 2–6 µm wide, golden brown to brown, thick walled (up to 2 µm), branched in arboriform pattern as in pileus, septations not observed. Skeleto ligative hyphae 2–4 µm wide, hyaline, highly branched, branchings of *Bovista* type, thick walled (1 µm), septations not observed. **Stipitipellis** a hymeniderm; end cells irregularly lobed, capitate to clavate, 4–13 µm wide, yellowish brown to brown, thick walled (up to 4 µm), mostly solid, with granular encrustations, strongly amyloid in Melzer's reagent.

Specimens examined: India. Kerala: Kozhikode district, Kakkodi, on dead stem of *Cocos nucifera*, 6 July 2015, Vinjusha N., ZGCVN10 (CAL1546); Koyilandy, Arikkulam, 10 January 2016, Vinjusha N., ZGCVN288 (CAL1543); Edakkara, Vallikkattukavu, on dead wood (unidentified), 11 July 2015, Vinjusha N., ZGCVN46 (CAL1544); 11 July 2015, Vinjusha N., ZGCVN47 (CAL1545).

Comments: The specimen represents an undescribed species of *Ganoderma*, belonging to *Ganoderma* laccate complex. The collections resembles *G. angustisporum* J.H. Xing, B.K. Cui & Y.C., a species recently described by Xing *et al.* (2018) from China on living trees of *Casuarina equisetifolia* L. According to the description (Xing *et al.* 2018), fruit bodies of *G. angustisporum* are sessile and broadly attached on the host. However, present specimens are mostly laterally stipitate in young condition. *Ganoderma angustisporum* possesses distinct black melanoid band in the context, wheras, such bands were ansent in the context of present collection. According to Xing *et al.* (2018), pileipellis cells of *G. angustisporum* are thin walled, without encrustations, whereas most of the pileipellis cells of *G. keralense* are thick walled and distinctly encrusted. *G. angustisporum* produces mostly almond shaped basidiospores which are narrower (4–5.2 µm, Xing *et al.* 2018). Whereas, basidiospores of *G. keralense* are always oblong ellipsoid and wider (4–7 µm) and never almond shaped. BLAST search in NCBI's GenBank nucleotide database using the newly generated ITS sequence of the collection resulted in 98% identity with *G. angustisporum* (MG279171) and RPB2 based sequence similarity search resulted in 96% identity with *G. angustisporum* (MG367507).

BLAST search using the sequences obtained from LSU gene region of present collection resulted in 92% similarity with the sequence of *G. orbiforme, G. tornatum*, *G. ecuadoriense, G. gibbosum* and *G. williamsianum*. *G. tornatum* and *G. gibbosum* can be easily separated from present specimen by their non laccate pileus surface (Steyaert 1975; Jargalmaa *et al.* 2017 respectively). *G. ecuadoriense* is distinguished from the present collection by having club shaped pileipellis end cells, without lobes or branches (Crous *et al*. 2016). According to Ryvarden (2004) and Torres-Torres *et al.* (2012), basidiospores of *G. orbiforme* are echinulate, with subfree inter wall pillars, and the pileal end cells lacked granular encrustations. The basidiospores of *G. keralense* possess free pillars with semi rugose ornamentation, and the pileal end cells are covered with distinct granular encrustations (Fig). Present specimen shows resemblances with *G. williamsianum* in some macroscopic and microscopic characters. However, there are differences. Basidiospores of *G. williamsianum* are described as strongly echinulate with spore size 11–15 × 8–10.5 µm (Corner 1983). Basidiospores of *G. keralense* are semi rugose and smaller (8–13 × 5–8 µm). Pileal end cells of *G. williamsianum* are semi agglutinated and without palisade layers. However, *G. keralense* possesses distinct palisade layers in the pileipellis region.

Ganoderma keralense shows close similarity with *G. boninense* in many macroscopic as well as microscopic characters. However, the two species can be distinguished morphologically and at the molecular level. *G. boninense* produces slightly wider spores (10–12 × 7–8 µm, Ryvarden 2004; 8.5–13 × 5–7 µm, Steyaert 1975b) than the present collection (8–13 × 4–7 µm). Again, basidiospores of *G. boninense* are finely echinulate (Zhou *et al.* 2014). Ryvarden (2004) describes it as finely asperulate. According to Steyaert (1975), basidiospores of this species possess thin short echinules, although non echinulate spores are rarely observed. Whereas, basidiospores of present specimen are semi rugose and not asperulate or echinulate. Concentric growth zones are absent in the context of *G. boninense* (Zhou *et al.* 2014). Present collection possesses concentric growth zones. Pore surface of mature species of *G. boninense* is described as straw yellow (Zhou *et al.* 2014), whereas, it is white in present collection. The RPB2 and ITS sequence based BLAST search results showed only 91% and 95% identity with the *G. boninense* respectively.

Ganoderma keralense also shows some similarities with another species, *G. zonatum*. According to Elliott & Broschat (2001), basidiomata of *G. zonatum* has distinct zones on the pileus. Bazzalo & Wright (1982), after studying the holotype of *G. zonatum*, described its pileal surface as usually one to three furrowed, inner one deeper and giving a wavy like appearance, central zone reddish brown with a narrow orangish brown marginal band, delimited by an external furrow. Such distinct zones or furrows were absent in present specimen. Bazzalo & Wright (1982) described pores in the hymenophore as 3–5 per mm; however, pore size of *G. keralense* is 5–6 per mm. According to Adaskaveg & Gilbertson (1988), *G. zonatum* had been reported exclusively from palms. According to Zhou *et al.* (2014), *G. zonatum* occurs on subtropical palms. However, few of present collections were also obtained from hardwoods (CAL1544, CAL1545). BLAST search using ITS and RPB2 sequences of present specimen showed only 95% and 90% identity with *G. zonatum* respectively.

Another species of *Ganoderma* that showed similarity with the present collection is *G. lucidum*. According to Corner (1983), a resinous layer is present on the pileus surface of *G. lucidum*, which dissolves in KOH, and the pileus consist of a regular layer of palisade cells that are not lobulate. A resinous layer was not observed in the pileus *G. keralense* and the pileal end cells were mostly lobed and irregular. According to the description of Corner (1983), colourless, ventricose cystidia are present in the hymenium of *G. lucidum*, whereas present collections lack cystidia. In the BLAST search, ITS and LSU sequences of present specimen showed only 93% and 92% identity with that of *G. lucidum* strains respectively. Similarly, BLAST search using RPB2 sequences of the collection resulted only in 89% identity with *G. lucidum* strains (KF233762, MG367502, MG367520).

The collection also shows morphological resemblance with *G. miniatocinctum*, a species reported from oil palm in Malaysia (Steyaert 1967). However, according to the original description (Steyaert 1967), *G. miniatocinctum* possesses sphaeropedunculate pileipellis cells, without lobes or branches, and their basidiospores are echinulate. Pileipellis end cells of present specimen are irregularly lobed, and basidiospores are not echinulate.

BLAST search using newly generated RPB2 sequence of the present collection (EMBL number: PRJEB36109) showed 90% similarity with *G. orbiforme* (Fr.) Ryvarden (GenBank number: MU367523) and *G. sinense* J.D. Zhao, L.W. Hsu & X.Q. Zhang (MG367529, MG367530). As per the description of Hapuarachchi *et al.* (2019), *G. sinense* produces elongate stipitate basidiomata (stipe 60–190 mm long), pileipellis with clavate end cells lacking lobes and branches, and finely echinulate basidiospores. However, present specimen produces short stipes in young stage (10–20 mm long, appears sessile at maturity), pileipellis with irregularly lobed, capitate to clavate end cells, and semi rugose basidiospores.

In the phylogenetic tree (Figure 133), *Ganoderma keralense* clustered as a distinct taxon, along with *G. angustisporum*, with 95% bootstrap support. The clade containing present new *Ganoderma* collection was distinct from the clades containing morphologically similar species, *G. lucidum*, *G. boninense* and *G. zonatum*.

Ganoderma tropicum (Jungh.) Bres., Annls mycol. 8 (6): 586 (1910)

Basionym: *Polyporus tropicus* Jungh., Verh. Batav. Genootsch. Kunst. Wet. 17 (2): 63 (1838)
Synonyms:
Fomes tropicus (Jungh.) Cooke, Grevillea 14 (no. 69): 19 (1885)
Scindalma tropicum (Jungh.) Kuntze, Revis. gen. pl. (Leipzig) 3 (3): 519 (1898)

FIGURE 47

Basidiomata annual, medium sized, solitary, hard and woody, light in weight, sessile to stipitate, up to 180 mm tall. Pileus 30–50 mm long, 11–20 mm thick, semicircular, applanate, smooth, shiny, laccate, slightly concentrically zonate, not sulcate, glabrous, reddish brown, yellow along margin, margin even, obtuse. **Hymenophore** poroid. **Pores** 5–6 per mm, round to oval, greyish white when fresh, brown on bruising, pore tubes 3–15 mm long, non stratified, brownish black. **Context** 8–12 mm thick, dark brown, homogenous, with concentric bands. **Stipe** lateral, 115–160 mm long, 9–16 mm thick, cylindrical, with a small branch towards upper part, broader towards base, laccate, shiny, glabrous, dark brownish red, brownish black on drying, tissue slightly fistulose, light brown. **Odour** not distinctive. **Spore print** not observed.

Basidiospores 7–11 × 4–7 µm, Q=1.3–1.7, Q_m=1.47, ellipsoid to ovoid, apex truncate, pale brown to brown, double walled, interwall pillars intermediate thick, pillar disposition free, surface echinulate, eguttulate, inamyloid in Melzer’s reagent. **Basidia** not observed. **Cystidia** absent. **Hymenial trama** interwoven. Generative hyphae very rarely observed, 1–2.5 µm wide, hyaline, smooth, thin walled, branched with clamp connections. Skeletal hyphae 2–5 µm wide, brown, smooth, thick walled (1µm), unbranched, septations not observed. Skeleto ligative hyphae 1–4 µm wide, hyaline to very pale brown, thick walled (1 µm), highly branched, branchings of *Bovista* type, septations not observed, lumen mostly absent. **Pileal trama** interwoven. Generative hyphae rarely observed, 2–3 µm wide, hyaline, smooth, thin walled, branched with clamp connections Skeletal hyphae predominant, 2–7 µm wide, yellowish brown, smooth, thick walled (1–2 µm), branched, septations not observed. Skeleto ligative hyphae present, but not frequent as in hymenium, 1–4 µm wide, hyaline to very pale brown, thick walled (1 µm), highly branched, branchings of *Bovista* type, septations not observed. **Pileipellis** hyphae composed of clavate end cells; mostly irregular with branches or lobes 5–10 µm wide, yellowish brown, smooth to weakly granular at tip, thick walled (1–2) µm, amyloid in Melzer's reagent. **Stipe trama** similar as pileal trama. Generative hyphae rarely observed, 2–3 µm wide, hyaline, smooth, thin walled, branched with clamp connections Skeletal hyphae 2–7 µm wide, yellowish brown, smooth, thick walled (1–2 µm), branched, septations not observed. Skeleto ligative hyphae predominant, but not frequent as in hymenium, 1–4 µm wide, hyaline to very pale brown, thick walled (1 µm), highly branched, branchings of *Bovista* type, septations not observed. **Stipitipellis** similar as pileipellis, composed of clavate end cells, mostly irregular with lobes, 5–10 µm wide, yellowish brown, smooth or encrusted, thick walled (1–2) µm, amyloid in Melzer's reagent.

Specimens examined: India. Kerala State: Kozhikode district, Peruvannamuzhy, on dead wood stump (unidentified), 11 August 2016, Vinjusha N., ZGCVN429; Kakkodi, Kootalida, Pathipara, on *Cocos nucifera*, 01 August 2019, Anju John, ZGCVN873; Palakkad district, Aryambavu, on live tree (unidentified), 20 July 2015, Abhijith S., ZGCVN80; Pattambi, on *Cocos nucifera*, 01 October 2018, Vinjusha N., ZGCVN732.

Comments: Morphological characters of the present specimen are in accordance with the descriptions of *G. tropicum* by Hapuarachchi *et al.* (2018a) and Luangharn *et al*. (2019). Present collection resembles *G. flexipes* Pat., *G. lingzhi* Sheng H. Wu, Y. Cao & Y.C. Dai, *G. lucidum* and *G. sichuanense*, by sharing similar macro morphological characters. According to Hapuarachchi *et al.* (2018a), *G. flexipes* possesses regulary arranged clavate pileal end cells, whereas, present collection mostly have irregular pileal end cells with lobes. In addition, *G. flexipes* produces thin stipe (4 mm thick, Hapuarachchi *et al.* (2018a). *G. lingzhi* generally produces distinct sessile basidiocarps (according to Luangharn *et al.* 2019), however, the present collection produces stipitate basidiocarps. *G. lucidum* and *G. sichuanense* are differentiated from the present collection in having almost regular pileipellis end cells without much branches or lobes (according to descriptions of Zhou *et al.* 2014 and Hapuarachchi *et al.* 2018a).

BLAST search using the ITS sequence generated from the collections resulted in 99% similarity with *G. tropicum* (GenBank numbers: EU021458, KF495000, EU021457, MK007291).

In the phylogenetic tree (FIGURE 133), present collection formed clade with accessions of *G. tropicum* from China (voucher numbers: Yuan 3490, Dai 16434, He 1232; GenBank numbers: JQ781880, MG279194, KF495000 respectively) with 85% bootstrap support. Morphologically related species such as *G. flexipes*, *G. lucidum*, and *G. multipileum* settled in distant phylogenetic lineages from the present collection.

Ganoderma tropicum has distribution in lowland tropical Asia and the subtropics (Hapuarachchi *et al.* 2018a). The species has not been reported from Kerala so far.

Ganoderma multiplicatum (Mont.) Pat., Bull. Soc. mycol. Fr. 5 (2, 3): 74 (1889)

Basionym: *Polyporus multiplicatus* Mont., Annls Sci. Nat., Bot., sér. 4 1: 128 (1854)
Synonyms:
Fomes multiplicatus (Mont.) Sacc., Grevillea 14 (no. 69): 18 (1885)
Scindalma multiplicatum (Mont.) Kuntze, Revis. gen. pl. (Leipzig) 3 (3): 519 (1898)
Ganoderma multiplicatum var. *vitalii* Steyaert, Bull. Jard. bot. État Brux. 32: 101 (1962)
Ganoderma subamboinense var. *laevisporum* Bazzalo & J.E. Wright, Mycotaxon 16 (1): 302 (1982)
Ganoderma subamboinense Henn., Syn. Fung. (Oslo) 11: 82 (1997)

FIGURE 48

Basidiomata annual, medium sized, solitary, hard and woody, light in weight, substipitate. Pileus 60 mm long, 13 mm thick, flabelliform, applanate, smooth, shiny, laccate, concentrically zonate, distinctly sulcate, glabrous, radially projected near the attachment, reddish brown, cuticle easily cracked when handled, reddish brown with light to dark brown zonations, yellowish towards margin, margin even, obtuse. **Hymenophore** poroid. **Pores** 4–6 per mm, angular, absent along margin, dull white when fresh, pale to dark brown on bruising, pore tubes 7 mm long, non stratified, coffee brown. **Context** up to 6 mm thick, brown, homogenous. **Substipe** lateral, up to 20 mm long, short cylindrical, as a small extension from pileus, laccate, shiny, glabrous, dark reddish brown, tissue solid, cream. **Odour** not distinctive. **Spore print** not observed.

Basidiospores 7.5–10 × 5–6 µm, Q=1.3–2, Q_m=1.64, ellipsoid to ovoid, some spores truncate, dark brown, double walled, interwall pillars thin, pillar disposition free, surface roughened, eguttulate, inamyloid in melzers reagent. **Basidia** not observed. **Cystidia** absent. **Hymenial trama** interwoven, with scattered crystals and trimitic. Generative hyphae very rarely observed, 2–3 µm wide, hyaline, smooth, thin to slightly thick walled (up to 1 µm), branched, with clamp connections. Skeletal hyphae 2–7 µm wide, yellowish brown, smooth, thick walled (1–2.5 µm), mostly branched towards extremities and becoming arboriform, septations not observed. Skeleto ligative hyphae 1–4 µm wide, hyaline, thick walled (1 µm), highly branched, septations not observed, lumen mostly absent. **Pileal trama** intertwined. Generative hyphae 2–3 µm wide, hyaline, smooth, thin to slightly thick walled (up to 1 µm), branched, with clamp connections. Skeletal hyphae 2–6 µm wide, yellowish brown, smooth, thick walled (1–2 µm), mostly branched towards extremities and becoming arboriform, septations not observed. Skeleto ligative hyphae 1–4 µm wide, hyaline, thick walled (1 µm), highly branched, septations not observed. **Pileipellis** hyphae composed of cylindrical clavate to clavate end cells, 3–7 µm wide, highly irregular with many protuberances and branches, yellowish to golden brown, smooth, thick walled (1–2 µm), without encrustations, amyloid in Melzer's reagent. **Stipe trama** similar as pileal trama, with sparse generative hyphae and dominating skeletal and skeleto ligative hyphae. Generative hyphae 2–3 µm wide, hyaline, smooth, thin to slightly thick walled (up to 1 µm), branched, with clamp connections. Skeletal hyphae 2–6 µm wide, yellowish brown, smooth, thick walled (1–2 µm), branched, branching arboriform, septations not observed. Skeleto ligative hyphae 1–4 µm wide, hyaline, thick walled (1 µm), highly branched, septations not observed. **Stipitipellis** similar to pileipellis, made of cylindrical clavate to clavate end cells, 3–8 µm wide, irregular with many tubercles or protuberances and branches, yellowish to golden brown, thick walled (1–2) µm, without encrustations, amyloid in Melzer's reagent.

Specimen examined: India. Kerala State: Thrissur district, Peechi, on fallen tree log (unidentified), VN529, Vinjusha N, 26 June 2017.

Comments: Characters of present collection match well with the available descriptions of *Ganoderma multiplicatum* (Ryvarden 2004; Torres-Torres *et al.* 2012; Zhou *et al.* 2014). Present specimen shows similarity with *G. orbiforme* in having irregular, branched, tuberculate, pileal end cells. However, *G. orbiforme* possesses larger basidiospores (10–11 × 6–7 µm, according to Ryvarden 2004) than the present specimen. The present specimen also resembles *G. enigmaticum* in having similar spore range, however the latter has cylindrical to narrowly clavate end cells without tubercles.

BLAST search using the ITS sequence generated from the specimen shows 97% identity with *G. mutiplicatum* strains (GenBank numbers: KU569549, KU569553, KU569542). The BLAST search also resulted in 96% similarity with *Ganoderma stipitatum* (Murrill) Murrill (GenBank numbers: KU569555, KU569530, KU569523, KU569521; as *Ganoderma parvulum*). According to Torres-Torres *et al*. (2012), *G. stipitatum* consists of black resinous bands up to half region of the context, whereas, present collection lacks black bands in the context. In addition, *G. stipitatum* possess dimitic hyphal system and almost entire clavate pileal end cells without tubercles. Present specimen has trimitic hyphal system and highly irregular pileal end cells with number of tubercles with branches.

In the phylogenetic tree (FIGURE 133), present collection settled along with *G. multiplicatum* from Brazil (voucher number: SPC9; GenBank number: KU569553) with 64% bootstrap support.

Ganoderma multiplicatum has tropical distribution (Ryvarden 2004). There are no reports of this species from Kerala so far.

Sanguinoderma Y.F. Sun, D.H. Costa & B.K. Cui

Basidiomata annual, central or lateral stipitate to sessile, woody hard. Pileus suborbicular to reniform, dark brown to almost black, concentrically zonate or furrowed, radially rugose, tomentose to glabrous. Hymenophore poroid, pores surface greyish white to dark grey, which turns blood red when bruised. Context pale brown to dark brown. Hyphal system trimitic, clamped generative hyphae, hyaline to yellowish brown, thick walled skeletal hyphae, hyaline to pale yellow, arboriformly branched skeleto ligative hyphae. Basidiospores subglobose, ellipsoid to reniform, pale yellow, double walled, sparsely to distinctly thick walled, inamyloid, with semi reticulate or vermiculate to verrucose exosporium and, solid, columnar to coniform endosporium. Members cause white rot on wood.

Sanguinoderma rugosum (Blume & T. Nees) Y.F. Sun, D.H. Costa & B.K. Cui, in Sun, Costa-Rezende, Xing, Zhou, Zhang, Gibertoni, Gates, Glen, Dai & Cui 2020

Basionym: *Polyporus rugosus* Blume & T. Nees, Nova Acta Phys.-Med. Acad. Caes. Leop.-Carol. Nat. Cur. 13: 21 (1826)
Synonyms:
Polyporus rugosus var. guineensis Fr., Epicr. syst. mycol. (Upsaliae): 436 (1838)
Polyporus rugosus var. *javanicus* Fr., Epicr. syst. mycol. (Upsaliae): 436 (1838)
Fomes rugosus (Blume & T. Nees) Cooke, Grevillea 13 (no. 68): 117 (1885)
Fomes rugosus var. *guineensis* (Fr.) Sacc., Syll. fung. (Abellini) 6: 152 (1888)
Fomes rugosus var. *javanicus* (Fr.) Sacc., Syll. fung. (Abellini) 6: 152 (1888)
Ganoderma rugosum (Blume & T. Nees) Pat., Bull. Soc. mycol. Fr. 5 (2, 3): 68 (1889)
Ganoderma bavianum Pat., J. Bot., Paris 4: 19 (1890)
Ganoderma bavianum f. *mesopodum* Pat., J. Bot., Paris 4: 19 (1890)
Scindalma rugosum (Blume & T. Nees) Kuntze, Revis. gen. pl. (Leipzig) 3 (3): 519 (1898)
Amauroderma elmerianum Murrill, Bull. Torrey bot. Club 34: 475 (1907)
Ganoderma elmerianum (Murrill) Sacc. & Trotter, Syll. fung. (Abellini) 21: 305 (1912)
Amauroderma rugosum (Blume & T. Nees) Torrend, Brotéria, sér. bot. 18 (no. 2): 127 (1920)

FIGURE 49

Basidiomata annual, medium sized, 80–140 mm tall, tough when fresh, becoming harder, light in weight on drying, narrowly infundibuliform, stipitate. **Pileus** 35–82 mm diameter, 3–8 mm thick, centrally attached with stipe, concentrically zonate, radially wrinkled in most fruit bodies, glabrous, slightly laccate when fresh, dull when dry, brownish black, greyish black to black, margin even to wavy, obtuse. **Hymenophore** poroid. **Pores** 6–7 per mm, regular, angular, absent at the margin, surface greyish brown, turning reddish to brownish black on exposure, pore tubes 3–4 mm long, concolourous with pore surface. **Context** 2–4 mm thick, tough, brown. **Stipe** 78–136 mm tall, 3–9 mm thick, brownish black, glabrous, cylindrical, slightly broadened towards base. **Odour** not distinctive. **Spore print** not observed.

Basidiospores 8–11 × 7.5–10 µm, Q= 1–1.2, Q_m=1, subglobose to globose, very pale yellow, finely rugose, double walled, inter wall pillars thin, pillar disposition free, inamyloid to slightly dextrinoid in Melzer's reagent. **Basidia** not observed. **Cystidia** not observed in any tissues of the fruit body. **Hymenial trama** interwoven and trimitic. Generative hyphae up to 4 µm wide, hyaline, smooth, thin walled, branched, with clamp connections. Skeletal hyphae 3–8 µm wide, hyaline to very pale yellow, thick walled (up to 2 µm), branched, with arboriform endings, septations not observed. Skeleto ligative hyphae 2–4 µm wide, pale yellow, slightly thick walled (up to 1 µm), highly branched. **Pileal trama** interwoven. Generative hyphae 2–3 µm wide, hyaline, thin walled, branched, with clamp connections. Skeletal hyphae more flexuous than hymenophore, 3–6 µm wide, hyaline to very pale yellow, thick walled (up to 2 µm), branched, with arboriform endings, septations not observed. Skeleto ligative hyphae 2–4 µm wide, pale yellow, slightly thick walled (up to 1 µm), highly branched. **Pileipellis** made of highly agglutinated, brownish, thick walled, parallel hyphal patches, made of hyphae that are up to 7 µm wide, closely septate. **Stipe trama** interwoven. Generative hyphae not observed. Skeletal hyphae 2–6 µm wide, hyaline to very pale yellow, thick walled (up to 2 µm), branched, with arboriform endings, septations not observed. Skeleto ligative hyphae 2–4 µm wide, pale yellow, highly branched, slightly thick walled (up to 1 µm). **Stipitipellis** composed of highly agglutinated, brownish, thick walled, parallel hyphal patches, consisting of hyphae that are up to 8 µm wide, closely septate.

Specimens examined: India. Kerala State: Kozhikode district, Eranjipalam, Sarovaram Biopark, on soil, 20 July 2018, Vinjusha N., ZGCVN68; Kannur district, Aralam, on soil, 28 June 2019, Krishnapriya K., ZGCVN811; Kottayam district, Pine Valley, on soil, 05 July 2019, Vinjusha N., ZGCVN837; Kollam district, Thenmala, on soil, 23 September 2019, Vinjusha N., ZGCVN904.

Comments: Characters of the present collections properly fit in the earlier descriptions of the *S. rugosum* (as *Amauroderma rugosum*) by Corner (1983), Ryvarden & Johansen (1980), and Núñez & Ryvarden (2000). Cunningham (1965) had reported parallel hyphae in the context of *S. rugosum*. However, parallelly arranged hyphae were not observed in the context of present specimens. Present collections resemble *S. rude* (Berk.) Y.F. Sun, D.H. Costa & B.K. Cui in many macroscopic and microscopic characters. Pore size of *S. rude* is described as 1–4 per mm and 2–5 per mm (Cunningham 1965; Furtado 1981). Whereas, present collection has smaller pores (6–7 per mm). Moreover, *S. rude* produces quite larger pilei (50–250 mm diameter, Cunningham 1965; Furtado 1981) than the present specimens (up to 82 mm diameter).

S. rugosum is distributed in Australia, Africa, Brazil, China, Guyana, India, Perak, Philippines and Sri Lanka (Leelavthy & Ganesh 2000; Hapuarachchi *et al.* 2018). From Kerala, *S. rugosum* has been documented by Florence & Yesodharan (2000), Leelavathy & Ganesh (2000) and Mohanan (2011).

Amauroderma Murrill

Basidiomata annual to perennial, terrestrial, infundibuliform, mostly hard and wood, stipite small to long. Pileus circular, centrally umblicate, concentrically zonate, pubescent to glabrous, purplish brown or brownish black to completely black. Hymenophore poroid, pore surface grey, cinnamon brown to dark brown, pore tubes concolourous with pore surface. Context brown, homogenous. Hyphal system trimitic, generative hyphae hyaline, thin walled, with clamp connections. Skeletal hyphae hyaline, light brown to brown, thick walled. Skeleto ligative hyphae hyaline to light brown, thick walled. Cystidia absent. Basidia clavate, 4 sterigmate. Basidiospores globose to ellipsoid, hyaline to pale yellow, non truncated, double walled, with smooth to ornamented inner layer. The genus causes white rot on wood.

Amauroderma fuscoporia Wakef., Bothalia 4 (4): 948 (1948)

FIGURE 50

Basidiomata annual, medium to large sized, 85–180 mm tall, hard and tough, water soaked and heavy when fresh, light in weight on drying, umblicate to flat, stipitate. **Pileus** 65–90 mm long, 6–20 mm thick, orbicular, centrally attached with stipe, weakly zoned, radially ridged, sometimes with minute tubercles, surface pubescent, hairs lesser towards attachment part, purplish brown to brownish black, with pale yellowish concentric zones, margin undulate, rounded. **Hymenophore** poroid. **Pores** 2–3 per mm, angular, mostly oblique, absent at the margin, surface cinnamon brown, dark brown to black on exposure, pores not decurrent on stipe, pore tubes 10–15 mm long, concolourous with pore surface. **Context** 2–5 mm thick, ochre to brown, homogenous. **Stipe** 45–160 tall, 0.5–12 mm thick, yellowish brown, dark brown to brownish black on exposure, glabrous, cylindrical, broadened towards upper part and narrower towards base, tissue fistulose, ochre, brown on bruising. **Odour** not distinctive. **Spore print** not observed.

Basidiospores 11–14 × 8–11 µm, Q=1.1–1.5, Q_m=1.3, broadly ellipsoid to subglobose, rarely ovoid, light brown, double walled, walls rugose, inter wall pillars intermediate thick, pillar disposition free, inamyloid in Melzer's reagent. **Cystidia** absent. **Basidia** not observed. **Hymenial trama** interwoven and trimitic. Generative hyphae rarely observed, 2–4 µm wide, hyaline to light brown, smooth, thin to thick walled (1 µm), branched, with clamp connections. Skeletal hyphae 4–6 µm wide, hyaline to pale brown, unbranched to sparsely branched, thick walled (up to 2 µm), septations not observed. Skeleto ligative hyphae present, but not frequent as generative hyphae, 2–4 µm wide, hyaline, thick walled (1µm), highly branched, lumen absent. **Pileal trama** interwoven, generative hyphae 2–5 µm wide, hyaline to pale brown, thin to thick walled (1 µm), smooth, branched, with clamp connections. Skeletal hyphae 3–7 µm wide, hyaline to pale brown, thick walled (up to 2 µm), sparsely branched, septations not observed. Skeleto ligative hyphae easily broken, 1.5–4 µm wide, hyaline, thick walled (1µm), highly branched, mostly with indistinct lumen. **Pileipellis** a trichodermium composed of light brown to brown hyphae; 3–6 µm wide, slightly thick to thick walled, with obtuse ends. **Stipe trama** with slightly parallel hyphal system. Generative hyphae not observed. Skeletal hyphae predominant, 2–7 µm wide, hyaline to pale brown, rarely branched, septations not observed, thick walled (up to 2 µm). Skeleto ligative hyphae less frequent, 2–4 µm wide, hyaline, highly branched, thick walled (1 µm), lumen absent. **Stipitipellis** a trichodermium composed of light brown to brown hyphae that are 3–6 µm wide, slightly thick to thick walled, with obtuse ends.

Specimen examined: India. Kerala State: Kasaragod district, Mannampurath Kavu, on soil, 03 September 2018, Vinjusha N, ZGCVN704.

Comments: Morphology of the present specimen matches well with the earlier taxonomic descriptions of *Amauroderma fuscoporia* provided by Wakefield & Tablot (1948), and Ryvarden & Johansen (1980). The size of basidiomata of the present collection are larger when compared to these earlier descriptions. According to Ryvarden & Johansen (1980), pore size of *A. fuscoporia* is 3–5 per mm. Present collection possess slightly larger pores (2–3 per mm). The present specimen also shows similarities with *Amauroderma preussii* (Henn.) Steyaert. However, presence of smaller pores (6–8 per mm) and smaller spores (8–11 × 7.5–10 µm) distinguish *A. preussii* from the present collection. *Amauroderma fuscoporia* was described from South Africa by Wakefield & Talbot (1948). From Kerala, this species has been reported by Mohanan (2011).

Lignosus Lloyd *ex* Torrend

Basidiomata annual, hard and woody, centrally stipitate. Pileus circular, applanate to centrally notched, finely tomentose to glabrous. Hymenophore poroid, pores angular, pore surface off white to light brown, pore tube concolourous with pore surface. Context pale coloured. Stipe arising from an underground sclerotium. Hyphal system dimitic to trimitic, generative hyphae hyaline, thin walled, with clamp connections. Skeletal hyphae hyaline, thick walled. Skeleto ligative hyphae hyaline to pale brown, thick walled. Cystidia absent. Basidiospores globose, isodiametric to ellipsoid, hyaline inamyloid in Melzer's reagent. Members cause white rot on wood.

Lignosus rhinocerus (Cooke) Ryvarden, Norw. Jl Bot. 19: 232 (1972)

Basionym: *Polyporus rhinocerus* Cooke, Trans. & Proc. Bot. Soc. Edinb. 13: 150 (1879)
Synonyms:
Fomes rhinocerus (Cooke) Sacc. [as *'rhinocerotis'*], Syll. fung. (Abellini) 6: 152 (1888)
Scindalma rhinocerus (Cooke) Kuntze, Revis. gen. pl. (Leipzig) 3 (3): 519 (1898)
Polyporus sacer var. *rhinocerus* (Cooke) Lloyd, Mycol. Writ. 6 (Letter 65): 1037 (1920)
Polystictus rhinocerus (Cooke) Boedijn, Bull. Jard. bot. Buitenz, 3 Sér. 16 (4): 390 (1940)
Microporus rhinocerus (Cooke) Imazeki, Bull. Gov. Forest Exp. Stn Tokyo 57: 113 (1952)

FIGURE 51

Basidiomata annual, large sized, solitary, hard and tough, centrally stipitate, up to 200 mm tall. **Pileus** 150 mm in diameter, 60 mm thick, circular in outline, narrowly infundibuliform, conectrically zonate, weakly sulcate, radially wrinkled, yellowish brown, with a greenish tint due to presence of algae, yellowish shades fades on drying, margin paler, wavy to lobed, thin. **Hymenophore** poroid. **Pores** 5–8 per mm, angular, irregular, absent along margin, minutely tuberculate, dirty white, brownish on bruising. **Context** 2 mm thick, creamish white, homogenous. **Stipe** 180 mm long, 15 mm thick, cylindrical, even with underground sclerotium, stipe surface having some irregular depressions, glabrous, light brown, tissue, cream, appear as more or less hollow**.** **Sclerotium** irregularly elongated, up to 80 mm long, cream, dirty and soiled, bone hard especially on drying. **Odour** not distinctive. **Spore print** not observed.

Basidiospores 3–4.5 × 1.5–2 µm, Q=1.5–2, Q_m=1.8, subcylndrical to broadly ellipsoid, hyaline, thin walled, guttulate or eguttulate, inamyloid in Melzer's reagent. **Basidia** not observed. **Cystidia** absent. **Hymenial trama** interwoven, and trimitic. Generative hyphae 2–3 µm wide, hyaline, thin walled, smooth, branched, with clamp connections. Skeletal hyphae 2–4 µm wide, hyaline smooth, thick walled (1 µm), branched, mostly without lumen. Skeleto ligative hyphae present, 1.5–3 µm wide, hyaline to very pale brown, thick walled (up to 1 µm), highly branched. **Pileal trama** interwoven. Generative hyphae 2–3 µm wide, hyaline, smooth, thin walled, branched, with clamp connections. Skeletal hyphae predominant, 2–5 µm wide, hyaline to pale brown, thick walled (1µm), branched. Skeleto ligative hyphae 2–3 µm wide, hyaline to pale brown, branched, mostly without lumen. **Pileipellis** interwoven at base to form short, more or less agglutinated trichodermal patches, that are 10–25 µm long, made of hyphae 2–4 µm wide, hyaline and solid. **Stipe trama** interwoven. Generative hyphae 2–3 µm wide, hyaline, smooth, thin walled, branched, with clamp connections. Skeletal hyphae predominant, 2–7 µm wide, hyaline, thick walled (up to 2 µm), rarely branched, septations not observed. Skeleto ligative hyphae less frequent, 2–5 µm wide, hyaline, highly branched, thick walled and solid. **Stipitipellis** similar as pileipellis, more agglutinated trichoderm than pileipellis, each hyphae 2–4 µm wide, hyaline, lumen absent.

Specimen examined: India. Kerala State: Kollam district, Thenmala, on soil, 23 September 2019, Vinjusha N, ZGCVN903.

Comments: Presence of large underground sclerotium, and long centrally stipitate basidiocarps undoubtly places the species in *Lignosus* Torrend. The species *Lignosus dimiticus* Ryvarden also produces basidiocarps with similar pore size and spore size as *L. rhinoceros* (according to the taxonomic description by Tan *et al.* 2013). However, the former is distinguished from the latter in having dimitic hyphal system, and lacks skeleto ligative hyphae. *L. tigris* is another close species, but, possesses larger pores (1–2 per mm) than the present collection (based on the description by Tan *et al.* 2013). Another species, *L. sacer* (Fr.) Torrend, also resembles present Kerala collection in morphology. However, *L. sacer* produces larger basidiospores (5–7 × 3–4.5 µm).

Lignosus rhinocerus is distributed in tropical to subtropical regions of Asia (Núñez & Ryvarden 2001). So far, there are no reports of the species from India.

***Theleporus* Fr.**

Basidiomata annual, resupinate, adnate, hymenophore poroid to radially elongated and oblique, white, greyish white to light cream. Hyphal system pseudodimitic to dimitic, generative hyphae hyaline, thin walled, with clamp connections. Skeletal hyphae hyaline, thick walled. Dendrohyphidia present or absent. Cystidia absent. Basidia clavate, 2 sterigmate. Basidiospores broadly ellipsoid, thin walled, smooth and inamyloid in Melzer's reagent. Members causes white rot on wood.

Theleporus minisporus Y.C. Dai & L.W. Zhou, Mycologia 104 (4): 919 (2012)

FIGURE 52

Basidiomata annual, small to medium sized when fresh, entirely resupinate, later effused and forming large patches, up to 120 mm long, 3 mm thick, margin entire, moderately hard when fresh, harder on drying. **Pileus** not distinct. **Hymenophore** poroid. **Pores** 8–11 per mm, angular, at some region radially elongated and oblique, with an appearance of irpicoid hymenium at some parts, pores not distinct towards margin, greyish white, irregularly cracked on drying. **Context** not distinct. Odour not distinct. Spore print not observed.

Basidiospores 3.5–4 × 2–3 µm, Q=1.3–1.6, Q_m=1.45, subglobose to broadly ellipsoid, hyaline, smooth, thin walled, inamyloid in Melzer's reagent. **Basidia** not observed. **Hymenial cystidia** absent. **Dendrohyphidia** present, difficult to observe, 2–3 µm wide, hyaline, smooth and thin walled. **Hymenial trama** interwoven, dimitic, with scattered irregular crystals. Generative hyphae 2–3 µm wide, hyaline, smooth, thin walled, branched with clamp connections. Skeletal hyphae 2–4 µm wide, hyaline, smooth, thick walled (1 µm), unbranched to shortly branched, septations not observed.

Specimen examined: India. Kerala State: Kozhikode district, Chungam, Butt Road, on dead branch (unidentified), 25 July 2015, Vinjusha N., ZGCVN88.

Comments: Present specimen shows resemblances with *Theleporus calcicolor* (Sac. & Sid.) Ryvarden in morphology, however the latter has larger basidiospores (5–7.5 × 4–5 µm). *Theleporus minisporus* is unique among other species in the genus by having smaller basidiospores (Zhou & Dai 2012).

So far, *T. minisporus* has been reported only from China (type locality, Zhou & Dai 2012). Present study is the first report of the species outside the type locality.

Theleporus venezuelicus (Ryvarden & Iturr.) Miettinen, Fungal Diversity 75: 232 (2015)

Basionym: *Diplomitoporus venezuelicus* Ryvarden & Iturr., Mycologia 95 (6): 1069 (2003)

FIGURE 53

Basidiomata annual, entirely resupinate, adnate, forming small to medium sized patches, up to 3 mm thick, soft and coriaceous, light in weight, margin uneven. **Pileus** absent. **Hymenophore** poroid. Pores 7–9 per mm, round to angular, oblique towards margin, white when fresh, dull white to creamish white on bruising, no reaction in KOH. **Context** indistinct. **Odour** not distinctive. **Spore print** not observed.

Basidiospores 2.5–4 × 1–1.5 µm, Q=2–2.5 µm, Q_m= 2.2 µm, cylindrical, hyaline, smooth, thin walled, eguttulate, inamyloid in Melzers reagent. **Basidia** 12–15 × 4–5.5 µm, clavate, 1–2 sterigmate. **Cystidia** absent. **Hymenial trama** interwoven and dimitic. Generative hyphae 1–2 µm wide, hyaline, smooth, highly branched, thin walled, with clamp connections. Skeletal hyphae rarely observed, 1–3 µm wide, hyaline, smooth, branched, slightly thick to thick walled (1 µm), septations not observed.

Specimen examined: India. Kerala State: Kozhikode district, Edakkara, Vallikkattukavu, on dead branch (unidentified), ZGCVN109, Vinjusha N., 01 August 2015.

Comments: Morphology of the present collection fits well the original description of *Theleporus venezuelicus* (Ryvarden & Iturriaga 2003). According to this description (Ryvarden & Iturriaga 2003), size of basidiospores of *T. venezuelicus* is 4–4.5 × 1.2–1.5 µm. When compared to this, Kerala collection of the species possesses slightly smaller basidiospores (2.5–4 × 1–1.5 µm). Ryvarden & Iturriaga (2003) have not reported dendrohyphidia in their holotype. Later, presence of dendrohyphidia was reported in *T. venezuelicus* by Ariyawansa *et al*. (2015). However, in the Kerala collection of in the *T. venezuelicus*, dendrohyphidia was not observed. Present specimen also showed similarity with *T. calcicolor*. However, as per the description of Ryvarden & Johansen (1980), *T. calcicolor* produces subglobose-ovoid basidiospores (5–7.5 × 4–5 µm). In the present collection, basidiospores are cylindrical in shape (2.5–4 × 1–1.5 µm).

BLAST search using the ITS sequences of the present specimen showed 94% identity with *T. venezuelicus* (GenBank number: KT361631). BLAST result also showed 92% similarity with accessions of *T. rimosus* H.S. Yuan and *Porogramme albocincta* (Cooke & Massee) Gibertoni (KY948727, KY948726). *T. rimosus* is morphologically distinguished from the present collection by their ellipsoid to fusiform basidiospores ((5.2–) 5.8–7.8 (–8) × (2.7–) 3–3.7 (–3.8) µm, as per the description of Yuan 2015). Similarly, *P. albopincta* is separted from the present collection by the dark bluish grey to brownish grey pore surface and broadly ellipsoid basidiospores (according to Ryvarden & Johansen 1980).

To date, *T. venezuelicus* has only been reported from South America (Ryvarden & Iturriaga 2003; Ariyawansa *et al*. 2015). Present study forms the first report of this species from Asia.

Echinochaete D.A. Reid

Basidiomata annual, solitary, laterally stipitate. Pileus flabelliform, applanate, azonate, minutely tomentose, rough, dark cinnamon brown. Hymenophore poroid. Pores angular to radially elongated, dark brown, pore tube brown. Context ochre, homogenous. Hyphal system dimitic, generative hyphae hyaline, thin walled, with clamp connections. Skeleto ligative hyphae hyaline to pale yellow, thick walled. Setoid cystidia frequent in the hymenium, clavate to lancelolate, spinulose, dark brown, thick walled. Basidia clavate, 4 sterigmate. Basidiospores ellipsoid to cylindrical, hyaline, smooth, thin walled inamyloid in Melzer's reagent. Members causes white rot on wood.

Echinochaete ruficeps (Berk. & Broome) Ryvarden, Norw. Jl Bot. 19: 231 (1972)

Basionym: *Favolus ruficeps* Berk. & Broome, J. Linn. Soc., Bot. 14 (no. 73): 57 (1873) [1875]
Synonym:
Hexagonia ruficeps (Berk. & Broome) Petch, Ann. R. bot. Gdns Peradeniya 6 (1): 143 (1916)

FIGURE 54

Basidiomata annual, medium sized, solitary, coriaceous when fresh, hard and brittle on drying. **Pileus** 55–60 mm wide, 6 mm thick, flabelliform, applanate, zonations or striations absent, minutely tomentose, rough, dark cinnamon brown, margin even, incurved on drying. **Hymenophore** poroid. **Pores** 1–2 per mm, angular, radially elongated, absent towards margin, dark brown, pore tube up to 2.5 mm long, brown, lighter than pore surface. **Context** up to 1.5 mm thick, ochre, homogenous. **Odour** not distinctive. **Spore print** not observed.

Basidiospores 11–14 × 4–5.5 µm, Q=2–2.8, Q_m=2.2, subcylindrical to ellipsoid, thin walled, hyaline, some spores with pale brown wall, smooth, guttulate, inamyloid in Melzer's reagent. **Basidia** not observed. **Setoid elements** frequent in the hymenium, 20–60 × 6–15 µm, clavate to lanceolate, dark brown, thick walled (1–2 µm), ornamented with numerous sharp points or spines. **Hymenial trama** interwoven and dimitic. Generative hyphae 2–4 µm wide, hyaline, smooth, thin walled, branched, with clamp connections. Skeleto ligative hyphae 2–6 µm wide, hyaline to pale yellow, thick walled (up to 2 µm), lumen solid to narrow, highly branched at the extremities, septations not observed. **Pileal trama** interwoven. Generative hyphae rare, 1.5–3 µm wide, hyaline, smooth, thin walled, branched, with clamp connections. Skeleto ligative hyphae 2–6 µm wide, hyaline to pale yellow, weakly dextrinoid in mass, thick walled (up to 2 µm), mostly solid, branched, septations not observed. **Pileipellis** composed of setoid cystidia, 3–6 µm wide, brown, paler than those present in hymenium, thick walled (1–1.5 µm), with acute to obtuse tip.

Specimen examined: India. Kerala State: Kozhikode district, Vattavada, on dead wood (unidentified), 28 July 2019, Vinjusha N., ZGCVN884.

Comments: Characters of the present collection fits well with the available descriptions of the species such as Reid (1976), Ryvarden (1972), Ryvarden & Johansen (1980), and Núñez & Ryvarden (2000, 2001). The present collection is distinguished from the closely related *Echinochaete brachyporus* (Mont.) Ryvarden, by the presence of abundant setoid elements in the pileipellis. *E. brachyporus* lacks setoid elements on their pileus or when present, they are few in number (Núñez & Ryvarden 2000). Present collection also shows similarities with *E. russiceps* (Berk. & Broome) D.A. Reid. However, the latter species produces smaller pores (4–6 per mm) than that of the present collection.

Echinochaete ruficeps has a paleotropical distribution (Núñez & Ryvarden 2000). From Kerala, this species has been reported by Mohanan (2011).

Microporellus Murrill

Basidiomata annual, coriaceous to hard and woody, sessile to stipitate. Pileus circular to flabelliform, cream with brownish to violet shades, concentrically zonate or zonations absent, glabrous. Hymenophore poroid, pores round to angular, pore surface white to cream, pore tubes concolourous with pore surface. Context white to pale cream, homogenous. Stipe woody, surface glabrous. Hyphal system dimitic, generative hyphae hyaline, thin walled, with clamp connections. Skeletal hyphae hyaline, inamyloid to strongly dextrinoid and cyanophilous, unbranched, thick walled. Cystidia present, mostly ventricose, hyaline to faintly yellowish, apically smooth or light to coarsely encrusted. Basidiospores subglobose to lacrymoid, hyaline, weakly to strongly dextrinoid, without germ pore. Members cause white rot on wood.

Microporellus violaceocinerascens (Petch) A. David & Rajchenb., Mycotaxon 22 (2): 303 (1985)

Basionym: *Polyporus violaceocinerascens* Petch, Ann. R. bot. Gdns Peradeniya 6 (1): 127 (1916)
Synonyms:
Ganoderma pallens Pat., Bull. Soc. mycol. Fr. 39 (1): 52 (1923)
Daedalea iocephala Pat., Bull. Mus. natn. Hist. nat., Paris 30 (6): 409 (1924)
Cystostiptoporus violaceocinerascens (Petch) Ryvarden, in Ryvarden & Johansen, Prelim. Polyp. Fl. E. Afr. (Oslo): 301 (1980)

FIGURE 55

Basidiomata annual, medium sized, solitary, centrally to eccentrically stipitate, 30–105 mm tall. Pileus 37–75 mm wide, almost coriaceous when young, hard when mature, fleshy, 2–6 mm thick , circular, slighty concave in the portion where stipe is attached, pubescent to velutinate especially near the attachment portion, lessening towards the margin, small irregular outgrowths and wrinkles present, violaceous grey with almost alternating grey brown to yellowish brown concentric circles, creamish white along margin, bruising to dark brown, instantly turning light orange in KOH, then to dark brown, margin even to wavy, fleshy. **Stipe** 23–90 mm long, 6–11 mm thick, cylindrical, broadening towards the base, covered by pubescent hairs, grayish cream when fresh, becoming brownish black to black on bruising, stipe tissue cream, tissue solid, moderately tough. **Hymenophore** poroid. **Pores** 2–3 per mm, angular, oblique towards margin, cream, brownish black on bruising, light orange reaction in KOH as in the pileus. **Context** up to 1 mm thick, cream, turning light brown. **Odour** not distinct. **Spore prints** not observed.

Basidiospores 6–9.5 × 5–6 µm, Q=1.1–1.5, Q_m=1.21, subglobose to broadly ellipsoid or slightly amygdaliform, smooth, thin to slightly thick walled (up to 1 µm), guttulate, dextrinoid in Melzer's reagent. **Basidia** 12–30 × 6.3–8.4 µm, clavate, 4 sterigmate, hyaline with basal clamp connections. **Cystidia** 40–74 × 8–16 µm, ventricose or broadly utriform, many with a tubular base (up to 12 µm long), rarely fusoid, with apical encrustations, hyaline, smooth, thick walled, especially towards the tip, weakly dextrinoid in Melzer's reagent. **Hymenial trama** highly interwoven and dimitic. Generative hyphae 2–3 µm wide, hyaline, thin walled, branched, with frequent clamp connections. Skeletal hyphae 2–4 µm wide, hyaline, smooth, thick walled (up to 1.5 µm), strongly dextrinoid in Melzer's reagent, cyanophilous, unbranched or sparsely branched, septations not observed. Skeleto ligative hyphae not observed. **Pileal trama** interwoven. Generative hyphae 2–4 µm wide, hyaline, thin walled, branched, with frequent clamp connections. Skeletal hyphae 2–5 µm wide, hyaline, smooth, thick walled (up to 1 µm), strongly dextrinoid in Melzer's reagent, unbranched, septations not observed. Skeleto ligative hyphae not observed. **Pileipellis** basically a cutis, with erect, ascending agglutinated trichodermial patches, 32–110 µm long, made of hyaline, thin walled, septate hyphae, that are 2–4 µm wide. **Stipe trama** interwoven. Generative hyphae 2–4 µm wide, hyaline, smooth, thin walled, branched, with clamp connections. Skeletal hyphae 2–5 µm wide, hyaline, thick walled (1–2 µm), unbranched, septations not observed. Skeleto ligative hyphae not observed. **Stipitipellis** basically a cutis, forming trichodermal patches of ascending or erect agglutinated hyphal elements, trichodermal patches 52–103 µm long, made of hyaline, thin walled, septate hyphae, 2–4 µm wide.

Specimens examined: India. Kerala State: Kozhikode district, Pokkunnu, ZG College campus, on soil, 21 July 2016, Vinjusha N., ZGCVN380; Koyilandy, Poyil Kavu, on soil, 23 June 2017, Vinjusha N., ZGCVN506; Chevayoor, on soil, 18 June 2018, Vinjusha N., ZGCVN681.

Comments: Morphology of present Kerala collection agrees well with the published taxonomic descriptions of *M. violaceocinerescens* by Ryvarden & Johansen (1980), David & Rajchenberg (1985), and Corner (1987). The present collection shows similarities with *Neolentiporus* Rajchenb. and *Polyporus* in having stipitate basidiocarps. The genus *Neolentiporus* is characterized by a stipitate basidiocarps, a dimitic hyphal system with clamped, irregularly thick walled generative hyphae and metachromatic, acyanophilous, unbranched skeletal hyphae and cylindric basidiospores (Rajchenberg 1995). Whereas, the present specimen possesses thin walled generative hyphae, and skeletal hyphae is cyanophilous and not metachromatic. The shape of the basidiospores also separates the two genera. Fruit body resembles a *Polyporus* species with centrally to laterally attached stipe. Microscopically, both genera have a dimitic hyphal system with clamped generative hyphae. However, instead of skeletal hyphae present in our collection, *Polyporus* species possess arboriform to dendriform skeleto ligative hyphae (Bernicchia 2005; Ryvarden & Melo 2014). Skeletal hyphae of the present collection shows dextrinoid reaction, whereas, *Polyporus* species never shows dextrinoid reaction on their hyphae. In addition, hymenial cystidia were observed in the present specimen, but *Polyporus* lacks cystidia. *Microporellus dealbatus* (Berk. & M.A. Curtis) Murrill is closely related with the present collection, however, separated by having smaller pores (8–10 per mm, David & Rajchenberg 1985).

Microporellus violaceocinerascens is an East Asian species (David & Rajchenberg 1985). This species has been reported from Kerala by Mohanan (2011).

Microporellus obovatus (Jungh.) Ryvarden, Norw. Jl Bot. 19: 232 (1972)

Basionym: *Polyporus obovatus* Jungh., Verh. Batav. Genootsch. Kunst. Wet. 17 (2): 65 (1838)
Synonyms:
Polyporus polygrammus Berk. & M.A. Curtis, J. Linn. Soc., Bot. 10 (no. 45): 307 (1868)
Polyporus tuba Berk. & M.A. Curtis, J. Linn. Soc., Bot. 10 (no. 45): 305 (1868)
Polyporus petaliformis Berk. & M.A. Curtis, J. Linn. Soc., Bot. 10 (no. 45): 307 (1868)
Polyporellus obovatus (Jungh.) P. Karst., Meddn Soc. Fauna Flora fenn. 5: 38 (1879)
Polystictus rasipes (Berk.) Cooke, Grevillea 14 (no. 71): 79 (1886)
Polystictus polygrammus Cooke, Grevillea 14 (no. 71): 78 (1886)
Microporus rasipes (Berk.) Kuntze, Revis. gen. pl. (Leipzig) 3 (3): 497 (1898)
Microporus polygrammus (Cooke) Kuntze, Revis. gen. pl. (Leipzig) 3 (3): 497 (1898)
Microporus caryophyllaceus (Berk. & M.A. Curtis *ex* Cooke) Kuntze, Revis. gen. pl. (Leipzig) 3 (3): 495 (1898)
Coriolus polygrammus (Cooke) Pat., in Duss, Enum. Champ. Guadeloupe (Lons-le-Saunier): 31 (1903)
Polyporus tigrinus Rostr., Bot. Tidsskr. 24: 359 (1902)
Polystictus obovatus (Jungh.) Bres., Annls mycol. 6 (1): 46 (1908)

Polyporus fumigatus Bres., Annls mycol. 10 (5): 503 (1912)
Polyporus krakataui Lloyd, Mycol. Writ. 7 (Letter 71): 1242 (1924)
Microporus obovatus (Jungh.) Imazeki, Bull. Tokyo Sci. Mus. 6: 95 (1943)
Flabellophora obovata (Jungh.) Corner, Beih. Nova Hedwigia 86: 36 (1987)
Flabellophora obovata var. *aurantiporus* Corner, Beih. Nova Hedwigia 86: 39 (1987)

FIGURE 56

Basidiomata annual, small to medium sized, slightly coriaceous when young, hard and woody when mature, light in weight, pileate. **Pileus** 45–90 mm long, 2–52 mm thick, laterally stipitate, flabelliform to spathulate, applanate, concentrically zonate, pruinose in young fruitbodies, glabrous when mature, radially wrinkled, cream to butter yellow with almost alternating brown, greyish brown to brownish black concentric bands, margin wavy to lobed. **Hymenophore** poroid. **Pores** 9–12 per mm, absent near margin, round, regular, cream, bruising to brown, pore tube 1–2 mm long, creamish white. **Context** 1–4 mm thick, cream, homogenous. **Stipe** 10–20 mm long, 2–6 mm thick, woody, cylindrical, broadened towards base, becoming discoid at base, glabrous, cream to pale yellow, inner tissue solid, cream to very pale ochre. **Odour** not distinctive. **Spore print** not observed.

Basidiospores 4–5 × 2.5–3 µm, Q=1.1–1.6, Q_m=1.39, sub globose to ovoid, hyaline, guttulate, thin walled, smooth, inamyloid in Melzer's reagent. **Basidia** not observed. **Cystidia** absent. **Hymenial trama** interwoven and dimitic. Generative hyphae 2–3 µm wide, hyaline, smooth, thin walled, branched, with clamp connections. Skeletal hyphae 2–4 µm wide, hyaline, thick walled (1µm), unbranched, septations not observed. Skeleto ligative hyphae not observed. **Pileal trama** almost parallel. Generative hyphae 2–3 µm wide, hyaline, smooth, thin walled, branched, with clamp connections. Skeletal hyphae 2–4 µm wide, hyaline, thick walled (1µm), unbranched, weakly septate. Skeleto ligative hyphae not observed. **Pileipellis** an agglutinated cutis made of hyaline, thin to slightly thick walled hyphae that are 2–4 µm wide. **Stipe** trama parallel. Generative hyphae 2–3 µm wide, hyaline, smooth, thin walled, branched, with clamp connections. Skeletal hyphae 2–5 µm wide, hyaline, thick walled (1µm), unbranched, septations not observed. Skeleto ligative hyphae not observed **Stipitipellis** an agglutinated cutis made of hyaline that 2–4 µm wide, hyaline to yellowish brown, thin to slightly thick walled hyphae, .

Specimens examined: India. Kerala State: Wayanad district, Pookod, on dead log (unidentified), 30 June 2017, Vinjusha N., ZGCVN549; Kozhikode district, Kakkad, on dead wood (unidentified), 13 July 2017, Vinjusha N., ZGCVN571; Peruvannamuzhy forest, on dead log (unidentified), 24 June 2018, Vinjusha N., VN683; Wayanad district, Chembra Peak, on dead branch, Vinjusha N., ZGCVN232.

Comments: According to the taxonomic descriptions (Ryvarden & Johansen 1980; Núñez & Ryvarden 2001), pore size of *Microporellus obovatus* is 6–8 per mm. However, pore size of present collections is slightly smaller (9–11) per mm. Otherwise, the characters of the present collections properly fits in with the published descriptions of *M. obovatus*. Flabelliform to spathulate basidiomata, hymenium with smaller pores and sub globose to ovoid basidiospores are the major features of the species.

Microporellus obovatus has pantropical distribution (Ryvarden & Johansen 1980). In Kerala, this species has been documented by Sankaran & Florence (1995), Florence & Yesodharan (1997), Leelavathy & Ganesh (2000), Mohanan (2011), and Iqbal *et al.* (2016).

Perenniporia Murrill

Basidiomata mostly perennial, rarely annual, hard and woody, resupinate to pileate. Pileus sessile to dimidiate, semicircular, concentric zonztions present or absent, glabrous, creamish white to brownisk black. Hymenophore poroid, pores small, isodiametric, pore surface white to cream. Context white to light ochraceous. Hyphal system dimitic to trimitic, generative hyphae hyaline, thin walled, with clamp connections. Skeletal hyphae hyaline to pale coloured, weakly to strongly dextrinoid in Melzer’s reagent, thick walled. Skeleto ligative hyphae hyaline to pale coloured, thick walled, Cystidia present or absent. Basidia narrowly clavate to clavate, 4 sterigmate. Basidiospores hyaline, ellipsoid to apically truncate, thick walled, cyanophilic and variably dextrinoid, with distinct apical germ pore. Members cause white rot on wood.

Perenniporia medulla-panis (Jacq.) Donk, Persoonia 5 (1): 76 (1967)

Basionym: *Boletus medulla-panis* Jacq., Miscell. austriac. 1: 141 (1778)
Synonyms:
Polyporus medulla-panis (Jacq.) Fr., Syst. mycol. (Lundae) 1: 380 (1821)
Poria medullaris Gray, Nat. Arr. Brit. Pl. (London) 1: 639 (1821)
Daedalea medullaris (Gray) Purton, Appendix Midl. Fl.: 250 (1821)
Polyporus medulla-panis var. *cretaceus* Pers., Mycol. eur. (Erlanga) 2: 100 (1825)
Physisporus medulla-panis (Jacq.) Chevall., Fl. gén. env. Paris (Paris) 1: 262 (1826)
Polyporus limitatus Berk. & M.A. Curtis, Grevillea 1 (no. 4): 54 (1872)
Polyporus xylostromatis Fuckel, Jb. nassau. Ver. Naturk. 27-28: 86 (1874)
Poria xylostromatis (Fuckel) Cooke, Grevillea 14 (no. 72): 111 (1886)
Poria medulla-panis (Jacq.) Cooke, Grevillea 14 (no. 72): 109 (1886)
Poria medulla-panis var. *prunicola* Pilát, Bull. trimest. Soc. mycol. Fr. 51 (3-4): 389 (1936)
Poria medulla-panis f. *megalopora* Pilát, Ann. Acad. tchecosl. Agric. 2: 468 (1936)
Poria laevis Speg., Brotéria, N.S. 33: 135 (1937)
Fomitopsis medulla-panis (Jacq.) Bondartsev & Singer, Annls mycol. 39 (1): 55 (1941)
Fomitopsis unita var. *multistratosa* (Pilát) Bondartsev, Trut. Grib Evrop. Chasti SSSR Kavkaza [Bracket Fungi Europ. U.S.S.R. Caucasus] (Moscow-Leningrad): 313 (1953)
Fomes unitus var. *multistratosus* (Pilát) Komarova, Opredelitel' trutovykh gribov Belorussii: 192 (1964)
Perenniporia medulla-panis var. *lateritia* (Bourdot & Galzin) Domański, Fungi, Polyporaceae 1, Mucronoporaceae 1, Revised transl. Ed. (Warsaw): 151 (1972)

FIGURE 57

Basidiomata annual to perennial, resupinate, sometimes slightly reflexed on vertical substrata, forming thick black crust, adnate, hard and tough and difficult to separate from host, forming large patches, 2–4 mm thick, margin thin, irregular. **Hymenophore** poroid. **Pores** 6–7 per mm, round to angular, mostly oblique or longitudinally elongated, sometimes resembling irpicoid, cream to pale brown, black in KOH. **Context** indistinct, less than 1 mm thick, cream. **Odour** not distinct. **Spore print** not observed.

Basidiospores 5–7 × 3–4 µm, Q=1.2–2, Q_m=1.56, ellipsoid, truncate at apex, hyaline, smooth, thin to slightly thick walled, often monoguttulate, inamyloid in Melzer’s reagent. **Basidia** 12–16 × 4–5 µm, narrowly clavate, slightly thick walled, 4 sterigmate. **Cystidia** absent. Cystidioles present, 10–21 × 4.5–6 µm, fusoid, hyaline, smooth, thin walled. **Hymenium** interwoven and trimitic. Generative hyphae 2–3 µm wide, hyaline, smooth, thin to slightly thick walled (1 µm), branched, with clamp connections. Skeletal hyphae 2–5 µm wide, hyphae at some portions widened up to 12 µm, and becoming bulbous, fuliginous brown, thick walled (1–1.5 µm), smooth, mostly unbranched, sometimes branched at extremities, weakly dextrinoid, septations not observed. Skeleto ligative hyphae rarely observed; 2–3 µm wide, hyaline to pale coloured, thick walled (1µm), smooth, branched, septations not observed.

Specimens examined: India. Kerala State: Kozhikode district, Puthiyangadi, on live tree (unidentified), 07 September 2018, Arun Kumar TK, ZGCVN711; Palakkad district, Dhoni, on *Swetenia mahagoni*, Vinjusha N., ZGCVN778; Idukki district, Pooppara, on fallen branch (unidentified), 30 July 2019, Vinjusha N., ZGCVN881.

Comments: Morphology of the present collections are in accordance with the earlier taxonomic descriptions of *P. medulla-panis* by Ryvarden & Johansen (1980), Lindsey (1985), Ryvarden & Gilbertson (1994), Núñez & Ryvarden (2001), and Ryvarden & Melo (2014). Present collection resembles *Truncospora japonica* (Yasuda) Zmitr. by having resupinate basidiomata and truncate basidiospores. However, the latter has dark brown coloured margin, rhizomorphic basidiomata and slightly smaller basidiospores (4–5 × 2.5–3.5 µm, Núñez & Ryvarden 2001).

Perenniporia medulla-panis has cosmopolitan distribution (Núñez & Ryvarden 2001). This species has not been recorded from Kerala till date.

Perenniporia ochroleuca (Berk.) Ryvarden, Norw. Jl Bot. 19: 233 (1972)

Basionym: *Polyporus ochroleucus* Berk., London J. Bot. 4: 53 (1845)
Synonyms:
Trametes scrobiculata Berk., Grevillea 6 (no. 38): 70 (1877)
Fomes compressus (Berk.) Sacc., Syll. fung. (Abellini) 6: 198 (1888)
Trametes ochroleuca (Berk.) Cooke, Grevillea 19 (no. 92): 98 (1891)
Polyporus turbinatus Pat., Revue mycol., Toulouse 13 (no. 51): 137 (1891)
Scindalma compressum (Berk.) Kuntze, Revis. gen. pl. (Leipzig) 3 (3): 518 (1898)
Ungulina ochroleuca (Berk.) Pat., Essai Tax. Hyménomyc. (Lons-le-Saunier): 102 (1900)
Fomes ochroleucus (Berk.) Lloyd, Mycol. Writ. 5: 714 (1917)
Polyporus zonifer Lloyd, Mycol. Writ. 7 (Letter 69): 1192 (1923)
Polyporus junctus Lloyd, Mycol. Writ. 7 (Letter 73): 1317 (1924)
Polyporus graciosus Beeli, Bull. Soc. R. Bot. Belg. 62: 63 (1929)
Truncospora ochroleuca (Berk.) Pilát, Atlas Champ. l'Europe, III, Polyporaceae (Praha) 1: 365 (1941)
Fomitopsis ochroleuca (Berk.) Imazeki, Bull. Tokyo Sci. Mus. 6: 92 (1943)
Truncospora ochroleuca (Berk.) Pilát, Sb. Nár. Mus. v Praze, Rada B, Prír. Vedy 9 (2): 108 (1953)
Truncospora ochroleuca var. *brevispora* Corner, Beih. Nova Hedwigia 96: 131 (1989)

FIGURE 58

Basidiomata perennial, small sized, solitary to imbricate, hard and woody, light in weight, pileate. Pileus 15–20 mm long, 4–6 mm thick, sessile, laterally attached, semicircular to circular, usually ungulate, concentrically zonate, sulcate, glabrous, cream ochraceous when young, turning yellowish brown to brown, sometimes with weak radial striations, margin even, obtuse. **Hymenophore** poroid. Pores 5-6 per mm, angular, present along margin, white to cream, brown to dark brown on bruising, pore tubes 3-4 mm long, straw coloured, weakly stratified. **Context** up to 1 mm thick, white to cream, homogenous. **Odour** not distinct. **Spore print** not observed.

Basidiospores 10–16 × 5–8 µm, Q=1.4–2, Q_m=1.69, ellipsoid to broadly ellipsoid, apex truncate, hyaline to pale yellow, smooth, thick walled (1 µm), eguttulate, dextrinoid in Melzer's reagent. **Basidia** 25–38 × 5–6 µm, clavate, 4 sterigmate. **Cystidia** absent. **Hymenial trama** interwoven and trimitic. Generative hyphae rarely observed, 2–3 µm wide, hyaline, smooth, thin walled, branched, with clamp connections. Skeletal hyphae 3–5 µm wide, hyaline, very weakly dextrinoid in Melzer's reagent, thick walled (1 µm), unbranched, septations not observed. Skeleto ligative hyphae frequent, 2–4 µm wide, hyaline, thick walled (1µm), highly branched, septations not observed. **Pileal trama** interwoven. Generative hyphae 2–3 µm wide, hyaline, smooth, thin walled, branched, with clamp connections. Skeletal hyphae 3–6 µm wide, hyaline, very weakly dextrinoid in Melzer's reagent, thick walled (1 µm), unbranched, septations not observed. Skeleto ligative hyphae 2–4 µm wide, hyaline, smooth, highly branched, septations not observed. **Pileipellis** an agglutinated hyphal mass; hyphae 2–3 µm wide, hyaline, thick walled (up to 1 µm).

Specimen examined: India. Kerala State: Kozhikode district, Pokkunnu, ZG College campus, on dead branch of *Peltophorum ferrugenium*, Vinjusha N., ZGCVN53; ZGCVN329; Poyil kavu, on dead branch (unidentified), 23 June 2017, Vinjusha N., ZGCVN511; Chelavoor, Thurayil Kotta, on dead branch (unidentified), 27 September 2015, Vinjusha N., ZGCVN219.

Comments: The small sized, ungulate, cream ochraceous, perennial basidiomata with large truncate basidiospores easily distinguishes *P. ochroleuca* from related species. The species has a cosmopolitan distribution (Ryvarden & Johansen 1980). From Kerala, this species has been recorded by Leelavathy & Ganesh (2000) and Mohanan (2011).

Perenniporia decurrata Corner, Beih. Nova Hedwigia 96: 105 (1989)

FIGURE 59

Basidiomata perennial, small to medium sized, solitary or in clusters, hard and woody, light in weight, brittle on drying, pileate. Pileus 10–45 mm long, 4–25 mm thick, sessile, broadly attached, sometimes with a small region of attachment, frequently ungulate, or applanate, semicircular to flabelliform, concentrically zonate, deeply sulcate, glabrous, orangish brown to pale cinnamon brown, margin thick, even to slightly wavy, acute, sometimes slightly up curved on drying. **Hymenophore** poroid. **Pores** 6–7 per mm, round, regular, absent along margin, white to cream, turning light brown on bruising, pore tubes up to 10–25 mm long, stratified, each strata 2–3 mm thick, light brown. **Context** up to 1 mm thick, white to cream, homogenous, sometimes with a narrow crust above in large fruit bodies. **Odour** not distinct. **Spore print** not observed.

Basidiospores 3–4.5 × 2–3 µm, Q=1.6–2.6, Q_m= 1.91, ellipsoid to broadly ellipsoid, apex truncate, hyaline, smooth, thick walled (1 µm), eguttulate, dextrinoid in Melzer's reagent. **Mature basidia** not observed. Cystidia absent. **Hymenial trama** interwoven, with scattered irregular crystals. Generative hyphae rarely observed; 2–3 µm wide, hyaline, smooth, thin walled, branched, with clamp connections. Skeletal hyphae 2–4 µm wide, hyaline, smooth, thick walled (1 µm), lumen narrow to solid, dextrinoid in Melzer's reagent, mostly unbranched, but sometimes branched at extremities, septations not observed. **Pileal trama** interwoven. Generative hyphae 2–3.5 µm wide, hyaline, smooth, thin walled, branched, with clamp connections. Skeletal hyphae 2–4 µm wide, hyaline, dextrinoid in Melzer's reagent, mostly unbranched, weakly branched at extremities, septations not observed, thick-walled (1 µm), lumen narrow to solid. **Pileipellis** an agglutinated hyphal mass; hyphae 2-3 µm wide, hyaline, thick walled (up to 1 µm), with obtuse ends.

Specimen examined: India. Kerala State: Kozhikode district, Peruvannamuzhy forest, on live *Sweitenia mahagoni*, 11 August 2016, Vinjusha N., ZGCVN418; Kuttyadi, Janaki forest, on live tree (unidentified), 18 July 2017, Vinjusha N., ZGCVN595.

Comments: Present collection shows high similarity with *Perenniporia contraria* (Berk. & M.A. Curtis) Ryvarden in basidiocarp morphology and having small basidiospores. *P. contraria* possess non dextrinoid basidiospores (Decock *et al.* 2001; Zhao & Cui 2013), whereas, basidiospores of present specimen are dextrinoid. According to Zhao & Cui (2013), *P. decurrata* is separated from *P. contraria* by the strictly truncate, dextrinoid basidiospores in the former and truncate or non truncate, inamyloid basidiospores in the latter. *Perenniporia subannosa* (Bres.) Decock, S. Herrera & Ryvarden also have smaller basidiospores as *P. decurrata*, however, differentiated by smaller pores (4–5 per mm), and indextrinoid basidiospores (Decock *et al.* 2001). BLAST search using the ITS sequence generated from the collection showed 92% similarity with an accession of *P. decurrata* (GenBank number: KX900669). Although the sequence similarity of present collection with accession of *P. deccurata* is not so high (less than 95%), the morphological characterizations properly fits Kerala collection within the available descriptions of *P. deccurata*.

Perenniporia decurrata has been recorded from tropical regions of south east Asia (Corner 1989a) and South America (Robledo *et al.* 2009). There are no records of the species from India so far.

Navisporus Ryvarden

Basidiomata annual, solitary to imbricate, hard and tough, resupinate to pileate. Pileus sessile, broadly attached, some fruit bodies effused at base, semicircular, applanate to irregular, concentric zonations absent, velutinate to glabrous, cream to yellowish brown or cinnamon brown. Hymenophore poroid, pores round to angular, or radially elongated, cream to brown, pore tubes cream to brown. Context creamish white to cinnamon brown. Hyphal system dimitic, generative hyphae hyaline, thin to slightly thick walled, with clamp connections.

Skeletal hyphae hyaline to brown, thick walled, weakly to strongly dextrinoid in Melzer's reagent. Cystidia present or absent. Basidia clavate, 4 sterigmate. Basidiospores ellipsoid to weakly amygdaliform, with distinct apicule, hyaline, smooth, thick walled, variably dextrinoid in Melzer's reagent. Members cause white rot on wood.

Navisporus floccosus (Bres.) Ryvarden [as '*floccosa*'], in Ryvarden & Johansen, Prelim. Polyp. Fl. E. Afr. (Oslo): 443 (1980)

Basionym: *Trametes floccosa* Bres., Annuar. R. Ist. bot. Roma 6: 179 (1896)
Synonyms:
Fomes introstuppeus sensu Hennings (Bot. Jb. 14: 343. 1891); fide Saccardo (Syll. fung. 14: 192. 1899)
Polyporus mollicarnosus Lloyd, Mycol. Writ. 4 (Letter 60): 11 (1915)
Fomes floccosus (Bres.) Lloyd, Mycol. Writ. (Letter 66): 8 (1917)
Ganoderma mollicarnosum (Lloyd) Sacc. & Trotter [as '*molli-carnosum*'], Syll. fung. (Abellini) 23: 401 (1925)
Tyromyces floccosus (Bres.) A. Roy & A.B. De [as '*floccosa*'], Norw. Jl Bot. 27 (4): 300 (1980)

FIGURE 60

Basidiomata annual, large, fleshy, hard and tough, especially towards the attachment portion, heavy, pileate. **Pileus** 80–320 mm long, 23–110 mm thick, sessile, broadly attached, some fruit bodies effused at base, irregular when young, becoming semicircular on maturity, applanate to irregular with depressions or projections, concentric zonations absent, slightly wrinkled towards the margin, glabrous to pruinose, cream, turning light to deep brown on bruising or exposure, margin even, rounded. **Hymenophore** poroid. **Pores** 2–4 per mm, round to angular, absent towards margin, cream, bruising to greyish brown, pore tubes 3–30 mm long, concolorous with pore surface, non stratified, possess narrow pale brown horizontal lines. **Context** 20–90 mm thick, concentric bands present, cream, turning light brown in KOH. **Odour** not distinct. **Spore print** not observed.

Basidiospores 9–15 × 5–7 µm, Q=1.5–2.4, Q_m=2.1, ellipsoid to weakly amygdaliform, hyaline, smooth, thick walled (up to 1 µm), some spores guttulate, dextrinoid in Melzer's reagent, cyanophilic in cotton blue, with distinct apicule. **Basidia** 19–35 × 7–12 µm, clavate, 4 sterigmate. **Hymenial cystidia** present; 24–42

× 9.5–12 µm, ventricose to broadly clavate, smooth, thin to thick walled (up to 1 µm). **Gloeocystidia** present in the hymenium; 18–45.5 × 7–11 µm, varying in shape such as flexuose, narrowly utriform, utriform, obovoid to ovoid, narrowly lageniform, conical, widely fusiform to fusiform, some with median constriction, hyaline, smooth, thin walled, brightly stained in phloxine. **Hymenial trama** interwoven. Generative hyphae 2–3 µm wide, hyaline, smooth, thin walled, branched, with clamp connections. Skeletal hyphae 2–8 µm wide, hyaline, pale brown in mass, unbranched or sparsely branched, rarely septate, thick walled (up to 4 µm), easily broken in sections, strongly dextrinoid in Melzer's reagent. Skeleto ligative hyphae not observed. **Pileal trama** interwoven. Generative hyphae sparsely observed, up to 4 µm wide, hyaline, smooth, thin walled, branched, with clamp connections. Skeletal hyphae 3–11 µm wide, hyaline, pale brown in mass, mostly unbranched, some hyphae with short branches, septations not observed, thick walled (2–5 µm), strongly dextrinoid in Melzer's reagent. Skeleto ligative hyphae not observed. **Pileipellis** a trichoderm consisting highly interwoven and irregularly arranged hyphal elements that are erect, each hyphae 2–3 µm wide, hyaline, thin walled.

Specimens examined: India. Kerala State: Kozhikode district, Mananchira, on dead wood stump of *Ficus* species, 2 July 15, Vinjusha N, ZGCVN7; Kakkodi, on dead wood stump of *Ficus* species, 6 July 2015,Vinjusha N, ZGCVN12; YMCA road, on live *Peltophorum ferrugineum*, 15 July 2015, Vinjusha N, ZGCVN54; Athanikkal, on dead wood stump (unidentified), 2 September 2017, Vinjusha N, ZGCVN491.

Comments: Present collections show high morphological similarity with species of *Perenniporia* and *Vanderbylia* D.A. Reid by having large sized pileate basidiocarps, dimitic hyphal system, with dextrinoid skeletal hyphae. However, the presence of distinct apicule on basidiospores of present present collections easily distinguishes it from *Perenniporia* and *Vanderbylia*.

Navisporus flocossus was originally described as acystidate (Ryvarden & Johansen 1980; Ryvarden 1983; Torress-Torress *et al.* 2007). Occurrence of cystidia in this species was later confirmed in the specimens from India, Malaysia, Papua

New Guinea and Caribbean (Roy & De 1980; Decock 2007; Prasher 2015). However, presence of gloeocystidia has not been reported for the species in these earlier descriptions. Possibly, those fruit bodies may be aged ones and their cystidia lacked granular contents. This might explain the reason why the previous descriptions did not report gloeocystidia in *Navisporus flocossus*. Present collection clearly possess both hymenial cystidia, similar as in the earlier descriptions, and typical gloeocystidia with rich granular contents.

BLAST search in NCBI's GenBank nucleotide database using the newly generated ITS sequence of the specimen resulted in 99% identity with three undescribed *Dichomitus* species (GenBank numbers: KR867652, KM084859, KR154972) from India. According to the available descriptions (Núñez & Ryvarden 2001; Ryvarden & Melo 2014), species of *Dichomitus* D.A. Reid produces arboriform hyphae which are branched and with tapering ends, cylindrical to oblong ellipsoid basidiospores, which are negative in Melzer's reagent. However, in our collection arboriform skeletal hyphae were absent, and the fruit bodies produced ellipsoid to slightly amygdaliform basidiospores, which were dextrinoid in Melzer's reagent. Thus, based on morphological characterization, the present specimen cannot be treated under the genus *Dichomitus*. It is belived that the above mentioned sequences available in GenBank, tagged as "*Dichomitus* sp." may be a misidentification.

BLAST search using the newly generated LSU sequence resulted in 99% identity with *Perenniporia cystidiata* (HQ654113), and 98% similarity with *P. fraxinea* (Bull.) Ryvarden (KX081164, KX081163) and *P. subtephropora*. According to Dai *et al.* (2002a), *P. cystidiata* produces laterally stipitate basidiocarps and slightly dextrinoid cystidia. Whereas, present collections had sessile basidiocarps and cystidia were inamyloid in Melzer's reagent. Moreover, *P. cystidiata* have smaller basidiospores (5.5–8.4 × 4.1–5.5 µm) than our collections (9–15 × 5–7 µm). The presence of subglobose to drop shaped basidiospores and absence of cystidia in *Perenniporia fraxinea* (Ryvarden & Gilbertson 1994; Corner 1987), distinguish it from our collections. *Perenniporia subtephropora* is separated from present collection by having resupinate basidiocarps and truncate basidiospores (Zhao & Cui 2013).

Navisporus flocossus ia s tropical species (Decock 2007). From India, this species has been reported by Roy & De (1980), Roy & De (1996) and Prasher (2015). *Navisporus flocossus* has been reported from Kerala by Mohanan (2011).

Pseudofavolus Pat.

Basidiomata annual to biennial. Pileus flabelliform to spathulate, sessile to laterally stipitate, Context thin. Hymenium poroid with angular to hexagonal pores. Hyphal system dimitic. Generative hyphae with clamp connections, skeleto ligative hyphae arboriform, showing variable dextrinoid reaction. Cystidia absent, sometimes cystidioles or dendrohyphidia present. Basidiospores cylindrical, hyaline, smooth, inamyloid in Melzer's reagent. Members of the genus cause white rot on wood.

Pseudofavolus tenuis (Fr.) G. Cunn., Bull. N.Z. Dept. Sci. Industr. Res. 164: 185 (1965)

Basionym: *Favolus tenuis* Fr. Epicr. syst. mycol. (Upsaliae): 498 (1838) [1836-1838]
Synonyms:
Polyporus tenuis (Fr.) Klotzsch, Linnaea 8 (4): 482 (1833)
Hexagonia tenuis (Fr.) Fr., Epicr. syst. mycol. (Upsaliae): 498 (1838)
Scenidium tenue (Fr.) Kuntze, Revis. gen. pl. (Leipzig) 3 (3): 516 (1898)
Daedaleopsis tenuis (Fr.) Imazeki, Bull. Tokyo Sci. Mus. 6: 78 (1943)
Trametes tenuis (Fr.) Corner, Beih. Nova Hedwigia 97: 170 (1989)

FIGURE 61

Basidiomata annual, small to large sized, solitary to imbricate, coriaceous, light in weight, effused reflexed to pileate. **Pileus** 18–75 mm long, 2–4 mm thick, sessile, broadly attached, semicircular to flabelliform, applanate, concentrically zonate, sometimes radially wrinkled, glabrous, dull or weakly shiny, bronze to dark brown or reddish brown, margin entire, sometimes upcurved on drying. **Hymenophore** poroid. **Pores** large, angular to hexagonal, extending to the margin, 0.5–2 per mm, sometimes smaller, surface beige, snuff brown, sometimes with greyish to ashy bluish shades, pore tubes up to 3.5 mm long, grey to brown. **Context**

up to 1 mm thick, beige to light brown, homogeneous, black in KOH. **Odour** not distinctive. **Spore print** not observed.

Basidiospores 8–12 × 3–4 µm, Q=2.6–3, Q_m=2.8, cylindrical, hyaline, smooth, thin walled, with guttulate contents, inamyloid in Melzer's reagent. **Basidia** not observed. **Cystidia** absent. **Hymenial trama** interwoven and trimitic. **Hyphal pegs** not observed. Generative hyphae 2–3 µm wide, hyaline, smooth, thin walled, branched, with clamp connections. Skeletal hyphae predominant, 2–4.5 µm, hyaline to yellow or pale yellowish brown, thick walled (1µm), unbranched, septations not observed. Skeleto ligative hyphae 2–3 µm, hyaline, thick walled (up to 1 µm), mostly with narrow lumen, branched. **Pileal trama** interwoven. Generative hyphae 2–3 µm wide, hyaline, smooth, thin walled, branched, with clamp connections. Skeletal hyphae predominant, 2–5 µm, hyaline, thick walled (1µm), unbranched, septations not observed. Skeleto ligative hyphae 2–3 µm, hyaline, thick walled (up to 1 µm), highly branched at the extremities. **Pileipellis** an irregular cutis composed of almost thick walled hyphae, that are 2–4 µm wide, hyaline to yellowish brown, with obtuse ends.

Specimens examined: India. Kerala State: Kozhikode district, Pokkunnu, ZG College campus, on dead branch (unidentified), 20 June 2015, Vinjusha N., ZGCVN19, ZGCVN27; 30 July 2015, Vinjusha N., ZGCVN101; on dead branch (unidentified), 22 September 2015, Vinjusha N., ZGCVN204; Eranjipalam, on dead branch (unidentified), 29 July 2015, Vinjusha N, ZGCVN72; Kakkayam, on dead branch (unidentified), 29 August 2015, Vinjusha N., ZGCVN149; Malappuram district, Thenjipalam, Calicut University Botanical Garden, on dead branch (unidentified), 15 September 2015, Vinjusha N., ZGCVN185; Chelavoor, Thurayil Kavu, on dead branch of *Diospyros paniculata*, 27 September 2015, Vinjusha N., ZGCVN216; Marad, on dead branch (unidentified), 03 January 2016, Athira C. K., ZGCVN281; Palazhi, Bhayankavu, 26 June 2016, on fallen branch of *Ficus* species, Vinjusha N., ZGCVN335; Wayanad district, Periya, 21 February 2016, on dead branch (unidentified), Vinjusha N., ZGCVN311; Kannur district, Aralam, on dead branch (unidentified), 09 January 2016, Vijisha P., ZGCVN303, ZGCVN324; 29

September 2016, Vinjusha N., ZGCVN458; Thrissur district, Peechi, on dead log, 12 December 2017, Vinjusha N., ZGCVN751.

Comments: Morphological characters of the present specimen fits well with the available descriptions of *P. tenuis* (Ryvarden & Johansen 1980; Núñez & Ryvarden 2001; Leelavathy & Ganesh 2000, reported as *Hexagonia tenuis*). *P. tenuis* is very common species encountered in most of the forest and non forest areas in Kerala.

P. tenuis is recorded from Kerala by different workers (Sankaran & Florence 1995; Florence & Yesodharan 1997, 2000; Leelavathy & Ganesh; Mohanan 2011).

Microporus P. Beauv.

Basidiomata annual, solitary, coriaceous to hard, centrally or laterally stipitate. Pileus circular, flabelliform or spathulate, concentrically zoned, smooth to hirsute. Hymenophore poroid with minute pores, pore surface white to cream. Context thin, white to cream, homogenous. Hyphal system dimitic to trimitic, with hyaline generative hyphae, having clamp connections, hyaline skeletal hyphae, and hyaline, branched, skeleto ligative hyphae. Coralloid dichophytic elements present in dissepiments, sometimes with hyphal pegs or cystidia like structures. Basidia clavate, 4 sterigmate. Basidiospores elliptical to allantoid, hyaline, thin walled, inamyloid in Melzer's reagent. *Microporus* species cause white rot on wood.

Microporus xanthopus (Fr.) Kuntze, Revis. gen. pl. (Leipzig) 3 (3): 494 (1898)

Basionym: *Polyporus xanthopus* Fr., Revis. gen. pl. (Leipzig) 3 (3): 494 (1898)
Synonyms:
Polyporus xanthopus var. *leucopus* Jungh., Verh. Batav. Genootsch. Kunst. Wet. 17 (2): 71 (1838)
Polyporus pterygodes Fr., Epicr. syst. mycol. (Upsaliae): 445 (1838)
Polystictus xanthopus (Fr.) Fr., Nova Acta R. Soc. Scient. upsal., Ser. 3 1 (1): 74 (1851)
Polystictus pterygodes (Fr.) Fr., Nova Acta R. Soc. Scient. upsal., Ser. 3 1 (1): 76 (1851)
Polyporus florideus Berk., Hooker's J. Bot. Kew Gard. Misc. 6: 137 (1854)
Polyporus polychrous Ces., Atti Accad. Sci. fis. mat. Napoli 8 (no. 3): 4 (1879)
Polystictus florideus (Berk.) Cooke, Grevillea 14 (no. 71): 78 (1886)
Microporus florideus (Berk.) Kuntze, Revis. gen. pl. (Leipzig) 3 (3): 496 (1898)
Microporus pterygodes (Fr.) Kuntze, Revis. gen. pl. (Leipzig) 3 (3): 497 (1898)
Polystictus crassipes f. *nigripes* Henn., Ann. Mus. Congo Belge, Bot., Sér. 5 2 (4): 358 (1908)
Polystictus xanthopus var. *nigripes* (Henn.) Bres., Annls mycol. 18 (1/3): 68 (1920)
Coriolus xanthopus (Fr.) G. Cunn., Proc. Linn. Soc. N.S.W. 75 (3-4): 247 (1950)
Trametes xanthopus (Fr.) Corner, Beih. Nova Hedwigia 97: 177 (1989)

FIGURE 62

Basidiomata annual**,** small to medium sized, solitary, coriaceus when fresh, moderately tough when dry, pileate, up to 10 mm tall. **Pileus** 25–110 mm wide, up to 3 mm thick, infundibuliform, glabrous, shiny, concentrically zonate with golden brown to dark brown shades, pale cream towards the depressed part, margin sharp, even to slightly lobed in some specimens. **Hymenophore** poroid. **Pores** 8–12 per mm, round to oval, regular, absent towards margin, creamish white. **Stipe** 10–30 mm long, 2–4 mm thick, central to eccentric, almost equal when young, flattening towards base, glabrous, solid; surface cream with light brownish patches. **Context** up to 25 mm thick, white, homogenous, drying to cream. **Odour** not distinctive. **Spore print** not observed.

Basidiospores 5–7 × 1.5–2.5 µm, Q=1.5–2, Q_m=1.67, cylindrical to subcylindrical, or weakly allantoid, thin walled, hyaline, smooth, inamyloid. **Basidia** 13–15 × 4–5 µm, narrowly clavate, with guttulate contents, 4 sterigmate. **Cystidia** absent. **Hymenial trama** interwoven and trimitic. Generative hyphae 2–3 µm wide, hyaline, smooth, thin walled, branched, with clamp connections. Skeletal hyphae 2–6 µm wide, hyaline, thick walled (up to 3 µm), branched, septations not observed. Skeleto ligative hyphae 1–2 µm wide, hyaline, thick walled (1 µm), highly branched, septations not observed. **Pileal trama** interwoven. Generative hyphae 2–4 µm wide, hyaline, smooth, thin walled, branched, with clamp connections. Skeletal hyphae 3–6 µm wide, hyaline, thick walled (up to 3 µm), branched, septations not observed. Skeleto ligative hyphae 1–2 µm wide, hyaline, thick walled (1 µm), highly branched, sepatations not observed. **Pileipellis** a cutis composed of hyphae 2–3 µm wide, pale brownish in colour, slightly thick walled (up to 1µm). **Stipe trama** interwoven. Generative hyphae 2–4 µm wide, hyaline, smooth, thin walled, branched, with clamp connections. Skeletal hyphae 3–5 µm wide, hyaline to pale brown, thick walled (up to 3 µm), branched, septations not observed. Skeleto ligative hyphae 2–4 µm, hyaline, thick walled (1 µm). **Stipitipellis** same as pileipellis, a cutis made of hyaline to light brown, slightly thick to thick walled hyphae, that are 2–4 µm wide.

Specimens examined: India. Kerala State: Kozhikode district, Pokkunnu, ZG college campus, on dead branches (unidentified), 18 July 2015, ZGCVN17, ZGCVN18; Vallikkattukavu, on dead branch of *Myristica fragrans*, 11 July 2015, Vinjusha N, ZGCVN33, ZGCVN34, ZGCVN35, ZGCVN36; Chelavoor, Thurayil Kotta, on dead branch (unidentified), 27 September 2015, Vinjusha N., ZGCVN214; Koyilandy, Muchikunnu, Kottayil Kavu, 04 October 2015, Vinjusha N., ZGCVN224; Kuttyadi, Janaki forest, on dead branch (unidentified), 11 December 2015, Vinjusha N., ZGCVN273, ZGCVN274; 09 April 2017, Vinjusha N., ZGCVN492; Poyilkavu, on dead branch (unidentified), 23 June 2017, Vinjusha N., ZGCVN510; Peruvannamuzhy forest, on dead branch (unidentified), 24 June 2017, Vinjusha N., ZGCVN518; Wayanad district, Pookod, on dead log (unidentified), 30 June 2017, Vinjusha N., ZGCVN547; Kannur district, Aralam, on dead branch (unidentified), 16 September 2015; Vijisha P., ZGCVN195, ZGCVN196; Wayanad district, Thirunelli, on dead branch (unidentified), 16 October 2015, Vinjusha N, ZGCVN234; Periya, on dead branch (unidentified), 22 February 2016, Vinjusha N., ZGCVN314; Idukki district, Vagamon, Mottakkunnu, on dead branch (unidentified), Vinjusha N., ZGCVN244.

Comments: The specimen is closely related to *M. affinis*, however, the latter produces laterally stipitate basidiocarps and smaller basidiospores (3–4 × 1.5–2 µm, Núñez & Ryvarden 2001). *Microporus xanthopus* is a widespread species in the tropical areas of Asia, Africa and Oceania (Núñez & Ryvarden 2001) and south America (Corner 1989a). From Kerala, *M. xanthopus* has been documented by Sankaran & Florence (1995), Florence & Yesodharan (1997), Leelavathy & Ganesh (2000), Mohanan (2011), Iqbal *et al.* (2016), and Adarsh *et al.* (2018). This species is widely encountered in most of the forest and non forest areas of Kerala.

Microporus affinis (Blume & T. Nees) Kuntze, Revis. gen. pl. (Leipzig) 3 (3): 494 (1898)

Basionym: *Polyporus affinis* Blume & T. Nees., Nova Acta Phys.-Med. Acad. Caes. Leop.-Carol. Nat. Cur. 13: 18 (1826)
Synonyms:
Polyporus flabelliformis Klotzsch, Linnaea 8 (4): 483 (1833)
Polyporus crenatus Berk., Ann. Mag. nat. Hist., Ser. 1 10: 372 (1843)

Polystictus affinis (Blume & T. Nees) Fr., Nova Acta R. Soc. Scient. upsal., Ser. 31 (1): 75 (1851)
Polystictus flabelliformis Fr., Nova Acta R. Soc. Scient. upsal., Ser. 3 1 (1): 74 (1851)
Polyporus carneoniger Berk. *ex* Cooke [as *'carneo-niger'*], Grevillea 12 (no. 61): 15 (1883)
Microporus flabelliformis (Fr.) Pat., Revis. gen. pl. (Leipzig) 3 (3): 496 (1898)
Microporus squamaeformis (Berk.) Kuntze, Revis. gen. pl. (Leipzig) 3 (3): 497 (1898)
Microporus trizonatus (Cooke) Kuntze, Revis. gen. pl. (Leipzig) 3 (3): 497 (1898)
Polystictus luteus var. *castaneus* Bres., Hedwigia 53 (1-2): 61 (1912)
Microporus affinis var. *fasciatus* Pat., Philipp. J. Sci., C, Bot. 10 (2): 90 (1915)
Polystictus subaffinis Lloyd, Mycol. Writ. 4 (Mycol. Notes 40): 550 (1916)
Polystictus flabelliformis var. *japonicus* Lloyd, Mycol. Writ. 5: 623 (1917)
Microporus luteus var. *castaneobrunneus* Biers, Bull. trimest. Soc. mycol. Fr. 40 (3): 229 (1925)
Microporus subaffinis (Lloyd) Imazeki, Bull. Tokyo Sci. Mus. 6: 95 (1943)
Coriolus carneoniger (Berk. *ex* Cooke) G. Cunn., Proc. Linn. Soc. N.S.W. 75 (3-4): 221 (1950)
Coriolus flabelliformis (Fr.) G. Cunn., Proc. Linn. Soc. N.S.W. 75 (3-4): 226 (1950)
Trametes carneonigra (Berk. *ex* Cooke) Corner, Beih. Nova Hedwigia 97: 88 (1989)
Trametes affinis var. *firmior* Corner, Beih. Nova Hedwigia 97: 65 (1989)
Microporus affinis var. *glabriceps* Nagadesi & A. Arya, Mycosphere 3 ['2'] (6): 1000 (2012)

FIGURE 63

Basidiomata annual, small to medium sized, hard and woody, light in weight, laterally stipitate, 40–120 mm long. **Pileus** 35–115 mm long, 1–6 mm thick, flabelliform to semicircular, applanate, concentrically zonate, glabrous at most part, velutinous towards the stipe, reddish brown to brown with alternating shades of yellow, white narrow zone along margin when fresh, which turn cream on bruising, fruit bodies turning brownish black to completely black with age, margin even, thin. **Hymenophore** poroid. **Pores** 7–13 per mm, absent near margin, ovoid, creamish white, pore tube 1mm long, creamish white. **Context** 1–4 mm thick at attachment region, white, no colour change on bruising. **Stipe** 10–25 mm long, 2–3 mm thick, woody, laterally attached, cylindrical with fibrillose hairs, brownish red with variant shades of yellow, greyish black when mature, base flattened to circular disc, inner tissue solid, white. **Odour** not distinctive. **Spore print** not observed.

Basidiospores 3–5 × 1.5–2 µm, Q=2–2.6, Q_m=2.35, cylindrical, hyaline, guttulate, thin walled, smooth, inamyloid in Melzer's reagent. **Basidia** 8–11 × 4–5 µm, clavate, 4 sterigmate. **Cystidia** absent. **Coralloid dichophytic elements** present, 2–5 µm wide, hyaline, thin walled. **Hymenial trama** interwoven and trimitic. Generative hyphae 2–5 µm wide, hyaline, smooth, thin walled, branched, with clamp connections. Skeletal hyphae 3–6 µm wide, hyaline, thick walled (1.5 µm), rarely branched, septations not observed, surface slighly irregular. Skeleto ligative hyphae 2–3 µm wide, hyaline, thick walled (1 µm), branched, but not of *Bovista* type, septations absent. **Pileal trama** interwoven. Generative hyphae 2–5 µm wide, hyaline, smooth, thin walled, branched, with clamp connections. Skeletal hyphae 3–7.5 µm wide, hyaline, thick walled (up to 1.5 µm), rarely branched, septations not observed. Skeleto ligative hyphae 2–3 µm wide, hyaline, thick walled (1 µm), branched, septations not observed. **Pileipellis** almost cutis made pale brown or hyaline, thick walled hyphae which are 2–5 µm wide. **Stipe trama** interwoven. Generative hyphae 2–5 µm wide, hyaline, smooth, thin walled, branched, with clamp connections. Skeletal hyphae 3–7.5 µm wide, hyaline, thick walled (up to 1.5 µm), rarely branched, septations not observed. Skeleto ligative hyphae 2–3 µm wide, hyaline, thick walled (1 µm), branched, septations not observed. **Stipitipellis** an irregular cutis, with erect, projecting, cylindrical, elongated, flexuose to club shaped, hyaline, hyphae that are 2–4 µm wide, thick walled, with obtuse ends.

Specimens examined: India. Kerala State: Kozhikode district, Chelavoor, Thurayilkavu, on live branch of tree (unidentified), 27 September 2015, Vinjusha N., ZGCVN211; Poyilkavu, on dead log (unidentified), 23 June 2017, Vinjusha N., ZGCVN510, ZGCVN512; Thusharagiri, on dead wood (unidentified), 17 June 2016, Vinjusha N., ZGCVN625; Thusharagiri, 14 September 2017, Vinjusha N., ZGCVN636; on dead wood (unidentified), 14 November 2017, Vinjusha N., ZGCV656, ZGCVN659; Kuttyadi, Janaki forest, on dead wood (unidentified), 11 December 2015, Vinjusha N., ZGCVN272; Kannur district, Aralam, on dead branch (unidentified), Vijisha P., ZGCVN198; Poongottukavu, on dead wood (unidentified), 12 September 2018, Vinjusha N., ZGCVN716; Pathanamthitta district, Sharamkutti, Shabarimala, on live tree (unidentified), 19 July 2015, Vinjusha N., ZGCVN78; Palakkad district, Mannarkkad, Silent Valley National Park areas, on dead log (unidentified), 09 January 2018, Manju A. C., ZGCVN669, ZGCVN670; Wayanad district, Chembra Peak, on dead branch of *Cinnamomum verum*, Vinjusha N., ZGCVN758.

Comments: Morphological characters of the present collections fits properly with the published descriptions of *M. affinis* by Corner (1989), Ryvarden & Johansen

(1980), and Núñez & Ryvarden (2001), *Microporus ocrotinctus* (Berk. & M.A. Curtis) Kuntze is closely related to the present specimen, however, is separated by having glabrous pileus and slightly longer basidiospores (4–4.5 µm, Núñez & Ryvarden 2001). *Microporus xanthopus* (Fr.) Kuntze is distinguished from the present collection by often centrally stipitate, infundibuliform basidiomata and larger basidiospores (Bernicchia 2005).

Microporus affinis is a common species in tropical regions of Asia, Africa and Oceania. The species is also found in subtropical and warm temperate zones of China, Japan, Taiwan, North Thailand and Vietnam (Núñez & Ryvarden 2001). From Kerala, *M. affinis* has been documented by Sankaran & Florence (1995), Florence & Yesodharan (1997, 2000), Leelavathy & Ganesh (2000), Mohanan (2011), Iqbal *et al.* (2016), and Adarsh *et al.* (2018).

Bresadolia Speg.

Basidiomata annual, fleshy and watery when fresh, turning papery and brittle on drying, laterally to centrally or eccentrically stipitate. Pileus flabelliform to infundibuliform, azonate, with wrinkled and papery cuticle, pale yellow to ochraceous, white to cream. Hymenophore poroid, pores round, angular to radially elongated, deccurent on stipe, pore surface white to pale brown, pore tubes concolourous with pore surface. Context white, homogenous. Stipe fleshy, eccentrical, cylindrical, dull white to light brown, minutely pubescent, inner tissue solid. Hyphal system dimitic, generative hyphae hyaline, thin to thick walled with clamp connections, sometimes inflatted. Skeleto ligative hyphae hyaline, thick walled. Cystidia absent. Basidia clavate, 4 sterigamte. Basidiospores cylindrical to subellipsoid, hyaline to slightly yellowish, thin walled, smooth, with large guttules, inamylod in Melzer’s reagent. Members cause white rot on wood.

Bresadolia uda (Jungh.) Audet, Index Fungorum 311: 1 (2016)

Basionym: *Polyporus udus* Jungh., Tijdschr. Nat. Gesch. Physiol. 7: 289 (1840)
Synonyms:
Polyporus udus Jungh., Tijdschr. Nat. Gesch. Physiol. 7: 289 (1840)
Polyporellus udus (Jungh.) P. Karst., Meddn Soc. Fauna Flora fenn. 5: 38 (1879)

Favolus udus (Jungh.) Zmitr. & Kovalenko, International Journal of Medicinal Mushrooms (Redding) 18 (1): 34 (2016)
Polyporus maculatus Berk., Hooker's J. Bot. Kew Gard. Misc. 3: 80 (1851)
Polyporus platyporus Berk., Hooker's J. Bot. Kew Gard. Misc. 3: 81 (1851)
Polyporus discoideus Berk. & M.A. Curtis, J. Linn. Soc., Bot. 10 (no. 45): 305 (1868)
Polyporus glutinifer Berk. *ex* Cooke, Grevillea 15 (no. 73): 19 (1886)
Polyporus squamosomaculatus Sacc., Syll. fung. (Abellini) 9: 161 (1891)
Polyporus squamulosus Henn., in Engler, Pflanzenw. Ost-Afrikas Nachbarg., Teil C: 57 (1895)
Polyporus fuscomaculatus Bres. & Pat., Mycol. Writ. 1: 49 (1901)
Polyporus marbleae Murrill, Tropical Polypores: 48 (1915)
Polyporus maculatissimus Lloyd, Mycol. Writ. 7 (Letter 66): 1113 (1922)
Polyporus cornucopiae Lloyd, Mycol. Writ. 7 (Letter 73): 1316 (1924)
Favolus annamensis Pat., Bull. trimest. Soc. mycol. Fr. 43: 32 (1927)
Piptoporus maculatissimus (Lloyd) G. Cunn., Bull. N.Z. Dept. Sci. Industr. Res. 164: 108 (1965)
Tyromyces udus (Jungh.) G. Cunn., Bull. N.Z. Dept. Sci. Industr. Res. 164: 133 (1965)
Neolentiporus maculatissimus (Lloyd) Rajchenb., Nordic Jl Bot. 15 (1): 106 (1995)

FIGURE 64

Basidiomata annual, small sized, solitary, soft and spongy when fresh, slightly hard on drying, light in weight, stipitate. **Pileus** 32 mm long, 5 mm thick, with a papery cuticle, wrinkled on drying, circular to flabelliform, concentric zonations absent, glabrous, light brown, paler towards margin, margin even, incurved on drying. **Hymenophore** poroid. Pores 1–3 per mm, angular, irregular, oblique and radially elongated towards stipe, white when fresh, turning pale brown on bruising, pore tube up to 2 mm long, non stratified, white. **Context** 1 mm thick, white, homogenous. **Stipe** 10–25 mm tall, 5–8 mm thick, eccentric, cylindrical, dull white, light brown on bruising, minutely pubescent, inner tissue solid. **Odour** not distinctive. **Spore print** not observed.

Basidiospores 7–14 × 3.5–4 µm, Q=1.7–2.7, Q_m=2.20, cylindrical to subcylindrical, mostly curved at one end, mostly hyaline, some spores light golden brown, guttulate, thin walled, smooth, inamyloid in Melzer' s reagent. **Basidia** 15–28 × 6–13 µm, clavate, 4 sterigmate. **Cystidia** absent. **Hymenial trama** parallel and monomitic. Generative hyphae 2–4 µm wide, in some region widened up to 9 µm, hyaline, smooth, thin to slightly thick walled (up to 1 µm), branched, with clamp connections. **Pileal trama** interwoven and dimitic. Generative hyphae 2–8 µm wide, hyaline, smooth, thin to slightly thick walled (up to 1 µm), branched, with clamp connections. Skeleto ligative hyphae difficult to observe; 2–6 µm wide, hyaline, thick walled (1 µm), branched, with tapering ends. **Pileipellis** an agglutinated cutis made of hyphae that are 2–5 µm wide, hyaline and thin to slightly thick walled. **Stipe trama** monomitic. Generative hyphae 2–9 µm wide, hyaline, smooth, branched, thin to slightly thick walled (<1 µm), with clamp connections. Skeleto ligative hyphae not observed. **Stipitipellis** an irregular, more or less agglutinated cutis at most part, interrupted by short, trichodermal patches; each hyphae 2–6 µm wide, hyaline, smooth, thin to thick walled (1 µm), and unbranched.

Specimens examined: India. Kerala State: Kozhikode district, Kakkodi, Chelapram, on dead wood of *Atrocarpus heterophillus*, 15 November 2015, Vinjusha N., ZGCVN265.

Comments: Excepts a slight variation in the colour of some basidiospores, rest characters of the present collection were matching with earlier descriptions of *B. uda* such as Ryvarden & Johansen (1980), Corner (1983), and Núñez & Ryvarden (2001). All these earlier descriptions of *B. uda* defines basidiospores of the species as hyaline. Although most of the spores of present collection were hyaline, some spores were light golden brown in colour.

Bresadolia uda was earlier treated under *Polyporus*, as *P. udus* Jungh (Ryvarden & Johansen 1980). Major diagnostic characters of this species are the fleshy basidiomata, with greyish brown papery cuticle, often having rose tints when fresh (Núñez & Ryvarden 2001). However, the present collection lacks rose shades on its pileus, may be because the specimen was collected in a more or less withered condition. Corner (1989) described hyphae of dissepiments of *B. uda* as monomitic, and contextual hyphae as dimitic. Whereas, Núñez & Ryvarden (1995, 2001), described both hymenium and context of the species as dimitic. In the present collection, true skeletal hyphae were only observed in contextual region, and were not observed in the hymenium as opposed to Núñez & Ryvarden (1995, 2001). According to the description of Corner (1989), hyphae in the context possessed encrustations, however, such a character was not observed in the present collection. Present collection resembles a young specimen of *Cerioporus squamosus* (Huds.) Quél. in morphology. However, *C. squamosus* produces more large sized basidiomata (up to 180 mm wide and 50 mm thick) and larger basidiospores (14–17 × 9–12 µm, Núñez & Ryvarden 2001; 10–14 (16) × 4–5 (6) µm, Ryvarden & Johansen 1980) than the present collection. Moreover, pileus of *C. squamosus* possesses distinct dark brownish squamules or scales, whereas, such scales are absent in the pileus surface of our collection.

BLAST search in NCBI's GenBank nucleotide database using the newly generated LSU sequence of the present specimen (ZGCVN265), showed 99% similarity with *B. uda* strains (GenBank numbers: KX851697, KX851696). BLAST search also resulted in 99% identity with some *Bresadolia cuticulata* (Y.C. Dai, Jing Si & Schigel) Audet strains (e.g., KX851675, KX851674, KX851673, KX851668). According to Motato-Vásquez *et al.* (2018), pileal surface of *B. cuticulata* is pale grey to greyish brown in colour, with buff-yellow to cinnamon radial lines. Whereas, pileus surface of present collection is light brown and lacks cinnamon coloured radial stripes. In addition, *B. cuticulata* possesses smaller pores (3–5 per mm) than the present collection (1–3 per mm).

Bresadolia uda is a pantropical species (Ryvarden & Johansen 1980). This species has not been reported from Kerala so far.

Pycnoporus P. Karst.

Basidiomata mostly annual, coriaceous, pileate. Pileus sessile, dimidiate to flabelliform, semicircular or some fruit bodies circular, with or without zonations, soft and velvety to glabrous, cinnabar to reddish orange colour. Hymenophore poroid, pores round to angular, pore surface orange to reddish orange, pore tube mostly concolourous with pore surface. Context corky to cottony floccose, reddish orange. Hyphal system trimitic, generative hyphae hyaline to pale yellow brown, thin walled, with clamp connections. Skeletal hyphae hyaline, thick walled, encrusted with orange crystals, which get dissolved in KOH. Skeleto ligative hyaline, thick walled. Cystidia absent. Basidia clavate, 4 sterigmate. Basidiospores cylindrical, hyaline, smooth, thin walled, inamyloid in Melzer's reagent. Members cause white rot on wood.

Pycnoporus sanguineus (L.) Murrill, Bull. Torrey bot. Club 31 (8): 421 (1904)

Basionym: *Boletus sanguineus* L., Sp. pl., Edn 2 2 (2): 1646 (1763)
Synonyms:
Boletus ruber Lam., Encycl. Méth. Bot. (Paris) 1(1): 50 (1783)
Polystictus sanguineus (L.) G. Mey., Nova Acta R. Soc. Scient. upsal., Ser. 1 1: 75 (1818)
Polyporus sanguineus (L.) Fr., Syst. mycol. (Lundae) 1: 371 (1821)
Polyporus sanguineus var. *amphiphorus* Fr., Elench. fung. (Greifswald) 1: 99 (1828)
Polyporus sanguineus f. *albozonatus* Henn., Bot. Jb. 17: 26 (1893)
Polystictus sanguineus var. *albozonatus* (Henn.) Sacc., Syll. fung. (Abellini) 11: 91 (1895)
Microporus sanguineus (L.) Pat., Essai Tax. Hyménomyc. (Lons-le-Saunier): 83 (1900)
Trametes sanguinea (L.) Lloyd, Mycol. Writ. 7 (Letter 72): 1291 (1924)
Polystictus sanguineus f. *lactescens* Henn., Hedwigia 43 (3): 179 (1904)
Microporus sanguineus f. *myriadoporus* Biers, Bull. trimest. Soc. mycol. Fr. 40 (3): 229 (1924)
Trametes cinnabarina var. *sanguinea* (L.) Pilát, in Kavina & Pilát, Atlas Champ. l'Europe, III, Polyporaceae (Praha) 1: 319 (1939)
Coriolus sanguineus (L.) G. Cunn., Bull. N.Z. Dept. Sci. Industr. Res., Pl. Dis. Div. 81: 17 (1949)
Trametes sanguinea var. *intermedia* Corner, Beih. Nova Hedwigia 97: 154 (1989)
Trametes sanguinea var. *major* Corner, Beih. Nova Hedwigia 97: 154 (1989)
Fabisporus sanguineus (L.) Zmitr., Mycena 1 (1): 93 (2001)

FIGURE 65

Basidiomata annual, small to large sized, light in weight, coriaceous when fresh, becoming hard towards the region of attachment with age, pileate. **Pileus** 20–105 mm long, 2–5 mm thick, sessile to dimidiate, semicircular to circular, applanate, shiny, concentrically zonate, zonations more prominent towards margin, glabrous, bright orange red, black in KOH, margin thin and papery, even to highly lobed, with layer of pores in aged fruit bodies. **Hymenophore** poroid. **Pores** 5–7 per mm, angular to irregular, visible to naked eye, absent at the margin, bright orange red, turning pale yellowish brown in KOH, pore tubes 2–3 mm long, concolorous with pore surface. **Context** 1.5–2 mm thick, pale yellowish orange, homohgenous. **Odour** not distinctive. **Spore print** not observed.

Basidiospores 4–5 × 2–2.5 µm, Q=1.6–2.5, Q_m=2.03, subcylindrical to oblong, hyaline, smooth, thin walled, with guttulate contents, inamyloid in Melzer's reagent. **Basidia** 11–15×5–7 µm, clavate to slightly ovoid, 4 sterigmate. **Hymenial trama** interwoven and trimitic. Generative hyphae 2–3 µm wide, hyaline, smooth, thin to slightly (up to 1 µm) thick walled, branched, with clamp connections. Skeletal hyphae 3–6 µm wide, hyaline, branched, septations not observed, thick walled (1–2 µm), encrusted with orange crystals, dissolved in KOH. Skeleto ligative 2–3 µm wide, hyaline, thick walled (up 1 µm), highly branched, encrusted with orange crystals. **Pileal trama** interwoven. Generative hyphae 2–3 µm wide, hyaline, smooth, thin to slightly (up to 1 µm) thick walled, branched, clamp connections present. Skeletal hyphae 2–7 µm wide, hyaline, thick walled (1–2 µm), branched, encrusted with orange crystals, septations not observed. Skeleto ligative up to 2 µm wide, hyaline, thick walled (up to 1 µm), highly branched, encrusted with orange crystals. **Pileipellis** an agglutinated cutis, made of hyphae that are 2– 5 µm wide, hyaline to light orange brown, thin to slightly (up to 1 µm) thick walled.

Specimen examined: India. Kerala State: Malappuram district, Tirur, Thalakkad, on dead wood (unidentified), 25 July 2015, Vinjusha N., ZGCVN89; Wayanad district, Kuruva Island, on dead log (unidentified), 22 February 2016, Vinjusha N., ZGCVN310; Muthanga, on *Ficus* species, Vinjusha N., ZGCVN391; Idukki district, Vattavada, on dead branch (unidentified), Vinjusha N., ZGCVN874.

Comments: *Pycnoporus sanguineus* is easily distinguished in the field by bright orangish red basidiomata. Microscopically, the species possesses orange to brownish orange coloured crystals on hyphae and subcylindrical basidiospores. *Pycnoporus cinnabarinus* (Jacq. *ex* Fr.) Karst is closely related, however differs by having thicker basidiomata with salmon to apricot orange colour (Núñez & Ryvarden 2001).

BLAST search using the ITS sequence generated from one of the collection (VN874) showed 99–100% similarity with *P. sanguineus* (GenBank numbers: KC848329, JN704807, FJ234188).

Pycnoporus sanguineus is a common pantropical species (Ryvarden & Johansen 1980). From Kerala, the species has been reported by Sankaran & Florence (1995), Florence & Yesodharan (1997, 2000), Leelavathy & Ganesh (2000), Mohanan (2011) and Iqbal *et al*. (2016).

Pycnoporus cinnabarinus (Jacq.) P. Karst., Revue mycol., Toulouse 3 (no. 9): 18 (1881)

Basionym: *Boletus cinnabarinus* Jacq., Fl. austriac. 4: 2 (1776)
Synonyms:
Boletus miniatus Libosch., Mém. Soc. Imp. nat. Moscou 5: 83 (1817)

Polyporus cinnabarinus (Jacq.) Fr. [as '*cinnabarrinus*'], Syst. mycol. (Lundae) 1: 371 (1821)
Polyporus miniatus (Libosch.) Fr., Syst. mycol. (Lundae) 3 (1): 60 (1829)
Polyporus cristula Klotzsch *ex* Berk., Ann. nat. Hist., Mag. Zool. Bot. Geol. 3: 387 (1839)
Trametes cinnabarinus (Jacq.) Fr., Summa veg. Scand., Sectio Post. (Stockholm): 323 (1849)
Trametes cinnabarina (Jacq.) Fr., Hymenomyc. eur. (Upsaliae): 583 (1874)
Hapalopilus cinnabarinus (Jacq.) P. Karst., Revue mycol., Toulouse 3 (no. 9): 18 (1881)
Leptoporus cinnabarinus (Jacq.) Quél., Enchir. fung. (Paris): 176 (1886)
Polystictus cinnabarinus (Jacq.) Cooke, Grevillea 14 (no. 71): 82 (1886)
Phellinus cinnabarinus (Jacq.) Quél., Fl. mycol. France (Paris): 395 (1888)
Polystictus cinnabarinus subsp. *cristula* (Klotzsch *ex* Berk.) Sacc., Syll. fung. (Abellini) 6: 245 (1888)
Coriolus cinnabarinus (Jacq.) G. Cunn., Bull. N.Z. Dept. Sci. Industr. Res., Pl. Dis. Div. 75: 8 (1948)
Pycnoporus cinnabarinus var. *osorninus* Burgos, in Burgos & Ortiz, Boletín Micológico, Valparaíso 3 (4): 229 (1988)

FIGURE 66

Basidiomata annual, medium sized, light in weight, coriaceous when fresh, becoming hard towards the region of attachment with age, pileate. **Pileus** 30–65 mm long, 2–9 mm thick, sessile to dimidiate, semicircular, applanate, shiny, weakly concentrically zonate, glabrous, cinnabar yellow to apricot orange, yellow towards margin, margin obtuse, even. **Hymenophore** poroid. **Pores** 3–4 per mm, round to angular, sometimes turning lacerate, absent at the margin, bright orange red, pore tubes up to 5 mm long, concolorous with pore surface. **Context** 2–4 mm thick, pale orange, soft, with concentric bands, homogenous. **Odour** not distinctive. **Spore print** not observed.

Basidiospores 5–7.5 × 2–3 µm, Q=2–2.5, Q_m=2.4, cylindrical, hyaline, smooth, thin walled, with guttulate contents, inamyloid in Melzer’s reagent. **Basidia** 18–28 × 5–7.5 µm, clavate to slightly ovoid, 4 sterigmate. **Hymenial trama** interwoven and trimitic. Generative hyphae 2–4 µm wide, hyaline, smooth, thin to slightly (up to 1 µm) thick walled, branched, with clamp connections. Skeletal hyphae 3–7 µm wide, hyaline, branched, thick walled (1–2 µm), encrusted with orange crystals, which get dissolved in KOH, septations not observed. Skeleto ligative 2–4 µm wide, hyaline, thick walled (up 1 µm), highly branched, encrusted with orange crystals. **Pileal trama** interwoven. Generative hyphae 2–4 µm wide, hyaline, smooth, thin to slightly (up to 1 µm) thick walled, branched, clamp connections present. Skeletal hyphae 2–8 µm wide, hyaline, thick walled (1–2 µm), branched, encrusted with orange crystals, septations not observed. Skeleto ligative 2–4 µm wide, hyaline, thick walled (up to 1 µm), highly branched, encrusted with orange crystals. **Pileipellis** an agglutinated cutis, made of hyphae that are 2–6 µm wide, hyaline to light orange brown, thin to slightly (up to 1 µm) thick walled.

Specimen examined: India. Kerala State: Wayanad district, Kuruva Island, on dead *Bambusa* species, 07 December 2018, Vinjusha N., ZGCVN790.

Comments: The cinnabar yellow to apricot orange coloured, thicker basidiomata distinguishes this species from closely related *Pycnoporus sanguineus*. Latter species produces thin basidiomata, that are more reddish in colour (Ryvarden & Johansen 1980).

Pycnoporus cinnabarinus is mainly a temperate species (Núñez & Ryvarden 2001). In East Asia, P. cinnabarinus has been documented from China, Japan, Taiwan, Far East Russia and Vietnam (Núñez & Ryvarden 2001) From Kerala, the species has been reported by Iqbal *et al*. (2016).

Favolus Fr.

Basidiomata annual, solitary, usually thin and soft when fresh, turns brittle and light weighted on drying, pileate. Pileus dimidiate, flabelliform to spathulate, azonate, smooth to radially striated, glabrous to weakly tomentose, white, cream to ochre. Hymenophore poroid, pores hexagonal to radially elongated, pore surface white to cream. Context homogenous and white in colour. Hyphal system dimitic, with hyaline, thin walled, generative hyphae having clamp connections, and hyaline, thick walled skeletal hyphae. Cystidia absent. Basidia broadly clavate to clavate, 2–4 sterigmate. Basidiospores cylindrical to weakly navicular, smooth, thin walled, inamyloid in Melzer’s reagent. *Favolus* species cause white rot on wood.

Favolus tenuiculus P. Beauv., Fl. Oware 1 (8): 74 (1806)

Synonyms:

Merulius daedaleus Link, Flora gött. Spec.: 37 (1789)
Polyporus tenuiculus (P. Beauv.) Fr., Syst. mycol. (Lundae) 1: 344 (1821)
Daedalea brasiliensis Fr., Syst. mycol. (Lundae) 1: 332 (1821)

Favolus daedaleus (Link) Fr., Syst. orb. veg. (Lundae) 1: 76 (1825)
Favolus brasiliensis (Fr.) Fr., Linnaea 5: 511 (1830)
Hexagonia rhombipora Mont., Annls Sci. Nat., Bot., sér. 4 5: 370 (1857)
Favolus scaber Berk. & Broome, J. Linn. Soc., Bot. 14 (no. 73): 57 (1873)
Scenidium rhombiporum (Mont.) Kuntze, Revis. gen. pl. (Leipzig) 3 (3): 516 (1898)
Favolus hispidulus Berk. & M.A. Curtis, J. Linn. Soc., Bot. 10 (no. 46): 321 (1868)
Hexagonia daedalea (Link) Murrill, Bull. Torrey bot. Club 31 (6): 328 (1904)
Hexagonia hispidula (Berk. & M.A. Curtis) Murrill, Bull. Torrey bot. Club 31 (6): 329 (1904)
Favolus caespitosus Lloyd, Mycol. Writ. 5: 821 (1919)
Polyporus spegazzinianus Bres., Annls mycol. 18 (1/3): 32 (1920)
Favolus roseus Lloyd, Mycol. Writ. 7 (Letter 67): 1157 (1922)
Favolus lutescens Lloyd, Mycol. Writ. 7(Letter 72): 1272 (1924)
Favolus mollis Lloyd, Mycol. Writ. 7 (Letter 73): 1330 (1924)
Favolus bresadolanus Speg. [as '*bresadolianus*'], Boln Soc. Cienc. Córdoba 28: 353 (1926)
Polyporus brasiliensis (Fr.) Corner, Beih. Nova Hedwigia 78: 58 (1984)
Polyporus arcularioides A. David & Rajchenb., Mycotaxon 22 (2): 306 (1985)

FIGURE 67

Basidiomata annual, medium sized, solitary or in clusters, 30–45 mm tall, soft and delicate, coriaceous, light in weight. Pileus up to 63 mm wide, laterally stipitate, flabelliform, applanate, glabrous, concentric zonations absent, radially striated, white when fresh, becoming pale ochre on drying, margin slightly wavy. **Hymenophore** elongated poroid. **Pores** 0.5–1.5 mm wide, angular, often radially elongated, absent along margin, white when fresh, cream on drying. **Context** not distinct, less than 1 mm thick, white. Stipe 30–50 mm long, cylindrical, even, slightly broadened towards base, glabrous, white. **Odour** not distinct. **Spore print** not observed.

Basidiospores 7–11 × 2–3 µm, Q=3–3.5, Q_m=3.3, cylindrical, smooth, thin-walled, guttulate, inamyloid in Melzer's reagent. **Basidia** not observed. **Cystidia** absent. **Hymenial trama** interwoven. Generative hyphae rarely observed, 2–4 µm wide, hyaline, thin walled, branched, with clamp connections. Skeletal hyphae predominant, 2–5 µm wide, hyaline, thick walled (1 µm), mostly flexuose, branched with long tapering ends, septations not observed. **Pileal trama** interwoven. Generative hyphae sparsely observed, 2–4 µm wide, septate, hyaline, thin walled, branched, with clamp connections. Skeletal hyphae 2–5 µm wide, hyaline, thick walled (1 µm), branched, septations not observed. **Pileipellis** an agglutinated cutis, hyaline, difficult to separate, hyphae 2–4 µm wide, hyaline, thin to thick walled (1 µm). **Stipe** trama interwoven. Generative hyphae not observed. Skeletal hyphae 2–6 µm wide, hyaline, branched, not flexuose as in pileus, thick walled (1 µm), septations not observed,. **Stipitipellis** an agglutinated cutis similar as pileipellis, hyphae hyaline, thin to thick walled (1 µm), septations not observed.

Specimens examined: India. Kerala State: Kozhikode district, Kakkadampoyil, on dead wood stump (unidentified), 13 July 2017, Vinjusha N, ZGCVN580; Malappuram district, Thenjipalam, Calicut University Botanical Garden, on dead branch (unidentified), 16 September 2015, Vinjusha N., ZGCVN190; Kannur district, Mattanur, Poongottukavu, on dead branch (unidentified), 12 September 2019, Vinjusha N., ZGCVN713.

Comments: Based on the descriptions of Ryvarden & Johansen (1980), Ryvarden & Gilbertson (1993), and Núñez & Ryvarden (2001), present specimen is placed as *F. tenuiculus*. According to (Núñez & Ryvarden 2001), *Favolus tenuiculus* shows great variations in morphology. In tropical and subtropical South America, *F. tenuiculus* producing pure white, tessellate basidiocarps were compatible with bright golden yellow, radially striated basidicarps (Núñez & Ryvarden 2001).

The species has a pantropical distribution (Núñez & Ryvarden (1995, 2001). *Favolus tenuiculus* has been reported from Kerala by Sankaran & Florence (1995), Florence & Yesodharan (2000), Leelavathy & Ganesh (2000) and Mohanan (2011). Sankaran & Florence (1995) and Leelavathy & Ganesh (2000) reported the species as *Favolus brasilienis* (Fr.) Fr.

Favolus grammocephalus (Berk.) Imazeki, Bull. Tokyo Sci. Mus. 6: 95 (1943)

Basionym: *Polyporus grammocephalus* Berk., London J. Bot. 1 (3): 148 (1842)
Synonyms:
Favolus multiplex Lév., Annls Sci. Nat., Bot., sér. 3 2: 203 (1844)
Favolus tener Lév., Annls Sci. Nat., Bot., sér. 3 2: 202 (1844)
Polyporus vibecinus Fr., K. svenska Vetensk-Akad. Handl., ser. 3: 6 (1848)
Polyporellus vibecinus (Fr.) P. Karst., Meddn Soc. Fauna Flora fenn. 5: 38 (1879)
Polyporellus grammocephalus (Berk.) P. Karst., Meddn Soc. Fauna Flora fenn. 15: 38 (1889)
Leucoporus vibecinus (Fr.) Pat., Essai Tax. Hyménomyc. (Lons-le-Saunier): 82 (1900)
Leucoporus grammocephalus (Berk.) Pat., Philipp. J. Sci., C, Bot. 10 (2): 89 (1915)
Polystictus vibecinus (Fr.) Lloyd, Mycol. Writ. 5 (Letter 49): 698 (1917)
Polystictus grammocephalus (Berk.) S. Ito & S. Imai, Trans. Sapporo nat. Hist. Soc. 16: 121 (1940)
Tyromyces grammocephalus (Berk.) G. Cunn., Bull. N.Z. Dept. Sci. Industr. Res. 164: 135 (1965)
Polyporus multiplex (Lév.) Corner, Beih. Nova Hedwigia 78: 65 (1984)
Coriolopsis vibecina (Fr.) Teng, Chung-kuo Ti Chen-chun, [Fungi of China]: 760 (1963)

Microporus libum (Berk.) Kuntze, Revis. gen. pl. (Leipzig) 3 (3): 496 (1898)
Polyporus grammocephalus var. *poris-minoribus* Berk. & Cooke [as *'poris minoribus'*], J. Linn. Soc., Bot. 15: 377 (1876)

FIGURE 68

Basidiomata annual, medium sized, solitary or in clusters, sometimes adjacent fruit bodies get fused, forming compound structures, coriaceous when fresh, tough on drying, solitary, or in clusters, substipitate to stipitate. **Pileus** 25–130 mm long, 2–5 mm thick, laterally or eccentrically stipitate, flabelliform, or sometimes weakly infundibuliform, applanate or centrally umblicate when infundibuliform, radially striated, concentrically zonations absent, glabrous, bright orangish yellow to brownish orange, brown towards attachment portion in many fruit bodies, mostly pale ochre on drying, margin even or wavy to highly lobed, thin, incurved on drying. **Hymenophore** poroid. **Pores** 4–6 per mm, angular, often radially elongated and becoming large in mature fruit bodies, especially near the centre and becoming less elongated towards margin, slightly deccurent on stipe, pore surface dull white to light yellow, pore tubes 1–1.5 mm long, concolorous with pore surface. **Context** 1–2 mm thick, white, homogenous. **Stipe** 4–9 mm long, up to 4 mm wide, lateral to eccentric, cylindrical, almost even, expanding towards base, minutely pubescent to glabrous, concolorous with pileus surface, tissue white, solid. **Odour** not distinctive. **Spore print** not observed.

Basidiospores 6–8 × 2–3 µm, Q=2.6–3, Q_m=2.8, cylindric ellipsoid, thin walled, hyaline, smooth, inamyloid in Melzers reagent. **Basidia** 12–18 × 4–6 µm, broadly clavate, 2–4 sterigmate. **Hymenial trama** dimitic and interwoven. Generative hyphae 1.5–3 µm wide, septate, thin walled, hyaline, clamped, branched, granular contents present. Skeletal hyphae 2–5 µm wide, hyaline, sometimes very pale coloured, thick walled (1 µm), branched, septations not observed, mostly solid and with narrow lumen. **Pileal trama** interwoven. Generative hyphae 1–3.5 µm wide, septate, thin walled, hyaline, clamped, branched, granular contents present. Skeletal hyphae 2–5 µm wide, hyaline, thick walled (1 µm), branched, sepatations not observed. **Pileipellis** an irregular cutis composed of thin to slightly thick walled, hyaline, weakly septate hyphae, 2–3 µm wide. **Stipe trama** interwoven. Generative hyphae similar as in pileus region, 1–3.5 µm wide, septate, thin walled, hyaline, clamped, branched, granular contents present. Skeletal hyphae 2–5 µm wide, hyaline, thick walled (1 µm), branched, sepatations not observed. **Stipitipellis** more or less a cutis with scattered small trichodermal patches, hyphae 2–4 µm wide, hyaline to pale coloured, slightly thick to thick walled. Cystidia not observed in any tissues of the fruit body.

Specimens examined: India: Kerala State: Kozhikode district, Pantheerankavu, Kariyathan Kottam, on dead wood (unidentified), Arun Kumar T. K., ZGCVN87; Pokkunnu, ZG College campus, on dead branch (unidentified), 29 July 2015, Vinjusha N., ZGCVN97; ZGCVN99, Edakkara, Vallikkatukavu, on dead log, 01 August 2015, Vinjusha N., ZGCVN102, ZGCVN103, ZGCVN104, ZGCVN111, ZGCVN119; Kakkayam forest, on dead branch (unidentified), 29 September 2015, Vinjusha N., ZGCVN155; Chelavoor, Thurayil Kotta, on dead branch (unidentified), 27 September 2015, Vinjusha N., ZGCVN217; Peruvannamuzhy forest, on dead branch (unidentified), 11 August 2016, Vinjusha N., ZGCVN404; on dead branch (unidentified), 24 June 2017, Vinjusha N., ZGCVN514; Koyilandy, Poyilkavu, on dead branch (unidentified), 23 June 2017, Vinjusha N., ZGCVN505; Kuttyadi, Janaki forest, on dead log (unidentified), 02 October 2018, Vinjusha N., ZGCVN725; on dead log (unidentified), 19 July 2017, Vinjusha N., ZGCVN588; on dead tree trunk (unidentified), 02 October 2018, Vinjusha N., ZGCVN725; Thusharagiri, on dead branch (unidentified), 28 August 2017, Vinjusha N., VN624; Thottilpalam, on dead branch (unidentified), 27 August 2019, Salna N., ZGCVN898; Kannur district, Neeliyar Kottom, on dead log (unidentified), 15 July 2016, Vinjusha N., ZGCVN359; Thrissur district, Peechi, on dead log (unidentified), 25 June 2017, Vinjusha N., ZGCVN537; Alappuzha district, Mavelikkara, Vallikkavu, on dead log (unidentified), 19 December 2018, ZGCVN799; Kottayam district, Kurinji Kavu, on dead branch (unidentified), 18 December 2018, Vinjusha N., VN801.

Comments: The closer species *Polyporus philippinensis* Berk. is differentiated by having larger pores (1–3 per mm, as per the description of Corner 1984). *Favolus grammocephalus* has a tropical and subtropical distribution (Núñez & Ryvarden 1995; Núñez, & Ryvarden 2001). From Kerala, *P. grammocephalus* has been widely documented by Sankaran & Florence (1995), Florence & Yesodharan (1997), Florence & Yesodharan (2000), Iqbal *et al.* (2016), and Adarsh *et al.* (2018).

Polyporus P. Micheli *ex* Adans.

Basidiomata annual, mostly centrally stipitate. Pileus smooth to scaly, squamulose or finely tomentose, light to dark brown or around purplish in colour. Hymenophore poroid, pores round to angular, small to large, pore surface white to cream. Context white. Stipe glabrous to finely tomentose, cream, light to deep brown or even blackish in colour, smooth or longitudinally wrinkled, with or without a cuticle, or crusted at the base, some species with underground sclerotium. Hyphal system consist of hyaline, thin walled generative hyphae, clamp connections, and hyaline, arboriformly branched skeleto ligative hyphae. Cystidia absent. Basidia clavate, 4 sterigmate. Basidiospores cylindrical, straight to slightly curved, hyaline, smooth, thin walled, inamyloid in Melzer's reagent. Members of the genus cause white rot on wood.

Polyporus dictyopus Mont., Annls Sci. Nat., Bot., sér. 2 3: 349 (1835)

Synonyms:
Polyporus rhizomorphus Mont., Annls Sci. Nat., Bot., sér. 2 13: 202 (1840)
Polyporus versiformis Berk., Hooker's J. Bot. Kew Gard. Misc. 6: 137 (1854)
Fomes rhizomorphus (Mont.) Cooke, Grevillea 13 (no. 68): 117 (1885)
Polystictus xerophyllus (Berk.) Cooke, Grevillea 14 (no. 71): 78 (1886)
Scindalma rhizomorphum (Mont.) Kuntze, Revis. gen. pl. (Leipzig) 3 (3): 519 (1898)
Microporus xerophyllus (Berk.) Kuntze, Revis. gen. pl. (Leipzig) 3 (3): 497 (1898)
Melanopus dictyopus (Mont.) Pat., Essai Tax. Hyménomyc. (Lons-le-Saunier): 80 (1900)
Melanopus infernalis (Berk.) Pat., Essai Tax. Hyménomyc. (Lons-le-Saunier): 80 (1900)
Microporus mollis Pat., Bull. Soc. mycol. Fr. 25 (1): 4 (1909)
Polystictus mollis (Pat.) Sacc. & Trotter, Syll. fung. (Abellini) 21: 308 (1912)
Mensularia vernicosa Lázaro Ibiza, Revta R. Acad. Cienc. exact. fis. nat. Madr. 14 (11): 740 (1916)
Fomes vernicosus (Lázaro Ibiza) Sacc. & Trotter, Syll. fung. (Abellini) 23: 398 (1925)
Microporellus burkillae (Lloyd) Corner [as 'burkillii'], Beih. Nova Hedwigia 86: 100 (1987)
Microporellus burkillae var. *griseiporus* Corner, Beih. Nova Hedwigia 86: 105 (1987)
Polyporus hypomelanus sensu Cunningham; fide Buchanan & Ryvarden (2000)
Neodictyopus dictyopus (Mont.) Palacio, Robledo & Drechsler-Santos, in Palacio, Robledo, Reck, Grassi, Góes-Neto & Drechsler-Santos, PLoS ONE 12(10): e0186183, 17 (2017)

FIGURE 69

Basidiomata annual, medium sized, 30–46 mm high, stipitate, tough, light in weight. Pileus 38–48 mm in diameter, flabelliform, glabrous, shiny, laccate, concentric zonations absent, wrinkled on drying, reddish brown to brownish black, becoming darker on drying, blacker towards the stipe, margin slightly wavy. **Hymenophore** poroid. **Pores** 8–11 per mm, round to angular, absent along margin, sharply limited towards the stipe, cream, turning light brown, pore tubes 1 mm long, non- stratified, cream. **Context** up to 1 mm thick, cream. **Stipe** 12 mm long, 4–8 mm thick, cylindrical, dark brown, black on drying, glabrous, flesh cream, solid, with a flat disc like base. **Odour** not distinct. **Spore print** not observed.

Basidiospores 5–6 × 2–3 µm, Q=2.6–5.3, Q_m=3.47, cylindrical, smooth, thin walled, guttulate, inamyloid in Melzer's reagent. **Basidia** not observed. **Hymenial trama** interwoven. Generative hyphae 2–3 µm wide, hyaline, smooth, thin walled, branched, with clamp connections. Skeleto ligative hyphae 2–4 µm wide, hyaline, thick walled (1 µm), branched, branchings of *Bovista* type, septations not observed. **Pileal trama** interwoven. Generative hyphae sparsely observed, 2–3 µm wide, hyaline, smooth, thin walled, branched, with clamp connections. Skeleto ligative hyphae 2–5 µm wide, hyaline, thick walled (1 µm), branched, branchings of *Bovista* type, septations not observed. **Pileipellis** an agglutinated cutis, made of hyphae that are 2–4 µm wide, yellowish brown to brown, thick walled. **Stipe** trama interwoven and dimitic. Generative hyphae sparsely observed; 2–3 µm wide, hyaline, smooth, thin walled, branched, with clamp connections. Skeleto ligative hyphae 2–5 µm wide, hyaline, thick walled (1 µm), branched, branchings of *Bovista* type, septations not observed. **Stipitipellis** similar as pileipellis, composed of agglutinated cutis, with hyphae 2–4 µm wide, yellowish brown to brown, thick walled.

Specimens examined: India. Kerala State: Kozhikode district, Kakkayam Dam areas, ZGCVN142, Vinjusha N., 29 August 2015; Thrissur district, Peechi, on dead branch (unidentified), 26 June 2017, Vinjusha N., ZGCVN533.

Comments: Morphology of the present specimens agrees with the taxonomic descriptions of *P. dictyopus* by Ryvarden & Johansen (1980), Corner (1983), Núñez & Ryvarden (1995), Leelavathy & Ganesh (2000), Ryvarden & Melo (2014).

Present collection shows similarity with *Picipes melanopus* (Pers.) Zmitr. & Kovalenko in having laterally stipitate basidiocarps with blackish brown pileus and stipe. However, it differs in having larger basidiospores (7–10 × 3–4 µm). As per the description of *Polyporus dicopytus* (Núñez & Ryvarden 2001), the size of basidiospores is 6–8.5 × 2.5–4 µm. However, the basidiospores of the present collection are slightly shorter basidiospores (5.3–6.3 µm).

Polyporus dictyopus has a pantropical distribution (Núñez & Ryvarden 1995). From Kerala, this species has been documented by Florence & Yesodharan (1997, 2000), Leelavathy & Ganesh (2000), and Mohanan (2011) and Iqbal *et al.* (2016).

Polyporus leprieurii Mont., Annls Sci. Nat., Bot., sér. 2 13: 203 (1840)

Synonyms:

Polyporus tephromelas Mont., Annls Sci. Nat., Bot., sér. 2 13: 203 (1840)
Polystictus leprieurii (Mont.) Fr., Nova Acta R. Soc. Scient. upsal., Ser. 3 1 (1): 71 (1851)
Polyporus hemicapnodes Berk. & Broome, J. Linn. Soc., Bot. 14 (no. 73): 47 (1873)
Polyporus hemicapnodes var. *dimorphus* Cooke, Grevillea 13 (no. 65): 1 (1884)
Polyporus calyculus Pat. & Gaillard, Bull. Soc. mycol. Fr. 4 (1): 32 (1888)
Polyporus savoyanus Pat., Revue mycol., Toulouse 13 (no. 51): 136 (1891)
Melanopus calyculus (Pat. & Gaillard) Pat., Essai Tax. Hyménomyc. (Lons-le-Saunier): 80 (1900)
Melanopus leprieurii (Mont.) Pat., Essai Tax. Hyménomyc. (Lons-le-Saunier): 80 (1900)
Polyporus atripes Rostr., Bot. Tidsskr. 24: 359 (1902)
Polyporus pusillus Rostr., Bot. Tidsskr. 24: 359 (1902)
Polystictus pusillus (Rostr.) Sacc. & D. Sacc., Syll. fung. (Abellini) 17: 126 (1905)
Polyporus subelegans Murrill, N. Amer. Fl. (New York) 9 (1): 62 (1907)
Polyporellus hemicapnodes (Berk. & Broome) Imazeki, Bull. Gov. Forest Exp. Stn Tokyo 57: 115 (1952)

FIGURE 70

Basidiomata annual**,** small to medium sized, 28–48 mm tall, solitary to imbricate, coriaceous when fresh, hard when dry, stipitate. **Pileus** 30–70 mm wide, 1–3 mm thick, semicircular to flabelliform, applanate, radially striated, glabrous, with minute tubercles, concentrically zonations absent, narrowly wrinkled towards attachment region, straw coloured to ochraceous yellow, brownish black towards stipe, margin even, thin and papery, incurved on drying. **Hymenophore** poroid. Pores 4–6 per mm, angular, absent along margin, slightly elongated towards stipe, pore surface surface pale to greyish brown, pore tube 1 mm long, concolorous with pore surface. **Context** up to 3 mm thick, cream, homogenous. **Stipe** 10–12 mm long, 2–5 mm thick, lateral, bilaterally flattened, broadened towards base, glabrous, brownish black, tissue cream, solid. **Odour** not distinctive. **Spore print** not observed.

Basidiospores 5–7 × 2–2.5 µm, Q=2–2 µm, Q_m= 2.63 µm, cylindrical to subcylindrical, thin walled, hyaline, smooth, eguttulate, inamyloid in Melzer's reagent. **Basidia** 10–27 × 4–5 µm, clavate, 4 sterigmate. **Cystidia** absent. **Hymenial trama** interwoven. Generative hyphae 1.5–3 µm wide, hyaline, smooth, thin walled, branched, with clamp connections. Skeleto ligative hyphae frequent; 2–4 µm wide, hyaline, smooth, thick walled (1 µm), mostly without lumen, highly branched, branchings of *Bovista* type, septations not observed. **Pileal trama** interwoven. Generative hyphae 2–3 µm wide, hyaline, smooth, thin walled, branched, with clamp connections. Skeleto ligative hyphae 2–5 µm wide, hyaline to pale yellow, smooth, thick walled (1 µm), highly branched, branching of *Bovista* type, septations not observed, lumen absent. **Pileipellis** an agglutinated, irregular cutis composed of hyphae that are 2–3 µm wide, thin to slightly thick walled, hyaline, weakly septate, with obtuse ends. **Stipe trama** interwoven. Generative hyphae 2–3 µm wide, hyaline, smooth, thin walled, branched, with clamp connections. Skeleto ligative hyphae 2–5 µm wide, hyaline to pale yellow, smooth, thick walled (1 µm), highly branched, branchings of *Bovista* type, septations not observed. **Stipitipellis** consisting of layer of clavate to cylindrical cells, 4–7 µm wide, light to dark brown, thick walled (1 µm), with obtuse ends.

Specimen examined: India. Kerala State: Malappuram district, Calicut University Botanical Garden, on decayed branch of *Ficus benghalensis*, 15 September 2015, Vinjusha N., ZGCVN187.

Comments: Present collection shows similarity with *Polyporus guianensis* Mont., however the latter possesses larger pores (1–2 per mm) and lacks palisade cells on the stipe (Núñez & Ryvarden 2001). The specimen also resembles *Favolus grammocephalus* in morphology, but the latter lacks the black stipe and the dark brown palisade cells on stipitipellis.

Polyporus leprieurii has tropical to subtropical distribution (Núñez & Ryvarden 2001). From Kerala, this species has been reported by Leelavathy & Ganesh (2000), Mohanan (2011) and Adarsh *et al.* (2018).

Cellulariella Zmitr. & Malysheva

Basidiomata annual to perennial, hard and woody, pileate. Pileus sessile, semicircular, applanate, concentrically zonate, even to radially wrinkled, cream, yellowish brown to brown. Hymenophore partly poroid, daedaloid to lamellate, white to cream. Context white to tan, homogenous. Hyphal system dimitic to trimitic, generative hyphae hyaline, thin walled, with clamp connections. Skeletal hyphae hyaline to pale yellow, thick walled. Skeleto ligative hyphae hyaline, thick walled. Cystidia absent, but pseudocystidia formed as sword like endings of skeletal hyphae. Basidia clavate, 4 sterigmate. Basidiospores cylindrical, hyaline, smooth, thin walled, inamyloid in Melzer's reagent. Members of the genus cause white rot on wood.

Cellulariella acuta (Berk.) Zmitr. & Malysheva, Index Fungorum 180: 1 (2014)

Basionym: *Lenzites acutus* Berk., London J. Bot. 1 (3): 146 (1842)
Synonyms
Lenzites acutus Berk., London J. Bot. 1 (3): 146 (1842)
Cellularia acuta (Berk.) Kuntze, Revis. gen. pl. (Leipzig) 3 (3): 451 (1898)
Trametes acuta (Berk.) Imazeki, Bull. Tokyo Sci. Mus. 6: 73 (1943)
Cellulariella acuta (Berk.) Zmitr. & Malysheva, Mikol. Fitopatol. 47 (6): 376 (2013)
Artolenzites acutus (Berk.) Mossebo & Ambit [as '*acuta*'], Mycosphere 6 (3): 282 (2015)
Artolenzites acutus (Berk.) Mossebo & Ambit, *Index Fungorum* 268: 1 (2015)

FIGURE 71

Basidiomata annual, medium to large sized, solitary or in clusters, hard and woody, light in weight, pileate. **Pileus** 20–150 mm long, 6–60 mm thick, sessile, broadly attached, semicircular, concentrically zonate, sometimes radially wrinkled, minutely pubescent when young, glabrous when mature, yellowish brown to dark brown, with alternating shades of cream, which fades on drying, white to cream along margin, margin round, even to wavy. **Hymenophore** sub poroid to daedaleoid or lamellate, lamellae usually bifurcate, surface creamish white, brown on bruising. **Context** 1–2 mm thick, cream to pale yellowish, homogenous. **Odour** not distinct. **Spore print** not observed.

Basidiospores 6–7.5 × 2.5–3.5 µm, Q=2.4–3, Q_m=2.7, cylindrical, hyaline, smooth, thin walled, guttulate, inamyloid in Melzer's reagent. **Basidia** 20–36 × 4–5 µm, clavate, 4 sterigmate. **Cystidia** absent. **Hyphal pegs** not observed. **Hymenial trama** interwoven and dimitic. Generative hyphae 2–3 µm wide, hyaline, smooth, thin to thick walled (1 µm), branched, with clamp connections. Skeletal hyphae 2–9 µm wide, hyaline to pale yellow, smooth, thick walled (1–2 µm), unbranched, septations not observed. Skeleto ligative hyphae 2–4 µm wide, hyaline, smooth, thick walled (1 µm), mostly solid, highly branched, septations not observed. Tips of skeleto ligative hyphae projects into hymenium as sword like ends. **Pileal trama** interwoven and dimitic. Generative hyphae 2–3 µm wide, hyaline, smooth, thin to thick walled (1 µm), branched, with clamp connections. Skeletal hyphae 2–9 µm wide, hyaline to pale yellow, smooth, thick walled (1–2 µm), unbranched, septations not observed. Skeleto ligative hyphae 2–5 µm wide, hyaline, smooth, thick walled (1 µm), mostly solid, highly branched, septations not observed. **Pileipellis** a trichodermium composed of hyphae that are 2–4 µm wide, hyaline to pale yellow, slightly thick to thick walled, with obtuse ends.

Specimens examined: India. Kerala State: Kozhikode district, Chalappuram, Kaloor road, on *Bambusa* species, 06 July 2015 Vinjusha N, ZGCVN14, ZGCVN14a, Thiruvannur, on dead *Cocos nucifera*, 16 July 2015, Vinjusha N., ZGCVN56; Eranjipalam, near Sarovaram Biopark, on dead branch (unidentified), 20 July 2015, Vinjusha N., ZGCVN63, ZGCVN67; Pokkunnu, ZG College campus, on dead branch (unidentified), 28 July 2015, Vinjusha N., ZGCVN98; Chungam, on dead wood (unidentified), 13 August 2015, Vinjusha N., ZGCVN128; Kakkayam, on dead wood (unidentified), 29 August 2015, ZGCVN143; Kakkodi, Edakkara, Vallikkattukavu, on dead wood (unidentified), 15 August 2015, Vinjusha N., ZGCVN131, Chelannur, on dead wood (unidentified), 06 September 2015, Vinjusha N, ZGCVN175; Koyilandy, Muchikunnu Kavu, on dead branch (unidentified), 04 October 2015, Vinjusha N, ZGCVN223; Peruvannamuzhy forest, on dead wood stump (unidentified), 11 August 2016, Vinjusha N., ZGCVN420; Vadakara, Madapally college campus, on dead tree log (unidentified), 01 August 2017, Vinjusha N., ZGCVN605; Kannur district, Puliakurumba, on dead branch, 15

January 2018, ZGCVN668; Neeliyarkottam, on dead branch, 15 July 2016, Vinjusha N., ZGCVN68; Thrissur district, Peechi Dam areas, on dead wood (unidentified), 20 October 2017, Vinjusha N., ZGCVN638, ZGCVN639, ZGCVN645; Malappuram district, Calicut University campus, on dead branch, 17 June 2016, Vinjusha N., ZGCVN269, ZGCVN330; Nilamur, KFRI campus, 17 November 2017, on dead wood of *Sweitenia mahagoni*, Vinjusha N., ZGCVN476; Wayanad district, Muthanga, on dead *Bambusa* species, 27 July 2016, Vinjusha N., ZGCVN386, ZGCVN392; Palakkad district, Aryambavu, on dead *Cocos nucifera*, 11 November 2015, Abhijith S., ZGCVN263; Kottayam district, Vagamon, Peruvanantham, on dead log (unidentified), 24 October 2015, Vinjusha N., ZGCVN248; Idukki, Vattavada, on dead wood (unidentified), 28 July 2019, Vinjusha N., ZGCVN891.

Comments: Chraracters of the present collections were properly matching with the earlier descriptions of the species by Ryvarden & Johansen (1980), Ryvarden & Gilbertson (1993), and Núñez & Ryvarden (2001).

The genus *Cellulariella* consists of only two species, *C. acuta* and *C. warnieri* (Durieu & Mont.) Zmitr. & Malysheva. *Cellulariella warnieri* produces slightly larger basidiospores than *C. acuta* (Niemelä & Uotila 1977). The hymenium of *C. acuta* shows extreme variations as poroid, daedaleoid or lamellate. Sometimes all the three hymenial types exists in a single basidiocarp (Ambit & Mossebo 2015).

Cellulariella acuta is mainly an Asian species (Ambit & Mossebo 2015), but also recorded from Africa (Ryvarden & Johansen 1980), North America (Ryvarden & Gilbertson 1993) and Australia (Núñez & Ryvarden 2001). From Kerala, the species has been reported (as *Lenzites acutus* Berk) by Sankaran & Florence (1995), Florence & Yesodharan (1997, 2000) and Leelavathy & Ganesh (2000).

Earliella Murrill

Basidiomata annual to perennial, effused relaxed to pileate basidiomata, often with a broad decurrent base. Pileus sessile, flabelliform to semicircular, applanate to uneven, concentrically zonate, usually radially wrinkled, crusty, glabrous, dark brown to violet brown. Hymenophore poroid, pores round to ovoid, sometimes oblique towards the base, pore surface white to cream, pore tubes concolorous with pore surface. Context white to cream, homogenous. Hyphal system dimitic, generative hyphae hyaline, thin walled, branched, with clamp connections. Skeletal hyphae hyaline to pale brown, weakly branched, thick walled. Skeleto ligative hyphae hyaline, unbranched, mostly thick walled (1 µm). Cystidia absent. Basidia clavate, 4 sterigmate. Basidiospores ellipsoid to cylindrical, hyaline, acyanophilous, inamyloid in Melzer's reagent. Members of the genus cause white rot on wood.

Earliella scabrosa (Pers.) Gilb. & Ryvarden, Mycotaxon 22 (2): 364 (1985)

Basionym: *Polyporus scabrosus* Pers., in Gaudichaud-Beaupré in Freycinet, Voy. Uranie., Bot. (Paris) 4: 172 (1827) [1826-1830]
Synonyms:
Polyporus fuscobadius Pers., in Gaudichaud-Beaupré in Freycinet, Voy. Uranie., Bot. (Paris) 4: 172 (1827)
Daedalea sanguinea Klotzsch, Linnaea 8 (4): 481 (1833)
Polyporus persoonii Mont., Voy. Indes Or., Bot. 2 (Cryptog.): 147 (1834)
Fomes scabrosus (Pers.) Fr., Grevillea 14 (no. 69): 17 (1885)
Polystictus persoonii (Mont.) Cooke, Grevillea 14 (no. 71): 85 (1886)
Trametes sanguinea (Klotzsch) Pat., Ann. Jard. Bot. Buitenzorg, suppl. 1: 110 (1897)
Scindalma scabrosum (Pers.) Kuntze, Revis. gen. pl. (Leipzig) 3 (3): 519 (1898)
Microporus persoonii (Mont.) Kuntze, Revis. gen. pl. (Leipzig) 3 (3): 497 (1898)
Earliella corrugata (Pers.) Murrill, Bull. Torrey bot. Club 34: 468 (1907)
Trametes persoonii (Mont.) Pat., Bull. Soc. mycol. Fr. 23: 80 (1907)
Trametes corrugata (Pers.) Bres., Hedwigia 51 (4): 316 (1912)
Fomitopsis corrugata (Pers.) Imazeki, Bull. Tokyo Sci. Mus. 6: 92 (1943)
Coriolus corrugatus (Pers.) G. Cunn., Proc. Linn. Soc. N.S.W. 75 (3-4): 222 (1950)
Pelloporus scabrosus (Pers.) Bondartsev, Botanicheskie Materialy 14: 199 (1961)
Trametes scabrosa (Pers.) G. Cunn., Bull. N.Z. Dept. Sci. Industr. Res. 164: 162 (1965)
Ischnoderma scabrosum (Pers.) Zmitr. [as '*scabrosa*'], Mycena 1 (1): 93 (2001)

FIGURE 72

Basidiomata annual, small to medium sized, coriaceous when young, hard and tough when mature, more rigid when dry, light in weight, effuso reflexed to pileate, sometimes adjacent fruit bodies get fused to form large compound basidiome, up to 230 mm long. **Pileus** 13–80 mm long, 2–6 mm thick, sessile or broadly attached, flabelliform to semicircular, sometimes dimidiate, applanate to uneven, concentrically zonate, zonations not so prominent in young fruit bodies, radially wrinkled, crusty, glabrous, laccate in many, dark brown to violet brown, sometimes wth greyish or greenish tints, often cream along margin, margin entire to lobed, round. **Hymenophore** mostly poroid, sometimes irregular and irpicoid, especially at the effused part. Pores 2–3 per mm, round to ovoid, rarely angular, absent towards margin, cream, pore tubes 1–2 mm long, concolorous with pore surface. **Context** 2–3 mm thick, homogenous, white to cream. **Odour** not distinct. **Spore print** not observed.

Basidiospores 7–8 × 2.5–4 µm, Q=2.3–2.8, Q_m=2.5, cylindrical to oblong ellipsoid, hyaline, smooth, thin walled, eguttulate, inamyloid in Melzer's reagent. **Basidia** not observed. Irregular crystals present in hymenium. **Hymenial trama** interwoven and trimitic. Generative hyphae 2–3 µm wide, hyaline, smooth, thin walled, branched, with clamp connections. Skeletal hyphae 3–4 µm wide, hyaline, pale brown in mass, thick walled (1 µm), weakly branched, septations infrequent. Skeleto ligative hyphae 2–3 µm, hyaline, mostly thick walled (1 µm), unbranched, septations not observed. **Pileal trama** interwoven. Generative hyphae 2–4 µm wide, septate, hyaline, smooth, thin walled, branched, with clamp connections. Skeletal hyphae 3–5 µm wide, hyaline to pale brown, thick walled (1 µm), weakly branched, septations infrequent. Skeleto ligative hyphae 2–3 µm, hyaline, unbranched, septations not observed, thick walled (1 µm). **Pileipellis** an irregular cutis made of hyaline to very pale brown, slightly thick walled hyphae with obtuse ends; hyphae 2–4 µm wide.

Specimens examined: India. Kerala State: Kozhikode district, Edakkara, Vallikkattukavu, on fallen twig of *Myristica fragrans*, 11 July 2015, Vinjusha N.; ZGCVN43; Eranjipalam, Sarovaram Biopark, on dead wood stump (unidentified), 20 July 2015, Vinjusha N., ZGCVN65; Chelavoor, Thurayil Kotta, on dead logs (unidentified), 27 September 2015, Vinjusha N., ZGCVN213, ZGCVN215; Chelapram, on dead stump of *Albizia lebbeck*, 23 October 2015, Vinjusha N., ZGCVN240; Palazhi, Bhayankavu, on dead wood of *Cocos nucifera*, 27 December 2015, Vinjusha N., ZGCVN276; Marad, on dead branch (unidentified), 3 January 2016, Athira C. K., ZGCVN283; Pantheerankavu, Kariyathan Kottom, on dead log (unidentified), 12 July 2016, Vinjusha N, ZGCVN349; Koyilandy, Poyil Kavu, on fallen tree trunk (unidentified), 16 July 2016, Vinjusha N., ZGCVN376; Puthiyangadi, on dead log (unidentified), 20 July 2016, Arun Kumar T.K., ZGCVN381; Peruvannamuzhy forest, on dead wood logs (unidentified), 11 August 2016, Vinjusha N., ZGCVN410, ZGCVN411, ZGCVN413, ZGCVN426, ZGCVN434; 24 June 2017, Vinjusha N., on dead wood of *Swietenia mahagoni*, 24 June 2017, Vinjusha N., ZGCVN530; Koyilandy, Poyilkavu, on dead log (unidentified), 23 June 2017, Vinjusha N., ZGCVN509; ZGCVN516; Vadakara, Madapally college campus, on fallen tree trunk (unidentified), 01 August 2017, Vinjusha N., ZGCVN606; Wayanad district, Thirunelli, on dead branch (unidentified), 22 February 2016, Vinjusha N. ZGCVN316; Malappuram district, Nilambur, KFRI campus, on dead wood of *Swietenia mahagoni*, 17 November 2016, Vinjusha N., ZGCVN465; on dead wood of *Swietenia mahagoni,* 17 November 2016, Vinjusha N., ZGCVN470; Ernakulam district, Iringole Kavu, on dead log, 08 July 2017, Vinjusha N., ZGCVN561; Alappuzha district, Vallikkavu, on dead log (unidentified), 19 December 2018, Vinjusha N., ZGCVN796.

Comments: *Earliella* is a monotypic genus, having only single species, *E. scabrosa*. Basidiocarps with reddish cuticle, and hymenium with large, irregular, elongated sinuous pores are the major diagnostic characters of this species (Gilbertson & Ryvarden 1986). *Earliella scabrosa* has pantropical distribution (Ryvarden & Johansen 1980; Corner 1989). From Kerala, the species has been reported by Leelavathy & Ganesh (2000), Mohanan (2011), Iqbal *et al*. (2016) and Adarsh *et al*. (2018).

Coriolopsis Murrill

Basidiomata annual, usually clustered and imbricate, coriaceous to moderately hard, resupinate to pileate. Pileus semicircular, applanate, concentrically zonate, sometimes zonations not distinct, velutinate to hirsute or glabrous, yellowish to umber brown. Hymenophore poroid to irpicoid, pores angular, pore surface concolorous with pileus, pore tubes paler than pore surface. Context golden to umber brown, homogenous. Hyphal system trimitic, with hyaline, thin walled generative hyphae, having clamp connections, hyaline to golden brown coloured skeletal hyphae, and hyaline to pale coloured skeleto ligative hyphae. Cystidia absent. Basidia clavate, with 4 sterigmata. Basidiospores cylindrical to ellipsoid in shape, thin walled, and inamyloid in Melzer's reagent. Members cause white rot on wood.

Coriolopsis caperata (Berk.) (Berk.) Murrill, N. Amer. Fl. (New York) 9 (2): 77 (1908)

Basionym: *Polyporus caperatus* Berk., Ann. nat. Hist., Mag. Zool. Bot. Geol. 3: 391 (1839)
Synonyms:
Microporus caperatus (Berk.) Kuntze, Revis. gen. pl. (Leipzig) 3 (3): 495 (1898)
Coriolus caperatus (Berk.) Murrill, N. Amer. Fl. (New York) 9 (2): 77 (1908)
Polystictus caperatus (Berk.) P.W. Graff, Nova Acta R. Soc. Scient. upsal., Ser. 4 3: 391 (1921)
Trametes caperata (Berk.) Teixeira, Bragantia 6 (7): 316 (1946)
Hexagonia caperata (Berk.) J.E. Wright & J.R. Deschamps, Revta Investnes agrop., Sér. 5: 1431 (1973)
Datronia caperata (Berk.) Ryvarden, Mycotaxon 23: 172 (1985)
Cerrena caperata (Berk.) Zmitr., Mycena 1 (1): 91 (2001)
Trametella caperata (Berk.) M. Pieri & B. Rivoire, Bull. Soc. mycol. Fr. 123 (1): 62 (2008)
Funalia caperata (Berk.) Zmitr. & Malysheva, Mikol. Fitopatol. 47 (6): 375 (2013)

FIGURE 73

Basidiomata annual, small to medium sized, found in clusters, hard and woody, light in weight, pileate. **Pileus** 35–50 mm long, 40–50 mm thick, sessile to dimidiate, often fused and imbricate, semicircular, applanate to slightly convex, concentrically zonate, sulcate, hirsute to tomentose, hairs lesser along sulcations, cinnamon brown to deep chocolate brown, cream along margin, margin even, round. **Hymenophore** poroid. **Pores** 3–4 per mm, round to angular, dull white, later turning pale brown on bruising, pore tube up to 2 mm long, weakly lacerate in some collections, brown. Context 2–3 mm thick, brown, separated from above tomentum by a distinct black line, especially towards the base. **Odour** not distinctive. **Spore print** not observed.

Basidiospores 7–9 × 2–3 µm, Q=3.5–4, Q_m=3.88, cylindrical, hyaline, guttulate, thin walled, smooth, inamyloid in Melzer' s reagent. **Basidia** not observed. Cystidia and other sterile structures absent. Hymenial trama interwoven. Generative hyphae 2–3 µm wide, hyaline to golden yellow, moderately branched to twisted, thin to thick walled (1 µm), with clamp connections. Skeletal hyphae dominant in the fruit body, 3–6 µm wide, golden brown to dark brown, thick walled (up to 1.5 µm), unbranched, sepatations not observed. Skeleto ligative hyphae 1–3 µm wide, golden brown, thick walled (1 µm), arboriformly branched, septations not observed. **Pileal trama** interwoven. Generative hyphae 2–3 µm wide, mostly hyaline, branched, thin to thick walled (1 µm), with clamp connections. Skeletal hyphae dominant in the fruit body, 3-6 µm wide, golden brown to dark brown, thick walled (up to 1.5 µm), unbranched, sepatations not observed or weakly septate. Skeleto ligative hyphae 1–4 µm wide, golden yellow, thick walled (1 µm), arboriformly branched as in hymenium. **Pileipellis** made of long and thick trichodermal patches made of hyphae that are 2–5 µm wide, hyaline to light brown, almost thick walled (1 µm), with slightly tapering ends.

Specimens examined: India. Kerala State: Idukki district, Anamudi, on dead wood stump (unidentified), 18 February 2018, Manju A. C., ZGCVN679.

Comments: Characters of the present specimen properly match with the taxonomic description of *Coriolopsis caperata* by Ryvarden & Johansen (1980). Our Kerala collection resembles species of *Trametes* in morphology, however, the latter always produced hyaline skeletal hyphae. According to the *Index Fungorum* database (accessed on 02 September 2020), *C. caperata* has been currently recognized under genus *Cerrena* Gray (as *Cerrena caperata* (Berk.) Zmitr.). However, species of *Cerrena* produces hyaline to yellowish skeletal hyphae (Núñez & Ryvarden 2001), while species of *Coriolopsis* produces subhyaline to deep golden brown coloured skeletal hyphae and skeleto ligative hyphae (Ryvarden & Johansen 1980; Ryvarden & Gilbertson 1993; Núñez & Ryvarden 2001; Justo & Hibbett 2011). Present Kerala collection produces golden brown to dark brown skeletal hyphae, which is a characteristics of the genus *Coriolopsis*, and not *Cerrena*. So, here the present collection is treated under *Coriolopsis*, as *Coriolopsis caperata*.

Coriolopsis caperata has its distribution in Africa, America, Brazil, French Antilles, French Guiana, India, Mauritius, Mexico, Philippines and Sri Lanka (Leelavathy & Ganesh 2000). This species has been reported from Kerala by Leelavathy & Ganesh (2000) and Adarsh *et al.* (2018).

Coriolopsis telfairii (Klotzsch) Ryvarden [as '*telfarii*'], Norw. Jl Bot. 19 (3-4): 230 (1972)

Basionym: *Polyporus telfairii* Klotzsch, Linnaea 8(4): 484 (1833)
Synonyms:
Polyporus zeylanicus Berk., Ann. Mag. nat. Hist., Ser. 1 10: 377 (1843)
Polystictus zeylanicus (Berk.) Fr., Nova Acta R. Soc. Scient. upsal., Ser. 3 1 (1): 91 (1851)
Trametes cristata Cooke, Grevillea 10 (no. 56): 132 (1882)
Polystictus cristatus (Cooke) Cooke, Grevillea 14 (no. 71): 81 (1886)
Hexagonia dybowskii Pat., Bull. Soc. mycol. Fr. 8 (2): 54 (1892)
Microporus zeylanicus (Berk.) Kuntze, Revis. gen. pl. (Leipzig) 3 (3): 497 (1898)
Microporus cristatus (Cooke) Kuntze, Revis. gen. pl. (Leipzig) 3 (3): 495 (1898)
Scenidium dybowskii (Pat.) Kuntze, Revis. gen. pl. (Leipzig) 3 (3): 516 (1898)
Polystictus dybowskii (Pat.) Lloyd, Mycol. Writ. 3 (Syn. *Polystictus*): 65 (1910)
Hexagonia expallida Bres., Annls mycol. 9 (3): 270 (1911)
Trametes telfairii (Klotzsch) Corner [as '*telfarii*'], Beih. Nova Hedwigia 97: 167 (1989)
Funalia telfairii (Klotzsch) A. David & Rajchenb. [as '*telfarii*'], Mycotaxon 45: 146 (1992)
Coriolopsis zeylanica (Berk.) A. Roy & A.B. De, Polyporaceae of India (Dehra Dun): 52 (1996)
Trametella telfairii (Klotzsch) M. Pieri & B. Rivoire [as '*telfarii*'], Bull. Soc. mycol. Fr. 123 (1): 62 (2008)

FIGURE 74

Basidiomata annual, small to medium sized, usually clustered and imbricate, almost coriaceous when fresh, hard and woody when dry, light in weight, resupinate to effused reflexed or pileate. **Pileus** 32–75 mm long, 30–50 mm thick, sessile or laterally attached with a distinct region of attachment, semicircular, applanate to convex, concentric zonations not distinct, but faint zonations present especially towards margin, radially striated and wrinkled, hispid to densly hirsute, ochraceous, margin thin, entire to wavy, sometimes slightly serrate. **Hymenophore** poroid to irpicoid. Pores large, usually 1 per mm, angular, becoming obliquely elongated or irpicoid, straw coloured or pale orangish brown, pore tubes 1–3 mm long, concolorous with pore surface, but usually lighter. **Context** up to 2 mm thick, cream, homogenous. **Odour** not distinct. **Spore print** not observed.

Basidiospores 8–10 × 2.5–3 µm, Q=3–4, Q_m=3.3, cylindrical, usually curved, hyaline, smooth, thin walled, eguttulate, inamyloid in Melzer's reagent. **Basidia** 12–23 × 4–5 µm, clavate, 4 sterigmate. **Cystidia** absent. **Hymenial trama** interwoven. Generative hyphae 2–3 µm wide, septate, hyaline, smooth, mostly flexuose, thin walled, branched, with clamp connections. Skeletal hyphae 3–6 µm wide, hyaline, smooth, thick walled (1 µm), unbranched, septations not observed. Skeleto ligative hyphae 1–3 µm wide, not frequent, hyaline, smooth, thick walled (1 µm), highly branched, septations not observed, lumen absent. **Pileal trama** interwoven. Generative hyphae 2–4 µm wide, septate, hyaline, smooth, mostly flexuose, thin walled, smooth, branched, with clamp connections. Skeletal hyphae 2–6.5 µm wide, hyaline, smooth, thick walled (1 µm), unbranched, septations not observed. Skeleto ligative hyphae 1–3 µm wide, hyaline, smooth, thick walled (1 µm), highly branched, septations not observed, lumen absent. **Pileipellis** interwoven at base and forming trichodermial patches, more than 100 µm long, made of hyphae that are 2–4 µm wide, hyaline, thin to thick walled, with obtuse ends.

Specimens examined: India. Kerala State: Wayanad district, Chembra Peak, on dead wood (unidentified), 16 November 2018, Vinjusha N., ZGCVN755; Kuttyadi, Janaki Forest, on dead log (unidentified), 02 October 2018, Vinjusha N., ZGCVN727; Kollam district, Thenmala, on dead branch (unidentified), 23 September 2019, Vinjusha N., ZGCVN910.

Comments: Characters of the present specimen properly match with the descriptions of *C. telfarii* by Ryvarden & Johansen (1980), Corner (1989) and Núñez & Ryvarden (1995, 2001). According to Ryvarden & Johansen (1980), pileus surface of *C. telfarii* possess antler like dichotomous hairs in fresh condition, which gradually disappears on drying. Present collection lacks antler like dichotomous branches on their pileus surface. *Coriolopsis telfarii* is a paleotropical species (Núñez & Ryvarden 2001). In East Asia, this species is known from China, Northern Thailand, Vietnam, Far East Russia, and Taiwan.

From Kerala, *C. telfarii* has been described by Leelavathy & Ganesh (2000).

Coriolopsis occidentalis (Klotzsch) Murrill, Bull. Torrey bot. Club 32 (7): 358 (1905)

Basionym: *Polyporus occidentalis* Klotzsch, Linnaea 8(4): 486 (1833)
Synonyms:
Polystictus occidentalis (Klotzsch) Sacc., Syll. fung. (Abellini) 6: 274 (1888)
Microporus occidentalis (Klotzsch) Kuntze, Revis. gen. pl. (Leipzig) 3(3): 496 (1898)
Coriolus occidentalis (Klotzsch) G. Cunn., Proc. Linn. Soc. N.S.W. 75(3-4): 233 (1950)

Cerrena occidentalis (Klotzsch) Zmitr., Mycena 1(1): 91 (2001)
Polystictus occidentalis var. daedaliformis Eichelb., Verh. Naturwiss. Vereins Hamburg, ser. 3 14: 54 (1906)
Polystictus occidentalis var. *lanatus* Lloyd, Mycol. Writ. 4 (Letter 39): 2 (1912)

FIGURE 75

Basidiomata annual, small to medium sized, solitary, almost coriaceous when fresh, hard on drying, light in weight, pileate. **Pileus** 30–40 mm long, 2-4 mm thick, laterally attached with a distinct region of attachment, semicircular, applanate, concentrically zonate, weakly sulcate, adpressed tomentose, lesser along sulcations, coffee brown to dark brown, black in KOH, margin even to lobed, slightly acute. **Hymenophore** poroid. **Pores** 4–5 per mm, round, absent along margin, greyish brown to brown, pore tubes 1 mm long, dark brown. **Context** 2–3 mm thick, brown, homogenous. **Odour** not distinct. **Spore print** not observed.

Basidiospores 5–9 × 2.5–3.5 µm, Q=2.2–2.5, Q_m=2.35, subcylindrical, hyaline, smooth, thin walled, mostly eguttulate, rarely monoguttulate, inamyloid in Melzer's reagent. **Basidia** 10–20 × 5–7 µm, clavate, 4 sterigmate. **Hymenial trama** interwoven. Generative hyphae rarely observed, 2–4 µm wide, hyaline, thin walled, branched, with clamp connections. Skeletal hyphae predominant, 3–7 µm wide, in some regions widened up to 10 µm, light yellowish brown, dark brown in KOH, mostly flexuose, unbranched, thick walled (1 µm), septations not observed. Skeleto ligative hyphae very rarely observed, 2–3 µm wide, hyaline to pale yellowish brown, thick walled, without lumen, branched, branches short. **Pileal trama** interwoven. Generative hyphae more frequent than in hymenium, 2–5 µm wide, hyaline, thin walled, branched, with clamp connections. Skeletal hyphae mostly wider than those present in hymenium, 3–11 µm wide, light yellowish brown, mostly flexuose, unbranched, thick walled (1 µm), septations not observed. Skeleto ligative hyphae rarely observed, 2–3.5 µm wide, hyaline to pale yellowish brown, thick walled, branches short. **Pileipellis** basically a cutis, forming ascending, erect trichodermium made of hypahe that are up to 6 µm wide, pale brown to brown, thick walled, with obtuse ends.

Specimen examined: India. Kerala State: Thrissur district, Peechi, on fallen *Tectonia grandis*, Chandini V. K., 08 August 2017, VN614.

Comments: Morphology of our collection agrees with the taxonomic descriptions of *Coriolopsis occidentalis* by Roy & De (1996), and Mohanan (2011). According to Roy & De (1996), *C. occidentalis* produces cylindrical basidiospores that are 4.5–7 × 2–2.5 µm. When compared to this, present Kerala collection produces slightly larger basidiospores. Mohanan (2011), However, present Kerala collection produces more brownish skeletal hyphae, and

Kerala collection resembles species of *Daedaleopsis* Schroet., *Datronia* Donk, and *Hexagonia*, *Nigrofomes* Murrill, *Nigroporus* Murrill in Fr. in having coloured hyphae. According to the the taxonomic descriptions (Ryvarden & Gilbertson 1993; Núñez & Ryvarden 2001), species of *Daedaleopsis* possesses lamellate to tubular hymenophore, and dendrohyphidia in hymenium. However, present Kerala collection lacks dendrohyphidia. Presence of cylindrical basidiospores in species of *Datronia* and *Hexagonia* distinguishes them from our collection (according to the description of Núñez & Ryvarden 2001). *Nigroporus* species always produces glabrous pileus, with a vinaceous brown to pink or violet shades, and smaller basidiospores, that are up to 5 µm long (Núñez & Ryvarden 2001). The present collection produces adpressed tomentose pileus, without vinaceous shades, and basidiospores are larger. Absence of clamp connections distinguishes species of *Nigrofomes* (according to the description of Núñez & Ryvarden 2001) from the present collection.

Coriolopsis occidentalis has distribution in India (Ranadive 2013). The species has been previously recorded from Kerala by Mohanan (2011).

Pilatotrama Zmitr.

Basidiomata annual to perennial, solitary or in clusters, hard and woody, effused reflexed to pileate. Pileus sessile to dimidiate, semicircular to flabelliform, azonate or weakly zonate, glabrous, white, ochraceous to brown. Hymenophore poroid, pores angular, pore surface cream. Context white to cream, tough. Hyphal system dimitic, with hyaline, clamped generative hyphae, and hyaline, thick walled, skeletal hyphae. Cystidia absent. Basidia clavate, having basal clamp connections. Basidiospores oblong ellipsoid, lacrymoid or cylindrical, hyaline, thin walled, inamyloid in Melzer's reagent. Member's causes white rot on wood.

Pilatotrama ljubarskyi (Pilát) Zmitrovich, Folia Cryptogamica Petropolitana (Sankt-Peterburg) 6: 80 (2018)

Basionym: *Trametes ljubarskyi* Pilát, Bull. trimest. Soc. mycol. Fr. 52 (3): 309 (1937)
Synonyms:
Haploporus ljubarskyi (Pilát) Bondartsev & Singer ex Bondartsev, Trut. Grib Evrop. Chasti SSSR Kavkaza [Bracket Fungi Europ. U.S.S.R. Caucasus] (Moscow-Leningrad): 523 (1953)
Haploporus ljubarskyi f. conifer Bondartsev, Trut. Grib Evrop. Chasti SSSR Kavkaza [Bracket Fungi Europ. U.S.S.R. Caucasus] (Moscow-Leningrad): 524 (1953)
Haploporus ljubarskyi f. opacus Bondartsev, Trut. Grib Evrop. Chasti SSSR Kavkaza [Bracket Fungi Europ. U.S.S.R. Caucasus] (Moscow-Leningrad): 524 (1953)

FIGURE 76

Basidiomata annual, small to medium sized, hard and tough, bone hard when dry, light in weight, pileate. **Pileus** 35–45 mm long, 2–5 mm thick, sessile, laterally attached, flabelliform to semicircular, sometimes dimidiate, applanate, concentrically zonate, narrowly sulcate, glabrous, cream, yellow along margin, margin entire to wavy, obtuse. **Hymenophore** poroid. Pores 6–7 per mm, angular, cream, turning light brown with age, pore tubes 1–2.5 mm long, concolorous with pore surface. **Context** up to 2 mm thick, homogenous, cream to pale yellow. **Odour** not distinct. **Spore print** not observed.

Basidiospores 4–5 × 2.5–3 µm, Q=1.3–2 µm, Q_m=1.65 µm, ellipsoid to broadly ellipsoid, hyaline, smooth, thin walled, eguttulate, inamyloid in Melzer's reagent. **Basidia** not observed. Irregular crystals present in hymenium. **Hymenial trama** interwoven. Generative hyphae 1.5–2.5 µm wide, septate, hyaline, smooth, thin walled, branched, with clamp connections. Skeletal hyphae 2–3 µm wide, hyaline, thick-walled (1µm), weakly branched, septations not observed. Skeleto ligative hyphae not observed. **Pileal trama** interwoven. Generative hyphae not frequent, 2–3 µm wide, septate, hyaline, smooth, thin walled branched, with clamp connections. Skeletal hyphae 2–6 µm wide, hyaline, more thick walled than those present in hymenium (1–1.5 µm), weakly branched, septations infrequent. Skeleto ligative hyphae not observed. **Pileipellis** an irregular cutis made of hyphae that are 2–4 µm wide, hyaline, thin to slightly thick walled hyphae with obtuse end.

Specimen examined: India. Kerala State: Idukki district, Chinnar, on dead wood (unidentified), 26 October 2015, Vinjusha N., ZGCVN249.

Comments: Characters of the present specimen properly match with the descriptions of *P. ljubarskyi* by Ryvarden & Gilbertson (1994) and Núñez & Ryvarden (2001) (as *Trametes ljubarskyi* Pilát). Present specimen resembled *Ranadivia modesta* (Kunze *ex* Fr.) Zmitr. and *T. menziezii* (Berk.) Ryvarden in morphology. However, the latter two species posseses trimitic hyphal system with skeleto ligative hyphae and narrower basidiospores.

BLAST search using the ITS sequences of the present collection also resulted in 100% identity with *P. ljubarskyi* (GenBank numbers: KP715547). The search result also showed 97% similarity with a sequence accession of *Trametes cingulata* (KC589133). However, the latter can be morphologically distinguished from the present specimen by trimitic hyphal system and slightly larger basidispores (5–6.5 × 3.5–4 µm, according to description of Ryvarden & Johansen 1980).

P. ljubarskyi has distribution in Far East Russia, China and North Thailand. This species has been documented from India by Rajput *et al.* (2015) and Gudikandula *et al.* (2017). So far, *P. ljubarskyi* has not been reported from Kerala.

Neofomitella Y.C. Dai, Hai J. Li & Vlasák

Basidiomata annual to perennial, solitary to imbricate, hard and woody, effused reflexed to pileate. Pileus often with concentric zonations or sulcations, glabrous to velutinate, creamish white to yellowish brown, fuscous to almost black. Hymenophore poroid, pores round to angular, pore surface white, cream to pale buff, pore tubes concolorous with pore surface. Context buff to yellowish brown or pale grey. Hyphal system trimitic, generative hyphae hyaline, thin to thick walled, with clamp connections. Skeletal hyphae and skeleto ligative hyphae hyaline, and thick walled. Cystidia absent. Basidiospores oblong ellipsoid to cylindrical, hyaline, thin walled, smooth basidiospores, inamyloid in Melzer's reagent. Species causes white rot on wood.

Neofomitella guangxiensis B.K. Cui & Xing Ji, in Ji, Wu, Song, Liu, Si & Cui, Mycol. Progr. 18 (4): 599 (2019)

FIGURE 77

Basidiomata annual, small to medium sized, usually in clusters, soft and coriaceous when fresh**,** becoming harder on drying, light in weight, effused reflexed. **Pileus** 20–35 mm long, 3–5 mm thick, sessile, circular to irregular, covering the host, applanate, concentric zonations absent, irregularly wrinkled, glabrous, creamish white, light brown on bruising, more brownish in KOH, margin even to slightly wavy. **Hymenophore** poroid. **Pores** 4–6 per mm, round, slightly angular, oblique towards attachment region, cream, turning light brown on bruising, pore tubes up to 3 mm long, concolourous with pore surface. **Context** 1.5–2 mm thick, creamish white, homogenous. **Odour** not distinctive. **Spore print** not observed.

Basidiospores 5.5–8 × 2–2.5 µm, Q=2.6–4, Q_m=3.36, cylindrical, hyaline, smooth, thin walled, sometimes monoguttulate, inamyloid in Melzer's reagent. **Basidia** not observed. **Cystidia** absent. **Hymenial trama** interwoven and trimitic. Generative hyphae 2–4 µm wide, hyaline, smooth, thin to slightly thick walled, branched, with clamp connections. Skeletal hyphae 2–4.5 µm wide, hyaline, weakly dextrinoid in Melzer's reagent, thick walled, unbranched, septations not observed, (up to 1µm). Skeleto ligative hyphae 1.5–2 µm wide, hyaline, weakly dextrinoid in Melzer's reagent, thick walled (up to 1 µm), highly branched, branches short, septations not observed. **Pileal trama** interwoven. Generative hyphae 2–4 µm wide, hyaline, smooth, thin to slightly thick walled, branched, with clamp connections. Skeletal hyphae 2–5 µm wide, hyaline, weakly dextrinoid in Melzer's reagent, thick walled, unbranched, septations not observed, (up to 1µm). Skeleto ligative hyphae 1.5–2 µm wide, hyaline, weakly dextrinoid in Melzer's reagent, thick walled (up to 1µm), highly branched than in hymenial trama, septations not observed, **Pileipellis** interwoven at base and forming an irregular cutis made of hyphae that are 2–3 µm wide, hyaline, slightly thick to thick walled.

Specimen examined: India. Kerala State: Kannur district, Madayi Kavu, on dead branch (unidentified), 07 July 2018 Vinjusha N, ZGCVN689.

Comments: Morphology of the present specimen agrees well with the original description of *N. guangxiensis* by Ji *et al.* (2019). According to Ji *et al.* (2019), pileus of *N. guangxiensis* possesses concentric sulcations, and hymenium produces fusoid cystidioles. The present collection lacks concentric zonations and sulcations on pileus, and fusoid cystidioles were not observed. Present collection resembles *N. fumosipora* in morphology, however the latter produces smaller pores (7–9 per mm) and smaller basidiospores (3–4 × 1.7–2.2 µm), as per the descriptions of Hattori (2005) and Li *et al*. (2014) respectively. The similar species *N. rhodophaea* is separated from the present specimen by having oblong ellipsoid basidiospores and smaller pores (according to description of Ji *et al.* 2019).

BLAST search using the ITS sequence generated from the study showed 100% identity with *N. guangxiensis* (GenBank number: MK192435). BLAST result also showed 99% similarity with *Trametes cotonea* (Pat. & Har.) Ryvarden (GenBank number MH861271). *Trametes cotonea* is morphologically separated from the present collection by slightly larger basidiospores (7–11×2.5–3.5 µm, Ryvarden & Johansen 1980). Moreover, hyphae of *T. cotonea* never show dextrinoid reaction in Melzer's reagent, whereas, skeletal and skeleto ligative hyphae of present specimen were weakly dextrinoid.

In the phylogenetic tree (Figure 136), present collection settled together with accessions of *N. guanxiensis* (voucher numbers: Cui 14029, Cui 13968; GenBnk numbers: MK192437, MK192434) from China, with 95% bootstrap support.

So far, *N. guangxiensis* has been recorded only from its type locality, China. Therefore present study forms the first report of the species outside its type locality.

Neofomitella fumosipora (Corner) Y.C. Dai, Hai J. Li & Vlasák, in Li, Li, Vlasák & Dai, Mycotaxon 129 (1): 12 (2015)

Basionym: *Trametes fumosipora* Corner, Beih. Nova Hedwigia 97: 106 (1989)
Synonym:
Fomitella fumosipora (Corner) T. Hatt., Mycoscience 46 (5): 309 (2005)

FIGURE 78

Basidiomata annual, medium sized, solitary or in imbricate clusters, hard and woody, light in weight on drying, pileate. **Pileus** 30–60 mm long, 3–15 mm thick, sessile, mostly broadly attached, semicircular, applanate, concentrically zonate, weaky sulcate, glabrous, yellowish brown with alternating dark brownish bands, white to cream along margin, margin even, round. **Hymenophore** poroid. **Pores** 9–11 per mm, round, regular, absent along margin, surface dull white to cream, light brown on bruising, pore tubes up to 2–3 mm long, light brown. **Context** 4–6 mm thick, cream, pale brown to brown, homogenous. **Odour** not distinctive. **Spore print** not observed.

Basidiospores 2.5–3×1.5–2 µm, Q=1.5–2.5, Q_m=1.7, broadly ellipsoid to ovoid, hyaline, smooth, thin walled, eguttulate, inamyloid in Melzer's reagent. **Basidia** not observed. **Cystidia** absent. **Hymenial trama** interwoven, trimitic, with scattered crystals. Generative hyphae difficult to observe, 2–3 µm wide, hyaline, smooth, thin walled, branched, with clamp connections. Skeletal hyphae predominant, 2–5 µm, hyaline, smooth, thick walled (2 µm), unbranched, very rarely septate. Skeleto ligative hyphae also frequent; 2–3 µm wide, hyaline, smooth, thick walled (1 µm) or solid, branched, septations not observed. **Pileal trama** interwoven. Generative hyphae rarely observed, 2–3 µm wide, hyaline, smooth, thin walled, branched, with clamp connections. Skeletal hyphae 2–5 µm, hyaline, smooth, thick walled (2 µm), unbranched, very rarely septate. Skeleto ligative hyphae 2–3 µm wide, hyaline, smooth, thick walled (1 µm) or solid, branched, branches short and stout, septations not observed. **Pileipellis** interwoven and agglutinated, composed of hyphae that are 2–4 µm wide, hyaline, thick walled and mostly solid.

Specimens examined: India. Kerala State: Kozhikode district, Peruvannamuzhy forest, on fallen *Swietenia macrophylla*, 26 July 2019, Vinjusha N., ZGCVN864.

Comments: *Neofomitella fumosipora* shows high similarity with *N. rhodophaea* (Lév.) Y.C. Dai, Hai J. Li & Vlasák. Basidiospores of *N. rhodophaea* is slightly wider (2.5–3 µm) than *N. fumosipora* (1.7–2 µm) (Li *et al.* 2014). Another distinguishing character that separates *N. fumosipora* from *N. rhodophaea* is their smaller basidiocarps (usually not exceeding 10 cm long), and dark coloured pileus and pore tubes (Hattori 2005). BLAST search using the ITS sequence generated from the specimen resulted in 98% identity with *N. fumosipora* (GenBank number KC867373). The BLAST search result also showed 97% similarity with *N. rhodophaea* (EU232216). Another species, *Funalia sanguinaria* (Klotzsch) Zmitr. & Malysheva also shows 97% sequence similarity with the present collection (FJ627251). However, *F. sanguinaria* is morphologically separated from the present specimen by their golden yellow to brown coloured skeletal hyphae and longer basidiospores (4–5.5 µm).

Neofomitella fumosipora has been reported only from Malaysia (Corner 1989; Hattori 2005) and China (Li *et al*. 2014) so far.

Neofomitella rhodophaea (Lév.) Y.C. Dai, Hai J. Li & Vlasák, in Li, Li, Vlasák & Dai, Mycotaxon 129 (1): 15 (2015)

Basionym: *Polyporus rhodophaeus* Lév., Annls Sci. Nat., Bot., sér. 3 2: 190 (1844)
Synonyms:
Fomes rhodophaeus (Lév.) Cooke, Grevillea 14 (no. 69): 18 (1885)
Fomitopsis rhodophaea (Lév.) Imazeki, Bull. Tokyo Sci. Mus. 6: 92 (1943)
Rigidoporus rhodophaeus (Lév.) Imazeki, Bull. Gov. Forest Exp. Stn Tokyo 57: 118 (1952)
Trametes rhodophaea (Lév.) Corner, Beih. Nova Hedwigia 97: 139 (1989)
Fomitella rhodophaea (Lév.) T. Hatt., Mycoscience 46 (5): 305 (2005)
Polyporus zonalis var. *semilaccatus* Berk., J. Linn. Soc., Bot. 16 (no. 89): 46 (1878)
Fomes semilaccatus (Berk.) Cooke, Grevillea 14 (no. 69): 21 (1885)
Polyporus semilaccatus (Berk.) Berk., Grevillea 15 (no. 73): 22 (1886)
Scindalma semilaccatum (Berk.) Kuntze, Revis. gen. pl. (Leipzig) 3 (3): 519 (1898)
Coriolopsis semilaccata (Berk.) Murrill, Bull. Torrey bot. Club 34: 466 (1907)
Fomitopsis semilaccata (Berk.) S. Ito [as 'semilaccatus'], Mycol. Fl. Japan 2 (4): 305 (1955)
Polyporus aurora Ces., Atti Accad. Sci. fis. mat. Napoli 8 (no. 3): 5 (1879)
Trametes aurora (Ces.) Sacc., Syll. fung. (Abellini) 6: 353 (1888)
Daedalea aurora (Ces.) Aoshima, Trans. Mycol. Soc. Japan 8 (1): 2 (1967)
Fomes roseoporus Pat. [as 'roseiporus'], Ann. Jard. Bot. Buitenzorg, suppl. 1: 111 (1897)
Fomes luzonensis Murrill, Bull. Torrey bot. Club 34: 476 (1907)
Trametes conglobata Murrill, Bull. Torrey bot. Club 35: 404 (1908)
Polyporus superniger Lloyd, Mycol. Writ. 6 (Letter 65): 1038 (1920)

FIGURE 79

Basidiomata annual, small to medium sized, often found in clusters, moderately hard when fresh, light in weight, becoming born hard on drying, effused reflexed to pileate. **Pileus** 26–65 mm long, 4–7 mm thick, sessile, mostly broadly attached with an effused base, sometimes imbricate, semicircular, applanate to slightly convex, weakly zonate, glabrous, light brown to greyish brown or dirty brown, cream towards margin, margin even, round, slightly incurved on drying. **Hymenophore** poroid. **Pores** 7–9 per mm, round to ovoid, absent along margin, surface greyish white to pale brown, more brownish towards margin, pore tubes up to 2–4 mm long, concolourous with pore surface, sometimes with a very pale pinkish tint. **Context** 5–6 mm thick, dull white, homogenous. **Odour** not distinctive. **Spore print** not observed.

Basidiospores 3.5–5 × 2–3 µm, Q=1.6–2, Q_m=1.7, ellipsoid, hyaline, smooth, thin walled, eguttulate, inamyloid in Melzer's reagent. **Basidia** not observed. **Cystidia** absent. **Hymenial trama** interwoven and trimtic. Generative hyphae 1.5–2 µm wide, hyaline, smooth, thin walled, branched, clamp connections frequent. Skeletal hyphae 2–5 µm, hyaline, smooth, thick walled (1µm), sparsely branched, septations not observed. Skeleto ligative hyphae not frequent; 2–3 µm wide, hyaline, smooth, thick walled (1 µm), mostly solid, branched, septations not observed. **Pileal trama** interwoven. Generative hyphae 1.5–2 µm wide, hyaline, smooth, thin walled, branched, with clamp connections. Skeletal hyphae 2–5 µm, hyaline, smooth, thick walled (1µm), sparsely branched, septations not observed. Skeleto ligative hyphae frequent than in hymenial trama, 2–3 µm wide, hyaline, smooth, thick walled (1 µm), mostly solid, branched, septations not observed. **Pileipellis** composed of hyphae that are slightly interwoven at the base to form a trichodermium, agglutinated at tip, with brown coloured deposits, hyphae 2-4 µm wide, hyaline, slightly thick to thick walled, with obtuse ends.

Specimen examined: India. Kerala State: Kozhikode district, Chelavoor, Thurayil Kavu, on dead wood (unidentified), 03 September 2018, Vinjusha N., ZGCVN707.

Comments: *Noefomitella rhodophaea* shows high similarity with *Neofomitella fumosipora*, however produces slightly wider (2.5–3 µm) basidiospores than *N.*

fumosipora (1.7–2 µm) (according to description of Li *et al.* 2014). *Neofomitella fumosipora* produces smaller basidiocarps (usually not exceeding 10 cm long), than *rhodophaea* (Ji *et al*. 2019). The similar species *N. guangxiensis* is separated from the present specimen by having cylindrical basidiospores and larger pores (Ji *et al.* 2019).

Neofomitella rhodophaea has tropical to subtropical distribution (Núñez & Ryvarden 2001). Records on the species from Kerala were made by Sankaran & Florence (1995), Florence & Yesodharan (1997, 2000), Leelavathy & Ganesh (2000), Mohanan (2011), and Adarsh *et al.* (2018).

Leiotrametes Welti & Courtec.

Basidiomata annual to perennial, often coriaceous pseuodostipitate, sometimes with discoid base, pileate. Pileus mostly semicircular, concentrically zonate, glabrous, cream to brownish. Hymenophore poroid to labyrinthine, surface cream to light brown. Context buff coloured. Hyphal system trimitic, generative hyphae hyaline, thin walled, with clamp connections. Skeletal hyphae hyaline to pale yellow coloured, with a brown resinous material in the lumen at the pileipellis. Cystidia absent. Basidiospores cylindrical, hyaline, smooth, thin walled basidiospores, inamyloid in Melzer's reagent. Species cause white rot on wood.

Leiotrametes menziesii (Berk.) Welti & Courtec., in Welti, Moreau, Favel, Courtecuisse, Haon, Navarro, Taussac & Lesage-Meessen, Fungal Diversity 55 (1): 60 (2012)

Basionym: *Polyporus menziesii* Berk., Ann. Mag. nat. Hist., Ser. 1 10: 378 (1843)
Synonyms:
Polyporus blumei Lév., Annls Sci. Nat., Bot., sér. 3 2: 185 (1844)
Polyporus murinus Lév., Annls Sci. Nat., Bot., sér. 3 2: 185 (1844)
Polyporus dilatatus Lév., Annls Sci. Nat., Bot., sér. 3 2: 184 (1844)
Polyporus gaudichaudii Lév., Annls Sci. Nat., Bot., sér. 3 2: 185 (1844)
Polystictus gaudichaudii (Lév.) Fr., Nova Acta R. Soc. Scient. upsal., Ser. 3 1 (1): 77 (1851)
Polystictus menziesii (Berk.) Fr., Nova Acta R. Soc. Scient. upsal., Ser. 3 1 (1): 74 (1851)
Polystictus blumei (Lév.) Cooke, Grevillea 14 (no. 71): 79 (1886)
Polystictus murinus Cooke, Grevillea 14 (no. 71): 79 (1886)
Trametes grisea Pat., J. Bot., Paris 11: 341 (1897)
Microporus menziesii (Berk.) Kuntze, Revis. gen. pl. (Leipzig) 3 (3): 496 (1898)
Microporus blumei (Lév.) Kuntze, Revis. gen. pl. (Leipzig) 3 (3): 495 (1898)
Microporus gaudichaudii (Lév.) Kuntze, Revis. gen. pl. (Leipzig) 3 (3): 496 (1898)

Spongipellis luzonensis Murrill, Bull. Torrey bot. Club 34: 473 (1907)
Polyporus luzonensis (Murrill) Sacc. & Trotter, Bull. Torrey bot. Club 34: 476 (1907)
Coriolus blumei (Lév.) G. Cunn., Proc. Linn. Soc. N.S.W. 75 (3-4): 219 (1950)
Trametes blumei (Lév.) G. Cunn., Bull. N.Z. Dept. Sci. Industr. Res. 164: 161 (1965)
Trametes menziesii (Berk.) Ryvarden [as '*menzeisii*'], Norw. Jl Bot. 19 (3-4): 236 (1972)
Coriolopsis luzonensis (Murrill) J.R. Sharma, Bull. bot. Surv. India 31 (1-4): 96 (1992)

FIGURE 80

Basidiomata annual, medium to large sized, coriaceous when fresh**,** light in weight, becoming harder and woody on drying, centrally to laterally stipitate. **Pileus** 40–100 mm wide, 2–30 mm thick, imbricate to laterally fused, either flabelliform or semicircular to circular, applanate to narrowly infundibuliform, concentrically zonate, glabrous to pubescent, radially wrinkled in some fruit bodies, dull white with alternating greyish black wider zones, margin white, entire to lobed, white mycelial pads present towards the attachment part, easily detachable by hand, near the stipe. **Hymenophore** poroid. **Pores** 2–3 per mm, angular to irregular, absent at the margin, creamish white, turning pale brown on bruising, pore tubes 1mm long and less. **Context** 1 mm thick, cream, homogenous. **Stipe** 80–250 mm long, lateral to centrally attached, cylindrical, base discoid, pubescent, white. **Odour** not distinctive. **Spore print** not observed.

Basidiospores 5–7 (8) × 2–3 µm, Q=2–4, Q_m=2.71, cylindric to subcylindric, hyaline, smooth, thin walled, with guttulate contents, inamyloid in Melzer’s reagent. **Basidia** not observed. **Cystidia** absent. **Hymenial trama** interwoven and trimitic. Generative hyphae 2–3 µm wide, hyaline, smooth, thin walled, branched, with clamp connections. Skeletal hyphae dominant, 2–7 µm wide, hyaline, thick walled (1 µm), unbranched, septations not observed. Skeleto ligative hyphae 2–4 µm wide, hyaline, thick walled (1 µm), highly branched, arboriform, septations not observed. **Pileal trama** interwoven. Generative hyphae sparsely observed, 2–3 µm wide, hyaline, smooth, thin walled, branched, with clamp connections. Skeletal hyphae 2–8 µm wide, hyaline, thick walled (1 µm), unbranched, septations not observed. Skeleto ligative hyphae 2–4 µm wide, hyaline, thick walled (1 µm), highly branched, arboriform, septations not observed. **Pileipellis** basically a cutis with short, erect to projecting hyphal elements with obtuse tips, hyphae 2–5 µm wide, hyaline, lumen with agglutinated brown resinous materials, thick walled. **Stipe trama** interwoven. Generative hyphae rare, 2–3 µm wide, hyaline, smooth, thin walled, branched, with clamp connections. Skeletal hyphae 2–7 µm wide, hyaline, thick walled (1 µm), unbranched, septations not observed. Skeleto ligative hyphae 2–4 µm wide, hyaline, thick walled (1 µm), highly branched, arboriform, septations not observed. **Stipitipellis** a cutis similar as pileipellis, made of hyphae that are 2–5 µm wide, hyaline, almost thick walled.

Specimens observed: India. Kerala State, Kozhikode district, Pokkunnu, on dead log (unidentified), 02 February 2015, Vinjusha N., ZGCVN28; Eranjipalam, near Sarovarm Biopark, on dead wood of *Cocos nucifera*, 20 July 2015, Vinjusha N., ZGCVN66; Kakkayam, on dead wood (un identified) Vinjusha N., ZGCVN146, Peruvannamuzhy forest, on fallen tree trunk of *Sweitenia mahagoni*, 11 August 2016, Vinjusha N., ZGCVN409, ZGCVN425; on dead log (unidentified), 24 June 2017, Vinjusha N., ZGCVN519; Meenchanda, on dead wood (unidentified), 12 July 2017, Vinjusha N., ZGCVN570; Palakkad district, Aryambavu, on live *Mangifera indica*, 18 August 2015, Abhijith S., ZGCVN129.

Comments: Present collection is similar to *Ranadivia modesta* (Kunze *ex* Fr.) Zmitr. in many morphological characters. According to Ryvarden & Johansen (1980), *R. modesta* (*Trametes modesta* (Kunze *ex* Fr.) Ryvarden) produces pinkish buff context that turns cherry red in KOH. However, present collection has cream context and shows no reaction in KOH.

Leiorametes menziesii has paleotropoical distribution, extending to south Australia (Núñez & Ryvarden 2001). From Kerala, *Leiorametes menziesii* has been recorded by Adarsh *et al.* (2018).

Trametes Fr.

Basidiomata annual to biennial, solitary or in clusters, hard and woody, effused reflex to pileate. Pileus sessile, dimidiate, semicircular to flabelliform, concentrically zonate, with or without sulcations, hispid, hirsute, tomenose to glabrous, creamish white, tan, ochraceous to yellowish brown, margin even. Hymenophore poroid, pores round to angular, pore surface white, cream to yellowish brown. Context white to cream, homogenous. Hyphal system trimitic, with hyaline, thin walled, generative hyphae having clamp connections, hyaline, thick walled, skeletal hyphae, and hyaline, thick walled skeleto ligative hyphae. Cystidia absent. Basidiospores ellipsoid to allantoid, smooth, thin walled, inamyloid in Melzer's reagent. *Trametes* causes white rot on wood.

Trametes apiaria (Pers.) Zmitr., Wasser & Ezhov, in Zmitrovich, Ezhov & Wasser, International Journal of Medicinal Mushrooms (Redding) 14 (3): 317 (2012)

Basionym: *Polyporus apiarius* Pers., in Gaudichaud-Beaupré in Freycinet, Voy. Uranie., Bot. (Paris) 4: 169 (1827)
Synonyms:
Hexagonia apiaria (Pers.) Fr., Epicr. syst. mycol. (Upsaliae): 497 (1838)
Hexagonia koenigii Berk., Ann. Mag. nat. Hist., Ser. 1 10: 379 (1843)
Scenidium apiarium (Pers.) Kuntze, Revis. gen. pl. (Leipzig) 3 (3): 516 (1898)
Hexagonia henschallii Lloyd, Mycol. Writ. 3: 11 (1910)
Hexagonia apiaria var. *wightii* Klotzsch, Hedwigia 33: 72 (1913)

FIGURE 81

Basidiomata annual, small to medium sized, solitary, hard, corky, light in weight, pileate. **Pileus** 100–180 mm long, 5–6 mm thick, sessile, some dimidiate, semicircular to flabelliform, applanate, radially ridged in some collections, concentrically zonate, sulcate, densely covered with long, simple to dichotomously branched hairs, hairs lesser along sulcations, dark cinnamon to black, margin even, acute. **Hymenophore** poroid. **Pores** large, single pore 2–5 mm wide (2–4 per cm), regular, hexagonal, brown, pore tubes up to 5 mm long, absent at the margin, concolourous with pore surface. **Context** 1 mm thick, brown, homogenous, black in KOH. **Odour** not distinctive. **Spore print** not observed.

Basidiospores 8–11 × 3–4 µm, Q=2.6–5.5, Q_m=3.75, cylindrical, hyaline, smooth, thin-walled, with guttulate contents, inamyloid in Melzer's reagent. **Basidia** not observed. **Cystidia** absent. **Hyphal pegs** present, conical, 25–68 µm wide, yellowish brown. **Hymenial trama** interwoven and trimitic. Generative hyphae very sparsely observed, 2–3 µm wide, hyaline, smooth, thin walled, branched, with clamp connections. Skeletal hyphae dominating, 2–6 µm, light brown, thick walled (1 µm), unbranched, weakly septate. Skeleto ligative hyphae 1–3 µm, yellow to pale brown, thick walled (up to 1 µm), mostly solid, branched. **Pileal trama** interwoven.

Generative hyphae rarely observed, 2–3 µm wide, hyaline, smooth, thin walled, branched, with clamp connections. Skeletal hyphae dominating, 2–7 µm wide, pale brown, thick walled (1 µm), unbranched, weakly septate. Skeleto ligative hyphae not frequent, 1–3 µm, yellow to pale brown, thick walled (up to 1 µm), lumen mostly absent. **Pileipellis** composed of long and thick trichodermal patches made of almost thick walled hyphae, 2–5 µm wide, light brown, with round ends.

Specimens examined: India. Kerala State: Kozhikode, Kakkayam, on dead wood (unidentified), 29 August 2015, Vinjusha N, ZGCVN151; Thrissur, Peechi, on dead log (unidentified), 12 December 2017, Chandini V. K., ZGCVN751.

Comments: *T. apiaria* is closely related to *Trametes hirta* (P. Beauv.) Fr., and is separated from the latter by smaller pores (3–7 per mm), and presence of cystidioid hyphae (Ryvarden & Johansen 1980). As per the taxonomic description of Ryvarden & Johansen (1980), basidiospore size of *T. apiaria* is 11–15 × 4.5–6 µm. Parmasto (1983a) describes spores of the species as (12.8) –13–15.5– (15.8) × (5.8) –6–7.5– (8) µm. According to Parmasto (1983), basidiospores of this species were not observed in many earlier studies such as that of Teng (1963), Cunningham (1965), and Ito (1955). Fidalgo (1968) had observed spores attached with basidia from one collection from Ceylon, and in some other collections, spores were obtained in between hairs of pileus. Basidiospores were not observed in the previous Kerala collection of this species (Mohanan 2011, reported as *Hexagonia apiaria* (Pers.) Fr.). In our collection, few basidiospores were obtained from in between hairs of pileus. However, the size of spores are much smaller (8–11 × 2–3 µm) than that in the available descriptions. It is supposed that the basidiospores of present Kerala collection may be immature. Most other characters place the species as *Trametes apiaria*. *Trametes apiaria* is known as an Asian species (Ryvarden & Johansen 1980).

Trametes gibbosa (Pers.) Fr., Epicr. syst. mycol. (Upsaliae): 492 (1838)

Basionym: *Merulius gibbosus* Pers., Ann. Bot. (Usteri) 15: 21 (1795)
Synonyms:
Boletus sinuosus Sowerby, Col. fig. Engl. Fung. Mushr. (London) 2 (no. 16): tab. 194 (1799)
Daedalea gibbosa (Pers.) Pers., Syn. meth. fung. (Göttingen) 2: 501 (1801)

Trametes crenulata Berk., Hooker's J. Bot. Kew Gard. Misc. 6: 164 (1854)
Trametes kalchbrenneri Fr., Mathem. Természettud. Közlem. 5: 264 (1867)
Polyporus gibbosus (Pers.) P. Kumm., Führ. Pilzk. (Zerbst): 59 (1871)
Polystictus kalchbrenneri (Fr.) Cooke, Grevillea 14 (no. 71): 77 (1886)
Bulliardia virescens Lázaro Ibiza, Revta R. Acad. Cienc. exact. fis. nat. Madr. 14 (12): 843 (1916)
Trametes nigrescens Lázaro Ibiza, Revta R. Acad. Cienc. exact. fis. nat. Madr. 14 (8): 523 (1916)
Daedalea virescens (Lázaro Ibiza) Sacc. & Trotter, Syll. fung. (Abellini) 23: 449 (1925)
Trametes gibbosa f. *amurensis* Pilát, Bull. trimest. Soc. mycol. Fr. 49 (3-4): 263 (1934)
Lenzites gibbosus (Pers.) Hemmi, Ann. phytopath. Soc. Japan 9: 12 (1939)
Trametes gibbosa f. *tenuis* Pilát, Atlas Champ. l'Europe, III, Polyporaceae (Praha) 1: 290 (1940)
Pseudotrametes gibbosa (Pers.) Bondartsev & Singer, in Singer, Mycologia 36 (1): 68 (1944)

FIGURE 82

Basidiomata annual, medium to large sized, coriaceous when fresh**,** light in weight, becoming harder and woody on drying, sessile or laterally stipitate. **Pileus** 35–100 mm long, 20–40 mm thick, solitary or imbricate to laterally fused, either flabelliform or semicircular, applanate, concentrically zonate, not sulcate, glabrous, radially wrinkled in some fruit bodies, dull white to pale ochre, or with light greyish zones, sometime with greenish shades due to presence of algae, margin white to light yellow, entire to weakly lobed, thin. **Hymenophore** poroid. **Pores** 1–3 per mm, angular, radially elongated, less elongated near the margin, creamish white, turning pale brown on bruising, pore tubes up to 1.5 mm long, concolourous with pore surface. **Context** 1 mm thick, cream, homogenous. **Stipe** up to 10 mm long and 4 mm wide, cylindrical, expanded at the base, glabrous, white. **Odour** not distinctive. **Spore print** not observed.

Basidiospores 4–5 × 1.5–2 µm, Q=2.2–3.3, Q_m=2.7, cylindrical, some spores slightly bent, hyaline, smooth, thin walled, inamyloid in Melzer's reagent. **Basidia** 10–15 × 4–6 µm, narrowly clavate to clavate, 4 sterigmate**. Cystidia** absent. **Hymenial trama** interwoven and trimitic. Generative hyphae 2–3 µm wide, hyaline, smooth, thin walled, branched, with clamp connections. Skeletal hyphae 3–7 µm wide, hyaline, thick walled (1 µm), unbranched, septations not observed. Skeleto ligative hyphae 2–3 µm wide, hyaline, thick walled (1 µm), highly branched, septations not observed. **Pileal trama** interwoven. Generative hyphae 2–4 µm wide, hyaline, smooth, thin walled, branched, with clamp connections. Skeletal hyphae 3–8 µm wide, hyaline, thick walled (1 µm), unbranched, septations not observed. Skeleto ligative hyphae 2–3 µm wide, hyaline, thick walled (1 µm), highly branched, arboriform, septations not observed. **Pileipellis** an irregular cutis made of slightly agglutinated hyphae that are 2–7 µm wide, hyaline, slightly thick to thick walled. **Stipe trama** interwoven. Generative hyphae 2–4 µm wide, hyaline, smooth, thin walled, branched, with clamp connections. Skeletal hyphae 2–7 µm wide, hyaline, thick walled (1 µm), unbranched, septations not observed. Skeleto ligative hyphae 2–3 µm wide, hyaline, thick walled (1 µm), highly branched, arboriform, septations not observed. **Stipitipellis** an agglutinated, irregular cutis similar as pileipellis, hyphae 2–6 µm wide, hyaline, slightly thick to thick walled.

Specimens examined: India. Kerala State: Kozhikode district, Chelannur, Kalarimala, on dead wood stump (unidentified), 06 September 2015, Vinjusha N, ZGCVN173, ZGCVN174, ZGCVN182; Kakkodi, Green world road, on rotten stump of *Cocos nucifera*, 15 September 2015, Vinjusha N., ZGCVN186.

Comments: Present collection resembles *Leiotrametes menziesii* in having similar basidiocarps with radially elongated pores. However, the latter possesses larger basidiospores (5–7 µm long) (Núñez & Ryvarden 2001). Present specimen also shows similarity with *Trametes glabrata* (Lloyd) Ryvarden, but the latter has more allantoid basidiospores (1–1.5 µm wide).

Trametes gibbosa has widespread distribution in Africa, Asia and Europe, but not known from North America (Ryvarden & Johansen 1980). So far, this species has not been reported from Kerala.

Trametes vernicipes (Berk.) Zmitr., Wasser & Ezhov, in Zmitrovich, Ezhov & Wasser, International Journal of Medicinal Mushrooms (Redding) 14 (3): 312 (2012)

Basionym: *Polyporus vernicipes* Berk., J. Linn. Soc., Bot. 16 (no. 89): 50 (1878)
Synonyms:
Polystictus vernicipes (Berk.) Cooke, Grevillea 14 (no. 71): 78 (1886)
Polystictus makuensis Cooke, Grevillea 16 (no. 78): [25] (1887)
Microporus makuensis (Cooke) Kuntze, Revis. gen. pl. (Leipzig) 3 (3): 496 (1898)
Microporus vernicipes (Berk.) Kuntze, Revis. gen. pl. (Leipzig) 3 (3): 497 (1898)
Coriolus vernicipes (Berk.) Murrill, Bull. Torrey bot. Club 34: 468 (1907)
Coriolus langbianensis Har. & Pat., Bull. Mus. natn. Hist. nat., Paris 20: 152 (1914)
Leucoporus vernicipes (Berk.) Pat., Philipp. J. Sci., C, Bot. 10 (2): 90 (1915)

FIGURE 83

Basidiomata annual, small to medium sized, 33–107 mm tall, coriaceous when young, hard when mature, light in weight, laterally stipitate. **Pileus** 23–95 mm long, 2–3 mm thick, flabelliform to semicircular, applanate, concentrically zonate, glabrous, dull to semi glossy, dark ochre to brown, irregular white mycelial pads near the attachment portion, white narrow zone along margin when fresh, which turn cream on bruising, margin even, thin. **Hymenophore** poroid. **Pores** 7–8 per mm, round to ovoid, absent near margin, creamish white, pore tube 1mm long, concolorous with pore surface. **Context** 1–1.5 mm thick at attachment region, white, slightly brownish towards upper region, no colour change on bruising. **Stipe** 10–12 mm long, 3–7 mm wide, woody, laterally attached, cylindrical, mostly glabrous, with scattered pubescent hairs, cream to brown, base flattened to circular disc, inner tissue solid, white. **Odour** not distinctive. **Spore print** not observed.

Basidiospores 5–6 × 2–2.5 µm, Q=2.5–3, Q_m=2.69, cylindrical to subcylindical, hyaline, guttulate, thin walled, smooth, inamyloid in Melzer’s reagent. **Basidia** 9–12 × 5–6 µm, clavate, 4 sterigmate. **Cystidia** absent. **Hymenial trama** interwoven and trimitic. Generative hyphae 2–3 µm wide, hyaline, smooth, thin walled, branched, with clamp connections. Skeletal hyphae 2–7 µm wide, hyaline, thick walled (1–2 µm), weakly branched, septations not observed. Skeleto ligative hyphae 2–4 µm wide, hyaline, thick walled (1 µm), highly branched, but not of *Bovista* type, septations absent. **Pileal trama** interwoven. Generative hyphae 2–3 µm wide, hyaline, smooth, thin walled, branched, with clamp connections. Skeletal hyphae 2–8 µm wide, hyaline to pale yellow, thick walled (up to 1–2 µm), rarely branched, septations not observed. Skeleto ligative hyphae 2–4 µm wide, hyaline, thick walled (1 µm), highly branched, septations absent. **Pileipellis** a cutis made of hyaline to yellowish brown, thick walled hyphae, which are slightly agglutinated, 2–5 µm wide, hyaline to pale yellow, thick walled. **Stipe** trama interwoven. Generative hyphae 2–3 µm wide, hyaline, smooth, thin walled, branched, with clamp connections. Skeletal hyphae 2–7 µm wide, hyaline, thick walled (1–2 µm), weakly branched, septations not observed. Skeleto ligative hyphae 2–4 µm wide, hyaline, thick walled (1 µm), highly branched, septations absent. **Stipitipellis** slightly interwoven at the base and forming ascending, erect, clavate to cylindrical hyphae, 2–8 µm wide, hyaline to pale brown, thick walled (1 µm), which are projecting up to 16 µm long from the cutis layer.

Specimens examined: India. Kerala State: Kozhikode district, Thusharagiri, on dead branch (unidentified), 14 November 2017, Vinjusha N., ZGCVN660; Kannur district, Aralam, on dead log (unidentified), 09 January 2016, Vijisha P., ZGCVN291.

Comments: This species was treated under genus *Microporus* (as *M. vernicipes* (Berk.) Kuntze) until recently (Zmitrovich *et al.* 2012). According to (Zmitrovich *et al.* 2012), the closest relative of *T. vernicipes* is *M. affinis*. However, *Microporus affinis* differs from *Trametes vernicipes* in having smaller basidiospores (3–4 × 1.5–2 µm; Núñez & Ryvarden 2001).

Trametes vernicipes has paleotropical distribution (Núñez & Ryvarden 2001). From, Kerala, this species has been reported by Mohanan (2011).

Trametes ochracea (Pers.) Justo, in Justo & Hibbett, Taxon 60 (6): 1580 (2011)

Basionym: *Boletus ochraceus* Pers., Ann. Bot. (Usteri) 11: 29 (1794)
Synonyms:
Boletus zonatus Nees, Syst. Pilze (Würzburg): 221 (1816)
Polyporus zonatus (Nees) Fr., Syst. mycol. (Lundae) 1: 368 (1821)
Polyporus versicolor var. ochraceus (Pers.) Pers., Mycol. eur. (Erlanga) 2: 72 (1825)
Polyporus ochraceus (Pers.) Sommerf., Suppl. Fl. lapp. (Oslo): 276 (1826)
*Polystictus zonatus (*Nees) Fr., Nova Acta R. Soc. Scient. upsal., Ser. 3 1(1): 86 (1851)
Hansenia zonata (Nees) P. Karst., Meddn Soc. Fauna Flora fenn. 5: 40 (1879)
Bjerkandera zonata (Nees) P. Karst., Acta Soc. Fauna Flora fenn. 2(no. 1): 30 (1881)
Coriolus zonatus (Nees) Quél., Enchir. fung. (Paris): 175 (1886)
Microporus multicolor (Schaeff.) Kuntze, Revis. gen. pl. (Leipzig) 3(3): 495 (1898)
Coriolus concentricus Murrill, N. Amer. Fl. (New York) 9(1): 23 (1907)
Polystictus concentricus (Murrill) Sacc. & Trotter, Syll. fung. (Abellini) 21: 313 (1912)
Polyporus lloydii (Murrill) Overh., Annual Report of the Missouri Botanical Garden, St. Louis 1: 95 (1914)
Bulliardia rufescens Lázaro Ibiza, Revta R. Acad. Cienc. exact. fis. nat. Madr. 14 (12): 844 (1916)
Polystictus ochraceus (Pers.) Lloyd, Mycol. Writ. 5: 651 (1917)
Polyporus aculeatus Velen., České Houby 4-5: 646 (1922)
*Daedalea rufescens (*Lázaro Ibiza) Sacc. & Trotter, Syll. fung. (Abellini) 23: 450 (1925)
Agaricus multicolor (Schaeff.) E.H.L. Krause, Basidiomycetum Rostochiensium, Suppl. 4: 142 (1932)
*Coriolus hirsutus var. ochraceus (*Pers.) Maire, Act. Inst. bot. Univ. Athèn. 1: 78 (1940)
Trametes multicolor (Schaeff.) Jülich, Persoonia 11(4): 427 (1982)
Coriolus ochraceus (Pers.) Prance, (1984)

FIGURE 84

Basidiomata annual, medium sized, hard and woody, light in weight, pileate. **Pileus** 21–45 mm wide, up to 5 mm thick, sessile, broadly attached, semicircular, applanate, concentrically zonate, tomentose, tomentum thick and raised along the concentric zonations, with a velvety appearance, light golden yellow, slightly shiny, brown in KOH, margin even, round. **Hymenophore** poroid. **Pores** 2–3 per mm, angular, regular, absent at the margin, pale yellow to yellowish brown, pore tubes 2–5 mm long, concolourous with pore surface. **Context** up to 2 mm thick, yellowish, almost homogenous, paler towards upper part. **Odour** not distinctive. **Spore print** not observed.

Basidiospores 4–7 × 2–3 µm, Q=2–2.7, Q_m=2.31, cylindrical to subcylindrical, hyaline, smooth, thinwalled, with guttulate contents, inamyloid in Melzer's reagent. **Basidia** 14–16 × 5–6 µm, clavate, 4 sterigmate. **Cystidia** absent. **Hymenial trama** interwoven and trimitic. Generative hyphae 2–3 µm wide, hyaline, smooth, thin walled, branched, with clamp connections. Skeletal hyphae dominant, 3–6 µm wide, hyaline to pale yellow, thick walled (1 µm), unbranched, septations not observed. Skeleto ligative hyphae 1–3 µm wide, hyaline to pale yellow, thick walled (1 µm), branched with short arboriform like branches, septations not observed, lumen mostly absent. **Pileal trama** interwoven. Generative hyphae 2–3 µm wide, hyaline, smooth, thin walled, branched, with clamp connections. Skeletal hyphae 3–6 µm wide, hyaline to pale yellow, thick walled (1 µm), unbranched, septations not observed. Skeleto ligative hyphae 1–3 µm wide, hyaline to pale yellow, thick walled (1 µm), highly branched, arboriform, branches short, septations not observed. **Pileipellis** made of long erect trichodermal patches; more than 100 µm long, made of hyphae, that are up to 5 µm wide, hyaline to pale brown, thick walled, with obtuse ends**.**

Specimen examined: India. Kerala State: Malappuram district, Nilambur, KFRI campus, on *Sweteinia mahagoni*, 17 November 2016, Vinjusha N, ZGCVN471.

Comments: Morphology of the present collection agrees with the published taxonomic description of *Trametes ochracea* by Núñez & Ryvarden (2001), except a slight variation in the colour of contextual region. According to the description of

Núñez & Ryvarden (2001), *T. ochracea* possesses cream coloured context. However, context of present collection was distinctly yellowish. The previous collection of this species from Kerala by Adarsh *et al.* (2019) also possessed a yellowish tinted context. Present collection resembles specimens of *Trametes hirsuta* (Wulfen) Lloyd in having yellowish ochraceous basidiocarps. According to Ryvarden & Johansen (1980), basidiocarps of fresh specimens of *T. hirsuta* possess greyish tometum, greyish pore surface and white context, and are not with yellowish shades. Moreover, *T. hirsuta* produces longer basidiospores (6–9 µm) (Núñez & Ryvarden 2001). The present collection also shows similarities with *T. polyzona*. However, the latter has oblong to subellipsoid basidiospores, that are larger in size ((4.5) 5 – 8.5 × (2) 2.5–3.5 µm) (according to description of Corner 1989).

Trametes ochracea has circumpolar distribution (Núñez & Ryvarden 2001). The species has been reported from Kerala by Adarsh *et al.* (2019).

Trametes flavida (Lév.) Zmitr., Wasser & Ezhov, in Zmitrovich, Ezhov & Wasser, International Journal of Medicinal Mushrooms (Redding) 14 (3): 310 (2012)

Basionym: *Daedalea flavida* Lév., Annls Sci. Nat., Bot., sér. 3 2: 198 (1844)
Synonyms:
Striglia flavida (Lév.) Kuntze, Revis. gen. pl. (Leipzig) 2: 871 (1891)
Daedaleopsis flavida (Lév.) A. Roy & A. Mitra, Can. J. Bot. 61 (12): 2979 (1984)
Leiotrametes flavida (Lév.) S. Falah, N.M. Sari & A. Hidayat, Biodiversitas 19 (2): 634 (2018)

FIGURE 85

Basidiomata annual, medium to large sized, hard and woody, light in weight, pileate. **Pileus** 95–235 mm long, 10–20 mm thick, laterally attached with a distinct region of attachment, semicircular, applanate, concentrically zonate, weakly sulcate, glabrous, with many irregular foldings in large fruit bodies, cream to light brown, pale yellow along margin in some collections, concentric zonations dark brown to brownisk black, margin even, round. **Hymenophore** daeadaleoid to lamellate, up to 1 cm long, yellowish brown. **Context** up to 2 mm thick, yellowish cream, homogenous. **Odour** not distinctive. **Spore print** not observed.

Basidiospores 5–6 × 2–3 µm, Q=2–2.5 µm, Q_m=2.2, cylindrical to subcylindrical, hyaline, smooth, thin walled, inamyloid in Melzer's reagent. **Basidia**

not observed. **Hymenial trama** interwoven and trimitic. Generative hyphae 2–3 µm wide, hyaline, smooth, thin to slightly thick walled (up to1 µm), branched, with clamp connections. Skeletal hyphae dominant, 3–6 µm wide, subhyaline to brown, thick walled (1–3 µm), unbranched, septations not observed. Skeleto ligative hyphae 2–6 µm wide, hyaline, with short and stout branches, long and tapering hyphae rarely observed, lumen absent. **Pileal trama** interwoven. Generative hyphae 2–3 µm wide, hyaline, smooth, mostly thin walled, some slightly thick walled (up to 1 µm), branched, with clamp connections. Skeletal hyphae 2–5 µm wide, subhyaline to brown, thick walled (up to 2 µm), unbranched, septations not observed. Skeleto ligative hyphae 2–4 µm wide, hyaline, thick walled, solid, highly branched, branches short, not long and tapering. **Pileipellis** an irregular cutis with scattered short and erect hyphal elements that are 2–4 µm wide, pale yellowish brown and thick walled.

Specimen examined: India. Kerala State: Kozhikode district, Thusharagiri, on fallen tree log (unidentified), 14 November 2017, Vinjusha N, ZGCVN654.

Comments: The present specimen highly resembles *Cellulariella acuta* in having similar form of basidiomata and also similar basidiospores. However, *Cellulariella acuta* is characterized by the presence of sword like hyphae (sometimes interpreted as pseudocystidia, Ryvarden & Johansen 1980), projecting from the hymenium, where as this collection lacks the sword like branches in the hymenium. Morphologically, present specimen also resembles *Trametes suaveolens* (L.) Fr., however, the latter has poroid hymenium and larger basidiospores (8–12 × 4–4.5 µm, Ryvarden & Gilbertson 1994).

Trametes flavida has been documented from India as *Daedaleopsis flavida* (Lév.) Roy & Mitra (Roy & Mitra 1983). From Kerala, this species has been recorded (as *Daedalea flavida* Lév.) by Mohanan (2011).

Trametes varians Van der Byl, S. Afr. J. Sci. 18: 281 (1922)

FIGURE 86

Basidiomata annual, small to medium sized, found in clusters, hard and woody, light in weight, pileate. **Pileus** up to 62 mm long, 6 mm thick, sessile to dimidiate, semicircular, applanate, concentric zonations absent, some with radial foldings, glabrous, creamish white, brownish near attachment part in young fruit bodies, whole surface more brown on bruising, margin even, obtuse. **Hymenophore** poroid. **Pores** 3–4 per mm, angular, cream, turning pale brown on bruising, pore tubes 2–3 mm long, cream. **Context** 1–3 mm thick, creamish white, homogenous. **Odour** not distinctive. **Spore print** not observed.

Basidiospores 4.5–5.5 × 2.5–3 µm, Q=1.6–2, Q_m=1.83, ellipsoid, hyaline, smooth, thin walled, inamyloid in Melzer's reagent. **Basidia** not observed. **Cystidia** absent. **Hymenial trama** interwoven. Generative hyphae 2–3 µm wide, hyaline, smooth, thin walled, branched, with clamp connections. Skeletal hyphae predominant, 3–5 µm wide, hyaline, unbranched, sometimes with very short branches at extremities, thick walled (1 µm), septations not observed. Skeleto ligative hyphae 1–3 µm wide, hyaline, thick walled (1 µm), mostly solid, highly branched, septations not observed. **Pileal trama** interwoven. Generative hyphae 2–3 µm wide, hyaline, smooth, thin walled, branched, with clamp connections. Skeletal hyphae 3–6 µm wide, hyaline, unbranched, sometimes with very short branches at extremities, thick walled (1 µm), septations not observed. Skeleto ligative hyphae 1–3 µm wide, hyaline, thick walled (1 µm), mostly solid, highly branched, septations not observed. **Pileipellis** composed of narrowly clavate to cylindrical hyphal endings arising from trama, 2–5 µm wide, hyaline, thick walled (1 µm), with obtuse tip.

Specimen examined: India. Kerala State: Kozhikode district, Vatakara, Madapally College campus, on dead wood (unidentified), 01 August 2017, Vinjusha N, ZGCVN608.

Comments: Present collection resembles *T. glabrata* (Lloyd) Ryvarden in having creamish white, glabrous pileus. However, the latter differs from the present collection by allantoid basidiospores (1–1.5 µm wide) (according to the taxonomic description of Núñez & Ryvarden 2001). *Trametes menziesii* also produces glabrous pileus as the present specimen, however, produces more large, compound and distinctly zonate basidiocarps (Ryvarden & Johansen 1980).

Trametes varians has been documented from East Africa, Mozambique, South Africa and India (Leelavathy & Ganesh 2000). Leelavathy & Ganesh (2000) reported this species from Kerala.

Trametes marianna (Pers.) Ryvarden, Persoonia 7(2): 309 (1973)

Basionym: *Polyporus mariannus* Pers., in Gaudichaud-Beaupré in Freycinet, Voy. Uranie., Bot. (Paris) 4: 173 (1827)
Synonyms:
Polyporus paleaceus Fr., Epicr. syst. mycol. (Upsaliae): 471 (1838)
Polyporus glabrescens Berk., Ann. nat. Hist., Mag. Zool. Bot. Geol. 3: 391 (1839)
Polyporus moritzianus Lév., Annls Sci. Nat., Bot., sér. 3 5: 130 (1846)
Trametes paleacea (Fr.) Fr., Nova Acta R. Soc. Scient. upsal., Ser. 3 1 (1): 97 (1851)
Trametes glabrescens (Berk.) Fr., Nova Acta R. Soc. Scient. upsal., Ser. 3 1 (1): 96 (1851)
Fomes glabrescens (Berk.) Cooke, Grevillea 14 (no. 69): 17 (1885)
Trametes moritziana (Lév.) Sacc., Syll. fung. (Abellini) 6: 352 (1888)
Leucoporus brachypus (Lév.) Pat., Essai Tax. Hyménomyc. (Lons-le-Saunier): 82 (1900)
Phellinus moritzianus (Lév.) Pat., Essai Tax. Hyménomyc. (Lons-le-Saunier): 97 (1900)
Coriolus brachypus (Lév.) Murrill, Bull. Torrey bot. Club 32 (12): 646 (1905)
Coriolus curranii Murrill [as '*currani*'], Bull. Torrey bot. Club 35: 395 (1908)
Polystictus curranii (Murrill) Sacc. & Trotter [as '*currani*'], Syll. fung. (Abellini) 21: 319 (1912)
Trametes paleacea f. *minor* Bres., Annls mycol. 18 (1/3): 38 (1920)
Poria subaurantiaca Rodway & Cleland, Pap. Proc. R. Soc. Tasm.: 79 (1930)
Coriolus paleaceus (Fr.) G. Cunn., Proc. Linn. Soc. N.S.W. 75 (3-4): 234 (1950)
Perenniporia subaurantiaca (Rodway & Cleland) P.K. Buchanan & Ryvarden, Aust. Syst. Bot. 6 (3): 225 (1993)

FIGURE 87

Basidiomata annual, small sized, solitary or in clusters, almost coriaceous when fresh, hard on drying, light in weight, pileate, often adjacent pilei get fused and form compound fruit bodies. **Pileus** 28–75 mm long, 2–9 mm thick, dimidiate or attached with a small substipe like base, semicircular to flabelliform, applanate, concentrically zonate, not sulcate, glabrous, with rough with minute tubercles, pinkish cream to ochraceous when fresh, pinkish shade disappearing with age, off white towards attachment region, white mycelia sheths often found near the base, margin thin, even. **Hymenophore** poroid. **Pores** 5–8 per mm, round, regular, absent along margin, cream, pore tubes 1–3 mm long, concolourous with pore surface. **Context** 1–4 mm thick, cream, homogenous. **Odour** not distinctive. **Spore print** not observed.

Basidiospores 3.5–6 × 2–2.5 µm, Q=2–2.6, Q_m= 2.15, subcylindrical, hyaline, smooth, thin walled, eguttulate, inamyloid in Melzer's reagent. **Basidia** not observed. **Hymenial trama** interwoven. Generative hyphae 2–4 µm wide, easily breaking, hyaline, smooth, thin walled, branched, with clamp connections. Skeletal hyphae 3–6 µm, hyaline, smooth, thick walled (1µm), mostly solid, unbranched, septations not observed. Skeleto ligative hyphae 2–4 µm wide, hyaline, smooth, thick walled (1µm), mostly solid, branched, septations not observed. **Pileal trama** interwoven. Generative hyphae 2–4 µm wide, easily breaking, hyaline, smooth, thin walled, branched, with clamp connections. Skeletal hyphae 3–7 µm, hyaline, smooth, thick walled (1µm), unbranched, septations not observed. Skeleto ligative hyphae 2–4 µm wide, hyaline, smooth, thick walled (1µm), branched, septations not observed. **Pileipellis** almost a cutis, composed of hyphae that are 2–4 µm wide, hyaline and thick walled.

Specimens examined: India. Kerala State: Malappuram district, Nilambur, KFRI campus, on fallen tree trunk of *Xylia Xylocarpa*, 17 November 2016, Vinjusha N., ZGCVN469; Kakkayam, on dead wood (unidentified), 26 October 2018, Vinjusha N., ZGCVN740; Thrissur, Peechi, on *Terminalia paniculata,* 20 October 2017, Vinjusha N., ZGCVN642, ZGCVN643.

Comments: Our collections show resemblances with young specimens of *Trametes cingulata* Berk. According to Ryvarden & Johansen (1980), pileus surface of *T. cingulata* becomes sooty black to black with age and their spores are broadly ellipsoid 5–6.5 × 3.5–4 µm. Another closely related species, *Ranadivia modesta* (Kunze *ex* Fr.) Zmitr. differs from the present collection by having more cylindrical basidiospores (1.5–2 µm).

Trametes marianna has paleotropical distribution (Ryvarden & Johansen 1980). From Kerala, this species was reported by Leelavathy & Ganesh (2000).

Trametes pubescens (Schumach.) Pilát, in Kavina & Pilát, Atlas Champ. l'Europe, III, Polyporaceae (Praha) 1: 268 (1939)

Basionym: *Boletus pubescens* Schumach., Enum. pl. (Kjbenhavn) 2: 384 (1803)
Synonyms:
Polyporus pubescens (Schumach.) Fr., Observ. mycol. (Havniae) 1: 124 (1815)
Polyporus sullivantii Mont., Annls Sci. Nat., Bot., sér. 2 18: 243 (1842)
Bjerkandera pubescens (Schumach.) P. Karst., Bidr. Känn. Finl. Nat. Folk 37: 41 (1882)
Polystictus sullivantii (Mont.) Cooke, Grevillea 14 (no. 71): 81 (1886)
Polystictus pubescens (Schumach.) Gillot & Lucand, Cat. Champ. sup. Saône-et-Loire: 351 (1890)
Microporus sullivantii (Mont.) Kuntze, Revis. gen. pl. (Leipzig) 3 (3): 497 (1898)
Leptoporus pubescens (Schumach.) Pat., Essai Tax. Hyménomyc. (Lons-le-Saunier): 84 (1900)
Coriolus sullivantii (Mont.) Murrill, Bull. Torrey bot. Club 32 (12): 650 (1905)
Coriolus pubescens f. *amurensis* Pilát, Bull. trimest. Soc. mycol. Fr. 48 (1): 13 (1932)
Coriolus pubescens f. *resupinatus* Pilát, Bull. trimest. Soc. mycol. Fr. 51 (3-4): 364 (1936)
Tyromyces pubescens (Schumach.) Imazeki, Bull. Tokyo Sci. Mus. 6: 84 (1943)
Coriolus pubescens f. *tenuis* Bondartsev, Trut. Grib Evrop. Chasti SSSR Kavkaza [Bracket Fungi Europ. U.S.S.R. Caucasus] (Moscow-Leningrad): 484 (1953)
Trametes pubescens var. *anthopora* Zmitr., Bukharova & Malysheva, Mikol. Fitopatol. 47 (6): 377 (2013)

FIGURE 88

Basidiomata annual, medium sized, solitary, hard and woody, light in weight, pileate. **Pileus** 32–70 mm long, 3–8 mm thick, sessile, laterally attached, semicircular, applanate, concentrically zonate, sulcate, tomentose, hairs lesser when mature, cream with shades of pale brown, turning more brown on handling, often greenish due to presence of algae, especially along the concentric zones, margin even, obtuse. **Hymenophore** poroid. **Pores** 3–4 per mm, round to ovoid, absent near margin, surface creamish white, bruising to pale yellowish brown, pore tubes up to 7 mm long, non stratified, concolorous with pore surface. **Context** 1 mm thick, white, soft, turning cream on handling. **Odour** indistinct. **Spore print** not observed.

Basidiospores 5–7 × 1.5–2 µm, Q=1.2–3.3, Q_m=2.5, subcylindrical, hyaline, smooth, thin walled, eguttulate, inamyloid in Melzer's reagent. **Basidia** not observed. **Hymenial trama** interwoven and trimitic. Generative hyphae 2–3 µm wide, hyaline, smooth, thin walled, branched, with clamp connections. Skeletal hyphae 3–7 µm wide, hyaline to pale coloured, thick walled (up to 1.5 µm), unbranched, septations not observed. Skeleto ligative hyphae 2–4 µm wide, hyaline, thick walled (up to 1 µm), highly branched, arboriform, septations not observed. **Pileal trama** interwoven. Generative hyphae very difficult to observe, 2–3 µm wide, hyaline, thin walled, branched, with clamp connections. Skeletal hyphae 3–6 µm wide, hyaline to pale coloured, thick walled (up to 2 µm), unbranched, septations not observed. Skeleto ligative hyphae 2–4 µm wide, hyaline, thick walled (up to 1µm), highly branched, septations not observed. **Pileipellis** interwoven at the base to form erect trichodermal patches that are up to 30 µm long, hyphae 2–5 µm wide, hyaline to pale brown, almost thick walled.

Specimens examined: India, Kerala, Ernakulam, Thalakkad, on fallen tree trunk (unidentified), 25 July 2015, Manjula K. M., ZGCVN90.

Comments: The specimen highly resembles *T. meyenii* in morphology, however the latter differs by ovoid ellipsoid basidiospores (2–4 µm) wide. According to Ryvarden & Johansen (1980), in the African collections of the species, pileus of aged fruit bodies possess a thin distinct adpressed layer consisting of agglutinated hyphae.

Trametes pubescens is a cosmopolitan species (Ryvarden & Johansen 1980). From Kerala, this species has been reported by Mohanan (2011).

Trametes meyenii (Klotzsch) Lloyd, Mycol. Writ. 5 (Letter 67): 14 (1918)

Basionym: *Polyporus meyenii* Klotzsch, Nova Acta Phys.-Med. Acad. Caes. Leop.-Carol. Nat. Cur., Suppl. 1 19: 239 (1843)
Synonyms:
Daedalea dregeana Mont., Annls Sci. Nat., Bot., sér. 3 7: 171 (1847)
Daedalea ochracea Kalchbr., in Thümen, Flora, Regensburg 61 (23): 354 (1878)
Trametes obstinata Cooke, Grevillea 12 (no. 61): 17 (1883)
Daedalea incompta Berk., Trans. Linn. Soc. London, Bot. 2 (3): 61 (1883)
Polystictus meyenii (Klotzsch) Cooke, Grevillea 14 (no. 71): 83 (1886)
Polystictus obstinatus (Cooke) Cooke, Grevillea 14 (no. 71): 83 (1886)
Trametes cornea Pat., J. Bot., Paris 4: 16 (1890)
Striglia ochracea (Kalchbr.) Kuntze, Revis. gen. pl. (Leipzig) 2: 871 (1891)
Striglia dregeana (Mont.) Kuntze, Revis. gen. pl. (Leipzig) 2: 871 (1891)
Striglia incompta (Berk.) Kuntze, Revis. gen. pl. (Leipzig) 2: 871 (1891)
Microporus obstinatus (Cooke) Kuntze, Revis. gen. pl. (Leipzig) 3 (3): 496 (1898)
Microporus meyenii (Klotzsch) Kuntze, Revis. gen. pl. (Leipzig) 3 (3): 496 (1898)
Daedalea papyracea Massee, Bull. Misc. Inf., Kew: 124 (1907)
Polystictus meyenii var. *obstinatus* (Cooke) Bres., Hedwigia 53 (1-2): 67 (1912)
Polystictus meyenii f. *corneus* (Pat.) Bres., Hedwigia 53 (1-2): 67 (1912)
Daedalea hobbsii Van der Byl, S. Afr. J. Sci. 18: 287 (1924)
Coriolus meyenii (Klotzsch) G. Cunn., Proc. Linn. Soc. N.S.W. 75 (3-4): 232 (1950)
Trametes capensis Lloyd, Bothalia 5: 544 (1950)
Coriolus meyenii (Klotzsch) Imazeki, Bull. Gov. Forest Exp. Stn Tokyo 57: 100 (1952)

Cerrena meyenii (Klotzsch) L. Hansen, Natural History of Rennell Island, British Solomon Lls (Copenhagen) 3: 129 (1960)
Sclerodepsis meyenii (Klotzsch) Ryvarden, Norw. Jl Bot. 19: 236 (1972)

FIGURE 89

Basidiomata medium sized, tough when fresh, becoming harder and woody on drying, pileate. **Pileus** 50–160 mm long, 10–20 mm thick, laterally attached, dimidiate, semicircular, applanate, surface tomentose towards the point of attachment, hairs sparser towards the margin, becoming less tomentose with age, concentrically sulcate, dull white to cream,hairs light green to dark green, alternating in concentric rings; green colour due to the presence of algal cells, margin whitish, bruising to darker shades of brown, thick, obtuse, slimy when fresh, even, irregularly wavy at some places, uplifted and incurved on drying. **Hymenophore** poroid. **Pores** 2–3 per mm, angular to irregular, pore tubes 3–10 mm long, visible to naked eye, absent at the margin, creamish white, turning pale brown on drying, pore margin concolorous. **Context** 2–5 mm thick, tough, cream, turning darker on handling. **Odour** not distinctive. **Spore print** not observed.

Basidiospores 4.5–7 (9) × 2–4 µm, Q=2–3.1, Q_m=1.98 µm, ellipsoid to ovoid, hyaline, smooth, thin walled, with guttulate contents, inamyloid in Melzer's reagent. **Basidia** 10–20 × 4–6 µm, clavate, 4 sterigmate. **Cystidia** not observed in any tissues of the fruit body. **Hymenial trama** highly interwoven and trimitic. Generative hyphae not observed, 2–4 µm wide, hyaline, smooth, thin walled, branched, with sparse clamp connections. Skeletal hyphae predominant; 3–5 µm wide, hyaline, thick walled (up to 2.5 µm), unbranched, septations not observed. Skeleto ligative hyphae 2–4 µm wide, hyaline to pale yellow, thick walled (up to 2 µm), highly branched, arboriform, septations not observed. **Pileal trama** loosely interwoven. Generative 2–5µm wide, hyaline, smooth, thin walled, branched, with clamp connections. Skeletal hyphae 4–6 µm wide, hyaline, thick walled (up to 2 µm), unbranched, septations not observed. Skeleto ligative hyphae 2–4 µm wide, hyaline, thick walled (up to 2 µm), many hyphae solid, highly branched, septations not observed. **Pileipellis** composed of hyphae that is interwoven at the base and aggregating to form erect trichodermial patches, 2–6 µm wide, hyaline, thick walled, with obtuse ends.

Specimens examined: India. Kerala State: Ernakulam district, Aluva, Palace road, on dead wood stump of unidentified tree, 20 June 2015, Vinjusha N., ZGCVN1; Alappuzha, Boat Jetty road, on dead log of *Acacia* species, 19 December 2018; Vinjusha N, ZGCVN793.

Comments: Present collection is separated from the similar species, *Trametes maxima* (Mont.) A. David & Rajchenb. by the absence of distinct black lines below the pileus (according to the description of Li & He 2011). In addition, *Trametes maxima* has smaller spores when compared to the present collection ((4.1) 4.2–5.1 (–5.8) × 2–2.4 (–2.5) µm). The specimen also shows morphological and microscopic resemblance with *T. gibbosa*. However, basidiospores are much smaller in the latter (4–5 × 2–2.5 µm, according to the taxonomic description of Núñez & Ryvarden 2001). In *T. gibbosa*, fusoid cystidioles are present, whereas, the present collections fusoid cystidioles were absent.

As per the description (Ryvarden & Johansen 1980), pileus surface of *T. meyenii* is adpressed tomentose when young and glabrous when mature. Even though pileus surface of large fruit bodies of our collection was not completely glabrous, it was less tomentose when compared to the young fruit bodies. According to Ryvarden & Johansen (1980), sulcate bands on the pileus of *T. meyenii* often appear as greenish due to presence of algae in tomentum. Colonies of unicellular algae were observed in the tomentum of the present collection. Corner (1989) had reported abundant hyphal pegs for the species, however, hyphal pegs were not observed in the present collection. Basidiospores of present collection are slightly larger than the spores size described for the species (4.5–6.5 (7) × 2–3 µm, as per the descriptions of Ryvarden & Johansen (1980) and Corner (1989).

Trametes meyenii has paleotropical distribution (Ryvarden & Johansen 1980). There are no reports of this species from Kerala so far.

Trametes villosa (Sw.) Kreisel, Monografias, Ciencias, Univ. Habana, Ser. 4 16: 83 (1971)

Basionym: *Boletus villosus* Sw., Prodr.: 148 (1788)
Synonyms:
Polyporus villosus (Sw.) Fr., Syst. mycol. (Lundae) 1: 344 (1821)
Polyporus tener Lév., Annls Sci. Nat., Bot., sér. 3 5: 139 (1846)
Polystictus umbonatus Fr., Nova Acta R. Soc. Scient. upsal., Ser. 3 1 (1): 87 (1851)
Polystictus villosus (Sw.) Fr., Nova Acta R. Soc. Scient. upsal., Ser. 3 1 (1): 83 (1851)
Hansenia umbonata (Fr.) P. Karst., Meddn Soc. Fauna Flora fenn. 5: 40 (1879)
Polystictus tener (Lév.) Cooke, Grevillea 14 (no. 71): 87 (1886)
Polystictus gibberulosus (Lév.) Cooke [as *'galberulosus'*], Grevillea 14 (no. 71): 83 (1886)
Polyporus sericeus Pat., in Patouillard & Lagerheim, Bull. Herb. Boissier 3 (1): 53 (1895)
Microporus gibberulosus (Lév.) Kuntze, Revis. gen. pl. (Leipzig) 3 (3): 496 (1898)
Microporus tener (Lév.) Kusntze, Revis. gen. pl. (Leipzig) 3 (3): 497 (1898)
Microporus umbonatus (Fr.) Kuntze, Revis. gen. pl. (Leipzig) 3 (3): 497 (1898)
Scenidium friesianum (Speg.) Kuntze, Revis. gen. pl. (Leipzig) 3 (3): 515 (1898)
Coriolus tener (Lév.) Murrill, Bull. Torrey bot. Club 32 (12): 653 (1905)
Coriolus fulvoumbrinus Murrill [as *'fulvo-umbrinus'*], N. Amer. Fl. (New York) 9 (1): 24 (1907)
Polystictus fulvoumbrinus (Murrill) Sacc. & Trotter, Syll. fung. (Abellini) 21: 314 (1912)
Favolus dussii Lloyd, Mycol. Writ. 7 (Letter 69): 1194 (1923)

FIGURE 90

Basidiomata annual, medium sized, almost coriaceous and soft when young, more hard and tough on drying, effused reflexed to pileate. **Pileus** 25–82 mm long, up to 3 mm thick, laterally or eccentrically attached with a distinct point of attachment, sometimes dimidiate, imbricate, applanate, semicircular, surface cream with shades of pale brown, turning more brown on handling, concentrically sulcate, tomentose, tomentum appeared as greenish in most fruit bodies due to presence of algae except at the margin, margin even, thin to slightly thick. **Hymenophore** poroid. **Pores** 5–7 per mm, absent near margin, angular to irregular, surface creamish white, bruising to pale yellowish brown, pore tubes 1–1.5 mm long, non stratified, concolorous with pore surface. **Context** 1mm thick, white, soft, turning cream on handling. **Odour** indistinct. **Spore print** not observed.

Basidiospores 3–6 × 2–3 µm, Q=1.5–2, Q_m=1.6, ellipsoid to broadly ellipsoid, hyaline, smooth, thin walled, eguttulate, inamyloid in Melzer's reagent. **Basidia** 16–19 × 4–6.2 µm clavate, hyaline, 4 sterigmate. **Cystidia** absent. **Hymenial trama** highly interwoven and trimitic. Generative hyphae 2–3 µm wide, hyaline, smooth, thin walled, branched, with clamp connections. Skeletal hyphae 4–6 µm wide, hyaline, thick walled (up to 2 µm), unbranched to weakly branched, septations not observed. Skeleto ligative hyphae 2 µm wide, hyaline, thick walled (up to 1 µm), highly branched, arboriform, septations not observed. **Pileal trama** interwoven. Generative hyphae not frequent, 2–3 µm wide, hyaline, smooth, thin walled, branched, with clamp connections. Skeletal hyphae 3–8 µm wide, hyaline, thick walled (1–3 µm), branched, septations not observed. Skeleto ligative hyphae 2–3 µm wide, hyaline, thick walled (up to1 µm), highly branched, septations not observed. **Pileipellis** a trichodermium, composed of hyphae ascending and aggregating to form patches, that are more than 100 µm long, made of hyphae that are 2–6 µm wide, hyaline, thin to thich walled, with obtuse ends.

Specimens examined: India. Kerala State: Kozhikode district, Pokkunnu, ZG college campus, on dead branch (unidentified), 05 August 2015, Vinjusha N., ZGC; Pokkunnu, on dead logs of *Albizia odoratissima*, 19 August 2015, Vinjusha N, ZGCVN194; Mankavu, Govindhapuram, on dead log (unidentified), 07 October 2015, Vinjusha N., ZGCVN230; Thusharagiri, on dead wood trunk (unidentified), 14 November 2017, Vinjusha N., ZGCVN661; Thamarassery, Kakkavayal, Vanaparvam Biodiversity Park, on dead branch (unidentified), Vinjusha N., ZGCVN695.

Comments: Present collections resemble *Trametes pubescens,* since both species produce cream coloured basidiocarps, villose, velutinous or tomentose pileus, and are often with greenish tints (due to algal growth). However, *Trametes pubescens* have thicker basidiomata than the former. Moreover, basidiospores of *T. pubescens* are cylindrical to allantoid,with a width of 1.5–2.5 µm (according to description of Ryvarden & Johansen 1980 and Ryvarden & Gilbertson 1994). However, basidiospores of present collections are ellipsoid to broadly ellipsoid (3–6 × 2–3 µm). According to the taxonomic description by Corner (1983), *T. villosa* possesses numerous hyphal pegs. However, hyphal pegs were not observed in the present Kerala collection of *T. villosa*.

Trametes villosa has distribution in Africa, America (Zmitrovich *et al.* 2012) and India (Ranadive 2013). From Kerala, this species has been reported by Mohanan (2011).

Trametes hirsuta (Wulfen) Lloyd, Mycol. Writ. 7 (Letter 73): 1319 (1924)

Basionym: *Boletus hirsutus* Wulfen, in Jacquin, Collnea bot. 2: 149 (1791)
Synonyms:
Polyporus hirsutus (Wulfen) Fr., Syst. mycol. (Lundae) 1: 265 (1821)
Polystictus hirsutus (Wulfen) Fr., Nova Acta R. Soc. Scient. upsal., Ser. 3 1 (1): 86 (1851)
Hansenia hirsuta (Wulfen) P. Karst., Meddn Soc. Fauna Flora fenn. 5: 40 (1879)
Bjerkandera hirsuta (Wulfen) Thüm., Bull. Soc. Imp. nat. Moscou 56 (2): 116 (1882)
Coriolus hirsutus (Wulfen) Pat., Cat. Rais. Pl. Cellul. Tunisie (Paris): 47 (1897)
Microporus hirsutus (Wulfen) Kuntze, Revis. gen. pl. (Leipzig) 3 (3): 496 (1898)
Polystictus hirsutus var. *fibula* Bres., Hedwigia 33: 65 (1913)
Polystictoides hirsutus (Wulfen) Lázaro Ibiza, Revta R. Acad. Cienc. exact. fis. nat. Madr. 14 (11): 756 (1916)
Polystictoides hirsutus var. *albescens* Lázaro Ibiza, Revta R. Acad. Cienc. exact. fis. nat. Madr. 14 (11): 757 (1916)
Coriolus hirsutus f. *abietis* Pilát, Bull. trimest. Soc. mycol. Fr. 48 (1): 13 (1932)
Trametes hirsuta f. *crassa* J. Schröt. ex Pilát, in Kavina & Pilát, Atlas Champ. l'Europe, III, Polyporaceae (Praha) 1: 67 (1936)
Trametes hirsuta f. *tenuis* Domański, Monographiae Botanicae, Societas Botanicorum Poloniae 15: 318 (1963)

FIGURE 91

Basidiomata annual, small sized, almost coriaceous when fresh, hard and woody, light in weight, pileate. **Pileus** 15–27 mm long, 2–5 mm thick, sessile to dimidiate, often fused and imbricate, semicircular, applanate to slightly convex, concentrically zonate, sulcate, hirsute, hairs dense along zonations and becoming sparser towards margin, golden yellow to brown, with alternating hirsute and glabrous zones, more brownish near the region of attachment, margin thin, wavy. **Hymenophore** poroid. Pores 5–7 per mm, round to angular, cream, turning light yellowish brown on bruising, pore tube up to 2 mm long, concolourous with pore surface. **Context** 2–3 mm thick, white, homogenous. **Odour** not distinctive. **Spore print** not observed.

Basidiospores 4–6 × 1.5–2.5 µm, Q=2.2–3.3, Q_m=3.11, cylindrical, hyaline, thin walled, smooth, eguttulate, inamyloid in Melzer's reagent. **Basidia** 10–15 × 4–6 µm, clavate, 4 sterigmate, with basal clamp connections. **Cystidia** absent. **Hymenial trama** interwoven and trimitic. Generative hyphae 2–3 µm wide, hyaline, smooth, thin walled, branched, with clamp connections. Skeletal hyphae 3–6 µm wide, hyaline, smooth, thick walled (up to 3 µm), lumen narrow to absent, unbranched, sepatations not observed. Skeleto ligative hypahe 2–6 µm wide, hyaline, thick walled (1–2 µm), with short and stout branches, septations not observed. **Pileal trama** interwoven. Generative hyphae 2–3 µm wide, hyaline, thin walled, smooth, with clamp connections. Skeletal hyphae 2.5–7 µm wide, hyaline, smooth, thick walled (1–2 µm), unbranched, sepatations not observed. Skeleto ligative hyphae 2–4 µm wide, hyaline, thick walled (1–1.5 µm), branched, short and stout branches not frequent as present in hymenium, septations not observed. **Pileipellis** an irregular cutis, forming erect, ascending hyphae that are 2–4 µm wide, hyaline, almost thick walled hyphae with obtuse ends.

Specimens examined: India. Kerala State: Idukki district, Munnar, on dead log of *Bambusa* species, 26 October 2015, Vinjusha N., ZGCVN250.

Comments: Morphologically, *Trametes hirsuta* comes closer to *T. versicolor* (L.) Lloyd, *T. ochracea* (Pers.) Gilb. & Ryvarden and *T. pubescens*. *T. versicolor* produces more adpressed velutinate and more zonate basidiocarps, often with bluish shades (Núñez & Ryvarden 2001). *Trametes ochracea* and *T. pubescens* have densly tomentose basidiocarps (Ryvarden & Gilbertson 1994). *Trametes hirsuta* often produces greyish coloured basidiomata with yellowish margin (Ryvarden & Gilbertson 1994). However, Leelavathy & Ganesh (2000) had reported mustard yellow coloured basidiocarps for the species. As per the descriptions (Ryvarden & Gilbertson 1994; Núñez & Ryvarden 2001), basidiospore size of *T. hirsuta* is 6–9 × 2–2.5 µm. Whereas, the present collection produces smaller basidiospores (4–6 × 1.5–2.5 µm). However, smaller basidiospores have been reported for previous Kerala collections of *T. hirsuta* (4.5–6.5 × 2–3 µm). Characters of the present collection properly matched with the description of *T. hirsuta* by Ryvarden & Gilbertson (1994), Leelavathy & Ganesh (2000), and Núñez & Ryvarden (2001).

Trametes hirsuta is circumpolar in boreal temperate regions of the world (Núñez & Ryvarden 2001). In addition to Leelavathy & Ganesh (2000), Iqbal *et al.* (2016) has also reported this species from Kerala.

Daedalea Pers.

Basidiomata perennial, hard and woody, solitary or clustered and imbricate, widely effused or effused reflexed to pileate. Pileus sessile and broadly attached, semicircular, concentrically zonate and sulcate, smooth to velutinate. Hymenophore poroid to sinuous labyrinthine, daedaleoid or lamellate, pore surface brownish, pore tubes concolorous with pore surface. Hyphal system trimitic, generative hyphae hyaline, thin walled, with clamp connections. Skeletal hyphae hyaline to pale brown, thick walled. Skeleto ligative hyphae hyaline to light yellowish brown, with short and stout branches. Cystidia present or absent. Basidia clavate, 2–4 sterigmate. Basidiospores oblong ellipsoid to cylindrical, hyaline, thin walled, inamyloid in Melzer’s reagent. *Daedalea* species causes brown rot on wood.

Daedalea dochmia (Berk. & Broome) T. Hatt., Mycoscience 46 (5): 307 (2005)

Basionym: *Polyporus dochmius* Berk. & Broome, J. Linn. Soc., Bot. 14 (no. 73): 50 (1873) [1875]
Synonyms:
Polyporus ferreus Berk., London J. Bot. 6: 502 (1847)
Fomes dochmius (Berk. & Broome) Cooke, Grevillea 14 (no. 69): 17 (1885)
Fomes ferreus Sacc., Syll. fung. (Abellini) 6: 200 (1888)
Fomes ferreus f. *cinereus* Henn. [as '*cinerea*'], Bot. Jb. 22: 88 (1895)
Scindalma dochmium (Berk. & Broome) Kuntze, Revis. gen. pl. (Leipzig) 3 (3): 518 (1898)
Fomes philippinensis Murrill, Bull. Torrey bot. Club 34: 477 (1907)
Fomes subferreus Murrill, N. Amer. Fl. (New York) 9 (2): 97 (1908)
Ganoderma ferreum (Sacc.) Overeem & B.A. Steinm., Arch. Rubbercult. Ned.-Indië 7: 453 (1923)
Ungulina dochmia (Berk. & Broome) Pat., Annals Cryptog. Exot. 1: 16 (1928)
Trametes ferrea (Sacc.) G. Cunn., Proc. Linn. Soc. N.S.W. 75 (3-4): 225 (1950)
Osmoporus dochmius (Berk. & Broome) G. Cunn., Bull. N.Z. Dept. Sci. Industr. Res. 164: 244 (1965)
Fomitopsis dochmia (Berk. & Broome) Ryvarden [as '*dochmius*'], Norw. Jl Bot. 19: 231 (1972)
Trametes dochmia (Berk. & Broome) Corner, Beih. Nova Hedwigia 97: 96 (1989)

FIGURE 92

Basidiomata perennial, medium to large sized, solitary, hard, firmly attached to the substrate, almost heavy when mature, pileate. **Pileus** 40–110 mm long, up to 20 mm thick, sessile, applanate to ungulate, semicircular, concentrically sulcate with wider zones, glabrous, crusted, cracked and deeply rimose with age, greyish black to black, margin white when young, later turning black, even, obtuse. **Hymenophore** poroid. **Pores** 7–12 per mm, round, absent at the margin, pale ochre, pore tubes up to 130 mm thick, stratified, tube layers distinct, pale ochre, turning brown. **Context** 5–150 mm thick, pale buff to light brown, homogenous with light brown zones. Whole fruit body turning brownish black in KOH. **Odour** not distinctive. **Spore print** not observed.

Basidiospores 5–6 × 1.5–2 µm, Q=1.3–2.4, Q_m=1.65, oblong ellipsoid, hyaline, smooth, thin walled, eguttulate, inamyloid in Melzers reagent. **Basidia** not observed. **Cystidia** absent. **Hymenial trama** interwoven with dimitic hyphal system. Generative hyphae not frequent; 2–3 µm wide, hyaline, smooth, thin walled, branched, with clamp connections. Skeletal hyphae dominant, 3–5 µm wide, hyaline to pale yellowish brown, smooth, thick walled (1 µm), unbranched, rarely septate. Skeleto ligative hyphae 2–4 µm wide, hyaline, thick walled, highly branched, with short branches, mostly without lumen. **Pileal trama** interwoven. Generative hyphae up to 3 µm wide, hyaline, smooth, thin walled, branched, with clamp connections. Skeletal hyphae dominant, 3–5 µm wide, hyaline to pale yellowish brown, smooth, thick walled (1 µm), unbranched, weakly septate, Skeleto ligative hyphae 2–4 µm wide, hyaline, thick walled, branched, without long and tapering branches, lumen mostly absent. **Pileipellis** an agglutinated crust, difficult to separate, made of 2–4 µm wide, brown, thick walled hyphae.

Specimens examined: India. Kerala State: Ernakulam district, Perumbavoor, on *Hopea ponga*, 08 July 2017, Vinjusha N., ZGCVN556; Pathanamthitta district, Gavi, on live tree (unidentified), 16 July 2017, Vinjusha N., ZGCVN599; Kollam district, Thenmala, on fallen tree trunk (*Sweitenia mahagoni*), 23 September 2019, Krishnapriya K., ZGCVN901; Palakkad district, Silent Valley National Park areas, on fallen tree (unidentified), 26 October 2019, Anjitha Thomas, ZGCVN916.

Comments: The Genus *Daedalea* is morphologically similar to genera *Lenzites* and *Daedaleopsis* (Roy & De 1996). Genus *Lenzites* possesses sword like branches on ends of skeletal hyphae, resembling a false cystidia and all types of their hyphae are hyaline. The characteristic sword like pseudocystidia are absent in other two genera and their skeletal hyphae are subhyaline to brown. The major difference between *Daedalea* and *Daedaleopsis* lies in the branching pattern of skeleto ligative hyphae. *Daedalea* members possess short and stout branches, a character absent in

Daedaleopsis. Latter produce skeleto ligative hyphae with long and tapering branches. Basidiospores of *Daedaleopsis* species are cylindrical and slightly curved whereas those of *Daedalea* are oblong ellipsoid to cylindrical, but not curved. Absence of sword like hyphal branches and straight oblong ellipsoid basidiospores perfectly place the present species in *Daedalea*. The species, *Daedalea pseudodochmia* (Corner) T. Hatt. also produces thick black crust on the pileus as the present collection, which turns rimose with age. However, the former possesses larger spores (1–3 per mm) and slightly wider spores (3–3.5 µm) (Lindner *et al.* 2011).

Daedalea dochmia has distribution in central and South America; Caribbean Islands, Asia and Australia (Carranza-Morse & Gilbertson 1986). In Kerala, this species has been reported by Florence & Yesodharan (2000), Leelavathy & Ganesh (2000), Mohanan (2011) and Adarsh *et al.* (2018).

Daedalea radiata B.K. Cui & Hai J. Li, Mycoscience 54 (1): 65 (2013)

FIGURE 93

Basidiomata perennial, medium to large sized, usually clustered and imbricate, almost coriaceous when fresh, fleshy, hard and woody when dry, light in weight, widely effused or effused reflexed to pileate. **Pileus** 23–115 mm long, 10–20 mm thick, sessile, semicircular, applanate or slightly convex, concentric zonations absent, hispid to hirsute hairs, lesser towards margin, yellowish brown to brown with creamish yellow along margin, margin entire to wavy, obtuse. **Hymenophore** poroid. Pores 2–3 per mm, angular, regular to daedaleoid, brown, pore tubes up to 8 mm long, stratified, concolorous with pore surface, black in KOH. **Context** 3-4 mm thick, brown, homogenous, brownish black in KOH. Context and pore tubes turns brownish black in KOH. **Odour** not distinct. **Spore print** not observed.

Basidiospores 4–4.5 × 2.5–3 µm, $Q=1.3–1.8$, $Q_m=1.55$, cylindrical to subcylindrical, hyaline, smooth, thin walled, eguttulate, inamyloid in Melzer's reagent. **Basidia** not observed. **Cystidia** absent, but ends of skeletal hyphae project from the hymenium, as cystidia like structures, with thick walled apices, sometimes weakly encrusted. Cystidioles not observed. **Hymenial trama** interwoven. Generative hyphae 1–2 µm wide, hyaline, smooth, mostly flexuose, thin walled, branched, with clamp connections (rarely observed). Skeletal hyphae 3–6 µm wide, hyaline, smooth, thick walled (1–2 µm), sparsely branched, septations not observed. Skeleto ligative hyphae 2–3 µm wide, irregularly widened at some regions, hyaline, smooth, thick walled (1 µm), flexuous, frequently branched, branches short. **Pileal trama** interwoven. Generative hyphae more frequent than hymenium; 2–2.5 µm wide, hyaline, mostly erect, smooth, thin walled, branched, with clamp connections. Skeletal hyphae 3–7 µm wide, hyaline, smooth, thick walled (1–2 µm), sparsely branched, septations not observed. Skeleto ligative hyphae 2–3 µm wide, hyaline, smooth, thick walled (1 µm), branched, branches short. **Pileipellis** forming long and thick trichodermial patches made of hyphae that are 2–5 µm wide, hyaline, mostly thick walled hyphae with obtuse ends.

Specimens examined: India. Kerala State: Ernakulam district, Iringole Kavu, on dead wood (unidentified), 08 July 2017, Vinjusha N ZGCVN564; Thiruvananthapuram district, Peppara, on rotten log (unidentified), 26 November 2018, Chandini V. K., ZGCVN774.

Comments: Morphology of the present collection properly matches with the description of *Daedalea radiata* by Li & Cui (2013) The specimen shows similarity with *Trametes trogii* Berk in morphological characters. Howerver the latter is separated from the present specimen by having large basidiospores (8–12 × 2.5–4 µm, as per the description of Ryvarden & Gilbertson 1993; 6.9–9 × 2.5–3.5 µm, as per the description of Niemelä *et al*. 1992). According to the original description of *Daedalea radiata* (Li & Cui 2013), hymenium of the species possesses fusoid cystidioles. However, fusoid cystidioles were not observed in the present specimen.

BLAST search using the newly generated ITS sequence of the specimen resulted in 99% identity with *Daedalea radiata* (GenBank number: KP171210). BLAST result also showed 98% similarity with *Trametes trogii* (AJ542522). So far, *Deadalea radiata* has been reported only from its type locality, China.

Rhodofomitopsis B.K. Cui, M.L. Han & Y.C. Dai

Basidiomata annual to perennial, leathery to woody hard, effused reflexed to Pileate. Pileus sessile, semicircular, with or without zonations and sulcations, velutinate to glabrous, straw, tan, brownish pink, rosy brown to blackish brown colours. Hymenophore poroid to weakly labyrinthiform, subdaedaleoid to sinuous-daedaleoid, pore surface rose, lilac to pinkish-brown or dirty brown. Context rose to pinkish brown. hyphal system dimitic, generative hyphae hyaline, thin walled, with clamp connections. Skeletal hyphae hyaline to pale golden yellow, thick walled. Cystidia absent. Basidia clavate, 4 sterigmate. Basidiospores ellipsoid, navicular, to cylindrical, hyaline, smooth, thin walled, inamyloid in Melzer’s reagent. Members cause brown rot on wood.

Rhodofomitopsis feei (Fr.) B.K. Cui, M.L. Han & Y.C. Dai, in Han, Chen, Shen, Song, Vlasák, Dai & Cui, Fungal Diversity 80: 366 (2016)

Basionym: *Polyporus feei* Fr., Linnaea 5: 518 (1830)
Synonyms:
Trametes marchionica Mont., in Dumont d'Urville, Voy. Pole Sud, Bot. 1: 204 (1845)
Polyporus marchionicus (Mont.) Lév., Annls Sci. Nat., Bot., sér. 3 5: 300 (1846)
Polystictus feei (Fr.) Fr., Nova Acta R. Soc. Scient. upsal., Ser. 3 1 (1): 83 (1851)
Polyporus eucalypti Kalchbr., Grevillea 4 (no. 30): 73 (1875)
Polyporus eucalypticola F. Muell., Fragm. phytogr. Austr. 11: 84 (1881)
Polystictus eucalypti (Kalchbr.) Cooke, Grevillea 14 (no. 71): 82 (1886)
Trametes sagrana (Mont.) Sacc. [as '*sagrœana*'], Syll. fung. (Abellini) 6: 336 (1888)
Microporus eucalypti (Kalchbr.) Kuntze, Revis. gen. pl. (Leipzig) 3 (3): 496 (1898)
Microporus feei (Fr.) Kuntze, Revis. gen. pl. (Leipzig) 3 (3): 496 (1898)
Trametes feei (Fr.) Pat., Essai Tax. Hyménomyc. (Lons-le-Saunier): 92 (1900)
Fomes sagranus (Mont.) Murrill [as '*sagrœanus*'], N. Amer. Fl. (New York) 9 (2): 96 (1908)
Trametes eucalypti (Kalchbr.) Lloyd, Mycol. Writ. 6 (Letter 59): 226 (1915)
Polystictus feei var. *substipitatus* Speg., Boln Soc. Cienc. Córdoba 28: 380 (1926)
Fomes feei (Fr.) J. Lowe, Mycologia 47 (2): 217 (1955)
Fomitopsis feei (Fr.) Kreisel, Ciencias Biológicas, Cuba 16: 83 (1971)
Trametes feei var. *irpicoidea* Corner, Beih. Nova Hedwigia 97: 101 (1989)

FIGURE 94

Basidiomata annual, medium sized, usually in clusters, hard and woody, effused reflexed to pileate. Pileus sessile, broadly attached, adjacent pilei often fused forming compound fruit bodies, applanate, semicircular, 25–70 mm long, 4–12 mm thick, hard and tough on drying, almost glabrous, slightly hispid at some regions, pink to pinkish white when fresh, brown with age, turning dark brown in KOH, margin even to slightly irregular. **Hymenophore** poroid. **Pores** 7–10 per mm, round to slighly angular, absent along margin, dull white, pale pinkish along margin, pore tubes non stratified, cream, light brown on bruising. **Context** up to 6 mm thick, pale pink to pinkish white, turning very pale brown on handling. **Odour** not distinctive. **Spore print** not observed.

Basidiospores 4–6 × 1.5–3 µm, Q=1.4–2.9, Q_m=1.8, cylindric ellipsoid, smooth, thin-walled, inamyloid in Melzer's reagent. **Basidia** 9.5–16 × 3.5–5 µm, clavate, 4 sterigmate, with basal clamp connection. Cystidia absent. **Hymenial trama** interwoven and interwoven. Generative hyphae 2–3 µm wide, hyaline, smooth, thin walled, branched, with clamp connections. Skeletal hyphae 3–5 µm wide, hyaline, thick walled (1 µm), unbranched or sparsly branched. Skeleto ligative hyphae 2–2.5 µm wide, hyaline, thick walled (1 µm), mostly solid, moderately branched. **Pileal trama** interwoven. Generative hyphae 1–3 µm wide, hyaline, smooth, thin walled, branched, with clamp connections. Skeletal hyphae 3–5 µm wide, hyaline, thick walled (1 µm), unbranched or sparsly branched, Skeleto ligative hyphae not frequent, 2–3 µm wide, hyaline, thick walled (1 µm), mostly solid, moderately branched. **Pileipellis** a cutis made of hyphae that are 2–4 µm wide, slightly thick walled and light brown in mass.

Specimens examined: India. Kerala State: Kottayam district: Vagamon, Pine valley, on dead wood of *Pinus* species, 24 October 2015, Vinjusha N., ZGCVN241; Kozhikode district, Peruvannamuzhy forest, on dead branch (unidentified), 11 August 2016, Vinjusha N., ZGCVN406; on dead logs (unidentified), 24 June 2017, Vinjusha N., ZGCVN513, ZGCVN521; on fallen *Sweitenia mahagoni*, 26 July 2019, Vinjusha N., ZGCVN863; Kakkad, on fallen tree trunk (unidentified), 13 July 2017, Vinjusha N., ZGCVN574, ZGCVN576; Kuttyadi, Janaki forest, on fallen tree (unidentified), Vinjusha N., ZGCVN720; Thrissur district, Peechi, on dead log (unidentified), 25 June 2017, Manju A. C., ZGCVN536; Wayanad district, Pookod, on dead wood stump (unidentified), 30 June 2017, Vinjusha N., ZGCVN553.

Comments: Pore size of *Fomitopsis feei* is described as 5–6 per mm (Gilbertson & Ryvarden 1986), and (3) 4–7 (–8) per mm (Carranza-Morse & Gilbertson 1986). Whereas, the present collections have smaller pores (7–10) per mm. *Rhodofomes* *cajanderi* (P. Karst.) B.K. Cui, M.L. Han & Y.C. Dai is the closely related species, but separated by having narrowly cylindric and curved spores (Han *et al*. 2016).

Rhodofomitopsis feei is widespread throughout tropical America and Asia (Núñez & Ryvarden 2001). From Kerala, this species has been recorded (as *Fomitopsis feei* (Fr.) Kreisel) by Leelavathy & Ganesh (2000), Iqbal *et al.* (2016) and Adarsh *et al.* (2018).

Pilatoporus Kotlaba & Pouzar

Basidiomata annual, tough to hard basidiomata, pileate. Pileus sessile to dimidiate, surface fibrous or rough. Hymenium poroid, with round pores. Context white. Hyphal system trimitic, generative hyphae hyaline, with clamp connections. Cystidia absent. Basidiospores cylindrical, hyaline, thin walled, smooth inamyloid in Melzer's reagent.

Pilatoporus ostreiformis (Berk.) Zmitr., Folia Cryptogamica Petropolitana (Sankt-Peterburg) 6: 89 (2018)

Basionym: *Polyporus ostreiformis* Berk. [as '*ostreaeformis*'], J. Linn. Soc., Bot. 16 (no. 89): 46 (1878)
Synonyms:
Trametes ostreiformis (Berk.) Murrill, Bull. Torrey bot. Club 34: 474 (1907)
Funalia ostreiformis (Berk.) Murrill, Bull. Torrey bot. Club 34: 474 (1907)
Tyromyces ostreiformis (Berk.) Imazeki, Bull. Tokyo Sci. Mus. 6: 84 (1943)
Daedalea ostreiformis (Berk.) A.B. De, Can. J. Bot. 59 (7): 1300 (1981)
Tyromyces ostreiformis var. *latiporus* Corner, Beih. Nova Hedwigia 96: 185 (1989)
Tyromyces ostreiformis var. *microsporus* Corner, Beih. Nova Hedwigia 96: 185 (1989)
Tyromyces ostreiformis var. *pertrimiticus* Corner, Beih. Nova Hedwigia 96: 185 (1989)
Fomitopsis ostreiformis (Berk.) T. Hatt., Mycoscience 44 (4): 272 (2003)

FIGURE 95

Basidiomata small to medium sized, often found in clusters, soft and fleshy when fresh, light in weight, becoming hard, margin incurved on drying, pileate. **Pileus** 35–85 mm long, 3–7 mm thick, laterally attached, dimidiate, semicircular to flabelliform, applanate, zonations absent, glabrous at most part, pubescent hairs present towards the margin, creamish white, turning dull greyish with age, margin wavy. **Hymenophore** poroid. **Pores** 4–5 per mm, irregular, pore tubes up to 4 mm long, absent at the margin, creamish white, turning pale brown on bruising, dissepiments 96–240 µm wide. **Context** 2 mm thick, cream, woody. **Odour** not distinctive. **Spore print** not observed.

Basidiospores 6–8 × 2–3 µm, Q=2.4–4, Q_m=2.7, cylindrical, hyaline, smooth, thin walled, with guttulate contents, inamyloid in Melzer's reagent. **Basidia** 14–22 × 5–7 µm, clavate, 4 sterigmate, with basal clamp connection. **Cystidia** absent. **Hymenial trama** interwoven and dimitic. Generative hyphae 2–3 µm wide, hyaline, smooth, slightly (up to 1 µm) thick walled, branched, with frequent clamp connections. Skeletal hyphae 2–4 µm, hyaline, smooth, thick walled (1 µm), sparsely branched, sepations not observed. Skeleto ligative hyphae not observed. **Pileal trama** interwoven. Generative hyphae 2–4 µm wide, hyaline, smooth, slightly (up to 1 µm) thick walled, branched, with frequent clamp connections. Skeletal hyphae 2–5 µm, hyaline, smooth, thick walled (1 µm), sparsely branched, sepations not observed. Skeleto ligative hyphae rarely observed; 1–3 µm, hyaline, thick walled (1 µm), lumen narrow or absent, branched, septations not observed. **Pileipellis** composed of hyphae that are slightly interwoven at the base to form a trichodermium; hyphae 2–4 µm wide, hyaline, thick walled, with obtuse ends.

Specimens examined: India. Kerala State: Kozhikode district, Chalappuram, on dead log of *Cocos nucifera*, 06 July 2015, Vinjusha N, ZGCVN16; Kaduppini, on dead wood of unknown tree, 01 September 2013, Vinjusha N., ZGCVN26; Kakkodi, on dead wood of *Cocos nucifera*, 22 August 2015, Vinjusha N., ZGCVN132.

Comments: *Pilatoporus ostreiformis* is closely related to *Deadalea quercina*, however, the latter possesses sinuous to daedaleoid pores (Ryvarden & Johansen 1980; De 1981). Fidalgo (1962) and Roy (1969) described the basidiocarps of *P. ostreiformis* as monomitic, and Bakshi (1971) described it as dimitic. Hyphal system of *Pilatoporus ostreiformis* was confirmed as trimitic in the study of De (1981, treated as *Daedalea ostreiformis* (Berk.) De). According to the study (De 1981), skeleto ligative hyphae was present in the context region and basal portion of the fruit bodies of the species. In the present collection, skeleto ligative hyphae was observed only in the context region.

BLAST search using the ITS sequence generated from the material showed 100% similarity with *P. ostreiformis* (GenBank numbers: KY449363, KY264027, KC595918). BLAST result also showed 99% similarity with *Trametes nivosa* (Berk.) Murrill, however, the latter possess slightly smaller pores (6–8 per mm) and gloeoplerous hyphae (Núñez & Ryvarden 2001).

Rubellofomes B.K. Cui, M.L. Han & Y.C. Dai

Basidiomata annual to perennial, hard and woody, resupinate to pileate. Pileus orange brown to dark brown, glabrous, often concentrically strongly zonate and sulcate. Hymenophore poroid, pores angular, pore surface white, cream to purple pink, turning straw coloured to cinnamon brown on drying. Context purple pink to light pinkish brown. Hyphal system dimitic, generative hyphae hyaline, thin walled, with clamp connections. Skeletal hyphae hyaline to pale brown, thick walled. Cystidia present or absent, when present, clavate to cylindrical, encrusted at tip. Basidiospores ellipsoid to cylindrical, hyaline, thin walled, inamyloid in Melzer's reagent. Species cause brown rot on wood.

Rubellofomes cystidiatus (B.K. Cui & M.L. Han) B.K. Cui, M.L. Han & Y.C.

Basionym: *Fomitopsis cystidiata* B.K. Cui & M.L. Han, in Han & Cui, Mycol. Progr. 13 (3): 908 (2014)

FIGURE 96

Basidiomata annual, medium sized, hard and woody, light in weight, especially on drying, pileate. **Pileus** 30–65 mm long, 14–20 mm thick, sessile, broadly attached, difficult to detach from the host when fresh, applanate to slightly irregular with minute ridges and grooves, almost semicircular, glabrous, purplish brown to cinnamon brown, orangish yellow towards margin, more brown on drying, turning brownish black in KOH, margin even, round. **Hymenophore** poroid. Pores large, 1–3 mm wide, less wider towards margin, angular, absent along margin, pale purplish brown, more brownish on drying, pore tubes 10–15 mm long, concolorous with pore surface. **Context** 3–5 mm thick, very pale pinkish brown, homogenous. **Odour** not distinctive. **Spore print** not observed.

Basidiospores 5–8 × 2–3 µm, Q=3–4, Q_m=3.4, cylindrical, often slightly bent, smooth, thin to slightly thick walled, eguttulate, inamyloid in Melzer's reagent. **Basidia** 26–32 × 3–4 µm, clavate, 2 sterigmate, with basal clamp connection. **Cystidia** 31–42 × 4–6.0 µm, clavate to cylindrical, hyaline, thick walled (1 µm), encrusted at most part. **Hymenial trama** interwoven and dimitic. Generative hyphae 2–3 µm wide, hyaline, slightly thick to thick walled, branched, with clamp connections. Skeletal hyphae 2–5 µm wide, hyaline, thick walled (1 µm), often unbranched, sometimes weakly branched, septations not observed. Skeleto ligative hyphae not observed. **Pileal trama** interwoven. Generative hyphae 2–3 µm wide, septate, hyaline, mostly thick walled, branched, with clamp connections. Skeletal hyphae 3–5 µm wide, hyaline, unbranched or sparsly branched, septations not observed, thick walled (1 µm). Skeleto ligative hyphae not observed. **Pileipellis** an agglutinated cutis, made of hyphae that are 2–3 µm wide, slightly thick walled and yellowish brown.

Specimen examined: India. Kerala State: Palakkad district, Mannarkkad, Silent Valley National Park areas, on dead wood (unidentified), 14 January 2018, Chandini V. K., ZGCVN667.

Comments: The genus *Rubellofomes* consist of only two species, *R. minutisporus* and *R. cystidiatus*. *R. minutisporus* is similar to the present collection. However absence of cystidia and smaller spores (4–5×2–3 µm) separates this species from our collection. As per the original description (Han *et al.* 2014), basidiospores size of *R. cystidiatus* is 4.9–6.2 (–6.5) × 2.0–2.8 (–2.9) µm. Whereas, present collections have slightly larger spores. According to Han *et al.* (2014), pileus surface of *R. cystidiatus* is concentrically zonate. However, proper zonations or concentric rings were not observed in present specimen.

Rubellofomes cystidiatus was described from South China (as *Fomitopsis cystidiata* B.K. Cui & M.L. Han) by Han *et al.* (2014). Since then, there are no reports of this species from other parts of the world. Therefore, this is the first report of the species outside its type locality.

Fomitopsis P. Karst.

Basidiomata annual to perennial, solitary or in clusters, hard and woody, effused-reflexed to pileate. Pileus sessile, semicircular to flabelliform, applanate, mostly azonate, white, cream or pale coloured. Hymenophore poroid, pores round to angular, pore surface white to tan, pore tubes concolorous with pore surface. Context white to cream, homogenouos. Hyphal system dimitic to trimitic, with hyaline generative hyphae, having clamp connections, and hyaline, thick walled skeletal hyphae, and skeleto ligative hyphae. Cystidia absent. Thin walled cystidioles may be present. Basidia clavate, 4 sterigmate, with basal clamp connections. Basidiospores subglobose to cylindrical, hyaline, smooth, thin to thick walled, negative in Melzer's reagent. Members causes brown rot on wood.

Fomitopsis palustris (Berk. & M.A. Curtis) Gilb. & Ryvarden, Mycotaxon 22 (2): 364 (1985)

Basionym: *Polyporus palustris* Berk. & M.A. Curtis, in Berkeley, Grevillea 1 (no. 4): 51 (1872)
Synonyms:
Pilatoporus palustris (Berk. & M.A. Curtis) Kotl. & Pouzar, Česká Mykol. 44 (4): 230 (1990)
Tyromyces palustris (Berk. & M.A. Curtis) Murrill, N. Amer. Fl. (New York) 9 (1): 31 (1907)
Trametes palustris (Berk. & M.A. Curtis) Ryvarden, Norw. Jl Bot. 24: 223 (1977)
Postia palustris (Berk. & M.A. Curtis) A.B. De, J. Mycopathol. Res. 33 (1): 9 (1995)

FIGURE 97

Basidiomata annual, medium sized, solitary, hard and woody, nearly coriaceous when fresh, hard, rigid and light in weight on drying, pileate. **Pileus** 100 mm long, 10 mm thick, dimidiate, broadly attached, semicircular, applanate, slightly umbonate near attachment part, concentric zonations absent, pelliculose, glabrous, rough with uneven minute tubercles, creamish white, light brown on bruising, margin even, round. **Hymenophore** irregularly poroid. Pores 2–4 per mm, absent along margin, off white, light brown on bruising, pore tubes 5 mm long, non stratified, concolorous with pore surface. **Context** 6 mm thick, creamish white, homogenous, turning very pale brown on handling. **Odour** not distinct. **Spore print** not observed.

Basidiospores 5.5–7 × 2–3 µm, Q=2–3, Q_m=2.5, cylindrical, hyaline, smooth, thin walled, eguttulate, inamyloid in Melzer's reagent. **Basidia** not observed. **Cystidia** absent. **Hymenial trama** interwoven and trimitic. Generative hyphae 2–3 µm wide, hyaline, smooth, thin walled, branched, with clamp connections. Skeletal hyphae 3–7 µm wide, hyaline, thick walled (1–2 µm), sparsly branched, septations not observed. Skeleto ligative hyphae 2–5 µm wide, hyaline, thick walled (1 µm), moderately branched, mostly without lumen. **Pileal trama** interwoven. Generative hyphae 2–4 µm wide, hyaline, smooth, thin walled, branched, with clamp connections. Skeletal hyphae 3–8 µm wide, hyaline, thick walled (up to 4 µm), sparsly branched. Skeleto ligative hyphae 2–4 µm wide, hyaline, thick walled (1 µm), branched. **Pileipellis** an irregular cutis, made of hyphae that are 2–6 µm wide, slightly thick walled and light brown in mass.

Specimen examined: India. Kerala State: Idukki district, Vattavada, on dead wood (unidentified), 28 July 2019, Vinjusha N., ZGCVN899.

Comments: Characters of the present collection properly fits with the description of *F. palustris* by Ryvarden & Gilbertson (1994), Núñez & Ryvarden (2001) and Ryvarden & Melo (2014). Present collection resembles a young specimen of *Fomitopsis betulina* (Bull.) B.K. Cui, M.L. Han & Y.C. Dai in morphology. Pileal surface of *F. betulina* usually have a scaly appearance (Ryvarden & Gilbertson 1994), whereas, scales are totally absent on pileus surface of present collection. In addition, *F. betulina* produces slightly allantoid basidiospores (1.5–1.7 µm wide), whereas, present collection produces cylindrical basidiospores that are 2–3 µm wide. The present collection of *F. palustris* have slightly larger pores (2–4 per mm), when compared to the previous Kerala collection of the species (4–5 per mm, Leelavathy & Ganesh 2000). From Kerala, *F. palustris* was also documented by Leelavathy & Ganesh (2000) and Mohanan (1994).

Fomitopsis caribensis B.K. Cui & Shun Liu, Mycological Progress 18: 1317–1327 (2019)

FIGURE 98

Basidiomata small to medium sized, found in imbricate clusters, hard and woody, light in weight, effused reflexed to pileate. **Pileus** 22–110 mm long, 5–21 mm thick, sessile, broadly attached, semicircular, applanate, zonations absent, rough, glabrous to minutely pubescent, cream buff, pale yellowish brown along margin, margin even, obtuse. **Hymenophore** poroid. **Pores** 7–10 per mm, round, cream, pore tubes 2–3 mm long, concolourous with pore surface. **Context** 2–3 mm thick, cream, homogenous. **Odour** not distinctive. **Spore print** not observed.

Basidiospores 5–5.5 × 2–3 µm, Q=1.8–2.5, Q_m=2.1, cylindrical, hyaline, smooth, thin walled, eguttulate, inamyloid in Melzer's reagent. **Basidia** not observed. **Cystidia** absent. **Hymenial trama** interwoven and dimitic. Generative hyphae 2–3 µm wide, hyaline, smooth, thin walled, branched, with clamp connections. Skeletal hyphae 3–5 µm, hyaline, smooth, thick walled (1µm), unbranched, septations not observed. Skeleto ligative hyphae not observed. **Pileal trama** interwoven. Generative hyphae 2–3 µm wide, hyaline, smooth, thin walled, branched, with clamp connections. Skeletal hyphae 2–6 µm, hyaline, smooth, thick walled (1 µm), unbranched, septations not observed. Skeleto ligative hyphae not observed. **Pileipellis** interwoven at base to form erect trichoderm, made of hyphae that are 2–5 µm wide, hyaline, thick walled, with obtuse ends.

Specimens examined: India. Kerala State: Palakkad district, Dhoni, on *Swietenia mahagoni*, *Hopea parviflora*, 28 November 2018, Vinjusha N., ZGCVN769; Wayanad district, Kuruva Island, on fallen tree trunk (unidentified), 07 December 2018, Vinjusha N., ZGCVN781.

Comments: The Kerala collection agrees with the original taxonomic description of *F. caribensis* by Liu *et al.* (2019). According to Liu *et al.* (2019), size of basidiospores of the species is 6–7.5 × 2.3–3.1 µm. When compared to this, present collection has slightly smaller basidiospores (5–5.5 × 2–3 µm).

BLAST search using the newly generated LSU sequence from the present collection showed 97% similarity with *Antrodia xantha* (Fr.) Ryvarden (GenBank number: JX507730), and *Ranadivia modesta* (Kunze *ex* Fr.) Zmitr. (KP171226), 96% similarity with *Phaeodaedalea incerta* (Curr.) Ţura, Zmitr., Wasser & Spirin (KP171234), *Daedalea stevensonii* Petr. (KP171235), *D. hydnoides* I. Lindblad & Ryvarden (KP171225), *D. circularis* B.K. Cui & Hai J. Li (KP171222), *Rhodofomitopsis feei* (Fr.) B.K. Cui, M.L. Han & Y.C. Dai, in Han, Chen, Shen, Song, Vlasák, Dai & Cui (KF999927), 95% similarity with *Fomitopsis ginkgonis* B.K. Cui & Shun Liu (NG_068655, MK860115), *F. eucalypticola* B.K. Cui & Shun Liu (NG_068654, MK860113), *F. caribensis* B.K. Cui & Shun Liu (MK860108), *Daedalea radiata* B.K. Cui & Hai J. Li (KP171233), and *F. pinicola* (MN217407). Although, *A. xantha* showed 97% similarity with the Kerala collection, morphology the former is separted from the present collections by having strictly resupinate, widely effused basidiomata or with nodulolose knobs or blocks, having bright sulphurous yellow coloured hymenophore (according to the descriptions by Lombard & Gilbertson 1965; Lowe 1966; Ryvarden & Gilbertson 1993; Roy & De 1997). *Ranadivia modesta* also showed 97% similarity with our collection, however, the former produces trimitic hyphal system, having skeleto ligative hyphae with dense branches in the hymenium (as per the descriptions of Corner 1989; Núñez & Ryvarden 2001). Present collection has a dimitic hyphal system, and skeleto ligative hyphae are entirely absent. Fruit bodies of *R. modesta* are usually with a distinct small stipe with a discoid base, and are rarely above 3–4 mm thick (Corner 1989; Núñez & Ryvarden 2001). However, our collections have sessile and broadly attached basidiocarps, that are never stipitate, with a thickness of 5–21 mm. In addition, *R. modesta* produces white rot on the host. However, present Kerala collection produced brown rot on wood.

Phaeodaedalea incerta is distinguished from the present specimens by having almost black coloured pileus in mature fruit bodies, daedaleoid to labyrinthine or lamellate pore surface, trimitic hyphal system, and presence of cystidia (according to the description of Ryvarden & Johansen (1980, as *Daedalea sprucei* Berk.). Perennial basidiomata with stratified pore tubes, presence of bluish grey to peach coloured pileus, and trimitic hyphal system separates *D. circularis* (as per the description of Li & Cui 2013) from our collections. The presence of hydnoid and daedaleoid pore surface distinghuishes *D. hydnoides* and *D. stevensonii* from present collections (Lindblad & Ryvarden 1999; Petrak 1959 respectively). in addition, *D. hydnoides* produces dark brown basidiomata, and skeletocystidia. Basidiocarps of *Rhodofomitopsis feei* always produces pink to pinkish brown pileus and pore surface and trimitic hyphal system (Ryvarden & Johansen 1980; Núñez & Ryvarden 2001; Ryvarden & Melo 2014).

Fomitopsis ginkgonis is morphologically distinguished from the present Kerala collections by having dirty grayish brown to mouse grey coloured pileal surface, trimitic hyphal system and larger basidiospores ((7–) 7.2–9 × (2–) 2.2–3 (−3.3) µm) (Liu *et al.* 2019). Similarly, trimitic hyphal system, and larger basidiospores ((5.5–) 5.8–9.1 (−11.5) × 2.7–5 (− 5.2) µm in *F. eucalypticola* separates it from the present collections. Other similar species, *Fomitopsis pinicola* and *Daedalea radiata* are distinguished from our collections by having trimitic hyphal system and also partly daedaleoid hymenium in the latter (as per the descriptions of Ryvarden & Gilbertson 1993 and Li & Cui 2013 respectively). In addition *F. pinicola* produces cylindric ellipsoid basidiospores, that are 3.5–4.5 µm wide) (Núñez & Ryvarden 2001).

Thus, the present collection is identified as *F. caribensis,* based on the original taxonomic description, and a sequence similarity of 95% with the accession of the species from the type material.

Antrodia P. Karst

Basidiomata annual to perennial, resupinate to effused reflexed, hard and woody. Pileus when present, sessile, zonate to azonate, glabrous, white to cream. Context white to cream, homogenous. Hymenophore poroid, pores round to angular, or elongated angular, pore surface dull white, cream to tan, pore tubes conclorous with pore surface. Hyphal system dimitic, generative hyphae hyaline, thin to slightly thick walled, with clamp connections. Skeletal hyphae hyaline, thick walled, weakly to strogly metachromatic in cresyl blue. Cystidia absent. Basidia clavate, 4 sterigmate. Basidiospores cylindrical, allantoid to oblong ellipsoid, hyaline, thinwalled, smooth, inamyloid in Melzer’s reagent. *Antrodia* causes brown rot on wood.

Antrodia albida (Fr.) Donk, Persoonia 4 (3): 339 (1966)

Basionym: *Daedalea albida* Fr., Observ. mycol. (Havniae) 1: 107 (1815)
Synonyms
Polyporus serpens Fr., Observ. mycol. (Havniae) 2: 265 (1818)
Daedalea serpens (Fr.) Fr., Syst. mycol. (Lundae) 1: 340 (1821)
Daedalea albida Schwein., Schr. naturf. Ges. Leipzig 1: 93 [67 of repr.] (1822)
Lenzites albidus (Fr.) Fr., Epicr. syst. mycol. (Upsaliae): 405 (1838)
Trametes sepium Berk., London J. Bot. 6: 322 (1847)
Trametes albida (Fr.) Fr., Summa veg. Scand., Sectio Post. (Stockholm): 324 (1849)
Trametes serpens (Fr.) Fr., Hymenomyc. eur. (Upsaliae): 586 (1874)
Antrodia serpens (Fr.) P. Karst., Meddn Soc. Fauna Flora fenn. 5: 40 (1879)
Physisporus serpens (Fr.) P. Karst., Acta Soc. Fauna Flora fenn. 2 (no. 1): 31 (1881)
Cellularia albida (Fr.) Kuntze, Revis. gen. pl. (Leipzig) 3 (3): 451 (1898)
Coriolellus sepium (Berk.) Murrill, Bull. Torrey bot. Club 32 (9): 481 (1905)
Trametes serpens subsp. *albida* (Fr.) Bourdot & Galzin, Bull. trimest. Soc. mycol. Fr. 41 (2): 167 (1925)
Agaricus serpens (Fr.) E.H.L. Krause, Basidiomycetum Rostochiensium, Suppl. 4: 143 (1932)
Coriolellus serpens (Fr.) Bondartsev, Trut. Grib Evrop. Chasti SSSR Kavkaza [Bracket Fungi Europ. U.S.S.R. Caucasus] (Moscow-Leningrad): 513 (1953)
Coriolellus albidus (Fr.) Bondartsev, Trut. Grib Evrop. Chasti SSSR Kavkaza [Bracket Fungi Europ. U.S.S.R. Caucasus] (Moscow-Leningrad): 504 (1953)

FIGURE 99

Basidiomata annual, resupinate, adnate, in small to medium sized patches, soft and coriaceous, light in weight, up to 2 mm thick, margin uneven, rhizomorphs absent. **Pileus** absent. **Hymenophore** elongated poroid. Pores 1–2 per mm, mostly oblique on the substratum, some areas irpicoid, dull white, cream to light brown on bruising. Context indistinct, less than 1 mm thick, cream, homogenous. **Odour** not distinctive. **Spore print** not observed.

Basidiospores 12–14 × 3–3.5 µm, Q=3.7–4, Q_m=3.85, cylindrical, hyaline, smooth, thin walled, monoguttulate, inamyloid in Melzer's reagent. **Basidia** not observed. **Cystidia** absent. **Hymenial trama** interwoven and dimitic. Generative hyphae 2–3 µm wide, hyaline, smooth, thin to slightly thick walled (up to 1 µm), highly branched, with clamp connections. Skeletal hyphae hyaline, weakly metachromatic in cresyl blue, thick walled (2 µm), unbranched, septations not observed, easily broken and stained along the broken walls. **Pileal trama** interwoven. Generative hyphae 2–3 µm wide, hyaline, smooth, thin to slightly thick walled (up to 1 µm), branched, with clamp connections. Skeletal hyphae predominant, hyaline, thick walled (2 µm), unbranched, septations not observed, easily broken and stained along the broken walls.

Specimen examined: India. Kerala State: Kozhikode district, Chelavoor, Thurayil Kotta, on dead branch (unidentified), 11 August 2018, Vinjusha N., ZGCVN701.

Comments: Characters of the present specimen fits well with the descriptions of *A. albida* by Ryvarden & Johansen (1980), Ryvarden & Gilbertson (1993), and Núñez & Ryvarden (2000). The larger size of basidiospores (12–14 µm long) of *Antrodia albidia* easily distinguishes it from other closely related resupinate species of the genus, like *A. gossypina* (Speg.) Ryvarden, *A. heteromorpha* (Fr.) Donk., and *A. sinuosa* (Fr.) P. Karst.

Antrodia albida is a widely distributed temperate species (Núñez & Ryvarden 2001). This species has been reported from Kerala by Mohanan (2011).

Neoantrodia Audet

Basidiomata annual to perennial, often found in imbricate clusters, coriaceous to hard and woody, effused reflexed to pileate. Pileus sessile, cream to pale brown. Hymenophore poroid, pores mostly angular to oblique, pore surface cream to pale brown, pore tubes creamish white to pale brown. Context cream to brownish in colour. Hyphal system dimitic, with hyaline, thin to thick walled generative hyphae, having clamp connections, and hyaline, thick walled skeletal hyphae. Cystidia absent. Encrusted cystidioles present or absent. Basidia clavate, 4 sterigmate. Basidiospores cylindrical to fusoid, hyaline, thin walled, inamyloid in Melzer's reagent. The genus causes brown rot on wood.

Neoantrodia serialis **(**Fr.) Audet, Mushrooms nomenclatural novelties 6: [2] (2017)

Basionym: *Polyporus serialis* Fr., Syst. mycol. (Lundae) 1: 370 (1821)
Synonyms:
Polyporus callosus Fr., Syst. mycol. (Lundae) 1: 381 (1821)
Boletus serialis (Fr.) Spreng., Syst. veg., Edn 16 4 (1): 278 (1827)
Trametes serialis (Fr.) Fr., Hymenomyc. eur. (Upsaliae): 584 (1874)
Fomitopsis serialis (Fr.) P. Karst., Revue mycol., Toulouse 3 (no. 9): 18 (1881)
Physisporus callosus (Fr.) P. Karst., Revue mycol., Toulouse 3(no. 9): 18 (1881)
Poria callosa (Fr.) Quél., Enchir. fung. (Paris): 110 (1886)
Trametes contigua Wettst., Verh. zool.-bot. Ges. Wien 38: 180 (1888)

Polyporus favogineus (Hoffm. ex Harz) Wettst., Verh. zool.-bot. Ges. Wien 38: 181 (1888)
Polyporus vaporarius var. *favogineus* Hoffm. ex Harz, Botan. Zbl. 36: 379 (1888)
Polyporus pseudoannosus Velen., České Houby 4-5: 659 (1922)
Coriolellus serialis f. *resupinatostratosus* Domański [as '*resupinatostratosa*'], Fragm. flor. geobot. (Kraków) 8 (4): 514 (1962)
Coriolus serialis f. *resupinatus* (Bourdot & Galzin) Komarova, Opredelitel' trutovykh gribov Belorussii: 143 (1964)
Antrodia serialis (Fr.) Donk, Persoonia 4 (3): 340 (1966)
Daedalea serialis (Fr.) Aoshima, Trans. Mycol. Soc. Japan 8 (1): 2 (1967)

FIGURE 100

Basidiomata small to medium sized, found in imbricate clusters, weakly coriaceous when fresh, becoming hard on drying, easily separated from the host as a sheath, light in weight, effused reflexed to pileate. **Pileus** 20–30 mm long, 25–30 mm thick, sessile, broadly attached, pileus always fused and becoming compound fruit bodies, semicircular, applanate, concentrically zonate, sulcate, with minute tubercles, glabrous, cream to pale brown, margin even, obtuse. **Hymenophore** poroid. **Pores** 3–4 per mm, angular, becoming oblique, large and elongated towards attachment region, cream with a pale brownish tint, pore tubes up to 2 mm long, creamish white, concolourous with pore surface. **Context** 2 mm thick, cream, light brown on upper side. **Odour** not distinctive. **Spore print** not observed.

Basidiospores 7–11 × 2.5–3 µm, Q=2.5–4, Q_m=3.55, cylindrical, hyaline, smooth, thin walled, with guttulate contents, inamyloid in Melzer's reagent. **Basidia** 12–20 × 5–6 µm, clavate, hyaline, 4 sterigmate, with basal clamp connection. **Cystidia** absent. **Hymenial trama** interwoven and dimitic. Generative hyphae 2–3 µm wide, hyaline, smooth, thin walled, branched, with clamp connections. Skeletal hyphae 2–5 µm, hyaline, smooth, thick walled (1 µm), sparsely branched, many hyphae flexuose, septations not observed. Skeleto ligative hyphae not observed. **Pileal trama** interwoven. Generative hyphae 2–3 µm wide, hyaline, smooth, thin walled, branched, with clamp connections. Skeletal hyphae 2–5 µm, hyaline, smooth, thick walled (1 µm), less flexuose than in hymenial trama, sparsely branched, septations not observed. Skeleto ligative hyphae not observed. **Pileipellis** an irregular cutis with in between erect, slightly projecting hyphae that are 2–4 µm wide, hyaline, thick walled, with obtuse ends.

Specimen examined: India. Kerala State: Malappuram district, Kadampuzha Temple, on dead wood of *Mangifera indica*, 04 November 2016, Vinjusha N., ZGCVN286.

Comments: Morphology of the present Kerala collection properly match with the taxonomic descriptions of *N. serialis* by Núñez & Ryvarden (2001) and Ryvarden & Melo (2014). The present specimen resembles *Antrodia heteromorpha* (Fr.) Donk in morphology, but differentiated by larger basidiospores (10–13 × 5–7 µm, according to the description of Ryvarden & Melo 2014). Another similar species, *Antrodia albida* is also separated from the present collection by larger basidiospores (10–14 × 3.5–5 µm, based on the description by Núñez & Ryvarden 2001).

Neoantrodia serialis has cosmopolitan distribution in coniferous forests (Ryvarden & Gilbertson (1993). The species is also reported on angiosperms, but not frequent (Lowe 1966). According to (Lowe 1966), the species has widespread distribution in temperate areas of Africa, Asia, Europe, North America and Oceania.

Hydnoporia Murrill

Basidiomata annual, found in imbricate clusters, resupinate to effused reflexed. Pileus sessile, semicircular, applanate, concentrically zonate, tomentose to hirsute, cinnamon brown to brown. Hymenophore smooth to hydnoid, surface brown, mostly paler towards margin. Context thin, yellowish brown, homogenous. Hyphal system monomitic to dimitic, hyphae yellow to dark brown, thick walled. Setae present, subulate, pointed towards tip, dark brown, Basidia clavate, narrowly clavate to cylindrical. Basidiospores cylindrical to allantoid, hyaline, smooth, thin walled, inamyloid in Melzer’s reagent. Members of the genus cause white rot on the wood.

Hydnoporia tabacina (Sowerby) Spirin, Miettinen & K.H. Larss., in Miettinen, Larsson & Spirin, Fungal Systematics and Evolution 4: 93 (2019)

Basionym: *Auricularia tabacina* Sowerby, Col. fig. Engl. Fung. Mushr. (London) 1(no. 5): tab. 25 (1796)
Synonyms:
Thelephora tabacina (Sowerby) Fr., Syst. mycol. (Lundae) 1: 118 (1822)

Thelephora tabacina var. *tabacina* (Sowerby) Fr., Syst. mycol. (Lundae) 1: 118 (1822)
Stereum tabacinum var. *tabacinum* (Sowerby) Fr., Epicr. syst. mycol. (Upsaliae): 550 (1838)
Stereum tabacinum (Sowerby) Fr., Epicr. syst. mycol. (Upsaliae): 550 (1838)
Hymenochaete tabacina (Sowerby) Lév., Annls Sci. Nat., Bot., sér. 3 5: 145 (1846)
Hymenochaete tabacina f. *tabacina* (Sowerby) Lév., Annls Sci. Nat., Bot., sér. 3 5: 145 (1846)
Pseudochaete tabacina (Sowerby) T. Wagner & M. Fisch., Mycol. Progr. 1 (1): 100 (2002)
Hymenochaetopsis tabacina (Sowerby) S.H. He & Jiao Yang, in Yang, Dai & He, Mycol. Progr. 15(2/13): 13 (2016)

FIGURE 101

Basidiomata annual, small, light in weight, coriaceous, effused-reflexed to pileate. **Pileus** 23–45 mm long, less than 1 mm thick, sessile, semicircular to flabelliform, applanate, concentrically zonate, matted tomentose, hairs more prominent along the concentric circles, lesser towards margin, dark ochre to yellowish brown, initially yellow along the margin, black in KOH, margin wavy, thin and papery. **Hymenphore** roughened**,** without pores, surface with projectiong brownish black setae. **Context** less than 1 mm thick, yellowish brown, turning black in KOH. **Odour** not distinctive. **Spore print** not observed.

Basidiospores 4–6 × 1.5–2 µm, Q=2–3, Q_m=2.7, cylindrical, slightly curved, hyaline, smooth, inamyloid in Melzer's reagent. **Basidia** 24–26.5 × 3–4 µm, cylindrical to narrowly clavate, hyaline to yellowish brown, 4 sterigmate, slightly thick–walled. **Hymenial setae** abundant, 69–95 × 5–11 µm, arising from the ends of contextual skeletal hyphae; subulate, tips acute, dark brown, thick walled (2–4 µm), often covered with agglutinated sheath. **Hymenial trama** interwoven and monomitic. Generative hyphae 2.6–4.5 µm wide, yellow to dark brown, smooth, thick walled (up to 1 µm), weakly branched. **Pileal trama** interwoven and monomitic. Generative hyphae 2–4 µm wide, yellow to dark brown, thick walled (up to 1 µm), unbranched to weakly branched. **Pileipellis** forming thick agglutinated trichodermal patches, 25–78 µm long; each hyphae 1.5–3 µm wide, brown, smooth to encrusted, thin to slightly (up to 1 µm) thick walled, with obtuse ends.

Specimens examined: India. Kerala State: Wayanad district, Thirunelli, 16 October 2015, Vinjusha N., ZGCVN233; Chembra Peak, on dead branch (unidentified), 16 November 2018, Vinjusha N., ZGCVN754; Idukki district, Munnar, on dead wood stump (unidentified), Vinjusha N., 26 October 2015, ZGCVN251.

Comments: Morphology of the present collections fits well with the previous descriptions of *H. tabacina* by Chamuris (1988), Parmasto (2001a), and Dai (2010). According to Parmasto (2001a) and Dai (2010), setal hyphae are present in *H. tabacina*. However, setal hyphae were not observed in the present collection. Parmasto (2001a) had opined that setal hyphae present in this species were rare and sometimes were absent in young specimens. This may be a reason for the lack of setal hyphae in the present collection. Present specimen resembles *H. intricata* in morphology. The closely related *Hymenocheatopsis intricata* is distinghuished from the present collecetion by having scanty setae that are broadly subulate (8–15 µm wide, according to description of Dai 2010). Moreover, the former has slightly smaller basidiospores ((3–) 3.5–5(–5.3) × (1.4–) 1.6–2 (–2.3) µm) than the present collection. *Hymenochaete rheicolor* (Mont.) Lév. also shows similarity with the present specimen, however, possesses larger basidiospores ((4.5–) 5–6.8 (–7) × 2–2.8 (–3) µm, based on Dai 2010). Another closely related species *Hydnoporia laricicola* (S.H. He & Jiao Yang) Spirin & Miettinen is separated from the present collection by their perennial basidiocarps and presence of hymenial hyphidia (according to description of Miettinen *et al.* 2019).

Hydnoporia tabacina is a cosmopolitan species (Corfixen & Parmasto 2017). The species has not been reported from Kerala so far.

Hymenochaete Lév.

Basidiomata characterized annual to perennial, often thin and membraneous, found in imbricate clusters, hard and woody, resupinate, effused reflexed to pileate or stipitate. Pileus circular to semicircular, applanate to concave, concentrically zonate, sulcations present or absent, tomentose to velutinous or pubescent, yellowish brown to brown. Hymenophore smooth to tuberculate hymenium, with projecting setae, surface light to dark brown, sometimes with yellowish shades towards margin. Hyphal system monomitic, generative hyphae hyaline or golden yellow to rusty brown hyphae, thick walled, without clamp connections. Setae present, subulate, dark brown, smooth to encrusted. Basidiospores cylindrical, ellipsoid, allantoid to subglobose, smooth, thin walled, inamyloid in Melzer's reagent. Members cause white rot on wood.

Hymenochaete boddingii Hembrom, A. Parihar, K. Das, A. Ghosh, in Rossi, Das, Hembrom, Santamaria, Parihar, Ghosh, Henkel, Hofstetter, Randrianjohany, Vizzini, Wang & Buyck, Cryptog. Mycol. 41 (4): 83 (2020)

FIGURE 102

Basidiomata 30–60 mm tall, annual, medium sized, light in weight, brittle when dry, stipitate pileate. **Pileus** 25–65 mm long, up to 1 mm thick, flabelliform to weakly infundibuliform by fusing of lateral sides of adjacent pilei, mostly imbricate, concentrically zonate, sometimes radially wrinkled, adpressed tomentose, hairs lesser when mature, cinnamon brown with almost alternating yellowish brown zones, a light yellowish brown margin, black in KOH, margin wavy to highly lobed, incurved on driying. **Hymenophore** smooth without pores, brownish black setae present throughout the surface except margin, sometimes tuberculate, dark fuliginous brown, yellowish brown towards margin. **Context** thin, less than .5 mm thick, brown, turning black in KOH. **Stipe** 20–50 mm tall, laterally attached, often laterally compressed, slightly broadened at base in some, mostly branched into two or three towards the pileus, adpressed velutinate with scattered projecting setae, setae absent towards base, dark brown to rusty brown, base always attached with leaf litters and small roots of adjacent trees, stipe tissue solid, brown. **Odour** not distinctive. **Spore print** not observed.

Basidiospores 2–3 × 1.2–2 µm, Q=1.2–1.5, Q_m=1.3, subglobose to broadly ellipsoid, mostly hyaline, but some spores pale yellow, eguttulate, thin walled, smooth, inamyloid in Melzer' s reagent. **Basidia** 26–42 × 22.5 µm, cylindrical, hyaline, thin walled, 4 sterigmate. **Cystidia** absent. **Hymenial setae** abundant and found in 2–3 layers, 30–72 × 5–9 µm, projecting more than 100 µm long from hymenium, subulate, tips acute, dark brown, thick walled (wall thickness 2–4 µm). **Hymenial trama** interwoven, tightly arranged, and monomitic. Generative hyphae 2–4 µm wide, yellowish brown to brown, thin to thick walled (wall thickness 1 µm), frequently septate, branched, without clamp connections. **Pileal trama** interwoven, loosely arranged, monomitic. Generative hyphae 2–4 µm wide, yellowish brown to brown, mostly thick walled (wall thickness 1 µm), not frequently septate as in hymenium, branched, without clamp connections. **Pileipellis** loosly interwoven at the base to form erect long trichodermium made of hyphae that are 2–3.5 µm wide, thin to thick walled (1 µm) yellowish brown with obtuse ends. Stipe trama similar as pileal trama, hyphae highly interwoven than in pileus, generative hyphae 2–4.5 µm wide, yellowish brown to brown, thin to thick walled (wall thickness 1 µm), branched, without clamp connections. **Stipitipellis** composed of trichodermium similar as pileipellis, but at some portion made of thick walled, agglutinated hyphae that are 2–4.5 µm wide, pale yellow to brown in colour. Projecting setae found scattered on upper regions of stipitipellis.

Specimens examined: India. Kerala State: Kasaragod district, Neeleshwaram, Kareem's Forest Park, on soil, 30 July 2019, Vinjusha N., ZGCVN869.

Comments: Characters of the present collection properly matched with the original description of *H. boddingii* (Rossi *et al.* 2020). The present collection resembles *H. damicornis* in morphology, but the later can be easily distinguished by the larger size of basidiospores (5.5–7 × 4–7.5 µm). Similarly, another closely related species, *H. reniformis* can be separated from our collection by larger basidiospores (5.5–6.5 × 4–5 µm) and wider setae (12–25 µm). Basidiospores of both *H. damicornis* and *H. reniformis* are described as a hyaline (Ryvarden 1985, Léger 1998) whereas some of the basidiospores of present collection were pale yellow. Another species, *Hymenochaete adusta* possesses smaller basidiospores as in the present collection, however, the former has an effused reflexed basidiomata and is entirely different in morphology from the latter.

In the BLAST search result, present specimen showed 95% similarity *H. boddingii* (GenBank numbers: MN030341, MN030343, MN030344). BLAST search result also showed 93% identity with *H. subferruginea*. Present collection shows resemblances with *H. subferruginea* in some macroscopic and microscopic characters. However, *H. subferruginea* never produces stipitate basidiocarps and their spores are slightly larger (2.8–3.5 × 2–2.5 µm) than present collection (2–3 × 1.2–2 µm).

In the phylogenetic tree (Figure 136), present collection settled along with accession of *H. boddingii* from the type material (voucher numbers: MEH-69996, MEH-66068, MEH-66150; GenBank numbers: MN030341, MN030343, MN030344 respectively) with 90% bootstrap support.

H. boddingii is a recently described species from India (Rossi *et al.* 2020). This species has not been reported from Kerala to date.

Hymenochaete ochromarginata P.H.B. Talbot, Bothalia 4 (4): 944 (1948)

Figure 103

Basidiomata annual, medium sized, light in weight, brittle when dry, effused-reflexed to pileate. **Pileus** 35–50 mm long, 1 mm thick, sessile to broadly attached, semicircular, applanate, concentrically zonate, sulcate, velutinous, hairs more prominent along the concentric circles, lesser towards margin, yellowish brown to brown, pale along the margin, black in KOH, margin wavy, thin. **Hymenophore** smooth without pores, brownish black setae present throughout the surface except margin, surface weakly transluscent, small irregular tubercles present, brown with a yellowish tinch, yellow to ochre along margin. **Context** up to 1 mm thick, brown, turning black in KOH. **Odour** not distinctive. **Spore print** not observed.

Basidiospores 2–4 × 1.6–2 µm, Q=1.2–1.8, Q_m=1.6, oblong ellipsoid, hyaline, eguttulate, thin walled, smooth, inamyloid in Melzer's reagent. Basidia 11–18 × 2–4 µm, cylindrical to narrowly clavate, hyaline to yellowish brown, thin walled, 4 sterigmate. **Cystidia** absent **Hymenial setae** abundant, 20–56 × 5–10 µm, subulate, with very short basal stalk like structure, tips acute, dark brown, thick walled (up to 4 µm). Cylindrical, narrow, paraphysis like cell observed between setae and basidia; 1–1.5 µm wide, hyaline, thin walled, with obtuse ends. **Hymenial trama** interwoven and monomitic. Generative hyphae 2–4 µm wide, brown to dark brown, thin to thick walled (up to 1 µm), moderately septate, sparsely branched.

Pileal trama interwoven and monomitic. Generative hyphae 2–4 µm wide, yellow to dark brown, thick walled (wall thickness up to 1.5 µm), moderately septate, unbranched to rarely branched. **Pileipellis** interwoven at the base to form erect trichodermal patches 36–72 µm long; each hyphae 2–4 µm wide, brown, smooth to encrusted, thin to slightly (up to 1 µm) thick walled, with obtuse ends.

Specimens examined: India. Kerala State: Kozhikode district, Palazhi, Bhayankavu, on dead log of *Ficus* species, 27 December 2015, Vinjusha N., ZGCVN268; Palazhi, Bhayankavu, on live *Ficus* species, 26 June 2016, Vinjusha N., ZGCVN334, ZGCVN337; Koyilandy, Poyilkavu, on *Mimusops elengi*, 16 July 2016, Vinjusha N., ZGCVN372; 22 August 2016; Malappuram, Nilambur, KFRI campus, on *Swietenia mahagoni* (L.) Jacq., 17 November 2016, Vinjusha N, ZGCVN475; Ernakulam district, Iringole Kavu, on *Swietenia mahagoni*, 08 July 2017, Vinjusha N., ZGCVN565.

Comments: Present collection was identified as *H. ochromarginata* based on the description of Dai (2010). The collections resemble *Hymenochaete rubiginosa* (Dicks.) Lév. in some macroscopic and microscopic characters. But the latter differs from present collections by having larger spores ((4) 4.3–5.1 (5.8) × (2.2) 2.5–3 µm and narrower hyphae (1.5–2.5 µm in diameter). *Hymenochaete ochromarginata* has been reported from Africa, Thailand and China (Dai 2010).

Mohanan (2011) had reported *H. rubiginosa* from a sacred grove in Kerala (Iringole Kavu, Ernakulam district). One of the present collections (voucher number: ZGCVN475) was obtained from Irigole Kavu, the same collection locality from where Mohanan (2011) had collected the species and described it as "*H. rubiginosa*". Based on the detailed morphological study of the specimen, it was found that the specimen identified by Mohanan (2011) was not *H. rubiginosa*, instead *H. ochromarginata*, because the former possesses larger basidiospores and narrower hyphae (according to description of Dai 2010) than the present collection.

Coltricia Gray

Basidiomata annual, terrestrial, centrally to laterally stipitate, soft and tough. Pileus circular, concentrically zonate, tomentose to silky fibrillose, yellowish to rusty brown. Hymenophore poroid, pores angular, pore surface brown to rusty brown, pore tubes brown. Context cinnamon to deep brown, homogenous. Hyphal system monomitic, generative hyphae thin to thick walled, yellowish brown to brown, without clamp connections. Setae absent. Basidia broadly clavate to clavate, 4 sterigmate. Basidiospores ellipsoid to cylindrical, smooth, golden yellow to rusty brown, with variable dextrinoid reaction in Melzer’s reagent. Members cause white rot on dead wood.

Coltricia cinnamomea (Jacq.) Murrill, Bull. Torrey bot. Club 31 (6): 343 (1904)

Basionym: *Boletus cinnamomeus* Jacq., Collnea bot. 1 (1): 116 (1787) [1786]
Synonyms:
Boletus cinnamomeus Jacq., Collnea bot. 1 (1): 116 (1787)
Strilia cinnamomea (Jacq.) Gray, Nat. Arr. Brit. Pl. (London) 1: 645 (1821)
Polyporus cinnamomeus (Jacq.) Pers., Mycol. eur. (Erlanga) 2: 41 (1825)
Polyporus parvulus Klotzsch, Linnaea 8 (4): 483 (1833)
Polystictus parvulus Fr., Nova Acta R. Soc. Scient. upsal., Ser. 3 1 (1): 71 (1851)
Polystictus cinnamomeus (Jacq.) Sacc., Syll. fung. (Abellini) 6: 210 (1888)
Pelloporus cinnamomeus (Jacq.) Quél., Fl. mycol. France (Paris): 402 (1888)
Pelloporus fimbriatus var. *cinnamomeus* (Jacq.) Quél., Fl. mycol. France (Paris): 402 (1888)
Microporus cinnamomeus (Jacq.) Kuntze, Revis. gen. pl. (Leipzig) 3 (3): 495 (1898)
Xanthochrous cinnamomeus (Jacq.) Pat., Essai Tax. Hyménomyc. (Lons-le-Saunier): 100 (1900)
Polystictus perennis f. *cinnamomeus* (Jacq.) Pilát, Atlas Champ. l'Europe, III, Polyporaceae (Praha) 1: 582 (1940)

FIGURE 104

Basidiomata annual, small to medium sized, coriaceous, light in weight, centrally stipitate, 35–60 mm tall. **Pileus** circular, 15–45 mm in diameter, up to 3 mm thick, flat to infundibuliform, concentrically zonate, shiny, silky fibrillose hairs present, hairs more prominent along concentric zonations, cinnamon brown, black in KOH, margin thin, mostly even, incurved on drying. **Hymenophore** poroid. Pores 2–4 per mm, angular, absent along margin, pores deccurent, surface golden yellow to brown, glancing, pore tube up to 2 mm long, brown. **Context** 1 mm thick, yellowish brown, soft, coriaceous. **Stipe** 25–35 mm long, 2–3 mm thick, cylindrical, laterally flat in some specimens, broadened near the pileus, dark brown with pale yellowish shades, velutinous to hirsute, tissue solid, dark brown. **Odour** not distinctive. **Spore print** not observed.

Basidiospores 5–8 × 4–5 µm, Q= 1.2–1.4, Q_m=1.3, ellipsoid to broadly ellipsoid, hyaline to pale yellowish, thin walled, smooth, guttulate, inamyloid in Melzer's reagent. **Basidia** 12–26 × 5–9 µm, broadly clavate, 2 sterigmate. **Setae** absent. **Hymenial trama** intertwined and monomitic. Generative hyphae 4–8 µm wide, light to dark brown, septate, thick walled (1 µm), smooth, branched, without clamp connections. **Pileal trama** almost parallelly arranged. Generative hyphae 5–7 µm wide, deep brown, septate, smooth, thick walled (1 µm), moderately branched. **Pileipellis** a cutis interrupted by patches of projecting hyphal elements that are 2–4 µm wide, light brown in colour, weakly encrusted, with obtuse ends. **Stipe trama** interwoven. Generative hyphae 6–8 µm wide, deep brown than present in pileus, septate, clamp connections absent, thick walled (1–2 µm), branched, some hyphae irregularly swollen at apex. **Stipitipellis** consist of cutis at the base and forming erect, long, simple to branched trichoderm; hyphae 2–5 µm wide, dark brown, thick walled, weakly encrusted, with obtuse ends.

Specimens examined: India. Kerala State, Kottayam district, Vagamon, Pine valley, on needles of *Pinus* species, 24 October 15, Vinjusha N, ZGCVN242; Kozhikode district, Peruvannamuzhy forest, on soil, Vinjusha N., ZGCVN868; Palakkad district, Mannarkkad, Silent Valley National Park areas, on soil, 26 October 2019, Krishnapriya K., ZGCVN918.

Comments: Morphology of the present collections fits well with the descriptions of *C. cinnamomea* by Ryvarden & Gilbertson (1993) and Dai (2010). Present collections resembles *Coltricia perennis* (L.) Murrill in many macroscopic and microscopic features. According to Ryvarden & Gilbertson (1993), *Coltricia perennis* possesses dichotomously branched hyphae at the pileipellis region. The present specimen lacked dichotomous branches. Based on the description of Ryvarden & Gilbertson (1993), *Coltricia cinnamomea* is separated from *C. perennis* by having more softer and darker, silky fibrillose hairs on pileus surface. In addition, *Coltricia cinnamomea* usually produces smaller basidiocarps than *C. perennis* (Dai

2010). By referring to these descriptions, the present collection can be undoubtedly placed as *C. cinnamomea*.

Coltricia cinnamomea is a cosmopolitan species (Ryvarden & Johansen 1980). This species has been described from Kerala by Mohanan (2011).

Coltricia pyrophila (Wakef.) Ryvarden, Norw. Jl Bot. 19: 231 (1972)

Basionym: *Polyporus pyrophilus* Wakef., Bull. Misc. Inf., Kew (3): 71 (1916)

FIGURE 105

Basidiomata annual, medium sized, solitary, infundibuliform, water soaked when fresh, corky and light in weight on drying, stipitate, up to 70 mm tall. **Pileus** circular, 40–70 mm in diameter, up to 10 mm thick, slightly depressed in the centre, uneven with irregular outgrowths, weakly zonate, zonations prominent towards margin, weakly pubescent to glabrous, yellowish brown to brown, dull, incurved on drying. **Hymenophore** poroid. Pores 4–5 per mm, angular to oblique, pores slightly deccurent, surface dull white when fresh and in young fruitbodies, dark brown when mature, pore tube 2–5 mm long, brown. **Context** 2–4 mm thick, dark brown, concentric zontions visible. **Stipe** 30–65 mm long, up to 12 mm thick, central, cylindrical, minutely pubescent, yellow when young, turning yellowish brown, slightly bulbous at the base. **Odour** not distinctive. **Spore print** not observed.

Basidiospores 4–6 × 3–4 µm, Q=1.2–1.8, Q_m=1.4, ellipsoid to broadly ellipsoid, hyaline to yellowish brown, thick walled, smooth, guttulate, inamyloid in Melzer’s reagent. **Basidia** not observed. **Setae** absent. **Hymenial trama** interwoven and monomitic. Generative hyphae 2–5 µm wide, golden to deep brown, smooth, thin walled, moderately branched, without clamp connections. **Pileal trama** almost parallel. Generative hyphae 3–6 µm wide, golden to deep brown, smooth, thin walled, septations more frequent than present in hymenium, moderately branched, without clamp connections. **Pileipellis** basically a cutis with scattered, irregularly projecting hyphal elements which are 2–5 µm wide, yellowish brown to brown, almost thick walled with obtuse ends. **Stipe trama** weakly parallel. Generative hyphae 3–6 µm wide, golden to deep brown, smooth, thin walled, moderately branched, without clamp connections. **Stipitipellis** a cutis similar as pileipellis, made of hyphae that are 2–5 µm wide, yellowish brown to brown, almost thick walled, with obtuse ends.

Specimen examined: India. Kerala State: Kozhikode district, Pokkunnu, on soil, 15 June 2017, Vinjusha N., ZGCVN497.

Comments: Morphology of the present specimen fits well with the available descriptions of *C. pyrophila* such as Ryvarden & Johansen (1980), Corner (1991), and Dai (2010), except a variation in the colour of basidiospores. According to Ryvarden & Johansen (1980), basidiospores of *C. pyrophila* are hyaline. Corner (1991) and Dai (2010) described the spores of the species as hyaline to pale yellow. However, some of the basidiospores of the present collection were yellowish brown in colour. Present specimen resembles *C. perennis* (L.) Murrill in morphology. However, latter produces larger basidiospores (6–11 × 4–6.5 µm (Corner 1991); 6–9 (–10) × 3.5–5 (–5.5) µm (Ryvarden & Gilbertson 1993; (6–) 6.5–9 (–10) × (4–) 4.1–5.1 µm (–6) µm (Dai 2010)) than the present collection.

C. pyrophila has distribution in Africa, Asia and Europe (Ryvarden & Johansen 1980; Ryvarden & Gilbertson 1991; Dai 2010). The species has been reported from India (Sexena 1961; Sharma 1989, 2012). There are no reports of this species from Kerala so far.

Fuscoporia Murrill

Basidiomata annual to perennial, solitary or in clusters, hard and woody, resupinate, pileate or laterally stipitate. Pileus semicircular, applanate, concentric zonate, sulcate, tomentose to velutinate, non crusted. Hymenophore poroid, pores round to ovoid, pore surface yellowish brown to brown, pore tubes brown. Context umber brown, homogenous. Hyphal system dimitic, generative hyphae hyaline, thin walled. Skeletal hyphae yellowish to brown, thick walled. Setae present, subulate, straight or hooked, mostly originating from tramal hyphae, dark brown, thick walled. Basidiospores cylindrical, oblong-ellipsoid, broadly ellipsoid or subglobose, hyaline, smooth, thin walled, inamyloid in Melzer's reagent. Members cause white rot on wood.

Fuscoporia rhabarbarina (Berk.) Groposo, Log.-Leite & Góes-Neto, Mycotaxon 101: 61 (2007)

Basionym: *Polyporus rhabarbarinus* Berk., Ann. nat. Hist., Mag. Zool. Bot. Geol. 3: 388 (1839)
Synonyms:
Polyporus rhabarbarinus Berk., Ann. nat. Hist., Mag. Zool. Bot. Geol. 3: 388 (1839)
Fomes rhabarbarinus (Berk.) Sacc., Syll. fung. (Abellini) 6: 16 (1888)
Scindalma rhabarbarinum (Berk.) Kuntze, Revis. gen. pl. (Leipzig) 3 (3): 519 (1898)
Fomes rheicolor Lloyd, Mycol. Writ. 4 (Syn. gen. Fomes): 245 (1915)
Phellinus rhabarbarinus (Berk.) G. Cunn., Bull. N.Z. Dept. Sci. Industr. Res. 164: 229 (1965)
Phellinus rheicolor (Lloyd) Ryvarden, Norw. Jl Bot. 19: 235 (1972)
Mucronoporus rhabarbarinus (Berk.) Zmitr., Malysheva & Spirin, Nov. sist. Niz. Rast. 40: 183 (2006)

FIGURE 106

Basidiomata perennial, large, either solitary or in clusters, hard and woody, light in weight especially on drying, effused reflexed to pileate. **Pileus** 70 mm long, 9 mm thick, broadly attached, sessile, semicircular, applanate, concentrically sulcate with narrow zones, adpressed velutinate, irregularly glabrous, cinnamon brown, black in KOH, margin even to slightly lobed, matted, obtuse. **Hymenophore** poroid. **Pores** 6–8 per mm, round, regular, dull brown, black in KOH, pore tubes up to 15 mm thick, brown, **Context** not distinct due to perennial growth of pore layers, observed region up to 4 mm thick, umber brown, homogenous. **Odour** not distinctive. **Spore print** not observed.

Basidiospores 3–4.5 × 2 µm, Q=1.5–2, Q_m=1.9, oblong to broadly ellipsoid, hyaline, smooth, thin walled, eguttulate, inamyloid in Melzer's reagent**. Basidia** not observed. **Hymenial setae** almost frequent, 25–35 × 5–7 µm, dark brown, thick walled (1–3 µm), ventricose, often with perpendicular bents at the base, with acuminate ends, heavily encrusted over the surface. **Hymenial trama** interwoven and dimitic with scattered crystals. Generative hyphae less frequent, 1.5–3 µm wide, hyaline, thin walled, branched, without clamp connections. Skeletal hyphae dominant, 2–4 µm wide, yellowish to brown, thick walled (1 µm), unbranched, septations not observed. Skeleto ligative hyphae not observed. **Pileal trama** interwoven. Generative hyphae 2–4 µm wide, hyaline, thin walled, branched, without clamp connections. Skeletal hyphae frequent, more wider than those present in hymenium, 3–5 µm wide, yellowish to brown, thick walled (1 µm), unbranched, septations not observed. Skeleto ligative hyphae not observed. **Pileipellis** a slightly agglutinated trichodermium made of thick walled, yellowish brown hyphae, that are 2–4 µm wide, with obtuse ends.

Specimen examined: India. Kerala State: Wayanad district, Thirunelli, on dead log (unidentified), 16 July 2017, Vinjusha N, ZGCVN598.

Comments: Morphology of the present collection fits well with earlier descriptions of *F. rhabarbarina*, by Cunningham (1965), Ryvarden & Johansen (1980), and Groposo *et al.* (2007). Present collection shows similarities with *Fuscoporia callimorpha* (Lév.) Groposo, Log.-Leite & Góes-Neto, *Fuscoporia senex* (Nees & Mont.) Ghob.-Nejh. and *Phellinus gilvus* (Schwein.) Pat in many morphological characters. According to Ryvarden & Johansen (1980), Corner (1991), and Groposo *et al.* (2007), *F. callimorpha* possesses straight hymenial setae, however, present specimen has ventricose hymenial setae, often with perpendicular bents. *Fuscoporia senex* produces slightly wider basidiospores than the present collection (3.5-5 µm, Ryvarden & Johansen 1980; Dai 2010). Although present collection resembles *Phellinus gilvus* by having ventricose hymenial cystidia and smaller basidiospores, the latter species can be easily separated by their annual basidiocarps with glabrous pileus. (Núñez & Ryvarden 2000).

Fuscoporia rhabarbarina has pantropical distribution. From India, *F. rhabarbarina* has been reported as *Fomes rhabarbarinus* Berk (Ranadive 2013). There are no reports of this species from Kerala so far.

Phylloporia Murrill

Basidiomata annual to perennial, solitary or in clusters, resupinate, effused reflexed to pileate or stipitate. Pileus sessile, semicircular to flabelliform, concentrically zonate, with distinct thick tomentum on pileus, margin even to wavy. Hymenophore poroid, pores round to angular, pore surface yellowish brown to brown, pore tubes brown. Context usually duplex with a darker line or zone below tomentum or sometimes homogenous. Hyphal system monomitic to dimitic, hyphae hyaline to rusty brown, without clamp connections. Setae absent. Basidiospores ellipsoid, yellow thickwalled, always less than 6 µm long, inamyloid in Melzer's reagent. Species causes white rot on wood.

Phylloporia weberiana (Bres. & Henn. *ex* Sacc.) Ryvarden, Norw. Jl Bot. 19: 235 (1972)

Basionym: *Fomes weberianus* Bres. & Henn. *ex* Sacc., Syll. fung. (Abellini) 9: 174 (1891)
Synonyms:
Scindalma weberianum (Bres. & Henn. *ex* Sacc.) Kuntze, Revis. gen. pl. (Leipzig) 3 (3): 519 (1898)
Ganoderma rivulosum Pat. & Har., Bull. Soc. mycol. Fr. 22 (2): 119 (1906)
Polyporus subcapucinus Bres., Mycologia 17 (2): 74 (1925)
Polyporus weberianus (Bres. & Henn. *ex* Sacc.) Sacc. & Trotter, Syll. fung. (Abellini) 23: 383 (1925)
Coltricia weberiana (Bres. & Henn. *ex* Sacc.) G. Cunn., Proc. Linn. Soc. N.S.W. 75 (3-4): 247 (1950)
Ganoderma weberianum (Bres. & Henn. *ex* Sacc.) Steyaert, Persoonia 7 (1): 79 (1972)

FIGURE 107

Basidiomata annual, medium sized, coriaceous and spongy when fresh, moderately hard when dry, light in weight, solitary, pileate. **Pileus** 12–55 mm long, 3–10 mm thick, sessile, most with an umbo near the region of attachment, semicircular, applanate to slightly convex, concentrically zonate, distinctly sulcate, densly tomentose, tomentum greater than 5 mm thick, soft and cottony, golden brown to rusty brown, paler along margin, margin obtuse, even, black in KOH. **Hymenophore** poroid. **Pores** 5–7 per mm, angular, absent at the margin, greyish brown, pore tube 1–2 mm long, yellowish brown. **Context** up to 20 mm thick, yellowish brown, dark brown towards pileus region, consist of a brownish black line below the tomentum, turning black in KOH. **Odour** not distinctive. **Spore print** not observed.

Basidiospores 3–4 × 2–3 µm, Q=1.1–2, Q_m=1.46, ellipsoid to broadly ellipsoid, pale yellow, smooth, moderately thick walled, eguttulate, inamyloid in Melzer's reagent. **Basidia** 8.5–16 × 4–6 µm, clavate, 4 sterigmate. **Setae** absent. **Hymenial trama** interwoven and monomitic. Generative hyphae 2–4 µm wide, hyaline to pale brown, more brown in KOH, smooth, often flexuose, slightly thick to thick walled (1 µm wide), weakly branched, frequently septate, without clamp connections. **Pileal trama** interwoven. Generative hyphae 2–5 µm wide, pale yellow brown, slightly thick to thick walled (1 µm wide), smooth, weakly branched, frequently septate. Hyphae of black zone in the trama 2–5 µm wide, thick walled, (up to 2 µm wide) more yellowish brown to brownish black, weakly branched, infrequently septate. **Pileipellis** a trichoredmium made of hyphae, that are 4–9 µm wide, pale yellowish brown to golden brown, slightly thick to thick walled, (up to 2.5 µm wide), weakly branched, frequently septate.

Specimen examined: India. Kerala State: Kannur district, Madayi Kavu, on live tree (unidentified), 7 July 2018, Vinjusha N., ZGCVN692.

Comments: Present collection is characteristic among other *Phylloporia* species in having thick cottony tomentum over pileus. *Phylloporia bibulosa* (Lloyd) Ryvarden is similar to present collection with regards to the tomentum and basidiospores. According to Dai (2010), tomentum of *P. bibulosa* is less than 5 mm thick, made of hyphae 4–6 µm diameter, whereas, that of *P. weberiana* is always more than 5 mm thick, made of wider hyphae (5–9 µm). *Phylloporia pectinata* also shows some similarity with the present collection, however has thin tomentum. Referring to the descriptions (Ryvarden & Johansen 1980; Dai 2010), present collection is safely placed as *P. weberiana*.

In the *Index Fungorum* database (accessed on 01 September 2020), *P. weberiana* is currently recognized as *Ganoderma weberianum* (Bres. & Henn. *ex* Sacc.) Steyaert. However, characters of *Ganoderma* species are entirely different from *Phylloporia* species, especially in the basidiospore morphology (truncate, double walled with interwall pillars, sometimes with warty or echinulate surface). Our Kerala collections show no features of *Ganoderma* and hence, here the species is treated in the genus *Phylloporia* itself.

Phylloporia weberiana has paleotropical distribution (Ryvarden & Johansen 1980). There are no reports of this species from Kerala so far.

Phylloporia pectinata (Klotzsch) Ryvarden, Syn. Fung. (Oslo) 5: 196 (1991)

Basionym: *Polyporus pectinatus* Klotzsch, Linnaea 8 (4): 485 (1833)
Synonyms:
Polyporus xerampelinus Kalchbr., Grevillea 4 (no. 30): 72 (1875)
Polystictus substygius Berk. & Broome ex Cooke, Nuovo G. bot. ital. 10 (1): 17 (1878)
Fomes substygius (Berk. & Broome ex Cooke) Cooke, Grevillea 14 (no. 69): 20 (1885)
Fomes pectinatus (Klotzsch) Gillet, Grevillea 14 (no. 69): 20 (1885)
Phellinus pectinatus (Klotzsch) Quél., Enchir. fung. (Paris): 173 (1886)
Polystictus xerampelinus (Kalchbr.) Cooke, Grevillea 14 (no. 71): 86 (1886)
Scindalma pectinatum (Klotzsch) Kuntze, Revis. gen. pl. (Leipzig) 3 (3): 519 (1898)
Microporus xerampelinus (Kalchbr.) Kuntze, Revis. gen. pl. (Leipzig) 3 (3): 497 (1898)
Scindalma substygium (Berk. & Broome *ex* Cooke) Kuntze, Revis. gen. pl. (Leipzig) 3 (3): 519 (1898)
Xanthochrous pectinatus (Klotzsch) Pat., Essai Tax. Hyménomyc. (Lons-le-Saunier): 101 (1900)
Phaeoporus ferrugineus Romell, K. svenska Vetensk-Akad. Handl., ny följd 26: 26 (1901)
Polyporus ferrugineus (Romell) Sacc. & P. Syd., Syll. fung. (Abellini) 16: 150 (1902)
Pyropolyporus pectinatus (Klotzsch) Murrill, Bull. Torrey bot. Club 34: 479 (1907)
Pyropolyporus subpectinatus Murrill, N. Amer. Fl. (New York) 9 (2): 109 (1908)
Fomes pectinatus var. *congoanus* Bres., in Wildeman, Bull. Jard. bot. État Brux. 4 (1): 19 (1914)
Fulvifomes subpectinatus (Murrill) Murrill, Tropical Polypores: 84 (1915)
Polyporus substygius (Berk. & Broome ex Cooke) Lloyd, Mycol. Writ. 4 (Syn. Apus): 364 (1915)
Boudiera pectinata (Klotzsch) Lázaro Ibiza, Revta R. Acad. Cienc. exact. fis. nat. Madr. 14 (12): 837 (1916)
Polyporus oroniger Lloyd, Mycol. Writ. 6 (Letter 65): 1044 (1920)
Fomes endozonus sensu Cunningham; fide Buchanan & Ryvarden (2000)

FIGURE 108

Basidiomata perennial, small to medium sized, usually clustered and imbricate, many pilei fused to form compound fruit bodies, firmly attached to the substrate, hard and woody, light in weight, especially on drying, pileate. **Pileus** 20–43 mm long, 5–10 mm thick, sessile, broadly attached, semicircular, applanate mostly uneven with ridges and grooves, concentrically zonate, sulcate, adpressed, velutinate, hairs lesser when mature, yellowish brown to cinnamon brown, distinctly black in KOH, margin obtuse, even to wavy. **Hymenophore** poroid. **Pores** 8–9 per mm, angular, absent near margin, yellowish brown, pore tubes up to 10 mm thick, stratified, tube layers distinct, brown, homogenous. **Context** thin and indistinct due to perennial growth of tube layers, less than 1 mm thick, brownish. **Odour** not distinctive. **Spore print** not observed.

Basidiospores 3–3.5 × 2–2.5 µm, Q=1.2–1.7, Q_m=1.43, subglobose to ellipsoid, pale yellow, brown in KOH, thick walled (1µm), smooth, eguttulate, inamyloid in Melzer’s reagent. **Basidia** not observed. **Hymenial setae** absent. **Hymenial trama** interwoven and dimitic. Generative hyphae 2–3 µm wide, hyaline, smooth, thin walled, weakly branched, septate, without clamp connections. Skeletal hyphae 2–4.5 µm wide, yellowish brown to rusty brown, thick walled (1 µm), unbranched, infrequently septate. **Pileal trama** interwoven. Generative hyphae 2–3 µm wide, hyaline, smooth, thin walled, weakly branched, without clamp connections. Skeletal hyphae 2–4.5 µm wide, yellowish brown to rusty brown, thick walled (1 µm), unbranched, infrequently septate. **Pileipellis** interwoven at base to form trichodermal patches, up to 32 µm long, composed of hyphae that are 2–3.5 µm wide, light brown to rusty brown, thick walled, with obtuse ends.

Specimen examined: India. Kerala State: Kannur district, Aralam, on dead log (unidentified), 18 January 2017, Vijisha P., ZGCVN489; Idukki district, Anamudi, 08 February 2018, Manju A. C., ZGCVN676.

Comments: The dimitic hyphal system makes this species easily distinguishable, since majority of *Phylloporia* species possess a monomitic hyphal system. *Phylloporia pectinata* is closely related to *P. pulla* (Mont. & Berk.) Decock & Yombiy., however, the latter produces smaller basidiocarps and slightly smaller basidiospores than the former (Ryvarden & Johansen 1980). According to Dai (2010), fruit body of *P. pulla* grows only up to 20 mm long. Basidiocarps of the present collection are more than 20 mm long.

Phylloporia pectinata has pantropical distribution, extending to subtropical China Japan Taiwan, and Vietnam (Núñez & Ryvarden 2000). *Phylloporia pectinata* has been documented from Kerala by Adarsh *et al.* (2018).

Phylloporia gabonensis Decock & Yombiy., in Decock, Yombiyeni & Memiagh, Cryptog. Mycol. 36 (4): 460 (2015)

FIGURE 109

Basidiomata annual, small to medium sized, gregarious, in imbricate clusters, mostly overlapped each other, hard and woody, light in weight, pileate. **Pileus** 20–40 mm long, 30–40 mm thick, attached with a discoid base, mostly flabelliform, to spathulate, weakly bent downwards, surface with faint concentrically zonations, glabrous, radially wrinkled, yellowish brown, more brownish towards attachment region, with darker concentric bands towards margin, margin dentate to lobed. **Hymenophore** poroid. **Pores** 6–7 per mm, angular, absent at the margin, coffee brown, pore tubes up to 2 mm long, non stratified, brown, homogenous. **Context** 1–2 mm thick, brown, homogenous. **Odour** not distinctive. **Spore print** not observed.

Basidiospores 3–4.5 × 2–2.5 µm, Q=1.4–1.8, Q_m=1.62, ellipsoid to ovoid, mostly pale yellow, brownish yellow in KOH, firm walled, smooth, eguttulate, inamyloid in Melzer's reagent. **Basidia** not observed. **Hymenial setae** absent. **Hymenial trama** interwoven and monomitic. Generative hyphae 3–6 µm wide, yellowish brown, thick walled (1 µm), unbranched to sparsely branched, septate, without clamp connections. **Pileal trama** parallel. Generative hyphae 3–8 µm wide, yellowish brown, thick walled (1 µm), unbranched, without clamp connections. **Pileipellis** consists of trichodermial patches that are 60–84 µm long, each hyphae 3–6 µm wide, yellowish brown, thick walled.

Specimen examined: India. Kerala State: Kannur district, Aralam, on live tree branch (unidentified), 28 June 2019, Anjitha Thomas, ZGCVN830.

Comments: Morphological characters of the present collection properly fits with the original description of *P. gabonensis* by Decock *et al.* (2015). Present collection shows high similarity with *Phylloporia flabelliformis* Decock & Yombiy, sharing similar macroscopic and microscopic features. According to Decock *et al.* (2015), pileus of *P. flabelliformis* is even to wavy, remaining white on maturity. Whereas, present specimens produce brownish pileus with mostly dentate margin. In addition, basidiospores of *P. flabelliformis* are slightly smaller (Decock *et al.* 2015).

So far, *P. gabonensis* has been reported only from its type locality, Gabon, Africa (Decock *et al.* 2015). Present study forms the first record of the species outside the type locality, and the first documentation of the species from Asia.

Phylloporia chrysites (Berk.) Ryvarden [as '*chrysita*'], Norw. Jl Bot. 19: 235 (1972)

Basionym: *Polyporus chrysites* Berk., Hooker's J. Bot. Kew Gard. Misc. 8: 233 (1856)
Synonyms:
Polystictus chrysites (Berk.) Cooke, Grevillea 14 (no. 71): 82 (1886)
Microporus chrysites (Berk.) Kuntze, Revis. gen. pl. (Leipzig) 3 (3): 495 (1898)
Inonotus corrosus Murrill, Bull. Torrey bot. Club 31 (11): 598 (1904)
Polyporus corrosus (Murrill) Sacc. & Trotter, Syll. fung. (Abellini) 21: 275 (1912)
Coltricia corrosa (Murrill) G. Cunn., Bull. N.Z. Dept. Sci. Industr. Res. 164: 194 (1965)
Inonotus wilsonii Murrill, Bull. Torrey bot. Club 31 (11): 598 (1904)
Polyporus wilsonii (Murrill) Sacc. & Trotter, Syll. fung. (Abellini) 21: 272 (1912)
Inonotus elmerianus Murrill, Bull. Torrey bot. Club 34: 471 (1907)
Polyporus elmerianus (Murrill) Sacc. & Trotter, Syll. fung. (Abellini) 21: 274 (1912)
Polystictus elmerianus (Murrill) P.W. Graff, Bull. Torrey bot. Club 48 (11): 294 (1921)
Polyporus pseudofruticum Lloyd, Mycol. Writ. 4 (Letter 54): 4 (1915)
Polystictus roseobrunneus Lloyd, Mycol. Writ. 7 (Letter 67): 1156 (1922)
Polyporus roseobrunneus (Lloyd) Lloyd [as '*roroseobrunneaseobrunnea*'], Mycol. Writ. 7 (Letter 72): 1290 (1924)

FIGURE 110

Basidiomata annual, small, found in clusters, hard and tough, light in weight, some fruit bodies laterally fused. **Pileus** up to 15 mm long, 1.5–2.5 mm thick, mostly attached with a small lateral point of attachment, semicircular, applanate to slightly convex, concentrically zonate, tomentose when young, turning glabrous on drying, surface yellowish brown to almost black with age, incurved on drying, margin wavy, young collections turned black in KOH. **Hymenophore** poroid. **Pores** 6–7 per mm, angular, absent at the margin, brownish black, pore tube 1–2 mm long, coffee brown. **Context** up to 1 mm thick, dark brown, with distinct brownish black bands. **Odour** not distinctive. **Spore print** not observed.

Basidiospores 2.5–3 × 2–2.5 µm, Q=1.2–1.5, Q_m=1.32, subglobose, yellow to yellowish brown, more dark brown in KOH, smooth, thick walled (up to 1µm), eguttulate, inamyloid in Melzer's reagent. **Basidia** 8.5–11 × 4–7 µm, ellipsoid to broadly clavate, hyaline, 4 sterigmate. **Setae** absent. **Hymenial trama** almost parallel along the tubes, monomitic, often glued together. Generative hyphae 2–5 µm wide, pale yellow to yellowish brown, thin to thick walled (up to 1.5 µm), smooth, branched, septate, without clamp connections. **Pileal trama** parallel. Generative hyphae 3–6 wide, pale yellow to yellowish brown, thin to thick walled (up to 2 µm), smooth, branched, septate, without clamp connections. **Pileipellis** an agglutinated cutis, made of hyphae that are 2–4 µm wide, thick walled, yellowish brown to brown.

Specimens examined: India. Kerala State: Malappuram district, Thenjipalam, Calicut University campus, on live tree (Sapotaceae), 17 June 2016, Vinjusha N., ZGCVN331; Kannur district, Poongottu Kavu, on dead branch (unidentified), 02 July 2019, Vinjusha N., ZGCVN833.

Comments: Present collection shows much similarity with *Phylloporia ribis* (Schumach.) Ryvarden, however, the latter has broadly ellipsoid basidiospores (Dai 2010). The collection also resembles *P. fruticum* (Berk. & M.A. Curtis) Ryvarden in morphology, however differs by having larger pores (2–4 per mm) and larger spores (3–4.5 × 2.5–3 µm) (Ryvarden & Johansen 1980).

The species has widespread distribution in Widespread in the tropics, and subtropical America and Asia (China, Japan, and North Thailand) (Núñez & Ryvarden 2000). From Kerala. *P. chrysites* has been recorded by Leelavathy & Ganesh (2000).

Fulvifomes Murrill

Basidiomata mostly perennial, corky to woody hard, resupinate, effused reflexed to pileate. Pileus tomentose to glabrous or crust covered, brown to black. Hymenophore poroid, mostly angular, pore surface brown. Context homogeneous to duplex. Hyphal system dimitic, generative hyphae hyaline to pale yellowish. Skeletal hyphae brown, thick walled. Setae generally absent. Basidiospores subglobose to ellipsoid, yellowish or brown, fairly thick to thick walled, inamyloid in Melzer's reagent. Members of the genus cause white rot on wood.

Fulvifomes cesatii (Bres.) Y.C. Dai, Fungal Diversity 45: 186 (2010)

Basionym: *Poria cesatii* Bres., Stud. Trent., Classe II, Sci. Nat. Econ. 7 (1): 7 (1926)
Synonyms:
Poria gilvoides Petch, Ann. R. bot. Gdns Peradeniya 6 (1): 138 (1916)
Phellinus cesatii (Bres.) Ryvarden, Norw. Jl Bot. 19: 234 (1972)

Phellinus gilvoides (Petch) Ryvarden, Norw. Jl Bot. 19: 234 (1972)

FIGURE 111

Basidiocarps perennial, resupinate, becoming widely effused, difficult to detach from the host, hard and woody, up to 400 mm long, up to 6 mm thick, narrower towards margin. **Pileus** indistinct. **Hymenophore** poroid. **Pores** 8–9 per mm, angular, pale yellowish brown, bright yellow along margin, greyish brown on drying, more dark with age, growing margin rounded, entire to irregular. **Context** not distinct due to perennial growth of tube layers, visible part hard, up to 4 mm thick, pore tubes concolorous with pore surface. **Odour** not distinct. **Spore print** not observed.

Basidiospores 5–6 × 3.5–4.5 µm, Q=1–1.2, Q_m=1.1, subglobose, hyaline when young, yellowish when mature, yellowish brown in KOH, smooth, thick walled, eguttulate, in amyloid in Melzer's reagent. **Basidia** 12–16 × 4–9 µm, broadly clavate, 4 sterigmate. **Setae** absent. **Hymenial trama** interwoven and dimitic. Crystals scattered throughout hymenium. Generative hyphae 1.5–3 µm wide, hyaline to subhyaline, smooth, thin to slightly thick walled (up to 1 µm), branched, frequently septate, without clamp connections. Skeletal hyphae 2–4 µm wide, yellowish brown, thick walled (1 µm wide), weakly branched, septate. **Pileal trama** Parallel. Generative hyphae very rarely observed, 1.5–3 µm wide, hyaline to subhyaline, smooth, thin to slightly thick walled (up to 1 µm), branched, septate, without clamp connections. Skeletal hyphae 2–4 µm wide, yellowish brown, thick walled (1 µm wide), weakly branched, septate.

Specimens examined: India. Kerala State: Kozhikode district, Pokkunnu, ZG College campus, on dead wood stump (unidentified), 29 July 2015, Vinjusha N, ZGCVN100.

Comments: Morphology of the present collection matches with the earlier taxonomic descriptions of *F. cesatii* (as *Phellinus gilvoides* (Petch) Ryvarden such as those of Petch (1916) and Ryvarden & Johansen (1980)). The present collection shows similarity with *Fomitiporia punctata* (P. Karst.) Murrill in the absence of setae, similar hyphal system and basidiospores. However, *Fomitiporia punctata* always produces cushion shaped basidiocarps and dextrinoid spores (Dai 2010). *Fulvifomes umbrinellus* (Bres.) Y.C. Dai also has similar resupinate basidiocarps, however separted by smaller basidiospores (3.5–4.5 × 2.5–3.5 µm, Lowe 1966; 4–5 × 3–3.5 µm, Ryvarden & Johansen 1980; 3.6–4.3 × 2.8–3.6 µm, Loguercio-Leite & Wright 1995).

Fulvifomes cesatii is described as a rarely known species, reported from Sri Lanka (Ryvarden & Johansen 1980; Leelavathy & Ganesh 2000). From Kerala, this species has been reported (as *Phellinus gilvoides* (Petch) Ryvarden) by Leelavathy & Ganesh (2000).

Cyclomyces Kunze *ex* Fr.

Basidiomata annual to perennial, mostly imbricate, effused reflexed to pileate or centrally to laterally stipitate. Pileus dimidiate, semicircular to flabelliform, tomentose to finely pubescent, rust brown to reddish brown. Hymenophore poroid or rarely lamellate, pores angular, pore surface cinnamon brown to brown, distinctly duplex context with black line separating upper tomentum and lower dense layer, pore tubes concolorous with pore surface. Hyphal system monomitic, generative hyphae yellowish brown to brown, thin to thick walled. Setae present, subulate, dark brown, thick walled, arising from tramal hyphae. Basidia narrowly clavate, 4 sterigmate. Basidiospores ellipsoid to cylindrical, hyaline, thin walled, acyanophilous to weakly cyanophilous, inamyloid in Melzer’s reagent. Members cause white rot on wood.

Cyclomyces setiporus (Berk.) Pat., Essai Tax. Hyménomyc. (Lons-le-Saunier): 98 (1900)

Basionym: *Polyporus setiporus* Berk., London J. Bot. 6: 505 (1847)
Synonyms:
Polyporus intybaceus Berk., London J. Bot. 1 (3): 149 (1842)
Polyporus fuscus Lév., Annls Sci. Nat., Bot., sér. 3 5: 137 (1846)
Inonotus setiporus (Berk.) G. Cunn., Proc. Linn. Soc. N.S.W. 75 (3-4): 242 (1950)
Polystictus setiporus (Berk.) Fr., Nova Acta R. Soc. Scient. upsal., Ser. 3 1 (1): 93 (1851)

Hexagonia tabacina Lév., in Zollinger, Syst. Verz.: 15 (1854)
Polystictus cichoriaceus Berk. *ex* Fr., Nova Acta R. Soc. Scient. upsal., Ser. 31 (1): 92 (1855)
Polystictus fuscus (Lév.) Cooke, Grevillea 14 (no. 71): 86 (1886)
Mucronoporus setiporus (Berk.) Ellis & Everh., J. Mycol. 5 (1): 29 (1889)
Mucronoporus cichoriaceus (Berk. *ex* Fr.) Ellis & Everh., J. Mycol. 5 (1): 28 (1889)
Polyporus cichoriaceus (Berk. *ex* Fr.) Pat., Bull. Soc. mycol. Fr. 12 (1): 48 (1896)
Microporus setiporus (Berk.) Kuntze, Revis. gen. pl. (Leipzig) 3 (3): 497 (1898)
Microporus fuscus (Lév.) Kuntze, Revis. gen. pl. (Leipzig) 3 (3): 496 (1898)
Scenidium tabacinum (Lév.) Kuntze, Revis. gen. pl. (Leipzig) 3 (3): 516 (1898)
Polystictus intybaceus Berk. *ex* Mussat, in Saccardo, Syll. fung. (Abellini) 15: 302 (1901)

FIGURE 112

Basidiomata annual to biennial, small sized, coriaceous, soft corky, light in weight, usually imbricate and found in clusters, pileate. **Pileus** 20–40 mm long, 1–3 mm thick, flabelliform, applanate, dimidiate, mostly attached with a small lateral or central extention at the base appearing as substipitate, sometimes sessile, concentrically zonate, zonations narrow, glancing, mostly adpressed velutinate, more velutinate towards the substipe, glabrous when mature, yellowish brown to dark brown, often with yellowish shades near margin, black in KOH, marging even to wavy, sometimes lacerate. **Hymenophore** poroid. **Pores** 1–2 per mm, angular, sometimes becoming obliquely toothed, cinnamon brown, yellow along margin, black in KOH. **Context** 1 mm thick, cinnamon brown, homogenous, turning black in KOH. **Odour** not distinctive. **Spore print** yellow.

Basidiospores 3–4 × 1.5–2 µm, Q=1.5–2, Q_m=1.7, subcylindric, hyaline, smooth, thin walled, eguttulate, inamyloid in Melzer’s reagent; spores often agglutinated together. **Basidia** 10–17×3–4 µm narrowly clavate, 4 sterigmate. **Setae** 38–60 × 5–8 µm, subulate, arising from sub hymenium, slightly curved at base, often covered with an agglutinated material, dark brown, thick walled. **Hymenial trama** interwoven and monomitic. Generative hyphae 3–5 µm wide, yellowish brown to brown, smooth, thin to thick walled (1 µm), weakly branched, frequently septate, without clamp connections. **Pileal trama** interwoven. Generative hyphae 3–6 µm wide, yellowish brown to brown, smooth, thin to thick walled (1 µm), weakly branched, septate, without clamp connections. **Pileipellis** interwoven at base to form erect trichodermium, often forming patches made of hyphae that are 3–4 µm wide, yellowish brown, thick walled, with obtuse ends.

Specimens examined: India. Kerala State: Kannur district, Aralam, on dead branch (unidentified), 16 September 2015, Vijisha P., ZGCVN200; Kasaragod district, Edayilakkad, on dead branch (unidentified), 01 September 2017, Vinjusha N., ZGCVN632; Wayanad district, Chembra Peak, on dead branch (unidentified), 16 November 2018, Vinjusha N., ZGCVN753.

Comments: Characters of the present collection match well with the earlier descriptions of *Cyclomyces setiporus* by Ryvarden & Johansen (1980) and Dai (2010). *C. setiporus* can be easily distinguished from the other species of *Cyclomyces* by their large sized lacerate pores (Dai 2010). According to Dai (2010), herbarium materials of Asian specimens of *C. setiporus* possesses cystidia. However, cystidia was not observed in the present collection.

Cyclomyces setiporus has their distribution in Africa (Ryvarden & Johansen 1980), Asia (Corner 1991; Núñez & Ryvarden 2000) and Australia (Suhirman & Núñez 1998). From Kerala, *C. setiporus* has been reported by Leelavathy & Ganesh (2000) and Mohanan (2011).

Inonotus P. Karst.

Basidiomata annual to perennial, hard and woody, resupinate, effused reflexed to pileate. Pileus sessile, dimidiate, flabelliform to semicircular, applanate, concentric zonations present or absent, hispid, velutinate to glabrous, yellowish brown to black. Hymenophore poroid, pores angular, pore surface brownish, pore tubes concolorous with pore surface or with lighter or darker shades. Context brown, homogenous. Hyphal system monomitic to dimitic, yellowish brown to brown, unbranched to weakly branched, thick walled. Setae present or absent, Basidiospores subglobose to broadly ellipsoid, hyaline to yellow to brown, thick walled, smooth inamyloid in Melzer's reagent. *Inonotus* cause white rot on wood.

Inonotus pachyphloeus (Pat.) T. Wagner & M. Fisch., Mycologia 94 (6): 1009 (2002)

Basionym: *Polyporus pachyphloeus* Pat., J. Bot., Paris 3: 257 (1889)
Synonyms:
Fomes pachyphloeus (Pat.) Bres., Bull. Soc. mycol. Fr. 6 (1): XLI (1890)

Scindalma pachyphloeum (Pat.) Kuntze, Revis. gen. pl. (Leipzig) 3 (3): 519 (1898)
Phellinus pachyphloeus (Pat.) Pat., Essai Tax. Hyménomyc. (Lons-le-Saunier): 97 (1900)
Elfvingia elmeri Murrill, Bull. Torrey bot. Club 34: 476 (1907)
Fomes pachyphloeus var. *stipitatus* Bres., Annls mycol. 5 (3): 238 (1907)
Fomes melanodermus var. *tomentosus* Bres., Annls mycol. 10 (5): 497 (1912)
Ganoderma elmeri (Murrill) Sacc. & Trotter, Syll. fung. (Abellini) 21: 295 (1912)
Fomes elmeri (Murrill) Lloyd, Mycol. Writ. 4 (Syn. gen. Fomes): 279 (1915)
Fomes pachyphloeus var. *inermis* Bres., Hedwigia 56 (4 ,5): 294 (1915)
Fomes oroniger Lloyd, Mycol. Writ. 7 (Letter 73): 1330 (1924)
Cryptoderma pachyphloeum (Pat.) Imazeki, Bull. Gov. Forest Exp. Stn Tokyo 57: 101 (1952)
Phellinus pachyphloeus f. *stipitatus* (Bres.) O. Fidalgo, Mem. N. Y. bot. Gdn 17 (2): 125 (1968)
Phellinus pachyphloeus var. *tomentosus* (Bres.) O. Fidalgo, Mem. N. Y. bot. Gdn 17 (2): 119 (1968)

FIGURE 113

Basidiomata perennial, medium to large sized, solitary, hard and woody, firmly attached to the substrate, hard on drying, moderately heavy, pileate. **Pileus** 82–450 mm long, 43–200 mm thick, sessile, semicircular, ungulate, concentrically zonate, sulcate, adpressed velutinate when young, glabrous and matted with thick crust (up to 8 mm) when mature, rimose, yellowish brown when young, brownish black to black from margin towards attachment region when mature, margin tough, even to slightly lacerate. **Hymenophore** poroid. **Pores** 8–12 per mm, round, absent at the margin, cinnamon brown, pore tubes up to 6 mm long, stratified, tube layers distinct, brown, homogenous. **Context** up to 1 mm thick or indistinct due to perennial growth of pore tubes, brown, homogenous. **Odour** not distinctive. **Spore print** not observed.

Basidiospores 5–5.5 × 4–5 µm, Q=1.1–1.2, Q_m=1.15, subglobose, hyaline to pale yellow, brownish in KOH, thick-walled (1µm), smooth, eguttulate, inamyloid in Melzer’s reagent. **Mature basidia** not observed. **Hymenial setae** present; 14–45 × 6–12 µm, ventricose, some with a curved base, tips acute, umber brown, smooth, thick walled (1–2 µm). **Setal hyphae** also present and frequent; 86–225 µm long, 7–16 µm wide, cylindrical, or sometimes widened at middle, dark brown, erect, smooth, thick walled (up to 4 µm), with acute tips. **Hymenial trama** interwoven and dimitic. Generative hyphae 1–2.5 µm wide, hyaline to pale yellow, thin to thick walled (less than 1 µm), branched, without clamp connections. Skeletal hyphae dominant 2–4 µm wide, yellowish brown, dark brown in KOH, smooth, thick walled

(1 µm wide), branched, sometimes almost arboriform, especially near the dissepiments, infrequently septate. **Pileal trama** interwoven. Generative hyphae 2–3 µm wide, hyaline to pale yellow, thin to thick walled (less than 1 µm), branched, septate, without clamp connections. Skeletal hyphae 2–4 µm wide, yellowish brown, dark brown in KOH, infrequently septate, smooth, thick walled (1 µm), moderately branched or arboriform, especially near the dissepiments. **Setal hyphae** present; 6–15 µm wide, cylindrical, dark brown, erect, smooth, thick walled (up to 4 µm), with acute tips. **Pileipellis** a thick crust with agglutinated hyphal mass, hyphae 2–3 µm wide, yellowish brown to dark brown, sparsely septate, sometimes with inbetween projecting setal hyphae arising from trama.

Specimens examined: India. Kerala State, Kasaragod district, Neeleshwaram, Mannampurath kavu, on live trees (unidentified), 03 September 2018, Vinjusha N., ZGCVN705, ZGCVN706, ZGCVN710; Wayanad district, Kuruava Island, on live tree (unidentified), 07 December 2018, Vinjusha N., ZGCVN787, ZGCVN788.

Comments: Morphology of the present Kerala collections are in accordance with the descriptions of *I. pachyphloeus* by Ryvarden & Johansen (1980) and Núñez & Ryvarden (2000). Present collections show close similarity with *Phellinus hoehnelii* (Bres.) Ryvarden in having hymenial setae and setal hyphae. However, *Phellinus hoehnelii* produces larger pores (3–4 per mm) and larger basidiospores (7–8.5 × 6–7.5 µm) (Ryvarden & Johansen 1980). *Phellinus melanodermus* (Pat.) M. Fidalgo also has similar setal hyphae as the present collection, but lacks hymenial setae.

The species has occurrence in Southern Africa, Asia, and Australia (Núñez & Ryvarden 1995). From Kerala, this species has been documented by Mohanan (2011).

Inonotus patouillardii (Rick) Imazeki, Bull. Tokyo Sci. Mus. 6: 105 (1943)

Basionym: *Polystictus patouillardii* Rick, Brotéria, sér. bot. 6 (no. 2): 89 (1907)
Synonyms:
Xanthochrous radiatovelutinus Pat., Annls mycol. 5 (4): 365 (1907)
Polyporus radiatovelutinus (Pat.) Sacc. & Trotter, Syll. fung. (Abellini) 21: 270 (1912)
Polyporus fuscobadius Bres., Hedwigia 56 (4, 5): 293 (1915)
Polyporus patouillardii Rick, Egatea 13: 433 (1928)

FIGURE 114

Basidiomata annual, medium sized, solitary, hard and woody, light in weight, pileate. **Pileus** 62 mm long, 11 mm thick, sessile, dimidiate, semicircular, applanate, weakly concentrically zonate, not sulcate, glabrous, smooth, slightly laccate, brownish black, cream along margin, turns light brown on bruising, margin tough, entire, obtuse. **Hymenophore** poroid. **Pores** 7–9 per mm, angular, absent at the margin, brownish black, pore tubes 2–3 mm long, non stratified, concolourous with pore surface. **Context** up to 6 mm thick, brown, concentric bands visible. **Odour** not distinctive. **Spore print** not observed.

Basidiospores 4–5.5 × 3–4 µm, Q=1.33–1.37, Q_m=1.35, ellipsoid to ovoid, yellowish brown, smooth, thick walled, eguttulate, inamyloid in Melzer's reagent. **Basidia** not observed. **Hymenial setae** absent. **Setal hyphae** present, 9–12 µm wide, yellowish brown to rusty brown, thick walled (1–3 µm), many solid, smooth to weakly encrusted, with obtuse tips. **Hymenial trama** almost interwoven and monomitic. Generative hyphae 3–5 µm wide, yellowish brown to brown, smooth, thick walled (1 µm wide), branched, rarely septate, without clamp connections. **Pileal trama** parallel. Generative hyphae 3–7 µm wide, yellowish brown to brown, smooth, thick walled (1 µm wide), branched, infrequently septate, without clamp connections. **Pileipellis** composed of cylindrical to narrowly clavate end cells, up to 4 µm wide, hyaline to brown, thick walled, with an agglutinated layer above, and interrupted by projecting hyphoid setae arising from trama.

Specimen examined: India, Kerala State: Kozhikode district, Peruvannamuzhy forest, on fallen trunk of *Terminalia bellirica*, 11 August 2016, Vinjusha N., ZGCVN423.

Comments: Characters of the present collection definitely fits in the descriptions of *I. patouillardii* by Budington & Gilbertson (1973), Ryvarden (2004), and Dai (2010). According to the descriptions of Budington & Gilbertson (1973) and Ryvarden (2004), this species lacks hymenial setae. However, hymenial setae have been reported in *I. patouillardii* by Pegler (1964), Ryvarden & Johansen (1980) and Núñez & Ryvarden (2000). The Kerala collection shows similarities with *Inonotus* *compositus* Han C. Wang by having setal hyphae. However, the latter has larger pores (2–3 per mm) and wider setal hyphae (8–18 µm) (Dai 2010).

Inonotus patouillardii has a tropical distribution (Núñez & Ryvarden 2000). The species has been reported from Kerala by Mohanan (2011).

Inonotus tabacinus (Mont.) G. Cunn., Bull. N.Z. Dept. Sci. Industr. Res., Pl. Dis. Div. 78: 3 (1948)

Basionym: *Polyporus tabacinus* Mont., Annls Sci. Nat., Bot., sér. 2 3: 349 (1835)
Synonyms:
Polystictus tabacinus (Mont.) Fr., Nova Acta R. Soc. Scient. upsal., Ser. 3 1 (1): 93 (1851)
Mucronoporus tabacinus (Mont.) Ellis & Everh., J. Mycol. 5 (1): 29 (1889)
Microporus tabacinus (Mont.) Kuntze, Revis. gen. pl. (Leipzig) 3 (3): 497 (1898)
Cyclomyces tabacinus (Mont.) Pat., Essai Tax. Hyménomyc. (Lons-le-Saunier): 98 (1900)
Cycloporellus barbatus Murrill, Bull. Torrey bot. Club 35: 397 (1908)
Polystictus barbatus (Murrill) Sacc. & Trotter, Syll. fung. (Abellini) 21: 321 (1912)
Polystictus tabacinus var. *barbatus* (Murrill) P.W. Graff, Bull. Torrey bot. Club 45: 451 (1918)
Inonotus tabacinus var. *alineatus* Corner, Beih. Nova Hedwigia 101: 155 (1991)
Inonotus tabacinus var. *dimiticus* Corner, Beih. Nova Hedwigia 101: 156 (1991)
Inonotus tabacinus var. *latiporus* Corner, Beih. Nova Hedwigia 101: 156 (1991)
Hymenochaete porioides T. Wagner & M. Fisch., Mycol. Progr. 1 (1): 101 (2002)
Polystictus iodinus sensu Lloyd; fide NZfungi (2008)

FIGURE 115

Basidiomata annual to biennial, medium sized, coriaceous when young, moderately tough when mature, hard and brittle when dry, light in weight, solitary or in clusters, pileate. **Pileus** 20–74 mm long, 1–2 mm thick, semicircular to flabelliform, applanate to wavy, laterally attached with a small point of attachment, concentrically zonate, weakly sulcate, zonations narrow, tomentose to adpressed velutinate, coffee brown, paler along margein when fresh, often with yellowish shades, black in KOH, margin even, rarely wavy. **Hymenophore** poroid. **Pores** 8–10 per mm, round to ovoid, rusty brown, yellowish brown along margin, black in KOH, pore tubes 1 mm long, concolourous with pore surface. **Context** 2 mm thick, dark brown, separated from tomentum by a distinct black line. **Odour** not distinctive. **Spore print** not observed.

Basidiospores 3.5–4 × 1.5–2 µm, Q=1.4–1.2, Q_m=1.6, ellipsoid, hyaline, smooth, thin walled, eguttulate, inamyloid in Melzer's reagent. **Basidia** 10–15 × 3–5 µm, clavate, 4 sterigmate. **Hymenial Setae** frequent, 27–45 × 8–10 µm, subulate, arising from sub hymenium, slightly curved at base, dark brown, thick walled (1–1.5 µm). **Hymenial trama** interwoven and monomitic. Hyphae 3–5 µm wide, yellowish brown to brown, thin to thick walled (1 µm), smooth, weakly branched, frequently septate without clamp connections. **Pileal trama** interwoven and monomitic. Hyphae along the black zone 3–4 µm wide, yellowish brown, septate, weakly branched, distinctly thick walled (1–1.5 µm wide). Hyphae below the context 3–5 µm wide, thick walled (1 µm), smooth, weakly branched, frequently septate without clamp connections**.** **Pileipellis** composed of long, erect, trichodermium, made of hyphae that are 2–4 µm wide, sparsely septate, yellowish brown, thick walled with obtuse ends.

Specimens examined: India. Kerala State: Kannur district, Aralam, on dead branch (unidentified), 24 September 2016, Vijisha P., ZGCVN464; Kozhikode district, Kuttyadi, Janaki forest, on dead branch (unidentified), 02 August 2018, Vinjusha N., ZGCVN726; Kakkayam, on fallen *Pinus* species, 26 October 2018, Vinjusha N., ZGCVN744; Wayanad district, Chembra Peak, on dead branch (unidentified), 16 November 2018, Vinjusha N., ZGCVN754; 900 Kandi forest, on dead branch (unidentified), 12 July 2019, Vinjusha N., ZGCVN850; Thiruvananthapuram district, Agastyamala areas, on dead branch (unidentified), Manju A. C., ZGCVN779.

Comments: Some authors consider this species under the genus *Cyclomyces* (Ryvarden & Johansen 1980; Núñez & Ryvarden 2000; Dai 2010). Although the species was treated under *Cyclomyces*, Dai (2010) had opined that *C. tabacinus* (Mont.) Pat. differed from the rest species of *Cyclomyces* by having minute pores in the hymenium and two black lines between tomentum and lower context. Present specimen show resemblances with *Hymenochaete xerantica* (Berk.) S.H. He & Y.C. Dai. However, the latter species have larger pores (3–5 per mm) and lacerate dissepiments.

Inonotus tabacinus is a common pantropical species (Ryvarden & Johansen 1980). From Kerala, this species has been reported (as *C. tabacinus*) by Leelavathy & Ganesh (2000).

Inonotus luteoumbrinus (Romell) Ryvarden [as '*luteo-umbrinus*'], Syn. Fung. (Oslo) 21: 79 (2005)

Basionym: *Phaeoporus luteoumbrinus* Romell, K. svenska Vetensk-Akad. Handl., ny följd 26: 27 (1901)
Synonyms:
Polyporus luteoumbrinus (Romell) Sacc. & P. Syd., Syll. fung. (Abellini) 16: 149 (1902)
Pyropolyporus sublinteus Murrill, N. Amer. Fl. (New York) 9 (2): 110 (1908)
Fomes sublinteus (Murrill) Sacc. & Trotter, Syll. fung. (Abellini) 21: 291 (1912)
Fulvifomes sublinteus (Murrill) Murrill, Tropical Polypores: 86 (1915)
Polyporus howellii W.B. Cooke & Bonar, Occ. Pap. Calif. Acad. Sci. 29: 2 (1961)
Aurificaria luteoumbrina (Romell) D.A. Reid, Kew Bull. 17 (2): 279 (1963)
Coltricia luteoumbrina (Romell) Teng, Chung-kuo Ti Chen-chun, [Fungi of China]: 759 (1963)
Phellinus sublinteus (Murrill) Ryvarden, Norw. Jl Bot. 19: 235 (1972)

FIGURE 116

Basidiomata annual, medium sized, solitary or in clusters, hard and woody, almost brittle on drying, light in weight, pileate. **Pileus** 95–120 mm long, 100 mm thick, sessile, semicircular, applanate, concentrically zonate, weakly sulcate, glabrous, rough, brown with alternate brownish black bands, yellowish brown towards margin, margin tough, entire, obtuse. **Hymenophore** poroid. **Pores** 4–6 per mm, angular, present near to the margin, yellowish brown, slightly glancing, pore tubes 3–4 mm long, umber brown, non stratified. **Context** up to 7 mm thick, yellow, homogenous. **Odour** not distinctive. **Spore print** not observed.

Basidiospores 5–6 × 4–5 µm, Q=1.25–1.5, Q_m=1.37, subglobose to broadly ellipsoid, yellowish brown, olivaceous brown in KOH, smooth, firm walled, often monoguttulate, in amyloid in Melzer's reagent. **Basidia** 8–10×5–6 µm, subglobose to broadly clavate, 4 sterigmate. **Hymenial setae** absent. **Setal hyphae** absent. **Hymenial trama** almost interwoven and monomitic, with scattered crystals. Generative hyphae 2.5–6 µm wide, yellowish brown to brown, smooth, thick walled (1 µm wide), unbranched, infrequently septate, without clamp connections. **Pileal trama** parallel. Generative hyphae wider than those in hymenium, 5–8 µm wide, yellowish brown, smooth, nearly thick walled (up to 1 µm wide), closely septate, without clamp connections. **Pileipellis** a cutis made of hyphae 3–6 µm wide, yellowish brown, thick walled, with few scattered crystals.

Specimen examined: India. Kerala State: Idukki district, Vattavada, on dead wood (unidentified), 28 July 2019, Salna N., ZGCVN880.

Comments: The collection properly matches with the description of *Inonotus luteoumbrinus* by Ryvarden & Johansen (1980) (as *Phellinus sublinteus* (Murr.) Ryv.). However, Murrill (1915) reported globose basidiospores for the species.

Inonotus luteoumbrinus is distributed in Africa (Ryvarden & Johansen 1980), North America (Murrill 1915), tropical Central America (Ryvarden & Johansen 1980), India (Ranadive 2013). From kerala, this species has been documented by Leelavathy & Ganesh (2000) and Iqbal *et al.* (2016).

Inonotus subhispidus Pegler & D.A. Reid, Trans. Br. mycol. Soc. 47 (2): 170 (1964)

FIGURE 117

Basidiomata annual, small sized, found in caespitose clusters, hard and tough, especially near the region of attachment, light in weight, pileate. **Pileus** 30–42 mm long, 6–10 mm thick, laterally attached, almost semicircular, surface velvety in appearance, irregular, covered with tuft of dark brown fasciculate hairs, hairs sparser towards margin, margin even, smooth. **Hymenophore** poroid. **Pores** 5–6 per mm, angular, absent at the margin, brown, yellowish brown towards margin, turning dark brown on handling, pore tubes 1–2 mm long, yellowish brown. **Context** 2–8 mm thick, turning slightly darker on bruising. Whole fruit body turning black in KOH. **Odour** not distinctive. **Spore print** not observed.

Basidiospores 5–7 × 4–7 µm, Q=1–1.2, Q_m=1.1 µm, subglobose to globose, yellowish brown to brown, thick walled (up to 1 µm,) smooth, guttulate, inamyloid in Melzer's reagent. **Basidia** not observed. **Setae and setal hyphae** absent. Basidioles 12.7–15 × 5.3–7.4 µm. **Hymenial trama** interwoven and monomitic.

Generative hyphae 3–7.5 µm, rarely with bulges up to 11 µm wide, hyaline, pale yellow to yellowish brown, thick walled (up to 2 µm), branched, sometimes arboriform, frequently septate, without clamp connections. **Pileal trama** interwoven. Generative yphae 2–6 (8) µm wide, hyaline to brown, thick walled (2–3 µm), moderately branched, frequently septate, without clamp connections. **Pileipellis** forming an irregular trichoderm; hyphae 3–6 µm wide, yellowish brown, with obtuse to nearly acute hyphal tip.

Specimens examined: India. Kerala State: Wayanad district, Wayanad Ghats, on dead wood stump (unidentified), 15 September 2014, Vinjusha N., ZGCVN3; Kozhikode, Calicut University campus, on daed wood stump (unidentified), 23 August 2017, Vinjusha N., ZGCVN621.

Comments: Present collection is similar to *Inonotus hispidus* (Bull.) P. Karst., however the latter produces larger basidiospores (8–10 × 7.5–9 µm; Ryvarden 2005). Sharma (1995) placed *I. subhispidus* as a synonym of *I. hispidus*. According to the description (Dai 2010), size of basidiospores of *I. subhispidus* is (6.3–) 6.5–7.3 (–7.6) × 5–5.9 (–6) µm. When compared to this, present collection has slightly smaller basidiospores. Ryvarden (2005) had described larger spores for this species (7–9 × 5–6.5 µm).

The species has been reported from India, Pakistan and Russia (Ryvarden 2005). There are no reports of this species from Kerala so far.

Tropicoporus L.W. Zhou, Y.C. Dai & Sheng H. Wu

Basidiomata annual to perennial, solitary or in clusters, hard and woody, resupinate, effused reflexed to pileate. Hymenophore poroid, pores round to angular, pore surface brown. Context homogeneous to duplex. Hyphal system monomitic to dimitic, hyphae hyaline, yellowish brown to brown, thin, slightly thick to thick walled. Hymenial setae present. Basidiospores subglobose to ellipsoid, yellowish, slightly thick to thickwalled, inamyloid in Melzer's reagent. Members cause white rot on wood.

Tropicoporus dependens (Murrill) L.W. Zhou, Y.C. Dai & Vlasák, in Zhou, Vlasák, Decock, Assefa, Stenlid, Abate, Wu & Dai, Fungal Diversity 77: 344 (2015)

Basionym: *Pyropolyporus dependens* Murrill, N. Amer. Fl. (New York) 9 (2): 106 (1908)
Synonyms:
Fomes dependens (Murrill) Sacc. & Trotter, Syll. fung. (Abellini) 21: 292 (1912)
Cryptoderma dependens (Murrill) Imazeki, Bull. Tokyo Sci. Mus. 6: 107 (1943)
Phellinus dependens (Murrill) Ryvarden, Norw. Jl Bot. 19 (3-4): 234 (1972)
Fulvifomes dependens (Murrill) Bondartseva & S. Herrera, Mikol. Fitopatol. 26 (1): 13 (1992)
Inonotus dependens (Murrill) Vlasák & Y.C. Dai, Phytotaxa 124 (1): 27 (2013)

FIGURE 118

Basidiomata perennial, small to large, solitary to imbricate, hard and woody, effused reflexed to pileate. **Pileus** 35–62 mm long, 10–15 mm thick, sessile, broadly attached, semicircular to irregular in shape, applanate to weakly ungulate, concentrically zonate, sulcate, adpressed tomentose when young, glabrous and crusted on maturity, weakly rimose, yellowish brown to brownish black, black in KOH, margin rigid, even to wavy. **Hymenophore** poroid. **Pores** 5–8 per mm, angular, pores absent near margin, surface fuscous brown, ochre along margin, pore tubes 10–15 mm long, concolourous with pore surface, black in KOH. **Context** about 2 mm thick, brown, developing black crusts above. **Odour** not distinctive. **Spore print** not observed.

Basidiospores 4–5 × 3.5–5 µm, globose, yellow to light brown, eguttulate, slightly thick walled, up to 1 µm, smooth, eguttulate, inamyloid in Melzer’s reagent. **Basidia** not observed. **Hymenial setae** present, 16–26 × 4–5 µm, ventricose, some with a slight bent at the base, tips acute, dark brown, thick walled (1–2 µm). **Hymenial trama** interwoven and dimitic. Generative hyphae very rarely observed, 2–3 µm wide, hyaline, thin walled, smooth, septate, branched. Skeletal hyphae dominant, 3–5 µm wide, yellowish brown to brown, smooth, thick walled (1 µm wide), weakly branched, septations absent. **Pileal trama** interwoven. Generative hyphae 1.5–3 µm wide, hyaline, smooth, thin walled. branched, septate. Skeletal hyphae 3–5 µm wide, yellowish brown to brown, thick walled (1 µm wide), weakly branched, septations absent. **Pileipellis** an agglutinated cutis made of thick walled brownish hyphae, that are 2–4 µm wide, weakly branched and rarely septate.

Specimens examined: India. Kerala State: Kozhikode district, Peruvannamuzhy, on *Terminalia bellirica*, 11 August 2016, Vinjusha N., ZGCVN408; on *Sweitenia mahagoni*, 24 June 2017, Vinjusha N., ZGCVN527; Kakkad, Vinjusha N, 13 July 2017, on fallen *Elaeocarpus tuberculatus* Roxb., ZGCVN572; Wayand district, Pookod, on live tree (unidentified), 30 June 2017, Vinjusha N., VN542.

Comments: Present collection is closely related to *Tropicoporus linteus* (Berk. & M.A. Curtis) Teng. According to Salvador-Montoya *et al*. (2018), the hyphal system of *T. linteus*, is monomitic in the context and dimitic in the tubes. Whereas, in the present collection, hyphal system was dimitic in both context and tubes. *Tropicoporus dependens* and *T. linteus* are mainly separated based on the size of basidiospores, where spores of the former are slightly smaller (3–4 µm long) than the latter (4–5 µm) (Ryvarden & Johansen 1980). Referring to the above descriptions (Ryvarden & Johansen 1980; Salvador-Montoya *et al*. 2018), present collection is identified as *T. dependens.*

The species has distribution in North, South, Central America and India (Ryvarden & Johansen 1980; Ranadive 2013). From Kerala, this species has been documented by Sankaran & Florence (1997, 2000), Leelavathy & Ganesh (2000), Mohanan (2011), and Iqbal *et al.* (2016).

Phellinus Quél.

Basidiomata mostly perennial, or annual, solitary or imbricate, hard and woody, resupinate, effused reflexed to pileate. Pileus sessile, applanate to ungulate, zonate to azonate, with or without sulcations, usually rimose with age, crusted, yellowish brown, brownish black to black. Hymenophore poroid, pores round to angular, pore surface brown, pore tobes usually stratified, brown. Context brown, homogenous. Hyphal system dimitic, with hyaline to pale brownish, thin to thick walled generative hyphae, and brownish, thick walled, skeletal hyphae. Setae present, originating from subhymenium, ventricose to subulate, yellowish brown to brown. Basidiospores subglobose to broadly ellipsoid or ovoid, hyaline to yellowish brown, almost thick walled, inamyloid in Melzer's reagent. Members causing white rot on living trees or dead woods.

Phellinus ferrugineovelutinus (Henn.) Ryvarden [as *'ferrugineo-velutinus'*], Norw. Jl Bot. 19: 234 (1972)

Basionym: *Poria ferrugineovelutina* Henn., Hedwigia 44: 59 (1905)

FIGURE 119

Basidiomata perennial, resupinate, effused, slightly reflexed along margin, but not distintly pileate, found as large patches, adnate, hard and woody, up to 6 mm thick, margin brownish black to black, hard and almost crusted, obtuse. **Hymenophore** poroid. Pores 5–7 per mm, absent near margin, round to angular, orangish to reddish brown, pore tubes 4–5 mm long, stratified, concolourous with pore surface, all tissue black in KOH. **Context** not distinct. **Odour** not distinctive. **Spore print** not observed.

Basidiospores 3–3.5 × 2–2.5 µm, Q=1.5–1.6, Q_m=1.55, subglobose to broadly ellipsoid, hyaline, eguttulate, thin walled, smooth, inamyloid in Melzer’s reagent. **Basidia** not observed. **Hymenial setae present** and frequent; 23–33 × 5–7 µm ventricose to setiform, rusty brown, thick walled (1–1.5 µm), usually straight with acute tips, sometimes curved at base. **Hymenial trama** interwoven and dimitic, with abundant irregular crystals. Generative hyphae 1–3 µm wide, hyaline, smooth, thin walled, weakly branched, without clamp connections. Skeletal hyphae predominant; 2–5 µm wide, yellowish brown to rusty brown, smooth, thick walled (1 µm), unbranched, septations not observed.

Specimens examined: India. Kerala State: Kannur district, Neeliyarkottam, on fallen tree wood (unidentified), 15 July 2016, Vinjusha N, ZGCVN366.

Comments: *Phellinus ferrugineo-velutinus* is highly similar to *P. johnsonianus* (Murr.) Ryv., however, the latter produces longer setae (up to 60 µm long, Ryvarden & Johansen 1980). This species also resembles *Fulvifomes glaucescens* (Petch) Y.C. Dai in morphology, but the latter produces larger basidiospores ((3.2–) 3.6–4 (–4.5) × (2.7–) 2.8–3.4 (–3.5) µm (Dai 2010).

Phellinus ferrugineo-velutinus has a widespread distribution in South America (Ryvarden & Johansen 1980), and has been recorded from south east Asia by Corner (1989). Leelavathy & Ganesh (2000) and Iqbal *et al*. (2016) have reported this species from Kerala.

Phellinus allardii (Bres.) S. Ahmad, Basidiomyc. W. Pakist. 6: 57 (1972)

Basionym: *Fomes allardii* Bres. [as '*allardi*'], in Wildeman, Bull. Jard. bot. État Brux. 4 (1): 19 (1914)
Synonym:
Fulvifomes allardii (Bres.) Bondartseva & S. Herrera, Mikol. Fitopatol. 26 (1): 13 (1992)

FIGURE 120

Basidiomata perennial, small sized, found in imbricate clusters, hard and woody, bony hard when dry, firmly attached to the substrate, light in weight, effused reflexed to pileate. **Pileus** 45–115 mm long, up to 22 mm thick, sessile, broadly attached, semicircular, applanate to convex, concentrically sulcate, glabrous, roughened with many small ridges and grooves in non crusted fruit bodies, cinnamon brown to brown when young, black on maturity, margin entire, obtuse, surface usually covered with bryophytes. **Hymenophore** poroid. **Pores** 7–11 per mm, round, regular, absent at the margin, brown, pore tubes up to 10 mm thick, stratified, concolourous with pore suface. **Context** 1–2 mm thick, or indistinct due to perennial growth brown, black in KOH. **Odour** not distinctive. **Spore print** not observed.

Basidiospores 3.5–5 × 3–4 µm, Q=1.1–1.6, Q_m=1.37, subglobose to broadly ellipsoid, pale yellow, brown in KOH, slightly thick walled (up to 1 µm), smooth, eguttulate, inamyloid in Melzer's reagent. **Basidia** not observed. **Setae** absent. **Hymenial trama** interwoven and dimitic. Generative hyphae 1.5–3 µm wide, hyaline, thin walled, branched, without clamp connections. Skeletal hyphae 2.5–5 µm wide, pale yellowish to brown, dark brown in KOH, smooth, thick walled (1–2 µm wide), unbranched, weakly septate. **Pileal trama** almost parallel. Generative hyphae 2–4 µm wide, hyaline, thin walled, branched, without clamp connections. Skeletal hyphae 2.5–5 µm wide, pale yellowish to brown, dark brown in KOH, smooth, thick walled (1–2 µm wide), unbranched, septate, septations frequent than in hymenial trama. **Pileipellis** an erect trichodermium**,** made of hyphae that are 3–5 µm wide, yellowish brown to brown, thick walled, almost frequently septate, with obtuse tips.

Specimen examined: India. Kerala State: Kozhikode district, Koyilandy, Poyil kavu, on live tree (unidentified), 23 June 2017, Vinjusha N., ZGCVN507; Kuttyadi, Janaki forest, on *Xylia xylocarpa*, 02 October 2018, Vinjusha N., ZGCVN724.

Comments: Morphology of the present collection fits well with the taxonomic descriptions of *P. allardii* by Ryvarden & Johansen (1980) and Gerber & Loguercio-Leite (1997). The species show much morphological resemblance with *Phellinus caryophilli* in morphology. However, the latter produces smaller basidiospores (3–4 × 2.5–3 µm, Ryvarden & Johansen 1980). According to Ryvarden & Gilbertson (1994), *P. allardii* is a variable species in the form and size of fruit bodies. *Phellinus allardii* has been described as distinctly triquentrous pileate (Ryvarden & Johansen 1980; Ryvarden & Gilbertson 1994), as well as resupinate to effused reflexed (Leelavathy & Ganesh 2000; Dai 2010). Characters of the present specimen properly matched with descriptions of Leelavathy & Ganesh (2000) and Dai (2010). According to Ryvarden & Johansen (1980), *P. allardii* possess a distinct black line, below the tomentum of the pileus, or along the margin. Dai (2010) had also mentioned a thin black line between the context and host in the effused reflexed fruit bodies of this species. A black line was not noticed in the present collection, since the context was indistinct due to the perennial growth of pore tubes. According to Gerber & Loguercio-Leite (1997), basidiospores size of *P. allardii* is 4–5 × 3.5–4 µm, similar as observed in the present collection. However, Ryvarden & Johansen (1980) reported slightly larger spores for this species (4.5–5.5 (6) × 4–5 µm).

Phellinus allardii has been recored from Africa, Asia and America (Gerber & Loguercio-Leite 1997; Ryvarden & Johansen 1980; Dai 2010). From Kerala, *P. allardii* has been reported by Leelavathy & Ganesh (2000).

Phellinus caryophylli (Racib.) G. Cunn., Bull. N.Z. Dept. Sci. Industr. Res. 164: 238 (1965)

Basionym: *Trametes caryophylli* Racib., Parasit. Alg. Pilze Java's (Jakarta) 1: 17 (1900)
Synonyms:
Fomes caryophylli (Racib.) Bres., Annls mycol. 10 (5): 498 (1912)
Pyropolyporus caryophylli (Racib.) Teng, Chung-kuo Ti Chen-chun, [Fungi of China]: 762 (1963)
Fomitiporella caryophylli (Racib.) T. Wagner & M. Fisch. [as '*caryophylii*'], Mycologia 94 (6): 1012 (2002)

FIGURE 121

Basidiomata perennial, small to medium sized, hard and tough, usually imbricate, effused reflexed to pileate. **Pileus** 25–40 mm long, 3–6 mm thick, sessile, mostly decurrent, semicircular to convex, concentrically zonate, deeply sulcate, glabrous, crusted with age, uneven with irregular outgrowths, surface brownish black, margin light brown, wavy, uplifted in many specimens, turned black in KOH. **Hymenophore** poroid. **Pores** 8–9 per mm, round to angular, absent at the margin, creamish white, golden yellow along margin, turning pale brown on bruising, pore tubes stratified, 3 mm long, coffee brown. **Context** up to 2 mm thick, chocolate brown, turning black in KOH. **Odour** not distinctive. **Spore print** yellow.

Basidiospores 3–4 × 2–3 µm, Q=1–1.6, Q_m= 1.21, sub globose to broadly ellipsoid, yellow to yellowish brown, more dark brown in KOH, smooth, thick walled (up to 1 µm), guttulate, inamyloid in Melzer's reagent; spores often agglutinated together. **Basidia** 8.5–11 × 4–7 µm, ellipsoid to broadly clavate, hyaline, 4 sterigmate. **Setae** absent. **Hymenial trama** almost parallel along the tubes and dimitic. Generative hyphae 1–3 µm wide, hyaline to pale yellow, thin walled, smooth, without clamp connections. Skeletal hyphae 2–4 µm wide, yellowish brown to brown, smooth, thick walled (1–1.5 µm), unbranched to sparsely branched, weakly septate. Skeleto ligative hyphae not observed. **Pileal trama** parallel. Generative hyphae rarely observed, 1–2 µm wide, pale yellow, thin walled, smooth, without clamp connections. Skeletal hyphae 2–4.5 µm wide, yellowish brown to brown, thick walled (up to 2 µm), weakly septate, unbranched to sparsely branched. Skeleto ligative hyphae not observed. **Pileipellis** a cutis, made of thick walled, yellowish brown to brown hyphae, that are 2–4 µm wide. Setae absent.

Specimens examined: India. Kerala State: Kozhikode district, Pokkunnu, ZG College campus, on live *Bridelia retusa*, 03 July 2015 Vinjusha N., ZGCVN9.

Comments: The effused fruit bodies of the present collections resemble *P. allardii*, however separated from latter by smaller basidiospores.

Phellinus caryophylli has been recorded from East Indies, Australia, New Guinea (Cunningham 1965) and tropical Asia (Núñez & Ryvarden 2000). From Kerala, this species was recorded (as *P. caryophylleus* (Cooke) Ryvarden) by Florence & Yesodharan (2000).

Phellinus rimosus (Berk.) Pilát, Annls mycol. 38 (1): 80 (1940)

Basionym: *Polyporus rimosus* Berk., London J. Bot. 4: 54 (1845)
Synonyms:
Fomes rimosus (Berk.) Cooke, Grevillea 14 (no. 69): 18 (1885)
Scindalma rimosum (Berk.) Kuntze, Revis. gen. pl. (Leipzig) 3 (3): 519 (1898)
Xanthochrous niaouli Pat., Bull. Jard. col. Jard. Essai col. fr. 1: 263 (1901)
Pyropolyporus underwoodii Murrill, Bull. Torrey bot. Club 30 (2): 116 (1903)
Fomes versicolor Henn., Hedwigia 42 (Beibl.): (75) (1903)
Fomes underwoodii (Murrill) Sacc. & D. Sacc., Syll. fung. (Abellini) 17: 117 (1905)
Polyporus niaouli (Pat.) Sacc. & D. Sacc., Syll. fung. (Abellini) 17: 109 (1905)
Fomes melleicinctus (Murrill) Murrill, Bull. New York Bot. Gard. 8: 153 (1912)
Pyropolyporus melleicinctus Murrill, Bull. New York Bot. Gard. 8: 150 (1912)
Fulvifomes melleicinctus (Murrill) Murrill, Tropical Polypores: 84 (1915)
Fulvifomes underwoodii (Murrill) Murrill, Tropical Polypores: 88 (1915)
Fomes niaouli (Pat.) Lloyd, Mycol. Writ. 4 (Syn. gen. *Fomes*): 250 (1915)
Hexagonia scabra (Berk.) Petch, Ann. R. bot. Gdns Peradeniya 6 (1): 143 (1916)
Fomes rimosus var. *niaouli* (Pat.) Cleland & Cheel, J. Proc. R. Soc. N.S.W. 51: 515 (1917)
Fomes rimosus var. *casuarinae* Cleland, in Maiden, Cleland & Burrow, Forestry Comm. N.S.W. Bull. 14: 17 (1920)
Fomes tepperi var. *casuarinae* (Cleland) G. Cunn., Bull. N.Z. Dept. Sci. Industr. Res. 164: 233 (1965)
Phellinus scaber (Berk.) M.J. Larsen, Mycotaxon 37: 356 (1990)
Fulvifomes sanjanii (Lloyd) Bondartseva & S. Herrera, Mikol. Fitopatol. 26 (1): 13 (1992)

FIGURE 122

Basidiomata perennial, small to large sized and robust, solitary, young fruit bodies sometimes found in clusters, hard and woody, bony hard when mature, firmly attached to the substrate, almost heavy, pileate. **Pileus** 20–150 mm long, up to 52 mm thick, sessile, semicircular, slightly ungulate when young, applanate when mature, semicircular, concentrically sulcate with wider zones, glabrous, matted, crustrose, cracked and deeply rimose with age, greyish black to black, sometimes covered by mosses, margin obtuse, entire. **Hymenophore** poroid. **Pores** 4–6 per mm, round, absent at the margin, dull brown, pore tubes up to 20 mm thick, stratified, tube layers distinct, brown, homogenous. **Context** 10–20 mm thick, brown, black in KOH, a distinct black crust present above the context. **Odour** not distinctive. **Spore print** not observed.

Basidiospores 4–6 × 3–5 µm, Q=1–1.3, Q_m=1.09, subglobose to globose, yellowish brown to brown, slightly thick walled (< 1µm), smooth, eguttulate, inamyloid in Melzers reagent. **Basidia** 10–15 × 4–6 µm, broadly clavate, 4 sterigmate. **Setae** absent. **Hymenial trama** almost parallel and somewhat agglutinated, with dimitic hyphal system. Generative hyphae not frequent, 2–3 µm wide, hyaline, smooth, thin walled, branched, septate, without clamp connections. Skeletal hyphae dominant, 3–5 µm wide, pale yellowish to brown, dark brown in KOH, smooth, thick walled (1–1.5 µm wide), unbranched, weakly septate. **Pileal trama** loosely interwoven. Generative hyphae less frequent, up to 3 µm wide, hyaline, smooth, thin walled, branched, without clamp connections. Skeletal hyphae dominant, 3–5 µm wide, hyaline to pale yellowish brown, unbranched, thick walled (1 µm), smooth. **Pileipellis composed of** an agglutinated crust, difficult to separate, made of yellowish brown thick walled hyphae that are 2–4 µm wide.

Specimen examined: India. Kerala State: Kozhikode district, Koyilandy, Muchikunnu, Kottayilkavu, 04 October 2015, Vinjusha N, ZGCVN225, ZGCVN226; Thamarassery, Kakkavayal, Vanaparvam Biopark, on fallen *Xylia xylocarpa*, Vinjusha N., ZGCVN694; Palakkad district, Dhoni, on *Sweitenia mahagoni*, 28 November 2018, Vinjusha N., ZGCVN771.

Comments: *Phellinus rimosus* is easily distinguished by the crusted and strongly rimose black fruit bodies, larger pores, and small, globose to subglobose, yellowish brown basidiospores. *Phellinus rimosus* shows similarity with *Phellinus nilgheriensis*. Although, the latter produces crust over the pileus, it is not as thick and rimose as present in the former. In addition, *P. nilgheriensis* produces smaller pores (7–9 per mm) (Ryvarden & Johansen 1980).

Phellinus rimosus has distribution in Africa, Asia, Australia and southern Europe (Ryvarden & Johansen 1980). From Kerala, this species has been recorded by Leelavathy & Ganesh (2000) and Mohanan (2011).

Phellinus gilvus (Schwein.) Pat., Essai Tax. Hyménomyc. (Lons-le-Saunier): 82 (1900)

Basionym: *Boletus gilvus* Schwein., Schr. naturf. Ges. Leipzig 1: 96 [70 of repr.] (1822)
Synonyms:
Polyporus gilvus (Schwein.) Fr., Elench. fung. (Greifswald) 1: 104 (1828)
Mucronoporus gilvus (Schwein.) Ellis & Everh., J. Mycol. 5 (1): 28 (1889)
Fomes gilvus (Schwein.) Speg., Anal. Mus. nac. Hist. nat. B. Aires 6: 165 (1898)
Hapalopilus gilvus (Schwein.) Murrill, Bull. Torrey bot. Club 31 (8): 418 (1904)
Phellinus stabulorum Pat., Bull. Soc. mycol. Fr. 23 (2): 74 (1907)
Fomes stabulorum (Pat.) Sacc. & Trotter, Syll. fung. (Abellini) 21: 286 (1912)
Polyporus stabulorum (Pat.) Lloyd, Mycol. Writ. 4 (Syn. Apus): 348 (1915)
Polyporus chrysellus Bres., Annls mycol. 18 (1/3): 33 (1920)
Polyporus pseudogilvus Lloyd, Mycol. Writ. 6: 940 (1920)
Trametes keetii Van der Byl, S. Afr. J. Sci. 18: 283 (1922)
Polyporus ursinulus Lloyd, Mycol. Writ. 7 (Letter 67): 1143 (1922)
Phellinus bolaris Pat., Bull. trimest. Soc. mycol. Fr. 43: 29 (1927)
Polyporus gilvus var. *sublicnoides* Rick, Brotéria, N.S. 5: 91 (1935)
Fuscoporia gilva (Schwein.) T. Wagner & M. Fisch., Mycologia 94 (6): 1013 (2002)

FIGURE 123

Basidiomata small, coriaceous when fresh, becoming moderately hard on drying, light in weight, solitary to mostly imbricate, pileate. **Pileus** 21–80 mm long, up to 5 mm thick, sessile, to broadly attached, semicircular, applanate to weakly convex, concentrically zonate, sometimes not prominent, yellowish brown to cinnamon brown, dark brown in some fruit bodies, yellowish near margin, black in KOH, mostly glabrous, hispid at some regions, margin even, round. **Hymenophore** poroid. **Pores** 7–14 per mm, angular, pores absent near margin, surface fuscous brown, light brown towards margin, pore tubes 2–3 mm long, concolourous with pore surface, black in KOH. **Context** 2–3 mm thick, golden yellow to yellowish brown, homogenous, black in KOH. **Odour** not distinctive. **Spore print** not observed.

Basidiospores 3–5 × 2–3 µm, Q= 1.3–2, Q_m=1.67, ellipsoid to broadly ellipsoid or oblong, pale yellowish brown, eguttulate, slightly thick walled, up to 1 µm, smooth, eguttulate, inamyloid in Melzer's reagent. **Basidia** not observed. **Hymenial setae** abundant, 15–35 × 5–8, ventricose to setiform, some with an extended base, tips acute, dark brown, often covered with agglutinated sheath, thick walled (1–2 µm). **Hymenial trama** interwoven. Generative hyphae 2– 4 µm wide, hyaline, smooth, thin walled, branched, without clamp connections. Skeletal hyphae 2–6 µm wide, yellowish brown to brown, smooth, thick walled, unbranched to rarely branched, septations absent. Skeleto ligative hyphae not observed. **Pileal trama** interwoven. Generative hyphae 2–3 µm wide, hyaline, thin walled, smooth, septate, branched, without clamp connections. Skeletal hyphae 2–7 µm wide, yellowish brown to brown, smooth, thick walled, unbranched to rarely branched, septations absent. Skeleto ligative hyphae not observed. **Pileipellis** forming short irregular trichoderm, almost agglutinated, made of pale yellow to yellowish brown hyphae, 2–6 µm wide, moderately thick walled, with obtuse ends.

Specimens examined: India. Kerala State, Kozhikode district, Edakkara, Vallikkattukavu, on dead log (unidentified), 11 July 2015, Vinjusha N., ZGCVN40; Koyilandy, Poyil kavu, on dead logs (unidentified), 16 July 2016, Vinjusha N., ZGCVN371; Thiruvannur, on dead log (unidentified), 15 January 2016, Vinjusha N., ZGCVN307; Peruvannamuzhy, on dead log (unidentified), 11 August 2016, Vinjusha N., ZGCVN407; Peruvannamuzhy, on dead log (unidentified), 11 August 2016, Vinjusha N., ZGCVN424; Pantheerankavu, Kariyathan kottom, on live tree (unidentified), 02 Februay 2017, Vinjusha N., ZGCVN344; Pokkunnu, ZG College campus, on *Mangifera indica*, Vinjusha N., 01 August 2018, ZGCVN699; Kannur district, Aralam, on dead branch (unidentified), 07 April 2016, Vijisha P., ZGCVN301, ZGCVN323; Neeliyarkottam, on live tree (Sapotaceae), 15 July 2016, Vinjusha N., ZGCVN367; Kottayam district, Vagamon, Pine valley, on dead *Pinus* species, 24 October 2015, Vinjusha N., ZGCVN243; Wayanad district, Pookod, on dead log (unidentified), 30 June 2017, Vinjusha N., ZGCVN545, ZGCVN546; Kuruva Island, on dead wood stump (unidentified), 07 December 2018, Vinjusha N., ZGCVN785; Kasaragod district, Edayilakkad, on dead wood trunk (unidentified), 11

September 2017, Vinjusha N., ZGCVN627; on dead wood (unidentified), 16 September 2019, Vinjusha N., ZGCVN911; Kottayam district, Kottamala, Kurinjikavu, on live tree (unidentified), 18 December 2018., Vinjusha N., ZGCVN800.

Comments: *Phellinus gilvus* is easily distinguished by their annual, medium sized basidiocarps, glabrous, yellowish brown to cinnamon brown pileus, absence of setae and small basidiospores. This species is very commonly distributed in all tropical zones of the world (Ryvarden 2004).

BLAST search using the ITS sequence generated from the present specimen resulted in 100% similarity with *Phellinus gilvus* strains (GenBank numbers: KP771705, KF692068, KT037022). From Kerala, this species has been recorded by Leelavathy & Ganesh (2000), Mohanan (2011), Iqbal *et al.* (2016, as *Fuscoporia gilva* (Schwein) T. Wagner & M. Fisch.), and Adarsh *et al.* (2018).

Phellinus fastuosus (Lév.) S. Ahmad, Basidiomyc. W. Pakist.: 56 (1972)

Basionym: *Polyporus fastuosus* Lév., Annls Sci. Nat., Bot., sér. 3 2: 190 (1844)
Synonyms:
Fomes fastuosus (Lév.) Cooke, Grevillea 14 (no. 69): 18 (1885)
Scindalma fastuosum (Lév.) Kuntze, Revis. gen. pl. (Leipzig) 3 (3): 518 (1898)
Xanthochrous fastuosus (Lév.) Pat., Essai Tax. Hyménomyc. (Lons-le-Saunier): 101 (1900)
Pyropolyporus fastuosus (Lév.) Murrill, Bull. Torrey bot. Club 34: 479 (1907)
Cryptoderma fastuosum (Lév.) Imazeki, Bull. Tokyo Sci. Mus. 6: 107 (1943)
Phellinus fastuosus var. *bullatosulcatus* Corner, Beih. Nova Hedwigia 101: 85 (1991)
Fulvifomes fastuosus (Lév.) Bondartseva & S. Herrera, Mikol. Fitopatol. 26 (1): 13 (1992)
Fomitiporella fastuosa (Lév.) Teixeira, Revista Brasileira de Botânica 15 (2): 125 (1992)

FIGURE 124

Basidiomata, annual to perennial, medium to large sized, solitary or in clusters, tough when fresh, hard and woody on drying, moderately heavy, pileate. **Pileus** 40–300 mm long, 5–40 mm thick, sessile to dimidiate, flabelliform to semicircular, applanate, concentrically zonate, sulcate, adpressed tomentose, lesser on maturity, sometimes turning glabrous, yellowish brown to reddish brown, sometimes with light greenish shades due to presence of algae, margin usually white to light yellow, even, obtuse. **Hymenophore** poroid. **Pores** minute, 8–13 per mm, angular, absent near margin, surface dark greyish brown, pore tubes 4–30 mm long, light brown than hymenial surface, non stratified or stratified in perennial species, sometimes intermixed with contextual layer. **Context** 3–11 mm thick, yellowish to yellowish brown, with a distinct black line near the middle region. **Odour** not distinctive. **Spore print** not observed.

Basidiospores 4–6 × 3–5 µm, Q=1–1.2, Q_m=1.12, subglobose to globose or broadly ellipsoid, shiny yellow to yellowish brown, eguttulate, slightly thick walled (up to 1 µm), smooth, inamyloid in Melzer’s reagent. **Basidia** not observed. **Setae** absent. **Hymenial trama** irregular and dimitic. Generative hyphae rarely observed, 1–2.5 µm wide, hyaline, smooth, thin walled, branched, branched, septate, without clamp connections. Skeletal hyphae dominant, 3–8 µm wide, yellow to dark brown, moderately branched, thick walled (wall thickness up to 1 µm), weakly septate. **Pileal trama** interwoven. Generative hyphae rarely observed, 1–2.5 µm wide, hyaline, smooth, thin walled, branched, branched, septate, without clamp connections. Skeletal hyphae dominant, 3–8 µm wide, yellow to dark brown, moderately branched, thick walled (wall thickness up to 1 µm), weakly septate. **Pileipellis** a trichoderm, made of hyphae that are 2–7 µm wide, yellowish brown to brown, thick walled, with obtuse tips.

Specimens examined: India. Kerala State: Kozhikode district, Chelavoor, Thurayil Kotta, on *Diospyros paniculata*, 11 July 2015, Vinjusha N., ZGCVN48; India, Kerala, Kozhikode, Chelavoor, Thurayil Kotta, on *Diospyros paniculata*, 27 September 2015, Vinjusha N., ZGCVN210; Palazhi, Bhayankavu, on *Ficus* species, 27 December 2016, Vinjusha N., ZGCVN277; 26 October 2016, Vinjusha N., ZGCVN336, ZGCVN339; Koyilandy, Poyilkavu, on *Vatica chinensis* L., 16 July 2017, Vinjusha N., ZGCVN370, ZGCVN373, ZGCVN377; on dead wood stump, 23 June 2017, Vinjusha N., ZGCVN508; on dead log, 01 August 2018, Vinjusha N., ZGCVN698; Kuttyadi, Janaki forest, on dead stump of *Xylia xylocarpa*, 02 October 2018, Vinjusha N., ZGCVN721; Malappuram district, Nilambur, KFRI campus, on *Xylia xylocarpa*, 17 November 2016, Vinjusha N., ZGCVN472; Kannur district, Aralam, on live tree (unidentified), 16 September 2015, Vijisha P., ZGCVN199; 09

January 2016, Vijisha P., ZGCVN290; Palakkad district, Dhoni, on *Terminalia arjuna*, 28 November 2018; Vinjusha N., ZGCVN772; Kasaragod district, Edayilakkad, on dead log (unidentified), 01 September 2017, Vinjusha N., ZGCVN631; Wayanad district, Kuruva Island, on *Sweitenia mahagoni*, Vinjusha N., ZGCVN783; Vaithiri, Padivayal estate, on dead logs (unidentified), Vinjusha N., ZGCVN341; Ernakulam district, Perumbavoor, Iringole Kavu, on dead tree (unidentified), 08 July 2017, Vinjusha N., ZGCVN562.

Comments: Present collection is very much similar to *Fulvifomes durissimus* (Lloyd) Bondartseva & S. Herrera in morphology. Ryvarden (1989) had opined *F. durissimus* to be treated as a synonym of *P. fastuosus,* because of their character similarities. However, acccording to Dai (2010), *F. durissimus* can be separated from *P. fastuosus* by the slightly smaller basidiospores ((3.9–) 4–5 (–5.2) × (3.3–) 3.6–4.4 (–4.6) µm. In addition, *P. fastuosus* always possesses a distinct black line below the tomentum (Núñez & Ryvarden 2000; Ryvarden 2004; Dai 2010), a character absent in *F. durissimus*.

Phellinus fastuosus has a widespread distribution in the tropical zones of the world (Ryvarden 2004). From Kerala, this species has been recorded by Sankaran & Florence (1995), Florence & Yesodharan (1997, 2000), Leelavathy & Ganesh (2000), Mohanan (2011), Iqbal *et al.* (2016) and Adarsh *et al.* (2018). According to Leelavathy & Ganesh (2000), *P. fastuosus* is commonly encountered in the manmade gardens and disturbed forests, than in undisturbed evergreen forests in Kerala. This species mostly produces basidiocarps on basal part of the trees (Leelavathy & Ganesh 2000).

Phellinus hoehnelii (Bres.) Ryvarden, in Ryvarden & Johansen, Prelim. Polyp. Fl. E. Afr. (Oslo): 173 (1980)

Basionym: *Fomes hoehnelii* Bres., Annls mycol. 10 (5): 499 (1912)
Synonym:
Pseudoinonotus hoehnelii (Bres.) Zmitr., Malysheva & Spirin, Nov. sist. Niz. Rast. 40: 163 (2006)

FIGURE 125

Basidiomata perennial, large and robust, solitary or in clusters, hard and woody, firmly attached to the substrate, light in weight, especially on drying, pileate. **Pileus** 160 mm long, up to 80 mm thick, sessile, semicircular, ungulate, surface often irregular, concentrically zonate, very weakly sulcate at some regions, glabrous, matted, crust present, yellowish brown when young, brownish black to black when mature, distinctly black in KOH, margin obtuse, entire to wavy. **Hymenophore** poroid. **Pores** 6–8 per mm, round, absent at the margin, cinnamon to umber brown, pore tubes up to 70 mm thick, stratified, tube layers distinct, brown, homogenous. **Context** up to 10 mm thick, brownish yellow, black in KOH, a distinct black crust present above the context; 10–20 mm thick. **Odour** not distinctive. **Spore print** not observed.

Basidiospores 4.5–6 × 2.5–4 µm, Q=1.2–2, Q_m=1.5, subglobose to ellipsoid, pale yellow, thick walled (1µm), smooth, eguttulate, inamyloid in Melzer's reagent. **Basidia** 11–17 × 4–6 µm, broadly clavate, 4 sterigmate. **Hymenial Setae** present; 34–60 × 6–8 µm, ventricose, some with a curved base, tips acute, umber brown, smooth, thick walled (1–1.5 µm). **Setal hyphae** present and frequent; more than 100 µm long, 5–11 µm wide, cylindrical, dark brown, erect, thick walled (1.5 µm), with obtuse ends. **Hymenial trama** interwoven. Generative hyphae 2–3 µm wide, hyaline, smooth, thin walled, septate, branched, without clamp connections. Skeletal hyphae dominant, 3–6 µm wide, yellowish brown, dark brown in KOH, thick walled (1–2 µm wide), smooth, unbranched, weakly septate. **Pileal trama** interwoven. **Setal hyphae** present in trama, 5–10 µm wide, cylindrical, dark brown, erect, thick walled (1.5 µm), with obtuse ends. Generative hyphae less frequent; up to 3 µm wide, hyaline, smooth, thin walled, branched. Skeletal hyphae 3–6 µm wide, yellowish brown, thick walled (1–2 µm), smooth, unbranched. **Pileipellis** composed of an agglutinated hyphal mass, difficult to differentiate, hyphae 2–5 µm wide, brown to dark brown.

Specimen examined: India. Kerala State: Kozhikode district, Kakkayam, 29 August 2015, Vinjusha N., ZGCVN139; Idukki district, Udumbanchola, Poopara, on dead wood trunk (unidentified), 28 July 2019, Krishnapriya K., ZGCVN890.

Comments: *Inonotus pachyphloeus* (Pat.) T. Wagner & M. Fisch. is the closest species, having similar basidiospores. However, the former differs from present collection by wider setae (6–12 µm), and wider setal hyphae (up to 32 µm) (Ryvarden & Johansen 1980).

The species has occurrence in Africa, Indonesia, Philippines (Ryvarden & Johansen 1980) and India (Ranadive 2013; Nagadesi & Arya 2013). This species is reported to cause white rot on living *Peltophorum ferrugineum* and *Terminalia* species in India (Nagadesi & Arya 2013). Ganesh & Leelavathy (1986) and Leelavathy & Ganesh (2000) reported this species from Kerala.

Phellinus nilgheriensis (Mont.) G. Cunn., Bull. N.Z. Dept. Sci. Industr. Res. 164: 226 (1965)

Basionym: *Polyporus nilgheriensis* Mont., Annls Sci. Nat., Bot., sér. 2 18: 22 (1842)
Synonyms:
Polystictus nilgheriensis (Mont.) Fr., Nova Acta R. Soc. Scient. upsal., Ser. 3 1 (1): 78 (1851)
Microporus nilgheriensis (Mont.) Kuntze, Revis. gen. pl. (Leipzig) 3 (3): 496 (1898)
Coriolus nilgheriensis (Mont.) Pat., Essai Tax. Hyménomyc. (Lons-le-Saunier): 94 (1900)
Xanthochrous nilgheriensis (Mont.) Teng, Chung-kuo Ti Chen-chun, [Fungi of China]: 764 (1963)
Fulvifomes nilgheriensis (Mont.) Bondartseva & S. Herrera, Mikol. Fitopatol. 26 (1): 13 (1992)
Phellinus nilgheriensis var. *crassior* Corner, Beih. Nova Hedwigia 101: 117 (1991)
Phellinus nilgheriensis var. *malesianus* Corner, Beih. Nova Hedwigia 101: 118 (1991)

FIGURE 126

Basidiomata perennial, large sized and robust, solitary or in clusters, extremely hard and woody, firmly attached to the substrate, heavy, pileate. **Pileus** up to 230 mm long, 6–30 mm thick, sessile, semicircular, applanate to convex, concentrically zonate, distinctly sulcate, rough with irregular protuberances, glabrous, with thick crust above (2–3 mm), deeply rimose with age, brownish black, often covered with bryophytes, margin tough, even to wavy or weakly lobed, obtuse. **Hymenophore** poroid. **Pores** 7–10 per mm, round, absent at the margin, cinnamon brown, pore tubes up to 28 mm thick, stratified, tube layers distinct, concolourous with pore surface. **Context** indistinct due to perennial growth of pore tubes, up to 1 mm thick, brown. **Odour** not distinctive. **Spore print** not observed.

Basidiospores 4–5 × 4–4.5 µm, Q=1–1.2, Q_m=1.13, subglobose to globose, yellowish brown to brown with black walls, slightly thick walled (up to 1µm), smooth, inamyloid in Melzer's reagent. **Basidia** 10–19 × 4–5 µm, broadly clavate, 4 sterigmate. **Setae** absent. **Hymenial trama** interwoven. Generative hyphae not frequent, 1–2 µm wide, hyaline, smooth, thin walled, branched, without clamp connections. Skeletal hyphae dominant, 3.5–5 µm wide, yellowish brown to brown, dark brown in KOH, smooth, thick walled (1 µm), straight to slightly flexuose, unbranched to weakly branched, sparsely septate. **Pileal trama** loosly interwoven. Generative hyphae very rarely observed, 1–2 µm wide, hyaline, smooth, thin walled, branched, septate. Skeletal hyphae dominant, 3.5–5 µm wide, yellowish brown to brown, dark brown in KOH, smooth, thick walled (1 µm), straight to slightly flexuose, unbranched to weakly branched, weakly septate. **Pileipellis** composed of an agglutinated crust, made of yellowish hyphae that are 2–4 µm wide, yellowish brown to brown, weakly septate and thick walled.

Specimen examined: India: Kerala State: Wayanad district, Kuruva Island, on *Sweitenia mahagoni*, 07 December 2018, Vinjusha N., ZGCVN782.

Comments: *P. nilgheriensis* is closely related with *Phellinus allardii* in many macroscopic and microscopic characters. The difference lies in the more applanate fruit bodies and slightly larger, almost globose basidiospores in the former (Ryvarden & Johansen 1980). Basidiospores of *P. allardii* are subglobose to broadly ellipsoid (Ryvarden & Gilbertson 1994). In addition, *P. allardii* has denser fruit bodies than *P. nilgheriensis* (Ryvarden & Johansen 1980). According to the descriptions (Ryvarden & Johansen 1980; Leelavathy & Ganesh 2000), *P. nilgheriensis* possesses a distinct black line in the context. In the present collection, context was indistinct because of the perennial growth of the pore tubes. Characters of the present collection properly match with the description of the previous Kerala collection of the species (Leelavathy & Ganesh 2000). Present collection produces more large sized basidiocarps than previous reports (Ryvarden & Johansen 1980; Leelavathy & Ganesh 2000). Corner (1991) had reported hymenial setae in this species, however according to Ryvarden & Johansen (1980), the concept of presence of setae in *P. nilgheriensis* is wrong. Dai (2010) also reported *P. nilgheriensis* as species without setae.

Phellinus nilgheriensis has pantropical distribution (Ryvarden & Johansen 1980). From Kerala, this species has been reported by Florence & Yesodharan (2000), Leelavathy & Ganesh (2000), Iqbal *et al.* (2016, as *Fulvifomes nilgheriensis* (Mont.) Bondartseva & S. Herrera) and Adarsh *et al.* (2018).

***Cotylidia* P. Karst.**

Basidiomata annual, terrestrial, spathulate to infundibuliform, centrally or laterally stipitate. Pileus azonate, off white to cream with brownish shades. Hymenophore smooth to setulose. Context pale coloured, homogenouos. Hyphal system monomitic, with hyaline to pale brown coloured generative hyphae, that are thin to thick walled, having clamp connections. Pileocystidia and caulocystidia present or absent, when present, cylindrical in shape with obtuse tips. Basidia cylindrical to clavate, 4 sterigmate. Basidiospores ellipsoid, smooth, thin walled, inamyloid in Melzer's reagent. Members causes white rot type of wood deacay.

Cotylidia pannosa (Sowerby) D.A. Reid, Beih. Nova Hedwigia 18: 81 (1965)

Basionym: *Helvella pannosa* Sowerby, Col. fig. Engl. Fung. Mushr. (London) 2 (no. 14): tab. 155 (1799)
Synonyms:
Craterella pallida Pers., Neues Mag. Bot. 1: 112 (1794)
Thelephora pallida (Pers.) Pers., Icon. Desc. Fung. Min. Cognit. (Leipzig): tab. 5 (1800)
Thelephora pannosa (Sowerby) Fr., Syst. mycol. (Lundae) 1: 430 (1821)
Auricularia pannosa (Sowerby) Fr., Syst. orb. veg. (Lundae) 1: 83 (1825)
Hyphoderma pannosum (Sowerby) Wallr., Fl. crypt. Germ. (Norimbergae) 2: 579 (1833)
Thelephora sowerbyi (Berk.) Berk. [as '*sowerbeii*'], Outl. Brit. Fung. (London): 266 (1860)
Podoscypha sowerbyi (Berk.) Pat. [as '*Sowerbeji*'], Essai Tax. Hyménomyc. (Lons-le-Saunier): 71 (1900)
Stereum pallidum (Pers.) Cooke, Cat. field-book brit. basidiomyc.: genus no. 88 (1909)
Bresadolina pallida (Pers.) Brinkmann, Annls mycol. 7 (3): 289 (1909)
Stereum pannosum (Sowerby) Lloyd, Mycol. Writ. 4: 21 (1913)
Craterellus pallidus (Pers.) Ricken, Vadem. Pilzfr.: 248 (1918)
Podoscypha pallida (Pers.) Pilát, Sb. csl. Akad. zemed. Ved, odd A 5: 405 (1930)
Cotylidia pallida (Pers.) Boidin, Revue Mycol., Paris 24: 201 (1959)

FIGURE 127

Basidiomata annual, medium sized, 30–50 mm high, weakly coriaceous when fresh, woody hard on drying, stipitate. **Pileus** 3–7 mm long, 3–6 mm thick, spathulate to infundibuliform, adjacent pilei imbricate and clustered together forming compound fruit bodies, glabrous, minutely pubescent at some regions, concentric zonations absent, radially wrinkled, creamish brown, dark brown towards margin, margin wavy. **Hymenophore** smooth, pores absent, uneven with minute scattered tubercles, cream, light brownish on maturity. **Stipe** up to 20 mm long, 2–6 mm thick, cylindrical, solid, glabrous, cream, even, generally fused at the base in clustered fruit bodies at the base covered by a white mycelial network. **Odour** not distinctive. **Spore print** not observed.

Basidiospores 7–8 × 5–6 µm, Q=1.1–1.4, Q_m=1.2, subglobose to broadly ellipsoid, smooth, thin walled, with granular contents, apiculus prominent, inamyloid in Melzer's reagent. **Basidia** cylindrical to clavate, 25–45 × 5–10 µm, 4 sterigmate. **Pseudocystidia** abundant in the hymenophore, 25–185 × 4–9 µm, projecting beyond basidia, cylindrical, sometimes widened at middle, tip even or apically papillate, hyaline, thin walled, highly granular. **Hymenial trama** interwoven and monomitic. Generative hyphae 2–5 µm wide, hyaline, smooth, thin to slightly thick walled (up to 1 µm), branched, without clamp connections. **Pileal trama** parallel. Generative hyphae 2–6 µm wide, hyaline, smooth, thin to slightly thick walled (up to 1 µm), branched, without clamp connections. **Pileipellis** a cutis made of hyaline, thin to slightly thick walled hyphae that are 2–4 µm wide. **Stipe** trama interwoven and monomitic. Generative hyphae slightly different from that of pileus region, 2–4 µm wide, hyaline to pale brown in mass, almost thick walled (1 µm), highly branched, mostly aseptate. Pseudocystidia present in trama, characters similar as those in hymenium. **Stipitipellis** composed of irregular, highly branched and twisted hyphae, interrupted by trichodermal patches; up to 45 µm long, made of hyphae that are 1.5–3 µm wide, hyaline, slightly thick to thick walled with obtuse ends.

Specimen examined: India. Kerala State: Malappuram district, Nilambur, KFRI campus, on dead log (unidentified), 03 July 2018, Vinjusha N., ZGCVN685.

Comments: Macroscopically, the present specimen resembles species of *Thelephora* Ehrh. *ex* Willd. However, *Thelephora* species produces coloured, often muricate basidiospores (Burt 1914), characters totally different from the present collection. Present specimen properly matches with the descriptions of *Cotylidia pannosa* by Reid (1965) and Eriksson & Ryvarden (1975). According to Kout & Zíbarová (2013), pileus surface margin of young fruit bodies of *C. pannosa* are bright red-orange in colour. However, an orange reddish shade was not observed in the pileus of present collection, may be because the fruit bodies were almost dry when collected.

Cotylidia pannosa is a rare species, having their occurrence in Asia, North America (Burt 1920; Reid 1965; Ryvarden 2010) and Europe (Bernicchia & Gorjón 2010). *Cotylidia pannosa* has been reported from India (as *Thelephora sowerbyi* (Berk.) Berk.) by Sharma *et al*. (2015). There are no reports of the species from Kerala so far.

Oxyporus (Bourdot & Galzin) Donk

Basidiomata annual to perennial, coriaceous to hard, resupinate, effused reflexed to pileate. Pileus dimidiate to broadly attached, applanate, concentrically zonate, ochraceous to brown. Hymenophore poroid, pores mostly angular, pore surface white, cream to straw coloured, pore tubes concolorous with pore surface. Context ochre, straw coloured to pale brownish, thin. Hyphal system monomitic, with hyaline to pale brownish, thin to thick walled generative hyphae, lacking clamp connections. Cystidia present, ventricose to tubular, hyaline to pale yellowish brown, smooth to apically encrusted. Basidia clavate, 4 sterigmate. Basidiospores globose to broadly ellipsoid, hyaline, smooth, thin walled, inamyloid in Melzer’s reagent. Members of the genus cause white rot on the wood.

Oxyporus ravidus (Fr.) Bondartsev & Singer, Annls mycol. 39 (1): 63 (1941)

Basionym: *Polyporus ravidus* Fr., Epicr. syst. mycol. (Upsaliae): 475 (1838)
Synonyms:
Polystictus ravidus (Fr.) Cooke, Grevillea 14 (no. 71): 81 (1886)
Cladomeris saligna var. *ravida* (Fr.) Quél., Enchir. fung. (Paris): 169 (1886)
Cladomeris ravida (Fr.) Bigeard & H. Guill., Fl. Champ. Supér. France (Chalon-sur-Saône) 1: 410 (1909)
Coriolus ravidus (Fr.) Bourdot & Galzin, Hyménomyc. de France (Sceaux): 564 (1928)
Trametes ravida (Fr.) Pilát, in Kavina & Pilát, Atlas Champ. l'Europe, III, Polyporaceae (Praha) 1: 272 (1939)

Oxyporus ravidus f. *tenuis* Bondartsev, Botanicheskie Materialy 16: 122 (1963)
Rigidoporus ravidus (Fr.) Pouzar, Folia geobot. phytotax. bohemoslov. 1 (4): 368 (1966)

FIGURE 128

Basidiomata annual, medium sized, usually clustered and imbricate, slightly coriaceous when young, later hard and woody, light in weight, effused reflexed when young, becoming pileate. **Pileus** 2–45 mm long, 2–30 mm thick, sessile, broadly attached, or with a distinct region of attachment, semicircular, applanate to wavy, concentrically zonate, indistinctly sulcate, radially wrinkled, with minute tubercles, adpressed velutinate, hairs lesser towards margin and washed away on decaying or drying, cream with pale yellow to yellowish brown zonations, more dark brown towards attachment part in some fruitbodies, margin thin, even, upcurved on drying. **Hymenophore** poroid. **Pores** 1–2 per mm, angular, oblique near attachment part with an irpicoid appearance, light yellow to ochre, pore tubes 1–2.5 mm long, concolourous with pore surface. **Context** 1–1.5 mm thick, pale yellowish brown, homogenous. **Odour** not distinctive. **Spore print** not observed.

Basidiospores 5.5–7.5 × 2.5–3 µm, Q=2–3.7, Q_m=2.78, ellipsoid, usually curved at one end, hyaline, smooth, thin walled, granular, inamyloid in Melzer's reagent. **Basidia** 25–34 × 4–5 µm, narrowly clavate, 4 sterigmate. **Hymenial cystidia** present; 33–49 × 6–9 µm, ventricose, hyaline to pale brown, thick walled (1–3 µm**),** heavily encrusted at tip, but encrustations easily dissolved in KOH, shortly projecting beyond hymenium. **Gloeocystidia** present in the hymenium; 45–70 × 5–8 µm, fusiform to cylindrical, sometimes very narrow towards tip, hyaline, smooth, thin walled. **Hymenial trama** intertwined and monomitic. Generative hyphae 3–6 µm wide, hyaline to pale brown, appearing as weakly dextrinoid in mass, smooth, slightly thick to thick walled (1 µm), branched, regularly septate, without clamp connections,. Skeletal hyphae and skeleto ligative hyphae not observed. **Pileal trama** interwoven. Generative hyphae hyaline, smooth, thin walled, without clamp connections. **Hymenial trama** intertwined and monomitic. Generative hyphae 3–7 µm wide, hyaline to pale brown, appearing as weakly dextrinoid in mass, smooth, slightly thick to thick walled (1 µm), branched, regularly septate without clamp connections. Skeletal hyphae and skeleto ligative hyphae not observed. **Pileipellis** a trichodermium made of hyphae that are 3–5 µm wide, hyaline to pale brown, thin to thick walled with obtuse ends**.**

Specimen examined: India. Kerala State: Palakkad district, Dhoni, on dead log (unidentified), 28 November 2018, Vinjusha N., ZGCVN767.

Comments: *Oxyporus ravidus* is characterized by effused reflexed to pileate basidiomata, presence of thick walled, ventricose, strongly encrusted cystidia and thin fusiform to cylindrical gloeocystidia. *Oxychaete cervinogilva* resembles *O. ravidus* in morphology and having encrusted cystidia, however, lacks gloeocystidia. On comparison with the available descriptions of *O. ravidus* (Roy & De 1996; Bala *et al*. 2020), Present collection has slightly narrower basidiospores (2.5–3 µm; 3–4 µm in the descriptions).

Oxyporus ravidus has distribution in Europe and India (Balwant 1961, Bakshi 1971; Roy & De 1996; Ranadive 2013; Bala *et al*. 2020). There are no reports of this species from Kerala so far.

Schizopora Velen.

Basidiomata annual, resupinate to effused reflexed, found in imbricate clusters, usually with decurrent pore layer. Hymenophore poroid or daedaleoid to irregularly hydnoid or irpicoid, surface cream to light buff that darkens with age. Hyphal system monomitic to dimitic, generative hyphae hyaline, thin walled, with clamp connections. Skeletal hyphae hyaline, thick walled, often encrusted at the dissepiments. Pseudocystidia present as hyphal endings that are fusiform to capitate, covered with resinous materials or crystals. Cystidia present or absent. Basidia clavate, 4 sterigmate. Basidiospores ellipsoid to subglobose, hyaline, smooth, thin walled, inamyloid in in Melzer's reagent. *Schizopora* species cause white rot on wood.

Schizopora paradoxa (Schrad.) Donk, Persoonia 5 (1): 76 (1967)

Basionym: *Hydnum paradoxum* Schrad., Spicil. fl. germ. 1: 179 (1794)
Synonyms:
Sistotrema paradoxum (Schrad.) Pers., Syn. meth. fung. (Göttingen) 1: 225 (1801)
Polyporus versiporus Pers., Mycol. eur. (Erlanga) 2: 105 (1825)
Xylodon paradoxus (Schrad.) Chevall., Fl. gén. env. Paris (Paris) 1: 274 (1826)
Irpex paradoxus (Schrad.) Fr., Epicr. syst. mycol. (Upsaliae): 522 (1838)
Xylodon obliquus (Schrad.) P. Karst., Acta Soc. Fauna Flora fenn. 2 (no. 1): 31 (1881)
Lenzites paradoxus (Schrad.) Pat., J. Micrographie 9: 23 (1885)
Poria versipora (Pers.) Sacc., Syll. fung. (Abellini) 6: 311 (1888)
Coriolus obliquus (Schrad.) Pat., Essai Tax. Hyménomyc. (Lons-le-Saunier): 94 (1900)
Polyporus obliquus (Schrad.) E.H.L. Krause, Mecklenburgs Basidiomyceten: 17 (1934)

Poria pseudoobducens Pilát, Acta Mus. Nat. Prag. 9: 107 (1953)
Irpex porosolamellatus Rick, in Rambo (Ed.), Iheringia, Sér. Bot. 5: 187 (1959)
Poria albofulva Rick, in Rambo (Ed.), Iheringia, Sér. Bot. 7: 282 (1960)
Poria membranicincta var. *megalospora* Rick, in Rambo (Ed.), Iheringia, Sér. Bot. 7: 278 (1960)
Poria versipora f. *obliqua* (Schrad.) Kreisel, Phytopath. Grosspilze Deutschl.: 154 (1961)
Xylodon versiporus var. *pseudoobducens* Pilát ex Domański, Acta Soc. Bot. Pol. 33 (1): 167 (1964)

FIGURE 129

Basidiomata annual, small to medium sized when fresh, entirely resupinate, later effused and forming large patches, up to 70 mm long, up to 8 mm thick, margin dull white, floccose, soft and spongy when fresh, hard on drying. **Pileus** not distinct. **Hymenophore** poroid. *Pores* 2–3 per mm, angular, at some region radially elongated and becoming irpicoid like, pores not distinct towards margin, creamish white, ochraceous to light brown on bruising. Odour not distinct. Spore print not observed.

Basidiospores 3.5–5 × 2.5–3 µm, Q=1.1–1.6, Q_m=1.4, subglobose to broadly ellipsoid, hyaline, usually guttulate, thin walled, smooth, inamyloid in Melzer's reagent. **Basidia** 15–21 × 4–5 µm, clavate, 4 sterigmate, with basal clamp connections. **Hymenial cystidia** present; 12–32 × 4–6 µm, cylindrical, ventricose, oblong, narrowly utriform, hyaline, thin walled, smooth. **Pseudocystidia** observed as capitate hyphal endings, 5–13 µm wide, hyaline, smooth and thin walled, usually with basal clamp connection. **Hymenial trama** interwoven and dimitic. Generative hyphae 2–4 µm wide, hyaline, smooth, thin walled, branched with clamp connections. Skeletal hyphae 2–4 µm wide, hyaline, thick walled (1 µm), encrusted, unbranched, usually with capitate swollen ends, up to 10 µm wide, either encrusted or covered with a resinous material, septations not observed.

Specimens examined: India. Kerala State: Kozhikode district, Eranjipalam, near Sarovarm Biopark, on dead branch (unidentified), 20 July 2015, Vinjusha N., ZGCVN57, ZGCVN59; Pantheerankavu, Kariathan Kottam, on dead branch (unidentified), 12 July 2016, Vinjusha N., ZGCVN343.

Comments: The creamish to ochraceous resupinate basidiocarps with irpicoid hymenium, and the encrusted skeletal hyphae, ventricose cystidia, capitate pseudocystidia, and small, subglobose to broadly ellipsoid basidiospores easily distinghuishes *S. paradoxa* from the morphologically related species (Ryvarden & Melo 2014).

Schizopora paradoxa has cosmopoliatan distribution (Núñez & Ryvarden 2001). The species has been reported by Mohanan (2011).

Leucophellinus Bondartsev & Singer

Basidiomata annual, solitary or in clusters, effused reflexed to pileate. Pileus sessile, tomentose to hispid, light coloured, turning yellow brown to ochraceous on drying, mostly concentrically sulcate. Hymenophore irregularly poroid to sub irpicoid, concolourus with pileus. Context concolourous with pileus, homogenous. Hyphal system monomitic, generative hyphae hyaline, thin to thick walled, without clamp connections. Cystidia present, cylindrical to ventricose, thin to thick walled, with or without encrustations. Basidiospores mostly globose to broadly ellipsoid, hyaline, thick walled. Members of the genus cause white rot on wood.

Leucophellinus hobsonii (Berk. *ex* Cooke) Ryvarden, Mycotaxon 31 (1): 51 (1988)

Basionym: *Polyporus hobsonii* Berk. *ex* Cooke, [as '*hobsoni*'], Grevillea 15 (no. 73): 20 (1886)
Synonyms:
Trametes hobsonii (Berk. *ex* Cooke) Sacc. [as '*hobsoni*'], Syll. fung. (Abellini) 6: 135 (1888)
Polyporus mollissimus Pat., J. Bot., Paris 11: 340 (1897)
Xanthochrous bernieri Har. & Pat., J. Bot., Paris 17: 9 (1903)
Polyporus bernieri (Har. & Pat.) Sacc. & D. Sacc., Syll. fung. (Abellini) 17: 110 (1905)
Spongipellis stramineus Pat., Bull. Soc. mycol. Fr. 24: 166 (1908)
Polyporus stramineus (Pat.) Sacc. & Traverso, Publ. Inst. nat. agron. Congo Belge, Ser. sci. 35: 8 (1911)
Poria xylina Lloyd, Mycol. Writ. 5: 630 (1917)
Trametes straminea (Pat.) Lloyd, Mycol. Writ. 5: 13 (1919)
Polyporus stramineus var. *africanus* (Pat. & R. Heim) Hendr., Publ. Inst. nat. agron. Congo Belge, Ser. sci. 35: 8 (1948)
Oxyflavus stramineus (Pat.) Ryvarden, Norw. Jl Bot. 20: 4 (1973)
Oxyporus mollissimus (Pat.) D.A. Reid, Microscopy 32: 456 (1975)

Leucophellinus mollissimus (Pat.) Parmasto, Eesti NSV Tead. Akad. Toim., Biol. seer 32 (4): 265 (1983)
Rigidoporus mollissimus (Pat.) Teixeira, Revista Brasileira de Botânica 15 (2): 126 (1992)

FIGURE 130

Basidiomata perennial, large, soft, water soaked and fleshy when fresh, becoming harder and woody on drying, pileate, effused vertically towards the base.

Pileus 210 mm long, 70 mm thick, sessile, broadly attached, and difficult to separate from the substratum, semicircular, applanate, concentrically zonate, sulcate towards margin, covered with short spine like hairs, dull white, with many small irregular projections, turning brown on handling, greenish near attachment portion due to the presence of algal growth, often with growth of bryophytes on pileus, margin even, round. **Hymenophore** irregularly poroid, mostly elongated angular, and appearing as dentate, especially towards the effused basal part, white when fresh, turning cream on exposure or drying, pore tubes up to 50 mm long, stratified, concolorous with pore surface. **Context** up to 20 mm thick, white, turning cream on handling. **Odour** not distinctive. **Spore print** not observed.

Basidiospores 9–12 × 6–8 µm, Q=1.2–1.8, Q_m=1.39, ellipsoid to broadly ellipsoid, hyaline, smooth, distinctly thick walled (1–1.5 µm), with guttulate contents, mostly with single large guttule, weakly cyanophilic, inamyloid in Melzer’s reagent, many spores centrally depressed. **Basidia** 13–22 × 7–9 µm, clavate, hyaline, 4 sterigmate, guttulate. **Hymenial cystidia** frequent; 20–40 × 5–8 µm, mostly setiform, to widely clavate, or conical with mucronate apex, smooth, thick walled (1–1.5 µm), septate towards base. **Hymenial trama** interwoven and monomitic. Generative hyphae 3–6 µm wide, hyaline, pale brown in mass, thick walled (1 µm), straight to flexuous, branched, frequently septate, without clamp connections. Skeletal hyphae and skeleto ligative hyphae not observed. **Pileal trama** interwoven. Generative hyphae 2–5 µm wide, hyaline, pale brown in mass, thick walled (1–2 µm), more flexuous than in hymenium, branched, frequently septate, without clamp connections. Skeletal hyphae and skeleto ligative hyphae not observed. **Pileipellis** made of agglutinated erect hyphal elements, not distinct due to proliferated algal growth.

Specimens examined: India. Kerala State: Wayanad district, Muthanga, on fallen tree (unidentified), 27 July 2016, Vinjusha N, ZGCVN394.

Comments: Thick walled basidispores and thick walled septate cystidia are important distinguishing features of the species. *Leucophllinus irpicoides* (Pilát) Bondartsev & Singer is closely related to this collection by having thick walled, septate cystidia and spores, however possesses smaller basidiospores (6.5–8.5 × 5.5–7, according to the description of Núñez & Ryvarden 2001). The species was earlier treated under the genus *Oxyporus* (Bourdot & Galzin) Donk as *O. mollissimus* (Pat.) D.A. Reid. According to Wu *et al.* (2017a), *Oxyporus* is separated from *Leucophellinus* by their thin walled spores.

Leucophellinus hobsonii has tropical distribution (Núñez & Ryvarden 2001). From Kerala, this species has been reported (as *O. mollissimus*) by Leelavathy & Ganesh (2000) and Iqbal *et al.* (2016).

Trichaptum Murrill

Basidiomata annual, resupinate, effused to pileate, usually imbricate with a decurrent pore layer. Pileus hispid to adpressed tomentose blackish, grey or dirty white. Hymenophore poroid, irpicoid, to lamellate, usually pale brownish to light violet in colour, pore tubes brownish. Context homogenous to duplex. Hyphal system dimitic to trimitic, generative hyphae hyaline, thin to thick walled, with clamp connections. Skeletal hyphae usually predominant, thick walled. Cystidia present, subulate to clavate, thin to thick walled, smooth or apically encrusted. Basidiospores cylindrical, slightly bent, smooth, hyaline, thin walled, inamyloid in Melzer’s reagent. Species causes white rot on wood.

Trichaptum biforme (Fr.) Ryvarden [as '*biformis*'], Norw. Jl Bot. 19 (3-4): 237 (1972)

Basionym: *Polyporus biformis* Fr., in Klotzsch, Linnaea 8 (4): 486 (1833)
Synonyms:
Polyporus friesii Klotzsch, Linnaea 8 (4): 487 (1833)
Polyporus prolificans Fr., Epicr. syst. mycol. (Upsaliae): 443 (1838)
Polystictus biformis (Fr.) Fr., Nova Acta R. Soc. Scient. upsal., Ser. 3 1 (1): 84 (1851)
Polyporus candicans Lév., Annls Sci. Nat., Bot., sér. 4 20: 285 (1863)
Bjerkandera biformis (Fr.) P. Karst., Bidr. Känn. Finl. Nat. Folk 37: 44 (1882)
Polystictus candicans (Lév.) Cooke, Grevillea 14 (no. 71): 82 (1886)
Polystictus friesii (Klotzsch) Cooke, Grevillea 14 (no. 71): 80 (1886)
Coriolus biformis (Fr.) Pat., Cat. Rais. Pl. Cellul. Tunisie (Paris): 48 (1897)
Microporus biformis (Fr.) Kuntze, Revis. gen. pl. (Leipzig) 3 (3): 495 (1898)
Microporus friesii (Klotzsch) Kuntze, Revis. gen. pl. (Leipzig) 3 (3): 496 (1898)
Microporus candicans (Lév.) Kuntze, Revis. gen. pl. (Leipzig) 3 (3): 495 (1898)
Microporus prolificans (Fr.) Kuntze, Revis. gen. pl. (Leipzig) 3 (3): 497 (1898)
Coriolus friesii (Klotzsch) Pat., Essai Tax. Hyménomyc. (Lons-le-Saunier): 94 (1900)
Coriolus prolificans (Fr.) Murrill, N. Amer. Fl. (New York) 9 (1): 27 (1907)
Trametes biformis (Fr.) Pilát, in Kavina & Pilát, Atlas Champ. l'Europe, III, Polyporaceae (Praha) 1: 277 (1939)

Trametes friesii (Klotzsch) G. Cunn., Bull. N.Z. Dept. Sci. Industr. Res. 164: 171 (1965)
Microporellus friesii (Klotzsch) Ryvarden, Norw. Jl Bot. 19: 232 (1972)
Hirschioporus friesii (Klotzsch) D.A. Reid, Contr. Bolus Herb. 7: 59 (1975)
Trichaptum biforme var. *fuscatum* Corner, Beih. Nova Hedwigia 86: 212 (1987)

FIGURE 131

Basidiomata annual, small to medium sized, coriaceous when fresh, rigid when dry, light in weight, pileate, some fruitbodies confluent. **Pileus** 35–60 mm long, up to 2 mm thick, laterally attached with a narrow converging base, flabelliform to semicircular, applanate, narrowly depressed near the region of attachment, concentrically zonate, adpresed tomentose, lesser towards margin, appear as velvety, cream, violet near the margin, which fades to light brown on drying, margin wavy and lobed, thin, slightly splitting. **Hymenophore** poroid to irpicoid. **Pores** when present, 3–5 per mm, angular, absent towards margin, cream, light violet along margin, which fades on drying, pore tubes 1 mm long, concolorous with pore surface. **Context** upto 1 mm thick, homogenous, cream. **Odour** not distinct. **Spore print** not observed.

Basidiospores 5–6 × 2 µm, Q=2.5–3.3, Q_m=2.95, slightly allantoid to cylindrical, hyaline, smooth, thin walled, inamyloid in Melzer's reagent. **Basidia** 11–15 × 4–5 µm, clavate, 4 sterigmate. **Hymenial cystidia** 14–26 × 4–6 µm, fusoid to conical or setiform, mostly with mucronate tip, some constricted at the middle, hyaline, smooth or apically encrusted, thin to slightly thick walled (1 µm). **Hymenial trama** interwoven and dimitic. Generative hyphae 2–3 µm wide, hyaline, smooth, thin walled, branched, with clamp connections. Skeletal hyphae 3–5 µm wide, hyaline, thick walled (1 µm), unbranched, septations not observed. Skeleto ligative hyphae not observed. **Pileal trama** interwoven. Generative hyphae more frequent than present in hymenium, up to 4 µm wide, hyaline, smooth, thin walled, branched, with clamp connections. Skeletal hyphae 3–5 µm wide, hyaline, thick walled (1 µm), unbranched, septations not observed. Skeleto ligative hyphae not observed. **Pileipellis** made of highly agglutinated trichodermal patches, 13–14 µm long, each hyphae 2–3 µm wide, hyaline, thin to thick walled, (up to 1 µm) with round apex.

Specimens examined: India. Kerala State: Idukki district, Anamudi, on dead tree (unidentified), 8 November 2017, Mufeed B., ZGCVN652; Palakkad district, Mannarkkad, Silent Valley National Park areas, on fallen tree trunk, 05 July 2019, Krishnapriya K., ZGCVN851.

Comments: The species is very similar to *Trichaptum byssogenum* (Jungh.) Ryvarden. The basidiospore shape of *T. byssogenum* is ellipsoid to broadly ellipsoid (Ryvarden & Johansen 1980; Núñez & Ryvarden 2001), whereas the present specimen has cylindrical basidiospores. *T. byssogenum* produce fruit bodies which are effused reflexed, and broadly attached. Our collections possess a distinct converging base. In addition, *T. byssogenum* has 1–3 pores per mm, whereas present specimen has 3–5 pores per mm.

Trichaptum biforme has pantropical distribution (Ryvarden & Johansen 1980). Leelavathy & Ganesh (2000) and Mohanan (2011) reported this species from Kerala.

Trichaptum byssogenum (Jungh.) Ryvarden [as '*byssogenus*'], Norw. Jl Bot. 19 (3-4): 237 (1972)

Basionym: *Polyporus byssogenus* Jungh., Verh. Batav. Genootsch. Kunst. Wet. 17 (2): 43 (1838)
Synonyms:
Polyporus venustus Berk., London J. Bot. 4: 55 (1845)
Polystictus venustus (Berk.) Fr., Nova Acta R. Soc. Scient. upsal., Ser. 3 1 (1): 80 (1851)
Daedalea pendula Berk., in Hooker, Bot. Antarct. Voy. Erebus Terror 1839-1843, II, Fl. Nov.-Zeal.: 180 (1855)
Poria byssogena (Jungh.) Cooke, in Saccardo, Syll. fung. (Abellini) 6: 329 (1888)
Polystictus hariotianus Speg., Revue mycol., Toulouse 11 (no. 42): 94 (1889)
Microporus venustus (Berk.) Kuntze, Revis. gen. pl. (Leipzig) 3 (3): 497 (1898)
Microporus hariotianus (Speg.) Kuntze, Revis. gen. pl. (Leipzig) 3 (3): 495 (1898)
Microporus cladotrichus (Berk. & M.A. Curtis) Kuntze, Revis. gen. pl. (Leipzig) 3 (3): 495 (1898)
Coriolus venustus (Berk.) Pat., Essai Tax. Hyménomyc. (Lons-le-Saunier): 94 (1900)
Trichaptum cladotrichum (Berk. & M.A. Curtis) Murrill, (1904)
Funalia bouei Pat., Bull. Soc. mycol. Fr. 23 (2): 81 (1907)
Polystictus bouei (Pat.) Sacc. & Trotter, Syll. fung. (Abellini) 21: 321 (1912)
Poria phytoderma var. *erythraea* Sacc., G. bot. ital., n.s. 23 (2): 233 (1916)
Trametes rubricosa Bres., Mycologia 17 (2): 74 (1925)
Coriolus bowmanii (Berk.) G. Cunn. [as '*bowmani*'], Proc. Linn. Soc. N.S.W. 75 (3-4): 219 (1950)
Trichaptum venustum (Berk.) G. Cunn., Bull. N.Z. Dept. Sci. Industr. Res. 164: 97 (1965)
Lenzites unicolor sensu Cunningham; fide Buchanan & Ryvarden (2000)
Irpex sinuosus sensu Colenso; fide NZfungi (2008)

FIGURE 132

Basidiomata annual, usually imbricate, coriaceous when young, almost hard when mature, light in weight, effused reflexed, usually effused for a long distance and easily gets rolled and detached from substratum as flaps. **Pileus** 35–40 mm long, 2–5 mm thick, sessile or with a distinct region of attachment in some, mostly semicircular, applanate, concentrically zonate, sulcate, tomentose, pale vinaceous brown when fresh, greyish brown to brown on drying, margin smooth, even to wavy. **Hymenophore** weakly irpicoid, irregulary poroid at some region, pores 1–3 per mm, surface pale purplish brown when fresh, more brown on drying. **Context** 2–3 mm thick, dull white, very pale brownish below pileus. **Odour** not distinctive. **Spore print** not observed.

Basidiospores 5–7 × 3–4 µm, Q=1.5–2.2, Q_m=1.78, ellipsoid to broadly ellipsoid, hyaline, thin walled, smooth, guttulate, inamyloid in Melzer's reagent. **Basidia** 13–41 × 4–6 µm. **Cystidia** present, 4–9 µm wide, fusoid to setiform, some with mucronate tip, smooth to apically encrusted, thick walled (up to 2 µm). **Hymenial trama** interwoven dimitic. Generative hyphae 2–4 µm wide, hyaline, smooth, thin to thick walled (1 µm), branched, with clamp connections. Skeletal hyphae 2–7 µm wide, hyaline, thick walled (1–4 µm), rarely branched, septations not observed. Skeleto ligative hyphae not observed. **Pileal trama** interwoven. Generative hyphae hyphae 2–5 µm wide, hyaline, smooth, thin to thick walled (1 µm), branched, with clamp connections. Skeletal hyphae 2–7 µm wide, hyaline, thick walled (1–4 µm), rarely branched, septations not observed. Skeleto ligative hyphae not observed. **Pileipellis** a trichodermium up to 70 µm long, made of hyaline, thick walled hyphae that are 3–6 µm wide.

Specimens examined: India. Kerala State: Kozhikode district, Nallalam, on dead wood trunk (unidentified), 25 July 2014, Vinjusha, ZGCVN30; Chelannur, Kalarimala, on *Anacardium occidentale*, 06 September 2015, Vinjusha N., ZGCVN176; Malappuram district, Thenjipalam, Calicut University Botanical Garden, on dead wood trunk (unidentified), 16 September 2015, Vinjusha N., ZGCVN192.

Comments: Present specimen shows similarity with *Trichaptum abietinum* (Pers. *ex* J.F. Gmel.) Ryvarden, in having effused reflexed basidiocarps and vinaceous or purplish hymenium. However, *T. abietinum* differs from the present collection by having small pores (4–6 per mm) and hyphal pegs (according to the description by Núñez & Ryvarden 2001).

Trichaptum byssogenum has pantropical distribution (Ryvarden & Johansen 1980). Leelavathy & Ganesh (2000) has reported this species from Kerala.

4.3. Pure culture establishment

Pure cultures of 32 polyporoid species were isolated during the study. Of these, 26 species belonged to the order Polyporales, and remaining six species belonged to the order Hymenochaetales (Table 6).

Table 6: List of species having pure cultures generated in the present study

Sl. No.	Species	Culture isolate number
Order polyporales		
1	*Cellulariella acuta*	VN269CUL, VN269aCUL, VN131CUL
2	*Earliella scabrosa*	VN470CUL, ZGCVN283CUL, VN276CUL
3	*Favolus grammocephalus*	VN111CUL, VN97CUL, VN102CUL
4	*F. tenuiculus*	VN190CUL
5	*Flavodon flavus*	VN61CUL
6	*Ganoderma keralense sp. nov*.	VN288CUL
7	*G. subresinosum*	VN550CUL
8	*Irpex lacteus*	VN478CUL
9	*Leiotrametes menziesii*	VN519CUL, VN129CUL
10	*Microporus affinis*	VN272CUL, VN512CUL
11	*M. xanthopus*	VN273CUL, VN273aCUL
12	*Navisporus floccosus*	VN54CUL
13	*Neoantrodia serialis*	VN286CUL, VN286aCUL
14	*Nigroporus vinosus*	VN247CUL
15	*Oxychaete cervinogilva*	VN282CUL
16	*Pilatotrama ljubarskyi*	VN249CUL
17	*Podoscypha involuta*	VN227CUL, VN543CUL
18	*P. petalodes*	VN548CUL
19	*Pseudofavolus tenuis*	VN72CUL
20	*Rhodofomitopsis feei*	VN241CUL
21	*Rigidoporus lineatus*	VN11CUL, VN55CUL
22	*Trametes gibbosa*	VN174CUL, VNI74aCUL
23	*T. marianna*	VN469CUL
24	*T. ochracea*	VN471CUL
25	*T. pubescens*	VN90CUL
26	*T. villosa*	VN230CUL
Order Hymenochaetales		
27	*Coltricia pyrophila*	VN497CUL
28	*Hymenochaete ochromarginat*	VN268CUL
29	*Phellinus fastuosus*	VN290CUL, VN277CUL
30	*P. gilvus*	VN301CUL
31	*Schizopora paradoxa*	VN59CUL
32	*Trichaptum byssogenum*	VN176CUL

4.4. Molecular characterization

The study generated 34 DNA sequences representing 27 species of polyporoid fungi of Kerala. This includes 29 ITS sequences, four LSU sequences, and one RPB2 sequence (Table 7).

Table 7: List of taxa, voucher numbers and the GenBank/EMBL accession numbers of sequences (ITS, LSU and RPB2) generated during the present study.

Sl. No.	Taxa	Voucher numbers	ITS	LSU	RPB2
1	*Bresadolia uda*	ZGCVN265		MT370383	-
2	*Daedalea radiata*	ZGCVN774	MT378376	-	-
3	*Fomitopsis caribensis*	ZGCVN781	-	MT873045	-
4	*Ganoderma applanatum australe complex*	CAL1547	MF072395	-	-
5	*Ganoderma australe*	ZGCVN85	MT364483	-	-
6	*Ganoderma enigmaticum*	ZGCVN731	MT364486	-	-
7	*Ganoderma enigmaticum*	ZGCVN73	MT364487	-	-
8	*Ganoderma keralense*	CAL1543	MF072394	MN795634	-
9	*Ganoderma keralense*	ZGCVN733	-	-	PRJEB36109
10	*Ganoderma multicornum*	ZGCVN308	MT772000	-	-
11	*Ganoderma multipileum*	ZGCVN402	MT765061	-	-
12	*Ganoderma multipileum*	ZGCVN534	MT765063	-	-
13	*Ganoderma multipileum*	ZGCVN481	MT765065	-	-
14	*Ganoderma multiplicatum*	ZGCVN529	MT396669	-	-
15	*Ganoderma orbiforme*	ZGCVN577	MT364488	-	-
16	*Ganoderma subresinosum*	ZGCVN826	MT364489	-	-
17	*Ganoderma tropicum*	ZGCVN429	MT364498	-	-
18	*Ganoderma tropicum*	ZGCVN873	MT364499	-	-
19	*Hymenochaete boddingii*	ZGCVN869	MT361095	-	-
20	*Navisporus floccosus*	ZGCVN491	MT361090	MT361091	-
21	*Neofomitella fumosipora*	ZGCVN864	MT365425	-	-
22	*Neofomitella guangxiensis*	ZGCVN689	MT365177	-	-
23	*Nigroporus durus*	ZGCVN722	MT371446	-	-
25	*Oxychaete cervinogilva*	ZGCVN239	MT365666	-	-
25	*Perenniporia decurrata*	ZGCVN595	MT365927	-	-
26	*Phellinus gilvus*	ZGCVN40	MT367522	-	-
27	*Pilatoporus ljubarskyi*	ZGCVN249	MT876574	-	-
28	*Phlebia acerina*	ZGCVN886	MT772236	-	-
29	*Pilatoporus ostreiformis*	ZGCVN16	MT371445	-	-
30	*Pycnoporus sanguineus*	ZGCVN874	MT635338	-	-
31	*Sebipora aquosa*	ZGCVN775	MT649883	-	-
32	*Theleporus venezuelicus*	ZGCVN109	MT876596	-	-

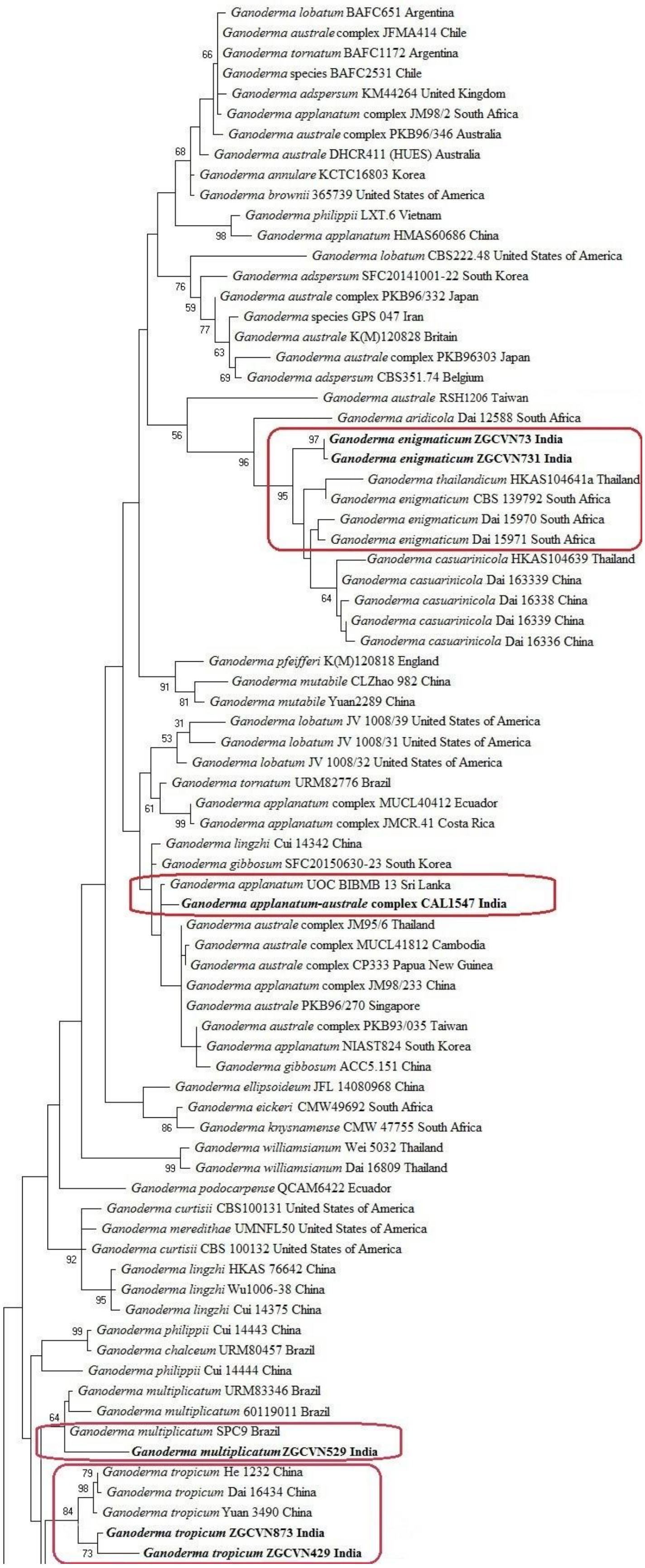
4.5. Phylogenetic analysis

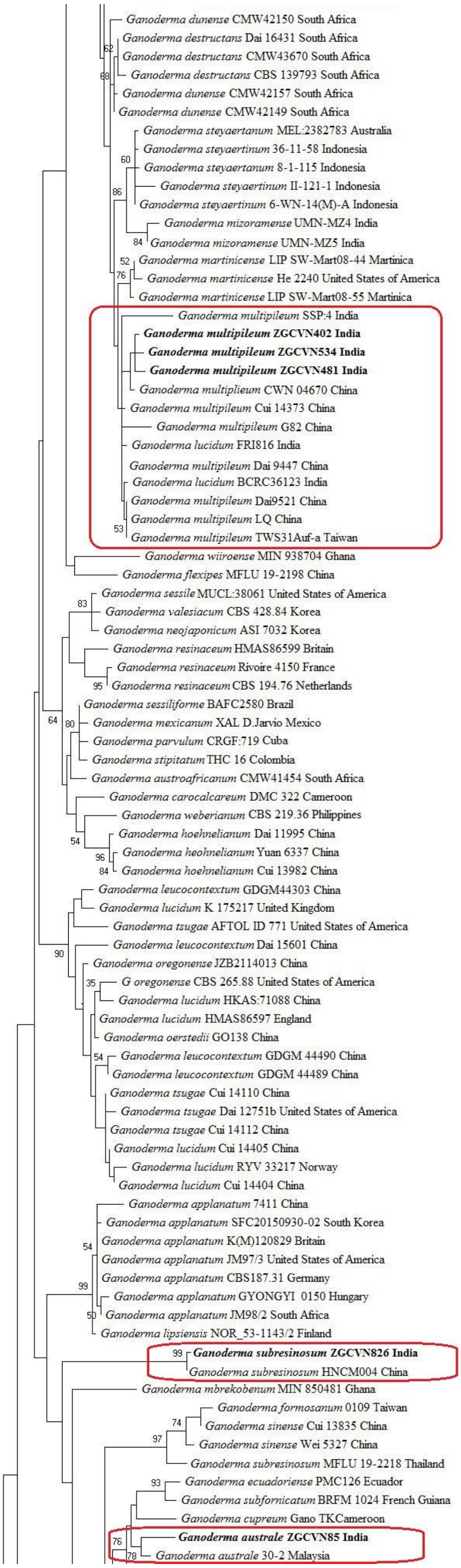
4.5.1. Phylogenetic analysis of *Ganoderma* species of Kerala

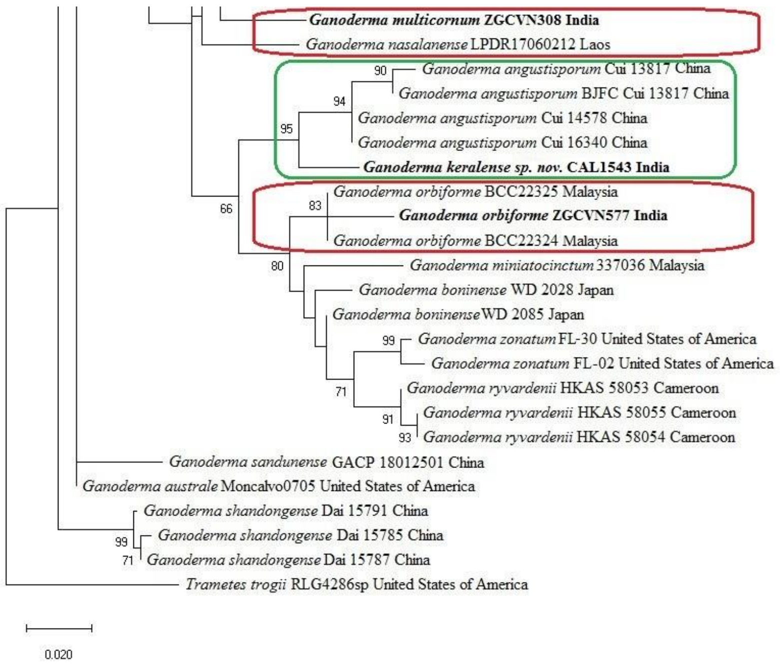
In the phylogenetic tree (Figure 133), all *Ganoderma* accessions of the present study (except the newly proposed *G. keralense sp. nov.* and species of *G.*

applanatum-australe complex) claded along with accessions of the same species, mostly from tropical countries like China and Malaysia. In the tree, Kerala collections of *G. enigmaticum* recorded during the present study clustered along with accessions of *G. enigmaticum* from South Africa (GenBank numbers: NR132918, KU572486, KU572487) with 95% bootstrap support. Present collections of *G. multiplicatum* settled along with *G. multiplicatum* from Brazil (KU569553, MG279185, JX310823), with 64% bootstrap support. Similarly, *G. tropicum* of the present study formed clade with accessions of same species from China (JQ781880, MG279194, KF495000), with 84% bootstrap support, and *G. subresinosum* of present study claded with *G. subresinosum* from China (MH537850), with 99% bootstrap support. Present collections of *G. australe* settled with an accession of the same species from Malaysia (LC084748) with 78% bootstrap support, and *G. orbiforme* of present study claded with accessions of *G. orbiforme* from Malaysia (KX421867, JX997990 with 93% bootstrap support. In the phylogenetic tree all the three accessions of *G. multipileum* from Kerala, settled near to *G. multipileum* accessions from China (KJ143913, MG279184, KX055556), and India (KY865255). Sequences of two Indian isolates, previously recognized as "*G. lucidum*" (X87351/X87361, EU021459), used in the present phylogenetic analysis, also clustered near to accessions of *G. multipileum*. In the phylogenetic tree, *G. multicornum* of the present study settled near to *G. australe* accession from Malaysia. *G. keralense sp. nov*. of the present study settled as a distinct lineage along with accessions of *G. angustisporum* from China (NR158431, MG279170, MG279171, MG279172), with 95% bootsrap support. In the tree, present "*Ganoderma* species of *applanatum-australe* complex" clustered along with "*G. applanatum*" from Sri Lanka (KR867655). In general, clades containing laccate *Ganoderma* species and non laccate *Ganoderma* species were alternatively positioned in the phylogenetic tree.

FIGURE 133: Maximum likelihood tree generated using ITS sequence data. Values at the nodes indicate Maximum Likelihood bootstrap values. Bootstrap values above 50% are shown. Bold names represent the species collected from Kerala. Voucher numbers and voucher localities are given along with the taxa. Names in boxes indicate the collections from Kerala, and the closely related taxa from other localities.


Ganoderma lobatum BAFC651 Argentina
Ganoderma australe complex JFMA414 Chile
66
Ganoderma tornatum BAFC1172 Argentina
Ganoderma species BAFC2531 Chile
Ganoderma adspersum KM44264 United Kingdom
Ganoderma applanatum complex JM98/2 South Africa
Ganoderma australe complex PKB96/346 Australia
68
Ganoderma australe DHCR411 (HUES) Australia
Ganoderma annulare KCTC16803 Korea
Ganoderma brownii 365739 United States of America
Ganoderma philippii LXT.6 Vietnam
98
Ganoderma applanatum HMAS60686 China
Ganoderma lobatum CBS222.48 United States of America
Ganoderma adspersum SFC20141001-22 South Korea
76
59
Ganoderma australe complex PKB96/332 Japan
Ganoderma species GPS 047 Iran
77
Ganoderma australe K(M)120828 Britain
63
Ganoderma australe complex PKB96303 Japan
69
Ganoderma adspersum CBS351.74 Belgium
Ganoderma australe RSH1206 Taiwan
Ganoderma aridicola Dai 12588 South Africa
56
97
Ganoderma enigmaticum ZGCVN73 India
Ganoderma enigmaticum ZGCVN731 India
96
Ganoderma thailandicum HKAS104641a Thailand
95
Ganoderma enigmaticum CBS 139792 South Africa
Ganoderma enigmaticum Dai 15970 South Africa
Ganoderma enigmaticum Dai 15971 South Africa
Ganoderma casuarinicola HKAS104639 Thailand
Ganoderma casuarinicola Dai 163339 China
64
Ganoderma casuarinicola Dai 16338 China
Ganoderma casuarinicola Dai 16339 China
Ganoderma casuarinicola Dai 16336 China
Ganoderma pfeifferi K(M)120818 England
91
Ganoderma mutabile CLZhao 982 China
81
Ganoderma mutabile Yuan2289 China
31
Ganoderma lobatum JV 1008/39 United States of America
53
Ganoderma lobatum JV 1008/31 United States of America
Ganoderma lobatum JV 1008/32 United States of America
Ganoderma tornatum URM82776 Brazil
61
Ganoderma applanatum complex MUCL40412 Ecuador
99
Ganoderma applanatum complex JMCR.41 Costa Rica
Ganoderma lingzhi Cui 14342 China
Ganoderma gibbosum SFC20150630-23 South Korea
Ganoderma applanatum UOC BIBMB 13 Sri Lanka
Ganoderma applanatum-australe complex CAL1547 India
Ganoderma australe complex JM95/6 Thailand
Ganoderma australe complex MUCL41812 Cambodia
Ganoderma australe complex CP333 Papua New Guinea
Ganoderma applanatum complex JM98/233 China
Ganoderma australe PKB96/270 Singapore
Ganoderma australe complex PKB93/035 Taiwan
Ganoderma applanatum NIAST824 South Korea
Ganoderma gibbosum ACC5.151 China
Ganoderma ellipsoideum JFL 14080968 China
Ganoderma eickeri CMW49692 South Africa
86
Ganoderma knysnamense CMW 47755 South Africa
Ganoderma williamsianum Wei 5032 Thailand
99
Ganoderma williamsianum Dai 16809 Thailand
Ganoderma podocarpense QCAM6422 Ecuador
Ganoderma curtisii CBS100131 United States of America
Ganoderma meredithae UMNFL50 United States of America
Ganoderma curtisii CBS 100132 United States of America
92
Ganoderma lingzhi HKAS 76642 China
Ganoderma lingzhi Wu1006-38 China
95
Ganoderma lingzhi Cui 14375 China
99
Ganoderma philippii Cui 14443 China
Ganoderma chalceum URM80457 Brazil
Ganoderma philippii Cui 14444 China
Ganoderma multiplicatum URM83346 Brazil
Ganoderma multiplicatum 60119011 Brazil
64
Ganoderma multiplicatum SPC9 Brazil
Ganoderma multiplicatum ZGCVN529 India
79
Ganoderma tropicum He 1232 China
98
Ganoderma tropicum Dai 16434 China
84
Ganoderma tropicum Yuan 3490 China
Ganoderma tropicum ZGCVN873 India
73
Ganoderma tropicum ZGCVN429 India


Ganoderma dunense CMW42150 South Africa
62
Ganoderma destructans Dai 16431 South Africa
Ganoderma destructans CMW43670 South Africa
88
Ganoderma destructans CBS 139793 South Africa
Ganoderma dunense CMW42157 South Africa
Ganoderma dunense CMW42149 South Africa
Ganoderma steyaertanum MEL:2382783 Australia
Ganoderma steyaertinum 36-11-58 Indonesia
60
Ganoderma steyaertanum 8-1-115 Indonesia
Ganoderma steyaertinum II-121-1 Indonesia
86
Ganoderma steyaertinum 6-WN-14(M)-A Indonesia
Ganoderma mizoramense UMN-MZ4 India
84
Ganoderma mizoramense UMN-MZ5 India
52
Ganoderma martinicense LIP SW-Mart08-44 Martinica
76
Ganoderma martinicense He 2240 United States of America
Ganoderma martinicense LIP SW-Mart08-55 Martinica
Ganoderma multipileum SSP:4 India
Ganoderma multipileum ZGCVN402 India
Ganoderma multipileum ZGCVN534 India
Ganoderma multipileum ZGCVN481 India
Ganoderma multiplieum CWN 04670 China
Ganoderma multipileum Cui 14373 China
Ganoderma multipileum G82 China
Ganoderma lucidum FRI816 India
Ganoderma multipileum Dai 9447 China
Ganoderma lucidum BCRC36123 India
Ganoderma multipileum Dai9521 China
Ganoderma multipileum LQ China
53
Ganoderma multipileum TWS31Auf-a Taiwan
Ganoderma wiiroense MIN 938704 Ghana
Ganoderma flexipes MFLU 19-2198 China
Ganoderma sessile MUCL:38061 United States of America
83
Ganoderma valesiacum CBS 428.84 Korea
Ganoderma neojaponicum ASI 7032 Korea
Ganoderma resinaceum HMAS86599 Britain
Ganoderma resinaceum Rivoire 4150 France
95
Ganoderma resinaceum CBS 194.76 Netherlands
Ganoderma sessiliforme BAFC2580 Brazil
64
80
Ganoderma mexicanum XAL D.Jarvio Mexico
Ganoderma parvulum CRGF:719 Cuba
Ganoderma stipitatum THC 16 Colombia
Ganoderma austroafricanum CMW41454 South Africa
Ganoderma carocalcareum DMC 322 Cameroon
Ganoderma weberianum CBS 219.36 Philippines
Ganoderma hoehnelianum Dai 11995 China
54
Ganoderma heohnelianum Yuan 6337 China
96
84
Ganoderma hoehnelianum Cui 13982 China
Ganoderma leucocontextum GDGM44303 China
Ganoderma lucidum K 175217 United Kingdom
Ganoderma tsugae AFTOL ID 771 United States of America
Ganoderma leucocontextum Dai 15601 China
90
Ganoderma oregonense JZB2114013 China
35
G oregonense CBS 265.88 United States of America
Ganoderma lucidum HKAS:71088 China
Ganoderma lucidum HMAS86597 England
Ganoderma oerstedii GO138 China
54
Ganoderma leucocontextum GDGM 44490 China
Ganoderma leucocontextum GDGM 44489 China
Ganoderma tsugae Cui 14110 China
Ganoderma tsugae Dai 12751b United States of America
Ganoderma tsugae Cui 14112 China
Ganoderma lucidum Cui 14405 China
Ganoderma lucidum RYV 33217 Norway
Ganoderma lucidum Cui 14404 China
Ganoderma applanatum 7411 China
Ganoderma applanatum SFC20150930-02 South Korea
54
Ganoderma applanatum K(M)120829 Britain
Ganoderma applanatum JM97/3 United States of America
Ganoderma applanatum CBS187.31 Germany
99
Ganoderma applanatum GYONGYI 0150 Hungary
50
Ganoderma applanatum JM98/2 South Africa
Ganoderma lipsiensis NOR_53-1143/2 Finland
99
Ganoderma subresinosum ZGCVN826 India
Ganoderma subresinosum HNCM004 China
Ganoderma mbrekobenum MIN 850481 Ghana
Ganoderma formosanum 0109 Taiwan
74
Ganoderma sinense Cui 13835 China
97
Ganoderma sinense Wei 5327 China
Ganoderma subresinosum MFLU 19-2218 Thailand
93
Ganoderma ecuadoriense PMC126 Ecuador
Ganoderma subfornicatum BRFM 1024 French Guiana
Ganoderma cupreum Gano TKCameroon
76
Ganoderma australe ZGCVN85 India
78
Ganoderma australe 30-2 Malaysia

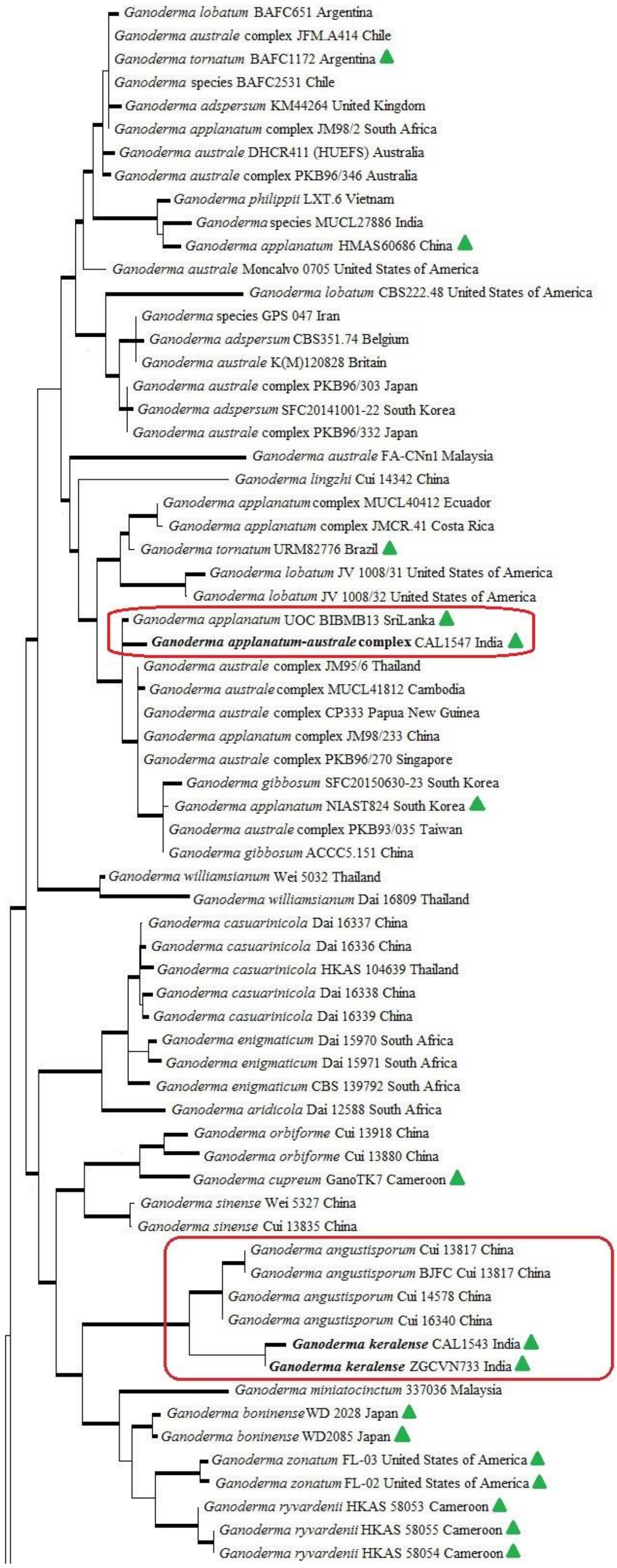


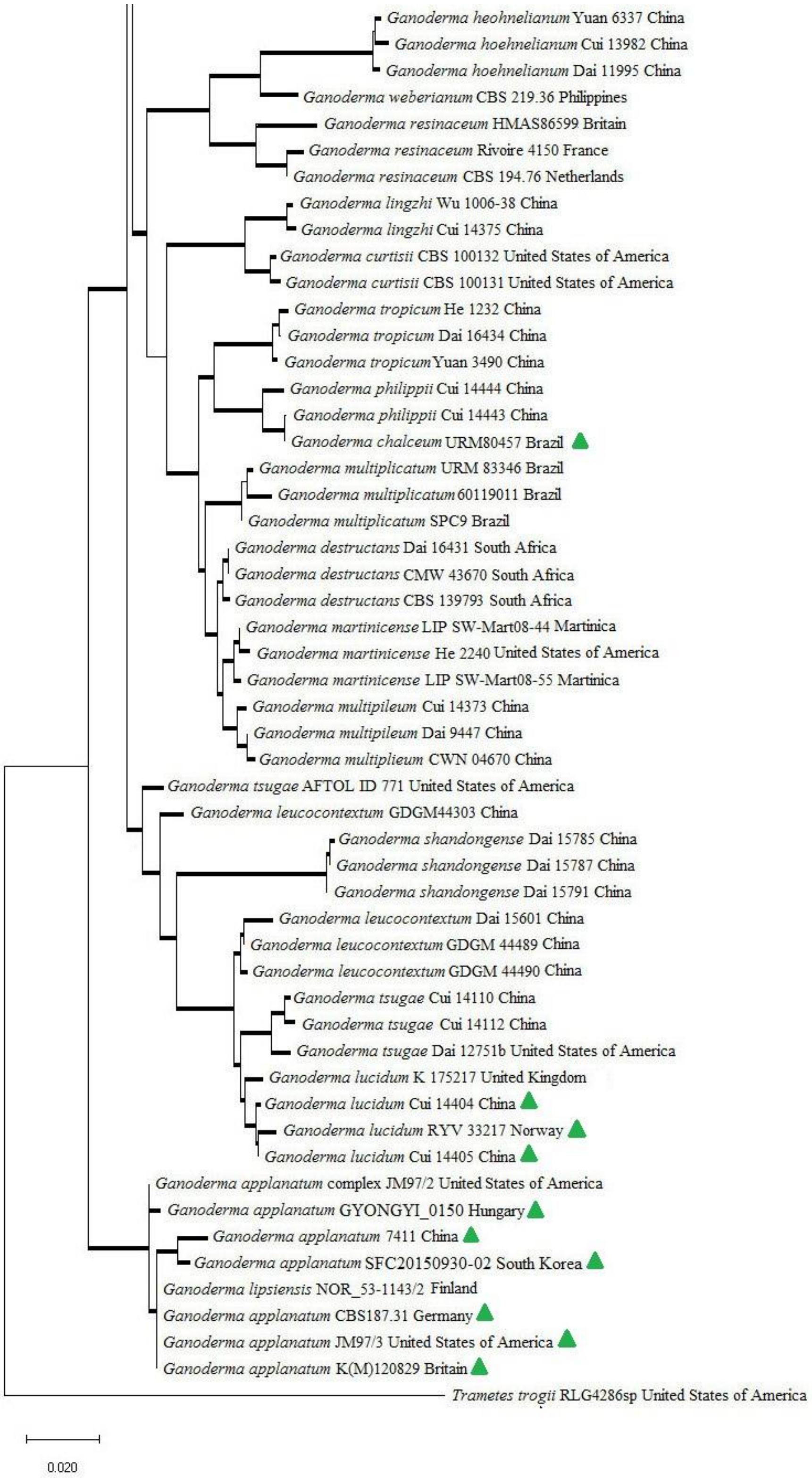
4.5.2. Phylogenetic analysis of *Ganoderma* species associated with stem rot disease of coconut in Kerala

Two types of *Ganoderma* fruit bodies that could be distinguished macroscopically were collected from diseased coconut palms in a field. One fruit body was with a laccate pileus (CAL1543) and the other one was non laccate (CAL1547), indicating the former's affinity to the *Ganoderma lucidum* complex and the latter's to the *G. applanatum* complex. Coconut palms in the field were showing the symptoms of basal stem rot disease (Figure 134). Severe rotting was observed on the roots and at the base of the stem Tissue decay was evident throughout the trunk; bark of the severely infected coconut palms was peeled off. Leaflets of most of the infected coconut palms had dried and were hanging down from the crown. Coconut palms in advanced stages of infection were entirely rotten, dead and were about to fall. Crowns of severely infected palms were seen detached from the main trunk. Brownish watery oozing was observed on the stem of many infected palms (Figure 134: C). The watery exudations were from single or multiple wounds, which extended up to the middle portion of the stem. *Ganoderma* fruit bodies at different developmental stages were present on some infected palms, mostly towards the stem base. ITS, LSU and RPB2 sequences were generated for the laccate fruit body and ITS sequence alone for the non laccate fruit body.

The molecular analyses (MP, ML, and Bayesian) generated trees that were indicative of the relative placement of *Ganoderma keralense sp. nov.* (laccate collection) with other closely related *Ganoderma* species (FIGURE 135). Trees generated from MP, ML, and Bayesian analyses were extremely similar in topology, with congruence regarding the terminal clades. Hence, only the ML trees are shown, with clade credibility and support values from each analyses indicated on the branches. Majority of the clades in all phylogenetic trees generated from the analyses were well supported. In all trees, *Ganoderma keralense sp. nov.* clustered as a distinct taxon, along with *G. angustisporum*, with good bootstrap support values in the ML analyses (93), MP analyses support values (86%) and Bayesian posterior probability values (1). The clade containing *Ganoderma keralense* was distinct from the clades containing morphologically similar species, *G. lucidum*, *G. boninense* and *G. zonatum*. In the tree, palm associated taxa of *Ganoderma* laccate complex, *G. boninense*, *G. ryvardenii*, *G. zonatum* (except *G. lucidum*), and *G. keralense* settled together (represented by “triangle” in the tree), indicating the close relationship of these species. In the tree, present collections of the non laccate *Ganoderma* species of *applanatum-australe* complex clustered along with “*G. applanatum*” from Sri Lanka. However, our collection and the Sri Lankan material settled as distinct phylogenetic lineage from the *G. applanatum* accessions from Europe, which is the type locality of *G. applanatum*.

FIGURE 135: The maximum likelihood tree generated using combined ITS, LSU and RPB2 sequence data. Thickened branches represent bootstrap/posterior probability value greater than 90%/0.90, at least in any of the three phylogenetic analyses (MP, ML, Bayesian). Taxa known to be isolated from palms are indicated by triangle. Bold names represent the species collected from coconut palms in Kerala. Voucher numbers and voucher localities are given along with taxa. Names in boxes indicate the collections from Kerala, and the closely related taxa from other localities.

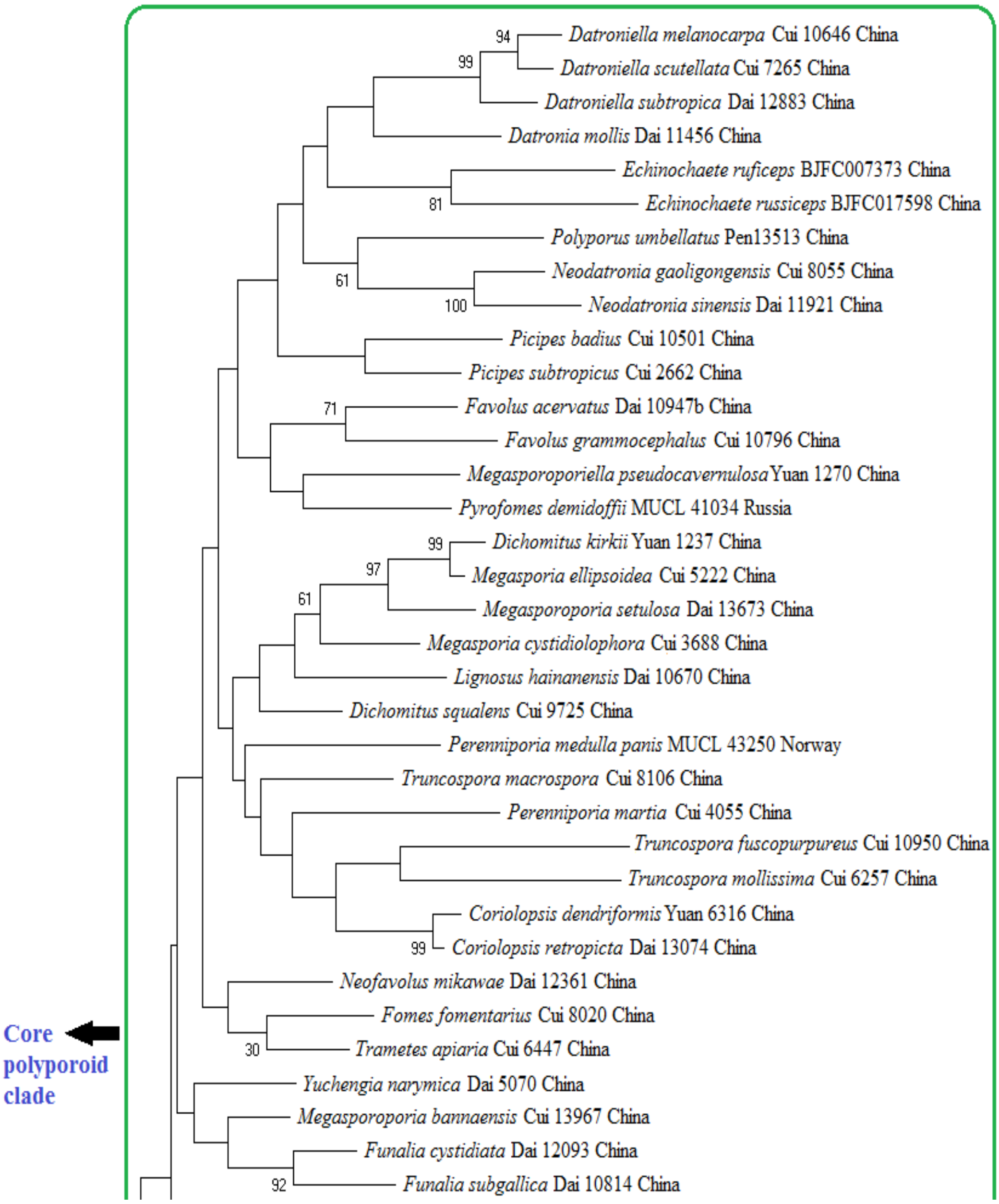

Ganoderma lobatum BAFC651 Argentina
Ganoderma australe complex JFM.A414 Chile
Ganoderma tornatum BAFC1172 Argentina ▲
Ganoderma species BAFC2531 Chile
Ganoderma adspersum KM44264 United Kingdom
Ganoderma applanatum complex JM98/2 South Africa
Ganoderma australe DHCR411 (HUEFS) Australia
Ganoderma australe complex PKB96/346 Australia
Ganoderma philippii LXT.6 Vietnam
Ganoderma species MUCL27886 India
Ganoderma applanatum HMAS60686 China ▲
Ganoderma australe Moncalvo 0705 United States of America
Ganoderma lobatum CBS222.48 United States of America
Ganoderma species GPS 047 Iran
Ganoderma adspersum CBS351.74 Belgium
Ganoderma australe K(M)120828 Britain
Ganoderma australe complex PKB96/303 Japan
Ganoderma adspersum SFC20141001-22 South Korea
Ganoderma australe complex PKB96/332 Japan
Ganoderma australe FA-CNn1 Malaysia
Ganoderma lingzhi Cui 14342 China
Ganoderma applanatum complex MUCL40412 Ecuador
Ganoderma applanatum complex JMCR.41 Costa Rica
Ganoderma tornatum URM82776 Brazil ▲
Ganoderma lobatum JV 1008/31 United States of America
Ganoderma lobatum JV 1008/32 United States of America
Ganoderma applanatum UOC BIBMB13 SriLanka ▲
Ganoderma applanatum-australe complex CAL1547 India ▲
Ganoderma australe complex JM95/6 Thailand
Ganoderma australe complex MUCL41812 Cambodia
Ganoderma australe complex CP333 Papua New Guinea
Ganoderma applanatum complex JM98/233 China
Ganoderma australe complex PKB96/270 Singapore
Ganoderma gibbosum SFC20150630-23 South Korea
Ganoderma applanatum NIAST824 South Korea ▲
Ganoderma australe complex PKB93/035 Taiwan
Ganoderma gibbosum ACCC5.151 China
Ganoderma williamsianum Wei 5032 Thailand
Ganoderma williamsianum Dai 16809 Thailand
Ganoderma casuarinicola Dai 16337 China
Ganoderma casuarinicola Dai 16336 China
Ganoderma casuarinicola HKAS 104639 Thailand
Ganoderma casuarinicola Dai 16338 China
Ganoderma casuarinicola Dai 16339 China
Ganoderma enigmaticum Dai 15970 South Africa
Ganoderma enigmaticum Dai 15971 South Africa
Ganoderma enigmaticum CBS 139792 South Africa
Ganoderma aridicola Dai 12588 South Africa
Ganoderma orbiforme Cui 13918 China
Ganoderma orbiforme Cui 13880 China
Ganoderma cupreum GanoTK7 Cameroon ▲
Ganoderma sinense Wei 5327 China
Ganoderma sinense Cui 13835 China
Ganoderma angustisporum Cui 13817 China
Ganoderma angustisporum BJFC Cui 13817 China
Ganoderma angustisporum Cui 14578 China
Ganoderma angustisporum Cui 16340 China
Ganoderma keralense CAL1543 India ▲
Ganoderma keralense ZGCVN733 India ▲
Ganoderma miniatocinctum 337036 Malaysia
Ganoderma boninense WD 2028 Japan ▲
Ganoderma boninense WD2085 Japan ▲
Ganoderma zonatum FL-03 United States of America ▲
Ganoderma zonatum FL-02 United States of America ▲
Ganoderma ryvardenii HKAS 58053 Cameroon ▲
Ganoderma ryvardenii HKAS 58055 Cameroon ▲
Ganoderma ryvardenii HKAS 58054 Cameroon ▲


Ganoderma heohnelianum Yuan 6337 China
Ganoderma hoehnelianum Cui 13982 China
Ganoderma hoehnelianum Dai 11995 China
Ganoderma weberianum CBS 219.36 Philippines
Ganoderma resinaceum HMAS86599 Britain
Ganoderma resinaceum Rivoire 4150 France
Ganoderma resinaceum CBS 194.76 Netherlands
Ganoderma lingzhi Wu 1006-38 China
Ganoderma lingzhi Cui 14375 China
Ganoderma curtisii CBS 100132 United States of America
Ganoderma curtisii CBS 100131 United States of America
Ganoderma tropicum He 1232 China
Ganoderma tropicum Dai 16434 China
Ganoderma tropicum Yuan 3490 China
Ganoderma philippii Cui 14444 China
Ganoderma philippii Cui 14443 China
Ganoderma chalceum URM80457 Brazil ▲
Ganoderma multiplicatum URM 83346 Brazil
Ganoderma multiplicatum 60119011 Brazil
Ganoderma multiplicatum SPC9 Brazil
Ganoderma destructans Dai 16431 South Africa
Ganoderma destructans CMW 43670 South Africa
Ganoderma destructans CBS 139793 South Africa
Ganoderma martinicense LIP SW-Mart08-44 Martinica
Ganoderma martinicense He 2240 United States of America
Ganoderma martinicense LIP SW-Mart08-55 Martinica
Ganoderma multipileum Cui 14373 China
Ganoderma multipileum Dai 9447 China
Ganoderma multiplieum CWN 04670 China
Ganoderma tsugae AFTOL ID 771 United States of America
Ganoderma leucocontextum GDGM44303 China
Ganoderma shandongense Dai 15785 China
Ganoderma shandongense Dai 15787 China
Ganoderma shandongense Dai 15791 China
Ganoderma leucocontextum Dai 15601 China
Ganoderma leucocontextum GDGM 44489 China
Ganoderma leucocontextum GDGM 44490 China
Ganoderma tsugae Cui 14110 China
Ganoderma tsugae Cui 14112 China
Ganoderma tsugae Dai 12751b United States of America
Ganoderma lucidum K 175217 United Kingdom
Ganoderma lucidum Cui 14404 China ▲
Ganoderma lucidum RYV 33217 Norway ▲
Ganoderma lucidum Cui 14405 China ▲
Ganoderma applanatum complex JM97/2 United States of America
Ganoderma applanatum GYONGYI_0150 Hungary ▲
Ganoderma applanatum 7411 China ▲
Ganoderma applanatum SFC20150930-02 South Korea ▲
Ganoderma lipsiensis NOR_53-1143/2 Finland
Ganoderma applanatum CBS187.31 Germany ▲
Ganoderma applanatum JM97/3 United States of America ▲
Ganoderma applanatum K(M)120829 Britain ▲
Trametes trogii RLG4286sp United States of America
0.020

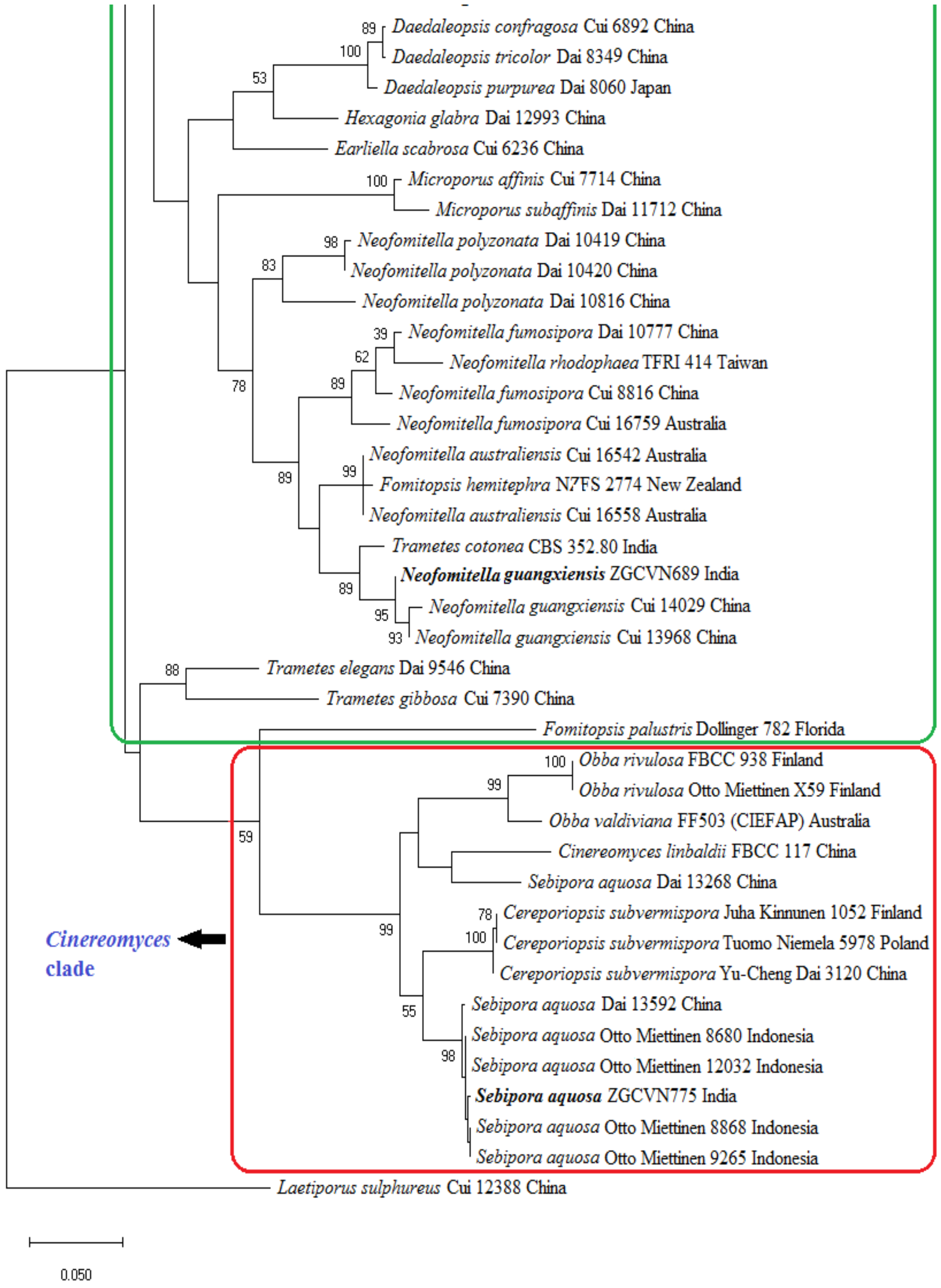
4.5.3. PHYLOGENETIC ANALYSIS OF *NEOFOMITELLA GUANGXIENSIS*, *SEBIPORA AQUOSA* AND RELATED TAXA

The Maximum Likelihood tree (FIGURE 136) shows the placement of present collections of *N. guangxiensis* and *S. aquosa* among other related taxa of order Polyporales. In the tree, two distinct monophyletic groups were recognized such as core polyporoid clade, and *Cinereomyces* clade. Kerala collection of *N. guanxiensis* settled along with the same species from China, with 95% bootstrap support in the core polyporoid clade. Similarly, Kerala collection of *S. aquosa* claded together with the four accessions of Indonesian *S. aquosa* (including the holotype), with 98% bootstrap support, in the *Cinereomyces* clade. *Ceriporiopsis subvermispora* formed the sister lineage to this clade, which is in accordance with the previous molecular phylogenetic stidies on this species (Miettinen & Rajchenberg 2012; Zhao *et al.* 2017).

FIGURE 136: Maximum likelihood tree generated using ITS sequence data. Values at the nodes indicate Maximum Likelihood bootstrap values. Bootstrap values above 50% are shown. Bold names represent the species collected from Kerala. Voucher numbers and voucher localities are given along with the taxa. Names in boxes indicate the collections from Kerala, and the closely related taxa from other localities.



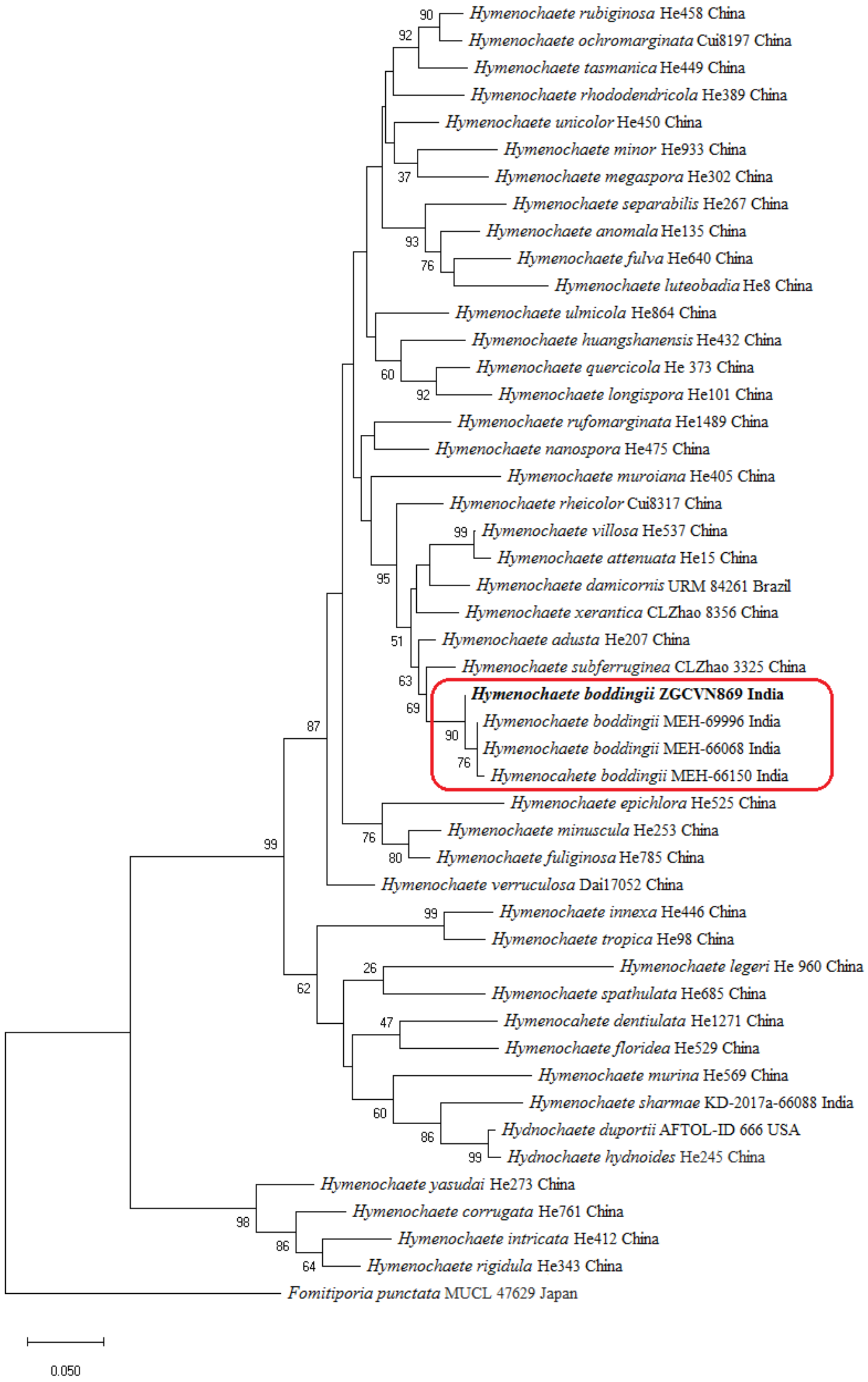
94
Datroniella melanocarpa Cui 10646 China
99
Datroniella scutellata Cui 7265 China
Datroniella subtropica Dai 12883 China
Datronia mollis Dai 11456 China
Echinochaete ruficeps BJFC007373 China
81
Echinochaete russiceps BJFC017598 China
Polyporus umbellatus Pen13513 China
61
Neodatronia gaoligongensis Cui 8055 China
100
Neodatronia sinensis Dai 11921 China
Picipes badius Cui 10501 China
Picipes subtropicus Cui 2662 China
71
Favolus acervatus Dai 10947b China
Favolus grammocephalus Cui 10796 China
Megasporoporiella pseudocavernulosa Yuan 1270 China
Pyrofomes demidoffii MUCL 41034 Russia
99
Dichomitus kirkii Yuan 1237 China
97
Megasporia ellipsoidea Cui 5222 China
61
Megasporoporia setulosa Dai 13673 China
Megasporia cystidiolophora Cui 3688 China
Lignosus hainanensis Dai 10670 China
Dichomitus squalens Cui 9725 China
Perenniporia medulla panis MUCL 43250 Norway
Truncospora macrospora Cui 8106 China
Perenniporia martia Cui 4055 China
Truncospora fuscopurpureus Cui 10950 China
Truncospora mollissima Cui 6257 China
Coriolopsis dendriformis Yuan 6316 China
99
Coriolopsis retropica Dai 13074 China
Neofavolus mikawae Dai 12361 China
Fomes fomentarius Cui 8020 China
30
Trametes apiaria Cui 6447 China
Yuchengia narymica Dai 5070 China
Megasporoporia bannaensis Cui 13967 China
Funalia cystidiata Dai 12093 China
92
Funalia subgallica Dai 10814 China
Core polyporoid clade


89
Daedaleopsis confragosa Cui 6892 China
100
Daedaleopsis tricolor Dai 8349 China
53
Daedaleopsis purpurea Dai 8060 Japan
Hexagonia glabra Dai 12993 China
Earliella scabrosa Cui 6236 China
100
Microporus affinis Cui 7714 China
Microporus subaffinis Dai 11712 China
98
Neofomitella polyzonata Dai 10419 China
83
Neofomitella polyzonata Dai 10420 China
Neofomitella polyzonata Dai 10816 China
39
Neofomitella fumosipora Dai 10777 China
62
Neofomitella rhodophaea TFRI 414 Taiwan
78
89
Neofomitella fumosipora Cui 8816 China
Neofomitella fumosipora Cui 16759 Australia
Neofomitella australiensis Cui 16542 Australia
99
89
Fomitopsis hemitephra N7FS 2774 New Zealand
Neofomitella australiensis Cui 16558 Australia
Trametes cotonea CBS 352.80 India
Neofomitella guangxiensis ZGCVN689 India
89
Neofomitella guangxiensis Cui 14029 China
95
93
Neofomitella guangxiensis Cui 13968 China
88
Trametes elegans Dai 9546 China
Trametes gibbosa Cui 7390 China
Fomitopsis palustris Dollinger 782 Florida
100
Obba rivulosa FBCC 938 Finland
99
Obba rivulosa Otto Miettinen X59 Finland
Obba valdiviana FF503 (CIEFAP) Australia
Cinereomyces linbaldii FBCC 117 China
59
Sebipora aquosa Dai 13268 China
78
Cereporiopsis subvermispora Juha Kinnunen 1052 Finland
99
Cinereomyces clade
100
Cereporiopsis subvermispora Tuomo Niemela 5978 Poland
Cereporiopsis subvermispora Yu-Cheng Dai 3120 China
Sebipora aquosa Dai 13592 China
55
Sebipora aquosa Otto Miettinen 8680 Indonesia
98
Sebipora aquosa Otto Miettinen 12032 Indonesia
Sebipora aquosa ZGCVN775 India
Sebipora aquosa Otto Miettinen 8868 Indonesia
Sebipora aquosa Otto Miettinen 9265 Indonesia
Laetiporus sulphureus Cui 12388 China
0.050

4.5.4. PHYLOGENETIC ANALYSIS OF *HYMENOCHAETE BODDINGII*

The phylogenetic tree (FIGURE 137) shows the position of Kerala collection of *H. boddingii* among other closely related species of genus *Hymenochaete*. Present collection clustered along with the holotype of *H. boddingii*, originally described from India (Rossi *et al.* 2020), with 90% bootstrap support. *H. subferruginea* formed the sister lineage. The tree also reveals the distinctness of present collection from the other morphologically related species of *Hymenochaete*, such as *H. adusta* and *H. damicornis*.

FIGURE 137: Maximum likelihood tree generated using ITS sequence data. Values at the nodes indicate Maximum Likelihood bootstrap values. Bootstrap values above 50% are shown. Bold names represent the species collected from Kerala. Voucher numbers and voucher localities are given along with the taxa. Names in boxes indicate the collections from Kerala, and the closely related taxa from other localities.


90
Hymenochaete rubiginosa He458 China
92
Hymenochaete ochromarginata Cui8197 China
Hymenochaete tasmanica He449 China
Hymenochaete rhododendricola He389 China
Hymenochaete unicolor He450 China
Hymenochaete minor He933 China
37
Hymenochaete megaspora He302 China
Hymenochaete separabilis He267 China
93
Hymenochaete anomala He135 China
76
Hymenochaete fulva He640 China
Hymenochaete luteobadia He8 China
Hymenochaete ulmicola He864 China
Hymenochaete huangshanensis He432 China
60
Hymenochaete quercicola He 373 China
92
Hymenochaete longispora He101 China
Hymenochaete rufomarginata He1489 China
Hymenochaete nanospora He475 China
Hymenochaete muroiana He405 China
Hymenochaete rheicolor Cui8317 China
99
Hymenochaete villosa He537 China
Hymenochaete attenuata He15 China
95
Hymenochaete damicornis URM 84261 Brazil
Hymenochaete xerantica CLZhao 8356 China
51
Hymenochaete adusta He207 China
Hymenochaete subferruginea CLZhao 3325 China
63
Hymenochaete boddingii ZGCVN869 India
69
Hymenochaete boddingii MEH-69996 India
90
Hymenochaete boddingii MEH-66068 India
76
Hymenocahete boddingii MEH-66150 India
87
Hymenochaete epichlora He525 China
76
Hymenochaete minuscula He253 China
80
Hymenochaete fuliginosa He785 China
99
Hymenochaete verruculosa Dai17052 China
99
Hymenochaete innexa He446 China
Hymenochaete tropica He98 China
26
Hymenochaete legeri He 960 China
62
Hymenochaete spathulata He685 China
47
Hymenocahete dentiulata He1271 China
Hymenochaete floridea He529 China
Hymenochaete murina He569 China
60
Hymenochaete sharmae KD-2017a-66088 India
86
Hydnochaete duportii AFTOL-ID 666 USA
99
Hydnochaete hydnoides He245 China
Hymenochaete yasudai He273 China
98
Hymenochaete corrugata He761 China
86
Hymenochaete intricata He412 China
64
Hymenochaete rigidula He343 China
Fomitiporia punctata MUCL 47629 Japan
0.050

5. DISCUSSION

Polyporoid fungi were collected from various localities of Kerala State, during a period of five years (June 2015–June 2020). Systematic studies were carried out using the freshly collected basidiomata, and with available preserved herbarium material. One hundred and thirty one species, belonging to 63 polyporoid genera were documented during the study. The documented species belonged to two orders, the Polyporales and the Hymenochaetales. The Polyporales were represented by 99 species, belonging to 12 families (Dacryobolaceae, Fomitopsidaceae, Gelatoporiaceae, Incrustoporiaceae, Irpicaceae, Meruliaceae, Meripilaceae, Panaceae, Phanerochaetaceae, Podoscyphaceae, Polyporaceae and Steccherinaceae). The Hymenochaetales were represented by 32 species, and belonged to four families (Hymenochaetaceae, Oxyporaceae, Rickenellaceae and Schizoporaceae). Among Polyporales, the family Polyporaceae was represented by the highest number of species (60), Fomitopsidaceae (9 spp.), Podoscyphaceae (6 spp.), Panaceae (5 spp.), Meruliaceae (4 spp), Phanerochaetaceae (4 spp.), Steccherinaceae (3 spp.), Dacryobolaceae (2 spp.), Meripilaceae (2 spp.), Irpicaceae (2 spp.), Gelatoporiaceae (1 sp.), Incrustoporiaceae (1 sp.). Among members of Polyporaceae, genus *Ganoderma* included the highest number of species (12 spp.), followed by *Trametes* (11 spp.), *Lentinus* (7 spp.). In the family Podoscyphaceae, highest number of species was in the genus *Podoscypha* (5 spp.).

Most of the species documented in the order Hymenochaetales belonged to the family Hymenochaetaceae (26 species). The family Schizoporaceae was represented by two species (*Leucophellinushobsonii* and *Schizopora paradoxa*). The Families Oxyporaceae and Rickenellaceae were represented by one species each. Genus *Phellinus* possessed the highest number of species (8 spp.), followed by *Inonotus* (5 spp.) and *Phylloporia* (4 spp.).

The family level classification of two taxa, *Trichaptum biforme* and *T. byssogenum* documented here remains uncertain due to their enigmatic phylogenetic relationships. Since *Index Fungorum* categorizes these two taxa as *incertae sedis*, the same is followed in this study. *Trichaptum* was earlier considered as belonging to the family Polyporaceae (Polyporales) (Murrill 1904).

Based on the recent molecular phylogenetic works by Justo *et al.* (2017) and Zmitrovich (2018), the family Ganodermataceae had been reduced as a synonym of the family Polyporaceae. All genera, which were earlier treated under the family Ganodermataceae, except the genus *Sanguinoderma*, have currently been shifted to the Polyporaceae (*Index Fungorum*, accessed on 22 October 2020). This taxonomic change has been accepted in this study, and all taxa from Kerala previously considered under Ganodermataceae are now placed under Polyporaceae. The present study also treats *Sanguinoderma* under the family Polyporaceae, although the change does not formally appear in any systematic resource. This is because the closely related genera of *Sanguinoderma*, including *Amauroderma*, *Haddowia*, *Furtadoa* are currently placed under the Polyporaceae.

Following are the species of the order Polyporales, documented during this study:

Family-Dacryobolaceae

1 *Postia tephroleuca*
2 *Spongiporus floriformis*

Family- Fomitopsidaceae

3 *Antrodia albida*
4 *Dadaelia dochmia*
5 *Daedalea radiata*
6 *Neoantrodia serialis*
7 *Fomitopsis caribensis*
8 *Fomitopsis palustris*
9 *Pilatoporus ostreiformis*
10 *Rhodofomitopsis feei*
11 *Rubellofomes cystidiatus*

Family- Gelatoporiaceae

12 *Sebipora aquosa*

Family- Incrustoporiaceae

13 *Tyromyces leucomallus*

Family- Irpicaceae

14 *Irpex lacteus*
15 *Flavodon flavus*

Family-Meripilaceae

16 *Rigidoporus lineatus*
17 *Rigidoporus vinctus*

Family-Meruliaceae

18 *Pappia fissilis*
19 *Phlebia acerina*
20 *Phlebia ludiviciana*
21 *Phlebia unica*

Family-Panaceae

22 *Panus hookerianus*
23 *Panus bambusinus comb. nov.*
24 *Panus neostrigosus*
25 *Panus similis*
26 *Panus velutinus*

Family- Phanerochaetaceae

27 *Bjerkandera adusta*
28 *Oxychaete cervinogilva*
29 *Phlebiopsis crassa*
30 *Terana coerulea*

Family-Podoscyphaceae

31 *Abortiporus biennis*
32 *Podoscypha involuta*
33 *Podoscypha mellissii*
34 *Podoscypha petalodes*
35 *Podoscypha thozetii*
36 *Podoscypha venustula*

Family- Polyporaceae

37 *Amauroderma fuscoporia*
38 *Bresadolia uda*
39 *Cellulariella acuta*
40 *Coriolopsis caperata*
41 *Coriolopsis occidentalis*
42 *Coriolopsis telfarii*
43 *Earliella scabrosa*
44 *Echinochaete ruficeps*
45 *Favolus grammocephalus*
46 *Favolus tenuiculus*

47 *Ganoderma* species of *applanatum-australe* complex
48 *Ganoderma australe*
49 *Ganoderma enigmaticum*
50 *Ganoderma keralense sp. nov.*
51 *Ganoderma multicornis*
52 *Ganoderma multipileum*
53 *Ganoderma multiplicatum*
54 *Ganoderma orbiforme*
55 *Ganoderma subresinosum*
56 *Ganoderma tropicum*
57 *Leiotrametes menziesii*
58 *Lentinus arcularius*
59 *Lentinus badius*
60 *Lentinus dicholamellatus*
61 *Lentinus polychrous*
62 *Lentinus sajor-caju*
63 *Lentinus squarrosulus*
64 *Lentinus tricholoma*
65 *Lignosus rhinocerus*
66 *Microporellus obovatus*
67 *Microporellus violaceocinerescens*
68 *Microporus affinis*
69 *Microporus xanthopus*
70 *Navisporus floccosus*
71 *Neofomitella fumosipora*
72 *Neofomitella guangxiensis*
73 *Neofomitella rhodophaea*
74 *Perenniporia decurrata*
75 *Perenniporia medulla-panis*
76 *Perenniporia ochroleuca*
77 *Pilatotrama ljubarskyi*
78 *Polyporus dictyopus*
79 *Polyporus lepreurii*
80 *Pseudofavolus tenuis*
81 *Pycnoporus cinnabarinus*
82 *Pycnoporus sanguineus*
83 *Sanguinoderma rugosum*
84 *Theleporus minisporus*
85 *Theleporus venezuelicus*

86 *Trametes apiaria*
87 *Trametes flavida*
88 *Trametes gibbosa*
89 *Trametes hirsuta*
90 *Trametes marianna*
91 *Trametes pubescens*
92 *Trametes varians*
93 *Trametes vernicipes*
94 *Trametes villosa*
95 *Trametes meyenii*
96 *Trametes ochracea*

Family- Steccherinaceae

97 *Butyrea luteoalba*
98 *Nigroporus durus*
99 *Nigroporus vinosus*

Following are the species belonging to the order Hymenochaetales:

Family-Hymenochaetaceae

100 *Coltricia cinnamomea*
101 *Coltricia pyrophila*
102 *Cyclomyces setiporus*
103 *Fulvifomes cesatii*
104 *Fuscoporia rhabarbarina*
105 *Hydnoporia tabacina*
106 *Hymenochaete boddingii*
107 *Hymenochaete ochromarginata*
108 *Inonotus luteoumbrinus*
109 *Inonotus pachyphloeus*
110 *Inonotus patouillardii*
111 *Inonotus subhispidus*
112 *Inonotus tabacinus*
113 *Phellinus alardii*
114 *Phellinus caryophylli*
115 *Phellinus fastuosus*
116 *Phellinus ferrugineo-velutinus*
117 *Phellinus gilvus*
118 *Phellinus hoehnelii*
119 *Phellinus nilgheriensis*
120 *Phellinus rimosus*
121 *Phylloporia chrysites*

122 *Phylloporia gabonensis*
123 *Phylloporia pectinata*
124 *Phylloporia weberiana*
125 *Tropicoporus dependens*

Family- Oxyporaceae

126 *Oxyporus ravidus*

Family- Rickenellaceae

127 *Cotylidia pannosa*

Family- Schizoporaceae

128 *Leucophellinus hobsonii*
129 *Schizopora paradoxa*

Family- *Insertae sedis*

130 *Trichaptum biforme*
131 *Trichaptum byssogenum*

Two species new to science were discovered during the study, and are described. *Ganoderma keralense* N. Vinjusha & T.K.A. Kumar, and a *Ganoderma* species belonging to the *applanatum-australe* complex are the two hitherto undescribed species.

A new taxonomic combination, *Panus bambusinus* (T.K.A. Kumar & Manim.) Vinjusha & T.K.A. Kumar) (for *Lentinus bambusinus*) is proposed during this study.

Three polyporoid species were found as new records to Asia. They are:

Fomitopsis caribensis, *Phylloporia gabonensis*, and *Theleporus venezuelicus*

The study documented 3 new genus records, and 21 species records to India. Following are the new genus records to India:

Pappia, *Rubellofomes*, and *Sebipora*

Following are the new species records to India:

Daedalea radiata, Fomitopsis caribensis, Ganoderma keralense sp. nov., Ganoderma species of *applanatum-australe complex, Hymenochaete* *ochromarginata, Lignosus rhinocerus, Neofomitella fumosipora, Neofomitella guangxiensis, Pappia fissilis, Perenniporia decurrata, Phlebia unica, Podoscypha involuta, Podoscypha mellissii, Podoscypha thozetii, Phylloporia gabonensis, Rubellofomes cystidiatus, Sebipora aquosa, Spongiporus floriformis, Theleporus minisporus, Theleporus venezuelicus* and *Tyromyces leucomallus*

The study also documented 10 new genus records, and new 47 species records to Kerala. Following are the new genus records to Kerala:

Bresadolia, *Cotylidia*, *Pappia*, *Phlebia*, *Phlebiopsis*, *Rubellofomes*, *Sebipora*, *Spongiporus*, *Terana*, and *Theleporus*

Following are the new species records to Kerala:

Bresadolia uda, Butyrea luteoalba, Coltricia pyrophila, Cotylidia pannosa, Daedalea radiata, Fomitopsis caribensis, Fuscoporia rhabarbarina, Ganoderma enigmaticum, Ganoderma keralense sp. nov., Ganoderma species of *applanatum-australe complex, Ganoderma multicornum, Ganoderma multipileum, Ganoderma multiplicatum, Ganoderma orbiforme, Ganoderma tropicum, Hymenochaete boddingii, Hymenochaete ochromarginata, Inonotus subhispidus, Lentinus badius, Lignosus rhinocerus, Neofomitella fumosipora, Neofomitella guangxiensis, Oxyporus ravidus, Pappia fissilis, Perenniporia decurrata, Perenniporia medulla-panis, Phlebia acerina, Phlebia ludiviciana, Phlebia unica, Phlebiopsis crassa, Phylloporia gabonensis, Phylloporia weberiana, Pilatotrama ljubarskyi, Podoscypha involuta, Podoscypha mellissii, Podoscypha petalodes, Podoscypha thozetii, Postia tephroleuca, Rubellofomes cystidiatus, Sebipora aquosa, Spongiporus floriformis, Terana coerulea, Theleporus minisporus, Theleporus venezuelicus, Trametes gibbosa, Trametes meyenii,* and *Tyromyces leucomallus*

Most of the polypores collected and studied were saprobes, living on dead and decayed wood, while some were pathogenic on the host (*Ganodermakeralensesp. nov*., *Navisporus floccosus*, *Phellinus ferrugineo-velutinus*, *P. gilvus*, *P. hoehnelii*, *P. rimosus*). A few collections of polypores were obtained from soil (*Coltricia cinnamomea*, *Lignosus rhinocerus*, *Microporellus* *violaceocinerescens*). Many of the polypore specimens collected during the present study belonged to the white rot wood decay group. *Cellulariella acuta*, *Earliella scabrosa*, *Favolus grammocephalus*, *Inonotus pachyphloeus*, *Microporus affinis*, *M. xanthopus*, *Phellinus gilvus*, *P. rimosus*, *Rigidoporus lineatus*, and *Trametes villosa* are some of the widely occurring taxa among polypores in most of the forest areas of Kerala, visited for the study. Among the frequently visited collection localities, Janaki forest, Kakkayam forest and Peruvannamuzhy forest of Kozhikode district and Muthanga forest of Wayanad district were found to be rich in species diversity of polypores throughout the seasons. Apart from the deep forest areas, many local collections were also obtained from both live trees and dead woods on roadside areas and college campuses.

Sacred groves of Kerala were found to be good habitat for polyporoid fungi, especially Vallikkattu Kavu, Poyil Kavu and Thurayil Kavu of Kozhikode district, Neeliyar Kottam, Poongottu Kavu of Kannur district, and Iringole Kavu of Ernakulam district. Among the sacred groves visited for the study, species diversity of polypores was higher in Thurayil Kavu of Kozhikode district and Iringole Kavu of Ernakulam district. Species of *Phellinus* were common on trees in most of these sacred groves visited. In addition to this, some species such as *Favolus grammocephalus*, *Rigidoporus lineatus* and *Microporus xanthopus* were also frequently seen in the forest areas of all these sacred groves. Some polypores were commonly observed on trees in different sacred groves throughout Kerala, but rarely seen in other deep forest areas. *H. ochromarginata* is a common species in Mannampurath Kavu (Kasaragod district), Poyil Kavu, Bayankavu (Kozhikode district) and Iringole Kavu (Ernakulam district), but other than from these scared groves, *H. ochromarginata* was only obtained from campus of KFRI campus, Malappuram district. In all sacred groves for study, polyporoid fruit bodies growing on soil are comparatively less than those occurring on wood.

Previous studies had recorded a total of 150 species of polypores from the State (Adarsh *et al.* 2018; Adarsh *et al.* 2019; Kiran *et al.* 2020). Among the earlier studies on polypores from Kerala, two major documentary works were those of

Leelavathy & Ganesh (2000) who reported 79 species belonging to 32 genera, and Mohanan (2011) reported 91 species belonging to 43 genera. Among the total 150 species of polypores recorded from Kerala so far, two species, *Lentinus giganteus* Berk and *L. tuber-regium* (Fr.) Fr. have been currently transferred to order Agaricales (as *Pleurotus giganteus* (Berk.) Karun. & K.D. Hyde and *P. tuber-regium* (Fr.) Singer respectively) (*Index Fungorum*, accessed on 06 September 2020). Thus, currently 148 polyporoid species are known from the State. Field trips were carried out to recollect all these species, however, 62 polypores were not encountered during the study, and have not been recollected. Species that were not recollected during this study are *Amauroderma conjunctum* (Lloyd) Torrend, *Coltricia focicola* (Berk. & Curt.) Murr., *Daedalea sulcata* (Berk.) Ryvarden (as *Hexagonia sulcata* Berk.), *Cerioporus leptocephalus* (Jacq.) Zmitr. (as *Polyporus leptocephalus* (Jacq.) Fr.), *Cerioporus meridionalis* (A. David) Zmitr. & Kovalenko (as *Polyporus meridionalis* (A. David) H. Jahn), *Cerioporus mollis* (Sommerf.) Zmitr. & Kovalenko (as *Datronia mollis* (Sommerf.) Donk), *Cerioporus squamosus* (Huds.) Quél. (as *Polyporus squamosus* (Huds.) Fr.), *Cinereomyces lindbladii* (Berk.) Jülich, *Flaviporus minutisporus* (D.A. Reid, K.S. Thind & Chatr.) Ginns, *Fomes extensus* (Lév.) Cooke (as *Phellinus troyanus* (Murrill) Bondartseva & S. Herrera), *Fomes pseudosenex* (Murrill) Sacc. & Trotter (as *Phellinus pseudosenex* (Murrill) Bondartseva & S. Herrera), *Fomes setulosus* Lloyd (as *Phellinus setulosus* (Lloyd) Imazeki), *Fomitiporia punctata* (P. Karst.) Murrill, *Fulvifomes durissimus* (Lloyd) Bondartseva & S. Herrera (as *Phellinus durissimus* (Lloyd) A. Roy), *Fulvifomes indicus* (Massee) L.W. Zhou (as *Aurificaria indica* (Massee) D.A. Reid), *Fulvifomes rhytiphloeus* (Mont.) Camp.-Sant. & Robledo (as *Phellinus rhytiphloeus* (Mont.) Ryvarden), *Funalia sanguinaria* (Klotzsch) Zmitr. & Malysheva (as *Coriolopsis sanguinaria* (Klotzsch) Teng), *Fuscoporia contigua* (Pers.) G. Cunn. (as *Phellinus contiguus* (Pers.) Pat.), *Fuscoporia ferrea* (Pers.) G. Cunn. (as *Phellinus ferreus* (Pers.) Bourdot & Galzin), *Fuscoporia ferruginosa* (Schrad.) Murrill, *Fuscoporia senex* (Nees & Mont.) Ghob.-Nejh. (as *Phellinus senex* ((Nees & Mont.) Imazeki), *Fuscoporia wahlbergii* (Fr.) T. Wagner & M. Fisch. (as *Phellinus wahlbergii* (Fr.) D.A. Reid, *Gloeoporus thelephoroides* (Hook.) G. Cunn., *Inonotus nothofagi* G. Cunn., *Junghuhnia crustacea* (Jungh.) Ryvarden, *J. nitida* (Pers.) Ryvarden *Laetiporus sulphureus* (Bull.) Murrill, *Leiotrametes lactinea* (Berk.) Welti & Courtec. (as *Trametes lactinea* (Berk.) Sacc., *Lentinus patulus* Lév., *Lentinus tigrinus* (Bull.) Fr., *Lenzites betulinus* (L.) Fr., *Melanoporia nigra* (Berk.) Murrill (as *Nigroporus niger* (Berk.) Ryvarden, *Neofavolus alveolaris* (DC.) Sotome & T. Hatt. (as *Polyporus alveolaris* (DC.) Bondartsev & Singer), *Oxyporus pellicula* (Jungh.) Ryvarden, *Panus caespiticola* (Pat. & Har.) Drechsler-Santos & Wartchow (as *L. caespiticola* Pat. & Har.), *Panus conchatus* (Bull.) Fr. (as *Lentinus conchatus* (Pers.) Lloyd, *Panus indicus* Sathe & J.T. Daniel, *Phellinus adamantinus* (Berk.) Ryvarden, *Phellinopsis conchata* (Pers.) Y.C. Dai (as *Phellinus conchatus* (Pers.) Quél.), *Phellinus grenadensis* (Murrill) Ryvarden, *Phellinus punctatiformis* (Murrill) Ryvarden, *Phellinus robiniae* (Murrill) A. Ames, *Picipes melanopus* Zmitr. & Kovalenko (as *Polyporus melanopus* (Pers.) Fr.), *Picipes virgatus* (Berk. & M.A. Curtis) J. L. Zhou & B.K. Cui (as *Polyporus virgatus* Berk. & M.A. Curtis), *Polyporus rugulosus* Lév., *Poria hypobrunnea* Petch, *Pyrofomes albomarginatus* (Zipp. *ex* Lév.) Ryvarden, *Ranadivia modesta* (Kunze *ex* Fr.) Zmitr. (as *T. modesta* (Kunze *ex* Fr.) Ryvarden), *Rigidoporus microporus* (Sw.) Overeem, *Rigidoporus ulmarius* (Sowerby) Imazeki, *Royoporus spatulatus* (Jungh.) A.B. De, *Skeletocutis indica* (as *Piloporia indica* Ganesh & Ryvarden), *Skeletocutis nivea* (Jungh.), *Trametes cingulata* Berk., Jean Keller, *Trametes cotonea* (Pat. & Har.) Ryvarden, *Trametes elegans* (Spreng.) Fr. (as *Lenzites elegans* (Spreng.) Pat.), *Trametes maxima* (Mont.) A. David & Rajchenb., *Trametes versicolor* (L.) Lloyd, *Trametes vespacea* (Pers.) Zmitr., Wasser & Ezhov (as *Lenzites vespaceus* (Pers.) Pat.), *Truncospora fuscopurpurea* (Pers.) Zmitr. (as *Loweporus fuscopurpureus* (Pers.) Ryvarden), *Truncospora tephropora* (Mont.) Zmitr. (as *Loweporus tephroporus* (Mont.) Ryvarden), and *Tyromyces pelliculosus* (Berk.) G. Cunn.

The polypore *Poria hypobrunnea* was recorded from Kerala by Rajalakshmi & Radhakrishnan (1978), and Bilgrami *et al.* (1991). Since then there are no other records of this species from Kerala till date. Similarly, the species *Phellinus setulosus* was documented from the Kerala by Bagchee (1954) and Bilgrami *et al.* (1991), and thereafter other records of this species are unavailable from the State.

Earlier records of some species like *Cerioporus meridionalis*, *Funalia sanguinaria*, *Junghuhnia crustacea*, *Panus indicus*, *Truncospora fuscopurpurea*, and *Truncospora tephropora* also date back to twenty years (Leelavathy & Ganesh 2000). Environmental conditions have changed a lot since this period, which may have affected the growth and distribution of polypores. It is highly possible that some species may not have produced macroscopic fruiting structures during the study periods. These may be reasons for the failure to recollect some of the species, which were previously recorded from Kerala.

Some fruit bodies especially certain resupinate ones, collected during the present study were immature ones, and had insufficient taxonomic characters. DNA extraction from these fruit bodies also failed in most cases, making the species identification difficult. Such collections are also excluded from this study. There is a possibility that some of such collections may represent certain species previously recorded from Kerala.

Attempts were made to study the herbarium materials of the polypore specimens previously recorded from Kerala, deposited at Herbarium of University of Calicut (CALI), KFRI Herbarium (KFRI MF), Forest Research Institute (FRI) (by Leelavathy & Ganesh 2000; Mohanan 2011), and College of Forestry, Kerala Agricultural University (Iqbal *et al.* 2016; Adarsh *et al.* 2019; Kiran *et al.* 2020). Since, the voucher specimens of many of the species previously recorded from Kerala, were not available for taxonomic verification, from the field and even in Herbaria, they could not be included in this study. However, the voucher specimens of the species deposited as "*Lentinus bambusinus*" by Kumar & Manimohan (2005) were available from the Calicut University Herbarium. Those Herbarium specimens (AK61c, AK61d, AK61e) were restudied. *L. bambusinus* is a species characterized by presence of cheilocystidia, conspicuous gloeocystidia, and absence of skeleto ligative hyphae and hyphal pegs. According to the latest concepts of Lentinoid fungi (Drechsler-Santos *et al.* 2012; Seelan *et al.* 2015; Senthilarasu 2015), genus *Lentinus* is characterized by presence of skeleto ligative hyphae, hyphal pegs, and absence of gloeocystidia or thick walled metuloids, whereas the genus *Panus* lacks skeleto ligative hyphae and hyphal pegs, but possesses gloeocystidia or metuloids. Thus, the combination of characters such as presence of gloeocystidia, and absence of hyphal pegs and skeleto ligative hyphae, fits the epithet "*bambusinus*" within the genus *Panus*, than in the genus *Lentinus*. Thus, in the present study, the species is treated under the genus *Panus*. Since nobody has formally changed the combination of *L. bambusinus* to *Panus, P. bambusinus* (T.K.A Kumar & Manim.) N. Vinjusha & T.K.A Kumar *comb. nov.* is proposed in the study.

5.1. PURE CULTURE ESTABLISHMENT

As part of efforts of conservation of polyporoid fungi of Kerala, attempts were made to isolate pure cultures from collected fruit bodies. The study generated pure cultures of 32 species, and the live cultures have been catalogued and maintained in refrigerator, in the Mycology laboratory of the Zamorin's Guruvayurappan College. This includes cultures of some polypores, which were newly recorded from Kerala during the present study. The cultures serve as live specimen source for future studies and applications, and contribute to the effort at *in vitro* conserving the economically important group.

Frequent contamination was the major problem that was encountered during culture isolation. Difficulty to obtain young fruit bodies with actively growing hyphae, and lack of propagules for growing in culture also contributed to the low number of culture isolations.

5.2 MOLECULAR CHARACTERIZATION

The study generated 34 DNA sequences (TABLE 7) representing 27 species documented here. Although attempts were made to isolate DNA from all fruit bodies, collected from Kerala, DNA extraction failed in most cases. In some cases, the extracted DNA was not amplified in PCR. All the 34 sequences generated from the study were subjected to BLAST (Basic Local Alignment Search Tool) search, for finding identical sequences in the GenBank. BLAST Search was found very helpful in the accurate identification of many tropical species, especially those of genus *Ganoderma,* in which several species misidentifications still exists.

During the study, a polypore that resembled a species of the genus *Polyporus* was encountered. The morphological characters of the collection were matching with that of *P. udus* (currently *Bresadolia uda*). However, according to the publically accepted taxonomic descriptions of *P. udus* (by Ryvarden & Johansen 1980; Corner 1983; Núñez & Ryvarden 2001), basidiospores were hyaline in colour. Although, size and shape of basidiospores were properly matching with the descriptions of *Bresadolia uda* (=*P. udus*), present Kerala collection produced some golden yellow coloured basidiospores, along with hyaline ones. Thus the identity of the collection was doubted for a while. However, the DNA sequence generated from the Kerala collection showed 99% similarity with accessions of *B. uda* available in the GenBank. Thus, the DNA sequence was very much helpful in confirming the identity of present collection as *B. uda*.

Hymenochaete boddingii is a stipitate species of *Hymenochaete* recently described from India (Rossi *et al.* 2020). The Kerala collection of this species was also encountered recently in a manmade forest, but before the formal publication of the taxa as *H. boddingii*. Morphology of the Kerala collection was well agreeing with the concept of the genus *Hymenochaete*. However, it differed from the other two stipitate species (*H. damicornis*, *H. reniformis*) known in the genus. Thus, the collection was considered as novel species of *Hymenochaete,* and was subjected to molecular study. By that time, *H. boddingii* was formally published by Rossi *et al.* (2020) with DNA sequences deposited in GenBank. BLAST search result using the sequence generated confirmed the identity of the Kerala collection as *H. boddingii*, with significant percentage of similarity (95).

Some of the polypores collected in the study could not be properly placed to species level based on morphological characters alone, using the available taxonomic keys. In such cases, molecular characterization was employed. DNA sequences generated from the fruit bodies helped in the accurate identification of those Kerala collections.

5.3. PHYLOGENETIC ANALYSIS

5.3.1. PHYLOGENETIC ANALYSIS OF *GANODERMA* SPECIES OF KERALA

Most of the *Ganoderma* species collected during the present study were similar in many morphological features, having a laccate and shiny pileus, similar hyphal characters, and some with even similar basidiospore shapes. However, there were distinctions in the features of pileipellis cells of some *Ganoderma* collections. Characteristics of pileipellis cells have been currently considered as a significant character for species level identification of *Ganoderma* (Torress-Torress & Guzmán-Devalos 2012; Torres-Torres *et al.* 2012). The proper identification of *Ganoderma* species of Kerala was difficult based on morphological characterization alone. This prompted the present study to generate molecular sequences of selected *Ganoderma* collections. The newly generated sequences were subjected to BLAST analysis. BLAST results and subsequent phylogenetic characterization, revealed that many morphologically similar collections of *Ganoderma*, inreality represents distinct species.

Phylogeny of the genus *Ganoderma* of Kerala was inferred using the Maximum Likelihood analysis of ITS sequence data matrix. A phylogenetic tree was generated based on this analysis, which shows the relative placement of Kerala collections of *Ganoderma* with other closely related *Ganoderma* species (FIGURE 133). In the phylogenetic tree, all *Ganoderma* accessions of the present study (excluding *G. keralense sp. nov*. proposed in the study, and species of *G. applanatum-australe* complex) claded along with accessions of the same species, mostly from tropical countries like China and Malaysia. These clades also showed moderate to good bootstrap support. In general, clades containing species belonging to *G. lucidum* complex and clades containing species of *G. applanatum* complex were alternatively positioned in the phylogenetic tree.

Among species of *Ganoderma*, *G. lucidum* and *G. multipileum* are two widely misidentified taxa (Wang *et al.* 2009). *G. lucidum* has a European origin (United Kingdom) and *G. multipileum* has an Asian origin (Taiwan) (Wang *et al.* 2009). *G. lucidum* is known to be reported worldwide (Ryvarden & Johansen 1980;

Bazzalo & Wright 1982; Ryvarden & Gilbertson 1993; Núñez & Ryvarden 2000; Zhao & Zhang 2000). However, Corner (1983) and Moncalvo *et al.* (1995) doubted the occurrence of typical *Ganoderma lucidum* in tropical Asia. In spite of this, '*Ganoderma lucidum*' has been frequently reported from India based on basidiocarp morphology, cultural characters and pathology (Bagchee *et al.* 1954; Bakshi 1971; Banerjee & Sarkar 1956; Sarkar & Anjali 1969; Thind *et al.* 1957; Bhaskaran *et al*. 1996; Roy & De 1996; Sharma 2000; Karthikeyan & Bhaskaran 2001; Naik 2001; Sankaran *et al*. 2005; Srinivasulu *et al*. 2008; Verma *et al.* 2008; Bhosle *et al*. 2010; Ranadive *et al.* 2011; Arulpandi & Kalaichelvan 2013; Prasher & Lalita 2013). *G. lucidum* was also reported from Kerala by Leelavathy & Ganesh (2000) and Mohanan (2011). However, in the phylogenetic analysis of *Ganoderma* species by Wang *et al.* (2009), the Indian isolates of '*G. lucidum*' (GenBank numbers: X87351/X87361 and EU021459) claded together with the tropical *G. multipileum*, and settled away from the true European *G. lucidum*. According to Wang *et al.* (2009), morphology of basidiocarps cultivated from pure cultures of Indian "*G. lucidum*" was very much similar with that of *G. multipileum*. Wang *et al.* (2009) also opined that the affinity shown by Indian '*G. lucidum*' to Leguminosae plants according to Sanakaran *et al.* (2005), were also a characteristic of *G. multipileum*. Therefore, based on Wang *et al.* (2009), the Indian *G. lucidum* actually belongs to *G. multipileum*. Recently, in a phylogenetic study on *Ganoderma*, Malarvizhi (2014) opined that all the identification studies on *Ganoderma* species in India are solely based on macroscopic, microscopic, and cultural characters of the basidiomata, without using molecular techniques. And, this has resulted in misidentification of many *Ganoderma* species, especially in the case of *G. lucidum*, *G. australe* and *G. applanatum*.

During the present study, some *Ganoderma* collections were obtained, whose morphological characters were matching with the available descriptions of *G. lucidum* from Kerala (Leelavathy & Ganesh 2000; Mohanan 2011). Of the specimens collected during the present study, three fruit bodies yielded DNA sequences, and were used in the phylogenetic analysis. In the phylogenetic tree (FIGURE 133) all the three accessions generated from the present collections

(MT765061, MT765065, MT765063) settled near to *G. multipileum* accessions, and were distinct from the European *G. lucidum* (Z37096/Z37073), which corroborates the study of Wang *et al.* (2009). Accessions of the two Indian isolates (X87351/X87361 and EU021459), mentioned by Wang *et al.* (2009) was also used in the present phylogenetic analysis, and these also clustered near to accessions of *G. multipileum*. The study suspects that the *Ganoderma* collections from Kerala identified as *G. lucidum* by various workers, in reality belongs to *G. multipileum.*

Ganoderma subresinosum of present study claded with the accession of *G. subresinosum* from China (MH537850), with 99% bootstrap support. In the phylogenetic tree, *G. mbrekobenum* (NR147647) from Ghana (Africa) settled near to Kerala collection of *G. subresinosum*. Morphologically, *G. mbrekobenum* is distinguished from Kerala collection by having brownish context, and much smaller basidiospores (8–11.5 × 6–8 µm) (according to the description by Otto *et al.* 2016). *G. subresinosum* is mainly a tropical species. This species has been recorded from China, Indonesia, Philippines, Eastern and Central Africa, West Africa, Malaysia, Myanmar, India, Sri Lanka, Borneo Island and Laos (Tai 1979; Teng 1996; Zhao 1989; Zhao & Zhang 2000; Hapuarachchi *et al.* 2019). A taxon named "*Ganoderma colossus*" has been previously recorded from Kerala by Mohanan (2011). A *Ganoderma* collection whose morphological characters agreed well with the taxonomic description by Mohanan (2011) was collected during the present study. The macrophotograph of the species provided in Mohanan (2011) was also exactly the same as that of present collections. Thus, the present Kerala collection was initially thought to be *G. colossus*. However, molecular characterization revealed that the present collection belongs to *G. subresinosum*. The BLAST result using the newly generated ITS sequence showed 100% similarity with sequences of *G. subresinosum*, available in GenBank, and showed no similarity with *G. colossus*. Reexamination of characters in detail showed that morphology of *G. colossus* was distinct from that of present collection. So, it is believed that the previous record of *G. colossus* from Kerala by Mohanan (2011) is a misidentification, and in reality those collections belonged to *G. subresinosum*.

Kerala collection of *G. tropicum* clustered along with *G. tropicum* from China (JQ781880, MG279194, KF495000) with 84% bootstrap support. *G. tropicum* also is a tropical species having distribution in including in mainland China (Cao *et al.* 2012; Wang *et al.* 2012; Hapuarachchi *et al.* 2018a), South America (Gottlieb & Wright 1999), and Taiwan (Wang *et al.* 2009). *G. multiplicatum* of present study claded with *G. multiplicatum* from Brazil (KU569553, MG279185, JX310823) with 64% bootstrap support. *G. multiplicatum* is mainly a South American species (Gottlieb & Wright 1999; Ryvarden 2004; Drechsler-Santos *et al.* 2008; Gomes-Silva & Gibertoni 2009; Gugliotta *et al.* 2011; Torres-Torres *et al.* 2012). Although a South American species, *G. multiplicatum* has been previously recorded from Africa, and in Asian countries including India and China (Steyaert 1980; Zhao 1989; Bhosle *et al.* 2010, Wang & Wu 2007; Bolaños *et al.* 2016).

In the phylogenetic tree (Figure 133), Kerala collection of *G. enigmaticum* recorded during the present study clustered along with accessions of *G.enigmaticum* from South Africa (NR132918, KU572486, KU572487), with 95% bootstrap support. In the tree, *G. thailandicum* settled near to present collection of *G. enigmaticum* as a sister lineage. However, morphologically, the former is separted from the latter in having smaller basidiospores ((5.8) 6.5–7.33 (7.7) × (6.8.) 8.4–9.7 (10.2) µm, according to the description of Luangharn *et al*. 2019). The clustering of *G. enigmaticum* and *G. thailandicum* as sister clades agrees with the previous molecular study on *Ganoderma* species by Luangharn *et al*. (2019).

Kerala collection of *G. australe* settled along with an accession of *G. australe* from Malaysia (LC084748) with 78% bootsrap support, distinct from the morphologically similar species, *G. applanatum*. However, in the tree, the clade containing Kerala collection of *G. australe*, and the *G. australe* from Malaysia clustered distinctly from *G. australe* accessions from Britain (AY884183) and Taiwan (AF255106/7). Present collection of *G. orbiforme* settled with an accession of *G. orbiforme* (JX997990) from Malaysia, with 83% bootstrap support. In the phylogenetic tree, species such as *G. miniatocinctum*, *G. boninense*, *G. ryvardenii*, and *G. zonatum* formed the sister clade with *G. orbiforme*.

Kerala collection of *G. multicornum* settled near to *G. australe* accession from Malaysia (LC084748) and *G. nasalanense* from Laos (MK345442). *G. australe* easily distinguished from the present collection by having non laccate pileus. Similarly, *G. nasalanense* is morphologically differentiated from present collection by having smaller basidiospores ((6.6) 8.6–9.5–10.4 (10.7) × (4.4) 4.9–5.5–6.1 (6.7)) and absence of antler like branched pileal end cells (according to the original description of *G. nasalanense* by Hapuarachchi *et al.* (2019). *G. multicorum* has been previously reported from India (Ranadive & Jagtap 2016). So far, no DNA sequences of *G. multicornum* are available in the GenBank or any other nucleotide database to compare with. Morphologically, *G. orbiforme* is the closest relative of *G. multicornum* (Ryvarden 2000b). However, *G. orbiforme* accessions used in the analysis settled in a separate clade from *G. multicornum*. Additional sampling and sequencing are required to resolve the phylogenetic relationship of this taxa.

In the phylogenetic tree, most of the Kerala collections of *Ganoderma* were closely related to the respective species in the tropical countries, mainly from China and Malaysia, than those from temperate countries. It is evident that the clustering of *Ganoderma* species are mostly correlated with their geographic origin.

5.3.2. Phylogenetic analysis of *Ganoderma* species associated with stem rot disease of coconut in Kerala

Ganoderma species were frequently encountered in many collection localities, especially on living or dead coconut palms. During the study, two types of *Ganoderma* fruit bodies that could be distinguished macroscopically were consistently found associated with diseased coconut palms in a field. Disease symptoms observed in the infected coconut plantations in Kerala were similar to those of earlier *Ganoderma* rot reports from India (Bhaskaran *et al*. 1996; Harrison & Jones 2003; Kandan *et al*. 2010; Snehalatharani *et al*. 2016; Thamban *et al*. 2016). One of the fruit bodies collected was with a laccate pileus and the other one was non laccate indicating the former’s affinity to the *Ganoderma lucidum* complex and the latter’s to the *G. applanatum* complex.

The molecular analyses (MP, ML, and Bayesian) generated trees that were indicative of the relative placement of *Ganoderma keralense sp. nov.* with other closely related *Ganoderma* species (Figure 135). Majority of the clades in all phylogenetic trees generated from the analyses were well supported. In all trees, *Ganoderma keralense sp. nov.* clustered as a distinct taxon, along with *G. angustisporum*, with good bootstrap support values in the ML analyses (93), MP analyses support values (86%) and Bayesian posterior probability values (1). The clade containing *G. keralense* was distinct from the clades containing morphologically similar species, *G. lucidum*, *G. boninense* and *G. zonatum*. In the tree, palm associated taxa of *Ganoderma* laccate complex, *G. boninense*, *G. ryvardenii*, *G. zonatum* (except *G. lucidum*), and *G. keralense* settled together (represented by "triangle" in the tree), indicating the close relationship of these species.

The phylogenetic tree (Figure 135) also shows the placement of present non laccate specimen (voucher number CAL1547), in relation to other closely related species in the *G. applanatum-australe* species complex (of Moncalvo & Buchanan 2008). In the tree, our collection clustered along with a taxon named as "*G. applanatum*" from Sri Lanka (voucher number-UOC BIB MB13, GenBank number: KR867655). However, our collection and the Sri Lankan material settled as distinct phylogenetic lineage from the *G. applanatum* accessions from Europe, which is the type locality of *G. applanatum* (Niemelä & Miettinen 2008). *G. applanatum* has also been considered as a widely misapplied name among the species of *Ganoderma* (Steyaert 1975a; Niemelä & Miettinen 2008; Demoulin 2010). For resolving nomenclatural problems associated with the species, Redhead *et al.* (2006) had designated a neotype for *G. applanatum* (as *Polyporus fomentarius* Fr. var. *applanatus*, Naturalis Biodiversity Centre, formerly Leiden University (L), "L0009227", from an unknown locality). However, the reliability or accessibility of this material is doubted, since many of the recent molecular phylogenetic studies on *Ganoderma* and related genera, seem to ignore data from the neotype (Moncalvo & Buchanan 2008; Costa-Rezende *et al*. 2017; Jargalmaa *et al.* 2017). In Moncalvo & Buchanan (2008), species belonging to *G. applanatum-australe* complex settled among eight groups/clades, based on different geographical areas such as, one Southern Hemisphere clade, one Southern Hemisphere-Eastern Asia clade, two temperate Northern Hemisphere clades, three Asian clades, and one neotropical clade. Moncalvo & Buchanan (2008) opined that morphological characterization alone was of limited use for separating distinct phylogenetic groups among *G. applanatum-australe* complex, and only the combined occurrence of phylogenetic groups, genetic divergence, and phylogenetic pattern based on geography, helps in the proper identification of species in the complex. According to Jargalmaa *et al.* (2017), only 46 out of 85 ITS sequences of *G. applanatum* available in GenBank database were properly labeled, and the rest were misidentifications. This question the authenticity of the species described as "*G. applanatum*" from Sri Lanka.

In the phylogenetic tree, present collection (CAL1547) settled in a one of the Asian clades of Moncalvo & Buchanan (2008), that includes other accessions of *G. applanatum* complex and *G. australe* complex from tropical countries (Cambodia, China, Thailand, and Singapore), and was phylogenetically distinct. Thus, our study indicates a possible existence of an undescribed non laccate species in Asian countries like Sri Lanka and India, which is close to *G. applanatum* and *G. australe*. This species would have been misidentified as "*G. applanatum*" for long, because of the morphological semblance with the latter. However, since our collection needs additional morphological study (mainly the examination of the neotype of *G. applanatum*, if available or any authentic herbarium materials of the species), and phylogenetic characterization based on multilocus data and broad sampling of similar species, for the time being considers the species from Kerala as species of *G. applanatum-australe* complex.

Collection of specimens of two different species of *Ganoderma* (one laccate and the other non laccate) from infected coconut palms from same plantations may be indicative of the involvement of more than one species in stem decay of coconut in Kerala. Such an involvement of multiple species causing rot of coconut stem is in agreement with earlier reports (Bhaskaran *et al.* 1996; Karthikeyan & Bhaskaran 2001; Elliott & Broschat 2001; Harrison & Jones 2003; Kandan *et al.* 2010;

Sankaran *et al.* 2005; Snehalatharani *et al.* 2016; Thamban *et al.* 2016). In India, *G. applanatum*, *G. boninense,* and *G. lucidum* are generally considered as the causal agents of *Ganoderma* rot of coconut (Bhaskaran *et al.* 1996; Karthikeyan & Bhaskaran 2001; Kandan *et al*. 2010; Thamban *et al.* 2016), and fruit bodies collected from infected coconut palms have always been identified to the above *Ganoderma* species. Harrison & Jones (2003) opined that an unidentified *Ganoderma* species with unknown affinities exist, which is distinct from and is often misidentified to be *G. applanatum*, *G. boninense* or *G. lucidum*. They suspect this unidentified *Ganoderma* species to be the pathogen responsible for rot of coconut palms in Sri Lanka and India.

Morphology of *G. keralense* was almost matching (except a variation in the size of basidiospores) with the taxonomic description of the *Ganoderma* species identified as pathogen of the disease in India by Snehalatharani *et al.* (2016). It is highly possible that earlier collections of *G. keralense* could have been misidentified or remained unrecognized because of their morphological similarities with closely related species like *G. angustisporum*, *G. boninense*, *G. zonatum* and *G. lucidum*. Previously, *G. applanatum*, *G. boninense* and *G. lucidum* were the only *Ganoderma* species known to be associated with stem rot infected coconut palms in India. Based on morphology and molecular phylogenetic analysis, *G. keralensesp. nov*. has been discovered as a cryptic species associated with diseased coconut palms in Kerala. It is also believed that, the non laccate species collected from diseased coconut palms (considered as species of *G. applanatum-australe* complex in this study) also may have some kind of associations with palms (direct or indirect), since similar fruit bodies were previously obtained from both live and dead coconut palms from different localities of Kerala. However, this need not imply a direct pathogenic role for both the *Ganoderma* species. Either one of the species can be pathogenic while the other may be saprobic. It might also be possible that the role is indirect, and both can be secondary invaders.

5.3.3. PHYLOGENETIC ANALYSIS OF *NEOFOMITELLA GUANGXIENSIS*, *SEBIPORA AQUOSA* AND RELATED TAXA

The Maximum Likelihood tree (FIGURE 136) shows the placement of present collections of *N. guangxiensis* and *S. aquosa* among other related taxa of order Polyporales. Two distinct monophyletic groups of Polyporales were recognized in the tree, such as core polyporoid clade, and *Cinereomyces* clade. Phylogenetic tree clearly reveals the identity of our other collection (ZGCVN689) as *N. guangxiensis*. Kerala collection of *N. guanxiensis* settled along with the same species from China (MK192437, MK192434) with 95% bootstrap support in the core polyporoid clade. *Trametes cotonea* formed the sister clade of Kerala collection of *N. guangxiensis*. Morphologically, *T. cotonea* can be separated from our collection by larger basidiospores (7–11 × 2.5–3.5 µm, according to the description of Ryvarden & Johansen 1980). So far, *N. guangxiensis* has been recorded only from its type locality, China. Kerala collection of *S. aquosa* (ZGCVN775) settled along the accessions *S. aquosa* from China (KU376422) and Indonesia (HQ659240, HQ659241, HQ659242, HQ659243), with 98% bootstrap support, in the *Cinereomyces* clade. *Ceriporiopsis subvermispora* formed the sister lineage to this clade, which is in accordance with the previous molecular phylogenetic stidies on this species (Miettinen & Rajchenberg 2012; Zhao *et al.* 2017). Morphologically, *C. subvermispora* is distinguished from present collection by having resupinate fruit bodies, hyphae with swellings, and allantoid, eguttulate basidiospores (according to the taxonomic descriptions of Lowe 1966; Niemelä 1985; Ryvarden & Gilbertson 1993; Miettinen & Rajchenberg 2012). *Ceriporiopsis subvermispora* is typically a North American species according to Miettinen & Rajchenberg (2012). *Sebipora aquosa* has been previously described from Indonesia, New Guinea and China (Miettinen & Rajchenberg 2012; Glen *et al*. 2014; Zhao *et al*. 2017).

5.3.4. PHYLOGENETIC ANALYSIS OF *HYMENOCHAETE BODDINGII*

The phylogenetic tree (FIGURE 137) shows the position of Kerala collection of *H. boddingii* among other closely related species of the genus *Hymenochaete*. Present collection clustered along with accessions of *H. boddingii* (MN030341, MN030343, MN030344) originally described from India (Rossi *et al.* 2020), with 90% bootstrap support. The morphologically related species such as *H. adusta*, *H. attenuata, H. boddingii*, *H. damicornis*, *H. subferruginea*, *H. villosa*, *H. xerantica*, clustered as a single monophyletic clade in the phylogenetic tree. *H. subferrugenia* formed the sister lineage of the Kerala collection. *H. subferrugenia* differs from the present collection in the absence of stipe, and presence of slightly larger (2.8–3.5 × 2–2.5 µm) (according to the description of Dai 2010). The phylogenetic tree also reveals the distinctness of present Kerala collection from other closely related species.

The documentation of 131 species of polyporoid fungi in the present work, that includes many new regional, national and continental records, unravels the species diversity of the group in Kerala State. However, it is still possible that many of the species of polyporoid fungi are still remaining cryptic and undocumented from this biodiversity rich region. Broad taxon sampling, and identification based on combined morphology and molecular data are essential for revealing the true identity of the members of the group in Kerala. Present study provides a significant representation of the tropical species of polypores. The voucher specimens of the taxa documented in the study, and their newly generated molecular sequences may help in future studies of the group in Kerala.

6. SUMMARY

Polyporoid fungi are a specialized group of wood inhabiting fungi. Although, most members of the group generally possess a poroid hymenial configuration, they are regarded as polyphyletic group of organisms having microscopic characters, cultural characters and biology. Polyporoid fungi are well known in forest ecosystems as symbionts and parasites. Some members of the group act as serious pathogens on various trees or palms. Many species of polyporoid fungi, especially those of the genus *Ganoderma* and *Trametes* possesses high medicinal properties. Different species of polypores are reported to have many ethnobotanical uses. Polyporoid fungi play a major role in wood decomposition and nutrient recycling of an ecosystem. Because of the presence of different cellulolytic and lignolytic enzymes, polypores are used as facilitators in various industrial processes like, clearing various industrial effluents, oil containing crop wastes, degradation of polycyclic aromatic hydrocarbons and decolourization of synthetic dyes.

Kerala State has rich diversity of polyporoid fungi, as evident from the published systematic works (Rangaswamy *et al.* 1970; Ganesh & Leelavathy 1986; Ganesh *et al.* 1988; Sankaran & Florence 1995; Roy & De 1996; Leelavathy & Ganesh 2000; Florence & Yesodharan 2000; Manimohan *et al.* 2004; Kumar & Manimohan 2005; Pradeep & Vrinda 2007; Mohanan 2011; Farook *et. al*. 2013; Iqbal *et al*. 2016; Adarsh *et al.* 2019, and Kiran *et al.* 2020). However, all the previous documentary studies on polyporoid fungi from Kerala are based on identifications using morphological characters alone. Molecular characterization has not been carried out in any of these previous studies on polypores. Also, the earlier works do not treat taxa according to the latest phylogenetic concepts in polyporoid taxonomy. This warranted a detailed revisionary study on polyporoid fungi of Kerala, incorporating morphological and molecular methods.

The objectives of the study were: 1. To prepare a comprehensive mycobiota of the polyporoid fungi (Agaricomycetes, Basidiomycota) of Kerala State; 2. To elucidate the phylogenetic relationships of the documented taxa.

Conventional morphology based techniques were employed for preparing descriptive taxonomic account. Macroscopic and microscopic characters were noted. Light microscopic techniques were used to study the taxonomically important structures of collected polypore specimens in detail. All examined materials were properly dried, packed, labeled and maintained in the Zamorin's Guruvayurappan College Herbarium (ZGC). A part of the collections were also deposited in the Central National Herbarium (CAL), Botanical Survey of India, Kolkata. Pure cultures were established from basidiocarps of polypore collections whenever possible. All the pure cultures obtained have been catalogued and maintained in refrigerator, in the Mycology laboratory of the Zamorin's Guruvayurappan College.

Molecular characterization was done for species with taxonomic ambiguities, and for those collections that lacked taxonomically important morphological characters. Morphological characters obtained from such species were combined with molecular characters for confirming taxonomic identities and for generating phylogenies. For DNA extraction, NucleoSpin® Plant II kit (Macherey-Nagel 2014) and CHROMOUS bacterial genomic DNA isolation kit (www.chromous.com) were used. For some collections, DNA was extracted according to the protocol described by Izumitsu *et al*. (2012). Three gene regions such as ITS, LSU, and RPB2 of selected specimens were amplified using GeneAmp PCR System. The newly generated sequences were deposited in the GenBank database and EMBL-EBI database. Sequence similarity assessments were conducted using BLAST search in NCBI's GenBank nucleotide database. The phylogenetic software MEGA X64 was used for aligning sequences of all data matrices, and generating phylogenetic trees. Maximum Likelihood (ML) analysis was conducted for studying the phylogeny of *Ganoderma* species of Kerala, and other selected taxa. In addition to ML analysis, Maximum Parsimony (MP) method (in PAUP 4.0d90) and Bayesian analysis (in MrBayes 3.1.2.) were also used for studying the phylogeny of newly newly proposed *Ganoderma* species. All aligned sequence data matrices have been deposited in TreeBase software.

Two species new to science were discovered during the study, and are described. *Ganoderma keralense* N. Vinjusha & T.K.A. Kumar, and a *Ganoderma* species belonging to the *applanatum-australe* complex are the two hitherto undescribed species. Proposal of a new taxonomic combination (*Panus bambusinus* (T.K.A. Kumar & Manim.) Vinjusha & T.K.A. Kumar) is an outcome of this study. Three species (*Fomitopsis caribensis*, *Phylloporia gabonensis*, *Theleporus venezuelicus*) collected from Kerala during the study were found to be new records to Asia. Three genera (*Pappia*, *Rubellofomes*, *Sebipora*) and 21 species were new records to India. The study also resulted in the documentation of 10 genera (*Bresadolia*, *Cotylidia*, *Pappia*, *Phlebia*, *Phlebiopsis*, *Rubellofomes*, *Sebipora*, *Spongiporus*, *Terana*, *Theleporus*), and 47 species as new records to Kerala.

Pure cultures of 32 polyporoid species collected from Kerala (including new species records) were established during the study. These pure cultures growing on suitable growth media are maintained according to short-term low temperature storage method. The cultures serve as live specimen source for future studies and applications, and contribute to the effort at *in vitro* conserving the economically important group.

The study generated 34 DNA sequences representing 27 species of polyporoid fungi of Kerala. As a result, DNA barcodes are now available for these species. Molecular analyses with these newly generated sequences and additional publicly available sequences generated phylogenetic trees for Kerala species of *Ganoderma*, and for other selected taxa. Phylogenetic trees that resulted from such analyses helped in resolving the evolutionary affinities, and taxonomic identities of many *Ganoderma* collections. Molecular phylogenetic analyses were also conducted to determine the relative placement and identities of species belonging to *Sebipora*, *Neofomitella*, and *Hymenochaete*. Molecular analyses supported the morphology-based placement of most of the taxa documented in the present study.

The study has also resulted in the taxonomic revision of *Ganoderma* species, associated with stem rot disease of coconut palms in India. *G. keralense* has been discovered as a cryptic species associated with diseased coconut palms in Kerala.

Previously, *G. applanatum*, *G. boninense* and *G. lucidum* were the only *Ganoderma* species known to be associated with stem rot infected coconut palms in India. Another *Ganoderma* species misidentified as *G. applanatum* for long was found out in this study to be yet another new species.

Present study forms the first effort to document the polyporoid fungi of Kerala using combined morphological and molecular characterization, and is a taxonomic revision of the polyporoid fungi recorded from Kerala so far. It updates the status of knowledge of the group in Kerala, and incorporates the latest phylogenetic concepts in polyporoid taxonomy. The study is also an effort to DNA barcode the group in Kerala. Phylogenetic relationships of many enigmatic taxa were elucidated. The work represents a detailed systematic account of the polyporoid fungi of Kerala.

7. REFERENCES

Abadulla E, Tzanov T, Costa S, Robra KH, Cavaco-Paulo A, Gübitz GM (2000). Decolorization and detoxification of textile dyes with a laccase from *Trametes hirsuta*. Applied Environmental Microbiology 66: 3357–62. DOI: 10.1128/AEM.66.8.3357-3362.2000.

Abraham J, Silambarasan S, Chauhan R. (2012). https://www.ncbi.nlm.nih.gov/nuccore/JQ746682.1

Abrahão MC, Gugliotta AM, Bononi VLR (2012). Xylophilous Agaricomycetes (Basidiomycota) of the Brazilian Cerrado. Check List 8: 1102–1116.

Adanson M (1763). *Familles des plantes*. Vol. 2. Fungi Sect V. Paris: Chez Vincent, 675 p.

Adarsh CK, Vidyasagran K, Ganesh PN (2018). A checklist of polypores of Kerala state, India. Studies in Fungi 3: 202–226. DOI: 10.5943/sif/3/1/21.

Adarsh CK, Vidyasagaran K, Ganesh PN (2019). The diversity and distribution of polypores (Basidiomycota: Aphyllophorales) in wet evergreen and shola forests of Silent Valley National Park, southern Western Ghats, India, with three new records. Journal of Threatened Taxa 11: 13886–13909. DOI: 0.11609/jott.3856.11.7.13886-13909.

Adarsh CK, Kumar V, Vidyasagaran K, Ganesh PN (2015). Decomposition of wood by polypore fungi in tropics-biological, ecological and environmental factors-A case study. Research Journal of Agriculture and Forestry Sciences 3: 15–37.

Adaskaveg J, Gilbertson R (1988). Basidiospores, pilocystidia, and other basidiocarp characters in several species of the *Ganoderma lucidum* Complex. Mycologia 80: 493–507. DOI: 10.1080/00275514.1988.12025571.

Adaskaveg JE, Blanchette RA, Gilbertson RL (1991). Decay of date palm wood by white–rot and brown–rot fungi. Canadian Journal of Botany 69: 615–629. DOI: 10.1139/b91-083.

Adebajo SO, Balogun SA, Akintokun AK (2017). Decolourization of Vat dyes by bacterial isolates recovered from local textile mills in southwest, Nigeria. Microbiology Research Journal International 18: 1–8. DOI: 10.9734/MRJI/2017/29656.

Adenipekun CO, Lawal R (2012). Uses of mushrooms in bioremediation: A Review. Biotechnology and Molecular Biology Review 7: 62–68. DOI: 10.5897/BMBR12.006.

Adhikari M, Bhusal S, Pandey MR, Raut JK, Bhatt LR (2019). Mycochemical and nutritional analysis of selected wild mushrooms from Gaurishankar Conservation Area, Nepal. International Journal of Pharmacognostic Chinese Medicine 3: 000169. DOI: 10.23880/ipcm-16000169.

Agrawal N, Verma P, Shahi SK (2018). Degradation of polycyclic aromatic hydrocarbons (phenanthrene and pyrene) by the ligninolytic fungi *Ganoderma lucidum* isolated from the hardwood stump. Bioresources and Bioprocessing 5: 9 p. DOI: 10.1186/s40643-018-0197-5.

Agrawal N, Verma P, Singh SR, Shahi SK (2017). Ligninolytic enzyme production by white rot fungi *Podoscypha elegans* Strain FTG4. International Journal of Current Microbiology and Applied Sciences 6: 2757–2764. DOI: 10.20546/ijcmas.2017.605.309 .

Ahti T, Hämet-Ahti L, Jalas J (1968). Vegetation zones and their sections in Northwestern Europe. Annales Botanici Fennici 5: 169–211.

Aime MC, Henkel TW, Ryvarden L (2003). Studies in neotropical polypores 15: new and interesting species from Guyana. Mycologia 95: 614–619. DOI: 10.2307/3761937.

Aime MC, Ryvarden L, Henkel TW (2007). Studies in Neotropical polypores 22: Additional new and rare species from Guyana. Synopsis Fungorum 23, Fungiflora, 130 p.

Ainsworth M (2004). *Hymenochaete carpatica* in Southern England: sites, spores, setae and how to distinguish it from *H. cinnamomea et al.* Field Mycology 5: 5–10. DOI: 10.1016/S1468-1641(10)60229-0.

Ajith TA, Janardhanan KK (2007). Indian medicinal mushrooms as a source of antioxidant and antitumor agents. Journal of Clinical Biochemistry and Nutrition 40: 157–162. DOI: 10.3164/jcbn.40.157.

Ajith TA, Janardhanan KK (2015). Medicinal mushroom cracked-cap polypore, *Phellinus rimosus* (Higher Basidiomycetes) attenuates acute ethanol-induced lipid peroxidation in Mice. International Journal of Medicinal Mushrooms 17: 1061–1068. DOI: 10.1615/intjmedmushrooms.v17.i11.60.

Ajith TA, Sudheesh NP, Roshny D, Abishek G, Janardhanan KK (2009). Effect of *Ganoderma lucidum* on the activities of mitochondrial dehydrogenases and complex I and II of electron transport chain in the brain of aged rats. Experimental Gerontology 44: 219–23. DOI: 10.1016/j.exger.2008.11.002.

Akash D, Earanna N, Subramanya S (2017). Mushroom diversity in the Biligiri rangana hills of Karnataka (India). Journal of Applied and Natural Science 9: 1381–1387.

Alaoui SM, Merzouki M, Penninckx MJ, Benlemlih M (2008). Relationship between cultivation mode of white rot fungi and their efficiency for olive oil mill wastewaters treatment. Electronic Journal of Biotechnology 11: 1–8. DOI: 10.4067/S0717-34582008000400013.

Alexander J, Welden AL, Ovebro CL (1989). *Trichaptum sector* (Ehrenb.:Fr.) Kreisel (Polypooraceae s.l.). Mycologia Helvetica 3: 291–302.

Alexopoulos CJ, Mims CW, Blackwell M (1996). Phylum Basidiomycota order Aphyllophorales, polypores, Chantharelles, tooth fungi, coral fungi and corticioids. In: Harris D (ed) Introductory Mycology, 4th edn. New York, USA, Wiley and sons Inc, 563–597 p.

Alexandropoulou M, Antonopoulou G, Ntaikou I, Lyberatos G (2015). Using *Leiotrametes menziesii* and *Abortiporus biennis* for biological pretreatment of willow sawdust for enhancing biogas production, 3rd International Conference on Sustainable Solid Waste Management, 2–4 July 2015, Tinos island, Greece, 19 p.

Al-Ghamdi AY (2016). Degradation of some textile industry effluent dyes by *Ganoderma applanatum*. International Journal of Biosciences 9: 144–147. DOI: 10.12692/ijb/9.5.144-147.

Almeida PH, Oliveira ACCD, Souza JPND, Friedrich JC, Linde GA, Colauto NB, And Valle JSD (2018). Decolorization of remazol brilliant blue R with laccase from *Lentinus crinitus* grown in agro-industrial by-products. Anais da Academia Brasileira de Ciências 90: 3463–3473. DOI: 10.1590/0001-3765201820170458.

Almonacid L, Fuentes A, Ortiz J, Salas C, García-Romera I, Ocampo JA, Arriagada C (2015). Effect of mixing soil saprophytic fungi with organic residues on the response *Solanum lycopersicum* to arbuscular mycorrhizal fungi. Soil Use Management 31: 155–164. DOI: 10.1590/0001-3765201820170458.

Alves MJ, Ferreira ICFR, Froufe HJC, Abreu RMV, Martins A, Pintado M (2013). Antimicrobial activity of phenolic compounds identified in wild mushrooms, SAR analysis and docking studies. Journal of Applied Microbiology 115: 346–357. DOI: 10.1111/jam.12196.

Amaral PF, Fernandes DL, Tavares AP, Xavier AB, Cammarota MC, Coutinho JA, Coelho MA (2004). Decolorization of dyes from textile wastewater by *Trametes versicolor*. Environmental Technology 25: 1313–1320. DOI: 10.1080/09593332508618376.

Ambit RT, Mossebo DC (2015). The first African record of *Artolenzites acuta comb. nov*. (Basidiomycota, Polyporaceae). Mycosphere 6: 280–289. DOI: 10.5943/mycosphere/6/3/6.

Ames A (1913). A consideration of structure in relation to genera of Polyporaceae. Annals of Mycology 11: 211–253.

Amoopour M, Ghobad-Nejhad M, Khodaparast SA (2016). *Nové nálezy chorošů pro Írán a checklist chorošů provincie Gilan*. Czech Mycology 68: 139–148.

Aneesh S, Thoppil JE (2019). Study on cytotoxicity and chemical profiling of *Hexagonia tenuis* (Hook.) Fr., a potential bracket fungus (Polyporaceae). International Journal of Pharmacy and Biological Sciences 9: 822–831. DOI: 10.21276/ijpbs.2019.9.3.103.

Ansor NM, Abdullah N, Aminudin N (2013). Anti-angiotensin converting enzyme (ACE) proteins from mycelia of *Ganoderma lucidum* (Curtis) P. Karst. BMC Complementary and Alternative Medicine 13: 8 p. DOI: 10.1186/1472-6882-13-256.

Antonín V, Gruna B, Hradílek Z, Vágner A, Vězda A (2000). Houby, lišejníky a mechorosty národního parku Podyjí [Fungi, lichens and mosses of National Park Podyjí], Brno., 220 p.

Aoshima K, Abe Y (1983). *Echinochaete ruficeps* found in Japan. Proceedings of the 27th annual meeting of the Mycological Society of Japan. Abstracts of submitted papers, 61 p.

Arata S, Watanabe J, Maeda M, Yamamoto M, Matsuhashi H, Mochizuki M, Kagami N, Honda K, Inagakic M (2016). Continuous intake of the Chaga mushroom (*Inonotus obliquus*) aqueous extract suppresses cancer progression and maintains body temperature in mice. Heliyon 2: e00111. DOI: 10.1016/j.heliyon.2016.e00111.

Aravindakshan D, Manimohan P (2015). Mycenas of Kerala. SporePrint Books, Calicut, Kerala, India, 213 p. DOI: 10.13140/RG.2.1.2116.4003.

Archibald F, Bourbonnais R, Jurasek L, Paice M, Reid I (1997). Kraft pulp bleaching and delignification by *Trametes versicolor*. Journal of Biotechnology 53: 215–236.

Arisdason W, Lakshminarasimhan P (2014). Plant diversity of Kerala state- an overview. Central National Herbarium, Botanical Survey of India, Howrah, 4 p.

Ariyawansa HA, Hyde KD, Jayasiri SC, Buyck B, Chethana KWT, Dai DQ, Dai YC, Daranagama DA, Jayawardena RS, Lücking R, Ghobad-Nejhad M, Niskanen T, Thambugala KM, Voigt K, Zhao RL, Li GJ, Doilom M, Boonmee S, Yang ZL, Cai Q, Cui YY, Bahkali AH, Chen J, Cui BK, Chen JJ, Dayarathne MC, Dissanayake AJ, Ekanayaka AH, Hashimoto A, Hongsanan S, Jones EBG, Larsson E, Li WJ, Li QR, Liu JK, Luo ZL, Maharachchikumbura SSN, Mapook A, McKenzie EHC, Norphanphoun C, Konta S, Pang KL, Perera RH, Phookamsak R, Phukhamsakda C, Pinruan U, Randrianjohany E, & Singtripop C, Tanaka K, Tian CM, Tibpromma S, Abdel-Wahab MA, Wanasinghe DN, Wijayawardene NN, Zhang JF, Zhang H, Abdel-Aziz FA, Wedin M, Westberg M, Ammirati JF, Bulgakov TS, Lima DX, Callaghan TM, Callac P, Chang CH, Coca LF, & Forno MD, Dollhofer V, Fliegerová K, Greiner K, Griffith JW, Ho HM, Hofstetter V, Jeewon R, Kang JC, Wen TC, Kirk PM, Kytövuori I, Lawrey JD, Xing J, Li

H, Liu ZY, Liu XZ, Liimatainen K, Lumbsch HT, Matsumura M, Moncada B, Nuankaew S, Parnmen S, Santiago ALCMA, Sommai S, Song Y, Souza CAF, Souza-Motta CM, Su HY, Suetrong S, Wang Y, Wei SF, Wen TC, Yuan HS, Zhou LW, Réblová M, Fournier J, Camporesi E, Luangsa-ard JJ, Tasanathai K, Khonsanit A, Thanakitpipattana D, Somrithipol S, Diederich P, Millanes AM, Common RS, Stadler M, Yan JY, Li XH, Lee HW, Nguyen TTT, Lee HB, Battistin E, Marsico O, Vizzini A, Vila J, Ercole E, Eberhardt U, Simonini G (2015). Fungal diversity notes 111–252 – taxonomic and phylogenetic contributions to fungal taxa. Fungal Diversity 75: 27–274. DOI: 10.1007/s13225-015-0355-4.

Arora D (1986). Mushrooms demystified. 2nd ed. Ten Speed Press, Berkeley, California, 959 p.

Arora DS, Gill PK (2000). Laccase production by some white rot fungi under different nutritional conditions. Bioresource Technology 73: 283–285. World Journal of Microbiology and Biotechnology 21: 1021–1028. DOI: 10.1007/s11274-004-7655-2.

Arora DS, Gill PK (2005). Production of ligninolytic enzymes by *Phlebia Floridensis*. World Journal of Microbiology and Biotechnology 21: 1021–1028. DOI: 10.1007/s11274-004-7655-2.

Arora DS, Rampal P (2002). Laccase production by some *Phlebia* species. Journal of Basic Microbiology 42: 295–301. DOI: 10.1002/1521-4028(200210)42.

Arora DS, Sharma RK (2009). Comparative ligninolytic potential of *Phlebia* species and their role in improvement of *in vitro* digestibility of wheat straw. Journal of Animal and Feed Sciences 18. DOI: 10.22358/jafs/66379/2009.

Arriagada C, Manquel D, Cornejo P, Soto J, Sampedro I, Ocampo JA (2012). Effect of the co-inoculation with saprobe and mycorrhizal fungi on *Vaccinium corymbosum* growth and some soil enzymatic activities. Journal of Soil Science and Plant Nutrition 12: 283–294. DOI: 10.4067/S0718-95162012000200008.

Arulpandi I, Kalaichelvan PT (2013). *Ganoderma adspersum* and *Ganoderma cupreum* from South India, First report based on molecular phylogeny.

International Journal of Current Microbiology and Applied Sciences 2: 693–702.

Arya A (2004). New and interesting records of basidiomycetous fungi from Gujarat, India. In: Vistas in Palaeobotany and Plant Morphology: Evolutionary and Environmental Perspectives, Prof DD Pant Memorial PC. Srivastava (ed) Published by UP Offset, Lucknow, India. 321–327 p.

Arya A, Albert S, Nagadesi PK (2008). New and interesting records of basidiomycetous fungi from Ratanmahal Wildlife Sanctuary, Gujarat, India. Journal of Mycology and Plant Pathology 38: 221–226.

Asan A, Sesli E, Gücin F, Stojehev G (2002). *Myriostoma coliforme* and *Phylloporia ribis* (Basidiomycetes): first reports from European Turkey. Bot. Chron. 15: 45–49.

Atkinson GF (1908). Notes on some new species of fungi from the United States. Annales Mycologici 6: 54–62.

Atri NS, Kumar S, Sharma BM (2010). *Lentinus torulosus* (Pers) Lloyd–a new fungus record from India. Mushroom Research 19: 33–35.

Audet S (2017). Mushrooms nomenclatural novelties 2: 1–1.

Awala SI, Oyetayo VO (2015). *In vitro* antiradical activities of *Trametes elegans* collected from Osengere, Ibadan, Nigeria. International Journal of Biological Chemistry 9: 249–259. DOI: 10.3923/ijbc.2015.249.259.

Awala SI, Oyetayo VO (2016). Assessment of free radical scavenging potentials of extracts of *Trametes lactinea* collected from Akure. Research Journal of Phytochemistry 10: 10–20. DOI: 10.3923/rjphyto.2016.10.20.

Azliza MA, Ong HC, Vikineswary S, Noorlidah A, Haron NW (2012). Ethno-medicinal resources used by the Temuan in Ulu Kuang Village. Studies on Ethno-Medicine 6: 17–22. DOI: 10.1080/09735070.2012.11886415.

Azmi MAAM, Jalil R, Kalil MS (2016). Production of cellulase from *Pycnoporus sanguineus*. Indian Journal of Science and Technology 9: 1–7. DOI: 10.17485/ijst/2016/v9i21/95230.

Badyalan SM, Barkhudaryan A, Rapior S (2019). Recent progress in research on pharmacological potential of mushrooms and prospects for their clinical application. In Agrawal DC & Dhanasekaran, Medicinal Mushrooms: Recent Progress in Research and Development, Springer; 1st ed., 419 p. DOI: 10.1007/978-981-13-6382-5_1.

Bagchee KD (1950). Principal diseases and decays of oaks in India. Indian Phytopathology 3: 124–139.

Bagchee KD (1951). The fungus diseases of Sal (*Shorea robusta* Gaertn.) –I. Indian Forest Records 1: 11–23.

Bagchee K (1954). The fungal disease of Sal (*Shorea robusta* Gaertn. f. & Fils.), Part II, secondary parasites of Sal. Indian Forest Records 8: 97–184.

Bagchee KD (1957). Fungal diseases of Sal (*Shorea robusta* Gaertn.) –III. The root disease of Sal due to *Polyporus shoreae* Wakef. (Partridge Wood rot). Indian Forest Records 1: 185–195.

Bagchee KD (1958). The fungal diseases of Sal (*Shorea robusta* Gaertn.) –V. The heart rot of Sal caused by *Trametes incerta* (Currey) Cooke. Indian Forest Records 2: 61–69.

Bagchee KD (1960). The fungal diseases of Sal (*Shorea robusta* Gaertn.) – II. Secondary parasites of ‘Sal’. Indian Forest Records 1: 97–184.

Bagchee KD (1961). The fungal diseases of Sal (*Shorea robusta* Gaertn.) – IV. *Fomes caryophylli* (Rec.) Bres. A destructive heart rot of ‘Sal’. Indian Forest Records 2: 25–58.

Bagchee KD, Bakshi BK (1950). Some fungi as wound parasites of Indian trees. Indian Forest Recorsd 76: 244–253.

Bagchee KD, Bakshi BK (1951). *Poria monticola* Murr on Chir (*Pinus longifolia* Roxb) in India. Nature (Lond) 167: 824.

Bagchee KD, Singh U (1960). List of common names of fungi attacking Indian forest trees, timber and the herbaceous and shrubby under growths and list of cultures of forest fungi. Indian Forest Records 1: 199–348.

Bagchee KD, Puri YN, Bakshi BK (1954). Principal diseases and decays of oaks and other hardwoods in India-II. Indian Phytopathology 7: 18–42.

Bagley ST, Richter DL (2001). Biodegradation by brown-rot fungi. Chapter 16. In: Osiewacz HD, ed. The Mycota: a comprehensive treatise on fungi as experimental systems and applied research. Vol. X. Industrial Applications. 327–341 p. DOI: 10.1007/978-3-662-10378-4_16.

Bak WC, Lee BH, Park YA, Kim HS (2011). Characteristics of bed-log of shiitake damaged by *Bjerkandera adusta* and antagonism between these two fungi. Korean Journal of Mycology 39: 44–47. DOI: 10.4489/KJM.2011.39.1.044.

Bakshi BK (1955). Diseases and decays of conifers in the Himalayas. Indian Forester 81: 779–797.

Bakshi BK (1956). Occurrence of *Polyporus squamosus* (Huds.) Fr. in India. Indian Phytopathology :191–194.

Bakshi BK (1957). Diseases of Khair (*Acacia catechu* Willd.) and their prevention. Indian Forester 83: 41–46.

Bakshi BK (1958). New records of Hymenomycetes in India. Indian Phytopathology 11: 88

Bakshi BK (1971). Indian Polyporaceae on trees and timber, Indian Council of Agricultural Research, New Delhi, 246 p.

Bakshi BK (1955). Diseases and decays of conifers in the Himalayas. Indian Forestor 81: 779–797.

Bakshi BK, Bagchee K (1950). Principal diseases and decays of oaks in India. Indian Phytopathology 3: 124–139.

Bakshi BK, Boyce JS (1959). *Polyporus shoreae* (root rot) on ‘Sal’. Indian Forester 85: 656–658.

Bakshi BK, Choudhury TG (1961). Sexuality and interfertility studies in *Polyporus abietinus*, *P. pargamenus* and *P. versatilis*. Canadian Journal of Botany 89: 997–999.

Bakshi BK, Singh S (1970). Heart rots in trees. International Journal of Pharmaceutical Sciences Review and Research 3: 197–251.

Bakshi BK, Singh S, Singh B (1963). A re examination of *Fomes lignosus* and *Polyporus zonalis*. Transactions of British Mycological Society 46: 426–430.

Bakshi BK, Singh S, Singh U (1966). A new root rot disease complex in ‘teak’. Indian Forester 92: 566–569.

Bakshi BK, Sehgal HS, Singh B (1969). Cultural diagnosis of Indian Polyporaceae. I. Genus *Polyporus*. Indian Forest Records 2: 205–244.

Bakshi BK, Sen M, Singh B (1970). Cultural diagnosis Indian Polyporaceae—II. Genera *Fomes* and *Trametes*. Indian Forest Records 2: 245–276.

Bal C, Akgül S, Sevindik M, Akata I, Yumrutas O (2017). Determination of the anti-oxidative activities of six mushrooms. Fresenius Environmental Bulletin 26: 6246–6252.

Bala B, Singh AP, Dhingra GS (2020). Additions to the List of Polypores to India. Advances in Zoology and Botany 8: 29–36. DOI: 10.13189/azb.2020.080105.

Balan DSL, Monteiro RTR (2001). Decolorization of textile indigo dye by ligninolytic fungi. Journal of Biotechnology 89: 141–145. DOI: 10.1016/s0168-1656(01)00304-2.

Balandaykin ME, Zmitrovich IV (2015). Review on chaga medicinal mushroom, *Inonotus obliquus* (higher Basidiomycetes): Realm of medicinal applications and approaches on estimating its resource potential. International Journal of Medicinal Mushrooms 17: 95–104. DOI: 10.1615/IntJ Med Mushrooms. v17.i2.10.

Balasubramanian A (2017). Kerala–at a glance. DOI: 10.13140/rg.2.2.19375.43680.

Balasubramanyan K, Induchoodan NC (1996). Plant diversity in sacred groves of Kerala. Evergreen 36: 3–4.

Baldrian P (2004). Purification and characterization of laccase from the white-rot fungus *Daedalea quercina* and decolorization of synthetic dyes by the enzyme. Applied Microbiology and Biotechnology 63: 560–563. DOI: 10.1007/s00253-003-1434-0.

Baltazar JM, Gibertoni TB (2009). A checklist of the aphyllophoroid fungi (Basidiomycota) recorded from the Brazilian Atlantic forest. Mycotaxon 109: 439–442. DOI: 10.5248/109.439.

Baltazar JM, Gibertoni TB (2010). New combinations in *Phellinus s.l.* and *Inonotus s.l.* Mycotaxon 111, 205–208.

Baltazar JM, Borges Da Silveira RM (2012). A new name for a *Coltricia* (Basidiomycota) from India. Mycotaxon 119: 385–389. DOI: 10.5248/119.385.

Baltazar JM, Ryvarden L, Gibertoni TB (2010). The genus *Coltricia* in Brazil: new records and two new species. Mycologia 102: 1253–1262. DOI: 10.3852/09-227.

Baltazar JM, Trierveiler-Pereira L, Loguercio-Leite C, Ryvarden L (2009). Santa Catarina Island mangroves 3: a new species of *Fuscoporia.* Mycologia 101: 859–863. DOI: 10.3852/08-082.

Baltazar JM, Drechsler SER, Ryvarden L, Cavalcanti MAQ, Gibertoni TB (2012). Contribution to the knowledge of polypores (Agaricomycetes) from the Atlantic forest and Caatinga, with new records from Brazil. Mycosphere 3: 267–280. DOI: 10.5943/mycosphere/3/3/1.

Baltazar JM, Pildain MB, Gorjón SP, da Silveira RMB, Rajchenberg M (2014). Phylogenetic relationships of *Hydnum peroxydatum* support the synonymy of *Hydnochaete* with *Hymenochaete* (Hymenochaetaceae, Agaricomycetes). Mycologia 106: 323–327. DOI: 10.3852/13-154.

Balwant S (1961). Occurrence of *Trametes ravida* (Fr.) Pilat in India. Indian Forester 87: 429–430.

Balwant S (1966). Studies on Indian *Poria*. II - Diagnoses of five species as new records. Ibid. 92: 680–683.

Balwant S (1966a). Timber decay due to five species of *Fomes* as new records in India. Ibid 92: 653–655.

Balwant S, Bakshi BK (1961). New records of *Fomes* from India. Ibid 87: 302–303.

Bandara A, Rapior S, Bhat Jayarama, Kakumyan P, Chamyuang S, Xu J, Hyde KD (2015). *Polyporus umbellatus*, an edible-medicinal cultivated mushroom with multiple developed health-care products as food, medicine and cosmetics: A review. Cryptogamie Mycologie 36: 3–42. DOI: 10.7872/crym.v36.iss1.2015.3.

Banerjee SN (1935). Thelephoraceae of Bengal. Journal of Indian Botanical Society 14: 13–48.

Banerjee SN (1935a). A historical account of the classification of Thelephoraceae. Scientific Culture 1: 314–317.

Banerjee SN (1946). Some higher fungi of Sikkim-Himalayas. Scientific Culture 11: 444–445.

Banerjee SN (1947). Fungus Flora of Calcutta and suburbs-I. Bulletin of the Botanical Society of Bengal 1: 37–54.

Banerjee SN, Chakravarthy M (1945). On the biology of *Polyporus agaricus* Berk, Proceedings of 32nd Indian Science Congress, Nagpur, 69.

Banerjee SN, Chatterjee SB (1945). Some observations on the identity of *Amaurodema rugosum* Nees, a rare species in Bengal. Proceedings of 32nd Indian Science Congress, Nagpur, 68.

Banerjee SN, Chatterjee SB (1945a). A note on the hyphal systems of the sporophores of *Amaurodema rugosum* Nees, Proceedings of 32nd Indian Science Congress, Nagpur, 68.

Banerjee SN, Chatterjee SB (1945b). Studies on "white rot" and "brown rot". Proceedings of 32nd Indian Science Congress, Nagpur, 68.

Banerjee SN, Ghosh T (1945). On the collection of Hymenomycetous fungi from the Sikkim-Himalayas, Proceedings of of 32nd Indian Science Congress, Nagpur, 69.

Banerjee SN, Bakshi BK (1954). Principal diseases and decays of oaks and other hardwoods in India-II. Indian Phytopathology 7: 18–42.

Banerjee SN, Anjali S (1956). Formation of sporophores of *Ganoderma lucidum* (Curtis) P. Karst. and *G. applanatum* (Pers.) Pat. in culture. Indian Journal of Mycological Research 2: 80–82.

Banerjee S, Sarkar A (1956). Formation of sporophores of *Ganoderma lucidum* (Leyss.) Karst. and *Ganoderma applanatum* (Pers.) Pat. in culture. Indian Journal of Mycological Research 2: 80–82.

Bang HT, Suhara H, Doi K, Ishikawa H, Fukami K, Parajuli GP, Katakura Y, Yamashita S, Watanabe K, Adhikari MK, Manandhar HK, Kondo R, Shimizu K (2014). Wild mushrooms in Nepal: Some potential candidates as antioxidant and ACE-Inhibition Sources. Evidence Based Complementary Alternative Medicine 2014: 195305. DOI: 10.1155/2014/195305.

Banik MT, Lindner DL, Santana BO, Lodge DJ (2012). A new species of *Laetiporus* (Basidiomycota, Polyporales) from the Caribbean basin. Kurtziana 37: 15–21.

Barros AB, Ferrão J, Fernandes T. A safety assessment of *Coriolus versicolor* biomass as a food supplement (2016). Food and Nutrition Research 60: 29953. DOI: 10.3402/fnr.v60.29953.

Barsukova TN (1998). Xylotrophic basidiomycetes of Altai state reserve. Mikologiya ifitopatologiya 32: 11–17 (in Russian).

Bayramoglu G, Celik G, Arica Y (2006). Studies on accumulation of Uranium by fungus *Lentinus sajor-caju*. Journal of Hazardous Materials 136: 345–53. DOI: 10.1016/j.jhazmat.2005.12.027.

Baxter DV (1940). Some resupinate polypores from the region of the Great Lakes. XI. Papers of the Michigan Academy of Sciences Part 1. 25: 145–170.

Bazzalo ME, Wright JE (1982). Survey of the Argentine species of the *Ganoderma lucidum* complex. Mycotaxon. 16: 293–325.

Beauvois P (1805). Fl. *Oware Benin* 1: 12.

Bendiksen E, Høiland K, Brandrud TE, Jordal JB (1998). Red list of threatened fungi in Norway. http://nhm2.uio.no/botanisk/sopp/redintro_gammel.htm. (accessed on 03 March November 2020).

Benson DA, Mizrachi IK, Lipman DJ, Ostell J, Sayers EW (2011). GenBank. Nucleic Acids Research 39: D32–7. DOI: 10.1093/nar/gkq1079.

Berkeley MJ (1839). Description of exotic fungi in the collection of Sir WJ Hooker, from memoirs and notes of JK Klotzsch, with additions and corrections. Annals of Natural History 3: 375–401.

Berkeley MJ (1845). Decades of fungi. Decades VIII-X. Australian and North American fungi. London Journal of Botany. 4: 298–315.

Berkeley MJ (1847). Decades XV-XIX. Ceylon fungi. London Journal of Botany 6: 479–514.

Berkeley MJ (1850). Decades of fungi. Decades XXV to XXX. Sikkim Himalaya fungi, collected by Dr JD Hooker. Hooker's Journal of Botany and Kew Garden Miscellany 2: 76–88.

Berkeley MJ (1851). Decades XXXII-XXXIII. Sikkim-Himalayan Fungi, collected by Dr JD Hooker. Hooker's Journal of Botany and Kew Garden Miscellany 3: 39–49.

Berkeley MJ (1851a). Decade XXXIV. Sikkim-Himalayan Fungi, collected by Dr Hooker. Hooker's Journal of botany and Kew Garden Miscellany 3: 77–84.

Berkeley MJ (1851b). Decade XXXV. Sikkim-Himalayan Fungi, collected by Dr Hooker. Hooker's Journal of Botany and Kew Garden Miscellany 3: 167–172.

Berkeley MJ (1851c). Decade XXXVI. Sikkim-Himalayan Fungi, collected by Dr Hooker. Hooker’s Journal of Botany and Kew Garden Miscellany 3: 200–206.

Berkeley MJ (1852). Decades XXXVII, XXXVIII. Sikkim and Khassya fungi. Journal of Botany and Kew Garden Miscellany 4: 97–107.

Berkeley MJ (1852a). Decades XXXIX, XL. Sikkim and Khassya fungi. Journal of Botany and Kew Garden Miscellany 4: 130–142.

Berkeley MJ (1852b). Enumeration of some fungi from St. Domingo. Annals and Magazine of Natural History 9: 192–200.

Berkeley MJ (1854). Decades XLI, XLIII. Indian fungi. Hooker’s Journal of Botany and Kew Garden Miscellany 6: 129–143.

Berkeley MJ (1854a). Decades XLIV, XLVI. Indian fungi. Hooker’s Journal of Botany and Kew Garden Miscellany 6: 161–174.

Berkeley MJ (1854b). Decades XLVII, XLVIII. Indian fungi. Hooker’s Journal of Botany and Kew Garden Miscellany 6: 204–212.

Berkeley MJ (1854c). Decades XLIX, L. Indian fungi. Hooker’s Journal of Botany and Kew Garden Miscellany 6: 225–235.

Berkeley MJ (1855). Fungi: in Hooker, W.J. (ed.). Botany of the Antarctic Voyage-II, Flora Nova-Zealandia, 2, London.

Berkeley MJ (1856). Decades of fungi. Decas 1-62, nos. 1-620. Hooker’s Journal of Botany 3–8: 1844–1856.

Berkeley MJ (1866). *Polyporous anthelminticus*.The Gardener’s Chronicle 8: 753.

Berkeley MJ (1867). Fungi of the plains of India. Intellectual Observer 12: 18–21.

Berkeley MJ (1872). Notices of North American fungi. Grevillea 1: 65–71.

Berkeley MJ (1873). Australian fungi, received principally from Baron F. von Mueller and Dr. R. Schomburgk. Botanical Journal of the Linnean Society 13: 155–177.

Berkeley MJ (1876). Three fungi from Kashmir. Grevellia 4: 137–138.

Berkeley MJ (1881). Australian fungi-II. Botanical Journal of the Linnean Society. 18: 383–389.

Berkeley MJ, Broome CE (1873). Enumeration of the fungi of Ceylon. Part II. Journal of the Linnean Society 14: 29–141.

Berkeley MJ, Cooke MC (1876). The fungi of Brazil, including those collected by J.W.H. Trail. Botanical Journal of the Linnean Society 15: 363–398.

Berkeley MJ (1877). Enumeration of the fungi collected during the expedition of H.M.S. 'Challenger', 1874–75. (Third notice). Journal of the Linnean Society of London, Botany. DOI: 10.1111/j.1095-8339.1874.tb00323.x.

Berkeley MJ, Curtis MA (1849). Decades of fungi. Decades XXIII and XXIV. North and South Carolina Fungi. Hooker's Journal of Botany and Kew Garden Miscellany 1: 234–239.

Bernicchia A (1990). Polyporaceae *s.l.* in Italia. Istituto di Patologia Vegetale, Università degli Studi di Bologna, Italy, 584 p.

Bernicchia A (1991). Polyporaceae *s.l.* in Italia. Istituto di Patologia Vegetale Università degli Studi di Bologna, Bologna (Italy)

Bernicchia A (2001). A checklist of Corticioid, Polyporoid and Clavarioid fungi (Basidiomycotina) from the Emilia-Romagna region, Italy. Sydowia 53: 1–33.

Bernicchia A (2005). Polyporaceae *s.l. Fungi Europaei* 10. Alassio: Ed. Candusso, 808 p.

Bernicchia A, Ryvarden L (2001). A new *Antrodia* species (Coriolaceae, Basidiomycetes). Mycotaxon 79: 57–66.

Bernicchia A, Gorjón SP (2010). Corticiaceae *s.l.* Fungi Europaei 12. Edizioni Candusso.Alazzio. Italia, 1008 p.

Bernicchia A, Savino E, Gorjón SP (2007). Aphyllophoraceous wood inhabiting fungi on *Pinus spp*. in Italy. Mycotaxon 101: 5–8.

Bernicchia A, Ainsworth AM, Perini C (2019). *Neolentiporus squamosellus*. The IUCN Red List of Threatened Species (2019): e.T70415439A70415650. DOI: 10.2305/IUCN.UK.2019-3.RLTS.T70415439A70415650.en.

Bernicchia A, Gorjón SP, Vampola P, Ryvarden L, Prodi A (2012). A phylogenetic analysis of *Antrodia s.l.* based on nrDNA ITS sequences, with emphasis on rhizomorphic European species. Mycological Progress 11: 93–100. DOI 10.1007/s11557-010-0732-z.

Bernicchia A, Fugazzola MA, Gemelli V, Mantovani B, Lucchetti A, Cesari M, Speroni E (2006). DNA recovered and sequenced from an almost 7000 y-old Neolithic polypore, *Daedaleopsis tricolor*. Mycological Research 110: 14–7. DOI: 10.1016/j.mycres.2005.09.012.

Bhaskaran R (2000). Management of basal stem rot disease of coconut caused by *Ganoderma lucidum*. In: Flood J, Bridge PD, Holderness M (eds), *Ganoderma* Diseases of Perennial crops. CAB International, Wallingford, UK. 121–128 p.

Bhaskaran R, Rajamannar M, Kumar SNS (1996). Basal stem rot disease of coconut. CPCRI Technical Bulletin No. 30.

Bhimba BV, Franco DAD, Jose GM, Mathew JM, Joel EL (2011). Characterization of cytotoxic compound from mangrove derived fungi *Irpex hydnoides* VB4. Asian Pacific Journal of Tropical Biomedicine 1: 223–226. DOI: 10.1016/S2221-1691(11)60031-2.

Bhosle SR, Lamrood P Y, Vaidya J G (2005). Diversity of Aphyllophoraceous fungi from the Western Ghats of Maharashtra. In: The fungi- Diversity and Conservation in India (Eds: Dargan J S, Atri N S, Dhingra G S), Bishan Singh Mahendra Pal Singh, Dehradun, U. K (India). 103–113 p.

Bhosle S, Ranadive K, Bapat G, Garad S, Deshpande G, Vaidya J (2010). Taxonomy and Diversity of *Ganoderma* from the Western parts of Maharashtra (India). Mycosphere 1: 249–262.

Bian LS, Dai YC (2017). Morphological and molecular evidence for three new species of *Coltricia* (Hymenochaetaceae, Basidiomycota) from southern China. Mycologia 109: 64–75. 10.1080/00275514.2017.1286571.

Bilgrami KS, Jamalludin, Rizwi AM (1979). Fungi of India. New Delhi: Today and Tomorrow’s Printers and Publishers.

Bilgrami KS, Jamalludin, Rizwi AM (1991). Fungi of India. New Delhi: Today and Tomorrow’s Printers and Publishers.

Binder M, Hibbett (2002). Higher-level phylogenetic relationships of homobasidiomycetes (mushroom-forming fungi) inferred from four rDNA regions. Molecular Phylogenetics and Evolution 22: 76–90. DOI: 10.1006/mpev.2001.1043.

Binder M, Hibbett DS (2003). Oligonucleotides. www.clarku.edu/faculty/dhibbett/protocols_folder/primers/primers.pdf.

Binder M, Hibbett DS, Larsson KH, Larsson E, Langer E (2005). The phylogenetic distribution of resupinate forms in the homobasidiomycetes. Systematics and Biodiversity 3: 113–157. DOI:10.1017/S1477200005001623.

Binder M, Justo A, Riley R, Salamov A, Giraldez FL, Sjökvist E, Copeland A, Foster B, Sun H, Larsson E, Larsson KH, Townsend J, Grigoriev IV, Hibbett DS (2013). Phylogenetic and phylogenomic overview of the Polyporales. Mycologia 105: 1350–1373. DOI: 10.3852/13-003.

Bishop S, McGrath WT (1978). Key to the Wood-Decaying Polyporaceae of the East Texas Region eBooks. Book 8, 107 p.

Bishop KS, Kao CH, Xu Y, Glucina MP, Paterson RRM, Ferguson LR (2015). From 2000 years of *Ganoderma lucidum* to recent developments in nutraceuticals. Phytochemistry 114. 56–65. DOI: 10.1016/j.phytochem. 2015.02.015.

Bisko NA, Mitropolskaya NY (1999). Some biologically active substances from medicinal mushroom *Ganoderma lucidum*. International Journal of Medicinal Mushrooms 5: 301–306.

Bittencourt F, Stürmer SL, Reck MA, Drechsler-Santos ER (2018). *Phylloporia minuta sp. nov.* (Basidiomycota, Hymenochaetales): a remarkable species discovered in a small protected urban area of Atlantic Forest. Phytotaxa 348: 199–210. DOI: 10.11646/phytotaxa.348.3.3.

Boa E (2006). *Champignons comestibles sauvages. Vue d'ensemble sur leurs utilisations et leur impor tance pour les populations*. Produits Forestiers Non Ligneux 17.

Bobadilla EA, Suirezs TM, Pereyra O, Weber E, Silva F, Stehr AM (2007). *Durabilidad de la madera del Pinus taeda L. impregnado con arseniato de cobre cromatado, frente a hongosxilófagos, Misiones* Argentina. Floresta 37: 15–20. DOI: 10.5380/rf.v37i1.7835.

Boh B, Berovic M, Zhang J, Zhi-Bin L (2007). *Ganoderma lucidum* and its pharmaceutically active compounds. Biotechnology Annual Review 13: 265–301. DOI: 10.1016/S1387-2656(07)13010-6.

Boidin J (1966). *Basidiomycètes Podoscyphaceae de la République Centrafricaine*. Cahiers de la Maboké. 4: 94–109.

Boidin J, Gilles G (2001). *Basidiomycètes* Aphyllophorales *De L'ile De La Réunion*. XXII-Podoscyphaceae. Bulletin De La Société Mycologique De France 117: 167–172.

Boidin J, Mugnier J, Canales R (1998). *Taxonomie moléculaire des Aphyllophorales*. Mycotaxon 66: 445–491.

Bolaños AC, Bononi VLR, Gugliotta ADM, Muñoz JE (2016). New records of *Ganoderma multiplicatum* (Mont.) Pat. (Polyporales, Basidiomycota) from Colombia and its geographic distribution in South America. Check List 12, 8p. DOI: http://dx.doi.org/10.15560/12.4.1948

Bolhassan MH (2013). Diversity of polyporales in the Malay Peninsular and the application of *Ganoderma australe* (Fr.) pat. in biopulping of empty fruit bunches of *Elaeis guineensis*. PhD Thesis. Institute of Biological Sciences, Faculty of Science, University Of Malaya, Kuala Lumpur.

Bolhassan MH, Abdullah N, Sabaratnam V, Hattori T, Abdullah S, Rashid NMN, Musa MY (2012). Diversity and distribution of Polyporales in Peninsular Malaysia. Sains Malaysiana 41: 155–161.

Bononi VLR, Trufem SFB, Grandi RAP (1981). *Fungos macroscópicos do Parque Estadual das Fontes do Ipiranga, depositados no Herbário do Instituto de Botânica*. Rickia 9: 37–53.

Bondartsev AS (1953). Polyporaceae of the European part of USSR and of the *Caucasus*. Moscow–Leningrad, Academy of Science USSR, 1106 p.

Bondartseva MA (1983). Definitorium fungorum Rossicum. Aphyllophorales 2. Albatrellaceae, Aporpiaceae, Boletopsidaceae, Bondarzewiaceae, Ganodermataceae, Corticiaceae (species porioideis), Lachnocladiaceae (species tubuliferae), Polyporaceae (genera poroidea), Poriaceae, Rigidoporaceae, Phaeolaceae, Fistulinaceae. Saint Petersburg, Nauka, 391 p. (in Russ.).

Bondartseva MA (1983a). The system of Polyporaceae *s. lato*. Mikol. Fitopatol. 17: 269–280 (in Russ.).

Bondartseva MA (1983b). The system of Polyporaceae *s. lato* and principles of their classification. Dr. Sci. Thesis. Leningrad, Komarov Botanical Institute, 558 p. (in Russ.).

Bondartseva MA (1998). Definitorium fungorum Rossicum. Aphyllophorales 2. Albatrellaceae, Aporpiaceae, Boletopsidaceae, Bondarzewiaceae, Ganodermataceae, Corticiaceae (species porioideis), Lachnocladiaceae (species tubuliferae), Polyporaceae (genera poroidea), Poriaceae, Rigidoporaceae, Phaeolaceae, Fistulinaceae. Saint Petersburg, Nauka, 391 p.

Bondartseva MA, Herrera-Figueroa S (1989). The genus *Navisporus* in Cuba. Mikologiya i Fitopatologiya 23: 193–197.

Bondarzew Von A, Singer R (1941). *Zur Systematik der Polyporacean*, Annals of Mycology 39: 43–65.

Bononi VLR, Trufem SFB, Grandi RAP (1981). *Fungos macroscópicos do Parque Estadual das Fontes do Ipiranga, São Paulo, Brasil, depositados no herbário do Instituto de Botânica*. Rickia 9: 37–53

Bontea V (1985). *Ciuperci parasite si saprofite din România*. 1. Editura Academiei Republicii Socialiste România, Bucuresti.

Borderes J, Costa A, Guedes A, Benathar L, Tavares B (2011). Antioxidant activity of the extract from *Pycnoporus sanguineus* mycelium. Brazilian Archives of Biology and Technology 54: 1167–1174. DOI: 10.1590/S1516-89132011000600012.

Borges Da Silveira RM, Guerrero RT (1991). Aphyllophorales *poliporóides* (Basidiomycetes) *do Parque Nacional de Aparados da Serra,* RS. Boletim do Instituto de Bifociências 48: 1–147.

Borges Da Silveira RM, Wright JE (2002). *Polyporus s. str*. in South America: mating tests. Mycological Research 106: 1323–1330.

Borges Da Silveira RM, Wright JE (2005). The taxonomy of *Echinochaete* and *Polyporus s. str*. in South America. Mycotaxon 93: 1–59.

Borges Da Silveira RM, Reck MA, Graf LV, Nogueira de Sá F (2008). Polypores from a Brazilian pine forest in Southern Brazil: pileate species. Hoehnea 35: 619–630. DOI: 10.1590/S2236-89062008000400012.

Bose SR (1918). Descriptions of the fungi in Bengal: I. In: Proceedings of the Indian Association for the Cultivation of Science, Jadavpur, Kolkata. 137 p.

Bose SR (1919). Descriptions of the fungi in Bengal: I. In: Proceedings of the Indian Association for the Cultivation of Science, Jadavpur, Kolkata. 109–114.

Bose SR (1919a). Descriptions of the fungi in Bengal: II. In: Proceedings of the Indian Association for the Cultivation of Science, Jadavpur, Kolkata. 136–143 p.

Bose SR (1920). Fungi of Bengal. Polyporaceae of Bengal-III. Bull Carmichael Med Coll 1: 1–5

Bose SR (1920a). Records of Agaricaceae from Bengal. Journal of Asiatic Society Bengal 16: 347–354.

Bose SR (1921). Polyporaceae of Bengal- IV. Bull Carmichael Med Coll 2: 1–5.

Bose SR (1921a). One new species of Polyporaceae and some Polypores new to Bengal. Annals of Mycology 19: 129–131.

Bose SR (1921b). Two new species of Polyporaceae. Journal of Indian Botany 2: 300–301.

Bose SR (1922). Polyporaceae of Bengal- V. Bull Carmichael Med Coll 3: 20–25.

Bose SR (1922a). *Une* Polyporaceae *nouvelle du Bengala*. Bull Soc Mycol Fr 38: 173.

Bose SR (1922b). Polyporaceae of Bengal: Polyporaceae of Bengal VI. In: Proceedings of the Indian Association for the Cultivation of Science, Jadavpur, Kolkata. 55–62 p.

Bose SR (1923). Polyporaceae of Bengal-VII. In: Proceedings of the Indian Association for the Cultivation of Science for the year 1920-21, Jadavpur, Kolkata. 27–36 p.

Bose SR (1923a). *Une Polyporaceae nouvelle d'Inde*. Bulletin de la Société mycologique de France 39: 226.

Bose SR (1924). *Les Polyporacees du Bengale*. Rev Path Veg Ent Agric Fr 11: 134–149.

Bose SR (1925). A new species of Polyporaceae from Bengal. Annals of Mycology 23: 179–181.

Bose SR (1928). Polyporaceae of Bengal-VIII. J. Dep Sci Calcutta Univ 9: 27–34.

Bose SR (1928a). Polyporaceae of Bengal-IX. J Dep Sci Calcutta Univ 9: 35–44.

Bose SR (1934). Polyporaceae of Bengal-X. J Dep Sci Calcutta Univ 11: 1–18.

Bose SR (1937). Polyporaceae of Lokra Hills (Assam). Annales of Mycology 35: 119–137.

Bose SR (1938). Polyporaceae of Bengal X. Bulletin of Carmichael Medical College 11: 1–18.

Bose SR (1944). Importance of anatomy in the systematics of Polyporaceae. Journal of Indian Botanical Society 23: 153–157.

Bose SR (1946). Polyporaceae of Bengal-XI. J Dep Sci Calcutta Univ 2: 53–87.

Bourdot H, Galzin A (1925). *Hymenomycetes de France* (XI. Pores). *Bulletin trimestriel de la Société mycologique de France* T. 41. 98—144.

Bourdot H, Galzin A (1928). *Hymenomycetes de France*, Sceaux, Paris, 761 p.

Brazee NJ, Lindner DL, Fraver S, Amato AW, Milo AM (2012). Wood-inhabiting, polyporoid fungi in aspen-dominated forests managed for biomass in the U.S. Lake States. Fungal Ecology 5: 600–609. DOI: 10.1016/ j.funeco.2012.03.002.

Brazee NJ, Lindner DL, Amato AWD, Fraver S, Forrester JA, Mladenoff DJ (2014). Disturbance and diversity of wood-inhabiting fungi: effects of canopy gaps and downed woody debris. Biodiversity Conservation 23: 2155–2172. DOI: 10.1007/s10531-014-0710-x.

Breitenbach J, Kränzlin F (1986). Pilze der Schweiz. B. II: Nichtblätterpilze. – Luzern. 412 p.

Bresadola G (1897). *Hymenomycetes Hungarici Kmetiani*. Atti Imp. Regia Accad. Roveroto Ser. III 3: 1–56.

Brethauer S, Lawrence R, Hans-Peter M (2017). Enhanced simultaneous saccharification and fermentation of pretreated beech wood by in situ treatment with the white rot fungus *Irpex lacteus* in a membrane aerated biofilm reactor. Bioresources Technology 237: 135–138. DOI: 10.1016/j.biortech.2017.03.050.

Breuil C (2008). Decay fungi and associated rates of decay in standing trees killed by mountain pine beetle. Natural Resources Canada, Canadian Forest Service, Pacific Forestry Centre, Victoria B.C. Mountain Pine Beetle Working Paper 2008-11, 19 p.

Briggs LH, Cambie RC, Dean IC, Hodges R, Ingram WB, Rutledge PS (1976). Chemistry of fungi XI. Corticins A, B and C, benzobisbenzofurans from *Corticium caeruleum*. Australian Journal of Chemistry 29: 179. DOI: 10.1071/CH9760179.

Brockus CW, Myers RK, Crandell JM, Sutton DA, Wickes BL, Nakasone KK (2012). Disseminated *Oxyporus corticola* infection in a German shepherd dog. Medical Mycology 47: 862–868. DOI:10.3109/13693780902962267.

Brown DC, Reetz J (2012). Single agent polysaccharopeptide delays metastases and improves survival in naturally occurring hemangiosarcoma. Evidence Based Complementary Alternative Medicine 384301. DOI: 10.1155/2012/38430.

Brusis OA (1972). A new species of *Fistulina* from Mexico. Mycologia 64: 1248–1251.

Buchanan PK, Hood IA (1992). New species and new records of Aphyllophorales (Basidiomycetes) from New Zealand. New Zealand Journal of Botany 30: 95–112.

Buchanan PK, Wilkie P (1994). Taxonomy of New Zealand *Ganoderma*-two non laccate species, 135 p.

Buchanan PK, Ryvarden L (2000). New Zealand polypore fungi: six new species and a redetermination. New Zealand Journal of Botany 38: 251–263. DOI: 10.1080/0028825X.2000.9512682.

Budington AB, Gilbertson RL (1973). Some Southwestern lignicolous Hymenomycetes of special interest. Southwestern Naturalist 17: 409–422.

Burdsall HH (1969). A new polypore from the Eastern United States. Mycologia 61: 647–651.

Burdsall HH (1985). A contribution to the taxonomy of the genus *Phanerochaete*. Mycologia Memoirs 10: 1–165.

Burkill IH (1966). A Dictionary of the Economic Products of the Malay Peninsula. Vol. I & II. Kuala Lumpur: Ministry of Agriculture.

Burt EA (1914). The Thelephoraceae of North America. Annals of the Missouri Botanical Garden 1: 185–228.

Burt EA (1918). The Thelephoraceae of North America. X. *Hymenochaete*. Annales Missouri Botanical Garden 5: 301–372.

Burt EA (1920). The Thelephoraceae of North America XII. *Stereum*. Annales of the Missouri Botanical Garden 7: 81–248.

Burt EA (1925). The Thelephoraceae of North America. XIV. *Peniophora*. Annals of the Missouri Botanical Garden 12: 213–357.

Butler EJ, Bisby GR (1931). The Fungi of India, Scientific monograph no I. ICAR, Delhi.

Butler EJ, Bisby GR (1960). The Fungi of India. (Revised by R. S. Vasudeva 1960). ICAR Publication, New Delhi India, 552 p.

Buthelezi SP, Olaniran AO, Pillay B (2012). Textile dye removal from wastewater effluents using bioflocculants produced by indigenous bacterial isolates. Molecules 2012: 14260–14274. DOI: 10.3390/molecules171214260.

Buzina W, Lass-Flörl C, Kropshofer G, Freund MC, Marth E (2005). The polypore mushroom *Irpex lacteus*, a new causative agent of fungal Infections. Journal of Clinical Microbiology 43: 2009–2011. DOI: 10.1128/JCM.43.4.2009-2011.2005.

Cambria MT, Minniti Z, Librando V, Cambria A (2008). Degradation of polycyclic aromatic hydrocarbons by *Rigidoporus lignosus* and its laccase in the presence of redox mediators. Applied Biochemistry and Biotechnology: 149: 1–8. DOI: 10.1007/s12010-007-8100-4.

Campacci TVS, Gugliotta AM (2009). A review of *Amauroderma* in Brazil, with *A. oblongisporum* newly recorded from the neotropics. Mycotaxon 110: 423–436. DOI: 10.5248/110.423.

Campanile G, Giove SL, Luisi N (2004). Genetic and morphologic variability of *Phellinus torulosus* isolates in some oak woods of Southern Italy. Journal of Plant Pathology 87: 105–115.

Campanile G, Schena L, Luisi N (2008). Blackwell Publishing Ltd Real-time PCR identification and detection of *Fuscoporia torulosa* in *Quercus ilex*. Plant Pathology 57: 76–83. DOI: 10.1111/j.1365-3059.2007.01709.x.

Campos-Santana M, Loguercio-Leite C (2012). Species of *Amauroderma* (Ganodermataceae) in Santa Catarina State, Southern Brazil. Biotemas 26: 1–5. DOI: 10.5007/2175-7925.2013v26n1p1.

Campos-Santana M, Robledo G, Decock C, Silveira RMB (2015). Diversity of the poroid Hymenochaetaceae (Basidiomycota) from the Atlantic Forest and Pampa in Southern Brazil. Cryptogamie, Mycologie 36: 43–78. DOI: 10.7872/crym.v36.iss1.2015.43.

Cao Y, Yuan HS (2013). *Ganoderma mutabile sp. nov.* from southwestern China based on morphological and molecular data. Mycological Progress 12: 121–126. DOI: https://doi.org/10.1007/s11557-012-0819-9.

Cao Y, Wu SH, Dai YC (2012). Species clarification of the prize medicinal *Ganoderma* mushroom ‘‘*Lingzhi*’’. Fungal Diversity 56: 49–62. DOI: 10.1007/s13225-012-0178-5.

Capelari M, Zadrazil F (1997). Lignin digestibility of wheat straw treated with Brazilian tropical species of white rot fungi. Folia Microbiolica 42: 481–487.

Cardoso BK, Linde G, Colauto NB, Valle JS (2018). *Panus strigellus* laccase decolorizes anthraquinone, azo, and triphenylmethane dyes. Biocatalysis and Agricultural Biotechnology 16: 558–563. DOI: 10.1016/j.bcab.2018.09.026.

Carlson A, Justo A, Hibbett DS (2014). Species delimitation in *Trametes*: a comparison of ITS, RPB1, RPB2 and TEF1 gene phylogenies. Mycologia 106: 735–746. DOI: 10.3852/13-275.

Carranza-Morse J (1982). Polypores new to Costa Rica. Mycotaxon 15: 405–408.

Carranza-Morse J (1992). Pore fungi of Costa Rica. II. Mycotaxon 43: 351–369.

Carranza-Morse J, Gilbertson RL (1986). Taxonomy of the *Fomitopsis rosea* complex (Aphyllophorales, Polyporaceae). Mycotaxon 25: 469–486.

Carranza-Morse J, Ruiz-Boyer A (2005). Checklist of polypores of Costa Rica. Rev. Mex. Mic. 20: 45–52.

Carranza-Morse J, Ryvarden L (1998). Additional list of pore fungi of Costa Rica. Mycotaxon 69: 377–390.

Cesarino I, Dias OAT, Negrão DR, Rocha LLN, Leão ALP (2019). Deterioration of wood plastics composites by the white rot fungus *Pycnoporus sanguineus*. Journal of Composites Science 2019, 16 p. DOI: 10.3390/jcs3010024.

Casieri L, Varese GS, Anastasi A, Prigione V, Svobodová K, Marchisio VF, Novotný C (2008). Decolorization and detixication of reactive industrial dyes by immobilized fungi *Trametes pubescens* and *Pleurotus ostreatus*. Folia microbiologica 53: 44–52. DOI: 10.1007/s12223-008-0006-1.

Chakraborty D, Hembrom ME, Parihar A, Hosen MI, Das K (2018). Additions to the Indian *Phylloporus* (Boletaceae) based on morphology and molecular phylogeny. Kavaka 50: 21–25.

Champagne PP (2009). Dye decolourization by immobilized laccase and impact of auxiliary chemicals on dye decolourization. Thesis, Queen’s University, Kingston, Ontario, Canada, 201 p.

Champion HG, Seth SK (1968). A revised survey of forest types of India. Government of India Press, New Delhi, 404 p.

Chamuris GP (1988). The non-stipitate steroid fungi in the northeastern United States and adjacent Canada. Mycologia Memoirs 14: 1–247.

Chan PM, Kanagasabapathy G, Tan YS, Sabaratnam V (2013). *Amauroderma rugosum* (Blume & T. Nees) Torrend: nutritional composition and antioxidant and potential anti inflammatory properties. Evidence-Based Complementary and Alternative Medicine 2013, 10 p. DOI: 10.1155/2013/304713.

Chan PM, Tan YS, Chua KH, Sabaratnam V, Kuppusamy UR (2015). Attenuation of inflammatory mediators (TNF-α and nitric oxide) and up-regulation of IL-10 by wild and domesticated basidiocarps of *Amauroderma rugosum* (Blume & T. Nees) Torrend in LPS-stimulated RAW264. 7 cells. PloS One 10: e0139593. DOI: 10.1371/journal.pone.0139593.

Chandra P, Arora DS, Pal M, Sharma RK (2019). Antioxidant potential and extracellular auxin production by white rot fungi. Applied Biochemistry and Biotechnology 187: 531–539. DOI: 10.1007/s12010-018-2842-z.

Chandrashekara UM, Sankar S (1998). Structure and functions of sacred groves: Case studies in Kerala. In: Ramakrishnan, P.S., Saxena, K.G. and Chandrashekara, U.M. (Editors), Conserving the Sacred for Biodiversity Management. UNESCO and OxfordIBH Publishing, New Delhi, 323–335 p.

Chandrasekharan C (1997). Forests as a resource perspective, World-Wide Fund for Nature, India, 411 p.

Chang ST, Buswell JA (1999). *Ganoderma lucidum* (Curt. Fr.) P. Karst. (Aphyllophoromyce-tideae) – A mushrooming medicinal mushroom. International Journal of Medicinal Mushrooms 1: 139–146.

Chang TT (1994). *Perenniporia formosana sp. nov.* on *Prunus* in Taiwan. Mycological Research 98: 954–956.

Chang TT, Chou WN (1998). *Antrodia lalashana sp. nov*. and *Antrodiella formosana sp. nov*. in Taiwan. Mycological Research 102: 400–402. DOI: 10.1017/S0953756297005157.

Chang TT, Chou WN (1999). *Antrodia* taxa *sp. nov*. and *Perenniporia celtis sp. nov*. in Taiwan. Mycological Research 103: 622–624. DOI: 10.1017/S0953756298007059.

Chang YS, Lee SS (2004). Utilisation of macrofungi species in Malaysia. Fungal Diversity 15: 15–22.

Chang S, Miles GP (2004). Mushrooms: cultivation, nutritional value, medicinal effects and environmental impact. CRC Press, Boca Raton, 436 p. DOI: 10.1201/9780203492086.

Chao CH, Wu HJ, Lu MK (2011). Promotion of fungal growth and underlying physiochemical changes of polysaccharides in *Rigidoporus ulmarius*, an edible Basidiomycete mushroom. Carbohydrate Polymers 85: 609–614. DOI: 10.1016/j.carbpol.2011.03.023.

Chaudhary R, Tripathy A (2015). Isolation and identification of bioactive compounds from *Irpex lacteus* wild fleshy fungi. Journal of Pharmaceutical Science & Research 7: 424–434.

Chemutai SM (2018). Characterization and antimicrobial activity of tropical basidiomycetes fungi and their secondary metabolites. Thesis, Biochemistry of Egerton University, 132 p.

Chen HP, Zhao ZZ, Li ZH, Feng T, Liu JK (2018). Seco-tremulane sesquiterpenoids from the cultures of the medicinal fungus *Irpex lacteus* HFG1102. Natural Products and Bioprospecting 8: 113–119. DOI: 10.1007/s13659-018-0157-y.

Chen JJ, Cui BK (2014). Studies on *Wrightoporia* from China 3. *Wrightoporia subavellanea sp. nov*. based on morphological characters and rDNA sequence data. Phytotaxa 175: 225–234. DOI: 10.11646/phytotaxa.175.4.4.

Chen JJ, Cui BK, Zhou LW, Korhonen K, Dai YC (2015). Phylogeny, divergence time estimation, and biogeography of the genus *Heterobasidion* (Basidiomycota, Russulales). Fungal Diversity 71: 185–200. DOI: 10.1007/s13225-014-0317-2.

Chen NH, Liu JW, Zhong JJ (2008). Ganoderic acid Me inhibits tumor invasion through down-regulating matrix metalloproteinases 2/9 gene expression. Journal of Pharmacological Science 108: 212–216. DOI: 10.1254/jphs.sc0080019.

Chen SC, Lu MK, Cheng JJ, Wang DL (2005a). Antiangiogenic activities of polysaccharides isolated from medicinal fungi. FEMS Microbiology Letters 249: 247–254.

Chen SH, Ting ASY (2015). Biodecolorization and biodegradation potential of recalcitrant triphenylmethane dyes by *Coriolopsis* sp. isolated from compost. Journal of Environmental Management 150: 274–280. DOI: 10.1016/j.jenvman.2014.09.014.

Chen Q, Yuan Y (2017). A new species of *Fuscoporia* (Hymenochaetales, Basidiomycota) from southern China. Mycosphere 8: 1238–1245. DOI: 10.5943/mycosphere/8/6/9.

Chen W, Deng B (2003). Determination of main components of sclerotia in wild and cultivated *Polyporus umbellatus* in Mt. Qinhing and Mt. Bashanr regions. Wuxi Qinggong Daxue Xuebao 22: 96–98.

Chen W, Luo S, Ll H, Yang H (2005). Effects of *Ganoderma lucidum* polysaccharides on serum lipids and lipoperoxidation in experimental hyperlipidemic rats. China journal of Chinese materia medica 30: 1358–60.

Chen W, Tan H, Liu Q, Zheng X, Zhang H, Liu Y, Xu L (2019). A Review: The bioactivities and pharmacological applications of *Phellinus linteus*. Molecules 16: 24. DOI: 10.3390/molecules24101888.

Chen X, Hu ZP, Yang XX, Huang M, Gao Y, Tang W, Chan SY, Dai X, Ye J, Ho PCL, Duan W, Yang HY, Zhu YZ, Zhou SH (2006). Monitoring of immune responses to a herbal immuno-modulator in patients with advanced colorectal cancer. International Immunopharmacology 6: 499–508. DOI: 10.1016/j.intimp.2005.08.026.

Chen YL, Ma QY, Huang SZ, Dai HF, Hua Y, Zhao YX (2016). Chemical constituents from fruiting bodies of *Amauroderma rude* 47: 881–885. DOI: 10.7501/j.issn.0253-2670.2016.06.004.

Chen YY, Cui BK (2015). Phylogenetic analysis and taxonomy of the *Antrodia heteromorpha* complex in China. Mycoscience 57: 1–10. DOI: 10. 1016/j.myc.2015.07.003.

Chen YY, Wu F (2017). A new species of *Antrodia* (Basidiomycota, Polypores) from China. Mycosphere 8: 878–885. DOI: 10.5943/mycosphere/8/7/4.

Chen YY, Li HJ, Cui BK (2015a). Molecular phylogeny and taxonomy of *Fibroporia* (Basidiomycota) in China. Phytotaxa 203: 47–54. DOI: 10.11646/phytotaxa.203.1.4.

Chen YY, Zhu L, Xing J, Cui BK (2017). Three new species of *Phylloporia* (Hymenochaetales) with dimitic hyphal systems from tropical China, Mycologia 109: 951–964. DOI: 10.1080/00275514.2017.1410692.

Chenaux PR, Lalji N, Lefebvre DD (2014). *Trametes meyenii* possesses elevated dye degradation abilities under normal nutritional conditions compared to other white rot fungi. AMB Expr 4: 74. DOI: 10.1186/s13568-014-0074-3.

Cheng GY, Wu GR, Zhou YZ, Cheng SL (1998). Extraction and characterization of proteoglycan from the mycelium of *Polystictus versicolor* (L.) Fr. by submerged culture (1998). Zhiwu Ziyuan Yu Huanjing 7: 19–23.

Cheng JJ, Lur HS, Huang KN, Chen HP, Lin CY, Lu MK (2009). Exploring the potential of biopharmaceutical production by *Rigidoporus ulmarius*: Cultivation, chemistry, and bioactivity studies. Process Biochemistry 44: 1237–1244. DOI: 10.1016/j.procbio.2009.06.018.

Cheng WN, Sim HK, Ahmad SA, Syed MA, Shukor MY, Yusof MT (2016). Characterization of an azo-dye-degrading white rot fungus isolated from Malaysia. Mycosphere 7: 560–569. DOI: 10.5943/mycosphere/7/5/3.

Chepkirui C, Yuyama KT, Wanga LA, Decock C, Matasyoh J, Abraham WR, Stadler M (2018). Microporenic acids A–G, biofilm inhibitors, and antimicrobial agents from the Basidiomycete *Microporus* species. Journal of Natural Products 81: 778–784. DOI: 10.1021/acs.jnatprod.7b00764.

Cherian E, Sudheesh NP, Krishnankutty K, Patani G (2009). Free radical scavenging and mitochondrial antioxidant activities of Reishi-*Ganoderma lucidum* (Curt: Fr) P. Karst and Arogyapacha-*Trichopus zeylanicus* Gaertn extracts. Journal of basic and clinical physiology and pharmacology 20: 289–307. DOI: 10.1515/JBCPP.2009.20.4.289.

Chin FH (1981). Edible and poisonous fungi from the forest of Sarawak. Part 1. Sarawak Museum Journal 50: 211–225.

Chinan VC, Fusu L, Manzu CC (2015). First record of *Inocutis tamaricis* in Romania with comments on its cultural characteristics. Acta Botanica Croatica 74: 187–193. DOI: 10.1515/botcro-2015-0001.

Chipp TF (1921). A list of fungi of the Malay Peninsula. Straits Settlements 2: 311–418.

Chiu (2007). Phylogenetic analysis of *Antrodia* species and *Antrodia camphorata* inferred from internal transcribed spacer region. Antonie van Leeuwenhoek 91: 267–276. DOI: 10.1007/s10482-006-9116-4.

Chiu LY, Hu ME, Yang TY, Hsin IL (2015). Immunomodulatory protein from *Ganoderma microsporum* induces pro-death autophagy through Akt-mTOR-p70S6K pathway inhibition in multidrug resistant lung cancer cells. PLoS ONE 10: e0125774. DOI: 10.1371/journal.pone.0125774.

Choeyklin R, Hattori T, Jones EBG (2011). A checklist of aphyllophoraceous fungi in Thailand: Part I. New records. Mycosphere 2: 161–177.

Choeyklin R, Hattori T, Jaritkhuan S, Jones EBG (2009). Bambusicolous polypores collected in Central Thailand. Fungal Diversity 36: 121–128.

Choi NS, Seo SY, Kim SH (1999). Screening of mushrooms having fibrinolytic activity. Korean Journal of Food Science and Technology 31: 553–557.

Choi D, Park SS, Ding LJ, Cha WS (2007). Effects of *Fomitopsis pinicola* extracts on antioxidant and antitumor activities. Biotechnology and Bioprocess Engineering 12: 516–524. DOI: 10.1007/BF02931349.

Choi YS, Long Y, Kim MJ, Kim JJ, Kim GH (2013). Decolorization and degradation of synthetic dyes by *Irpex lacteus* KUC8958. Journal of Environmental Science and Health Part A Toxic/hazardous substances and environmental engineering 48: 501–508. DOI: 10.1080/10934529.2013.730419.

Choi YS, Seo JY, Lee H, Yoo J, Jung J, Kim JJ, Kim GH (2013a). Decolorization and detoxification of wastewater containing industrial dyes by *Bjerkandera adusta* KUC9065. Water, Air, & Soil Pollution 225: 1801, 11 p. DOI: 10.1007/s11270-013-1801-0.

Chopra RN, Nayer SL, Chopra IC (1956). Glossary of Indian Medicinal Plants, New Delhi, CSIR. 9–27 p.

Chowdhary A, Agarwal K, Kathuria S, Singh PK, Roy P, Gaur SN, Rodrigues AM, Hoog GS, Meis JF (2012). First human case of pulmonary fungal ball due to a *Perenniporia* species (a Basidiomycete). Journal of Clinical Microbiology 50: DOI: 3786–3791. 0.1128/JCM.01863-12.

Chrenkova V, Kolarik M & Hubacek P, Kolarik J, Simonek J, Lischke R, Drevinek P (2014). Possible *Tyromyces fissilis* (Basidiomycota, Polyporales) co-infection in a lung transplant recipient. Folia Microbiolica 60: 33–35. DOI: 10.1007/s12223-014-0336-0.

Christiansen MP (1960). Danish resupinate fungi. Part II. Homobasidiomycetes. Dansk Botanisk Arkiv 19, 388 p.

Chu KKW, Ho SS, Chow AHL (2002). *Coriolus versicolor*: a medicinal mushroom with promising immunotherapeutic values. Journal of Clinical Pharmacology 42: 976–84. DOI: 10.1177/009127002401102894.

Chuzho K, Dkhar M. S, Lyngdoh A (2017). Wood-rotting fungi in two forest stands of Kohima, north-east India: a preliminary report. Current Research in Environmental & Applied Mycology 7: 1–7. DOI: 10.5943/cream/7/1/1.

Cifuentes J, Villegas M, Perez-Ramirez L (1986). Hongos. In Manual de Herbario. A. Lot and F. Chiang.Consejo Nacional de la Flora, Mexico D.F.

Clemençon H (2004). Cytology and plectology of the Hymenomycetes. Bibliotheca Mycologica 199, 520 p.

Clements FE, Shear CL (1931). The genera of fungi. Clements Edith, ill. New York: H.W. Wilson Co., 496 p.

Coelho G, Borges Da Silveira RM (2014). Taxonomy of *Polyporus sensu lato* and related genera (Basidiomycota) from Santa Maria, southern Brazil. Ciência e Natura 36: 688–710. DOI: 10.5902/2179460X14939.

Coelho G, Borges Da Silveira RM, Rajchenberg M (2006). A new *Gloeoporus* species growing on bamboo from southern Brazil. Mycologia 98: 821–827. DOI: 10.1080/15572536.2006.11832653.

Coelho G, Cortez VG, Guerrero RT (2007). New morphological data on *Amauroderma brasiliense* (Polyporales, Basidiomycota). Mycotaxon 100: 177–183.

Coelho G, Borges Da Silveira RM, Guerrero RT, Rajchenberg M (2009). On poroid Hymenochaetales growing on bamboos in Southern Brazil and NE Argentina. Fungal Diversity 36: 1–8.

Coelho G, Silveira Ado, Antoniolli Zi, Yurchenko E (2016). *Tropicoporus stratificans sp. nov*. (Hymenochaetales, Basidiomycota) from southern Brazil. Phytotaxa 245: 144–152. DOI: 10.11646/phyotaxa245.2.5.

Coetzee MP, Marincowitz S, Muthelo VG, Wingfield MJ (2015). *Ganoderma* species, including taxa associated with root rot of the iconic *Jacaranda mimosifolia* in Pretoria, South Africa. IMA Fungus 6: 249–256. DOI: 10.5598/imafungus.2015.06.01.16.

Coleman LC (1927). Structure of spore wall in *Ganoderma*. Botanical Gazette 83: 48–60.

Colombo JC, Cabello M, Arambarri AM (1996). Biodegradation of aliphatic and aromatic hydrocarbons by natural soil microflora and pure culture of imperfect and ligninolitic fungi. Environmental Pollution 94: 355–362.

Colombo ML, Bianco MA (2007). Screening of statin production by fungal strains. Planta Medica 73: 896–897. DOI: 10.1055/s-2007-987015.

Cooke MC (1880). On *Hymenochaete* and its allies. Grevillea 8: 145–150.

Cooke MC (1881). Some Exotic Fungi. Grevellia 9: 97–101.

Cooke WB (1940). A nomenclatural survey of the genera of pore fungi. Lloydia 3: 81–104.

Cooke WB (1953). Genera of the Homobasidiomycetes exclusive of the Gasteromycetes. sp. Div. Mycol. Dis. Survey, U.S. Dept. Agric. Beltsville, Maryland, 100 p.

Cooke WB (1956). The genus *Phlebia*. Mycologia 48: 386–405.

Cooke WB (1959). The genera of pore fungi. Lloydia 22: 163–207.

Cooke WB (1884–1886). Some exotic fungi. Grevillea 12: 85 (1884). Some exotic fungi, Grevillea 14: 11–14 (1885), Praecursors and Monographia Polyporarum. Grevillea 15: 19–27.

Corfixen P, Parmasto E (2017). *Hymenochaete* and *Hymenochaetopsis* (Basidiomycota) in Europe. Karstenia 57: 49–80. DOI: 10.29203/ka.2017.483.

Corner EJH (1932). The Fruitbody of *Polystictus xanthopus* Fr. Annals of Botany 46: 71–111.

Corner EJH (1932a). A *Fomes* with two systems of hyphae. Transactions of British Mycological Society 17: 51–81.

Corner EJH (1932b). The identification of the Brown-Rot Fungus. The Gardens' bulletin; Straits Settlements 5: 317–350.

Corner EJH (1950). A monograph of *Clavaria* and allied genera. Annals of Botany Memoirs 1: 1–740.

Corner EJH (1981). The agaric genera *Lentinus, Panus* and *Pleurotus*. Beihefte zur Nova Hedwigia 69: 1–169.

Corner EJH (1983). *Ad Polyporaceas* I. *Amauroderma* and *Ganoderma*. Beih Nova Hedwigia 75: 1–182.

Corner EJH (1984). *Ad Polyporaceas* II and III. Beihefte zur Nova Hedwigia 78: 1–222.

Corner EJH (1987). *Ad Polyporaceas* IV. Beihefte zur Nova Hedwigia 86: 1–265.

Corner EJH (1989). *Ad Polyporaceas* VI: the genus *Trametes*. Beihefte zur Nova Hedwigia 97: 191–197.

Corner EJH (1989a). Ad Polyporaceas V. The genera *Albatrellus, Boletopsis, Coriolopsis* (dimitic), *Cristelloporia, Diacanthodes, Elmerina, Fomitopsis* (dimitic), *Gloeoporus, Grifola, Hapalopilus, Heterobasidion, Hydnopolyporus, Ischnoderma, Loweporus, Parmastomyces, Perenniporia, Pyrofomes, Steccherinum, Trechispora, Truncospora* and *Tyromyces*. Beih. Nova Hedwigia 96: 218 p

Corner EJH (1990). *Ad Polyporaceas* VI. The genus *Trametes*. Beih. Nova Hedwigia. H. 97, 206 p.

Corner EJH (1991). *Ad Polyporaceas* VII. *Beihefte zur Nova Hedwigia*. 101: 1–175.

Corner, EJH (1992). Additional resupinate non-xanthochroic polypores from Brazil and Malesia. Nova Hedwigia 55: 119–152.

Correa E, Cardona D, Quinones W, Torres F, Franco AE, Vélez ID, Robledo S, Echeverri F (2006). Leishmanicidal activity of *Pycnoporus sanguineus*. Phytotherapy Research 20: 497–499. DOI: 10.1002/ptr.1890.

Costa-Rezende DH, Gugliotta AM, Góes-Neto A, Reck MA, Robledo GL, Drechsler-Santos ER (2016). *Amauroderma calcitum sp. nov.* and notes on taxonomy and distribution of *Amauroderma* species (Ganodermataceae). Phytotaxa 244: 101–124. DOI: 10.11646/phytotaxa.244.2.1.

Costa-Rezende DH, Robledo GL, Góes-Neto A, Reck MA, Crespo E, Drechsler-Santos ER (2017). Morphological reassessment and molecular phylogenetic analyses of *Amauroderma s. lat.* raised new perspectives in the generic classification of the Ganodermataceae family. Persoonia 39: 254–269. DOI: 10.3767/persoonia.2017.39.10.

Costa-Rezende DH, Lopez VF, Salvador-Montoya CA, Silva GA, Melo A, Elisandro, Drechsler-Santos ER (2015). New records of *Perenniporia sensu lato* and *Pyrofomes* for the Brazilian Cerrado. Iheringia Serie Botanica 70: 157–166.

Crous PW, Wingfield MJ, Burgess TI, Hardy GS *et al.* (2017). Fungal planet description sheets: 558–624. Persoonia 38: 240–384. DOI: 10.3767/003158517X698941.

Cruz A, Pimentel L, Rodríguez-Alcalá LM, Fernandes T, Pintado M (2016). Health benefits of edible mushrooms focused on *Coriolus versicolor*: A review. Journal of Food and Nutrition Research 4: 773–781. DOI: 10.12691/jfnr-4-12-2.

Cui BK (2013). *Antrodia tropica sp. nov*. from southern China inferred from morphological characters and molecular data. Mycological Progress 12: 223–230. DOI: 10.1007/s11557-012-0829-7.

Cui J, Chisti Y (2003). Polysaccharopeptides of *Coriolus versicolor*: Physiological activity, uses, and production. Biotechnology Advances: 109–22. DOI: 10.1016/S0734-9750(03)00002-8.

Cui BK, Wei YL (2004). *Haploporus subtrameteus*–a new polypore to China. Fungal Science 19: 35–38.

Cui BK, Li HJ. (2012). A new species of *Postia* (Basidiomycota) from Northeast China. Mycotaxon 120: 231–237. DOI: 10.5248/120.231.

Cui BK, Zhao CL (2012). Morphological and molecular characters for a new species of *Perenniporia* (Basidiomycota) described from Tibet, southwestern China. Mycoscience 53: 365–372. DOI: 10.1007/s10267-011-0180-x.

Cui BK, Dai YC, Decock C (2006). Two species of *Perenniporia* (Basidiomycota, Aphyllophorales) new to China. Fungal Science 21: 23–28. DOI:10.7099/FS.200612.0023.

Cui BK, Dai YC, Decock C (2007). A new species of *Perenniporia* (Basidiomycota, Aphyllophorales) from eastern China. Mycotaxon 99: 175–180.

Cui BK, Dai YC, Li BD (2009). Notes on the genus *Rigidoporus* (Basidiomycota, Aphyllophorales) in China. Nova Hedwigia 88: 189–197. DOI: 10.1127/0029-5035/2009/0088-0189.

Cui BK, Du P, Dai YC (2011). Three new species of *Inonotus* (Basidiomycota, Hymenochaetaceae) from China. Mycological Progress 10: 107–114. DOI: 10.1007/s11557-010-0681-6.

Cui BK, Li HJ, Dai YC (2011a). Wood-rotting fungi in eastern China 6. Two new species of *Antrodia* (Basidiomycota) from Mt Huangshan, Anhui Province. Mycotaxon 116: 13–20. DOI: 10.5248/116.13.

Cui BK, Tang L, Dai YC (2011b). Morphological and molecular evidences for a new species of *Lignosus* (Polyporales, Basidiomycota) from tropical China. Mycological Progress 10: 267–271. DOI: 10.1007/s11557-010-0697-y.

Cui BK, Vlasák J, Dai YC (2014). The phylogenetic position of *Osteina obducta* (Polyporales, Basidiomycota) based on samples from northern hemisphere. Chiang Mai Journal of Science 41: 838–845.

Cui BK, Wang Z, Dai YC (2008). *Albatrellus piceiphilus sp. nov*. on the basis of morphological and molecular characters. Fungal Diversity 28: 41–48.

Cui BK, Yuan HS, Dai YC (2010a). Two new species of *Phylloporia* (Basidiomycota, Hymenochaetaceae) from China. Mycotaxon 113: 171–178. DOI: 10.5248/113.171.

Cui BK, Zhao CL, Li HJ, He SH (2010). Polypores from Chebaling Nature Reserve, Guangdong Province. Mycosystema 29: 834–840.

Cui BK, Li HJ, Ji X, Zhou JL, Song J, Si J, Yang ZL, Dai YC (2019). Species diversity, taxonomy and phylogeny of Polyporaceae (Basidiomycota) in China. Fungal Diversity 97: 137–392. DOI: 10.1007/s13225-019-00427-4.

Cui DZ, Zhao M, Yang HY, Wang C, Dai HB (2011c). Molecular phylogeny of *Trametes* and related genera based on internal transcribed spacer (ITS) and nearly complete mitochondrial small subunit ribosomal DNA (mt SSU rDNA) sequences. African Journal of Biotechnology 10: 18111–18121. DOI: 10.5897/AJB10.1830.

Cunningham GH (1927). The Polyporaceae of New Zealand. Transactions and Proceedings of the New Zealand Institute 58: 202–250.

Cunningham GH (1948). New Zealand Polyporaceae. 7. The genus *Inonotus*. Bulletin of the New Zealand Department of Scientific and Industrial Research, Plant Diseases Division 78: 1–5.

Cunningham (1957). Thelephoraceae of New Zealand. XIV. The *Genus Hymenochaete*. Transactions of Royal Society of New Zealand 85: 1–51.

Cunningham GH (1963). The Thelephoraceae of Australia and New Zealand. Bulletin of the New Zealand Department of Scientific and Industrial Research 145: 1–359.

Cunningham GH (1965). Polyporaceae of New Zealand. Bulletin of the New Zealand Department of Scientific and Industrial Research 164: 1–304.

Currey F (1874). On a collection made by Mr. SulpizKurz Curator of the Botanic Garden, Calcutta. Transactions of the Linnean Society of London II: Bot. 1: 119–131.

Da Silva M, Minter DW (1995). Fungi from Brazil recorded by Batista and co-workers. Mycological Papers 169: 1–585.

Daâssi D, Rodríguez-Couto S, Nasri M, Mechichi T (2014). Biodegradation of textile dyes by immobilized laccase from *Coriolopsis gallica* into Ca-alginate beads. International Biodeterioration & Biodegradation 90: 71–78. DOI: 10.1016/j.ibiod.2014.02.006.

Dahlberg A (2019). *Hapalopilus croceus*. *The IUCN Red List of Threatened Species* 2019:e.T58521209A58521216. DOI:10.2305/IUCN.UK.20192.RLTS.T58521209A58521216.en.

Dai YC (1995). *Phellinus sensu lato* (Aphyllophorales, Hymenochaetaceae) in East Asia. Acta Botanica Fennica 116: 1–115.

Dai YC (1995a). Changbai wood-rotting fungi-3. The genus *Phellinidium* (Basidiomycetes) and a new species, *P. aciferum*. Annales Botanici Fennici 32: 63–73.

Dai YC (1996). Changbai wood-rotting fungi 5. Study on *Polyporus mongolicus* and *P. tubaeformis*. Annals Botanici Fennici 33: 153–163.

Dai YC (1998). Changbai wood rotting fungi 9: three new species and other species in *Rigidoporus*, *Skeletocutis* and *Wolfiporia* (Basidiomycota, Aphyllopholares). Annales botanici Fennici 35: 2–9.

Dai YC (1999). Changbai wood-rotting fungi 11. Species of *Polyporus sensu stricto.* Fungal Science 14: 67–77.

Dai YC (2000). A checklist of polypores from Northeast China. Karstenia 40: 23–29.

Dai YC (2010). Hymenochaetaceae (Basidiomycota) in China. Fungal Diversity 45: 131–343. DOI: 10.1007/s13225-010-0066-9.

Dai YC (2011). A revised checklist of corticioid and hydnoid fungi in China for 2010. Mycoscience 52: 69–79. DOI: 10.1007/S10267-010-0068-1.

Dai YC (2012). Polypore diversity in China with an annotated checklist of Chinese polypores. Mycoscience 53: 49–80. DOI: 10.1007/s10267-011-0134-3.

Dai YC (2012a). Two new polypores from tropical China, and renaming two species of *Polyporus* and *Phellinus*. Mycoscience 53: 40–44. DOI: 10.1007/s10267-011-0135-2.

Dai YC, Bau T (2007). Illustrations of Edible and Medicinal Fungi in Northeastern China. Science Press, Beijing, 231 p.

Dai YC, Cui BK (2005). Two new species of Hymenochaetaceae from Eastern China. Mycotaxon 94: 341–347.

Dai, YC, Hattori T (2007). *Postia japonica* (Basidiomycota), a new polypore from Japan. Mycotaxon 102: 113–118.

Dai YC, Li HJ (2012). Type studies on *Coltricia* and *Coltriciella* described by EJH Corner from Southeast Asia. Mycoscience 53: 337–346. DOI: 10.1007/s10267-011-0174-8.

Dai YC, Niemelä T (1995). Changbai wood-rotting fungi 4. Some species described by A.S. Bondartsev and L.V. Lyubarsky from the Russian Far East. Annales Botanicci Fennici 32: 211–226.

Dai YC, Niemelä T (2002). Changbai wood-rotting fungi 13. *Antrodia sensu lato*. Annales Botanici Fennici 39: 257–265.

Dai YC, Niemelä T (2006). Hymenochaetaceae in China: hydnoid, stereoid and annual poroid genera, plus additions to *Phellinus*. Acta Botanica Fennica 179: 1–78.

Dai YC, Penttilä R (2006). Polypore diversity of Fenglin Nature Reserve, northeastern China. Annales Botanici Fennici 43: 81–96.

Dai YC, Wu SH (2002). The finding of *Inonotus rodwayi* in Taiwan. Fungal Science 17: 19–22.

Dai YC, Yang ZL (2008). A revised checklist of medicinal fungi in China. Mycosystema 27: 801–824. DOI: 10.1111/j.1439-0329.2007.00485.x.

Dai YC, Yuan HS (2007). Type studies on polypores described by G.Y. Zheng and Z.S. Bi from Southern China. Sydowia 59: 25–31.

Dai YC, Yuan HS (2010). Type studies on polypores described by J. D. Zhao. *Annales Botanici Fennici* 47: 113–117. DOI: 10.5735/085.047.0204.

Dai YC, Zhang XQ (2001). *Inonotus diverticuloseta*, new to the Chinese polypore flora. Fungal Science 16: 13–16.

Dai YC, Zhang XQ, Zhou TS (2001). New and noteworthy species of Hymenochaetaceae. Mycosystema 20: 16–21.

Dai YC, Niemela T, Kinnunen J (2002). The polypore genera *Abundisporus* and *Perenniporia* (Basidiomycota) in China with notes on *Haploporus*. Annales Botanici Fennici 39: 169–182.

Dai YC, Wu SH, Chou WN (2002a). Two new polypores (Basidiomycota) from Taiwan. Mycotaxon 83: 209–216.

Dai YC, Härkonen M, Niemelä T (2003). Wood-inhabiting fungi in southern China 1. Polypores from Hunan Province. Annales Botanici Fennici 40: 381–393.

Dai YC, Wei YL, Wang Z (2004). Wood-inhabiting fungi in southern China 2. Polypores from Sichuan Province. Annals Botanici Fennici 41: 319–329.

Dai YC, Yuan HS, Cui BK (2010). *Coltricia* (Basidiomycota, Hymenochaetales) in China. Sydowia 62: 11–21.

Dai YC, Wang Z, Binder M, Hibbett DS (2006). Phylogeny and a new species of *Sparassis* (Polyporales, Basidiomycota): evidence from mitochondrial atp6, nuclear rDNA and rpb2 genes. Mycologia 98: 584–592. DOI:10.3852/mycologia.98.4.584

Dai YC, Cui BK, Yuan HS, Li BD (2007). Pathogenic wood-decaying fungi in China. Forest Pathology 37: 105–120. DOI: 10.1111/j.1439-0329.2007.00485.x.

Dai YC, Yuan HS, Wang HC, YangF, Wei YL (2009). Polypores (Basidiomycota) from Qin Mts. in Shaanxi Province, central China. Annales Botanici Fennici 46: 54–61. DOI: 10.5735/085.046.0105.

Dai YC, Yang ZL, Cui BK, Yu CJ, Zhou LW (2009a). Species diversity and utilization of medicinal mushrooms and fungi in China (Review). International Journalof Medicinal Mushrooms 11: 287–302. DOI: 10.1615/IntJMedMushr.v11.i3.80.

Dai YC, Zhou LW, Cui BK, Chen YQ, Decock C (2010). Current advances in *Phellinus sensu lato*: medicinal species, functions, metabolites and mechanisms. Applied Microbiology and Biotechnology 87: 1587–93. DOI: 10.1007/s00253-010-2711-3.

Dai YC, Xue HJ, Vlasák J, Rajchenberg M, Wang B, Zhou LW (2014). Phylogeny and global diversity of *Polyporus* group *Melanopus* (Polyporales, Basidiomycota). Fungal Diversity 64: 133–144. DOI: 10.1007/s13225-013-0248-3.

Dai YC, Cui BK, Yuan HS, He SH, Wei YL, Qin WM, Zhou LW, Li HJ (2011). Wood-inhabiting fungi in southern China 4. Polypores from Hainan Province. Annales Botanici Fennici 48: 219–231. DOI: 10.5735/085.048.0302.

Danielson RM (1984). Ectomycorrhizal associations in jack pine stands in northeastern Alberta. Canadian Journal of Botany 62: 932–939.

Dar RA, Saba I, Shahnawaz M, Qazi PH, Khan IA (2017). Antimicrobial potential of fungal endophytes from selected high value medicinal plants of the Kashmir valley – India. Journal of Phytopharmacology 6: 307–310. DOI:10.19046/abp.v04i02.02.

David A (1967). *Lenzites reichardtii* Schulz., expece nouvelle pour Ia flore Francaise. - Bull. Soc. Linn. Lyon 36: 155–163.

David A (1974). *Une nouvelle espèce de* Polyporaceae: *Tyromyces subcaesius*. Bulletin de la Société Linnéenne de Lyon 43: 119–126.

David A (1980). *É tude du genre Tyromyces sensu lato: répartition dans les genres Leptoporus, Spongiporus et Tyromyces sensu stricto.* Bull Soc Linn Lyon 49: 6–56.

David A (1988). *Bedeutung des Studiums des Kernverhaltens in der Systematik der* Polyporaceae. In: Wolkinger F, ed. Internationales Aphyllophorales-Symposium Eisenstadt 1982. Graz: Austrian Academy of Sciences. 23–28 p.

David A, Dequatre B (1985). *Antrodia albidoides* (Polyporaceae) nouvelle ultraspecies meridionale. Mycologia Helvetica 1: 357–369.

David A, Rajchenberg M (1985). Pore fungi from French Antilles and Guiana. Mycotaxon 22: 285–325.

David A, Rajchenberg M (1992). West African polypores: New species and combinations. Mycotaxon 45: 131–148.

David A, Tortič M (1984). *Amyloporiella gen. nov.* (Polyporaceae). Transactions of British Mycological Society 83: 659–667. DOI: 10.1016/ S0007-1536(84)80185-0.

De AB (1981). Taxonomy of *Polyporus ostreiformis* in relation to its morphological and cultural characters. Canadian Journal of Botany 59: 1297–1300.

De AB (2018). Record of a new host of the wood-rotting fungus *Hexagonia tenuis*. Plant Pathology & Quarantine 8: 58–62. DOI: 10.5943/ppq/8/1/8.

De Silva DD, Rapior S, Fons F, Bahkali AH, Hyde KD (2012). Medicinal mushrooms in supportive cancer therapies: an approach to anti-cancer effects and putative mechanisms of action - A Review. Fungal Diversity 55: 1–35. DOI: 10.1007/s13225-012-0151-3.

De AB, Roy A (1981). Studies on Indian Polypores. IV. Morphological and cultural characters of *Polyporus grammocephalus*. Mycologia 73: 150–156.

De Koker TH, Nakasone KK, Haarhof J, Burdsall HH, Janse BJH (2003). Phylogenetic relationships of the genus *Phanerochaete* inferred from the internal transcribed spacer region. Mycological Research 107: 1032–1040. DOI: 10.1017/s095375620300827x.

Decock C (2001). Studies in *Perenniporia*. Some Southeast Asian taxa revisited. Mycologia 93: 774–795.

Decock C (2007). On the genus *Microporellus*, with two new species and one recombination *M. papuensis spec. nov*., *M. adextrinoideus spec. nov*., and *M. terrestris comb. Nov*. Czech Mycology 5: 153–170.

Decock C (2011). Studies in *Perenniporia s.l.* (Polyporaceae): African taxa VIII. *Truncospora oboensis sp. nov*., an undescribed species from high elevation, mist forest of São Tome. Cryptogamie Mycologie 32: 383–390. 10.7872/crym.v32.iss4.2011.383.

Decock C, Ryvarden L (1999). Studies in *Perenniporia*. *P. detrita* and its taxonomic synonyms. Mycologia 91: 386–395.

Decock C, Ryvarden L (1999a). Studies in neotropical polypores 1. Some coloured resupinate *Perenniporia* species. Mycological Research 103: 1138–1144.

Decock C, Herrera-Figueroa S (2000). Studies in *Perenniporia*. *Navisporus ortizii*, a synonym of *Perenniporiu martius*, and a note on *Navisporus* and *Perenniporia* in Cuba. Cryptogamie Mycologie 21: 153–162. DOI: 10.1016/s0181-1584(00)01041-1.

Decock C, Ryvarden L (2000). Studies in neotropical polypores. 6. New resupinate *Perenniporia* species with small pores and small basidiospores. Mycologia 92: 354–360.

Decock C, Mossebo DC (2002). Studies in *Perenniporia* (Basidiomycetes, Polyporaceae): African Taxa III. The new species *Perenniporia djaensis* and some records of *Perenniporia* for the Dja Biosphere Reserve, Cameroon. Systematics and Geography of Plants 72: 55–62. DOI: 10.2307/3668763.

Decock C, Ryvarden L (2002). Two undescribed *Microporellus* species and notes on *M. clemensiae*, *M. setigerus*, and *M. subincarnatus*. Czech Mycology 54: 1–2.

Decock C, Ryvarden L (2003). *Perenniporiella* gen. nov. segregated from *Perenniporia*, including a key to neotropical *Perenniporia* species with pileate basidiomes. Mycological Research 107: 93–103. DOI: 10.1017/S0953756202006986.

Decock C, Herrera-Figueroa S (2006). Neotropical Ganodermataceae (Basidiomycota): *Amauroderma sprucei* and *A. dubiopansum*. Criptogamie Mycologie 27: 3–10.

Decock C, Bitew A (2012). Studies in *Perenniporia* (Basidiomycota). African taxa VI. A new species and a new record of *Perenniporia* from the Ethiopian Afromontane forests. Plant Ecology and Evolution 145: 272–278. DOI: 10.5091/plecevo.2012.628.

Decock C, Stalpers J (2006). Studies in *Perenniporia*; *Polyporus unitus*, *Boletus medulla-panis,* and the nomenclature of *Perenniporia, Poria*, and *Physisporus*, with a note on the European *Perenniporia* taxa with a resupinate basidiome. Taxon 55: 759–778. DOI: 10.2307/25065650.

Decock C, Ryvarden L (2013). Neotropical *Perenniporia*: *Perenniporia subovoidea sp. nov.,* new records of little known species, and a key to the species with resupinate basidiome. Cryptogamie Mycologie 146: 234–239. DOI: 10.5091/plecevo.2013.808.

Decock C, Buchanan PK, Ryvarden L (2000). Revision of some Australasian taxa of *Perenniporia* (Basidiomycota, Aphyllophorales). Australian Systematic Botany 13: 823–844.

Decock C, Herrera-Figueroa S, Ryvarden L (2001). Studies in *Perenniporia*. *P. contraria* and its presumed taxonomic synonym *Fomes subannosus*. Mycologia 93: 196–204.

Decock C, Yombiyeni P, Memiaghe H (2015). Hymenochaetaceae from the Guineo-Congolian rainforest: *Phylloporia flabelliforma sp. nov*. and *Phylloporia gabonensis sp. nov.*, two undescribed species from Gabon. Cryptogamie Mycologie 36: 1–20. DOI: 10.7872/crym/v36.iss4.2015.449.

Decock C, Herrera-Figueroa S, Robledo G, Castillo G (2007). *Fomitiporia punctata* (Basidiomycota, Hymenochaetales) and its presumed taxonomic synonyms in America: taxonomy and phylogeny of some species from tropical/subtropical areas. Mycologia 99: 733–752. DOI: 10.1080/15572536.2007.11832537.

Demoulin V (2010). Why conservation of the name *Boletus applanatus* should be rejected. Taxon 59: 283–286. DOI: 10.2307/27757070.

Dennis RWG (1970). Fungus flora of Venezuela and adjacent countries. Kew Bulletin Additional Series 3: 1–531.

Deshpande (2003). Some living standing tree diseases caused by Aphyllophorales from campus of Pune University and some other places of Pune city. M. Phil Thesis, University of Pune.

Dhanda RS, Ryvarden L (1975). Two remarkable polypores from India. Transactions of British Mycological Society 65: 413–417.

Dhingra GS (1987). The genus *Phlebiopsis* in the Eastern Himalayas. Nova Hedwigia 44: 221–227.

Dhingra GS (1989). Genus *Hyphoderma* Wallr. Em Donk in the Eastern Himalayas. In Plant Science Research in India. (Eds : Trivedi M L, Gill G S and Saini S S). Today and Tomorrow’s printers and publishers, New Delhi: 197–212.

Dhingra GS (1989a). Genus *Phlebia* Fr. in the Eastern Himalaya. Journal of the Indian Botanical Society 84: 111–117.

Dhingra GS, Priyanka (2011). *Hallenbergia* (Agaricomycetes), a new corticioid genus. Mycotaxon 118: 289–292.

Dhingra GS, Singla N (1993). Studies in the North West Himalayan Corticiaceae (Basidiomycetes) I. Some interesting species from Dalhousie Hills. Indian Journal of Botanical Society 72: 29–33.

Dhingra GS, Singla N (2005). Resupinate aphyllophoraceous fungi of Mussorie Hills. J, Punjab Academy of Sciences 2: 69–72.

Dhingra GS, Singh AP, Kaur J, Priyanka, Kaur H, Rani M, Sood S, Singla N, Kaur H, Jain N, Gupta S, Kaur M, Sharma J, Rajnish, Kaur G (2014). A checklist of resupinate, non–poroid Agaricomycetous fungi from Himachal Pradesh, India. Synopsis Fungorum 32: 8–37.

Dollinger NR, Vlasák J (2016). First report of *Amauroderma* from Florida. Fungi 9: 41–42.

Domanski S (1972). Fungi. Polyporaceae I (resupinatae), Mucronoporaceae I (resupinatae). Natl. Center Sei. Econ Inform, Warsaw, 234 p.

Domański S, Orłoś H, Skirgiełło A (1967). Basidiomycetes, Aphyllophorales, Polyporaceae pileatae, Mucronoporaceae pileatae, Ganodermataceae, Bondarzewiaceae, Boletopsidaceae, Fistulinaceae. In: J. Kochman & A. Skirgiełło (eds), Flora Polska. Rośliny zarodnikowe Polski i ziem ościennych. Grzyby (Mycota). 3. Państwowe Wydawnictwo Naukowe, Warszawa.

Domański S., Orłoś H., Skirgiełło A (1973). Fungi. Polyporaceae II (pileate), Mucronoporaceae I (pileate), Ganodermataceae, Bondarzewiaceae, Boletopsidaceae, Fistulinaceae. Foreign Scientific Publications Department of the National Center for Scientific, Technical and Economic Information, Warsaw, 330 p.

Dombrovská OM, Kostyshyn SS (1998). Biotransformation of lignocellulse by the fungi *Pleurotus floridae* (Fries) Kummer and *Phellinus igniarius* (Linnearus: Fries) Quelet--the pathogens of white rot in trees. Ukrainskii Biokhimicheskii Zhurnal 70: 68–74.

Dong XM, Song YH, Dong CS (2017). Nutritional requirements of the mycelial growth of *Irpex lacteus* (Basidiomycetes) in submerged culture. International Journal of Medicinal Mushrooms 19. DOI: 10.1615/IntJ Med Mushrooms.2017024530

Dong Y, He Y, Yu Z, Zhang Y, Wang N, Shou D, Li C (2016). Metabolomic investigation of rat serum following oral administration of the willow bracket medicinal mushroom, *Phellinus igniarius* (Agaricomycetes), by UPLC-HDMS. International Journal of Medicinal Mushrooms 18: 699–711. DOI: 10.1615/IntJMedMushrooms.v18.i8.60.

Donk MA (1933). *Revision de Niederlandischen Homobasidiomycetes*. Aphyllophoraceae II. Meded Bot Mus Herb Rijks Univ Utrecht 9: 1–141.

Donk MA (1948). Notes on Malesian fungi. I. Bulletin of the Botanical Gardens Buitenzorg 17: 473–482.

Donk MA (1957). Notes on resupinate hymenomycetes IV. Fungus 27: 1–29.

Donk MA (1960). The generic names proposed for polyporaceae. Persoonia 1: 173–302.

Donk MA (1962). The generic names proposed for the Agaricaceae. Beihefte zur Nova Hedwigia 5: 1–320.

Donk MA (1962a). The generic names proposed for the Polyporaceae. Additions and corrections. Persoonia 2, Part 2: 201–210.

Donk MA (1964). A conspectus of the families of Aphyllophorales. Persoonia 3: 199–324.

Donk MA (1966). Notes on European polypores - I. Persoonia. 4: 337–343.

Donk MA (1967). Notes on European polypores-II. Notes on *Poria*. Persoonia 5: 47–130.

Donk MA (1971). Progress in the study of the classification of the higher Basidiomycetes. In: Petersen, RH (ed.) Evolution in the higher Basidiomycetes, Knoxville, USA. 3–24 p.

Donk MA (1974). Checklist of European Polypores. Verhandelingen Koninklijke Nederlandse Akademie van Wetenschappen Afdeling Natuurkunde 62: 1–469.

Doskocil I, Havlik J, Verlotta R, Tauchen J, Vesela L, Macakova K, Opletal L, Kokoska L, Rada V (2016). *In vitro* immunomodulatory activity, cytotoxicity and chemistry of some central European polypores.

Pharmaceutical Biology 54: 2369–2376. DOI: 10.3109/13880209.2016. 1156708.

Douanla-Meli C, Langer EJ (2003). A new species of *Lignosus* (Polyporaceae) from Cameroon. Mycotaxon 86: 389–394.

Douanla-Meli C, Langer EJ (2004). A taxonomic study of the family Podoscyphaceae (Basidiomycetes), new species and new records in Cameroon. Mycotaxon 90: 323–335.

Douanla-Meli C, Langer EJ (2010). Reassessment of phylogenetic relationships of some lentinoid fungi with velutinate basidiomes based on partial 28S ribosomal RNA gene sequencing. Sydowia 62: 23–35.

Douanla-Meli C, Ryvarden L, Langer EJ (2007). Studies of tropical African pore fungi (Basidiomycota, Aphyllophorales): Three new species from Cameroon. Nova Hedwigia 84: 409–420. DOI: 10.1127/0029-5035/2007/0084-0409.

Drechsler-Santos ER, Gibertoni TB, Cavalcanti AMDQ (2007). *Podoscypha aculeata*, a new record for the neotropics. Mycotaxon 101: 69–72.

Drechsler-Santos ER, Groposo C, Loguercio-Leite C (2008). Additions to the knowledge of lignocellulolytic Basidiomycetes (Fungi) in forests from Santa Catarina State, Brazil. Mycotaxon 103: 197–200.

Drechsler-Santos ER, Gibertoni TB, Góes-Neto A, Cavalcanti MAQ (2009). A re-evalutation of the lignocellulolytic Agaricomycetes from the Brazilian semi-arid region. Mycotaxon 108: 241–244. DOI: 10.5248/108.241.

Drechsler-Santos ER, Gibertoni TB, Cavalcanti MAQ, Ryvarden L, Góes-Neto A (2013). Basidiomycota: *Polypores-Orelhas de pau*. In Neves MA, Baseia IG, Drechsler-Santos ER & Góes-Neto A, Eds, Guide to the common fungi of the semiarid region of Brazil. TECC Editora, Florianópolis, Brazil, 51–82 p.

Drechsler-Santos ER, Wartchow F, Coimbra VRM, Gibertoni TB, Cavalcanti MAQ (2012). Studies on lentinoid fungi (*Lentinus* and *Panus*) from the semi-arid region of Brazil. Journal of the Torrey Botanical Society 139: 437–446. DOI: 10.3159/TORREY-D-12-00019.1.

Drechsler-Santos ER, Vasconcellos-Net JRT, Gibertoni T, Góes-Neto A, Cavalcanti MA (2007). Notes on *Navisporus*: *N. terrestris* and *N. floccosus* from Brazil. Mycotaxon. 101: 265–269.

Drummond AJ, Ashton B, Buxton S, Cheung M, Cooper A, Heled J, Kearse M, Moir R, Stones-Havas S, Sturrock S, Thierer T and Wilson A (2010). Geneious v5.1, Available from http://www.geneious.com.

D'souza TM, Boominathan K, Reddy CA (1996). Isolation of laccase gene-specific sequences from white rot and brown rot fungi by PCR. Applied and Environmental Microbiology 62: 3739–3744.

Du P, Cui BK, Wang W (2009). Wood-rotting fungi in eastern China 3. A species of *Antrodia* new to China with notes on the genus. Mycosystema 28: 44–48.

Duarte M, Seixas A, Peres de Carvalho M, Tasca T, Macedo AJ (2016). Amaurocine: anti-trichomonas vaginalis protein produced by the basidiomycete *Amauroderma camerarium*. Experimental Parasitology 161: 6–11. DOI: 10.1016/j.exppara.2015.12.012.

Duhem B (2013). *Phlebia rhodana sp. nov. et Phlebia jurassica sp. nov* (Agaricomycotina), *deux espèces nouvelles de France avec hyménophore tuberculé*. Cryptogamie Mycologie 34: 291–301. DOI: 10.7872/crym.v34.iss4.2013.291.

Duru MH, Çayan GT, Deveci E (2019). Evaluation of phenolic profile, antioxidant and anticholinesterase effects of *Fuscoporia torulosa*. International Journal of Secondary Metabolite 6: 79–89. DOI: 10.21448/ijsm.496327.

Eberhardt TL, Han JS, Micales JA, Young RA (1994). Decay resistance in conifer seed cones–role of resin acids as inhibitors of decomposition by white-rot fungi. Holzforschung 48: 278–284.

Ediriweera SS, Wijesundera RLC, Nanayakkara CM, Weerasena J (2014). Macrofungi from the Sigiriya wilderness in Sri Lanka. Journal of Mycopathological Research 52: 47–51.

Eggert C, Temp U, Eriksson KE (1996). The ligninolytic system of the white rot fungus *Pycnoporus cinnabarinus*: purification and characterization of the laccase. Applied and Environmental Microbiology 62: 1151–1158.

Eik LF, Naidu M, David P, Wong KH, Tan YS, Sabaratnam V (2012). *Lignosus rhinocerus* (Cooke) Ryvarden: A medicinal mushroom that stimulates neurite outgrowth in PC-12 Cells. Evidence-Based Complementary and Alternative Medicine 2012, Article ID 320308, 7 p. DOI: 10.1155/ 2012/ 320308.

Elliot ML, Broschat TK (2001). Observations and pathogenicity experiments on *Ganoderma zonatum* in Florida. Palms 45: 62–72.

El Dine RS, El Halawany AM, Ma CM, Hattori M (2009). Inhibition of the dimerization and active site of HIV-1 protease by secondary metabolites from the Vietnamese mushroom *Ganoderma colossum*. Journal of Natural Products 72: 2019–2023. DOI: 10.1021/np900279u.

El-Mekkawy S, Meselhy MR, Nakamura N, Tezuka Y, Hattori M, Kakiuchi N (1998). Anti-HIV-1 and anti-HIV-1-protease substances from *Ganoderma lucidum*. Phytochemistry 49: 1651–1657.

Eo S, Kim Y, Lee C, Han S (1999). Antiviral activities of various water and methanol soluble substances isolated from *Ganoderma lucidum*. Journal of Ethnopharmacology 68: 129–136.

Eo SK, Kim YS, Lee CK, Han SS (2000). Possible mode of antiviral activity of acidic protein bound polysaccharide isolated from *Ganoderma lucidum* on herpes simplex viruses. Journal of Ethnopharmacology 72: 475–481.

Erden E, Ucar MC, Gezer T, Pazarlioglu NK (2009). Screening for ligninolytic enzymes from autochthonous fungi and applications for decolorization of remazole marine blue. Brazilian Journal of Microbiology 40: 346–353. DOI: 10.1590/S1517-838220090002000026.

Ergönül PG, Ilgaz Akata, Kalyoncu F, Ergönül B (2013). Fatty acid compositions of six wild edible mushroom species. The Scientific World Journal 2013: 4 p. DOI: 10.1155/2013/163964.

Eriksson J (1958). Studies in the heterbasidiomycetes and the homobasidiomycetes-Aphyllophorales of Muddus. National park in North Sweden. Symb. Bot. Upsal.1: 1–172.

Eriksson J, Ryavrden L (1975). The corticiaceae of Northern Europe- III. Fungiflora Oslo: 287–546.

Eriksson J, Ryavrden L (1976). The Corticiaceae of North Europe 4: 547–886.

Eriksson J, Hjortstam K, Ryvarden L (1981). *Phlebia-Sarcodontia*. In: The Corticiaceae of North Europe 6. Fungiflora, Oslo, 233 p.

Eriksson J, Hjortstam K, Ryvarden L (1984). The Corticiaceae of North Europe 7. *Schizopora-Suillosporium*, Fungiflora, Oslo, 169 p.

Erkkilä R, Niemelä T (1986). Polypores in the parks and forests of the city of Helsinki. Karstenia 26: 1–40.

Erkut HA (2010). Biodegradation of Azo Dyes. Springer-Verlag Berlin Heidelberg, 216 p. DOI: 10.1007/978-3-642-11847-0

Escobar GA (1978). Contribution towards a monograph of the neotropical species of Hymenochaete. Ph.D. dissertation, University of Washington. University Microfilms, Ann Arbor.

Eshghia H, Alishahib Z, Zokaeib M, Daroodia A, Tabasib E (2011). Decolorization of methylene blue by new fungus: *Trichaptum biforme* and decolorization of three synthetic dyes by *Trametes hirsuta* and *Trametes gibbosa*. European Journal of Chemistry 2: 463–468. DOI: 10.5155/eurjchem.2.4.463-468.425.

Esquivel RE, Carranza-Morse J (1996). Pathogenicity of *Phylloporia chrysita* (Aphyllophorales: Hymenochaetaceae) on *Erythrociton gymnanthus* (Rutaceae). Revista de Biologia Tropical 44: 137–145.

Estrada Alvarado I, Navarro D, Record E, Mi A, Asther M (2003). Fungal biotransformation of p-coumaric acid into caffeic acid by *Pycnoporus cinnabarinus*: an alternative for producing a strong natural antioxidant. World Journal of Microbiology and Biotechnology 19: 157–160. DOI: 10.1023/A:1023264200256.

Eugenio ME, Carbajo JM, Martin A, González AE, Villar JC (2009). Laccase production by *Pycnoporus sanguineus* under different culture conditions. Journal of Basic Microbiology 49: 433–40. DOI: 10.1002/jobm.200800347.

Evans S, Henrici A, Ing B (2006). Red data list of threatened British fungi. http://www.britmycolsoc.org.uk/mycology/conservation/red-data-list/. (accessed 15 Febuary 2013).

Fakoya S, Oloketuyi SF (2012). Antimicrobial Efficacy and phytochemical screening of Mushrooms, *Lenzites Betulinus*, and *Coriolopsis Gallica* extracts. TAF Preventive Medicine Bulletin 11: 695–698. DOI: 10.5455/pmb.1-1327262044.

Falconnier B, Lapierre C, Lesage-Meessen L, Yonnet G, Brunerie P, Colonna Ceccaldi B, Corrieu G, Asther M (1994). Vanillin as a product of ferulic acid biotransformation by the white-rot fungus *Pycnoporus cinnabarinus* I-937: identification of metabolic pathways. Journal of Biotechnology 37: 123–132.

Farook VA, Khan SS, Manimohan P (2013). A checklist of agarics (gilled mushrooms) of Kerala State, India. Mycosphere 4: 97–131. DOI: 10.5943/mycosphere/4/1/6.

Farooq M, Akram A, Afzal R, Nazir KS (2013a). Ethno-morphological studies of mushrooms collected from Soon Valley. IOSR Journal of Pharmacy and Biological Sciences 8: 05-11. DOI: 10.9790/3008-0850511.

Fernández-López J, Martín MP, Dueñas M, Tellería MT (2015). Taxonomy and phylogeny of the genus *Schizopora* (O. Hymenochaetales). XVII Congress of European Mycologists, Madeira, Portugal, 2 p.

Fernando MDM, Wijesundera RLC, Soysa P, Silva ED, Nanayakkara CM (2015). Strong radical scavenging macrofungi from the dry zone forest reserves in Sri Lanka. Frontiers in Environmental Microbiology 1: 32–38. DOI: 10.11648/j.fem.20150102.15.

Fernando MDM, Wijesundera RLC, Soysa P, Silva ED, Nanayakkara CM (2016). Antioxidant potential and content of the polyphenolic secondary metabolites of white rot macrofungi; *Flavodon flavus* (Klotzsch.) and *Xylaria feejeensis* (Berk.). Journal of Plant Science 1: 10–15. DOI: 10.25177/JPS.1.1.2.

Fernando THPS, Jayasinghe CK, Wijesundara RLC, Siriwardane D (2012). Development of an early detection method for white root disease caused by *Rigidoporus microporus*. Proceedings of the International Forestry and Environment Symposium 17: 94.

Ferreira ICFR, Barros L, Abreu RMV (2009). Antioxidants in wild mushrooms. Current Medicinal Chemistry 16: 1543–1560. DOI: 10.2174/092986709787909587.

Fiasson JL (1982). Distribution of styrylpyrones in the basidiocarps of various Hymenochaetaceae. Biochemical Systematics and Ecology10: 289–296.

Fiasson JL, Bernillon J (1983). *Recherche d'activite´s enzymatiques dans les myce´liums d'hyme´noche´tace´es pore´es d'Europe: apport taxonomique*. Bulletin trimestriel de la Société mycologique de France 99: 93–107.

Fiasson JL, Niemelä T (1984). The Hymenochaetales: a revision of the European poroid taxa. Karstenia 24: 14–28.

Fidalgo MEPK (1968). The genus *Hexagona*. Memoirs of the New York Botanical Garden. 17: 35–108.

Fidalgo O (1962). *Rick, o pai da micologia brasileira*. Rickia 1: 1–11.

Fischer M (1995). *Phellinus igniarius* and its closest relatives in Europe. Mycological Research 99: 735–744.

Fischer M (1996). On the species complexes with in *Phellinus*: *Fomitiporia* revisited. Mycological Research 100: 1459–1467.

Fischer M, Bresinsky A (1992). *Phellinus torulosus*-sexuality and evidence of intersterility groups. Mycologia 84: 823–833.

Fischer M, Wagner T (2008). RFLP analysis as a tool for identification of lignicolous basidiomycetes: European polypores. Forest Pathology 29: 295–304. DOI: 10.1046/j.1439-0329.1999.00057.x.

Fischer M, Ainsworth M, Wagner T (2001). *Phellinus cavicola*: a species not assignable to European subgroups of *Phellinus s.l.* Mycologist 15: 16–18.

Flippova & Zmitrovich (2013). Wood decay community of raised bogs in west Siberia. Environmental dynamics and global climate change 4: 1–16. DOI: 10.17816/edgcc411-16.

Florence EJM (2004). Biodiversity Documentation for Kerala, Part 2: Microorganisms (Fungi). KFRI Handbook No.17. Kerala Forest Research Institute, Peechi, Kerala, India, 292 p.

Florence EJM, Balasundaran M (2000). Mushroom cultivation using forest litter and waste wood. Kerala Forest Research Institute Research Report No. 195.

Florence EJM, Yesodharan K (1997). Status survey of macrofungal flora of Peechi-Vazhani Wildlife Sanctuary. Proceedings of Ninth Kerala Science Congress, STEC, Thiruvanathapuram, 477–479 p.

Florence EJM, Yesodharan K (2000). Macrofungal fungal flora of Peechi-Vazhani Wildlife Sanctuary. Kerala Forest Research Institute. Report No. 191.

Floudas D, Hibbett DS (2015). Revisiting the taxonomy of Phanerochaete (Polyporales, Basidiomycota) using a four gene dataset and extensive ITS sampling. Fungal Biology 119: 679–719. DOI: 10.1016/j.funbio. 2015.04.003.

Floudas D, Binder M, Riley R, Barry K, Blanchette RA, Henrissat B, Martı´nez AT, Otillar R, Spatafora JW, Yadav JS, Aerts A, Benoit I, Boyd A, Carlson A, Copeland A, Coutinho PM, de Vries RP, Ferreira P, Findley K, Foster B, Gaskell J, Glotzer D, Go´recki P, Heitman J, Hesse C, Hori C, Igarashi K, Jurgens JA, Kallen N, Kersten P, Kohler A, Ku¨es U, Kumar TK, Kuo A, LaButti K, Larrondo LF, Lindquist E, Ling A, Lombard V, Lucas S, Lundell T, Martin R, McLaughlin DJ, Morgenstern I, Morin E, Murat C, Nagy LG, Nolan M, Ohm RA, Patyshakuliyeva A, Rokas A, Ruiz-Duen˜as FJ, Sabat G, Salamov A, Samejima M, Schmutz J, Slot JC, St John F, Stenlid J, Sun H, Sun S, Syed K, Tsang A, Wiebenga A, Young D, Pisabarro A, Eastwood DC, Martin F, Cullen D, Grigoriev IV, Hibbett DS (2012). The Paleozoic origin of enzymatic lignin decomposition reconstructed from 31 fungal genomes. Science 336: 1715–1719. DOI: 10.1126/science.122174

Fossli TE, Andersen J (1998). Host preference of *Cisidae* (Coleoptera) on tree-inhabiting fungi in nothern Norway. Entomologica Fennica 9: 65–78.

Foroutan AN (2006). Studies in Park and road side tree diseases with special inference to root and heart rot fungi. PhD Thesis, University of Pune, Pune.

Foroutan AN, Vaidhya JG (2007). Record of new species of *Phellinus* in Maharashtra India. Asian Journal of Plant Sciences 6: 633–637. DOI: 10.3923/ajps.2007.633.637.

Fries EM (1815). *Observationes mycologicae* 1: 1–230.

Fries EM (1818). *Observationes mycologicae* 2: 1–372.

Fries EM (1821). *Systema Mycologicum1*, Mauritius: Greifswald, 520 p.

Fries EM (1825). *Systema Orbis Vegetabilis*. 1: 1–374.

Fries EM (1828). *Elenchus fungorum*–I. Ernestus Mauritius, Greifswald.

Fries EM (1830). *Eclogae fungorum, praecipue ex herbarus germanorum de scriptorum. Linnaea* 5: 497–553.

Fries EM (1836). *Corpus florarum provincialium Sueciae*.I. Floram scanicam, partic. 22. Uppsala: Palmblad, Sebell & C, Upsala.

Fries EM (1838). *Epicrisis systematis Mycologici*. E Typographia Academica, Uppsala, 610 p.

Fries EM (1847). *Öfvers. K. Förh. Kongl. Svenska Vetensk*. Akad. 4: 106

Fries EM (1855). *Novae Symbolae Mycologicae*. K., Vetenskapssoc. Nova acta Regiae Societatis Scientiarum Upsaliensis III, I: 17–136.

Fries EM (1874). *Hymenomycetes Europaei*. Upsala, 756 p.

Freitag M, Morrell JJ (2011). Decolorization of the polymeric dye Poly R-478 by wood-inhabiting fungi. Canadian Journal of Microbiology 38: 811–822. DOI: 10.1139/m92-133.

Fritz H, Kennedy DA, Ishii M, Fergusson D, Fernandes R, Cooley K, Seely D (2015). Polysaccharide K and *Coriolus versicolor* extracts for lung cancer: a systematic review. Integrated Cancer Therapy 14: 201–211. DOI: 10.1177/1534735415572883.

Furtado JS (1965). Relation of microstructures to the taxonomy of the *Ganodermoideae* (Polyporaceae) with special reference to the structure of the cover of the pilear surface. Mycologia 57: 588–611.

Furtado JS (1967). Some tropical species of *Ganoderma* (Polyporaceae) with pale context. Persoonia 4: 379–389.

Furtado JS (1981). Taxonomy of *Amauroderma* (Basidiomycetes, Polyporaceae). Memoirs of the New York Botanical Garden 34: 1–109.

Gadgil M, Chandran MDS (1992). Sacred groves. In: Sen, G. (Editor) Indigenous Vision. Sage Publications (India) and International Centre, New Delhi, 183–187 p.

Gafforov Y, Tomšovský M, Langer E, Zhou LW (2014). *Phylloporia yuchengii sp. nov*. (Hymenochaetales, Basidiomycota) from Western Tien Shan Mountains of Uzbekistan based on phylogeny and morphology. Cryptogamie Mycologie 35: 313–322. DOI: 10.7872/crym.v35.iss4.2014.313.

Gamboa-Trujillo P, Wartchow F, Martinez CC, Andi D, Uwinjin P, Grefa G, Entza M, Chimbo E, Chimbo J, Payaguaje J, Piyaguaje N, Payaguaje D, Licuy V, López V, Mendua M, Criollo M, Jati M, Cruz SD, Calazacón M, Flores S, Aules E, Aigaje C, Aro MD, Morales A, Murillo Y, Farinango G, Gibertoni TB (2019). Edible mushrooms of Ecuador: consumption, myths and implications for conservation. Ethnobotany Research and Applications 18: 16 p. DOI: 10.32859/era.18.38.1-15.

Ganesh PN, Leelavathy KM (1986). New records of *Phellinus* from India. Current Science 55: 727–728.

Ganesh PN, Leelavathy KM, Ryvarden L (1988). *Piloporia indica sp. nov*. from India. Transactions of British Mycological Society 91: 169–171.

Gao Y, Zhou SF, Jiang WQ, Huang M, Dai XH (2003). Effects of Ganopoly (a *Ganoderma lucidum* polysaccharide extract) on immune functions in advanced-stage cancer patients. Immunological Investigations 32: 201–215. DOI: 10.1081/IMM-120022979.

Gao Y, Wang P, Wang Y, Wu L, Wang X, Zhang k, Liu Q (2017). *In vitro* and *in vivo* activity of *Fomitopsis Pinicola* (Sw. *ex* Fr.) Karst chloroform (Fpkc) extract against S180 tumor cells. Cell Physiology and Biochemistry 44: 2042–2056. DOI: 10.1159/0004859.

Gao Y, Gao H, Tang W, Xu A, Yang H, Huang M, Lan J, Li X, Duan W, Xu C, Zhou S (2005). Antitumor activity and underlying mechanisms of Ganopoly, the refined polysaccharides extracted from *Ganoderma lucidum*, in mice. Immunological Investigations 34: 171–98.

Garcia T, Santiago MF, Ulhoa C (2006). Properties of laccases produced by *Pycnoporus sanguineus* induced by 2,5-xylidine. Biotechnology Letters 28: 633–639. DOI: 10.1007/s10529-006-0026-3

García-Sandoval R, Wang Z, Binder M, Hibbett DS (2011). Molecular phylogenetics of the Gloeophyllales and relative ages of clades of Agaricomycotina producing a brown rot. Mycologia 103: 510–524. DOI: 10.3852/10-209.

Gardes M, Bruns TD (1993). ITS primers with enhanced specifity for Basidiomycetes: application to identification of mycorrhizae and rusts. Molecular Ecology 2: 113–118.

Gäumann E (1926). Vergleichende Morphologie der Pilze, 626 p.

Gautam AK (2013). Notes on wood rotting fungi from India (1): *Trametes versicolor* - The Turkey Tail. Journal on New Biological Reports 2: 67–70.

Gaylan CM, Estebal JC, Tantengco OAG, Ragragio EM (2018). Anti-staphylococcal and antioxidant properties of crude ethanolic extracts of macrofungi collected from the Philippines. Pharmacognosy Journal 10: 106–109. DOI : 10.5530/pj.2018.1.19.

Gebhardt P, Dornberger K, Gollmick FA, Grafe U, Hartl A, Gorls H, Schlegel B, Hertweck C (2007). Quercinol, an anti-inflammatory chromene from the wood-rotting fungus *Daedalea quercina* (Oak Mazegill). Bioorganic and Medicinal Chemistry Letters 17: 2558–2560. DOI: 10.1016/j.bmcl. 2007.02.008.

Geetha D, Nair MC, Bhavanidevi S (1989). Mushroom mycelia as poultry feed. Indian Phytopathology 42: 462–463.

Gerber AL, Loguercio-Leite C (1997). New records of Polypores (Aphyllophorales) from Southern Brazil. Mycotaxon. 62: 305–318.

Gerber AL, Neves MA, Loguercio-Leite EC (1999). Some species of *Perenniporia* Murrill (Poriales, Basidiomycotina) from Southern Brazil. Revta brasil. Bot., São Paulo 22: 185–193.

Gerhold N (2000). *Zur Verbreitnung des Zimfarbenen Borstenscheiblings, Hymenochaete cinnamomea* (Pers.:Fr.) Bres. *und der Gattung Hymenochaete in Österreich* (Macromycetes). Ber. Nat.med. Verein. Innsbruck 87: 15–40.

Géry A, Dubreule C, André V, Rioult JP, Bouchart V, Heutte N, Eldin de Pécoulas P, Krivomaz T, Garon D (2018). Chaga (*Inonotus obliquus*), a future potential medicinal fungus in oncology? a chemical study and a comparison of the cytotoxicity against human lung adenocarcinoma cells (A549) and human bronchial epithelial cells (BEAS-2B). Integrated Cancer Therapy 17: 832–843. DOI: 10.1177/1534735418757912.

Ghate SD, Sridhar KR (2017). Bioactive potential of *Lentinus squarrosulus* and *Termitomyces clypeatus* from the Southwestern region of India. Indian Journal of Natural Products and Resources 8: 120–131.

Ghobad-Nejhad M (2011). Updated checklist of corticioid and poroid basidiomycetes of the *Caucasus* region. Mycotaxon 117: 508.

Ghobad-Nejhad M, Dai YC (2007). The genus *Phellinus s.l.* (Basidiomycota) in Iran. Mycotaxon. 101: 201–222.

Ghobad-Nejhad M, Kortiranta H (2008). The genus *Inonotus sensu lato* in Iran, with keys to *Inocutis* and *Mensularia* worldwide. Annales Botanici Fennici 45: 465–476. DOI: 10.5735/085.045.0605.

Ghobad-Nejad M, Hallenberg N, Parmasto E, Kotiranta H (2009). A first annotated checklist of corticoid and polypore basidiomycetes of the Caucasus region. Mycologia Balcanica 6: 123–168.

Ghosh SK (2013). Isolation of polysaccharides and terpenoids from some basidiomycota and their antibacterial activities. British Microbiology Research Journal 4: 155–166. DOI: 10.9734/BMRJ/2014/4615.

Gibertoni TB (2008). Polyporoid fungi (Agaricomycetes, Basidiomycota) in the Estação Científica Ferreira Penna (State of Pará, Brazilian Amazonia): diversity and ecological aspects. Scientifica Acta 2: 70–74.

Gibertoni TB, Cavalcanti MAQ (2003). A mycological survey of the Aphyllophorales (Basidiomycotina) of the Atlantic rain forest in the state of Pernambuco, Brazil. Mycotaxon 87: 203–211.

Gibertoni TB, Drechsler-Santos ER (2010). Lignocellulolytic Agaricomycetes from the Brazilia Cerrado biome. Mycotaxon 111: 87–90. DOI: 10.5248/111.87.

Gibertoni TB, Ryvarden L, Cavalcanti MAQ (2004). Studies in neotropical polypores 18 New species from Brazil. Synopsis Fungorum 18: 44–56.

Gibertoni TB, Ryvarden L, Cavalcanti MAQ (2004a). Poroid fungi (Basidiomycota) of the Atlantic Rain Forest in northern Brazil. Synopsis Fungorum 18: 33–43.

Gibertoni TB, Santos PJP, Cavalcanti MAQ (2007). Ecological aspects of Aphyllophorales in the Atlantic Rain Forest in Northeast Brazil. Fungal Diversity 25: 49–67.

Gibertoni TB, Bernicchia A, Ryvarden L, Gomes-Silva AC (2008). Bresadola's polypore collection at the Natural History Museum of Trento, Italy 2. Mycotaxon 104: 321–323.

Gibertoni TB, Drechsler-Santos ER, Baltazar JM, Gomes-Silva A, Nogueira-Melo GS, Ryvarden L, Cavalcanti MAQ (2011). The genus *Trichaptum* (Agaricomycetes, Basidiomycota) in Brazil. Nova Hedwigia 93: 85–96. DOI: 10.1127/0029-5035/2011/0093-0085.

Gibertoni TB, Gomes-Silva A, Lira CRS, Melo GSN, Silva VF, Araújo-neta L, Drechsler-Santos ER (2012). Hymenochaetales in *Lista de Espécies da Flora do* Brasil. Jardim Botaˆnico do Rio de Janeiro. http:// floradobrasil.jbrj.gov.br/2012/FB092348.

Gilbertson RL (1976). The genus *Inonotus* (Aphyllophorales, Hymenochaetaceae) in Arizona. Memoirs of the New York Botanical Garden 28: 67–85.

Gilbertson RL (1979). The genus *Phellinus* (Aphyllophorales: Hymenochaetaceae) in western North America. Mycotaxon 9: 51–89.

Gilbertson RL (1980). Wood Rotting Fungi of North America. Mycologia 72: 1–49.

Gilbertson RL (1981). North American wood-rotting fungi that cause brown rots. Mycotaxon 12: 372–416.

Gilbertson RL, Adaskaveg JE (1993). Studies on wood-rotting basidiomycetes of Hawaii. Mycotaxon 49: 369–397.

Gilbertson RL, Burdsall HH (1972). *Phellinus torulosus* in North America. Mycologia 64: 1258–1269.

Gilbertson RL, Canfield ER (1973). A New *Poria* from Southern Arizona. Mycologia 65: 1117–1124.

Gilbertson RL, Martin KJ (1976). *Polyporus coronadensis*, a new species from Arizona. Mycologia 68: 1116–1120.

Gilbertson RL, Ryvarden L (1985). Some new combinations in Polyporaceae. Mycotaxon 22: 363–365.

Gilbertson RL, Ryvarden L (1986). North American Polypores. Vol. 1. Oslo, Norway: Fungiflora, 433 p.

Gilbertson RL, Ryvarden L (1987). North American polypores, vol. 2. Synopsis Fungorum Special Volume. Fungiflora, Oslo, 885 p.

Gill PK, Arora DS, Chander M (2002). Biodecolourization of azo and triphenylmethane dyes by *Dichomitus squalens* and *Phlebia spp*. Journal of Industrial Microbiology & Biotechnology 28: 201–203.

Gillet CC (1876–1878). *Les Hyménomycètes ou Description de tous les Champignons qui Croissent en France*. Ch. Thomas, Alençon.

Glen M, Bougher NL, Francis AA, Nigg SQ, Lee SS, Irianto R, Barry KM, Beadle CL, Mohammed CL (2009). *Ganoderma* and *Amauroderma* species associated with root–rot disease of *Acacia mangium* plantation trees in Indonesia and Malaysia. Australasian Plant Pathology 38: 345–356. DOI: 10.1071/AP09008.

Glen M, Yuskianti V, Puspitasari D, Francis A, Agustini L, Rimbawanto A, Indrayadi H, Gafur A, Mohammed CL (2014). Identification of basidiomycete fungi in Indonesian hardwood plantations by DNA barcoding. Forest Pathology 44: 496–508. DOI: 10.1111/efp.12146.

Göçenoğlu A, Pazarlioglu N (2014). Cinnabarinic acid: Enhanced production from *Pycnoporus cinnabarinus*, characterization, structural and functional properties. The Journal of Biological Chemistry 42: 281–290.

Góes-Neto A (1999). Polypore diversity in the state of Bahia, Brazil: a historical review. Mycotaxon 72: 43–56.

Góes-Neto A, Marques MA de O, Dias-Andrade J, Santos DS (2003). Lignicolous aphyllophoroid Basidiomycota in an Atlantic Forest fragment in the semi-arid catinga region, Brazil. Mycotaxon 88: 359–364.

Goh SM, Chan MY, Ong LGA (2016). Screening and identification of *Trametes lactinea* and *Pycnoporous coccineus* isolated from Kampar for laccase production. Malaysian Journal of Microbiology 12: 428–432.

Gomes-Silva AC, Gibertoni TB (2009). Checklist of the aphyllophoraceous fungi (Agaricomycetes) of the Brazilian Amazonia. Mycotaxon 108: 319–322. DOI: 10.5248/108.319.

Gomes-Silva AC, Gibertoni TB (2012). Neotypification of *Amauroderma picipes* Torrend, 1920 (Ganodermataceae, Agaricomycetes). Mycosphere 3: 23–27. DOI: 10.5943/mycosphere/3/1/2.

Gomes-Silva AC, Baltazar JM, Gibertoni TB (2012a). *Coltricia* and *Hymenochaete* (Hymenochaetaceae) from the Amazonia and the Atlantic Forest, Brazil: One new combination and new records. Journal of the Torrey Botanical Society 139: 428–436. DOI: 10.3159/torrey-d-12-00029.1.

Gomes-Silva AC, Ryvarden L, Gibertoni TB (2008). *Coltricia fragilissima*, a new record for Brazil. Mycotaxon 105: 469–472.

Gomes-Silva AC, Ryvarden L, Gibertoni TB (2009). New and interesting species of Hymenochaetaceae from the Brazilian Amazonia. Mycological Progress 8: 273–279. DOI: 10.1007/s11557-009-0606-4.

Gomes-Silva AC, Ryvarden L, Gibertoni TB (2011). New records of Ganodermataceae (Basidiomycota) from Brazil. Nova Hedwigia 92: 83–94. DOI: 10.1127/0029-5035/2011/0092-0083.

Gomes-Silva AC, Baltazar MB, Ryvarden L, Gibertoni TB (2010). *Amauroderma calcigenum* (Ganodermataceae, Basidio-mycota) and its presumed synonym *A. Partitum*. Nova Hedwigia 90: 449–455. DOI: 10.1127/0029-5035/2010/0090-0449.

Gomes-Silva AC, Ryvarden L, Medeiros PS, Pontes Sotão HM, Gibertoni TB (2012). *Polyporus* (Basidiomycota) in the Brazilian Amazonia, with notes on *Polyporus indigenus* I.J. Araujo & M.A. de Sousa and P. sapurema A. Møller. Nova Hedwigia 94: 227–238. DOI: 10.1127/0029-5035/2012/0094-0227.

Gomes-Silva AC, Lima-Júnior NCD, Malosso E, Ryvarden L, Gibertoni TB (2015). Delimitation of taxa in *Amauroderma* (Ganodermataceae, Polyporales) based in morphology and molecular phylogeny of Brazilian specimens. Phytotaxa 227: 201–228. DOI: 10.11646/phytotaxa.227.3.1.

Gomes-Silva AC, Medeiros PS, Mayra A, Soares DS, Sotão HMP, Ryvarden L, Gibertoni TB (2014). Two new species of *Rigidoporus* (Agaricomycetes) from Brazil and new records from the Brazilian Amazonia. Phytotaxa 156: 191–200. DOI: 10.11646/phytotaxa.156.4.1.

Gómez J, Rodríguez D, Pazos M, Sanromán MA (2006). Applicability of *Coriolopsis rigida* for biodegradation of polycyclic aromatic hydrocarbons. Biotechnology Letters 28: 1013–1017. DOI: 10.1007/s10529-006-9039-1.

González-Ball R, Ruiz-Boyer A, Carranza-Morse J (2004). *Lenzites acuta* Berk (Polyporaceae, Polyporales), *un Nuevo registro para Costa Rica y Panamá*. Brenesia 62: 75–75.

Gorjón SP (2012). Some species of *Hyphodontia s.l.* with encrusted cystidial elements. Mycosphere 3: 464–474. DOI: 10.5943 /mycosphere/3/4/10.

Gorjón SP, Bernicchia A (2009). *Antrodia sandaliae* (Polyporales, Basidiomycota) an interesting polypore collected in the Iberian Peninsula. Cryptogamie Mycologie 30: 53–56.

Gottlieb AM, Wright JE (1999). Taxonomy of *Ganoderma* from southern South America: subgenus *Ganoderma*. Mycological Research 103: 661–673.

Gottlieb AM, Wright JE (1999a). Taxonomy of *Ganoderma* from southern South America: subgenus *Elfvingia*. Mycological Research 103: 1289–1298.

Gottlieb AM, Ferrer E, Wright JE (2000). rDNA analyses as an aid to the taxonomy of species of *Ganoderma*. Mycological Reserach 104: 1033–1045.

Gottlieb AM, Saidman BO, Wright JE (1995). Characterization of six isoenzymatic systems in Argentine representatives of two groups of *Ganoderma*. Proceedings of Contributed Symposium, 59A, B 5th International Mycological Congress (eds. PK Buchanan, RS Hseu and JM Moncalvo), 25–29 p.

Gottlieb AM, Saidman BO, Wright JE (1998). Isozymes of *Ganoderma* species from southern South America. Mycological Research 102: 415–426.

Gottlieb AM, Wright JE, Moncalvo JM (2002). *Inonotus s. l.* in Argentina – morphology, cultural characters and molecular analyses. Mycological Progress 1: 299–313. DOI: 10.1007/s11557-006-0028-5.

Gowri RS, Vijayaraghavan R, Meenambigai P (2014). Microbial degradation of reactive dyes-a review. International Journal of Current Microbiology and Applied Sciences 3: 421–436.

Grand EA (2004). Systematics and species concepts in the genera *Lentinus* Fr. and *Panus* Fr., with emphasis on the *Lentinus tigrinus*, *L. crinitus* and *Panus lecomtei* complexes. PhD dissertation, University of Tennessee, 127 p. https://trace.tennessee.edu/utk_graddiss/4544.

Grand LF, Vernia CS (2002). New taxa and hosts of poroid wood-decay fungi in North Carolina. Castanea 67: 193–200.

Grand LF, Vernia CS (2005). Biogeography and hosts of poroid decay fungi in North Carolina: species of *Coltricia*, *Coltriciella* and *Inonotus*. Mycotaxon 91: 35–38.

Grand LF, Vernia CS (2007). Biogeography and hosts of poroid wood decay fungi in North Carolina: species of *Abortiporus*, *Bondarzewia*, *Grifola*, *Heterobasidion*, *Laetiporus* and *Meripilus*. Mycotaxon 99: 99–102.

Grand LF, Vernia CS, Munster MJ (2009). Biogeography and hosts of poroid wood decay fungi in North Carolina: species of *Trametes* and *Trichaptum*.

Grienke U, Zöll M, Peintner U, Rollinger JM (2014). European medicinal polypores – A modern view on traditional uses. Journal of Ethnopharmacology 154: 564–583. DOI: 10.1016/j.jep.2014.04.030.

Grigoriev IV, Nikitin R, Haridas S, Kuo A, Ohm R, Otillar R, Riley R, Salamov A, Zhao X, Korzeniewski F, Smirnova T (2013). Myco-Cosm portal: gearing up for 1000 fungal genomes. Nucleic Acids Research 42: 699–704. DOI: 10.1093/nar/gkt1183.

Greslebin A, Nakasone KK, Rajchenberg M (2004). *Rhizochaete,* new genus of phanerochaetoid fungi. Mycologia 96: 260–27. DOI: 10.1080/15572536. 2005.11832976.

Griensven LJV, Verhoeven HA (2013). *Phellinus linteus* polysaccharide extracts increase the mitochondrial membrane potential and cause apoptotic death of THP-1 monocytes. Chinese Medicine 8: 25. DOI: 10.1186/1749-8546-8-25.

Groposo C, Loguercio-Leite C (2002). *Fungos poliporóides (Basidiomycetes) da Reserva Biológica Tancredo Neves, Cachoeirinha, Rio Grande do Sul, Brasil.* Iheringia, Série Botânica 57: 39–59.

Groposo C, Loguercio-Leite C (2005). Contribution to the lignocellulolytic fungi (Basidiomycetes) of the Atlantic Rain Forest in Southern Brazil. Mycotaxon 92: 103–106.

Groposo C, Loguercio-Leite C, Góes-Neto (2007). *Fuscoporia* (Basidiomycota, Hymenochaetales) in southern Brazil. Mycotaxon 101: 55–63.

Gudikandulaa K, Vadapally P, Charyaa MAS (2017). Biogenic synthesis of silver nanoparticles from white rot fungi: Their characterization and antibacterial studies. OpenNano 2: 64–78.

Guerra G, Domínguez O, Ramos-Leal M, Manzano AN, Sánchez MI, Hernández I, Palacios H, Arguelles J (2008). Production of laccase and manganese peroxidase by white-rot fungi from sugarcane bagasse in solid bed: Use for dyes decolourisation. Sugar Technology volume 10: 260–264. DOI: 10.1007/s12355-008-0046-5.

Guerrero JJG, General MA, Serrano JE (2018). Culturable foliar fungal endophytes of mangrove species in Bicol Region, Philippines. Philippine Journal of Science 147: 563–574.

Gugliotta AM, Bononi VLR (1999). Polyporaceae *do Parque Estadual da Ilha do Cardoso, São Paulo*, Brasil. Bol. Inst. Bot. (São Paulo) 12: 1–112.

Gugliotta AM, Capelari M (1995). Polyporaceae from Ilha do Cardoso, SP, Brazil. Mycotaxon 56: 107–113.

Gugliotta AM, Abrahão MC, Gibertoni TB (2013). Polyporales in *Lista de Espécies da Flora do* Brasil. Jardim Botânico do Rio de Janeiro. http://floradobrasil.jbrj.gov.br/jabot/floradobrasil/FB121022.

Gugliotta AM, Capelari M, Bononi VLR (1996). *Estudo taxonoãmico e sinomizacëão das espeâcies do grupo Polyporus dictyopus* Mont. (Polyporaceae, Aphyllophorales). Revista Brasileira de BotaÃnica 19: 185–192.

Gugliotta AM, Poscolere GD, Campacci TVS (2011). *Criptógamos do Parque Estadual das Fontes do Ipiranga, São Paulo, Sp,* Brasil. Fungos 10: Ganodermataceae. Hoehnea 38: 687–695.

Gugliotta AM, Silveira RMB, Loguercio Leite C, Campos-Santana M, Gibertoni TB, Drechsler-Santos ER, Gomes-Silva AC, Baltazar JM (2010). Polyporales. *In Lista de Espécies da Flora do* Brasil. Jardim Botânico do Rio de Janeiro. (http://floradobrasil.jbrj.gov.br/2010/FB092405).

Gugliotta AM, Abrhão MC, Gibertoni TB, Chikowski RS, Lira CRS, Gomes-Silva AC, Araújo-Neta L, Silveira RMB, Drechsler-Santos ER (2014). Polyporales in *Lista de Espéces da Flora do* Brasil. Jardim Botânico do Rio de Janeiro. http://floradobrasil.jbrj.gov.br/jabot/flo.

Gugliotta AM, Gibertoni TB, Drechsler-Santos ER, Silveira RMB, Chikowski RS, Pires RM, Montoya CAS, Souza JF, Palacio M, Rezende DHC (2015). Polyporales in *Lista de Espécies da Flora do* Brasil. Jardim Botânico do Rio de Janeiro. http://floradobrasil.jbrj.gov.br/jabot/floradobrasil/FB92405.

Guindon S, Gascuel O (2003). A simple, fast, and accurate algorithm to estimate large phylogenies by maximum likelihood. Systematic Biology 52: 696–704. DOI: 10.1080/10635150390235520.

Gulaid H, Ryvarden L (1998). Two new species of *Amauroderma* (Ganodermataceae, Basidiomycetes). Mycologia Helvetica 10: 25–30.

Guo J, Rong S, Haiying B, Cui BK (2010). Antitumor activity of whole culture preparations of *Phellinus igniarius* and *Phellinus vaninii*. Acta Edulis Fungi 17: 84–88.

Hadibarata T, Yusoff ARM, Kristanti RA (2011). Decolorization and metabolism of anthraquionone-type dye by laccase of white-rot fungi *Polyporus* sp. S133. Water, Air and Soil Pollution: 9 p. DOI 10.1007/s11270-011-0914-6.

Hadibarata T, Yusoff ARM, Ayu R (2012). Acceleration of anthraquinone-type dye removal by white-rot fungus under optimized environmental conditions. Water, Air and Soil Pollution 223: 4669–4677. DOI: 10.1007/s11270-012-1177-6.

Hågvar S (1999). Saproxylic beetles visiting living sporocarps of *Fomitopsis pinicola* and *Fomes fomentarius*. Norwegian Journal of Entomology 46: 25–32.

Hakimi (2008). Study in some resupinate Aphyllophorales. PhD Thesis, University of Pune, Pune.

Hallenberg N (1981). Synopsis of wood-inhabiting Aphyllophorales (Basidiomycetes) and Heterobasidiomycetes from N. Iran. Mycotaxon 12: 473–502.

Hallenberg N (1983). On the *Schizopora paradoxa* complex (Basidiomycetes). Mycotaxon 18: 303–313.

Hallenberg N, Ryberg M, Nilsson RH, Wood AR, Wu SH (2008). *Pseudolagarobasidium* (Basidiomycota): on the reinstatement of a genus of parasitic, saprophytic, and endophytic resupinate fungi. Botany 86: 1319–1325. DOI: 10.1139/b08-088.

Han ML, Cui BK (2015) Morphological characters and molecular data reveal a new species of *Fomitopsis* (Polyporales) from southern China. Mycoscience 56: 168–176. DOI: doi:10.1016/j.myc.2014.05.004.

Han ML, Song J, Cui BK (2014). Morphology and molecular phylogeny for two new species of *Fomitopsis* (Basidiomycota) from South China. Mycological Progress 13: 905–914. DOI: 10.1007/s11557-014-0976-0.

Han ML, Vlasak J, Cui BK (2015). *Daedalea americana sp. nov*. (Polyporales, Basidiomycota) evidenced by morphological characters and phylogenetic analysis. Phytotaxa 204: 277–286. DOI: 10.11646/phytotaxa.204.4.4.

Han ML, Chen YY, Shen LL, Song J, Vlasák J (2016). Taxonomy and phylogeny of the brown rot fungi: *Fomitopsis* and its related genera. Fungal Diversity 80: 343–373. DOI 10.1007/s13225-016-0364-y.

Han SB, Lee CW, Jeon YJ, Hong ND, Yoo ID, Yang KH, Kim HM (1999). The inhibitory effect of polysaccharides isolated from *Phellinus linteus* on tumor growth and metastasis. Immunopharmacology 41: 157–64. DOI: 10.1016/s0162-3109(98)00063-0.

Hansen L, Knudsen H (1997). Nordic Macromycetes. Vol. 3. Heterobasidioid, aphyllophoroid and gastromycetoid basidiomycetes. Copenhagen, Denmark: Nordsvamp, 444 p.

Hansen EM, Goheen EM (2000). *Phellinus weirii* and other native root pathogens as determinants of forest structure and process in western North America. Annual Review of Phytopathology 38: 515–39. DOI: 10.1146/annurev.phyto.38.1.515.

Hao L, Hao J, Zhao M, Hou B (2011). Composition of traditional Chinese medicine preparation for resisting AIDS. China patent application CN102068671A. 2011.05.25, 11 p.

Hapuarachchi KK, Cheng CR, Wen TC, Jeewon R, Kakumyan P (2017). Mycosphere Essays 20: Therapeutic potential of *Ganoderma* species: Insights into its use as traditional medicine. Mycosphere 8: 1653–1694. DOI: 10.5943/mycosphere/8/10/5.

Hapuarachchi KK, Wen TC, Deng CY, Kang JC, Hyde KD (2015). Mycosphere Essays1: Taxonomic confusion in the *Ganoderma lucidum* species complex. Mycosphere 6: 542–559. DOI: 10.5943/mycosphere/6/5/4.

Hapuarachchi KK, Wen TC, Jeewon R, Wu XL, Kang JC, Hyde KD (2016). Mycosphere Essays 7: *Ganoderma lucidum*-are the beneficial anti-cancer properties substantiated? Mycosphere 7: 305–332. DOI: 10.5943/mycosphere/7/3/6.

Hapuarachchi KK, Karunarathna SC, Phengsintham P, Kakumyan P, Hyde KD, Wen TC (2018). *Amauroderma* (Ganodermataceae, Polyporales), bioactive compounds, beneficial properties and two new records from Laos. Asian Journal of Mycology 1: 121–136. DOI: 10.5943/ajom/1/1/10.

Hapuarachchi KK, Karunarathna SC, Phengsintham P, Yang HD, Kakumyan P, Hyde KD, Wen TC (2019). Ganodermataceae (Polyporales): Diversity in Greater Mekong Subregion countries (China, Laos, Myanmar, Thailand and Vietnam). Mycosphere 10: 221–309. DOI: 10.5943/mycosphere/10/1/6.

Hapuarachchi KK, Karunarathna SC, Raspé O, De Silva KHWL, Thawthong A, Wu XL, Kakumyan P, Hyde KD, Wen TC (2018a). High diversity of *Ganoderma* and *Amauroderma* (Ganodermataceae, Polyporales) in Hainan Island, China. Mycosphere 9: 931–982. DOI: 10.5943/mycosphere/9/5/1.

Hapuarachchi KK, Elkhateeb WA, Karunarathna SC, Cheng CR, Bandara AR, Kakumyan P, Hyde KD, Daba GM, Wen TC (2018b). Current status of global *Ganoderma* cultivation, products, industry and market. Mycosphere 9: 1025–1052. DOI: 10.5943/mycosphere/9/5/6.

Haritash AK, Kaushik CP (2009). Biodegradation aspects of polycyclic aromatic hydrocarbons (PAHs): a review. Journal of Hazardous Materials 169: 1–15. DOI: 10.1016/j.jhazmat.2009.03.137.

Hartikainen S, Miettinen O, Hatakka A, Kähkönen M (2015). Decolorization of six synthetic dyes by fungi. American Journal of Environmental Sciences 12: 77–85. DOI: 10.3844/ajessp.2016.77.85.

Harrison NA, Jones P (2003). Diseases of Coconut. In: Ploetz RC (ed) Diseases of Tropical Crops. CABI Publishing MA, 197–207 p.

Hassan KF, David A (1983). Studies on the cultural characterization of 16 species of *Hyphodontia* Eriksson and *Chaetoporellus* Bond. and Sing. *ex* Sing. Sydowia 36: 139–149.

Hattori T (1999). *Phellinus setifer sp. nov*. and *P. acontextus*, two noteworthy polypores from temperate areas of Japan, with notes on their allies. Mycoscience 40: 483–490.

Hattori T (2001). Type studies of the polypores described by EJH Corner from Asia and the West Pacific 2. Species described in *Gloeophyllum*, *Heteroporus*, *Microporellus*, *Oxyporus*, *Paratrichaptum*, and *Rigidoporus*. Mycoscience 42: 19–28.

Hattori T (2003). Type studies of the polypores described by E.J.H. Corner from Asia and West Pacific Areas. V. Species described in *Tyromyces* (2). Mycoscience. 44: 265–276.

Hattori T (2005). Diversity of wood-inhabiting polypores in temperate forest with different vegetation types in Japan. Fungal Diversity 18: 73–88.

Hattori T, Lee S (1999). Two new species of *Perenniporia* described from a lowland rainforest of Malaysia. Mycologia 91: 525–531.

Hattori T, Murakami Y (1993). Some A phyllophorales Fungi from Pakistan. Cryptogamic Flora of Pakistan 2: 93–103.

Hattori T, Ryvarden L (1994). Type studies in the Polyporaceae. 25. Species described from Japan by R. Imazeki & A. Yasuda. Mycotaxon 50: 27–46.

Hattori T, Ryvarden L (1996). Polypores from Bonin Is. (Japan) II two new species of *Phellinus* (Hymenochaetaceae, Basidiomycotina). Mycotaxon 58: 129–135.

Hattori T, Sotome K (2013). Type studies of the polypores described by E.J.H. Corner from Asia and west Pacific areas VIII. species described in *Trametes* (2). Mycoscience 54: 297–308. DOI:10.1016/j.myc.2012.10.008.

Hattori T, Sotome K, Ota Y (2011). *Postia stellifera sp. nov.*, a stipitate and terrestrial polypore from Malaysia. Mycotaxon 114: 151–161. DOI: 10.5248/114.151.

Hattori T, Yamashita S, Lee S (2012). Diversity and conservation of wood-inhabiting polypores and other aphyllophoraceous fungi in Malaysia. Biodiversity and Conservation 21: 2375–2396. DOI: 10.1007/s10531-012-0238-x.

Hattori T, Sotome K, Ota Y, Thi B, Lee S, Salleh B (2010). *Postia stellifera sp. nov.*, a stipitate and terrestrial polypore from Malaysia. Mycotaxon 114: 151–161. DOI: 10.5248/114.151.

Hattori T, Sakayaroj J, Jones EBG, Suetrong S, Preedanon S, Klaysuban A (2014). Three species of *Fulvifomes* (Basidiomycota, Hymenochaetales) associated with rots on mangrove tree *Xylocarpus granatum* in Thailand. Mycoscience 55: 344–354. DOI: 10.1016/j.myc.2014.01.001.

Hayashi M, Wada K, Munakata K (1981). New nematicidal metabolites from a fungus, *Irpex lacteus*. Agricultural and Biological Chemistry 45: 1527–1529.

He P, Pan L, He X, Xu C (2014). Optimization of culture conditions for laccase production from *Abortiporus biennis* in a pilot-scale bioreactor. Archives of Biological Science 66: 1567–1574. DOI: 10.2298/ABS1404567H.

He SH, Dai YC (2012) Taxonomy and phylogeny of *Hymenochaete* and allied genera of Hymenochaetaceae (Basidiomycota) in China. Fungal Diversity 56: 77–93. DOI: 10.1007/s13225-012-0174-9.

He SH, Li HJ (2011). Two new species of *Hymenochaete* (Hymenochaetales) from China. Mycotaxon 115: 375–382. DOI: 10.5248/115.375.

He SH, Li HJ (2011a). *Hymenochaete rhododendricola* and *H. quercicola sp. nov*. (Basidiomycota, Hymenochaetales) from Tibet, southwestern China. Nordic Journal of Botany 29: 484–487. DOI: 10.1111/j.1756-1051.2011.01217.x.

He SH, Li HJ (2013). *Pseudochaete latesetosa* and *P. subrigidula sp. nov.* (Hymenochaetales, Basidiomycota) from China based on morphological and molecular characters. Mycological Progress 12: 331–339. DOI: 10.1007/s 11557-012-0838-6.

He SH, Li HJ (2014). *Hymenochaete* (Hymenochaetales, Basidiomycota) in China 7. H. *cana sp. nov*. and *H. denticulata* New to China. Chiang Mai Journal of Science 41: 781–788.

He SH, Liu SL, Li HJ, DAI YC (2017). Two new species of *Hymenochaete* (Hymenochaetaceae, Basidiomycota) and *H. colliculosa* new to China from Shanxi Province. Phytotaxa 324: 168–178. DOI: 10.11646/phytotaxa.324.2.5

He Y, Li X, Hao C, Zeng P, Zhang M, Liu Y, Chang Y, Zhang L (2018). *Grifola frondosa* polysaccharide: a review of antitumor and other biological activity studies in China. Discovery Medicine 25: 159–176.

Heinfling A, Martínez MJ, Martínez AT, Bergbauer M, Szewzyk U (1998). Purification and characterization of peroxidases from the dye-decolorizing fungus *Bjerkandera adusta*. FEMS Microbiology Letters: 165: 43–50. DOI: 10.1111/j.1574-6968.1998.tb13125.x.

Heinfling A, Martínez MJ, Martínez AT, Bergbauer M, Szewzyk U (2011). Transformation of industrial dyes by manganese peroxidases from *Bjerkandera adusta* and *Pleurotus eryngii* in a manganese independent reaction. Applied Environmental Microbiology 64: 2788–93. DOI: 10.1128/AEM.64.8.2788-2793.1998.

Hembrom ME, Das K, Parihar A, Sengupta C (2017). *Hymenochaete conchata* (Hymenochaetaceae), a new record for Indian mycobiota. Indian Journal of Plant Sciences 6: 1–9.

Hembrom, ME, Parihar A, Das K (2013). New Distributional Records of *Ganoderma colossus* (Ganodermataceae) from Jharkhand and Rajasthan. Indian Journal of Plant Sciences 2: 49–53.

Hembrom ME, Parihar A, Das K (2015). Three interesting wood rotting macrofungi from Jharkhand (India). Journal of Threatened Taxa 8: 8518–8525. DOI: 10.11609/jott.2133.8.2.8518-8525.

Hennings P (1900). *Einige uredinean aus verschiedenan gebieten*. Hedwigia 39: 153–155.

Henrici A, Ryvarden L (1997). *Antrodia pseudosinuosa sp. nov*. Mycologist 11: 152–154. DOI: 10.1016/S0269- 915X (97) 80088-2.

Hibbett DS (1996). Phylogenetic evidence for horizontal transmission of group I introns in the nuclear ribosomal DNA of mushroom-forming fungi. Molecular Biology and Evolution 13: 903–917.

Hibbett DS, Binder M (2002). Evolution of complex fruiting body morphologies in homobasidiomycetes. Proceedings of Royal Society of London: 269: 1963–1969. DOI: 10.1098/rspb.2002.2123.

Hibbett DS, Donoghue MJ (1995). Progress toward a phylogenetic classification of the Polyporaceae through parsimony analyses of mitochondrial ribosomal DNA sequences. Canadian Journal of Botany 73 (Suppl 1): S853–S86.

Hibbett DS, Thorn RG (2001). Basidiomycota: Homobasidiomycetes. In: McLaughlin FJ, McLaughlin EG, Lemke PA, eds. Systematics and evolution. Berlin: Springer-Verlag, Mycota VII: 121–168.

Hibbett DS, Vilgalys R (1991). Evolutionary relationships of *Lentinus* to the Polyporaceae: evidence from restriction analysis of enzymatically amplified ribosomal DNA. Mycologia 83: 425–439.

Hibbett DS, Vilgalys R (1993). Phylogenetic relationships of *Lentinus* (Basidiomycotina) inferred from molecular and morphological characters. Systematic Botany 18: 409–433.

Hibbett DS, Pine EM, Langer E, Langer G, Donoghue MJ (1997). Evolution of gilled mushrooms and puffballs inferred from ribosomal DNA sequences. Proceedings of the National Academy of Sciences of the United States of America 94: 12002–12006.

Hibbett DS, Bauer R, Binder M, Giachini AJ, Hosaka K, Justo A, Larsson E, Larsson KH, Lawrey JD, Miettinen O, Nagy JG, Nilsson RH, Weiss M, Thorn RG (2014). Agaricomycetes. Systematics and Evolution, 2nd Edition, The Mycota VII Part ADJ McLaughlin and JW Spatafora (Eds.), Springer-Verlag Berlin Heidelberg 2. 373–429 p.

Hibbett DS, Bischoff JF, Blackwell M, Cannon PF, Eriksson OE, Huhndorf S, James T, Kirk PM, Lücking R, Lumbsch T, Lutzoni F, Matheny PB, Mclaughlin DJ, Powell MJ, Redhead S, Schoch CL, Spatafora JW, Stalpers JA, Vilgalys R, Aime MC, Aptroot A, Bauer R, Begerow D, Benny GL, Castlebury LA, Crous PW, Dai YC, Gams W, Geiser DM, Griffith GW, Gueidan C, Hawksworth DL, Hestmark G, Hosaka K, Humber RA, Hyde K, Ironside JE, Kõljalg U, Kurtzman CP, Larsson KH, Lichtwardt R, Longcore J, Miadlikowska J, Miller A, Moncalvo JM, Mozley-Standridge S, Oberwinkler F, Parmasto E, Reeb V, Rogers JD, Roux C, Ryvarden L, Sampaio JP, Schüssler A, Sugiyama J, Thorn RG, Tibell L, Untereiner WA, Walker C, Wang Z, Weir A, Weiss M, White MM, Winka K, Yao YJ, Zhang N (2007). A higher level phylogenetic classification of the Fungi. Mycological Research 111: 509–547. DOI: 10.1016/j.mycres.2007.03.004.

Hickman GW, Perry EJ (1997). Ten Common Wood Decay Fungi on Landscape Trees–Identification Handbook. Sacramento: Western Chapter, ISA.

Hickman GW, Perry EJ, Davis RM (2011). Wood decay fungi in landscape Trees. Pest Notes, University of California Statewide Integrated Pest Management Program Agriculture and Natural Resources, 4 p.

Hjortstam K (1983). Studies in tropical Corticiaceae (Basidiomycetes). V. Specimens from East Africa collected by L. Ryvarden. Mycotaxon 17: 555–572.

Hjortstam K, Ryvarden L (1982). Aphyllophorales from Northern Thailand. Nordic Journal of Botany 2: 273–281.

Hjortstam K, Ryvarden L, Walting (1993). Preliminary checklist of non agaricoid macromycetes in the Korup National Park, Cameroon and surrounding area. Edinburg Journal of Botany 50: 105–119.

Hjortstam K, Roberts PJ, Spooner BM (1998). Corticioid fungi from Brunei Darussalam. Kew Bulletin Additional Series 53: 805–827.

Hmd RFK (2011). Degradation of some textile dyes using biological and physical Treatments. MSC Thesis, Microbiology Department, Faculty of Science, Ain-Shams University, 231 p.

Hobbs C (1995). Medicinal Mushrooms: An Exploration of Tradition, Healing, and Culture. Santa Cruz CA, USA. Botanica Press, 252 p.

Hobbs C (2004). Medicinal Value of Turkey Tail Fungus *Trametes versicolor* (L.:Fr.) Pilat (Aphyllophoromycetideae). A Literature Review. International Journal of Medicinal Mushrooms 6: 195–218. DOI: 10.1615/IntJMedMushr.v6.i3.10.

Holec J, Beran M (2006). *Červený seznam hub (makromycetů) České republiky* (Red list of fungi (macromycetes) of the Czech Republic). Příroda 24: 1–282 (in Czech).

Hong SG, Jeong W, Jung HS (2002). Amplification of mitochondrial small subunit ribosomal DNA of polypores and its potential for phylogenetic analysis. Mycologia 94: 823–833.

Hong SJ, Jung SH (2004). Phylogenetic analysis of *Ganoderma* based on nearly complete mitochondrial small-subunit ribosomal DNA sequences. Mycologia 96: 742–755.

Hooker JD (1855). The botany of the Antarctic Voyage II, Flora Novae-Zealandiae 2: 378 p.

Hopple JS, Vilgalys R (1999). Phylogenetic relationships in the mushroom genus *Coprinus* and dark-spored allies based on sequence data from the nuclear gene coding for the large ribosomal subunit RNA: divergent domains, outgroups, and monophyly. Molecular Phylogenetics and Evolution 13: 1–19.

Horak E, Ryvarden L (1984). *Polyporus nigrocristatus sp. n.*, a new polypore from New Zealand. Sydowia 37: 47–49.

Hosagoudar VB, Abraham TK, Pushpangadan P (1996). Fungi of Kerala. Tropical Botanic Garden and Research Institute, Palode, Thiruvananthapuram, Kerala, India, 151 p.

Hou D (1950). A new species of *Ganoderma* from Taiwan. Quarterly Journal of the Taiwan Museum 3: 101–105.

Hseu RS, Wang HH, Wang HF, Moncalvo JM (1996). Differentiation and grouping of Isolates of the *Ganoderma lucidum* complex by random amplified polymorphic DNA-PCR compared with groping on basis on the internal transcribed spacer sequences. Applied and Environmental Microbiology 62: 1354–1363.

Hsu CA, Wen TN, Su YC, Jiang ZB, Chen CW, Shyur LF (2012). Biological degradation of anthroquinone and azo dyes by a novel laccase from *Lentinus* sp. Environmental Science and Technology 46: 5109–5117. DOI: 10.1021/es2047014.

Huang KC (1993). The Pharmacology of Chinese Herbs. Boca Raton: CRC 388 p.

Huang N (1998). Colored illustrations of macrofungi (Mushrooms) of China. China Agric Press, 293 p.

Hung DX, Kuo PC, Tuan NN, Trung HV, Thanh NT, Ha NT, Giang BL, Trung NQ, Ngan NT, Hai HV, Phuong DL, Quang DN, Thang TD (2019). Triterpenoids and steroids from the fruiting bodies of *Hexagonia tenuis* and their cytotoxicity. Natural Products Research 10: 1–6. DOI: 10.1080/ 14786419.2019.1624963.

Huang HC, Liu YC (2007). Acceleration of mycelia growth by adding *Grifola umbellata* broth concentrate in solid-state and submerged cultures. Biochemical Engineering Journal 37: 139–143. DOI: 10.1016/j.bej. 2007.04.003.

Huang SQ, Ning ZX (2010). Extraction of polysaccharide from *Ganoderma lucidum* and its immune enhancement activity. International Journal of Biological Macromolecules 47: 336–341. DOI: 10.1016/j.ijbiomac.2010.03.019.

Hussein JM, Tibuhwa DD, Mshandete AM, Kivaisi AK (2015). Antioxidant properties of seven wild edible mushrooms from Tanzania. African Journal of Food Science 9: 471–479. DOI: 10.5897/AJFS2015.1328.

Hutchison LJ (1991). Descriprion and identification of cultures of ectomycorrhizal fungi found in North America. Mycotaxon. 42: 387–504.

Hyder R, Pennanen T, Hamberg L, Vainio EJ, Piri T, Hantula J (2013). Two viruses of *Heterobasidion* confer beneficial, cryptic or detrimental effects to their hosts in different situations. Fungal Ecology 6: 387–396. DOI: 10.1016/j.funeco.2013.05.005.

Ibrahim J, Altuwaijri M (2018). Chaga mushroom (*Inonotus obliquus*) inhibits growth of lung adenocarcinoma (a549) cells but not *Aspergillus fumigatus*. Current Topics in Nutraceutical Research 16: 289–296. DOI: 10.1099/acmi.ac2019.po0006.

Igmámdy Z (1962). *A fekete lemezestapló* (*Lenzites reichardtii Schulzer*). Erdézettudományi i Közlemények 1: 137–146.

Imazeki R (1939). Studies in *Ganoderma* of Nippon. Bulletin of the Tokyo Science Museum 1: 29–52.

Imazeki R (1943). Genera of Polyporaceae of Nippon. Bulletin of the Tokyo Science Museum 6: 1–111.

Ipulet P, Ryvarden L (2005). New and interesting polypores from Uganda. Synopsis Fungorum 20: 87–99.

Iqbal AM, Vidyasagaran K, Ganesh PN (2016). New records of polypores (Basidiomycota: Aphyllophorales) from the southern Western Ghats with an identification key for polypores in Peechi-Vazhani Wildlife Sanctuary, Kerala, India. Journal of Threatened Taxa 8: 9198– 9207. DOI: 10.11609/jott.2553.8.9.9198-9207.

Isanapong J, Mataraj S (2018). Application of ligninolytic enzyme of *Lentinus polychrous* on synthetic dye decolorization. Fouth International Conference on Agricultural and Biological Sciences, IOP Conf. Series: Earth and Environmental Science 185: 012004. DOI: 10.1088/1755-1315/185/ 1/012004.

Isikov VP, Kuznetzov VN (1990). Bioecological characteristics of *Phellinus torulosus* (Pers.) Bourd. et Galz. and *Ganoderma applanatum* (Pers. *ex* Wallr.) Pat. in the Crimea. Mikologiya i Fitopatologiya 24: 513–519.

Ito S (1955). Mycological Flora of Japan. Vol. II. Basidiomycetes No. 4. Auriculariales, Tremellales, Dacrymycetales, Aphyllophorales (Polyporales). Tokyo, Yokendo, 450 p.

Ivanova TS, Krupodorova TA, Barshteyn VY, Artamonova AB, Shlyakhovenko VA (2014). Anticancer substances of mushroom origin. Experimental Oncology 36: 58–66.

Izumitsu K, Hatoh K, Sumita T, Kitade Y, Morita A, Gafur A, Ohta A, Kawai M, Yamanaka T, Neda H, Ota Y, Tanaka C (2012). Rapid and simple preparation of mushroom DNA directly from colonies and fruiting bodies for PCR. Mycoscience 53: 396–401. DOI: 10.1007/S10267-012-0182-3.

Jackson HS, Dearden ER (1949). Studies of Canadian Thelephoraceae. III. Some new species from British Columbia. Canadian Journal of Research 27: 147–156.

Jahn H (1963). *Mitteleuropäische Porlingen (Polyporaceae s. lato) und ihr Vorkommen in Westfalen*. Westfäl Pilzbr 4: 91–112.

Jahn H (1981). *Die resupinaten Phellinus-Arten in Mitteleuropa mit Hinweisen auf die resupinaten Inonotus-Arten und Poria expansa* (Desm.) (=*Polyporus megaloporus* Pers.). Bibliotheca Mycologica 81: 37–151.

Jahn H, Jahn MA (1986). *Konstanz und Fluktuation der Pdzvegetation in Norra Warleda (Uppland). Beobachtungen auf einem schwedischen Bauernhof.* Westfalische Pil: briefe 10–11: 352-378.

Jamaluddin, Goswami MG, Ojha BM (2004). Fungi of India (1989–2001). Scientific Publisher, Jodhpur, 326 p.

Jaouani A, Tabka MG, Penninckx MJ (2006). Lignin modifying enzymes of *Coriolopsis polyzona* and their role in olive oil mill wastewaters decolourisation. Chemosphere 62: 1421–1430.

Jaouani A, Sami Sayadi S, Vanthournhout M, Penninckx M (2003). Potent fungi for decolourisation of olive oil mill wastewaters. Enzyme and Microbial Technology 33: 802–809. DOI: 10.1016/S0141-0229(03)00210-2.

Jaouani A, Guillénb F, Penninckx MJ, Martínez AT, Martínez MJ (2005). Role of *Pycnoporus coccineus* laccase in the degradation of aromatic compounds in olive oil mill wastewater. Enzyme and Microbial Technology: 478–486. DOI: 10.1016/j.enzmictec.2004.11.011.

Jargalmaa S, Eimes JA, Park MS, Park JY, Oh S, Lim YW (2017). Taxonomic evaluation of selected *Ganoderma* species and database sequence validation. Peer J 5: e3596. DOI: 10.7717/peerj.3596.

Jargalmaa S, Park MS, Park JY, Fong JJ, Jang Y3, Lim YW (2015). Taxonomic Study of the Genus *Abundisporus* in Korea. Mycobiology 43: 225–230. DOI: 10.5941/MYCO.2015.43.3.225.

Jarosz-Wilkołazkaa A, Kochmańska-Rdesta A, Malarczyka E, Wardasb W, Leonowicza A (2002). Fungi and their ability to decolourize azo and anthraquinonic dyes. Enzyme and Microbial Technology 30: 566–572.

Järva L, Parmasto E (1980). List of Estonian fungi. Scripta Mycolica 7: 1–331.

Jaszek M, Kos K, Matuszewska A, Grąz M, Stefaniuk D, Osińska-Jaroszuk M, Prendecka M, Jóźwik E, Grzywnowicz K (2014). Effective stimulation of the biotechnological potential of the medicinal white rot fungus: *Phellinus pini* by menadione-mediated oxidative stress. Applied Biochemistry and Biotechnology 174: 644–656. DOI: 10.1007/s12010-014-1064-2.

Jaszek M, Kos K, Matuszewska A, Grąz M, Stefaniuk D, Osińska-Jaroszuk M, Prendecka M, Jóźwik E, Grzywnowicz K (2014). Effective stimulation of the biotechnological potential of the medicinal white rot fungus: *Phellinus pini* by menadione-mediated oxidative stress. Applied Biochemistry and Biotechnology 174: 644–656. DOI: 10.1007/s12010-014-1064-2.

Jaya lakshmi R, Mallika DS, Amos SJ, Kasturi K (2015). A noval approach for treating cancer by using laccases from marine fungi. International Journal of Pharmaceutical Sciences Review and Research 34: 124–129.

Jayasinghe CK, Jayasuriya KE, Fernando THPS (1995). Pentachlorophenol-Effective and economical fungicide for the management of white root disease caused by *Rigidoporus lignosus* in Sri Lanka. Journal of the Rubber Research Institute of Sri Lanka 75: 61–70.

Jayasuriya KE (1996). Biological control of plant pathogens and possible biocontrol approaches against *Rigidoporus lignosus*, the cause of white root disease of rubber. Bulletin of the Rubber Research Institute of Sri Lanka 33: 1–12.

Jayasuriya KE, Deacon JW (1995). *In vitro* interactions between *Rigidoporus lignosus*, the cause of white root disease of rubber and some potentially antagonistic fungi. Journal of the Rubber Research Institute of Sri Lanka 76: 36–54.

Jayasuriya KE, Deacon JW (1996). A possible role for 2-Furaldehyde in the biological control of *Rigidoporus lignosus*, the cause of white root disease of rubber. Journal of the Rubber Research Institute of Sri Lanka 77: 15–27.

Jayasuriya KE, Thennakoon BI (2007). Biological control of *Rigidoporus microporus*, the cause of white root disease in rubber. Ceylon Journal of Science (Biological Sciences) 36: 9–16.

Jayasuriya KE, Deacon JW, Fernando THPS (1996). Weakening effect of 2-Furaldehyde on biological control of *Rigidoporus lignosus*, the cause of white root disease of rubber. Journal of the Rubber Research Institute of Sri Lanka 77: 54–65.

Jayasuriya KE, Deacon JW, Fernando THPS (1996a). *In vitro* antagonism caused by some species of fungi on *Rigidoporus lignosus*. Journal of the Rubber Research Institute of Sri Lanka 78: 89–101.

Jebapriya GR, Gnanadoss JJ (2013). Bioremediation of textile dye using white rot fungi: a review. International Journal of Current Research and Review 5: 1–14.

Jena R, Thatoi HN (2019). Screening and evaluation of phytochemicals and anticancer activities of *Pycnoporus coccineus*–a medicinal mushroom from similipal Biosphere Reserve, Odisha. Journal of Basic and Applied Research International 25: 271–277.

Jeong SC, Cho SP, Yang BK, Jeong YT, Ra KS, Song CH (2004). Immunomodulating activity of the exopolymer from submerged mycelia culture of *Phellinus pini*. Journal of Microbiology & Biotechnology 37: 128–132. DOI: 10.4489/MYCO.2009.37.2.128.

Jerusalem M, Yombiyeni P, Castillo G, Decock C (2019). Hymenochaetaceae (Basidiomycota, Hymenochaetales) from the Guineo-Congolian phytochorion: *Phylloporia rinoreae sp. nov*., an additional undescribed species from the Forest Global Earth Observatory Plot in Gabon. Plant Ecology and Evolution 152: 531–538. DOI: 10.5091/plecevo.2019.1567

Ji XH, Thawthong A, Wu F (2017). A new species of *Perenniporia* (Polyporales, Basidiomycota) from Thailand. Mycosphere 8: 1102–1107: DOI: 10.5943/mycosphere/8/8/10.

Ji XH, Wu F, Dai YC, Vlasák J (2017a). Two new species of *Fulvifomes* (Hymenochaetales, Basidiomycota) from America. Mycokeys 22: 1–13. DOI: 10.3897/mycokeys0.22.12380.

Ji W, Wu DM, Song CG, Liu S, Si J, Cui BK (2019). Two new *Neofomitella* species (Polyporaceae, Basidiomycota) based on morphological and molecular evidence. Mycological Progress 18: 593–602. DOI: 10.1007/s11557-019-01472-8.

Jiao C, Xie YZ, Yang X, Li H (2013). Anticancer activity of *Amauroderma rude*. PLoS ONE 8: e66504. DOI: 10.1371/journal.pone.0066504.

Jin JW, Lim YW, Lee SJ, Jung HS (2005). Phylogeny of *Phellinus* and related genera inferred from combined data of ITS and mitochondrial SSU rDNA sequences. Journal of Microbiology and Biotechnology 15: 1028–1038.

Jo SK, Ryu YH, Uhm JY (2007). Morphological Characteristics of *Phellinus linteus*, *Phellinus baumii*, and *Phellinus gilvus* Mushrooms. Conference: Spring Conference in 2007 (Korean Society oF Mycology) at: Gwangju City, Korea.

Job DJ (1985a). *Basidiomicetos xilófilos de la región mesopotámica* VI. Espécies del género *Hymenochaete* Lév. Revista de Investigaciones Agropecuárias 20: 143–165.

Job DJ (1985b). The South American collections of *Hymenochaete* Lév. (Aphyllophorales) in J. Rick’s Herbarium. Mycotaxon 24: 227–235.

Job DJ (1987). South African species of *Hymenochaete* (Aphyllophorales). South African Journal of Botany 53: 293–299.

Job DJ (1990). *Le genre Hymenochaete dans les zones tempérées de l’hémisphère sud*. Mycologia Helvetica 4: 1–51.

Jong SC, Birmingham JM (1991). Medicinal benefit of the mushroom *Ganoderma*. Advances in Applied Microbiology 37: 104–132.

Jonsell M (1998). A new anobiid-beetle for Sweden: Dorca toma minor Zahradnik (Coleoptera: Anobiidae) and its host preference. Entomologisk Tidskrift 119: 105–109.

Jonsell M, Nordlander G (1995). Field attraction of Coleoptera to odours of the wood-decaying polypores *Fomitopsis pinicola* and *Fomes fomentarius*. Annates Zoologici Fennici 32: 391–402.

Jonsell M, Nordlander G (2002). Insects in polypore fungi as indicator species: a comparison between forest sites differing in amounts and continuity of dead wood. Forest Ecology and Management 157: 101–118.

Jonsell M, Nordlander G (2004). Host selection patterns in insects breeding in bracket fungi. Ecological Entomology 29: 697–705.

Jonsell M, Nordlander G, Jonsson M (1999). Colonization patterns of insects breeding in wood-decaying fungi. Journal of Insect Conservation 3: 145–161. DOI: 10.1023/A:1009665513184.

Jonsell M, Nordlander G, Ehnström B (2001): Substrate associations of insects breeding in fruiting bodies of wood-decaying fungi. Ecological Bulletins 49: 173–194. DOI: 10.2307/20113275.

Jonsell M, Schroeder M, Larsson T (2003). The saproxylic beetle *Bolitophagus reticulatus*: its frequency in managed forests, attraction to volatiles and flight period. Ecography 26: 421–428. DOI: 10.1034/j.1600-0587.2003.03449.x.

Jonsson M (2003). Colonisation ability of the threatened tenebrionid beetle *Oplocephala haemorrhoidalis* and its common relative *Bolitophagus reticulatus*. Ecological Entomology 28: 159–167. DOI: 10.1046/j.1365-2311.2003.00499.x.

Jorge RPA, Carlos RRC, Rebeca RO; Vivian LL, Jorge LOM (2011). *Actividad antifúngica in vitro de extractos de Navisporus floccosus Y Ganoderma* sp. *contra hongos fitopatógenos*. Fitosanidad 15: 123–128.

Josefsson T, Spirin VA (2010). Records of rare aphyllophoroid fungi on Scots pine in northern Sweden. Karstenia 50: 45–52.

Joshi (2012). Marine biodiversity of Kerala. Kerala Calling 32: 34–37.

Juliette-Ornely OB, Calixte ENH, Rick-Léonid NMM, Cédric SO, Yembiyéni P, Joseph-Privat O, Roger NAG, Louis-Clément OE (2019). Phytochemical Screening, antioxidant and antiangiogenic activities of *Daedaleopsis nitida*, *Pycnoporus sanguineus* and *Phellinus gilvus* medicinal mushrooms from Gabon. The Pharmaceutical and Chemical Journal 6: 71–80.

Jülich W (1974). The genera of the *Hyphodermoideae* (Corticiaceae). Persoonia 8: 59–97.

Jülich W (1978). Studies in resupinate Basidiomycetes-V. Some new genera and species. Persoonia 10: 137–140.

Jülich W (1981). Higher taxa of Basidiomycetes. Bibliotheca Mycologica 85: 1–485.

Jülich W (1982). Notes on some Basidiomycetes (Aphyllophorales and Heterobasidiomycetes). Persoonia 11: 421–428.

Jülich W (1984). *Die Nichtblätterpilze, Gallertpilze und Bauchpilze*. Stuttgart, Germany: Gustav Fischer, 626 p.

Juma I, Mshandete AM, Tibuhwa DD, Kivaisi AK (2016). Identification of Tanzanian saprophytic edible mushrooms by amplification and sequencing of ITS/LSU regions of ribosomal RNA operon. Tanzania Journal of Science 42: 109–121.

Jung HS (1975). Revision of the Korean Aphyllophorales. M.Sc. Thesis. Seoul National University, Seoul, Korea. 34 p.

Jung HS (1991). Fungal flora of Kwanak Mountain. Proc. Coll. Natur. Sci. SNU 16: 35–71.

Jung HS (1994). Floral studies on Korean wood rotting fungi-on the flora of the Aphyllophorales (Basidiomycotina). Korean Journal of Mycology 22: 62–99.

Jung M, Liermann JC, Opatz T, Erkel G (2011). Ganodermycin, a novel inhibitor of CXCL10 expression from *Ganoderma applanatum*. Journal of Antibiotics 64: 683–686. DOI: 10.1038/ja.2011.64.

Jung P, Fong JJ, Park MS, Oh SY, Kim C, Lim YW (2014). Sequence Validation for the Identification of the White-Rot Fungi *Bjerkandera* in Public Sequence Databases. Journal of Microbiology and Biotechnology. DOI: 10.4014/jmb.1404.04021.

Junghuhn FW (1840). *Nova genera et species plantarum florae javanicae*. Tijdschr Nat Geschied 7: 285–317.

Justo A, Hibbett DS (2011). Phylogenetic classification of *Trametes* (Basidiomycota, Polyporales) based on a five-marker dataset. Taxon 60: 1567–1583. DOI: 10.1002/tax.606003.

Justo A, Miettinen O, Floudas D, Ortiz-Santana B, Sjokvist E, Lindner D, Nakasone K, Niemelä T, Larsson KH, Ryvarden L, Hibbett DS (2017). A revised family-level classification of the Polyporales (Basidiomycota). Fungal Biology 121: 798–824. DOI: 10.1016/j.funbio.2017.05.010.

Kaewchai S, Soytong K (2010). Application of biofungicides against *Rigidoporus microporus* causing white root disease of rubber trees. Journal of Agricultural Technology 6: 349–363.

Kaipper-Figueiró G, Robledo G, Reck MA, Góes-Neto A, Drechsler-Santos ER (2016). *Antrodia neotropica sp. nov*. (Polyporales,Basidiomycota): A new South American species of *Antrodia s.s.* from Brazil based on morphological, molecular and ecological data. Nova Hedwigia 103, 19 p. DOI: 10.1127/nova_hedwigia/2016/0340.

Kaliyaperumal M (2013). Molecular Taxonomy of *Ganoderma cupreum* from Southern India Inferred from ITS rDNA Sequences Analysis. Mycobiology 41: 248–51. DOI: 10.5941/MYCO.2013.41.4.248.

Kaliyaperumal M, Kalaichelvan PT (2008). *Ganoderma australe* from southern India. Microbiol Research 163: 286–92. DOI: 10.1016/j.micres.2007.01.003.

Kälvö D, Menkis A, Broberg A (2018). Secondary metabolites from the root rot biocontrol gungus *Phlebiopsis gigantea.* Molecules 23: 1417, 11 p. DOI: 10.3390/molecules23061417.

Kalyoncu F, Oskay M, Kayalar H (2010). Antioxidant activity of the mycelium of 21 wild mushroom species. Mycology 1: 195–199. DOI: 10.1080/21501203. 2010.511292.

Kamalebo HM, Malale HNSW, Ndabaga CM, Degreef J, Kesel AD (2018). Uses and importance of wild fungi: traditional knowledge from the Tshopo province in the Democratic Republic of the Congo. Journal of Ethnobiology and Ethnomedicine 14: 13. DOI 10.1186/s13002-017-0203-6.

Kamiyama M, Horiuchi M, Umano K, Kondo K, Otsuka Y, Shibamoto T (2013). Antioxidant/anti-inflammatory activities and chemical composition of extracts from the mushroom *Trametes versicolor*. International Journal of Nutrition and Food Sciences 2: 85–91. DOI: 10.11648/j.ijnfs.20130202.19.

Kanda T, Nakakubo S, Wakabayashi K, Nisizawa K (1978). Purification and properties of an exo-cellulase of avicelase type from a wood-rotting fungus, *Irpex lacteus* (*Polyporus tulipiferae*). Journal of Biochemistry 84: 1217–1226.

Kandan A, Bhaskaran R, Samiyappan R (2010). *Ganoderma*–a basal stem rot disease of coconut palm in south Asia and Asia Pacific regions. Archives of Phytopathology and Plant Protection 43: 1445–1449. DOI: 10.1080/03235400802536527.

Kang HW, Yang YH, Kim WS, Kim S, Ro HS (2014). Decolorization of triphenylmethane dyes by wild mushrooms. Biotechnology and Bioprocess Engineering 19: 519–525. DOI 10.1007/s12257-013-0663-z.

Kantelinen A, Hatakka A, Viikari L (1989). Production of lignin peroxidase and laccase by *Phlebia radiata*. Applied Microbiology and Biotechnology 31: 234–239.

Karadelev M, Rusevska K (2004). Ecology and distribution of genus *Hymenochaete* (Hymenochaetaceae) in Republic of Macedonia. Biologia Macedonica 57/58: 39–53.

Karsten PA (1879). *Symbolae ad mycologiam Fennicam*, VI, Meddel. *Acta Societatis pro Fauna et Flora Fennica* 5: 15–46.

Karsten PA (1881). *Enumeratio Boletinearum et Polyporearum Fennicum, Systemate novo dispositarum*. *Revue de Mycologie* 3: 16–19.

Karsten PA (1882). *Enumeratio Fungorum et Myxomycetum in Lapponia orientaliaestate. Notiser ur Sällskapets pro Fauna et Flora Fennica förhandlingar* 8: 193–224.

Karsten PA (1883). *Symbolae ad Mycologiam fennicam. Meddelanden af Societas pro Fauna et Flora Fennica* 9: 57–67.

Karsten PA (1887). *Fungi novi vel minus bene cogniti Fenniae et Galliae. Rev Mycol Toulouse* 9: 9–11.

Karsten PA (1889). *Symbolae ad mycologicam* XXXIX. *Meddelanden af Societas pro Fauna et Flora Fennica* 16: 84–106.

Karthikeyan A, Bhaskaran R (2001). Effect of intercrops on the intensity of basal stem rot of coconut and soil microbial population. Tropical Agricultural Research &extension 4: 117–119.

Karunarathna SC, Yang ZL, Zhao RL, Vellinga EC, Bahkali AH, Chukeatirote E, Hyde KD (2011). Three new species of *Lentinus* from northern Thailand. Mycological Progress 10: 389–398. DOI: 10.1007/s11557-010-0701-6.

Kasinath A, Novotný C, Svobodová K, Patel K, Šašek V (2003). Decolorization of synthetic dyes by *Irpex lacteus* in liquid cultures and packed-bed bioreactor.

Enzyme and Microbial Technology 32: 167–173. DOI: 10.1016/S0141-0229(02)00279-X.

Katoh K, Kuma K, Toh H, Miyata T (2005). MAFFT version 5: improvement in accuracy of multiple sequence alignment. Nucleic Acids Research 33: 511–518.

Kaur G, Kaur H, Singh AP, Dhingra GS (2014). Four new records of the genus *Hyphoderma* Wallr. From Punjab. Kavavka 42: 25–29.

Kaur M, Malik NA, Rather HA (2016). Two species of genus *Lentinus* Fr. from India. Kavaka 46: 45–47.

Kaur N, Sharma J, Singh AP, Dhingra JS (2015). Additions to genus *Hymenochaete* lév. from Himachal Pradesh. International Journal of Advanced Research 3: 836–843.

Kavina C, Pilát A (1939). *Atlas des Champignons de l'Europe*, vol. 3, Polyporaceae. Praha.

Kawashima N, Deveaux TE, Yoshida N, Matsumoto K, Kato K (2012). Choreito, a formula from Japanese traditional medicine (Kampo medicine), for massive hemorrhagic cystitis and clot retention in a pediatric patient with refractory acute lymphoblastic leukemia. Phytomedicine 19: 1143–1146. DOI: 10.1016/j.phymed.2012.06.012.

Keller J (1985). *Les cystides cristalliferes des Aphyllophorales*. Mycol. Helv.1: 277–340.

Kerekes J, Desjardin DE (2009). A monograph of the genera *Crinipellis* and *Moniliophthora* from Southeast Asia including a molecular phylogeny of the nrITS region. Fungal Diversity 37: 101–152.

Khammuang S, Sarnthima R (2007). Laccase from spent mushroom compost of *Lentinus polychrous* Lev. and its potential for Remazol Brilliant Blue R decolourisation 6: 408–413. 10.3923/biotech.2007.408.413.

Khan J, Sher HH, Khalid N (2016). *Abortiporus biennis*: the third record of this fungus and a new genus name for the Pakistan funga. Austrian Journal of Mycology 25: 19–22.

Kim C, Lee JS, Jung HS, LimYW (2009). The wood-rotting fungal flora of three islands in the Yellow Sea, Korea. Mycobiology 37: 147–151. DOI: 10.4489/MYCO.2009.37.2.147.

Kim CS, Jo JW, Kwag YN, Sung GH, Lee SG, Kim SY, Shin CH, Han SK (2015). Mushroom flora of Ulleung-gun and a newly Recorded *Bovista* species in the Republic of Korea. Mycobiology 43: 239–257. DOI: 10.5941/MYCO. 2015.43.3.239.

Kim HE, Choi YS, Kim YM (2019). Antioxidative and anti-inflammatory effect of *Phellinus igniarius* on RAW 264.7 macrophage cells. Journal of Exercise Rehabilitation 15: 2–7. DOI: 10.12965/jer.1938010.005.

Kim JS, Kim JE, Choi BS, Park SE, Sapkota K, Kim S, Lee HH, Kim CS, Park Y, Kim MK, Kim YS, Kim SJ (2008). Purification and characterization of fibrinolytic metalloprotease from *Perenniporia fraxinea* mycelia. Mycological Research 112: 990–998. DOI: 10.1016/j.mycres.2008.01.029.

Kim KM, Lee JS, Jung HS (2007). *Fomitopsis incarnatus sp. nov.* based on generic evaluation of *Fomitopsis* and *Rhodofomes*. Mycologia 99: 833–841. DOI: 10.3852/mycologia.99.6.833.

Kim KM, Yoon YG, Jung HS (2005). Evaluation of the monophyly of *Fomitopsis* using parsimony and MCMC methods 97: 812–22. DOI: 10.3852/mycologia.97.4.812.

Kim SH, Song YS, Kim SK, Kim BC, Lim CJ, Eun-Hee (2004). Anti-inflammatory and related pharmacological activities of the n-BuOH subfraction of mushroom *Phellinus linteus*. Journal of Ethnopharmacology 93: 141–146. DOI: 10.1016/j.jep.2004.03.048.

Kim SY, Jung HS (2000). Phylogenetic relationships of the Aphyllophorales inferred from sequence analysis of nuclear small subunit ribosomal DNA. Journal of Microbiology 38: 122–131.

Kim SY, Park SY, Jung HS (2001). Phylogenetic classification of *Antrodia* and related genera based on ribosomal RNA Internal Transcribed Spaces sequences. Journal of Microbiology and Biotechnology 11: 475–481.

Kim SY, Park SY, Ko KS, Jung HS (2003). Phylogenetic analysis of *Antrodia* and related taxa based on partial mitochondrial SSU rDNA sequences. Antonie Leeuwenhoek 83: 81–88.

Kimura F, Obara N, Kofujita H (2009). Screening for condensed tannin-degrading fungi with a synthetic 14C-labeled compound. Journal of Wood Science 55: 350–358. DOI 10.1007/s10086-009-1035-3.

Kinge TR, Mih AM (2011). *Ganoderma ryvardense sp. nov*. associated with basal stem rot (BSR) disease of oil palm in Cameroon. Mycosphere 2: 179–188.

Kinge TR, Mih AM (2014). *Ganoderma lobenense* (basidiomycetes), a new species from oil palm (*Elaeis guineensis*) in Cameroon. Journal of Plant Sciences 2: 242–245. DOI: 10.11648/j.jps.20140205.25.

Kiran M, Adarsh CK, Vidyasagran K, Ganesh PN (2020). Diversity of polypores In Kerala Agricultural University main campus, Vellanikkara, Kerala, India. Journal of Threatened Taxa 12: 15889–15904. DOI: 10.11609/jot.4471.12.8.15889-15904.

Kirk PM, Cannon PF, Minter MW, Stalpers JA (2008). Dictionary of the Fungi, 10th ed. CABI Publishing, Surrey, 771 p.

Kirschner R, Wu SH (2005). *Echinoporia hydnophora*, a polypore new for Taiwan. Fungal Science 20: 99–103.

Klaiklay S, Rukachaisirikul V, Phongpaichit S, Buatong J, Preedanon S, Sakayaroj J (2013). Flavodonfuran: a new difuranylmethane derivative from the mangrove endophytic fungus *Flavodon flavus* PSU-MA201, Natural Product Research: Formerly Natural Product Letters 27: 1722–1726. DOI: 10.1080/14786419.2012.750315.

Klonowska A, Gaudin C, Ruzzi M, Colao MC, Tron T (2003). Ribosomal DNA sequence analysis shows that the basidiomycete C30 belongs to the genus *Trametes*. Research in Microbiology 154: 25–8. DOI: 10.1016/S0923-2508(02)00005-0.

Klotzsch JF (1832). *Mycologische Berichtigungen*. Linnaea 7: 193–204.

Klotzsch JF (1833). *Fungi exotici et collectionibus Britannorum*. Linnaea 8: 478–490.

Knežević AZ, Milovanović N, Vukojević1 JB (2017). Antioxidative activity of *Lenzites warnieri* basidiocarps. Matica Srpska J. Nat. Sci. Novi Sad. 133: 163–171. DOI: 10.2298/zmspn1733163k.

Ko KS (2000). Phylogenetic study of polypores based on molecular sequences. Thesis (Supervisor Prof. H.S. Jung) for the Degree of Doctor in Philosophy, School of Biological Sciences, Seoul National University, 324 p.

Ko KS, Jung HS (1999). Phylogenetic re-evaluation of *Trametes consors* based on mitochondrial small subunit ribosomal DNA sequences. F. E. M. S. Microbiology Letters 170: 181–186.

Ko KS, Jung HS (2002). Phylogenetic evaluation of *Polyporus s. str*. based on molecular sequences. Mycotaxon 82: 315–322.

Ko KS, Hong SG, Jung SH (1997). Phylogenetic Analysis of *Trichaptum* Based on Nuclear 18S, 5.8S and ITS Ribosomal DNASequences 89: 727–734.

Kobayashi Y, Kariya K, Saigenji K, Nakamura K (1994). Enhancement of anti cancer activity of cisdiaminedichloroplatinum by the protein-bound polysaccharide of *Coriolus versicolor* QUEL (PS-K) in vitro. Cancer Biotherapy 9: 351–8.

Kobayashi H, Kasamo K, Mizuno H, Kim H, Kusakabe I, Murakami K (1992). Crystallization and preliminary X-ray diffraction studies of aspartic proteinase from *Irpex lacteus*. Journal of Molecular Biology 226: 1291–1293.

Komoda Y, Shimizu M, Sonoda Y, Sato Y (1989). Ganoderic acid and its derivatives as cholesterol synthesis inhibitors. Chemical and Pharmaceutical Bulletin 37: 531–533.

Komonen A (2003). Insects in wood-decaying fungi: ecology, diversity and response to forest management. Ph.D. thesis, Faculty of Forestry, University of Joensuu.

Komonen A, Ikävalko J, Weiying W (2003). Diversity patterns of fungivorous insects: comparison between glaciated vs. refugial boreal forests. Journal of Biogeography 330: 1873–1881.

Kondo R (2005). Evaluation of white rot fungi for treatment of organic wastes without enviromental impact. The 2005 World Sustainable Building Conference, Tokyo, 27–29 September 2005 (SB05Tokyo).

Korneichik TV, Kapich A (2011). Prooxidant activity of *Bjerkandera adusta* BIMF-260 and *Pleurotus ostreatus* BIMF-247 fungi in a solid-state culture. Moscow University Biological Sciences Bulletin 66: 60–62. DOI: 10.3103/S0096392511020039.

Kothari D, Patel S, Kim K (2018). Anticancer and other therapeutic relevance of mushroom polysaccharides: A holistic appraisal. Biomedicine & Pharmacotherapy 105: 377–394. DOI: 10.1016/j.biopha.2018.05.138.

Kotiranta H, Penzina T (1998). Notes on The North Ural Aphyllophorales (Basidiomycetes). In Mukhin VA, Knudsen H. (eds.). Arctic and Alpine Mycology 5: 67–81. Yaekateringburg Publ., Yaekateringburg, 172 p.

Kotiranta H, Saarenoksa R (2002). New combinations in *Irpex* (Aphyllophorales, Basidiomycetes). Polish Botany Journal 47: 103–107.

Kotiranta H, Saarenoksa R, Kytövuori I (2009). Aphyllophoroid fungi of Finland. A check list with ecology, distribution, and threat categories. Norrlinia. 19: 1–223.

Kotlaba F (1962). *Mykózy ovocných stromů působené vyššími houbami stopkovýtrusými* (Mycoses of fruit trees caused by Basidiomycetes). In: Benada J. and Špaček J., Zemědělská fytopatologie 4: 98–176, Praha.

Kotlaba F (1975). Geographical distribution and ecology of the polypore *Phellinus torulosus* (Pers. *ex* Pers.) Bourd. *et* Galz. with special regard to Czechoslovakia. Česká mykologie 29: 5–24.

Kotlaba F (1984). *Zeměpisné rozšíření a ekologe chorošů/Polyporales s.l./ v Československu*. Academia, Praha, (in Czech), 240 p.

Kotlaba F (1997). Some uncommon or rare polypores (*Polyporales* s.l.) collected on uncommon hosts. Czech Mycology 50: 133–142.

Kotlaba F, Pouzar Z (1957). On the classification of European pore fungi. Czech Mycology 11: 152–170.

Kotlaba F, Pouzar Z (1978). Notes on the *Phellinus rimosus* complex (Hymenochaetaceae). Acta Bot. Croatica 37: 171–182.

Kotlaba F, Pouzar Z (1988). Type studies of polypores described by A. Pilát – I. Czech Mycology 42: 129–136.

Kotlaba F, Pouzar Z (1990). Type studies of polypores described by Pilát 4. Czech Mycology 44: 228–237.

Kotlába F, Pouzar Z (1993). *Pilatoporus maroccanus sp. nov.* a new polypore of the *Polyporus palustris* group. Cryptogamie Mycologie 14: 215–218.

Kotlaba F, Pouzar Z (2003). Polypores (Polyporales *s.l.*) collected in Cuba. – Czech Mycologia 55: 7–50.

Klotzsch JF (1832). *Mycologische Berichtigungen*, *Linnaea* 7, 193–204.

Klotzsch JF (1833). *Fungi exoticie collectionibus britannorum, Linnaea* 7: 478–490.

Kout J, Vlasák J (2009). *Antrodia serialiformis* from the eastern USA, a new and abundant polypore similar to *A. serialis*. Mycotaxon 108: 329–335. DOI: 10.5248/108.329.

Kout J, Zíbarová L (2013). Revision of the genus *Cotylidia* (Basidiomycota, Hymenochaetales) in the Czech Republic. Czech Mycology 65: 1–13.

Kout J, Vlasak J, Spirin V (2014). Contribution to the *Antrodiella americana* species complex (Basidiomycota, *Polyporales*). Czech Mycology 66: 53–60.

Kovács B, Zomborszki ZP, Orbán-Gyapai O, Csupor-Löffler B, Liktor-Busa E, Lázár A, Papp V, Urbán E, Hohmann J, Ványolós A (2017). Investigation of antimicrobial, antioxidant, and xanthine oxidase-inhibitory activities of *Phellinus* (Agaricomycetes) mushroom species native to Central Europe. International Journal of Medicinal Mushrooms 19: 387–394. DOI: 10.1615/IntJMedMushrooms.v19.i5.10.

Krastanov A, Koleva R, Alexieva Z, Stoilova I (2013). Decolorization of industrial dyes by immobilized mycelia of *Trametes versicolor*. Biotechnology & Biotechnological Equipment 27: 4263–4268. DOI: 10.5504/BBEQ. 2013.0096.

Kreisel H. (ed.) (1987). *Pilzflora der Deutschen Demokratischen Republik*. Basidiomycetes (Gallert-, Hut- und Bauchpilze). VEB G. Fischer Verlag, Jena.

Krieglsteiner GJ (1991). Verbreitungsatlas der Großpilze Deutschlands (West). 1. Ständerpilze, Teil A. Nichtblätterpilze. E. Ulmer GmbH & Co., Stuttgart.

Krieglsteiner GJ (2000). *Die Grosspilze Baden-Würtenbergs*. Stuttgart, 629 p.

Krishna G, Samatha B, Nidadavolu SVSSSLHB, Prasad MR, Rajitha B, Charaya MAS (2015). Macrofungi in some forests of Telangana State, India. Journal of Mycology 2015: 7 p. DOI: 10.1155/2015/382476.

Krüger D (2002). Monographic studies in the genus *Polyporus* (Basidiomycotina). PhD Thesis, The University of Tennessee, Knoxville, TN, USA.

Krüger D, Gargas A (2004). The basidiomycete genus *Polyporus*-an emendation based on phylogeny and putative secondary structure of ribosomal RNA molecules. Feddes Repert 115: 530–546. DOI: 10.1002/fedr.200311052.

Krüger D, Petersen RH, Hughes KW (2006). Molecular phylogenies and mating study data in *Polyporus* with special emphasis on group ‘‘*Melanopus*’’ (Basidiomycota). Mycological Progress 5: 185–206. DOI: 10.1007/s11557-006-0512-y.

Küçükaydin S, Duru ME (2017). Lipid compositions of *Bjerkandera adusta* (Willd) P Karst. Sigma Journal of Engineering & Natural Sciences 35: 405–410.

Kühner R (1980). *Les Hyménomycètes agaricoides*. Bulletin Mensuel de la Société Linnéenne de Lyon. 49: 1–1027.

Kühner R (1928). *Le développement et la position taxonomique de l'Agaricus disseminatus Pers.* Le Botaniste 20: 1 47–195.

Kumar A, Arora S, Jain KK, Sharma KK (2019). Metabolic coupling in the co-cultured fungal-yeast suite of *Trametes ljubarskyi* and *Rhodotorula mucilaginosa* leads to hypersecretion of laccase isozymes. Fungal Biology 123: 913–926. DOI: 10.1016/j.funbio.2019.09.013.

Kumar R, Negia S, Sharma P, Prasher IB, Chaudhary S, Dhau JS, Umar A (2018a). Wastewater cleanup using *Phlebia acerina* fungi: An insight into mycoremediation. Journal of Environmental Management 228: 130–139. 10.1016/j.jenvman.2018.07.091.

Kumar S, Stecher G, Li M, Knyaz C, Tamura K (2018). MEGA X: Molecular evolutionary genetics analysis across computing platforms. Molecular Biology and Evolution 35: 1547–1549. DOI: 10.1093/molbev/msy096.

Kumar TKA, Manimohan P (2005). A new species of *Lentinus* from India. Mycotaxon 92: 119–123.

Kumar TKA, Thomas A, Kuniyil K, Nanu Salna, Nellipunath V (2018). A checklist of the non gilled fleshy fungi (Basidiomycota) of Kerala State, India. Mycotaxon 134: 221. DOI: 10.5248/134.221.

Kumar TKA, Celio GJ, Matheny PB, McLaughlin DJ, Hibbett DS, Manimohan P (2007). Phylogenetic relationships of *Auriculoscypha* based on ultrastructural and molecular studies. Mycological Research 111: 268–274.

Kuntze G (1830). In Fries E. *Ecologae fungorum*. Linnaea 5: 512.

Kuo M (2016). *Perenniporia robiniophila*. Retrieved from the MushroomExpert.Com. http://www.mushroomexpert.com/perenniporia_robiniophila.html.

Kuo MC, Weng CY, Ha CL, Wu MJ (2006). *Ganoderma lucidum* mycelia enhance innate immunity by activating NF-kappa B. Journal of Ethnopharmacology 103: 217–222. DOI: 10.1016/j.jep.2005.08.010

Lai KM, Wong KH, Cheung PCK (2008). Antiproliferative effects of sclerotial polysaccharides from *Polyporus rhinocerus* Cooke (Aphyllophoromycetideae) on different kinds of leukemic Cells. International Journal of Medicinal Mushrooms 10: 255–264. DOI: 10.1615/IntJMedMushr.v10.i3.60.

Lai WH, Siti Murni MJ, Fauzi D, Abas Mazni O, Saleh NM (2011). Optimal culture conditions for mycelial growth of *Lignosus rhinocerus*. Mycobiology 39: 92–95. DOI: 10.4489/MYCO.2011.39.2.092.

Lai WH, Loo SS, Rahmat N, Shaharuddin S, Daud F, Zamri Z, Saleh NM (2013). Molecular phylogenetic analysis of wild tiger’s milk mushroom (*Lignosus* *rhinocerus*) collected from Pahang, Malaysia and its nutritional value and toxic metal content. International Food Research Journal 20: 2301–2307.

Lalita, Prasher IB (2014). Wood rotting agaricomycetes from Uttrakhand-new to India. Journal on New Biological Reports 3: 29–37.

Lalita, Prasher IB (2014a). Additions to the wood rotting agaricomycetes of North Western Himalayas. Indian Journal of Plant Sciences 3: 130–135.

Lalita, Prasher IB (2015). Qualitative screening of lignocellulolytic enzymes in wood rotting Agaricomycetes from North Western Himalayas. Journal of Advanced Botany and Zoology V 113. DOI: 10.15297/JABZ.V1I3.07.

Lamrood P (2004). Studies of some medicinally important fungi. PhD Thesis, University of Pune, Pune, 490 p.

Langer E (1994). Die Gattung *Hyphodontia* John Eriksson. J. Cramer; Berlin.

Langer E (1998). Evolution in *Hyphodontia* (Corticiaceae, Basidiomycetes) and related Aphyllophorales inferred from ribosomal DNA sequences. Folia Cryptogama Estonica 33: 57–62.

Langer E (2002). Phylogeny of non-gilled and gilled basidiomycetes: DNA sequence inference, ultrastructure and comparative morphology. Habilitationsschrift, Universiät Tübingen, Tübingen, Germany, 48 p.

Langer EJ, Oberwinkler F (1993). Corticioid Basidiomycetes I. Morphology and Ultrastructure. Windahlia 20: 1–28. Göteborg, 29 p.

Larkin MA, Blackshields G, Brown NP, Chenna R, Mcgettigan PA, Mcwilliam H, Valentin F, Wallace IM, Wilm A, Lopez R, Thompson JD, Gibson TJ, Higgins DG (2007). Clustal W and Clustal X version 2.0. Bioinformatics 23: 2947–2948. DOI: 10.1093/bioinformatics/btm404.

Larking DM, Crawford RJ, Christie GBY, Lonergan AGT (1999). Enhanced degradation of polyvinyl alcohol by *Pycnoporus cinnabarinus* after pretreatment with Fenton’s Reagent. Applied and Environmental Microbiology 65: 1798–1800.

Larsen MJ, Cobb-Poulle LA (1990). *Phellinus* (Hymenochaetaceae). A survey of the world taxa. Synopsis Fungorum 3, Fungiflora, Oslo, 206 p.

Larsen MJ, Lombard FF (1986). New combinations in the genus *Postia* Fr. (Polyporaceae) Mycotaxon 26: 271–273.

Larsson KH (2007). Molecular phylogeny of *Hyphoderma* and reinstatement of *Peniophorella*. Mycological Research 111: 185–195. DOI: 10.1016/j.mycres. 2006.10.002.

Larsson KH (2007a). Re thinking the classification of corticioid fungi. Mycological Research 111: 1040–1063. DOI: 10.1016/j.mycres.2007.08.001.

Larsson KH, Larsson E, Koljalg U (2004). High phylogenetic diversity among corticioid homobasidiomycetes. Mycological Research 108: 983–1002. DOI: 10.1017/S0953756204000851.

Larsson KH, Parmasto E, Fischer M, Langer EJ, Nakasone KK, Redhead S (2006). Hymenochaetales: A molecular phylogeny for the hymenochaetoid clade. Mycologia 98: 926–936. DOI: 10.3852/mycologia.98.6.926.

Læssøe, Ryvarden L (2010). Studies in Neotropical polypores 26. Some new and rarely recorded polypores from Ecuador. Synopsis Fungorum 27: 34–58. Fungiflora, Oslo.

Lau BF, Abdullah N, Aminudin N, Lee HB, Yap KC, Sabaratnam V (2014). The potential of mycelium and culture broth of *Lignosus rhinocerotis* as substitutes for the naturally occurring sclerotium with regard to antioxidant capacity, cytotoxic effect, and low-molecular-weight chemical constituents. PLoS ONE 9: e102509. DOI: 10.1371/journal.pone.0102509.

Lawal B, Shittu OK, Oibiokpa FI, Berinyuy EB, Mohammed H (2016). African natural products with potential antioxidants and hepatoprotectives properties: a review. Clinical Phytoscience 2: 66 p. DOI 10.1186/s40816-016-0037-0.

Le TH, Nuytinck J, Verbeken A, Lumyong S, Desjardin ED (2007). *Lactarius* in Northern Thailand: 1. *Lactarius* subgenus *Piperites*. Fungal Diversity 24: 173–224.

Le XT, Le QHN, Pham ND, Duong VH, Dentinger BTM, Moncalvo JM (2012) *Tomophagus cattienensis sp. nov.*, a new Ganodermataceae species from Vietnam: Evidence from morphology and ITS DNA barcodes. Mycological Progress 11: 775–780. DOI: 10.1007/s11557-011-0789-3.

Leal GR, Gugliotta AM (2008). *Criptógamos do Parque Estadual das Fontes do Ipiranga,* São Paulo, SP. Fungos, 9: Meripilaceae. Hoehnea 35: 99–110. DOI: 10.1590/S2236-89062008000100007.

Lee H, Jang Y, Choi YS, Kim MJ, Lee J, Lee H, Hong JH, Lee YM, Kim GH, Kim JJ (2014). Biotechnological procedures to select white rot fungi for the degradation of PAHs. Journal of Microbiological Methods 97: 56–62. DOI: 10.1016/j.mimet.2013.12.007.

Lee HJ, Lee KT, Park Y, Lee MW (2002). Chemical constituents of the sclerotia of *Grifola umbellata*. Journal of Korea Forestry Energy 21: 16–24.

Lee J, Lim YW (2010). *Cerrena aurantipora sp. nov*. (Polyporaceae) from eastern Asia. Mycologia 102: 211–216. DOI: 10.3852/09-048.

Lee J, Hong JH, Kim JD, Ahn BJ, Kim BS, Kim GH, Kim JJ (2013). The antioxidant properties of solid-culture extracts of basidiomycetous fungi. Journal of General Applied Microbiology 59: 279–285. DOI: 10.2323/jgam.59.279.

Lee JS, Kim CM, Lim YW (2008). *Irpex hacksungii sp. nov*. (Polyporaceae) from Korea. Mycotaxon 106: 423–429.

Lee JS, Woo EJ, Oh KH, Kim JJ, Lim YW (2010). The first report of two species of *Polyporus* (Polyporaceae, Basidiomycota) from South Korea. The Journal of Microbiology 48: 748–753. DOI: 10.1007/s12275-010-0105-y.

Lee JW, Shin YJ, Cho DJ, Lim HJ, Choi WE, Lee YK (2004). Antitumor and antimutagenic effect of the protein polysaccharides from *Polyporus umbellatus*. Han'guk Sikp'um Yongyang Kwahak Hoechi 33: 475–479.

Lee JY (1975). The Common Names of Korean Higher Fungi. Korean Journal of Mycology 3: 27–30.

Lee JY (1988). Coloured Korean Mushrooms. Academic Publishing Co., Ltd., Seoul, Korea, p 204–213.

Lee JS, Kim CM, Lim YW (2008). *Irpex hacksungii sp. nov*. (Polyporaceae) from Korea. Mycotaxon 106: 423–429.

Lee TS (1990). The full list of recorded mushrooms in Korea. Korean Journal of Mycology 18: 233–259.

Lee ML, Tan NH, Fung SY, Tan CS, Ng3 ST (2012a). The antiproliferative activity of sclerotia of *Lignosus rhinocerus* (tiger milk mushroom). Evidence-Based Complementary and Alternative Medicine 2012: 5 p. DOI: 10.1155/2012/697603.

Lee S, Lee SY, Shi KS (2009). Biodegradation of 2,4,6-trinitrotoluene by white-rot fungus *Irpex lacteus.* Mycobiology 37: 17–20. DOI: 10.4489/MYCO. 2009.37.1.017.

Lee SO, Kim HY, Choi GJ, Lee HB, Jang KS, Choi YH, Kim JC (2009a). Mycofumigation with *Oxyporus latemarginatus* EF069 for control of post harvest apple decay and *Rhizoctonia* root rot on moth orchid. Journal of Applied Microbiology 106: 1213–1219. DOI: 10.1111/j.1365-2672.2008.04087.x.

Lee SS, Chang YS, Noraswati MNR (2009b). Utilisation of macrofungi by some indigenous communities for food and medicine in Peninsular Malaysia. Forest Ecology and Management 257: 2062–2065. DOI: 10.1016/j. foreco.2008.09.044.

Lee SS, Helmut B, Salmiah U (1995). Some fungi of the Sungai Halong and surrounding areas, Temenggor Forest Reserve, Hulu Perak, Malaysia. Malaysia Nature Journal 48: 147–155.

Lee SS, Alias SA, Jones EGB, Zainuddin Z, Chan HT (2012). Checklist of fungi of Malaysia. Research Pamplet, Forest Research Institute Malaysia, Swan Printing Sdn. Bhd. Seri Kambangan, 527 p.

Leelavathy KM, Ganesh PN (2000). Polypores of Kerala. Daya Publishing House. Chawla Offset Printers, 164 p.

Léger JC (1998). *Le genre Hymenochaete* Léveillé. Bibliotheca Mycologica 171: 1–319.

Leliebre-Lara V, Pferschy-Wenzig EM, Widowitz U, Ortmann S, Lima CN, Bauer R (2015). Influence of *Navisporus floccosus* (higher Basidiomycetes) n-Hexane extract on arachidonate metabolism *in vitro*. International Journal of

Medicinal Mushrooms 17: 463–469. DOI: 10.1615/IntJMedMushrooms.v17.i5.60.

Lentz PL (1955). *Stereum* and Allied Genera of Fungi in the Upper Mississippi valley. Agriculture Monograph No. 24 U. S. Department of Agriculture, Washington D. C., 98 p.

Leonard AC (1998). Two *Ganoderma* species compared. Mycologist 12: 65–68.

Leontievsky AA, Myasoedova NM, Golovleva LA (1994). Production of ligninolytic enzymes of the white rot fungus *Panus tigrinus*. Journal of Biotechnology 32: 299–307.

Lesage-Meessen L, Haon M, Uzan E, Levasseur A, Piumi F, Navarro D, Taussac S, Favel A, Lomascolo A (2011). Phylogeographic relationships in the polypore fungus *Pycnoporus* inferred from molecular data. FEMS Microbiology Letters 325: 37–48. DOI: 10.1111/j.1574-6968.2011.02412.x

Leštan D, Lamar R (1996). Development of fungal inocula for bioaugmentation of contaminated soils. Applied Environmental Microbiology 62: 2045–2052.

Léveillé JH (1846). *Description des Champignons de I and herbier du Museum de Paris*. Annales des Sciences Naturelles Botanique 5: 111–167.

Li CH, Chen PY, Chang UM, Kan LS, Fang WH, Tsai KS, Lin SB (2005). Ganoderic acid X, a lanostanoid triterpene, inhibits topoisomerases and induces apoptosis of cancer cells. Life Sciences 77: 252–265. DOI: 10.1016/j.lfs.2004.09.045.

Li HJ, Cui BK (2013). Two new *Daedalea* species (Polyporales, Basidiomycota) from South China. Mycoscience 54: 62–68. DOI: 10.1016/j.myc.2012.07.005.

Li HJ, He SH (2011). Notes on *Trametes* (Basidiomycota) in China. Mycotaxon 116: 265–281. DOI: 10.5248/116.265.

Li HJ, Cui BK, Dai YC (2014a). Taxonomy and multi-gene phylogeny of *Datronia* (Polyporales, Basidiomycota). Persoonia 32: 170–182. DOI: 10.3767/003158514X681828.

Li HJ, Han ML, Cui BK (2013). Two new *Fomitopsis* species from southern China based on morphological and molecular characters. Mycological Progress 12: 709–718. DOI: 10.1007/s11557-012-0882-2.

Li HJ, Li XC, Vlasák J, Dai YC (2014). *Neofomitella polyzonata* gen. *et sp. nov*., and *N. fumosipora* and *N. rhodophaea* transferred from *Fomitella*. Mycotaxon 129: 7–20. DOI: 10.5248/129.7

Li HJ, Si J, Zhang YZ, Sun J, He SH (2016). Taxonomic and phylogenetic studies reveal a new species from *Funalia gallica* complex (Polyporales, Basidiomycota). Mycological Progress 15: 1–8. DOI: 10.1007/s11557-016-1167-y.

Li HJ, Meng G, Zheng F, Yuan Y, Si J (2017a). Antioxidant activities of *Perenniporia robiniophila*, *P. subacida*, and *P. fraxinea* during liquid cultivation. Mycosystema 36: 229–241. DOI: 10.13346/j.mycosystema.150269.

Li J, Xiong HX, Zhou XS, Dai YC (2007a). Polypores (Basidiomycetes) from Henan Province in central China. Sydowia 59: 125–137.

Li L, Wenkui D, Peng Y, Jian Z, Yinbo Q (2009). Decolorisation of synthetic dyes by crude laccase from *Rigidoporus lignosus* W1. Journal of Chemical Technology and Biotechnology 84: 399–404. DOI: 10.1002/jctb.2053.

Li MJ, Yuan HS (2015). Type studies on *Amauroderma* species described by J.D. Zhao *et al.* and the phylogeny of species in China. Mycotaxon 130: 79–89. DOI: 10.5248/130.79.

Li T, Wu D, Yan Y, Chen L (2019). Review on structural characteristics and biological activities of *Phellinus* polysaccharides. AIP Conference Proceedings 2058: 1.

Li TY, Tian GY, Xu GB, Li YR, Jin QR, Wang HR, Fu YJ, Han ZZ (2007). Effect of polysaccharides from mycelium of *Grifola umbellata* on mice’s immunological level. Chinese Journal of Veterinary Science 1: 88–90.

Li X, Wu Q, Xie Y, Ding Y, Du WW, Sdiri M, Yang BB (2015). Ergosterol purified from medicinal mushroom *Amauroderma rude* inhibits cancer growth *in* *vitro* and *in vivo* by up-regulating multiple tumor suppressors. Oncotarget 6: 17832–17846. DOI: 10.18632/oncotarget.4026

Li Y, Simmons DR, Bateman CC, Short DPG, Kasson MT, Rabaglia RJ, Hulcer J (2015a). New fungus-insect symbiosis: culturing, molecular, and histological methods determine saprophytic Polyporales mutualists of *Ambrosiodmus Ambrosia* beetles. PLoS ONE 10: e0137689. DOI:10.1371/ journal.pone. 0137689.

Li Y, Bateman CC, Skelton J, Jusino MA, Nolen ZJ, Simmons DR, Hulcr J (2017). Wood decay fungus *Flavodon ambrosius* (Basidiomycota: Polyporales) is widely farmed by two genera of ambrosia beetles. Fungal Biology 121: 984–989. DOI: 10.1016/j.funbio.2017.08.004.

Li YQ, Wang SF (2006). Anti-hepatitis B activities of ganoderic acid from *Ganoderma lucidum*. Biotechnology letters 28: 837–41. DOI: 10.1007/s10529-006-9007-9.

Liang C, Li H, Zhou H, Zhang S, Liu Z, Zhou Q, Sun F (2012). Recombinant Lz-8 from *Ganoderma lucidum* induces endoplasmic reticulum stress-mediated autophagic cell death in SGC-7901 human gastric cancer cells. Oncology Reports 1079–1089. DOI: 10.3892/or.2011.1593.

Liew GM, Khong HY, Kutoi CJ, Sayok AK (2015). Phytochemical screening, antimicrobial and antioxidant activities of selected fungi from Mount Singai, Sarawak, Malaysia. International Journal of Research Studies in Biosciences 3: 191–197.

Lim G (1972). Some common large fungi in Malaysia and Singapore. Malaysian Nature Journal 25: 84–89.

Lim YW (2001). Systematic study of corticioid fungi based on molecular sequence analyses. Ph.D. Thesis, School of Biological Sciences, Seoul National University, Korea.

Lim JH, Kim BJ (1972). Taxonomic investigations on Korean higher fungi (I). Korean Journal of Pharmacognacy 3: 11–20.

Lim YW, Jung HS (2003). *Irpex hydnoides*, *sp. nov.* is new to science, based on morphological, cultural and molecular characters. Mycologia 95: 694–699. DOI: 10.2307/3761945.

Lim YW, Lee JS, Jung HS (2010). Fungal Flora of Korea. Basidiomycota: Hymenomycetes: Aphyllophorales, 20–22 p. The National Institute of Biological Resources, Incheon, Korea.

Lima Júnior NC de, Gibertoni TB, Malosso E (2014). Delimitation of some neotropical laccate *Ganoderma* (Ganodermataceae): molecular phylogeny and morphology. *Revista de Biología* Tropical 62: 1197–1208. DOI: 10.15517/RBT.V62I3.12380.

Lima X, Lira V, Chikowski CS, Santos CRS, Lima N, Gibertoni TB (2020). Additions to neotropical stereoid fungi (Polyporales, Basidiomycota): one new species of *Lopharia* and one new combination in *Phlebiopsis*. Mycological Progress 19: 31–40. DOI: 10.1007/s11557-019-01538-7.

Lin IH, Hau DM, Chang YH (1996). Restorative effect of *Coriolus versicolor* polysaccharides against gamma-irradiation-induced spleen injury in mice. Acta Pharmacol Sinica 6: 102–4.

Lin ZB (2005). Cellular and molecular mechanisms of immuno-modulation by *Ganoderma lucidum*. Journal of Pharmacological Science 99: 144–153.

Lindblad I, Ryvarden L (1999). Studies in neotropical polypores. 3. New and interesting Basidiomycetes (Poriales) from Costa Rica. Mycotaxon. 71: 335–359.

Lindequist U, Niedermeyer THJ, Jülich WD (2005). The Pharmacological Potential of Mushrooms. eCAM 2: 285–299. DOI: 10.1093/ecam/neh107.

Lindner DL, Banik MT (2008). Molecular phylogeny of *Laetiporus* and other brown-rot genera in North America. Mycologia 100: 417–430. DOI: 10.3852/07-124R2.

Lindner DL, Banik MT (2009). Effects of cloning and root-tip size on observations of fungal ITS sequences from *Picea glauca* roots. Mycologia 101: 157–165. DOI: 10.3852/08-034.

Lindner DL, Banik MT (2011). Intragenomic variation in the ITS rDNA region obscures phylogenetic relationships and inflates estimates of operational taxonomic units in genus *Laetiporus*. Mycologia 103: 731–740. DOI: 10.3852/10-331.

Lindner DL, Burdsall HH, Stanosz GR (2006). Species diversity of polyporoid and corticioid fungi in northern hardwood forests with differing management histories. Mycologia 98: 195–217. DOI: 10.1080/15572536.2006.11832692.

Lindner DL, Ryvarden L, Baroni TJ (2011). A new species of *Daedalea* (Basidiomycota) and a synopsis of core species in *Daedalea sensu stricto*. North American Fungi 6: 1–12. DOI: 10.2509/naf2011.006.004.

Lindsey JP (1985). Basidiomycetes that decay Gambel Oak in Southwestern Colorado. Mycotaxon 22: 327–362.

Linnaeus C (1753). *Species Plantarum.* Impensis Laurentii Salvii. Stockholm.

Linnaeus C (1764). *Species Plantarum*. Vindobonae.

Linnaeus C (1780). *Systema plantarum. ed. novissima*, Curr. J. J. Reichard, part IV.

Liu B (1974). The Chinese medical fungi. Shanxi Peoples Press, Taiyuan 1–196.

Liu B, Bau YS (1994). Fungi Pharmacopoeia (Sinica) Oakland: Kinoko 295 p.

Liu B, Ichinose T, He M, Kobayashi F, Maki T, Yoshida S, Yoshida Y, Arashidani K, Takano H, Nishikawa M, Sun G, and Shibamoto T (2014). Lung inflammation by fungus, *Bjerkandera adusta* isolated from Asian sand dust (ASD) aerosol and enhancement of ovalbumin-induced lung eosinophilia by ASD and the fungus in mice. Allergy, Asthma & Clinical Immunology 2014 10: DOI: 10. 10.1186/1710-1492-10-10.

Liu DZ, Wang F, Yang LM, Zheng YT, Liu JK (2007). A new cadinane sesquiterpene with significant anti-HIV-1 activity from the cultures of the basidiomycete *Tyromyces chioneus.* Journal of Antibiotics 60: 332–334. DOI: 10.1038/ja.2007.44.

Liu J, Mcintosh H, Lin H (2001). Chinese medicinal herbs for chronic hepatitis B: a systematic review. Liver 21: 280–286.

Liu JK, Hyde KD, Gareth Jones EB, Ariyawansa HA, Bhat DJ, Boonmee S, Maharachchikumbura SSN, McKenzie EHC, Phookamsak R, Phukhamsakda C, Shenoy BD, Abdel-Wahab MA, Buyck B, Chen J, Chethana KWT, Singtripop C, Dai DQ, Dai YC, Daranagama DA, Dissanayake AJ, Doilom M, D'souza MJ, Fan XL, Goonasekara ID, Hirayama K, Hongsanan S, Jayasiri SC, Jayawardena RS, Karunarathna SC, Li WJ, Mapook A, Norphanphoun C, Pang KL, Perera RH, Peršoh D, Pinruan U, Senanayake IC, Somrithipol S, Suetrong S, Tanaka K, Thambugala KM, Tian Q, Tibpromma S, Udayanga D, Wijayawardene NN, Wanasinghe D, Wisitrassameewong K, Zeng XY, Abdel-Aziz FA, Adamčík S, Bahkali AH, Boonyuen N, Bulgakov T, Callac P, Chomnunti P, Greiner K, Hashimoto A, Hofstetter V, Kang JC, Lewis D, Li XH, Liu XZ, Liu ZY, Matsumura M, Mortimer PE, Rambold G, Randrianjohany E, Sato G, Sri-Indrasutdhi V, Tian CM, Verbeken A, Brackel W, Wang Y, Wen TC, Xu JC, Yan JY, Zhao RL, Camporesi E (2015). Fungal diversity notes 1–110: taxonomic and phylogenetic contributions to fungal species. Fungal Diversity 72: 1–110.

Liu S, Song CG, Cui BK (2019). Morphological characters and molecular data reveal three new species of *Fomitopsis* (Basidiomycota). Mycological Progress 18: 1317–1327. DOI: 10.1007/s11557-019-01527-w.

Liu Y, Wang C, Li J, Li T, Zhang Y, Liang Y, Yuxia M (2019a). *Phellinus linteus* polysaccharide extract improves insulin resistance by regulating gut microbiota composition. The FASEB Journal 34: 1065–1078. DOI: 10.1096/fj.201901943RR

Liu Z, Liu L (2009). Essentials of Chinese medicine, Springer, Verlag, London, 378 p.

Lizoň P (2001). *Červený zoznam húb Slovenska*. 3. verzia (december 2001) (Red list of Slovak fungi. 3rd version). In: Baláž D, Marhold K, Urban P, eds, Červený zoznam rastlín a živočíchov Slovenska, Ochr. Prír. 20 (Suppl.): 6–13 (in Slovak).

Lloyd CG (1898–1925). Mycological notes nos. 1–75, many paltes, figs. Cincinnati, Ohio, 1–1364 p.

Lloyd CG (1904–1919). Mycological Letters 1–69 each separately paged. Cincinnati, Ohio.

Lloyd CG (1912). Synopsis of the stipitate Polyporoids. Bulletin of the Lloyd library of botany, pharmacy and materia medica 7: 95–208.

Lloyd CG (1920). Mycological Notes 62. Mycological Writings 6: 904–944.

Lodge DJ, Cantrell S (1995). Fungal communities in wet tropical forests: variation in time and space. Canadian Journal of Botany 73: S1391–S1398.

Lodge DJ, Ryvarden L, Perdomo-Sánchez OP (2001). Studies in Neotropical Polypores 11: *Antrodia aurantia*, a new species from the Dominican Republic, Greater Antilles. Mycotaxon 80: 261–266.

Loguercio-Leite C (1994). *Polyporaceae na Ilha de Santa Catarina* III: o genero *Hexagonia* Fr. Insula 23: 3–14.

Loguercio-Leite C, Wright JE (1991). New South American Pileate Polypores (Polyporales) from Santa Catarina Island, SC, Brazil. Mycotaxon 41: 167–172.

Loguercio-Leite C, Wright JE (1995). The Genus *Phellinus* (Hymenochaetaceae) on the Island of Santa Catarina, Brazil. Mycotaxon 54: 361–388.

Loguercio-Leite C, Groposo C, Halmenschlager MA (2005). Species of *Ganoderma* Karsten in a subtropical area (Santa Catarina State, Southern Brazil. Iheringia, Sér. Bot., 60: 135–139.

Loguercio-Leite C, Michels J, Baltazar JM (2008). Austro-American lignolytic polypores (Agaricomycetes)-New records for Southern Brazil. Mycotaxon: 205–213.

Lohwag K (1941). *Zur anatomie des Deckgeflechtes der Polyporaceen*. Annals of Mycology 38: 401–452.

Lomascolo A, Cayol JL, Roche M, Guo L, Robert JL, Record E, Lesage-Meessen L, Ollivier B, Sigoillot JC, Asther M (2002). Molecular clustering of *Pycnoporus* strains from various geographic origins and isolation of monokaryotic strains for laccase hyperproduction. Mycological Research 106: 1193–1203.

Lomascolo A, Uzan-Boukhris E, Herpoël-Gimbert I, Sigoillot JC, Lesage-Meessen L (2011). Peculiarities of *Pycnoporus* species for applications in biotechnology. Applied Microbiology and Biotechnology 92: 1129–1149. DOI 10.1007/s00253-011-3596-5.

Lomascolo A, Cayol JC, Rochi M, Guo L, Robert JL, Record E, Lesage-Meessen L, Ollivier B, Sigoillot JC, Asther M (2002). Molecular clustering of *Pycnoporus* strains from various geographic origins and isolation of monokaryotic strains for laccase hyperproduction. Mycological Research. 106. 1193–1203. 10.1017/S0953756202006494.

Lombard FF (1990). A cultural study of several species of *Antrodia* (Polyporaceae, Aphyllophorales). Mycologia 82: 185–191.

Lombard FF, Gilbertson RL (1965). Studies on some western Porias with negative or weak oxidase reactions. Mycologia. 57: 43–76.

Lonati G (2000). *Una nuova specie*: *Cotylidia marsicana*. Micologia e vegetazione mediterranea 15: 3–5.

Lopes VF, Robledo GL, Reck MA, Neto AG (2016). *Phylloporia spathulata sensu stricto* and two new South American stipitate species of *Phylloporia* (Hymenochaetaceae). Phytotaxa 257: 133–148. DOI: 10.11646/phytotaxa. 257.2.3.

López-Quintero CA, Straatsma G, Franco-Molano AE, Boekhout T (2012). Macrofungal diversity in Colombian Amazon forests varies with regions and regimes of disturbance. Biodiversity conservation 21: 2221–2243. DOI: 10.1007/s10531-012-0280-8.

Louza G, Gugliotta (2006). *Polyporus* Fr. (Polyporaceae) of "*Parque Estadual das Fontes do Ipiranga*", São Paulo, SP, Brazil. Hoehnea 34. 365–382. DOI: 10.1590/S2236-89062007000300007.

Lowe JL (1942). The Polyporaceae of New York State (Except *Poria*). Technical Publication of the State University College of Forestry at Syracuse University. 60: 1–128.

Lowe JL (1966). Polyporaceae of North America. The genus *Poria*. New York State Univ. Coll. Forestry 90: 1–183.

Lowe JL (1975). Polyporaceae of North America. The genus *Tyromyces*. Mycotaxon 2: 1–82.

Loyd Andrew, Linder ER, Anger, NA, Spakes-Richter B, Blanchette Robert, & Smith JA (2018). Pathogenicity of *Ganoderma* species on landscape trees in the Southeastern United States. Plant Diseases 102: 1944–1949. DOI: 10.1094/PDIS-02-18-0338-RE.

Luangharn T, Karunarathna SC, Mortimer PE, Hyde KD, Thongklang N, Xu J (2019). A new record of *Ganoderma tropicum* (Basidiomycota, Polyporales) for Thailand and first assessment of optimum conditions for mycelia production. MycoKeys 51: 65–83. DOI: 10.3897/mycokeys.51.33513.

Lutzoni F1, Kauff F, Cox CJ, McLaughlin D, Celio G, Dentinger B, Padamsee M, Hibbett D, James TY, Baloch E, Grube M, Reeb V, Hofstetter V, Schoch C, Arnold AE, Miadlikowska J, Spatafora J, Johnson D, Hambleton S, Crockett M, Shoemaker R, Sung GH, Lücking R, Lumbsch T, O'Donnell K, Binder M, Diederich P, Ertz D, Gueidan C, Hansen K, Harris RC, Hosaka K, Lim YW, Matheny B, Nishida H, Pfister D, Rogers J, Rossman A, Schmitt I, Sipman H, Stone J, Sugiyama J, Yahr R, Vilgalys R (2004): Assembling the fungal tree of life: Progress, classification and evolutionof subcellular traits. American Journal of Botany 91: 1446–1480. DOI: 10.3732/ajb.91.10.1446.

Lyngdoh A, Dkhar MS (2014). Wood-rotting fungi in East Khasi Hills of Meghalaya, northeast India, with special reference to *Heterobasidion perplexa* (a rare species–new to India). Current Research in Environmental & Applied Mycology 4: 117–124. DOI: 10.5943/cream/4/1/10.

Lyra ES, Moreira KA, Porto TS, Cunha MNC, Júnior FBP, Neto BB, Lima-Filho JL, Cavalcanti MAQ, Converti A, Porto ALP (2009). Decolorization of synthetic dyes by basidiomycetes isolated from woods of the Atlantic Forest (PE), Brazil. World Journal of Microbiology and Biotechnology volume 25: 1499–1504. DOI: 10.1007/s11274-009-0034-2.

Maas Geesteranus RA (1971). Hydnaceous fungi of the Eastern old world. North Holland Publishing Company, Amsterdam, 184 p.

Maas Geesteranus RA (1974). Studies in the genera *Irpex* and *Steccherinum*. Persoonia 7: 443–581.

Machado KMG, Matheus DR, Bononi VLR (2005). Ligninolytic enzymes production and remazol brilliant blue R decolorization by tropical brazilian basidiomycetes fungi. Brazilian Journal of Microbiology 36: 246–252.

Macherey-Nagel (2014). NucleoSpin® Plant II: Genomic DNA from Plant User manual, June 2014/Rev.03. Macherey-Nagel GmbH & Co. KG. Düren.

Madushani HKI, Fernando THPS, Wijesundara RLC, Siriwardane D (2013). First report of white root disease of *Artocarpus nobilis* in Sri Lanka caused by *Rigidoporus microporus.* Journal of Natuarl Science Foundation of Sri Lanka 42: 197–198. DOI: 10.4038/jnsfsr.v42i2.6998.

Maekawa N (1993). Taxonomic study of Japanese Corticiaceae (Aphyllophorales). I. Reports of the Tottori Mycological Institute 31: 1–149.

Maekawa N (1994). Taxonomic study of Japanese Corticiaceae (Aphyllophoraceae) II. Report of the Tottori Mycological Institute 32: 1–123.

Magasi LP (1976). Incompatibility factors in *Polyporus abietinus*, their numbers and distributions. Memoirs of New York Botanical Garden 28: 163–173.

Magdalene AE, Temitope AI (2019). Evaluation of compounds extracted from eight genera of wild mushrooms from Nigeria for anti-cell proliferation activity *in vitro*. Iraqi Journal of Science 60: 952–960. DOI: 10.24996/ijs.2019.60.5.3.

Maisterra M, Castroa MA, Muñoz-Centeno LM, Calhelhac RC, Ferreirac ICFR, Garcíaa PA (2012). Cytotoxic terphenyl neolignans from fungus *Terana coerulea*: New natural corticins D and E, and revised structure for corticin A. Natural Product Communications 12: 695–698. 10.1177/1934578X1701200513.

Mäkelä MR (2009). The white-rot fungi *Phlebia radiata* and *Dichomitus squalens* in wood-based cultures: expression of laccases, lignin peroxidases, and oxalate decarboxylase. Academic Dissertation, Department of Applied Chemistry and Microbiology, Division of Microbiology, University of Helsinki, Finland, 93 p.

Malachová K, Pavlícková Z, Novótny C, Svobodová K, Lednická D, Musílková E (2006). Reduction in the mutagenicity of synthetic dyes by successive treatment with activated sludge and the ligninolytic fungus, *Irpex lacteus*.

Environmental and Molecular Mutagenisis 47: 533–540. DOI: 10.1002/em.20224.

Malarvizhi K (2014). Phylogenetic relationships of *Ganoderma* species based on mitochondrial and nuclear dna sequences from Tamil nadu, India. Proceedings of the 8th International Conference on Mushroom Biology and Mushroom Products (ICMBMP8), 9 p.

Malgaonkar M, Zaware BN, Cholke PB (2015). Phylogenetic analysis of some Hymenochaetaceae members. Journal of Pharmacy and Biological Sciences 10: 1–6. DOI: 10.9790/3008-10530106.

Mali T, Kuuskeri J, Shah F, Lundell TK (2017). Interactions affect hyphal growth and enzyme profiles in combinations of coniferous wood-decaying fungi of Agaricomycetes. PloS one 12: e0185171. DOI: 10.1371/journal.pone.0185171.

Maltseva OV, Golovleva LA, Leont’evskii AH, Nerud F, Misurcova Z, Musilek V (1989). Dynamics of enzymes generating hydrogen peroxide in SSF of *Panus tigrinus* on wheat straw. Folia Microbiolica 34: 261–266.

Manimohan P, Divya N, Kumar TKA, Vrinda KB, Pradeep CK (2004). The genus *Lentinus* in Kerala Stae, India. Mycotaxon 90: 311–318.

Manjula B (1983). A revised list of the agaricoid and boletoid basidiomycetes from India and Nepal. Proceedings of the Indian Academy of Sciences, Plant Science 92: 81–213.

Mao BD, Shi CW, Wu J, Xu C (2013). Optimization of exopolysaccharide production in submerged culture of *Daedalea dickinsii* and its antioxidant activity. Bioprocess and Biosystems Engineering 37. DOI: 10.1007/s00449-013-1111-3.

Mao XW, Archambeau JO, Gridley DS (1996). Immunotherapy with low-dose interleukin-2 and a polysaccharopeptide derived from *Coriolus versicolor*. Cancer Biotherapy and Radiopharmaceuticals 11: 393–403.

Marchand A (1975). *Champignons du nord et du midi* 3. Boletales et Aphylloohorales. 275 p. Perpignan.

Marimuthu T, Rajendran S, Manivannan M (2013). Fungal decolorization of dye water. International Journal of Scientific & Engineering Research 4: 1635–1645.

Martin KJ, Gilbertson RL (1976). Cultural and other morphological studies of *Sparassis* radicata and related species. Mycologia 68: 622–639.

Massee G (1889–1912) Fungi exotici I. Kew Bull 1898:113–136, 1898; Fungi exotici 2. Kew Bull 1899; Fungi exotici 3. Kew Bull 1901: 150–169, 1901; Fungi exotici 4. Kew Bull 1906: 91–94, 1906; Fungi exotici 6. Kew Bull 1907: 121–124, 1907; Fungi exotici 8. Kew Bull 1908: 216–219, 1908; Fungi exotici 10. Kew Bull 1910: 249–253, 1910; Fungi exotici 13. Kew Bull 1912: 189–191, 1912; Fungi exotici 14. Kew Bull 1912: 253–255, 1912.

Masuka AJ, Ryvarden L (1992). Aphyllophorales on *Pinus* and *Eucalyptus* in Zimbabwe. Mycotaxon 44: 243–250.

Masuka A, Ryvarden L (1993). Two new polypores from Malawi. Mycologia Helvetica 5: 143–148.

Matheny PB (2006). PCR primers to amplify and sequence rpb2 (RNA polymerase II second largest subunit) in the Basidiomycota (Fungi). https://www2.clarku.edu/faculty/dhibbett/downloads2%20syllabi%20proposals%20etc/rpb2%20primers.pdf.

Matheny PB, Wang Z, Binder M, Curtis JM, Lim YW, Nilsson RH, Hughes KW, Hofstetter V, Ammirati JF, Schoch CL, Langer E, Langer G, Kerrigan RW, Slot JC, Yang Z, Baroni TJ, Fisher M, Hosaka K, Matsuura K, Seidl MT, Vauras J, Hibbett DS (2007). Contributions of rpb2 and tef1 to the phylogeny of mushrooms and allies (Basidiomycota, Fungi). Molecular Phylogenetic Evolution 43: 430–451. DOI: 10.1016/j.ympev.2006.08.024.

Mayer P, Drews J (1980). Effect of a protein-bound polysaccharide from *Coriolus versicolor* on immunological parameters and experimental infections in mice. Infection 8: 13– 21.

Medeiros PS, Ryvarden L (2011). The genus *Microporellus* Murrill in South America. Synopsis Fungorum 29: 71–73, Fungiflora, Oslo.

Meghalatha R, Ashok C, Nataraja S, Krishnappa M (2014). Studies on chemical composition and proximate analysis of wild mushrooms. World Journal of Pharmaceutical Sciences 2: 357–363.

Meijer AAR (2001). Mycological work in the Brazilian state of Paraná. Nova Hedwigia 72: 105–159.

Meijer AAR (2006). Preliminary list of the macromycetes from the Brazilian state of Paraná –Boletim do Museo Botânico Municial 68: 1–53.

Melik-Hacatryan D, Martirosyan S (1971). Mikoflora Armyanskoj SSR 2. *Gasteromicety i afilloforovye griby*, Erevan, 382 p.

Melo GSN, Medeiros P S, Silva ACG, Ryvarden L, Sotão HMP, Gibertoni T B (2012). *Coriolopsis psila* comb. nov. (*Agaricomycetes*) and two new *Coriolopsis* records for Brazil. Mycotaxon 120: 223–230.

Melo GSN, Santos P J, Gibertoni T B (2014). The community structure of macroscopic basidiomycetes (Fungi) in Brazilian mangroves influenced by temporal and spatial variations. Revista de biologia tropical 62: 1587–1595. DOI: 10.15517/rbt.v62i4.12598.

Menkis A, Burokienė D, Gaitnieks T, Uotila A, Johannesson H, Rosling A, Finlay RD, Stenlid J, Vasaitis R (2012). Occurrence and impact of the root-rot biocontrol agent *Phlebiopsis gigantea* on soil fungal communities in *Picea abies* forests of northern Europe. FEMS Microbiology Ecology 81: 438–445. DOI: 10.1111/j.1574-6941.2012.01366.x

Micheli PA (1729). *Nova Plantarum* Genera. Richmond Publishing, Florence, Italy, 234 p.

Miettinen O, Larsson KH (2010). *Sidera*, a new genus in Hymenochaetales with poroid and hydnoid species. Mycological Progress 10: 131–141.

Miettinen O, Rajchenberg M (2012). *Obba* and *Sebipora*, new polypore genera related to *Cinereomyces* and *Gelatoporia* (Polyporales, Basidiomycota). Mycological Progress 11: 131e147. DOI: 10.1007/s11557-010-0736-8.

Miettinen O, Ryvarden L (2016). Polypore genera *Antella*, *Austeria*, *Butyrea*, *Citripora*, *Metuloidea* and *Trulla* (Steccherinaceae, Polyporales). Annales Botanici Fennici 53: 157–172.

Miettinen O, Larsson KH, Spirin V (2019). *Hydnoporia*, an older name for *Pseudochaete* and *Hymenochaetopsis*, and typification of the genus *Hymenochaete* (Hymenochaetales, Basidiomycota). Fungal Systematics and Evolution 4: 77–96. DOI: 10.3114/fuse.2019.04.07.

Miettinen O, Niemelä T, Ryvarden L (2007). A new polypore *Irpex cremicolor* described from North Europe. Mycotaxon 102: 415–424.

Miettinen O, Larsson E, Sjokvist E, Larsson KH (2012). Comprehensive taxon sampling reveals unaccounted diversity and morphological plasticity in a group of dimitic polypores (Polyporales, Basidiomycota). Cladistics 28: 251–270. DOI: 10.1111/j.1096-0031.2011.00380.x.

Miettinen O, Vlasák J, Rivoire B, Spirin V (2018). *Postia caesia* complex (Polyporales, Basidiomycota) in temperate Northern Hemisphere. Fungal Systematics and Evolution 1: 101–129. DOI: 10.3114/fuse.2018.01.05.

Miettinen O, Spirin V, Vlasák J, Rivoire B, Stenroos S, Hibbett DS (2016). Polypores and genus concepts in Phanerochaetaceae (Polyporales, Basidiomycota). MycoKeys 17: 1–46. DOI: 10.3897/mycokeys.17.10153.

Miklašēvičs Z (2019). Evaluation of heartrot caused *Phellinus pini* and related yield loss in *Pinus sylvestris* stands. Environment. Technology. Resources. Rezekne, Latvia, Proceedings of the 12th International Scientific and Practical Conference. Volume III, 166–171. DOI: 10.17770/etr 2019vol3.4081.

Miller OK, Manning DL (1976). Distribution of the lignicolous Tricholomataceae in the southern Appalachians. In: Distributional history of the biota of the southern Appalachians IV. In: Park BC, Roane MK, eds. Algae & Fungi. Biogeography, systematics, & ecology. Charlottesville: Univ. Virginia Press, 307–344 p.

Miller SA, Roth-Johnson L, Kania SA, Bemis DA (2012). Isolation and sequence-based identification of *Oxyporus corticola* from a dog with generalized lymphadenopathy. Journal of Veterinary Diagnostic Investigation 24: 178–181. DOI: 10.1177/1040638711425944.

Min B, Park H, Jang Y, Kim JJ, Kim KH, Pangilinan J, Lipzen A, Riley R, Grigoriev IV, Spatafora JW, Choi IG (2015). Genome sequence of a white rot fungus *Schizopora paradoxa* KUC8140 for wood decay and mycoremediation. Journal of Biotechnology 211: 42–3. DOI: 10.1016/ j.jbiotec.2015.06.426.

Mitter JH, Tandon RN (1932). Fungus flora of Nainital-I. The Journal of Indian Botanical Society 11: 178–180

Mitter JH, Tandon RN (1938) Fungi of Nainital-II. The Journal of Indian Botanical Society 17: 177–182.

Mizuno T (1995). Bioactive biomolecules of mushrooms: food function and medicinal effect of mushroom fungi. Food Reviews International 11: 7–21.

Mohanan C (1994). Decay of standing trees in natural forests. KFRI Handbook No. 97. Kerala Forest Research Institute, Peechi, Kerala, India, 34 p.

Mohanan C (1994a). Diseases of Bamboos and Rattans in Kerala. KFRI Research Report 98. Peechi, India: Kerala Forest Research Institute, 120 p.

Mohanan C (2011). Macrofungi of Kerala. Kerala Forest Research Institute, Kerala, 597 p.

Mohanarji S, Dharmalingam S, Kalusalingam A (2011). Screening of *Lignosus rhinocerus* extracts as antimicrobial agents against selected human pathogens. Journal of pharmaceutical and biomedical sciences 18: 1–4.

Mohanty PS, Harsh NSK, Amit P, Belbahri L (2012). Molecular phylogeny of *Ganoderma lucidum* isolates collected from northern India. Forest Pathology. 42. DOI: 10.1111/j.1439-0329.2012.00778.x.

Moncalvo (2000). Systematics of *Ganoderma*. In: Flood J, Bridge PD, Holderness M, editors. *Ganoderma* diseases of perennial crops. CABI Bioscience, Egham, UK, 23–45 p.

Moncalvo JM, Buchanan PK (2008). Molecular evidence for long distance dispersal across the Southern Hemisphere in the *Ganoderma applanatum-australe* species complex (Basidiomycota). Mycological Research 112: 425–436. DOI: 10.1016/j.mycres.2007.

Moncalvo JM, Ryvarden L (1997). A nomenclatural study of the Ganodermataceae. Synopsis Fungorum 11. Fungiflora, Oslo, 114 p.

Moncalvo JM, Wang HF, Hseu RS (1995). Phylogenetic relationships in *Ganoderma* inferred from the internal transcribed spacers & 25s ribosomal DNA sequences. Mycologia 87: 223–238.

Moncalvo JM, Wang HF, Hseu RS (1995a). Gene phylogeny of *Ganoderma lucidum* complex based on ribosomal sequences comparison with traditional taxonomic characters. Mycological Research 99: 1489–1499.

Moncalvo JM, Wang HF, Wang HH, Hseu RS (1994). The use of ribosomal DNA sequence data for species identification and phylogeny in the Ganodermataceae. In: Buchanan PK, Hseu RS, Moncalvo JM, eds. *Ganoderma*: systematics, phytopathology and pharmacology. Proceedings of contributed symposium 59A, B, 5th International Mycological Congress. Vancouver, 31–44 p.

Moncalvo JM, Vilgalys R, Redhead SA, Johnson JE, James TY, Aime MC, Hofstetter V, Verduin S, Larsson E, Baroni TJ, Thorn RG, Jacobsson S, Cle´mencon H, Miller OK (2002). One hundred and seventeen clades of euagarics. Molecular Phylogenetics and Evolution 23: 357–400.

Montagne JFC (1856). *Sylloge generum specierumque plantarum cryptogamarum*. 1–498.

Moon BH, Lee WL (2009). Studies on the anti-cancer activity of chaga mushroom extract. Journal of Korean Oriental Medicine 30: 12 p.

Moore RT (1985). The challenge of the dolipore/parenthesome septum. In Moore D, Casselton LA, Wood DA, Frankland J (eds) Developmental Biology of Higher Fungi. (p 175–212). Cambridge University Press, Cambridge.

Morató-Cruz C, Ferrando-Climent L, Rodriguez-Mozaz S, Barceló D, Marco-Urrea E, Vicent T, Sarrà M (2013). Degradation of pharmaceuticals in non-sterile urban wastewater by *Trametes versicolor* in a fluidized bed bioreactor. Water Research 47: 5200-5210. DOI: 10.1016/j.watres.2013.06.007

Moradali MF, Mostafavi H, Ghods S, Hedjaroude GA (2007). Immunomodulating and anticancer agents in realm of macromycetes fungi (macrofungi). International Immunopharmacology 7: 701–724. DOI: 10.1016/j.intimp. 2007.01.008.

Moreau PA, Wuilbaut JJ, Courtecuisse R (2008). *Cyphellostereum, Cotylidia et autres Podoscyphaceae stipitées* d'Europe. Doc. Mycologia 34: 53–75.

Moreira-Neto SL, Mussatto SI, Machado KMG, Milagres AMF (2013). Decolorization of salt-alkaline effluent with industrial reactive dyes by laccase-producing basidiomycetes strains. Letters in Applied Microbiology 56: 283–290. DOI: 10.1111/lam.12049.

Moreira MT, Mielgo I, Feijoo G, Lema JM (2000). Evaluation of different fungal strains in the decolourisation of synthetic dyes. Biotechnology Letters 22: 1499–1503.

Morigiwa A, Kitabatake K, Fujimoto Y, Ikekawa N (1986). Angiotensin converting enzyme-inhibitory triterpenes from *Ganoderma lucidim*. Chemical and Pharmaceutical Bulletin 34: 3025–3028. DOI: 10.1248/cpb.34.3025.

Moser M (1978). Keys to agarics and boleti. London: R. Phillips.

Mossebo DC (2002). Growth of wood-inhabiting *Lentinus* species from Cameroon in laboratory culture. Mycologist 16: 168–171.

Mossebo DC, Ryvarden L (1997). *Fomitopsis africana nov. sp*. (Polyporaceae, Basidiomycotina). Sydowia 49: 147–149.

Motato-Vásquez V, Gugliota AM (2013). Polypores from an Atlantic rainforest area in southeast Brazil: resupinate species. Brazilian Journal of Botany. DOI: 10.1007/s40415-013-0031-4.

Motato-Vásquez V, Gugliotta AM (2016). The genus *Microporellus* (Basidiomycota, Polyporales) in the Neotropics. Nova Hedwigia. 103: 225–238. DOI: 10.1127/nova_hedwigia/2016/0347.

Motato-Vásquez V, Pires RM, Gugliotta AM (2015). A new species of *Fuscoporia* (Hymenochaetaceae, Basidiomycota) from the Brazilian Atlantic Rainforest. 21ª Reunião Anual do Instituto de Botânica, São Paulo, 5 p.

Motato-Vásquez V, Grassi E, Gugliotta AM, Robledo GL (2018). Evolutionary relationships of *Bresadolia* (Basidiomycota, Polyporales) based on molecular and morphological evidence. Mycological Progress 17: 1031–1048. DOI: 10.1007/s11557-018-1416-3.

Motta E, Annesi T, Biocca M (1996). *Processi di carie a carico di Eucalyptus spp. in un parco cittadino*. Monti e Boschi 1: 55–7.

Mtui G, Nakamura Y (2008). Lignocellulosic enzymes from *Flavodon flavus*, a fungus isolated from Western Indian ocean off the Coast of Dar es Salaam, Tanzania. African Journal of Biotechnology 7: 3066–3072.

Müller J, Müller K, Quandt D (2010). PhyDE – Phylogenetic Data Editor, version 0.997. http://phyde.de.–123.

Munir E, Priyani N, Suryanto D, Naimah Z (2017). Potential of basidiomycetous fungi isolated from Gunung Barus forest, North Sumatera, in decolorization of wastewater of textile industry. IOP Conf. Series: Materials Science and Engineering 180: 012095. DOI: 10.1088/1757-899X/180/1/012095.

Murrill WA (1902). The Polyporaceae of North America: I. The genus *Ganoderma*. Bulletin of the Torrey Botanical Club. 29: 599–608.

Murill WA (1903). A historical review of the genera of the polyporaceae. Journal of Mycology 9: 87–102.

Murrill WA (1904). The Polyporaceae of North America VI. The genus *Polyporus*. Bulletin of Torrey Botanical Club 31: 29–44.

Murrill WA (1905). The Polyporaceae of North America. XI. A synopsis of the brown pileate species. Bull. Torrey Bot. Club 32: 353–371.

Murill W A (1905a). The Polyporaceae of North America-XII.-Bull. Torrey. Bot. Club 32: 469–493.

Murrill WA (1905b). *Tomophagus* for *Dendrophagus*. Torreya. 5:197–197.

Murrill WA (1907). Polyporaceae, Part 1. North American Flora. 9: 1–72

Murrill WA (1907a). Some Philippine Polyporaceae, Bulletin of Torrey Botanical Club 34: 465–481.

Murrill WA (1908). (Agaricales) Polyporaceae. North American Flora 9: 73–131

Murrill WA (1910). The Polyporaceae of Jamaica. Mycologia 2: 183–197.

Murrill WA (1914). Northern Polypores, New York, 64 p.

Murrill WA (1915). Tropical Polypores. (Reprinted) Bibliotheca Mycologica band 40 (1973), 113 p.

Murrill WA (1920). Corrections and additions to the polypores of temperate North America. Mycologia. 12(1): 6–24

Murrill WA (1942). Florida resupinate polypores. Mycologia 34: 595–596.

Murugesan K, Kalaichelvan PT (2003). Synthetic dye decolourization by white rot fungi. Indian Journal of Experimental Biology 41: 1076–1087.

Murugesan K, Nam I, Kim Y, Chang Y (2007). Decolorization of reactive dyes by a thermostable laccase produced by *Ganoderma lucidum* in solid state culture. Enzyme and Microbial Technology 40: 1662–1672. DOI: 10.1016/j.enzmictec.2006.08.028.

Mustafa MM, Jamal P, Alkhatib MF, Mahmod SS, Jimat DN, Ilyas NN (2017). *Panus tigrinus* as a potential biomass source for reactive blue decolorization: Isotherm and kinetic study. Electronic Journal of Biotechnology 26: 7–11. DOI: 10.1016/j.ejbt.2016.12.001.

Nagadesi PK, Arya A (2014). A new heart rot disease in *Ailanthus excelsa* Roxb. caused by *Navisporus floccosus* (Bres.) Ryvarden. International Letters of Natural Sciences 6: 1–7.

Nagadesi PK, Arya A. (2012). New records of Lignicolous fungi deteriorating wood in India. Mycosphere 3: 997–1003. DOI: 10.5943/mycosphere/3/6/13.

Nagadesi PK, Arya A (2013). Rotting of *Peltophorum ferrugineum* (Decne.) Benth. by pathogenic lignicolous fungi in Rajpipla, Gujarat, India. Journal on New Biological Reports 2: 17–27.

Nagadesi PK, Bhavani J, Arya A (2014). New records of Lignicolous fungi from Krishna District, Andhra Pradesh, India. *International Letters of Natural Sciences* 12: 55–69. DOI: 10.18052/www.scipress.com/ILNS.17.55.

Nahata A (2013). *Ganoderma lucidum*: A potent medicinal mushroom with numerous health benefits. Pharmaceutica Analytica Acta 4. e159. DOI: 10.4172/2153-2435.1000e159.

Naidu GVB, Kumar SNS, Sannamarappa M (1966). Anabe roga, *Ganoderma lucidum* (Leys.) Karst. on arecanut palm: a review and further observations. Journal of Mysore Horticultural Society 11: 14–20.

Naik RG (2001). Chemical control of basal stem rot of coconut. Agricultural Science Digest 21: 247–249.

Nair SSC (2011). The changing landscape of Kerala. 30–53, in: C Sashikumar & *al*. (eds). Birds of Kerala, Status and distribution. DC Books, Kottayam.

Nakajima Y, Sato Y, Konishi T (2007). Antioxidant small phenolic ingredinets in *Inonotus obliquus* (Persoon) Pilat (Chaga). Chemical and Pharmaceutical Bulletin 55: 1222–1226. DOI: 10.1248/cpb.55.1222.

Nakasone KK (1990). Cultural studies and identification of wood-inhabiting Corticiaceae and selected Hymenomycetes from North America. Mycologia Memoirs 15: 1–412.

Nakasone KK (1996). Morphological and molecular studies on *Auriculariopsis albomellea* and *Phlebia albida* and a reassessment of *A. ampla*. Mycologia 88: 762–775.

Nakasone KK (1997). Studies in *Phlebia*. Six species with teeth. Sydowia 49: 49–79.

Nakasone KK (2002). *Mycoaciella*, a synonym of *Phlebia*. Mycotaxon 81: 477–490.

Nakasone KK, Burdsall HH (1984). *Merulius*, a synonym of *Phlebia*. Mycotaxon. 21: 241–246.

Nakasone KK, Burdsall HH (1995). *Phlebia* species from eastern and southeastern United States. Mycotaxon 54: 335–359.

Nakasone KK, Sytsma KJ (1993). Biosystematic studies on *Phlebia acerina, P. rufa*, and *P. radiata* in North America. Mycologia 85: 996–1016.

Nakasone KK, Hhjr B, Noll LA (1982). Species of *Phlebia* section Leptocystidiophlebia (Aphyllophorales, Corticiaceae) in North America. Mycotaxon 14: 3–12.

Nallathamby N, Phan CW, Seow SLS, Baskaran A, Lakshmanan H, Abd Malek SN, Sabaratnam V (2018). A status review of the bioactive activities of tiger milk mushroom *Lignosus rhinocerotis* (Cooke) Ryvarden. Frontiers in Pharmacology 8: 998 . DOI: 10.3389/fphar.2017.00998.

Nandal P, Ravella SR, Kuhad RC (2013). Laccase production by *Coriolopsis caperata* RCK2011: Optimization under solid state fermentation by Taguchi DOE methodology. Scientific Reports 3: 1386. DOI: 10.1038/Srep01386.

Natarajan K (1978). South Indian Agaricales VI. Kavaka 6: 65–70.

Natarajan K, Kolandavelu K (1998). Resupinate Aphyllophorales of Tamil Nadu, CAS in Botany, University of Madras, Udayam offset, Chennai 2-India, 131 p.

Natarajan K, Manjula B (1978). Studies on *Lentinus squarrosulus* Lév. In: Indian Mushrooms Science I (Atal C, Bhat BK, Kaul TN, eds) 1: 451–456. USA: Indo-American Literature House.

Natarajan K, Raman N (1980). South Indian agaricales-IX. Sydowia 33, 225–235.

Natarajan K, Raman N (1981). South Indian Agaricales. Nova Hedwigia 34: 163–176.

Natarajan K, Kumaresan V, Narayanan K (2005). A checklist of Indian agarics and boletes (1984–2002). Kavaka 33: 61–128.

Nayar NM (2010). Agrobiodiversity in a biodiversity hotspot: Kerala State, India. Its origin and status. Genetic Resources and Crop Evolution 58: 55–82. DOI: 10.1007/s10722-010-9555-7.

Nazura Z, Lee SS, Chan HT, Thi BK, Siti AA (2010). Macrofungi of Pulau Redang, Terengganu and Pulau Aur, Johor in the south China Sea. Journal of Science and Technology in the Tropics 6: S120–S125.

Newsam A, John KP, Rao BS (1967). Decay of rubber wood in a replanting and its effect on root disease. Journal of Rubber Research Institute of Malaysia 20: 1–7.

Ng TB (1998). A review of research on the protein bound polysaccharide (polysaccharopeptide, PSP) from the mushroom *Coriolus versicolor* (Basidiomycetes: Polyporaceae). General Pharmacology 30: 1–4.

Ng T, Wang H, Wan DCC (2006). Polysaccharopeptide from the turkey tail fungus *Trametes versicolor* (L.:Fr.) Pilát inhibits Human Immunodeficiency Virus Type 1 reverse rransciptase and protease. International Journal of Medicinal Mushrooms 8: 39–43. DOI: 10.1615/IntJMedMushr.v8.i1.40

Nicole M, Chamberland H, Geiger JP, Lecours GN, Valero J, Rio B, Ouellette GB (1992). Immunocytochemical localization of laccase in wood decayed by *Rigidoporus lignosus*. Applied and environmental microbiology 58: 1727–1739.

Nidadavolu SVSSSLHB, Charya SMA (2017). Biological Activities of Exopolysaccharide from *Fomitopsis feei*. International Journal of Microbiological Research: 48–58. DOI: 10.5829/idosi.ijmr.2017.48.58.

Nidadavolu SVSSSLHB, Gudikandula K, Pabba SK, Maringanti SC (2013). Decolorization of triphenyl methane dyes by *Fomitopsis feei.* Natural Science 5: 30–35. DOI: 10.4236/ns.2013.56A005.

Nie T, Tian Y, Liu S-L, Yang J, He SH (2017). Species of *Hymenochaete* (Hymenochaetales, Basidiomycota) on bamboos from East Asia, with descriptions of two new species. MycoKeys 20: 51–65. DOI: 10.3897/mycokeys.20.11754.

Niemelä T (1971). On Fennoscandian Polypores. I. *Haploporus odorus* (Sommerf.) Bond & Sing. Annales Botanici Fennici 8: 237–244.

Niemelä T (1974). On Fennoscandian Polypores. III. *Phellinus tremulae* (Bond.) Bond. & Borisov. Annales Botanici Fennici 11: 202–215.

Niemelä (1975). On Fennoscandian polypores 4. *Phellinus igniarius*, *P. nigricans* and *P. populicola*, *n. sp*. Annales Botanici Fennici 12: 93–122.

Niemelä T (1985). On Fennoscandian polypores 9. *Gelatoporia n. gen*. and *Tyromyces canadensis*, plus notes on *Skeletocutis* and *Antrodia*. Karstenia 25: 21–40.

Niemelä T (2005). Polypores, lignicolous fungi. Norrlinia 13: 1–320.f.

Niemelä T (2013). Polypores of the Białowieża Forest. Białowieski Park Narodowy, Białowieża.

Niemelä T, Kotiranta H (1982). Polypore survey of Finland 2. The genus *Phellinus*. Karstenia 22: 27–42.

Niemelä T, Miettinen O (2008). The identity of *Ganoderma applanatum* (Basidiomycota). Taxon 57: 963–966. DOI: 10.1002/tax.573024.

Niemelä T, Ryvarden L (1975). Studies in the aphylloporales of Africa IV: *Antrodia juniperina*, new for East Africa. Transactions of British Mycological Society 65: 427–432. DOI: 10.1016/S0007-1536(75)80040-4.

Niemelä T, Uotila P (1977). Lignicolous macrofungi from Turkey and Iran. Karstenia 17: 33–39.

Niemelä T, Kinnunen J, Lindgren M (2001). Novelties and records of poroid Basidiomycetes in Finland and adjacent Russia. Karstenia 41: 1–21.

Niemelä T, Kotiranta H, Penttilä R (1992). New records of rare and threatened polypores in Finland. Karstenia 32: 81–94.

Niemelä T, Kinnunen J, Lindgren M, Manninen O, Miettinen O, Penttilä E, Turunen O (2001). Novelties and records of poroid Basidiomycetes in Finland and adjacent Russia. Karstenia 41: 1–21.

Niku-Paavola ML, Karhunen E, Kantelinen EK,Viikari L, Lundell T, Hatakka A (1990). The effect of culture conditions on the production of lignin modifying enzymes by the white-rot fungus *Phlebia radiata*. Journal of Biotechnology 13: 211–221. DOI: 10.1016/01681656(90)90106-L.

Nilsson T (1997). Spatial population dynamics of the black tinder fungus beetle *Bolitophagus reticulatus* (Coleoptera: Tenebrionidae). Acta Universitatis Upsaliensis. Comprehensive Summaries of Uppsala Dissertations from the Faculty of Science and Technology 311: 1–44.

Nithya V, Bhaskar A (2013). 16S and 18S rRNA Gene Sequencing of A typical Clinical Isolated Microorganisms Identified in Keratitis Patients. Clinical Research 2013, 6 p.

Njouonkou A, Mossebo DC, Akoa A (2013). The genera *Lentinus* and *Panus* in the Dja Biosphere Reserve and its periphery, Cameroon. Kew Bulletin 68: 517–521. DOI: 10.1007/s12225-013-9461-1.

Njouonkou A, Watling R, Degreef J (2013a). *Lentinus cystidiatus sp. nov.* (Polyporaceae): an African lentinoid fungus with an unusual combination of both skeleto-ligative hyphae and pleurocystidia. Plant Ecology and Evolution 146: 240–245. DOI: 10.5091/plecevo.2013.792.

Nobles MK (1948). Studies in forest pathology VI. Identification of cultures of wood-rotting fungi. Canadian Journal of Research 26: 281–431.

Nobles MK (1958) Cultural characters as a guide to the taxonomy and phylogeny of the Polyporaceae. Canadian Journal of Botany 36: 883–926.

Nobles MK (1971) Cultural characters as a guide to the taxonomy of the Polyporaceae. In: Petersen RH (ed) Evolution in the higher basidiomycetes. The University of Tennessee Press, Knoxville.169–196 p.

Nobles MK, Frew BP (1962). Studies in wood-inhabiting Hymenomycetes V. The genus *Pycnoporus* Karst. Canadian Journal of Botany 40: 987–1016.

Nogueira-Melo GS, Santos PJP, Gibertoni TB (2014). The community structure of macroscopic basidiomycetes (Fungi) in Brazilian mangroves influenced by temporal and spatial variations. Revista de Biología Tropical 62: 1587–95. DOI: 10.15517/rbt.v62i4.12598.

Nogueira-Melo GS, Santos PJP, Gibertoni TB (2017). Host-exclusivity and host-recurrence by wood decay fungi (Basidiomycota-Agaricomycetes) in Brazilian mangroves. Acta Botanica Brasilica 31: 566–570. DOI: 10.1590/0102-33062017abb0130.

Nogueira-Melo GS, Medeiros PS, Gomes-Silva AC, Ryvarden L, Sotão HMP, Gibertoni TB (2012). *Coriolopsis psila* comb. nov. (Agaricomycetes) and two new *Coriolopsis* records for Brazil. Mycotaxon 120: 223–230. DOI: 10.5248/120.223.

Noorlidah A, Vikineswary S, Yusoff M, Desjardin DE (2005). Higher fungi of northeast Langkawi. Malaysian Journal of Science 24: 95–102.

Norris DM (1980). Isolation of Lignocellulose Transforming Microbes. Progress report no. 5, 15 Feb–14 Aug 80. Department of Entomology, University of Wisconsin, Madison (WI, USA).

Novotný C, Svobodová K, Aparna K, Pavla E (2004). Biodegradation of synthetic dyes by *Irpex lacteus* under various growth conditions. International Biodeterioration & Biodegradation 54: 215–223. DOI: 10.1016/j.ibiod.2004.06.003.

Novotný Č, Cajthaml T, Svobodová K, Šušla M, Šašek V (2009). *Irpex lacteus*, a white-rot fungus with biotechnological potential–review. Folia Microbiologica 54: 375–390. DOI: 10.1007/s12223-009-0053-2.

Novotný P, Erbanová T, Cajthaml N, Rothschild C, Dosoret, Šašek V (2000). *Irpex lacteus*, a white rot fungus applicable to water and soil bioremediation. Applied Microbiology and Biotechnology 54: 850–853.

Novotný B, Rawal M, Bhatt M, Patel V, Sasek, Molitoris HP (2001). Capacity of *Irpex lacteus* and *Pleurotus ostreatus* for decolorization of chemically different dyes. Journal of Biotechnology 89: 113–122.

Nowacka N, Nowak R, Drozd M, Olech M, Los R, Malm A (2015). Antibacterial, antiradical potential and phenolic compounds of thirty-one Polish mushrooms. PLoS ONE 10: e0140355. DOI: 10.1371/journal.pone.0140355.

Núñez M, Ryvarden L (1995). *Polyporus* (Basidiomycotina) and related genera. Synopsis Fungorum 10. Oslo, 85 p.

Núñez M, Ryvarden L (1995a). *Polyporus* new to Japan 1. Species of *Polyporus*, with a note on *P. hartmanni*. Mycoscience 36: 61–65.

Núñez M, Ryvarden L (1999). New and interesting polypores from Japan. Fungal Diversity 3: 107–121.

Núñez M, Ryvarden L (2000). East Asian polypores 1. Synopsis Fungorum. 13: 1–168.

Núñez M, Ryvarden L (2001). East Asian polypores 2. *Polyporaceae* s. lato. Synopsis Fungorum 14: 170–522.

Núñez M, Parmasto E, Ryvarden L (2001). New and interesting polypores from East Russia. Fungal Diversity 6: 107–114.

Núñez M, Suhirman, Stokland JN (2001). Patterns of polypore distribution in the Lesser Sunda Islands, Indonesia. Is Wallace's line significant? In book: Tropical Mycology: volume 1, Macromycetes, Editors: Watling, R, Frankland, J.C., Ainsworth, A.M., Isaac, S. and Robinson, C.H. (eds).

Nzokou P, Wehner K, Kamdem DP (2005). Natural durability of eight tropical hardwoods from Cameroon. Journal of Tropical Forest Science 17: 416–427.

Oberwinkler F (1977). *Das neue System der Basidiomyceten*. In BeitraXge zur Biologie der niederen Pflanzen (W. Frey, H. Hurka & F. Oberwinkler, eds): 59–105. Gustav Fischer, Stuttgart.

Oddou J, Stentelaire C, Lesage-Meessen L, Asther M, Colonna-Ceccaldi B (1999). Improvement of ferulic acid bioconversion into vanillin by use of high-density cultures of *Pycnoporus cinnabarinus*. Applied Microbiology and Biotechnology 53: 1–6. DOI: 10.1007/s002530051605.

Ogawa H, Fujimura M, Takeuchi Y, Makimura K (2009). Is *Bjerkandera adusta* Important to fungus-associated chronic cough as an allergen? eight cases' reports. Journal of Asthma 46: 849–55. DOI: 10.3109/02770900903199946.

Ogawa H, Fujimura M, Ohkura N, Makimura K (2014). Atopic cough and fungal allergy. Journal of Thorac Diseases 6: S689–S698. DOI:10.3978/j.issn.2072-1439.2014.09.25.

Ogawa H, Fujimura M, Takeuchi Y, Makimura K, Satoh K (2011). Sensitization to *Bjerkandera adusta* enhances severity of cough symptom in patients with fungus-associated chronic cough (FACC). Medical Mycology Journal 52: 205–12. DOI: 10.3314/mmj.52.205.

Oghenekaro AO, Daniel G, Asiegbu FO (2015). The saprotrophic wood-degrading abilities of *Rigidoporus microporus*. Silva Fennica 49, 10 p. DOI: 10.14214/sf.1320.

Oghenekaro AO, Miettinen O, Omorusi V, Evueh GA, Farid MA, Gazis R, Asiegbu FO (2014). Molecular phylogeny of *Rigidoporus microporus* isolates associated with white rot disease of rubber trees (*Hevea brasiliensis*). Fungal Biology 118: 495–506. DOI: 10.1016/j.funbio.2014.04.001.

Ohtsuka S, Ueno S, Yoshikumi C, Hirose F, Ohmura Y, Wada T, Fujii T, Takahashi E (1973). Polysaccharides having an anticarcinogenic effect and a method of producing them from species of Basidiomycetes. UK Patent 1331513.

Oldridge SG, Pegler DN, Reid DA, Spooner BM (1986). A collection of fungi from Pahang and Negeri Sembilan, Malaysia. Kew Bulletin 41: 855–872.

Oliva J, Messal M, Wendt L, Elfstrand M (2017). Quantitative interactions between the biocontrol fungus *Phlebiopsis gigantea*, the forest pathogen *Heterobasidion annosum* and the fungal community inhabiting Norway spruce stumps. Forest Ecology and Management 402: 253–264. DOI: 10.1016/j.foreco.2017.07.046.

Olou BA, Ordynets A, Langer E (2019). First new species of *Fulvifomes* (Hymenochaetales, Basidiomycota) from tropical Africa. Mycological Progress 18: 1383–1393. DOI: 10.1007/s11557-019-01536-9

Omarini A, Lechner BE, Albertó E (2009). *Polyporus tenuiculus*: a new naturally occurring mushroom that can be industrially cultivated on agricultural waste. Journal of Industrial Microbiology and Biotechnology 36: 635–642. DOI: 10.1007/s10295-009-0530-2.

Onar O, Ilgaz A, Celep G, Yildirim O (2016). Antioxidant activity of extracts from the red-belt conk medicinal mushroom, *Fomitopsis pinicola* (Agaricomycetes), and its modulatory effects on antioxidant enzymes. International Journal of Medicinal Mushrooms 18: 501–508. DOI: 10.1615/IntJMedMushrooms.v18.i6.40.

Onofre SB, Santos ZMQ, Kagimura FM, Shaiana PM (2015). Cellulases produced by the endophytic fungus *Pycnoporus sanguineus* (L.) Murrill. African journal of agricultural research 10: 1557–1564. DOI: 10.5897/AJAR2015.9487.

Ornely OBJ, Calixte ENH, Atome JRN, Misso RLNM, Obiang CS, Ondo JP, Engonga LCO (2018). Chemical screening, antioxidant potential and antiangiogenic effect of *Microporus xanthopus* (fr.) Kuntze, *Ganoderma orbiforme* (fr.) Ryvarden and *Polyporus fasciculatus* (pat) lloyd, Medicinal

Mushrooms from Gabon. American Journal of Pharmacy and Health Research 6, 17 p. DOI: 10.21276/ajphr.2018.06.10.02.

Ortiz-Santana B, Lindner DL, Miettinen O, Justo A, Hibbett DS (2013). A phylogenetic overview of the *Antrodia* clade (Basidiomycota, Polyporales). Mycologia 105: 1391–1411. DOI: 10.3852/13-051.

Otieno NC (1968). Polyporaceae of Eastern Africa: II. The genus *Amauroderma* Murrill. Sydowia 22: 173–178.

Otto EC, Blanchette, Held, Barnes CW, Obodai (2016). Fungal Planet Description Sheets 449. Persoonia 36: 416–417.

Ouseph A, Geetha D, Suharban M (2001). Lignocellulose degradation by oyster mushroom. Mushroom Research 10: 37–40.

Overholts LO (1941). New species of Polyporaceae. Mycologia 33: 90–102.

Overholts LO (1953). The Polyporaceae of the United States, Alaska and Canada. Ann Arbor: Univ. Mich. Press. 466 p.

Oyetayo OV (2011). Medicinal uses of mushrooms in Nigeria: towards full and sustainable exploitation. African Journal of Traditional, Complementary and Alternative Medicines 8: 267–274. DOI: 10.4314/ajtcam.v8i3.65289.

Oyetayo OV (2014). Molecular identification of *Trametes* species collected from Ondo and Oyo States, Nigeria. Jordan Journal of Biological Sciences 7: 165–169. DOI: 10.12816/0008234

Oyetayo OV, Ogidi CO (2011). Phytochemical screening and antibacterial properties of a wild macrofungus, *Coriolopsis polyzona* against microbial isolates from wastewater and leftover foods. Asian Journal of Pharmaceutical and Biological Research 1: 486–492.

Özgör E, Meltem U, İrem Ç, Semiha SY, Nevin K (2016). Investigation of antimicrobial activity of different *Trametes versicolor* extracts on some clinical isolates. Biological Chemistry 43: 267–272. DOI: 10.15671/HJBC.20164420569.

Padhiar A, Albert S, Kumar NP, Arya A (2010). Lignin degradation by *Flavodon flavus* (Klotzsch.) Ryv. and *Schizophyllum commune* Fr. on *Mangifera indica* and *Syzygium cumini* woods. Journal of Wood Chemistry and Technology 30: 129–139. DOI: 10.1080/02773810903207770.

Palacio M, Robledo G, Reck MA, Grassi E, Góes-Neto A, Drechsler-Santos ER (2017). Decrypting the *Polyporus dictyopus* complex: Recovery of *Atroporus* Ryvarden and segregation of *Neodictyopus gen. nov*. (Polyporales, Basidiomyocta). PLoS ONE 12: e0186183. 10.1371/journal.pone.0186183.

Palacios-Pacheco MR, Raymundo T, Valenzuela R (2010). *Primer registro de Ischnoderma resinosum* (Schrad.) P. Karst. and *Tyromyces fissilis* (Berk. & M. A. Curtis) Donk (Polyporales, Basidiomycota) *en* México. Polibotánica 30: 35–41.

Palmer JM, Lindner DL, Volk TJ (2008). Ectomycorrhizal characterization of an American chestnut (*Castanea dentata*)–dominated community in Western Wisconsin. Mycorrhiza 19: 27–36. DOI: 10.1007/s00572-008-0200-7.

Pan H, Han Y, Huang J, Yu X (2015). Purification and identification of a polysaccharide from medicinal mushroom *Amauroderma rude* with immunomodulatory activity and inhibitory effect on tumor growth. Oncotarget 10: 17777–17791. DOI: 10.18632/oncotarget.4397.

Panconesi A, Santini A, Casini N (1994). *Phellinus torulosus* on *Cupressus sempervirens* in Italy. European Journal of Forest Pathology 24: 238–240.

Papinutti VL, Mouso N, Forchiassin F (2006). Removal and degradation of the fungicide dye malachite green from aqueous solution using the system wheat bran–*Fomes sclerodermeus*. Enzyme and Microbial Technology 39: 848–853. DOI: 10.1016/j.enzmictec.2006.01.013.

Papp V (2013). Corticoid Basidiomycetes of Hungary I. The genus *Hymenochaete*. Mikol. Közlem. Clusiana 52: 45–56.

Papp V (2014). Nomenclatural novelties in the *Postia caesia* complex. Mycotaxon 129: 407–413. DOI: 10.5248/129.407.

Papp V, Dima B (2017). *Favolus gracilisporus* (Polyporaceae, Basidiomycota), an East Asian polypore species new to the European mycobiota. Mycosphere 8: 1177–1184. DOI: 10.5943/mycosphere/8/6/7.

Parihar J, Tiwari CK, Ayachi A, Verma RK (2012). Biodegradation of cellulose by wood decaying fungi. Sciences in Environmental Sanitation 7: 209–214.

Park YK, Lee HB, Jeon EJ, Jung HS, Kang MH (2004). Chaga mushroom extract inhibits oxidative DNA damage in human lymphocytes as assessed by comet assay. Biofactors 21: 109–12. DOI: 10.1002/biof.552210120.

Park SY, Lee JH, Kim KY, Kim EK, Yun SJ, Kim CD, Lee WS, Hong KW (2008). Cilostazol increases 3T3-L1 preadipocyte differentiation with improved glucose uptake associated with activation of peroxisome proliferator-activated receptor-γ transcription. Atherosclerosis 201: 258–265. DOI: 10.1016/j.atherosclerosis.2008.02.006

Park DS, Sung JM, Kim YS, Yoo YB, Ryu YJ, Cha DY (1994). Analysis of interspecific allozyme variation within the genus *Ganoderma* by polyacrylamide gel isoelectric focusing. RDA Journal of Agricultural Science Biotechnology 36: 212–221.

Parmasto E (1962). *Species varietatesque novae fungorum*. Tremellales et Aphyllophorales. Botanicheskie Materialy Otdela Sporovyh Rastenij Botanicheskogo Instituti Imeni V.L. Komarova. 15: 125–137.

Parmasto E (1968). *Conspectus Systematis Corticiaceaerum* Tartu. 262 p.

Parmasto E (1983). *Leucophellinus mollissimus*, a tropical polypore found in Soviet Far East. Eesti NSV Teaduste 32 (Ser. Biol. 4): 269–272.

Parmasto E (1983a). The spores of *Hexagonia apiaria* and *H. tenuis* (Aphyllophorales). Mycotaxon 18: 49–51.

Parmasto E (1985). Species concept in Hymenochaetaceae (Fungi, Hymenomycetes). Proceedings of Indian Acadamy of Sciences 94: 369–380.

Parmasto E (1988). What is *Ochroporus ossatus* (Hymenochaetaceae)? Mycotaxon 32: 219–222.

Parmasto E (1995). The genus *Hymenochaete* (Hymenomycetes): infrageneric classification and satellite genera. Doc Mycol 25: 305–315.

Parmasto E (2001). *Gilbertsonia*, a new genus of polypores (Hymenomycetes, Basidiomycota. Harvard Papers in Botany 6: 179–182.

Parmasto E (2001a). Hymenochaetoid fungi (Basidiomycota) of North America. Mycotaxon 79: 107–176.

Parmasto E (2001b). *Hymenochaete cruenta* and *H. sphaericola*, two sibling species of Hymenochaetales (Hymenomycetes, Basidiomycota). Czech Mycology 52: 307–315.

Parmasto E (2005). New data on rare species of *Hydnochaete* and *Hymenochaete* (Hymenochaetales). Mycotaxon 91: 137–163.

Parmasto E, Hallenberg N (2000). A taxonomic study of phlebioid fungi (Basidiomycota). Nordic Journal of Botany 20: 105–118.

Parmasto E, Parmasto I (1979). The xanthochroic reaction in Aphyllophorales. Mycotaxon 8: 201–231.

Parmasto E, Nilsson RH, Larsson KH (2009). Cortbase ver. 2.1–a nomenclatural database of corticioid fungi (Hymenomycetes). http://andromeda.botany.gu.se/cortbase.html.

Parmasto E, Saar I, Larsson E, Rummo S (2014). Phylogenetic taxonomy of *Hymenochaete* and related genera (Hymenochaetales). Mycological Progress 13: 55–64. DOI 10.1007/s11557-013-0891-9.

Park DS, Sung JM, Kim YS, Yoo YB, Ryu YJ, Cha DY (1994). Analysis of interspecific allozyme varition within genus *Ganoderma* by polyacrylamide gel isoeletric focusing RDA. Journal of Agriculture 36: 212–221.

Park SM, Quan Y, Jung EP,Oh SY, Jang Y, Kim JJ, Lim YW (2014). Re-evaluation of the genus *Antrodia* (Polyporales, Basidiomycota) in Korea. Mycobiology 42: 114–119. DOI: 10.5941/MYCO.2014.42.2.114.

Parrent JL, Garbelotto M, Gilbert GS. (2004). Population genetic structure of the polypore *Datronia caperata* in fragmented mangrove forests. Mycological Research 108: 403–410. 10.1017/S0953756204009773.

Parveen A, Khataniar L, Goswami G, Hazarika DJ, Das P, Gautom T, Barooah M, Boro RC (2017). A Study on the diversity and habitat specificity of macrofungi of Assam, India. International Journal of Current Microbiology and Applied Sciences 6: 275–297.

Passauer U (1976). *Ober einen Fund von Daedalea quercina Fries f. lenzitoidea* Bres. aus NiederC\sterreich. Annals of Natural history Museum Wien 80: 87–91.

Paterson R (2006). *Ganoderma*-A therapeutic fungal biofactory. Phytochemistry 67: 1985–2001. DOI: 10.1016/j.phytochem.2006.07.004.

Pathania J, Chander H (2018). Notes on some common macrofungi of Hamirpur region, Himachal Pradesh. CPUH-Research Journal 3: 191–201.

Patouillard NT (1887). *Les Hymenomycetes d'Europe Anatomie generale et classification des champignons superieurs*. Paris. 166 p.

Patouillard NT (1889). *Champignons extra-européens*. Journal de Botanique (Morot). 3: 165–168.

Patouillard NT (1889a). *Le genre Ganoderma*. Bulletin de la Société Mycologique de France 5: 64–80

Patouillard MN (1894). *Quelques espèces nouvelles de champignons du nord de l' Afrique*. Journal of Botany (Morot) 8: 219–221.

Patouillard NT (1900). *Essai Taxonomique Sur Les Families Et Les Genres Des* Hymenomycetes. 184 p.

Patouillard NT (1907). *Champignons nouveaux du Tonkin*. Bulletin de la Société Mycologique de France 23: 69–79.

Patouillard NT, Gaillard A (1888). *Champignons du Vénézuéla et principalement de la région du Haut-Orénoque, récoltés en* 1887 par MA Gaillard. Bulletin de la Société Mycologique de France 4: 7–46.

Patouillard NT, Lagerheim G (1892). *Champignons de l'Equateur (Pugillus II)*. Bulletin de la Société Mycologique de France 8: 113–140.

Pattanayak M, Maity P, Samanta S, Sen IK, Manna DK, Nandi AK, Ghosh S, Acharya K, Islam SS (2018). Studies on structure and antioxidant properties of a heteroglycan isolated from wild edible mushroom *Lentinus sajor-caju*. International Journal of Biological Macromolecules 107: 322–331. DOI: 10.1016/j.ijbiomac.2017.08.163.

Paul S, Singh ARJ, Sasikumar CS (2014). An antioxidant and bioactive compound studies of *Parmelia perlata*, *Ganoderma lucidum* and *Phellinus igniarius*. Supplimentory Drug, Asian Journal of Pharmaceutical Technology & Innovation 02: 13–22.

Paulus B, Hallenberg N, Buchanan PK, Chambers GK (2000). A phylogenetic study of the genus *Schizopora* (Basidiomycota) based on ITS DNA sequences. Mycological Research 104: 1155–1163.

Pauzar Z (1972). Amyloidity in polypores I. The genus *Polyporus* Mich. *ex* Fr. Ceska Mykol 26: 82–90.

Peck CH (1889). Report of the Botanist (1888). Annual Report on the New York State Museum of Natural History 42: 101–144.

Pegler DN (1964). New species of *Inonotus* (Polyporaceae). Transactions of the British Mycological Society 47: 167–173.

Pegler DN (1967). Notes on Indian Hymenochaetoideae. Kew Bulletin 21: 39–49.

Pegler DN (1971). *Lentinus* Fr. and related genera from Congo-Kinshasa (Fungi). Bulletin du Jardin Botanique National de Belgique. Brussels 41:273–281.

Pegler DN (1973). Aphyllophorales IV: Poroid families: 397–420. In Ainsworth, G. C. F. K. Sparrow and A. S. Sussamen ed. the fungi Vol. IVB. A taxonomic review with keys; Basidiomycetes and lower fungi. Academic Press, New York, 504 p.

Pegler DN (1973a). The Polypores. Bulletin of British Mycological Society 7: 1–43.

Pegler DN (1983). The genus *Lentinus*: a world monograph. Kew Bull Add Ser 10, 281 p.

Pegler DN, Hills AE (1996). A new variety of *Boletus luridiformis*. Mycologist. 10: 80–81.

Peláez F, Martinez MJ, Martinez AT (1995). Screening of 68 species of basidiomycetes for enzymes involved in lignin degradation. Mycological Research 99: 37–42.

Peng K, Lan LS, Yan WX, Jie SL, Wu YJ, Hua ZY, Shu-Chen L (2012). *Polyporus umbellatus* polysaccharides ameliorates carbon tetrachloride-induced hepatic injury in mice. African Journal of Pharmacy and Pharmacology 6: 2686–2691. DOI: 10.5897/AJPP12.689.

Peng TV, Don MM (2013). Antifungal activity of *in vitro* grown *Earliella scabrosa*, a Malaysian fungus on selected wood-degrading fungi of rubberwood. Journal of Physical Science 24: 21–33.

Peng Y, Zhang L, Zeng F, Kennedy JF (2005). Structure and antitumor activities of the water-soluble polysaccharides from *Ganoderma tsugae* mycelium. Carbohydrate Polymers 59: 385–392. DOI: 10.1016/j. carbpol.2004.10.009.

Peries OS (1969). Economics of control of the white root disease (*Fomes lignosus*) of *Hevea brasiliensis* in Ceylon. In: Toussoun, T.A., Bega, R.V. and Nelson, P.A. (Eds), root diseases and soil-born pathogens. Second International Symposium on Factors Determining the Behaviour of Plant Pathogens in Soil, Imperial College, London. University of California Press.

Persoon CH (1794). *Stereum* Hill *ex* Pers., *Neues Mag. Bot.* 1: 110P

Persoon CH (1801). *Synopsis Methodica Fungorum*, Gottingen: 1–706.

Persoon CH (1825). *Mycologia Europea*. Palm, Erlangen 2: 1–214.

Petch T (1909). New Ceylon fungi. Annales of the Royal Botanic Gardens Peradeniya. 4: 299–307.

Petch T (1916). A preliminary list of Ceylon Polypori. Annals of the Royal Botanic Garden Paradeniya 6: 145–152.

Petrak F (1950). Index of Fungi. 1936–39 (8), CMI, 117 p.

Petrak F (1959). *Über eine neue Daedalea-Art aus Borneo*. Sydowia. 13: 139–142.

Piątek M (1999). *Tyromyces fissilis* (Fungi, Poriales)–taxonomy, bionomics and distribution in Poland. Fragm. Florist. Geobot. Ser. Polonica 6: 189–197.

Piątek M (2003). Notes on polish polypores. 2. *Oxyporus latemarginatus*. Polish Botanical Journal 48: 63–68.

Pieri M, Rivoire B (1998). *Postia inocybe* (David & Malençon) Jülich f. *inocybe et f. pileatus, f. nov. Notes nomenclaturales sur le genre Postia*. Bulletin trimestriel de la Société mycologique de France 114: 19–33.

Pieri M, Rivoire B (2005). *Postia mediterraneocaesia, une nouvelle espèce de polypore découverte dans le sud de l'*Europe. Bulletin Semestriel de la Fédération des Associations Mycologiques Méditerranéennes 28: 33–38.

Pilát A (1930). *Monographie der europaischen stereaceen*. Hedwigia 70: 10–132.

Pilát A (1936–1942). Polyporaceae. In Kavina, C. cS: Pilat, A., Atlas des Champignons de I' Europe, 3. Praha.

Pilát A (1937). Polyporaceae. In: Kavina K., Pilát A. *Atlás des Champignons de l'Europe.* T. III, 1. Praha, 624 p.

Pilát A (1953). *Hymenomycetes novi vel minus cogniti Cechoslovakiae* II. Acta Musei Nationalis Pragae 2:1–109.

Pildain MB, Rajchenberg M (2013). The phylogenetic position of *Postia s.l.* (Polyporales, Basidiomycota) from Patagonia, Argentina. Mycologia 105: 357–367. DOI: 10.3852/12-088.

Pilotti CA, Sanderson FR, Aitken EAB (2003). Genetic structure of a population of *Ganoderma boninense* on oil palm. Plant Pathology 52: 455–463. DOI: 10.1046/j.1365-3059.2003.00870.x.

Pilotti CA, Sanderson Frank R, Aitken EA, Armstrong W (2004). Morphological variation and host range of two *Ganoderma* species from Papua New Guinea. Mycopathologia 158: 251–65. DOI: 10.1023/B:MYCO. 0000041833.41085.6f.

Pinedo-Rivilla C, Aleu J, Collado IG (2009). Pollutants biodegradation by fungi. Current Organic Chemistry 13: 1194–1214. DOI: 10.2174/ 138527209788921774.

Pires RM, Motatovásquez V, De Gugliotta AM (2015). *Fuscoporia atlantica sp. nov.,* a new polypore from the Brazilian Atlantic Rainforest. Mycotaxon 130: 843–855. DOI: 10.5248/130.843.

Pires RM, Motato-Vásquez V & Westphalen MC, & Gugliotta A (2017). Polyporales and similar poroid genera (Basidiomycota) from Parque Estadual da Serra do Mar, São Paulo State, Brazil. Hoehnea 44: 145–157. DOI: 10.1590/2236-8906-93/2016.

Pliz D (2004). Chaga and other fungal resources-assessment of sustainable commercial harvesting in Khabarovsk and Primorsky Krais, Russia. PilzWald Forestry Applications of Mycology, 541.753.6209, 57 p.

Pongen, AS, Chuzho K, Harsh NSK, Dkhar MS, Kumar M (2018). *Coltriciella dependens* (Berk. & M.A. Curtis) Murrill, a new addition to wood-rotting fungi of India. Journal of Threatened Taxa 10: 12140–12143. DOI: 10.11609/jott.4123.10.8.12140–12143.

Popoff OF, Wright JE (1998). Fungi of Paraguay. I. Preliminary check-list of wood-inhabiting polypores (Aphyllophorales, Basidiomycota). Mycotaxon 67: 323–340.

Pouzar Z (1966). Studies in the taxonomy of polypores. 1. Czech Mycology 20: 171–177.

Pouzar Z (2003): A new polypore from Cuba: *Junghuhnia kotlabae*. Czech Mycology 55: 1–6.

Pradeep CK, Vrinda KB (2007). Some noteworthy agarics from Western Ghats of Kerala. Journal of Mycopathological Research 1: 1–14.

Pradhan P, Dutta AK, Acharya K (2015). A low cost long term preservation of macromycetes for fungarium. Protocol Excllange, 8 p. DOI: 10.1 038 protex.2015.026.

Pramanik S, Chaudhuri S (2018). Laccase activity and azo dye decolorization potential of *Podoscypha elegans*. Mycobiology 46: 79–83. DOI: 10.1080/12298093.2018.1454006.

Prasher IB (1999) Fungi of Chandigarh. IBD, Dehradun. 1–165.

Prasher IB (2015). Wood-rotting non-gilled Agaricomycetes of Himalayas. Springer Netherlands, 653 p. DOI: 10.1007/978-94-017-9858-7.

Prasher IB, Ashok D (2013). A Checklist of wood-rotting fungi (non-gilled Agaricomycotina) of Himachal Pradesh. Journal on New Biological Reports 2: 71–98.

Prasher IB, Chander H (2006). Polyporoid fungi of Nanda Devi Biosphere Reserve. Punjab University Research Journal (Sci) 56: 103–12.3

Prasher IB, Chander H (2007). A preliminary report on the macro fungi and lichens of the Nanda Devi Biosphere Reserve (Uttranchal). In: Prasher IB, Sharma MP (eds) Advances in mycology and plant pathology. Bishen Singh Mahendra Pal Singh, Dehra Dun. 129–166 p.

Prasher IB, Lalita (2013). A Checklist of wood-rotting fungi (non-gilled Agaricomycotina) of Uttarakhand. Journal of New Biological Reports 2: 108–123.

Prasher IB, Lalita, Ashok D (2011) Polyporoid fungi of District Bilaspur (Himachal Pradesh). Journal of Indian Botanical Society 90: 268–273.

Prasher IB, Lalita, Ashok D (2012). Polyporoid fungi of District Mandi, (Himachal Pradesh). Journal of Indian botanical Society 91: 204–212.

Prateep A, Sumkhemthonga S, Suksomtipa M, Chanvorachote P, Chaothama C (2017). Peptides extracted from edible mushroom: *Lentinus squarrosulus* induces apoptosis in human lung cancer cells. Pharmaceutical Biology 55: 1792–1799. DOI: 10.1080/13880209.2017.1325913.

Pratiwi D & Indrianingsih A, Darsih C, Mudjijono H (2017). Decolorization and degradation of Batik dye effluent using *Ganoderma lucidum*. IOP Conference Series: Earth and Environmental Science 101: 012034. DOI: 10.1088/1755-1315/101/1/012034.

Pratt JE, Gibbs JN, Webber JF (2010). Registration of *Phlebiopsis gigantea* as a forest biocontrol agent in the UK. Recent Experience, Biocontrol Science and Technology, 9: 113–118. DOI: 10.1080/09583159929974/.

Przystas W, Zabłocka-Godlewska E, Grabińska-Sota E (2018). Efficiency of decolorization of different dyes using fungal biomass immobilized on different solid supports. Environmental Microbiology 49: 285–295. DOI: 10.1016/j.bjm.2017.06.010.

Punnapayak H, Prasongsuk S, Messner K, Danmek K (2009). Polycyclic aromatic hydrocarbons (PAHs) degradation by laccase from a tropical white rot fungus *Ganoderma lucidum*. African Journal of Biotechnology 8: 5897–5900. DOI: 10.5897/AJB09.1073.

Punugu A, Dunn MT, Welden AL (1980). The peniophoroid fungi of the West Indies. Mycotaxon 10: 428–454.

Puri YN (1956). Studies on Indian *Poria*. Journal of Indian Botanical Society 35: 277–283.

Purkayastha RP, Chandra A (1985). Manual of Indian Edible Mushrooms. Jagmander Book Agency, New Delhi.

Purnomo AS, Mauliddawati VT, Khoirudin M, Yonda AF, Nawfa R, Putra SR (2019). Bio-decolorization and novel bio-transformation of methyl orange by brown-rot fungi. International Jounal of Environmental Science and Technology 16: 7555–7564. DOI: 10.1007/s13762-019-02484-3.

Qin WM, Wang XW, Sawahata T, Zhou LW (2018). *Phylloporia lonicerae* (Hymenochaetales, Basidiomycota), a new species on *Lonicera japonica* from Japan and an identification key to worldwide species of *Phylloporia*. MycoKeys 30: 17–30. DOI: 10.3897/mycokeys.30.23235.

Qin X, Zhang J, Zhang X, Yang Y (2014). Induction, purification and characterization of a novel manganese peroxidase from *Irpex lacteus* CD2 and its application in the decolorization of different types of dye. PLoS One 9: e113282. DOI: 10.1371/journal.pone.0113282.

Quang DN, Hashimoto T, Tanaka M, Takaoka S, Asakawa Y (2004). Tyromycic acids B-E, new lanostane triterpenoids from the mushroom *Tyromyces fissilis*. Journal of Natural Products 67: 148–151. DOI: 10.1021/np030264+.

Quanten E (1997). The polypores of Papua New Guinea. Opera Botanica Belgica 11. Meise: National Botanic Garden of Belgium, 352 p.

Quélet L (1886). *Enchiridion Fungorum in Europa media et praesertim in Gallia Vigentium*: 1–352.

Quiroz-Castañeda RE, Balcázar-López E, Dantán-González E, Martinez A, Folch-Mallol J, Anaya CM (2009). Characterization of cellulolytic activities of

Bjerkandera adusta and *Pycnoporus sanguineus* on solid wheat straw medium. Electronic Journal of Biotechnology 12: 1–8 p. DOI: 10.2225/vol12-issue4-fulltext-3.

Rabba (1997). Studies in the genus *Phellinus* Quel. from Maharashtra. PhD Thesis, University of Pune, India.

Radwan FF, Perez JM, Haque A (2011). Apoptotic and immune restoration effects of ganoderic acids define a new prospective for complementary treatment of cancer. Journal of Clinical & Cellular Immunology S3: 4. DOI: 10.4172/2155-9899.S3-004.

Raghukumar C (2000). Fungi from marine habitats: An application in bioremediation. Mycological Research 104: 1222–1226. DOI: 10.1017/S095375620000294X.

Raghukumar C, Rivonkar G (2001). Decolorization of molasses spent wash by the white-rot fungus *Flavodon flavus*, isolated from a marine habitat. Applied Microbiology and Biotechnology 55: 510–4. DOI: 10.1007/s002530000579.

Raghukumar C, D'souza TM, Thorn RG, Reddy CA (1999). Lignin-Modifying Enzymes of *Flavodon flavus*, a Basidiomycete Isolated from a Coastal Marine Environment. Applied and Environmental Microbiology 65: 2103–2111.

Raghukumar C, Mohandas C, Kamat S, Shailaja MS (2004). Simultaneous detoxification and decolorization of molasses spent wash by the immobilized white-rot fungus *Flavodon flavus* isolated from a marine habitat. Enzyme and Microbial Technology 35: 197–202. DOI: 10.1016/j.enzmictec.2004.04.010.

Raj AKN (2015). A floristic study of the family Entolomataceae (Agaricales, Basidiomycota, Fungi) of kerala. Thesis, Department of Botany, University of Calicut, 355 p.

Rajalekshmy VK, Radhakrishnan PPN (1978). *Poria* root rot of rubbering India. Indian phytopatholgy 31: 199–202.

Rajchenberg M (1982). *El género Coriolus* (Polyporaceae) *en la República* Argentina. Bol Soc Bot Argent 21: 17–57.

Rajchenberg M (1986). On *Trametes aethalodes* and other species of *Daedalea* (Polyporaceae). Canadian Journal of Botany 64: 2130–2135.

Rajchenberg M (1987). Type studies of Polyporaceae (Aphyllophorales) described by J. Rick. Nordic Journal of Botany 7: 553–568.

Rajchenberg M (1995). New polypores from the *Nothofagus* forests of Argentina. Mycotaxon 54: 427–453.

Rajchenberg M (2006). *Los Políporos* (Basidiomycetes) *de los Bosques Andino-Patagónicos de Argentina*. Bibliotheca Mycologica, 201. J Cramer, Berlin-Stuttgart. 300 p.

Rajchenberg M (2011). Nuclear behavior of the mycelium and phylogeny of polypores Basidiomycota. Mycologia 103: 677–702. DOI: 10.3852/10-310.

Rajchenberg M, Meijer AAR (1990). New and noteworthy polypores from Paraná and São Paulo States, Brazil. Mycotaxon 38: 173–185.

Rajchenberg M, Buchanan PK (1996). Two newly described polypores from Australasia and southern South America. Australian Systematic Botany 9: 877–885. DOI: 10.1071/SB9960877.

Rajchenberg M, Wright JE (1998). Two Interesting Polypore species from Argentina. Folia Cryptogamica Estonica 3: 119–122.

Rajchenberg M, Robledo G (2013). Pathogenic polypores in Argentina. Forest Pathology 43: 171–184. DOI: 10.1111/efp.12032.

Rajchenberg M, Gorjón SP, Pildain MB (2011). The phylogenetic disposition of *Antrodia s. l.* (Polyporales, Basidiomycota) from Patagonia Argentina. Australian Systematic Botany 24: 111–120. DOI: 10.1071/SB11003.

Rajendraprasad M, Krishnan PN, Pushpangadan P (2000). Vegetational characterisation and litter dynamics of the sacred groves of Kerala, southwest India. Journal of Tropical Forest Science 12: 320–335.

Rajput KS, Koyani RD, Patel HP, Vasava AM, Patel RS, Patel AD, Singh AP (2015). Preliminary checklist of fungi of Gujarat State, India. Current Research in Environmental & Applied Mycology 5: 285–306. DOI: 10.5943/cream/5/4/1.

Rakib MRM, Bong CFJ, Khairulmazmi A, Idris AS. (2014). Genetic and morphological diversity of *Ganoderma* species isolated from infected oil palms (*Elaeis guineensis*). International Journal of Agriculture & Biology 16: 691–699.

Ramakrishnan TS (1959). Notes on some fungi from South India. Proceedings of the Indian Academy of Science 49: 124–128.

Rameshaiah GN, Jagadish Reddy ML (2015). Applications of ligninolytic enzymes from a white rot fungus *Trametes versicolor*. Universal Journal of Environmental Research and Technology 5: 1–7.

Ranadive KR (2012). Studies in Aphyllophoraceous fungi from the Western Ghats of Pune Districts, Maharashtra State. Ph.D. Thesis, University of Pune, 163 p.

Ranadive KR (2013). An overview of Aphyllophorales (wood rotting fungi) from India. International Journal of Current Microbiology and Applied Sciences 2: 112–139.

Ranadive KR (2014). Three new records of poroid Aphyllophorales to Indian fungal flora from Pune district. Current Research in Environmental & Applied Mycology 4: 126–135

Ranadive KR (2016). Checklist of *Ganoderma* P. Karst (Ganodermataceae) From India. ‘International Conference on Plant Research and Management’and 25th APSI Silver Jubilee Scientists Meet 2016, Tuljaram Chaturchand College, Baramati, India, 45–48 p.

Ranadive KR, Jagtap NV (2016). Preliminary checklist of fungal flora of Kas lateritic plateau and surroundings from the North Western Ghats of Maharashtra State. Applied Botany-Elixir International Journal: 16637–16640.

Ranadive KR, Jagtap N, Vaidya J (2012). Host diversity of genus *Phellinus* from world. Elixir Applied Botany 52: 11402–11408.

Ranadive KR, Jite PK, Ranade VD, Vaidya JG (2013). Flora of Aphyllophorales from Pune District- Part I. Journal on New Biological Reports 2: 188–227.

Ranadive KR, Belsare MH, Deokule SS, Jagtap NV, Jadhav HK, Vaidya JT (2013a). Glimpses of antimicrobial activity of fungi from World. Journal on New Biological Reports 2: 142–162.

Ranadive KR, Vaidya JG, Jite PK, Ranade VD, Bhosale SR, Rabba AS2, Hakimi M, Deshpande GS, Rathod MM, Forutan A, Kaur M, Naik-Vaidya CD, Bapat GS, Lamrood P (2011). Checklist of Aphyllophorales from the Western Ghats of Maharashtra State, India. Mycosphere 2: 91–114.

Rangaswamy G, Seshadri VS, Lucy Channamma KA (1970). Fungi of South India. University of Agricultural Science. Bangalore, 193 p.

Rashid NMR (2010). Diversity and antioxidant activity of *Trametes* Fr. in Malaysia. Dissertation submitted of fulfilment of the requirements for the degree of master of science, University Malaya, Kuala Lumpur, 110 p.

Rassi P, Hyvärinen E, Juslén A, Mannerkoski I (2010). The 2010 Red List of Finnish species. Ministry of the Environment & Finnish Environment Institute.

Ratanapongleka K, Phetsom J (2014). Decolorization of synthetic dyes by crude laccase from *Lentinus Polychrous* Lev. International Journal of Chemical Engineering and Applications 5: 26–30. DOI: 10.7763/IJCEA.2014.V5.345.

Rathod MM (2011). Taxonomic studies on the daedaloid and hexagonoid polypores form the forest of Western Maharasta. Recent Research in Science and Technology 3: 50–56.

Rathod MM, Bendre KB (2015). Studies of the fungi *Lenzites acuta* Berk. from Western Maharashtra, India, International Journal of Life Sciences, Special Issue, A5: 37–41.

Rattan SS (1977). The resupinate Aphyllophorales of North Western Himalayas. Bibliotheca Mycologica 60 Cramer, Germany, 427 p.

Ravikumar KS, Greeshma PV, George V, Janardhanan KK (2016). Antioxidant and anti-inflammatory activities of *Fomitopsis Dochmius* (Berk. & Broome) Ryvarden. International Journal of Pharmaceutical Sciences and Research 7: 3666–3674. DOI: 10.13040/IJPSR.0975-8232.7(9).3666-74.

Raymundo T, Valenzuela R, Bautista-Hernández S, Esqueda M, Cifuentes J, Pacheco L (2013). The genus *Fuscoporia* (Hymenochaetales, Basidiomycota) in Mexico. Revista Mexicana de Biodiversidad: S50-S69. DOI: 10.7550/rmb.31604.

Razaq A, Shahzad S (2016). Additions to the polyporales of Pakistan. Pakistan Journal of Botany 48: 387–391.

Razarinah WAR, Noor Zalina M, Abdullah N (2011). Screening method for selecting the potential fungi for use in the bioremediation of leachate. 2011 2nd International Conference on Environmental Science and Technology (ICEST 2011).

Rea C (1922). British Basidiomycetae: A handbook to the larger British fungi, Cambridge University Press 799 p.

Reck MA, Silveira RMB (2008). *Ordem* Polyporales (Basidiomycota) *no Parque Estadual de Itapuã, Viamão, Rio Grande do Sul*. Revista Brasileira de Biociências 6: 301–314.

Reck MA, Westphalen MC, Silveira, RMB (2011). Rediscovery of *Microporellus iguazuensis* in Southern Brazil. Mycotaxon 115: 5–10. DOI: 10.5248/115.5.

Redberg GL, Hibbett DS, Ammirati JF, Rodriguez RJ (2003). Phylogeny and genetic diversity of *Bridgeoporus nobilissimus* inferred using mitochondrial and nuclear rDNA sequences. Mycologia 95: 836–845.

Reddy CS, Pattanaik C, Reddy KN, Raju VS (2007). Census of endemic flowering plants of Kerala, India. Journal of Plant Sciences 2: 489–503. DOI: 10.3923/jps.2007.489.503

Redhead SA (1981). Parasitism of bryophytes by agarics. Canadian Journal of Botany 59: 63–67.

Redhead SA, Ginns J (1985). A reappraisal of agaric genera associated with brown rots of wood. Transactions of the Mycological Society of Japan 26: 349–381.

Redhead SA, Ginns J, Moncalvo JM (2006). Proposal to conserve the name *Boletus applanatus* against *B. lipsiensis* (Basidiomycota). Taxon 55: 1029–1030.

Redhead SA, Moncalvo JM, Vilgalys R, Lutzoni F (2002). Phylogeny of agarics: partial systematics solutions for bryophilous omphalinoid agarics outside of the Agaricales (euagarics). Mycotaxon 82: 151–168.

Reeves FJ, Welden AL (1967). West Indian species of *Hymenochaete*. Mycologia 59: 1034–1049.

Rehill PS, Bakshi BK (1965). Studies on Indian Thelephoraceae II. Indian Species of *Peniophora* and *Corticium*. Indian Forest Bull Dehra Dun 242: 1–31.

Rehill PS, Bakshi BK (1966). Studies on Indian Thelephoraceae III. The genus *Stereum.* Indian For Bull Dehra Dun 250: 1–20.

Reid DA (1963). New or interesting records of Australasian Basidiomycetes: V // Kew Bullettin17: 267–308.

Reid DA (1965). A monograph of stipitate stereoid fungi. Beih Nova Hedwig 18: 1–382.

Reid DA (1976). Notes on polypores. 2. Memoirs of the New York Botanical Garden. 28: 179–198.

Reid DA, Thind KS, Adlakha KL (1958). The Thelephoraceae of Mussoorie Hills II. Trans Br Mycol Soc 41:129–134.

Ren GJ, Wu F (2017). *Phylloporia lespedezae sp. nov*. (Hymenochaetaceae, Basidiomycota) from China. Phytotaxa 299: 243–251. DOI: 10.11646/phytotaxa.299.2.8.

Renvall P (1992). Basidiomycetes at the timberline in Lapland 4. *Postia lateritia n. sp.* and its rust-coloured relatives. Karstenia 32: 43–60.

Renvall P, Niemelä T (1992). Basidiomycetes at the timberline in Lapland 3. Two new boreal species with intricate hyphal systems. Karstenia 32: 29–42.

Rezende DH, Lopes VF, Montoya C AS, Silva GA, Mello A, Santos ERD (2015). New records of *Perenniporia sensu lato* and *Pyrofomes* for the Brazilian Cerrado. Iheringia Serie Botanica 70: 157–166.

Rhodes CJ (2014). Mycoremediation (bioremediation with fungi) growing mushrooms to clean the earth, Chemical Speciation & Bioavailability 26: 196–198. DOI: 10.3184/095422914X14047407349335

Rich MR, Dulay RMR, Flores KS, Tiniola RC, Hannah D, Marquez H, Cruz AGD, Kalaw SP, Reyes RG (2015). Mycelial biomass production and antioxidant activity of *Lentinus tigrinus* and *Lentinus sajor-caju* in indigenous liquid culture. Mycosphere 6: 659–666. DOI: 10.5943/mycosphere/6/6.

Rick JE (1935). *Polysticti Riograndenses. Brotéria Série Trimestral*. Ciências Naturais 4: 121–138.

Rick JE (1959). *Basidiomycetes Eubasidii in Rio Grande do Sul-Brasilia*. 3. Hypochnaceae, Clavariaceae, Craterellaceae, Hydnaceae. Iheringia 5: 125–192.

Rick JE (1960). *Basidiomycetes Eubasidii in Rio Grande do Sul-Brasilia* 4. Meruliaceae, Polyporaceae e Boletaceae. Iheringia Série Botânica 7: 193–295.

Risna RA, Suhirman (2002). Ligninolytic enzyme production by Polyporaceae from Lombok, Indonesia. Fungal Diversity 9: 23–34.

Rich MR, Dulay RMR, Flores KS, Tiniola RC, Hannah D, Marquez H, Cruz AGD, Kalaw SP, Reyes R (2015). Mycelial biomass production and antioxidant activity of *Lentinus tigrinus* and *Lentinus sajor-caju* in indigenous liquid culture. Mycosphere 6: 659–666. DOI: 10.5943/mycosphere/6/6/2.

Richter C, Wittstein K, Kirk P M, Stadler M (2014). An assessment of the taxonomy and chemotaxonomy of *Ganoderma*. Fungal Diversity 71: 1–15. DOI: 10.1007/s13225-014-0313-6. DOI: 10.1007/s13225-014-0313-6.

Riebesehl J, Langer E (2017). *Hyphodontia s.l.* (Hymenochaetales, Basidiomycota): 35 new combinations and new keys to all 120 current species. Mycological Progress 16: 637–666. DOI: 10.1007/s11557-017-1299-8.

Rizqi HD, Purnomo AS (2017). The ability of brown-rot fungus *Daedalea dickinsii* to decolorize and transform methylene blue dye. World Journal of Microbiology and Biotechnology 33: 9 p. DOI 10.1007/s11274-017-2256-z.

Roberts P (2000). Corticioid fungi from Korup National Park, Cameroon. Kew Bulletin. 55: 803–842.

Roberts P, Ryvarden L (2006). Poroid fungi from Korup National Park, Cameroon. Kew Bulletin 61: 55–78.

Robledo GL, Rajchenberg M (2007). South American polypores: first annotated checklist from Argentinean Yungas. Mycotaxon 100: 5–9.

Robledo GL, Amalfi M, Castillo G, Rajchenberg M, Decock C (2009). *Perenniporiella chaquenia sp. nov.* and further notes on *Perenniporiella* and its relationships with *Perenniporia* (Poriales, Basidiomycota). Mycologia 101: 657–673. DOI: 10.3852/08-040.

Robles CA, Carmaran C, Lopez SE (2011). Screening of xylophagous fungi associated with *Platanus acerifolia* in urban landscapes: Biodiversity and potential biodeterioration. Landscape and Urban Planning 100: 129–135. DOI: 10.1016/j.landurbplan.2010.12.003.

Rodríguez RD, Heredia G, Siles JA, Jurado M, & Saparrat MCN, García-Romera I, Sampedro I (2018). Enhancing laccase production by white-rot fungus *Funalia floccosa* LPSC 232 in co-culture with *Penicillium commune* GHAIE86. Folia Microbiologica 64: 91–99. DOI: 10.1007/s12223-018-0635-y.

Rogers R (2011). The Fungal Pharmacy: The complete guide to medicinal mushrooms and lichens of North America. North Atlantic Books, Berkeley, California, 590 p.

Rogers R (2012). Three under-utilized medicinal polypores. Journal of the American Herbalists Guild 12: 15–21.

Rony KA, Mathew J, Neenu PP, Janardhanan K (2011). *Ganoderma lucidum* (Fr.) P. Karst occurring in South India attenuates gastric ulceration in rats. Indian Journal of Natural Products and Resources 2. 19–27.

Rony KA, Ajith TA, Mathew J, Janardhanan KK (2013). The medicinal cracked-cap polypore mushroom *Phellinus rimosus* (higher Basidiomycetes) attenuates alloxan-induced hyperglycemia and oxidative stress in rats. International Journal of Medicinal Mushrooms 15: 287–300. DOI: 10.1615/IntJMedMushr.v15.i3.60.

Ronquist F, Huelsenbeck JP (2003). MrBayes 3: Bayesian phylogenetic inference under mixed models. Bioinformatics 19: 1572–1574.

Rossi W, Das K, Hembrom ME, Santamaria S, Ghosh A, Henkel TW, Valerie H, Randrianjohany E, Vizzini A, Wang X-H, Buyck, Natio M (2020). Fungal Biodiversity Profiles 91-100. Cryptogamie Mycologie 41: 69. DOI: 10.5252/cryptogamie-mycologie2020v41a4.

Rop O, Mlcek J, Jurikova T (2009). Beta-glucans in higher fungi and their health effects. Nutrition Reviews 67: 624–31. DOI: 10.1111/j.1753-4887.2009.00230.x.

Roy A (1968). Anatomy of Indian Polyporaceae I. *Trametes cingulata* and *Trametes persooni* Fr. Bulletin of Botanical Society of Bengal 22: 45–54.

Roy A (1968a). Anatomy of Indian Polyporaceae II. *Daedalea flavida* Lev. and *D. microzona* Lev. Bulletin of Botanical Society of Bengal 22: 131–134.

Roy A (1969) Anatomy of Indian Polyporaceae III. *Polyporus adustus* Willd. *ex* Fr. and *Polyporus ostreiformis* Berk. Bulletin of Botanical Society of Bengal 23: 205–211.

Roy A (1970) Anatomy of Indian Polyporaceae IV. *Polyporus calcuttensis* Bose. Bulletin of Botanical Society of Bengal 24: 151–156.

Roy A (1971) Anatomy of Indian Polyporaceae V. *Polyporus anthelminticus* Berk. Visva-Bharati Annals (Sc) Part II 14: 20–29.

Roy A (1981). Studies on Indian Polypores-VI. Morphological and cultural characters of *Irpex flavus* Klotzsch. Ibid. 34: 259–263.

Roy A (1981a). Studies on Indian Polypores IV, Morphological and cultural characters of *Polyporus grammocephalus*. Mycologia 73: 150–156.

Roy A (1989). Taxonomy of *Fomes durissimus*. Mycologia 71: 1005–1008.

Roy A, De AB (1977. A record of *Polyporus tricholoma* Mont. from India. Transactions of the British Mycological Society 68: 442–444.

Roy A, De AB (1979). Interfertility studies on eight species of Polyporaceae. Mycologia 71: 655–658.

Roy A, De AB (1980): Studies on Indian Polypores. III. Morphological and cultural characters of *Trametes floccosa*. Norwegian Journal of Botany 27: 297–300.

Roy A, Mitra A (1983). *Taxonomy of Daedaleopsis flavida comb. nov*. Canadian Journal of Botany 61: 2979–2983.

Roy A, De AB (1996). Polyporaceae of India, International Book Distributor, Dehradun, India, 287.

Roy A, De AB (1997). Taxonomy of *Daedalea xantha comb. nov*. Mycotaxon 61: 421–425.

Rune F (1994). *Neolentinus*-a well-founded genus in Pleurotaceae that includes *Heliocybe*. Mycological Research 98: 542–544.

Rungjindamai N, Pinruan U, Choeyklin R, Hattori T, Jones EBG (2008). Molecular characterization of basidiomycetous endophytes isolated from leaves, rachis and petioles of the oil palm, *Elaeis guineensis*, in Thailand. Fungal Diversity 33: 139–162.

Ruán-Soto F, Garibay-Orijel R, Cifuentes J (2006). Process and dynamics of traditional selling wild edible mushrooms in tropical Mexico. Journal of Ethnobiology and Ethnomedicine 2: 3. DOI: 10.1186/1746-4269-2-3.

Rukke BA, Midtgaard F (1998). The importance of scale and spatial variables for the fungivorous beetle *Bolitophagus reticulatus* (Coleoptera: Tenebrionidae) in a fragmented forest landscape. Ecography 21: 561–572.

Ryvarden L (1972). A critical checklist of the Polyporaceae in tropical East Africa. Norwegian Journal of Botany 19: 229–238.

Ryvarden L (1973). New genera in the Polyporaceae. Norwegian Journal of Botany. 20: 1–5.

Ryvarden L (1974) Type studies in the Polyporaceae II. Species described by M Billi. Bulletin du Jardin Botanique National de Belgique 44: 65–76.

Ryvarden L (1975). Studies in the Aphyllophorales of Africa II. Some new species from East Africa. Nordic Journal of Botany 22: 25–34.

Ryvarden L (1976). The Polyporaceae of North Europe, vol I, *Albatrellus-Incrustoporia*. Fungiflora, Oslo, 214 p.

Ryvarden L (1977). Type studies in the Polyporaceae 9. Species described by EM Wakefield. Mycotaxon 5: 331–336.

Ryvarden L (1978). Studies in the Aphyllophorales of Africa 6. Some species from eastern Central Africa. Bull Jard Bot Nat Belg 48: 79–117.

Ryvarden L (1979). *Porogram*e and related genera. Transactions of British Mycological Society 73: 9–19.

Ryvarden L (1981). Type studies in the Polyporaceae -12. Species described by FW Junghun. Persoonia 11: 369–372.

Ryvarden L (1982) Synopsis of genus *Wrightoporia*. Nordic Journal of Botany 2: 145–149. DOI: 10.1111/j.1756-1051.1982.tb01174.x.

Ryvarden L (1982a). The genus *Hydnochaete* Bres. (Hymenochaetaceae). Mycotaxon 15: 425–447.

Ryvarden L (1983). The genus *Navisporus* (Polyporaceae). Nordic Journal of Botany 3: 411–413. DOI: 10.1111/j.1756-1051.1983.tb01955.x.

Ryvarden L (1984). Type studies in the Polyporaceae. 16. Species described by J. M. Berkeley, either alone or with other mycologists from 1856 to 1886. Mycotaxon 20: 329–363.

Ryvarden L (1985). *Stipitochaete gen. nov*. (Hymenochaetaceae, Basidiomycotina). Transactions of British Mycological Society 85: 535–539. DOI: 10.1016/S0007-1536(85)80056-5.

Ryvarden L (1988). Type studies in the Polyporaceae. 20. Species described by G. Bresadola. Mycotaxon 33: 303–327.

Ryvarden L (1989). Type studies in the Polyporaceae 21. Species described by C. G. Lloyd in *Cyclomyces*, *Daedalea*, *Favolus*, *Fomes* and *Hexagonia*. Mycotaxon 35: 229–236.

Ryvarden L (1991). Genera of polypores. Nomenclature and taxonomy. Synopsis Fungorum 5: 1–363.

Ryvarden L (1997). *Podoscypha warneckii*. Mycotaxon 64: 401–403. DOI: 10.11646/phytotaxa.387.3.2.

Ryvarden L (1998). African Polypores–A Review. Belgian Journal of Botany 131: 150-155.

Ryvarden L (2000). Studies in Neotropical polypores 8. Poroid fungi from Jamaica, a preliminary checklist. Mycotaxon 76: 349–360.

Ryvarden L (2000a). A critical checklist of African polypores. In Associazione Micologica Bresadola (eds), Micologia 2000 471-483+ incl.colour plates Trento: Associazione Micologica Bresadola.

Ryvarden L (2000b). Studies in neotropical polypores 2: a preliminary key to neotropical species of *Ganoderma* with a laccate pileus. Mycologia 92: 180–191.

Ryvarden L (2004). Neotropical Polypores Part 1. Introduction, Ganodermataceae & Hymenochaetaceae. Synopsis Fungorum 19: 1–229.

Ryvarden L (2004a). Studies in Neotropical polypores 19. Two wood inhabiting *Amauroderma* species. Synopsis Fungorum 18: 57–61.

Ryvarden L (2005). The genus *Inonotus*, a synopsis. Synopsis Fungorum 21: 1–149.

Ryvarden (2010). Stereoid fungi of America. Synopsis Fungorum 28. Fungiflora, Oslo, 232 p.

Ryvarden L (2014). Studies in neotropical polypores 38. Synopsis Fungorum 32: 68–71.

Ryvarden L (2015). Neotropical polypores, Part 2: Polyporaceae, *Abortiporus–Nigroporus*. Synopsis Fungorum 34: 232–443.

Ryvarden L (2016). Neotropical polypores Part 3, Polyporaceae, *Obba-Wrightoporia*, Fungiflora, Oslo, 562 p.

Ryvarden L (2018). Studies in African Aphyllophorales 25. New poroid species from East and Central Africa. Synopsis Fungorum 38: 25–32.

Ryvarden L (2019). Synopsis Fungorum 39, Oslo, 80 p.

Ryvarden L, Johansen I (1980). A preliminary polypore flora of East Africa. Fungiflora, Oslo, 630 p.

Ryvarden L, Wright JE (1982). *Megasporoporia*, a new genus of resupinate polypores. Mycotaxon 16: 172–182.

Ryvarden L, Gilbertson RL (1993). European Polypores I. Synopsis Fungorum 6: 1–387.

Ryvarden L, Gilbertson RL (1994). European polypores II. Synopsis Fungorum 7: 394–743.

Ryvarden L, Iturriaga T (2001). Studies in neotropical polypores 9 A critical checklist of poroid fungi from Venezuela. Mycotaxon 78: 393–405.

Ryvarden L, Meijer AAR de (2002). Studies in neotropical polypores 14. New species from the state of Paraná, Brazol. Synopsis Fungorum 15: 34–69.

Ryvarden L, Itturiaga T (2003). Studies in Neotropical polypores. 10. New polypores from Venezuela. Mycologia 95: 1066–1077. DOI: 10.1080/15572536.2004.11833021.

Ryvarden L, Iturriaga T (2004). Studies in Neotropical polypores 21. New and interesting species from Venezuela. Oslo, Norway, Fungiflora. 68–75 p.

Ryvarden L, Melo I (2014). Poroid fungi of Europe. Synopsis Fungorum. 31: 1–455.

Ryvarden L, Hausknecht A, Greilhuber IK (2006). *Coltricia grandispora* and *Tyromyces vitellinus,* two new polypore. Österreichische Zeitschrift für Pilzkunde 15: 143–147.

Ryvarden L, Aime MC, Baroni TJ (2009). Studies in neotropical polypores 26. A new species of *Trametes* and revisitation of an old. Synopsis Fungorum 26: 27–32.

Saar M (1991). Fungi in khanty folk medicine. Journal of Ethnopharmacology 31: 175–179. DOI: 10.1016/0378-8741(91)90003-V.

Saccardo PA (1887). Sylloge Fungorum (Abellini) 5: 618.

Saccardo PA (1888). Sylloge Fungorum 7: 1–882.

Saccardo PA, Sydow P (1899). *Supplementum Universale,* Pars IV. Sylloge Fungorum 14: 1–1316.

Saha R, Das D, Tarafder E, Roy A, Acharya K (2018). Contribution to the macromycetes of West Bengal, India: 34–39. Research Journal of Pharmacy and Technology 11: 5123. DOI: 10.5958/0974-360X.2018.00935.6.

Saitou N, Nei M (1987). The neighbor-joining method: A new method for reconstructing phylogenetic trees. Molecular Biology and Evolution 4: 406–425. DOI: 10.1093/oxfordjournals.molbev.a040454.

Sakayaroj J, Preedanon S, Suetrong S, Klaysuban A, Jones EBG, Hattori T (2012). Molecular characterization of basidiomycetes associated with the decayed mangrove tree *Xylocarpus granatum* in Thailand. Fungal Diversity 56: 145–156. DOI: 1007/s13225-012-0195-4

Salmiah U (1997). Basidiomycota in forest reserves and plantation forest in Peninsular Malaysia. PhD thesis, University of Portsmouth, United Kingdom.

Salmiah U, Jones EBG (2001). Occurrence of wood-inhabiting fungi in forest of peninsular Malaysia. Journal of Tropical Forest Science 13: 237–245.

Salmiah U, Thillainathan P (1998). Some common macrofungi in Malaysia. FRIM Tech Inform 64.

Salmones D, Mata G, Waliszewski KN (2005). Comparative culturing of *Pleurotus spp* on coffee pulp and wheat straw: biomass production and substrate biodegradation. Bioresource Technology 96: 537–544. DOI: 10.1016/j. biortech.2004.06.019.

Saltarelli R, Ceccaroli P, Lotti M, Zambonelli A, Buffalini M, Casadei L, Vallorani L, Stocchi V (2009). Biochemical characterisation and antioxidant activity of mycelium of *Ganoderma lucidum* from central Italy. Food Chem. 116: 143–51. DOI: 10.1016/j.foodchem.2009.02.023.

Salvachúa D, Prieto A, Vaquero EM, Martínez AT, Martínez MJ (2013). Sugar recoveries from wheat straw following treatments with the fungus *Irpex lacteus*. Bioresource Technology 131: 218–225. DOI: 10.1016/j. biortech.2012.11.089.

Salvador-Montoya CA, Millán B, Janovec JP, Drechsler-Santos ER (2012). A preliminary checklist of polypores of Peru, with notes on distribution in the Andes-Amazon region and new records for the country. Mycosphere 3: 282–287. DOI: 10.5943/mycosphere/3/3/2.

Salvador-Montoya CA, Robledo GL, Cardoso D, Marco A, Borba-Silva MA, Fernandes M, Drechsler-Santos ER (2015). *Phellinus piptadeniae* (Hymenochaetales: Hymenochaetaceae): taxonomy and host range of a species with disjunct distribution in South American seasonally dry forests. Plant Systematics and Evolution 301: 1887–1896. DOI: 10.1007/s00606-015-1201-6.

Salvador-Montoya CA, Costa-Rezende DH, Ferreira-Lopes V, Borba-Silva MA, Orlando Popoff OF (2018). *Tropicoporus drechsleri* (Hymenochaetales, Basidiomycota), a new species in the "*Inonotus linteus*" complex from northern Argentina. Phytotaxa 338: 75–89. DOI: 10.11646/phytotaxa. 338.1.6.

Sampedro I, Aranda E, Martín J, García-Garrido JM, García-Romera I, Ocampo JA (2004). Saprobic fungi decrease plant toxicity caused by olive mill residues. Applied Soil Ecology 26: 149–156. DOI: 10.1016/j.apsoil.2003.10.011.

Sánchez-López MI, Vanhulle SF, Mertens V, Guerra G, Figueroa SH, Decock C, Corbisier AM, Penninckx MJ (2008). Autochthonous white rot fungi from the tropical forest: potential of Cuban strains for dyes and textile industrial effluents decolourisation. African Journal of Biotechnology 7: 1983–1990. DOI: 10.5897/AJB08.042.

Sandoval LP, Rajchenberg M (2011). *Fomitopsis minutispora* Rajchenb., *nuevo registro de Polyporales para la micobiota chilena*, Gayana. Botanica 68: 319–322. DOI: 10.4067/S0717-66432011000200021.

Sankaran KV, Florence EJM (1995). Macrofungal fungal flora and checklist of Malayattoor forests (Kerala). In: Advances in Forestry Research in India: 12 (Ed.) Ramprakash, International Book Distributors, Dehra Dun,147–198 p.

Sankaran KV, Bridge P, Gokulapalan C (2005). *Ganoderma* diseases of perennial crops in India–an overview. Mycopathalogia 159: 143. DOI: 10.1007/s11046-004-4437-1.

Santana MC, Leite CL (2013). Species of *Amauroderma* (Ganodermataceae) in Santa Catarina State, Southern Brazil. Biotemas 26: 1–5. DOI: 10.13140/2.1.3444.8004.

Santos CD, Silva RO, Soares ACF, Drechsler-Santos ER, Bezerra JL (2018). First record of *Daedalea ryvardeniana* Drechsler-Santos & Robledo (Agaricomycetes, Polyporales, Fomitopsidaceae) in the Caatinga area of Bahia, Brazil. Check List 14 (1): 173–176. https://doi.org/10.15560/14.1.173.

Santos ERD, Groposo C, Leite CL (2008). Additions to the knowledge of lignocellulolytic basidiomycetes in forests from Santa Catarina, Southern Brazil. Summary published in Mycotaxon 103: 197–200.

Santos ERD, Neto JRTDV, Gibertoni TB, Neto AG, Cavalcanti MADQ (2007). Notes on *Navisporus*; *N. terrestris* and *N. floccosus* from Brazil. Mycotaxon 101: 265–269.

Santos ERD, Ryvarden L, Bezerra JL, Gibertoni TB, Montoya CAS, Calvacanti MAQ (2013). New records of Auriculariales, Hymenochaetales and Polyporales (Fungi: Agaricomycetes) for the Caatinga Biome. Check List 9: 800–805. DOI: 10.15560/9.4.800.

Saparrat MC, Balatti P, Arambarri AM, Martínez MJ (2014). *Coriolopsis rigida*, a potential model of white-rot fungi that produce extracellular laccases: a review. Journal of Industrial Microbiology and Biotechnology 41: 607–617. DOI: 10.1007/s10295-014-1408-5.

Saparrat MC, Bucsinszky AM, Tournier HA, Cabello MN, Arambarri AM (2000). Extracellular ABTS oxidizing activity of autochthonous fungal strains from Argentina in solid medium. Revista iberoamericana de micologia 17: 64–68.

Sarbhoy AK, JL Varshney, DK Aggarwal (1996). Fungi of India (1982–92). CBS Publishers and Distributors, New Delhi.

Sarkar A, Anjali R (1969). Developmental anatomy and differentiation of tissue systems of *Ganoderma lucidum* (Leyss. *ex* Fr.) Karst. Phyton 13: 89–104.

Sasidharan N (2006). Flowering Plants of Kerala: A Checklist (CD). Kerala Forest Research Institute, Peechi.

Sasidharan N (2012). Flowering plants of Kerala- Version 2.0 DVD No. 14. Kerala Forest Research Institute, Peechi.

Sathe AV, Daniel J (1980). Agaricales (mushrooms) of Kerala State–Part III. In: Agaricales (Mushrooms) of South West India: 75–108. (MACS Monograph no 1.) Pune: Maharashtra Association for the Cultivation of Science.

Sathe AV, Deshpande S (1980). Agaricales (mushrooms) of Maharashtra State – Part I. In: Agaricales (Mushrooms) of South West India: 9–42. (MACS Monograph no, 1.) Pune: Maharashtra Association for the Cultivation of Science.

Sathe AV, Kulkarni SM (1980). Agaricales (mushrooms) of Karnataka State – Part II. In: Agaricales (Mushrooms) of South West India: 43–73. (MACS Monograph no 1.) Pune: Maharashtra Association for the Cultivation of Science.Schaeffer JC (1762–1774), *Fungorum qui in Bavaria et Palatinatn circa Ratisbonam nascuntur icones*, vol I–IV. Typis Zunkelianis, Ratisbonae.

Savino E, Girometta C, Staleva J, Kostadinova A, Krumova E (2016). Wood decay macrofungi: Strain collection and studies about antioxidant properties. *Comptes rendus de l'Académie bulgare des Sciences* 69, 747 p.

Savino E, Girometta C, Chinaglia S, Guglielminetti ML, Rodolfi M, Bernicchia A, Perini C, Salerni E, & Picco A. (2014). Medicinal mushrooms in Italy and their *ex situ* conservation through culture collection. Proceedings of the 8th International Conference on Mushroom Biology and Mushroom Products (ICMBMP8) 2014.

Schaeffer JC (1762–1774). *Fungorum qui in Bavaria et Palatinatn circa Ratisbonam nascuntur icones*, vol I–IV. *Typis Zunkelianis, Ratisbonae.*

Schigel DM (2011). Polypore–beetle associations in Finland. Annales Zoologici Fennici 48: 319–348. DOI: 10.5735/086.048.0601.

Schigel DS, Niemelä T, Kinnunen J (2006). Polypores of Western Finnish Lapland and seasonal dynamics of polypore beetles. Karstenia 46: 37–64. DOI: 10.29203/ka.2006.415.

Schliephake K, Lonergan GT, Jones CL, Mainwaring DE (1999). Decolourisation of a pigment plant effluent by *Pycnoporus cinnabarinus* in a packed-bed bioreactor. Biotechnology Letters 15: 1185–1188.

Schliephake K, Mainwaring DE, Lonergan GT, JFones IK, Baker WL (2000). Transformation and degradation of the disazo dye Chicago Sky Blue by a purified laccase from *Pycnoporus cinnabarinus*. Enzyme and Microbial Biotechnology 27: 100–107. DOI: 10.1016/s0141-0229(00)00181-2.

Schmidt O (2007). Indoor wood-decay basidiomycetes: damage, causal fungi, physiology, identification and characteristics, prevention and control. Mycological Progress 6: 261–279. DOI: 10.1007/s11557-007-0534-0.

Schmidt O, Moreth U (2003). Molecular identity of species and isolates of internal pore fungi *Antrodia* spp. and *Oligoporus placenta*. Holzforschung 57: 120–126. DOI: 10.1515/HF.2003.019.

Schrader HA (1794). *Spicilegium Florae Germanicae*. Ritscher, Hannover.

Schwarze F, Ferner D (2003). *Ganoderma* on trees-Differentiation of species and studies of invasiveness. Arboricultural Journal 27: 59–77. 10.1080/03071375.2003.9747362.

Seelan JSS, Justo A, Nagy LG, Grand EA, Readhead HA, Hibbett D (2015). Phylogenetic relationships and morphological evolution in *Lentinus*, *Polyporellus* and *Neofavolus*, emphasizing southeastern Asian taxa. Mycologia 107: 460–474. DOI: 10.3852/14-084.

Sehgal HS, Sen M, Bakshi BK (1966). Temperature relations of Indian Polypores. Indian Forest Rec. (n.s.). Forest Pathology 2: 131–137.

Sehgal D, Sharma JR, Hembrom ME (2008). A rare polypore from Western Himalaya, Uttarakhand. Indian Journal of Forestry 3: 659–660.

Sell I (2008). Taxonomy of the species in the *Phellinus igniarius* group. Mycotaxon 104: 337–347.

Selonen VAO, Ahlroth P, Kotiaho JS (2005). Anthropogenic disturbance and diversity of species: polypores and polypore-associated beetles in forest, forest edge and clear-cut. Scandinavian Journal of Forest Research 20: 49–58. DOI: 10.1080/14004080510041002.

Selvakumar S, Manivasagan R, Karthikeyan C (2012). Biodegradation and decolourization of textile dye wastewater using *Ganoderma lucidum*. Biotechnology 3: 71–79. 10.1007/s13205-012-0073-5.

Selvam K, Shanmuga PM (2012). Biological treatment of AZO dyes and textile industry effluent by newly isolated White ROT fungi *Schizophyllum commune* and *Lenzites eximia.* International Journal of Environmental Sciences 2: DOI: 1926–1935. 10.6088/ijes.00202030076.

Seng CK, Abdullah N, Aminudin N (2017). Lipid modulating effect of black *lingzhi* medicinal mushroom, *Amauroderma rugosum* (Agaricomycetes) on oleate-induced human hepatocellular liver carcinoma eells. International journal of medicinal mushrooms 19: 1101–1111. DOI: 10.1615/IntJ MedMushrooms. 2017024589.

Seng CK, Abdullah N, Aminudin N (2017a). Antioxidative and inhibitory effects of the fruiting body of black *lingzhi* mushroom, *Amauroderma rugosum* (Agaricomycetes), on LDL oxidation and HMG-CoA deductase activity. International journal of medicinal mushrooms 19: 797–807. DOI: 10.1615/IntJMedMushrooms.2017024374.

Senn-Irlet B, Bieri G, Egli S (2007). Rote Liste Grosspilze. 92 p. Bern.

Senthilarasu G (2014). Diversity of agarics (gilled mushrooms) of Maharashtra, India. Current Research in Environmental & Applied Mycology 4: 58–78. DOI: 10.5943/cream/4/1/5.

Senthilarasu G (2015). The lentinoid fungi (*Lentinus* and *Panus*) from Western Ghats, India. IMA Fungus 6: 119–128.

Senthilarasu G, Singh SK (2012). A new species of *Lentinus* from India. Mycotaxon 121: 69–74. DOI: 10.5248/121.69.

Seo GS, Kirk PM (2000). Ganodermataceae: Nomenclature and classification. In J Flood PD Bridge M Holderness (Eds) *Ganoderma* Diseases of Perennial Crops CABI Publishing UK, 3–22 p.

Seto SW, Lam TY, Tam HL, Au AL, Chan SW, Wu JH, Yu PH, Leung GP, Ngai SM, Yeung JH, Leung PS, Lee SM, Kwan YW (2009). Novel hypoglycemic effects of *Ganoderma lucidum* water-extract in obese/diabetic (+db/+db) mice. Phytomedicine: international journal of phytotherapy and phytopharmacology 16: 426–436. DOI: 10.1016/j.phymed.2008.10.004.

Sexena MC (1961). Fleshy fungi of Raipur district (Madhya Pradesh) Polyporaceae II. Proccedings of Indian Science Association, Part III: 245–246.

Shahbazyan TA (2017). Antifungal activity of mycelia of *Trametes gibbosa* regarding potentially pathogenic for humans and animals filamentous fungi. Chemistry & Biology 51: 118–122.

Shao BM, Dai H, Xu W, Lin ZB, Gao XM (2004). Immune receptors for polysaccharides from *Ganoderma lucidum*. Biochemical and Biophysical Research Communications 323: 133–141. 10.1016/j.bbrc.2004.08.069.

Sharif S, Atta A, Huma T, Shah AA, Afzal G, Rashid S, Shahid M, Mustafa G (2018). Anticancer, antithrombotic, antityrosinase, and anti-α-glucosidase activities of selected wild and commercial mushrooms from Pakistan. Food Science Nutrition 6: 2170–2176. DOI: 10.1002/fsn3.781.

Sharma D, Goel G, Sud A, Chauhan RS (2015). A novel laccase from newly isolated *Cotylidia pannosa* and its application in decolorization of synthetic dyes. Biocatalysis and Agricultural Biotechnology 4: 661–666. DOI: 10.1016/j.bcab.2015.07.008.

Sharma JK, Mohanan C, Florence EJM (1985). Disease survey in nurseries and plantations of forest tree species grown in Kerala. KFRI Research Report 36: 1–268.

Sharma JR (1989). Polypores new to India-II. Bulletin of Botanical Survey of India 31: 103–107.

Sharma JR (1995). Hymenochaetaceae of India. Botanical Survey of India, Kolkata, 219 p.

Sharma JR (2000). Genera of Indian polypores. BSI, Northern Circle, Dehra Dun, 188 p.

Sharma JR (2012). Aphyllophorales of Himalaya. Botanical Survey of India, Calcutta, 590 p.

Sharma SK, Atri NS (2015). The genus *Lentinus* (Basidiomycetes) from India - an annotated checklist. Journal of Threatened Taxa 7: 7843–7848. DOI: 10.11609/JoTT.o3864.7843-8.

Sharma JR, Das K, Mishra D (2013). The genus *Inonotus* and its related species in India. Mycosphere 4: 809–818: DOI: 10.5943/mycosphere/4/4/16.

Sharma S, Singh A, Mathur N, Verma A (2013a). Development of fungal consortium for biodecolorization of textile waste effluents: a review. International Journal of Chemical Science 11: 891–910.

Sharp C, Ryvarden (2020). Aphyllophorales of Africa 38 - Some new poroid species from Southern Africa. Synopsis Fungorum. 40: 109–111.

Sheikh IA, Vyas D, Ganaie MA, Dehariya K, Singh V (2014). HPLC determination of phenolics and free radical scavenging activity of ethanolic extracts of two polypore mushrooms. International Journal of Pharmacy and Pharmaceutical Science 6: 679–684.

Sheena N, Ajith TA, Janardhanan KK (2003). Prevention of nephrotoxicity induced by the anticancer drug cisplatin, using *Ganoderma lucidum*, a medicinal mushroom occurring in South India. Current Science 85: 478‒482.

Shen LL, Cui BK, Dai YC (2014). A new species of *Postia* (Polyporales, Basidiomycota) from China based on morphological and molecular evidence. Phytotaxa 162: 147–156. DOI: 10.11646/phytotaxa.162.3.3.

Shen LL, Wang M, Zhou JL, Xing ZH, Cui BK, Dai YC (2019). Taxonomy and phylogeny of *Postia*. Multi-gene phylogeny and taxonomy of the brown-rot fungi: *Postia* (Polyporales, Basidiomycota) and related genera. Persoonia 42: 101–126. DOI: 10.3767/persoonia.2019.42.05.

Shen S, Ma X, Xu TM, Zhao CL (2018). *Phlebia ailaoshanensis sp. nov.* (Polyporales, Basidiomycota) evidenced by morphological characters and phylogenetic analyses. Phytotaxa 373: 184–196. DOI: 10.11646/ phytotaxa.373.3.2.

Shiao (2003). Natural products of the medicinal fungus *Ganoderma lucidum*: occurrence, biological activities, and pharmacological functions. The Chemical Record 3: 172–80. DOI: 10.1002/tcr.10058.

Shijitha M, Francis KM, Sabu PJ (2020). Land use pattern in climatic physiological zones of Kerala. International Journal of Multidisciplinary Educational Research 9: 50–57.

Shin KS (2004). The role of enzymes produced by white-rot fungus *Irpex lacteus* in the decolorization of the textile industry effluent. Journal of Microbiology 42: 37–41.

Shin KS, Kim YH, Lim JS (2005). Purification and characterization of manganese peroxidase of the white-rot fungus *Irpex lacteus*. Journal of Microbiology 43: 503–509.

Shintani N, Sugano Y, Shoda M (2002). Decolorization of kraft pulp lignin bleaching effluent by a newly isolated fungus, *Geotrichum candidum*. Journal of Wood Science 48: 402–408. DOI: 10.1007/BF00770700.

Shirin AHS, Thomas R (2015). Regionalization of Rainfall in Kerala State. International Conference on Emerging Trends in Engineering, Science and Technology (ICETEST-2015). Procedia Technology 24: 15–22.

Shirin AHS, Thomas R (2016). Regionalization of Rainfall in Kerala State. Procedia Technology 24: 15–22. DOI: 10.1016/j.protcy.2016.05.004.

Shon MY, Kim TH, Sung NJ (2003). Antioxidant and free radical scavenging activity of *Phellinus baumii* (*Phellinus*, Hymenochaetacea) extracts. Food Chemistry 82: 593–597. DOI: 10.1016/S0308-8146(03)00015-3.

Shokrzadeh M, Azdo S, ahmadi MA, Habibi E (2017). Anti-diabetic effect of methanol extract of *Trametes versicolor* on male mice. Journal of Mazandaran University of Medical Sciences 26: 165–175.

Shraddha, Shekher R, Sehgal S, Kamthania M, Kumar A (2011). Laccase: microbial sources, production, purification, and potential biotechnological applications. Enzyme Research 2011: 217861. DOI: 10.4061/2011/217861.

Shri TA, Deepa P, Nithya T (2013). Screening, optimization and separation of ligninolytic enzyme by polyporaceae group fungi. International Journal of Science Innovations and Discoveries 3: 434–444.

Si J, Cui BK, Dai YC (2012). Decolorization of chemically different dyes by white-rot fungi in submerged cultures. Annals of Microbiology 63: 1099–1108. DOI: 10.1007/s13213-012-0567-8.

Si J, Dai YC (2016). Wood decaying fungi in eastern Himalayas 5. Polypore diversity. Mycosystema 35: 252–278.

Si J, Li XC, Cui BK (2014). Decolorization of heterocycle dye neutral red by white rot fungus *Perenniporia subacida*. Desalination and water treatment 52: 28–30. DOI: 10.1080/19443994.2013.814008.

Si J, Cui BK, He S, Dai YC (2011). Optimization of conditions for laccase production by *Perenniporia subacida* and its application in dye decolorization. Chinese Journal of Applied and Environmental Biology 17: 736–741 (in Chinese). DOI: 10.3724/SP.J.1145.2011.00736.

Sierota Z, Nowakowska JA, Sikora K, Wrzosek M, Żółciak A, Małecka M (2015). What is important in selecting *Phlebiopsis gigantea* strain for commercial use? Journal of Agricultural Science and Technology 5: 55–64. DOI: 10.17265/2161-6264/2015.01.006.

Silberborth S, Erkel G, Anke T, Sterner O (2000). The irpexans, a new group of biologically active metabolites produced by the basidiomycete *Irpex* sp. 93028. Journal of Antibiotics (Tokyo) 53: 1137–44. DOI: 10.7164/antibiotics.53.1137.

Silva ACG, Ryvarden L, Gibertoni TB (2012). Resupinate poroid fungi from tropical rain forests in Brazil: two new species and new records. Mycolical Progress 11: 879–885. DOI: 10.1007/s11557-011-0803-9.

Silva FS, Sá MS, Costa JFO, Pinto FP, Lima MS, Lucchese AM, Góes-Neto A, Zalis MG, Santos RR, Soares MBP (2009). *In vitro* pharmacological screening of macrofungi extracts from the Brazilian northeastern region. Pharmaceutical Biology 47: 384–389. DOI: 10.1080/13880200902755226.

Silveira RMB, Guerrero RT (1989). *Os gêneros Rigidoporus Murr. e Flaviporus Murr. (Basidiomycetes) do Parque Nacional de Aparados da Serra*, RS. Acta Botanica Brasilica 3: 29–45. DOI: 10.1590/S0102-33061989000300004.

Simmons DR, Li Y, Bateman CC, Hulcr J (2016). *Flavodon ambrosius sp. nov.*, a basidiomycetous mycosymbiont of *Ambrosiodmus ambrosia* beetles. Mycotaxon 131: 277-285. DOI: 10.5248/131.277.

Singer R (1944). Notes on taxonomy and nomenclature of the polypores. Mycologia 36: 65–69.

Singer R (1951). The Agaricales (Mushrooms) in modern taxonomy. Lilloa 22, 832 p.

Singer R (1961). Fungi of northern Brasil. Publ. Inst. Micol. Univ. Recife 304: 3–26.

Singer R (1975). The Agaricales in Modern Taxonomy. 2nd Ed. A. R. Gantner Verlag KG., Germany, 912 p.

Singer R (1986). The Agaricales in modern taxonomy, 4th ed. Germany: Koeltz Scientific Books, 981 p.

Singh AP, Kaur G, Dhingra GS (2014). Diversity of poroid mushrooms in Punjab: family hymenochaetaceae. Proceedings of the 8th International Conference on Mushroom Biology and Mushroom Products (ICMBMP8), Delhi, vol I.

Singh B (1961). Occurrence of *Trametes ravida* (Fr.) Pilat in India. Indian Forester 87: 429–430.

Singh B (1966). Timber decay due to five species of *Fomes*, as new records in India. Indian Forester 92: 653–655.

Singh B (1966a) Studies on Indian *Poria*, II. Diagnosis of five new records in India. Indian Forester 92: 680–683.

Singh B, Bakshi BK (1961). New records of *Fomes* from India. Indian Forester: 302–303.

Singh L (2017). Biodegradation of synthetic dyes: a mycoremediation approach for degradation/decolourization of textile dyes and effluents. Journal of Applied Biotechnology and Bioengineering 3: 430–435. DOI: 10.15406/jabb.2017.03.00081.

Singh R, Singh AP, Dhingra GS, Shri R (2014). Taxonomy, physicochemical evaluation and chemical investigation of *Ganoderma applanatum* and *G. brownii*. International Journal of Advanced Research 2: 702–711.

Singh RL, Singh PK, Singh RP (2019a). Recent advances in decolorization and degradation of dyes in textile effluent by biological approaches. Boca Raton, CRC Press, 88 p. DOI: 10.1201/9780429244322.

Singh RP, Kashyap AS, Pal A, Singh P, Tripathi NN (2019). Macrofungal diversity of North-Eastern part of Uttar Pradesh (India). International Journal of

Current Microbiology and Applied Sciences 8: 823–838. DOI: 10.20546/ijcmas.2019.802.094.

Singh S, Youssouf M, Malik ZA, Bussmann RW (2017a). Sacred Groves: myths, beliefs, and biodiversity conservation-a case study from Western Himalaya, India. International Journal of Ecology 2017: 12 p. DOI: 10.1155/2017/3828609.

Singh S, Singh B, Bakshi BK (1961). Fungus flora of South Andamans. Indian Forester 87: 248–250.

Singh S, Singh B, Bakshi BK (1961a). *Merulius tremellosus* (Schrad.) Fr. and its Ptyogaster stage. Canadian Journal of Botany 39: 1845–1847.

Singh SN, Mishra S, Jauhari N (2014a). Degradation of anthroquinone dyes stimulated by Fungi. Microbial Degradation of Synthetic Dyes in Wastewaters, Environmental Science and Engineering. 333–356. DOI 10.1007/978-3-319-10942-8_15.

Siripong P, Oraphin B, Duanporn P (2009). The ability of five fungal isolates from nature to degrade of polyaromatic hydrocarbons (PAHs) and polychlorinated biphenyls (PCBs) in Culture Media. Australian Journal of Basic and Applied Sciences 3: 1076–1082.

Sjökvist E, Larsson E, Eberhardt U, Ryvarden L, Larsson KH (2012). Stipitate stereoid basidiocarps have evolved multiple times. Mycologia 104: 1046–1055. DOI: 10.3852/11-174.

Sliva D (2010). Medicinal mushroom *Phellinus linteus* as an alternative cancer therapy (Review). Experimental and Therapeutic Medicine 1: 407–411. DOI: 10.3892/etm_00000063.

Smânia A, Delle Monache F, Smânia EFA, Gil ML, Benchetrit LC, Cruz FS (1995). Antibacterial activity of a substance produced by the fungus *Pycnoporus sanguineus* (Fr.) Murr. Journal of Ethnoparmacology 45: 177–181.

Smânia A, Marques CJS, Smânia EFA, Zanetti CR, Carobrez SG, Tramonte R, Loguercio-Leite C (2003). Toxicity and antiviral activity of cinnabarin obtained from *Pycnoporus sanguineus* (Fr.) Murr. Phytotherapy Research 17: 1069–1072. DOI: 10.1002/ptr.1304.

Smith A, Javed S, Barad A, Myhre V, Li WM, Reimer K, Lee CH (2017). Growth-inhibitory and immunomodulatory activities of wild mushrooms from North-Central British Columbia (Canada). International Journal of Medicinal Mushrooms 19: 485-497. DOI: 10.1615/IntJMedMushrooms.v19.i6.10.

Smith BJ, Sivasithamparam K (2000). Internal transcribed spacer ribosomal DNA sequence of five species of *Ganoderma* from Australia. Mycological Research 104: 943–951. DOI: 10.1017/S0953756200002458

Smith BJ, Sivasithamparam K (2003). Morphological studies of *Ganoderma* (Ganodermataceae) from the Australasian and Pacific regions. Australian Systematic Botany 16: 487–503. DOI: 10.1071/SB02001.

Smith JE, Rowan NJ, Sullivan R (2002). Medicinal Mushrooms: Their therapeutic properties and current medical usage with special emphasis on cancer treatments. Cancer Research UK, University of Strathclyde, UK, 273 p.

Smith KT (2018). Tree disease and wood decay as agents of environmental and social change. Pages 25-30 in the Proceedings of the landscape disease symposium held by the University of California Division of Agriculture and Natural Resources in Santa Paula, CA on January 16, 2018.

Smith WG (1908). Synopsis of the British Basidiomycetes. British Museum (Natural History), London.

Snehalatharani A, Maheshwarappa HP., Devappa V, Malhotra SK (2016). Status of coconut basal stem rot disease in India – A review. Indian Journal of Agricultural Sciences 86: 1519–1529.

Soares AM, Nogueira-Melo G, Plautz HL, Gibertoni TB (2017). A new species, two new combinations and notes on Fomitopsidaceae (Agaricomycetes, Polyporales). Phytotaxa 331: 10 p. DOI: 10.11646/phytotaxa.331.1.5.

Somchai R (2012). The biology of *Lentinus polychrous* Lev. in Nakhon Phanom province, Thailand and Kwaeng Kham Muan, Laos. International Journal of Environment and Rural Development 3: 121–126.

Sonawane HB, Ghole VS, Garad S, Bapat G, Bhosle S, Apte K (2013). Hypoglycemic effect of Phansomba (*Phellinus Badius* Berk *ex* Cooke) G.

Cunn. on alloxan-induced diabetic rats. Journal Of Natural Remedies 13: 29–34. DOI: /10.18311/jnr/2013/115.

Song J, Xing JH, Decock C, He XL, Cui BK (2016). Molecular phylogeny and morphology reveal a new species of *Amauroderma* (Basidiomycota) from China. Phytotaxa 260: 47–56. DOI: 10.11646/phytotaxa.260.1.5.

Sotão HMP, Gibertoni TB, Maziero R, Baseia I, Medeiros PS, Martins-Júnior A, Capelari M (2009). *Fungos macroscópios da Floresta nacional de Caxiuanã, Pará,* Brasil: Basidiomycota (Agaricomycetes). In: Lisboa P.L.B. (org.). Caxiuanã: Desafios para conservação de uma Floresta Nacional na Amazônia. Belém: Museu Paraense Emílio Goeldi, 383–396 p.

Sotome K, Hattori T, Ota Y (2011). Taxonomic study on a threatened polypore, *Polyporus pseudobetulinus*, and a morphologically similar species. *P. subvarius*. Mycoscience 52: 319–326. DOI 10.1007/s10267-011-0111-x.

Sotome K, Akagi Y, Lee SS, Ishikawa NK, Hattori T (2013). Taxonomic study of *Favolus* and *Neofavolus gen. nov*. segregated from *Polyporus* (Basidiomycota, Polyporales). Fungal Diversity 58: 245–266. DOI: 10.1007/s13225-012-0213-6.

Sotome K, Hattori T, Ota Y, To-anun C, Salleh B, Kakishima M (2008). Phylogenetic relationships of *Polyporus* and morphologically allied genera. Mycologia 100: 603–615. DOI: 10.3852/07-191R.

Sotome K, Hattori T, Ota Y, Lee SS, Vikineswary S, Abdullah N, Kakishima M (2009). Taxonomic study of Asian species of *Echinochaete* (Polyporaceae, Basidiomycota) and description of *E. maximipora sp. nov*. Mycological Progress 8: 123–132. DOI 10.1007/s11557-009-0584-6.

Spegazzini C (1883) Fungi Guaranitici. Pugillus 1. Anales Soc Ci Argent 16: 272–284.

Spinosa R (2006). The Chaga Story. The Mycophile 47: 1–24.

Spirin V (2007). New and noteworthy *Antrodia* species (Polyporales, Basidiomycota) in Russia. Mycotaxon 101: 149–156.

Spirin V, Ryvarden L (2016). Some basidiomycetes (Aphyllophorales) from Mexico. Synopsis Fungorum 35: 34–42.

Spirin V, Ryvarden L (2019). Studies in Aphyllophorales of Africa 29. Some corticoid species from Uganda. Synopsis Fungorum, Oslo, 39: 42.

Spirin V, Shirokov AI (2002). The features of wood decomposition in Virgin abies-spruce forests of Nizhny Novgorod Region. Mikol. Fitopath. 36: 25–31.

Spirin V, Zmitrovich IV (2004). A contribution to the taxonomy of corticioid fungi: *Merulius* Fr., *Phlebia* Fr., and related genera. Novosti Sistematiki Nizshikh Rastenii. 37: 166–188.

Spirin V, Zmitrovich IV, Wasser SP (2006). *Oligoporus balsameus*-rare Eurasian species plus notes on some related taxa. Mycotaxon 97: 73–82.

Spirin V, Vlasák J, Niemelä T (2014). *Fuscoporia insolita* (Hymenochaetales, Basidiomycota), a new species from Russian Far East. Annales Botanici Fennici 51: 403–406.

Spirin V, Vlasák J, Miettinen O (2017). Studies in the *Antrodia serialis* group (Polyporales, Basidiomycota). Mycologia 109: 217–230. DOI: 10.1080/00275514.2017.1300087.

Spirin V, Miettinen O, Pennanen J, Kotiranta H, Niemela (2012). *Antrodia hyalina*, a new polypore from Russia, and *A. leucaena*, new to Europe. Mycological Progress 12: 53–61. DOI: 10.1007/s11557-012-0815-0.

Spirin V, Vlasák J, Niemela T, Miettinen O (2013). What is *Antrodia sensu stricto* (Polyporales, Basidiomycota). Mycologia 105: 1555–1576. DOI: 10.3852/13-039.

Sprin V, Miettinen O, Pennanen J, Kotiranta H, Niemelä T (2013a). *Antrodia hyalina*, a new polypore from Russia, and *A. leucaena*, new to Europe. Mycological Progress 12: 53–61. DOI: 10.1007/s11557-012-0815-0.

Spirin WA (2001). *Tyromyces* P. Karst. and related genera. Mycena 1: 64–71.

Spirin WA (2003). *Antrodiella romellii* (Irpicaceae, Basidiomycetes) in Russia. Mycena 3: 47–52.

Sreedharan (2004). Biological Diversity of Kerala: A survey of Kalliasseri panchayat, Kannur district. Discussion Paper No. 62, Kerala Research

Programme on Local Level Development Centre for Development Studies, Thiruvananthapuram, 176 p.

Srinivasulu B, Sujatha A, Kalpana M, Rani AP, Chandran BSRS, Krishna Y (2008). Biocontrol of *Ganoderma* wilt (basal stem rot) disease of Coconut. AICRP of Palms, ICAR, HRS, Ambajipeta Technical Bulletin, Andhra Pradesh Horticutural University.

Standish LJ, Wenner CA, Sweet ES, Bridge C, Nelson A, Martzen M, Novack J, Torkelson C (2008). *Trametes versicolor* mushroom immune therapy in breast cancer. Journal of Society for Integrative Oncology 6: 122–8.

Staniszewska J, Szymański M, Ignatowicz E (2017). Antitumor and immunomodulatory activity of *Inonotus obliquus*. Herba Polonica 63: 48–58. DOI: 10.1515/hepo-2017-0013.

Steyaert RL (1967). *Les Ganoderma palmicoles*. Bulletin du Jardin Botanique Nationale Belgique 37: 465–492.

Steyaert RL (1972). Species of *Ganoderma* and related genera mainly of the Bogor and Leiden herbaria. Persoonia 7: 55–118.

Steyaert RL (1975). The concept and circumscription of *G. tornatum*. Transactions of British Mycological Society 65: 451–467.

Steyaert RL (1975a). *Ganoderma applanatum*. CMI Descriptions of Pathogenic Fungi and Bacteria 443: 1–2.

Steyaert RL (1975b). *Ganoderma boninense*. CMI Descriptions of Pathogenic Fungi and Bacteria 444: 1–2.

Steyaert RL (1980). Study of some *Ganoderma* species. Bulletin du Jardin Botanique Nationale Belgique 50: 135–186.

Sudha M, Saranya A, Selvakumar G, Sivakumar N (2014). Microbial degradation of azo dyes: a review. International Journal of Current Microbiology and Applied Sciences 3: 670–690.

Sudiana KI, Sastrawidana IDK, Sukarta N (2018). Decolorization study of remazol Black B textile dye using local fungi of *Ganoderma* sp. and their ligninolytic enzymes. Journal of Environmental Science and Technology 11: 16–22. DOI: 10.3923/jest.2018.16.22.

Sugawara K, Igeta E, AmanoY, Hyuga M, Sugano Y (2019). Degradation of antifungal anthraquinone compounds is a probable physiological role of DyP secreted by *Bjerkandera adusta*. AMB Express 9: 56. DOI: 10.1186/s13568-019-0779-4.

Suhirman, Núñez M (1998). Indonesian aphyllophorales 3. Poroid and stereoid species from Kerinci-Seblat National Park, western Sumatra. Mycotaxon 68: 273−292.

Sułkowska-Ziaja K, Maślanka A, Szewczyk A, Muszynska B (2017). Physiologically active compounds in four species of *Phellinus*. Natural product communications 12: 363–366. DOI: 10.1177/1934578X1701200313.

Sułkowska-Ziaja K, Szewczyk A, Galanty A, Gdula-Argasińska J, Muszyńska B (2018). Chemical composition and biological activity of extracts from fruiting bodies and mycelial cultures of *Fomitopsis betulina*. Molecular Biology Reports 45: 2535–2544. DOI: 10.1007/s11033-018-4420-4.

Sullivan G, Henry ED (1971). Occurrence and distribution of phenoxazinone pigments in the genus *Pycnoporus*. Journal of Pharmaceutical Sciences 60: 1097–1098.

Sum WC, Indieka SA, Matasyoh JC (2019). Antimicrobial activity of Basidiomycetes fungi isolated from a Kenyan tropical forest. African Journal of Biotechnology 18: 112–123. DOI: 10.5897/AJB2018.16660.

Sumaiyah A, Noorlidah A, Vikineswary S, Grand E (2007). Basidiomycota: Distribution and new records of *Lentinus*. In: Malaysian Fungal Diversity (Jones EBG, Hyde KD, Vikineswary S, eds). Mushroom Research Centre, University of Malaya and Ministry of Natural Resources and Environment, Malaysia, 83–93 p.

Sumkhemthong S, Suksomtip M, Chanvorachote P, Chaotham C (2016). Anticancer activity of peptide extracted from edible mushroom; *Lentinus squarrosulus* in human lung cancer cells. Planta Medica 81: S1–S381. DOI: 10.1055/s-0036-1596829.

Sun H, Paulin L, Alatalo E, Asiegbu FO (2011). Response of living tissues of *Pinus sylvestris* to the saprotrophic biocontrol fungus *Phlebiopsis gigantea*, Tree Physiology 31: 438–451. DOI: 10.1093/treephys/tpr027.

Sun Y, Yasukawa K (2008). New anti-inflammatory ergostane-type ecdysteroids from the sclerotium of *Polyporus umbellatus*. Bioorganic and Medicinal Chemistry Letters 18: 3417–3420. DOI: 10.1016/j.bmcl.2008.04.008.

SunYF, Costa-Rezende DH, Xing JH, Zhou JL, Zhang B, Gibertoni TB, Gates G, Glen M, Dai YC, Cui BK (2020). Multi-gene phylogeny and taxonomy of *Amauroderma s. lat.* (Ganodermataceae). Persoonia 44: 206–239. DOI: 10.3767/persoonia.2017.39.10.

Sundararaman S, Marudarajan D (1925). Some polyporaceae of the Madras Presidency. Madras Agric Dept Year Book, 75 p.

Sunhede S, Vasiliauskas R (2002). Ecology and decay pattern of *Phellinus robustus* in old-growth *Quercus robur*. Karstenia 42: 1–11.

Sunthudlakhar P, Sithisarn P, Wannissorn B, Jarikasem S, Rojsanga P (2018). Phytochemical profiles, antioxidant and antibacterial activities of 11 *Phellinus* mushrooms collected in Thailand. The Natural Products Journal 9: DOI: 10.2174/2210315508666180621160917.

Standish LJ, Wenner CA, Sweet ES, Bridge C, Nelson A, Martzen M, Novack J, Torkelson C (2008). *Trametes versicolor* mushroom immune therapy in breast cancer. Journal of Society for Integrative Oncology 6: 122–130. DOI: 10.2310/7200.2008.0016.

Švarcman S (1964). *Geterobazidial'nye i avtobazidial'nye griby*. In: Flora sporovyh rastenij Kazahstana 4, 716 p.

Sverdrup-Thygeson A, Lindenmayer DB (2003). Ecological continuity and assumed indicator fungi in boreal forest: The importance of the landscape matrix. Forest Ecology and Management 174: 353.

Swapna S, Syed A, Krishnappa M (2008). Diversity of macrofungi in semievergreen and moist deciduous forest of Shimoga District-Karnataka, India. Journal of Mycology and Plant Pathology 38: 21–26.

Swartz OP (1788). *Nova genera et species Plantarum seu prodromus descriptioneum vegetabilium maximam parte incognitorum qua sub itinere in Indiam Occidentalem annis* 1783-1787 digessit Olof Swartz M.D.

Sweety (2018). Bioremediation of textile dyes: appraisal of conventional and biological approaches. In: Kumar V., Kumar M., Prasad R. (eds) Phytobiont and Ecosystem Restitution. Springer, Singapore. DOI: 10.1007/978-981-13-1187-1_23. 459-487 p.

Swift MJ (1982). Basidiomycetes as components of forest ecosystems. In: Frankland, J. C., Hedger, J. N. & Swift, M. J. (eds.), Decomposer Basidiomycetes: their biology and ecology: 307–337. Cambridge University Press, Cambridge, 355 p.

Swofford DL (2002). PAUP*. Phylogenetic analysis using Parsimony (*and other methods). Version 4.0d90. Sinauer Associates, Sunderland, MA.

Sysouphanthong P, Thongkantha S, Zhao R, Soytong K, Hyde KD (2010). Mushroom diversity in sustainable shade tea forest and the effect of fire damage. Biodiversity Conservation DOI: 10.1007/s10531-009-9769-1.

Szczepkowski A (2004). *Perenniporia fraxinea* (fungi, Polyporales), a new species for Poland. Polish Botanical Journal 49: 73–77.

Tai FL (1979). Sylloge Fungorum Sinicorum. Sci Press, Acad Sin Peking, 1527 p.

Tamrakar S, Nishida M, Amen Y, Tran HB, Suhara H, Fukami K, Parajuli GP, Shimizu K (2017). Antibacterial activity of Nepalese wild mushrooms against *Staphylococcus aureus* and *Propionibacterium acnes*. Journal of Wood Science 63: 379–387. DOI 10.1007/s10086-017-1636-1.

Tamura K, Nei M (1993). Estimation of the number of nucleotide substitutions in the control region of mitochondrial DNA in humans and chimpanzees. Molecular Biology and Evolution 10: 512–526.

Tamura K, Dudley J, Nei M, Kumar S (2007). MEGA4: Molecular Evolutionary Genetics Analysis (MEGA) software version 4.0. Molecular Biology and Evolution 24: 1596–1599.

Tan CS, Ng ST, Tan J (2013). Two new species of *Lignosus* (Polyporaceae) from Malaysia –*L. tigris* and *L. cameronensis*. Mycotaxon 123: 193–204. DOI: 10.5248/123.193.

Tanaka H, Itakura S, Enoki A (1999). Hydroxyl radical generation and phenol oxidase activity in wood degradation by the white rot basidiomycete *Irpex lacteus*. Material und Organismen 33: 91–105.

Tang Y, Zhao ZZ, Li ZH, Feng T, Chen HP, Liu JK (2018). Irpexoates A–D, four triterpenoids with malonyl modifications from the fruiting bodies of the medicinal fungus *Irpex lacteus*. Natural Products and Bioprospecting 8: 171–176. DOI: 10.1007/s13659-018-0160-3.

Tarafder E, Dutta AK, Pradhan P, Mondal B, Chakraborty N, Paloi S, Roy A, Acharya K (2017). Contribution to the macromycetes of West Bengal, India: 13–17. Research Journal of Pharmacy and Technology 10: 1123–1129. DOI: 10.5958/0974-360X.2017.00203.7.

Tavčar M, Svobodová K, Kuplenk J, Novotný C, PavkoA (2006). Biodegradation of azo dye RO16 in different reactors by immobilized *Irpex lacteus*. Acta Chimica Slovenica 53: 338–343.

Tchoumi JMT, Coetzee MPA, Rajchenberg M, Roux J (2019). Taxonomy and species diversity of *Ganoderma* species in the Garden Route National Park of South Africa inferred from morphology and multilocus phylogenies. Mycologia 111: 1–18. DOI: 10.1080/00275514.2019.1635387.

Tedersoo L, Suvi T, Beaver K, Saar I (2007). Ectomycorrhizas of *Coltricia* and *Coltriciella* (Hymenochaetales, Basidiomycota) on Caesalpiniaceae, Dipterocarpaceae and Myrtaceae in Seychelles. Mycological Progress 6: 101–107. DOI: 10.1007/s11557-007-0530-4.

Teixeira AR (1956). *Metodo para o estudo das hifas do carpoforo de fungos poliporaceos.* Publ. Inst. Bot. S. Paulo, 22 p.

Teixeira AR (1989). Suppl. *Géneros de Poliporáceos Xantocróicos* (1). Acta Botánica Brasilica 3: 57–62.

Telleria MT (1980). *Contribuci6n al estudio de los Aphyllophorales espanoles*. Bibliotheca Mycol6gica 74, Cramer, Vaduz 333 p.

Telleria MT (1990). Annotated list of Corticiaceae, *sensu lato* (Aphyllophorales, Basidiomycotina), for Peninsular Spain and Balearic Islands. Bibliotheca Mycologica, Band 135. Berlin, Stuttgart. 152 p.

Téllez-Téllez M, Villegas E, Rodríguez A, Acosta-Urdapilleta ML, Díaz-Godínez G (2016). Mycosphere Essay 11: Fungi of *Pycnoporus* genus: morphological and molecular identification, worldwide distribution and biotechnological potential. Mycosphere (special issue), 26 p. DOI: 10.5943/ mycosphere/si/3b/3.

Teodoro NG (1937). An enumeration of Philippine fungi. Technical Bulletin of Department of Agriculture, Philippines 4: 1.

Teng SC (1936). Additional fungi from China III. Sinensia 7: 529–569.

Teng SC (1963). Zhong Guo De Zhen Jun (Fungi of China) 1–808.

Teng SC (1996). Fungi of China. Mycotaxon Ithaca 1–586.

Teplyakova TV, Psurtseva NV, Kosogova TA, Mazurkova NA, Khanin VA, Vlasenko VA (2012). Antiviral activity of polyporoid mushrooms (higher Basidiomycetes) from Altai Mountains (Russia). International Journal of Medicinal Mushrooms 14: 37–45. DOI: 10.1615/intjmedmushr.v14.i1.40.

Terhonen E, Sun H, Buée M, Paulin L, Kasanen R, Asiegbu FO (2013). Effects of the use of biocontrol agent (*Phlebiopsis gigantea*) on fungal communities of *Picea abies* stumps. Forest Ecology and Management 310. DOI: 10.1016/j.foreco.2013.08.044.

Teston D (1953). *Étude de la différenciation des hyphes chez les Polypores dimidids de la flore franqaise*. Bull. Soc. Nat. Oyonnax 7: 80–110.

Tetianec L, Chaleckaja A, Vidziunaite R, Kulys J, Bachmatova I, Marcinkeviciene L, Meskys R (2014). Development of a laccase/syringaldazine system for NAD (P) H oxidation. Journal of Molecular Catalysis B: Enzymatic 101: 28–34. DOI: 10.1016/j.molcatb.2013.12.013

Thamban C, Prathibha VH, Chandran KP (2016). Integrated management of *Ganoderma* wilt/Thanjavur wilt-Need for farmer participatory intervention. Indian Coconut Journal 59: 9–11.

Thang TD, Kuo PC, Ngoc NT, Hwang TL, Yang ML, Ta SH, Lee EJ, Kuo DH, Hung NH, Tuan NN, Wu TS (2015). Chemical constituents from the fruiting bodies of *Hexagonia* apiaria and their anti-inflammatory activity. Journal of Natural Products 78: 2552–2558. DOI: 10.1021/acs.jnatprod.5b00449.

Thawthong A, Hapuarachchi KK, Wen TC, Raspé O, Thongklang N, Kang JC, Hyde KD (2017). *Ganoderma sichuanense* (Ganodermataceae, Polyporales) new to Thailand. MycoKeys 22: 27–43. DOI: 10.3897/ mycokeys.22.13083.

Theissen F (1911). *Polyporaceae austro-brasillienses imprimis Rio Graddenses*. Denkschr. Akad. Wiss. Wien. Math-Natrorw. KI. 83: 213–250.

Thind KS, Adlakha KL (1956). Thelephoraceae of Mussoorie Hills- I. Indian Journal of Mycological Research 2: 57–64.

Thind KS, Chatrath MS (1957). Polyporaceae of Mussoorie Hills-II. Res.Bull.Punjab.Univ. 25: 431–442.

Thind KS, Chatrath MS (1960). Polyporaceae of Mussoorie Hills-I. Indian Phytopatholgy 13: 76–89.

Thind KS, Dhanda RS (1979). The Polyporaceae of India-IX. Kavaka 7: 51–58

Thind KS, Dhanda RS (1979a). The Polyporaceae of India XII. The genus *Albetrellus*. Indian Phytopathology 32: 55–60.

Thind KS, Dhanda RS (1980). The Polyporaceae of India X. Kavaka 8: 59–67.

Thind KS, Dhanda RS (1980a). The Polyporaceae of India XIII. Indian Phytopathology 33: 380–387.

Thind KS, Rattan SS (1968) The Thelephoraceae of North Western Himalayas. Bulletin of Indian Phytopathological Society 4: 15–24.

Thind KS, Rattan SS (1970). The Thelephoraceae of India- III. The genus *Tubulicrinis* and Hyphoderma. Proceedings of Indian Acadamy of Sciences 71: 118–131.

Thind KS, Rattan SS (1971). Type studies in the Polyporaceae IV. The genus *Tomentella*. Indian Phytopathology 24: 32–42.

Thind KS, Rattan SS (1971a). The Polyporaceae of India-V. Indian Phytopathology 24: 50–57.

Thind KS, Rattan SS (1971b). The Polyporaceae of India-VII. Indian Phytopathology 24: 290–294.

Thind KS, Rattan SS (1971c). The Polyporaceae of India-VIII. Research Bulletin of Panjab University 22: 29–36.

Thind KS, Rattan SS (1972). Type studies in the Polyporaceae VIII. Research Bulletin of Panjab University 23: 125–136.

Thind KS, Rattan SS (1973). Type studies in the Polyporaceae X. Mycologia 65: 1250–1258.

Thind KS, Rattan SS (1973a). Type studies in the Polyporaceae VI, VII. Indian Phytopathology 26: 485–494

Thind KS, Rattan SS (1976). Type studies in the Polyporaceae XI. Research Bulletin of Panjab University 27: 29–39.

Thind KS, Bindra PS, Chatrath MS (1957). The Polyporaceae of the Mussoorie hills–III. – Research Bulletin (N.S.), Panjab University Chandigarh 129: 471–483.

Thomas B (2011). Cobalt crust, *Terana caerulea*. A lovely fungus. http://www.loyno.edu/lucec/natural-history-writings/cobalt-crust-terana-caerulea-lovely-fungus.

Thomas KA (2000). Floristic studies on some dark-spored agarics of Kerala-Thesis. Department of Botany, University of Calicut, Kerala, India.

Thongkred P, Lotrakula P, Prasongsuka S, Imaib T, Punnapayak H (2011). Oxidation of polycyclic aromatic hydrocarbons by a tropical isolate of *Pycnoporus coccineus* and its laccase. Science Asia 37: 225–233. DOI: 10.2306/scienceasia1513-1874.2011.37.225.

Thorn RG (1991). Taxonomic studies of cultures of selected Corticiaceae 1–398.

Thorn RG (2000). Some polypores misclassified in *Piptoporus*. Karstenia 40: 181–187.

Thorn RG, Moncalvo J-M, Reddy CA, Vilgalys R (2000). Phylogenetic analyses and the distribution of nematophagy support a monophyletic Pleurotaceae within the polyphyletic pleurotoid–lentinoid fungi. Mycologia 92: 241–252. DOI: 10.2307/3761557.

Thunes KH (1994). The coleopteran fauna of *Piptoporus betulinus* and *Fomes fomentarius* (Aphyllophorales: Polyporaceae) in western Norway. Entomologica Fennica 5: 157–168.

Tian XM, Yu HY, Zhou LW, Decock C, Vlasák J, Dai YC (2013). Phylogeny and taxonomy of the *Inonotus linteus* complex. Fungal Diversity 58: 159–169. DOI: 10.1007/s13225-012-0202-9.

Tibpromma S, .Hyde KD, Jeewon R, Maharachchikumbura SSN, Liu JK, Bhat DJ, Jones EBG, McKenzie EHC, Camporesi E, Bulgakov TS, Doilom M, de Azevedo Santiago ALCM, Das K, Manimohan P, Gibertoni TB, Lim YW, Ekanayaka AH, Thongbai B, Lee HB, Yang JB, Kirk PM, Sysouphanthong P, Singh SK, Boonmee S, Dong W, Raj KNA, Latha KPD, Phookamsak R, Phukhamsakda C, Konta S, Jayasiri SC, Norphanphoun C, Tennakoon DS, Li JF, Dayarathne MC, Perera RH, Xiao Y, Wanasinghe DN, Senanayake IC, Goonasekara ID, de Silva NI, Mapook A, Jayawardena RS, Dissanayake AJ, Manawasinghe IS, Chethana KWT, Luo ZL, Hapuarachchi KK, Baghela A, Soares AM, Vizzini A, Meiras-Ottoni A, Mešić A, Dutta AK, de Souza CAF, Richter C, Lin CG, Chakrabarty D, Daranagama DA, Lima DX, Chakraborty D, Ercole E, Wu F, Simonini G, Vasquez G, DA Silva GA, Plautz Jr HL, Ariyawansa HA, Lee H, Kušan I, Song J, Sun J, Karmakar J, Hu K, Semwal KC, Thambugala KM, Voigt K, Acharya K, Rajeshkumar KC, Ryvarden L, Jadan M, Hosen MI, Mikšík M, Samarakoon MC, Wijayawardene NN, Kim NK, Matočec N, Singh PN, Tian Q, Bhatt RP, de Oliveira RJV, Tulloss RE, Aamir S, Kaewchai S, Svetasheva STY, Nguyen TTT, Antonín V, Li WJ, Wang Y, Indoliya Y, Tkalčec Z, Elgorban AM, Bahkali AH, Tang AMC, Su HY, Zhang H, Promputtha I, Luangsa-ard J, Xu JC, Yan J, Chuan KJ, Stadler M, Mortimer PE, Chomnunti P, Zhao Q, Phillips AJL, Nontachaiyapoom S, Wen TC, Karunarathna SC (2017). Fungal diversity notes 491–602: taxonomic and phylogenetic contributions to fungal taxa. Fungal Diversity 83: 1–261. DOI: 10.1007/s13225-017-0378-0

Tiwari CK, Parihar J, Verma R K (2010). Additions to wood decaying fungi of India. Journal of Threatened Taxa 2: 970–973.

Tiwari CK, Parihar J, Verma RK (2011). *Hapalopilus nidulans* (*Polyporales*: *Polyporaceae*) a new record from India. Journal of Threatened Taxa 3: 1872–1874. DOI: 10.11609/JoTT.o2622.1872-4.

Tomšovský M (2008). Molecular phylogeny and taxonomic position of *Trametes cervina* and description of a new genus *Trametopsis*. Czech Mycology 60: 1–11.

Tomšovský M, Jankovský L (2007). DNA sequence analysis of extraordinary fruiting specimens of *Fuscoporia torulosa* (*Phellinus torulosus*) on *Pyrus* spp. Czech Mycology 59: 91–99.

Tomšovský M, Menkis A, Vasaitis R (2010). Phylogenetic relationships in European *Ceriporiopsis* species inferred from nuclear and mitochondrial ribosomal DNA sequences. Fungal Biology 114: 350–8. DOI: 10.1016/j.funbio.2010.02.004.

Tomšovský M, Kolařík M, Pažoutová S, Homoka L (2006). Molecular phylogeny of European *Trametes* (Basidiomycetes, Polyporales) species based on LSU and ITS (nr DNA) sequences. Nova Hedwigia 82: 269–280. DOI: 10.1127/0029-5035/2006/0082-0269.

Torrend C (1920). *Les Polyporacées du Brésil*. I. *Polyporacées stipités*. Brotéria Série Botânica 18: 121–143.

Torres-Torres MG, Guzmán-Dávalos (2007). New data and localities for *Navisporus* in America. Mycotaxon 100: 319–326.

Torres-Torres MG, Guzmán-Dávalos L, Mello GA (2012). *Ganoderma* in Brazil: known species and new records. Mycotaxon 121: 93–132. DOI: 10.5248/121.93.

Torres-Torres MG, Guzmán-Dávalos L (2012a). The morphology of *Ganoderma* species with a laccate surface. Mycotaxon 119: 201–216. DOI: 10.5248/119.201.

Torres-Torres MG, Ryvarden L, Laura D (2015). *Ganoderma* subgenus *Ganoderma* in Mexico. Revista Mexicana de Micología. 41: 27–45.

Traquair JV, McKeen WE (1978). Ultrastructure of the dolipore septum in *Hischioporus pergamenus* (Polyporaceae). Canadian Journal of Microbiology 24: 67–771.

Tripathi A, Upadhyay RC, Singh S (2012). Extracellular Ligninolytic Enzymes in *Bjerkandera adusta* and *Lentinus squarrosulus*. Indian Journal of Microbiology 52: 381–387. DOI: 10.1007/s12088-011-0232-0.

Tulasne LR (1853). *Observations sur l'organisation des tremellinees*. Annales des sciences naturelles. Botanique 19: 193–231.

Tulasne LR (1872). *Nouvelles notes sur les fungi tremellini et lour allies*. Annales des sciences naturelles. Botanique 15: 215–235.

Tuomela M, Lyytikäinen M, Oivanen P, Hatakka A (1998). Mineralization and conversion of pentachlorophenol (PCP) in soil inoculated with the white-rot fungus *Trametes versicolor*. Soil Biology and Biochemistry 31: 65–74. DOI: 10.1016/S0038-0717(98)00106-0.

Ţura D, Spirin WA, Zmitrovich IV, Wasser SP, Nevo E (2008). Polypores new to Israel – 1: Genera *Ceriporiopsis, Postia and Skeletocutis*. Mycotaxon 103: 217–227.

Ţura D, Zmitrovich IV, Wasser SP, Spirin WA, Nevo E (2010). Biodiversity of Heterobasidiomycetes and non-gilled Hymenomycetes (former Aphyllophorales) of Israel. A. R. A. Gantner Verlag K.G., Ruggell, 566 p.

Tzean Y, Shu PY, Liou RF, Tzean SS (2016). Development of oligonucleotide microarrays for simultaneous multi-species identification of *Phellinus* tree-pathogenic fungi. Microbial Biotechnology 9: 235–244. DOI: 10.1111/1751-7915.12341.

Udu-Ibiam, OE, Ogbu O, Ibiam UA, Nnachi AU, Agah MV, Ukaegbu CO, Chukwu OS, Agumah NB, Ogbu KI (2014). Phytochemical and antioxidant analyses of selected edible mushrooms, ginger and garlic from Ebonyi State, Nigeria. Journal of Pharmacy and Biological Sciences 9: 86–91. DOI: 10.9790/3008-09348691.

Ueitele ISE, Chimwamurombe PM, Kadhila NK (2018). Molecular phylogeny of *Trametes* and related genera from Northern Namibia. Jordan Journal of Biological Sciences 11: 99–105.

Ueno Y, Abe M, Yamauchi R, Kato K (1980). Structural analysis of the alkali-soluble

polysaccharide from the sclerotia of *Grifola umbellata* (Fr.) Pilát. Carbohydrate Research 87: 257–264.

Ugbogu EA, Akubugwo IE, Ude VC, Gilbert J, Ekeanyanwu B (2019). Toxicological evaluation of phytochemical characterized aqueous extract of wild dried *Lentinus squarrosulus* (Mont.) mushroom in rats. Toxicology Research 35: 181–190. DOI: 10.5487/TR.2019.35.2.181.

Upadhyaya J, Raut JK, Koirala N (2017). Analysis of nutritional and nutraceutical properties of wild-grown mushrooms of Nepal. EC Microbiology 12: 136–145.

Upton R (2006). Reishi Mushroom, *Ganoderma lucidum*, Standards of analysis, quality control and therapeutics. California, United States of America: American Herbal Pharmacopoeia and Therapeutic Compendium.

Urbizu M, Siqueiros ME, Abrego N, Salcedo I (2014). New records of aphyllophoroid fungi from Aguascalientis, Mexico and an approach to their ecological preferences. Revista Mexicana De Biodiversidad 85: 1007–1018. DOI: 10.7550/rmb.35264.

Usha N, Janardhana GR (2014). Diversity of macrofungi in the Western Ghats of Karnataka (India). Indian Forester 140: 531–536.

Vaidya A, Singh T (2012). Pre-treatment of *Pinus radiata* substrates by basidiomycetes fungi to enhance enzymatic hydrolysis. Biotechnology Letters 34: 1263–1267. DOI: 10.1007/s10529-012-0894-7.

Vaidya JG, Bhor GL (1990). Medicinally important wood rotting fungi with special emphasis on Phansomba. Deerghyu, Pune. 6, 1–4.

Vaidya JG, Rabba AS (1993). Fungi in folk medicine. Mycologist 7: 13 1–133.

Vaidya JG, Lamrood P (2001). Pharmacognostic studies in the members of Phansomba, a folk medicine belonging to the genus *Phellinus* Quel. International Journal of Medicinal Mushrooms 3: 1. DOI: 10.1615/IntJMedMushr.v3.i2-3.1520.

Vaidya JG, Lamrood P, Deshpande G (2001). Market Survey for Phansomba, a Medicinal Mushroom from Pune, Mumbai, and Konkan for Reconfirming Its Authenticity. International Journal of Medicinal Mushrooms 3:1. DOI: 10.1615/IntJMedMushr.v3.i2-3.1530

Vaidya JG, Bhosle SR, Gauri B, Garad SA, Sonawane HB, Ashghar S, Mirzae A, Prasad L, Sawant A, Varghese N (2010). Phansomba: an Indian herbal, folk medicine. In Awaad AS, Govil JN, Singh VK, Studium Press LLC, USA. 289–305 p.

Vaidya JG, Nanda MK, Rabba AS (1991). Community and substratum composition for wood Rotting Aphyllophorales from Bhimashankar, Western Ghats. Proceedings of the Sixth Engineering Congress on Transidisciplinary premise of Ecology and Environment, Institute of Engineers, Pune: India. 2: 56–70.

Vainio EJ, Lipponen K, Hantula J (2001). Persistence of a biocontrol strain of *Phlebiopsis gigantea* in conifer stumps and its effects on within-species genetic diversity. Forest Pathology 31: 85–295.

Valenzuela R, Nava R, Cifuentes YJ (1994). The genus *Albatrellus* from Mexico I. Revista Mexicana de Micologia 10: 113–152.

Valenzuela R, Raymundo T, Cifuentes J (2013). *El género Inonotus s. l.* (Hymenochaetales: Agaricomycetes*) en México*. Revista Mexicana de Biodiversidad: S70–S90. DOI: 10.7550/rmb.31605.

Valenzuela R, Raymundo T, Palacios-Pacheco MR, Díaz- Moreno R. (2008). *La familia Polyporaceae en México* VIII. *Nuevos registros de Antrodia* (Basidiomycota, Polyporales). Revista mexicana de micología 28: 41–47.

Valenzuela R, Raymundo T, Cifuentes J, Castillo G, Amalfi M, Decock C (2011). Two undescribed species of *Phylloporia* from Mexico based on morphological and phylogenetic evidence. Mycological Progress 10: 341–349. DOI 10.1007/s11557-010-0707-0.

Vampola P (1989). *Oxyporus late-marginatus* (Dur. *et* Mont. *ex* Mont.) Donk *auf der Böhmisch-Mährischen Höhe*. Vlastivedny´ Sborník Vysocˇiny, Oddíl ved prˇírodních 9: 203–05 (in Czech with German summary).

Vampola P (2009). *Poznámky k choroši pórnatce žlutobílé-Junghuhnia luteoalba*. Mykologické listy, Praha 108: 14–16.

Vampola P, Vlasak J (2011). *Antrodiella niemelaei*, a new polypore species related to *Antrodiella americana*. Czech Mycology 63: 195–201. DOI:10.33585/cmy.63208.

Vampola P, Vlasak J (2012). *Rigidoporus pouzarii*, a new polypore species related to *Rigidoporus crocatus*. Czech Mycology 64: 3–11. DOI:10.33585/cmy.64102.

Vantamuri A, Tuwar SM, Aminabhavi VA, Ramadurg GP, Joshi HB, Sushma SM (2017). Decolourization of selected synthetic dyes by *Ganoderma* sp. European Journal of Biotechnology and Bioscience 5: 2321–9122. DOI: 10.22271/bioscience.

Varghese SP, Pradeep CK, Vrinda KB (2010). Mushrooms of tribal importance in Wayanad area of Kerala. Journal of Mycopathological Research 48: 311–320.

Vasudeva RS (1960). The fungi of India (revised edition of Butler and Bisby's work). ICAR, New Delhi, 552 p.

Velenovský J (1922). Ceske Houby. Prague, 633–950 p.

Velíšek J, Cejpek K (2011). Pigments of Higher Fungi: A Review. Czech Journal of Food Science 29: 87–102.

Verma RK, Pandro V, Verma P (2020). *Navisporus floccosus* causing heart rot in tropical trees. Flora and Fauna 26: 29–36. DOI: 10.33451/florafauna.v26i1pp29-36.

Verma RK, Sharma N, Soni KK, Jamaluddin (2008). Forest Fungi of Central India. International Book Distributing Co., Lucknow, India, 418 p.

Vesterholt J (1997). Podoscyphaceae DA Reid. In: Hansen L., Knudsen H., eds., Nordic macromycetes 3: 192–193, Copenhagen.

Vesterholt J (2012). *Cotylidia* P. Karst.–In: Knudsen H, Vesterholt J, eds, Funga Nordica, Copenhagen, 82–83 p.

Viecelli CA, Stangarlin JR, Kuhn OJ, Schwan-Estrada KRF (2009). Induction of resistance in beans against *Pseudocercospora griseola* by culture filtrates of *Pycnoporus sanguineus*. Tropical Plant Pathology 34: 87–96.

Vieira ML, Hughes AF, Gil VB, Vaz AB, Alves TM, Zani CL, Rosa CA, Rosa LH (2012). Diversity and antimicrobial activities of the fungal endophyte community associated with the traditional Brazilian medicinal plant *Solanum cernuum* Vell. (Solanaceae). Canadian Journal of Microbiology 58: 54–66. DOI: 10.1139/W11-105.

Vikineswary S, Abdullah N, Renuvathani M, Sekaran M, Pandey A, Jones EBG (2006). Productivity of laccase in solid substrate fermentation of selected agro-residues by *Pycnoporus sanguineus*. Bioresource Technology 97: 171–177. DOI: 10.1016/j.biortech.2005.02.015.

Vizzini A (2010). *Segnalazioni di muscinputa laevis* (Basidiomycota, Agaricomycetes) *per il Nord Italia*. Micologia e Vegetazione Mediterranea 25: 141–148.

Vlasák J, Kout J (2010). *Sarcoporia polyspora* and *Jahnoporus hirtus*: two rare polypores collected in South Bohemia, Czech Republic. Czech Mycology 61: 187–195. DOI: 10.33585/cmy.61209.

Vlasák J, Kout J (2011). Tropical *Trametes lactinea* is widely distributed in the eastern USA. Mycotaxon 115: 271–279. DOI: 10.5248/115.271.

Vlasák J, Vlasák J Jr (2017). *Trichaptum* (Basidiomycota) in tropical America: a sequence study. Mycosphere 8: 1217–1227. DOI: 10.5943/mycosphere/8/6/8.

Vlasák J, Vlasák JJ, Ryvarden L (2012). Four new polypore species from the western United States. Mycotaxon 119: 217–231. DOI: 10.5248/119.217.

Vlasák J, Kout J, Vlasák J Jr, Ryvarden L (2011). New records of polypores from southern Florida. Mycotaxon 118: 159–176. DOI: 10.5248/118.159.

Vlasenko VA (2010). Novelties of the genus *Polyporus* (Polyporaceae, Basidiomycota) for mycobiota of Altai. Rastitelnyy mir Aziatskoy Rossii 1: 29–32. (in Russian).

Vlasenko VA (2011). Genus *Polyporus* (Polyporaceae, Basidiomycota) in the forest-steppe zone of Western Siberia. Rastitelnyy mir Aziatskoy Rossii. 8: 9–14. (in Russian).

Vlasenko VA, Vlasenko AV (2015). Diversity, distribution and ecology of the genus *Polyporus* south of Western Siberia (north Asia). Current Research in Environmental & Applied Mycology 5: 82–91. DOI: 10.5943/cream/5/2/2.

Vrinda KB, Pradeep CK (2014). Wild edible mushrooms from Kerala forests- A source of food and income. Final technical report, Jawaharlal Nehru Tropical Botanic Garden & Research Institute, Thiruvananthapuram, Kerala, India, 124 p.

Wagner T, Fischer M (2001). Natural groups and a revised system for the European poroid Hymenochaetales (Basidiomycota) supported by nLSU rDNA sequence data. Mycological Research 105: 773–782. DOI: 10.1017/S0953756201004257.

Wagner T, Fischer M (2002). Proceedings towards a natural classification of the worldwide taxa *Phellinus s.l.* and *Inonotus s.l.*, and phylogenetic relationships of allied genera. Mycologia 94: 998–1016. DOI: 10.1080/15572536.2003.11833156.

Wagner T, Fischer M (2002a). Classification and phylogenetic relationships of *Hymenochaete* and allied genera of the Hymenochaetales, inferred from rDNA sequence data and nuclear behaviour of vegetative mycelium. Mycological Progress 1: 93–194. DOI: 10.1007/s11557-006-0008-9.

Wagner T, Ryvarden L (2002). Phylogeny and taxonomy of the genus *Phylloporia* (Hymenochaetales). Mycological Progress 1: 105–116. DOI: 10.1007/s11557-006-0009-8.

Wakefield EM, Talbot PHB (1948). Descriptions of some new Hymenomycetes. Bothalia 4: 939–949.

Walder R, Kalvatchev Z, Garzaro DJ, Barrios M (1995). Natural products from the tropical rain forest of Venezuela as inhibitors of HIV-1 replication. Acta científica venezolana 46: 110–4.

Walker J (1996). An opinion on the validity of the generic name *Postia* Fries 1874 (Eumycota: Aphyllophorales). Australasian Mycological Society Newsletter 15: 23–26.

Wallroth CFW (1833). *Flora Cryptogamica Germaniae* 2 J. L. Schrag, Nurnberg, 923 p.

Wang B, Cui BK, Li HJ, Du P, Jia BS (2011). Wood rotting fungi in eastern China 5. Polypore diversity in Jiangxi Province. Annales Botanici Fennici 48: DOI: 237–246. 10.5735/085.048.0304.

Wang DM, Wu SH (2007). Two species of *Ganoderma* new to Taiwan. Mycotaxon 102: 373–378.

Wang DM, Wu SH (2008). A taxonomic revision of the Ganodermataceae reported from Taiwan. Mycotaxon 104: 297–308.

Wang DM, Zhang XQ, Yao YJ (2005). Type studies of some *Ganoderma* species from China. Mycotaxon 93: 61–70.

Wang DM, Wu SH, Yao YJ (2014). Clarification of the Concept of *Ganoderma orbiforme* with High Morphological Plasticity. PLoS ONE 9: e98733. DOI: 10.1371/journal.pone.0098733.

Wang DM, Wu SH, Su CH, Peng JT, Shih YH, Chen LC (2009). *Ganoderma multipileum*, the correct name for '*G. lucidum'* in tropical Asia. Botanical Studies 50: 451–458.

Wang FF, Shi C, Yang Y, Fang Y, Sheng L, Li N (2018). Medicinal mushroom *Phellinus igniarius* induced cell apoptosis in gastric cancer SGC-7901 through a mitochondria-dependent pathway. Biomedicine & pharmacotherapy 102: 18–25. DOI: 10.1016/j.biopha.2018.03.038.

Wang H, Ng TB (2006). Ganodermin, an antifungal protein from fruiting bodies of the medicinal mushroom *Ganoderma lucidum*. Peptides. 27: 27–30. DOI: 10.1016/j.peptides.2005.06.009.

Wang HX, Ng TB, Liu WK, Ooi VEC, Chang ST (1996). Polysaccharide–peptide complexes from the cultured mycelia of the mushroom *Coriolus versicolor* and their culture medium activate mouse lymphocytes and macrophages. International Journal of Biochemistry and Cell Biology 28: 601–607.

Wang M, Yin H, Peng H, Feng M, Lu G, Dang Z (2019). Degradation of 2,2′,4,4′-tetrabromodiphenyl ether by *Pycnoporus sanguineus* in the presence of copper ions. Journal of Environmental Sciences 83: 133–143. DOI: 10.1016/j.jes.2019.03.020

Wang Q, Wang YG, Ma QY, Huang SZ, Kong FD, Zhou LM, Dai HF, Zhao YX (2016). Chemical constituents from the fruiting bodies of *Amauroderma subresinosum*. Journal of Asian Natural Products Research 18: 1030–5. DOI: 10.1080/10286020.2016.1183650.

Wang Q, Qi Y (2016). Antioxidant activity of *Amauroderma rudis*-roots of *Lentinus* solid fermentation compounds. Journal of Food Safety and Quality 7: 682–685.

Wang XC, Xi RJ, Li Y, Wang DM, Yao YJ (2012). The species identity of the widely cultivated *Ganoderma*, '*G. lucidum*' (Ling–zhi), in China. PLoS ONE 7–40857. DOI: 10.1371/journal.pone.0040857.

Wang Z, Binder M, Hibbett DS (2006). Phylogeny and a new species of *Sparassis* (Polyporales, Basidiomycota): evidence from mitochondrial atp6, nuclear rDNA and rpb2 genes. Mycologia 98: 584–592. DOI:10.3852/mycologia.98.4.584.

Wasser SP (2014). Medicinal mushroom science: current perspectives, advances, evidences, and challenges. Medicinal mushroom science 37: 345–356. DOI: 10.4103/2319-4170.138318.

Watling R (1993). Comparison of the macromycete biotas in selected tropical areas of Africa and Australia. In: Isaac S, Frankland J, Watling R, Whalley AJS, eds. Aspects of tropical mycology. Cambridge, UK: Cambridge Univ. Press. 171–182 p.

Watling R (1994). A Malaysian fungus foray. Mycologist 8: 179–180.

Watling R, Gregory NM (1980). Large fungi from Kashmir. Nova Hedwegia 32: 494–564.

Watling R, Frankland JC, Ainsworth AM, Isaac S, Robinson CH (2002). Tropical Mycology, Volume 1. CABI Publishing, Wallingford, Oxon OX10 8DE., 175 p. DOI: 10.1017/S0269915X02214032.

Wei YL, Dai YC (2006). Three new species of *Postia* (Aphyllophorales, Basidiomycota) from China. Fungal Diversity 23: 391–402.

Wei YL, Qin WM (2010). Two new species of *Postia* from China. Sydowia-Horn- 62: 165–170.

Weir JR (1926). A pathological survey of the para rubber tree (*Hevea Brasiliensis*) in the Amazon Valley: 1–130.

Welden AL (1993). Notes on Tropical and Warm Temperate Basidiomycetes. II. Mycotaxon 48: 69–84.

Welden AL, Ovebro CL (1989). Notes on tropical and warm temperate Basidiomycetes. Mycotaxon: 601–614.

Welti S, Moreau PA, Favel A, Courtecuisse R, Haon M, Navarro D, Taussac S, Lesage-Meessen L (2012). Molecular phylogeny of *Trametes* and related genera and description of a new genus *Leiotrametes*. Fungal Diversity 55: 47–64. DOI: 10.1007/s13225-011-0149-2.

Westphalen MC, Borges Da Silveira RM (2012). Resupinate polypores from mixed ombrophilous forests in southern Brazil. Mycotaxon 122: 111–122. DOI: 10.5248/122.111.

Westphalen MC, Borges Da Silveira RM (2013). Pileate polypores from Araucaria Forests in Southern Brazil. Hoehnea 40: 77–86. DOI: 10.1590/S2236-89062013000100003.

Westphalen MC, Reck MA, Borges Da Silveira RM (2010). *Ganoderma chalceum* and *Junghuhnia meridionalis*: new records from Brazil. Mycotaxon 111: 11–18. DOI: 10.5248/111.11.

Westphalen MC, Reck MA, Borges Da Silveira RM (2010a). Polypores from Morro Santana, Rio Grande do Sul, Brazil. Hoehnea 37: 645–661.

Westphalen MC, Reck MA, Borges Da Silveira RM (2012). The Genus *Junghuhnia* in Brazil. Nova Hedwigia 94: 209–220. DOI: 10.1127/0029-5035/2012/0094-0209.

Westphalen MC, Tomšovský M, Kout J, Gugliotta AM (2015). *Bjerkandera* in the Neotropics: phylogenetic and morphological relations of *Tyromyces atroalbus* and description of a new species. Mycological Progress 14: 100. DOI 10.1007/s11557-015-1124-1

White TJ, Bruns T, Lee S, Taylor JW (1990). Amplification and direct sequencing of fungal ribosomal RNA genes for phylogenetics. In: Innis MA, Gelfand DH, Sinisky JJ, White TJ (eds) PCR protocols: a guide to method and application. Academic, San Diego, 315–322 p.

Wind P, Pihl S (2010). The Danish red list. The National Environmental Research Institute, Aarhus University. http://redlist.dmu.dk. (accessed on November 2012).

Wold CW, Corthay A, Kjeldsen C, Duus J.Ø, Christensen BE, Inngjerdingen KT (2017). Fungi & Health: can polysaccharides from the fungus *Inonotus obliquus* (CHAGA) inhibit tumor growth? Abstract from 19th European Carbohydrate Symposium, Barcelona, Spain.

Wolfe D (2011). Chaga: King of the Polypores. The Longevity Now Conference Costa Mesa, California, 26 p.

Wong KH, Cheung PCK (2008).“Sclerotia: emerging functional food derived from Mushrooms,” in Mushrooms as Functional Foods, P. C. K. Cheung, Ed., 111–146 p, John Wiley & Sons, Hoboken, NJ, USA.

Wong KH, Lai CKM, Cheung PCK (2011). Immunomodulatory activities of mushroom sclerotial polysaccharides. Food Hydrocolloids 25: 150–158. DOI: 10.1016/j.foodhyd.2010.04.008.

Wright JE, Deschamps JR (1975). Fungi, Basidiomycetes, Aphyllophorales, Fistulinaceae, Mucronoporaceae, Polyporaceae. Flora Criptogámica de Tierra del Fuego. 11: 1–61.

Wu F, Qin WM, Euatrakool O, Zhou LW (2015). *Tropicoporus boehmeriae sp. nov.* (Hymenochaetaceae, Basidiomycota) from Thailand, a new member of the

Inonotus linteus complex. Phytotaxa 231: 073–080. DOI: 10.11646/phytotaxa.231.1.7.

Wu F, Zhou LW, Ji XH, Tian XM, He SH (2016). *Grammothele hainanensis sp. nov.* (Polyporales, Basidiomycota) and related species from Hainan, southern China. Phytotaxa 255: 160–166. DOI: 10.11646/phytotaxa.255.2.5.

Wu F, Fan LF, Liu SL, Zhou XJ, Yuan HS (2017). Diversity of wood-decaying fungi from Shanxi Province, China. Mycosystema 36: 1487–1497. DOI: 10.13346/j.mycosystema.170082.

Wu F, Chen JJ, Ji XJ, Vlasák J, Dai (2017a). Phylogeny and diversity of the morphologically similar polypore genera *Rigidoporus*, *Physisporinus*, *Oxyporus*, and *Leucophellinus*. Mycologia 109: 749–765. DOI: 10.1080/00275514.2017.1405215.

Wu SH (1990). The Corticiaceae (Basidiomycetes) subfamilies Phlebioideae, Phanerochaetoideae and Hyphodermoideae in Taiwan. Acta Botanica Fennica 142: 1–123.

Wu SH (1997). New species and new records of *Hyphoderma* (Basidiomycotina) from Botanical bulletin of Academia Sinica 38: 63–72.

Wu SH, Chen ZC (1992). Notes on the genus *Jacksonomyces* Jul. (Corticiaceae, Basidiomycetes), with special emphasis on the species collected in Taiwan. Bulletin of the National Museum of Natural Science 3: 259–266.

Wu SH, Zhang XQ (2003). The Finding of Three Ganodermataceae Species in Taiwan. Collection and Research 16: 61–66.

Wu SH, Chen CC, Wei CL (2018). Three new species of *Phanerochaete* (Polyporales, Basidiomycota). MycoKeys 41: 91–106. DOI: 10.3897/mycokeys.41.29070.

Wu SH, Chou WN, Wang YZ, Wang BC (2000). The cultural atlas of potentially edible and medicinal fungi in Taiwan. Food Ind. Res. and Develop. Inst. Press, Hsinchu, 139 p.

Wu SH, Dai YC, Hattori T, Yu T, Wang D, Parmasto E, Chang H, Shih S (2012). Species clarification for the medicinally valuable ‘*sanghuang*’ mushroom. Botanical Studies 53: 135–149.

Wu SH, Yu ZH, Dai YC, Chen CT, Su CH, Chen LC, Hsu WC, Hwang GY (2004). *Taiwanofungus*, a polypore new genus. Fungal Science 19: 109–116.

Wu Y, Wang D (2009). A new class of natural glycopeptides with sugar moiety-dependent antioxidant activities derived from *Ganoderma lucidum* fruiting bodies. Journal of Proteome Research 8: 436–42.

Wu YX, Shen S, Zhao C (2019). *Podoscypha yunnanensis sp. nov*. (Polyporales, Basidiomycota) evidenced by morphological characters and phylogenetic analyses. Phytotaxa 387: 210–218. DOI: 10.11646/phytotaxa.387.3.2.

Wu ZQ, Liu WL, Wang ZH, Zhao CL (2017b). *Perenniporiopsis*, a new polypore genus segregated from *Perenniporia* (Polyporales). Cryptogamie, Mycologie. 38: 285–299. DOI: 10.7872/crym/v38.iss3.2017.285.

Wunschel J, Fasano M, Ford B, Porterfield H (2018). *Oxyporus*: a potential emerging pathogen in chronic granulomatous disease patients. Annales of Allergy, Asthma & Immunology 121: S63−S134. DOI: 10.1016/j.anai.2018.09.333.

Xiao C, Wu QP, Cai W, Tan JB, Yang XB, Zhang JM (2012). Hypoglycemic effects of *Ganoderma lucidum* polysaccharides in type 2 diabetic mice. Archives of Pharmacal Research 35: 793–801. DOI: 10.1007/s12272-012-1012-z.

Xing JH, Sun YF, Han YL, Cui BK, Dai YC (2018). Morphological and molecular identification of two new *Ganoderma* species on *Casuarina equisetifolia* from China. MycoKeys 34: 93–108. DOI: 10.3897/mycokeys.34.22593.

Xing YM, Zhang LC, Liang HQ, Lv J, Song C, Guo SX, Wang CL, Lee TS, Lee MW (2013). Sclerotial formation of *Polyporus umbellatus* by low temperature treatment under artificial conditions. PLoS ONE 8: e56190. DOI: 10.1371/journal.pone.0056190.

Xiong HX, Dai YC, Cui BK (2008). *Perenniporia minor* (Basidiomycota, Aphyllophorales), a new polypore from China. Mycotaxon 105: 59–64.

Xiong LL (1993). Therapeutic effect of combined therapy of *Salvia miltiorrhizae* and *Polyporus umbellatus* polysaccharide in the treatment of chronic hepatitis B. Zhongguo Zhong Xi Yi Jie He Za Zhi (Chinese Journal of Integrated Traditional and Western Medicine) 13: 533–535.

Xu C, Ma F, Zhang X, Chen S (2010). Biological pre treatment of corn stover by *Irpex lacteus* for enzymatic hydrolysis. Journal of Agricultural Food Chemistry 58: 10893-10898. DOI: 10.1021/jf1021187.

Xu X, Feng L, Han Z, Luo S, Wu A, Xie J (2016). Selection of high laccase-producing *Coriolopsis gallica* Strain T906: mutation breeding, strain characterization, and features of the extracellular laccases. Journal of Microbiology and Biotechnology 26: 1570–1578. DOI: 10.4014/jmb. 1604.04011.

Xue HJ, Zhou LW (2014). *Polyporus hapalopus sp. nov*. (Polyporales, Basidiomycota) from China based on morphological and molecular data. Mycolocical Progress 13: 811–817. DOI: 10.1007/s11557-014-0964-4.

Yahaya AZ, Don MM (2012). Evaluation of *Trametes lactinea* extracts on the inhibition of hyaluronidase, lipoxygenase and xanthine oxidase activities *in vitro.* Journal of Physical Science 23: 1–15.

Yamashita S, Hattori T, Ohkubo T, Nakashizuka T (2009). Spatial distribution of the basidiocarps of aphyllophoraceous fungi in a tropical rainforest on Borneo Island, Malaysia. Mycological Research 113: 1200–1207. DOI: /10.1016/j.mycres.2009.08.004.

Yamuna M, Meenakshi R, Rajkumar R, Rajesh P and Selvam K (2017). Decolorization of azo dyes and dye industry effluent by the screening of novel wood rot fungi. International Journal of ChemTech Research 10: 515–524.

Yan JK, Pei JJ, Ma HL, Wang ZB, Liu YS (2017). Advances in antitumor polysaccharides from *Phellinus sensu lato*: Production, isolation, structure, antitumor activity, and mechanisms. Critical Reviews in Food Science and Nutrition 57: 1256–1269. DOI: 10.1080/10408398.2014.984802.

Yance (2013). Adaptogens in Medical Herbalism: Elite Herbs and Natural Compounds for Mastering Stress, Aging, and Chronic Disease. Simon and Schuster, 672 p.

Yang DQ, Wang XM, Shen J, Wan H (2004a). A rapid method for evaluating antifungal properties of various barks. Forest Products Journal 54: 37–39.

Yang DQ, Wan H, Wang XM, Liu ZM (2007). Use of fungal metabolites to protect wood-based panels against mould infection. BioControl 52: 427–436. DOI: 10.1007/s10526-006-9022-8.

Yang J, Dai LD, He SH (2016). *Hymenochaetopsis nom. nov.* proposed to replace *Pseudochaete* (Hymenochaetales, Basidiomycota) with descriptions of *H. laricicola sp. nov* and *H. gigasetosa* new to China. Mycological Progress 15: 1–8. DOI: 10.1007/s11557-015-1153-9.

Yang LJ, Wang RT, Liu JS, Tong H, Deng YQ, Li QH (2004). The effect of *Polyporus umbellatus* polysaccharide on the immunosuppression property of culture supernatant of S180 cells. Xi Bao Yu Fen Zi Mian Yi Xue Za Zhi 20: 234–237.

Yang P, Jin J, Liu Q, Ma D, Li J, Zhang Y, Liu Y (2019). Optimization of degradation conditions with PRG, a polysaccharide from *Phellinus ribis*, by RSM and the neuroprotective activity in PC12 cells damaged by $A\beta_{25\text{-}35}$. Molecules 24: 1–15. DOI: 10.3390/molecules24163010.

Yang QY, Jong SC, Li XY, Zhou JX, Chen RT, Xu LZ (1992). Antitumor and immunomodulating activities of the polysaccharide–(PSP) of *Coriolus versicolor*. Journal of Immunology and Immunopharmacology 12: 29–34.

Yang X, Zheng J, Lu YM, Jia R (2016a). Degradation and detoxification of the triphenylmethane dye malachite green catalyzed by crude manganese peroxidase from *Irpex lacteus* F17. Environmental Science and Pollution Research 23: 9585–9597. DOI: 10.1007/s11356-016-6164-9.

Yang ZL (2000). Notes on five common but little known higher basidiomycetes from tropical Yunnan, China. Mycotaxon 74: 45–56.

Yang ZL, Feng B (2013). What is the Chinese "*Lingzhi*"? – A taxonomic mini–review, Mycology, An International Journal on Fungal Biology 4: 1–4. DOI: 10.1080/21501203.2013.774299.

Yao M, Li W, Duan Z, Zhang Y, Jia R (2017). Genome sequence of the white-rot fungus *Irpex lacteus* F17, a type strain of lignin degrader fungus. Standards in Genomic Sciences 12: 55. DOI 10.1186/s40793-017-0267-x.

Yao YJ, Pegler DN, Chase MW (1999). Application of ITS (nrDNA) sequences in the phylogenetic study of *Tyromyces s. l.* Mycological Research 103: 219–229. DOI: 10.1017/S0953756298007138.

Yap HYY, Chooi YH, Firdaus-Raih M, Fung SY, Ng, Tan CS, Tan NH (2014). The genome of the tiger milk mushroom, *Lignosus rhinocerotis*, provides insights into the genetic basis of its medicinal properties. BMC Genomics 15: 635. DOI: 10.1186/1471-2164-15-635

Yap HY, Fung SY, Ng ST, Tan CS, Tan NH (2015). Shotgun proteomic analysis of tiger milk mushroom (*Lignosus rhinocerotis*) and the isolation of a cytotoxic fungal serine protease from its sclerotium. Journal of Ethnopharmacology 174: 437–451. DOI: 10.1016/j.jep.2015.08.042.

Yap HY, Tan NH, Ng ST, Tan CS, Fung SY (2018). Molecular attributes and apoptosis-inducing activities of a putative serine protease isolated from tiger milk mushroom (*Lignosus rhinocerus*) sclerotium against breast cancer cells in vitro. PeerJ 6:e4940. DOI: 10.7717/peerj.4940.

Yesilada O, Cing S, Asma D (2002). Decolorisation of the textile dye Astazon Red FBL by *Funalia trogii* pellets, Bioresource Technology 81: 155–157. DOI: 10.1016/S0960-8524(01)00117-1.

Yin L, Ye J, Kuang S, Guan Y, You R (2017). Induction, purification, and characterization of a thermo and pH stable laccase from *Abortiporus biennis* J2 and its application on the clarification of litchi juice. Bioscience, Biotechnology, and Biochemistry 81: 1033–1040. DOI: 10.1080/09168451.2017.1279850.

Ying J, Mao X, Ma Q, Zong Y., Wen H (1987). Icones of medicinal fungi from China, Science Press, Beijing, China, 575 p.

Yogita R, Simanta S, Aparna S, Kamlesh S (2011). Biodegradation of malachite green by wild mushroom of Chhatisgrah. Journal of Experimental Sciences 2: 69–72.

Yombiyeni P, Decock C (2017). Hymenochaetaceae (Hymenochaetales) from the Guineo-Congolian phytochorion: *Phylloporia littoralis sp. nov.* from coastal vegetation in Gabon, with an identification key to the local species. Plant Ecology and Evolution 150: 160–172. DOI: 10.5091/plecevo.2017.1289.

Yombiyeni P, Balezi A, Amalfi M, Decock C (2015). Hymenochaetaceae from the Guineo-Congolian rainforest: three new species of *Phylloporia* based on morphological, DNA sequences and ecological data. Mycologia 107: 996–1011. DOI: 10.3852/14-298.

Younes SB, Mechichi T, Sayadi S (2007). Purification and characterization of the laccase secreted by the white rot fungus *Perenniporia tephropora* and its role in the decolourization of synthetic dyes. Journal of Applied Microbiology 102:1033–1042. DOI: 10.1111/j.1365-2672.2006.03152.x.

Yu HY, Zhao CL, Dai YC (2013). *Inonotus niveomarginatus* and *I. tenuissimus spp. nov*. (*Hymenochaetales*), resupinate species from tropical China. Mycotaxon 124: 61–68. DOI: 10.5248/124.61.

Yu ZH, Wu SH, Wang DM, Chen CT (2010). Phylogenetic relationships of *Antrodia* species and related taxa basedon analyses of nuclear large subunit ribosomal DNA sequences. Botanical Studies 51: 53–60.

Yuan D, Mori J, Komatsu KI, Makino T, & Kano Y (2004). An anti-aldosteronic diuretic component (drain dampness) in *Polyporus sclerotium*. Biological and Pharmaceutical Bulletin 27: 867–870. DOI: 10.1248/bpb.27.867.

Yuan HS (2015) Molecular and morphological evidences reveal two new species in *Grammothele* and *Theleporus* (Basidiomycota) from southern China. Phytotaxa 213: 46–56. DOI: 10.11646/phytotaxa.213.1.4.

Yuan HS, Wan XN (2012). Morphological and ITS rDNA-based phylogenetic identification of two new species in *Tinctoporellus*. Mycological Progress 11: 947–952. 10.1007/s11557-012-0810-5.

Yuan HS, Dai YC, Wei YL (2010). *Postia cana sp. nov.* (Basidiomycota, Polyporales) from Shanxi Province, northern China. Nordic Journal of Botany 28: 629–631. DOI: 10.1111/j.1756-1051.2010.00849.x.

Zaini HM, Halimoon N (2013). Stems extract of Kemuning cina (*Catharanthus roseus*) as biofungicides against white root fungal (*Rigidoporus microporus*) of rubber trees (*Hevea brasiliensis*). Journal of Biofertilizers and Biopesticides 4: 1–4. DOI: 10.4172/2155-6202.1000136.

Zakaria L, Ali NS, Salleh B, Zakaria M (2009). Molecular analysis of *Ganoderma* species from different hosts in Peninsula Malaysia. Journal of Biological Sciences 9: 12–20. DOI: 10.3923/jbs.2009.12.20.

Zakaria MP, Ghasempouri SM, Tan SG (2005). Random amplified polymorphic DNA (RAPD) and random amplified microsatellite (RAMS) of *Ganoderma* from infected oil palm and coconut stumps in Malaysia. Asia-Pacific Journal of Molecular Biology and Biotechnology 13: 23–34.

Zaluma A, Bruna L, Klavina D, Burnevica N, Kenigsvalde K, Lazdins A, Gaitnieks T (2019). Growth of *Phlebiopsis gigantea* in wood of seven conifer species. Forest Pathology 49: e12555. DOI: 10.1111/efp.12555.

Zeng X, Cai Y, Lia X, Zeng X, Li W, Zhang D (2011). Decolorization of synthetic dyes by crude laccase from a newly isolated *Trametes trogii* strain cultivated on solid agro-industrial residue. Journals of Hazardous Materials 187: 517–525. DOI: 10.1016/j.jhazmat.2011.01.068.

Zhang G, Tianc T, Liua YP, Wangb H and Chena Q (2011). A laccase with anti-proliferative activity against tumor cells from a white root fungus *Abortiporus biennis*. Process Biochemistry 46: 2336–2340. DOI: 10.1016/j.procbio.2011.09.020.

Zhang J, Tang Q, Zhou C, Jia W, Da Silva L, Nguyen LD, Reutter W, Fan H (2010). GLIS, a bioactive proteoglycan fraction from *Ganoderma lucidum*, displays anti-tumour activity by increasing both humoral and cellular immune response. Life Sciences 87: 628–637. DOI: 10.1016/j.lfs. 2010.09.026.

Zhang JJ, Li Y, Zhou T, Xu DP, Zhang P, Li S, Li HB (2016). Bioactivities and health benefits of mushrooms mainly from China. Molecules 17: 938. DOI: 10.3390/molecules21070938.

Zhang M, Wu F, Wei Z, Xiao Y, Gong W (2006a). Characterization and decolorization ability of a laccase from *Panus rudis*. Enzyme and Microbial Technology 39: 92–97. DOI: 10.1016/j.enzmictec.2005.09.012.

Zhang SS, Ma QY, Zou XS, Dai HF, Huang SZ, Luo Y, Yu ZF, Luo HR, Zhao YX (2013). Chemical constituents from the fungus *Amauroderma amoiensis* and their in vitro acetylcholinesterase inhibitory activities. Planta Medica 79: 87–91. DOI: 10.1055/s-0032-1327951.

Zhang XQ, Yuan J, Xiao YZ, Hong YZ, Tang C (2006). A primary studies on molecular taxonomy of *Trametes* species based on the ITS sequences of rDNA. Mycosystema 25: 23–30.

Zhang YH, Liu YL, Yan SC (1991). Effect of *Polyporus umbellatus* polysaccharide on function of macrophages in the peritoneal cavities of mice with liver lesions. Zhong Xi Yi Jie He Za Zhi (Chinese Journal of Modern Developments in Traditional Medicine) 11: 225–226.

Zhao CL, Cui BK (2012). A new species of *Grammothelopsis (Polyporales, Basidiomycota)* from southern China. Mycotaxon 121: 291–296. DOI: 10.5248/121.291.

Zhao CL, Cui BK (2012a). A new species of *Perenniporia* (Polyporales, Basidiomycota) described from southern China based on morphological and molecular characters. Mycological Progress 11: 555–560. DOI: 10.1007/s11557-011-0770-1.

Zhao CL, Cui BK (2013). Five species of *Perenniporia* (Polyporales) new to China. Mycosystema 32: 192–201.

Zhao CL, Cui BK, Dai YC (2013). New species and phylogeny of *Perenniporia* based on morphological and molecular characters. Fungal Diversity 58: 47–60. DOI: 10.1007/s13225-012-0177-6.

Zhao CL, Cui BK, Steffen KT (2013a). *Yuchengia*, a new polypore genus segregated from *Perenniporia* (Polyporales, Basidiomycota) based on morphological and molecular characters. Nordic Journal of Botany 31: 331–338. DOI: 10.1111/j.1756-1051.2012.00003.x.

Zhao CL, Liu SH, Ren GJ, Ji XH, He S (2017). Three species of wood-decaying fungi in Polyporales new to China. Mycotaxon 132: 29–42. DOI: 10.5248/132.29.

Zhao GM, Zhang LX, Yu TM, Liu SM, Zhang LP (2005). Chemical structure of water soluble polysaccharide from spores of *Ganoderma lucidum*. The Journal of Chinical Pharmacology 41: 902–957.

Zhao H, Zhang M, Liu Q, Wang X, Zhao R, Geng Y, Wong T, Li S, Wang X (2018). A comprehensive screening shows that ergothioneine is the most abundant antioxidant in the wild macrofungus *Phylloporia ribis* Ryvarden. Journal of Environmental Science and Health Part C Environmental Carcinogenesis & Ecotoxicology Reviews 36: 98–111. DOI: 10.1080/ 10590501.2018.1450201.

Zhao JD (1989). Studies on the taxonomy of Ganodermataceae in China. XI. Subgen. *Ganoderma* Sect. *Ganoderma*. Acta Mycologica Sinica 8: 25–34.

Zhao JD (1998). Flora fungorum sinicorum 3, Polyporaceae. Science Press, Beijing, 456 p (in Chinese).

Zhao JD, Zhang XQ (1986). Studies on the taxonomy of Ganodermataceae in China V. Acta Mycologia Sinica 5: 219–225. Chinese.

Zhao JD, Zhang XQ (1987). Studies on the taxonomy of Ganodermataceae in China VII - the genus *Amauroderma*. Acta Mycologia Sinica Suppliment 1: 258–272.

Zhao JD, Zhang XQ (1992). The Polypores of China. Bibliotheca Mycologica 145: 1–154.

Zhao JD, Zhang XQ (2000). *Flora fungorum sinicorum* (Vol. 18, Ganodermataceae). Beijing: Science Press: 204 p. (in Chinese).

Zhao JD, Hsu LW, Zhang XQ (1979). Taxonomic studies on the subfamily Ganodermoideae of China (in Chinese). Acta Mycologica Sinica 19: 265–279.

Zhao JD, Xu LW, Zhang XQ (1981). Ganodermoideae of China. Beijing: Science Press, 1–106 (in Chinese).

Zhao JD, Xu LW, Zhang XQ (1983). Taxonomic studies on the family Ganodermataceae of China II. Acta Mycolia Sinica 2: 159–167.

Zhao Q, Feng B, Zhu L, Yang, Dai Y C, Wang Z, Tolgor B (2012). New species and distinctive geographical divergences of the genus *Sparassis* (Basidiomycota): evidence from morphological and molecular data. Mycological Progress 12: 445–454. DOI: 10.1007/s11557-012-0853-7.

Zhao Y (2009). RP-HPLC determination of ergosterol in *Polyporus umbellatus* (Pers.) Fries. Chinese Journal of Pharmaceutical Analysis 29: 898–900.

Zheng HD, Liu PG (2008). Additions to our knowledge of the genus *Albatrellus* (Basidiomycota) in China. Fungal Diversity 32: 157–170.

Zheng WF, Liu T, Xiang XY, Gu Q (2007). Sterol composition of field-grown and cultured mycelia of *Inonotus obliquus*. Acta Pharmaceutica Sinica 42: 750–756.

Zhiqing L, Fen GS, Qingxin S, Shangcai F, Xiangjie L (2017). Comparative study on polysaccharide content and its antioxidant activity of *Phylloporia ribis* (Schumach.:Fr.) Ryvarden of Different Years. Shandong Agricultural Sciences 2017-01. http://en.cnki.com.cn/Article_en/CJFDTotal-AGRI 201701014.htm.

Zhou JL, Cui BK (2017). Phylogeny and taxonomy of *Favolus* (Basidiomycota). Mycologia 109: 5766–5779. DOI: 10.1080/00275514.2017.1409023.

Zhou JL, Zhu L, Chen H, Cui BK (2016b). Taxonomy and phylogeny of *Polyporus* group *Melanopus* (Polyporales, Basidiomycota) from China. PLoS ONE 11: e0159495. 10.1371/journal.pone.0159495.

Zhou LW (2014). *Fulvifomes hainanensis sp. nov*. and *F. indicus comb. nov.* (Hymenochaetales, Basidiomycota) evidenced by a combination of morphology and phylogeny. Mycoscience 55: 70–77. DOI: 10.1016/j. myc.2013.05.006.

Zhou LW (2015). *Fulvifomes imbricatus* and *F. thailandicus* (Hymenochaetales, Basidiomycota): two new species from Thailand based on morphological and molecular evidence. Mycological Progress 14: 89. DOI: 10.1007/s11557-015-1116-1.

Zhou LW (2016). *Phylloporia minutipora* and *P. radiata spp. nov.* (Hymenochaetales, Basidiomycota) from China and a key to worldwide species of *Phylloporia*. Mycological Progress 15: 57. DOI: 10.1007/s11557-016-1200-1.

Zhou LW, Dai YC (2012). Wood-inhabiting fungi in southern China 5. New species of *Theleporus* and *Grammothele* (Polyporales, Basidiomycota). Mycologia 104: 915–924. DOI: 10.3852/11-302.

Zhou LW, Dai YC (2012a). Phylogeny and taxonomy of *Phylloporia* (Hymenochaetales): new species and a worldwide key to the genus. Mycologia 104: 211–222. DOI: 10.3852/11-093.

Zhou LW, Tedersoo L (2012). *Coltricia australica sp. nov.* (Hymenochaetales, Basidiomycota) from Australia. Mycotaxon 122: 123–128. DOI: 10.5248/122.123.

Zhou LW, Wei YL (2012). Changbai wood-rotting fungi 16. A new species of *Fomitopsis* (Fomitopsidaceae). Mycological Progress 11: 435e441; DOI: 10.1007/s11557-011-0758-x.

Zhou LW, Zhang WM (2012). A new species of *Fulvifomes* (Hymenochaetaceae) from Cambodia. Mycotaxon 119: 175–179. DOI: 10.5248/119.175.

Zhou LW, Vlasák J, Kin WM, Dai YC (2016a). Global diversity and phylogeny of the *Phellinus igniarius* complex (Hymenochaetales, Basidiomycota) with the description of five new species. Mycologia 108: 192–204. DOI: 10.3852/15-099.

Zhou LW, Cao Y, Wu SH, Vlasak J, Li DW, Li MJ, Dai YC (2014). Global diversity of the *Ganoderma lucidum* complex (*Ganodermataceae, Polyporales*) inferred from morphology and multilocus phylogeny. Phytochemistry 114: 7–15. DOI: 10.1016/j.phytochem.2014.09.023.

Zhou LW, Vlasák J, Decock C & Assefa A & Stenlid J, Abate D, Wu SH, & Dai YC (2015). Global diversity and taxonomy of the *Inonotus linteus* complex (Hymenochaetales, Basidiomycota): *Sanghuangporus gen. nov*., *Tropicoporus excentrodendri* and *T. guanacastensis gen. et spp. nov*., and 17 new combinations. Fungal Diversity 77: 335–347. DOI 10.1007/s13225-015-0335-8.

Zhou LW, Nakasone KK, Burdsall HH, Ginns J, Vlasák J, Miettinen O, Spirin V, Niemelä T, Yuan HS, He SH, Cui BK, Xing JH, Dai YC (2016). Polypore diversity in North America with an annotated checklist. Mycological Progress 15: 771–790. DOI 10.1007/s11557-016-1207-7.

Zhu K, Nie S, Li C, Lin S, Xie M, Li W, Gong D, Xie M (2013). A newly identified polysaccharide from *Ganoderma* atrum attenuates hyperglycemia and hyperlipidemia. International journal of biological macromolecules 57: 142–150. DOI: 10.1016/j.ijbiomac.2013.03.009.

Zhukov AM (1980). Wood-decay fungi of Priobie. Algae, fungi and lichens of southern Siberia. Moscow, Nauka. 144–183 (in Russian).

Zhuo-Teng Y, Bo L, Purna M, Newburg DS (2013). *Trametes versicolor* extract modifies human fecal microbiota composition *in vitro*. Plant Foods for Human Nutrition 68: 107–112. DOI: 10.1007/s11130-013-0342-4.

Zibarova L, Kout J (2014). First record of *Skeletocutis ochroalba* (*Polyporales*) in the Czech Republic. Czech Mycology 66: 61–69.

Ziegenbein C, Hanssen HP, König WA (2006). Secondary metabolites from *Ganoderma lucidum* and *Spongiporus leucomallellus*. Phytochemistry 67: 202–211. DOI: 10.1016/j.phytochem.2005.10.025.

Zimbardi AL, Camargo PF, Carli S, Neto SA, Meleiro LP, Rosa JC, Andrade ARD, Jorge JA Furriel RPM (2016). A high redox potential laccase from *Pycnoporus sanguineus* RP15: potential application for dye decolorization. International Journal of Molecular Sciences 17: 672. DOI:10.3390/ ijms17050672.

Zmitrovich IV (2018). *Conspectus systematis Polyporacearum* v. 1.0. Folia Cryptogamica Petropolitana 6: 3–145.

Zmitrovich IV, Kovalenko AE (2016). Lentinoid and polyporoid fungi, two generic conglomerates containing important medicinal mushrooms in molecular perspective. International Journal of Medicinal Mushrooms 18: 23–38. DOI: 10.1615/IntJMedMushrooms.v18.i1.40.

Zmitrovich IV, Malysheva VF (2013). Towards a phylogeny of *Trametes* alliance (Basidiomycota, Polyporales. Mikologia i Fitopatologia. 47: 358–380.

Zmitrovich IV, Malysheva VF (2014). Nomenclatural novelties. Index Fungorum. 180: 1–1.

Zmitrovich IV, Malysheva VF (2014a). Studies on *oxyporus*. I. Segregation of *Emmia* and general topology of phylogenetic tree. Микология и фитопатология 48. 161–171.

Zmitrovich IV, Bondartseva MA, Vasilyev NP (2016). The Meruliaceae of Russia. I. *Bjerkandera*. Turczaninowia 19: 5–18. DOI: 10.14258/turczaninowia.19.1.1.

Zmitrovich IV, Ezhov ON, Wasser SP (2012). A survey of species of genus *Trametes* Fr. (Higher Basidiomycetes) with estimation of their medicinal source potential. International Journal of Medicinal Mushrooms 14: 307–319. DOI: 10.1615/IntJMedMushr.v14.i3.70.

Zmitrovich IV, Malysheva VF, Spirin WA (2006). A new morphological arrangement of the Polyporales. I. Phanerochaetineae. Mycena 6: 4–56.

Zmitrovich IV, Ezhov ON, Ranadive KR, Wasser SP (2017). Profiles of little-known medicinal polypores: *Earliella scabrosa* (Agaricomycetes). International Journal of Medicinal Mushrooms 19: 1023–1027. DOI: 10.1615/IntJMedMushrooms.2017024496.

APPENDIX-I

LIST OF FIGURES

APPENDIX-II

LIST OF TABLES

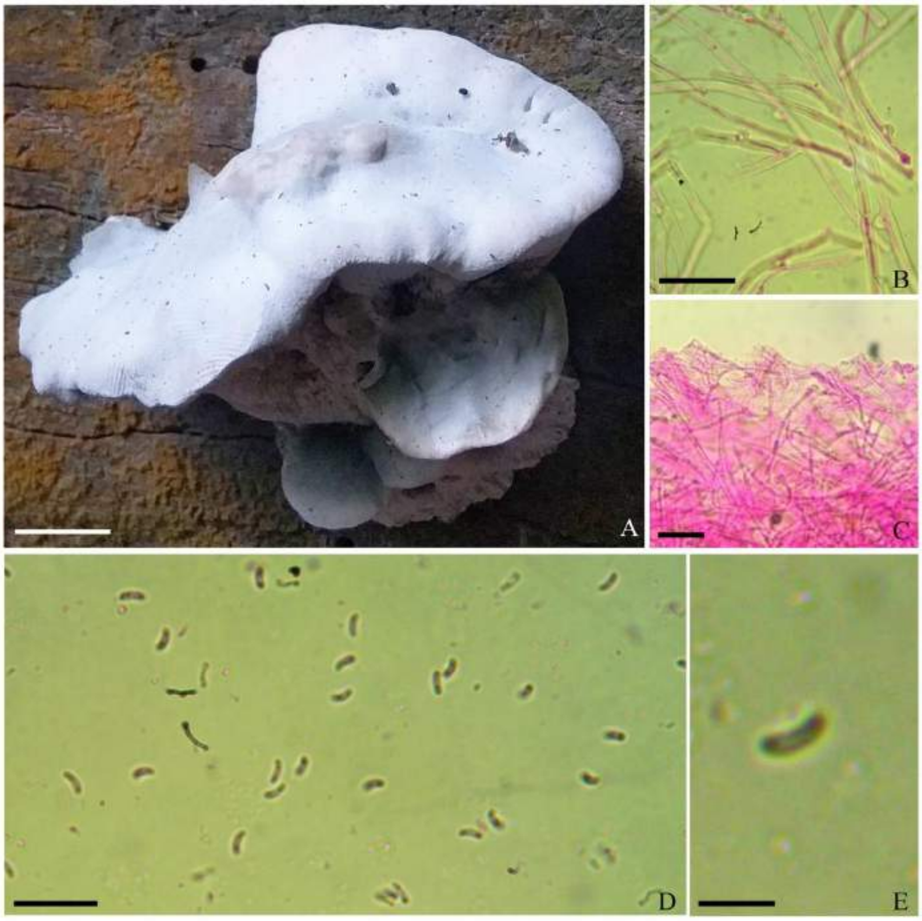


Figure 2: *Postia tephroleuca*-A. Basidiomata B. Generative hyphae showing clamp connections C. Pileipellis D. Basidiospores F. Basidiospore enlarged. Scale bars: A=10 mm, B=20 μm, C=32 μm, D=12 μm, E=5 μm.

Figure 3: *Spongiporus floriformis*-A. Basidiomata B. Generative hyphae C. Generative hyphae showing clamp connection (arrow) D. Pileipellis E. Basidiospores F. Basidiospore enlarged. Scale bars: A=5 mm, B, C=12 μm, D=16 μm, E=10 μm, F=4 μm.

Figure 4: *Flavodon flavus*-A. Basidiomata B Generative hyphae C Skeletal hyphae D. Encrusted cystidia E, F. Pileipellis G. Basidiospore. Scale bars: A=35 mm, B=12 µm, C=20 µm, D=8 µm, E, F=12 µm, G=5 µm.

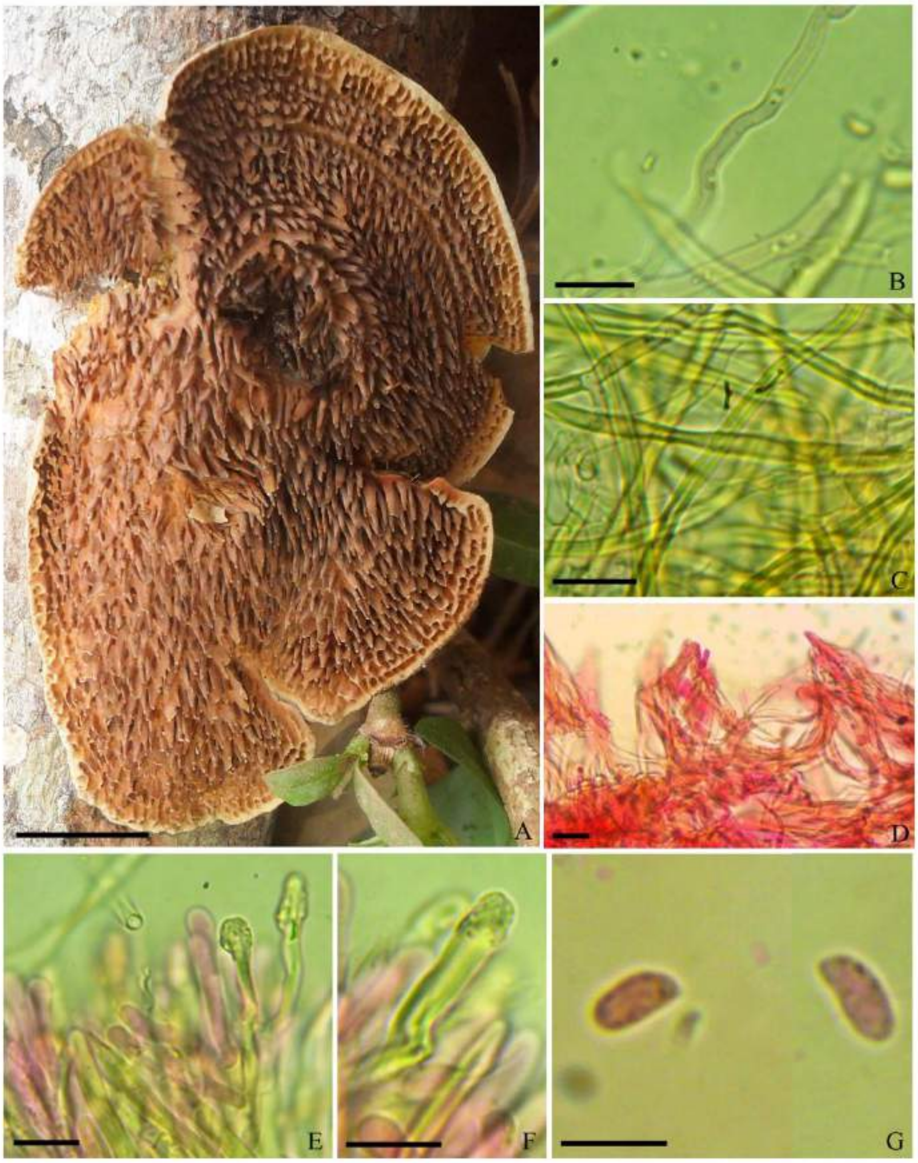


Figure 5: *Irpex lacteus*-A. Basidiomata B. Generative hyphae C. Skeletal hyphae D. Pileipellis F. A portion of hymenial trama showing basidioles and encrusted cystidia F. Cystidia enlarged G. Basidiospores. Scale bars: A=5 mm, B, C, D, E, F=12 µm, G=7 µm.

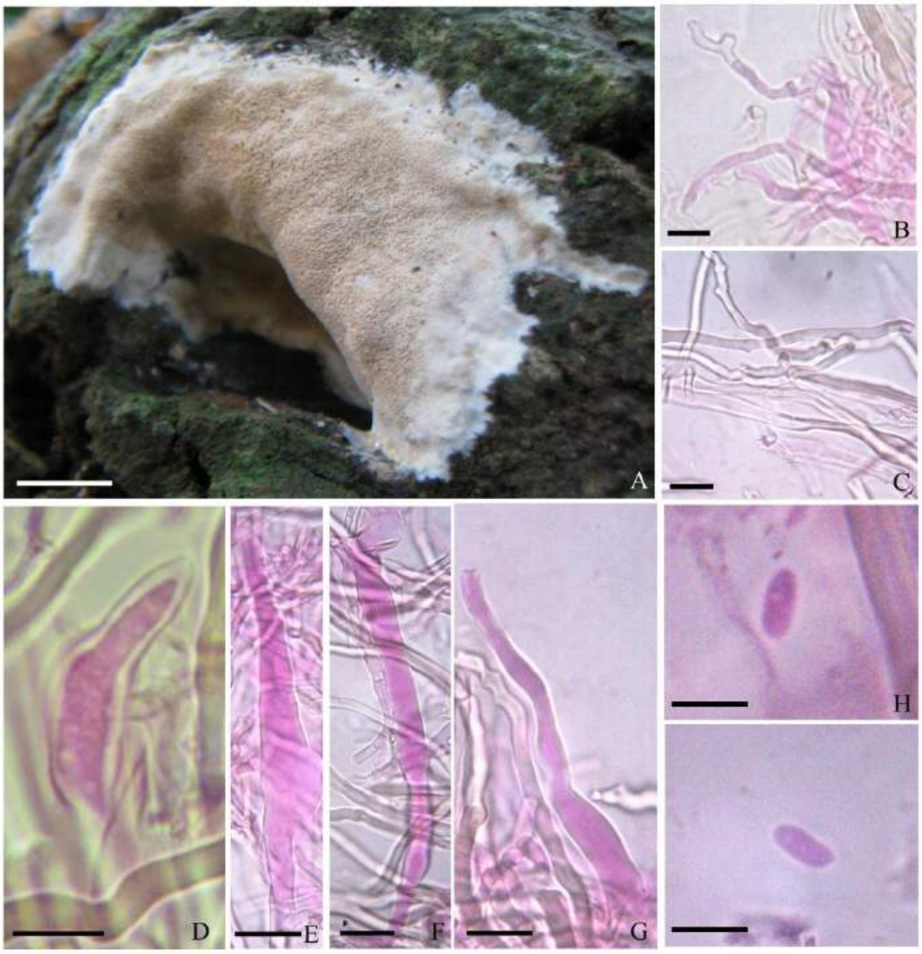


Figure 6: *Butyrea luteoalba*-A. Basidiomata B. Generative hyphae C. Skeletal hyphae D. Cystidia E, F, G. Gloeocystidia H, I. Basidiospores. Scale bars: A=10 mm, B, C=8 μm, D, E, F, G=10 μm, H, I=5 μm.

Figure 7: *Nigroporus vinosus*-A. Basidiomata B. Generative hyphae C. Skeletal hyphae D. Pileipellis E. Basidiospore. Scale bars: A=10 mm, B=12 µm, C=24 µm, D=12 µm, E=5 µm.

Figure 8: *Nigroporus durus*-A. Basidiomata B. Generative hyphae showing clamp connection C. Skeletal hyphae D. Pileipellis E. Basidiospore. Scale bars: A=10 mm, B=7 μm, C=24 μm, D=20 μm, E=5 μm.

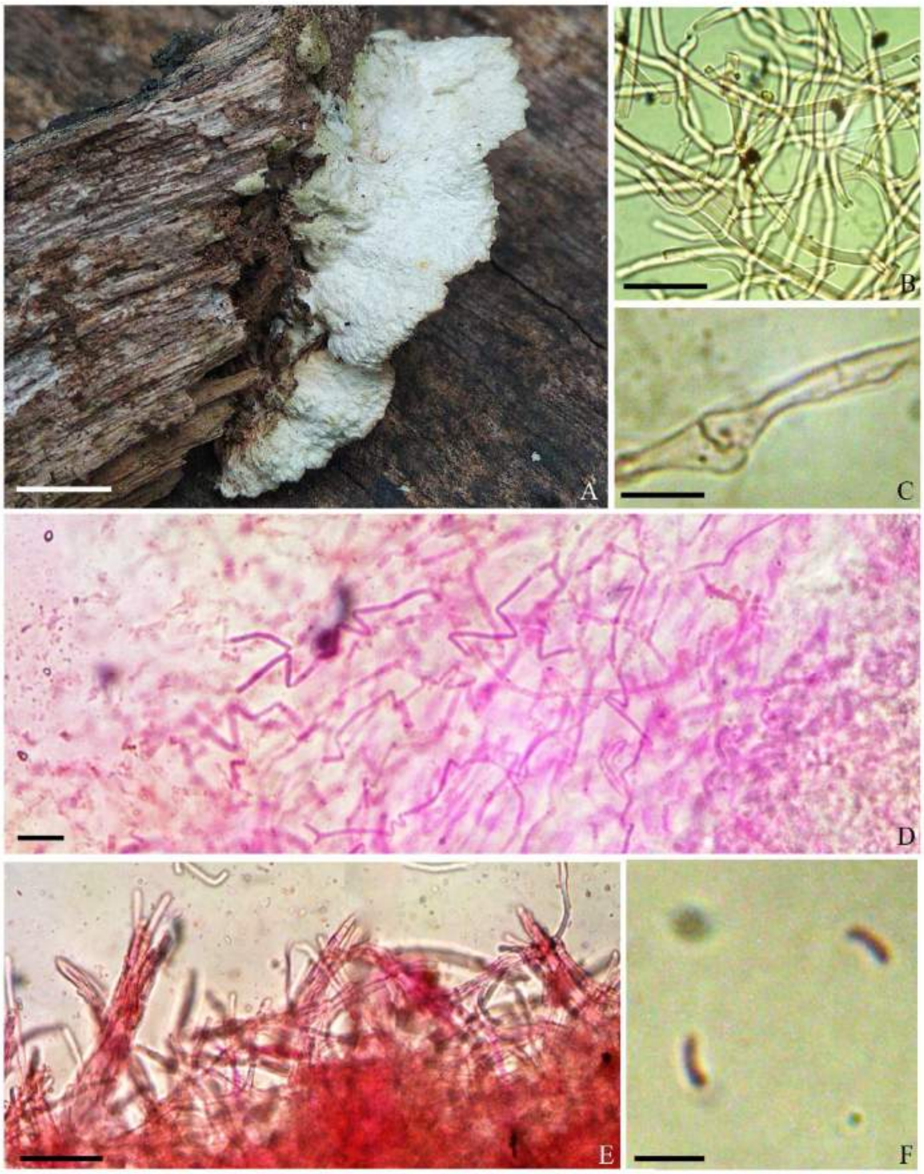


Figure 9: *Tyromyces leucomallus*-A. Basidiomata B. Generative hyphae C. Generative hyphae showing clamp connection D. Gloeopherous hyphae E. Pileipellis F. Basidiospores. Scale bars: A=10 mm, B=30 µm, C, D=12 µm, E=24 µm, F=4 µm.

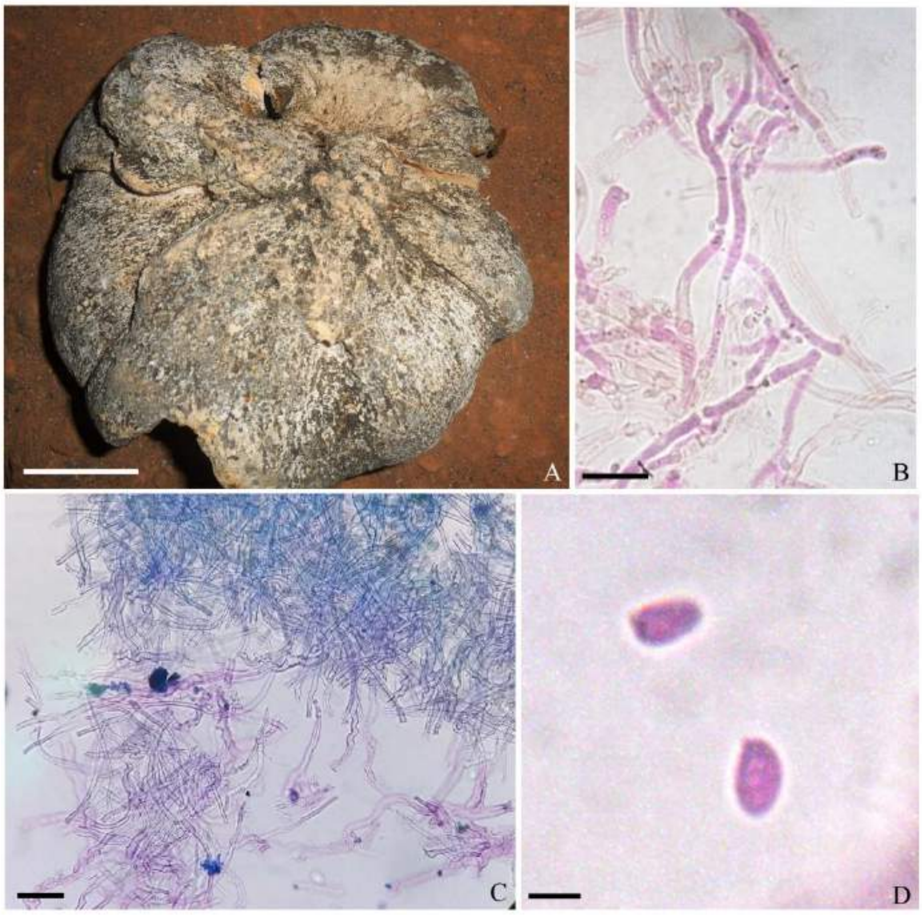


Figure 10: *Pappia fissilis*-A. Basidiomata B. Generative hyphae C. Generative hyphae showing metachromatic reaction in cresyl blue D. Basidiospores. Scale bars: A=40 mm, B, C=12 µm, D=3 µm.

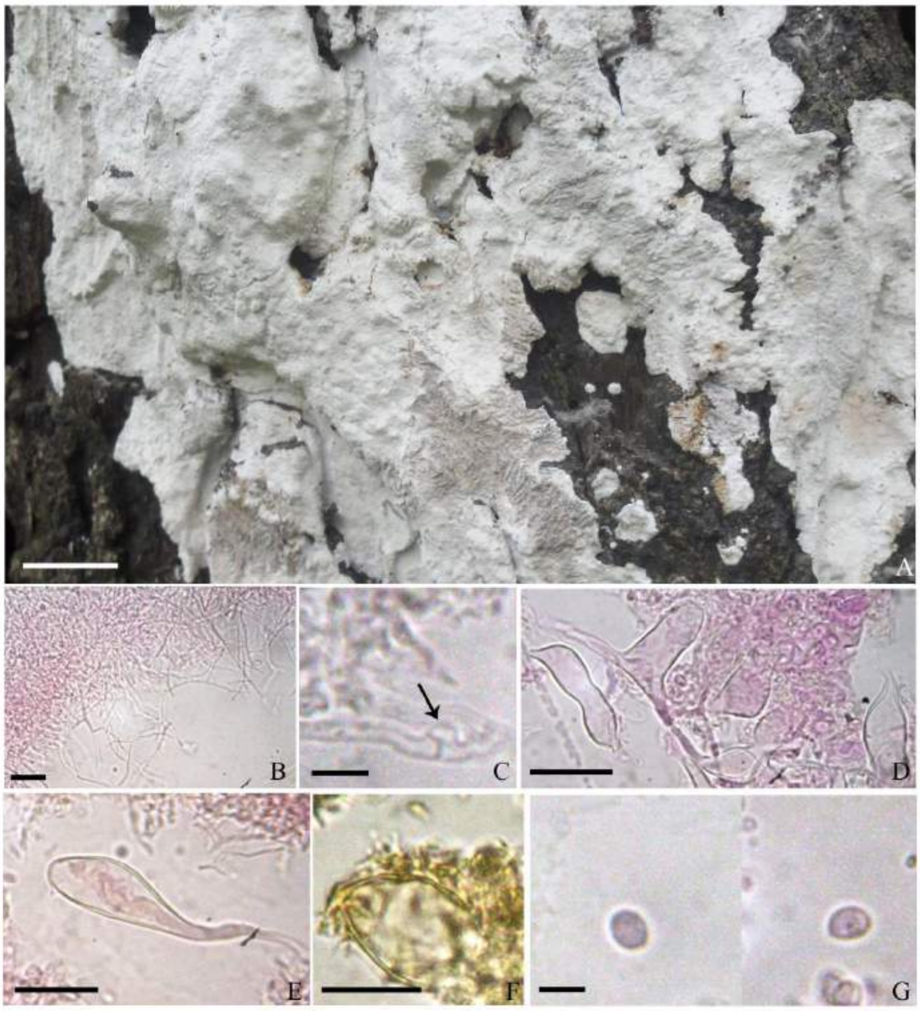


Figure 11: *Phlebia unica*-A. Basidiomata B. Generative hyphae C. Generative hyphae showing clamp connection (arrow) D, E. Hymenial cystidia F. Cystidia showing weak encrustations G. Basidiospores. Scale bars: A=10 mm, B=18 µm, C=5 µm, D, E, F=12 µm, G=4 µm.

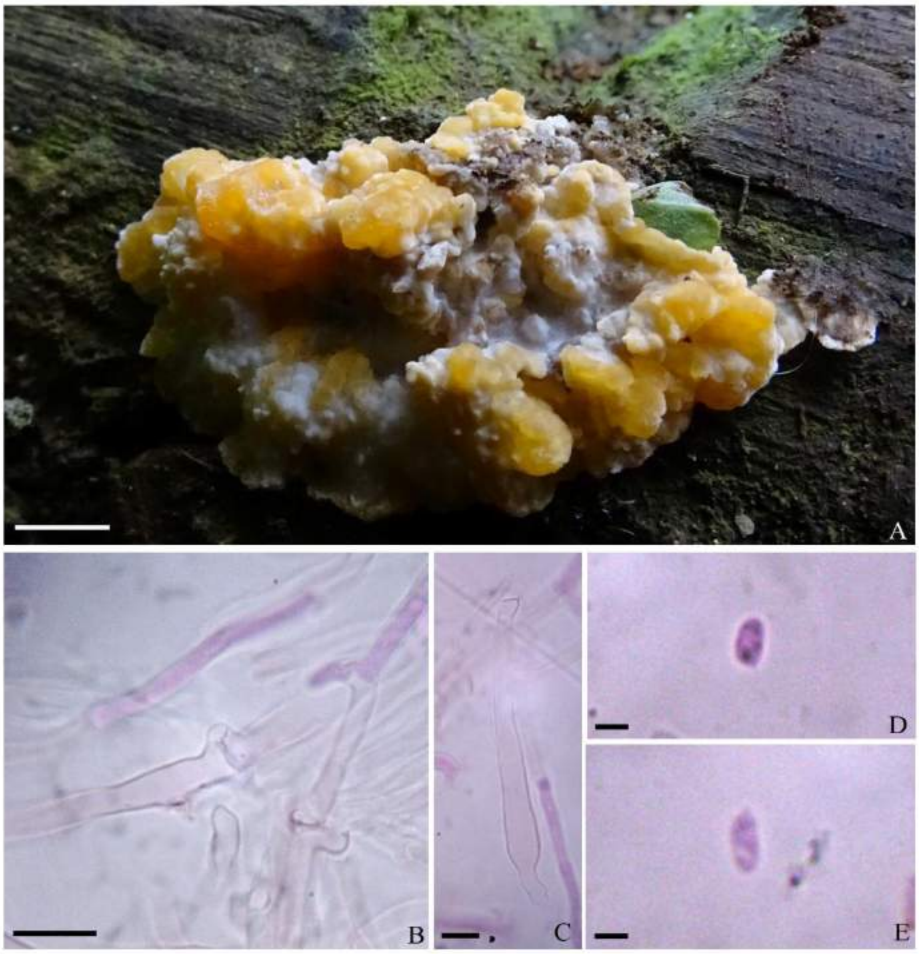


Figure 12: *Phlebia acerina*-A. Basidiomata B. Generative hyphae showing clamp connections C. Cystidia D, E. Basidiospores. Scale bars: A=10 mm, B=6, C=7 µm, D, E=3 µm.

Figure 13: *Phlebia ludoviciana*-A. Basidiomata B. Generative hyphae showing clamp connections, C, D, E, F. Encrusted cystidia G. Basidiospores. Scale bars: A=10 mm, B=9 μm, C, D, E, F, G=6 μm.

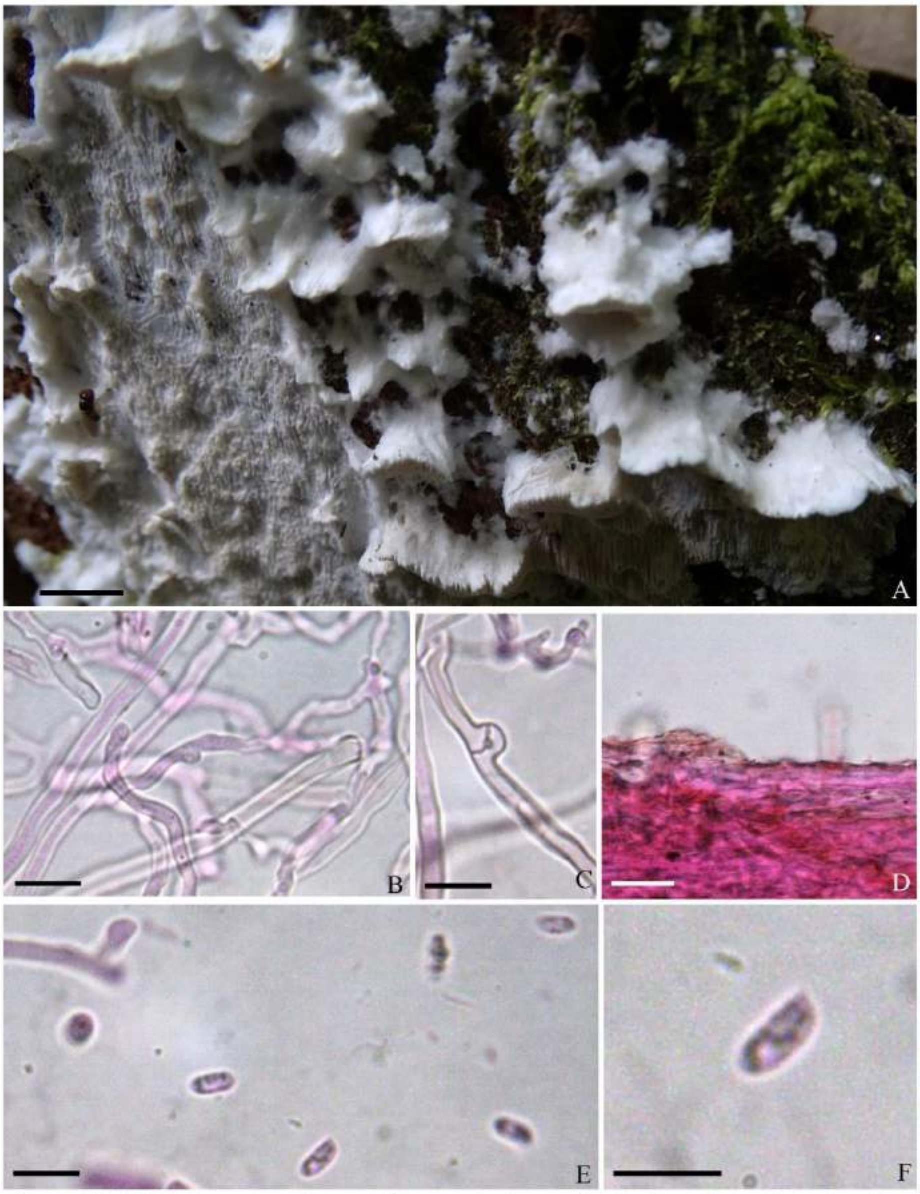


Figure 14: *Sebipora aquosa*-A. Basidiomata B. Generative hyphae C. Hyphae showing clamp connection D. Pileipellis E. Basidiospores F. Basidiospore enlarged. Scale bars: A=10 mm, B, C=12 μm, D=9 μm, E, F=7 μm.

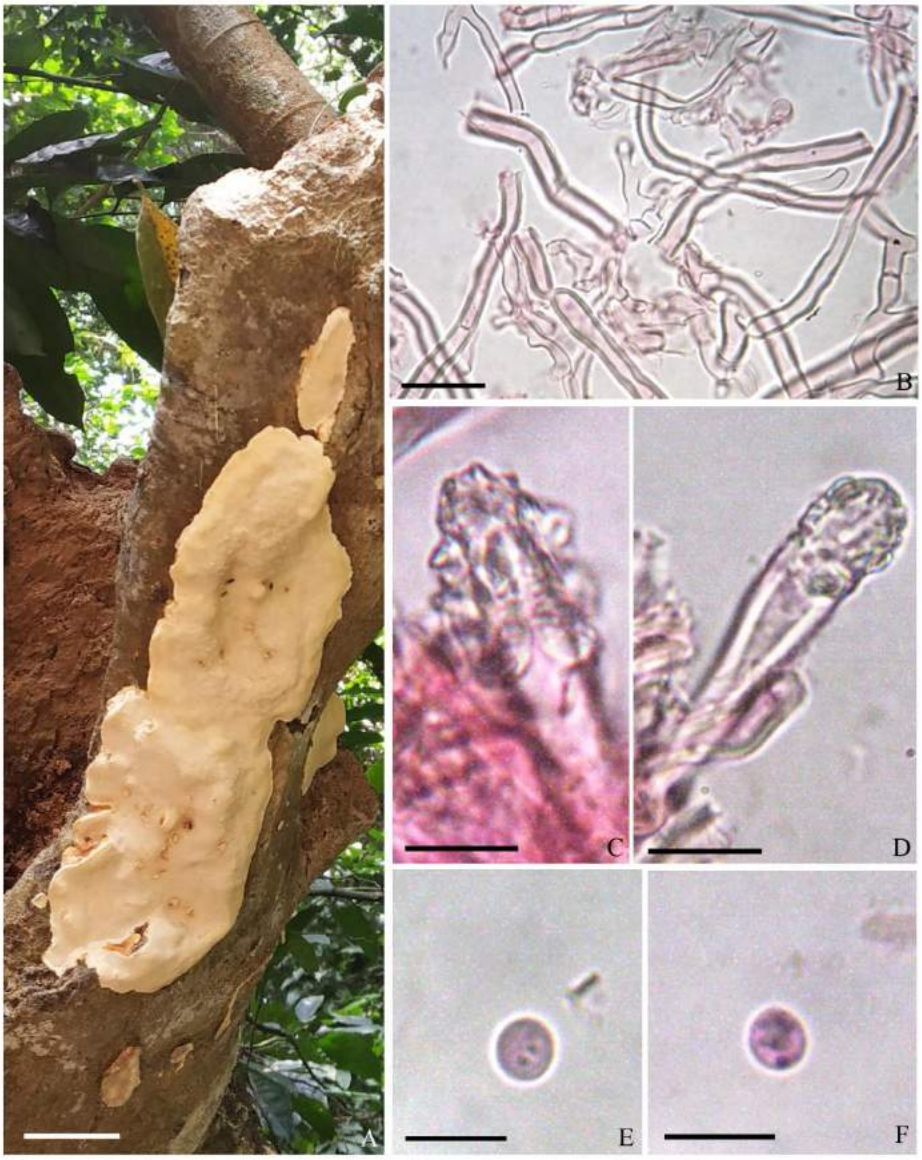


Figure 15: *Rigidoporus vinctus*-A. Basidiomata B. Generative hyphae C, D. Encrusted cystidia E, F. Basidiospores. Scale bars: A=100 mm, B=21 μm, C, D, E, F=10 μm.

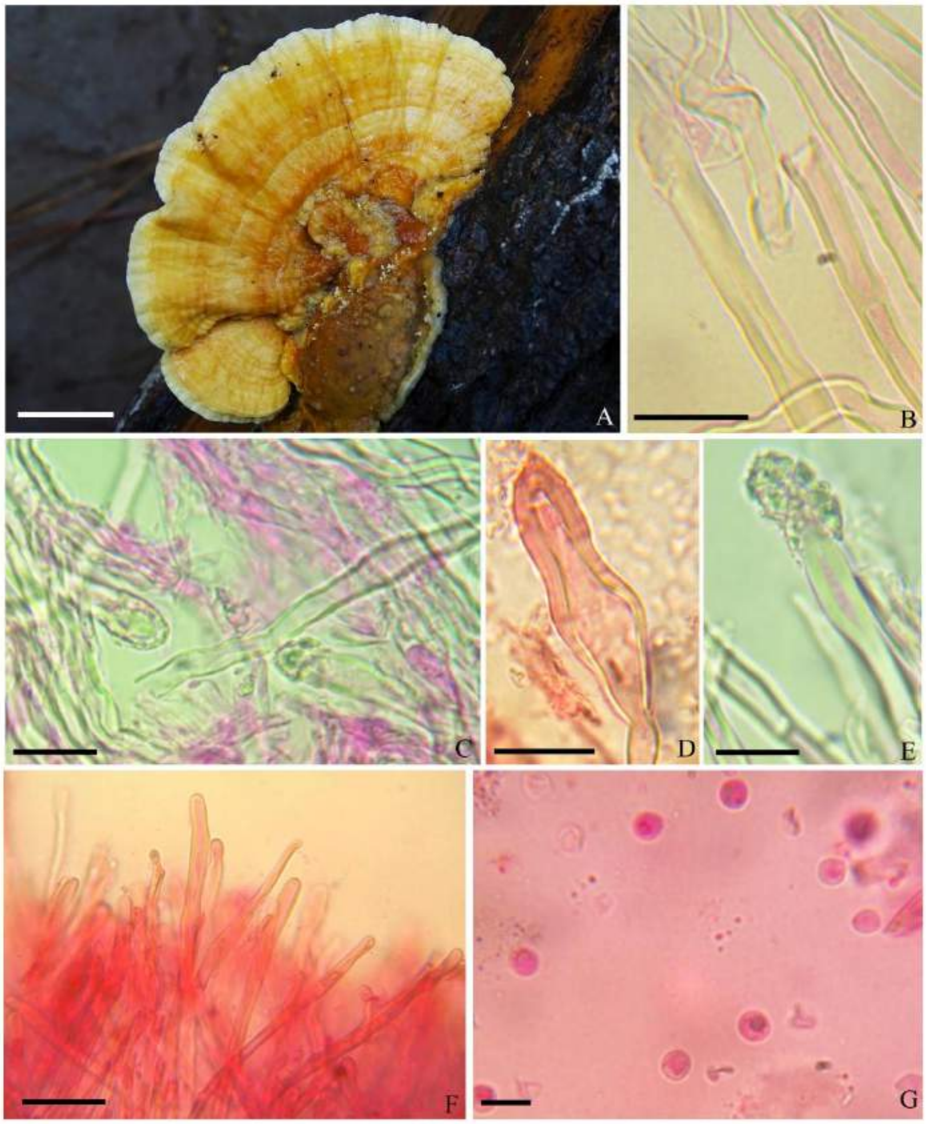


Figure 16: *Rigidoporus lineatus*-A. Basidiomata B. Generative hyphae C. Hymenium with embeded cystidia D. Cystidia E. Cystidia showing encrustations F. Pileipellis G. Basidiospores. Scale bars: A=10 mm, B=12 µm, C, D, E=10 µm, F=10 µm, G=8 µm.

Figure 17: *Terana coerulea*-A. Basidiomata B. Generative hyphae C Hyphae showing clamp connection D. Encrustations on hyphae E. Blue colour of hyphae disappeared on treatment with KOH F, G, H, I. Dendrohyphidia. Scale bars: A=20 mm, B=20 µm, C=10 µm, D=10 µm, E=20 µm, F, G, H, I=14 µm.

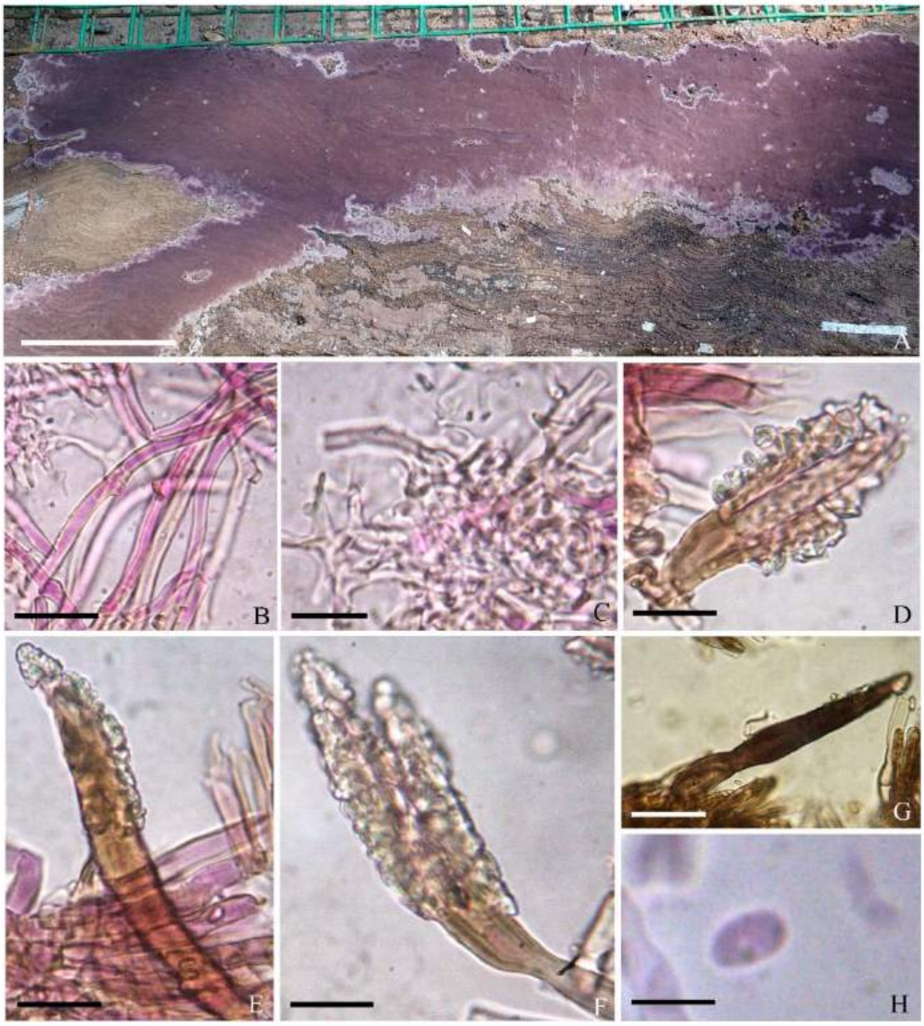


Figure 18: *Phlebiopsis crassa*-A. Basidiomata B. Generative hyphae C. Hyphae showing arboriform branchings D, E, F. Encrusted cystidia G. Encrustations dissolved in KOH H. Basidiospore. Scale bars: A=50 mm, B, C=16 μm, D, E, F, G=12 μm, H=8 μm.

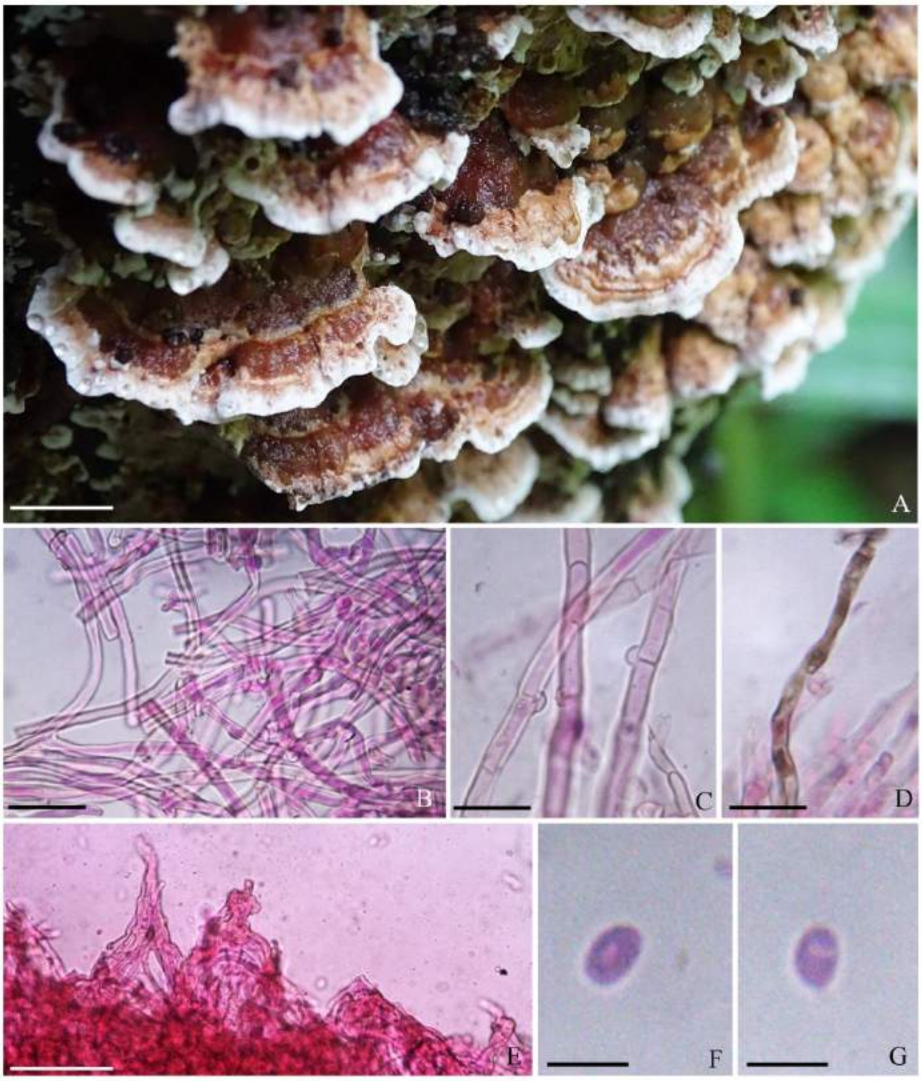


Figure 19: *Bjerkandera adusta*-A. Basidiomata B. Generative hyphae C. Generative hyphae showing clamp connections D. Hyphae showing brown pigmentation E. Pileipellis F, G. Basidiospores. Scale bars: A=10 mm, B=18 µm, C, D=15 µm, E=20 µm, F, G=5 µm.

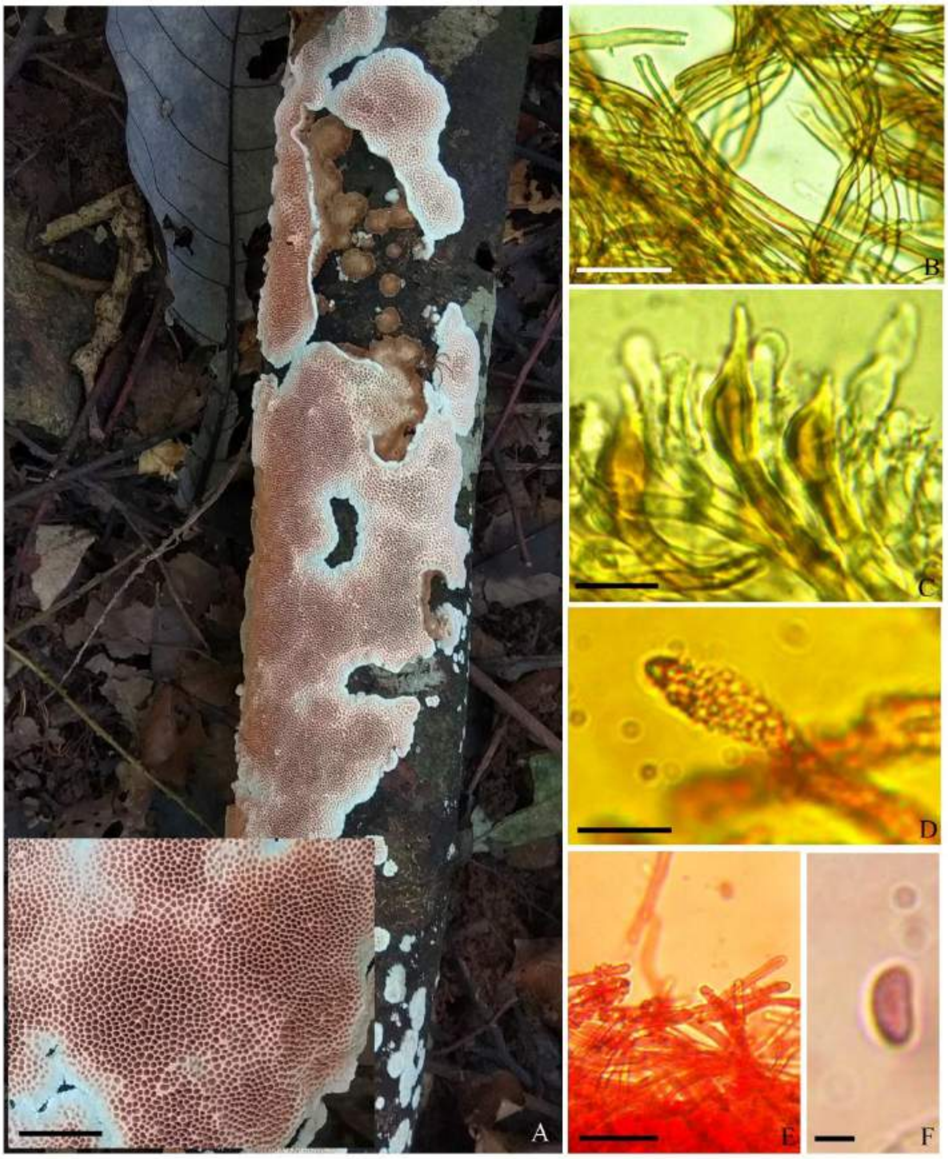


Figure 20*: Oxychaete cervinogilva*-A. Basidiomata (inset-pores enlarged) B. Generative hyphae C. Hymenial setae D. Setae with encrustations on surface E. Pileipellis F. Basidiospore. Scale bars: A=10 mm, B=20 µm, C=30 µm, D=10 µm, E= 20 µm, F=2 µm.

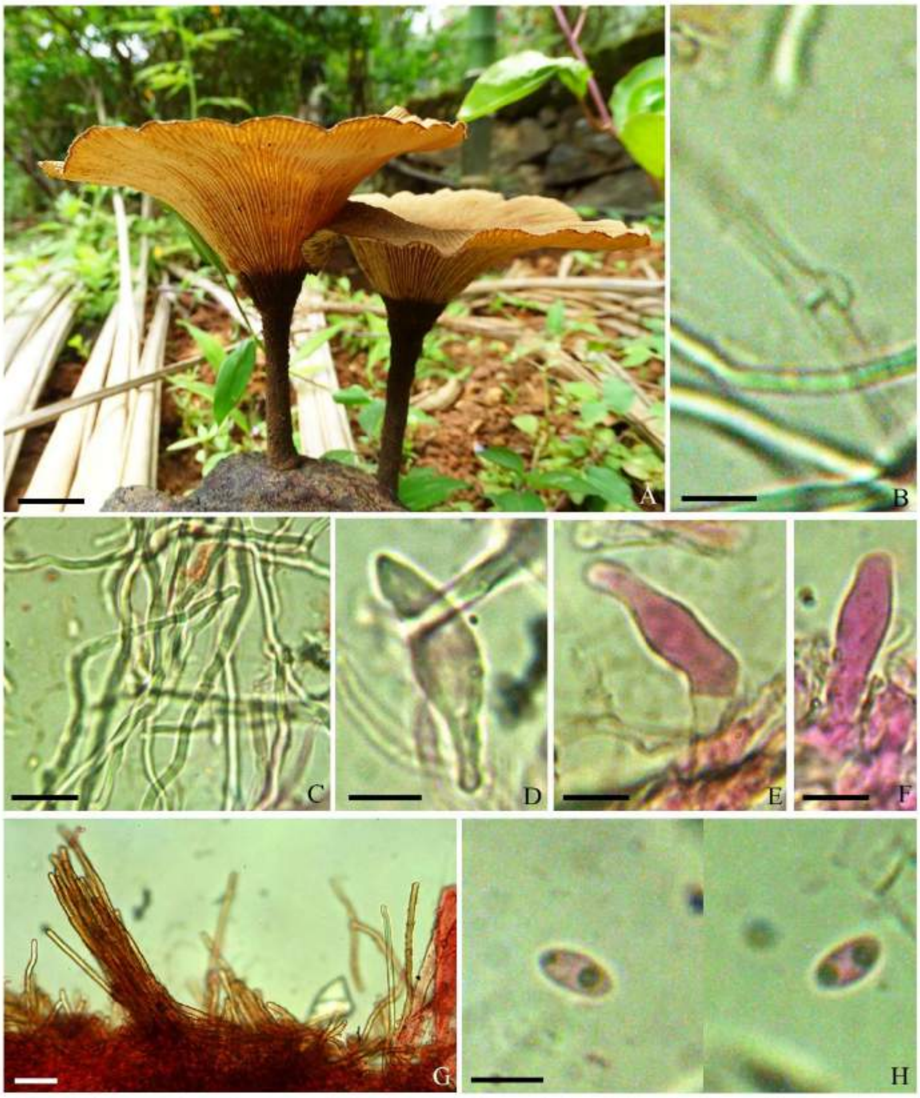


Figure 21: *Panus simils*-A. Basidiomata B. Generative hyphae showing clamp connection C. Skeletal hyphae D. Metuloid cystidia E, F. Pleurocystidia G. Pileipellis H. Basidiospores. Scale bars: A=10 mm, B=6 µm, C=16 µm, D, E=7 µm, F=12 µm, H=6 µm.

Figure 22: *Panus neostrigosus*-A. Basidiomata B. Generative hyphae showing clamp connection C. Skeletal hyphae D, E. Skeletocystidia F, G. Cheilocystidia H. Pileipellis I. Basidiospores. Scale bars: A=10 mm, B=12 µm, C=30 µm, D=14 µm, E=12 µm, F, G=14 µm, H=24 µm, I, J=7 µm.

Figure 23: *Panus bambusinus*-A. Basidiomata (photo taken from the herbarium specimen, AK61d) B. Generative hyphae showing clamp connection (arrow) C. Skeletal hyphae D. Hymenium with projecting gloeocystidia E, F, G. Gloeocystidia H. Cheilocystidia I. Pileipellis J. Basidiospores K. Basidiospore enlarged. Scale bars: A=20 mm, B, C=16 µm, D=26 µm, E, F, G=12 µm, H=18 µm, I=24 µm, J=6 µm, K=4 µm.

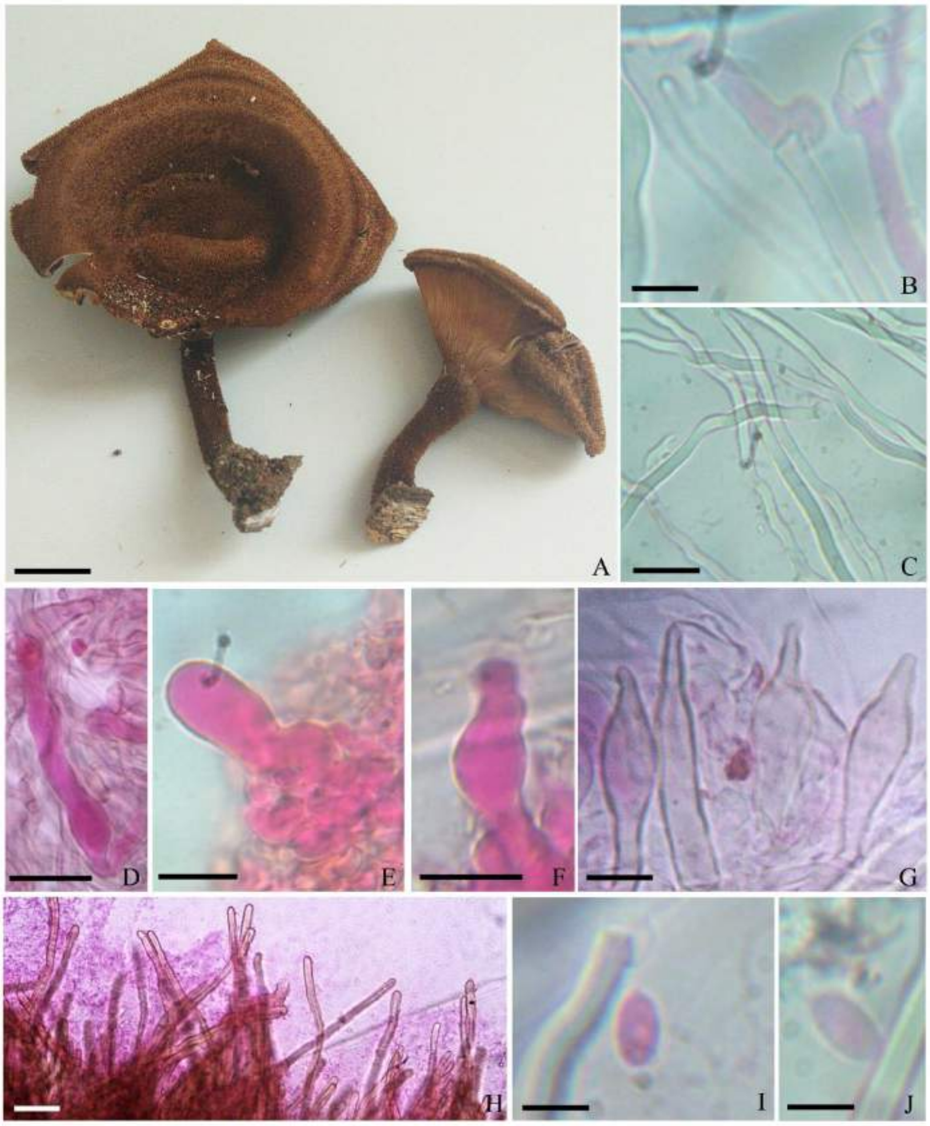


Figure 24: *Panus hookerianus*-A. Basidiomata B. Generative hyphae showing clamp connections C. Skeletal hyphae D, E, F. Cheilocystidia G. Metuloid cystidia H. Pileipellis I, J. Basidiospores. Scale bars: A=10 mm, B=5 µm, C=16 µm, D, E, F, G=8 µm, H=12 µm, I, J=4 µm.

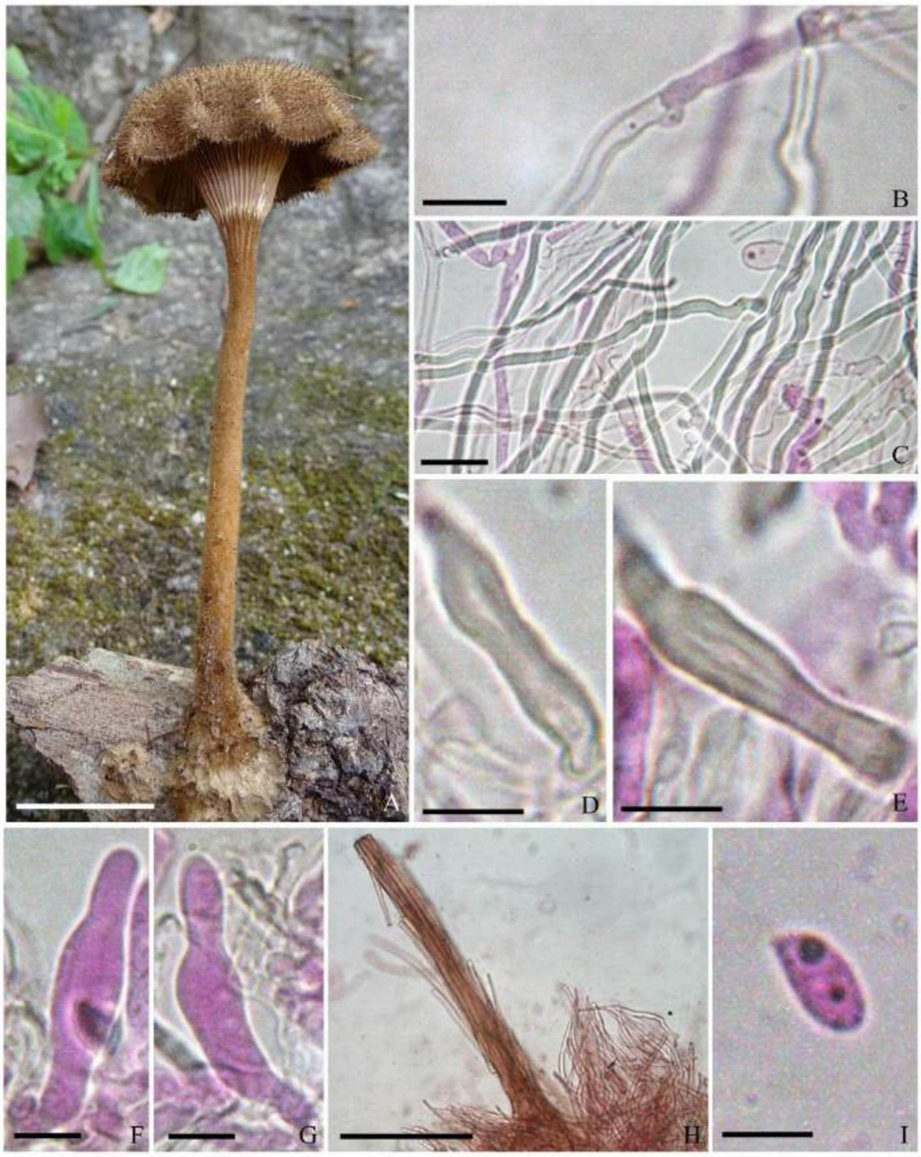


Figure 25: *Panus velutinus*-A. Basidiomata B. Generative hyphae showing clamp connections C. Skeletal hyphae D., E. Metuloides F, G. Cheilocystidia H. Pileipellis I. Basidiospore. Scale bars: A=20 mm, B=8 µm, C=6 µm, D, E=7 µm, F, G=8 µm, H=40 µm, I=7 µm.

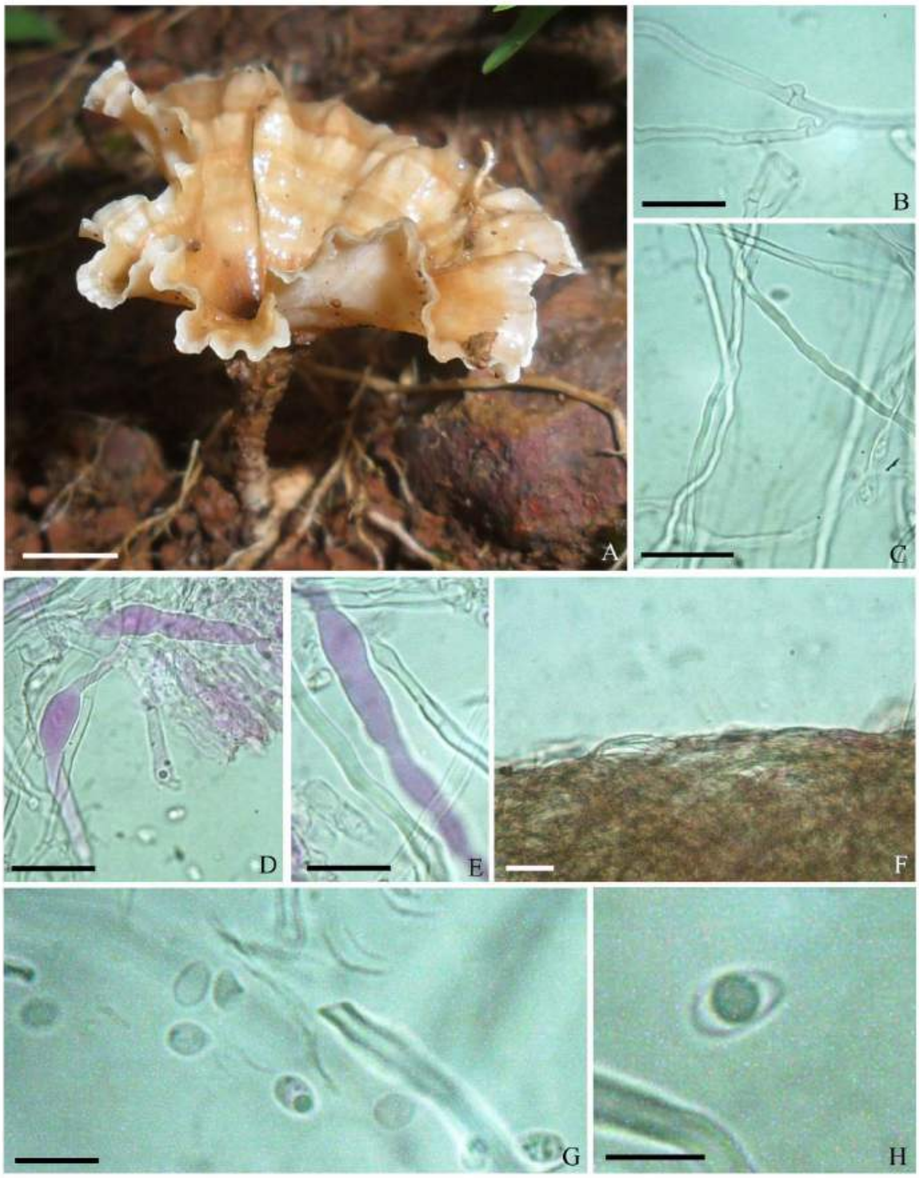


Figure 26: *Podoscypha thozetii*-A. Basidiomata B. Generative hyphae showing clamp connections C. Skeletal hyphae D, E. Gloeocystidia F. Pileipellis G. Basidiospores H. Basidiospore enlarged. A=30 mm, B, C=16 µm, D, E=20 µm, F=9 µm, G=10 µm, H=7 µm.

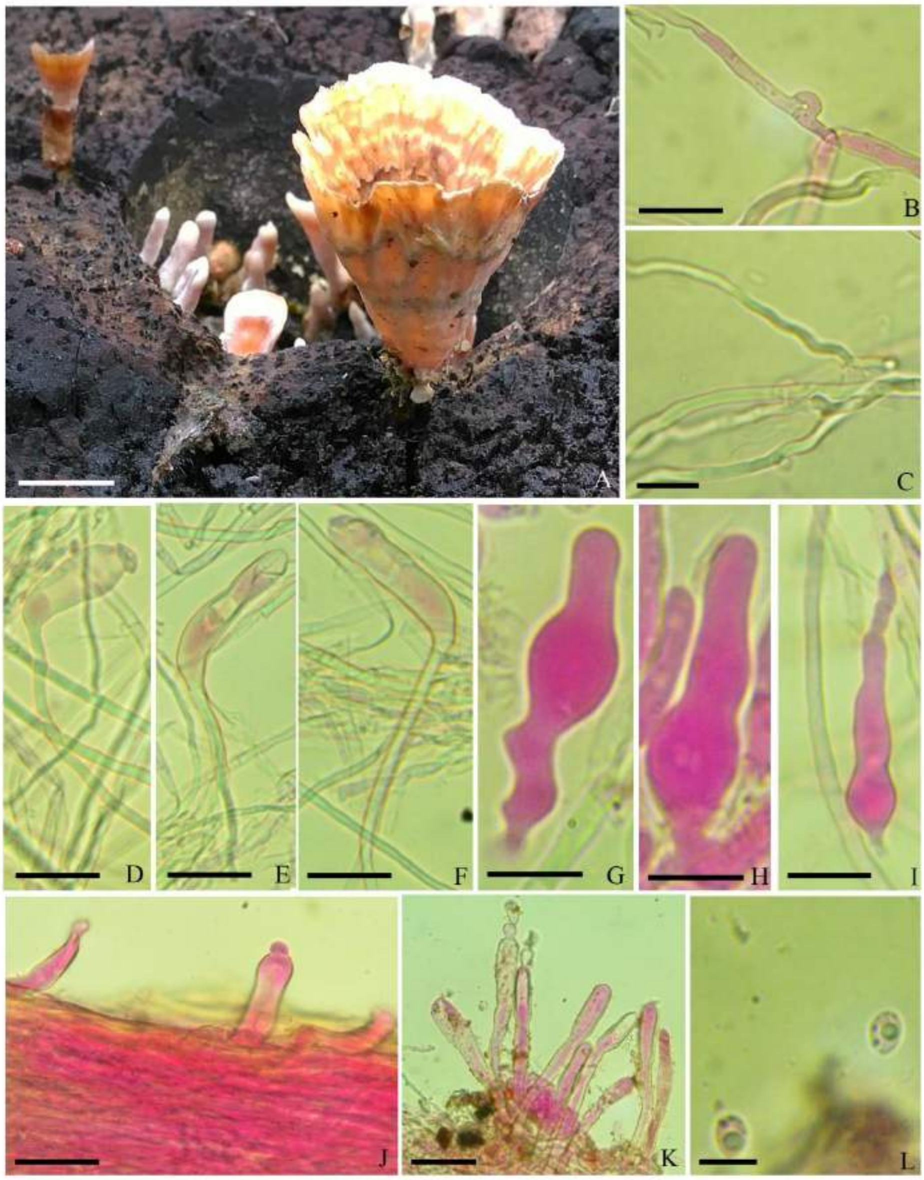


Figure 27: *Podoscypha venustula*-A. Basidiomata B. Generative hyphae showing clamp connection C. Skeletal hyphae D, E, F. Skeletocystidia G, H, I. Gloeocystidia J. Pileocystidia K. Caulocystidia L. Basidiospores. Scale bars: A=10 mm, B, C=12 µm, D, E, F, G, H, I=10 µm, J, K=20 µm, I=5 µm.

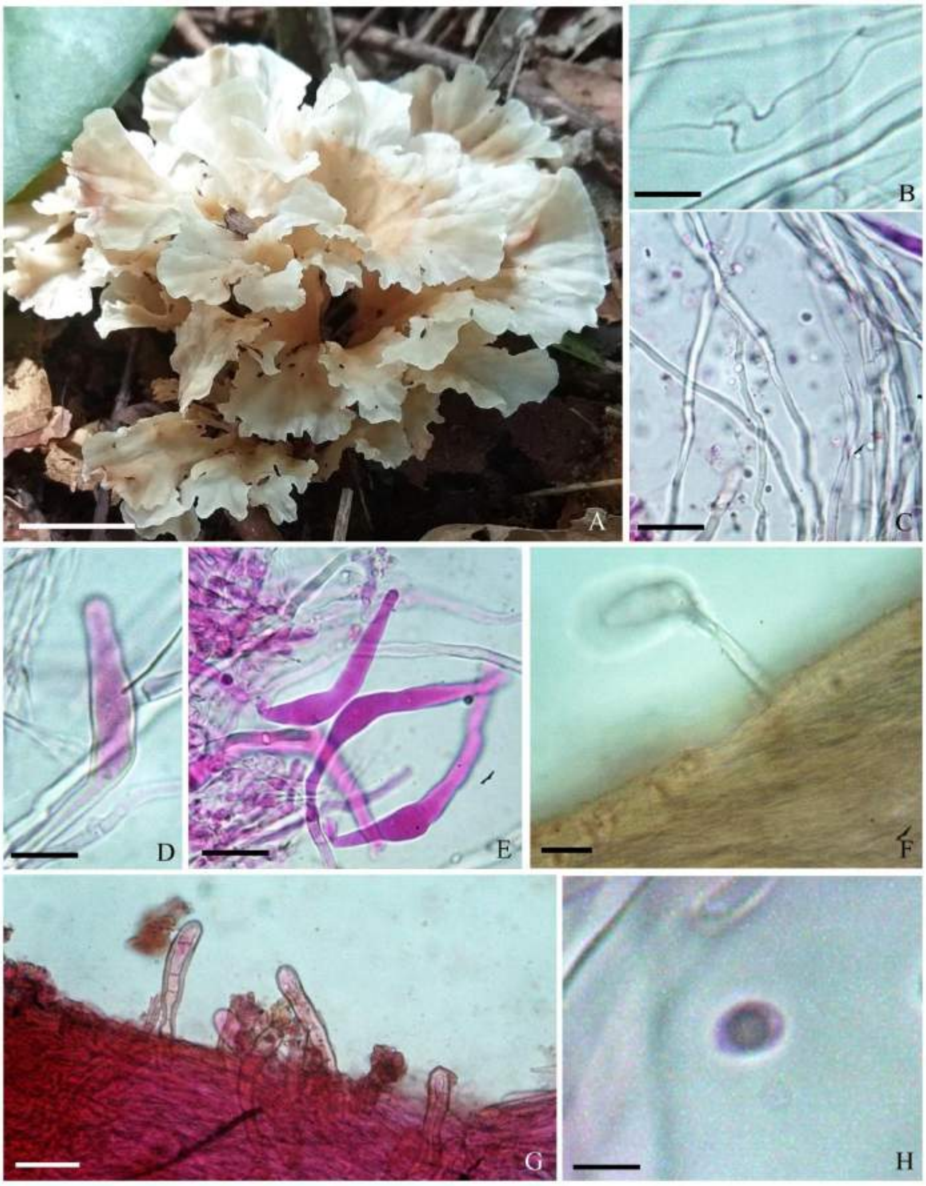


Figure 28: *Podoscypha petalodes*-A. Basidiomata B. Generative hyphae showing clamp connections C. Skeletal hyphae D. Skeletocystidia E. Gloeocystidia F. Pileocystidia G. Caulocystidia H. Basidiospore. Scale bars: A=10 mm, B=5 μm, C=16 μm, D=7 μm , E=12 μm, F=5 μm, G=10 μm, H=5 μm.

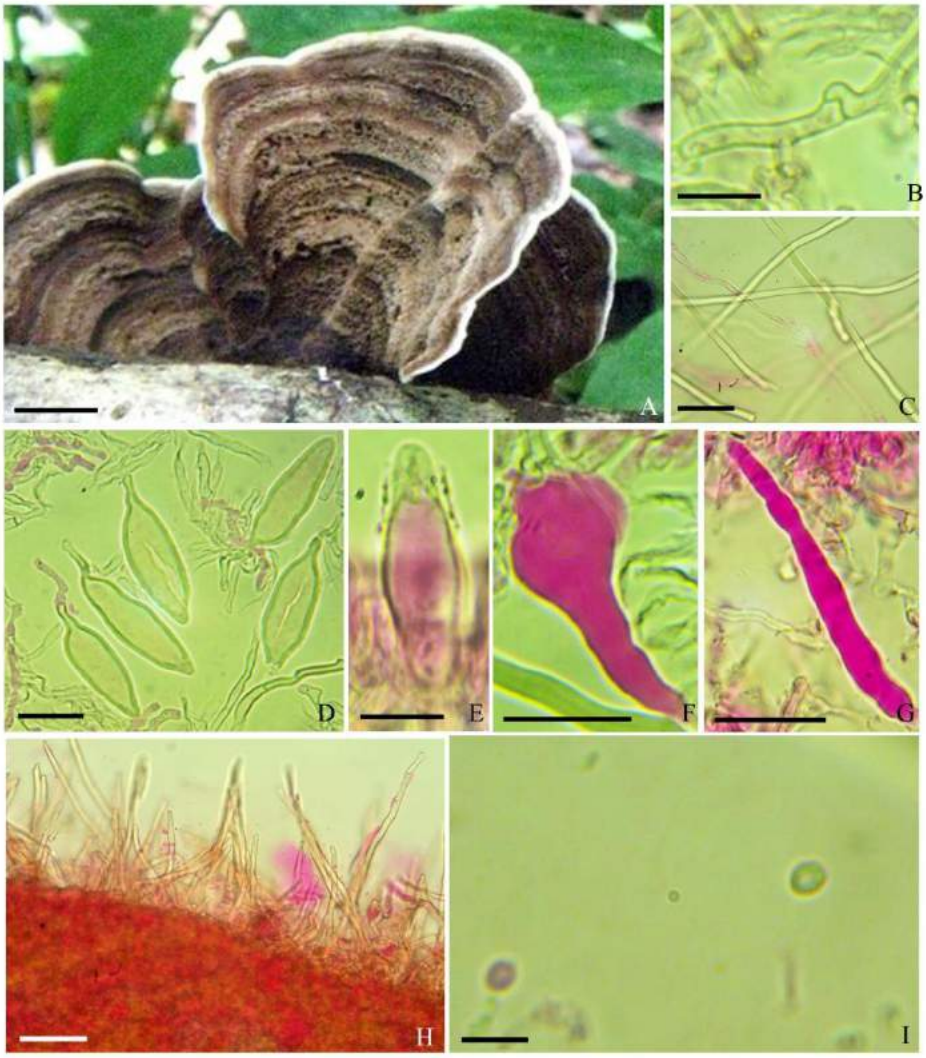


Figure 29: *Podoscypha involuta*-A. Basidiomata B. Generative hyphae showing clamp connection C. Skeletal hyphae D. Metuloid cystidia E. Metuloid cystidia with encrustations on apex F, G. Gloeocystidia H. Pileipellis I. Basidiospores. Scale bars: A=35 mm, B=9 μm, C=20 μm, D, E=18 μm, F, G, H=20 μm, I=6 μm.

Figure 30: *Podoscypha mellissii*-A. Basidiomata B. Generative hyphae showing clamp connections C. Skeletal hyphae D. Skeletocystidia E, F. Gloeocystidia G. Pileipellis H. Caulocystidia I. Basidiospore. Scale bars: A=25 mm, B=5 µm, C=12 µm, D=4 µm, E, F=8 µm, G=24 µm, H=15 µm, I=4 µm.

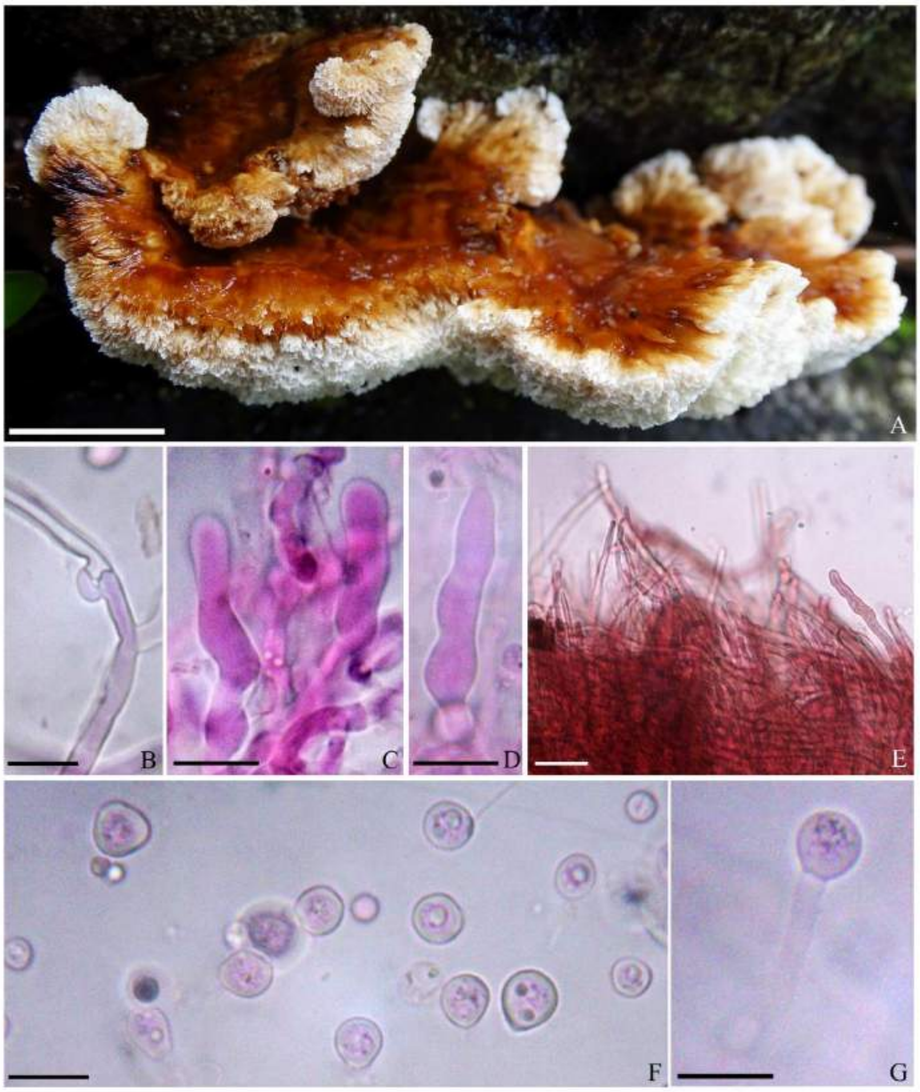


Figure 31: *Abortiporus biennis*-A. Basidiomata B. Generative hyphae showing clamp connection C, D. Gloeocystidia E. Piliepellis F. Clamydospores G. A clamydospore showing attachment on hyphae. Scale bars: A=10 mm, B, E=15 µm, C, D, F, G=10 µm.

Figure 32*: Lentinus arcularius*-A. Basidiomata B. Generative hyphae showing clamp connection C. Skeleto ligative hyphae D. Stipitipellis E. Basidiospore. Scale bars: A=6 mm, B=9 mm, C, D= 20 µm, E=9 µm.

Figure 33: *Lentinus tricholoma*-A. Basidiomata (inset-cilia on pileus margin) B. Generative hyphae showing clamp connection C. Inflated generative hyphae D. Skeleto ligative hyphae E. Pileipellis F. Basidioles and basidiospores. Scale bars: A=70 mm, B=9 µm, C=16 µm, D=12 µm, E=9 µm, F=7 µm.

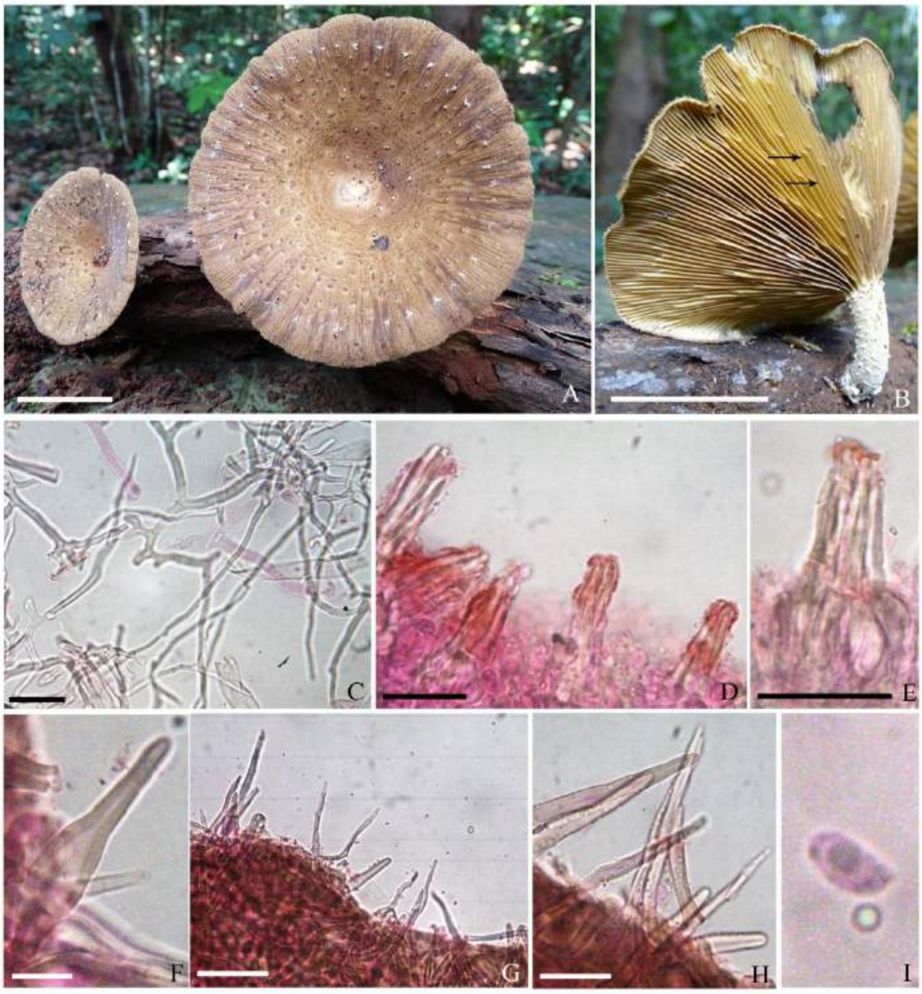


Figure 34: *Lentinus badius*-A. Basidiomata B. Hymenial surface showing dichotomously branched lamellae (arrows) C. Generative hyphae and Skeleto ligative hyphae D. Hyphal pegs E. Hyphal peg enlarged F. Single sclerified hyphae of hyphal peg G. Pileipellis H. Pileipellis hairs enlarged I. Basidiospore. Scale bars: A, B=30 mm, C, D=24 µm, E=30 µm, F=5 µm, G=40 µm, H=24 µm, I=6 µm.

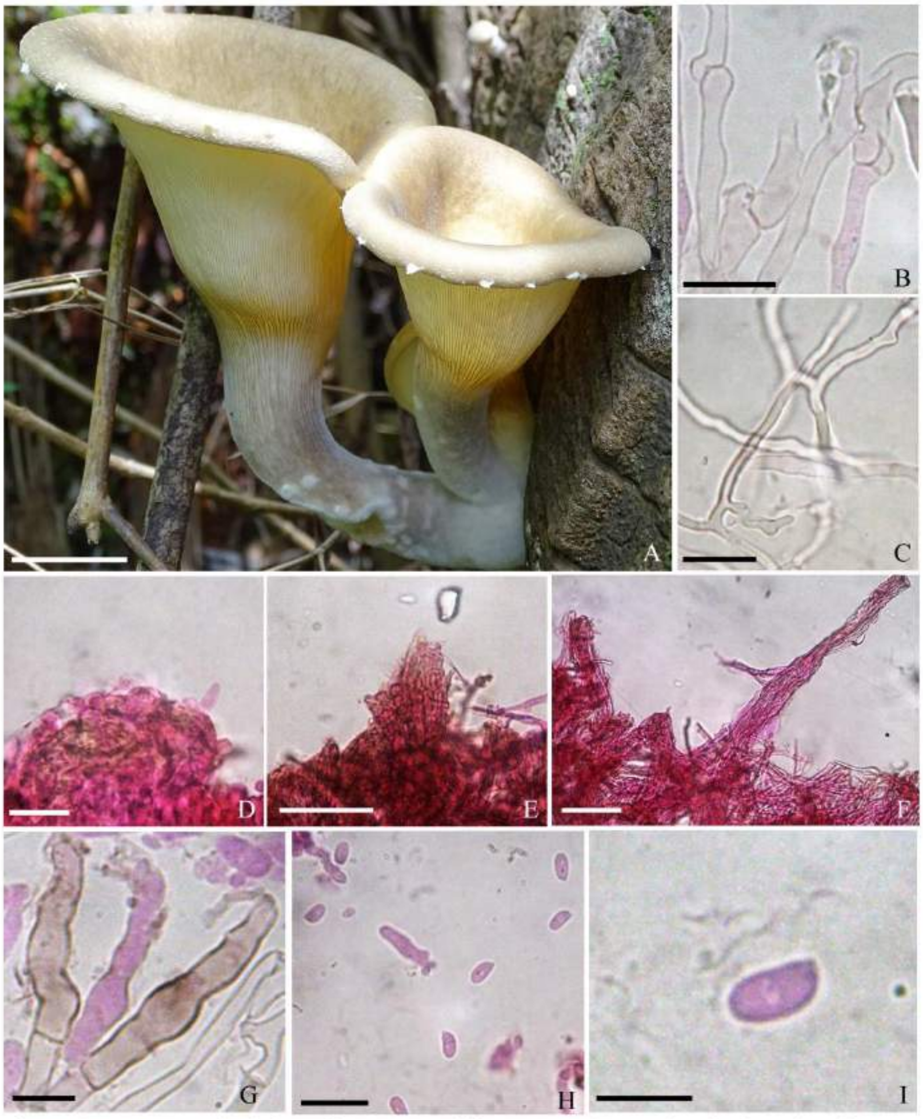


Figure 35: *Lentinus dicholamellatus*-A. Basidiomata B. Generative hyphae showing clamp connections C. Skeleto ligative hyphae D. Hyphal peg E. Pileipellis F. Stipitipellis G. Cheilocystidia H. Basidiospores I. Basidiospore enlarged. Scale bars: A=10 mm, B=10 μm, C, D=12 μm, E=50 μm, F=11 μm, G=7 μm, H=12 μm, I=8 μm.

Figure 36: *Lentinus sajor-caju*-A. Basidiomata B. Generative hyphae showing clamp connection C. Skeleto ligative hyphae D. Pileipellis E=Basidiospores F. Basidiospore enlarged. Scale bars: A=5 mm, B=5 µm, C=20 µm, D=30 µm, E=10 µm, F=5 µm.

Figure 37: *Lentinus polychrous*-A. Basidiomata B. Generative hyphae showing clamp connection C. Skeleto ligative hyphae D. Pileipellis E. Stipitipellis F. Basidiospores G. Basidiospore enlarged. Scale bars: A=15 mm, B=8 μm, C=10 μm, D=16 μm, E=50 μm, F=16 μm, G=3 μm.

Figure 38: *Lentinus squarrosulus*-A. Basidiomata B. Generative hyphae showing clamp connection C. Skeleto ligative hyphae D. Hyphal pegs E. Pileipellis F. Basidiospore. Scale bars: A=70 mm, B=8 µm, C=16 µm, D=60 µm, E=16 µm, F=7 µm.

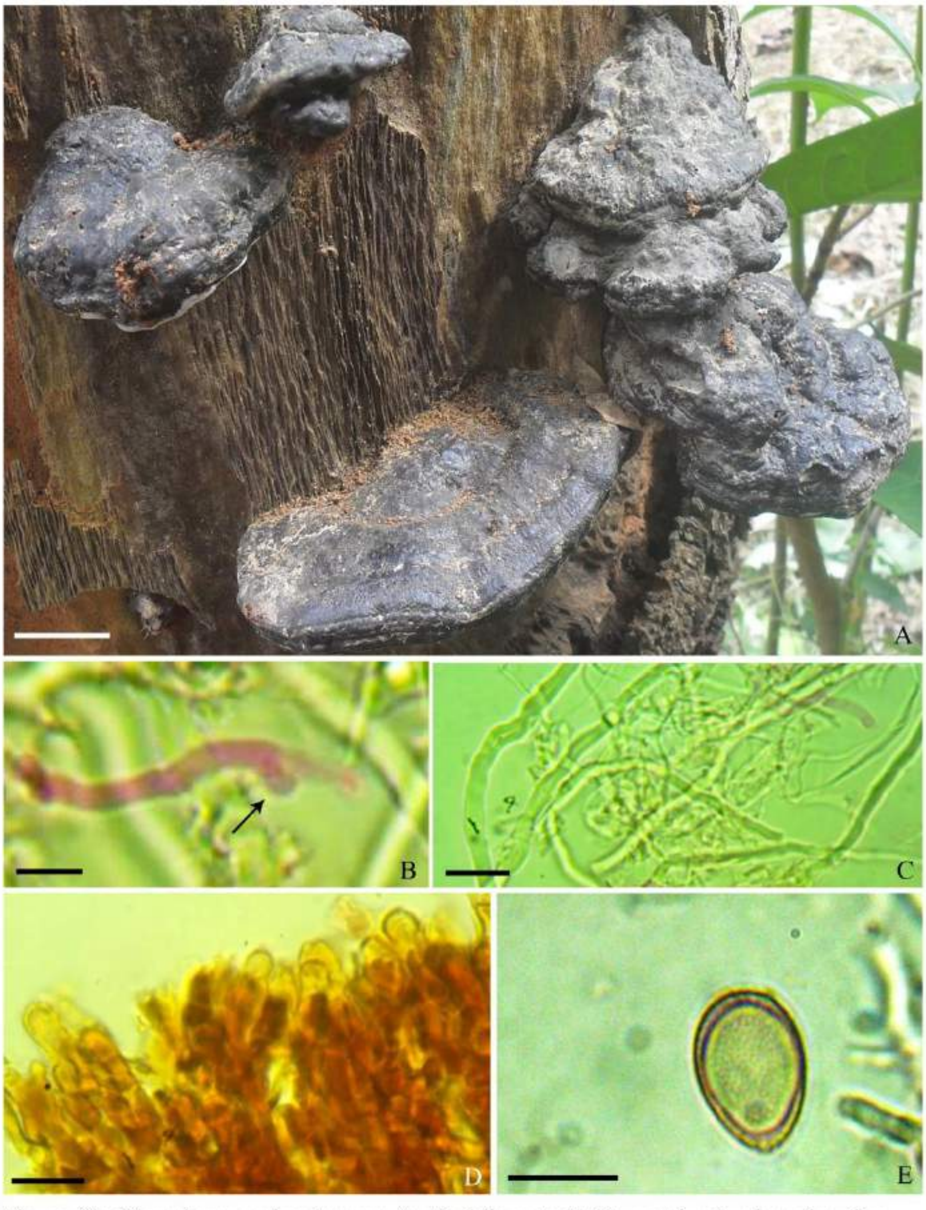


Figure 39: *Ganoderma subresinosum*-A. Basidiomata B. Generative hyphae showing clamp connection (arrow) C. Skeletal and skeleto ligative hyphae D. Pileal end cells E. Basidiospores. Scale bars: A=30 mm, B=5 µm, C=12 µm, D= 20 µm, E=12 µm.

Figure 40: *Ganoderma* species of *applanatum-australe* complex-A. Basidiomata B. Generative hyphae showing clamp connection (arrow), C. Skeletal hyphae D. Skeleto ligative hyphae E. Pileipellis F. Basidiospores. Scale bars: A=30 mm, B=8 µm, C=15 µm, D=10 µm, E=15 µm, F=7 µm.

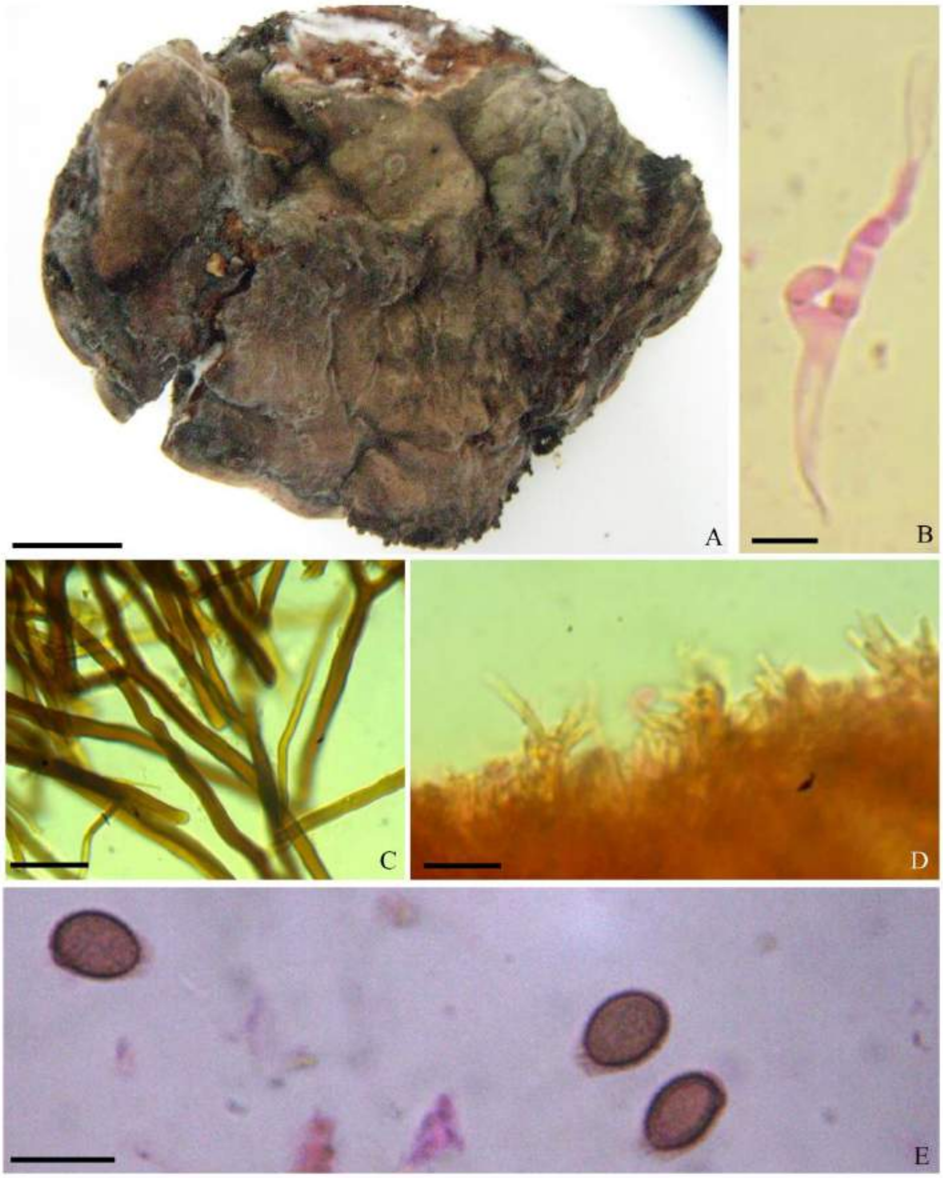


Figure 41: *Ganoderma australe*-A. Basidiomata B. Generative hyphae showing clamp connection C. Skeletal hyphae D. Pileipellis F. Basidiospores. Scale bars: A=20 mm, B=9 µm, C, D=22 µm, E=12 µm.

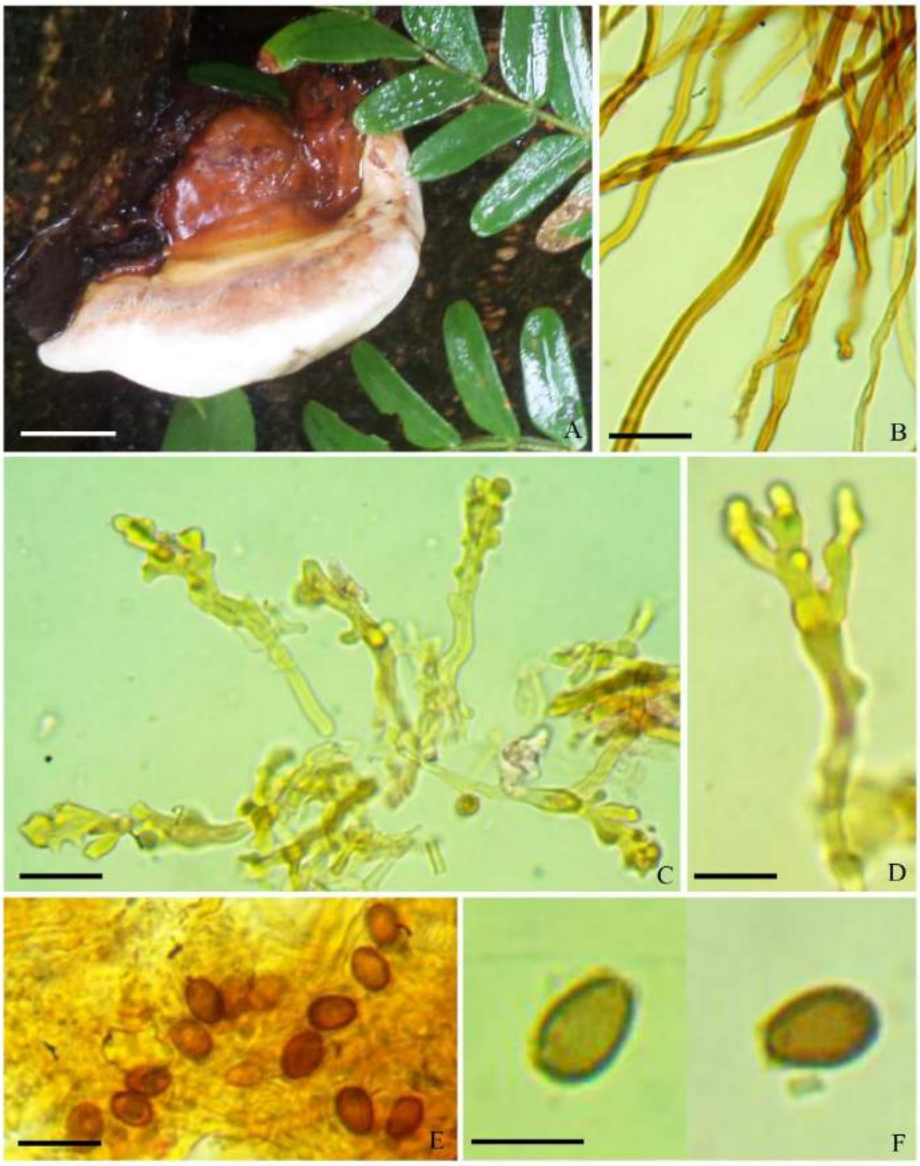


Figure 42*:* *Ganoderma multicornum*-A. Basidiomata B. Skeletal hyphae C. Pileal end cells D. Antler like branching of pileal end cell E. Basidiospores F. Basidiospores enlarged. Scale bars: A=10 mm, B=15 μm, C, D=16 μm, E, F=10 μm.

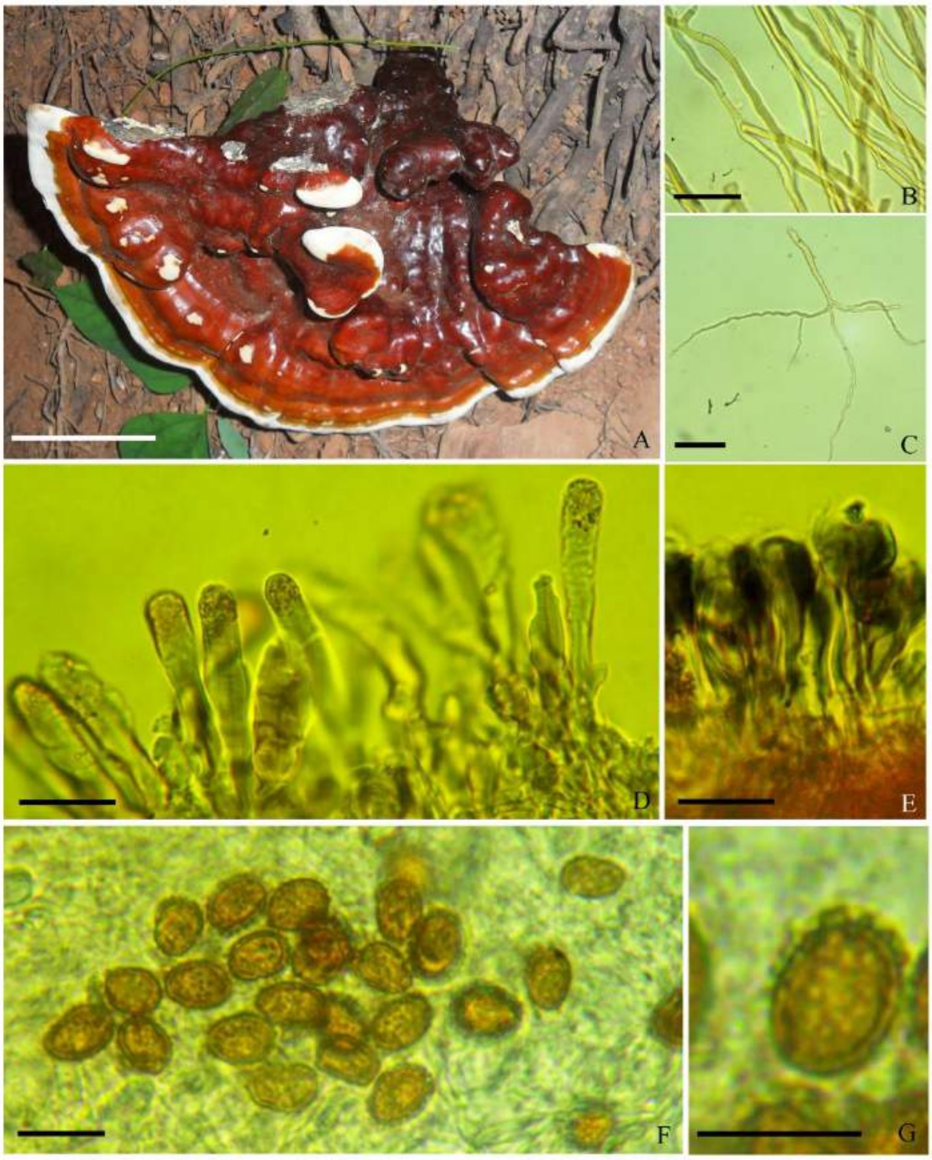


Figure 43: *Ganoderma multipileum*-A. Basidiomata B. Skeletal hyphae C. Skeleto ligative hyphae D. Pileal end cells showing encrustations at apex E. Pileal end cells showing amyloid reaction in Melzer's reagent F. Basdiospores G. Basidiospores enlarged. Scale bars: A=50 mm, B=24 µm, C=10 µm, D, E =20 µm, F, G=12 µm.

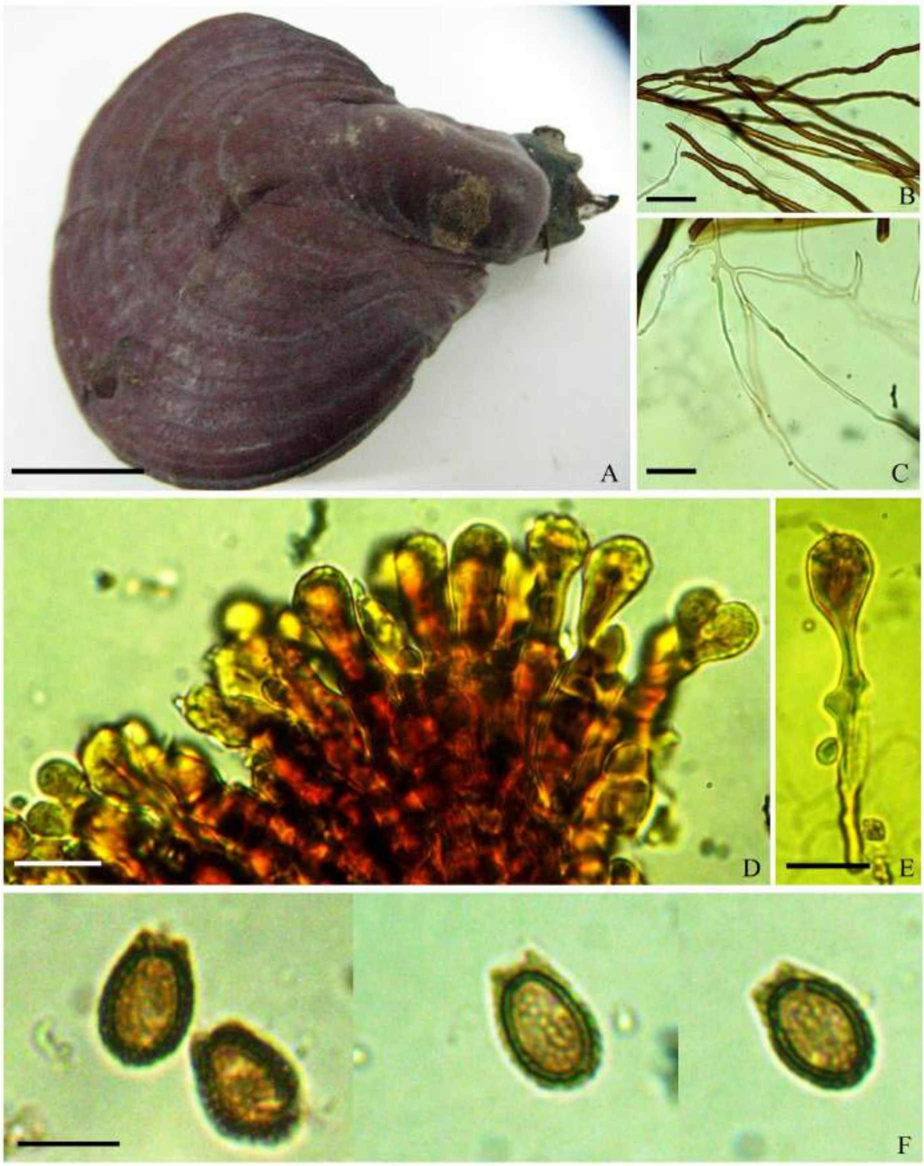


Figure 44: *Ganoderma enigmaticum*-A. Basidiomata B. Skeletal hyphae C. Skeleto ligative hyphae D. Pileal end cells F. Pileal end cell showing weak amyloid reaction in Melzer's reagent F. Basidiospores. Scale bars: A=20 mm, B, C=10 µm, D, E=10 µm, F=7 µm.

Figure 45: *Ganoderma orbiforme*-A. Basidiomata B. Skeletal hyphae C. Skeleto ligative hyphae D, E. Pileal end cells F. Pileal end cells showing amyloid reaction in Melzer's reagent G. Basidiospores. Scale bars: A=20 mm, B, C=15 μm, D, E, F=18 μm, G=12 μm.

Figure 46: *Ganoderma keralense*-A. Basidiomata B. Young basidiomata showing lateral stipe attachment C. Skeletal hyphae D. Pileal end cells E. Pileal end cells showing amyloid reaction in Melzer's reagent F. Encrustations on pileal end cell (arrow) G. Basidiospores H. Basidiospore enlarged I. Basidiospore showing free pillar arrangement. Scale bars: A=30 mm, B=50 mm, C=16 µm, D, E=20 µm, F, G=15 µm, H, I=8 µm.

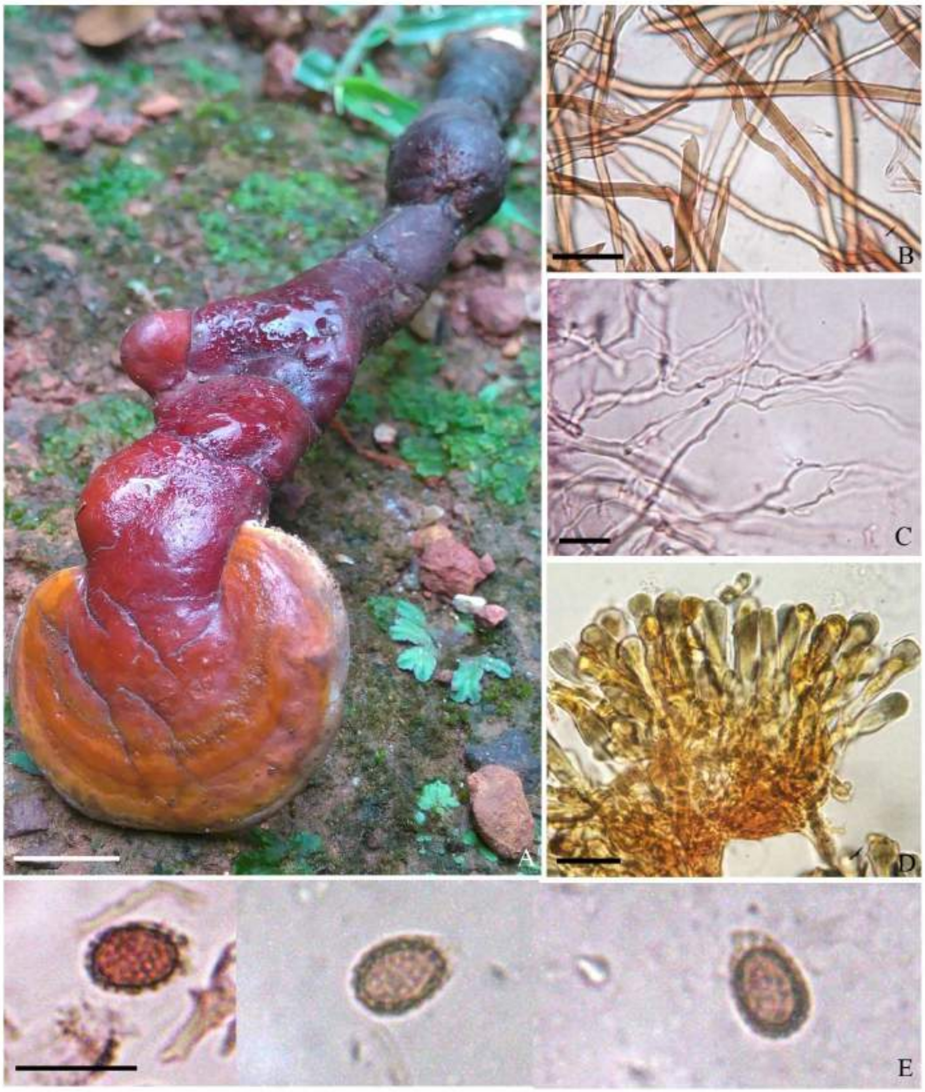


Figure 47: *Ganoderma tropicum*-A. Basidiomata B. Skeletal hyphae C. Skeleto ligative hyphae D. Pileal end cells showing amyloid reaction in Melzer's reagent E. Basidiospores. Scale bars: A=10 mm, B=15 μm, C=10 μm, D=20 μm, E=11 μm.

Figure 48: *Ganoderma multiplicatum*-A. Basidiomata B. Skeletal hyphae C. Arboriform branchings of skeletal hyphae D. Pileal end cells E. Pileal end cells showing amyloid reaction in Melzer's reagent F. Basidiospores G. Basidiospore enlarged. Scale bars: A=10 mm, B=24 µm, C=12 µm, D=21 µm, E=14 µm, F=10 µm, G=6 µm.

Figure 49: *Sanguinoderma rugosum:* A. Basidiomata B. Generative hyphae showing clamp connection (arrow) C. Skeletal hyphae D. Skeleto ligative hyphae E. Pileipellis F. Basidiospores. Scale bars: A=10 µm, B=12 µm, C=18 µm, D=12 µm, E, F=15 µm.

Figure 50: *Amauroderma fuscoporia*-A . Basidiomata B. Thick walled generative hyphae showing clamp connection (arrow) C. Skeleto ligative hyphae D. Skeletal hyphae E. Piliepellis F. Basidiospores G. Basidiospores enlarged. A=20 mm, B, C, D=15 µm, E=20 µm, F, G=14 µm.

Figure 51: *Lignosus rhinocerus*-A. Basidiomata B. Stipe showing sclerotium C. Generative hyphae showing clamp connection D. Skeletal hyphae E. Skeleto ligative hyphae F. Pileipellis G. Basidiospores. Scale bars: A=20 mm, B=40 mm, C=8 µm, D, E=12 µm, F=15 µm, G=8 µm.

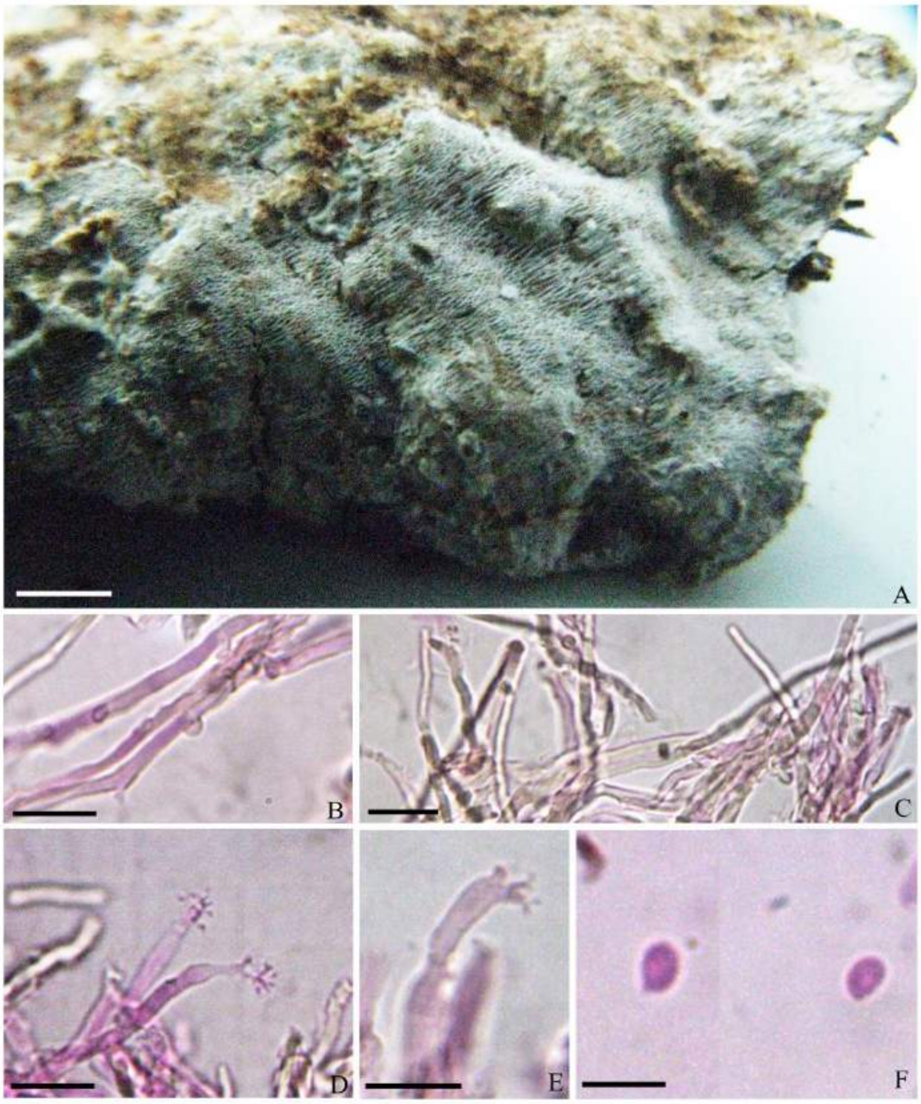


Figure 52: *Theleporus minisporus*-A. Basidiomata B. Generative hyphae C. Skeletal hyphae D, E. Dendrohyphidia F. Basidiospores. Scale bars: A=8 mm, B, C, D, E=10 µm, F=7 µm.

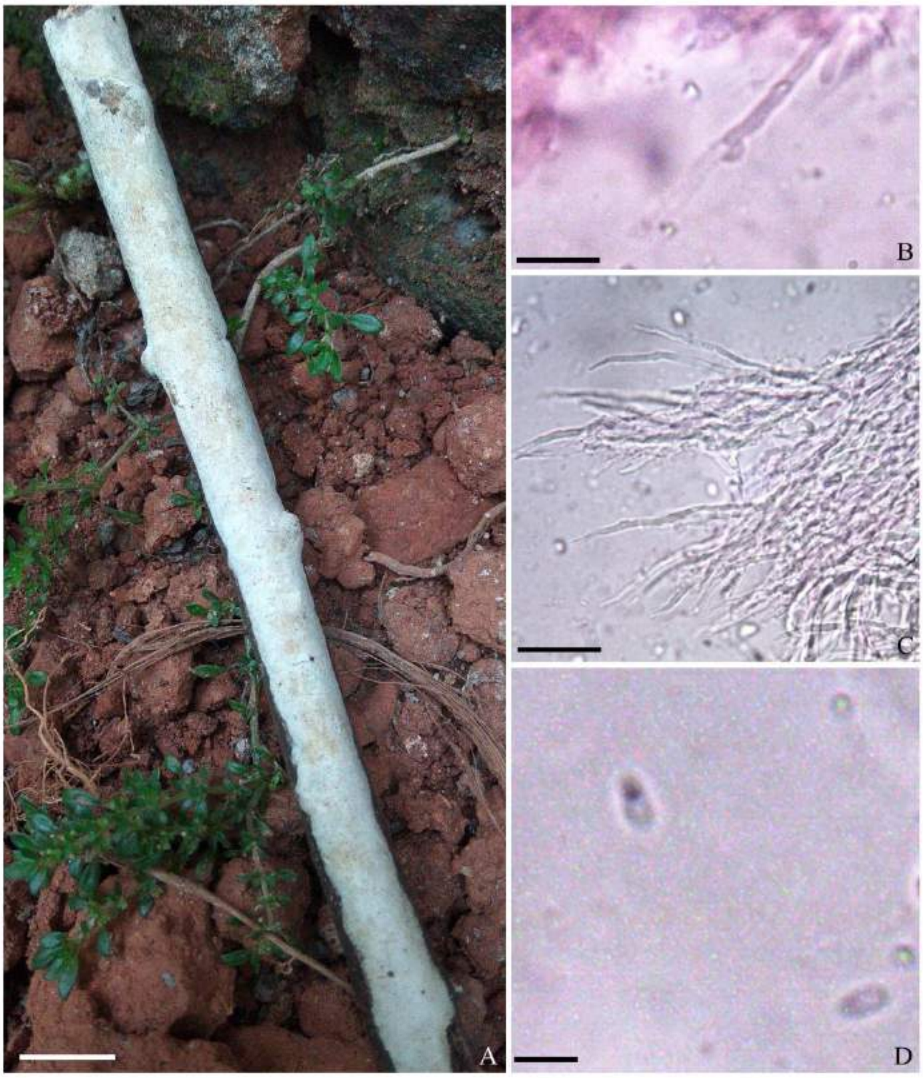


Figure 53: *Theleporus venezuelicus*-A. Basidiomata B. Generative hyphae showing clamp connection C. Skeletal hyphae D. Basidiospores. Scale bars: A=10 mm, B=2 µm, C=12 µm, D=4 µm.

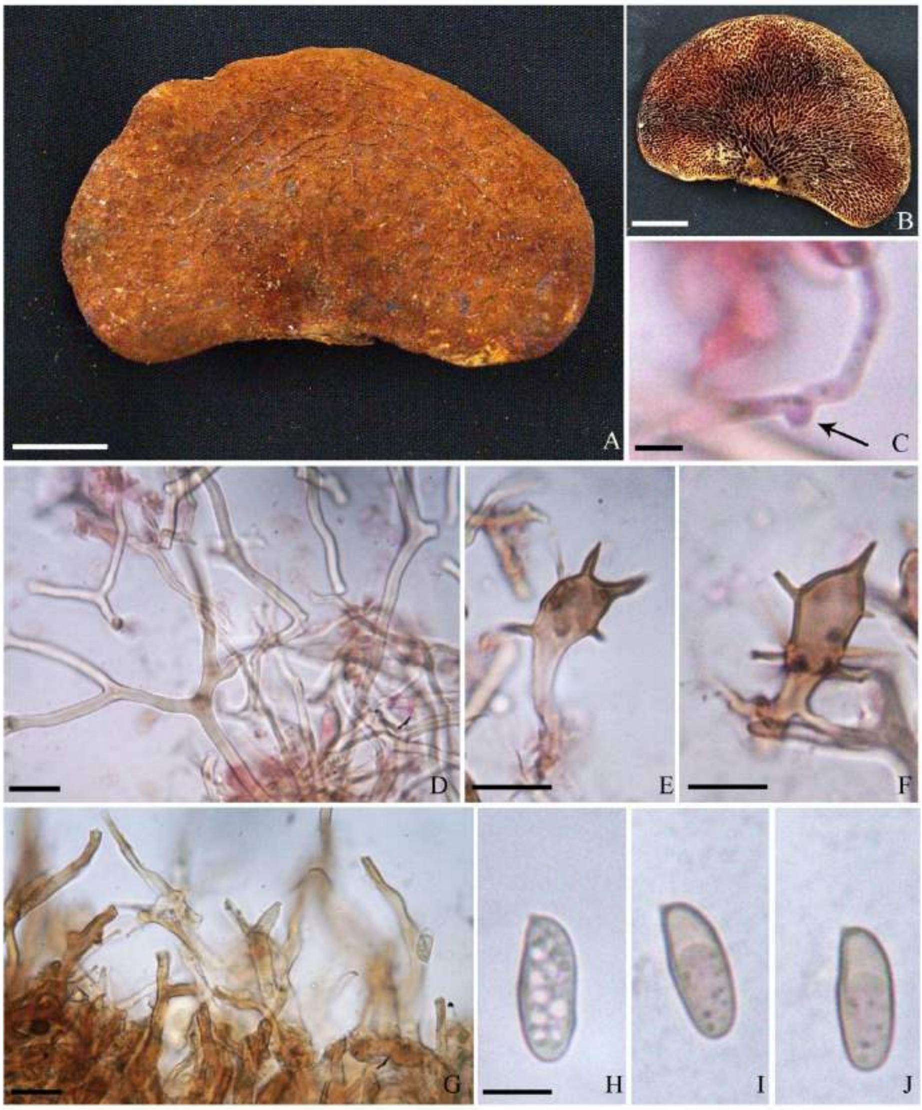


Figure 54: *Echinochaete ruficeps*-A. Basidiomata B. Hymenial surface C. Generative hyphae D. Skeleto ligative hyphae E, F. Setoid elements G. Pileipellis H, I, J=Basidiospores. Scale Bars: A, B=10 mm, C=6 µm, D, E, F, G=15 µm, H, I, J=6 µm.

Figure 55: *Microporellus violaceocinerascens*-A. Basidiomata B. Generative hyphae showing clamp connection C. Skeletal hyphae D. Skeletal hyphae showing dextrinoid reaction in Melzer's reagent E. Metuloid cystidia F. Metuloid cystidia showing encrustations on apex and dextrinoid reaction in Melzer's reagent G. Pileipellis H. Basidiospores I. Basidiospores showing dextrinoid reaction. Scale bars: A=10 mm, B=12 µm, C, D=16 µm, E, F=14 µm, G=25 µm, H, I=9 µm.

Figure 56: *Microporellus obovatus*-A. Basidiomata B. Generative hyphae showing clamp connection C. Skeletal hyphae D. Pileipellis E. Basidiospores. Scale bars: A=40 mm, B=5 µm, C=8 µm, D=12 µm, E=5 µm.

Figure 57: *Perenniporia medulla-panis*-A. Basidiomata B. Generative hyphae showing clamp connection (arrow) C. Skeletal hyphae D. Basidiospores E. Basidiospore enlarged. Scale bars: A=50 mm, B=10 µm, C=30 µm, D=18 µm, E=7 µm.

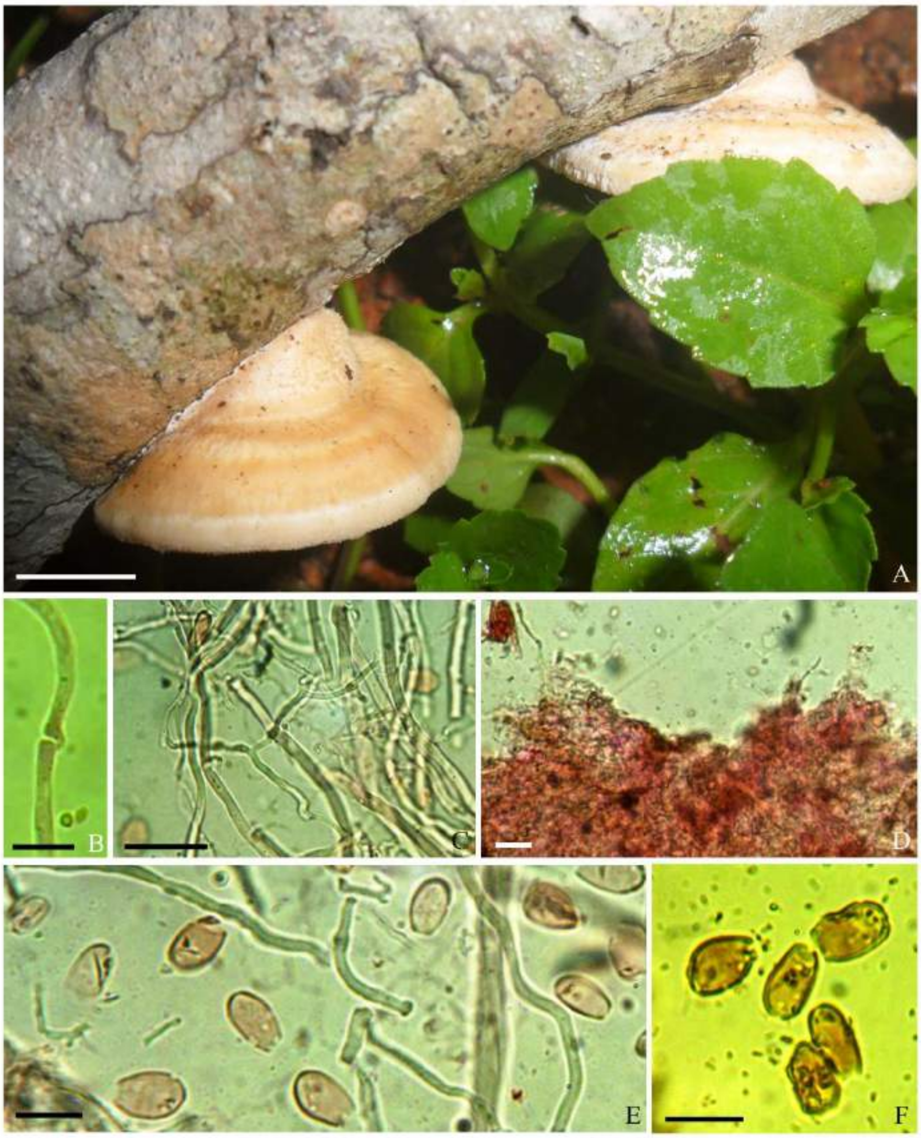


Figure 58: *Perenniporia ochroleuca*-A. Basidiomata B. Generative hyphae showing clamp connection C. Skeletal and skeleto ligative hyphae D. Pileipellis E. Basidiospores F. Basidiospores showing dextrinoid reaction in Melzer's reagent. Scale bars: A=5 mm, B=10 µm, C=16 µm, D=12 µm, E, F=16 µm.

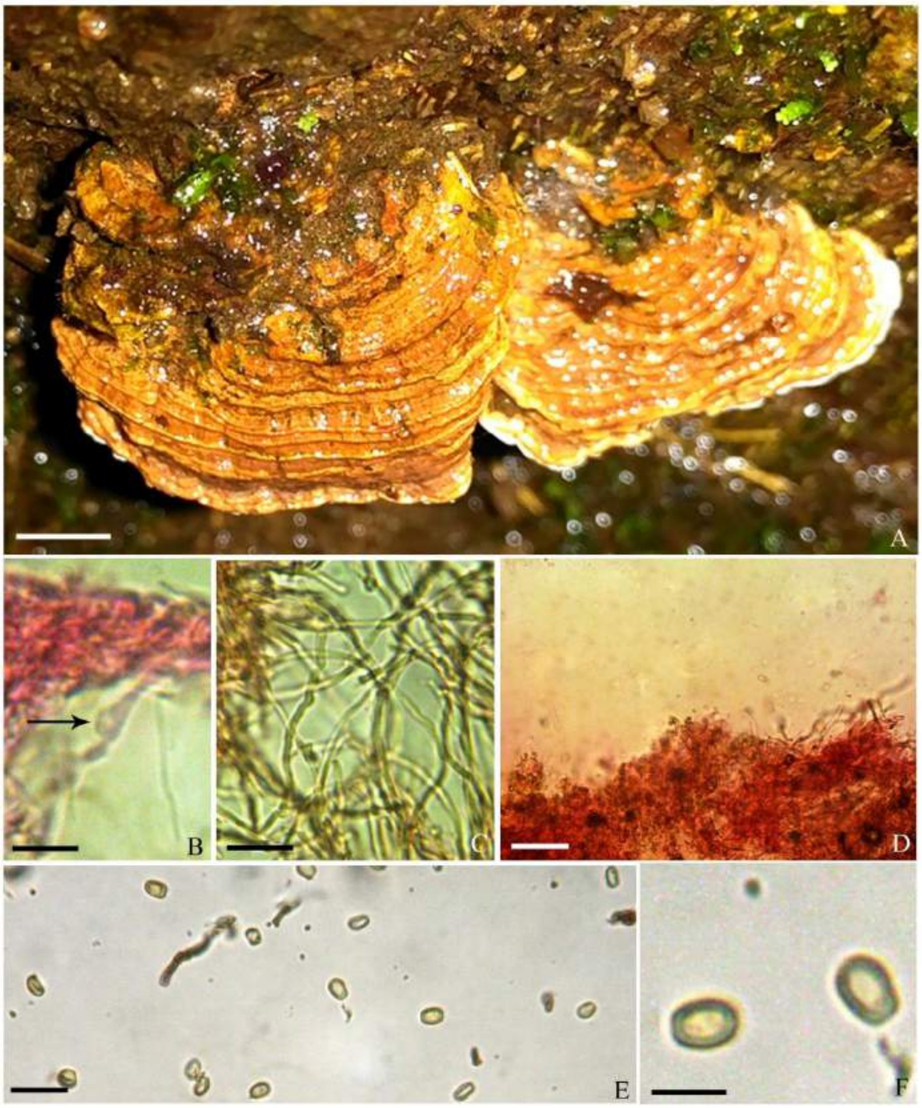


Figure 59: *Perenniporia decurrata*-A. Basidiomata B. Generative hyphae showing clamp connection (arrow) C. Skeletal hyphae D. Pileipellis E. Basidiospores F. Basidiospores enlarged. Scale bars: A=9 mm, B=8 μm, C=16 μm, D=20 μm, E=10 μm, F=5 μm.

Figure 60: *Navisporus flocossus*-A. Basidiomata B. Generative hyphae showing clamp connection C. Skeletal hyphae D. Skeletal hyphae showing dextrinoid reaction in Melzer's reagent E. Pileipellis F, G, H. Gloeocystidia I. Hymenial cystidia J. Basidiospore K. Basidiospore showing distinct apicule L. Basidiospores showing dextrinoid reaction in Melzer's reagent. Scale bars: A=50 mm, B=8 µm, C, D=12 µm, E=6 µm, F, G, H, I=40 µm, J, K, L=15 µm.

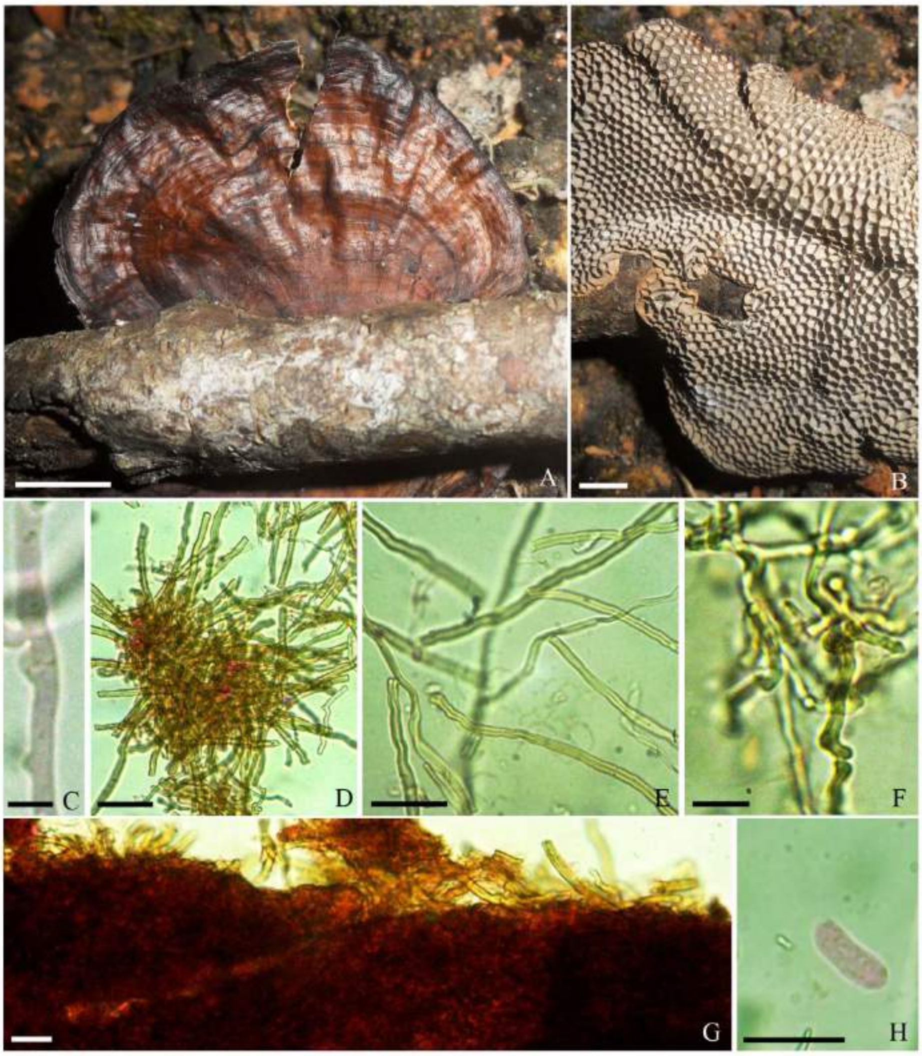


Figure 61: *Pseudofavolus tenuis*-A. Basidiomata B. Hymenophore C. Generative hyphae showing clamp connection D. Skeletal hyphae E. Skeletal hyphae enlarged F. Skeleto ligative hyphae G. Pileipellis H. Basidiospore. Scale bars: A=10 mm, B=0.5 mm, C=1.5 µm, D, E=25 µm, F, G=10 µm, H=12 µm.

Figure 62: *Microporus xanthopus*-A. Basidiomata B. Vetical section through basidiomata C. Generative hyphae showing clamp connection (arrow) D. Skeletal and skeleto ligative hyphae E. Pileipellis F. Basidiospores G. Basidiospore enlarged. Scale bars: A=20 mm, B=1000 µm, C=9 µm, D=18 µm, E, F=15 µm, G=6 µm.

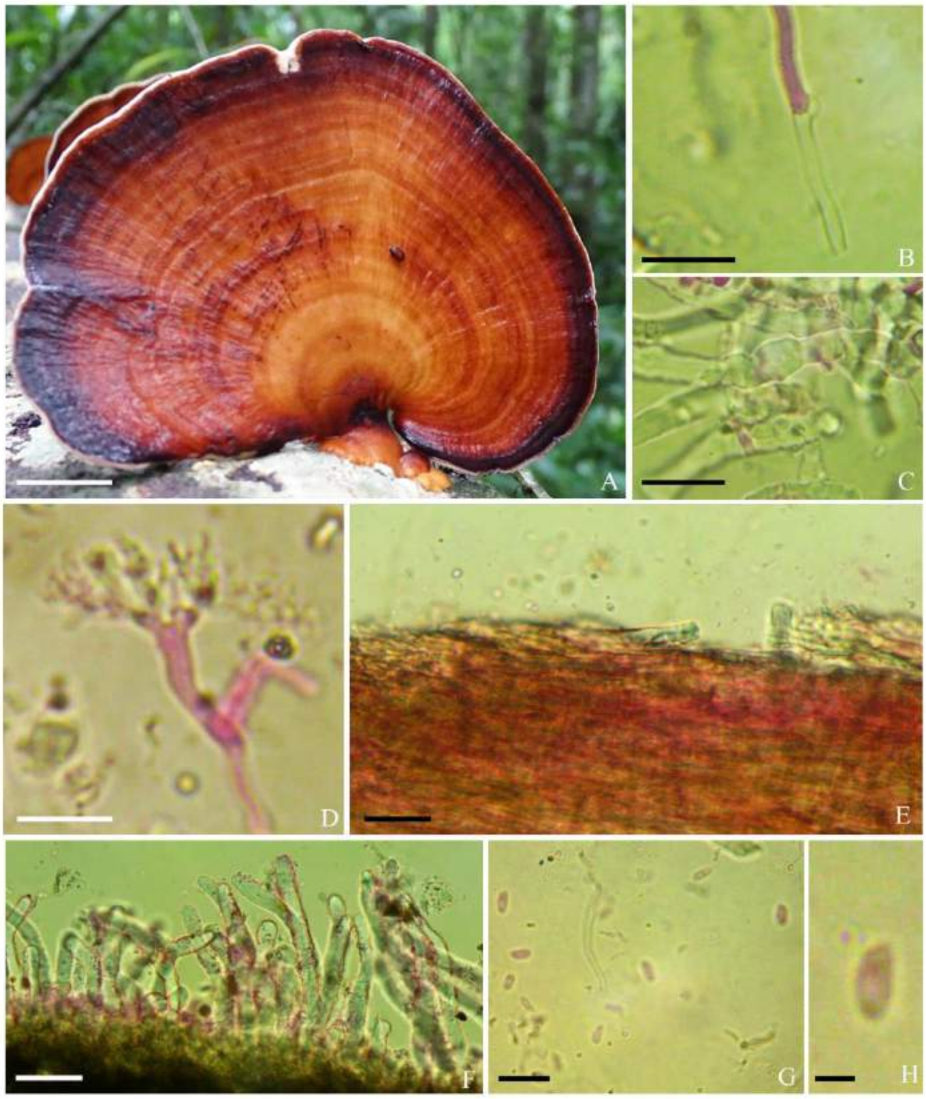


Figure 63: *Microporus affinis*-A. Basidiomata B. Generative hyphae showing clamp connection C. Skeletal hyphae D. Pileipellis E. Coralloid dichophytic element in hymenium F. Stipitipellis G. Basidiospores H. Basidiospore enlarged. Scale bars: A=10 mm, B=16 μm, C, D, E=12 μm, F=10 μm, G=8 μm, H=2 μm.

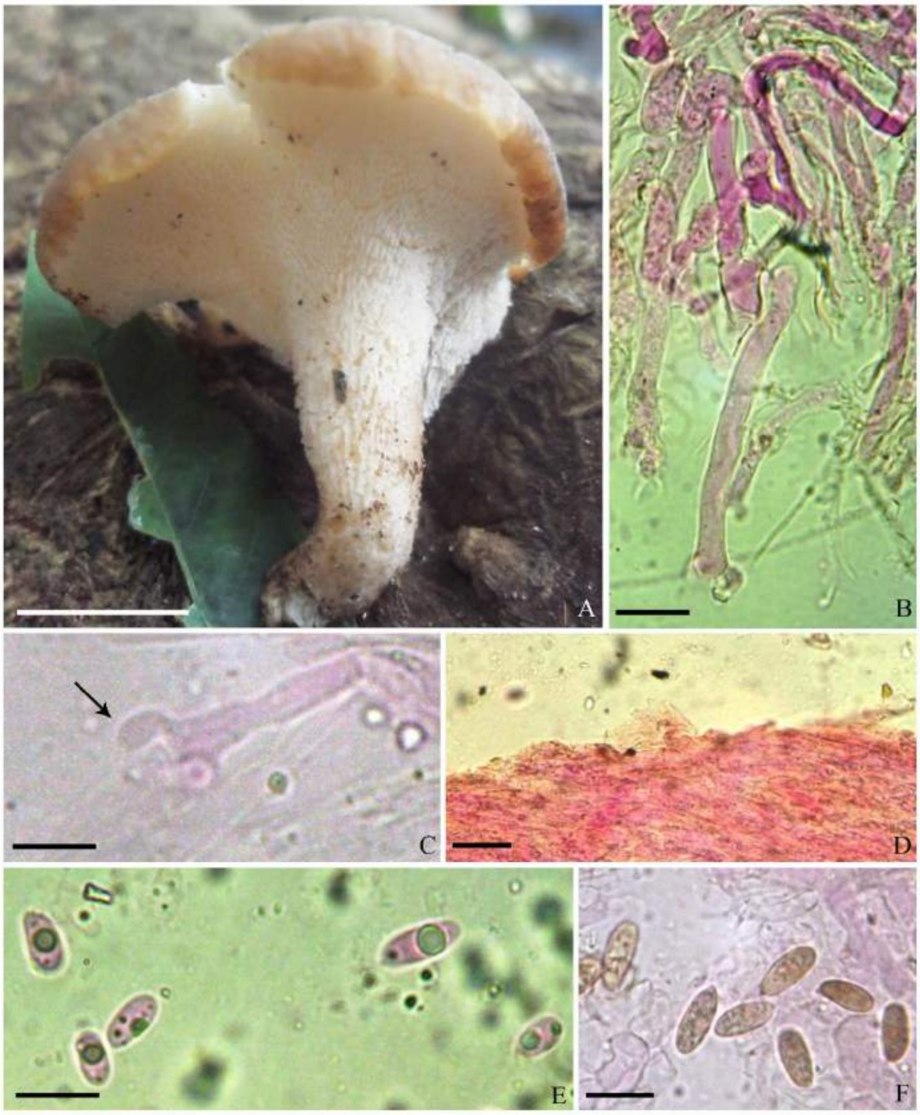


Figure 64: *Bresadolia uda*-A. Basidiomata B. Generative hyphae C. Generative hyphae showing clamp connection (arrow) D. Pileipellis E, F. Basidiospores (hyaline and pale golden brown in colour respectively). Scale bars: A=6 mm, B=14 µm, C=7 µm, D=30 µm, E, F=12 µm.

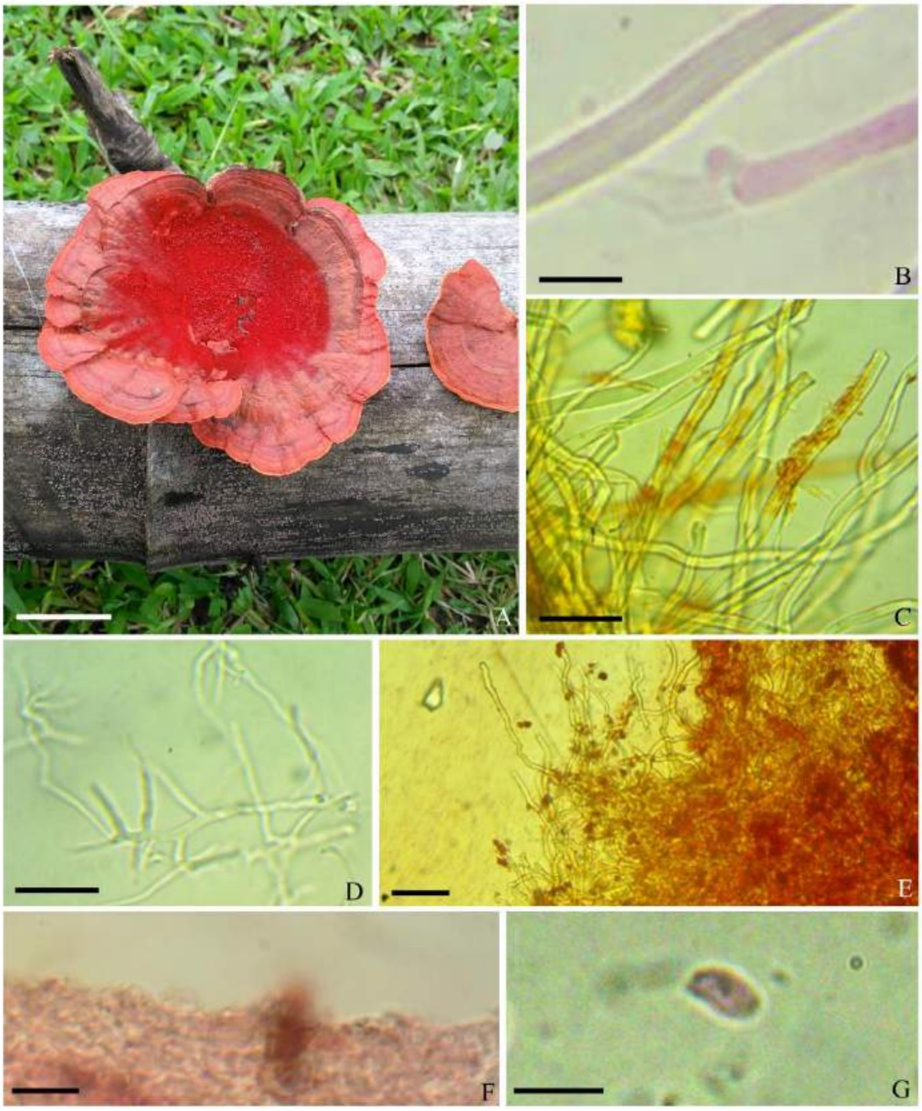


Figure 65: *Pycnoporus sanguineus*-A. Basidiomata B. Generative hyphae showing clamp connection C. Skeletal hyphae with encrusted orange crystals D. Skeleto ligative hyphae E. Orange crystals in hymenium F. Pileipellis G. Basidiospore. Scale bars: A=25 mm, B=6 µm, C=15 µm, D, E=30 µm, F=16 µm, G=5 µm.

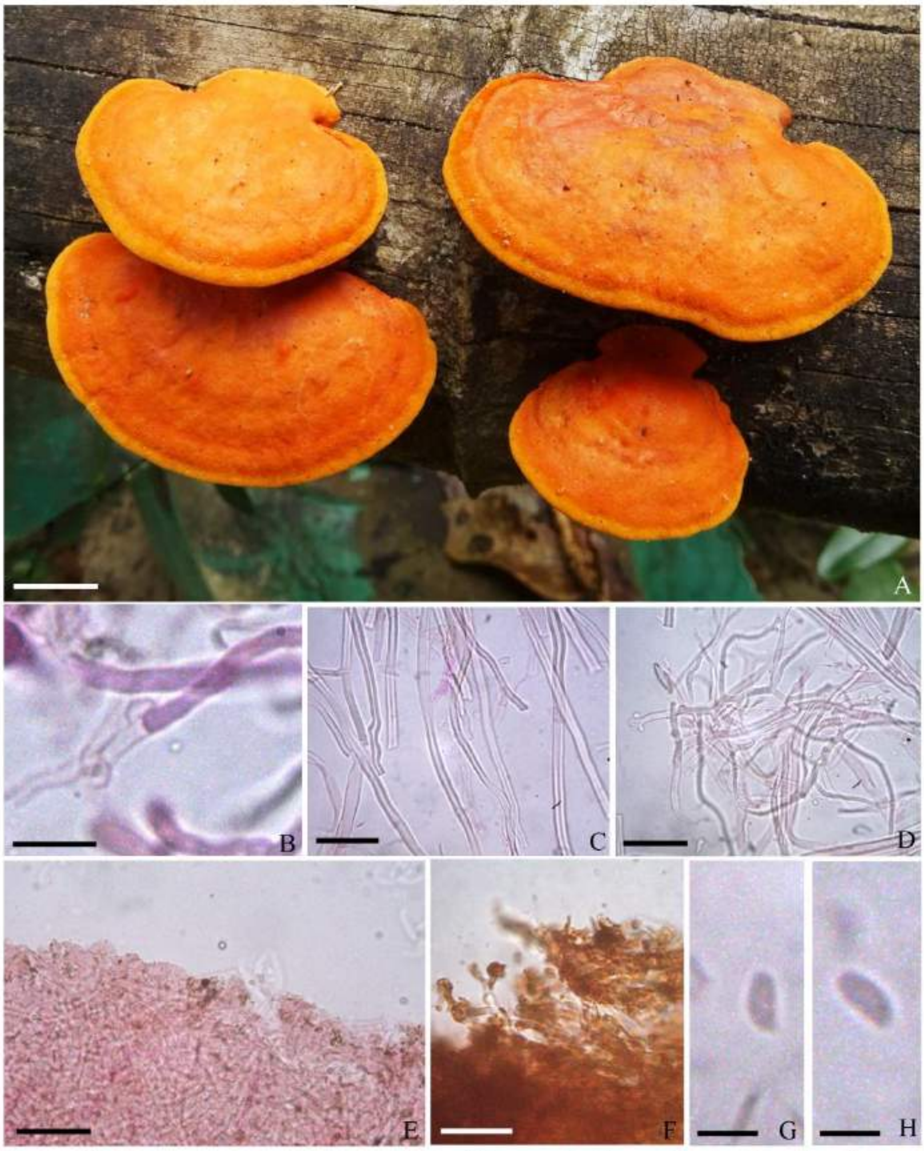


Figure 66: *Pycnoporus cinnabarinus*-A. Basidiomata B. Generative hyphae showing clamp connections C. Skeletal hyphae D. Skeleto ligative hyphae E. Pileipellis F. Hymenial portion showing orange crystals G, H. Basidiospores. Scale bars: A=10 mm, B, C=12 µm, D, E=24 µm, F=16 µm, G, H=6 µm.

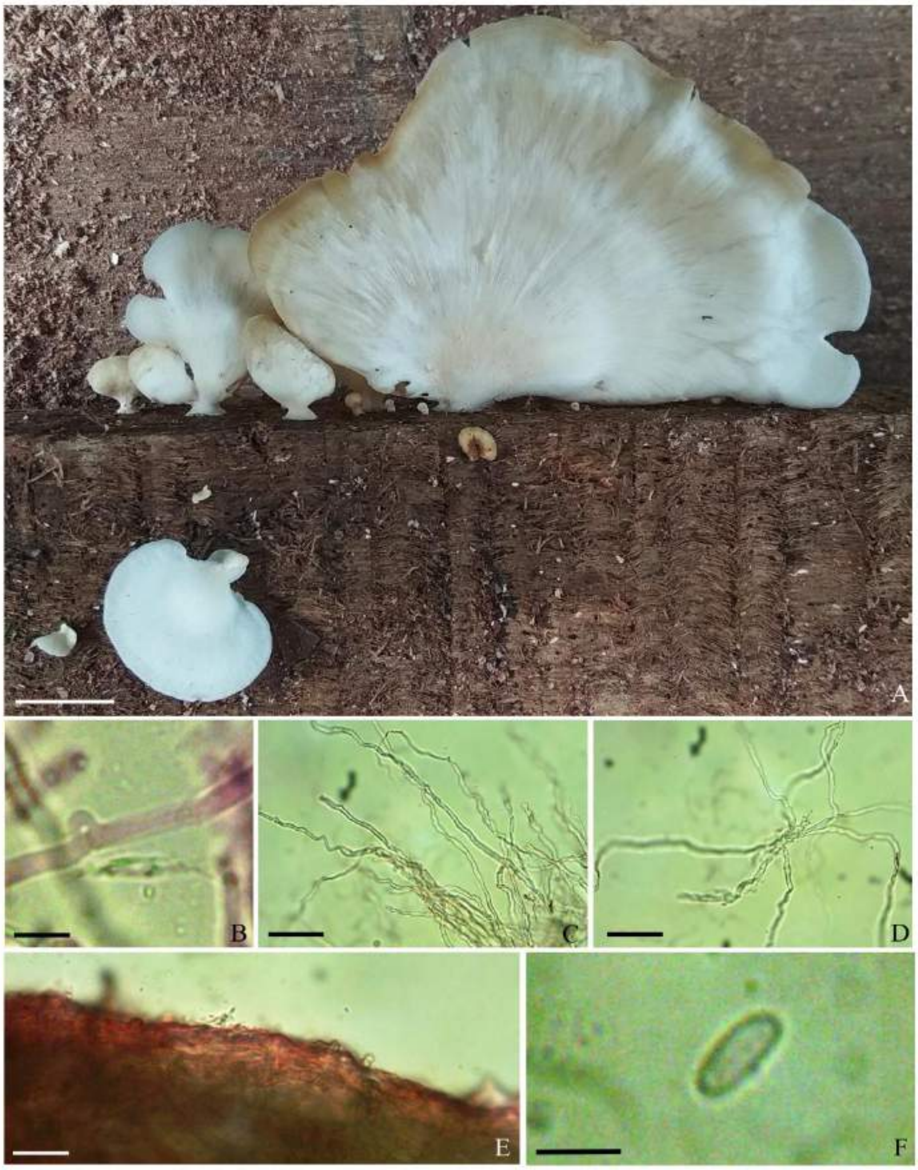


Figure 67: *Favolus tenuiculus*-A. Basidiomata B. Generative hyphae showing clamp connection C, D. Skeleto ligative hyphae E. Pileipellis F. Basidiospore. Scale bars: A=10 mm, B=8 µm, C, D, E=15 µm, F=6 µm.

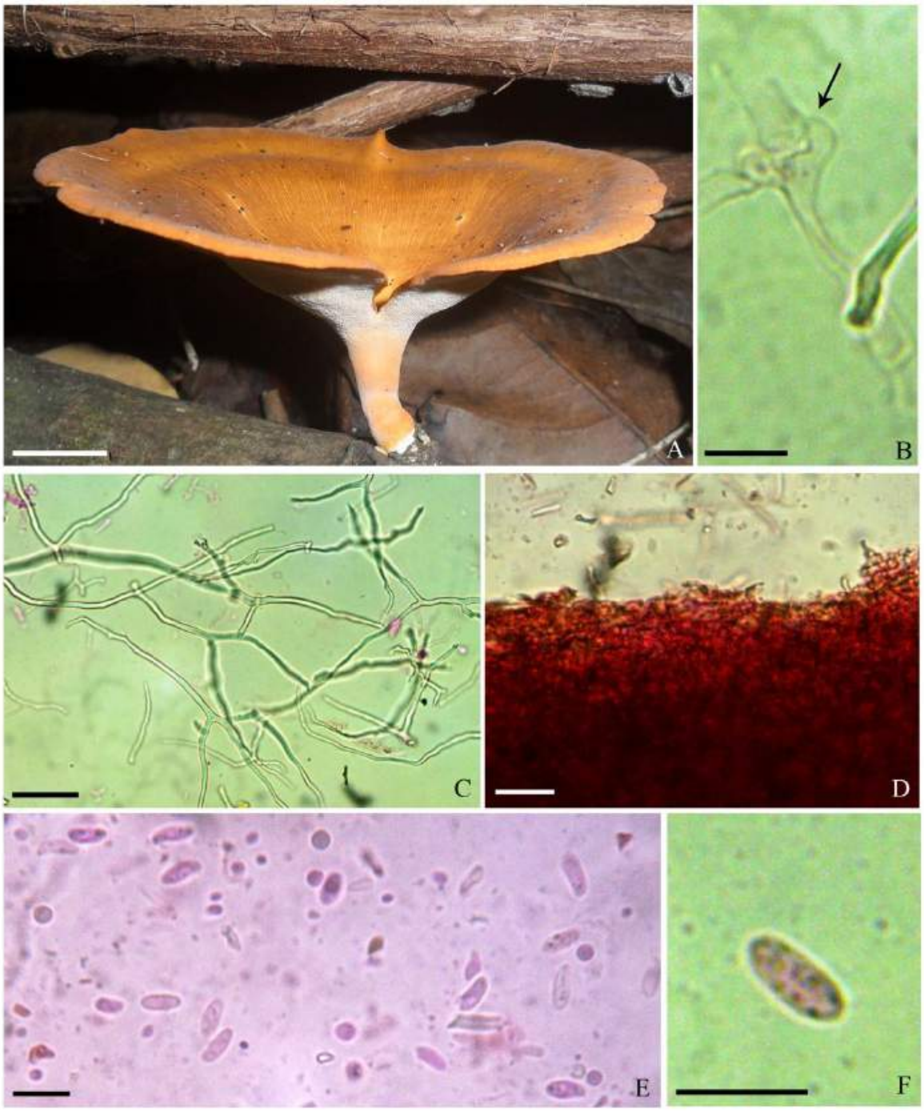


Figure 68: *Favolus grammocephalus*-A. Basidiomata B. Generative hyphae showing clamp connection (arrow) C. Skeleto ligtaive hyphae D. Pileipellis E. Basidiospores F. Basidiospore enlarged. Scale bars: A=10 mm, B=5 µm, C=20 µm, D=12 µm, E, F=10 µm.

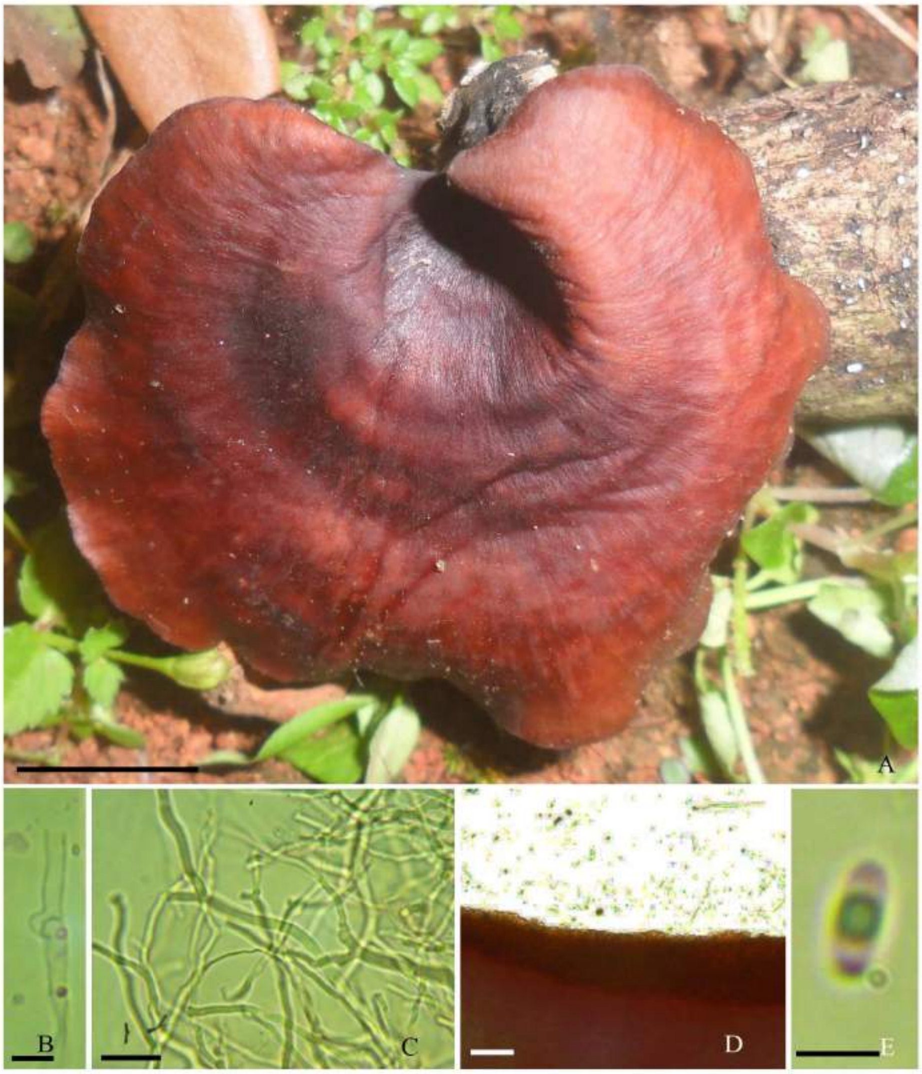


Figure 69: *Polyporus dictyopus*-A. Basidiomata B. Generative hyphae showing clamp connection C. Skeleto ligative hyphae D. Pileipellis E. Basidiospore. A=10 mm, B=5 µm, C=10 µm, D=18 µm, E=5 µm.

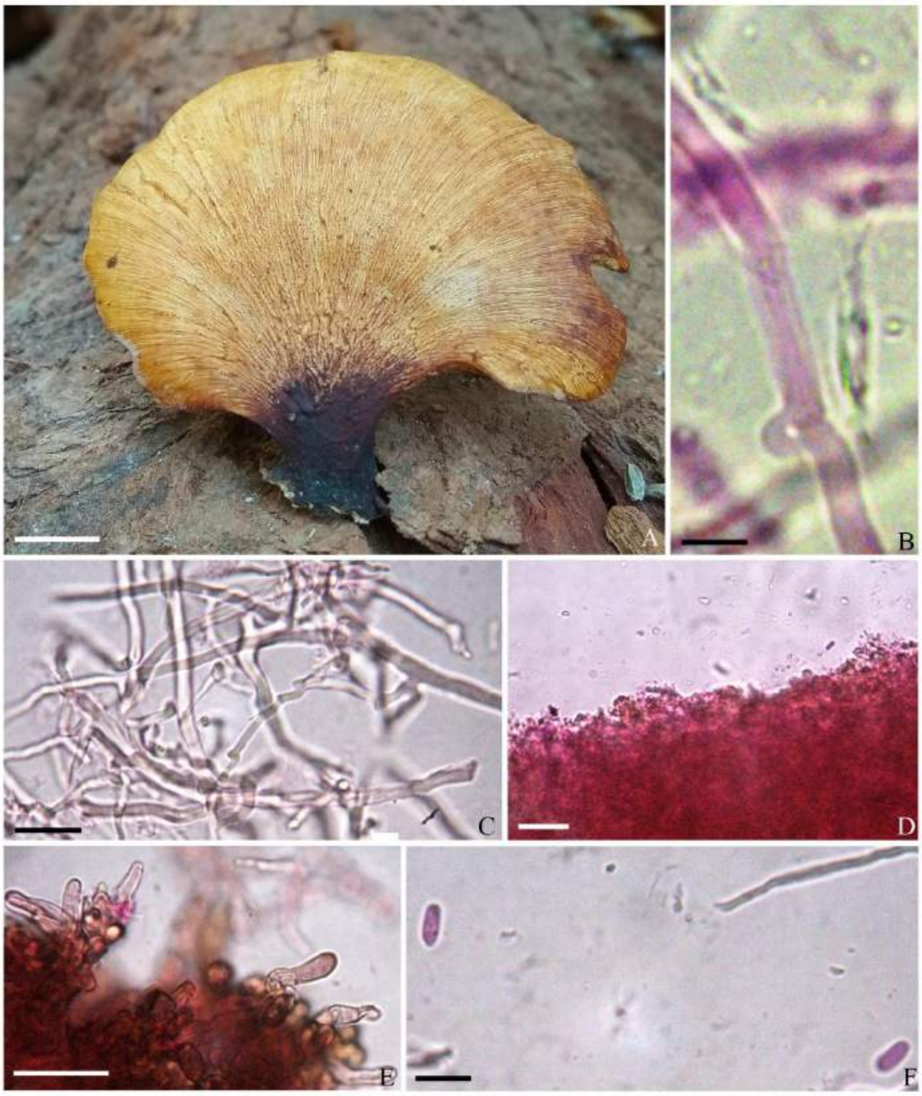


Figure 70: *Polyporus leprieurii*-A. Basidiomata B. Generative hyphae showing clamp connection C. Skeleto ligative hyphae D. Pileipellis E. Stipitipellis F. Basidiospores. Scale bars: A=70 mm, B=6 µm, C=10 µm, D=16 µm, E=24 µm, F=6 µm.

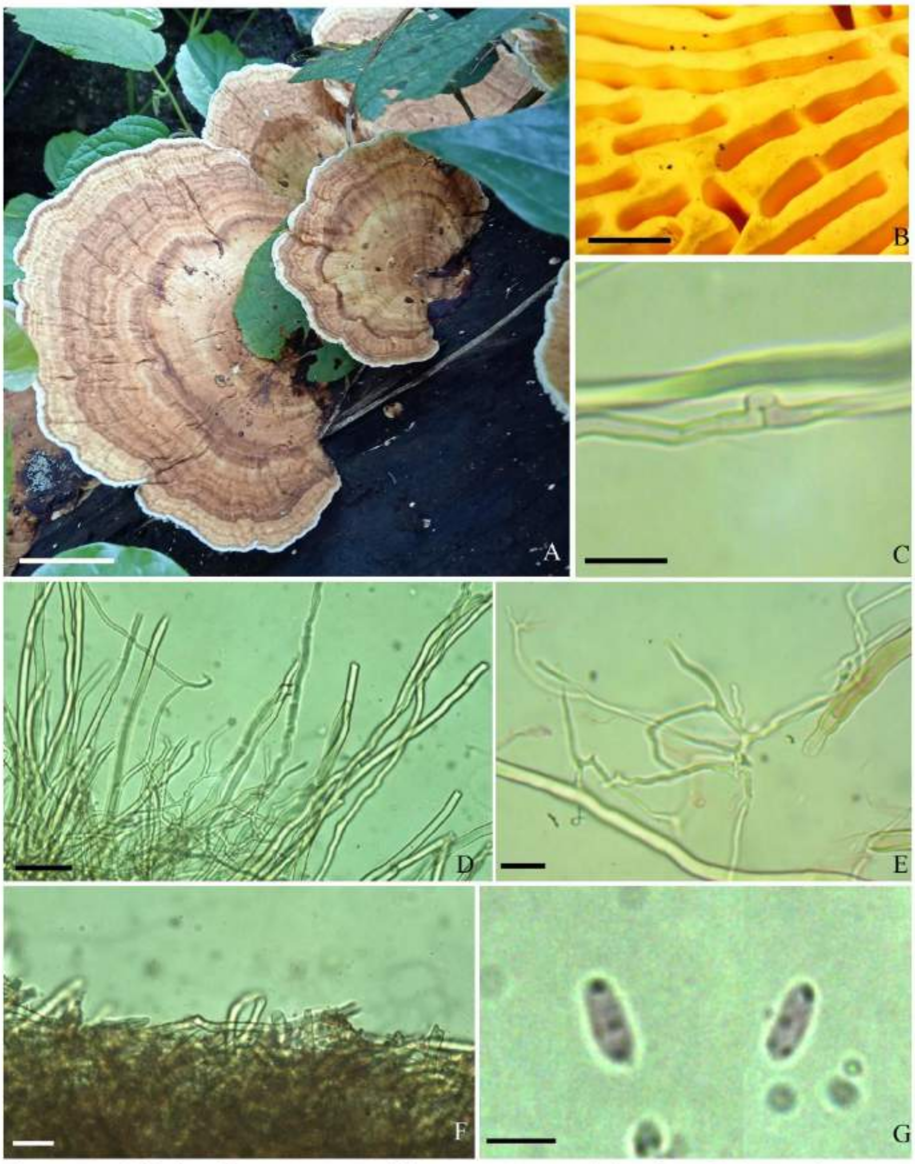


Figure 71: *Cellulariella acuta*-A. Basidiomata B. Hymenial surface C. Generative hyphae showing clamp connection D. Skeletal hyphae E. Skeleto ligative hyphae F Pileipellis G. Basidiospores. Scale bars: A=10 mm, B=5 mm, C=9 μm, D=18 μm, E=6 μm, F=14 μm, G=6 μm.

Figure 72: *Earliella scabrosa*-A, B. Basidiomata C. Generative hyphae showing clamp connection (inset) D. Skeletal hyphae E. Skeleto ligative hyphae F. Pileipellis G. Basidiospore. Scale bars: A, B=25 mm, C=6 µm, D, E, F=15 µm, G=8 µm.

Figure 73: *Coriolopsis caperata*-A. Basidiomata B. A portion of context with distinct brownish black line C. Generative hyphae showing clamp connection D. Skeletal hyphae E. Dendroid hyphae F. Thick trichodermal patch on Pileipellis G. Basidiospore. Scale bars: A=5 mm, B=3 mm, C=6 μm, D, E=12 μm, F=20 μm, G=5 μm.

Figure 74: *Coriolopsis telfairii*-A. Basidiomata B. Generative hyphae showing clamp connection C. Skeletal hyphae D. Skeleto ligative hyphae E. Pileipellis F. Single trichodermal patch on pileipellis G. Basidiospores. Scale bars: A=10 mm, B=8 µm, C=12 µm, D=8 µm, E, F=16 µm, G=10 µm.

Figure 75: *Coriolopsis occidentalis*-A. Basidiomata B. Generative hyphae showing clamp connection C. Skeletal hyphae D. Skeleto ligative hyphae E. Pileipellis F. Basidiospores. Scale bars: A=10 mm, B=8 μm, C, D=15 μm, E=22 μm, F=9 μm.

Figure 76: *Pilatotrama ljubarskyi*-A. Basidiomata B. Generative hyphae showing clamp connection (arrow) C. Skeletal hyphae D. Pileipellis E. Basidiospore. Scale bars: A=10 mm, B=9 μm, C=18 μm, D=24 μm, E=6 μm.

Figure 77: *Neofomitella guangxiensis*-A. Basidiomata B. Generative hyphae C. Skeletal hyphae D. Skeleto ligative hyphae E. Pileipellis F. Basidiospore. A=8 mm, B=10 µm, C=12 µm, D=12 µm, E, F=10 µm.

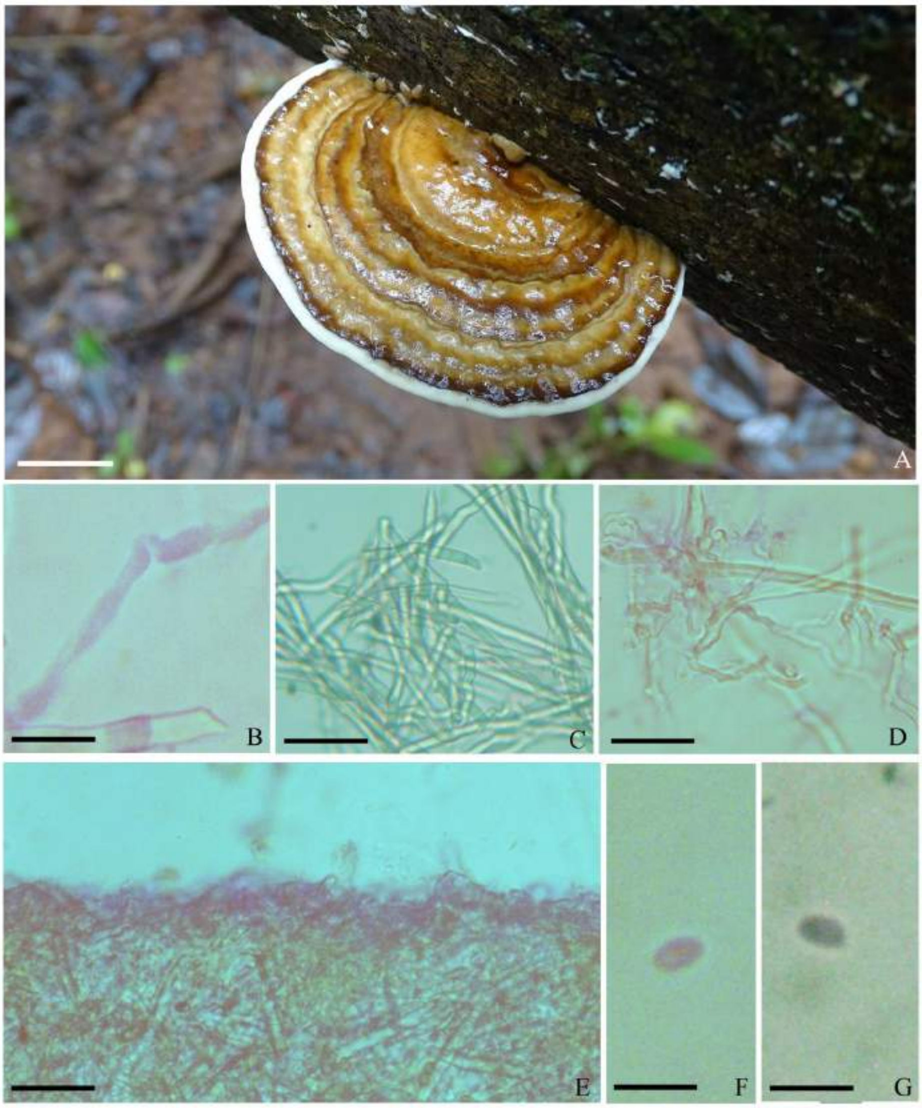


Figure 78: *Neofomitella fumosipora*-A. Basidiomata B. Generative hyphae C. Skeletal hyphae D. Skeleto ligative hyphae E. Pileipellis F, G. Basidiospores. Scale bars: A=6 mm, B=10 μm, C= 20 μm, D=16 μm, E=16 μm, F, G=3 μm.

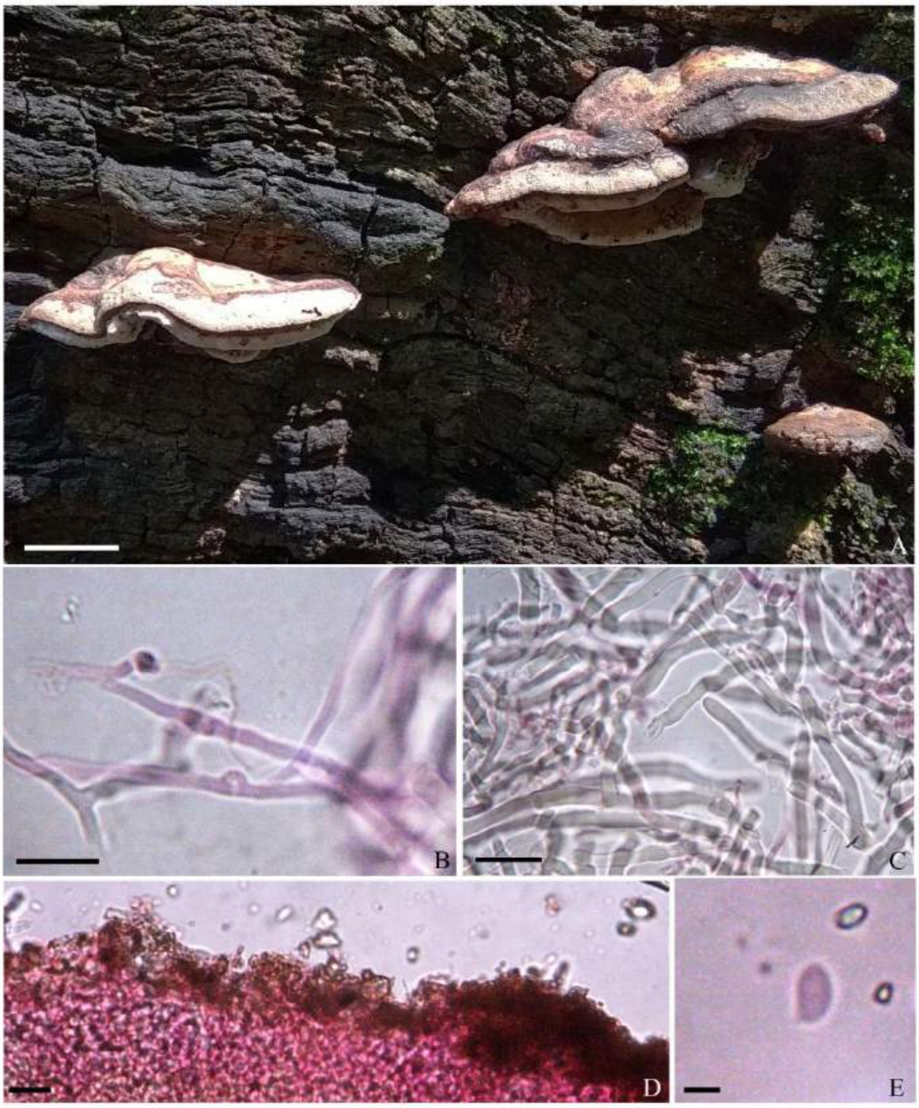


Figure 79: *Neofomitella rhodophaea*-A. Basidiomata B. Generative hyphae showing clamp connection C. Skeletal hyphae D. Pileipellis E. Basidiospore. Scale bars: A=10 mm, B=9 µm, C, D=15 µm, E=3 µm.

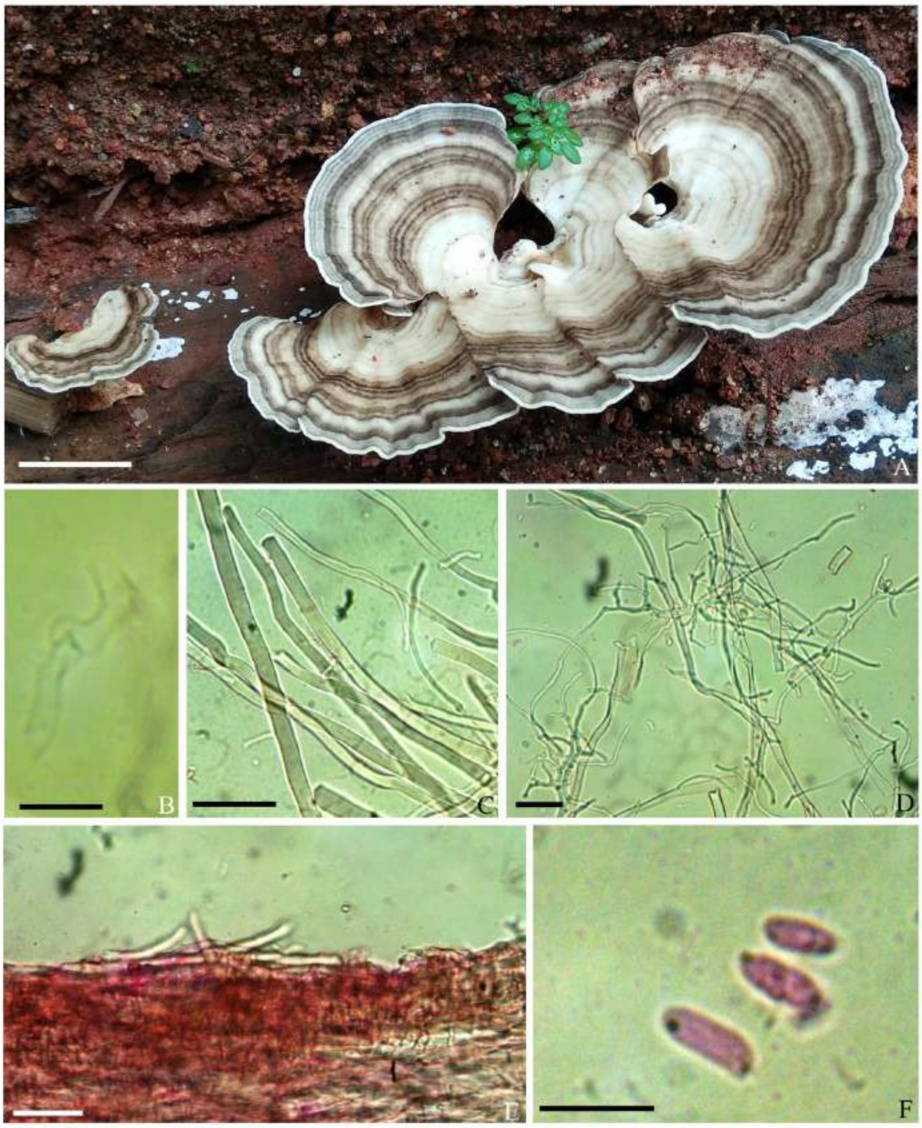


Figure 80: *Leiotrametes menziesii*-A. Basidiomata B. Generative hyphae showing clamp connection C. Skeletal hyphae D. Skeleto ligative hyphae E. Pileipellis F. Basidiospores. Scale bars: A=10 mm, B=11 μm, C, D=24 μm, E=20 μm, F=9 μm.

Figure 81: *Trametes apiaria*-A. Basidiomata B. Generative hyphae showing clamp connection C. Skeletal hyphae D. Skeleto ligative hyphae E. Pileipellis F. Hyphal peg G, H. Basidiospores. Scale bars: A=10 mm, B=10 μm, C=30 μm, D=18 μm, E=24 μm, F=60 μm, G, H=4 μm.

Figure 82*: Trametes gibbosa*-A. Basidiomata B. Generative hyphae showing clamp connection C. Skeletal and skeleto ligative hyphae D. Pileipellis E. Basidiospore. Scale bars: A=8 mm, B=9 µm, C=21 µm, D=15 µm, E=6 µm.

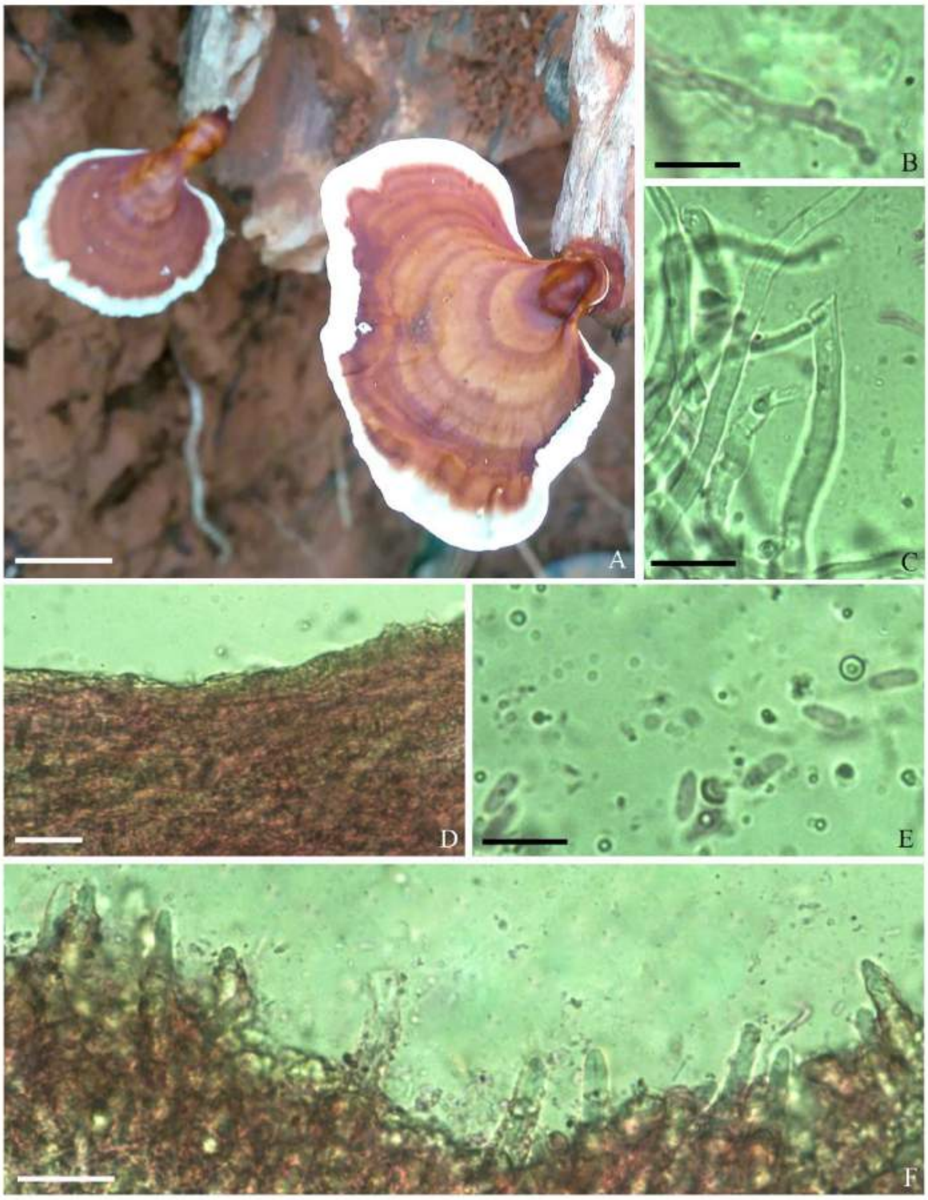


Figure 83: *Trametes vernicipes*-A. Basidiomata B. Generative hyphae showing clamp connection C. Skeletal hyphae D. Pileipellis E. Basidiospores F. Stipitipellis. Scale bars: A=10 mm, B=10 μm, C=21 μm, D=18 μm, E=7 μm, F=22 μm.

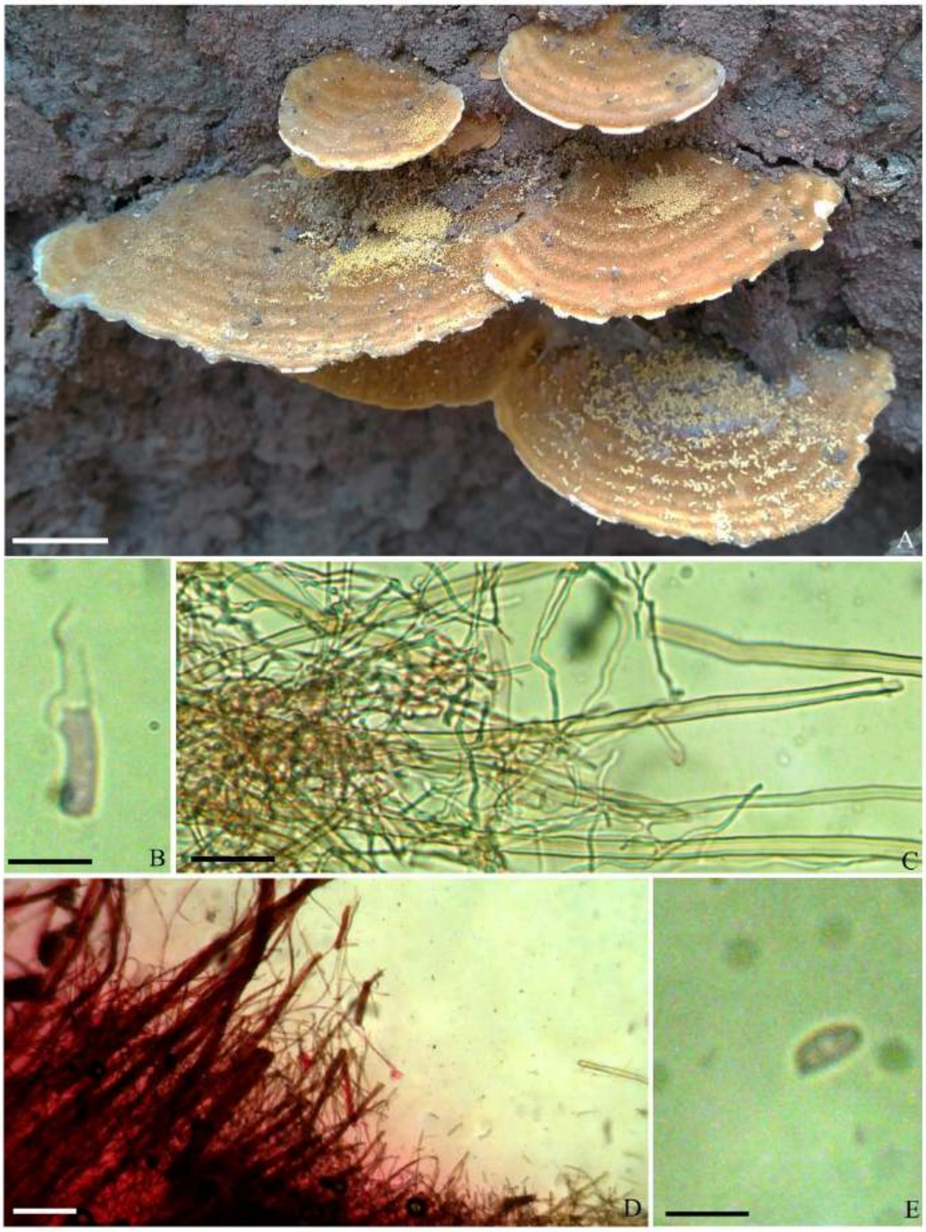


Figure 84: *Trametes ochracea*-A. Basidiomata B. Generative hyphae showing clamp connection C. Skeletal and skeleto ligative hyphae D. Pileipellis F. Basidiospore. Scale bars: A=7 mm, B=8 μm, C=18 μm, D=24 μm, E=6 μm.

Figure 85: *Trametes flavida*: A. Basidiomata B. Generative hyphae C. Skeletal hyphae D. Skeleto ligative hyphae E. Pileipellis F. Basidiospores. Scale bars: A=50 mm, B=8 µm, C, D=15 µm, E=12 µm, F=5 µm

Figure 86: *Trametes varians*-A. Basidiomata B. Generative hyphae showing clamp connection C. Skeletal hyphae D. Skeleto ligative hyphae E. Pileipellis F, G. Basidiospores. Scale bars: A=10 mm, B=10 µm, C=20 µm, D=12 µm, E=24 µm, F, G=5 µm.

Figure 87: *Trametes marianna*-A. Basidiomata B. Generative hyphae showing clamp connection C. Skeletal hyphae D. Pileipellis E. Basidiospores. A=10 mm, B=12 µm, C=18 µm, D=24 µm, E=7 µm.

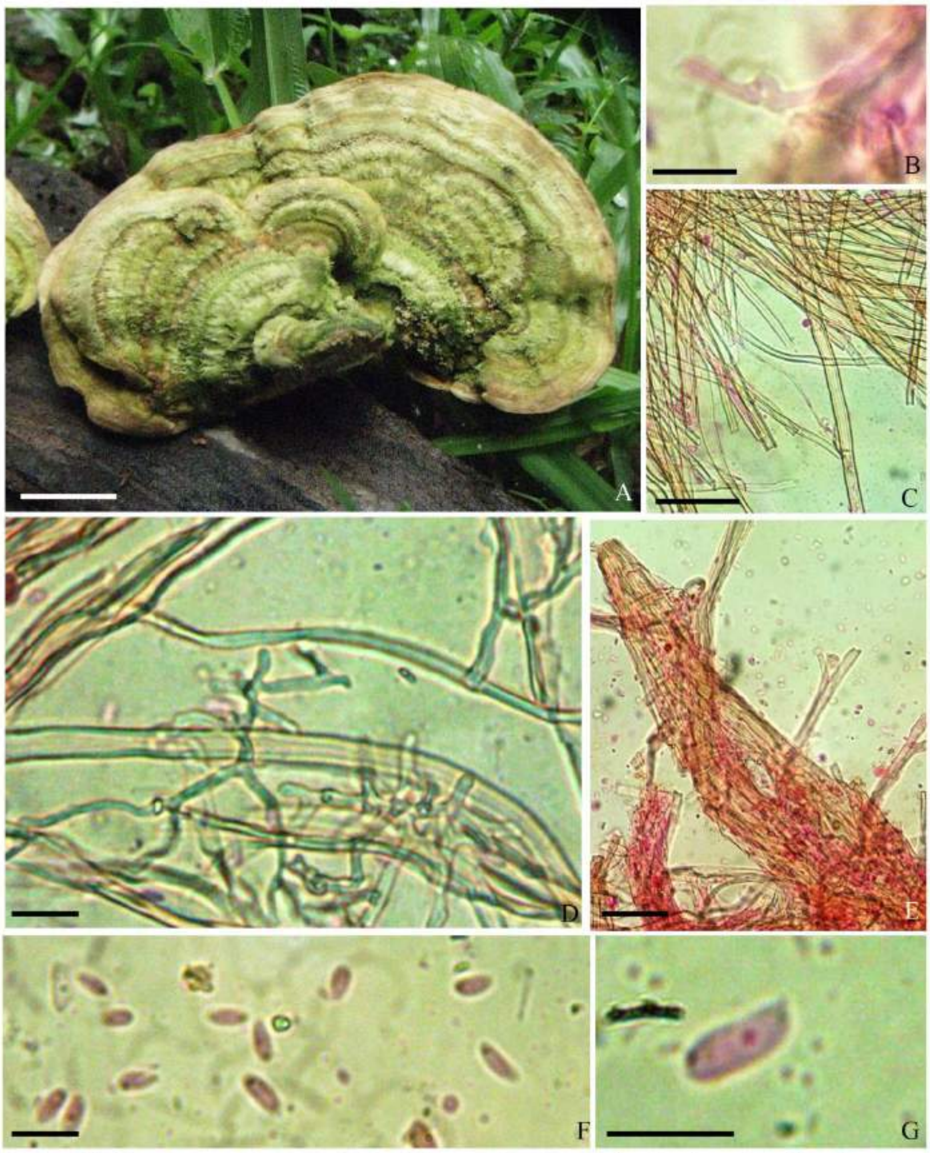


Figure 88: *Trametes pubescens*-A. Basidiomata B. Generative hyphae showing clamp connection C. Skeletal hyphae D. Skeleto ligative hyphae E. Pileipellis F. Basidiospores G. Basidiospore enlarged. Scale bars: A=70 mm, B=13 µm, C=24 µm, D=12 µm, E=20 µm, F, G=7 µm.

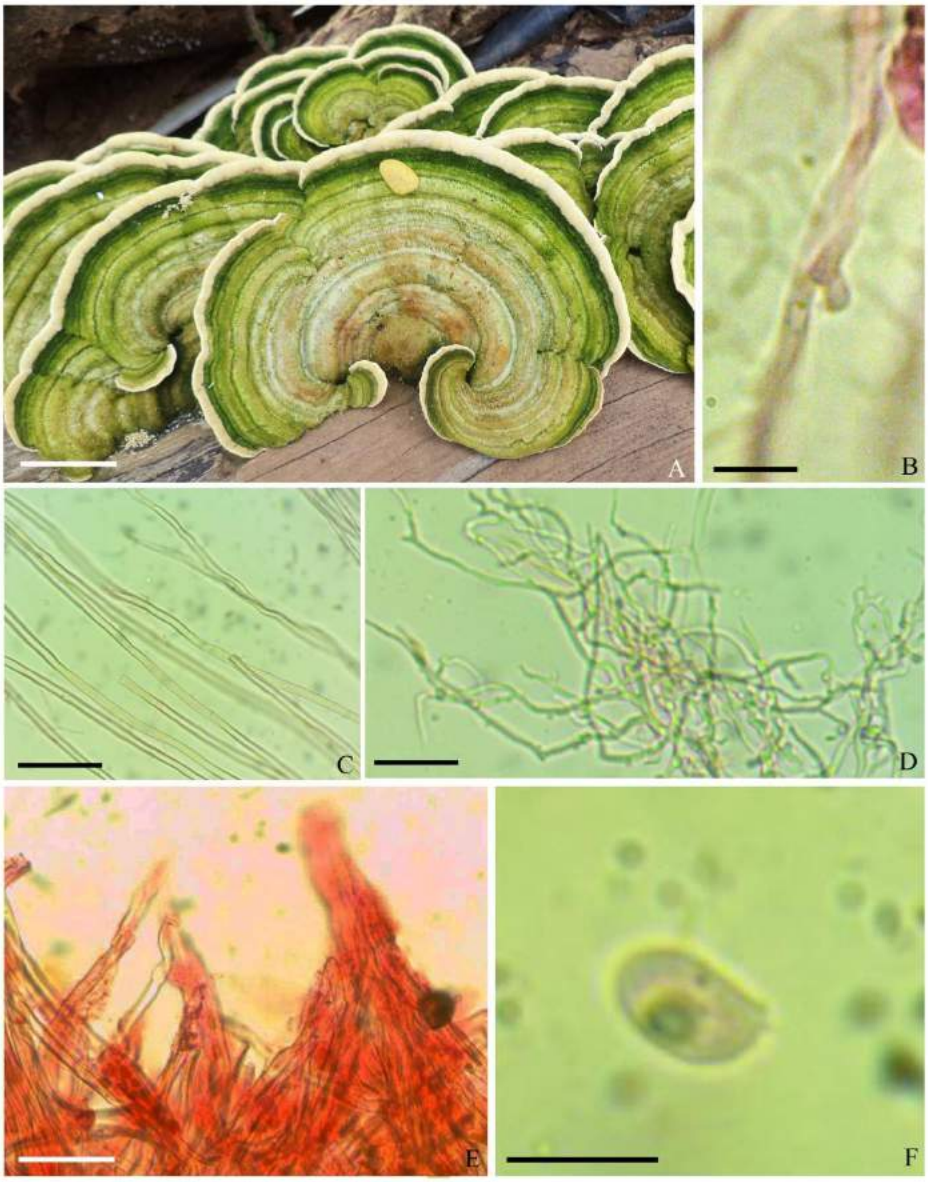


Figure 89: *Trametes meyenii*-A. Basidiomata B. Generative hyphae showing clamp connection C. Skeletal hyphae D. Skeleto ligative hyphae E. Pileipellis F. Basidiospore. Scale bars: A=30 mm, B=12 µm, C=22 µm, D=14 µm, E=22 µm, F=7 µm.

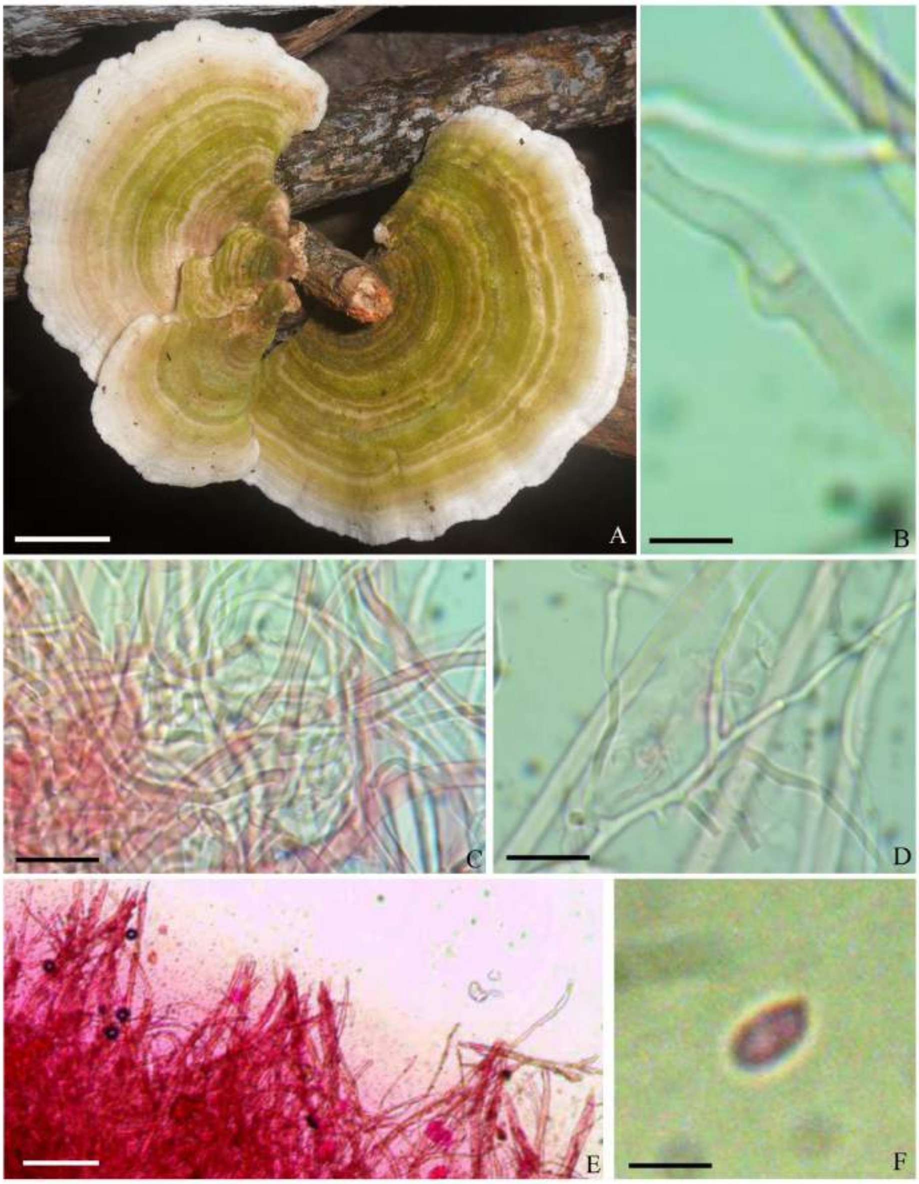


Figure 90: *Trametes villosa*- A. Basidiomata B. Generative hyphae showing clamp connection C. Skeletal hyphae D. Skeleto ligative hyphae E. Pileipellis F. Basidiospore. Scale bars: A=10 mm, B=6 µm, C=20 µm, D=8 µm, E=25 µm, F=5 µm.

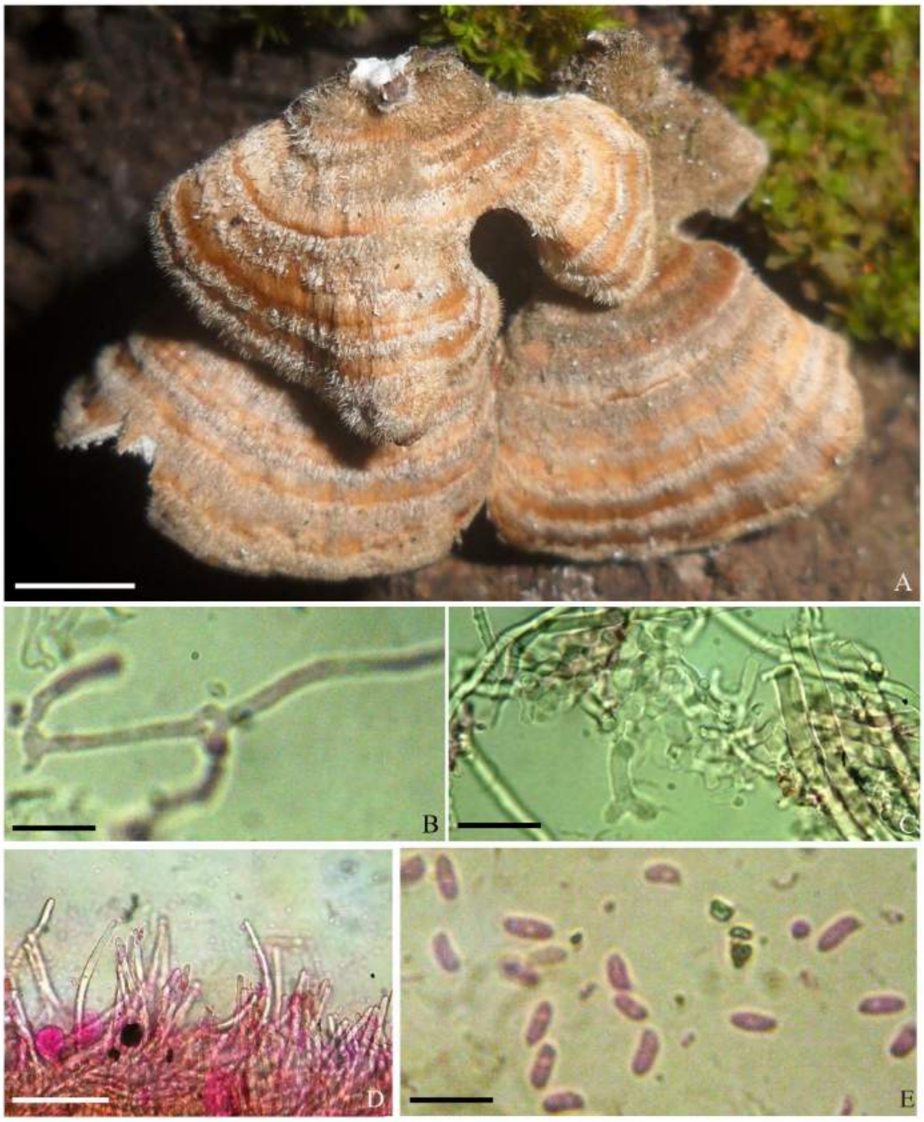


Figure 91: *Trametes hirsuta*-A. Basidiomata B. Generative hyphae showing clamp connection C. Skeletal and skeleto ligative hyphae D. Pileipellis E. Basidiospores. Scale bars: A=5 mm, B=12 µm, C=20 µm, D=32 µm, E=8 µm.

Figure 92: *Daedalea dochmia*-A. Basidiomata B. Generative hyphae C. Skeletal hyphae D. Pileipellis E. Basidiospore. Scale bars: A=20 mm, B, C=10 µm, D=12 µm, E= 6 µm.

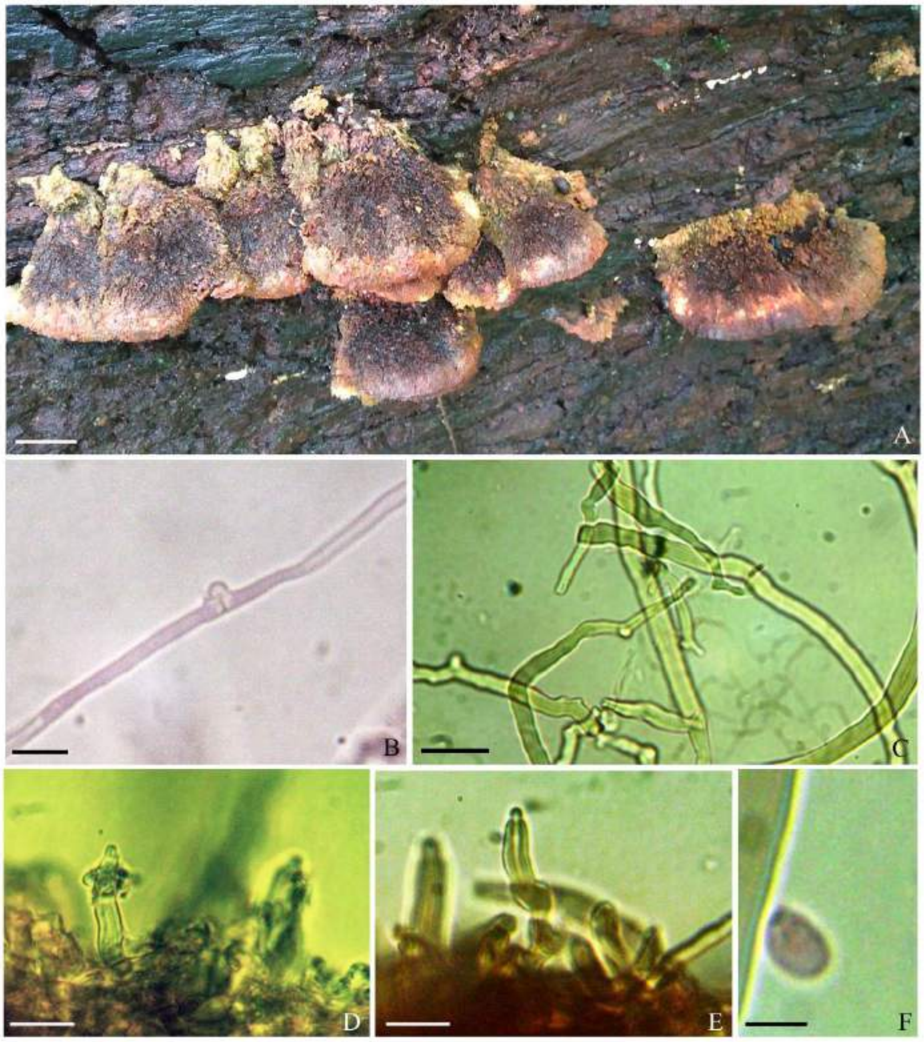


Figure 93: *Daedalea radiata*-A. Basidiomata B. Generative hyphae showing clamp connection C. Skeletal hyphae D. Pileipellis E. Basidiospore. Scale bars: A=10 mm, B=6 µm, C, D, E=15 µm, F=3 µm.

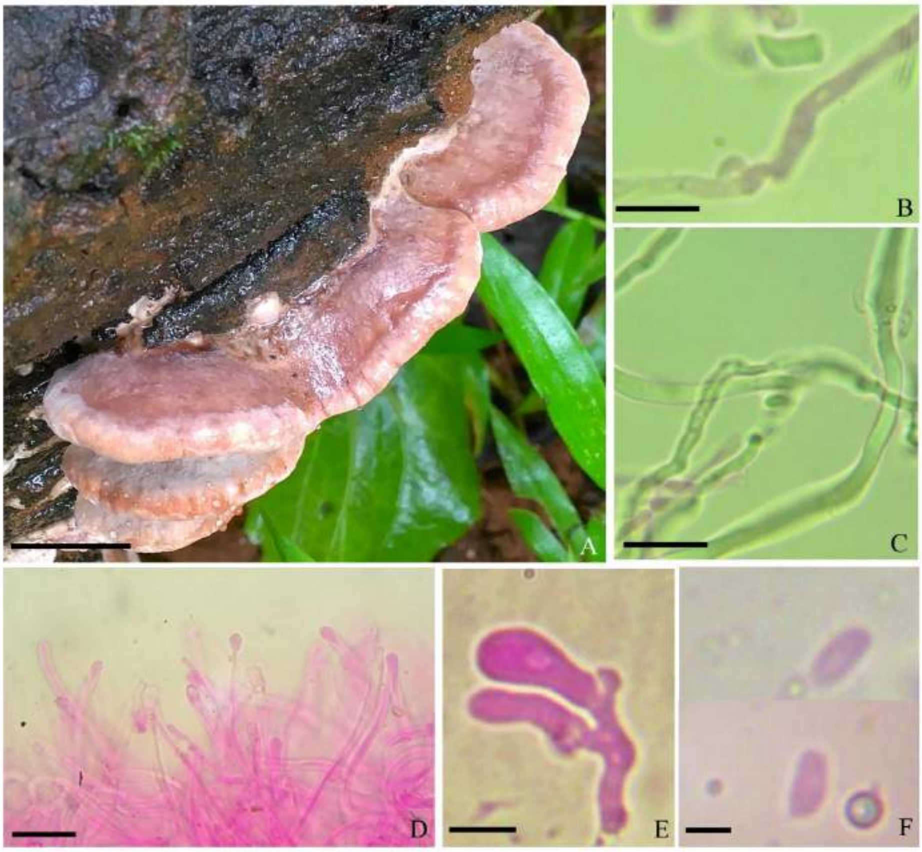


Figure 94: *Rhodofomitopsis feei*-A. Basidiomata B. Generative hyphae showing clamp connection C. Skeletal hyphae D. Pileipellis E. Basidioles with basal clamp connections F. Basidiospores. Scale bars: A=10 mm, B=10 µm, C, D=15 µm, E, F=4 µm.

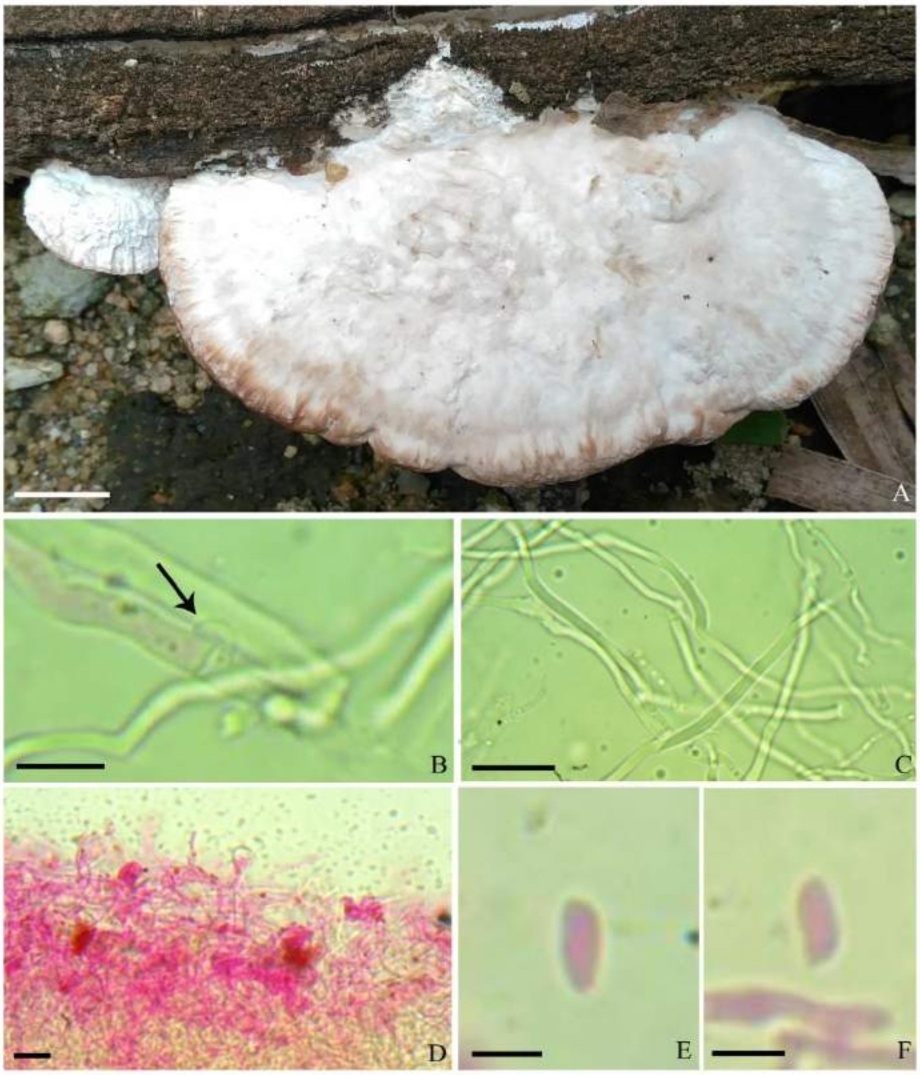


Figure 95: *Pilatoporus ostreiformis*-A. Basidiomata B. Generative hyphae showing clamp connection (arrow) C. Skeletal hyphae D. Pileipellis E, F. Basidiospores. Scale bars: A=8 mm, B=5 µm, C, D=16 µm, E, F=6 µm.

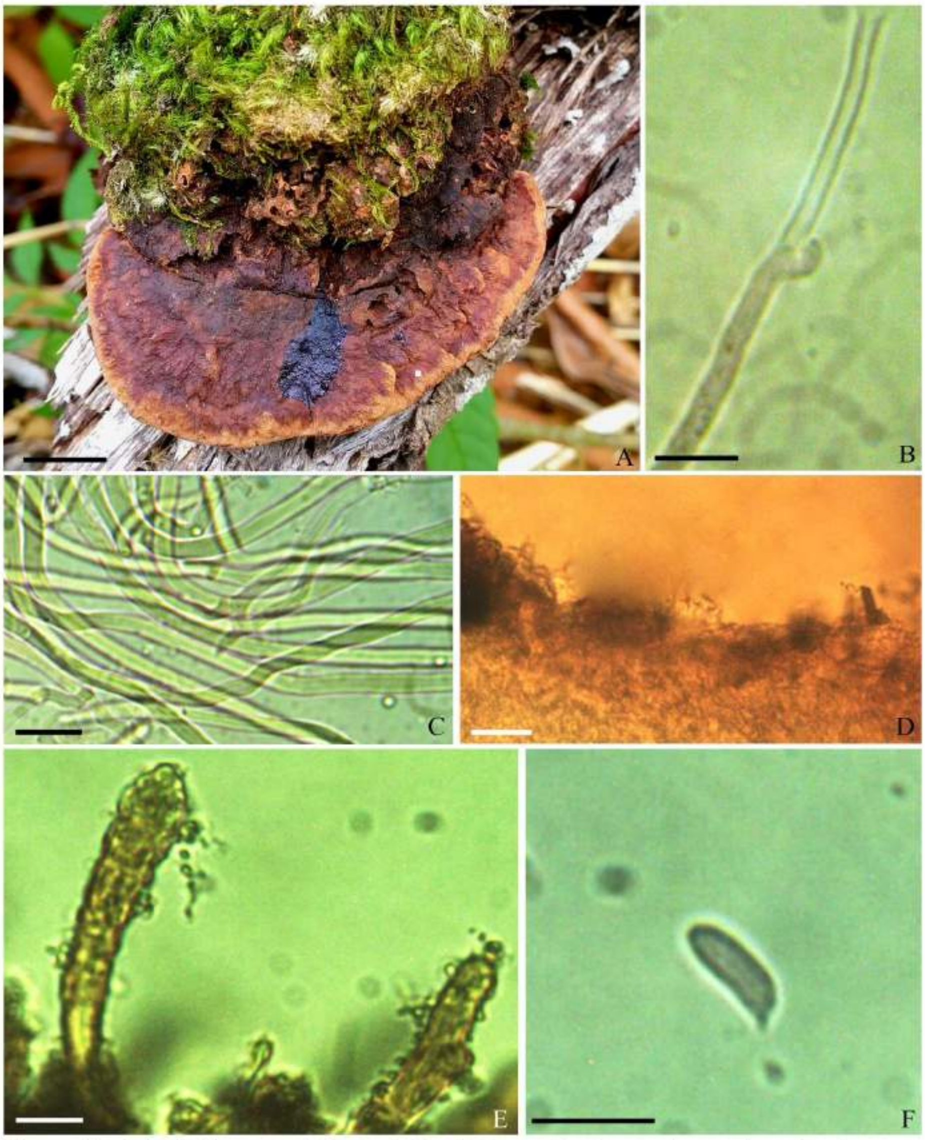


Figure 96: *Rubellofomes cystidiatus*-A. Basidiomata B. Generative hyphae showing clamp connection C. Skeletal hyphae D. Pileipellis E. Encrusted cystidia F. Basidiospore. Scale bars: A=10 mm, B=8 µm, C=10 µm, D=18 µm, E=6 µm, F=8 µm.

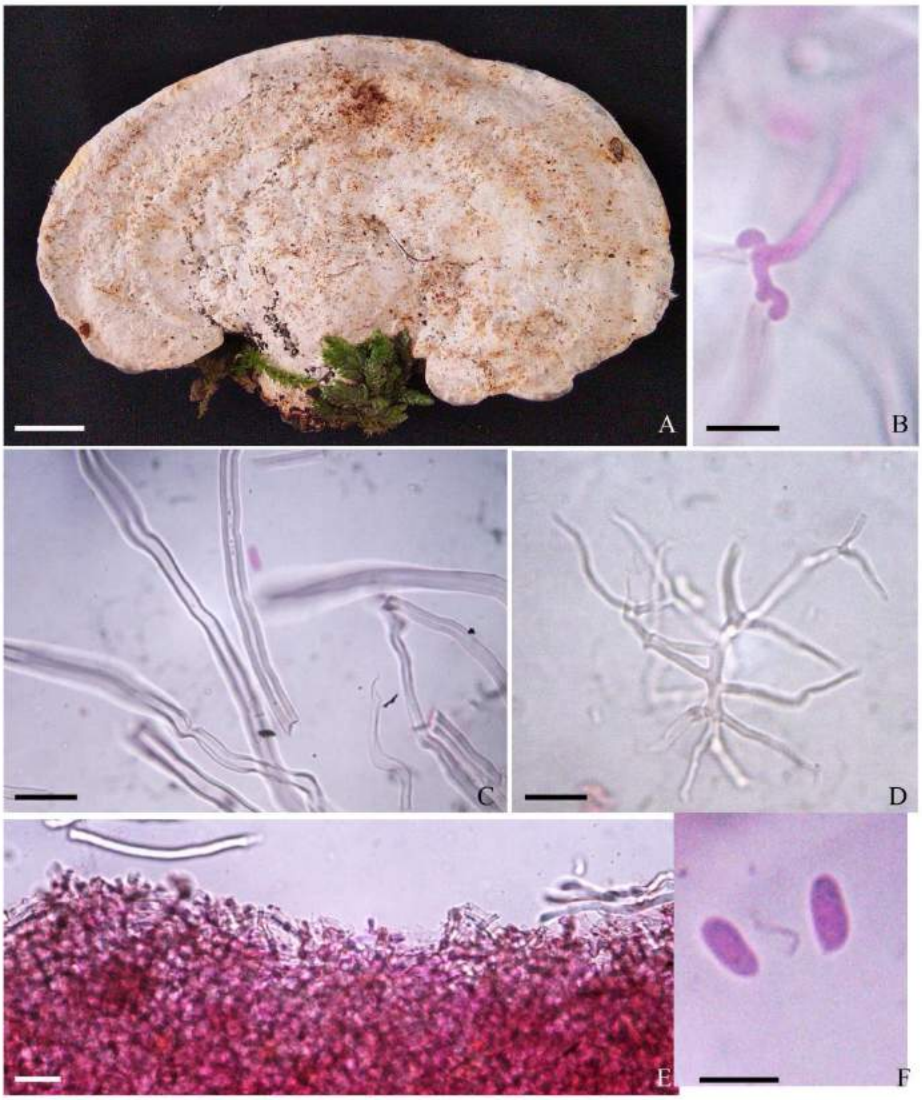


Figure 97: *Fomitopsis palustris*-A. Basidiomata B. Generative hyphae showing clamp connections C. Skeletal hyphae D. Skeleto ligative hyphae E. Pileipellis F. Basidiospores. Scale bars: A=10 mm, B=6 µm, C, D=12 µm, E=10 µm, F=8 µm.

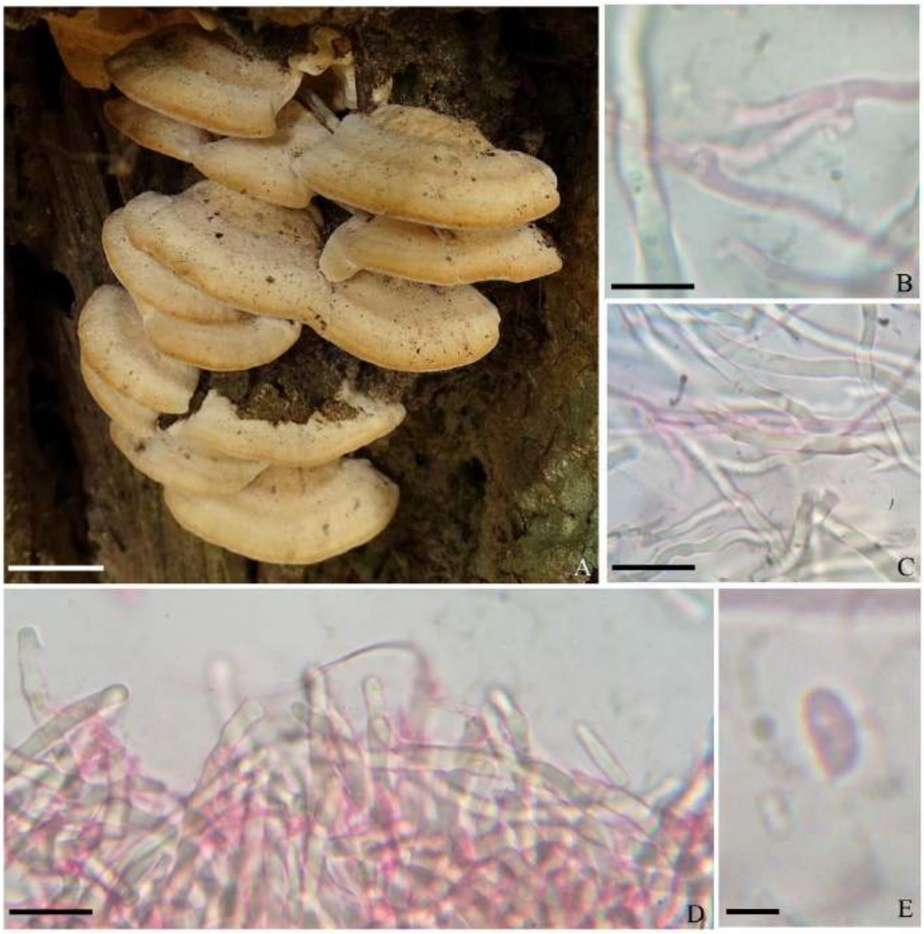


Figure 98: *Fomitopsis caribensis*-A. Basidiomata B. Generative hyphae showing clamp connections C. Skeletal hyphae D. Pileipellis E. Basidiospore. Scale bars: A=10 mm, B=12 µm, C=20 µm, D=15 µm, E=2 µm.

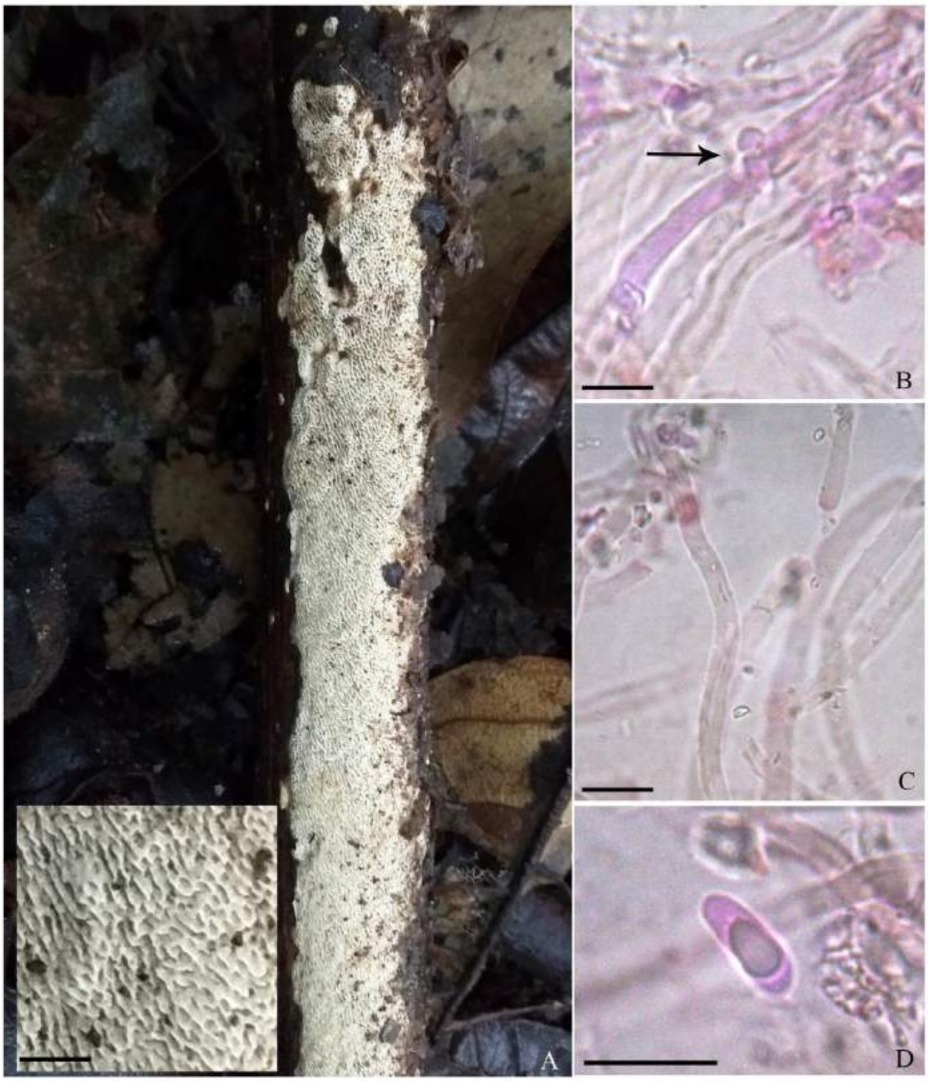


Figure 99: *Antrodia albida*-A. Basidiomata (inset- hymenial surface portion enlarged) B. Generative hyphae showing clamp connection (arrow) C. Skeletal hyphae D. Basidiospore. Scale bars: A=10 mm, B=8 µm, C, D=12 µm.

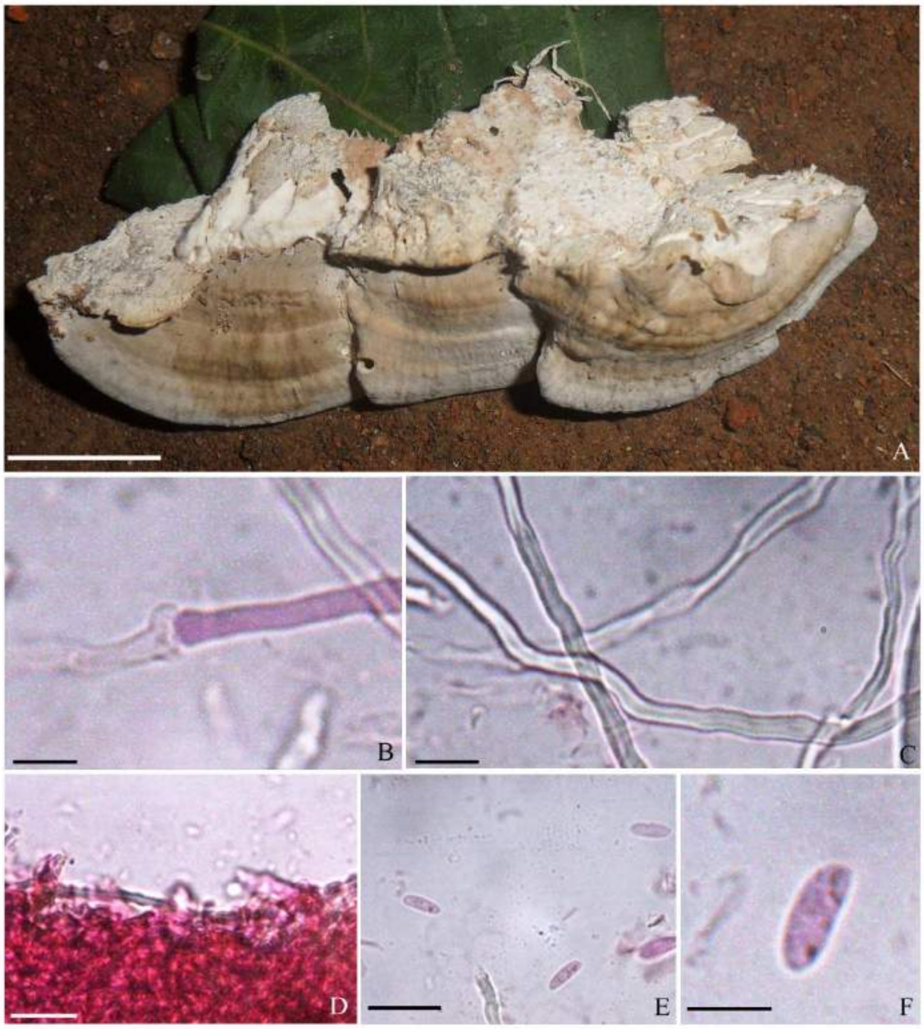


Figure 100: *Neoantrodia serialis*-A. Basidiomata B. Generative hyphae showing clamp connection C. Skeletal hyphae D. Pileipellis E. Basidiospores F. Basidiospore enlarged. Scale bars: A=15 mm, B, C=6 μm, D=15 μm, E=20 μm, F=6 μm.

Figure 101: *Hydnoporia tabacina*-A. Basidiomata (inset-hymenial surface with projecting setae) B. Generative hyphae C. Pileipellis D, E. Hymenial setae F. Basidiospore. Scale bars: A=20 mm, B, C=10 μm, D=40 μm, E=12 μm, F=8 μm.

Figure 102: *Hymenochaete boddingii*-A, B. Basidiomata C. Generative hyphae D. Hymenial setae E. Stipitipellis showing projecting setae F. Basidiospores attached on basidium G. Basidiospores enlarged. Scale bars: A, B=10 mm, C=8 µm, D, E=25 µm, F=10 µm, G=5 µm

Figure 103: *Hymenochaete ochromarginata*-A. Basidiomata B. Generative hyphae C, D. Hymenial setae E. Pileipellis F. Basidiospore. Scale bars: A=10 mm, B=16 µm, C=20 µm, D=15 µm, E=16 µm, F=4 µm.

Figure 104: *Coltricia cinnamomea*-A. Basidiomata B. Generative hyphae C. Pileipellis D. Stipitipellis E. Basidiospores F. Basidiospore enlarged. Scale bars: A=10 mm, B, C=20 µm, D=10 µm, E=16 µm, F=8 µm.

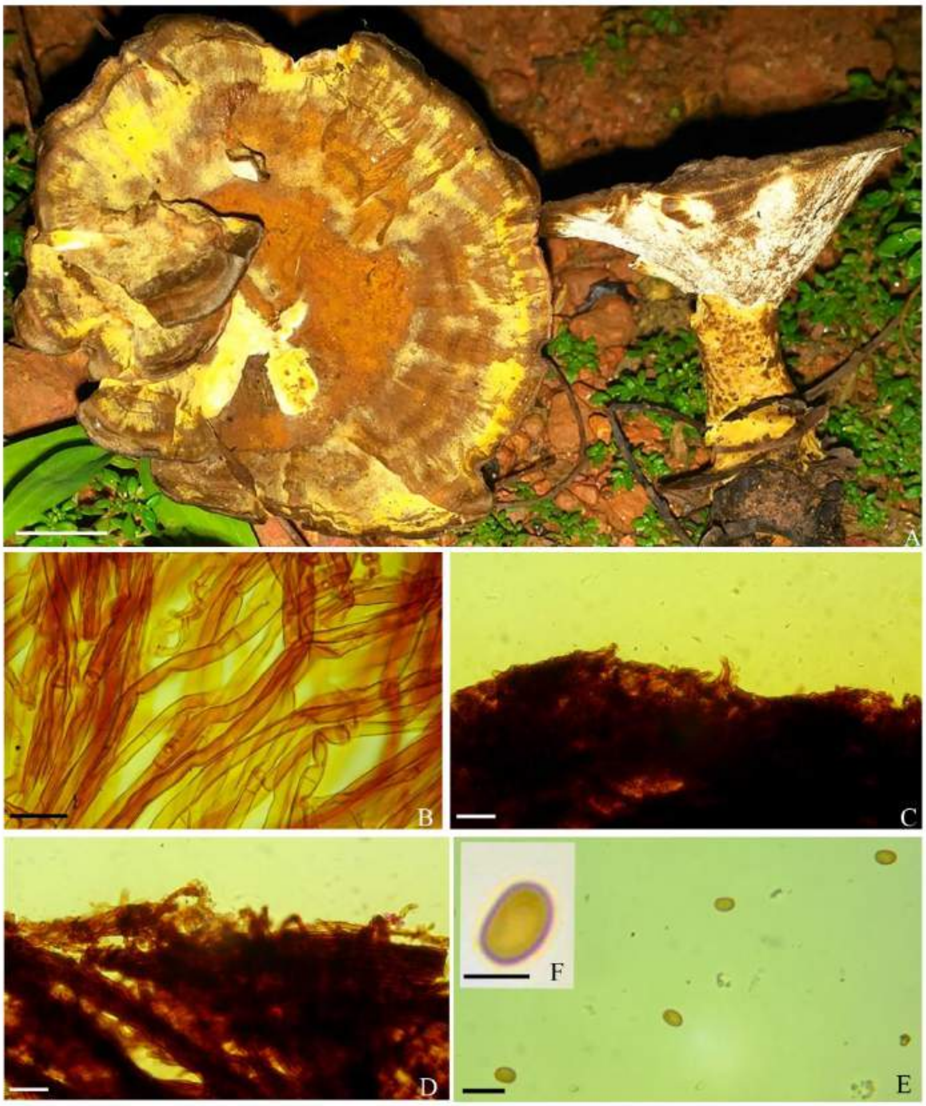


Figure 105: *Coltricia pyrophila*-A. Basidiomata B. Generative hyphae C. Pileipellis D. Stipitipellis E. Basidiospores F. Basidiospore enlarged (inset). A=10 mm, B, C, D=15 µm, E=12 µm, F=4 µm.

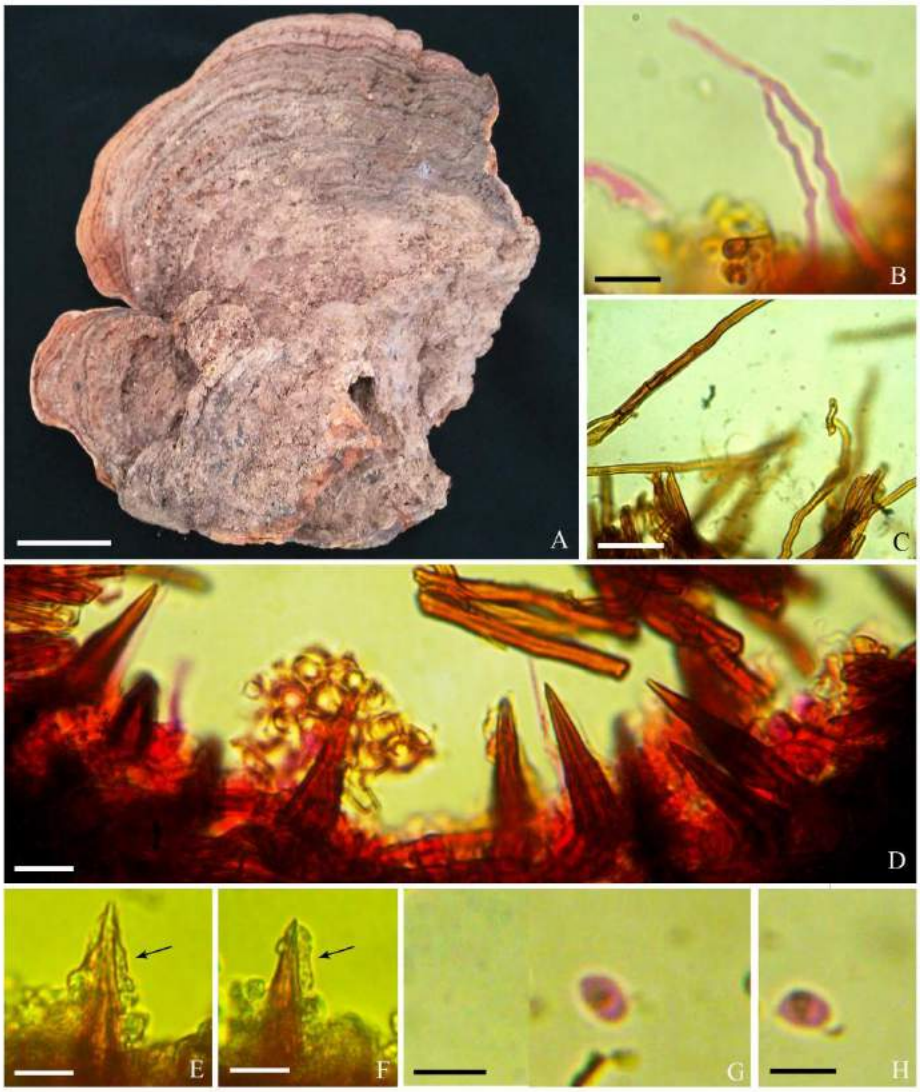


Figure 106: *Fuscoporia rhabarbarina*-A. Basidiomata B. Generative hyphae C. Skeletal hyphae D. Hymenial setae E, F. Hymenial setae showing encrustations (arrows) G, H. Basidiospores. Scale bars: A=10 mm, B, C=15 µm, D, E, F=7 µm, G, H=4 µm.

Figure 107: *Phylloporia weberiana*-A. Basidiomata B. Generative hyphae C. Pileipellis D. Basidiospores. Scale bars: A=8 mm, B, C=14 µm, D=5 µm.

Figure 108: *Phylloporia pectinata*-A. Basidiomata B. Vertical section of the basidiocarp showing distinct black line in the context (arrows) C. Generative hyphae D. Skeletal hyphae E. Pileipellis F. Basidiospores G. Basidispore enlarged. Scale bars: A, B=5 mm, C, D=7 µm, E=12 µm, F=5 µm, G=3 µm.

Figure 109: *Phylloporia gabonensis*-A. Basidiomata B. Generative hyphae C. Pileipellis D. Basidiospores. Scale bars: A=10 mm, B=24 μm, C=24 μm, D=10 μm.

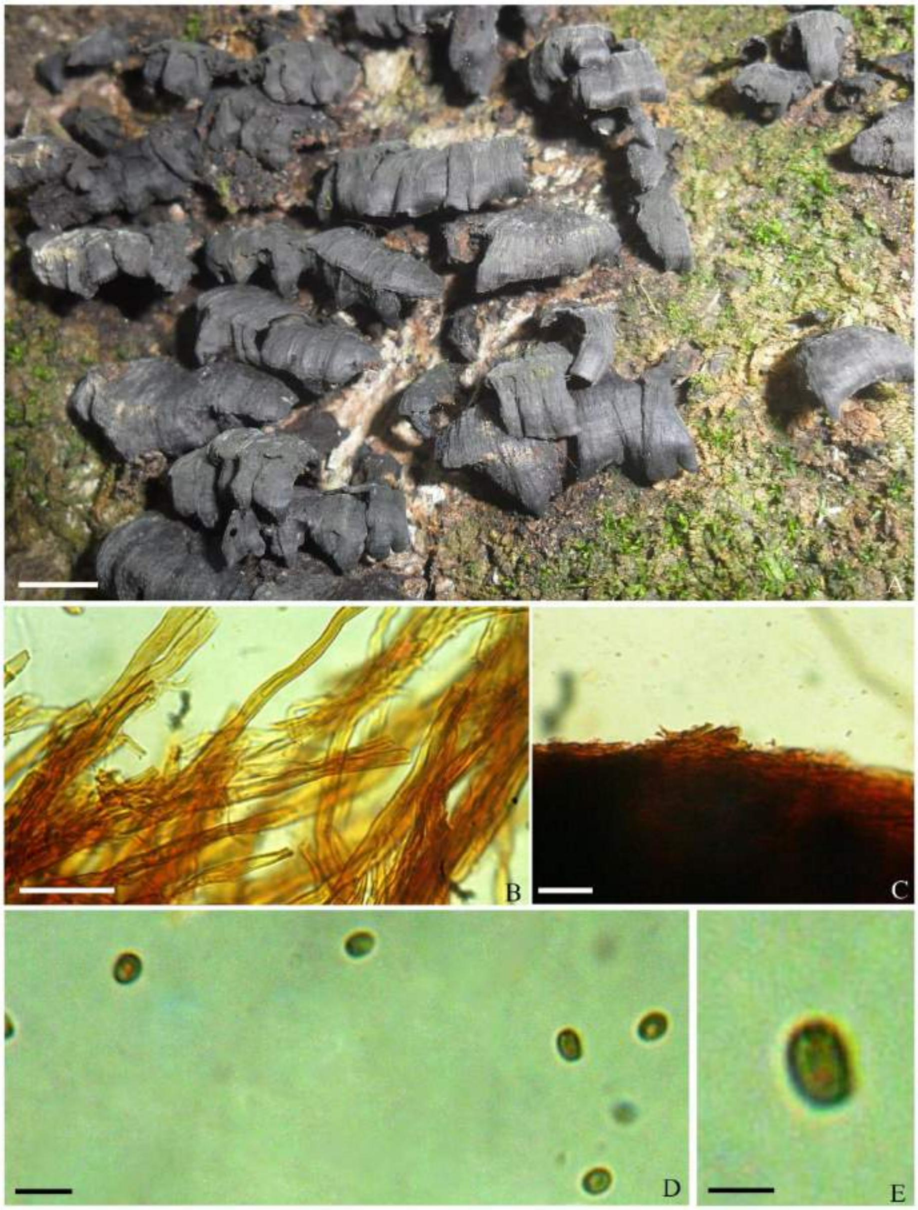


Figure 110*: Phylloporia chrysites*-A. Basidiomata B. Generative hyphae C. Pileipellis D. Basidiospores E. Basidiospore enlarged. Scale bars: A=5 mm, B=20 mm, C=45 µm, D=5 µm, E=2.5 µm.

Figure 111: *Fulvifomes cesatii*-A. Basidiomata B. Hymenial surface showing pores C. Generative hyphae D. Skeletal hyphae E. Basidiospores. Scale bars: A=50 mm, B=2 mm, C=9 µm, D=18 µm, E=5 µm.

Figure 112: *Cyclomyces setiporus*-A. Basidiomata B. Generative hyphae C, D, E. Hymenial setae F. Pileipellis G. Basidiospores. Scale bars: A=10 mm, B=20 µm, C=20 µm, D, E=8 µm, F=18 µm, G=4 µm.

Figure 113: *Inonotus pachyphloeus*-A. Basidiomata B. Generative hyphae C. Skeletal hyphae D, E. Setal hyphae F. Hymenial setae G. Pileipellis H. Basidiospore. Scale bars: A=20 mm, B=5 µm, C=12 µm, D=32 µm, E=16 µm, F=12 µm, G=10 µm, H=5 µm.

Figure 114: *Inonotus patouillardii*-A. Basidiomata B. Generative hyphae C. Setal hyphae D. Pileipellis, E. Basidiospore. Scale bars: A=10 mm, B=20 μm, C=24 μm, D, E=10 μm.

Figure 115: *Inonotus tabacinus*-A. Basidiomata B. Generative hyphae C, D. Hymenial setae E. Pileipellis F. Basidiospore. Scale bars: A=10 mm, B=20 µm, C=10 µm, D, E=16 µm, F=4 µm.

Figure 116: *Inonotus luteoumbrinus*-A. Basidiomata B. Generative hyphae of pileal trama C. Generative hyphae of hymenium D. Pileipellis E. Basidiospores. Scale bars: A=30 mm, B, C=16 µm, D=15 µm, E=12 µm.

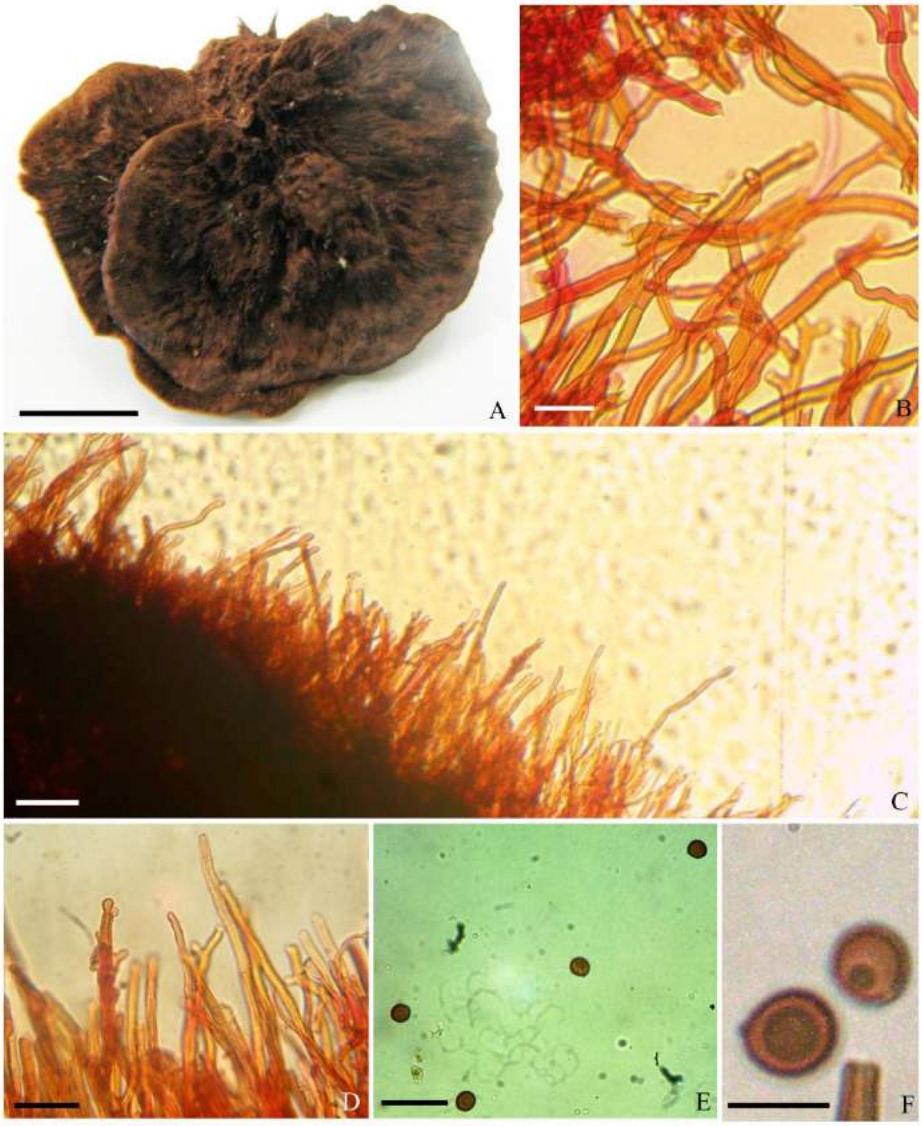


Figure 117: *Inonotus subhispidus*-A. Basidiomata B. Generative hyphae C. Pilepellis D. Pileipellis hyphae enlarged E. Basidiospores F. Basidiospores enlarged. Scale bars: A=10 mm, B=10 µm, C, D=24 µm, E=20 µm, F=8 µm.

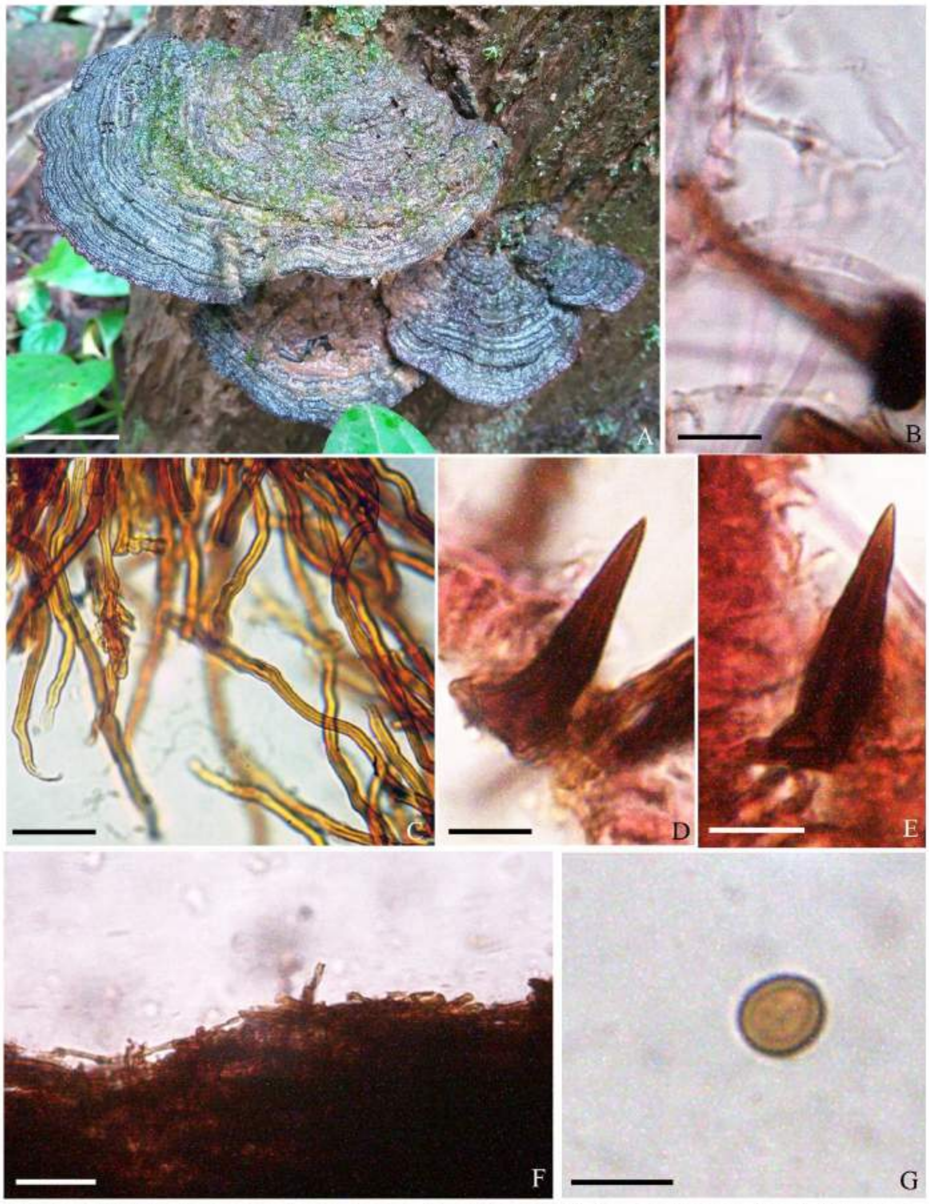


Figure 118: *Tropicoporus dependens*-A. Basidiomata B. Generative hyphae C. Skeletal hyphae D, E. Hymenial setae F. Pileipellis G. Basidiospore. Scale bars: A=10 mm, B=10 μm, C=24 μm, D, E=7 μm, F=24 μm, G=5 μm.

Figure 119: *Phellinus ferrugineovelutinus*-A. Basidiomata B. Hymenial region with crystals C. Generative hyphae D. Skeletal hyphae E, F. Hymenial setae G. Basidiospore. Scale bars: A=10 mm, B=12 µm, C=9 µm, D, E, F=15 µm, G=3 µm.

Figure 120: *Phellinus allardii*-A. Basidiomata B. Generative hyphae C. Skeletal hyphae D. Pileipellis E. Basidiospores F. Basidiospore enlarged. Scale bars: A=10 mm, B=8 µm, C=18 µm, D=8 µm, E=12 µm, F=5 µm.

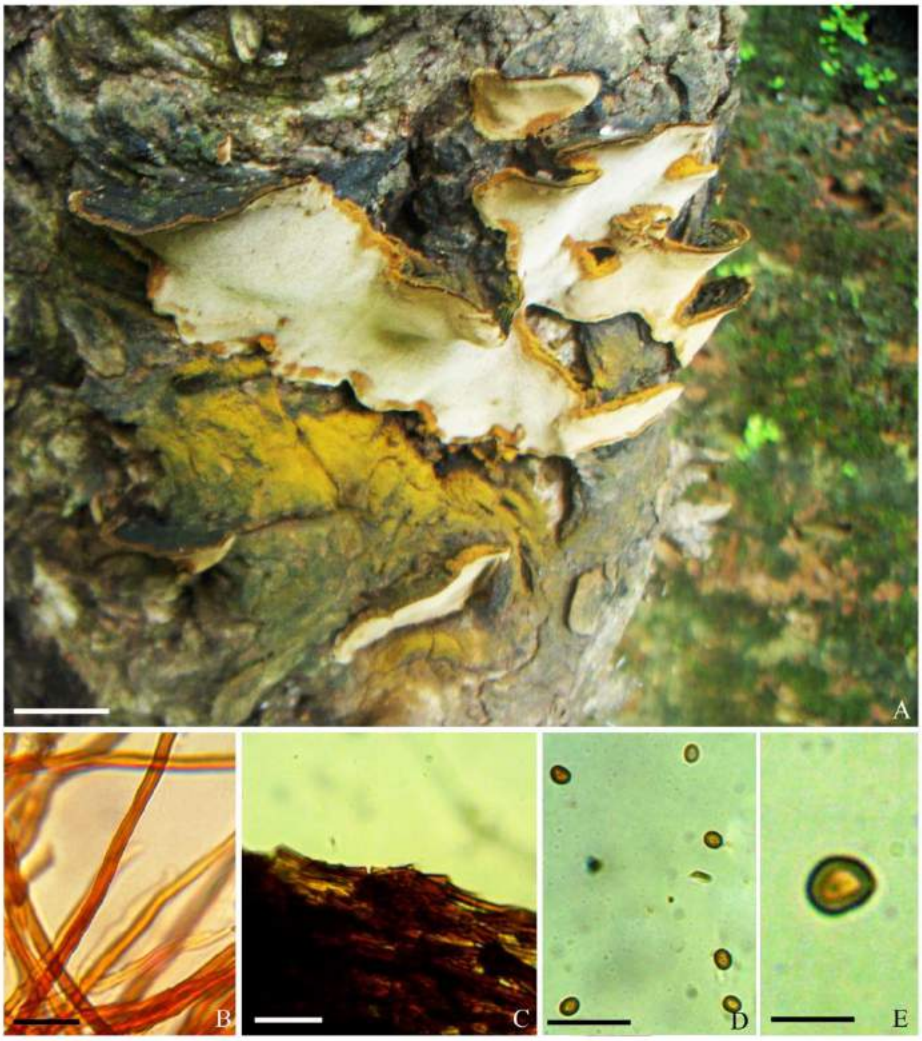


Figure 121: *Phellinus caryophilii*-A. Basidiomata B. Skeletal hyphae C Pileipellis D. Basidiospores. E. Basidiospore enlarged. Scale bars: A=10 mm, B, C=15 μm, D=20 μm, E=4 μm.

Figure 122: *Phellinus rimosus*-A. Basidiomata B. Generative hyphae C. Skeletal hyphae D. Pileipellis E. Basidiospores F. Basidiospore enlarged. Scale bars: A=20 mm, B=7 µm, C=15 µm, D=16 µm, E=20 µm, F=5 µm.

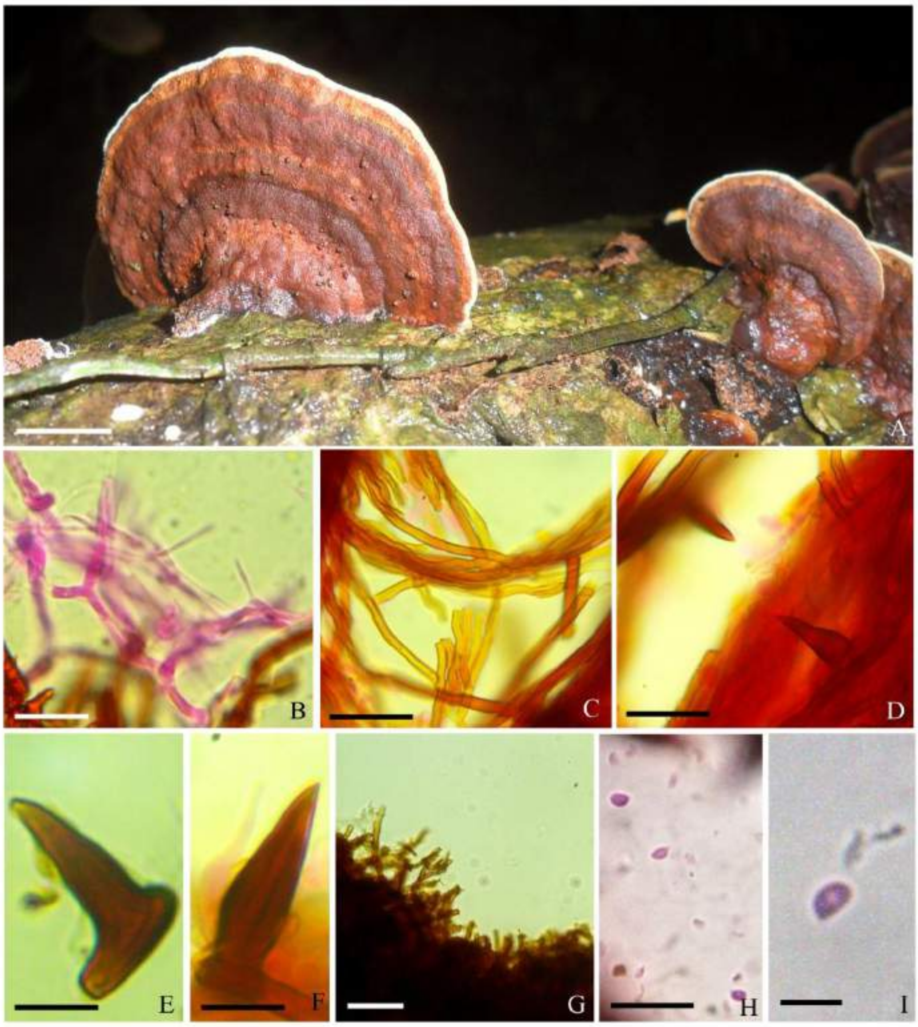


Figure 123: *Phellinus gilvus*-A. Basidiomata B. Generative hyphae C. Skeletal hyphae D. Hymenial region showing projecting setae E, F. Hymenial setae G. Pileipellis H. Basidiospores I. Basidiospore enlarged. Scale bars: A=10 mm, B=10 µm, C=24 µm, D=15 µm, E, F=6 µm, G=35 µm, H=15 µm, I=5 µm.

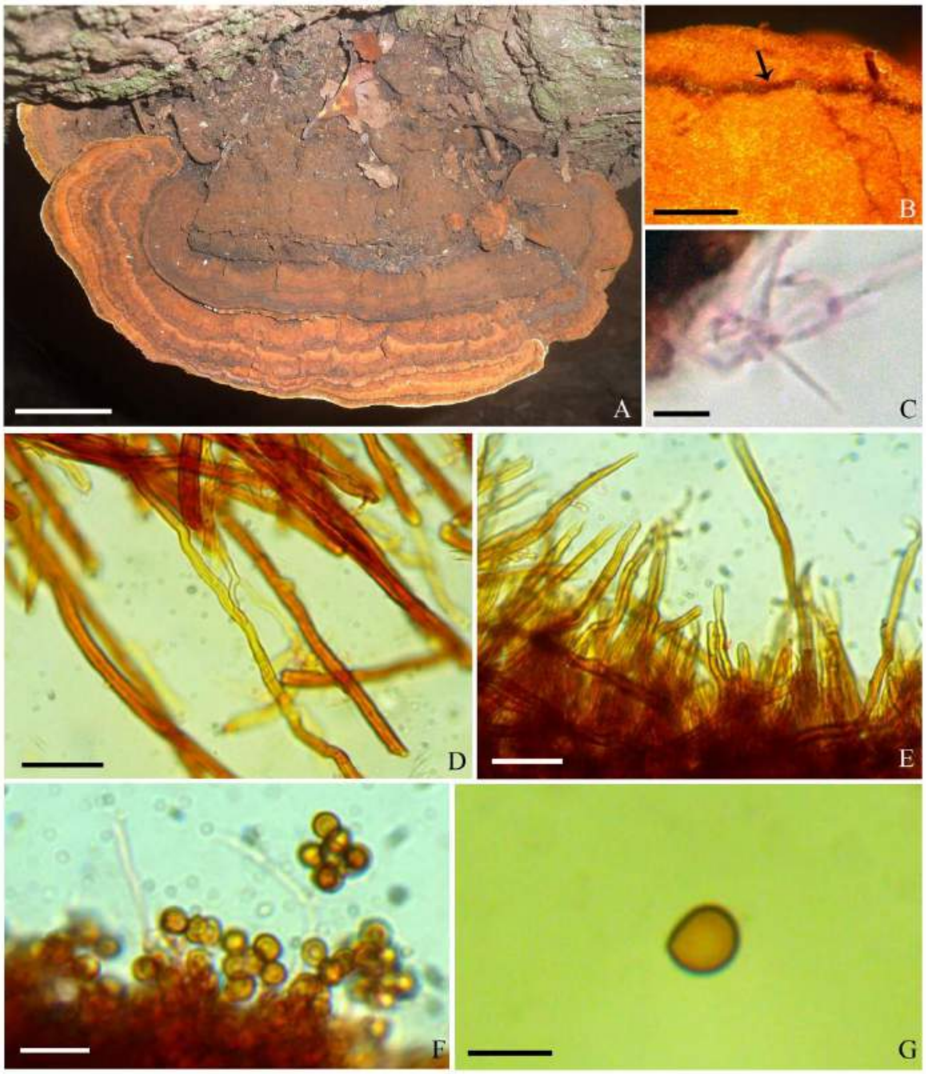


Figure 124: *Phellinus fastuosus*-A. Basidiomata B. Context showing distinct black line (arrow) C. Generative hyphae D. Skeletal hyphae E. Pileipellis F. Basidiospores G. Basidiospore enlarged. Scale bars: A=20 mm, B=5 mm, C=8 µm, D, E=20 µm, F=12 µm, G=6 µm.

Figure 125: *Phellinus hoehnelii*-A. Basidiomata B. Generative hyphae C. Skeletal hyphae D. Setal hyphae E, F. Hymenial setae G. Pileipellis H. Basidiospores. Scale bars: A=20 mm, B=9 μm, C, D=20 μm, E, F=12 μm, G=20 μm, H=6 μm.

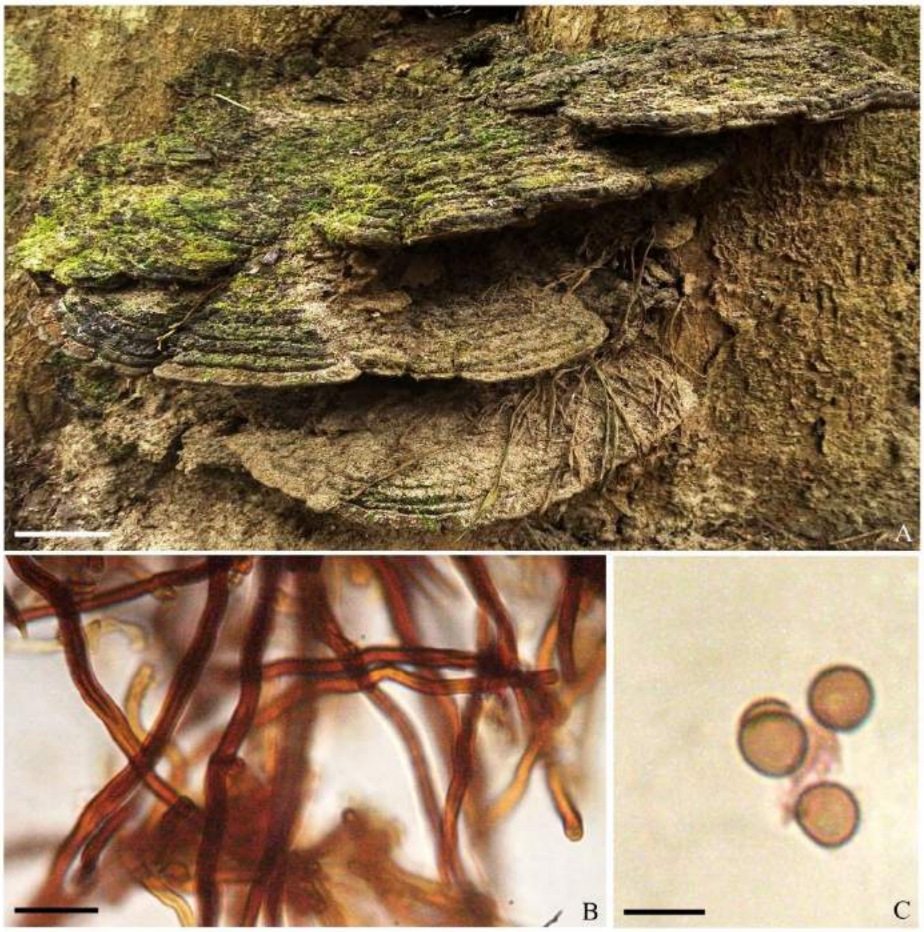


Figure 126: *Phellinus nilgheriensis*-A. Basidiomata B. Skeletal hyphae C. Basidiospores. Scale bars: A=20 mm, B=15 µm, C=5 µm.

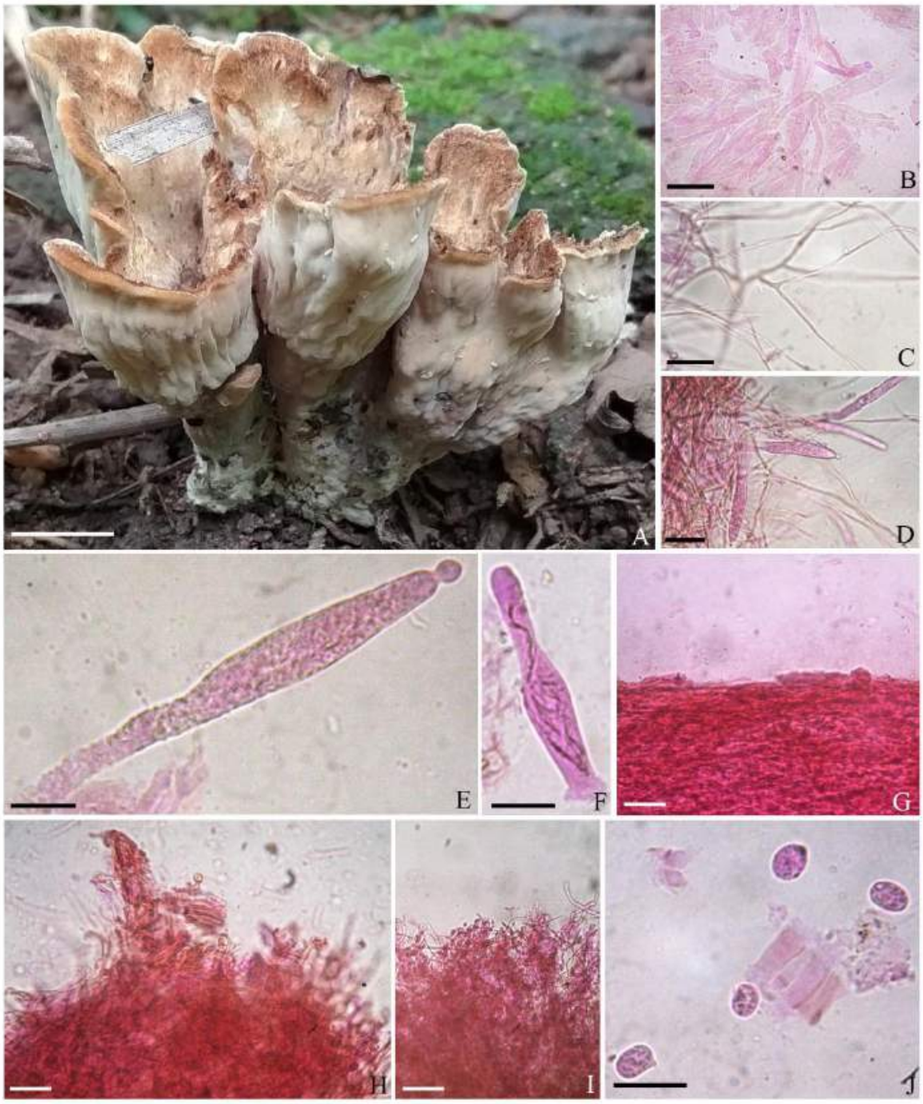


Figure 127: *Cotylidia pannosa*-A. Basidiomata B. Generative hyphae from hymenium C. Generative hyphae from stipe D, E, F. Pseudocystidia G. Pileipellis H, I. Stipitipellis J. Basidiospores. Scale bars: A=10 mm, B, C=10 µm, D=24 µm, E, F, G, H, I=10 µm, J=15 µm.

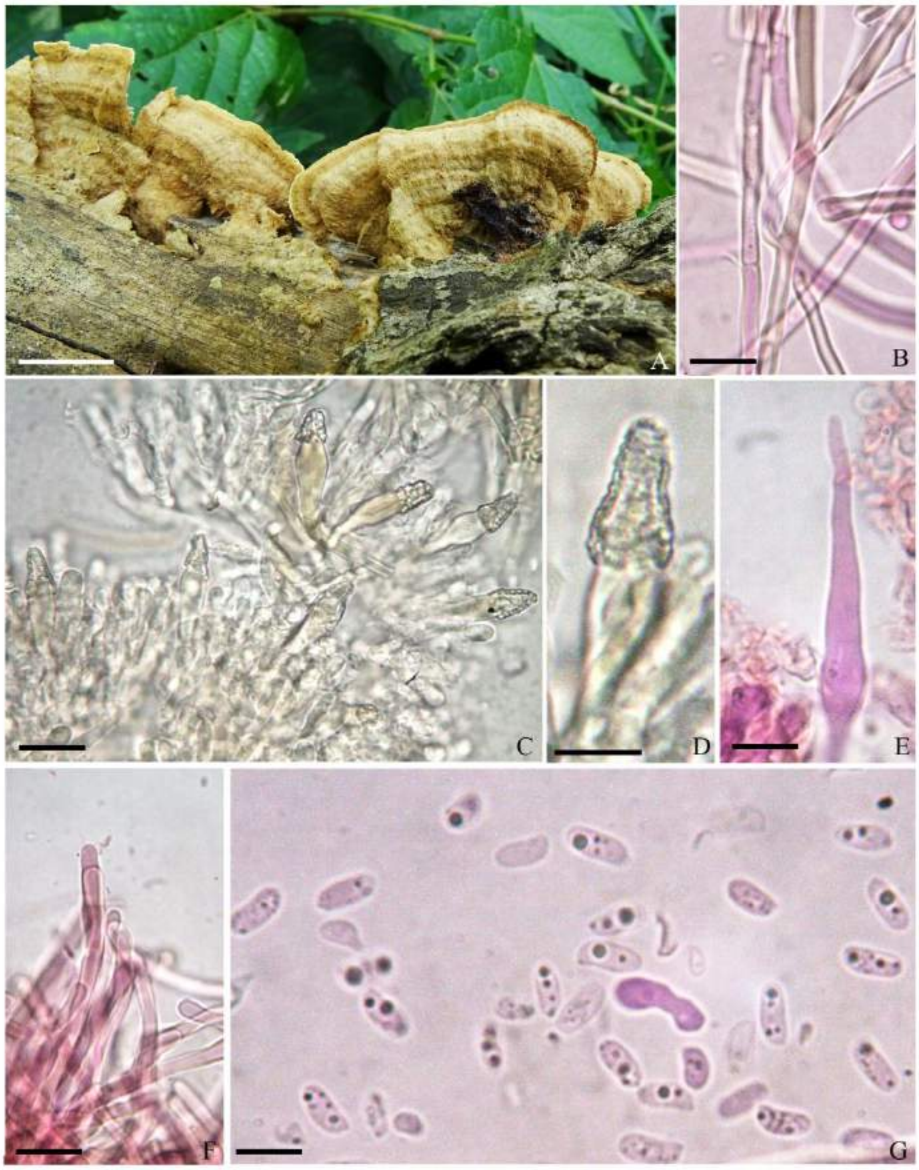


Figure 128: *Oxyporus ravidus*-A. Basidiomata B. Generative hyphae C. Hymenium showing encrusted cystidia D. Encrusted cystidia enlarged E. Gloeocystidia F. Pileipellis G. Basidiospores. Scale bars: A=40 mm, B, C=18 µm, D, E=9 µm, F=16 µm, G=7 µm.

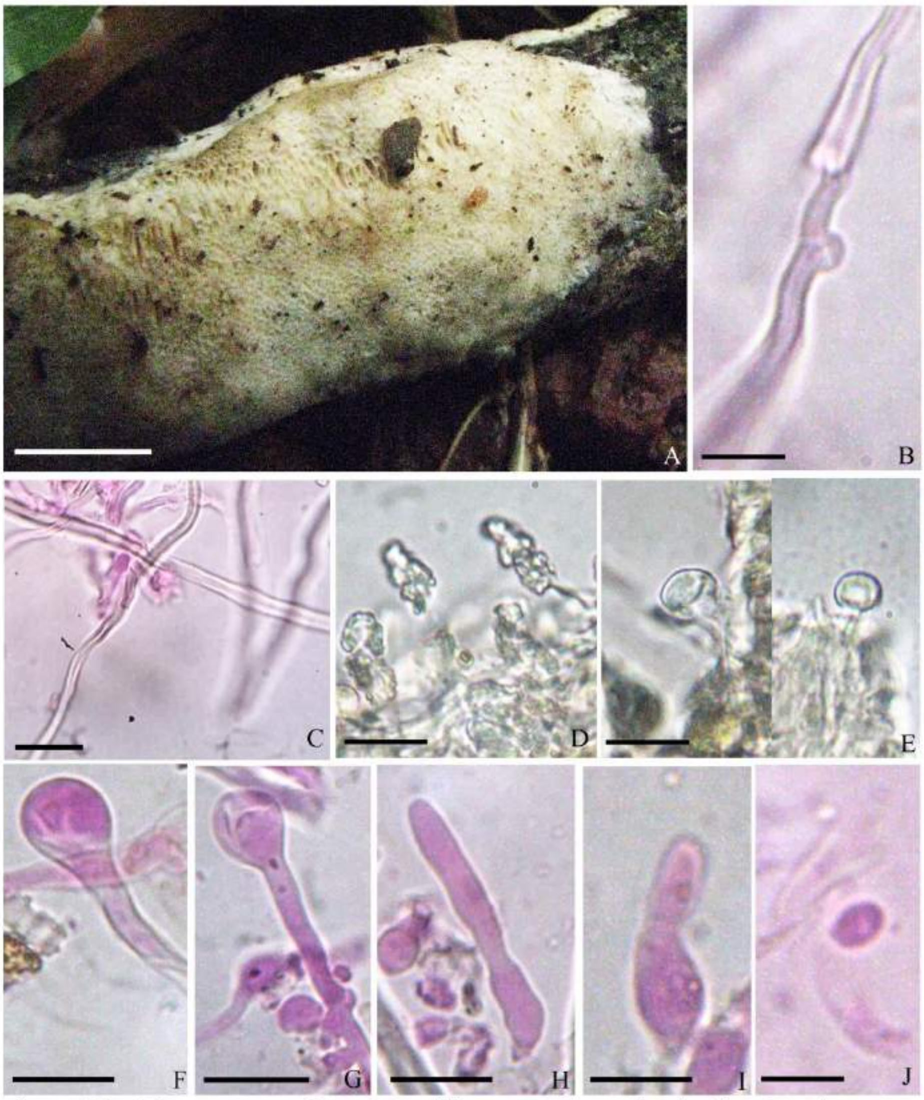


Figure 129: *Schizopora paradoxa*-A. Basidiomata B. Generative hyphae showing clamp connection C. Skeletal hyphae D. Encrustations on hyphal endings E. Capitate endings of skeletal hyphae F, G. Pseudocystidia H, I. Hymenial cystidia J. Basidiospore. Scale bars: A=10 mm, B, C, D=12 µm, E=7 µm, F, G=13 µm, H, I=8 µm, J=7 µm.

Figure 130: *Leucophellinus hobsonii*-A. Basidiomata B. Generative hyphae C. Hymenial portion with cystidia D. Cystidia enlarged E. Cystidia showing septation (arrow) F. Basidiospores G. Basidiospore enlarged. Scale bars: A=50 mm, B, C=12 µm, D, E=7 µm, F=24 µm, G=12 µm.

Figure 131: *Trichaptum biforme*-A. Basidiomata B. Generative hyphae and skeletal hyphae C. Generative hyphae showing clamp connections D. Hymenium showing projecting cystidia E, F. Cystidia G. Pileipellis H. Basidiospore. Scale bars: A=60 mm, B, C, D=15 µm, E, F=6 µm, G=18 µm, H=6 µm.

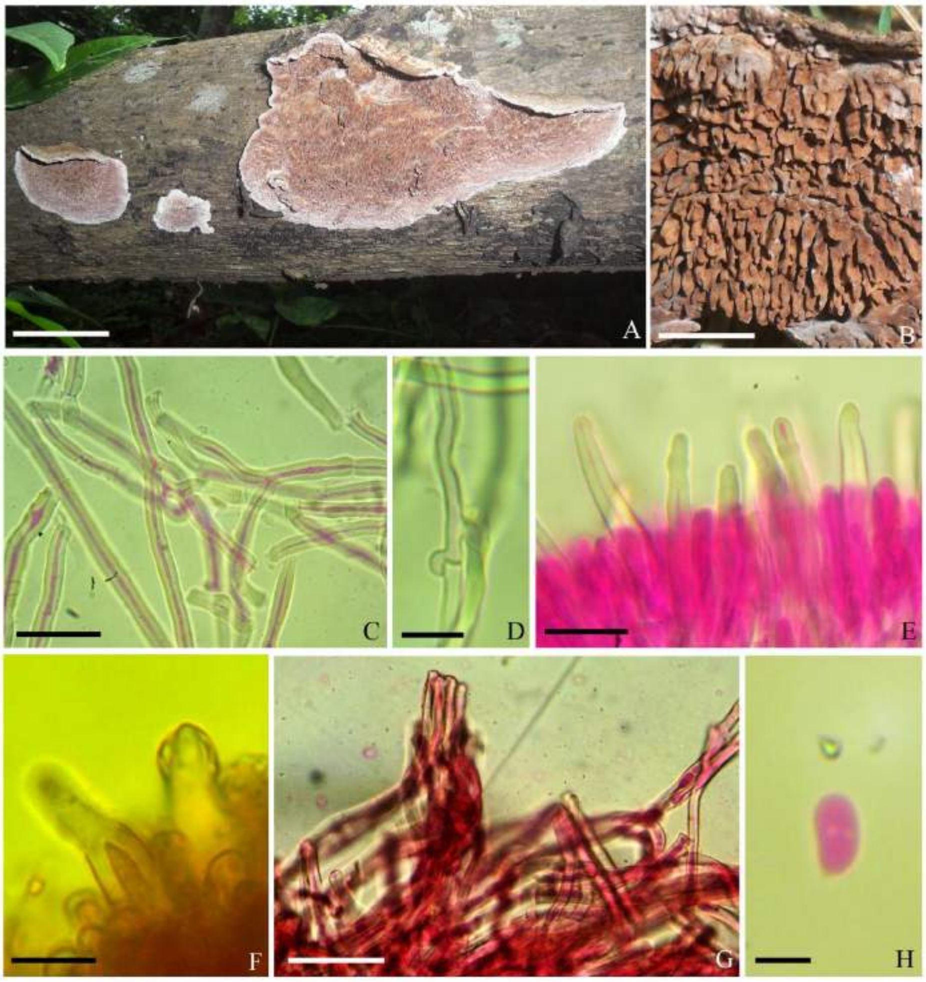


Figure 132: *Trichaptum byssogenum*-A. Basidiomata B. Hymenial surface C. Generative hyphae D. Generative hyphae showing clamp connection E. Hymenium showing basidia and projecting skeletocystidia F. Skeletocystidia G. Pileipellis H. Basidiospore. Scale bars: A= 80 mm, B=10 µm, C, D=13 µm, E=18 µm, F=10 µm, G=25 µm, H=5 µm.

Figure 134: Coconut palms infected with *Ganoderma* stem rot B. Coconut palm with *Ganoderma* fruit bodies C. Palm showing bleeding symptom D. Fruit body of *G. keralense* E. Young fruit bodies of *G. keralense* showing lateral stipe attachment F. Fruit body of species of *G. applanatum-australe* complex. Scale bars: D, E, F=40 mm.