

**INVESTIGATION ON THE ALPHA TAXONOMY OF
BETHYLIDAE (HYMENOPTERA: CHRYSIDOIDEA)
OF SOUTHERN WESTERN GHATS**

Thesis Submitted to the Faculty of Science, University of Calicut
in Fulfilment of the Degree of
DOCTOR OF PHILOSOPHY IN ZOOLOGY

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Date: 30. 08. 2010

CERTIFICATE

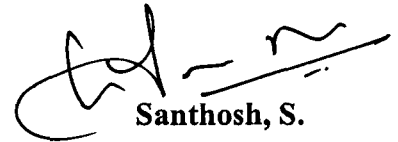
This is to certify that this thesis is an authentic record of the work done by Mr. Santhosh, S. in the Integrated Ph.D. Course Programme of the University of Calicut from April 2005 to May 2010 under my guidance and supervision in fulfilment of the requirements of the Degree of Doctor of Philosophy in Zoology, under the Faculty of Science of the University of Calicut. No part of the thesis has been presented before for any other degree. It is further certified that the candidate, Mr. Santhosh, S. has passed the M.Phil. Degree Examination, 2005 of the University of Calicut.

Prof. T. C. Narendran

DECLARATION

I hereby declare that this is an authentic record of the work carried out by me under the supervision of Prof. T.C. Narendran, Systematic Entomology Laboratory, Department of Zoology, University of Calicut and no part of this has previously formed the basis for the award of any Degree or Diploma as stipulated in the statutes of the University of Calicut.

Date: 30. 08. 2010



Santhosh, S.

Acknowledgements

This study would not have been possible without the intellectual and practical input of many people. I express my heartfelt gratitude towards Prof. T.C. Narendran, Department of Zoology, University of Calicut, for his scholarly guidance and suggestions to the present investigation. I am indebted to him for the expert training, timely advice and immense patience. I consider his advice and guidance as a rare privilege.

My heart is filled with gratitude towards Dr. M. Nasser, Sr. Lecturer, University of Calicut for the critical review of the thesis, for accompanying me in collection trips, donating specimens, scanning the line drawings, and above all for his innovative criticism and constant encouragement throughout the study. His friendliness and helpfulness is highly appreciated. My thanks goes towards Ms. Seena Narayanan Karimbumkara, Research Associate, Ashoka Trust for Research in Ecology and the Environment, Bangalore for contributing specimens, literature and running malaise trap for the seasonal collection. She has offered support and assistance in innumerable instances throughout the study and was helpful in reviewing the thesis as well. I thank Dr. Sudheer, K., Lecturer, ZGM College, Calicut for the critical review of the thesis, for accompanying me in the collection trips, and for the encouragement to complete the present investigation. I thank Dr. Rajmohana, K., Scientist, ZSI Calicut for the critical review of the thesis.

I extend my respectful gratitude to Prof. N. Ramani, Prof. M. Gokuldas, Prof. K.P. Janardhan, and Prof. V.S. Krishnan Nair, the heads of the department during the course period and the authorities of the University of Calicut for providing the laboratory, library, and other facilities of the department to the investigation. My appreciation also goes towards the staff of this department for their support.

I acknowledge my gratefulness to Mr. Jeroen de Rond, Netherlands, who inspired and supported me with motivating letters and assistance in several instances. He has been a strong supporter of the present investigation by sending literatures and standing as a guarantor for the loaned specimens from Amsterdam and Genova Natural History Museums. I thank Prof. V.V. Ramamurthy, Indian Agricultural Research Institute for providing me facilities for the type examination in his laboratory. I acknowledge his help in issuing a couple of loans of unidentified materials from National Pusa Collections, New Delhi.

I thank Dr. Fabio Penati, Curator-Hymenoptera, Museo Civico di Storia Naturale 'Giacomo Doria', Genova, Italy, James E. Hogan, Curator-Hymenoptera, Hope Entomological Collections, Oxford University Museum of Natural History, U.K., and Dr. Willem Hogenes, Curator-Hymenoptera, Zoologisch Museum, Amsterdam, Netherlands for loan of unidentified and type materials for the present investigation. I thank Dr. Mike Gates, Smithsonian Institution, Washington D.C.,

USA for providing malaise traps on loan for collecting specimens for the present study.

I thank Ms. Elahe Sadeghi, Ph.D. Candidate, Plant Pests and Disease Research Institute, Tehran, Iran, Dr. Andrew Polaszek, British Natural History Museum, London, Dr. Frank Burger, Natural History Museum, Erfurt, Germany, Dr. Chandrika Mohan, Central Plantation Crop Research Institute, Kayangulam, Dr. M. Sheeba, NSS College, Manjeri, Ms. Bindu, K. University of Calicut, for donating specimens to the present investigation. I thank Dr. Girish Kumar, P. ZSI, Kolkata and Mr. Abhilash Peter for accompanying me in collection trips.

I acknowledge the valuable contributions from the collaborative research with the UK Govt. funded Darwin Initiative Project "Bees, Diversity and Forest Livelihood in the Nilgiri Biosphere Reserve" carried out by Keystone Foundation, Kothagiri, Tamil Nadu, India. I thank Dr. Pratim Roy, Director and Ms. Anita Varghese, Programme Coordinator of Keystone Foundation and Mr. Stuart P. M. Roberts, Entomology Consultant, Reading University for facilitating the loan of specimens to the present investigation. I thank Ms. T.A. Priya, Mr. Justin Raj, Mr. Mahadesha, Research Assistants for collecting specimens.

I express my sincere gratitude to Dr. Celso O. Azevedo, Universidade Federal do Espirito Santo, Vitória, Brazil, Dr. Mamoru Terayama, University of Tokyo, Dr. L. Moczar, Magyar Természettudományi Múzeum, Budapest, Dr. Polaszek, British Natural History Museum, London, Dr. G. Gordh, United States Department of Agriculture, Dr. Ronald de Rooter, Library museum Naturalis, Leiden, Dr. Anil K. Dubey, National Taiwan University, Dr. Anantanarayana Raman, Charles Stuart University, Australia, Mr. Stuart P.M. Roberts, University of Reading, United Kingdom, Dr. Mike Gates, Smithsonian Institution, Washington D.C., Dr. Lynda Brooks, Librarian of the Linnean Society of London, Prof. Zaifu Xu, South China Agricultural University, Ms. Lidiana Zamprogno, Universidade Federal do Espirito Santo, Brazil, Mr. Jongok Lim, College of Agriculture and Life Science, Seoul National University, South Korea Ms. Asha Thomas, Entomology Division, Indian Agricultural Research Institute, New Delhi, Dr. Shanas Sudheer, Central Marine Fisheries Research Institute, Kochi, Ms. Seema Talwar, University of Delhi and Dr. Anjum Rizvi, ZSI, Dehra Dun for sending literature. I acknowledge the help rendered by Jayasree, and Santhosh, Librarian, Department of Zoology. I thank Rajesh and Balu of Bina Photostat for typesetting and preparing the print copy. I thank Ajesh, P., Technician, University Instrumentation Centre for recovering some of the image files.

I thank Haseena Pokakillath, Kuwait, Padmaja Ramakrishnan, Bangalore, Jumailath Pacheri and Reetha, K. of Govt. Higher Secondary School, Chelari, Ajaykumar, A.P., University of Calicut, Raseena Farsana, Farook College, Calicut, Veena, T., Malabar Christian College, Calicut and C. K. Abdul Rabbi Nistar, Mampad MES College for the motivation and support to carry out the present investigation. During my course of study, I have had the privilege to build much appreciated friendships. Sharing the evenings with Shameer Kundari meant a lot to

me. I have enjoyed sharing a room with a fellow Ph.D. student Sharshad Khan. It was good to learn more about Lakshadweep islands and its people.

My gratitude also goes towards Ministry of Environment and Forests, Govt. of India, New Delhi for the financial support. I thank Bob and Jan Clements, Royal Entomological Society, London for the travel grant to participate in the Hymenoptera Course 2006, Portal and visit to American Museum of Natural History. I thank the Education Department, Govt. of Kerala and Director of Higher Secondary Education for sanctioning me one year extension of joining of duty. I thankfully acknowledge the valuable help from Mr. T. K. Narayana Das, Syndicate Member, University of Calicut and Mr. Prakashan, Secretariat, Trivandrum in my effort to get this extension.

I am deeply grateful to my brother, Mr. Satheesh Kumar Shreevihar and sisters Ms. Shilaja Shreevihar and Ms. Sreelatha Shreevihar, who have been a great source of encouragement and emotional support during the course of the present study. And finally, but immensely Dad, Mr. T. P. Sankunni Nair and Mom, Ms. K. Chandralekha for their love and support.

Thank you

Santhosh S.

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"If we and the rest of the backboned animals were to disappear overnight, the rest of the world would get on pretty well. But if they were to disappear, the land's ecosystems would collapse. The soil would lose its fertility. Many of the plants would no longer be pollinated. Lots of animals, amphibians, reptiles, birds, mammals would have nothing to eat. And our fields and pastures would be covered with dung and carrion. These small creatures are within a few inches of our feet, wherever we go on land – but often, they're disregarded. We would do very well to remember them."

Sir David Frederick Attenborough

CHAPTER 1

INTRODUCTION TO THE THESIS

The desire to arrange, organize, describe, name and classify is fundamental in human activity. Such an urge operates at all levels of social organization. Even in ancient civilizations, names were assigned to organisms. Taxonomy, the branch of science involving the identifying, naming and classifying of organisms has become critically important in this era of declining biodiversity. Cataloguing species is fundamental to conservation and sustainable use of biodiversity.

Our planet, Earth is in a biodiversity crisis. Destruction of natural habitats and depletion of the world's biodiversity is presently proceeding at an alarming rate. We are living in a time of unprecedented mass extinction. Around the globe, biological communities that took millions of years to evolve are being devastated by human activity. The realization of biological diversity as an uncharted resource of immense worth intensified the popular interest in protecting the world's biological wealth. In order to conserve it, we need to know what we have in the first place. Thus, discovering and documenting the flora and fauna is in its heightened relevance. As the resources required to survey and assess diversity are dwindling and insufficient for current needs, it has become imperative to choose groups of greatest importance for priority study (LA SALLE and GAULD, 1991). Parasitic wasps are one among such focal groups.

1.1 Importance of Taxonomy in Biological Control

The knowledge of biosystematics of any group of organisms is the foundation of all meaningful research (NARENDRAN, 2001). The scientific name of an organism provides a key to the published literature regarding any zoological taxon and without the correct name the researcher has no access to the published works about an animal of interest. The need for accurate identification is essential in the biological control programmes. Differentiating the intraspecific variations in the taxonomic

characters from the interspecific differences is often difficult in the parasitic hymenopterans. Understanding of the functional significance of the diversity of observed morphological features has immense importance. The morphological differences often reflect the significant differences in the biologies of the organisms under study. The so called minor external structural differences may dictate the difference between pest and non-pest status of species or between success and failure to bring about regulation in the case of natural enemies. Thus, considerable amount of basic taxonomic research, particularly with entomophagous forms need to be pursued.

This thesis centers on the alpha taxonomy of the bethylid wasps of Southern Western Ghats and the adjoining areas. They are external parasites of lepidopterous and coleopterous larvae. Due to their host associations, bethylids are potentially beneficial in agriculture and forestry as biological control agents of various insect pests. Although this group is important in the agricultural, forestry, and medical fields, applied studies of bethylids have not been advanced due to the lack of taxonomic, phylogenetic and biological knowledge. Bethylid wasps, frequently encountered as parasitoids of crop pests, especially in the tropics have been used in attempted biological control programmes (GORDH and EVANS, 1976; HEMPEL, 1934). Successful identification of Bethylidae is therefore important for any programme of pest management involving these parasitoids.

1.2 Bethylidae: Systematics

1.2.1 Taxonomy

In the order Hymenoptera, family Bethylidae belongs to the superfamily Chrysidoidea together with other six families, viz. Chrysididae, Dryinidae, Embolemidae, Sclerogibbidae, Scolebythidae and Plumariidae. The first three are diverse and abundant ones, whereas the other four are rare minors. Bethylidae is considered as one of the most primitive hymenopteran families (MALYSHEV, 1968; BROTHERS and CARPENTER, 1993; INFANTE, 2001). This group of primitive aculeate Hymenoptera is widely distributed from the tropics to the subarctic regions of the world. Bethylidae is represented by about 2216 nominal

species in 97 genera of 7 subfamilies (AZEVEDO, 2006a). The estimated number of world Bethylid fauna is 6000 species, with only less than 30% of them described at present (AZEVEDO, 1999b). Hence, among the members of the superfamily Chrysidoidea, Bethylidae represents the most diversity rich group to be explored.

There are three opposing views about the recognition of subfamilies in Bethylidae: (1) ARGAMAN (1988) and STREJCEK (1990) recognize six subfamilies, viz. *Pristocerinae*, *Afgoiogfinae*, *Epyrinae*, *Galodoxinae*, *Mesitiinae*, and *Bethylinae*; (2) GORDH and MÓCZÁR (1990) recognize five subfamilies as *Afgoiogfinae* is included in *Pristocerinae*; (3) FINNAMORE and BROTHERS (1993) recognize only four subfamilies. According to them, *Afgoiogfinae* and *Galodoxinae* are unrecognizable and included in *Pristocerinae*; (4) TERAYAMA (2003a) cladistically analyzed the family and recognized six subfamilies viz. *Pristocerinae*, *Parapensiinae*, *Epyrinae*, *Galodoxinae*, *Mesitiinae*, and *Bethylinae*. He proposed a new subfamily *Parapensiinae* and included *Afgoiogfinae* in *Pristocerinae*. AZEVEDO (2006a) recognizes all the seven subfamilies valid. The higher classification in this investigation follows the latest findings.

1.2.2 Phylogeny

The family Bethylidae is grouped with other chrysidoid families due to the following characteristics: 1) modified head capsule associated with prognathy; 2) clypeus with longitudinal median carina; 3) anteriorly broadened metasternum; 4) hindwing costal vein absent except at the extreme base; 5) metasoma with six to seven exposed terga (CARPENTER, 1986; BROTHERS and CARPENTER, 1993; GAULD and BOLTON, 1988). The phylogentic analysis suggests that the sister group of Bethylidae is *Scolebythidae* (BROTHERS, 1975), or *Chrysididae* (CARPENTER, 1986). The most recent cladistic analysis (BROTHERS and CARPENTER, 1993) definitely indicates that *Chrysididae* is the sister group.

1.2 Bethylidae: General Description

Bethylids are ant-like small, nimble wasps that are readily recognized by their strong flattened body and prognathus head. Important morphological characters are short to

medium length antenna; antennal flagellum with 11 (rarely 10 or 8) segments; pronotum with an anterior flange and so propleuron is concealed when viewed dorsally. The prosternum is small, somewhat transverse, often concealed in ventral view and the metasoma has 6-7 exposed tergites. Sexual dimorphism is slight to extreme: male macropterous, rarely brachypterous; female macropterous, brachypterous, or apterous.

1.3 Bethylidae: Biology and Behaviour

1.3.1 Host Preference

Bethylids are mostly primary, external, larval parasitoids of Lepidoptera and Coleoptera. Bethylidae attacks species that live in cryptic situations, such as in the ground, burlap, wood and seeds (EVANS, 1964). Most species develop externally on their hosts *in situ*, such as in burrows, tunnels, leaf rolls and cocoons; others carry their host to and seal them in crevices. In their adult stage, these wasps feed themselves on the nectar of plants, whereas larval forms are idiobionts. It is known that these wasps, especially the apterous females, attack species that nest or live in conditions difficult to penetrate, for example, in wood, structures of cement or between stones (EVANS, 1964; AZEVEDO, 1999b). The morphological adaptations in the females of Bethylidae like the flattened body, prognathous head and strongly developed anterior femora allow them to explore these microhabitats.

Some species of *Apenesia* Westwood, *Pseudisobrachium* Kieffer and *Dissomphalus* Ashmead maintain an association with ants (ASHMEAD, 1893; BRUCH, 1916, 1917a, 1917b; EVANS, 1963a). EVANS (1964) observed that in laboratory conditions some Bethylidae are developed on larvae of ants. In spite of this, there is no reference on ant-like hosts of Bethylidae in natural conditions (AZEVEDO, 1999b). The only report of Bethylidae being developed in larvae of Hymenoptera in natural conditions is of *Goniozus microstigma* Evans on *Microstigma similes* de Melo (Sphecidae) (MELO and EVANS, 1993).

All the species of Pristocerinae and most of the species of Epyrinae have their hosts in the coleopteran families Scolytidae, Cerambycidae, Ciidae,

Buprestidae, Anobiidae, Dermestidae, Tenebrionidae, Elateridae, Bruchidae, Cucujidae, Ptinidae, Bostrichidae, Lyctidae, Cleridae and Curculionidae (AZEVEDO, 1999b). For the species of Bethylinae and some species of Epyrinae, hosts are microlepidoptera (FINNAMORE and GAULD, 1995). Bethylinae attacks microlepidoptera of the species of Tineoidea, Gelechioidea, Tortricoidea and Pyraloidea (FINNAMORE and GAULD, 1995).

1.3.2 Life Cycle and Habits

The biology of bethylid wasps are of interest particularly because of their interesting mating and food habits. Some of them have maternal care of the brood and a tendency in some species toward community life, such as *Sclerodermus domesticus* Latreille that develops activities of parental care and subsocial behaviour (CASALE, 1991). There are solitary and gregarious forms. Regarding adult habits in the gregarious species of the family, the males of the brood usually emerge a little in advance of females. They have the habit of then tear opening the female cocoons and often of entering them to mate with the newly emerging females. This habit of males assisting in the emergence of females results in very extensive inbreeding, which is normal in many species. However, its effects are offset by the repeated mating that is necessary during the life of individual females and the mating following the first are in most cases with males of unrelated broods. The closest inbreeding occurs in species that are able to produce several successive broods on a single host individual. Under such conditions, a female may mate with males of several generations of her own descendants (CLAUSEN, 1940, 1962)

Regarding host transport, some species attack their hosts in the open and after stinging they transport their host, much larger in size compared to them to a suitable crevice or cavity in the manner of fossorial wasps. Host paralysis is usually complete and permanent. In several species of *Goniozus* Förster, it is only temporary (30 minutes duration) (CLAUSEN, 1940, 1962). Some species of *Laelius* Ashmead find and attack the larvae of Dermestidae and place them in inaccessible sites (EVANS, 1964). This behaviour seems to be very common in other genera also (AZEVEDO, 1999b).

Adult females feed on the body fluids of the host, which is essential for their egg development. In many species, females spend their entire lives in the burrow, cell or cocoon of their hosts, where the body fluids are the only food available. *Goniozus* Förster need sugary food, *Sclerodermus* Latreille feed only on host fluids and the *Epyris* Westwood feed on both. The numbers of hosts that are attacked and paralyzed by a female is often considerably in excess of that which receives eggs. Females of *Goniozus nephantidis* (Muesebeck) were observed to immobilize full-grown caterpillars and kill them (RAO and CHERIAN, 1928).

The position of the egg on the host varies, though there is some uniformity within genera. Eggs of solitary species lay longitudinally, with the anterior end directed caudad. Among the species with gregarious habits, the eggs are usually placed transversely, exceptions to this being *Goniozus gallicola* (Kieffer), where eggs lie longitudinally on one side of the dorsum (GORDH, 1976). Evidence suggests that females of the different gregarious species regulate the number of eggs deposited on a single host to some extent in relation to its size. *Goniozus emigrates* (Rohwer) deposits only two eggs on small *Ereunetis* Meyrick larvae and an average of eight on larger larvae of *Cryptophlebia illepidia* (Butler) (CLAUSEN, 1962). Solitary species probably produce smaller numbers of eggs. A study of *Goniozus legneri* Gordh showed that oviposition behaviour was significantly influenced by variations in host/parasitoid densities (LEGNER and WARKENTIN, 1988).

On the larval development, the newly hatched larvae are for the most part unable to move and therefore make their feeding punctures and fix themselves before they are completely freed from the eggshell. A single feeding puncture is used throughout their life. Maternal care of the developing offspring is exhibited in a number of species, ranging from attention for only a few days after oviposition in *Cephalonomia gallicola* (Ashmead) to the completion of larval development in *Sclerodermus immigrans* Bridwell and *S. macrogaster* (Ashmead) (CLAUSEN, 1940, 1962). The females of the latter often stand over the brood and lick their bodies, at which time they are held between the forefeet (WHEELER, 1928). They will at times eat their own eggs, but not their larvae, and this habit is thought to be

associated with a tendency towards regulation of the size of the brood rather than being the result of food shortage (CLAUSEN, 1940, 1962). Most species spin cocoons, which in the gregarious species are usually matted together.

There is a lot of variation in size among the individuals that develop on a single host, largely due to crowding. Where the number of eggs deposited is above that which can be brought to maturity, the surplus larvae succumb, presumably by being forced away from the available food supply. However, superparasitism has not been authentically reported in Bethylidae (LEGNER and WARKENTIN 1988).

Reported life cycles of various bethylids range between a minimum of 9-12 days to a more frequent 30-35 days. The larval feeding period is usually followed by a prolonged resting period in the cocoon prior to pupation. The time spent in the cocoon may range from 10-20 days, though *Goniozus nephantidis* (Muesebeck) on *Opisina arenosella* Walker is said to require only four days (RAO and CHERIAN, 1928; REMADEVI *et al.*, 1981). Adult life of females ranges from one to three months under summer conditions with hosts available for feeding and reproduction. The life of adult males is much shorter, being only six days in *Cephalonomia tarsalis* (Ashmead), and no feeding takes place during this period (POWELL, 1938).

Apenesia Westwood, *Pseudisobrachium* Kieffer and *Dissomphalus* Ashmead exhibit phoretic copulation in the family Bethylidae and it is also found in some other families of Hymenoptera such as Mutillidae and Tiphiidae (AZEVEDO, 1999b).

1.4 Bethylidae: Their Relationship to Man

These wasps can be found in human habitats, mainly in the wooden structures of windows, doors, floor and ceiling (AZEVEDO, 1999b). Several cases of contacts between humans and bethylids exist, marked by accidents (stings). *Cephalonomia* Evans, *Epyris* Westwood, and *Sclerodermus* Latreille species have been well known as sanitary injurious pests that cause serious dermatitis for humans by their frequent stinging (TACHIKAWA, 1980a, 1980b, 1985a, 1985b). *Holepyris glabratus* (Fabricius) (PEMBERTON, 1932), *Laelius anthrenivorus* Trani (NAGY, 1968a)

and *Epyris californicus* (Ashmead) sting people severely (ESSIG, 1932). *Laelius utilis* Cockerell and *Sclerodermus nipponicus* Yuasa attacked hundreds of pupils in Japan (ASAHINA, 1953). The sting of bethylids in men resemble mosquito bites, produces pain, swelling and a reddish coloration of one centimeter in diameter that remains more or less for two weeks (AZEVEDO, 1999b).

1.5 Bethylidae: Economic importance

Since bethylid wasps are primary, external, larval parasitoids of many pest species of Lepidoptera and Coleoptera, investigations have been successfully pursued to make use of their mode of living in biological control programmes, giving good results. *Goniozus pakmanus* Gordh (GORDH and MEDVED, 1986), *G. aethiops* Evans (GORDH and EVANS, 1976), and *G. legneri* Gordh (GORDH, 1982b) had been imported to Pakistan, Ethiopia, Uruguay and California to control the cotton pest, *Pectinophora gossypiella* (Saunders) and *Amylois transitella* (Walker). Probably the significant economic importance of the bethylids in the tropical belt has been through the introduction of two exotic species: *Cephalonomia stephanoderis* Betrem and *Prorops nasuta* Waterston to control the pest of coffee, *Hypothenemus hampei* (Ferrari). *Goniozus nephantidis* (Muesebeck) has been an effective parasite of the black-headed caterpillar pest of coconut, *Opisina arenosella* Walker in India, Burma and Sri Lanka, which is presently used in Kerala for biological control (JAYARATNAM, 1941; DHARMARAJU, 1952; ANTONY and KURIAN, 1960; KURIAN and ANTONY, 1961; REMADEVI *et al.*, 1978). *Goniozus marasmi* Kurian found to parasitize upto 60% of *Marasima trapezalis* (Guenée) populations (VENKATRAMAN and CHACKO, 1961). *Apenesia sahyadrica* Azevedo and Waichert is used as an effective natural enemy of coffee white stem borer, *Xylotrechus quadripes* Chevrolat (Cerambycidae) in Southern India (AZEVEDO and WAICHERT, 2006).

1.6 Why Study Bethylidae?

1.6.1 Scope of bethylid taxonomy

Bethylid taxonomy has enough problems to solve and hence, it attracts and offers a good challenge to a taxonomy student. There is great scope in developing expertise in bethylid taxonomy as the estimated number of world species in this group is very high with 60% still awaiting discovery. Despite being one of the most abundant groups of Chrysoidea in the tropics they are the least worked out.

The grey zone that bethylids occupy in between the ordinary fossorial Hymenoptera and true parasites of Parasitica in terms of their habits is much to be investigated in the evolutionary perspective. Basic understanding of their taxonomy is crucial for expanding the knowledge of their biology and evolution. Their dazzling diversity and significance as natural enemies in regulating the host populations are of the reasons for prioritizing them as a focal group for the present investigation.

1.6.2 Neglected Group and Lack of Knowledge

The study of Bethylidae has been much neglected in the Indian subcontinent. Apart from isolated new species descriptions by WESTWOOD (1832), MOTSCHULSKY (1863), CAMERON (1888, 1897, 1899b, 1904, 1907, 1910), ASHMEAD (1903), KIEFFER (1904c, 1905b), BRUES (1906), BRETHERS (1913), TURNER (1914), ROHWER (1915), MUESEBECK (1934) and LAL (1939), the only comprehensive study on Bethylidae of Indian region was by KURIAN (1952, 1954a, 1954b, 1955), who described 45 taxa and prepared an Oriental catalogue and key to Indian genera. Most of the specimens studied by Kurian were confined to northern India. After Kurian's investigation, bethylid taxonomy was restricted to only isolated new species descriptions like MENON *et al.* (1959), GORDH (1988), RAM and SUBBARAO (1968), NAGY (1968b), MÓCZÁR (1970b, 1971b, 1976, 1977, 1984a), RAM (1969), AZEVEDO and WAICHERT (2006), TERAYAMA (2001, 2004b, 2005) and KROMBEIN (1996). Most of these studies carried out by Westerners based either on specimens sent out by Indian agricultural entomologists or specimens

accrued in western museums by collectors, who visited India during the British Raj. Beyond these works, nothing has been attempted on bethylids taxonomically.

Our present knowledge of the Indian Bethylidae is limited to the above mentioned isolated studies and the works by KURIAN (1952, 1954a, 1954b, 1955), which is in fact badly in need of a thorough revision. On the lacuna in the knowledge of Indian bethylid wasps, GORDH (1986b) commented “*The bethylid fauna of India is no doubt very interesting, but the current nomenclatural and taxonomic condition must be improved before meaningful comments can be made regarding the endemism and its relation to adjacent regions*”.

As per records, there are 97 species under 20 genera of Bethylidae from India as of 2009. So far, no revisionary work on this family has been conducted with special reference to the unique ecologically diverse zone called Southern Western Ghats. Much of the knowledge on these scientifically recorded species is restricted to their collection data and taxonomic description. Their potential as biological control agents have not been exploited in our country. There are enormous number of bethylid species waiting to be discovered and documented in the undergrowth and canopy. Sound systematic revision is essential to the conservation and sustainable use of this dazzling diversity. The lack of knowledge on this very group of parasitic wasps with enormous potential in the biological control arena is well enough a reason for taking up the present investigation.

1.6.3 Difficulty in Authoritative Identification

There are several problems associated specifically with the taxonomy of Indian Bethylidae. One among these difficulties is that type specimens for many of the species described from India cannot be located (GORDH, 1986b). Several species described from other parts of the world have been reported as taken from India, but materials of some of these species are not available for study.

The present keys to species in KIEFFER’S (1914a) world monograph are quite unworkable (RICHARDS, 1939). Some of the previous descriptions and keys, for instance KURIAN’S (1955) key to *Goniozus* used unreliable characters like leg

colouration to differentiate species. Another factor that causes difficulty with Kurian's descriptions is that they antedated EVAN'S (1964) pioneering work on bethylid taxonomy. Kurian had not included measurements and ratios that later workers found most useful in characterizing taxa (KROMBEIN, 1996). However, until types can be located one has to depend the original descriptions to understand the concept of each species.

Most of the bethylids are rare and it is difficult to obtain adequate material for study. To make matters worse, many previous records have often been based on misdeterminations (RICHARDS, 1939). Successful identification of Bethylidae has been extremely difficult because the most recent revision was published 96 years ago (KIEFFER, 1914a) and contains many errors (POLASZEK and KROMBEIN, 1994). Even at the generic level, identification is very difficult, particularly of Paleotropical species. The lack of sound revisionary works based on extensive collections, unavailability of types for examination and grave shortage of expertise in Oriental bethylids make it almost impossible for an authoritative identification.

The urge to provide more clarity to Indian bethylid taxonomy and to solve some of the above mentioned taxonomic problems associated with the Indian Bethylidae are among the many significant reasons for taking up this study.

1.7. Objectives of the Study

The broad objective of this investigation is to update the taxonomy at the species level and to assess the distribution of the family Bethylidae in Southern Western Ghats. Objectives envisaged in the investigation are the following:

1. To discover and describe the new taxa in the selected genera of Bethylidae.
2. To re-describe the poorly known taxa from the available types and pleisiotypes.
3. To provide workable illustrated dichotomous keys for the identification of the species and genera.

4. To provide computer based interactive keys providing easy and flexible order of characters for identification.
5. To gather information on the habitat and hosts of the bethylid wasps and to prepare a host parasitoid index.
6. To prepare a check-list of Oriental Bethylidae.
7. To provide updated information on the distribution of this family in Southern Western Ghats and to generate distribution maps for the species under study.

Since this investigation uncovered the presence of 24 genera, some of which are highly speciose such as *Epyris* Westwood, *Holepyris* Kieffer, *Goniozus* Förster, *Sulcomesitius* Móczár, and *Apenesia* Westwood and accrued many undescribed species in the collections, the present study is restricted to the revisionary studies of the four genera viz. *Goniozus*, *Sierola* Cameron, *Odontepyrus* Kieffer and *Sclerodermus* Latreille, first three falling in the subfamily Bethylinae and the fourth in the tribe Sclerodermini of the subfamily Epyrinae from the study area. The criteria for selecting the four genera are either singly or in combination of the following aspects:

- Abundance of specimens,
- Availability of the types for examination,
- Need for taxonomic revision
- Economic importance of the species in the light of their biological control potential.

CHAPTER: 2

LITERATURE REVIEW

2.1 General Historical Overview of Family Bethylidae

HALIDAY (1839) first used the name Bethylidae. FÖRSTER (1856) used a different name Bethyloide for the same group, which ASHMEAD (1902) corrected to Bethylidae. However, ASHMEAD (1893) treated the family Bethylidae as a subfamily of the old family Proctotrypidae, when he published some new species. CAMERON (1883) incorporated the subfamily Bethylinae in the family Proctotrupidae. DALLA TORRE (1898) divided Cameron's Bethylinae into two subfamilies, Bethylinae and Pristocerinae. On the other hand, ASHMEAD (1902) and BROWN (1906) placed Bethylidae or Bethylinae in the superfamily Vespoidea.

In the early 20th century, Kieffer studied the fauna of Bethylidae of the entire world and described many genera and species. In '*Genera Insectorum*' KIEFFER (1908) gave descriptions for 491 species under 58 genera of Bethylidae of the world. Furthermore, in '*Das Tierreich*', KIEFFER (1914) recognized 660 species under 102 genera, and presented a key to known species. He also established 5 tribes, namely Pristocerini, Sclerodermini, Epyrini, Mesitiini, and Bethylini.

Since the great world-wide revision of KIEFFER (1914), many workers described more than 1,000 species of this family. However, none of the authors provided world-wide inventory thereby producing a dispersed knowledge for the different regions of the planet. This has resulted in the difficulty of establishing relations between the faunas of the zoogeographical regions. With the intention to overcome such difficulties, GORDH and MÓCZÁR (1990) provided a catalogue for all the species of the family in the world, registering about 1,800 species, placed in 104 genera. Moreover, TERAYAMA (1995a, 1995b, 1996a) has carried out thorough revision of the subfamilies and tribes based on cladistic analysis and this has promoted a better agreement on the group, establishing some synonymies and placing genera *incertae sedis* in specific tribes.

2.2 World Bethylidae

The major systematic treatment of world Bethylidae were carried out by the following researchers in the past. BRUCH (1916, 1917a, 1917b) and OGLOBLIN (1925a, 1925b 1930, 1938, 1950, 1954, 1960, 1963) had been the first South American scientists to study the fauna of South America, particularly of Argentina, in the beginning and middle of 20th century. BENOIT (1957, 1963a, 1981, 1982a, 1982b) published his extensive works on the African fauna in 5 parts, especially of the various genera of Pristocerinae. RICHARDS (1932, 1935, 1939), BERLAND (1928, 1943, 1951, 1976), NAGY (1969, 1970, 1972, 1974, 1976) and ARGAMAN (1988, 1989) had studied the fauna of Bethylidae of certain areas of Europe, having included the European east, and of the entire Mediterranean region. MÓCZÁR (1966a, 1966b, 1970a, 1970b, 1971a, 1971b, 1976, 1977, 1979, 1981, 1982, 1984a, 1984b) thoroughly studied the fauna of the Europe, having published some texts on the species of Mesitiinae of the Mediterranean Europe, Africa and of the eastern region. KROMBEIN (1957, 1958, 1967, 1979, 1987a, 1987b, 1989, 1990) studied the fauna of Sri Lanka and Botswana. ASHMEAD (1893, 1895a, 1895b, 1900, 1901, 1903, 1904a, 1904b, 1905), CAMERON (1881, 1883, 1886, 1888, 1897, 1899a, 1899b, 1900, 1904, 1906), BRUES (1903, 1906, 1907a, 1907b, 1908a, 1908b, 1910a, 1910b, 1933) and FOUTS (1928, 1936, 1939) are the major taxonomic treatments in the family. EVANS (1964, 1978) studied American Bethylidae and published more than 40 articles on the group, including revisions on diverse genera of the continent. KURIAN (1952, 1954a, 1954b, 1955) studied the fauna of the eastern region, with special reference to the species of India and prepared a catalogue of the species of Bethylidae of this region. AZEVEDO (1999a, 1999b, 2001, 2004) has contributed to the study of the Neotropical fauna and TERAYAMA (1995a, 1995b, 1996a, 1996b, 2003a, 2003b, 2006) to the Palaearctic fauna.

PANZER (1801) described the first known Bethylid species *Bethylus cenopterus* (= *Tiphia cenoptera*) and *Bethylus hemipterus* (= *Tiphia hemiptera*) from Germany. LATREILLE (1802) erected the very first genus, *Bethylus*. KLUG (1808)

erected the genus *Pristocera*. LATREILLE (1809) erected the genus, *Sclerodermus* with the type species, *Sclerodermus domesticus* Klug. In some papers, the species *Sclerodermus domesticus* (Latreille) is named *Scleroderma domesticum* Latreille (KÜHNE and BECKER, 1974). They affirmed that although the species was described by Klug, the author of the concerned publication was Latreille. WESTWOOD (1832) conducted studies on Bethylids and erected *Epyris*. WESTWOOD (1833) erected the genus *Cephalonomia*. HALIDAY (1834) published notes on Bethyli. HALIDAY after four years in 1838, studied and published notes on the genus *Epyris* Westwood. WESTWOOD (1839) published a monograph on the genus *Sclerodermus*. DAHLBOM (1854) erected the genus *Cleptes* that was subsequently designated as *Heterocoelia* Dahlbom by BODENSTEIN (1939). FÖRSTER (1856) erected the genus *Goniozus*.

WESTWOOD (1874) erected the genera *Apenesia* Westwood and *Eupsenella* Westwood. In addition to that, WESTWOOD (1881) published descriptions of the following; *Sclerodermus bicolor*, *Sclerodermus wollastonii*, *Sclerodermus vigilans*, *Sclerodermus thwaitesiana*, *Sclerodermus soror*, *Sclerodermus linearis*, *Sclerodermus fonscolombi*, *Cephalonomia cursor* and *Cephalonomia peregrina*. ASHMEAD (1893) published a monograph on the North American Proctotrypidae in which he included the Bethylid wasps. KIEFFER (1904a) erected the genera *Pseudisobrachium* and *Homoglenus*. KIEFFER (1904b) erected the genus *Rhabdepyris*. KIEFFER (1904c) erected the genera *Odontepyris* Kieffer, *Discleroderma* Kieffer and *Parascleroderma*. KIEFFER (1905a) erected the genera *Trissomalus*, *Allepyris*, *Bradepyris*, *Disepyris*, *Glenosema*, *Holepyris*, *Neurepyris*, *Planepyris*, *Pristepyris*, *Proscleroderma*, *Scaphepyris*, *Trachepyris*, *Trissepyris* and *Anisobrachium*. KIEFFER (1905b) erected the genera *Prosierola*, *Allobethylus* and *Anisepyris*. KIEFFER (1905c) published a paper on Bethylidae of Europe and Algeria. TURNER conducted studies on fossorial Hymenoptera with special reference to Bethylidae (1915a, 1915b, 1917).

ROHWER (1917) described *Goniozus emigratus* (Rohwer) from material collected from Oahu, a parasite of the pink bollworm, *Pectinophora gossypiella*

(Saunders). BRIDWELL (1917a, 1917b) studied Bethylidae of Hawaii and published notes on *Epyris* and other Bethylids. BRUCH (1917a, 1917b) published a systematic study on Bethylidae. WATERSTON (1923) erected the genus *Prorops*. Extended summaries of the habits of the family were presented by BRIDWELL (1919, 1920). GELDERN (1927) studied the systemic effects following the sting of a species of *Epyris* Westwood. BERLAND (1928) separated superfamily Bethyloidea from superfamily Proctotrupoidea [= Proctotrupidae in CAMERON (1883)] and raised Kieffer's 5 tribes to subfamily rank. The name Mesitinae was given initially by BERLAND (1928) which was later changed to Mesitiinae, according to the International Code of Zoological Nomenclature (4th Edition). WHEELER (1928) presented summaries of the main habits of the family Bethylidae. GAHAN (1930) presented synonymical and descriptive notes on parasitic Hymenoptera including Bethylidae. One of the most thorough studies on a single species was that by VAN EMDEN (1931) on *Cephalonomia gallicola* Ashmead, a gregarious external parasitoid of the larvae and pupae of the anobiid beetle, *Stegobium paniceum* Linne.

ESSIG (1932) and ESSIG and MICHELbacher (1932) conducted studies on stinging Bethylids with special reference to the genus *Epyris*. RICHARDS (1932) prepared notes on the genus *Bethylus* Latreille (= *Perisemus* Förster). RICHARDS (1933, 1939) carried out further studies and contributed a thorough revision of the British Bethylidae. HOFFER (1936) described and presented a systematic treatment on Bethylidae of France. BACK and COTTON (1938) studied the parasites including Bethylids of the grain pests. Immature stages of the family were discussed in detail by CLAUSEN (1940). REID (1941) published his studies on the thorax of the wingless and short-winged Hymenoptera with special reference to Bethylidae. ASAHINA (1953) reported a remarkable case of the biting of *Sclerodermus nipponicus* Yuasa in Tokyo. KAWASHIMA (1959) reported eye injury caused by the sting of *Sclerodermus nipponicus* Yuasa and discussed the morphology of the wasp.

EVANS (1961) revised the genus Kieffer of North and Central America. EVANS (1962) revised the genus *Bethylus* of North America. EVANS (1963a) revised the genus *Apenesia* Westwood in the Americas. EVANS (1963b) revised the genus *Pristocera* Klug in the Americas. BENOIT (1963a) thoroughly studied the African Bethylidae and presented a monograph on subfamily Pristocerinae. BENOIT (1963b) published rectifications to the Monograph on African Bethylidae in the same year. EVANS (1964) conducted an extensive revisionary study and contributed to the taxonomy of the New World Bethylid fauna. In this revision, he recognized 4 subfamilies in Bethylidae, namely Pristocerinae, Epyrinae, Mesitiinae and Bethylinae, and regarded Berland's subfamily Scleroderminae as a tribe of subfamily Epyrinae. EVANS (1964) contributed a revision of the American Bethylidae. EVANS (1965) revised the genus, *Rhabdepyris* in the New World.

KROMBEIN (1967) presented supplement to the synoptic Catalog of Hymenoptera of America North of Mexico. EVANS (1969a) studied Phoretic copulation in Hymenoptera, especially in Bethylidae. EVANS (1969b) revised the genus, *Epyris* Westwood in the Americas. NAGY (1969) conducted his systematic studies on Mesitiinae. NAGY (1970) contributed a revision of the European species of the genus *Epyris* Westwood. MÓCZÁR's work on Mesitiinae from around the world was published in two parts, the first part (MÓCZÁR, 1970a) contains description of some new genera and species in which he erected the genus *Sulcomesitius* and the second part (MÓCZÁR, 1970b) was a revision of genera *Sulcomesitius* and *Mettrionotus*. MÓCZÁR (1971a) erected genus *Pycnomesitius*. The third part of the "Mesitiinae of World" by MÓCZÁR (1971b) deals with genera *Mesitius* Spinola, *Pycnomesitius* Móczár, *Parvovculus* Móczár, *Pilomesitius* Móczár and *Heterocoelia* Dhalbom.

TACHIKAWA and YUKINARI (1974) studied parasites of *Goniozus japonicus* Ashmead in Japan. KÜHNE and BECKER (1974) published a paper, which is probably the most comprehensive paper on *Scleroderma domesticum*. HEDQVIST (1975) published keys to subfamily, genera and species of Bethylidae in his revision of Bethylids of Sweden with description of a new genus *Snappania*,

which was later synonymized with *Plastanoxus* Kieffer. TACHIKAWA (1976) published the record of *Cephalonomia gallicola* (Ashmead) from Japan. GORDH (1976) studied the morphology and biology of *Goniozus gallicola* (Kieffer) in detail. BERLAND (1976) conducted studies on Bethylids of France and presented an Atlas of French hymenopterans with special reference to Bethylidae. EVANS (1977) revised the genus, *Holepyris* Kieffer in the Americas. EVANS (1978) did the recent revision on American Bethylidae, which is a classic contribution to the systematics of the family and provides an impetus for sorting biological details of the Bethylid species. All known species were described and key to differentiate genera and species within genera were provided. TRJAPITZIN (1978) described Bethylids from the European Part of the USSR. GORDH (1979) catalogued the Hymenoptera including Bethylidae in America, North of Mexico.

RUBINK and EVANS (1979) published notes on the nesting behaviour of the Bethylid wasp, *Epyris eriogoni* Kieffer and the morphology also was discussed. MAMAEV and YAGDYEV (1979) published a paper on problems of practical use of the entomophagous insects of the genus *Sclerodermus*. VASKOV (1981) published notes on the insect fauna which are potential prey of *Sclerodermus turcmenicum*. GORDH and HAWKINS (1981) published a paper on *Goniozus emigratus* (Rohwer), a primary external parasite of *Paramyelois transitella* (Walker) with the comments on bethylids attacking Lepidoptera. GORDH (1982a) presented taxonomic recommendations concerning biological control. GORDH (1982b) described a species of *Goniozus* imported into California for the biological control of the navel orange worm. EVANS (1984) studied biology of insects, especially Bethylidae. MERTINS (1985) studied the biology and morphology of *Laelius utilis* Cockerell, a parasitoid of *Anthrenus fuscus* in Iowa. GORDH (1986a) studied a species of *Goniozus* Förster from southern Africa parasitizing sugarcane borer, *Eldana saccharina* Walker, and taxonomic notes on species of the genus in Africa were also presented.

HAWKINS and GORDH (1986) contributed to the bibliography of the world literature of the Bethylidae. EVANS (1987) conducted observations on immature

stages of Bethylidae. ARGAMAN (1988) erected a new subfamily A Ngoiogfinae based on the genus *A ngoiogfa* Argaman from Italy and included *Parascleroderma* Kieffer in this subfamily as the second genus. ARGAMAN (1989) studied and published notes on some Western Palaearctic Pristocerinae, in which *Dissomphalus claudivani* Argaman is described from Israel, confirming the occurrence of the genus in the Western Palaearctic Region. Three new specific synonyms and two new combinations were proposed. KROMBEIN (1989) revised the subfamily Pristocerinae from Botswana. GORDH and MÓCZÁR (1990) presented a Catalogue of World Bethylidae. This checklist outlined bibliographic information and distribution of each species, treating 1794 species in 91 genera in 5 subfamilies excluding fossil records. In this checklist they rejected the segregation of subfamily A Ngoiogfinae from Pristocerinae. KROMBEIN (1990) revised Epyrinae from Botswana. STREJCEK (1990) erected the genus *Acephalonomia* under the tribe Cephalonomiini with the type *Acephalonomia cisidophaga*. CARPENTER (1990) published notes on Brother's aculeate phylogeny.

AZEVEDO (1992) erected the genus *Alongatepyris*, under the tribe Sclerodermini. KROMBEIN (1992) conducted a major systematic study of the genera of Epyrinae with ramose male antennae. FINNAMORE and BROTHERS (1993) contributed a chapter on Chrysidoidea in the Hymenoptera of the World. They did not recognize subfamilies A Ngoiogfinae of Argaman and Galodoxinae of Nagy and provided key to the subfamilies of Bethylidae and key to families of the superfamily Chrysidoidea. BROTHERS and CARPENTER (1993) published the phylogeny of Aculeata that includes Chrysidoidea and Vespoidea. POLASZEK and KROMBEIN (1994) reassessed the taxonomic status of the genera comprising the bethylid subfamily Bethylinae using computerized phylogenetic analysis. They synonymised *Trissomalus* Kieffer with *Odontepyris* Kieffer and *Anoxus* Thomson with *Bethylus* Latreille. In addition, several species were transferred generically, several new combinations were presented and distribution and biology of Bethylinae were summarized.

TERAYAMA (1995a) briefly revised the subfamily Bethylinae with a key to world genera and their distribution maps. In that work, 7 genera were recognized and their distributions were treated along with which possible phylogenetic relationships were discussed. FINNAMORE and GAULD (1995) synonymised *Apenesia* with the genus *Pristocera* without any explanation. TERAYAMA (1995b) revised the Bethylid tribe Sclerodermini, recognized 9 genera and discussed possible phylogenetic relationships, synonymized *Nesepyrus* Bridwell with *Allobethylus* Kieffer and included the genus *Bethylopsis* Fouts in the tribe. The genus *Bethylopsis*, the precise taxonomic position of which being unknown, was included in this tribe. He provided a key to the world genera under Sclerodermini. TERAYAMA (1995c) revised Taiwanese *Pristocera* and gave a key to species.

TERAYAMA (1996a) revised the subfamily Pristocerinae, in which he discussed the phylogenetic relationships and raised the subgenus *Acrepyris* of the genus *Pristocera* to the generic status and provided a key to world genera of Pristocerinae. TERAYAMA (1996b) newly recorded the genus *Glenosema* Kieffer from the Oriental Region on the basis of 3 species, *G. siamensis* Terayama, *G. Chiangmaiensis* Terayama and *G. doiinthanonensis* Terayama. A key to Oriental *Glenosema* was also provided. TERAYAMA (1997a) conducted a historical review of the taxonomic and systematic studies of Bethylidae in which phylogenetic hypothesis, family level relationships within Chrysidoidea and genus level relationships within each subfamily were provided and the present status of faunal surveys were also discussed.

SANTOS and AZEVEDO (2000) studied *Anisepyrus* Kieffer from Brazil in which the eleven described species were considered and 19 new species were described. ROND (2001) provided the most recent list of Bethylidae found in Germany with references and remarks. VARGAS and TERAYAMA (2002) described five new species from Colombia. TERAYAMA (2003a) cladistically analyzed the higher phylogeny of Bethylidae using all possible subfamilies and published the results in two parts. Although the 'Parapenesia problem' has been unsolved, he erected a new subfamily Parapenesiinae based on the type genus

Parapenesia Kieffer from South Africa. The first part contains the opposing views on the subfamily classification, a short historical background and the internal phylogeny of Pristocerinae, Epyrinae, Bethylinae, Mesitiinae, Galodoxinae, and the newly erected Parapenesiinae. He provisionally synonymized Afoiogfinae with Pristocerinae by the cladistic analysis. The second part of "Phylogenetic systematics of the subfamily Bethylidae" by TERAYAMA (2003b) provided keys to all the six subfamilies, three tribes and 64 world genera. In this, he synonymised the genera *Homoglenus* Kieffer and *Procalyza* Kieffer with genera *Epyris* Westwood and *Anisepyris* Kieffer respectively. Along with that Terayama transferred genus *Bradepyrus* Kieffer from Epyrinae to Mesitiinae. WAICHERT and AZEVEDO (2004) described 14 new taxa of *Pseudisobrachium* from Brazil. PLOEG and NEL (2004) described a new fossil bethylid, *Protobethylus eocenicus* from lowermost Eocene amber of France.

VIKBERG and KOPONEN (2005) treated *Laelius* Ashmead from Finland and Sweden with descriptions of three new taxa. They designated a neotype for *Bethylus femoralis* Förster, lectotype for *Bethylus rufipes* Förster and listed all nominal species of *Laelius* from Palaearctic region and keys were presented for females and males. AZEVEDO (2005) described a new species of *Allobethylus* from Australia and a key to seven world species were also provided. AZEVEDO (2006a) studied the geographical distribution of Bethylidae in Australia. AZEVEDO (2006b) proposed two new genera, *Megaprosternum* from Australia and *Solepyris* from Brazil and Ecuador under the tribe Sclerodermini and provided a key to world genera of the same tribe. GOBBI and AZEVEDO (2006) investigated the Brazilian fauna of the genera *Holepyris*. TERAYAMA (2006) carried out thorough systematic treatment of 20 genera of the family Bethylidae from Japan. He described 52 new species and one new genus, *Allplastanoxus* Terayama. He also published the phylogenetic analysis using cladistic method at the subfamily level for Epyrinae in the same publication. AZEVEDO (2008a) studied Neotropical *Pseudisobrachium* and made twelve nomenclatural acts and recognized 110 valid species and two lectotypes were designated. AZEVEDO (2008b) investigated nine valid species of the rarely collected New World bethylid genera *Prosierola* Kieffer. ALENCAR and

AZEVEDO (2008) proposed a new species group, *microstictus* of *Dissomphalus* and thirteen new species were described from Neotropics. VARGAS and AZEVEDO (2008) revised the rarely collected Neotropical genus *Alongatepyris* of the tribe Sclerodermini and described a new species from Columbia. According to the study of LANES and AZEVEDO (2008) on the phylogeny and taxonomy of Sclerodermini, the genus *Discleroderma* Kieffer is polyphyletic and transferred *Discleroderma yakushimensis* Terayama and *D. undulatum* Krombein to *Sclerodermus* Latreille, reinstated the genus *Nothepyris* Evans to accommodate *Lepidosternopsis sulcata* and *L. brasiliensis* (Evans) and described two new genera *Platepyris* and *Tuberepyris* from Ethiopian region. LIM *et al.* (2009) described *Odontepyris telortis* based on materials from Korea. BARBOSA and AZEVEDO (2009) recorded *Laelius* from Afrotropical region for the first time and two species were discovered. AZEVEDO (2009) amended the diagnosis of the rarely collected bethylid genus *Solepyris* Azevedo based on the second species of the genus described from Brazil. BARBOSA and AZEVEDO (2010) studied *Laelius* from Arabian Peninsula. AZEVEDO *et al.* (2010) published the preliminary results of the investigation on Bethylidae collected by light traps and Malaise traps at genus level from the Arabian Peninsula. AZEVEDO and ALENCAR (2010) rediscovered and synonymised the Afrotropical genus *Trissepyris* Kieffer with *Epyris* Westwood. AZEVEDO (2010) reviewed the Afrotropical *Dissomphalus* with emphasis on genitalia.

2.3 Oriental Bethylidae

MOTSCHULSKY (1863) catalogued Sri Lankan insects including Bethylids and described *Goniozus montanus* Kieffer (= *Bethylus distigmus* Motschulsky) and *Holepyris amplipennis* (Motschulsky). CAMERON (1888) described *Epyris orientalis* Cameron from Bengal, India which was later transferred to *Pristocera* by KIEFFER (1914). CAMERON (1897) described *Epyris amatorius* Cameron from Bengal. MAGRETTI (1897) described *Acrepyris antennatus* (Magretti) (= *Pristocera antennata* Magretti), *Pristocera cariana* Magretti, *Sulcomesitius haemorrhoidalis* (Magretti) (= *Mesitius carcell* var. *haemorrhoidalis*), and *Discleroderma*

tuberculatum (Magretti) (= *Scleroderma tuberculata*) from Burma. CAMERON (1899b) conducted a major study on Indian hymenopteran fauna including many Bethylids and described *Rhabdepyris fuscinervis* (Cameron) (= *Epyris fuscinervis* Cameron).

ASHMEAD (1903) described *Goniozus indicus* from Coimbatore, India. ASHMEAD (1904b, 1905) studied Bethylidae from Philippines. CAMERON (1904) discovered the presence of *Epyris albopilosus* from Darjeeling, India. CAMERON (1907) conducted studies on the parasitic hymenopterans and described *Disepyrus pallidinervis* from Bombay, India. CAMERON (1910) described *Goniozus borneanus* from Borneo. ENDERLEIN (1912) erected the genus *Calyozina* Enderlein on the basis of *Calyozina ramicornis* from Taiwan. TURNER (1914) described many fossorial hymenopterans including *Pristocera eironeformis* from Koornool District, India. ROHWER (1915) described *Goniozus fulvicornis* (Rohwer) (= *Trissomalus fulvicornis* Rohwer) from Karnataka, India and LAL (1939) described *Goniozus cuttockensis* from Orissa.

AYYAR (1917) catalogued wasps and bees described from Indian region. ENDERLEIN (1920) erected the genus *Calyozella* based on the type species *C. flavipennis* from the Indonesian island of Sumatra. KIEFFER (1922) conducted studies on Bethylids of Philippines. AYYAR (1927) presented notes on the parasitic hymenopterans of economic importance including Bethylids from South India. RAO and CHERIAN (1928) studied the biology and habits of females of *Goniozus nephantidis* (Muesebeck), the Bethylid parasite of *Opisina arenosella* Walker. MUESEBECK (1934) described seven species of Indian Bethylidae viz. *Trachepyrus indicus* (= *Pristobethylus indicus*), *Goniozus nephantidis* (= *Perisierola nephantidis*), *Goniozus mellipes* (= *Perisierola mellipes*), *Odontepyrus quadriveatus* (= *Parasierola quadriveata*), *Pristocera areolata*, *Epyris politiceps* and *Epyris coriaceous* from southern India and published the results in the Indian Museum Notes. MIWA and SONAN (1935) described *Pristocera formosana*, a species of Bethylid wasp parasitizing on Elaterid larvae from Korea and Taiwan. BEESON and CHATTERJEE (1939) presented their studies on the biology and morphology of

parasites of teak defoliators in India. MUESEBECK (1940) studied two bethylid parasites of sugarcane borers from India. PRUTHI and MANI (1942) studied distribution, hosts and habits of the Indian Bethyloidea.

AYYAPPA and CHEEMA (1952) studied *Laelius voracis* Muesebeck, an ectoparasite on the larvae of *Anthrenus vorax* (Waterhouse). DHARMARAJU (1952) studied biological control of the black-headed caterpillar of coconut using bethylid parasitoids in the East Godavari District of India. KURIAN (1952) presented descriptions of four bethylid species from India. KRISHNAMURTI and USMAN (1954) reported some insect parasites of economic importance from Mysore, India. KURIAN (1954a) published 'Catalogue of Oriental Bethyloidea'. KURIAN (1954b) described three species viz. *Rhabdepyris sanctipauli*, *Goniozus pulveriae* and *Goniozus salvadorae*. He redescribed *Laelius voracis* in the same work. PEYRÍ (1953) published detailed morphology of *Sclerodermus domesticus*. KURIAN (1955) described 36 species from India that includes 12 species of *Goniozus*, five species of *Neodisepyrus*, four species each of *Epyrus* and *Rhabdepyris*, three species each of *Sulcomesitius* and *Sclerodermus*, two species of *Odontepyrus* and one species each of *Cephalonomia* and *Laelius*. KROMBEIN (1958) presented a synoptic catalogue of Hymenoptera of America North of Mexico. PRASAD and ALI (1958) published notes on *Goniozus* species parasitic on stem and root-borers of sugarcane in Bihar. MENON *et al.* (1959) described *Rhabdepyris rhizoperthae*, parasitic on *Rhizopertha dominica* Fabricius, a pest of stored cereals. ANTONY and KURIAN (1960) studied the morphology, habits and life history of *Goniozus nephantidis* (Muesebeck). BUTANI (1960) recorded the parasites and predators of sugarcane pests in India, which includes bethylid species as well.

KURIAN and ANTONY (1961) studied the systematic position, host preference and distribution of *Goniozus nephantidis* (Muesebeck), a larval parasite of *Opisina arenosella* and its allied species. VENKATRAMAN and CHACKO (1961) published some factors influencing the efficiency of *Goniozus marasmi* Kurian, a parasite of the maize and jowar leaf roller. DHARMARAJU (1962) presented a checklist of parasites, hyperparasites, predators and pathogens including

Bethylids of the black headed caterpillar pest of coconut, *Opisina arenosella* Walker recorded in Ceylon and in India and their distribution in these countries. DHARMARAJU (1963) continued studies on biological control of *Opisina arenosella* Walker using Bethyrids in Sri Lanka. AVASTHY and CHAUDHARY (1963) studied the morphology and biology of a species of *Goniozus* attacking the armyworm *Pseudaletia unipuncta* Haw. GIFFORD (1965) revised the reported *Goniozus indicus* Ashmead as a parasite of sugarcane borer. AVASTHY and CHAUDHARY (1966) further studied the morphology and biology of a species of *Goniozus* attacking the armyworm *Pseudaletia unipuncta* Haw. RAM and SUBBARAO (1968) provided the description of *Goniozus stomopterycis*, a primary larval parasite of *Stomopteryx nerteria* (Meyrick) in South India and a revised key to the Oriental species of *Goniozus* Förster. NAGY (1968b) described *Pycnomesitius krombeini* (= *Mesitius krombeini*) from Mangalore; *Sulcomesitius discolor* (= *Mesitius discolor*) from Delhi and *Sulcomesitius pondo* (Benoit) (= *M. clavicornis* (Nagy)) from an unknown locality in Kerala.

RAM (1969) described *Goniozus delhiensis* a primary larval parasite of *Dichocrocis punctiferalis* (Guen.). MÓCZÁR (1970b) described *Sulcomesitius evansi* from South India. MÓCZÁR (1971b) described *Metrionotus biroi* from Bombay. SATPATHY and KOTWAL (1973) conducted studies on the sex ratio of *Goniozus nephantidis* (Muesebeck) as influenced by external factors. NAGY (1974) erected a new subfamily Galodoxinae based on type genus *Galodoxa* Nagy collected from Philippines, in which he stated that the subfamily Galodoxinae is allied, on the ground of some features, to the fossil subfamily Protopristocerinae, which is very much like the genus *Pristocera* of Pristocerinae but has the winged female. MÓCZÁR (1977) described *Sulcomesitius indicus* from Anamalai Hills of South India in his revisionary work on the genus *Sulcomesitius*.

SUNDARAMURTHY and SANTHANAKRISHNAN (1979) studied the effect of population density of parasite *Goniozus nephantidis* on the mortality of coconut caterpillar, *Opisina arenosella*. DIVAKAR *et al.*, (1983) recorded parasitism of *Goniozus* sp. on *Heliothis armigera* Hubn. MÓCZÁR (1984a)

published his revisionary work on Oriental Mesitiinae that contains description of 13 new species, keys to world genera and key to species of *Heterocoelia* Dahlbom, *Sulcomesitius* Móczár, *Pycnomesitius* Móczár, *Metriorotus* Móczár and *Anaylax* Móczár. GEORGE and ABDURAHIMAN (1985) conducted studies on reproductive biology of *Goniozus* sp., an external parasite of a mango leaf webber, *Lamida moncusalis* Walker. MÓCZÁR (1986) described five species of Mesitiinae from Gibraltar, Nigeria and Nepal. GORDH (1986b) described *Goniozus keralensis* from India and contributed taxonomic notes on related species. XIAO and WU (1987) described the new taxa, *Goniozus sinicus* from China. BROWN (1987) synonymised the genus *Neochlystospesella* Kurian with *Tapinoma* of Formicidae. KROMBEIN (1987a) published the synonymic notes on the Bethylidae described by Motschulsky in which he synonymised the genus *Dolus* Motschulsky with *Epyris*. KROMBEIN (1987b) continued his studies on Ceylonese wasps with special reference to the genus *Trachepyrus* Kieffer and several species of Bethylids were described along with which new combinations and new synonymies were proposed. He presented results in the 18th part of the biosystematic studies of Ceylonese wasps, in which he published a review of the genera *Trachepyrus* Kieffer. GORDH (1988) described *Goniozus sensorius* from India used in biological control of *Diaphania indica* (Saunders) attacking Ivy Gourd, *Coccinia grandis* (Linn.) Voight (reported as *Coccinia indica* Wright and Arnott).

GORDH *et al.* (1993) described *Goniozus hanoiensis* new to science and studied the biology of the same species emerged from *Cnaphalocrosis medinalis* from Vietnam. TERAYAMA (1993) presented a checklist of Bethylidae of the Oriental and Southeastern part of Palaearctic regions. TERAYAMA (1995c) also studied the Taiwanese *Pristocera*. TERAYAMA (1995d) erected two new genera viz. *Caloapenesia* based on the type species, *Caloapenesia thailandiana* and *Caloapenesia philippinensis* and *Neoapenesia* based on the type species, *Neoapenesia leytensis* from Oriental Region. In this paper, he synonymized two genera viz. *Psilobethylus* Kieffer with *Dissomphalus* and *Nausakosia* Benoit with *Prosapenesia* Keiffer. TERAYAMA (1995e) discovered *Protisobrachium* from Oriental region. TERAYAMA (1995f) described three new species of the genus

Dissomphalus from Southeast Asia. TERAYAMA (1996c) revised Taiwanese *Apenesia* and described six new species. TERAYAMA (1997b) described four new species of *Odontepyris* Kieffer from Taiwan and Korea along with the list of world species of *Odontepyris*. TERAYAMA and YAMANE (1997) described one species each of *Apenesia* and *Dissomphalus* from Borneo. TERAYAMA (1998) recorded the genus *Parascleroderma* from the Oriental region on the basis of *P. atayal* Terayama, *P. thaiana* Terayama, *P. okajimai* Terayama and *P. renaiensis* Terayama. TERAYAMA and YAMANE (1998) described 4 species of the genus *Pristocera* Klug from South East Asia along with which *P. carinate* Magretti was redescribed and recorded *P. formosana* Miwa and Sonan for the first time from Korea.

TERAYAMA (2001) described seven new species of *Dissomphalus* Ashmead from Oriental region, mostly from Southeast Asia and one from Nepal and provided a key to Oriental *Dissomphalus*. TERAYAMA *et al.* (2002) described three new species of *Acrepyris* from China. XU *et al.* (2002a) described *Odontepyris fujianus* from China. XU *et al.* (2002b) discovered a new species of *Parascleroderma* Kieffer and published the description with the key to the Chinese species of the genus. XU *et al.* (2002c) described three new species of *Goniozus* from China. XU, TERAYAMA and HE (2002) studied Chinese *Apenesia* and described three new species. XU *et al.* (2003a) described the first species of *Laelius* from China. XU *et al.* (2003b) studied Mesitiinae of China and described five new taxa and provided keys to species of *Sulcomesitius* from China. XU, HE and MA (2003a) examined the systematic relationships of Chinese species of *Holepyris* and provided descriptions of seven new taxa along with a key to *Holepyris* species from China. XU, HE and MA (2003b) described four species of *Epyris* from China. TERAYAMA (2004a) erected a new genus *Formosiepyris* based on the type species, *F. marishi* from Thailand. He described two more species, *F. shiva* from India and *F. takasago* from Taiwan. TERAYAMA (2004b) described seventeen new species of the subfamily Pristocerinae, most of them from Nepal. AZEVEDO (2004) discovered the female of the genus *Caloapenesia* Terayama from Vietnam. Description of the species *Caloapenesia brevis* Azevedo and a key to males of the same genus are also presented in the same. TERAYAMA (2004c) described seven

bethylids belonging to subfamily Bethylinae as new to science from Asia and Australia; *Goniozus hualienensis* from Taiwan, *Bethylus himalayanus* from Nepal, *Sierola indra* from Bangalore, India and proposed a new genus *Archaeopristocera* based on a specimen from Dominican amber.

XU and HE (2005) described a new species of *Formosiepyris* from China and provided a key to world species. TERAYAMA (2005) described 43 new species from Oriental and Ethiopian region, established a new genus *Proplatanoxus* from Thailand and redefined *Calyozina*. That work includes one new species, *Epyris karnatakensis* from Yellapur, India. AZEVEDO and WAICHERT (2006) described *Apenesia sahyadrica* emerged from *Xylotrechus quadripes* Chevrolat, Coffee berry borer from Coffee Research Station, Chikmagalur, India. The new species is compared to other related Oriental *Apenesia*. XU and HE (2006a) described three new taxa of *Odontepyrus* and provided a key to the Chinese species of *Odontepyrus*. XU and HE (2006b) revised the Chinese *Heterocoelia* Dahlbom with a key to Oriental species. VARKONYI and POLASZEK (2007) rediscovered and revised the rarely collected genus *Foenobethylus* Kieffer with the description of four new species from Southeast Asia and assigned it to the subfamily Pristocerinae based on preliminary phylogenetic assessment. XIAO and XU (2008) described *Odontepyrus hainanus* and provided a key to the Chinese species of *Odontepyrus*. XU *et al.* (2008) discovered and described a Chinese species, *Cephalonomia rhizoperthae* that emerged from *Rhizopertha dominica* (F.). SANTHOSH and NARENDRAN (2009) described *Goniozus armigerarum* parasitic on *Helicoverpa armigera* (Hübner.)

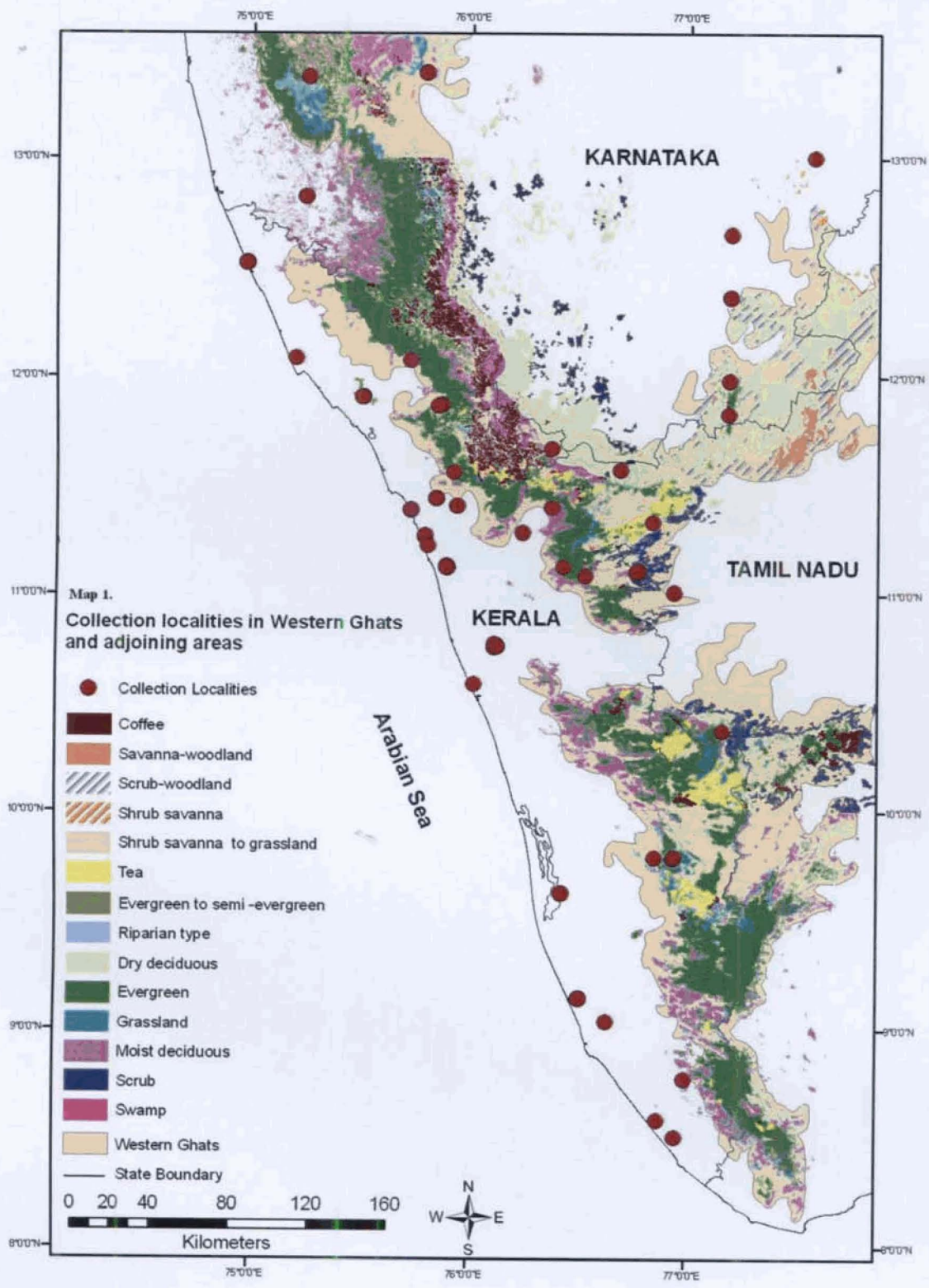
CHAPTER 3

MATERIALS AND METHODS

3.1 Study Area - Southern Western Ghats

The Western Ghats is a mountain range that runs approximately 1600 km along the western edge of the Deccan Plateau, India and separates the plateau from a narrow coastal plain along the Arabian Sea. It is home to four tropical and subtropical moist broadleaf forest ecoregions – lowland equatorial evergreen rain forests or tropical rainforests, moist deciduous and semi-evergreen seasonal forests, montane rain forests and freshwater swamp forests. The northern portion of the Ghats is generally drier than the southern parts. The southern ecoregions are generally wetter and more species-rich. Southern Western Ghats (Map.1) located between 8° N and 14° N latitude and 74° 40' E and 78° E falls within the biodiversity hotspot, Western Ghats and Sri Lanka.

Specimens were collected from the Southern Western Ghats and the adjoining regions falling in the three states viz. Kerala, Karnataka and Tamil Nadu. The survey was carried out in Kerala, Southern Karnataka and North Western Tamil Nadu, with a special emphasis to the wet western slope of the mountain range falling in Kerala. This narrow strip of land extends north-south between Lakshadweep Sea and the Western Peninsular Indian Hill range, the Western Ghats. The state is about 850 kms. in length north-south and its average width varies from 32 kms to over 120 kms with an area of 38,863 sq. kms. The hill range demarcating this strip of land from the rest of the peninsula, rises abruptly to an average elevation of 1500m above sea level with many sections ascending to 2000 or even 2500m. More than half the geographical area of the state is above 200m. in elevation with a complex topography of rocky ridges, high plateau and narrow valleys.



According to the geographical features, Kerala can be divided into three regions; highlands above 76m, midlands 7.6m to 76m and low lands below 7.6m. With an average height of 900m and a number of peaks well over 1800 m in height, the highlands of the Western Ghats comprise of forest areas, with major important hotspot areas of biodiversity of flora and fauna. The midlands with extreme undulating hills and valleys form an excellent area for the cultivation of cashew, coconut, arecanut, tapioca, banana, rice and different kinds of vegetables. The deposition of the sediments brought down by the rivers of Western Ghats and the sand deposited by the tidal inflow constitutes the lowlands of the coastal areas. The area also includes lagoons and backwaters formed by the excess flood waters accumulating in shallow basins during the rainy season, often separated from the sea by only a narrow strip of sand.

3.2 Climate

The annual temperature range is between a maximum of 35.9°C and a minimum of 23.8°C. Day temperatures are more or less uniform over the plains throughout the year except during the monsoon months, when the temperature drops by about 3°–5°C. The mean relative humidity value ranges from 60 – 90%, the maximum during the rainy season of June-September. The total annual rainfall is excessive with over 3200 mm, with even more than 70% of it received in the three month period of south west monsoon, during June to August. About 20% of the annual rainfall is received during the months, October to December, i.e. during the south east monsoon and the remaining 10% is obtained as occasional showers and pre-monsoon showers in April and May.

3.3 Collecting methods

The specimens for this systematic investigation were collected dead or alive from the field. Collecting is preferred in disparate habitats such as mountain meadows, grasslands, dense forests, agricultural plains, forest canopy etc. Sometimes the best spot to collect is not in some exotic, distant locale but rather locally. Local areas are advantageous in that they can be sampled consistently over longer periods of time and do not require extensive outlays of cash and time as would in extended trips.

Successful collections were made from what appeared to be "crummy" habitat like bushes along roadsides and overgrown, weedy lots. Undoubtedly undisturbed sites can provide a wealth of interesting taxa.

Productive areas within a particular habitat may include blooming plants, spring or seepage areas with lush vegetative growth, or plants infested with insects. These areas have a common factor that is something that the bethyilids want, possibly the host to parasitize. They were collected from underside of stones and crevices in the tree trunks. Various collection techniques were used. Each method has its own advantages and special uses and in general all methods were used, whenever possible.

Bethyilids were collected by using two broadly defined methods:

- 1) Active collecting
- 2) Passive collecting

3.3.1 Active Collecting

3.3.1.1 Sweeping

Sweeping is found to be the most rewarding method for collection in clear windless weather. The early hours of morning and evening were found good for collecting. The net was swept across vegetation from low-growing grasses up to tree canopies.

The type of net most suitable for sweeping one with a triangular frame. While sweeping, the triangular shape of the frame allows a larger area of vegetation to get in contact with the opening of the net. The results obtained using this type of net show that the insects collected is roughly ten times more than the insects obtained by the conventional type of round nets (NOYES, 1982). The present investigation used a modified model designed by Noyes (fig.1). The sides of the frame measure 48 cm X 22 cm X 46 cm. The handle measures about 106 – 122 cm long and 3.5 cm girth. The long handle increases the proximity to underneath of long hanging bushes and extends the area of each sweep. The frame can be fitted to one end of the handle and can be easily separated, while not in use. The net bag is made

up of 60 cm long durable white cotton cloth or terelene cloth, which have fine mesh that will permit the easy passage of air, but at the same time this prevents the escape of small insects of less than even 1 mm in size. To withstand the potential damage while sweeping, the rim of the bag is reinforced with thick material, preferably canvas. This canvas is either folded or sewn over the frame or is tied in position, through the small round holes of the frame.

As the materials accumulate after sweeping over the vegetation, a bolus will form at the bottom of the net bag. This bolus is pinched off and small to minute wasps were aspirated. Aspirator was used to collect the wasps from the net bag. It consists of a glass or perspex vial, with a stopper by two flexible tubes. The end of one of the tubes is covered by a small piece of gauze to prevent specimens from being drawn into the operator's mouth. It is operated by sucking at the end of the gauze covered pipe and holding the end of the other tube close to the specimen. Parasitic wasps appear as small, often black or brown specks walking and flying about. Since they are attracted to light, it is best to position the net bag so that sunlight shines through the top of the net rather than into the net opening. Alternatively, the bolus may be placed into an alcohol container (whirl-pak bag) for later processing.

3.3.1.2 Rearing

This is typically the most labor-intensive (but also potentially the most rewarding) form of obtaining bethylids. It is advantageous not only in that host associations and habitat requirements of the parasitoid can be identified, but also male and female associations can be ascertained, which is something difficult to do definitively with sexually dimorphic taxa which are collected by sweeping. Obvious things to collect for rearing are galls, leaf mines, larvae, pupae, etc. Any type of clear container will enable daily checking of materials for emergence. For large host samples such as plant materials containing larvae, leaf mines, etc. emergence cages were used. The emerging insects were attracted towards light and collected into a glass tube placed over an inverted glass filter funnel stuck on the roof or sides of the cage to prevent the return of the insects into the cage itself.

3.3.2 Passive Collecting

3.3.2.1 Malaise Trapping

The most common passive flight-intercept trap is an open-sided tent-like structure called a Malaise trap (fig.3). Insects strike the central panel of the trap and either drop to the ground, or fly/crawl to the highest point. Those flying upwards are contained by the roof and concentrated in the collecting head of the trap where they are killed. Generally the trap is dark in colour with a light roof which reinforces any positive response to light in diurnal insects. The collecting head is attached to the higher end of the trap to take advantage of insects moving to the highest and sunlit area. Insects caught in the collecting head are killed by drowning in a solution of preservative. Ground Malaise traps catch flying insects up to one meter above ground level, in or above surface vegetation. They are most effective at sampling arthropods along forest edges and can also be used in forest interiors, and in associated habitats such as forest wetlands. This trapping has two advantages. Beyond the advantage of a passive sampling method, it can be emptied once in a week even by a non-entomologist.

This tent like trap was originally designed by R. Malaise (MALAISE, 1937) and later modified by Townes (TOWNES, 1972) and several others. Many Malaise trap designs are available. The latest model made by M/s Marris House nets, England has been used in the present investigation.

Factors such as likely flight paths, prevailing winds and Malaise head position can affect both the numerical and taxonomic composition of the catch. The following points should be adhered to when setting up Malaise traps. (1) The collecting head (high end of the trap) should be oriented consistently with the head pointing to the sunniest part of the forest habitat facing the open area (clearing or water) when placed in a forest edge. (2) Shrub vegetation directly beneath the trap should be cut back to a standard height of several centimeters above the surface. (3) Perturbations by large mammals (e.g., dogs) can be a problem with Malaise traps.

In order to fully sample any site or habitat, trapping should be continued throughout the active season. Such an extended trapping period is required to accommodate the different phenologies exhibited by the various taxa. In the last two years of the survey (2007 and 2008), extended trapping of the family was done using Malaise traps fixed at two different sites in the study area; the scrub jungle of Panayathanparamba near Kannur and Arboretum in the botanical garden of Calicut university campus. No malaise trapping was done during the monsoon season (June to August) as the heavy and continuous rains kept the trap netting wet and sticky.

3.3.2.2 Pitfall Trapping (unbaited)

Pitfall traps (fig. 4) are deep, small containers (cups) that are sunk into the ground to sample surface-active arthropods. They function in a manner similar to pan traps by collecting arthropods that fall into the container and drown in the collecting fluid at the bottom of the trap. Pitfall traps collect smaller samples of arthropods than pan traps because of the smaller trap perimeter of the pitfall trap. They are easier to install and service because of the smaller volume of collecting fluid needed to operate the trap, less expensive in materials to construct the trap, and less expensive in labour to process the smaller samples.

Isopropyl alcohol of 70% or propylene glycol mixture is placed in the trap and acts as the collecting medium and preservative. Pitfall traps can be used in any ground level substrate except water and rock. They can be used to sample arthropods in a variety of microhabitats such as rotting wood, surface litter, or peat lands, but the most common application is in soil substrate for surface-active arthropod fauna, like bethylids.

3.3.2.3 Pan Trapping (Moericke trap)

Pan traps are shallow, relatively large containers (compared to pitfall traps) that are placed on or sunk into the ground to sample arthropods. The most common modification to pan traps is the colour. Insects, particularly of low-flying nature are differentially attracted to a variety of colours, but most are attracted to bright yellow Moericke traps (fig. 5). In their simplest form, they function in nearly the same manner as pitfall traps, collecting arthropods that fall into the container and drown in the collecting fluid. Pan traps not only collect larger samples of arthropods than

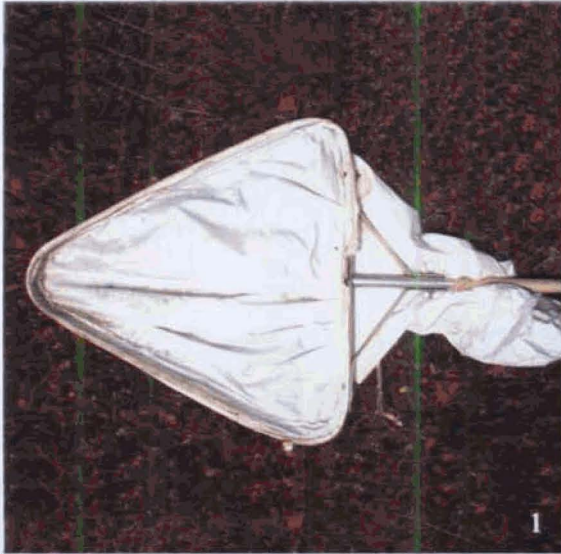
pitfall traps, they also differ with respect to the light response of the diurnal (day-active) arthropod species that are captured. Pan traps collect more specimens than pitfall traps because of the increased surface perimeter of the trap. Although both pitfall and pan traps are neutral with respect to the light response of nocturnal (night-active) species, they differ in the light response of the diurnal species captured.

Yellow pans are placed in areas of the habitat which are likely to be productive for Bethylidae (insect infestations, under shrubs or near seeps, etc.). The shallow tray, about 60-75 mm deep and about 30 sq. cms area, painted bright yellow inside and some neutral colour such as black on the outside are then filled with a saturated salt solution or water (salt solution when emptying every 3-4 days or water when emptying 1-2 days) and 1-2 drops of liquid soap is mixed in to reduce the surface tension of the water. Many small insects will be attracted to the yellow colour and collect in the bowl. A small aquarium net is perfect for straining the catch, which can then be easily rinsed with fresh water to remove salt/soap residue and transferred to the vial containing ethanol.

Pan traps can be used in just about any terrestrial habitat or suspended in tree canopies, but the most common application is in a soil substrate for surface-active fauna. Traps should be placed where they are likely to remain undisturbed by humans or weather phenomena (rising water, flooding, etc.). Pan traps collect a diverse sample of ground-dwelling arthropods (similar to pitfall traps) but also collect a diverse sample of low-flying, agile arthropods.

3.3.2.4 Canopy collection

Since collection permission in the Nilgiri Biosphere reserve was difficult to obtain, the present investigation sought help from the UK Government funded Darwin Initiative project on Bees, Biodiversity and Forest Livelihoods conducted by Keystone Foundation, Kothagiri, Tamil Nadu for materials from the core forest areas within the study region. During the project, a year long survey was conducted in 2007 at 16 sites within the Nilgiri Biosphere reserve. Specimens were collected from the forest canopy in elevated yellow, white and blue pan traps. The traps were hung near the flowers as it was mainly meant for collecting anthophilous insects.



1. Sweep Net; 2. Aspirator; 3. Malaise Trap; 4. Pitfall Trap; 5. Yellow Pan Trap; 6. Sorting Tray

3.3.3 Basic Collecting Equipments

Sweep net: The triangular framed sweep net with bag made out of durable white cotton cloth or terelene cloth, fitted to the long handle.

Aspirators: Aspirators are used to suck up the specimens from the net.

Vials of alcohol: 70% ethyl alcohol (ethanol) is preferred for dispatching aspirated bethyliids, although isopropyl alcohol can be used in a pinch. Leak-proof, screw top glass vials are best for storing individual samples.

Nalgene bottle: Small, screw-top Nalgene bottles are convenient for bringing along additional alcohol or ethyl acetate.

Killing tubes: Ethyl acetate or acetone is probably the safest and easiest to acquire killing agent for charging tubes.

Fine tip forceps & Brushes: Useful for manipulating small insects that become lodged in tight spaces during transfers to and from killing to storage receptacles or re-capturing stunned escapees.

Writing implements: Pens and pencils are essential for recording field observations, host identifications and collecting locality information.

Pan traps: Yellow pan traps are an inexpensive and simple means of passively sampling micro hymenoptera in an area.

Glassine envelopes and brown paper bags: The small-medium sized bags are of great use while collecting potentially parasitized host materials for rearing or host plant samples for identification. Placing plant samples or live insect host samples inside the paper/glassine bags retards sample desiccation and the condensation inside the plastic bag. Samples so packaged can be maintained for 3-4 days on ice or in the refrigerator.

Field notebook: A simple field notebook to record the collection details is compulsory.

Magnifying lens: A small magnifying glass is optional and allows one to examine specimens in the field.

3.3.4 Processing

Processing the collected wasps involves sorting, relaxing, mounting, labeling, registering and preserving the mounted and un-mounted materials. Specimens from the field should be stored in a cool dark place (refrigerate, if possible), but not in direct sunlight or near a heat source. Replace alcohol with fresh 80% alcohol after one to two weeks. The sooner the catch is processed the better in terms of quality specimens and reduced sample backlog. For long-term storage (several months to years) it is essential to replace alcohol (to prevent ice crystal formation) and to keep the catch below 0°C. Sample processing consists of sorting, mounting, and labeling specimens in preparation for identification.

3.3.4.1 Un-mounted material

The un-mounted specimens were stored in 70% alcohol (ethanol) in small vials and kept in a refrigerator. The preservative was periodically changed and replenished to prevent damage to the stored specimens. Specimens are sorted using a sorting tray (fig. 6).

3.3.4.2 Relaxing

For relaxing, the specimens are kept in an atmosphere of acetic acid for at least 6 – 8 hours. This method was found very suitable for the specimens, which had been killed using ethyl acetate or other killing agent. Relaxing helped to prevent breakage of specimens when they were being card mounted. In order to achieve best results, a clear plastic sandwich box with a tight fitting lid was taken and the bottom was covered with a thick layer of cotton wool. Specimens to be relaxed were placed on top of the piece of tissue in a glass dish and the whole dish, kept in the box, which was then closed.

3.3.4.3 Card Mounting

The method followed in the present work is that adopted by Boucek and Noyes (NOYES, 1982). The specimen was mounted on a triangular or rectangular card, measuring 14 mm in length and 4 mm in width, with properties of medium absorption. The specimen was mounted on the card, tilted slightly on its sides (at about 45° to the plane of the card) in such a way that the face and mandibles were clearly visible.

The materials used for the card mounting were;

- i. A fine zero point brush
- ii. A pair of fine needles or pins
- iii. A pair of fine forceps
- iv. Water soluble glue
- v. Mounting cards measuring 14 mm X 4 mm

Before mounting, it was made sure that the glue is cold water soluble, when dry as well as when wet and also that it had the right consistency. For large specimens thick glue was used.

Before mounting, (both freshly killed and relaxed) specimens had to be thoroughly dried. For this, the specimens were placed with a drop of alcohol on an absorbent piece of card. The wings, legs and antennae were then correctly positioned. After drying, it was placed on the stage of the microscope; near-by a card triangle. Using a fine pointed pin, a tiny drop of glue (approximately 2/3 the volume of the thorax of the specimen to be mounted) was put on the card at the point where the imaginary lines bisecting the angles at the top corners of the card met. Then a fine pointed brush was picked taken and moistened by a minute quantity of saliva from the tongue, the specimen was thus picked up by touching the brush against the mesopleuron. It was then positioned with the midpoint of the thorax on the glue, the body lying length wise along the card and the head pointing towards the

far end. Then the body was tilted so that it lay on its sides at about 45° to the card. The specimen was pressed down firmly but gently with the brush for a good adhesion. Care was taken to avoid the glue sticking to head, antenna and wings etc. all body parts need to remain well spread.

3.3.4.4 Labeling and Registering

Temporary labels were written in the field at the time of collecting. After mounting, permanent labels indicating the name of the country, state, date of collection, etc. were added. Registering of the specimens was done after the specimens have been identified at least up to generic level. The registering of entries is as follows:

- i. Collection number
- ii. Scientific name
- iii. Name of locality of collection
- iv. Date of collection
- v. Name of host
- vi. Name of collector
- vii. Identification
- viii. Remarks

3.3.4.5 Storage and preservation

Serial numbers were also given to each specimen. The specimens mounted were held on entomological pins (Asta Insect pins No.3, 38 mm X 0.53 mm made by Newy Goodman & Co. England), labeling and kept in insect boxes, for detailed systematic studies. Naphthalene balls were placed in the boxes to protect from insect attacks. Thymol crystals were used as fungicides. 1,2- Dichlorobenzene can also be used to prevent fungal growth.

3.3.5 Observations and Illustrations

For sorting, mounting and dissecting, Olympus (Japan) microscope was used. Observation and description of the card mounted specimens were done using Leica MZ6 Stereozoom (Switzerland). The figures were drawn using the drawing tube (photo tube) of the Leica MZ6 Stereozoom (Switzerland). The digital images of the specimens were obtained using Cannon Powershot G5 digital camera attached to Carl Zeiss (Germany) Stereozoom microscope.

Since each frame of the digital images from microscope is in focus at a different depth into the specimen, all parts of the wasp were not in focus in any single frame. This is due to depth of field limitations. *CombineZM* is used to process the stacks of digital images. This is an open source image processing software package that helps to blend the focused areas of several partially focused digital images in order to create a composite image with an extended depth of field, created from the in-focus areas of each image. On an average 12 serial frames were taken for a single final composite photograph. In total, 2050 frames were used to make 173 composite images.

3.3.6 Specimens on Loan

Specimens already collected and well preserved in museums and depositories around the world were studied. Types and unidentified materials from the museums were also studied in this investigation. Many specimens collected in the past from the study area are deposited in foreign museum holdings. Several attempts were made to procure the Indo - Malayan materials and some of them met with success. Materials from natural history museums of Amsterdam, London and Genova were studied on loan. Holotype of *Sclerodermus bicolor* Smith deposited in Oxford University Natural History Museum (Hope Museum) was in a very bad condition and so no direct study was conducted, but photographs were made available for this investigation.

3.3.7 Distribution maps

The latitudinal and longitudinal co-ordinates and elevation of collection locality are marked with the help of Global Positioning System (GPS) by GARMIN etrex®H. The forest map layers are digitized and compiled from forest maps. They are generalized for forest types in GIS. Forest types are represented using different colors on Western Ghats boundary. The GIS software used is ArcGIS version 9.3. The GPS locations corresponding to the collection localities are converted into shape files and plotted on forest map layers. These automated layers together give the forest type in which a particular species was found.

3.3.8 Interactive keys

The DELTA (DEscription Language for TAXonomy) software (DALLWITZ, 1993) is used to record taxonomic descriptions for computer processing and generating interactive keys for identification. The program runs on Windows XP and later versions. The interactive keys (DELTA) to the species of four genera revised in this study is included in the Compact Disc (CD) attached to the back cover of the thesis.

CHAPTER: 4

GENERAL MORPHOLOGY AND KEY TO SUBFAMILIES, TRIBES AND GENERA OF BETHYLIDAE

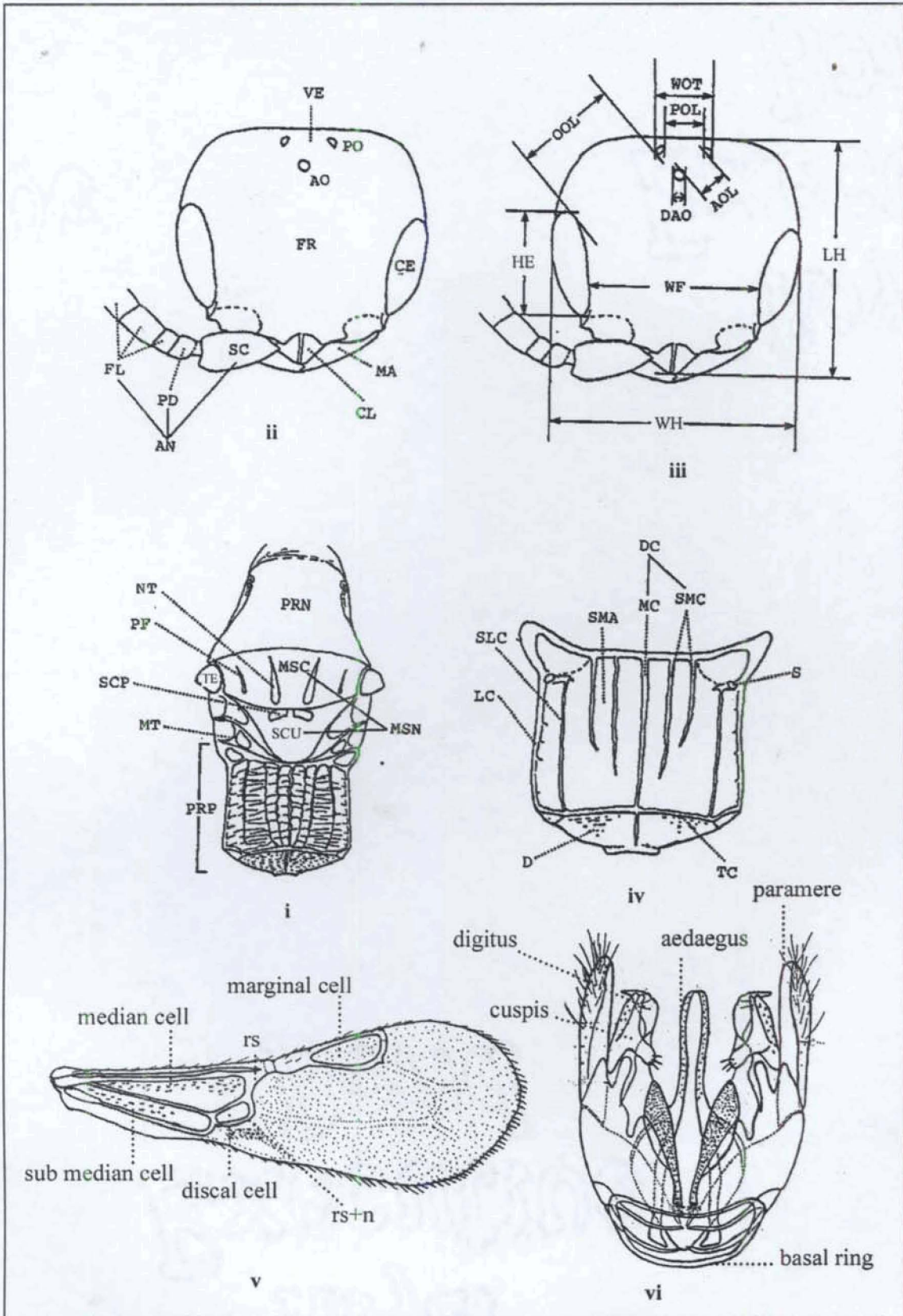
Morphological terms used in this study follows EVANS (1964) and AZEVEDO (1999a) and TERAYAMA (2006). Terms used in the keys and descriptions are defined in Appendix - I. Some of the terms widely used in other insect groups and known to majority of entomologists are not included in the list. Abbreviations used in the thesis are listed in Appendix-II.

4.1 General Morphology

Bethylids are relatively small wasps, 1-15 mm in body length. Adults are predominantly black or dark brown, although several New World species are with metallic green, yellow, blue reflections. They are readily recognized by their strongly flattened body.

Head prognathus, elongated and depressed. The format, width, size and relative position of the eyes and ocelli are of utmost importance for the classification of the species. Eyes of Apterous forms are often dot like and ocelli are absent. In this family, antennal flagellum have 11 (rarely 10 or 8) segments, the same number of segments in both the sexes and is attached near the margin of mouth. The clypeus is of great importance for the recognition of taxa and many of them have a vertical median carina that can be extended backwards between the antennal toruli. Maxillary palpi with maximum 6 segments and the labial palpi with 3. The jaws with 1 to 5 apical teeth, exception in a case with 7.

Pronotum has an anterior flange, propleuron is thus concealed, when viewed dorsally. Prosternum is small somewhat transverse, often concealed in ventral view. Mesonotum is with centrally placed notauli and parapsidal furrows on either side, which can be extended, bent, short or absent in many sorts. Scutellum with a pair of anterior fovea of varied forms and sizes. Propodeum is often sculptured by carina forming specific designs. Median segment is usually long. Legs short, femora especially forefemora often greatly swollen.



Figs. i - vi: Bethylidae. i. body, dorsal view; ii and iii. head, full face view; iv. propodeum; v. forewing; vi. male genitalia

Venation of forewings reduced to varying degrees. Costal cell narrow, sometimes absent; medial and submedial cells well developed, sometimes absent; some genera characterized by closed discoidal and brachial cells. Pterostigma usually present, sometimes prostigma situated ahead of it in the form of an apical thickening of subcosta. Some tropical bethylids characterized by more complete venation of forewings. Hindwings are without closed cells, sometimes costal cell is present, but with anal lobe.

Abdominal petiole very short. Abdomen with 6 tergites in females and 7 tergites in males. Genitalia relatively simple in male; parameres always branched and of varied size, generally in form of claws for the phoretic copulation, cuspis and digits varied between genera. Sexual dimorphism is slight to extreme. Male macropterous, rarely brachypterous and female macropterous, brachypterous or pterous. Brachypterous and pterous forms do not have the deep ventral constriction between the mesothorax and the metathorax. In some genera and in some species, it is difficult to correlate the sexes because females are usually pterous or subapterous whereas males are winged, but in some species winged and pterous forms appear in both sexes.

4.2 Key to Subfamilies, Tribes and Genera of Bethylidae from Southern Western Ghats

- 1 Propodeum with distinct spines at dorso-posterolateral corners; second metasomal segment large, accounting for considerably more than half length of metasoma in dorsal view (**Mesitiinae**).....4
- Propodeum without spine at dorso-posterolateral corners; second metasomal segment much smaller, accounting for much less than half of metasoma in dorsal view2
- 2 Metanotum of male developed; scutellum and propodeum not nearly contacting medially; metanotum with a small fovea at middle; females completely apterous; eye of females small to absent, eye height at most 0.25x head width (**Pristocerinae**)6

- ___ Metanotum much reduced in both sexes; scutellum in contact with propodeum medially or nearly so; metanotum without fovea medially; females fully winged, brachypterous, or apterous; eye of females large, eye height more than 0.30x head width3
- 3 Basal vein of forewing simple, not giving rise to a vein or stub; tarsal claws weakly to moderately curved; frons without longitudinal median carina or polished streak extending from clypeus (**Epyrinae**)14
- ___ Basal vein of forewing giving rise to a vein; tarsal claws strongly curved; frons usually with a longitudinal median or polished streak extending for a short distance from clypeus (**Bethylinae**)22

4.2.1 Key to Genera of Subfamily Mesitiinae from Southern Western Ghats

4. Almost whole surface of second tergite deeply and extremely densely punctured, interspaces narrower than punctures at densest part. Mesonotum with less developed longitudinal furrow..... *Pynomesitius* Móczár
- ___ Second tergite at most partly with deep and dense, though not extremely dense punctures, interspaces everywhere larger than punctures. Mesonotum with longitudinal furrow mostly well developed 5
5. Median furrow of mesonotum indistinct or absent; lateral spine on posterior margin of propodeum short and stumpy, rather obtuse in lateral view; parallel carinae below lateral margin of disc ending before spine..... *Heterocoelia* Dahlbom
- ___ Median furrow of mesonotum distinct, at least on posterior portion; lateral spine on the posterior margin of propodeum long, acute in lateral view; parallel carinae below lateral margin of disc mostly penetrating into spine *Sulcomesitius* Móczár

4.2.2 Key to Genera of Subfamily Pristocerinae from Southern Western Ghats

6. Male; fully winged; tegula present 7

___ Female; Apterous; tegula absent 13

(Male)

7. Subgenital plate deeply divided into two lobes; cubital and subdiscoidal veins of forewing barely visible, not reaching wing margin; median vein of hind wing obscure to absent, if present not reaching wing margin *Pristocera* Klug

___ Subgenital plate simple, posterior margin at most weakly concave, never deeply divided into two lobes; other characters partially or completely different.....8

8. Second metasomal tergite with a pair of spots, pits or depressions *Dissomphalus* Ashmead

___ Second metasomal tergite without spots, pits or depressions9

9. Anterior margin of clypeus trapezoidal and truncate apically; eye densely covered with hairs; genitalia with parameres deeply divided into two lobes *Pseudisobrachium* Kieffer

___ Anterior margin of clypeus not trapezoidal and truncate; eye glabrous, or only with short scattered hairs; genitalia with parameres not deeply divided into two lobes 10

10. Notauli absent or nearly so *Protisobrachium* Benoit

___ Notauli complete or nearly so11

11. Ocelli forming a flat triangle and situated almost near occipital margin (fig. 38); postmarginal vein absent; anterior margin of clypeus with a single median projection *Parascleroderma* Kieffer

___ Ocelli more or less forming a right triangle, situated far from occipital margin; postmarginal vein present; anterior margin of clypeus different.....12

12 Median lobe of clypeus depressed near antennal insertion; basal most tooth of mandible directed inward; cuspis simple, not divided nor setose; aedeagus consisting of 3 valves *Acrepyris* Kieffer

— Median lobe of clypeus not depressed near antennal insertions; basal most tooth of mandible triangular, not directed inward, or mandible with an apical tooth only; cuspis divided into two arms, dorsal arm simple and ventral one setose (except in a few species); paramere simple, not consisting of 3 valves *Apenesia* Westwood

(Female)

13 Propodeum strongly constricted at its anterior end, forms a pair of small processes which embrace apex of elongate mesonotum: eye absent, sometimes present *Pseudisobrachium* Kieffer

— Propodeal constriction less strong, maximum width of propodeum less than twice that at constriction; eye small, consisting of less than 15 facets..... *Apenesia* Westwood

4.2.3 Key to Tribes and Genera of Subfamily Epyrinae from Southern Western Ghats

14. Antenna with 12 segments or less; clypeus short, truncate apically; radial vein not developed, only a stub or absent...(Tribe: Cephalonomiini) *Cephalonomia* Westwood

— Antenna with 13 segments (second or third segment very small but visible in some species); maxillary palpus with 5-6, labial palpus with 2-3 segments, body more than 3mm in many species 15

15. Anterior margin of clypeus truncate; eye situated forward on head(Tribe: Sclerodermiini)...16

— Anterior margin of clypeus with a projecting median lobe (Fig. 53); eye situated in lateral portion on head.....(Tribe: Epyrini)... 17

(Tribe: **Sclerodermini**)

16. Mandible elongate with 7 small teeth, upper margin denticulate in female; mandible with 5 large teeth in male *Glenosema* Kieffer
- ___ Mandible short with 2-3 apical sharp teeth and 1-3 small basal teeth; upper margin of mandible not denticulate *Sclerodermus* Latreille

(Tribe: **Epyrini**)

- 17 Scutellum with a pair of basal pits, either completely separate or connected by a very thin and shallow line18
- ___ Scutellum basally with a transverse, undivided groove, straight or deflected backward at each end, if broadened at each end, then termini still connected by a deep groove19
- 18 Antennal scape with strong setae; mandible long, forming a straight shaft with apical blunt tooth *Trachepyrus* Kieffer
- ___ Antennal scape without distinct large setae; mandible shorter, more or less triangular *Epyris* Westwood
19. Clypeus with 3 prominent lobes; basal vein reaching subcosta basad of pterostigma by approximately length of pterostigma *Holepyris* Kieffer
- ___ Clypeus with only a median lobe; basal vein reaching subcosta close to base of pterostigma 20
- 20 Radial vein very short, at most slightly longer than basal vein..... 21
- ___ Radial vein long, distinctly longer than basal vein*Rhabdepyris* Kieffer
21. Large pterostigma present; prostigma present; foretarsus with lake*Disepyrus* Kieffer
- ___ Pterostigma small; prostigma absent; foretarsus without lake.....*Laelius* Ashmead

4.2.4 Key to Genera of Subfamily Bethylinae from Southern Western Ghats

- 22. Propodeal disc with a median longitudinal carina and a pair of pits near its base; rs vein longer than median vein *Odontepyris* Kieffer
- ___ Propodeum without discal carina and basal pits; rs vein shorter than median vein..... 23
- 23. Radial vein curved upward and joining post marginal vein to form a closed marginal cell*Sierola* Cameron
- ___ Radial vein not reaching anterior wing margin; marginal cell open*Goniozus* Förster

CHAPTER: 5

OBSERVATIONS AND RESULTS

GENUS *GONIOZUS* FÖRSTER 1856

Goniozus Förster 1856, 2: 95-96. Type species: *Bethylus claripennis* Förster, subsequent designation. (ASHMEAD, 1893, 45: 72).

Parasierola Cameron 1883, 197. Type species: *Parasierola testaceicornis* Cameron, monotypic. (synonymized by EVANS, 1978)

Progoniozus Kieffer 1905b, 29: 105. Type species: *Perisemus floridanus* Ashmead, original designation (synonymized by EVANS, 1978)

Perasierola Kieffer 1914, 41: 533. Type species: *Parasierola gallicola* Kieffer 1905c, subsequent designation (MUESEBECK and WALKLEY, 1951). (synonymized by EVANS, 1978)

Diagnosis: Maxillary palpi with 5 segments, labial palpi 3; mandible with several (usually 4) small apical teeth; clypeus with a strongly produced angular or subangular median lobe, with a median, polished streak, ridge or carina which extends onto frons for a short distance; malar space rather long; eye glabrous or setose. Posterior margin of pronotum arcuate or slightly sinuate; scutellum with a pair of very small pits, sometimes obsolescent, connected by a weak groove; propodeum margined laterally, transverse carina margining disc behind complete, medially interrupted or absent; disc roundly elevated mediobasally and usually more polished; mesopleura with a strong pit above; claw of female bifid, male claw trifid. Forewing with or without areolet; pterostigma large, with convex posterior margin; prostigma strong and subtriangular; radial vein not reaching anterior margin of wing, marginal cell open; basal vein gently curved and not forming an angle. Metasoma shining sessile, slightly depressed; male subgenital plate typically truncate and with the median notch; male genitalia with parameres divided or undivided.

Statistics: This is a highly speciose genus of Bethylidae and clearly the largest in the subfamily Bethylineae, represented by 145 nominal species around the World (GORDH and WITETHOM, 1994). So far, 51 species are recorded from Oriental region (SANTHOSH and NARENDRAN, 2009) of which, 37 are from the Indian subcontinent, and only 11 are known to be distributed in Southern Western Ghats.

Biology: Available records suggest that many species are relatively unspecific as to hosts, and the species are adaptive to many and so are widely distributed. They are gregarious parasitoids of microlepidopteran larvae. One New World species is known to attack larvae in nests of sphecid *Microstigmus xylicola* Melo and *M. similis* Melo (MELO and EVANS, 1993). Besides, RAU (1922) reported that *Goniozus* sp. was reared from a nest of *Ceratina* bee (needs confirmation). Males are less encountered than females in field collections, hence many species are known from the females only.

Distribution: It is a cosmopolitan genus with representation in all the zoogeographical realms, mostly in the tropical and subtropical regions.

Phylogeny: The phylogenetic analysis (POLASZEK and KROMBEIN, 1994) of 11 taxa of Bethylineae for 22 morphological characters provided more stable classification of the subfamily. In this context, the newly described species were manually analyzed and the character coding and data matrix are given in tables (see tables 1 and 2).

Clypeus with longitudinal median carina is a character that bethylids share with other chrysidoid families. Apomorphic states to varying degrees are present in the following; *G. aproaeremae* sp. nov., *G. malabaricus* sp. nov., *G. borneanus* Cameron, *G. indicus* Ashmead, *G. mustus* sp. nov., *G. jeroeni* sp. nov., *G. kottiyooricus* sp. nov. and *G. recentis* sp. nov. having their clypeal carina very weak and sometimes reduced to only a smooth ridge or completely absent as in *Goniozus platycephalus* sp. nov. and *G. fulgidus* Krombein.

Regarding the number of antennal segments, the plesiomorphic condition in Bethylineae is the possession of 13 segmented antennae. The three genera studied viz. *Goniozus*, *Odontepyrus* and *Sierola* shows this plesiomorphy. In *Bethylus*, a

reduction to 12 segmented antennae has occurred. Regarding labial and maxillary palp segments, the plesiomorphy is the possession of 3 segmented labial and 6 segmented maxillary palps. *Sierola* and *Bethylus* have 2 segmented labial palpi, whereas all other genera in the subfamily showed the plesiomorphic character. The six segmented maxillary palpi are found in the Australian genus, *Eupsenella* Westwood and the Neotropical genus *Lytopsenella* Kieffer. Both *Goniozus* and *Odontepyris* show the apomorphic reduction to five segments, whereas in *Sierola* the maxillary palpi are 4 segmented. The presence of unsculptured shiny frontal streak from the proximal end of the clypeal carina to the frontal ocellus is the plesiomorphic character shared between *Lytopsenella*, *Eupsenella* and *Odontepyris*. In the other genera the head sculpturing is reduced and the streak is absent. *Goniozus*, *Odontepyris* and *Sierola* do not possess notauli. Their presence is low throughout the Hymenoptera. In Bethylinae, it is reported only from the basal taxa, *Lytopsenella* and *Eupsenella* (POLASZEK and KROMBEIN, 1994).

Goniozus show the apomorphic character, development of smooth, triangular area on the dorsal propodeum. In the present investigation, *G. mustus* sp. nov. and *G. alarius* sp. nov. showed tendency towards plesiomorphy in varying degrees of development ranging from triangular impression, but coriaceous to total absence of smooth triangle and entire propodeal disc strongly coriaceous. Similarly, the absence of posterior propodeal transverse carina is a plesiomorphic character in Bethylinae, shown by *Lytopsenella*, *Eupsenella*, *Sierola* and *Bethylus*, whereas in all studied *Odontepyris* spp. posterior propodeal transverse carina are present. In *Goniozus*, it is in varying degrees of development, with transverse carina narrowly interrupted, broadly interrupted and completely absent as in *G. platycephalus* sp. nov., *G. orthogae* sp. nov., *G. rutherfordi* Krombein, *G. indicus* Ashmead, *G. mustus* sp. nov., *G. neoteropus* sp. nov., *G. comatus* Krombein, *G. ecarinatus* Krombein, *G. clypeatus* sp. nov., *G. longigastralis* sp. nov., and *G. kottiyooricus* sp. nov. The other apomorphic characters found in *Goniozus* are absence of submarginal cell, absence of closed marginal cell, and the development of prostigma. Submarginal cell is present in basal taxa, *Lytopsenella* and *Eupsenella*. Presence of closed marginal cell is shown by basal taxa, and in *Sierola*. The rs+m vein is long and well developed in

all *Goniozus*. The discoidal cell is open in the 42 species of the genus from Indian subcontinent and in the 21 species, it is closed as in the basal taxa.

Remarks: Six Oriental species viz. *chowdhari* Kurian, *madrassippattanami* Kurian, *morindae* Kurian, *nephoterycis* Kurian, *ahmeadi* Kurian and *thalasodes* Kurian are known only from the male, and these males may be conspecific with named females (GORDH and WITETHOM, 1994). EVANS (1964) attempted to revise this large genus for the first time. Most of the species are from the isolated new species descriptions because many species of the genus are with biological control potential and authors found it convenient to provide a name rather than wait several years until a monograph could be prepared. Hence, a revisionary study is definitely required.

Table – 1. Character List and Coding of *Goniozus* species from Indian Subcontinent

- #1. Forewing areolet/
 - 0. absent/
 - 1. present/
- #2. Head in lateral view/
 - 0. weakly compressed, LH 1.60 – 1.74x WH/
 - 1. moderately compressed, LH 1.75 – 1.88x WH/
 - 2. strongly compressed, LH 1.89 – 2.2x WH/
- #3. Head in full face view/
 - 0. transverse, WH equal to or longer than 1.03x LH/
 - 1. elongate, WH equal to or less than 0.88x LH/
 - 2. as long as wide, WH 0.89 – 1.02x LH/
- #4. Posterior propodeal carina/
 - 0. absent/
 - 1. complete/
 - 2. broadly interrupted medially/
 - 3. narrowly interrupted medially/
- #5. Mandible/
 - 0. yellow/
 - 1. brown/
 - 2. dark brown black/
- #6. Antenna/
 - 0. subequal to head length in full face view/
 - 1. distinctly longer than head in full face view/
- #7. Head sculpture/

- 0. frons smooth and polished, sometimes vertex weakly coriaceous/
 - 1. frons and vertex moderately coriaceous/
 - 2. frons and vertex strongly coriaceous/
- #8. Vertex margin/
 - 0. straight in full face view/
 - 1. emarginate in full face view/
- #9. Vertex/
 - 0. ecarinate/
 - 1. carinate/
 - 2. weakly carinate/
- #10. Scrobe/
 - 0. ecarinate/
 - 1. weakly carinate/
 - 2. strongly carinate/
- #11. Ocellar triangle/
 - 0. obtuse/
 - 1. acute or right angled/
- #12. Eye/
 - 0. glabrous/
 - 1. setose, setae as long as or shorter than diameter of single facet/
 - 2. setose, setae longer than diameter of single facet/
- #13. Forefemur/
 - 0. shorter than 2x its width/
 - 1. 2x as long as wide/
 - 2. longer than 2x its width/
- #14. Forewing median and submedian cells/
 - 0. aetose/
 - 1. sparsely setose/
 - 2. profusely setose/
- #15. Ocellocular line (OOL)/
 - 0. shorter than 0.89x width of ocellar triangle (WOT)/
 - 1. 0.89 – 1.09x width of ocellar triangle (WOT)/
 - 2. longer than 1.1x width of ocellar triangle (WOT)/
- #16. Posterior ocelli/
 - 0. contiguous with vertex or away from vertex margin by distance less than 0.5x its diameter/
 - 1. away from vertex margin by distance 1 – 2x its diameter/
 - 2. away from vertex margin by distance more than 2x its diameter/
- #17. Anterior clypeal margin/
 - 0. acute/
 - 1. right angled/
 - 2. obtuse/
- #18. Clypeal carina/
 - 0. strong or moderately strong/
 - 1. very weak, only as a smooth ridge or completely absent/
- #19. Clypeus/

- 0. with median carina extending onto front upto posterior margin of scrobal impression/
- 1. with median carina extending onto front beyond posterior margin of scrobal impression/
- #20. Ventral mandibular teeth/
 - 0. straight or weakly curved/
 - 1. strongly curved backwards and downwards/
- #21. Anteromedian propodeal area/
 - 0. elevated, smooth and polished triangle/
 - 1. smooth polished rectangle/
 - 2. weakly coriaceous triangle/
 - 3. smooth and polished triangle, but not elevated/
- #22. Pedicel/
 - 1. shorter than F1/
 - 2. as long as F1/
 - 3. longer than F1/
- #23. Scape/
 - 0. shorter than 2x pedicel/
 - 1. as long as 2x pedicel/
 - 2. longer than 2x pedicel/
- #24. Width of frons (WF)/
 - 0. shorter than 0.97x height of eye (HE)/
 - 1. 0.98 – 1.07x height of eye (HE)/
 - 2. longer than 1.07x height of eye (HE)/
- #25. Maximum distance from top of the eye to posterior margin of vertex (EV)/
 - 0. shorter than 0.50x height of eye (HE)/
 - 1. 0.57 – 0.89x height of eye (HE)/
 - 2. longer than 0.90x height of eye (HE)/
- #26. Shape of areolet/
 - 0. subtriangular/
 - 1. subrectangular/
- #27. Gena/
 - 0. smooth and polished/
 - 1. weakly coriaceous/
- #28. Metasoma/
 - 0. as long as mesosoma/
 - 1. longer than mesosoma/
 - 2. shorter than mesosoma/
- #29. Metasoma sculpture/
 - 0. completely smooth and polished/
 - 1. T1 completely smooth others with a basal coriaceous band/
- #30. Propodeal disc/
 - 0. sharply inclined to lateral margin, usually with a sublateral ridge/
 - 1. smoothly inclined to lateral margin/

Table – 2. Data Matrix of *Goniozus* spp. from Indian Subcontinent

Taxon	Character coding																														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
<i>Goniozus sringeriensis</i> sp. nov.	0	0	0	1	0	1	2	1	1	0	0	1	0	1	0	0	0	0	0	0	0	0	2	2	0	0	N	0	1	0	0
<i>Goniozus palghatensis</i> sp. nov.	0	1	1	2	1	0	2	0	0	1	0	2	0	2	1	0	0	0	0	0	0	0	0	1	0	0	N	0	2	1	1
<i>Goniozus buddhai</i> sp. nov.	0	0	1	1	0	0	2	1	1	1	0	1	2	1	1	0	2	0	0	1	0	2	0	0	0	N	0	1	1	1	
<i>Goniozus nuperus</i> sp. nov.	0	2	1	1	1	0	2	0	1	0	0	1	0	2	1	0	2	0	1	1	0	2	0	1	1	N	0	1	1	0	
<i>Goniozus kainophanestus</i> sp. nov.	0	1	1	1	0	0	2	0	2	0	0	1	0	1	1	0	2	0	0	1	3	2	0	0	0	N	0	1	1	1	
<i>Goniozus novellus</i> sp. nov.	0	1	1	1	1	0	2	0	0	0	0	1	0	1	1	0	2	0	0	1	0	2	0	1	1	N	0	1	1	1	
<i>Goniozus propodeatus</i> sp. nov.	0	1	1	1	1	1	2	0	2	0	0	2	0	2	1	0	0	0	0	0	0	2	2	1	0	N	0	1	1	0	
<i>Goniozus platycephalus</i> sp. nov.	0	2	2	0	0	1	1	1	0	0	0	1	2	1	0	0	2	1	N	0	3	2	1	2	1	N	0	1	1	0	
<i>Goniozus orthogae</i> sp. nov.	0	0	2	0	1	1	2	0	0	0	0	1	0	2	1	0	2	0	0	0	0	2	1	1	0	N	0	1	1	0	
<i>Goniozus aproaeremae</i> sp. nov.	0	1	2	2	1	0	2	0	?	0	0	1	1	1	1	0	2	1	N	0	0	2	0	1	0	N	0	2	0	1	
<i>Goniozus malabaricus</i> sp. nov.	0	0	0	1	1	1	0	1	0	0	0	1	0	0	1	0	2	1	N	1	0	0	1	2	0	N	0	1	1	1	
<i>Goniozus prosphatosis</i> sp. nov.	0	1	2	2	0	1	2	1	1	1	0	1	2	1	0	0	2	0	0	0	0	2	0	1	0	N	0	1	1	0	
<i>Goniozus mandibularis</i> sp. nov.	0	0	2	3	1	1	2	0	0	0	0	1	2	1	1	0	2	0	1	1	0	0	0	1	0	N	0	1	1	0	
<i>Goniozus antennalis</i> sp. nov.	0	1	2	3	1	1	2	0	2	0	0	1	1	1	0	0	2	0	0	0	0	0	0	0	0	N	0	1	1	0	
<i>Goniozus armigerae</i> Santhosh and Narendran	0	0	1	1	0	1	2	0	0	1	0	1	0	1	1	0	2	0	0	0	0	2	0	1	0	N	0	0	1	1	
<i>Goniozus borneanus</i> Cameron	0	?	1	0	0	?	2	?	?	?	0	?	?	?	?	0	2	1	N	?	?	?	?	?	?	N	?	0	?	?	
<i>Goniozus chatterjii</i> Kurian	0	?	1	1	1	?	2	?	1	?	0	0	2	?	?	?	?	0	0	0	0	2	0	?	0	N	?	?	1	?	
<i>Goniozus fulgidus</i> Krombein	0	?	0	1	1	?	0	?	?	0	?	1	0	1	1	?	2	1	N	?	?	0	0	2	0	N	?	?	?	?	
<i>Goniozus keralensis</i> Gordh	0	1	2	0	0	?	2	0	0	0	0	0	?	?	?	0	0	0	0	0	0	0	1	1	0	N	?	?	1	1	
<i>Goniozus pakmanus</i> Gordh	0	?	0	1	1	?	1	0	?	0	0	?	0	1	2	0	2	0	0	?	0	0	2	0	0	N	?	?	?	1	
<i>Goniozus rutherfordi</i> Krombein	0	?	2	0	1	0	1	?	?	1	0	0	0	?	1	0	?	0	0	0	0	2	0	0	0	N	?	?	?	?	
<i>Goniozus cuttockensis</i> Lal	0	?	2	?	?	1	0	1	?	?	0	0	?	1	2	0	?	0	?	?	0	1	2	2	2	N	?	1	?	?	
<i>Goniozus delhiensis</i> Ram	0	0	0	2	1	1	1	1	2	0	0	1	0	1	2	0	2	0	1	0	0	1	2	0	0	N	0	1	0	1	
<i>Goniozus fulvicornis</i> (Rohwer)	0	?	?	3	?	?	0	?	?	?	?	?	?	?	?	?	?	0	?	?	?	?	?	?	?	N	?	?	0	?	
<i>Goniozus hybleae</i> Kurian	0	?	0	1	2	?	2	0	1	?	0	0	1	?	?	?	?	0	1	0	0	0	0	?	0	N	?	1	1	?	
<i>Goniozus indicus</i> Ashmead	0	0	1	0	2	?	0	0	?	0	2	1	2	1	2	2	0	1	N	?	3	2	0	2	2	N	0	?	?	1	
<i>Goniozus lygropiae</i> Kurian	0	?	0	1	1	?	2	0	1	?	0	0	0	?	?	?	?	0	1	0	0	0	0	?	0	N	?	0	0	?	
<i>Goniozus marasmi</i> Kurian	0	?	2	3	2	?	2	0	0	?	0	0	0	?	?	?	?	0	1	0	0	1	1	?	0	N	?	0	1	?	
<i>Goniozus montanus</i> Kieffer	0	?	2	1	1	?	1	?	?	1	0	1	P	?	P	0	0	0	0	0	0	0	2	P	0	N	?	?	?	?	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	

Taxon	Character coding																														
<i>Goniozus mori</i> Kurian	0	?	2	1	2	?	2	?	1	?	0	0	0	?	?	?	?	0	0	0	?	0	N	?	0	0	?				
<i>Goniozus nilamburensis</i> Kurian	0	?	2	1	2	?	1	?	1	?	?	0	0	?	2	0	?	0	1	?	0	2	0	?	0	N	?	1	1	?	
<i>Goniozus rugosus</i> Samad	0	?	0	?	2	1	?	?	?	?	?	?	?	?	?	2	2	0	?	0	?	?	?	0	1	N	?	1	?	?	
<i>Goniozus sanctijohannis</i> Kurian	0	?	2	1	2	?	2	0	1	?	0	0	0	?	?	0	?	0	1	?	0	2	0	?	0	N	?	?	?	?	
<i>Goniozus sensorius</i> Gordh	0	0	2	1	0	?	1	0	?	0	?	1	?	?	0	0	2	0	1	0	0	1	0	1	0	N	?	1	1	?	
<i>Goniozus stomopterycis</i> Ram and Subba Rao	0	1	2	3	2	1	2	0	0	0	0	1	0	1	1	0	2	0	0	0	0	2	0	0	0	N	0	2	0	1	
<i>Goniozus triangulus</i> Kieffer	0	?	0	0	0	?	?	?	?	?	?	?	?	?	?	0	0	0	0	0	0	?	?	?	?	N	?	?	?	?	
<i>Goniozus mustus</i> sp. nov.	1	1	2	0	1	1	2	0	0	1	0	1	1	1	1	0	1	1	N	1	2	1	1	1	0	0	0	?	?	1	
<i>Goniozus neoteropus</i> sp. nov.	1	0	2	0	0	1	2	0	1	1	0	2	0	2	1	0	0	0	1	0	1	1	1	1	0	0	0	?	?	1	
<i>Goniozus comatus</i> Krombein	1	?	2	0	0	?	2	?	?	0	?	2	0	?	0	0	?	0	1	?	?	0	2	1	?	?	?	?	?	?	
<i>Goniozus ecarinatus</i> Krombein	1	?	2	0	?	?	2	?	?	1	?	1	0	?	1	0	?	0	0	?	0	0	2	2	?	?	?	?	?	?	
<i>Goniozus mellipes</i> (Muesebeck)	1	?	2	1	0	0	1	?	1	?	?	?	?	1	?	?	?	0	0	?	0	1	?	1	0	?	?	?	0	1	?
<i>Goniozus cotha</i> sp. nov.	1	0	2	1	2	1	2	1	0	0	0	1	0	2	1	0	0	0	0	0	2	2	0	1	0	1	0	1	1	1	1
<i>Goniozus pulveriae</i> (Kurian)	1	?	2	1	2	?	2	1	?	?	?	0	0	2	?	?	?	0	0	?	0	2	2	?	1	0	?	2	?	?	
<i>Goniozus lucidulus</i> Krombein	1	?	2	1	0	?	1	?	?	1	0	0	0	?	0	0	?	0	0	?	0	2	1	?	0	?	?	?	?	?	
<i>Goniozus villosus</i> Krombein	1	?	2	1	1	?	2	?	?	1	?	2	0	?	0	0	?	0	0	?	?	2	1	0	0	?	?	?	?	?	
<i>Goniozus jeroeni</i> sp. nov.	1	0	2	1	1	1	2	1	0	0	0	1	0	1	0	0	2	1	N	0	0	2	1	1	0	0	0	1	0	1	
<i>Goniozus nephantidis</i> (Muesebeck)	1	1	2	2	2	0	1	0	1	2	0	1	0	2	2	0	?	0	0	?	1	2	2	2	0	0	0	0	1	1	
<i>Goniozus alarius</i> sp. nov.	1	1	2	2	1	0	2	0	0	1	0	2	0	2	2	0	0	0	0	0	2	1	0	1	0	0	1	1	1	1	
<i>Goniozus setosus</i> sp. nov.	1	2	1	2	2	0	2	0	0	1	0	2	0	2	0	0	0	0	1	0	3	2	1	0	0	1	1	1	0	1	
<i>Goniozus kuriani</i> sp. nov.	1	2	1	2	2	0	2	1	0	0	1	1	0	1	0	1	2	0	0	0	3	2	1	2	1	0	0	1	0	1	
<i>Goniozus inauditus</i> sp. nov.	1	0	1	2	1	0	2	0	0	2	0	1	0	2	2	0	0	0	1	0	1	2	1	1	1	0	0	1	0	1	
<i>Goniozus clypeatus</i> sp. nov.	1	0	1	0	1	1	2	0	0	0	0	2	0	2	2	0	0	0	0	0	1	0	0	1	0	0	0	?	?	1	
<i>Goniozus longigastralis</i> sp. nov.	1	1	1	0	2	1	1	1	0	1	1	1	0	2	2	0	2	0	1	0	0	1	2	2	1	0	1	?	?	1	
<i>Goniozus kottiyooricus</i> sp. nov.	1	0	1	0	2	1	2	0	0	0	0	1	2	1	2	0	2	1	N	0	0	2	1	2	1	0	0	?	?	1	
<i>Goniozus valvolicola</i> Krombein	1	?	1	2	?	?	2	1	?	0	2	1	2	?	2	1	0	0	0	?	0	0	1	2	1	?	?	?	?	?	
<i>Goniozus recentis</i> sp. nov.	1	0	0	1	1	1	2	1	0	1	0	1	0	2	1	0	2	1	N	1	0	1	2	2	2	0	0	1	?	1	
<i>Goniozus salvadorae</i> (Kurian)	1	?	0	1	2	?	2	1	0	?	?	0	2	?	?	?	2	0	0	?	1	?	?	?	1	?	?	?	?	?	

? - Unknown; N - Not applicable; P - Polymorphic state

5.1.1 Key to species of *Goniozus* Förster from Indian Subcontinent

(Based on female and male specimens)

1. Females: metasoma with 6 exposed segments, last segment conical as viewed from above, sting frequently exerted ----- 2
- Males: metasoma with 7 exposed segments, terminal segments occasionally telescoped, last segment with apical margin broadly rounded----- 58
- 2(1). Forewing with areolet (fig.174) ----- 3
- Forewing without areolet, but only short stub arising from basal vein (fig.178)----- 23
- 3(2). Propodeal disc posteriorly without transverse carina (fig.193, 226) ----- 4
- Propodeal disc posteriorly with transverse carina either complete or interrupted medially (fig. 282, 286)----- 10
- 4(3). Head length subequal to its width, WH 0.89 - 1.09x LH (fig.98, 72, 240); OOL less than 1.08x WOT (fig. 240, 244) ----- 5
- Head distinctly elongate, WH equal to or less than 0.89x LH (fig. 56, 217, 226); OOL more than 1.1x WOT (fig.193, 217. 226)----- 8
- 5(4). Mandible pale yellow; ocular setae 3x diameter of single facet (fig.72, 244) -
----- 6
- Mandible brown or dark red; ocular setae as long as diameter of single facet (fig. 240)----- 7
- 6(5). Pedicel shorter than F1; scape length more than 2x length of pedicel; WF 1.07x HE; OOL 0.88x WOT ----- *comatus* Krombein
- Pedicel length equal to F1; scape length 2x length of pedicel (fig. 245); WF = HE; OOL = WOT (fig.72)----- *neoterosus* sp. nov.
- 7(5). Clypeal carina moderately strong, restricted to clypeus, 0.41x as long as HE; smooth elevated anteriomedian propodeal triangle present; pedicel shorter

- than F1; scape longer than 2x pedicel; WF 1.35x HE -----
-----*ecarinatus* Krombein
- Clypeal carina absent, but represented by a smooth ridge on clypeus (fig.68);
no anteriomedian propodeal triangle (fig.69); entire propodeal disc strongly
coriaceous; pedicel as long as F1; scape 2x pedicel (fig.241); WF 1.06x HE-
-----*mustus* sp. nov.
- 8(4). M and SM of forewing with single row of setae (fig.221), speculum asetose;
clypeal carina moderately strong, not extending onto frons; malar space
distinct with malar groove (fig.219); forefemur 2.1x as long as wide (220)---
----- *kottiyooricus* sp. nov.
- M and SM of forewing profusely setose (fig.193, 226), speculum setose;
clypeal carina strong, extending onto frons (fig.23, 24, 226); malar space
narrow without malar groove (fig.195); forefemur 1.6 – 1.8x as long as wide
(fig. 196, 229)----- 9
- 9(8). Ocular setae 3x as long as diameter of single facet (fig.24); ocellar triangle
obtuse (fig.193); frons and vertex strongly coriaceous (fig.24); OOL 1.10-
1.23x WOT; anterior clypeal margin acute (fig.24); propodeal disc with a
smooth median band, extending posteriorly onto declivity (fig.25, 193);
pedicel shorter than F1 (fig.194); WF 0.92-0.97x HE ----- *clypeatus* sp. nov.
- Ocular setae as long as diameter of single facet (fig.56); ocellar triangle acute
(fig.56, 226); frons and vertex weakly coriaceous (fig.56); OOL 1.75x WOT
(fig.226); anterior clypeal margin obtuse (fig.56); propodeal disc with a
smooth anterior median elevated triangle, extending to posterior margin by a
median line (fig.226); pedicel as long as F1 (fig.227); WF 1.18x HE -----
----- *longigastralis* sp. nov.
- 10(3). Propodeal disc posteriorly with a complete transverse carina, without any
interruption medially (fig. 29, 108, 197, 209, 282)----- 11
- Propodeal disc posteriorly with a transverse carina interrupted medially
(fig.174) ----- 18

- 11(10). Head transverse, WH equal to or more than 1.2x LH ----- 12
 -- Head length subequal to its width, WH 0.89 - 1.09x LH ----- 13
- 12(11). Mandible black brown; forefemur 2.33x as long as wide; clypeal carina strong extending onto frons upto posterior scrobal margin; anteromedian propodeal area with a smooth area, not elevated triangle; EV 0.67x HE; metasoma shorter than head plus mesosoma ----- *salvadorae* Kurian
 -- Mandible yellow brown; forefemur 1.83x as long as wide; clypeal carina absent, present only as median smooth ridge; anteromedian propodeal area with a smooth elevated triangle; EV 0.28-0.29x HE; metasoma distinctly longer than head plus mesosoma ----- *recentis* sp. nov.
- 13(12). Frons and vertex smooth or weakly coriaceous, polished; mandible yellow -
 ----- 14
 -- Frons and vertex strongly coriaceous, not polished; mandible dark brown to black ----- 15
- 14(13). Posterior transverse propodeal carina weakly complete; EV 0.38x HE; pedicel longer than F1 ----- *lucidulus* Krombein
 -- Posterior transverse propodeal carina distinct, complete; EV 0.5x HE; pedicel as long as F1 ----- *mellipes* (Muesebeck)
- 15(13). Median clypeal carina absent, represented as a smooth ridge restricted to clypeus (fig.39); M and SM sparsely setose (fig.209); EV 0.46x HE -----
 ----- *jeroeni* sp. nov.
 -- Median clypeal carina strong and extending onto frons as a low carina; other characters partially or completely different ----- 16
- 16(15). Eye profusely setose, setae 2x as long as diameter of single facet; EV 0.18x HE; scape 2x as long as pedicel; mandible slender, brown -----
 ----- *villosus* Krombein

- Eye aetose or if setose, setae sparse, as long as diameter of single facet; EV more than 0.29x HE; scape more than or less than 2x as long as pedicel; mandible stout, black ----- 17
- 17(16). Eye sparsely setose, setae as long as diameter of single facet (fig.28); scape shorter than 2x as long as pedicel (fig.198); EV 0.31x HE; areolet subrectangular (fig.197); mesosoma shorter than metasoma (fig.26); rs = m ----- *cotha* sp. nov.
- Eye bare; forefemur 1.94x as long as wide; scape longer than 2x as long as pedicel; EV 0.67x HE; areolet subtriangular; mesosoma longer than metasoma; rs shorter than m ----- *pulveriae* (Kurian)
- 18(10). Head length subequal to its width, WH 0.89 - 1.09x LH; OOL 1.22-1.33x WOT----- 19
- Head distinctly elongate, WH equal to or less than 0.88x LH; OOL more than 1.33x WOT or less than 1.22x WOT ----- 20
- 19(18). Eye sparsely setose, setae 2x diameter of single facet; forefemur 1.76 - 1.9x as long as wide; anterior median propodeal triangle smooth and polished; pedicel longer than F1; scape 2.5x pedicel ----- *nephantidis* (Muesebeck)
- Eye profusely setose, setae 4x as long as diameter of single facet (fig.9); forefemur 1.54x as long as wide (fig.177); anterior median propodeal triangle coriaceous (fig.10); pedicel = F1; scape 2.8x pedicel (fig.175) -----
----- *alarius* sp. nov.
- 20(18). Vertex straight; scrobe weakly or strongly carinate; M and SM profusely setose; posterior ocelli contiguous with vertex margin; EV 0.35-0.55x HE --
----- 21
- Vertex emarginate; scrobe ecarinate; M and SM sparsely setose; posterior ocelli equal to or more than 0.5x its diameter away from vertex margin; EV 0.75-0.85x HE ----- 22
- 21(20). Eye profusely setose, setae 3x as long as diameter of single facet (fig.111); forefemur 1.67x as long as wide (fig.289); OOL 0.82-0.94x WOT (fig.286);

- WF 0.84-0.93x HE; EV 0.35-0.39x HE; gena weakly coriaceous -----
----- *setosus* sp. nov.
- Eye sparsely setose, setae as long as diameter of single facet (fig.33, 201);
forefemur 1.92x as long as wide (fig.204); OOL 1.09-1.10x WOT (fig.201);
WF = HE; EV 0.47-0.67x HE; gena smooth and polished -----
----- *inauditus* sp. nov.
- 22(20). Ocellar triangle acute (fig.51); forefemur 1.92x as long as wide (fig.225);
OOL 0.66x WOT (fig.51, 222); clypeal apical margin weakly produced,
obtuse (fig.51); anteromedian propodeal area rectangular, smooth, not
elevated (fig.52); pedicel longer than F1 (fig.223) ----- *kuriani* sp. nov.
- Ocellar triangle right angled; forefemur 2.07x as long as wide; OOL 1.54 –
1.58x WOT; clypeal apical margin strongly produced, acute; anteromedian
propodeal area triangular, smooth, elevated; pedicel shorter than F1 -----
----- *valvolicola* Krombein
- 23(2). Frons and vertex smooth and polished (fig.36, 60)----- 24
- Frons and vertex coriaceous (fig.115)----- 28
- 24(23). Clypeal carina absent, represented only by a smooth ridge (fig.60) ----- 25
- Clypeal carina present (fig.36) ----- 26
- 25(24). Head distinctly transverse, WH 1.11x LH; scape less than 2x as long as
pedicel----- *fulgidus* Krombein
- Head subequal, WH 1.04-1.05x LH (fig.60); scape 2-2.3x as long as pedicel
(fig.231)----- *malabaricus* sp. nov.
- 26(24). Antenna 2x as long as head ----- *cuttockensis* Lal
- Antenna not as long as 2x head length ----- 27
- 27(26). Eye small, HE shorter than EV (fig.36, 205); thorax slender, narrower than
head (fig.35); propodeum without transverse carina (fig.205); median clypeal
carina weak, not extending to frons (fig.36); head nearly parallel sided
(fig.205)----- *indicus* Ashmead

- Eye larger; thorax stouter; propodeum with transverse carina notched in the middle; other characters partially or completely different-*fulvicornis* Kieffer
28(23).Head transverse, WH 1.03 - 1.07x LH (fig.115, 290)----- 29
- Head longer than or as long as wide (fig.87, 256)----- 35
- 29(28).EV 0.8x HE; Posterior ocelli separated from vertex by more than its own diameter----- *rugosus* Samad
- EV equal to or less than 0.5x HE; Posterior ocelli contiguous or separated from vertex by less than 0.5x its diameter ----- 30
- 30(29).Posterior transverse carina absent; anteromedian propodeal triangle smooth, long extending upto posterior margin ----- *triangulus* Kieffer
- Posterior transverse carina present, complete or medially interrupted; anteromedian propodeal triangle smooth, run upto or slightly beyond middle ----- 31
- 31(30).Scape 2x as long as pedicel; EV 0.5x HE; WF 0.75x WH ----- 32
- Scape longer than 2x pedicel; EV 0.23 – 0.42x HE; WF 0.49 - 0.57x WH-33
- 32(31).F2 0.8x F1; clypeal carina running upto a level of 0.25x HE; POL 0.6x OOL; thorax 1.75x as long as its width; forewing 3x as long as its width; metasoma as long as thorax ----- *lygropiae* Kurian
- F2 1.8x F1; clypeal carina running upto a level of more than 0.33x HE; POL = OOL; thorax 2x as long as its width; forewing more than 3x as long as its width; metasoma slightly longer than thorax ----- *hybleae* Kurian
- 33(31).Mandible yellow (fig.115); OOL 0.63-0.73x WOT (fig.115); clypeal margin acute (fig.115); pedicel longer than F1 (fig.291); propodeal disc sharply inclined to lateral margin with weak sublateral ridge (fig.290)-----
-----*sringeriensis* sp. nov.
- Mandible brown-black; OOL 1.12 – 1.25x WOT; clypeal margin obtuse; pedicel equal to or less than F1; propodeal disc smoothly inclined to lateral margin, no sublateral ridge ----- 34

- 34(33).Posterior propodeal transverse carina weak, but complete; vertex straight in full face view; pedicel shorter than F1 ----- *pakmanus* Gordh
- Posterior propodeal transverse carina broadly interrupted medially; vertex emarginate in full face view; pedicel = F1 ----- *delhiensis* Ram
- 35(28).Head subequal, WH 0.91 –1.02x LH (fig.95, 256, 267)----- 36
- Head elongate, WH equal to or less than 0.89x LH (fig.91, 99, 263, 272) - 50
- 36(35).Posterior propodeal transverse carina absent (fig.88, 96, 256, 267) ----- 37
- Posterior propodeal transverse carina present, either complete or interrupted medially (fig.18, 182, 178)----- 40
- 37(36).Head strongly compressed, LH 2.17x WH in lateral view (fig.94, 269); clypeal carina completely absent (fig.95); forefemur 2.14x as long as wide (fig.270)----- *platycephalus* sp. nov.
- Head moderately compressed, LH less than 2x as long as WH in lateral view; clypeal carina present; forefemur less than 2x as long as wide----- 38
- 38(37).Mandible yellow; pedicel shorter than F1 ----- *keralensis* Gordh
- Mandible brown-black; pedicel longer than F1 (fig.256)----- 39
- 39(38).OOL 0.91x WOT (fig.87); scape 2x pedicel (fig.256); posterior ocelli not contiguous with vertex (fig.256); mandible stout -----*orthogae* sp. nov.
- OOL = WOT; scape shorter than 2x pedicel; posterior ocelli contiguous with vertex; mandible slender ----- *rutherfordi* Krombein
- 40(36).Posterior propodeal transverse carina complete----- 41
- Posterior propodeal transverse carina interrupted medially----- 45
- 41(40).Scape longer than 2x pedicel; pedicel shorter than F1; scrobe weakly carinate ----- *montanus* Kieffer
- Scape shorter than 2x pedicel; pedicel equal to or more than F1; scrobe ecarinate ----- 42

- 42(41).Mandible yellow; eye sparsely setose; propodeal declivity medially smooth;
WF = HE; anterior clypeal margin obtuse ----- *sensorius* Gordh
-- Mandible brown-black; eye aetose; propodeal declivity entirely coriaceous;
other characters partially or completely different----- 43
- 43(42).Forefemur 1.58x as long as wide; parapsidal furrow absent -----
----- *sanctijohannis* Kurian
-- Forefemur 1.92 - 1.96x as long as wide; parapsidal furrow present ----- 44
- 44(43).Metasoma as long as mesosoma; pedicel shorter than F1; clypeal carina
extending slightly above lower orbital margin ----- *mori* Kurian
-- Metasoma distinctly longer than mesosoma; pedicel longer than F1; clypeal
carina extends on to frons, 0.33x as long as HE ----- *nilamburensis* Kurian
- 45(40).Posterior transverse propodeal carina broadly interrupted medially ----- 46
-- Posterior transverse propodeal carina narrowly interrupted medially ----- 47
- 46(45).Mandible yellow (fig.103); antenna distinctly longer than head; vertex
emarginate (fig.276); forefemur 2.1x as long as wide (fig.277); clypeal carina
present (fig.103); malar space distinct (fig.278); setae on vertex distinctly
longer than that of frons (fig.276)----- *prosphtosis* sp. nov.
-- Mandible brown-black (fig.17); antenna as long as head (fig.17); vertex
straight (fig.182); forefemur 2x as long as wide (fig.185); clypeal carina
absent, represented by a smooth ridge (fig.17); malar space narrow (fig.184);
setae on vertex not distinctly longer than that of frons (fig.182) -----
----- *aproaeremae* sp. nov.
- 47(45).Forefemur equal to or more than 2x as long as wide (fig.181, 238); pedicel
shorter than F1 (fig.179, 236); metasoma longer than mesosoma (fig.62)-- 48
-- Forefemur less than 2x as long as wide; pedicel equal to or more than F1;
metasoma shorter than or as long as mesosoma ----- 49

- 48(47). OOL 0.75-0.86x WOT; ventral most tooth of mandible straight; anteromedial smooth elevated propodeal triangle extends upto middle of propodeal disc, not connected to posterior margin; WF 0.81-0.89x HE--- ***antennalis* sp. nov.**
- OOL 0.89-1x WOT; ventral most tooth of mandible strongly curved downwards; anteromedial smooth elevated propodeal triangle extends beyond middle of propodeal disc, connected to posterior margin by a smooth line; WF 1-1.07x HE-----***mandibularis* sp. nov.**
- 49(47). Pedicel as long as F1; scape as long as 2x pedicel; metasoma as long as mesosoma; forefemur 1.91x as long as wide; eye asetose----***marasmi* Kurian**
- Pedicel longer than F1; scape shorter than 2x pedicel; metasoma shorter than mesosoma (fig.117); forefemur 1.81x as long as wide; eye sparsely setose (fig.118)-----***stomopterycis* Ram & SubbaRao**
- 50(35). Parapsidal furrow absent; propodeal disc without median carina and posterior transverse carina, propodeal dorsum shorter than mesoscutum and scutellum combined; POL = OOL -----***borneanus* Cameron**
- Parapsidal furrows present; propodeal disc with posterior transverse carina, other characters partially or completely different ----- 51
- 51(50). Anterior clypeal margin acute (fig.91, 99, 263, 272); scape equal to or more than 2x pedicel (fig.263, 272); eye profusely setose, setae longer than diameter of single facet (fig.91, 99); M, SM profusely setose (fig.263, 272)52
- Anterior clypeal margin obtuse (fig.21, 43, 79, 83, 248, 252); scape shorter than 2x pedicel (fig.191, 214, 249, 253); eye sparsely setose, setae as long as diameter of single facet (fig.21); M, SM with few scattered setae (fig.190, 248, 252)----- 53
- 52(51). Posterior propodeal transverse carina complete (fig.272); propodeal disc sharply inclined to lateral margin, with sublateral ridges (fig.100); antenna distinctly longer than head in full face view (fig.99); pedicel longer than F1; scape longer than 2x pedicel (fig.273); metasoma longer than mesosoma (fig.97); frons and vertex with shallow punctures (fig.99); ocular setae

- slightly longer than diameter of single facet (fig.99) -----
-----***propodeatus* sp. nov.**
- Posterior propodeal transverse carina broadly interrupted medially (fig.92); propodeal disc smoothly inclined to lateral margin, no sublateral ridges (fig.92); antenna as long as head in full face view; pedicel shorter than F1; scape as long as 2x pedicel (fig.90); metasoma shorter than mesosoma (fig.89); frons and vertex without shallow punctures; ocular setae 2.8x as long as diameter of single facet (fig.91)-----***palghatensis* sp. nov.**
- 53(51).Forefemur longer than 2x as long as wide; EV 0.25 – 0.39x HE----- 54
- Forefemur shorter than 2x as long as wide (fig.189, 216, 251, 255); EV 0.44 – 0.83x HE----- 55
- 54(53).Mandible yellow (fig.21); ventral most mandibular tooth strongly curved downwards; tip of anteromedian propodeal triangle reaching posterior transverse carina (fig.190)----- ***buddhai* sp. nov.**
- Mandible brown-black; ventral most mandibular tooth straight; tip of anteromedian propodeal triangle connected to posterior transverse carina by means of median carina----- ***chatterjii* Kurian**
- 55(53).Head in lateral view weakly compressed, 1.5x as long as wide (fig.188); antenna distinctly longer than head; ventral most mandibular tooth straight; metasoma as long as mesosoma (fig.186) -----
-----***armigerae* Santhosh and Narendran**
- Head in lateral view strongly compressed, 1.8 - 2x as long as wide (fig.215, 250, 254); antenna as long as or slightly longer than head (fig.79, 83); ventral most mandibular tooth strongly curved downwards; metasoma distinctly longer than mesosoma (fig.41, 78, 81) ----- 56
- 56(55).Mandible yellow (fig.43); forefemur 1.67x as long as wide (fig.216); anteromedian smooth propodeal triangle not elevated, continued as a smooth patch to transverse carina (fig.44); EV 0.42-0.44x HE -----
-----***kainophanestus* sp. nov.**

- Mandible brown-black (fig.79,83); forefemur 1.82-1.92x as long as wide (fig.251, 255); anteromedian smooth propodeal triangle elevated, either not continued or connected to the transverse carina by a smooth median line, but not a smooth patch (fig. 80, 84, 248, 252); EV 0.53 – 0.60x HE ----- 57
- 57(56).OOL 1.05-1.11x WOT; anteromedian propodeal triangle smooth, elevated, connected to transverse carina by a smooth median line (fig.84, 252); head in lateral view 2x as long as wide (fig.82, 254); mandible stout; antenna slightly longer than head ----- **nuperus sp. nov.**
- OOL 0.94x WOT; anteromedian propodeal triangle smooth, elevated, only upto middle of disc, not connected to the transverse carina (fig.80, 248); head in lateral view 1.87x as long as wide (fig.250); mandible slender; antenna as long as head ----- **novellus sp. nov.**

Males

- 58(1). Forewing with closed areolet ----- 59
- Forewing without closed areolet, only short stub arising from basal vein -- 62
- 59(58).Head elongate, WH 0.80x LH; mandible red-brown; eye asetose -----
----- **salvadorae** (Kurian)
- Head subequal or transverse, WH equal to or more than 0.90x LH; mandible red-brown; eye asetose ----- 60
- 60(59).Posterior transverse propodeal carina complete; head transverse, WH 1.18x LH; OOL 0.77x WOT; posterior ocelli contiguous with vertex -----
----- **recentis sp. nov.**
- Posterior transverse propodeal carina broadly interrupted medially; head subequal, WH 0.90 - 1.00x LH; OOL more than 0.94x WOT; posterior ocelli separated from vertex by 1.5x its diameter ----- 61
- 61(60).Anterior clypeal margin acute; sides of head behind eyes parallel before curving inward at posterolateral angles; EV 0.75x HE; OOL 1.36x WOT; antenna pale yellow; metasoma dark brown----- **valvolicola** Krombein

- Anterior clypeal margin obtuse; sides of head behind eyes curving towards rounded posterolateral angles; EV 0.56 - 0.61x HE; OOL 0.94 - 1.10x WOT; antenna brown; metasoma black ----- *nephantidis* Musebeck
- 62(58).Head longer than wide----- 63
- Head length equal to or less than its width ----- 66
- 63(62).Propodeum without transverse carina separating dorsum from posterior declivity, metasoma brown----- 64
- Propodeum with a transverse carina separating dorsum from posterior declivity, metasoma black----- 65
- 64(63).Antenna brown and mandibles pale yellow; clypeus with weak carina not extending to frons; LH 1.04x HW; EV 0.41x HE ----- *rutherfordi* Krombein
- Antenna and mandibles reddish brown; clypeus with carina running up to a level slightly above insertion of antenna; LH 1.13x HW; EV 1.75x HE ----- *ahmeadi* Kurian
- 65(63).Subgenital plate with a well defined posteromedial notch, anteromedial propodeal triangle elevated, connected to transverse carina by a median carina ----- *pakmanus* Gordh
- Subgenital plate without posteromedial notch, anteromedial propodeal triangle elevated, continued posteriorly as median carina, but not reaching transverse carina ----- *keralensis* Gordh
- 66(62).Head as long as wide (fig.259) ----- 67
- Head wider than long (fig. 280) ----- 71
- 67(66).Posterior transverse propodeal carina complete; vertex emarginate; forefemur 2.15x as long as wide; pedicel = F1; parapsidal furrow distinct and complete; mandible red-brown----- *thalasodes* (Kurian)
- Posterior transverse propodeal carina broadly interrupted medially (fig.259); vertex straight; forefemur as long as or less than 2x as long as wide; other characters not as above, partially or completely different ----- 68

- 68(67). Forefemur 2x as long as wide (fig.262); forewing with M and SM profusely setose (fig.259); clypeal carina weak; EV 0.62x HE----- *orthagae* sp. nov.
- Forefemur less than 2x as long as wide; forewing with M and SM sparsely setose; clypeal carina strong; EV 0.22 – 0.46x HE----- 69
- 69(68). Pedicel shorter than F1; scape longer than 2x pedicel; head weakly coriaceous; mandible slender ----- *montanus* Kieffer
- Pedicel longer than F1; scape shorter than 2x pedicel; head strongly coriaceous; mandible stout ----- 70
- 70(69). Mandible red-brown; OOL 0.62x WOT (fig.280); setae on vertex distinctly longer than other setae on head (fig.280); head in lateral view 1.76x as long as wide (fig.281)----- *prosphtosis* sp. nov.
- Mandible yellow; OOL 0.94x WOT; setae on vertex as long as other setae on head; head in lateral view 1.54x as long as wide -----
----- *stomopterycis* Ram & SubbaRao
- 71(67). Scape as long as or longer than 2x length of pedicel----- 72
- Scape less than 2x length of pedicel ----- 73
- 72(71). Clypeus without median longitudinal carina; antenna uniformly honey yellow, F1 and F2 slightly serrate; POL 0.75x OOL----- *morindae* Kurina
- Clypeus with median longitudinal carina extending to one-third eye length; antenna reddish brown, F1 and F2 not serrate; POL 0.6x OOL -----
----- *nephterycis* Kurian
- 73(71). Posterior transverse propodeal carina weak, interrupted medially; EV 0.20x HE; parapsidal furrow weak and incomplete---- *madrassippattanami* Kurian
- Posterior transverse propodeal carina distinct, complete; EV 0.40-0.41x HE; parapsidal furrow distinct and complete ----- 74
- 74(73). Mandible pale yellow; anteromedial propodeal triangle connected to transverse carina by a median carina ----- *sensorius* Gordh

- Mandible red – brown; anteromedial propodeal triangle upto middle of disc, not connected to transverse carina ----- *chowdhari* Kurian

***Goniozus alarius* sp. nov.**

(figs. 7-10, 174-177)

Diagnosis: Head slightly longer than wide, WH 0.91x LH; strongly compressed in lateral aspect, 1.83x as long as wide; frons and vertex coriaceous, with scattered shallow punctures, profusely setose; gena weakly coriaceous; eye profusely setose, setae 4x as long as diameter of single facet; malar space distinct; malar groove present; OOL 1.31-1.33x WOT. Antenna slightly longer than head in full face view; all funicular segments longer than wide; pedicel shorter than F1; scape longer than 2x pedicel. Basal median propodeal triangle not smooth, elevated and distinct; only weakly coriaceous impression; posterior transverse propodeal carina broadly interrupted medially. Forewing 2.97x as long as wide with subtriangular areolet; M, SM, and areolet profusely setose. Forefemur 1.54x as long as wide.

Description: *Holotype* – Female.

Measurements: Length 3.11mm; LH 0.73mm; WH 0.66mm; WF 0.38mm; FWL 2.16mm; LM 1.13mm; LP 0.32mm; WPD 0.51mm; LPD 0.24mm.

Colour: Body black, metasoma with dark brown tinge; antenna brown-yellow, last 3 segments fuscous; mandible reddish brown, teeth red; leg yellow, except light brown forefemur and forecoxa. Wing hyaline; costa, prostigma, pterostigma, light brown; other veins colourless.

Head: Head (figs.9, 174) longer than wide, WH 0.91x LH, compressed in lateral aspect, 1.83x as long as wide (figs.8, 176); frons and vertex coriaceous, with scattered shallow punctures (fig.9); gena weakly coriaceous; vestiture short, profuse, decumbent; six pairs of long setae on vertex, longest being 0.18m; two of them lie close to outer posterolateral ocular margin; anterior clypeal margin strongly produced, sharply angulated, acute; clypeal carina 0.67x HE, strong, arcuate in profile, extending onto frons upto level of posterior scrobal margin; scrobe weakly

carinate; mandible stout with 4 short, pointed teeth, ventral most straight; WF 0.53x LH; WF = HE; EV 0.47x HE; LH 2x HE; malar space distinct; malar groove present; eye profusely setose with long setae, 4x diameter of single facet; ocelli in obtuse triangle; posterior ocelli contiguous with vertex margin; OOL 1.33x WOT; POL: AOL: DAO = 4:2:2.3; vertex straight in full face view, acute, sharply angulated, ecarinate. Relative lengths of first five antennal segments (fig.175) 8:4.2:3.5:3.5:3.8; scape 1.33x as long as wide, 2.8x pedicel; pedicel shorter than F1; all funicular segments longer than wide; antenna slightly longer than head in full face view (29:32).

Mesosoma: Pronotum, mesonotum and scutellum uniformly coriaceous (fig.10); vestiture short, profuse; sparse on scutellum; pronotal disc 0.46x as long as wide; two pits on base of scutellum connected by a narrow groove, parapsidal furrow complete; notauli absent; propodeum 0.62x as long as wide, smoothly inclined to lateral margin; basal median propodeal triangle not smooth, elevated and distinct, only weakly coriaceous impression in basal median area; propodeal disc and declivity entirely coriaceous, shallow longitudinal depression on sides of propodeal disc; few setae on disc around spiracles; posterior transverse propodeal carina broadly interrupted medially. Forewing (fig.174) 2.97x as long as wide; areolet present; areolet subtriangular in shape; M, SM, speculum and areolet profusely setose. Forefemur (fig.177) 1.54x as long as wide; SI 5.14.

Metasoma: Metasoma (fig.7) distinctly longer than mesosoma (42:34), shorter than head plus mesosoma (42:57); T1 smooth and polished, others weakly coriaceous. T1-T2 with few setae restricted to lateral margin; other tergites sparsely setose all across dorsal side.

Male: Unknown.

Ecology and Biology: Collected from the forest canopy. Host unknown.

Etymology: The species epithet is after the Latin word, *ala* meaning wing, in allusion to the characteristically hairy forewing cells of the species.

Distribution: India – Karnataka - Nilgiris; Kerala.

Material Examined: *Holotype* – Female. INDIA: Tamil Nadu, Nilgiris, Chamrajnagar, Kurimandai, 4.78kms NW Punanjanur, 11°81.89'N 77°11.28'E, 1013 m, DDF, YPT, 31.i.2007; Mahadesha, leg.; VRN 159 (DZUC). *Paratype*. 1♀. INDIA: Kerala, Calicut University Botanical Garden, Arboretum, 11°07.58'N 75°53.24'E, 80m, MT, 14-27.xii.2006, S. Santhosh, leg., VRN 111 (DZUC).

Variation: EV 0.36x HE. See table- 3 for the morphometric ratios of type materials examined.

Discussion: *Goniozus alarius* sp. nov. is very closely related to *G. nephantidis* (Muesebeck) in having head length subequal to its width, WH 0.89 - 1.09x LH and OOL 1.22-1.33x WOT. *Goniozus alarius* sp. nov. differs from *G. nephantidis* in having eye profusely setose, ocular setae 4x as long as diameter of single facet, forefemur 1.54x as long as wide, anterior median propodeal triangle coriaceous, pedicel shorter than F1 and scape 2.8x pedicel, whereas in *G. nephantidis* eye sparsely setose, ocular setae as long as the diameter of single facet, forefemur 1.76 - 1.9x as long as wide, anterior median propodeal triangle smooth and polished, pedicel longer than F1 and scape 2.5x pedicel.

Table – 3. Morphometric ratios of *Goniozus alarius* sp. nov.

VRN	WH / LH	OOL / WOT	EV / HE	WF / HE	LH / LA	LS / PL	PL / LF1
159	0.91	1.33333333	0.3125	1.1875	0.76923	2.8	0.83333
111	0.913793	1.3125	0.357143	1.21429	0.76316	2.8	0.83333
Mean Values	0.91	1.32	0.33	1.20	0.64	2.8	0.83

***Goniozus antennalis* sp. nov.**

(figs.11-14, 178-181)

Diagnosis: Head longer than wide, WH 0.92-0.96x LH, strongly compressed in lateral aspect, 1.84x as long as wide; frons and vertex coriaceous with scattered shallow punctures; ventral most tooth of mandible straight; WF 0.81-0.89x HE; OOL 0.75-0.86x WOT. Propodeal disc sharply inclined to lateral margin; sublateral carina on posterolateral corner; anteromedial propodeal triangle smooth elevated,

extends upto middle of propodeal disc, not connected to posterior margin; posterior transverse propodeal carina narrowly interrupted medially. Forewing without areolet, but only short stub arising from basal vein; M, SM with single row of setae; speculum asetose; metasoma longer than mesosoma.

Description: *Holotype – Female.*

Measurements: Length 3.06mm; LH 0.75mm; WH 0.68mm; WF 0.37mm; FWL 2.1mm; LM 0.37mm; LP 0.39mm; WPD 0.52mm; LPD 0.29mm.

Colour: Body dark brown; metasoma especially first 2 tergites, pronotum lighter; mandible yellowish brown, basally dark brown, teeth brown; antenna brownish yellow; scape, terminal 6 segments brown; coxa, femur dark brown, trochanter, tibia, tarsi brown-yellow. Wing infumated; costa, subcosta, prostigma, pterostigma light brown; other veins straw coloured.

Head: Head longer than wide, WH 0.92x LH (figs.13, 178), compressed in lateral aspect, 1.84x as long as wide (figs.12, 180); frons and vertex coriaceous with scattered shallow punctures; gena smooth and polished; vestiture sparse, long, erect; 3 pairs of long setae on vertex, longest being 0.13mm; mandible robust with 4 long, pointed teeth; ventral most tooth blunt and weakly curved; anterior clypeal margin strongly produced, obtuse; clypeal carina strong, arcuate in profile, 0.5x HE, extending onto frons upto level of posterior scrobal margin; scrobe ecarinate; WF 0.49x LH; WF 0.86x HE; EV 0.36x HE; LH 1.84x HE; malar space narrow; malar groove absent; eye sparsely setose; setae as long as diameter of single facet; ocelli in obtuse triangle; posterior ocelli contiguous with vertex margin; OOL 0.86x WOT; POL:AOL:DAO = 5.5:2.5:2.5; vertex straight in full face view, weakly carinate. Relative lengths of first five antennal segments (fig.179) 9:5:6:5:5; scape 1.5x as long as wide, equal to or more than 2x pedicel; pedicel shorter than F1; all antennal segments longer than wide; antenna longer than head in full face view (51: 37).

Mesosoma: Pronotum, mesonotum and scutellum uniformly coriaceous (fig.14); vestiture sparse, long; setae on pronotum long; pronotal disc (fig.178) 0.57x as long as wide; scutellum with pair of basal slits; propodeal dorsum with basal median smooth elevated triangle extending upto middle, not connected to posterior margin,

rest of disc and declivity coriaceous; transverse carina strong and narrowly interrupted medially; propodeal disc 0.59x as long as wide, sharply inclined to lateral margin; sublateral carina on posterolateral corner of propodeum. Forewing (fig.178) 2.75x as long as wide; without areolet, only a short stub arising from basal vein; M, SM with single row of setae; setae absent in distal one-third of M cell; speculum asetose; m:rs:rs+m = 6.5:4.5:5. Forefemur (fig.181) 2x as long as wide; SI 5.12.

Metasoma: Metasoma (fig.11) slightly longer than mesosoma (29:25), shorter than head plus mesosoma (29:41); tergites smooth and polished; T1 completely smooth; other tergites with delicately coriaceous basal band; T1-T3 with few setae restricted to lateral margin; other tergites sparsely setose all across dorsal side.

Male: Unknown.

Ecology and Biology: Collected from the paddy ecosystem. Host unknown.

Etymology: The species epithet is after the characteristically long antenna of the species.

Distribution: India – Kerala; Chhattisgarh – Durg.

Material Examined: *Holotype* – Female. INDIA: Kerala, Palghat, Silent valley, 11°05.14'N 76°31.48'E, 595m, 10.vii.1990, sweeping, TEF, T.C. Narendran leg., VRN 5 (DZUC). *Paratypes*. 1♀. INDIA: Kerala, Palghat, Puliampettakayal, 1.64kms NW of Koottanad, 10°45.67'N 76°07.10'E, 8m, 28.ii.2008, sweeping, paddy field, S. Santhosh, leg., VRN 13; 1♀. Kasaragode, 5kms NW Kasaragode Town, 12°31.04'N 74°57.10'E, 18m, 27.ii.1988, K. Surekha leg., VRN 101; 2♀. INDIA: Chhattisgarh, Dhanora, 8kms SE of Durg Stadium, 21°06.24'N 81°20.32'E, 300m, 24.iv-09.v.2008, MT, paddy field, S. Santhosh leg., VRN 106, VRN 108 (DZUC).

Variation: In one paratype, scape is less than 2x length of pedicel. See table- 4 for morphometric ratios of the type materials examined.

Discussion: *Goniozus antennalis* sp. nov. is closely related to *G. mandibularis* sp. nov. in having forefemur equal to or more than 2x as long as wide, pedicel shorter

than F1 and metasoma longer than mesosoma. *Goniozus antennalis* sp. nov. is different from *G. mandibularis* sp. nov. in having OOL 0.75-0.86x WOT, ventral most tooth of mandible straight, anteromedial smooth elevated propodeal triangle extends upto middle of propodeal disc not connected to posterior margin and WF 0.81-0.89x HE, whereas in *G. mandibularis* sp. nov., OOL 0.89-1x WOT, ventral most tooth of mandible strongly curved downwards, anteromedial smooth elevated propodeal triangle extends beyond middle of propodeal disc connected to posterior margin by a smooth line and WF 1-1.07x HE.

Table – 4. Morphometric ratios of *Goniozus antennalis* sp. nov.

VRN	WH / LH	OOL / WOT	EV / HE	WF / HE	LH / LA	LS / PL	PL / LF1
5	0.916667	0.85714286	0.357143	0.82857	0.75	1.66667	1
13	0.916667	0.85714286	0.357143	0.85714	0.77419	2	0.83333
101	0.92	0.8	0.357143	0.89286	0.80645	2	1
106	0.961538	0.75	0.322581	0.80645	0.83871	2	0.90909
108	0.923077	0.75	0.34375	0.8125	0.78788	2.5	0.8
Mean Values	0.93	0.80	0.35	0.84	0.79	2.03	0.91

***Goniozus aproaeremae* sp.nov.**

(figs.15-18, 182-185)

Diagnosis: Head subequal, WH 0.90-1x LH; head strongly compressed in lateral aspect, 1.85x as long as wide; mandible brownish black; clypeal carina absent, represented by a smooth ridge; eye sparsely setose, setae minute, as long as diameter of single facet; malar space narrow; vertex straight. Antenna as long as head; scape shorter than 2x pedicel; pedicel longer than F1; pedicel and F11 longer than wide; F1-F3 wider than long; F4-F10 as long as wide. Posterior transverse propodeal carina broadly interrupted medially. Forefemur 2x as long as wide. Forewing without areolet, but only short stub arising from basal vein.

Description: *Holotype* – Female.

Measurements: Length 2.29mm; LH 0.57mm; WH 0.52mm; WF 0.31mm; FWL 1.68mm; LM 0.91mm; LP 0.2mm; WPD 0.4mm; LPD 0.34mm.

Colour: Body black, basal 2 tergites dark brown; mandible reddish brown; antenna yellow, terminal 4 segments light brown; coxa and femur dark brown, rest of leg brown-yellow; Wing hyaline, pterostigma light brown, other veins colourless.

Head: longer than wide, WH 0.92x LH (figs.17, 182), compressed in lateral aspect, 1.85x as long as wide (figs.16, 184); frons and vertex coriaceous with scattered shallow punctures; gena smooth and polished; vestiture short, sparse, suberect; setae on vertex not distinctly longer than other head setae; anterior clypeal margin weakly projecting, broadly rounded, obtuse; clypeal carina weak, appear as smooth ridge, 0.54x HE, extending onto frons, falling short of level of posterior scrobal margin; scrobe ecarinate; mandible robust with 4 short, blunt teeth, ventral most weakly curved; WF 0.54x LH; WF 0.97x HE; EV 0.41x HE; LH 1.89x HE; malar space narrow; malar groove absent; eye sparsely setose, setae minute, as long as diameter of single facet; ocelli in obtuse triangle, posterior ocelli contiguous with vertex margin; OOL = WOT; POL: AOL: DAO = 6.5: 2.8: 3; vertex straight in full face view, ecarinate. Relative lengths of first five antennal segments (fig.183) in the ratio of 6:3.5:2:2.5:3; scape 1.2x as long as wide, shorter than 2x length of pedicel; pedicel longer than F1; pedicel and F11 longer than wide; F1-F3 wider than long; F4-F10 as long as wide; antenna subequal to head length in full face view (40:38).

Mesosoma: Pronotum strongly coriaceous, mesonotum and scutellum polished (fig.18), weakly coriaceous, with scattered shallow punctures; vestiture on pronotum sparse, long, suberect; mesonotum and scutellum with only few scattered setae; pronotal disc (fig.182) 0.55x as long as wide; parapsidal furrow weak, but complete; notauli absent; scutellum with a pair of basal slits connected by a narrow groove; propodeal disc 0.54x as long as wide, smoothly inclined to lateral margin; basal median propodeal triangle smooth, extending to posterior margin of disc, propodeal triangle elevated only in basal half of dorsum; transverse carina broadly interrupted medially, only smooth impression of transverse carina in middle; rest of dorsum and declivity coriaceous. Forewing (fig.182) 3.26x as long as wide, without areolet; only a short stub arising from basal vein; M and SM setose; distal one third of M setose;

speculum with only a pair of setae near short stub from basal vein; m:rs:rs+m 6:3:4. Forefemur (fig.185) 2x as long as wide; SI 5.21.

Metasoma: Metasoma (fig.15) slightly shorter than mesosoma (31:34), shorter than head plus mesosoma (31:57); tergites smooth and polished; T1-T3 with few setae restricted to lateral margin; other tergites sparsely setose all across dorsal side.

Male: Unknown.

Ecology and Biology: ex. larvae of groundnut leaf miner, *Aproaerema modicella* (Deventer) (Lepidoptera: Gelechiidae). It was also collected from the paddy fields in Palghat.

Etymology: The species epithet is after the host's generic name, *Aproaerema*.

Distribution: India – Kerala; Tamil Nadu; Chhattisgarh – Durg.

Material Examined: *Holotype* – Female. INDIA: Kerala, Kozhikode, Pookad, 1.5kms E Kappad beach, 11°23.45'N 75°43.36'E, 157m, 31.viii.2001, sweeping, K. Sudheer, leg., VRN 124 (DZUC). *Paratypes*: 2♀. INDIA: Kerala, Trivandrum, Palode, 30kms NE Trivandrum, 08°46.23'N 76°59'45'E, 157m, 11-16.xii.2004, MT, EGF, S. Santhosh leg., VRN 55, VRN 56; 1♀. Palghat, Anakatti, 11°06.14'N 76°45.51'E, 707m, 12.xii.1987, sweeping, T.C. Narendran leg., VRN 58; 1♀. Palghat, Anakatti, 11°06.51'N 76°46.03'E, 628m, 7.i.1989, sweeping, T.C. Narendran leg., VRN 59; 1♀. Palghat, Koottanad, 10°46.14'N 76°06.50'E, 8m, paddy field, sweeping, 13.viii.2003, S. Santhosh, leg., VRN 22; 1♀. Puliampetta, 1.64kms NW Koottanad, 10°45'67"N 76°07'10"E, 8m, 28.ii.2008, YPT, paddy field, S. Santhosh, leg., VRN 14; 1♀. Kozhikode, Thiruvannur, 11°13.45'N 75°48.03'E, 17m, 20.ii.1995, sweeping, K. Rajmohana, leg., VRN 163; 1♀. Kannur, Panayathanparamba, 3kms W Kannur Airport, 11°54.32'N 75°30.27'E, 70m, 10-24.ii.2008, MT, scrub jungle, S. Santhosh, leg., VRN 133; 1♀. Malappuram, Calicut University Botanical Garden, 11°07.58'N 75°53.24'E, 80m, 12.vii.2004, sweeping, S. Santhosh, leg., VRN 169; 1♀. INDIA: Chhattisgarh, Durg, Belhari, 4kms NW Durg stadium, 21°12.39'N 81°14.51'E, 287m, 24.iv.2007, sweeping, mixed vegetable field, S. Santhosh leg., VRN 105; 1♀. INDIA: Tamil Nadu, Coimbatore, TNAU campus, 11°00.52'N 76°56.00'E, 435m, 8.xi.2005, rearing, ex. larvae of

groundnut leaf miner, *Aproaerema modicella* (Deventer), G. Santharam, VRN 132 (DZUC).

Variation: Mandible brownish yellow (VRN 132); prostigma, pterostigma straw coloured, teeth of mandible dark red (VRN 14); teeth red (VRN 105); scape red-brown concolourous with mandible (VRN 169). In few paratypes, WH = LH, OOL 0.83x WOT, WF = HE, LH 0.86x LA, LS 1.7x PL and PL 1.16x LF1. See table- 5 for morphometric ratios of the type materials examined.

Discussion: *Goniozus aproaeremae* sp. nov. is similar to *G. prosphtosis* sp. nov. in having posterior transverse propodeal carina broadly interrupted medially and head as long as wide in full face view, WH 0.91x – 1.02x LH, but it differs in having brown-black mandible, antenna as long as head, vertex straight, forefemur 2x as long as wide, clypeal carina absent, malar space narrow and setae on vertex as long as that of frons, whereas in *G. prosphtosis* sp. nov., mandible is yellow, antenna distinctly longer than head, vertex emarginate, forefemur 2.1x as long as wide, clypeal carina present, malar space distinct and setae on vertex distinctly longer than that of frons.

Table – 5. Morphometric ratios of *Goniozus aproaeremae* sp. nov.

VRN	WH / LH	OOL / WOT	EV / HE	WF / HE	LH / LA	LS / PL	PL / LF1
133	1	1	0.432432	1	0.944444	1.714286	1.25
169	0.914286	1	0.35	1	0.875	2	1.5
58	0.933333	1	0.411765	1	0.857143	1.666667	1.5
55	0.882353	1	0.388889	1	0.918919		
56	0.881356	1	0.4375	1	0.867647	1.666667	1.5
124	0.9	1	0.410256	0.974359	0.972222	1.5	1.6
105	0.904762	0.9	0.411765	1	0.9	1.571429	1.4
132	0.909091	0.863636	0.388889	1	0.916667		
22	0.930233	0.892857	0.375	1	0.924731	1.4	1.666667
163	0.888889	0.833333	0.421053	1	0.923077	1.5	2
14	0.944444	0.875	0.425	1	0.878049	1.75	1.6
59	0.9	0.84	0.355556	0.888889	0.952381	1.714286	1.166667
Mean values	0.91	0.93	0.40	0.98	0.91	1.37	1.26

***Goniozus armigerae* Santhosh and Narendran**
(figs.186-189)

Goniozus armigerae Santhosh and Narendran, 2009. *J. Ent. Res. Soc.*, 11(1): 37-45, figs. 1-4. *Holotype* ♀ and *Paratypes* ♀ - Examined (INPC).

Diagnosis: Head elongate, WH 0.84-0.89x LH, clypeal margin obtuse, eye setose, mandible and antenna brown- yellow, F1 1.14-1.29x as long as wide; OOL 0.84-0.95x WOT; EV 0.42x HE. Anterior median propodeal carina connected to posterior transverse carina by a smooth line, scape less than 2x pedicel and areolet absent.

Redescription: *Holotype – Female.*

Measurements: Length 3.15mm; FWL 2.35mm; LH 0.79mm; WH 0.70mm; WF 0.43mm; LM 0.95mm; LP 0.43mm; WPD 0.55mm; LPD 0.33mm.

Colour: Body black; mandible brownish yellow, basal, dorsal and ventral margin dark brown, teeth red; antenna uniformly yellow except single brown terminal segment; coxa and forefemur of all legs and hindfemur brown, hindfemur lighter than forefemur and coxa, other segments yellow. Wing hyaline, stigma and prostigma brown, costa and subcosta light brown, other veins colourless.

Head: Distinctly longer than wide, WH 0.84x LH (fig.186), somewhat compressed in lateral aspect, 1.5x as long as wide (fig.188); frons and vertex coriaceous with scattered shallow punctures; gena smooth and polished; vestiture suberect, short and sparse, longest on vertex margin being 0.13mm; vertex margin straight, ecarinate; mandible robust with 4 teeth; anterior clypeal margin obtuse; clypeal carina strong, arcuate in profile, 0.68-0.78x HE, extending onto frons upto level of posterior scrobal margin; scrobe weakly carinate; WF 0.54x LH; WF 1x HE; EV 0.42x HE; LH 1.89x HE; malar space narrow; malar groove absent; eye sparsely setose, setae minute as long as single facet; ocelli in obtuse triangle, posterior pair separated from vertex crest by less than their own diameters; OOL 0.91x WOT; POL: AOL: DAO = 6:2.5:2.5. Relative lengths of first five antennal segments (fig.187) 8:4.2:4:4:3.5; scape 1.44x as long as wide, shorter than 2x pedicel; F1 1.25x as long as wide; F2 -

F5 wider than long; F6 - F10 as long as wide; F11 longer than wide; antenna slightly longer than head in full face view (25:20).

Mesosoma: Pronotum dull coriaceous, 0.45x as long as wide, vestiture longer than that of head; mesoscutum rather smooth and shining, and only weakly coriaceous with relatively sparse punctures; propodeum (fig.186) 0.63x as long as maximum width at level posterior to spiracles, with complete transverse carina on posterior margin; disc smoothly inclined to lateral margin; median basal triangle of propodeal dorsum smooth and polished, extending beyond middle of propodeal dorsum and connected to posterior transverse carina as a smooth line, rest of disc and posterior declivity coriaceous. Forewing (fig.186) without areolet, M sparsely setose, SM with a row of setae, rs+m slightly curved at apex, m:rs:rs+m = 9:5:7. Forefemur (fig.189) length 1.78-1.85x its width; SI 4.72;

Metasoma: (fig.1) Metasoma (fig.186) subequal to mesosoma (52:50), shorter than head plus mesosoma (50:85); tergites smooth and polished; T1-T3 with few setae restricted to lateral margin; other tergites sparsely setose all across dorsal side.

Male: Unknown.

Ecology and Biology: ex. larvae of *Helicoverpa armigera* (Hübner.) (Lepidoptera: Noctuidae).

Distribution: India – Himachal Pradesh.

Material Examined: *Holotype* – Female. INDIA: Himachal Pradesh, Solan, 30°54'N 77°05'E, 06.ii.1995, rearing, ex. larvae of *Helicoverpa armigera*, J. N. Thakur leg., VRN 25. (INPC) ON LOAN. *Paratypes* – 4 ♀. same data as holotype except VRN 23, VRN 24, VRN 26, VRN 27 (INPC) ON LOAN.

Variation: In the paratypes, VRN 23, scape is 1.55x pedicel and OOL 0.83x WOT. See table- 6 for morphometric ratios of all the type materials examined.

Discussion: *Goniozus armigeriae* is closely related to *G. kainophanestus* sp. nov., *G. nuperus* sp. nov., and *G. novellus* sp. nov., but in all the three later species head is strongly compressed in lateral view; ventral most mandibular tooth strongly curved downwards; metasoma distinctly longer than mesosoma; antenna as long as head in

full face view; *G. armigerae* is similar to *G. chatterjii* Kurian, but in *G. armigerae*, the mandible is yellow in colour, EV 0.42x HE, and the propodeal triangle is connected to the transverse carina by a smooth line, whereas in *G. chatterjii* mandible is red-brown in colour, EV 0.25x HE, and the anteromedial propodeal triangle smooth, connected to the posterior transverse carina by a raised median carina. This species is also similar to *G. japonicus* Ashmead, but in *G. armigerae* the clypeal margin is obtusely angulated, the posterior transverse carina is complete, eye setose, and the anteromedial smooth propodeal triangle is connected to the transverse carina by a median smooth line, whereas in *G. japonicus* the clypeal margin is acutely angulated, the posterior transverse carina of propodeum is evanescent in the middle, the eye bare, and the anteromedial smooth propodeal triangle is connected to the posterior margin by a smooth blotch.

Remarks: *Goniozus* (= *Parasierola*) species emerged from *Helicoverpa* (= *Heliothis*) *armigera* (Hübner) had been previously recorded from Coimbatore, Tamil Nadu (VADIVELU *et al.*, 1975), from maize fields of Bangalore, Karnataka (DIVAKAR and PAWAR, 1982; DIVAKAR *et al.*, 1983) but none were described so far. These undescribed species may be conspecific to new species but specimens of previous records are not available to study for confirmation. The types are deposited in INPC. Some parts of the description given above are adapted from SANTHOSH and NARENDRAN (2009). The species is redescribed here for the comprehensive treatment of the genus *Goniozus*.

Table – 6. Morphometric ratios of *Goniozus armigerae* Santhosh and Narendran

VRN	WH / LH	OOL / WOT	EV / HE	WF/HE	LH / LA	LS / PL	PL / LF1
25	0.83784	0.90909	0.42105	1	0.860465	1.8	1.25
26	0.88571	0.90476	0.42105	1	0.833333	1.90476	1.2
24	0.86111	0.95238	0.42444	1	0.837209	1.77778	1.125
23	0.88571	0.83636	0.42105	1	0.833333	1.55556	1.125
27	0.88889	0.89091	0.42105	1	0.837209	1.77778	1.125
Mean values	0.87	0.90	0.42	1	0.84	1.76	1.16

***Goniozus buddhai* sp. nov.**

(figs.19-21, 190-192)

Diagnosis: Head elongate, WH 0.87-0.89x LH; mandible yellow; ventral most mandibular tooth strongly curved downwards; EV 0.31x – 0.39x HE; scape shorter than 2x pedicel; eye sparsely setose, setae as long as diameter of single facet; anterior clypeal margin obtuse. Parapsidal furrow present; propodeal disc with complete posterior transverse carina; anteromedian propodeal triangle elevated, smooth, as such reaching posterior transverse carina; forefemur longer than 2x as long as wide. Forewing without areolet, but a short stub arising from basal vein only; M, SM, speculum with few scattered setae.

Description: Holotype – Female.

Measurements: Length 2.45mm; FWL 1.83mm; LH 0.61mm; WH 0.53mm; WF 0.32mm; LM 0.98mm; LP 0.33mm; WPD 0.42mm; LPD 0.26mm.

Colour: Body dark brown, base of metasoma lighter; mandible dark yellow with brown teeth; antenna yellow, scape and 4 terminal segments fuscous; leg brown except yellow tarsi and tibia. Wing hyaline, costa, subcosta, prostigma and stigma light brown, other veins colourless.

Head: Head (figs.21, 190) distinctly longer than broad, WH 0.87x LH, compressed in lateral aspect, 1.71x as long as wide (figs.20, 192); frons and vertex dull coriaceous with scattered shallow punctures (fig.21); gena smooth and polished; vestiture short, sparse, decumbent, longest on vertex margin being 0.1mm; vertex emarginate, carinate; anterior clypeal margin strongly projecting, bluntly angulated, obtuse; clypeal carina 0.63x HE, extending onto frons upto level of posterior margin of scrobe; scrobe weakly carinate; mandible moderately slender with 4 short, pointed teeth, ventral most curved; WF 0.51x LH; WF 0.89x HE; EV 0.39x HE; LH 1.89x HE; malar space narrow; malar groove absent; eye sparsely setose, setae minute, as long as diameter of single facet; ocelli in obtuse triangle; posterior ocelli contiguous with vertex margin; OOL 0.90x WOT; POL:AOL:DAO = 6:3:2.5. Relative lengths of first five antennal segments (fig.191) 5:3:2.5:2.5:3; scape 1.25x as long as wide, shorter than 2x pedicel length; pedicel longer than F1; F1 – F4

wider than long, F5-F10 as long as wide; terminal segment longer than wide; antenna slightly longer than head in full face view (38:35).

Mesosoma: Pronotum coriaceous with scattered shallow punctures; sculpture of mesonotum and scutellum same as that of head and pronotum but weaker; pronotal disc (fig.190) 0.45x as long as wide; mesonotum with weak parapsidal furrow, no notauli; scutellum with a pair of basal slits; propodeal disc 0.53x as long as wide, smoothly inclined to lateral margin; basal median propodeal triangle smooth and shining, elevated, reaching posterior margin; rest of propodeal disc, declivity coriaceous; posterior transverse carina complete. Forewing (fig.190) 2.82x as long as wide, without areolet, M, SM with a row of setae; speculum asetose; m:rs:rs+m = 5:4:4. Forefemur (fig.192) 2.1x as long as wide; SI 6.

Metasoma: Metasoma (fig.19) distinctly longer than mesosoma (67:56), shorter than head plus mesosoma (67:91); tergites smooth and polished; T1-T2 completely smooth, others with a weak coriaceous basal band; T1-T3 with few setae restricted to lateral margin; other tergites sparsely setose all across dorsal side.

Male: Unknown.

Ecology and Biology: Unknown.

Etymology: The species epithet is after the Great Buddhist Spiritual Master, Gauthama Buddha.

Distribution: India – Kerala.

Material Examined: *Holotype* – Female. INDIA: Kerala, Palghat, Silent valley, 11°07.49'N 76°25.40'E, 915m, vii.1990, TEF, sweeping, T.C. Narendran leg., VRN 1. (DZUC). *Paratypes*. 4♀. same data of holotype, VRN 2, VRN 3, VRN 4, VRN 6; 2♀. INDIA: Kerala, Malappuram, Calicut University Botanical Garden, 11°07.58'N 75°53.24'E, 80m, 12.vii.2004, sweeping, S. Santhosh leg., VRN 164, VRN 165; 1♀. Calicut University Botanical Garden, 11°07.58'N 75°53.24'E, 80m, 9.x.2002, sweeping, T.C. Narendran leg., VRN 162; 1♀. Calicut University Botanical Garden, 11°07.58'N 75°53.24'E, 80m, 27.ii.1989, sweeping, K. Surekha leg., VRN 99 (DZUC).

Variation: In some paratypes WF = HE, OOL 1.05x WOT and LS 2x PL. See table-7 for morphometric ratios of all the type materials examined.

Discussion: *Goniozus chatterjii* Kurian is closely related to *G. buddhai* sp. nov. in having forefemur longer than 2x as long as wide and EV 0.25-0.39x HE, but differs in having mandible brown-black; ventral most mandibular tooth straight; tip of anteromedian propodeal triangle elevated, smooth, and connected to posterior transverse carina by means of median carina, whereas in *G. buddhai* sp. nov., mandible yellow; ventral most mandibular tooth strongly curved downwards; tip of anteromedian propodeal triangle elevated, smooth, reaching posterior transverse carina. *Goniozus buddhai* sp. nov. is also related to *G. armigerae*, but in *G. armigerae* forefemur is less than 2x as long as wide and EV 0.44 – 0.83x HE whereas in *G. buddhai* sp. nov. forefemur is more than 2x as long as wide and EV 0.25 – 0.39x HE.

Remarks: The paratype VRN 165 is with a damaged head. Hence morphometric measurements were not taken from the same.

Table – 7. Morphometric ratios of *Goniozus buddhai* sp. nov.

VRN	WH / LH	OOL / WOT	EV / HE	WF / HE	LH / LA	LS / PL	PL / LF1
1	0.870968	0.9	0.388889	0.88889	0.92537	1.66667	1.30435
2	0.892857	1.05555556	0.375	0.90625	0.96552	2	1.25
3	0.878571	1	0.3125	0.96875	0.96552	1.66667	1.5
4	0.873333	0.9	0.333333	0.88889	0.9375	1.66667	1.30435
6	0.863226	0.95	0.388889	0.94444	0.96875	1.83333	1.5
164	0.890909	0.94444444	0.388889	0.83333	0.85938	1.6	1.38889
165	?	?	?	?	?	?	?
162	0.89	1.05882353	0.366667	1	0.89286	1.8	1.25
99	0.894286	0.8	0.375	1	0.96552	2	1.30435
Mean Values	0.88	0.95	0.37	0.92	0.93	1.78	1.35

***Goniozus clypeatus* sp. nov.**

(figs.22-25, 193-196)

Diagnosis: Head longer than wide, WH 0.87-0.89x LH, compressed in lateral aspect, 1.73x as long as wide; frons and vertex strongly coriaceous with scattered shallow punctures; anterior clypeal margin acute; clypeal carina strong, extending onto frons; eye profusely setose; setae long, 3x as long as diameter of single facet; OOL 1.10-1.23x WOT; EV 0.32-0.37x HE; vertex slightly convex in full face view, carinate. Antenna slightly longer than head in full face view; pedicel shorter than F1; F2 and F3 wider than long, F4-F10 as long as wide. Propodeal disc with a smooth median band, extending posteriorly onto declivity; propodeal disc posteriorly without transverse carina. Forewing with subtriangular areolet, M, SM profusely setose.

Description: *Holotype* – Female.

Measurements: Length 3.16mm; LH 0.73mm; WH 0.64mm; WF 0.41mm; FWL 2.07mm; LM 1.12mm; LP 0.32mm; WPD 0.5mm; LPD 0.25mm.

Colour: Body black, basal and terminal abdominal tergites brown; antenna brownish yellow, terminal six segments dark brown; mandible yellow, teeth darker; leg yellow; coxa, femur of foreleg and hindleg with a brown patch on dorsal margin; wing hyaline, costa, subcosta, prostigma and stigma light brown, other veins colourless.

Head: Head (fig.24, 193) longer than wide, WH 0.87x LH, compressed in lateral aspect, 1.73x as long as wide (fig. 23, 195); frons and vertex strongly coriaceous with scattered shallow punctures; gena smooth and polished; vestiture long, profuse, decumbent; four pairs of long setae on vertex, longest being 0.25mm; anterior clypeal margin strongly produced, sharply angulated, acute; clypeal carina 0.67x HE, strong and arcuate in profile, extending onto frons as a low carina upto level of posterior scrobal margin; scrobe ecarinate; mandible moderately stout with 4 short, blunt teeth, ventral most straight; WF 0.56x LH; WF 0.96x HE; OOL 1.16x WOT; EV 0.35x HE; LH 1.78x HE; malar space narrow; malar groove absent; eye profusely setose; setae long, 3x as long as diameter of single facet; ocelli in obtuse

triangle; posterior ocelli contiguous with vertex margin; POL:AOL:DAO = 5:2.7:2:2; vertex slightly emarginated, convex in full face view, sharply angulate, carinate. Relative lengths of first five antennal segments (fig. 194) 8:5:3.5:4:3.5:3.5; scape 1.55x as long as wide, shorter than 2x pedicel; pedicel shorter than F1; F2 and F3 wider than long, F4-F10 as long as wide; terminal segment longer than wide; antenna slightly longer than head in full face view (28:23).

Mesosoma: Pronotum, mesonotum, scutellum uniformly coriaceous (fig.25); vestiture long, profuse, decumbent; pronotal disc (fig. 25, 193) 0.54x as long as wide; parapsidal furrow complete; notauli absent; scutellum with a pair of basal pits connected by narrow groove; propodeal disc 0.64x as long as wide, smoothly inclined to lateral margin; basal median propodeal area with smooth, polished band, not elevated, extending beyond posterior margin of disc to declivity, rest of disc and declivity coriaceous; posterior transverse carina absent; setae on propodeal disc around inner margin of spiracles. Forewing (fig.193) 2.84x as long as wide; areolet present, subtriangular in shape; M, SM, areolet speculum profusely setose. Forefemur (fig. 196) 1.64x as long as wide; SI 5.23.

Metasoma: Metasoma (fig.22) longer than mesosoma (36:28), shorter than head plus mesosoma (36:43); tergites smooth and polished; T1-T3 with few setae restricted to lateral margin; other tergites sparsely setose all across dorsal side.

Male: Unknown.

Ecology and Biology: Unknown.

Etymology: The species epithet is after the clypeus of the species with an acute anterior margin.

Distribution: India – Kerala.

Material Examined: *Holotype* – Female. INDIA: Kerala, Kannur, Panayathanparamba, 3kms W Kannur Airport, 11°54.32'N 75°30.27'E, 70m, scrub jungle, MT, 10-24.ii.2008, K. Seena Narayanan, leg., VRN 155. (DZUC). *Paratypes*. 2♀. same data as holotype, VRN 156, VRN 154; 2♀. same data as holotype except 13-27.iii.2008, VRN 140, VRN 139; 1♀. Kozhikode, Nanminda, 11°26.45'N

75°50.25'E, 29m, 4.iv.2004, sweeping, K.P. Girish Kumar, leg., VRN 75; 2♀.
Malappuram, Calicut University Botanical Garden, Arboretum, 11°07.58'N
75°53.24'E, 80m, MT, 5-15.iv.2007. S. Santhosh leg., VRN 179, VRN 178; 1♀.
Malappuram, Calicut University Botanical Garden, Arboretum, 11°07.58'N
75°53.24'E, 80m, MT, 19-27.xii.2006, S. Santhosh leg., VRN 112. (DZUC).

Variation: In paratypes, WH 0.81x LH, OOL – WOT and EV 0.44x HE. See table- 8 for morphometric ratios of all the type materials examined.

Discussion: *Goniozus clypeatus* sp. nov. is similar to *G. longigastralis* sp. nov. in having M and SM of forewing profusely setose, speculum setose, clypeal carina strong extending onto frons, malar space narrow without malar groove and forefemur 1.6 – 1.8x as long as wide. *Goniozus clypeatus* sp. nov. differ from *G. longigastralis* sp. nov. in having ocular setae 3x as long as diameter of single facet, ocelli in obtuse triangle, frons and vertex strongly coriaceous, OOL 1.10-0.23x WOT, anterior clypeal margin acute, propodeal disc with a smooth median band extending posteriorly onto declivity, pedicel shorter than F1 and WF 0.92-0.97x HE, whereas in *G. longigastralis* sp. nov. ocular setae as long as diameter of single facet, ocellar triangle acute, frons and vertex weakly coriaceous, OOL 1.75x WOT, anterior clypeal margin obtuse, propodeal disc with a smooth anterior median elevated triangle extending to posterior margin by a median line, pedicel as long as F1 and WF 1.18x HE.

Table – 8. Morphometric ratios of *Goniozus clypeatus* sp. nov.

VRN	WH / LH	OOL / WOT	EV / HE	WF / HE	LH / LA	LS / PL	PL / LF1
155	0.87234	1.16666667	0.346154	0.96154	0.81034	2.5	0.8
156	0.875	1.23636364	0.357143	0.92857	0.8	2.5	0.8
154	0.877551	1.07692308	0.333333	1	0.79032	2.5	0.8
140	0.88	1.15384615	0.321429	0.96429	0.86207	2.5	0.8
139	0.86	1.07142857	0.37037	1	0.83333	2.5	0.8
75	0.810811	1	0.444444	0.94444	0.97368	2.33333	0.6
178	0.897959	1.15384615	0.321429	0.96429	0.84483	2.25	0.8
179	0.897959	1.15384615	0.321429	0.96429	0.84483	2.25	0.8
112	0.888889	1.07142857	0.333333	0.96667	0.87097	2.9	0.8
Mean Values	0.87	1.12	0.35	0.97	0.85	2.47	0.78

***Goniozus cotha* sp. nov.**

(figs.26-29, 197-200)

Diagnosis: Head slightly longer than wide, WH 0.91x LH; weakly compressed in lateral aspect, 1.66x as long as wide; frons and vertex strongly coriaceous with scattered shallow punctures; anterior clypeal margin strongly produced, sharply angulated, acute; gena smooth and polished; malar space distinct; malar groove present; mandible black, EV 0.31x HE; metasoma distinctly longer than mesosoma. Antenna longer than head in full face view; scape shorter than 2x pedicel; pedicel longer than F1; F1 and F2 longer than wide; F3- F8 as long wide; F9-F11 longer than wide. Forewing 2.74x as long as wide with subrectangular areolet; M, SM, areolet sparsely setose.

Description: *Holotype* – Female.

Measurements: Length 3.83mm; LH 0.81mm; WH 0.74mm; WF 0.45mm; FWL 2.21mm; LM 1.14mm; LP 0.38mm; WPD 0.61mm; LPD 0.31mm.

Colour. Body black, metasoma dark brown; mandible black, teeth brown; antenna yellowish brown, terminal 5 segments darker; coxa, femur dark brown, foretibia, tarsus yellow; midtibia, hindtibia brown. Wing hyaline; prostigma, pterostigma, subcosta light brown, other veins straw coloured.

Head: Head (figs.28, 197) longer than wide, WH 0.91x LH, compressed in lateral aspect, 1.66x as long as wide (figs.27, 199); frons and vertex strongly coriaceous with scattered shallow punctures; gena smooth and polished; vestiture moderately long, 0.086mm; sparse, suberect; setae on vertex distinctly longer than setae on head, longest being 0.24mm; anterior clypeal margin strongly produced, sharply angulated, acute; clypeal carina strong, arcuate in profile, 0.64x HE; extending onto frons as a low carina upto level of posterior margin of scrobe; scrobe ecarinate; mandible stout, teeth 4, short, ventral most straight; WF 0.55x LH; WF = HE; EV 0.31x HE; LH 2.1x HE; malar space distinct; malar groove present; eye setose, setae minute, as long as diameter of single facet; ocelli in obtuse triangle; posterior ocelli contiguous with vertex margin; OOL 0.9x WOT; POL: AOL: DAO = 6:2.5:2; vertex slightly emarginate in full face view, acute, sharply angled to occiput, ecarinate. Relative lengths of first five antennal segments (fig.198) 7:4:3:3:3; scape 1.89x as long as wide, shorter than 2x pedicel; pedicel longer than F1; F1 and F2 longer than wide; F3- F8 as long wide; F9-F11 longer than wide; antenna longer than head in full face view (43:34).

Mesosoma. Pronotum, mesonotum, and scutellum (fig.29) strongly coriaceous uniformly, with scattered shallow punctures; vestiture long, sparse, suberect on pronotum, mesonotum and scutellum; pronotal disc 0.33x as long as wide; mesonotum with distinct, complete parapsidal furrow; notauli absent; scutellum with a pair of basal slits connected by a weak transverse groove; propodeal disc 0.49x as long as wide, smoothly inclined to lateral margin; basal median propodeal elevated triangle weakly coriaceous, not well defined at edges, extending to posterior margin by a smooth line; rest of propodeal disc and declivity strongly coriaceous; posterior transverse propodeal carina complete. Forewing (fig.197) 2.74x as long as wide; areolet present; areolet subrectangular in shape; M, SM and areolet sparsely setose, speculum profusely setose. Forefemur (fig.200) 1.68x as long as wide; SI 5.36.

Metasoma. *Metasoma* (fig.26) distinctly longer than mesosoma (79:48), slightly shorter than head plus mesosoma (79:82); tergites generally smooth and polished; T1 completely smooth, other tergites with weakly coriaceous basal half; T1-T2 with few setae restricted to lateral margin; other tergites sparsely setose all across dorsal side.

Male: Unknown.

Ecology and Biology: Collected from the forest canopy. Host unknown.

Etymology: The name of the species is technically an arbitrary combination of letters, but the pronunciation of this name is after the Nilgiris tribal group, Kotha for their help in the exploration leading to the collection of this specimen.

Distribution: India – Tamil Nadu – Nilgiris.

Material Examined: *Holotype* – Female. INDIA: Tamil Nadu, Nilgiris, Coonoor, Pudukadu, 3.88kms SE Coonoor, 11°19.93'N 76°50.02'E, 890m, SEF, YPT, 27.xii.2007, T.A. Priya leg., VRN 158 (DZUC).

Discussion: *Goniozus cotha* sp. nov. is similar to *G. pulveriae* (Kurian) in having frons and vertex strongly coriaceous, mandible dark brown to black and median clypeal carina strong and extending onto frons as a low carina, but differ in having eye sparsely setose, setae as long as diameter of single facet, scape shorter than 2x as long as pedicel, EV 0.31x HE, areolet subrectangular, rs = m and mesosoma shorter than metasoma, whereas in *G. pulveriae* eye is asetose, forefemur 1.94x as long as wide, scape longer than 2x as long as pedicel, EV 0.67x HE, areolet subtriangular, rs shorter than m and mesosoma longer than metasoma. *Goniozus villosus* Krombein is also similar to *G. cotha* sp. nov. and *G. pulveriae* in having frons and vertex strongly coriaceous, mandible dark brown to black and median clypeal carina strong and extending onto frons as a low carina, but differ in having eye profusely setose, ocular setae 2x as long as diameter of single facet, EV 0.18x HE, scape 2x as long as pedicel, and mandible is slender and brown.

***Goniozus delhiensis* Ram**

(fig.30)

Type species. *Goniozus delhiensis* Ram, 1969. *Bull. Ent.*, 10(1): 68-70, figs. 1-6. *Holotype* and *Paratype* – examined (INPC).

Diagnosis: Head transverse, WH 1.07x LH, compressed in lateral aspect, 1.72x as long as wide; frons and vertex polished, weakly coriaceous with scattered shallow punctures; clypeal margin obtuse; mandible red brown; vertex emarginate in full face view; OOL 1.12x WOT; EV 0.39x HE. Antenna slightly longer than head in full face view; scape shorter than 2x pedicel; pedicel = F1. Parapsidal furrow complete, but anteriorly weak; propodeal disc smoothly inclined to lateral margin, no sublateral ridge; posterior propodeal transverse carina broadly interrupted medially. Forewing without areolet, but only short stub arising from basal vein.

Redescription: *Paratype* – Female.

Measurements: Length 3.37mm; LH 0.68mm; WH 0.73mm; WF 0.42mm; FWL 2.44mm; LM 1.27mm; LP 0.51mm; WPD 0.54mm; LPD 0.37mm.

Colour: Body dark brown, mandible red brown with dark brown teeth; antenna yellow, 6 terminal segments fuscous; leg brown except yellow tarsi and tibia; wing hyaline, costa, subcosta, prostigma and stigma light brown, other veins colourless.

Head: Head transverse, WH 1.07x LH; compressed in lateral aspect, 1.72x as long as wide; frons and vertex polished and weakly coriaceous with scattered shallow punctures; gena smooth and polished; vestiture short, sparse, decumbent, setae along vertex margin are not distinctly longer than other setae on head; anterior clypeal margin strongly produced, bluntly angulated, obtuse; clypeal carina 0.61x HE, extending onto frons beyond level of posterior scrobal margin; scrobe ecarinate; mandible stout with 4 moderately long, blunt teeth, ventral most straight; WF 0.55x LH; WF 0.94x HE; EV 0.39x HE; LH 1.83x HE; eye sparsely setose, setae minute, shorter than diameter of single facet; ocelli in obtuse triangle; posterior ocelli contiguous with vertex margin; OOL 1.12x WOT; POL: AOL: DAO = 4.5:4:2.5; vertex straight in full face view, weakly carinate. Relative lengths of first five antennal segments 5.5:2.5:2.5:2.5:3; scape 1.72x as long as wide, longer than 2x

pedicel length; pedicel = F1; F2 and F3 wider than long, F4-F10 as long as wide; terminal segment longer than wide; antenna slightly longer than head in full face view (33:28).

Mesosoma: Pronotum (fig.30) strongly coriaceous with scattered shallow punctures; sculpture of mesonotum and scutellum weaker and polished; vestiture sparse, short, suberect; pronotal disc 0.41x as long as wide; parapsidal furrow complete, but anteriorly weak; notauli absent; scutellum with a pair of basal slits connected by a narrow transverse groove; propodeal disc 0.68x as long as wide, smoothly inclined to lateral margin; basal median propodeal triangle smooth, shining, and elevated extending beyond middle of disc, reaching to posterior margin by a weak carina; rest of propodeal disc and declivity coriaceous; posterior transverse carina broadly interrupted medially. Forewing 2.78x as long as wide, without areolet, only a short stub arising from basal vein; M, SM with single row of setae; speculum aetose; m:rs:rs+m = 7:5:5. Forefemur 1.74x as long as wide; SI 4.7.

Metasoma: Metasoma slightly longer than mesosoma (58:52), shorter than head plus mesosoma (58:80); tergites smooth and polished; T1-T3 with few setae restricted to lateral margin; other tergites sparsely setose all across dorsal side.

Male: Unknown.

Ecology and Biology: ex. *Dichocrocis punctiferalis* (Guenee) (Lepidoptera: Pyralidae).

Distribution: India – Delhi.

Material Examined: *Holotype* – Female. INDIA: Delhi, 219m, 20.x.1964, rearing, ex. *Dichocrocis punctiferalis* (Guenee), Atma Ram, (INPC). *Paratype*, 1♂. same data of holotype, (INPC).

Discussion: *Goniozus delhiensis* Ram is similar *G. pakmanus* Gordh in having brown-black mandible, OOL 1.12 – 1.25x WOT, clypeal margin obtuse, pedicel equal to or less than F1, propodeal disc smoothly inclined to lateral margin and no sublateral ridge on propodeal disc. *Goniozus delhiensis* is having posterior propodeal transverse carina broadly interrupted medially, vertex emarginate in full

face view and pedicel = F1, but *G. pakmanus* is having posterior propodeal transverse carina weak, but complete, vertex straight in full face view and pedicel shorter than F1. *Goniozus sringeriensis* sp. nov. differ from both *G. delhiensis* and *G. pakmanus* in having yellow mandible, OOL 0.70x WOT, clypeal margin acute, pedicel longer than F1, propodeal disc sharply inclined to lateral margin with weak sublateral ridge.

Remarks: Since the original description is inadequate for specific identification the species is redescribed here with complete details. Holotype is in bad condition, fungal infested and antennal terminal segments are lost. The diagrams and descriptions were based on the paratype.

***Goniozus inauditus* sp. nov.**

(figs.31-34, 201-204)

Diagnosis: Head distinctly longer than wide, WH 0.83-0.85x LH, compressed in lateral aspect, 1.72x as long as wide; frons and vertex strongly coriaceous, with scattered shallow punctures; gena smooth and polished; malar space distinct; malar groove present; eye sparsely setose, setae as long as diameter of single facet; posterior ocelli contiguous with vertex margin; ocelli in obtuse triangle; OOL 1.09-1.1x WOT; WF = HE; EV 0.47-0.55x HE. Anteromedian smooth propodeal triangle absent; median smooth longitudinal band not elevated, extending to posterior margin of propodeal disc, wider in posterior half. Forewing with subtriangular areolet, M, SM profusely setose. Forefemur 1.92x as long as wide;

Description: Holotype – Female.

Measurements: Length 3.08mm; LH 0.64mm; WH 0.54mm; WF 0.31mm; FWL 1.66mm; LM 0.9mm; LP 0.29mm; WPD 0.39mm; LPD 0.21mm.

Colour: Body brownish black, metasoma brown at apex; mandible, teeth dark brown; antenna yellow, terminal 5 segments light brown; coxa, femur light brown, other segments yellow. Wing hyaline; prostigma, pterostigma costa, subcosta light brown, other veins straw coloured.

Head: Head (figs.33, 201) distinctly longer than wide, WH 0.85x LH, compressed in lateral aspect, 1.72x as long as wide (figs.32, 203); frons and vertex strongly coriaceous, with scattered shallow punctures; gena smooth and polished; vestiture moderately long, 0.066mm; profuse, decumbent; setae on vertex distinctly longer than setae on head, longest being 0.15mm; anterior clypeal margin strongly produced, bluntly angulated, acute; clypeal carina 0.73x HE, strong, arcuate in profile, extending onto frons as a low carina slightly beyond posterior scrobal margin; scrobe carinate; mandible stout with 4 short, blunt teeth, ventral most straight and longest; WF 0.48x LH; WF = HE; EV 0.50x HE; LH 1.74x HE; malar space distinct; malar groove present; eye sparsely setose, setae minute, as long as diameter of single facet; ocelli in obtuse triangle; posterior ocelli contiguous with vertex margin; OOL 1.09x WOT; POL:AOL:DAO = 4:2:2; vertex straight in full face view, acutely, smoothly curving to occiput, ecarinate. Relative lengths of first five antennal segments (fig.202) 7:3.5:2.5:3:3; scape 1.4x as long as wide, 2x as long as pedicel; pedicel longer than F1; F1 segment as long as wide; F2- F7 wider than long; F8-F9 as long wide; F10-F11 longer than wide; antenna slightly shorter than head in full face view (25:27).

Mesosoma: Pronotum, mesonotum, and scutellum (fig.34) strongly coriaceous uniformly; vestiture long, profuse, decumbent; sparse on scutellum, mesonotum; pronotal disc 0.55x as long as wide; mesonotum with complete parapsidal furrow; notauli absent; scutellum with a pair of slits at base connected by a weak narrow groove; propodeal disc 0.55x as long as wide, smoothly inclined to lateral margin; basal median smooth triangle absent; median smooth longitudinal band not elevated, extending to posterior margin of propodeal disc, wider in posterior half; rest of propodeal disc and declivity strongly coriaceous; transverse propodeal carina medially interrupted broadly. Forewing (fig.201) 2.8x as long as wide; areolet present; areolet subtriangular in shape; M, SM profusely setose, areolet sparsely setose; speculum profusely setose. Forefemur (fig.204) 1.92x as long as wide; SI 10.74.

Metasoma: Metasoma (fig.31) distinctly longer than mesosoma (36:27), shorter than head plus mesosoma (36:41); tergites completely smooth and polished; T1-T3 with

few setae restricted to lateral margin; other tergites sparsely setose all across dorsal side.

Male: Unknown.

Ecology and Biology. ex. leaf galls (fig.144) of thrips on *Memecylon umbellatum* Brum.f. (Memecylaceae); associate host: undetermined Staphylinidae. The species is also reported from *Opisina arenosella* Walker (Oecophoridae). This host record needs verification.

Etymology: The species epithet is after the Latin word *inauditus* meaning new.

Distribution: India – Karnataka; Kerala.

Material Examined: *Holotype* – Female. INDIA: Karnataka, Sringeri, Souwbnabitta, 13°23.59'N 75°47.30'E, 689m, 27.iv.2007, rearing, ex. leaf galls of thrips on *Memecylon umbellatum*, MDF, Community Managed Forests, M. Nasser, leg., VRN 160 (DZUC). *Paratype*. 1♀. INDIA: Kozhikode, Areyadatupalam, 1km E Kozhikode, 11°16.16'N 75°47.30'E, 8m, 22.iv.2006, K. Bindu leg., VRN 131; 1♀. Malappuram, Thenjipalam, 11°07.44'N 75°53.44'E, 67m, 6.viii.1988, T.C. Narendran leg., VRN 114; 1♀. collection locality unknown, ex. *Opisina arenosella* Walker (Oecophoridae), 2-6.i.1993, unknown leg., VRN 16 (DZUC).

Variation: See table - 9 for the morphometric ratios of the type materials examined.

Discussion: It comes close to *G. nephantidis* but differ in having ocular setae as long as diameter of single facet, scape 2x pedicel, WF = HE, EV 0.62x HE, mandible black brown and antenna shorter than head in full face view, whereas in *G. nephantidis* ocular setae 2x as long as diameter of single facet, scape longer than 2x pedicel, WF 1.15x – 1.20x HE, EV 0.36 – 0.47x HE, mandible black and antenna slightly longer than head in full face view. *Goniozus inauditus* sp. nov. comes close to *G. alarius* sp. nov. in having eye sparsely setose, setae 2x diameter of single facet, forefemur 1.76 - 1.9x as long as wide, anterior median propodeal triangle smooth and polished, pedicel longer than F1 and scape longer than 2x pedicel, whereas in *G. alarius* sp. nov. eye is profusely setose, setae 4x as long as diameter of single facet,

forefemur 1.54x as long as wide, anterior median propodeal triangle coriaceous, pedicel = F1 and scape shorter than 2x length of pedicel

Table – 9. Morphometric ratios of *Goniozus inauditus* sp. nov.

VRN	WH / LH	OOL / WOT	EV / HE	WF / HE	LH / LA	LS / PL	PL / LF1
160	0.846154	1.09090909	0.5	1	1	2.22222	1.2
131	0.829268	1.09090909	0.55	1	1	2.22222	1.2
114	0.861111	1.1	0.473684	1	1	2.22222	1.5
16	0.852941	1.1	0.529412	1	0.89474	1.94444	1.5
Mean Values	0.85	1.09	0.51	1	0.97	2.15	1.35

***Goniozus indicus* Ashmead**

(figs.35-36, 205-208)

Goniozus indicus Ashmead, 1903. *Ind. Mus. Notes* 5: 178. (Not described)

Goniozus indicus Muesebeck, 1940. *Proc. Ent. Soc. Wash.*, 42(6): 121. *Holotype* ♀. Not examined (USNM).

Diagnosis: Head smooth and polished, longer than wide, WH 0.87x LH; anterior margin of clypeus acute; clypeal carina absent; mandible stout; antenna distinctly longer than head; mandible brown-black; eye sparsely setose, setae as long as diameter of single facet; EV 1.79x HE; OOL 2.15x WOT. Anteromedian propodeal triangle smooth, not elevated, beyond posterior margin of disc; no transverse carina. Forefemur 2.11x as long as wide. Forewing 3.69x as long as wide, without areolet, only a short stub curved at end arising from basal vein; M, SM with single row of setae. Metasoma distinctly longer than mesosoma, slightly longer than head plus mesosoma.

Redescription: *Plesiotype* - Female.

Measurements: Length 4.4mm; LH 0.84mm; WH 0.74mm; WF 0.45mm; FWL 2.53mm; LM 1.37mm; LP 0.53mm; WPD 0.59mm; LPD 0.34mm.

Colour: Body dark brown, first two segments light brown; mandible brown-black, teeth brown; antenna uniformly yellow except brown scape; leg brown, lighter than body colour. Wing hyaline; subcosta, pterostigma, prostigma brown; other veins straw coloured.

Head: Head (fig.36, 205) longer than wide, WH 0.87x LH, compressed in lateral aspect, 1.74x as long as wide (fig.207); frons and vertex smooth polished with sparse shallow punctures; gena smooth and polished; vestiture sparse, short, suberect; vertex straight in full face view sides behind eyes slightly convex before curving inward at posterolateral angles; mandible stout, with 4 long blunt teeth, ventral most straight; anterior margin of clypeus acute, carina weak, not extending onto frons; scrobe ecarinate; vertex ecarinate, without distinctly long setae; WF 0.53x LH; EV 1.79x HE; WF 1.78 HE; LH 3.37x HE; malar space distinct; malar groove present; eye sparsely setose, setae as long as diameter of single facet; ocelli in right angled triangle; posterior ocelli away from vertex by 3x its' diameter; OOL 2.15x WOT; POL:AOL:DAO = 4:3:1.5. Relative lengths of first five antennal segments (fig.206) 10:4:2.5:3:3; scape 1.82x as long as wide, longer than 2x pedicel; F1 as wide as long, terminal segment longer than wide, rest of them wider than long; F1 shorter than pedicel; antenna distinctly longer than head in full face view (32:39).

Mesosoma: Pronotum, mesonotum, scutellum (fig.35) polished, weakly coriaceous; vestiture short, decumbent, sparse on pronotum, only few setae on mesonotum and scutellum; pronotal disc (fig.205) 0.48x as long as wide; scutellum with a pair of basal shallow slits connected by a narrow groove; parapsidal furrow weak, incomplete, posteriorly absent; notauli absent; propodeal dorsum 0.59x as long as wide, smoothly inclined to lateral margin; basal median propodeal triangle smooth, not elevated; reaching beyond posterior margin of disc connected to smooth and polished median region of declivity; rest of dorsum and declivity coriaceous; posterior transverse carina absent. Forewing 3.69x as long as wide, without areolet, only a short stub arising from basal vein curved at the tip; M, SM with single row of setae; speculum sparsely setose; m:rs:rs+m = 6:3:5. Forefemur (fig.208) 2.11x as long as wide; SI 5.3.

Metasoma: Metasoma (fig.35, 205) distinctly longer than mesosoma (110:52), longer than head plus mesosoma (110:90); tergites generally smooth and polished; T1-T3 with few setae restricted to lateral margin; other tergites profusely setose all across dorsal side.

Male: Same as female except following; head as long as wide, sides behind eyes strongly convex before curving to straight vertex; EV 0.82x HE; WF 1.27x HE; LH 2.09x HE; malar space narrow; malar groove absent; posterior ocelli away from vertex by its' diameter; OOL = WOT; POL:AOL:DAO = 3.5:2:3; length of first 5 antennal segments are in a ratio of 7.5:4:5:3.5:4; scape shorter than 2x pedicel; pedicel shorter than F1.

Measurements: Length 3.24mm; LH 0.61mm; WH 0.61mm; WF 0.37mm; LM 1.24mm.

Ecology and Biology: ex. *Emmalocera depressella* (Swinhoe) (Lepidoptera: Pyralidae) on Sugarcane.

Distribution: India – Bihar.

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TH
SAN/1

Material Examined: Plesiotype - 2♀. INDIA: Bihar, Pusa, 69kms NE Patna, 25°59.03'N 85°41.30'E, 59m, collection date unknown, Vivai leg., ex. *Emmalocera depressella* on Sugarcane, VRN 1804, VRN 1807(INPC). 1♂. same data except VRN 1805 (INPC).

Discussion: *Goniozus indicus* closely resembles *G. fulvicornis* in having frons and vertex smooth and polished and well defined clypeal carina, but differ in having the head nearly parallel sided, small eye, HE shorter than EV, median clypeal carina not extending to frons, thorax slender, narrower than head and propodeum without transverse carina. In *G. fulvicornis*, eye is larger, thorax stouter and propodeum with transverse carina notched in the middle.

***Goniozus jeroeni* sp. nov.**

(figs.37-40, 209-212)

Diagnosis: Head slightly longer than wide, WH 0.96x LH; weakly compressed in lateral aspect, 1.65x as long as wide; frons and vertex strongly coriaceous with

scattered shallow punctures; clypeal carina absent, only smooth polished ridge present; ocelli in obtuse triangle; antenna slightly longer than head in full face view; 2x as long as pedicel; pedicel longer than F1; F1- F10 as long as wide; EV 0.46x HE. Basal median propodeal triangle elevated, smooth, extending to posterior margin of propodeal disc as a weak carina; posterior transverse propodeal carina in a zigzag fashion, complete. Forewing with subtriangular areolet; M, SM sparsely setose.

Description: Holotype – Female.

Measurements: Length 2.79mm; LH 0.56mm; WH 0.53mm; WF 0.33mm; FWL 1.64mm; LM 0.98mm; LP 0.28mm; WPD 0.43mm; LPD 0.23mm.

Colour. Body brownish black, metasoma dark brown; mandible yellowish brown, teeth yellow; antenna brownish yellow, scape, terminal 5 segments brown; leg brown, apex of tibia and tarsi yellow. Wing hyaline; prostigma, pterostigma brown, other veins colourless.

Head: Head (figs.39, 209) slightly longer than wide, WH 0.96x LH, compressed in lateral aspect, 1.65x as long as wide (figs.38, 211); frons and vertex strongly coriaceous with scattered shallow punctures; gena smooth and polished; vestiture moderately long, sparse, decumbent; setae on vertex moderately longer than setae on head, longest being 0.11mm; anterior clypeal margin strongly produced, bluntly angulate; obtuse; clypeal carina absent, very smooth, polished ridge present; scrobe ecarinate; mandible robust with 4 short blunt teeth, ventral most straight and longest; WF 0.59x LH; WF = HE; EV 0.46x HE; LH 1.75x HE; malar space distinct; malar groove present; eye sparsely setose, setae minute, as long as diameter of single facet; ocelli in obtuse triangle; posterior ocelli contiguous with vertex margin; OOL 0.88x WOT; POL:AOL:DAO = 5:2.5:1.5; vertex slightly emarginated in full face view; acutely angled, sharply margined; ecarinate. Relative lengths of first five antennal segments (fig.210) 7:3.5:2.5:3:3; scape 1.46x as long as wide, 2x as long as pedicel; pedicel longer than F1; F1- F10 as long as wide; terminal segment longer than wide; antenna slightly longer than head in full face view (45:35).

Mesosoma: Pronotum, mesonotum, and scutellum (fig.40) uniformly coriaceous, with scattered shallow punctures; vestiture on pronotum moderately long, profuse, decumbent; sparse on scutellum, mesonotum; pronotal disc 0.5x as long as wide; mesonotum with complete parapsidal furrow, notauli absent; scutellum with two pits at base connected by a very narrow transverse groove, propodeal disc 0.53x as long as wide, smoothly inclined to lateral margin; basal median propodeal triangle elevated, smooth, extending to posterior margin of propodeal disc as a weak carina; rest of propodeal disc, declivity coriaceous; posterior transverse propodeal carina in a zigzag fashion, complete. Forewing (fig.209) 2.88x as long as wide; areolet present, subtriangular in shape with single setae; M, SM sparsely setose; speculum sparsely setose. Forefemur (fig.212) 1.83x as long as wide; SI 5.39.

Metasoma: Metasoma (fig.37) distinctly longer than mesosoma (35:26), slightly shorter than head plus mesosoma (35:39); tergites smooth and polished; T1-T3 with few setae restricted to lateral margin; other tergites sparsely setose all across dorsal side.

Male: Unknown.

Ecology and Biology: Collected from the forest canopy. Host unknown.

Etymology: The species epithet is after Jeroen de Rond, the Dutch bethylid taxonomist.

Distribution: India – Tamil Nadu – Nilgiris.

Material Examined: *Holotype* – Female. INDIA: Tamil Nadu, Nilgiris, Mudumalai WLS, Sigur, 4.69kms E Chemmanatham, 11°34.32'N 76°41.08'E, 883 m, 3.v.2007, scrub jungle, YPT, Justinraj leg., VRN 144 (DZUC).

Discussion: *Goniozus jeroeni* sp. nov. is similar to *G. villosus* Krombein, *pulveriae* (Kurian) and *G. cotha* sp. nov. in having frons and vertex strongly coriaceous and mandible dark brown to black, but differ in having no median clypeal carina, M, SM sparsely setose and EV 0.46x HE. *Goniozus villosus*, *G. pulveriae* and *G. cotha* sp. nov. have strong median clypeal carina. The new species and *G. villosus* have brown mandible and scape as long as 2x pedicel, but differ in having ocular setae as long

the diameter of single facet, whereas in *G. jeroeni* sp. nov. it is 2x the diameter of single facet and EV 0.18x HE. *Goniozus pulveriae* and *G. cotha* sp. nov. differ from *G. jeroeni* sp. nov. in having brown-black mandible, M, SM with numerous setae.

***Goniozus kainophanestus* sp. nov.**

(figs.41-44, 213-216)

Diagnosis: Head longer than wide, WH 0.86 – 0.89x LH; strongly compressed, 1.78x as long as wide; antenna as long as or slightly longer than head; scape shorter than 2x pedicel; mandible yellow; ventral most mandibular tooth strongly curved downwards; anterior clypeal margin obtuse; EV 0.42-0.44x HE; eye sparsely setose, setae as long as diameter of single facet; OOL 0.94-1x WOT; parapsidal furrows present; anteromedian smooth propodeal triangle not elevated, continued as a smooth patch to transverse carina; forefemur 1.67x as long as wide; forewing without areolet, but only short stub arising from basal vein; M, SM and speculum with few scattered setae; metasoma distinctly longer than mesosoma.

Description: Holotype – Female.

Measurements: Length 2.54mm; LH 0.62mm; WH 0.54mm; WF 0.31mm; FWL 1.6mm; LM 0.94mm; LP 0.33mm; WPD 0.43mm; LPD 25mm.

Colour: Body dark brown, pronotum, propodeum and base of metasoma (T1 and half of T2) brown; mandible yellow, teeth brown; antenna brown-yellow, terminal 5 segments brown, scape brown-yellow; coxa and femur brown; forefemur dark brown; trochanter, tibia, basitarsus brown-yellow, other tarsi yellow. Wings hyaline, costa, subcosta, prostigma, pterostigma, and stigmal vein straw coloured; other veins colourless.

Head: Head (figs.43, 213) longer than wide, WH 0.86x LH, compressed in lateral aspect, 1.78x as long as wide (figs.42, 215); frons and vertex strongly coriaceous; with scattered shallow punctures; gena smooth and polished; vestiture short, sparse, decumbent; anterior clypeal margin strongly produced, bluntly angulated, obtuse; clypeal carina strong and arcuate in profile, 0.56x HE, extending onto frons upto

level of posterior scrobal margin; scrobe ecarinate; mandible stout with 4 long pointed teeth, ventral most curved; WF 0.5x LH; WF 0.92x HE; EV 0.42x HE; LH 1.75x HE; malar space narrow; malar groove absent; eye sparsely setose, setae minute, as long as diameter of single facet; ocelli in an obtuse triangle; posterior ocelli contiguous with occipital margin; OOL = WOT; POL:AOL:DAO = 6:3:2; vertex straight in full face view; sharply angulate, weakly carinate; with a pair of long setae, longest being 0.08mm. Relative lengths of first five antennal segments (fig.214) 7:4.5:2.5:3:3; scape 1.4x as long as wide, shorter than 2x pedicel; pedicel longer than F1; F2 as long as wide, other funicular segments wider than long; antenna subequal to head in full face view (33:32).

Mesosoma: Pronotum mesonotum and scutellum (fig.44) coriaceous without scattered shallow punctures same as that of head; vestiture short, sparse, suberect; pronotal disc (fig.213) 0.48x as long as wide; mesonotum with distinct parapsidal furrow; propodeal disc 0.59x as long as wide, smoothly inclined to lateral margin; basal median propodeal triangle smooth, margins not distinctly elevated and demarcated posteriorly; smooth blotch present between triangle and transverse carina; other parts of disc and declivity coriaceous; posterior transverse carina complete. Forewing (fig.213) 2.86x as long as wide, without areolet; M with single row setae, SM with single setae; speculum asetose; m: rs: rs+m = 6.5:5:4. Forefemur (fig.216) 1.67x as long as wide; SI 4.9.

Metasoma: Metasoma (fig.41) distinctly longer than mesosoma (65:50), shorter than head plus mesosoma (65:82); T1-T2 completely smooth and polished, other segments with weakly coriaceous basal band. T1-T3 with few setae restricted to lateral margin; other tergites sparsely setose all across dorsal side.

Male: Unknown.

Ecology and Biology: Unknown

Etymology: The species epithet is from the Greek word, *kainophanes* meaning new.

Distribution: India – Kerala.

Material Examined: Holotype – Female. INDIA: Kerala, Kollam, DB college campus, Shasthamkota, 09°02.21'N 76°38.03'E, 19m, 12.xii.2004. sweeping, scrub jungle near fresh water lake, S. Santhosh leg., VRN 81 (DZUC). *Paratypes*. 2♀. same data as holotype, VRN 82, 83; 1♀. Idukki, Moolamattam, 09°47.26'N 76°51.03'E, 14.xi.1988, sweeping, T. C. Narendran leg., VRN 120; 1♀. Malappuram, Calicut University Botanical Garden, 11°07.58'N 75°53.24'E, 80m, 17.xi.1995, K. Rajmohana leg., VRN 166 (DZUC).

Variation: Some of the paratypes have OOL 0.94-0.97x WOT. In one of the paratypes (VNR 82) LH 0.88x LA. See table- 10 for the morphometric ratios of the type materials examined.

Discussion: *Goniozus kainophanestus* sp. nov. is closely related to *G. nuperus* sp. nov. and *G. novellus* sp. nov. but differs in having yellow mandible, forefemur 1.67x as long as wide, anteromedian smooth propodeal triangle is not elevated and continued as a smooth patch to the transverse carina and EV 0.42-0.44x HE, whereas in *G. nuperus* sp. nov. and *G. novellus* sp. nov., mandible is brown-black, forefemur 1.82-1.92x as long as wide and EV 0.53 - 0.60x HE. Anteromedian smooth propodeal triangle elevated not connected to the transverse carina in *G. novellus* sp. nov., whereas it is connected by a smooth median line in *G. nuperus* sp. nov.

Table – 10. Morphometric ratios of *Goniozus kainophanestus* sp. nov.

VRN	WH / LH	OOL / WOT	EV / HE	WF / HE	LH / LA	LS / PL	PL / LF1
81	0.857143	1	0.423077	0.92308	0.94231	1.6	1.66667
82	0.891304	1	0.423077	0.96154	0.88462	1.6	1.66667
83	0.884615	0.9375	0.448276	0.93103	0.92857	1.6	1.66667
166	0.9	0.9375	0.444444	0.96296	0.92593	1.6	1.66667
120	0.888889	0.97142857	0.423077	0.92308	0.9	1.6	1.66667
Mean Values	0.88	0.97	0.43	0.94	0.92	1.6	1.67

***Goniozus kottiyooricus* sp. nov.**

(figs.45-48, 217-221)

Diagnosis: Head distinctly longer than wide, WH 0.83x LH, compressed in lateral aspect, 1.74x as long as wide; frons and vertex strongly coriaceous; anterior clypeal margin weakly projecting, broadly rounded, obtuse; clypeal carina moderately strong, not extending onto frons; WF 0.61x LH; EV 0.68x HE; malar space distinct; malar groove present; OOL 1.43x WOT; eye very sparsely setose; setae minute, as long as diameter of single facet. Forewing 2.96x as long as wide with subtriangular areolet; M, SM with single row of setae; areolet asetose. Forefemur 2.1x as long as wide.

Description: *Holotype* – Female.

Measurements: Length 2.84mm; LH 0.67mm; WH 0.62mm; WF 0.41mm; FWL 1.69mm; LM 0.93mm; LP 0.26mm; WPD 0.45mm; LPD 0.19mm.

Colour. Body black, metasoma dark brown; mandible black, teeth and base of mandible brown; antenna uniformly yellow, scape basally brown; leg yellow; coxa, femur, and basal half of mid and hind tibia brown. Wing hyaline; prostigma, pterostigma light brown, other veins colourless.

Head: Head (figs.47, 217) distinctly longer than wide, WH 0.83x LH, compressed in lateral aspect, 1.74x as long as wide (figs.46, 219); frons and vertex strongly coriaceous; gena smooth and polished; vestiture short, sparse, suberect; setae on vertex longer than setae on head, longest being 0.1mm; anterior clypeal margin weakly projecting, broadly rounded, obtuse; clypeal carina moderately strong, restricted to clypeus and not extending onto frons; scrobe smoothly margined, ecarinate; mandible robust with 4 short blunt teeth, ventral most straight; WF 0.61x LH; WF 1.24x HE; EV 0.68x HE; LH 2.05x HE; malar space distinct; malar groove present; eye very sparsely setose; setae minute, as long as diameter of single facet; ocelli in obtuse triangle; posterior ocelli separated from vertex margin by half of its diameter; OOL 1.43x WOT; POL:AOL:DAO = 6:3:2.5; vertex straight in full face view, smoothly margined, acutely angulated to occiput, ecarinate. Relative lengths of first five antennal segments (fig.218) 7:3.5:2:3:3; scape 1.46x as long as wide, 2x

pedicel length; pedicel longer than F1; F1 wider than long; F2-F10 as long as wide; terminal segment longer than wide; antenna longer than head in full face view (44:39).

Mesosoma: Pronotum, mesonotum and scutellum (fig.48) strongly coriaceous with scattered shallow punctures; vestiture sparse, long, decumbent; Pronotal disc 0.39x as long as wide; mesonotum with parapsidal furrow weak in anterior half, notauli absent; scutellum with a pair of basal slits connected by weak transverse groove; propodeal disc 0.42x as long as wide, smoothly inclined to lateral margin; basal median propodeal triangle smooth, not elevated, extending to posterior margin by a smooth line that joins a smooth blotch extending to posterior declivity; rest of propodeal disc, declivity coriaceous; transverse propodeal carina absent. Forewing (fig.221) 2.96x as long as wide, areolet present, subtriangular in shape; M, SM with single row of setae; areolet, speculum aetose. Forefemur (fig.220) 2.1x as long as wide; SI 6.

Metasoma: Metasoma (fig.45) distinctly longer than mesosoma (52:39), shorter than head plus mesosoma (41:52); tergites smooth and polished; T1-T3 with few setae restricted to lateral margin; other tergites sparsely setose all across dorsal side.

Male: Unknown.

Ecology and Biology: Unknown.

Etymology: The species epithet is after the type locality, Kottiyoor.

Distribution: India – Kerala.

Material Examined: *Holotype* – Female. INDIA: Kerala, Kannur, Kottiyoor, 11°52.33'N 75°51.91'E, 140m, 25.ii.1989, sweeping, T.C. Narendran leg., VRN 145 (DZUC).

Discussion: *Goniozus clypeatus* sp. nov. and *G. longigastralis* sp. nov. are similar to *G. kottiyooricus* sp. nov. in having no propodeal transverse carina on the posterior margin, but differ in having M, SM of the forewing profusely setose, speculum setose, clypeal carina strong, extending onto frons, malar space narrow without malar groove and forefemur 1.6 – 1.8x as long as wide, whereas in *G. kottiyooricus*

sp. nov., M, SM of forewing with single row of setae, speculum asetose; clypeal carina absent, only represented by a median ridge; malar space distinct with malar groove; forefemur 2.1x as long as wide.

***Goniozus kuriani* sp. nov.**

(figs.49-53, 222-225)

Diagnosis: Head distinctly longer than wide, WH 0.77-0.81x LH, compressed in lateral aspect, 2x as long as wide; sides behind eye are parallel before curving inwards to vertex clypeal apical margin weakly produced, obtuse; antenna slightly shorter than head in full face view; pedicel longer than F1; malar space distinct; malar groove present; ocelli triangle acute; posterior ocelli equal to or more than 0.5x its diameter away from vertex margin; EV 0.72–0.83x HE; OOL 0.61-0.67x WOT; vertex emarginate. Anteromedian propodeal area rectangular, smooth, not elevated. Forewing with areolet, M, SM sparsely setose. Forefemur 1.92x as long as wide.

Description: Holotype – Female.

Measurements: Length 2.75mm; LH 0.66mm; WH 0.52mm; WF 0.32mm; FWL 1.75mm; LM 0.91mm; LP 0.27mm; WPD 0.41mm; LPD 0.20mm.

Colour: Body black, metasoma dark brown; mandible black, teeth brown; antenna yellow, terminal 5 segments brown, last being darkest; legs yellow; coxa, femur with dorsal margin brown. Wing hyaline, subcosta, prostigma, pterostigma brown, others colourless.

Head: Head (figs.51, 222) longer than wide, WH 0.81x LH, compressed in lateral aspect, 2x as long as wide (figs.50, 224); sides behind eye are parallel before curving inwards to slightly emarginated vertex; frons and vertex coriaceous with scattered shallow punctures; gena smooth and polished; vestiture short, sparse, suberect; setae on vertex not distinctly longer than setae on rest of head, longest being 0.068mm; anterior clypeal margin weakly produced, obtuse; clypeal carina strong and weakly arcuate in profile, extending onto frons as a low carina upto level of posterior

scrobal margin; scrobe ecarinate; mandible robust, 4 teeth, ventral most straight longest teeth; WF 0.48x LH; WF = HE; EV 0.83x HE; LH 2.3x HE; malar space distinct; malar groove present; eye sparsely setose, setae minute, shorter than diameter of single facet; ocelli in acute triangle; posterior ocelli separated from vertex margin by half its diameter; OOL 0.67x WOT; POL:AOL:DAO = 3.5:2:1.8; vertex smoothly curved to occiput, ecarinate. Relative lengths of first five antennal segments (fig.223) 6:3:2.3:2.3:2.7; scape 1.33x as long as wide, 2x as long as pedicel; pedicel longer than F1; all segments wider than long except terminal single segment; antenna slightly shorter than head in full face view (27:29).

Mesosoma: Pronotum, mesonotum, and scutellum (fig.52) uniformly coriaceous, with scattered shallow punctures; vestiture short, sparse, decumbent; pronotal disc 0.52x as long as wide; mesonotum with complete parapsidal furrow, notauli absent; scutellum with a pair of basal pits at base connected by a narrow transverse groove, propodeal disc 0.53x as long as wide, smoothly inclined to lateral margin; basal median propodeal triangle absent, median smooth band, not elevated, extending beyond posterior margin of propodeal disc; rest of propodeal disc, declivity coriaceous; posterior transverse propodeal carina broadly interrupted medially. Forewing (fig.222) 2.88x as long as wide; areolet present; M, SM with single row of setae; areolet and speculum sparsely setose. Forefemur (fig.225) 1.92x as long as wide; SI 7.67.

Metasoma: Metasoma (fig.49) distinctly longer than mesosoma (54:40), shorter than head plus mesosoma (54:67); tergites smooth and polished, T1-T3 with few setae restricted to lateral margin; other tergites sparsely setose all across dorsal side.

Male: Unknown.

Ecology and Biology: ex. unidentified leaf galls (fig.53) of *Syzygium cumini* L. (Myrtaceae). The species was also collected from the plant host, *Dipterocarpus indicus* Bedd. (Dipterocarpaceae).

Etymology: The species epithet is after Chandy Kurian, Indian bethyloid taxonomist.

Distribution: India – Kerala; Karnataka.

Material Examined: Holotype – Female. INDIA: Kerala, Trivandrum, Art gallery campus, 08°30.31'N 76°57.16'E, 50m, 20.i.2008, rearing, M. Sheeba leg., VRN 186. (DZUC). *Paratypes*. 2♀. data same as holotype, VRN 161, VRN 187; 1♀. INDIA: Karnataka, Makutta, 30kms from Virajpet, 12°04.39'N 75°43.37'E, 119m, 28.vi.2006, rearing, P. Sarasija, on plant host. *Dipterocarpus indicus* Bedd., VRN 28 (DZUC).

Variation: In paratypes, OOL 0.62x WOT and EV 0.72x HE. See table- 11 for the morphometric ratios of the type materials examined.

Discussion: *Goniozus kuriani* sp. nov. is closely related to *G. valvolicola* Krombein in having vertex emarginate, scrobe ecarinate, M, SM sparsely setose, posterior ocelli equal to or more than 0.5x its diameter away from vertex margin and EV 0.75–0.85x HE. *Goniozus kuriani* sp. nov. differs from *G. valvolicola* in having ocellar triangle acute, forefemur 1.92x as long as wide, OOL 0.66x WOT, clypeal apical margin weakly produced and obtuse, anteromedian rectangular smooth propodeal area, but not elevated and pedicel longer than F1, whereas in *G. valvolicola* ocellar triangle in right angle, forefemur 2.07x as long as wide, OOL 1.54 – 1.58x WOT, clypeal apical margin strongly produced, acute, anteromedian triangular smooth propodeal area is elevated and pedicel is shorter than F1.

Table – 11. Morphometric ratios of *Goniozus kuriani* sp. nov.

VRN	WH / LH	OOL / WOT	EV / HE	WF / HE	LH / LA	LS / PL	PL / LF1
186	0.809524	0.66666667	0.8333333	1	1.05	2	1.33333
161	0.809524	0.66666667	0.8333333	1	1.05	2	1.33333
187	0.8	0.61538462	0.7222222	1	1	2	1.33333
28	0.769231	0.61538462	0.8125	1	0.975	2	1.33333
Mean Values	0.80	0.64	0.80	1	1.02	2	1.33

***Goniozus longigastralis* sp. nov.**

(figs.54-57, 226-229)

Diagnosis: Head distinctly longer than wide, WH 0.83x LH, compressed in lateral aspect, 1.82x as long as wide; frons and vertex weakly coriaceous; anterior clypeal margin obtuse; pedicel as long as F1; scape longer than 2x pedicel; WF 1.18x HE; EV 0.88x HE; eye sparsely setose, setae as long as diameter of single facet; ocellar triangle acute; OOL 1.75x WOT. Propodeal disc with a smooth anterior median elevated triangle, extending to posterior margin by a median line; posterior transverse propodeal carina absent, represented by a weak smooth line. Forewing 3.1x as long as wide subtriangular areolet; S, SM and areolet profusely setose.

Description: Holotype – Female.

Measurements: Length 4.6mm; LH 0.93mm; WH 0.77mm; WF 0.46mm; FWL 2.86mm; LM 1.29mm; LP 0.42mm; WPD 0.56mm; LPD 0.33mm.

Colour: Body black, metasoma brownish black; mandible black, teeth red; antenna yellow, terminal 7 segments brown; legs yellow; forefemur brown, coxa, mid and hind femur brownish yellow. Wing hyaline; prostigma, pterostigma costa brown, other veins straw coloured.

Head: Head (figs.56, 226) distinctly longer than wide, WH 0.83x LH, compressed in lateral aspect, 1.82x as long as wide (figs.55, 228); frons and vertex weakly coriaceous with scattered shallow punctures; gena very weakly coriaceous, polished; vestiture long (0.095mm), sparse, erect; setae on vertex, four pairs slightly longer than setae on head, longest being 0.19mm; anterior clypeal margin obtusely angulated; clypeal carina 0.91x HE, strong, arcuate in profile, extending onto frons well beyond posterior scrobal margin; scrobe ecarinate; mandible robust with four long, blunt teeth, ventral most straight; WF 0.49x LH; WF 1.18x HE; EV 0.88x HE; LH 2.29x HE; malar space narrow; malar groove absent; eye sparsely setose, setae minute, as long as diameter of single facet; ocelli in acute triangle; posterior ocelli separated from vertex margin by its diameter; OOL 1.75x WOT; POL:AOL:DAO = 3.5:2.5:3; vertex slightly emarginate in full face view, smoothly angled to occiput, ecarinate. Relative lengths of first five antennal segments (fig.227) 11:4.5:4.5:5:5;

scape 1.83x as long as wide, longer than 2x pedicel length; pedicel = F1; F1-F4, F11 longer than wide; other funicular segments subequal; antenna longer than head in full face view (44:39).

Mesosoma: Pronotum, mesonotum, and scutellum (fig.57) weakly coriaceous with scattered shallow punctures; vestiture long, sparse, erect; pronotal disc (fig.226) 0.47x as long as wide; mesonotum with weak complete parapsidal furrow, notauli absent; scutellum with a pair of basal slits connected by a weak groove; propodeal disc 0.6x as long as wide, smoothly inclined to lateral margin; few short setae on lateral margin; basal median propodeal triangle smooth, extending to posterior margin by a smooth line that slightly wider posteriorly; rest of propodeal disc and declivity coriaceous; posterior transverse propodeal carina absent, represented at posterolateral margin by a smooth line. Forewing (fig.226) 3.1x as long as wide; areolet present, subtriangular in shape; M, SM,, areolet, speculum profusely setose. Forefemur (fig.229) 1.83x as long as wide; SI 5.39.

Metasoma: Metasoma (fig.54) distinctly longer than mesosoma (100:54), slightly longer than head plus mesosoma (100:93); tergites smooth and polished; T1-T3 with setae restricted to lateral margin; other tergites with setae all across dorsal side.

Male: Unknown.

Ecology and Biology: Collected from semi-evergreen forest canopy. Host unknown.

Etymology: The species epithet is after the characteristically long gaster of the species.

Distribution: India – Tamil Nadu.

Material Examined: *Holotype* – Female. INDIA: Tamil Nadu, Chamrajnagar, Galidhimbam, 7.84kms SW Hasanur, 11°58'90"N 77°11'10"E, 1245 m, SEF, YPT, 10.i.2007, Mahadesha leg., VRN 143 (DZUC).

Discussion: *Goniozus longigastralis* sp. nov. is similar to *G. clypeatus* sp. nov. in having SM of the forewing profusely setose, speculum setose, clypeal carina strong, extending onto frons, malar space narrow without malar groove and forefemur 1.6 – 1.8x as long as wide, but differ in having ocular setae as long as diameter of single

facet, ocellar triangle acute, frons and vertex weakly coriaceous, OOL 1.75x WOT, anterior clypeal margin obtuse, propodeal disc with a smooth anterior median elevated triangle extending to posterior margin by a median line, pedicel as long as F1, scape longer than 2x pedicel and WF 1.18x HE. *Goniozus clypeatus* sp. nov. has ocular setae 3x as long as diameter of single facet, ocellar triangle obtuse, frons and vertex strongly coriaceous, OOL 1.10-1.23x WOT, anterior clypeal margin acute, propodeal disc with a smooth median band extending posteriorly onto declivity, pedicel shorter than F1, scape shorter than 2x pedicel and WF 0.92-0.97x HE.

***Goniozus malabaricus* sp. nov.**

(fig.58-61, 230-234)

Diagnosis: Head slightly wider than long, WH 1.04-1.05x LH; strongly compressed in lateral aspect, 1.73x as long as wide; frons smooth and polished; ventral most mandibular teeth long and distinctly curved downwards; clypeal carina absent, represented only by a smooth ridge; EV 0.35-0.39x HE; vertex weakly coriaceous. Antenna distinctly longer than head in full face view scape 2-2.3x as long as pedicel, pedicel shorter than F1. Forewing without areolet, but only short stub arising from basal vein.

Description: Holotype – Female.

Measurements: Length 4.53mm; LH 0.84mm; WH 0.86mm; WF 0.52mm; FWL 2.73mm; LM 1.53mm; LP 0.4mm; WPD 0.73mm; LPD 0.29mm

Colour: Body black; mandible yellowish brown; mandible base, teeth black; antenna brown-yellow, scape basally, terminal 8 segments brown; femur dark brown; trochanter, tibia and tarsi yellow, tibia darker than rest. Wing hyaline; costa, subcosta, prostigma and stigmal vein tainted; pterostigma darker, other veins straw coloured.

Head: Head (figs.60, 230) wider than long, WH 1.04x LH, compressed in lateral aspect, 1.73x as long as wide (figs.59, 232); frons smooth and polished; vertex weakly coriaceous; gena smooth and polished; vestiture sparse, short, decumbent;

anterior clypeal margin strongly produced, obtuse; clypeal carina weak, appear as smooth ridge, restricted to clypeus, not extending onto frons; mandible (fig.234) robust, visible in full face view with 4 teeth; ventral most teeth long and distinctly curved downwards; scrobe ecarinate; vertex slightly emarginated in full face view, smoothly angulated, ecarinate; setae along vertex longer than others, longest being 0.14mm; WF 0.62x LH; WF 1.1x HE; EV 0.35x HE; LH 1.81x HE; malar space narrow; malar groove absent; eye sparsely setose, minute as long as diameter of single facet; ocelli in obtuse triangle; posterior ocelli contiguous with vertex margin; OOL 1.05 WOT; POL: AOL: DAO = 6.5:3:3. Relative lengths of first five five antennal segments (fig.231) 8:3.8:5.5:4.5:4; all segments longer than wide; scape 2.3x pedicel; scape 1.6x as long as wide; pedicel shorter than F1; antenna distinctly longer than head in full face view (55:37).

Mesosoma: Pronotum (fig.61) weakly coriaceous; mesonotum and scutellum smooth and polished with scattered shallow punctures; pronotum (fig.230) 0.58x as long as wide; vestiture long, sparse; mesonotum with distinct, complete parapsidal furrow; notauli absent; scutellum with a pair of basal slits connected by a weak transverse groove; propodeal disc 0.41x as long as wide, smoothly inclined to lateral margin; basal median smooth triangle elevated and extend upto midline of propodeal disc and connected to complete transverse carina by a median carina; rest of dorsum and declivity coriaceous. Forewing 2.79x as long as wide, without areolet, only a short stub arising from basal vein; M, SM and speculum asetose; region posterior to pro and pterostigma devoid of setae; m:rs:rs+m = 6:5:5. Forefemur (233) 1.87x as long as wide; SI 4.2.

Metasoma: *Metasoma* (fig.58) distinctly longer than mesosoma (42:30), slightly shorter than head plus mesosoma (46:42); tergites generally smooth and polished; T1 – T2 completely smooth; others with weakly coriaceous basal band; T1-T3 with few setae restricted to lateral margin; other tergites sparsely setose all across dorsal side.

Male: Unknown.

Ecology and Biology: Unknown.

Etymology: The species epithet is after the type locality, Malabar.

Distribution: India – Kerala – Malabar.

Material Examined: *Holotype* – Female. INDIA: Kerala, Kannur, Panayathanparamba, 3kms W Kannur Airport, 11°54'32"N 75°30'27"E, 70m, MT, scrub jungle, 13-17.i.2008, S. Santhosh leg., VRN 117 (DZUC). *Paratypes*. 1♀. INDIA: Kerala, Kozhikode, Kakkayam, 11°33.57'N 75°55.27'E, 888m, 9.ii.1996, sweeping, TEF, Mini leg., VRN 173; 1♀. Kozhikode, Nanminda, 1.5kms W Balusseri, 11°26.45'N 75°50.25'E, 29m, 14.ii.2004, sweeping, P. Girishkumar leg., VRN 77 (DZUC).

Variation: In the paratypes, LS 2x PL and PL 0.87x LF1. See table- 12 for morphometric ratios of all the type materials examined.

Discussion: *Goniozus malabaricus* sp. nov. is similar to *G. fulgidus* Krombein in having smooth polished head in dorsal side and no clypeal carina, but it differs in having head as long as wide, WH 1.04-1.05x LH and scape 2-2.3x as long as pedicel. In *G. fulgidus* Krombein, head is distinctly transverse, WH 1.11x LH and scape less than 2x as long as pedicel.

Table – 12. Morphometric ratios of *Goniozus malabaricus* sp. nov.

VRN	WH / LH	OOL / WOT	EV / HE	WF / HE	LH / LA	LS / PL	PL / LF1
117	1.043478	1.04761905	0.35	1.1	0.73404	2.28571	0.7
173	1.054545	1.11764706	0.387097	1.12903	0.6875	2	0.875
77	1.050847	1.11764706	0.352941	1.11765	0.81944	2	0.77778
Mean Values	1.05	1.09	0.36	1.11	0.75	2.09	0.78

***Goniozus mandibularis* sp. nov.**

(figs.62-65, 235-239)

Diagnosis: Head subequal in full face view, WH 0.91-0.97x LH, weakly compressed in lateral aspect, 1.65x as long as wide; OOL 0.89-1x WOT; ventral most tooth of mandible strongly curved downwards; WF 1-1.07x HE; EV 0.33-0.44x HE. All funicular segments longer than wide; antenna distinctly longer than head in full face view; pedicel shorter than F1. Anteromedial smooth elevated propodeal triangle extends beyond middle of propodeal disc, connected to posterior

margin by a smooth line; propodeal disc sharply inclined to lateral margin; posterior transverse propodeal carina narrowly interrupted medially; metasoma longer than mesosoma. Forefemur 2.15x as long as wide; forewing without areolet, but only short stub arising from basal vein.

Description: *Holotype* – Female.

Measurements: Length 3.23mm; LH 0.77mm; WH 0.75mm; WF 0.44mm; FWL 2.3mm; LM 1.26mm; LP 0.42mm; WPD 0.35mm; LPD 0.31mm.

Colour: Body black; mandible brown, basally darker, teeth red; antenna yellowish brown, basal area of scape and apical 9 funicular segments fuscous; coxa and femur black; trochanter, tibia, and tarsi yellow; midtibia and hindtibia brown. Wing hyaline; costa, subcosta, and prostigma yellow, other veins colourless.

Head: Head (figs.64, 235) longer than wide in full face view, HW 0.97x LH, weakly compressed in lateral aspect, 1.65x as long as wide (figs.63, 237); frons and vertex coriaceous with shallow punctures; gena smooth and polished; vestiture sparse, long and decumbent; vertex margin with a pair of long setae, longest being 0.14mm; anterior clypeal margin strongly produced, obtuse, clypeal carina 0.76x HE, extending onto frons beyond level of posterior scrobal margin; scrobe ecarinate; mandible stout with 4 long pointed teeth, ventral most curved; WF 0.57x LH; WF 1.03x HE; EV 0.40x HE; LH 1.76x HE; malar space narrow; malar groove absent; eye sparsely setose, setae minute, shorter than diameter of single facet; ocelli in obtuse triangle; posterior ocelli contiguous with vertex margin; POL: AOL: DAO = 7.5:3.5:3; OOL 0.94x WOT; vertex margin straight in full face view, ecarinate, margin sharply angled, acute. Relative lengths of first five antennal segments (fig.236) 8:4.2:5:4.5:4.2; scape 1.82x as long as wide, shorter than 2x pedicel; pedicel shorter than F1; all funicular segments longer than wide; F1 is longer than F2; F2 subequal to F3; antenna distinctly longer than head in full face view (105:77).

Mesosoma: Pronotum (fig.65) coriaceous; mesoscutum and scutellum weakly coriaceous; vestiture long, sparse, decumbent; mesonotum with parapsidal furrow, weak towards anterior end; pronotal disc (fig.235) narrow, 0.56x as long as wide,

propodeal disc 0.59x as long as wide, sharply inclined to lateral margin; basal triangular area smooth and elevated, rest of disc and declivity coriaceous; transverse carina narrowly interrupted in middle; basal triangle connected to smooth blotch at posterior margin of propodeal disc by smooth line, visible in certain play of lights. Forewing (fig.239) 2.86x as long as wide, without areolet; M, SM with a single row of setae; speculum aetose; m; rs; rs+m = 7:6:5. Forefemur (fig.238) 2.15x as long as wide; SI 3.64.

Metasoma: Metasoma (fig.62) distinctly longer than mesosoma (93:65), shorter than head plus mesosoma (93:103); tergites smooth and polished; T1 completely smooth, other tergites with weakly coriaceous basal band. T1-T3 with few setae restricted to lateral margin; other tergites sparsely setose all across dorsal side.

Male: Unknown.

Ecology and Biology: Collected from the paddy ecosystem. Host is unknown.

Etymology: The species epithet is after the strongly curved mandibular tooth.

Distribution: India – Karnataka; Kerala.

Material Examined: *Holotype* – Female. INDIA: Kerala, Palghat, Puliampettakayal, 1.64kms NW of Koottanad, 10°45.67'N 76°07.10'E, 8m, 28.ii.2008, rice field, sweeping, S. Santhosh leg., VRN 10 (DZUC). *Paratypes*. 2♀. same data as holotype, VRN 8, VRN 9; 5♀. Koottanad, 10°45.34'N 76°06.58'E, 2.vi.2004, 48m, sweeping, scrub jungle, S. Santhosh, leg., VRN 84, VRN 85, VRN 86, VRN 20, VRN 21; 1♀. Kozhikode, Kodanjeri, NW of Kozhikode, 11°24.35'N 75°56.16'E, 45m, 3.iv.2007, sweeping, agricultural plot – mixed vegetation, S. Santhosh leg., VRN 5; 1♀. Alappuzha, Kayankulam, CPCRI Campus, 09°08.42'N 76°30.47'E, 13m, 12.iv.2004, sweeping, S. Santhosh leg., VRN 97; 1♀. Idukki, Cheruthoni, near reservoir, 09°47.52'N 76°56.48'E, 727m, 10.i.2004, sweeping, TEF, short stretch of lemon grass field, S. Santhosh leg., VRN 90; 1♀. Kannur, Payyannore, 12°05'N 75°12'E, 9m, 26.xii.1988, sweeping, T.C. Narendran leg., VRN 95; 1♀. Kasaragode, CPCRI Campus, 5kms NW Kasaragode Town, 12°31.04'N 74°57.10'E, 18m, 27.ii.1988, sweeping, K. Surekha leg., VRN 100; 2♀. INDIA: Karnataka, Uppinangady, 12°49.42'N 75°14.49'E, 65m, 17.xii.1988, sweeping, T.C. Narendran leg., VRN 79, VRN 80 (DZUC).

Variation: A pair of setae is present below the short stub from basal vein in one of the paratypes. In some paratypes, LH 1.03x WH, EV 0.33-0.35x HE; OOL 0.85x WOT; LS 2.2x PL. See table- 13 for morphometric ratios of all the type materials examined.

Discussion: This new species is closely related to *G. antennalis* sp. nov. In *G. mandibularis* sp. nov., OOL 0.89-1x WOT, ventral most tooth of mandible strongly curved downwards, anteromedial smooth elevated propodeal triangle extends beyond middle of propodeal disc connected to posterior margin by a smooth line and WF 1-1.07x HE, whereas in *G. antennalis* sp. nov. OOL 0.75-0.86x WOT, ventral most tooth of mandible straight, anteromedial smooth elevated propodeal triangle extends upto middle of propodeal disc not being connected to posterior margin, WF 0.81-0.89x HE. This new species is also related to *G. stomopterycis* Ram and SubbaRao and *G. marasmi* Kurian, but differ in having forefemur equal to or more than 2x as long as wide, pedicel shorter than F1 and metasoma longer than mesosoma, whereas in *G. stomopterycis* and *G. marasmi* forefemur less than 2x as long as wide, pedicel equal to or more than F1 and metasoma shorter than or as long as mesosoma.

Table – 13. Morphometric ratios of *Goniozus mandibularis* sp. nov.

VRN	WH / LH	OOL / WOT	EV / HE	WF / HE	LH / LA	LS / PL	PL / LF1
9	0.971831	0.95652174	0.410256	1.07692	0.69608	2.2	0.83333
8	1	0.9375	0.4	1.03333	0.68421	2	0.83333
97	1	0.9375	0.4	1.03333	0.66667	1.8	0.83333
10	0.966667	0.9375	0.4	1.03333	0.69767	1.8	0.83333
86	0.966667	0.89473684	0.411765	1.02941	0.68182	1.71429	0.875
21	0.966667	0.85	0.411765	1.02941	0.65217	1.6	0.90909
20	0.966667	1	0.424242	1.06061	0.69767	1.8	0.83333
85	0.935484	0.89473684	0.424242	1.06061	0.72093	2.2	0.71429
80	1	0.9	0.333333	1	0.6383	1.8	0.83333
79	0.966667	0.94736842	0.342857	1	0.75	2	0.71429
90	0.90625	1	0.4	1	0.7619	2	0.83333
100	0.966667	0.89473684	0.352941	1.02941	0.625	2	0.76923
84	0.967742	0.89473684	0.411765	1.05882	0.68889	1.66667	0.85714
95	0.966667	0.89473684	0.441176	1.02941	0.69767	1.8	0.83333
54	1.035714	0.9	0.411765	1.02941	0.71795	1.83333	0.85714
Mean Values	0.97	0.92	0.4	1.03	0.69	1.88	0.82

***Goniozus mustus* sp. nov.**

(figs.66-69, 240-243)

Diagnosis: Head as long as wide, compressed in lateral aspect, 1.76x as long as wide; frons and vertex strongly coriaceous; clypeal carina absent, represented by a smooth ridge on clypeus; malar space distinct; malar groove present; mandible brown; ocular setae as long as diameter of single facet; pedicel is along as F1; scape 2x pedicel; WF 1.06x HE; no anteriomedian propodeal triangle; entire propodeal disc strongly coriaceous; propodeal disc posteriorly without transverse carina.

Description: *Holotype* – Female.

Measurements: Length 3.5mm; LH 0.69mm; WH 0.69mm; WF 0.43mm; FWL 2.09mm; LM 1.07mm; LP 0.41mm; WPD 0.57mm; LPD 0.31mm.

Colour: Body black, metasoma with brown tinge; mandible brown, darker at base and teeth; antenna yellow, terminal 6 segments brown; leg yellow; coxa, femur brown. Wings hyaline; prostigma, pterostigma costa, subcosta, stigmal vein light brown, other veins colourless.

Head: Head (figs.68, 240) as long as wide, WH = LH, compressed in lateral aspect, 1.76x as long as wide (figs.67, 242); frons and vertex strongly coriaceous with scattered shallow punctures; gena smooth and polished; vestiture moderately long, 0.069mm; sparse, decumbent; setae on vertex slightly longer than setae on head, longest being 0.086mm; anterior clypeal margin strongly produced, sharply right angled; clypeal carina weak, only a smooth ridge, 0.41x HE, weakly arcuate in profile, not extending onto frons as a low carina; scrobe weakly carinate; mandible stout, 4 moderately long teeth, ventral most curved downwards; WF 0.62x LH; WF 1.06x HE; EV 0.35x HE; LH 1.73x HE; malar space distinct; malar groove present; eye sparsely setose, setae minute, as long as diameter of single facet; ocelli in obtuse triangle; posterior ocelli contiguous with vertex margin; OOL = WOT; POL:AOL:DAO = 5.5:2.5:2.2; vertex straight in full face view, smoothly angled to occiput, ecarinate. Relative lengths of first five antennal segments (fig.241) 6:3:3:3:3; scape 2x as long as wide, 2x pedicel; pedicel = F1; all antennal segments longer than wide; antenna longer than head in full face view (42:29).

Mesosoma. Pronotum, mesonotum, and scutellum (fig.69) uniformly coriaceous, vestiture short, sparse, decumbent, pronotal disc (fig.240) 0.38x as long as wide; mesonotum with complete parapsidal furrow; notauli absent; scutellum with a pair of basal slits connected by a weak transverse groove; propodeal disc 0.5x as long as wide, smoothly inclined to lateral margin; basal median propodeal elevated smooth triangle absent; entire propodeal disc and declivity strongly coriaceous; posterior transverse propodeal carina absent. Forewing (fig.240) 2.84x as long as wide; areolet present, subtriangular in shape; M, SM, areolet and speculum sparsely setose. Forefemur (fig.243) 2x as long as wide; SI 5.56.

Metasoma: *Metasoma* (fig.66) distinctly longer than mesosoma (45:73), subequal to head plus mesosoma; tergites smooth and polished; T1-T3 with few setae restricted to lateral margin; other tergites sparsely punctuate and setose all across dorsal side.

Male: Unknown.

Ecology and Biology: Unknown.

Etymology: The species epithet is after the Latin word *mustus* meaning new.

Distribution: India – Kerala – Malappuram.

Material Examined: *Holotype* – Female. INDIA: Kerala, Botanical Garden, Calicut University Campus, 11°07.58'N 75°53.24'E, 80m, sweeping, 4.ix.2003, S. Santhosh leg., VRN 115 (DZUC).

Discussion: *Goniozus mustus* sp. nov. is similar to *G. ecarinatus* Krombein in having the mandible brown or dark red, ocular setae as long as diameter of single facet, but differ in having clypeal carina absent, sometimes as median ridge only, extending onto frons for a short distance not beyond posterior scrobal margin, no anteromedian propodeal triangle and entire propodeal disc strongly coriaceous, pedicel is along as F1, scape 2x pedicel and WF 1.06x HE. In *G. ecarinatus*, clypeal carina moderately strong, restricted to clypeus, 0.41x as long as HE, smooth elevated anteromedian propodeal triangle present, pedicel shorter than F1; scape longer than 2x pedicel and WF 1.35x HE.

***Goniozus neoteropus* sp. nov.**

(figs.70-73, 244-247)

Diagnosis: Head slightly longer than wide, WH 0.92x LH, compressed in lateral aspect, 1.73x as long as wide; frons and vertex strongly coriaceous, profusely setose; mandible pale yellow; eye profusely setose, setae 3x diameter of single facet; clypeal carina strong, extending onto frons beyond posterior scrobal margin; pedicel equal to F1; scape 2x pedicel; F1-F4 longer than wide; WF = HE; OOL = WOT. Propodeal disc posteriorly without transverse carina. Forewing with subtriangular areolet; M, SM profusely setose.

Description: Holotype – Female.

Measurements: Length 3.31mm; LH 0.74mm; WH 0.68mm; WF 0.4mm; FWL 2.1mm; LM 1.2mm; LP 0.36mm; WPD 0.54mm; LPD 0.29mm.

Colour: Body black; mandible brown-yellow, teeth brown; antenna yellow, terminal 5 segments light brown; legs yellow, dorsal margin of coxa, forefemur and hindfemur brown. Wing hyaline; prostigma, pterostigma, costa brown, other veins straw coloured.

Head: Head (figs.72, 244) longer than wide, WH 0.92x LH, compressed in lateral aspect, 1.73x as long as wide (figs.71, 246); frons and vertex strongly coriaceous with scattered shallow punctures; gena smooth and polished; vestiture long (0.12mm); profuse, subappressed; setae on vertex, 3 pairs distinctly longer than setae on head, longest being 0.26mm; anterior clypeal margin strongly produced, sharply angulated, acute; clypeal carina 0.7x HE, strong, arcuate in profile, extending onto frons well beyond posterior scrobal margin; scrobe ecarinate; mandible robust, 4 short, blunt teeth, ventral most straight; WF 0.54x LH; WF = HE; EV 0.35x HE; LH 1.82x HE; malar space narrow; malar groove absent; eye profusely setose, setae long, 3x as long as diameter of single facet; ocelli in obtuse triangle; posterior ocelli contiguous with vertex margin; OOL = WOT; POL:AOL:DAO = 5:2:2; vertex straight in full face view, sharply angled to occiput, carinate in middle. Relative lengths of first five antennal segments (fig.245) 8:4:4:4:4; scape 1.4x as long as wide, 2x pedicel; pedicel = F1; F1-F4, F11 longer

than wide; other funicular segments subequal; antenna longer than head in full face view (39:31).

Mesosoma: Pronotum and mesonotum (fig.73) strongly coriaceous with scattered shallow punctures; scutellum weakly coriaceous, sparsely punctuate; vestiture long, sparse, suberect; pronotal disc (fig.244) 0.43x as long as wide; mesonotum with distinct complete parapsidal furrow, notauli absent; scutellum with a pair of basal slits connected by a weak groove; propodeal disc 0.43x as long as wide, smoothly inclined to lateral margin; few short setae on lateral margin; median propodeal smooth band extending to declivity, elevated only in anterior one fourth; basal median smooth triangle absent; rest of propodeal disc, declivity coriaceous; posterior transverse propodeal carina absent. Forewing (fig.244) 2.8x as long as wide; areolet present, subtriangular in shape; M, SM profusely setose; areolet, speculum setose. Forefemur (247) 1.75x as long as wide; SI 3.9.

Metasoma: Metasoma (fig.70) slightly longer than mesosoma (58:50), distinctly shorter than head plus mesosoma (58: 81); tergites smooth and polished in general; T1-T3 completely smooth, setae restricted to lateral margin; other tergites with setae all across dorsal side, weakly coriaceous basal half.

Male: Unknown.

Ecology and Biology: Unknown.

Etymology: The species epithet is after the Greek word, *neos* meaning new or recent.

Distribution: India – Kerala.

Material Examined: *Holotype* – Female. INDIA: Kerala, Kannur, Panayathanparamba, 3kms W Kannur Airport, 11°54'32"N 75°30'27"E, 70m, 11-26.v.2008, scrub jungle, MT, S. Santhosh leg., VRN 29 (DZUC).

Discussion: *Goniozus neoteropus* sp. nov. is closely similar to *G. comatus* Krombein in having pale yellow mandible, ocular setae 3x diameter of single facet, clypeal carina strong extending onto frons beyond posterior scrobal margin, but differ in having pedicel equal to F1, scape 2x pedicel, WF = HE, OOL = WOT. *Goniozus comatus* is having pedicel less than F1, scape more than 2x pedicel, WF 1.07x HE, OOL 0.88x WOT.

***Goniozus nephantidis* (Muesebeck)**

(figs.74-77)

Perisierola nephantidis Muesebeck, 1934. *Rec. Ind. Mus.*, 36: 225-226, 227.
Holotype ♀. Not examined (USNM). Transferred by GORDH, 1988: 363.

Diagnosis: *Female.* Mandible robust, dark brown; clypeal carina (fig.76) strong, arcuate in profile, extending onto frons a distance equal to its length on clypeus; front dull delicately coriaceous with scattered shallow punctures; antennal scrobe carinate; WH 0.94-0.95x LH; WF 1.15-1.2x HE; EV 0.36-0.47x HE (fig.75); ocelli in flat triangle. Posterior pair one half their diameter from posterior margin of head, OOL 1.22-1.33x WOT; eye sparsely setose, ocular setae 2x diameter of single facet; posterior transverse propodeal carina (fig.77) medially evanescent. Forefemur (fig.74) length 1.76-1.9x width. Forewing with closed areolet; M, SM and speculum profusely setose. Scape longer than 2x pedicel; pedicel longer than F1; antenna as long as or slightly longer than head in full face view (29:30).

Male: Mandible relatively slender compared to that of female, pale yellow; clypeal carina weaker than that of female; front delicately coriaceous, shinier and with sparser punctuation than in female; antennal scrobes weakly carinate; WH 0.90-1.00x LH; WF 1.17-1.22x HE; EV 0.56-0.61x HE; ocelli almost right triangle; OOL 0.94-1.10x WOT; posterior transverse propodeal carina present only laterally and quite weak; forefemur length 2.06-2.27x width; forewing with closed areolet.

Ecology and Biology: ex. *Opisina arenosella* Walker (Oecophoridae) larvae on *Cocos nucifera*; ex. *Corcyra cephalonica* (Stainton) (Pyralidae).

Distribution: India – Tamil Nadu, Kerala, Karnataka; Sri Lanka.

Material Examined: 5♀. INDIA: Kerala, Alappuzha, Kayankulam, CPCRI Campus, 09°08.42'N 76°30.47'E, 13m, 17.iv.2004, rearing, ex. *Opisina arenosella*, S. Santhosh leg., VRN 65, VRN 61, VRN 60, VRN 69, VRN 67; 7♀. Kasaragode, CPCRI Campus, 5kms NW Kasaragode Town, 12°31.04'N 74°57.10'E, 18m, 21.vii.2006, rearing, ex. *Corcyra cephalonica*, S. Santhosh leg., VRN 191, VRN 195, VRN 190, VRN 192, VRN 19, VRN 18, VRN 189; 7♀. INDIA: Karnataka,

Channapatna, 12°39.25'N 77°11.40'E, 661m, 22.v.2006, C. Viraktamath leg., VRN 32, VRN 36, VRN 38, VRN 44, VRN 34, VRN 40, VRN 35; 1♀. Malappuram, Calicut University Botanical Garden, 11°07.58'N 75°53.24'E, 27m, 18.iv.2005, sweeping, S. Santhosh leg., VRN 185; 1♀. Malappuram, Calicut University Campus, 2-6.i.1993, rearing, ex. *Opisina arenosella*, O.K. Remadevi leg., VRN 17; 1♀. Kasaragode, CPCRI Campus, 5kms NW Kasaragode Town, 12°31.04'N 74°57.10'E, 18m, 5.xi.1996, rearing, ex. *Corcyra cephalonica*, Sujatha leg., VRN 109; 7♂. INDIA: Kerala, Alappuzha, Kayankulam, CPCRI Campus, 09°08.42'N 76°30.47'E, 13m, 17.iv.2004, rearing, ex. *Opisina arenosella*, S. Santhosh leg., VRN 62, VRN 64, VRN 66, VRN 68, VRN 63, VRN 70, VRN 71; 4♂. Kozhikode, Areyadatupalam, 1km E Kozhikode, 11°16.10'N 75°47.33'E, 13m, 22.iv.2006, ex. *Opisina arenosella*, K. Bindu leg., VRN 130, VRN 127, VRN 128, VRN 129; 1♂. Malappuram, Calicut University Campus, 2-6.i.1993, rearing, ex. *Opisina arenosella*, O.K. Remadevi leg., VRN 15; 1♂. Kozhikode, Kappad beach, 11°23.14'N 75°43.26'E, 23m, 19.i.2006, ex. *Opisina arenosella*, K. Bindu leg., VRN 188; 1♂. Malappuram, Calicut University Botanical Garden, 18.iv.2005, sweeping, S. Santhosh leg., VRN 183. 6♂. INDIA: Karnataka, Channapatna, 12°39.25'N 77°11.40'E, 661m, 22.v.2006, C. Viraktamath leg., VRN 33, VRN 39, VRN 43, VRN 41, VRN 42, VRN 37 (DZUC).

Discussion: *Goniozus nephantidis* closely related to *G. alarius* sp. nov. in having head length subequal to its width, WH 0.89 - 1.09x LH; OOL 1.22-1.33x WOT, but differ in having eye sparsely setose, setae as long as the diameter of single facet; forefemur 1.76 - 1.9x as long as wide; anterior median propodeal triangle smooth and polished; pedicel longer than F1; scape longer than 2x pedicel. In *G. alarius* sp. nov., eye profusely setose, setae 4x as long as diameter of single facet; forefemur 1.54x as long as wide; anterior median propodeal triangle coriaceous; pedicel = F1; scape shorter than 2x pedicel.

***Goniozus novellus* sp. nov.**

(figs.78-80, 248-251)

Diagnosis: Head longer than wide, WH 0.83x LH, compressed in lateral view, 1.87x as long as wide; clypeus beak like in lateral view; anterior margin of clypeus obtuse; mandible slender; antenna as long as head; mandible brown-black; eye sparsely setose, setae minute, shorter than diameter of single facet; EV 0.60x HE; OOL 0.94x WOT; anteromedian propodeal triangle smooth, elevated, only upto middle of disc, not connected to transverse carina; metasoma distinctly longer than mesosoma. Forefemur 1.82x as long as wide. Forewing 3x as long as wide, without areolet, only a short stub arising from basal vein; M, SM with single row of setae.

Description: Holotype – Female.

Measurements: Length 2.8mm; LH 0.68mm; WH 0.57mm; WF 0.34mm; FWL 1.9mm; LM 1.1mm; LP 0.34mm; WPD 0.45mm; LPD 0.28mm.

Colour: Body black, first two segments and last segment of metasoma brown; mandible, antenna uniformly yellow-brown; leg orange brown; tibiae light-brown. Wing hyaline; subcosta, pterostigma, prostigma, brown; other veins straw coloured.

Head: Head (figs.79, 248) longer than wide, WH 0.83x LH, compressed in lateral aspect, 1.87x as long as wide (fig.250) ; frons and vertex coriaceous; gena smooth and polished; vestiture sparse, long, decumbent; vertex straight in full face view sides behind eyes parallel before curving inward at posterolateral angles; mandible slender hidden under clypeus in dorsal view, with 4 long pointed teeth, ventral most curved downwards; clypeus beak like in lateral view; anterior margin of clypeus obtuse, carina moderately strong, arcuate in profile extending onto frons as a low carina upto level of posterior margin of scrobe; scrobe ecarinate; vertex ecarinate with a row of long setae, longest being 0.09mm; WF 0.5x LH; EV 0.6x HE; WF = HE; LH 2x HE; malar space narrow; malar groove absent; eye sparsely setose, setae minute, shorter than diameter of single facet; ocelli in obtuse triangle; posterior ocelli contiguous with vertex; OOL 0.94x WOT; POL:AOL:DAO = 8:4:3. Relative lengths of first five antennal segments (fig.249) 6.5:3.5:2:3:4; scape 1.44x as long as wide, shorter than 2x pedicel; F1 wider than long, terminal segment longer than

wide, rest of them as long as wide; F1 shorter than pedicel; antenna subequal to head length in full face view (24:22).

Mesosoma: Pronotum, mesonotum, scutellum (fig.80) coriaceous; vestiture long, decumbent, sparse on pronotum, only few setae on mesonotum and scutellum; pronotal disc (fig.248) 0.5x as long as wide; scutellum with a pair of basal slits connected by a narrow groove; parapsidal furrow weak, but complete; notauli absent; propodeal dorsum 0.65x as long as wide, smoothly inclined to lateral margin; basal median propodeal triangle smooth, elevated, reaching upto middle of disc, not reaching to posterior margin, rest of dorsum and declivity coriaceous; posterior transverse carina narrowly interrupted medially. Forewing (fig.248) 3x as long as wide, without areolet, only a short stub arising from basal vein; M, SM with single row of setae; setae present in distal 1/3rd of M and speculum sparsely setose; m:rs:rs+m = 9:5.5:6. Forefemur (fig.251) 1.82x as long as wide; SI 6.1.

Metasoma: Metasoma (fig.78) slightly longer than mesosoma (45:38), shorter than head plus mesosoma (45:61); tergites generally smooth and polished; T1 completely smooth; T2-T4 with weakly coriaceous basal band; T1-T3 with few setae restricted to lateral margin; other tergites sparsely setose all across dorsal side.

Male: Unknown.

Ecology and Biology: Unknown.

Etymology: The species epithet is after the Latin word, *novellus* meaning recent.

Distribution: India – Kerala.

Material Examined: *Holotype* – Female. INDIA: Kerala, Malappuram, Calicut University Botanical Garden, 11°07.58'N 75°53.24'E, 80m, 17.iv.2003, S. Santhosh, leg. VRN 113 (DZUC).

Discussion: *Goniozus novellus* sp. nov. is closely related to *G. nuperus* sp. nov. in having brown-black mandible, forefemur 1.82-1.92x as long as wide and EV 0.53 - 0.60x HE. *Goniozus novellus* sp. nov. differs from *G. nuperus* sp. nov. in having OOL 0.94x WOT, anteromedian propodeal triangle smooth elevated not connected to the transverse carina, head in lateral view 1.87x as long as wide, mandible slender

and antenna as long as head, whereas in *G. nuperus* sp. nov. OOL 1.05-1.11x WOT, anteromedian propodeal triangle smooth elevated connected to transverse carina by a smooth median line, head in lateral view 2x as long as wide, mandible stout and antenna slightly longer than head.

***Goniozus nuperus* sp. nov.**

(figs.81-84, 252-255)

Diagnosis: Head longer than wide, WH 0.86 - 0.91x LH, strongly compressed in lateral view, 2x as long as wide; antenna distinctly longer than head in full face view; mandible stout, brown-black, ventral most tooth strongly curved downwards; anterior clypeal margin obtuse; OOL 1.05-1.11x WOT; EV 0.53-0.58x HE; eye sparsely setose, setae as long as diameter of single facet; parapsidal furrow present; propodeal disc sharply inclined to lateral margin; sublateral carina distinct only on posterolateral corner of propodeum; posterior transverse propodeal carina complete; anteromedian propodeal triangle smooth, elevated, connected to transverse carina by a median smooth line; metasoma distinctly longer than mesosoma. Forefemur 1.92x as long as wide. Forewing without areolet, but only short stub arising from basal vein; M with numerous setae, SM and speculum with few scattered setae.

Description: Holotype – Female.

Measurements: Length 3.35mm; LH 0.68mm; WH 0.596mm; WF 0.35mm; FWL 2mm; LM 1.17mm; LP 0.44mm; WPD 0.5mm; LPD 0.34mm.

Colour: Body black; mandible yellow, teeth brown; antenna yellow-brown, scape basally darker; terminal 9 segments progressively darker towards apex; all coxae, forefemur black; mid and hind femur dark brown; tibia yellow-brown; trochanter, tarsi yellow. Wing hyaline, prostigma and pterostigma brown, other veins straw coloured.

Head: Head (figs.83, 252) longer than wide, WH 0.88x LH, strongly compressed in lateral aspect, 2x as long as wide (figs.82, 254); frons and vertex coriaceous with scattered shallow punctures; gena smooth and polished; vestiture short, sparse,

decumbent; 3 pairs of long setae on vertex, longest being 0.096mm; anterior clypeal margin strongly produced, broadly rounded, obtuse; clypeal carina strong and arcuate in profile, 0.71x HE, extending onto frons beyond level of posterior scrobal margin; scrobe ecarinate; mandible stout with 4 short, pointed teeth, ventral most curved; WF 0.51x LH; WF = HE; EV 0.53x HE; LH 2x HE; malar space narrow; malar groove absent; eye sparsely setose, setae minute, as long as diameter of single facet; ocelli in obtuse triangle, posterior ocelli not contiguous, separated from vertex margin by less than half its diameter; OOL 1.1x WOT; POL:AOL:DAO = 6:3:2.5; vertex straight in full face view, carinate. Relative lengths of first five antennal segments (fig.253) 9:5:4:4.3:5; scape 1.88x as long as wide, shorter than 2x pedicel length; pedicel longer than F1; all funicular segments are longer than wide; antenna slightly longer than head in full face view (42:49).

Mesosoma: Pronotum, mesonotum and scutellum (fig.84) uniformly coriaceous, similar to head in dorsal view; vestiture sparse, short, decumbent; pronotal disc (fig.252) 0.57x as long as wide; mesonotum with parapsidal furrow, anteriorly weak; notauli absent; scutellum with a pair of basal slits; propodeal disc 0.69x as long as wide, sharply inclined to lateral margin; sublateral carina only on posterolateral corner of propodeum; basal median propodeal triangle smooth, shining, and elevated, extending to middle of propodeal disc, continued as weak line to transverse carina; rest of propodeal disc and declivity coriaceous; posterior transverse carina complete. Forewing (fig.252) 3.71x as long as broad, without areolet, only a short stub arising from basal vein; M with numerous setae and SM with single row of setae; speculum sparsely setose; m:rs:rs+m = 6:5:6. Forefemur (fig.255) 1.92x as long as wide; SI 4.31.

Metasoma: Metasoma (fig.81) distinctly longer than mesosoma (78:61), shorter than head plus mesosoma (78:96); tergites smooth and polished; T1 completely smooth, others with a weak coriaceous basal band; distinctly longer than mesosoma; T1-T4 with few setae restricted to lateral margin; other tergites sparsely setose all across dorsal side.

Male: Unknown.

Ecology and Biology: Collected from the riverside woodlands, paddy field and mixed agricultural plots. Host unknown.

Etymology: The species epithet is after the Latin word, *nuperus* meaning new.

Distribution: India – Kerala.

Material Examined: *Holotype* – Female. INDIA: Kerala, Kozhikode, Kodanjeri, NW of Kozhikode, 11°24.35'N 75°56.16'E, 45m, 3.iv.2007; sweeping, agricultural plot – mixed vegetation; S. Santhosh leg., VRN 51 (DZUC). *Paratypes*. 2♀. same data of holotype, VRN 52, VRN 53; 1♀. Palghat, Koottanad, Puliampettakayal, 1.64kms NW Koottanad, 10°45.67'N 76°07.10'E, 8♂, 28.ii.2008, sweeping, paddy field, S. Santhosh leg., VRN 12; 1♀. Idukki, Kulamavu, near reservoir, 09°47.11'N 76°56.09'E, 737m, TEF, 1.xii.1989. T.C. Narendran leg., VRN 168; 2♀. Kozhikode, Nanminda, 11°26.45'N 75°50.25'E, 29m, 14.ii.2004, sweeping, P. Girish Kumar leg., VRN 74, VRN 76; 1♀. Malappuram, Nilambur, Chungathara, near Chaliyar river, 11°17.02'N 76°14.10'E, 72m, 11.x.2004, sweeping, S. Santhosh leg., VRN 123; 1♀. Kannur, Kottiyoor, 11°52.33'N 75°51.91'E, 140m, 25.ii.1989, sweeping, TEF, riverside woodlands, T.C. Narendran leg., VRN 126; 1♀. Kottayam, Kumarakom, RARS campus, 09°37.37'N 76°25.50'E, 3m, 17.iv.2008, sweeping, paddy field, S. Santhosh leg., VRN 92 (DZUC).

Variation: In one paratype (VRN 168) OOL 0.91x WOT; EV 0.41x HE and WH 0.91x LH. See table- 14 for morphometric ratios of all the type materials examined.

Discussion: *Goniozus nuperus* sp. nov. is closely related to *G. novellus* sp. nov. in having mandible brown black, forefemur 1.82-1.92x as long as wide, anteromedian smooth propodeal triangle elevated, either not continued or connected to transverse carina by a smooth median line, but not with a smooth patch and EV 0.53-0.60x HE. *Goniozus nuperus* sp. nov. differs from *G. novellus* sp. nov. in having OOL 1.05-1.11x WOT, anteromedian propodeal triangle is smooth, elevated, connected to the transverse carina by a smooth median line, head in lateral view 2x as long as wide, mandible stout, and antenna slightly longer than head, whereas in *G. novellus* sp. nov. OOL 0.94x WOT, anteromedian propodeal triangle is smooth, elevated, only upto the middle of disc, not connected to the transverse carina, head in lateral view

1.87x as long as wide, mandible slender, and antenna as long as head. *Goniozus kainophanestus* sp. nov. is also related to *G. nuperus* sp. nov., but differs in having yellow mandible; forefemur 1.67x as long as wide, anteromedian smooth propodeal triangle not elevated continued as smooth patch to the transverse carina and EV 0.42-0.44x HE, whereas in *G. nuperus* sp. nov. mandible is brown-black, forefemur 1.82-1.92x as long as wide, anteromedian smooth propodeal triangle elevated, either not continued or connected to the transverse carina by a smooth median line, but not a smooth patch, and EV 0.53 - 0.60x HE.

Table – 14. Morphometric ratios of *Goniozus nuperus* sp. nov.

VRN	WH / LH	OOL / WOT	EV / HE	WF / HE	LH / LA	LS / PL	PL / LF1
51	0.878788	1.1	0.529412	1	0.733333	1.75	1.333333
52	0.857143	1.11111111	0.5625	1	0.7	1.71429	1.25
53	0.866667	1.11764706	0.580645	0.96774	0.75	1.71429	1.25
12	0.866667	1.05882353	0.5333333	1	0.75	1.71429	1.25
123	0.8833333	1.05555556	0.5625	0.96875	0.66667	1.71429	1.25
126	0.857143	1.125	0.5625	0.9375	0.875	1.66667	1.5
92	0.892857	1.125	0.5625	0.90625	0.66667	1.71875	1.14286
168	0.914286	0.90909091	0.526316	1	0.81395	1.71429	1.16667
74	0.866667	1.05882353	0.580645	1	0.76923	1.71429	1.4
76	0.870968	1.05555556	0.529412	0.97059	0.7381	1.71429	1.16667
Mean Values	0.87	1.07	0.55	0.98	0.75	1.71	1.27

***Goniozus orthagae* sp. nov.**

(figs.85-88, 256-262)

Diagnosis: Head strongly coriaceous, subequal, WH 0.91x LH; head in lateral view moderately compressed, 1.7x as long as wide; mandible stout, brown-black; scape 2x pedicel; pedicel longer than F1; anterior clypeal margin strongly produced, obtuse; clypeal carina 0.67x HE, extending onto frons as low carina upto level of posterior scrobal margin; OOL 0.91x WOT. Posterior ocelli not contiguous with

vertex; propodeal disc sharply inclined to lateral margin; posterior propodeal transverse carina absent; forefemur 1.85x as long as wide. Forewing without areolet, but only short stub arising from basal vein; M, SM profusely setose.

Description: *Holotype* – Female.

Measurements: Length 2.67mm; LH 0.67mm; WH 0.61mm; WF 0.38mm; FWL 1.89mm; LM 1.06mm; LP 0.34mm; WPD 0.50mm; LPD 0.26mm.

Colour: Body brownish black; mandible yellow, teeth brown; antenna uniformly yellow, scape basally brown; legs yellow except coxae, forefemur and hind femur dark brown, hindfemur lighter than forefemur. Wing hyaline; subcosta, prostigma and pterostigma light brown, other veins colourless.

Head: Head (figs.87, 256) longer than wide, WH 0.91X LH, compressed in lateral aspect, 1.7x as long as wide (figs. 86, 257); frons and vertex strongly coriaceous with scattered shallow punctures; gena smooth and polished; vestiture long, sparse, decumbent; long setae on vertex, longest being 0.14mm; anterior clypeal margin strongly produced, obtuse; clypeal carina 0.67x HE, extending onto frons as low carina upto level of posterior scrobal margin; scrobe ecarinate; mandible robust with 4 short, pointed teeth, ventral most tooth pointed, straight; WF 0.57x LH; WF = HE; EV 0.3x HE; LH 1.85x HE; malar space narrow; malar groove absent; eye sparsely setose, setae minute, shorter than diameter of single facet; ocelli in obtuse triangle; posterior ocelli separated from occipital margin by less than half their diameter; OOL 0.91x WOT; POL:AOL:DAO = 7:3:3; vertex straight, weakly carinate. Relative lengths of first five antennal segments (fig.256) 6:3:2.5:3:2.8; scape 1.5x as long as wide, 2x pedicel length; pedicel longer than F1; F3 wider than long, F1, F2, F4-F10 as long as wide; F11 longer than wide; antenna distinctly longer than head in full face view (43:36).

Mesonotum: Pronotum (fig.88) strongly coriaceous without scattered shallow punctures; mesoscutum coriaceous, with shallow punctures, anteriorly with weak sculpture; scutellum weakly coriaceous, with few punctures; vestiture long, sparse, decumbent; pronotal disc (fig.256) 0.48x as long as wide; mesonotum with weak parapsidal furrow; notauli absent; scutellum with narrow basal transverse groove

expanded into small pits on either end; propodeal disc 0.69x as long as wide, sharply inclined to lateral margin, basal propodeal triangle smooth, elevated, reaching posterior margin as a smooth line, rest of disc and posterior declivity coriaceous; posterior transverse carina is restricted to posterolateral corner, inner ends anteriorly curving. Forewing 2.8x as long as wide, without areolet; M, SM with numerous hairs; speculum setose; m:rs:rs+m = 7.5:5.5:6. Forefemur (fig.258) 1.85x as long as wide; SI 4.32.

Metasoma: Metasoma (fig.85) distinctly longer than mesosoma (68:57), shorter than head plus mesosoma (68:93); T2 weakly coriaceous at base; other tergites smooth and polished; T1-T3 completely with few setae restricted to lateral margin; other tergites sparsely setose all across dorsal side.

Male. Allotype

Male: Same as female except the following (fig.259-262), body brown-black; legs except forefemur and coxa yellow; forefemur red-brown. Antenna and mandible uniformly yellow. HW 0.97x LH (fig.259); WF 0.88x HE; OOL 0.58x WOT; POL: AOL = 7:3.3; m: rs: rs+m = 8:6:5; EV 0.62x HE (fig.261). Forefemur (fig.262) 2x as long as wide.

Ecology and Biology: ex. larvae of *Orthaga exvinacea* Hampson (Lepidoptera: Pyralidae) on *Mangifera indica* L. (Anacardiaceae).

Etymology: The species epithet is after the genus name of the host species, *Orthaga*.

Distribution: India – Kerala.

Material Examined: *Holotype* – Female. INDIA: Trichur, Chawaghad, 10°35.21'N 76°01.07'E, 01.iii.2006, K. Bindu leg., VRN 30 (DZUC). *Paratype*: 1m, same data as holotype, VRN 31 (DZUC).

Discussion: *Goniozus rutherfordi* is closely related to *G. orthagae* sp. nov., but it differs in having OOL as long as WOT, scape is less than 2x pedicel, posterior ocelli contiguous with vertex and mandible is slender, whereas in *G. orthagae* sp. nov. OOL 0.91x WOT, scape 2x pedicel, posterior ocelli is not contiguous with vertex and mandible is stout. *Goniozus orthagae* sp. nov. is also related to *G. keralensis*,

but the mandible is yellow and pedicel shorter than F1, whereas in *G. orthogae* sp. nov. mandible is brown-black and pedicel is longer than F1.

***Goniozus palghatensis* sp. nov.**

(figs.89-92, 263-266)

Diagnosis: Head longer than wide, WH 0.79x LH; head and thorax uniformly strongly coriaceous and profusely setose; frons and vertex without shallow punctures; antenna as long as head in full face view; anterior clypeal margin acute, pedicel shorter than F1; scape as long as 2x pedicel; eye with long profuse setae; ocular setae 2.8x as long as diameter of single facet; OOL = WOT. Parapsidal furrow present; posterior propodeal transverse carina broadly interrupted medially; propodeal disc smoothly inclined to lateral margin; propodeal declivity medially smooth; metasoma shorter than mesosoma. Forewing without areolet, but only short stub arising from basal vein; M, SM and speculum profusely setose.

Description: Holotype – Female.

Measurements: Length 2.34mm; LH 0.63mm; WH 0.5mm; WF 0.3mm; FWL 1.61mm; LM 0.9mm; LP 0.3mm; WPD 0.44mm; LPD 0.24mm.

Colour: Body black; metasoma basally brown; mandible brown, teeth darker; antenna uniformly yellow; coxa, femur light brown; other leg segments yellow. Wing hyaline, prostigma and pterostigma brown, other veins straw coloured.

Head: Head (figs.91, 263) longer than wide, WH 0.79x LH, compressed in lateral aspect, 1.79x as long as wide (figs.90, 265); frons and vertex coriaceous without shallow punctures; gena smooth and polished; vestiture short, profuse, suberect; setae longer on vertex, longest being 0.11mm;; anterior clypeal margin strongly produced, sharply angulate, acute; clypeal carina strong and arcuate in profile, 0.56x HE, extending onto frons falling short of level of posterior scrobal margin; scrobe weakly carinate; mandible stout with 4 long, pointed teeth, ventral most weakly curved inwards; WF 0.48x LH; WF 0.91x HE; EV 0.5x HE; LH 1.95x HE; malar space narrow; malar groove absent; eye profusely setose, setae long, 2.8x as long as

diameter of single facet; ocelli in obtuse triangle, posterior ocelli separated from vertex margin by less than half its diameter; OOL = WOT; POL:AOL:DAO = 7.5:4:2.5; vertex straight in full face view, ecarinate. Relative lengths of first five antennal segments (fig.264) 7:3.5:3.8:3.5:3; scape 1.27x as long as wide, 2x pedicel; pedicel shorter than F1; pedicel, F1, F11 longer than wide; other funicular segments as long as wide; antenna subequal to head length in full face view (37:36).

Mesosoma: Pronotum, mesonotum and scutellum (fig.92) strongly coriaceous without shallow punctures; vestiture long, profuse, suberect; pronotal disc (fig.263) 0.48x as long as wide; mesonotum with distinct, complete parapsidal furrow; notauli absent; scutellum with a pair of basal slits connected by narrow groove; propodeal disc 0.56x as long as wide, smoothly inclined to lateral margin; sublateral carina on posterolateral corner of propodeal disc; basal median triangular area smooth, elevated, reaching posterior margin by weak median smooth line, declivity medially smooth; rest of disc and declivity coriaceous; posterior transverse carina broadly interrupted medially. Forewing (fig.263) 2.89x as long as wide, without areolet; M, SM with abundant setae; speculum with numerous setae; m; rs; rs+m = 6.5:3:6.5. Forefemur (fig.266) 1.75x as long as wide; SI 5.3.

Metasoma: Metasoma (fig.89) slightly shorter than mesosoma (54:60), distinctly shorter than head plus mesosoma (54:102); tergites with weakly coriaceous in apical band rest smooth, polished; T1-T3 with few setae restricted to lateral margin; other tergites sparsely setose all across dorsal side.

Male: Unknown.

Ecology and Biology: Unknown.

Etymology: The species epithet is after the type locality, Palghat.

Distribution: India – Kerala.

Material Examined: *Holotype* – Female. INDIA: Kerala, Palghat, Anakatti, 11°06.15'N 76°46.01'E, 690m, 12.xii.1987, sweeping, T.C. Narendran leg., VRN 57 (DZUC).

Discussion: *Goniozus palghatensis* sp. nov. is closely related to *G. propodeatus* sp. nov. in having the anterior clypeal margin acute, scape equal to or more than 2x pedicel, eye profusely setose, setae longer than diameter of single facet, and M, SM and speculum profusely setose. *Goniozus propodeatus* sp. nov. differ from *G. palghatensis* sp. nov. in having the posterior propodeal transverse carina complete, propodeal disc sharply inclined to lateral margin with sublateral ridges, antenna distinctly longer than head in full face view, pedicel longer than F1, scape longer than 2x pedicel; metasoma longer than mesosoma, frons and vertex with shallow punctures and ocular setae slightly longer than diameter of single facet, whereas in *G. palghatensis* sp. nov. posterior propodeal transverse carina broadly interrupted medially, propodeal disc smoothly inclined to lateral margin without sublateral ridges, antenna as long as head in full face view, pedicel shorter than F1, scape as long as 2x pedicel, metasoma shorter than mesosoma, frons and vertex without shallow punctures and ocular setae 2.8x as long as diameter of single facet.

Goniozus platycephalus sp. nov.

(figs.93-96, 267-271)

Diagnosis: Head weakly coriaceous, subequal in full face view, WH 0.93x LH, head strongly compressed in lateral view, 2.17x as long as wide; clypeal carina completely absent; eye sparsely setose, setae minute, shorter than diameter of single facet; vertex ecarinate, emarginate; posterior propodeal transverse carina absent. Forefemur 2.14x as long as wide. Forewing without areolet, but only short stub arising from basal vein.

Description: Holotype – Female.

Measurements: Length 3.25mm; LH 0.73mm; WH 0.68mm; WF 0.40mm; FWL 2.35mm; LP 0.5mm; LM 1.38mm; WPD 0.52mm; LPD 0.38mm.

Colour: Body black; mandible brownish yellow, teeth darker; antenna yellow, apical two segments and base of scape fuscous; coxae and femora brown; trochanters,

tibiae and tarsi yellow. Wing hyaline; subcosta, prostigma and pterostigma light brown, other veins colourless.

Head: Head (figs.95, 267) longer than wide, WH 0.93x LH; strongly compressed in lateral aspect, 2.17x as long as wide (figs.94, 269); frons and vertex weakly coriaceous with scattered shallow punctures; gena smooth and polished; vestiture short, sparse and suberect, longest on vertex margin being 0.08mm; anterior clypeal margin strongly produced, broadly rounded, obtuse; clypeal median ridge and carina absent; frons without polished streak; scrobe ecarinate; mandible slender with long, pointed 4 teeth, ventral most straight; WF 0.55x LH; WF 1.1x HE; EV 0.68x HE; LH 2.05x HE; malar space distinct; malar groove absent; eye sparsely setose, setae minute, shorter than diameter of single facet; ocelli in obtuse triangle; posterior ocelli separated from vertex margin by less than half of their diameter; OOL 0.85x WOT; POL:AOL:DAO = 8.5:4:3; vertex ecarinate, emarginate. Relative lengths of first five antennal segments (fig.268) 8:4:3.5:3:3; scape 2x as long as wide; pedicel longer than F1; F2 to F3 as long as wide, other funicular segments longer than wide, antenna longer than head in full face view (38:47).

Mesosoma: Pronotum (fig.96) coriaceous with scattered shallow punctures; mesonotum weakly coriaceous; scutellum smooth and glossy; vestiture sparse, long, suberect; pronotal disc 0.64x as long as wide, mesonotum with parapsidal furrow, absent in posterior one-third, notauli absent; scutellum with a pair of basal slits; propodeal disc as long as wide; sharply inclined to lateral margin, basal median propodeal triangle polished, not elevated, extending into declivity, rest of propodeal disc coriaceous, weaker towards posterior margin, declivity medially smooth; transverse carina absent, restricted to posterolateral corners as very short carina. Forewing (fig.271) 3x as long as wide, without areolet, only a short stub arising from basal vein; M, SM and speculum sparsely setose; m:rs:rs+m= 8:4.5:5. Forefemur (fig.270) 2.14x as long as wide; SI 6.6.

Metasoma: Metasoma (fig.93) slightly longer than mesosoma (86:75), shorter than head plus mesosoma (86:113); tergites smooth and polished; T1-T2 completely smooth, others with weakly coriaceous basal band; T1-T3 with few setae restricted to lateral margin; other tergites sparsely setose all across dorsal side.

Male: Same as female except the following; HW 1.02x LH; WF = HE; OOL 0.63x WOT; POL: AOL: DAO = 4.5:2:2; m: rs: rs+m = 9:5:7; EV 0.43x HE. Forefemur 2.3x as long as wide.

Ecology and Biology: ex. larvae of rice leaf folder, *Cnaphalocrocis medinalis* (Guenee) (Lepidoptera: Pyralidae)

Etymology: The species epithet is from the Latin *platy* meaning flat and *cephalus* meaning head in allusion to the strongly flat head of the species.

Distribution: India – Manipur; Karnataka.

Material Examined: *Holotype* – Female. INDIA, Manipur, Imphal University Campus, 24°45'N 93°55'E, 783m, 20.x.2006, rearing, R.E. Varatharajan leg., VRN 104. (DZUC). *Paratype*. 1♂. INDIA: Karnataka, Uppinangady, 12°49.42'N 75°14.49'E, 65m, 17.xii.1988, sweeping, T.C. Narendran leg., VRN 78 (DZUC).

Discussion: This new species falls into the group of seven species of *Goniozus* without areolet and posterior propodeal transverse carina, viz. *Goniozus orthogae* sp. nov., *G. borneanus*, *G. keralensis*, *G. rutherfordi*, *G. indicus*, and *G. triangulus*. *Goniozus platycephalus* sp. nov. strongly differs from all other related species in having an extremely flat head, 2.17x as long as wide in lateral view; forefemur more than 2x as long as wide; anteromedian propodeal triangle smooth and not elevated, clypeus devoid of median carina. In *G. platycephalus* sp. nov., head sculpture is weakly coriaceous like *G. rutherfordi*, whereas in *G. indicus* head is smooth and in *G. orthogae* sp. nov., *G. keralensis* and *borneanus* head is strongly coriaceous with shallow punctures. Mandible is yellow in *G. platycephalus* sp. nov., *G. borneanus*, *G. keralensis*, and *G. triangulus*, whereas in *G. orthogae* sp. nov. and *G. rutherfordi* mandible is brown.

Remarks: The configuration and concomitant ratios of the head differ between the sexes, but the propodeal shape and sculpture remains consistent within the species. The male specimen collected from Uppinangady in Karnataka closely resembles the female collected from Manipur except in the configuration and concomitant ratios of the head. Though the male and female specimens are geographically separated, the male specimen from the Western Ghats is tentatively kept as a paratype of the

female from Eastern Himalaya in the present investigation. It is expected that further study of the species involving more specimens from the study area may support this view.

***Goniozus propodeatus* sp. nov.**

(figs.97-100, 272-275)

Diagnosis: Head longer than wide, WH 0.88x LH; in lateral aspect, strongly compressed, 1.78x as long as wide; frons and vertex coriaceous with shallow punctures; anterior clypeal margin acute; antenna distinctly longer than head in full face view; pedicel longer than F1; scape longer than 2x pedicel; eye profusely setose, setae longer than diameter of single facet; parapsidal furrows present; posterior propodeal transverse carina complete; propodeal disc sharply inclined to lateral margin, with distinct sublateral ridges; metasoma longer than mesosoma. Forewing without areolet, only a short stub arising from basal vein; M, SM and speculum profusely setose.

Description: Holotype – Female.

Measurements: Length 3.38mm; LH 0.75mm; WH 0.66mm; WF 0.39mm; FWL 2.05mm; LM 1.11mm; LP 0.36mm; WPD 0.52mm; LPD 0.27mm.

Colour: Body brownish black, metasoma basally (T1) brown; mandible red-brown with brown teeth; antenna uniformly yellow with 4 terminal segments light brown; coxa, trochanter, femur dark brown, tibia and tarsi yellowish brown. Wing hyaline; prostigma and pterostigma brown, other veins straw coloured.

Head: Head (figs.99, 272) longer than wide, WH 0.88x LH, compressed in lateral aspect, 1.78x as long as wide (figs.98, 274); frons and vertex coriaceous with scattered shallow punctures; gena smooth and polished; vestiture short, long, decumbent; anterior clypeal margin strongly produced, acute; clypeal carina strong, arcuate in profile, 0.6x HE, extending onto frons upto level of posterior scrobal margin; scrobe ecarinate; mandible stout with 4 short, pointed teeth, ventral most straight; WF 0.52x LH; WF = HE, EV 0.53x HE; LH 1.88x HE; malar space

narrow; malar groove absent; eye sparsely setose, setae slightly longer than diameter of single facet; ocelli in obtuse triangle; posterior ocelli separated from vertex margin by less than half its diameter; OOL = WOT; POL: AOL: DAO = 6:3:3; vertex straight in full face view, weakly carinate with 3 pairs of long setae, longest being 0.21mm; 2 pairs of setae near outer posterior ocular margin very long. Relative lengths of first five antennal segments (fig.273) 9:4:3:3.5:3.5; scape 1.8x as long as wide, longer than 2x pedicel; pedicel longer than F1; F2-F11 longer than wide; antenna longer than head in full face view (30:26).

Mesosoma: Pronotum, mesonotum and scutellum (fig.100) coriaceous; scutellum with shallow punctures; vestiture profuse, long, decumbent; pronotal disc 0.52x as long as wide; parapsidal furrow weak, complete; notauli absent; scutellum basally with a pair of pits connected in between by a narrow groove; propodeal dorsum 0.52 x as long as wide, sharply inclined to lateral margin; disc with distinct sublateral ridges, basal median propodeal triangle smooth, shining, elevated, extending beyond middle of disc, connected to posterior margin by a smooth line, rest of propodeal disc and declivity coriaceous; posterior transverse carina complete. Forewing 2.73x as long as wide, without areolet, only a short stub arising from basal vein; M, SM, speculum with numerous setae; m:rs:rs+m = 5:4:4.5. Forefemur (fig.275) 1.62x as long as wide; SI 5.57.

Metasoma: Metasoma (fig.97) distinctly longer than mesosoma (47:39), shorter than head plus mesosoma (47:62); tergites smooth and polished; T3 and T4 weakly coriaceous. T1-T3 with few setae restricted to lateral margin; other tergites sparsely setose all across dorsal side.

Male: Unknown.

Ecology and Biology: Unknown.

Etymology: The species epithet is after the propodeum, which shows distinct sublateral ridges.

Distribution: India – Kerala.

Material Examined: Holotype – Female. INDIA: Kerala: Malappuram, Calicut University Botanical Garden, Arboretum, 11°07.58'N 75°53.24'E, 80m, MT, 5-12.xii.2006, S. Santhosh leg., VRN 110 (DZUC).

Discussion: Goniozus propodeatus sp. nov. and *G. palghatensis* sp. nov. are similar in having anterior clypeal margin acute, scape equal to or more than 2x pedicel, eye profusely setose, setae longer than diameter of single facet and M, SM and speculum profusely setose. *Goniozus propodeatus* sp. nov. differ from *G. palghatensis* sp. nov. in having complete posterior propodeal transverse carina, propodeal disc sharply inclined to lateral margin with sublateral ridges, antenna distinctly longer than head in full face view, pedicel longer than F1, scape longer than 2x pedicel, metasoma longer than mesosoma, frons and vertex with shallow punctures and ocular setae slightly longer than diameter of single facet, whereas in *G. palghatensis* sp. nov., posterior propodeal transverse carina is broadly interrupted medially, propodeal disc smoothly inclined to lateral margin without sublateral ridges, antenna as long as head in full face view, pedicel shorter than F1, scape as long as 2x pedicel, metasoma shorter than mesosoma, frons and vertex without shallow punctures and ocular setae 2.8x as long as diameter of single facet.

***Goniozus prosphatosis* sp. nov.**

(figs.101-104, 276-281)

Diagnosis: Head slightly longer than wide in full face view, WH 0.94-0.95x LH; strongly compressed in lateral aspect, 1.83x as long as wide; frons and vertex strongly coriaceous with scattered shallow punctures; clypeal carina present; mandible yellow; antenna distinctly longer than head; scape shorter than 2x pedicel; pedicel longer than F1; malar space distinct; vertex emarginate; propodeal disc 0.5x as long as wide, sharply inclined to lateral margin; disc with distinct sublateral ridges; posterior transverse propodeal carina broadly interrupted medially; metasoma distinctly longer than mesosoma. Forefemur 2.1x as long as wide. Forewing without areolet, but only short stub arising from basal vein.

Description: *Holotype* – Female.

Measurements: Length 3.26mm; LH 0.74mm; WH 0.7mm; WF 0.41mm; FWL 2.32mm; LM 1.1mm; LP 0.32mm; WPD 0.5mm; LPD 0.25mm.

Colour: Body black, antenna light yellow, terminal 4 segments with brown tinge; mandible yellow, teeth brown; coxa, femur light to dark brown, other leg segments yellow. Wing hyaline; pterostigma, prostigma brown; costa, subcosta, stigmal vein straw coloured.

Head: Head (figs.103, 276) longer than wide in full face view, WH 0.95x LH, compressed in lateral aspect, 1.83x as long as wide (figs.102, 278); frons and vertex strongly coriaceous with scattered shallow punctures; gena smooth and polished; vestiture sparse, long, suberect; 4 pairs of long setae on vertex margin, longest being 0.15mm long; anterior clypeal margin strongly produced, bluntly angulated, obtuse; clypeal carina 0.8x HE, strong, arcuate in profile, extending onto frons upto level of posterior scrobal margin; scrobe weakly carinate; mandible robust, 4 short, pointed teeth, ventral most short, slightly curved inwards; WF 0.55x LH; WF = HE; EV 0.30x HE; LH 1.83x HE; malar space distinct; malar groove absent; eye sparsely setose; setae minute, shorter than diameter of single facet; ocelli in obtuse triangle; posterior ocelli contiguous with vertex margin; OOL 0.82x WOT; POL:AOL:DAO = 5:2.3:2.8; vertex emarginate in full face view, carinate. Relative lengths of first five antennal segments (fig.277) 7:5:3.5:4:4.5; scape 1.4x as long as wide, shorter than 2x pedicel; pedicel longer than F1; pedicel and F11 longer than wide; F1-F10 as long as wide; antenna longer than head in full face view (35:29).

Mesosoma: Pronotum (fig.104) coriaceous similar to head in full face view; mesonotum, scutellum weakly coriaceous; vestiture sparse, long; longest on pronotum being 0.14mm; pronotal disc (fig.276) very short, 0.42x as long as wide; mesonotum with parapsidal furrow, anteriorly absent; notauli absent; scutellum with a pair of basal slits; propodeal disc 0.5x as long as wide, sharply inclined to lateral margin; disc with distinct sublateral ridges; median basal triangle smooth, polished, elevated extending slightly beyond middle, continued as smooth line to posterior margin of disc; rest of dorsum and declivity coriaceous; transverse carina broadly interrupted medially, substituted with smooth line in middle; propodeal disc sharply inclined to lateral margin. Forewing (fig.276) 3.09x as long as wide, without areolet,

only a short stub arising from basal vein; M, SM with single row of setae; setae present in distal one-third of M cell; speculum with a pair of setae; m:rs:rs+m = 6:3.5:4. Forefemur (fig.279) 2.1x as long as wide; SI 4.

Metasoma: Metasoma (fig.101) distinctly longer than thorax (45:34), shorter than head plus mesosoma (45:54); tergites smooth and polished; T1-T2 completely smooth; other tergites with weakly coriaceous basal band; T1-T4 with few setae restricted to lateral margin; other tergites sparsely setose all across dorsal side.

Male. Allotype.

Measurements: Length 2.66mm; LH 0.66mm; WH 0.64mm; WF 0.36mm; FWL 2.1mm; LM 1.1mm; LP 0.29mm; WPD 0.48mm.

Description: Similar to female except leg, antenna, mandible light yellow; teeth red; terminal 4 antennal segments light brown; metasoma shorter than thorax; POL:AOL:DAO = 5:2.5:3; antenna longer than head in full face view (25:19).

Ecology and Biology: Unknown.

Etymology: The species epithet is after the Greek word, *prospatos* meaning new.

Distribution: India – Kerala; Tamil Nadu – Chennai.

Material Examined: *Holotype* – Female. INDIA: Kerala, Nilambur, Ganapathikallu, 11°24.06'N 76°22.11'E, 303m, 30.i.2003, sweeping, MDF, K. Sudheer leg., VRN 172 (DZUC). *Paratypes*: 1♀. same data as holotype, VRN 170; 1♂. same data as holotype, VRN 171; 2♀. INDIA: Tamil Nadu, Chennai, 13°03.22'N 80°14.05'E, 14m, 16.x.2007, rearing, Alexander Yesudasan leg., VRN 193, VRN 194. (DZUC).

Variation: Teneral female specimens are light brown in colour; antenna light yellow, concolourous to mandible and leg. In paratypes, OOL 0.72x WOT, EV 0.37x HE, WF 0.96x HE, LS 1.7-1.8x PL and PL 1.36-1.4x LF1. See table- 15 for morphometric ratios of all the type materials examined.

Discussion: *Goniozus prospatos* sp. nov. closely resembles *G. aproaeremae* sp. nov. in having posterior transverse propodeal carina broadly interrupted medially and head as long as wide in full face view, WH 0.91x – 1.02x LH, but it differs in having yellow mandible, antenna distinctly longer than head, vertex emarginate,

forefemur 2.1x as long as wide and clypeal carina present, malar space distinct and setae on vertex distinctly longer than that of frons, whereas in *G. aproaeremae* sp. nov., brown-black mandible, antenna as long as head, vertex straight, forefemur 2x as long as wide and clypeal carina absent, malar space narrow and setae on vertex as long as that of frons.

Table – 15. Morphometric ratios of *Goniozus prosphtosis* sp. nov.

VRN	WH / LH	OOL / WOT	EV / HE	WF / HE	LH / LA	LS / PL	PL / LF1
172	0.945946	0.81818182	0.3	1	0.88095	1.5	1.6
170	0.95122	0.83333333	0.297872	0.95745	0.87234	1.5	1.6
193	0.935484	0.72727273	0.333333	1	0.86111	1.83333	1.36364
194	0.941176	0.81818182	0.368421	1	0.87179	1.71429	1.4
Mean Values	0.94	0.80	0.32	0.99	0.87	1.64	1.49

***Goniozus recentis* sp. nov.**

(figs.105-108, 282-285)

Diagnosis: Head strongly transverse in full face view, WH 1.19x LH, compressed in lateral view, 1.71x as long as wide; head vestiture long, moderately profuse, clypeal carina absent, only as smooth ridge, extending onto frons, not reaching level of posterior scrobal margin; mandible yellow-brown; ventral most mandibular tooth long, strongly curved inward and backward; WF 0.73x LH; EV 0.28-0.29x HE. Scape longer than 2x pedicel length; pedicel = F1; all antennal segments longer than wide. Posterior propodeal carina complete metasoma distinctly longer than mesosoma. Forewing with subtriangular areolet, 1.7x as long as maximum width, aetose; M, SM profusely setose.

Description: *Holotype – Female.*

Measurements: Length 4.11mm; LH 0.79mm; WH 0.95mm; WF 0.58mm; FWL 2.84mm; LM 1.62mm; LP 0.43mm; WPD 0.81mm; LPD 0.35mm.

Colour: Body black; mandible brown, basal area, teeth darker; antenna yellowish brown, scape, terminal 7 segments darker; coxa, femur dark brown, other leg segments yellow-brown. Wing hyaline; pterostigma, prostigma dark brown; other veins light brown.

Head: Head (figs.107, 282) strongly transverse in full face view, WH 1.19x LH; compressed in lateral aspect, 1.71x as long as wide (figs.106, 284); frons and vertex strongly coriaceous with scattered shallow punctures; gena smooth and polished; vestiture long, moderately profuse, decumbent; 4 pairs of setae on vertex distinctly longer than others, longest being 0.19mm; anterior clypeal margin strongly produced, bluntly angulated, obtuse; median carina weak as a ridge, extending onto frons, not reaching level of posterior scrobal margin; scrobe deep, distinctly margined, weakly carinate; mandible moderately robust, with 4 blunt long teeth, ventral most long, strongly curved inwards and backwards; WF 0.73x LH; WF 1.13x HE; EV 0.29x HE; LH 1.68x HE; malar space narrow; malar groove absent; eye sparsely setose; setae minute, as long as diameter of single facet; ocelli in obtuse triangle; posterior ocelli contiguous with vertex margin; OOL = WOT; POL: AOL: DAO = 5.8:3:2.5; vertex emarginated in full face view, ecarinate. Relative lengths of first five antennal segments (fig.283) 13:6:6:6.8:7; scape 1.53x as long as wide; longer than 2x pedicel; pedicel = F1; all segments longer than wide. Antenna distinctly longer than head in full face view (42:32).

Mesosoma: Pronotum, mesonotum, scutellum (fig.108) coriaceous as on frons; vestiture on pronotum and mesonotum profuse, long, decumbent, but sparsely on scutellum; pronotal disc (fig.282) 0.47x as long as wide; parapsidal furrow distinct and complete; notauli absent; scutellum with basal pair of pits connected by narrow groove in middle; propodeum 0.42x as long as wide, smoothly inclined to lateral margin; median basal triangle elevated, coriaceous similar to scutellum, extending slightly beyond middle of disc, not reaching posterior margin, rest of propodeal dorsum and declivity strongly coriaceous; no sublateral carina on posterolateral corner; posterior transverse carina distinct and complete. Forewing (fig.282) 2.76x as long as wide, with areolet present, subtriangular in shape, 1.7x as long as

maximum width; M, SM profusely setose; speculum sparsely setose; areolet asetose. Forefemur (fig.285) 1.83x as long as wide; SI 4.69.

Metasoma: Metasoma (fig.105) distinctly longer than mesosoma (42:25), longer than head plus mesosoma (42:39); tergites generally smooth and polished; T1 completely smooth; others with scattered shallow punctures; T1-T3 with few setae restricted to lateral margin; other tergites sparsely setose all across dorsal side.

Male. Allotype.

Measurements: Length 2.73mm; LH 0.62mm; WH 0.73mm; WF 0.43mm; FWL 1.78mm; LM 1.08mm; LP 0.35mm; WPD 0.54mm; LPD 0.28mm.

Similar to female except following: mandible yellow, base brown; F1-F3 as long as pedicel; WF 1.1x HE; WH 1.17x LH; length of first 5 antennal segments in a ratio of 9:5:5:5:5; scape shorter than 2x pedicel; OOL 0.71x WOT; POL: AOL: DAO 4.5:2:2.3.

Ecology and Biology: Collected from the paddy fields. Host unknown.

Etymology: The species epithet is after the Latin word, *recens* meaning new.

Distribution: India – Kerala.

Material Examined: *Holotype* – Female. INDIA: Kerala, Kannur, Panayathanparamba, 3kms W Kannur Airport, 11°54.32'N 75°30.27'E, 70m, scrub jungle, MT, 10-24.ii.2008. K. Seena Narayanan leg., VRN 141 (DZUC). *Paratypes*: 1♀. INDIA: Kerala, Kottayam, Kumarakom, RARS campus, 09°37.37'N 76°25.50'E, 3m, 17.iv.2008, sweeping, paddy field, S. Santhosh leg., VRN 93; 1♂. Trivandrum, Kazhakoottam, 08°35.08'N 76°52.21'E, 21m, 25.ii.1989, T. C. Narendran leg., VRN135 (DZUC).

Variation: In paratype scape is 2x as long as pedicel. See table- 16 for morphometric ratios of all the type materials examined.

Discussion: *Goniozus recentis* sp. nov. comes close to *G. salvadorae* Kurian in having the head transverse, WH equal to or more than 1.2x LH, propodeal disc posteriorly with a complete transverse carina and forewing with areolet, but differs in having yellow-brown mandible, forefemur 1.83x as long as wide, clypeal carina

absent, anteromedian propodeal area with a smooth elevated triangle, EV 0.28-0.29x HE and metasoma distinctly longer than head plus mesosoma, whereas in *G. salvadorae*, mandible is black brown, forefemur 2.33x as long as wide, clypeal carina strong extending onto frons upto posterior scrobal margin, anteromedian propodeal area with a smooth area, but not an elevated triangle, EV 0.67x HE and metasoma shorter than head plus mesosoma.

Table – 16. Morphometric ratios of *Goniozus recentis* sp. nov.

VRN	WH / LH	OOL / WOT	EV / HE	WF / HE	LH / LA	LS / PL	PL / LF1
141	1.186441	1	0.289474	1.13158	0.67045	2.16667	1
93	1.137931	1	0.277778	1.11111	0.65909	2	1
Mean Values	1.16	1	0.28	1.12	0.66	2.08	1

***Goniozus setosus* sp. nov.**

(figs.109-112, 286-289)

Diagnosis: Head distinctly longer than wide, WH 0.73-0.78x LH, strongly compressed in lateral aspect, 1.89x as long as wide; frons and vertex strongly coriaceous with scattered shallow punctures, profusely setose; gena weakly coriaceous; eye profusely setose, setae 3x as long as diameter of single facet; OOL 0.82-0.94x WOT; WF 0.84-0.93x HE; EV 0.35-0.39x HE; vertex straight. Metasoma distinctly longer than mesosoma. Forefemur 1.67x as long as wide. Forewing 3x as long as wide, with subrectangular, setose areolet, 1.83x as long as wide; M, SM profusely setose.

Description: *Holotype* – Female.

Measurements: Length 2.38mm; LH 0.56mm; WH 0.43mm; WF 0.26mm; FWL 1.33mm; LM 0.75mm; LP 0.25mm; WPD 0.32mm; LPD 0.19mm.

Colour: Body black; mandible dark brown, teeth yellow; antenna yellow- brown, scape basally and terminal six segments brown; coxa, femur dark brown; trochanter, tibia, tarsi yellow; base of tibia fuscous. Wing hyaline; costa, stigmal vein straw coloured; prostigma, pterostigma dark brown; other veins colourless.

Head: Head (figs.111, 286) longer than wide, WH 0.78x LH; compressed in lateral aspect, 1.89x as long as wide (figs.110, 288); frons and vertex strongly coriaceous with scattered shallow punctures; gena weakly coriaceous; vestiture long, profuse, decumbent; setae on vertex margin distinctly very long; long and strong setae near posterolateral ocular margin, longest being 0.22mm in length; anterior clypeal margin strongly produced, sharply angulate, acute; clypeal carina 0.62x HE, strong, arcuate in profile, extending onto frons slightly beyond posterior scrobal margin; scrobe deep, weakly carinate; mandible robust, with very short, pointed teeth ventral most straight; WF 0.46x LH; WF 0.93x HE; EV 0.39x HE; LH 1.84x HE; malar space distinct; malar groove absent; eye profusely setose; setae 3x diameter of single facet; ocelli in obtuse triangle; posterior ocelli contiguous with vertex margin; OOL 0.82x WOT; POL: AOL: DAO = 6:3:2; vertex straight in full face view, smoothly angulated, ecarinate. Relative lengths of first five antennal segments (fig.287) 7:3.5:2.5:2.5:3; scape 1.49x as long as wide M with numerous setae, 2x pedicel length; pedicel longer than F1; F1-F10 as long as wide; F11 longer than wide; antenna slightly longer than head in full face view (26:21); head as wide as maximum width of thorax.

Mesosoma: Pronotum, mesonotum and scutellum (fig.112) strongly coriaceous; vestiture long, sparse, suberect; pronotal disc (fig.286) 0.54x as long as wide; scutellum with a pair of basal pits connected by a narrow groove; parapsidal furrow complete; notauli absent; propodeal disc 0.65x as long as wide, smoothly inclined to lateral margin, no sublateral carina on posterolateral corner of disc; basal median propodeal area smooth, rectangular, not elevated, not reaching posterior margin of disc, rest of disc and declivity coriaceous; posterior transverse carina broadly interrupted medially. Forewing (fig.286) 3x as long as wide; areolet present, subrectangular in shape; 1.83x as long as wide; setose; M, SM with numerous setae; speculum and areolet profusely setose. Forefemur (fig.289) 1.67x as long as wide; SI 9.6x.

Metasoma: Metasoma (fig.109) distinctly longer than mesosoma (46:30), shorter than head plus mesosoma (46:53); tergites smooth and polished; T1-T3 with few setae restricted to lateral margin; other tergites sparsely setose all across dorsal side.

Male: Unknown.

Ecology and Biology: Collected from plantain and coconut plantations. Host unknown.

Etymology: The species epithet '*setosus*' is after the profusely setose head of the species.

Distribution: India – Kerala.

Material Examined: *Holotype* – Female. INDIA: Kerala, Kannur, Panayathanparamba, 3kms W Kannur Airport, 11°54.32'N 75°30.27'E, 70m, 10-24.i.2008, MT, scrub jungle, S. Santhosh leg., VRN 147 (DZUC). *Paratype*. 4♀. same data as Holotype except VRN 146, 149, 150, 153; 3♀. same data as holotype except 10-24.ii.2008; VRN 136, VRN 137, VRN 138, VRN 148, VRN 151, VRN 152; 1♀. same data as holotype except 13-27.iii.2008; VRN 177; 1♀. same data as holotype except 10-24.iv.2008, VRN 180; 1♀. Kasaragode, CPCRI Campus, plantain and coconut mixed field, 5kms NW Kasaragode Town, 12°31.04'N 74°57.10'E, 18m, 21.i.2003, sweeping, P. Girish Kumar leg., VRN 102; 1♀. Kasaragode, CPCRI Campus, 12°31.04'N 74°57.10'E, 18m, 20.i.2008, sweeping, coconut plantation, Divakaran leg., VRN 102 (DZUC).

Variation: In some of the paratypes, WH 0.80x LH, OOL 0.98x WOT and EV 0.41x HE. See table- 17 for morphometric ratios of all the type materials examined.

Discussion: *Goniozus setosus* sp. nov. is closely related to *G. inauditus* sp. nov. in having vertex straight, scrobe weakly or strongly carinate, M, SM profusely setose, posterior ocelli contiguous with vertex margin and EV 0.35–0.39x HE. *Goniozus setosus* sp. nov. differs from *G. inauditus* sp. nov. in having eye profusely setose, ocular setae 3x as long as diameter of single facet, forefemur 1.67x as long as wide, OOL 0.82-0.94x WOT, WF 0.84-93 HE, EV 0.35-0.39x HE, gena weakly coriaceous, whereas in *G. inauditus* sp. nov. eye sparsely setose, ocular setae as long as diameter of single facet, forefemur 1.92x as long as wide, OOL 1.09-1.1x WOT, WF = HE, EV 0.47-0.55x HE and gena smooth and polished.

Table – 17. Morphometric ratios of *Goniozus setosus* sp. nov.

VRN	WH / LH	OOL / WOT	EV / HE	WF / HE	LH / LA	LS / PL	PL / LF1
147	0.775862	0.82352941	0.387097	0.90323	0.87879	2.4	1.38889
146	0.759259	0.93333333	0.387097	0.83871	0.93103	2.2	1.66667
149	0.8	0.94117647	0.375	0.90625	0.85714	2.32143	1.55556
150	0.785714	0.9375	0.387097	0.90323	0.93333	2.2	1.38889
153	0.785714	0.9375	0.387097	0.90323	0.93333	2.2	1.38889
136	0.759259	0.93333333	0.387097	0.83871	0.93103	2.2	1.66667
137	0.757576	0.88888889	0.388889	0.86111	0.86842	1.71429	1.52174
138	0.793651	0.94117647	0.40625	0.9375	0.92647	2.33333	1.5
177	0.774194	0.94117647	0.388889	0.80556	0.91176	2.2	1.08696
180	0.762712	0.97647059	0.375	0.875	0.92188	2.4	1.25
102	0.766667	0.82352941	0.375	0.875	0.9375	2.4	1.25
148	0.785714	0.9375	0.387097	0.90323	0.90323	2.4	1.25
151	0.733333	0.93333333	0.354839	0.83871	0.90909	2.4	1.25
152	0.766667	0.9375	0.387097	0.90323	0.88235	2.4	1.25
Mean Values	0.77	0.92	0.38	0.88	0.91	2.27	1.39

***Goniozus sringeriensis* sp. nov.**

(figs.113-116, 290-293)

Diagnosis: Head transverse, WH 1-1.03x LH; clypeal margin acute; mandible yellow; scape less than 2x as long as pedicel; pedicel longer than F1; EV 0.23-0.27x HE; WF 0.56x WH; OOL 0.63-0.73x WOT; eye sparsely setose; setae minute, shorter than diameter of single facet. Propodeal disc sharply inclined to lateral margin with distinct sublateral ridge; posterior transverse carina present, complete; anteromedian smooth propodeal triangle slightly beyond middle connected to posterior margin by weak median carina; posterior ocelli contiguous or separated from vertex by less than 0.5x its diameter. Forewing without areolet, but only short

stub arising from basal vein; M, SM with single row of setae; speculum with scattered setae.

Description: *Holotype* – Female.

Measurements: Length 4.1mm; LH 0.77mm; WH 0.81mm; WF 0.45mm; FWL 2.59mm; LM 1.43mm; LP 0.57mm; WPD 0.66mm; LPD 0.37mm.

Colour: Body brownish black; mandible light yellow, teeth brown; antenna uniformly light yellow; leg dark brown except yellow trochanter, tibia, and tarsi. Wing hyaline; costa, subcosta, and prostigma light brown, other veins straw coloured.

Head: Head (figs.115, 290) wider than long in full face view; HW 1.03x LH; weakly compressed in lateral aspect, 1.6x as long as wide (figs.114, 292); frons and vertex coriaceous with scattered shallow punctures; gena smooth and polished; vestiture long, sparse, decumbent; vertex margin with long setae, longest being 0.19mm; anterior clypeal margin strongly produced, acute, clypeal carina 0.6x HE, strongly arcuate in profile, extending onto frons upto level of posterior scrobal margin; scrobe ecarinate; moderately stout with 4 short, blunt teeth, ventral most straight; WF 0.58x LH; WF 0.95x HE; EV 0.27x HE; LH 1.76x HE; malar space distinct; malar groove absent; eye sparsely setose; setae minute, shorter than diameter of single facet; ocelli in obtuse triangle; posterior ocelli separated from vertex margin by less than half its diameter; OOL 0.73x WOT; POL: AOL: DAO = 4.5:2.5:2.5; vertex margin slightly emarginate in full face view, carinate, acutely angled to occiput. Relative lengths of first five antennal segments (fig.291) 8.5:4:3.5:4.5:4.5; scape 1.6x as long as wide, longer than 2x pedicel; pedicel longer than F1; F2-F10 as long as wide, F11 longer than wide; antenna slightly longer than head in full face view (35:30).

Mesosoma: Pronotum (fig.116) strongly coriaceous with scattered shallow punctures; mesoscutum weakly coriaceous; scutellum anteromedially weakly coriaceous, posterolaterally smooth and polished; vestiture long, sparse, suberect; pronotal disc (fig.290) 0.35x as long as wide; mesonotum with parapsidal furrow only in posterior half; notauli absent; scutellum with a pair of basal slits connected

by narrow groove; propodeal disc 0.55x as long as wide, sharply inclined to lateral margin; disc with distinct sublateral ridges; basal median triangular area smooth and elevated, reaching posterior margin by weak median carina, rest of disc and declivity coriaceous; posterior transverse carina complete. Forewing (fig.290) 2.64x as long as wide, without areolet; M, SM with single row of setae; speculum with scattered setae; m: rs: rs+m = 5:3:4. Forefemur (fig.293) 1.86x as long as wide; SI 4.

Metasoma: Metasoma (fig.113) distinctly longer than mesosoma (63:48), shorter than head plus mesosoma (63:74); Tergites smooth and polished; T1-T3 with few setae restricted to lateral margin; other tergites sparsely setose all across dorsal side.

Male: Unknown.

Biology: Ex. unknown larvae on *Hibiscus* spp.

Etymology: The species epithet is after the type locality, Sringeri.

Distribution: India – Karnataka.

Material Examined: *Holotype* – Female. INDIA: Karnataka, Sringeri, 13°22.24'N 75°15.07'E, 668m, 27.ix.2003, grassland, rearing, P. A. Sinu leg., VRN 48. (DZUC).

Paratype. 3♀. same data as holotype, VRN 46, VRN 47, VRN 49 (DZUC).

Variation. In one of the paratypes (VRN 46), OOL 0.63x WOT and EV 0.23x HE. See table- 18 for morphometric ratios of all the type materials examined.

Discussion: *Goniozus sringeriensis* sp. nov. is closely related to *G. pakmanus* Gordh and *G. delhiensis* Ram in having scape longer than 2x pedicel, EV 0.23x – 0.42x HE and WF 0.49x - 0.57x WH, whereas *G. pakmanus* and *G. delhiensis* differ from *G. sringeriensis* sp. nov. in having the brown-black mandible, OOL 1.12x – 1.25x WOT, obtuse clypeal margin and propodeal disc smoothly inclined to lateral margin devoid of sublateral ridge, whereas in *G. sringeriensis* sp. nov. mandible is yellow, OOL 0.63-0.73x WOT, clypeal carina acute, pedicel longer than F1 and propodeal disc sharply inclined to lateral margin with weak sublateral ridge.

Table – 18. Morphometric ratios of *Goniozus sringeriensis* sp. nov.

VRN	WH / LH	OOL / WOT	EV / HE	WF / HE	LH / LA	LS / PL	PL / LF1
48	1.027778	0.733333	0.272727	0.954545	0.81818	2.22222	1.25
47	1	0.733333	0.272727	0.954545	0.83333	2.22222	1.25
49	1.012987	0.715447	0.272727	0.977273	0.85555	2.22222	1.25
46	1	0.631068	0.235294	0.970588	0.77582	2.22222	1.25
Mean Values	1.01	0.70	0.26	0.96	0.82	2.22	1.25

***Goniozus stomopterycis* Ram and SubbaRao**

(figs.117-118)

Type species. *Goniozus stomopterycis* Ram and Subba Rao, 1967. *Bull. Ent.*, 8(2): 73-78, figs. 1-6. Holotype. ♀ - Examined (INPC).

Diagnosis: Head as long as wide, compressed in lateral aspect, 1.78x as long as wide; antenna longer than head in full face view; pedicel longer than F1; scape shorter than 2x pedicel; F2 and F3 wider than long, F4-F10 as long as wide; eye sparsely setose, setae minute, shorter than diameter of single facet; OOL 0.94x WOT; EV 0.4-0.43x HE. Posterior transverse propodeal carina narrowly interrupted medially; metasoma shorter than mesosoma. Forewing without areolet, but only short stub arising from basal vein. Forefemur 1.81x as long as wide.

Redescription: *Holotype – Female.*

Measurements: Length 2.46mm; LH 0.53mm; WH 0.53mm; WF 0.31mm; FWL 1.83mm; LM 0.89mm; LP 0.39mm; WPD 0.51mm; LPD 0.29mm.

Colour: Body dark brown, base of metasoma lighter; mandible brown, teeth darker; antenna uniformly pale yellow; leg brown except yellow tarsi and tibia. Wing hyaline, costa, subcosta, prostigma and stigma light brown, other veins colourless.

Head: Head (fig.118) as long as wide, WH = LH, compressed in lateral aspect, 1.78x as long as wide; frons and vertex dull coriaceous with scattered shallow

punctures; gena smooth and polished; vestiture short, sparse, decumbent, vertex margin without distinctly long setae; anterior clypeal margin strongly produced, bluntly angulated, obtuse; clypeal carina 0.57x HE, extending onto frons upto level of posterior scrobal margin; scrobe ecarinate; mandible stout with 4 long blunt teeth, ventral most straight; WF 0.55x LH; WF 0.96x HE; EV 0.43x HE; LH 0.94x HE; eye sparsely setose, setae minute, shorter than diameter of single facet; ocelli in obtuse triangle; posterior ocelli contiguous with vertex margin; OOL 0.94x WOT; POL: AOL: DAO = 5:3:2; vertex straight in full face view, ecarinate. Relative lengths of first five antennal segments 4.5:2.5:2:2:2.5; scape 1.6x as long as wide, shorter than 2x pedicel length; pedicel longer than F1; F2 and F3 wider than long, F4-F10 as long as wide; terminal segment longer than wide; antenna longer than head in full face view (64: 55).

Mesosoma: Pronotum coriaceous with scattered shallow punctures; sculpture of mesonotum and scutellum same as that of head and pronotum, vestiture sparse, short, suberect; pronotal disc 0.36x as long as wide; mesonotum with parapsidal furrow, anteriorly weak; notauli absent; scutellum with a pair of basal slits; propodeal disc 0.53x as long as wide, smoothly inclined to lateral margin; basal median propodeal triangle smooth, shining, and elevated, extends slightly beyond middle reaching posterior margin by weak carina, rest of propodeal disc and declivity coriaceous; posterior transverse carina narrowly interrupted medially. Forewing 2.78x as long as wide, without areolet, only a short stub arising from basal vein; M, SM with single row of setae; speculum sparsely setose; m:rs:rs+m = 5:4.5:4.5. Forefemur 1.81x as long as wide; SI 4.61.

Metasoma: Metasoma (fig.117) distinctly shorter than mesosoma (20:25), distinctly shorter than head plus mesosoma (20:40); tergites smooth and polished; T1-T3 with few setae restricted to lateral margin; other tergites sparsely setose all across dorsal side.

Male: Smaller in size (1.72mm); same as female except for sexual characters, metasoma shorter than mesosoma; head compressed in lateral aspect 1.54x as long as wide; WOT 1.64x OOL; EV 0.4x HE; forefemur 2.09 as long as wide.

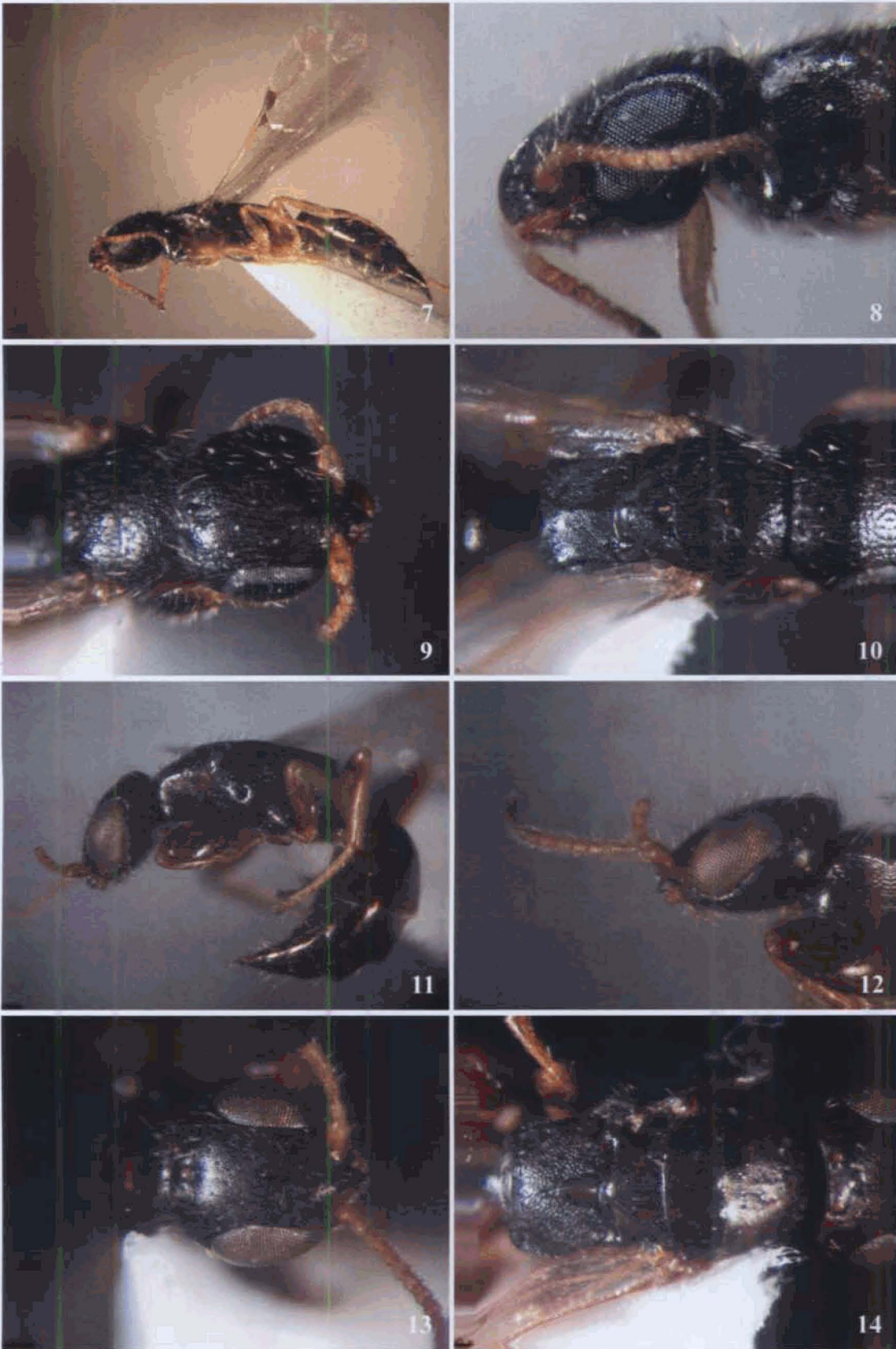
Ecology and Biology: ex. larvae of *Stomopteryx nerteria* (Meyrick) (Lepidoptera: Gelechiidae).

Distribution: India – Andhra Pradesh – Anantapur.

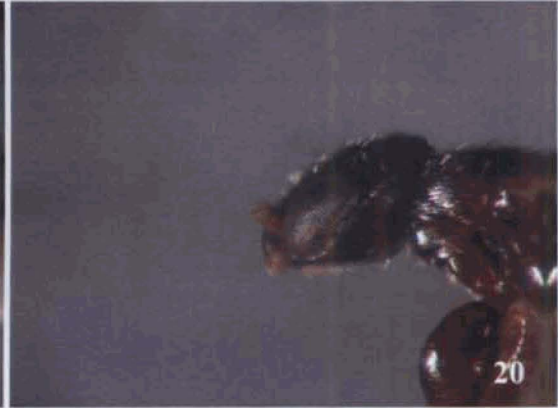
Material Examined: *Holotype* – Female. INDIA: Andhra Pradesh, Anantapur, 14°41.46'N 77°36.03'E, 331m, 20.ix.1964, rearing, G.G. Kundu leg. (INPC). Type collection – VRN 13/11. *Paratypes:* 1♀, 1♂; same data of holotype. (INPC)

Discussion: *Goniozus stomopterycis* Ram and SubbaRao is similar to *G. marasmi* Kurian in having forefemur less than 2x as long as wide, pedicel equal to or more than F1, EV 0.40 - 0.43x HE and metasoma shorter than or as long as mesosoma. *Goniozus stomopterycis* is having pedicel longer than F1, scape shorter than 2x pedicel, metasoma shorter than mesosoma, forefemur 1.81x as long as wide and eye sparsely setose, but *G. marasmi* has pedicel as long as F1, scape as long as 2x pedicel, metasoma as long as mesosoma, forefemur 1.91x as long as wide and eye asetose.

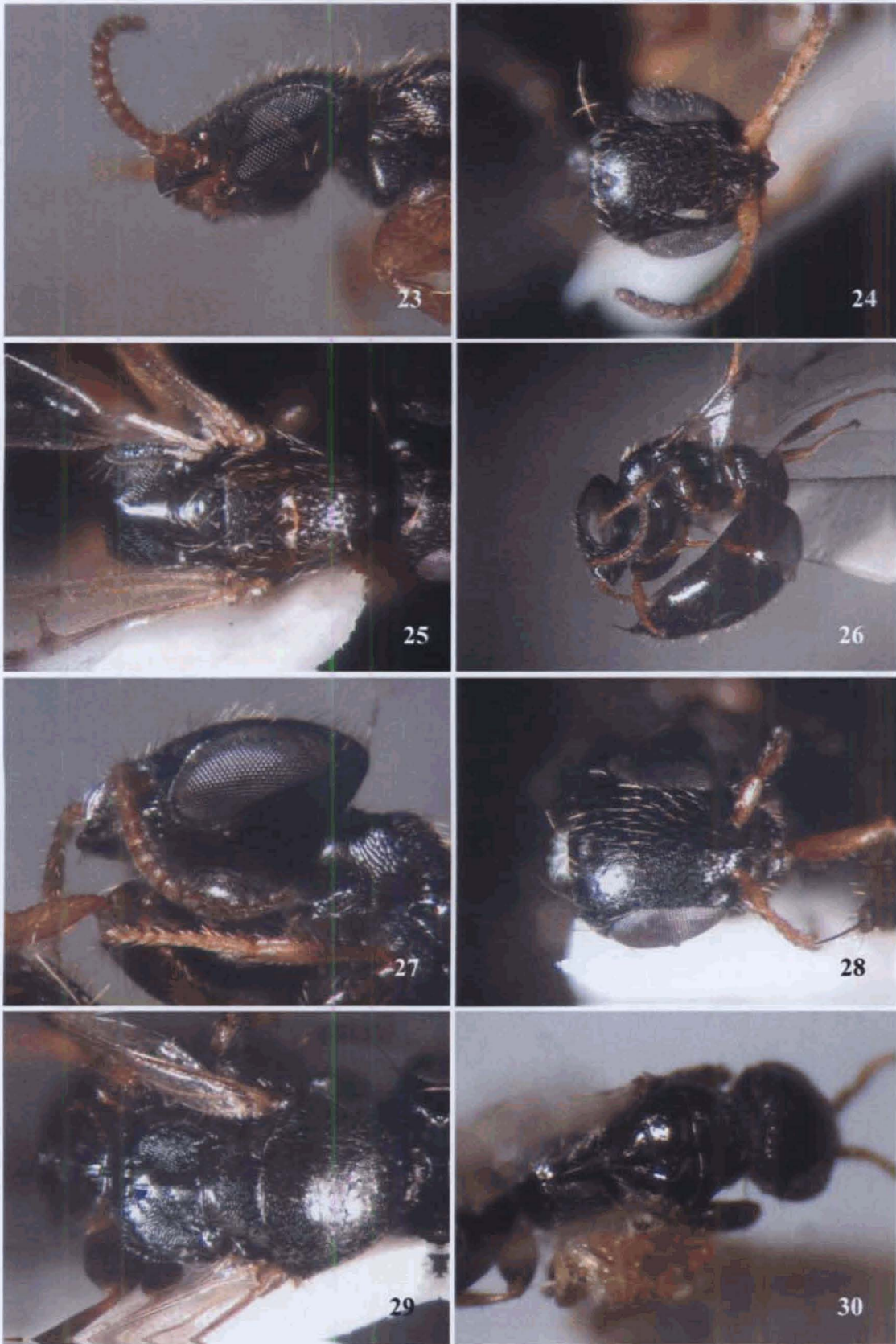
Remarks: Right forewing, right hind and mid legs of the holotype is missing. Both holotype and one paratype are brown in colour with mesoscutum slightly collapsed. Both of them appear to be teneral specimens. The other paratype is dark brown to black and mesoscutum is not collapsed. Thus, shallow lateral depression on mesoscutum mentioned in original description which is based on the teneral specimen is not of any taxonomic value.



Goniozus alarius sp. nov. Female, 7. body profile; 8. head, side view; 9. head, full face view; 10. mesosoma, dorsal view. *Goniozus antennalis* sp. nov. Female, 11. body profile; 12. head, side view; 13. head, full face view; 14. mesosoma, dorsal view.



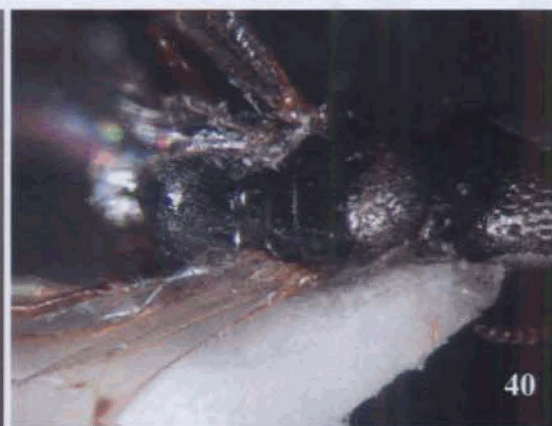
Goniozus aproaeremae sp. nov. Female, 15. body profile; 16. head, side view; 17. head, full face view; 18. mesosoma, dorsal view. *Goniozus buddhai* sp. nov. Female, 19. body profile; 20. head, side view; 21. head, full face view. *Goniozus clypeatus* sp. nov. Female, 22. body profile.



Goniozus clypeatus sp. nov. Female, 23. head, side view; 24. head, full face view; 25. mesosoma, dorsal view. *Goniozus cotha* sp. nov. Female, 26. body profile; 27. head, side view; 28. head, full face view; 29. mesosoma, dorsal view. *Goniozus delhiensis* Ram, Holotype. Female, 30. mesosoma, dorsal view



Goniozus inauditus sp. nov. Female, 31. body profile; 32. head, side view; 33. head, full face view; 34. mesosoma, dorsal view. *Goniozus indicus* Ashmead, Female, 35. body profile; 36. head, full face view. *Goniozus jeroeni* sp. nov. Female, 37. body profile; 38. head, side view.



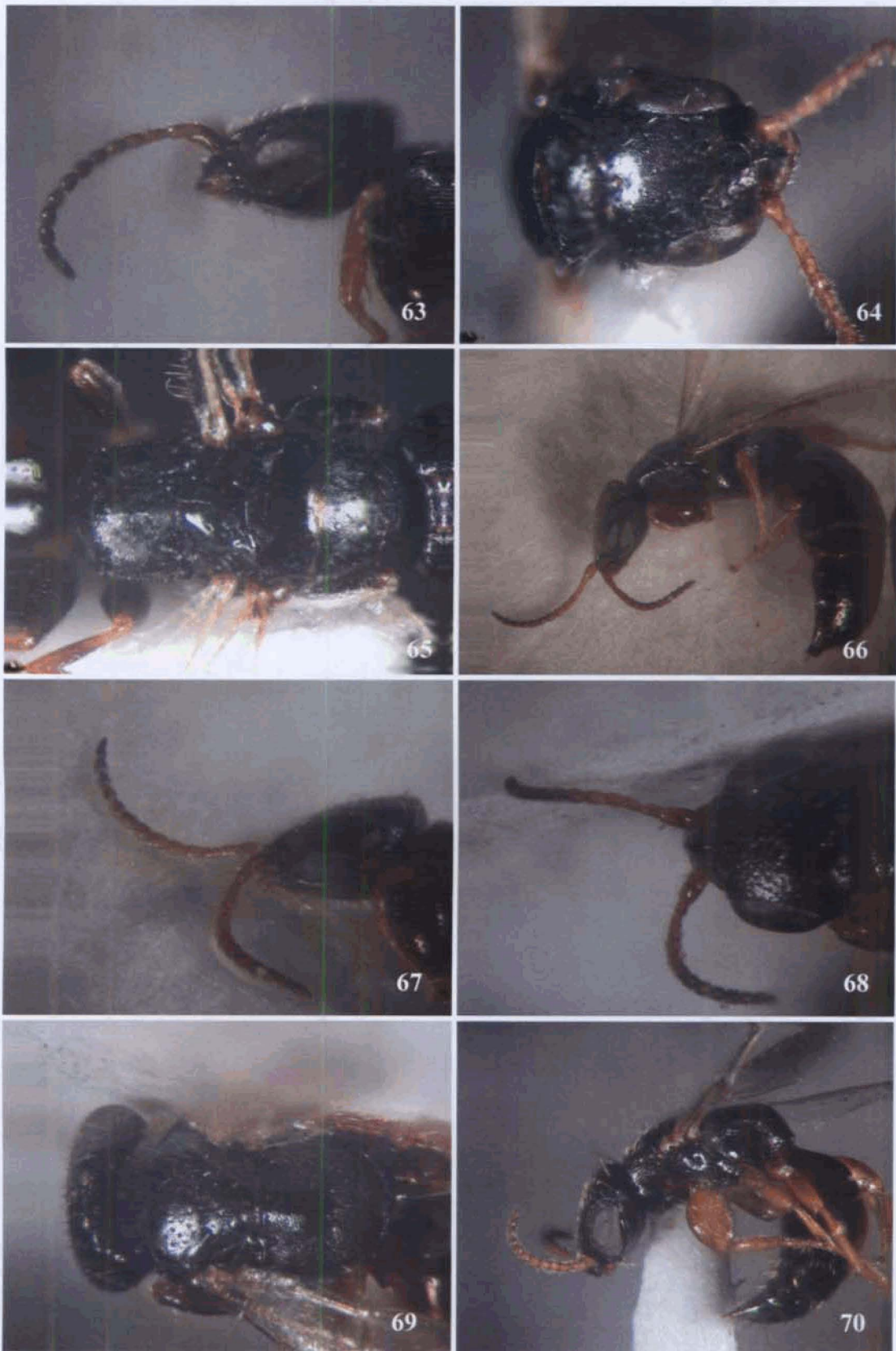
Goniozus jeroeni sp. nov. Female, 39. head, full face view; 40. mesosoma, dorsal view. *Goniozus kainophanestus* sp. nov. Female, 41. body profile; 42. head, side view; 43. head, full face view; 44. mesosoma, dorsal view. *Goniozus kottiyooricus* sp. nov. Female, 45. body profile; 46. head, side view.



Goniozus kottiyooricus sp. nov. Female, 47. head, full face view; 48. mesosoma, dorsal view. *Goniozus kuriani* sp. nov. Female, 49. body profile; 50. head, side view; 51. head, full face view; 52. mesosoma, dorsal view; 53. leaf galls of *Syzygium cumini* L. *Goniozus longigastralis* sp. nov. Female, 54. body profile



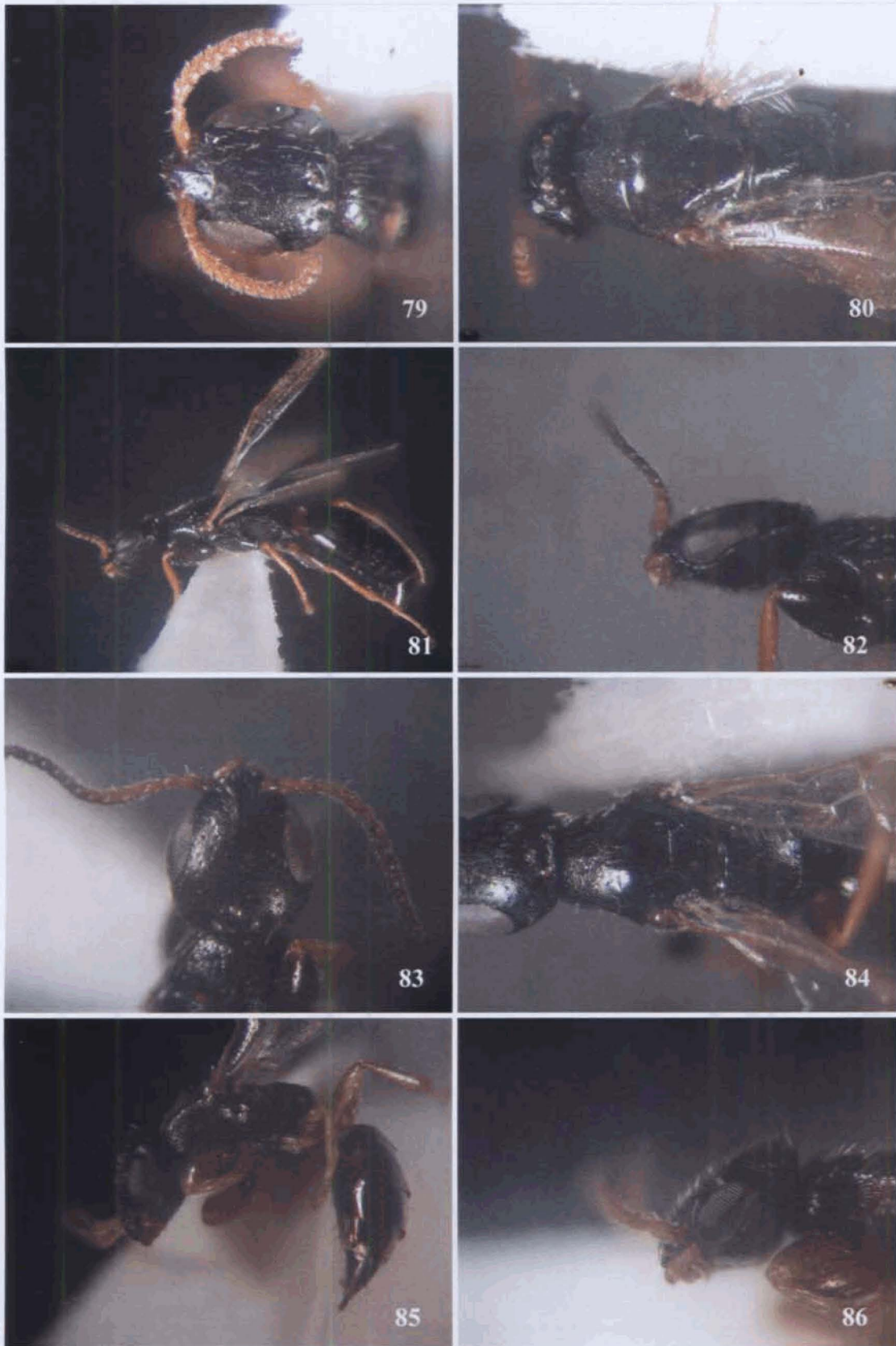
Goniozus longigastralis sp. nov. Female, 55. head, side view; 56. head, full face view; 57. mesosoma, dorsal view. *Goniozus malabaricus* sp. nov. Female, 58. body profile; 59. head: side view; 60. head, full face view; 61. mesosoma, dorsal view. *Goniozus mandibularis* sp. nov. Female, 62. body profile.



Goniozus mandibularis sp. nov. Female, 63. head, side view; 64. head, full face view; 65. mesosoma, dorsal view. *Goniozus mustus* sp. nov. Female, 66. body profile; 67. head, side view; 68. head, full face view; 69. mesosoma, dorsal view. *Goniozus neoteropus* sp. nov. Female, 70. body profile.



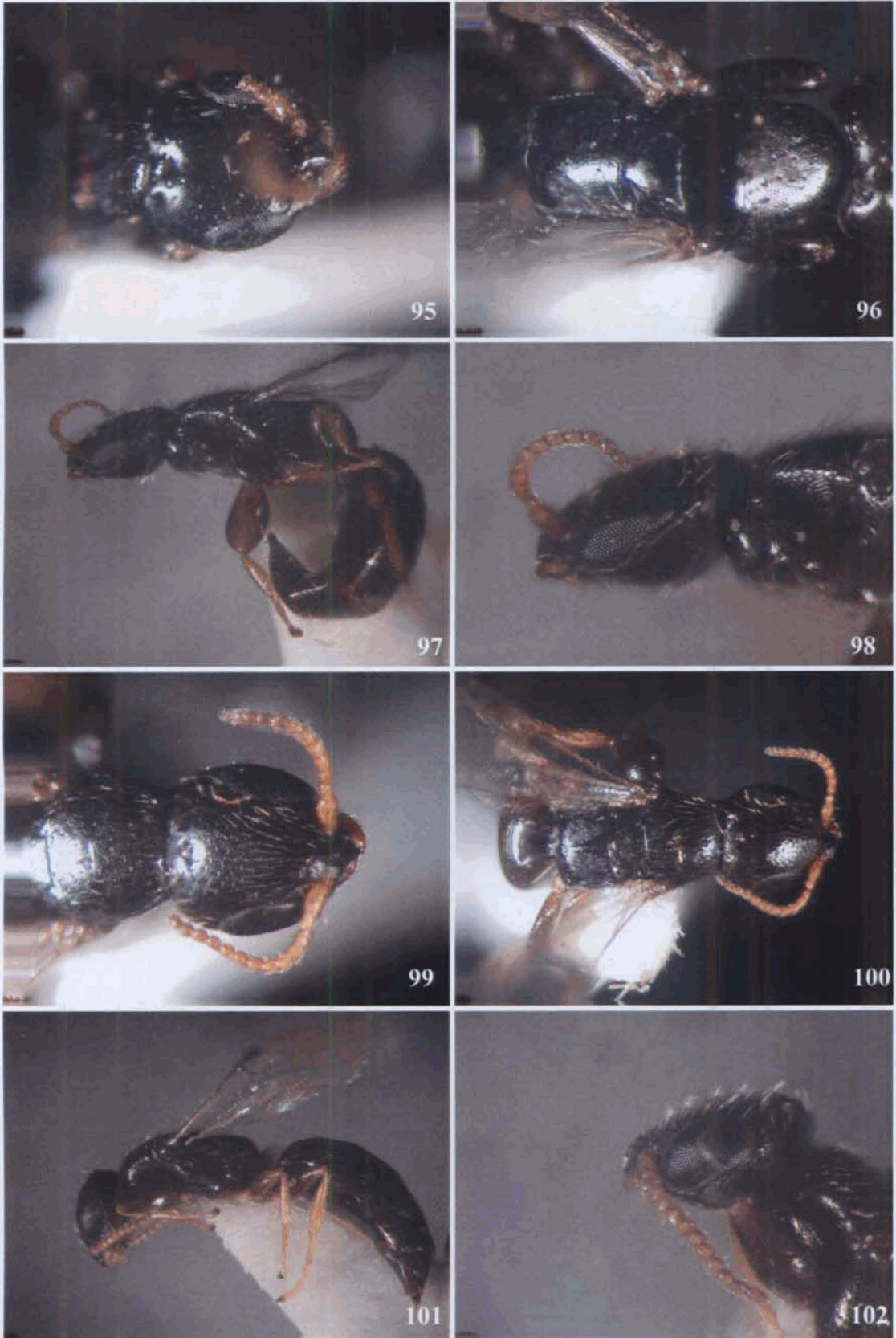
Goniozus neoterusus sp. nov. Female, 71. head, side view; 72. head, full face view; 73. mesosoma, dorsal view. *Goniozus nephantidis* (Muesebeck), Female, 74. body profile; 75. head, side view; 76. head, full face view; 77. mesosoma, dorsal view. *Goniozus novellus* sp. nov. Female, 78. body profile.



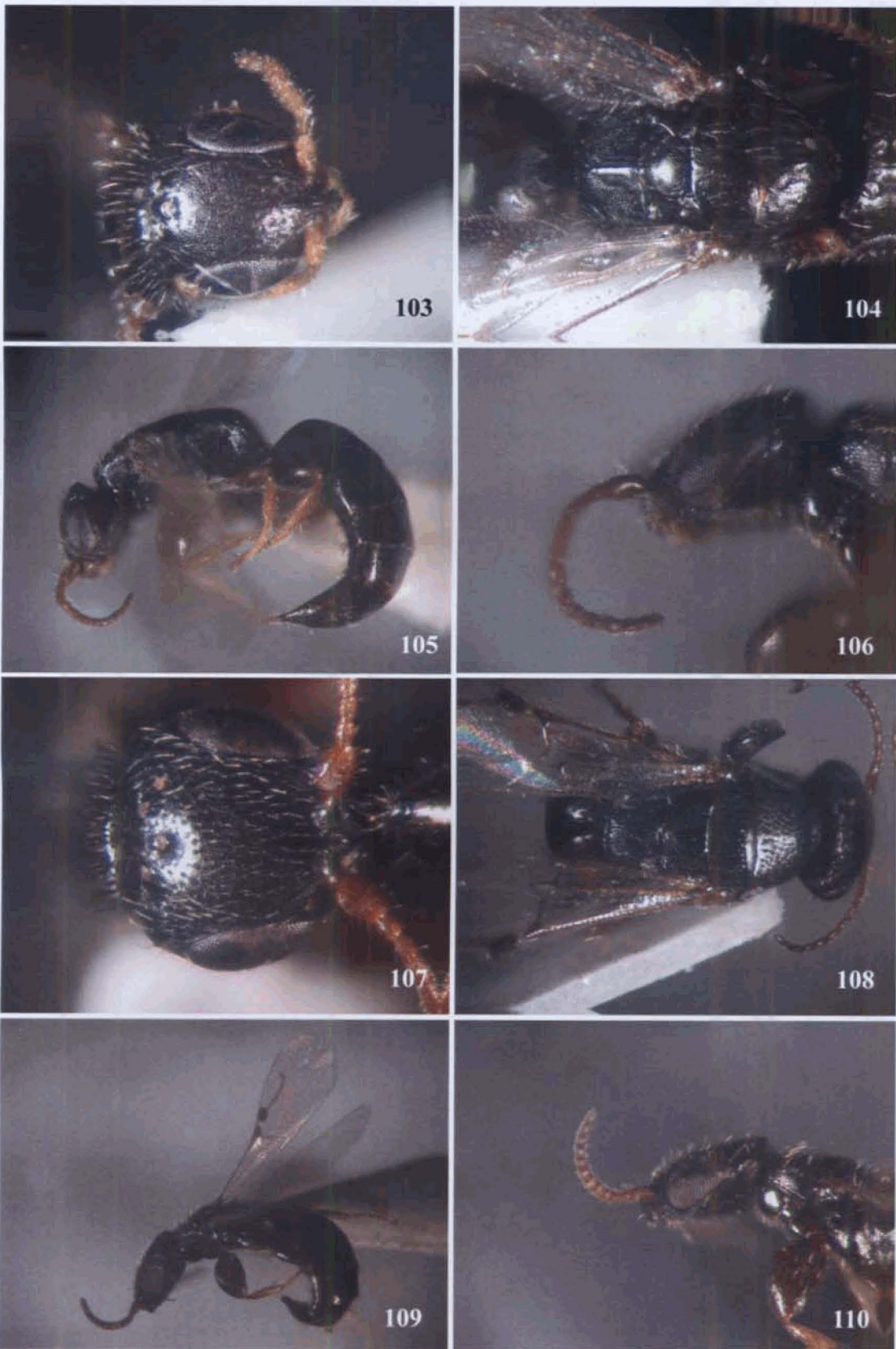
Goniozus novellus sp. nov. Female, 79. head, full face view; 80. mesosoma, dorsal view. *Goniozus nuperus* sp. nov. Female, 81. body profile; 82. head, side view; 83. head, full face view; 84. mesosoma, dorsal view. *Goniozus orthagae* sp. nov. Female, 85. body profile; 86. head, side view.



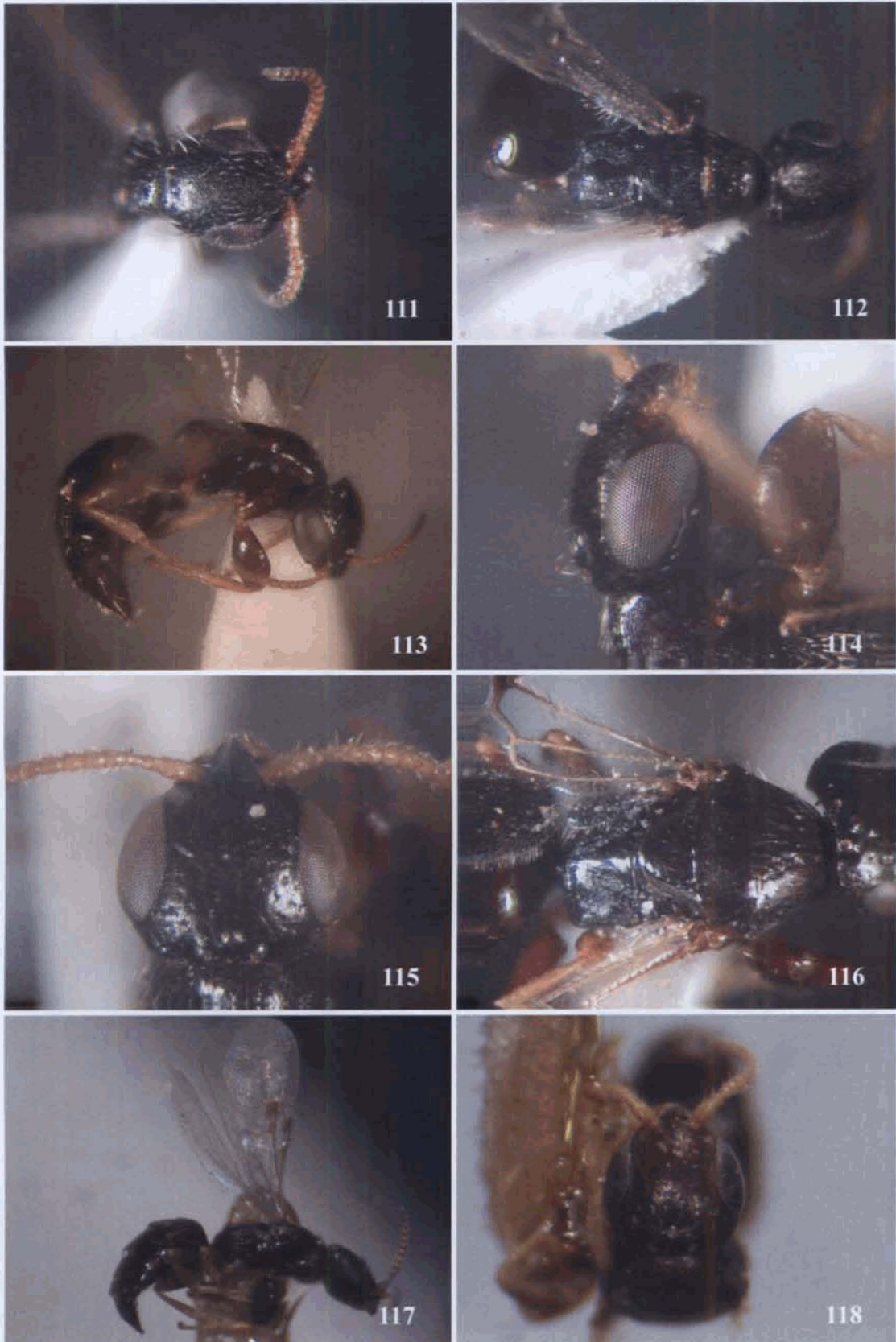
Goniozus orthagae sp. nov. Female, 87. head, full face view; 88. mesosoma, dorsal view. *Goniozus palghatensis* sp. nov. Female, 89. body profile; 90. head, side view; 91. head, full face view; 92. meso soma, dorsal view. *Goniozus platycephalus* sp. nov. Female, 93. body profile; 94. head, side view.



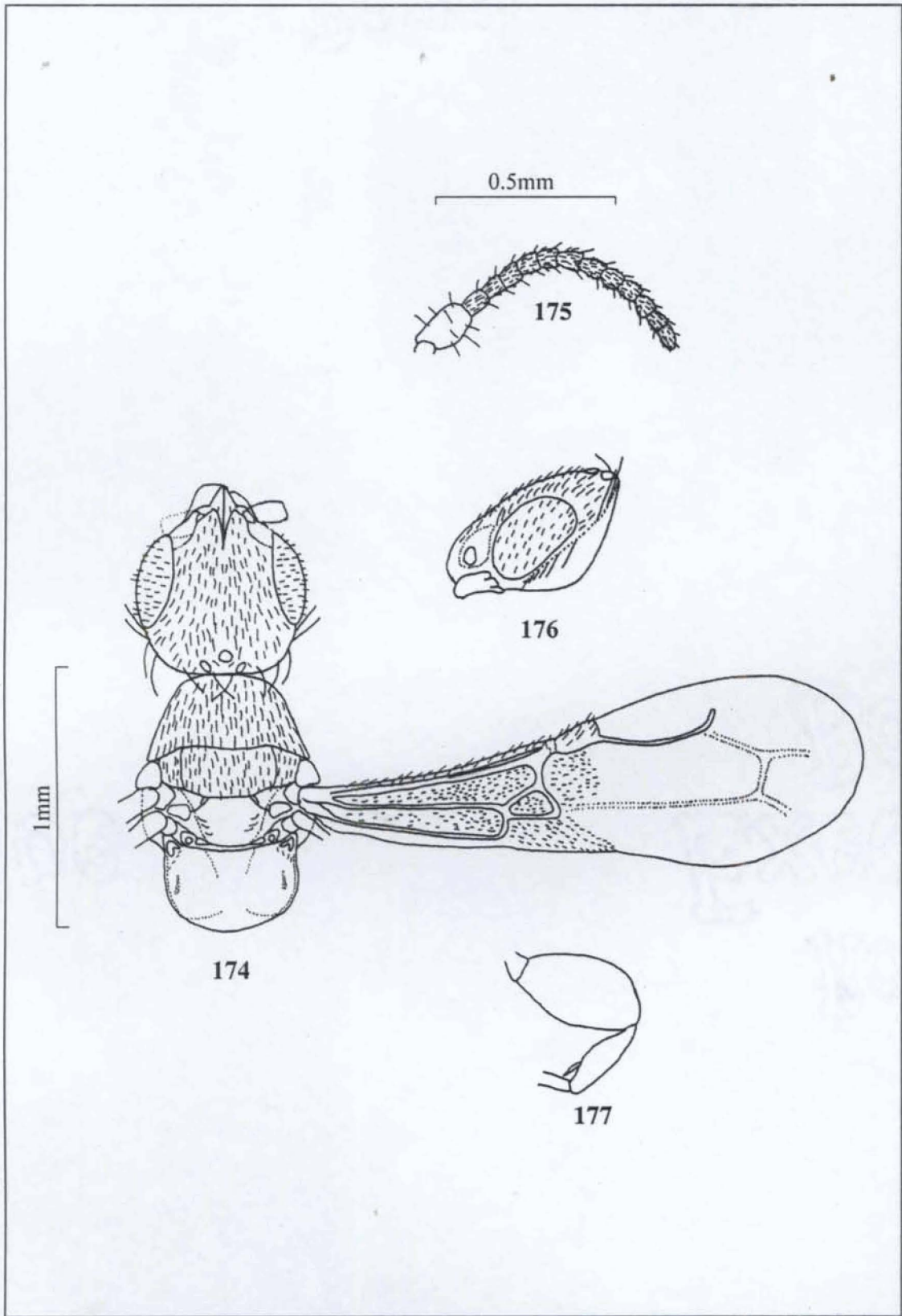
Goniozus platycephalus sp. nov. Female, 95. head, full face view; 96. mesosoma, dorsal view. *Goniozus propodeatus* sp. nov. Female, 97. body profile; 98. head, side view; 99. head, full face view; 100. mesosoma, dorsal view. *Goniozus prosphatosis* sp. nov. Female, 101. body profile; 102. head, side view.



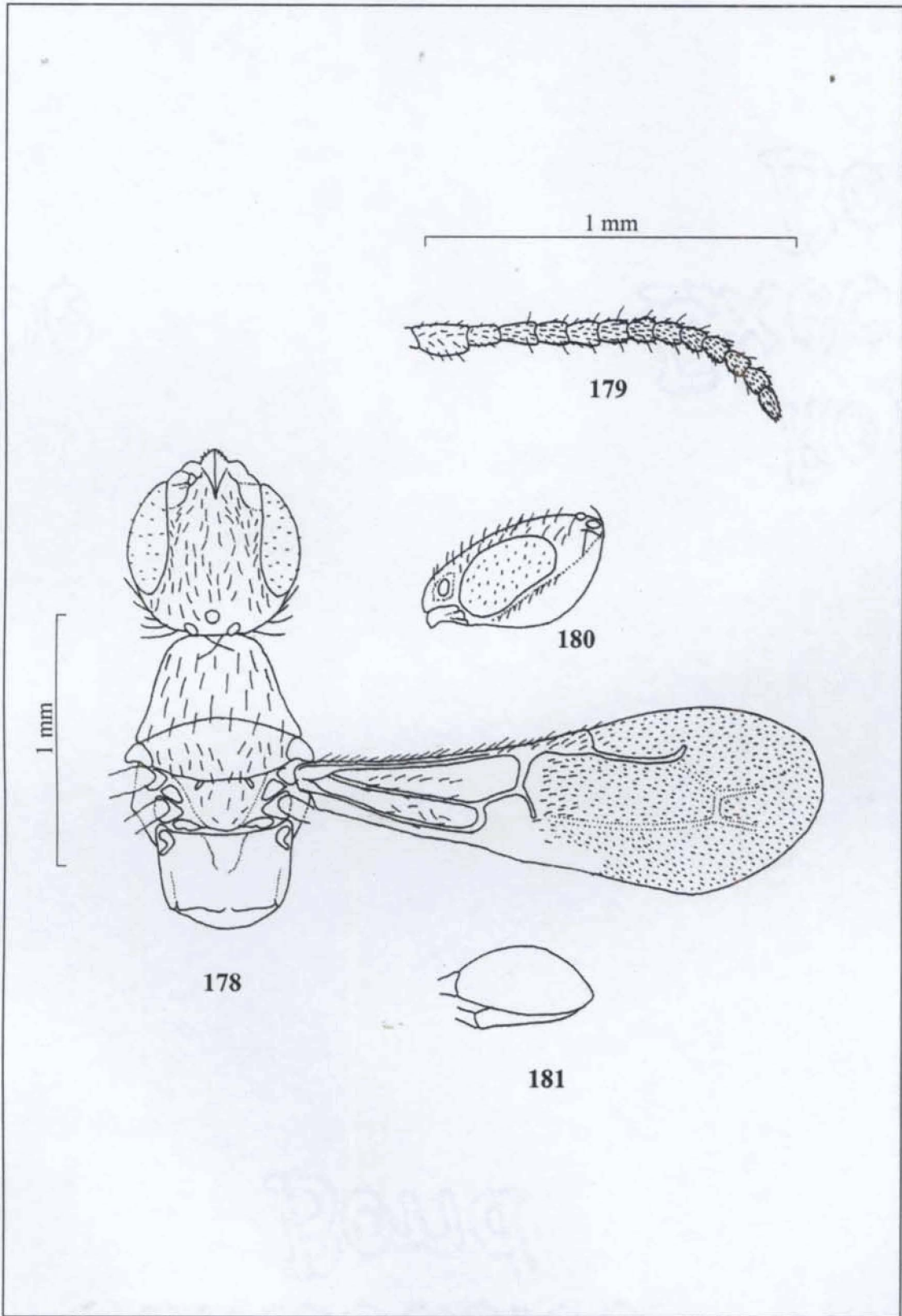
Goniozus prosphtosis sp. nov. Female, 103. head, full face view; 104. mesosoma, dorsal view. *Goniozus recentis* sp. nov. Female, 105. body profile; 106. head, side view; 107. head, full face view; 108. mesosoma, dorsal view. *Goniozus setosus* sp. nov. Female, 109. body profile; 110. head, side view.



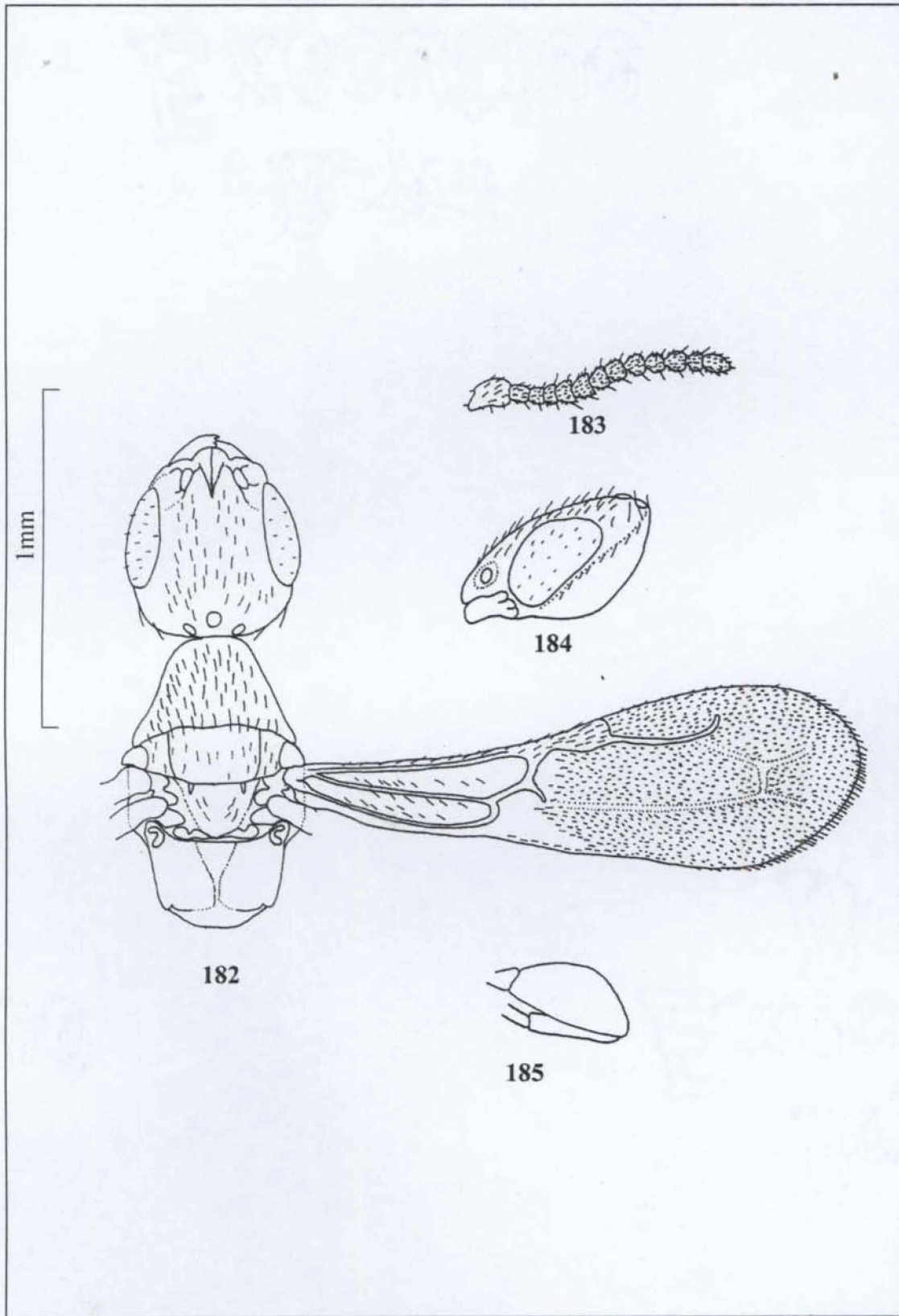
Goniozus setosus sp. nov. Female, 111. head, full face view; 112. mesosoma, dorsal view. *Goniozus sringeriensis* sp. nov. Female, 113. body profile; 114. head, side view; 115. head, full face view; 116. mesosoma, dorsal view. *Goniozus stomopterycis* Ram and SubbaRao, Paratype. Female, 117. body profile; Holotype. Female, 118. head, full face view.



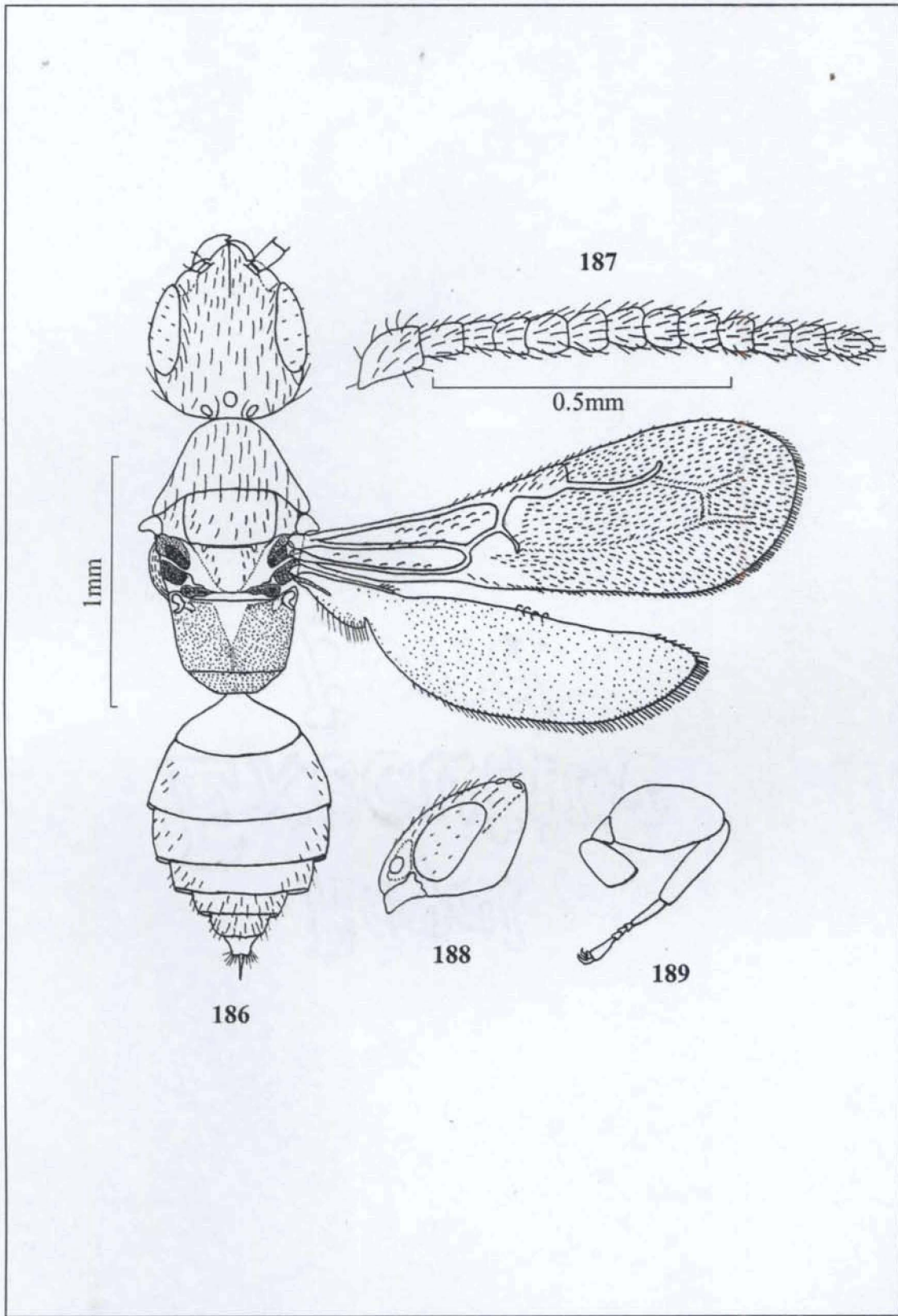
Figs. 174 - 177. *Goniozus alarius* sp. nov. Female, 174. body, dorsal view; 175. antenna; 176. head, side view; 177. foretibia.



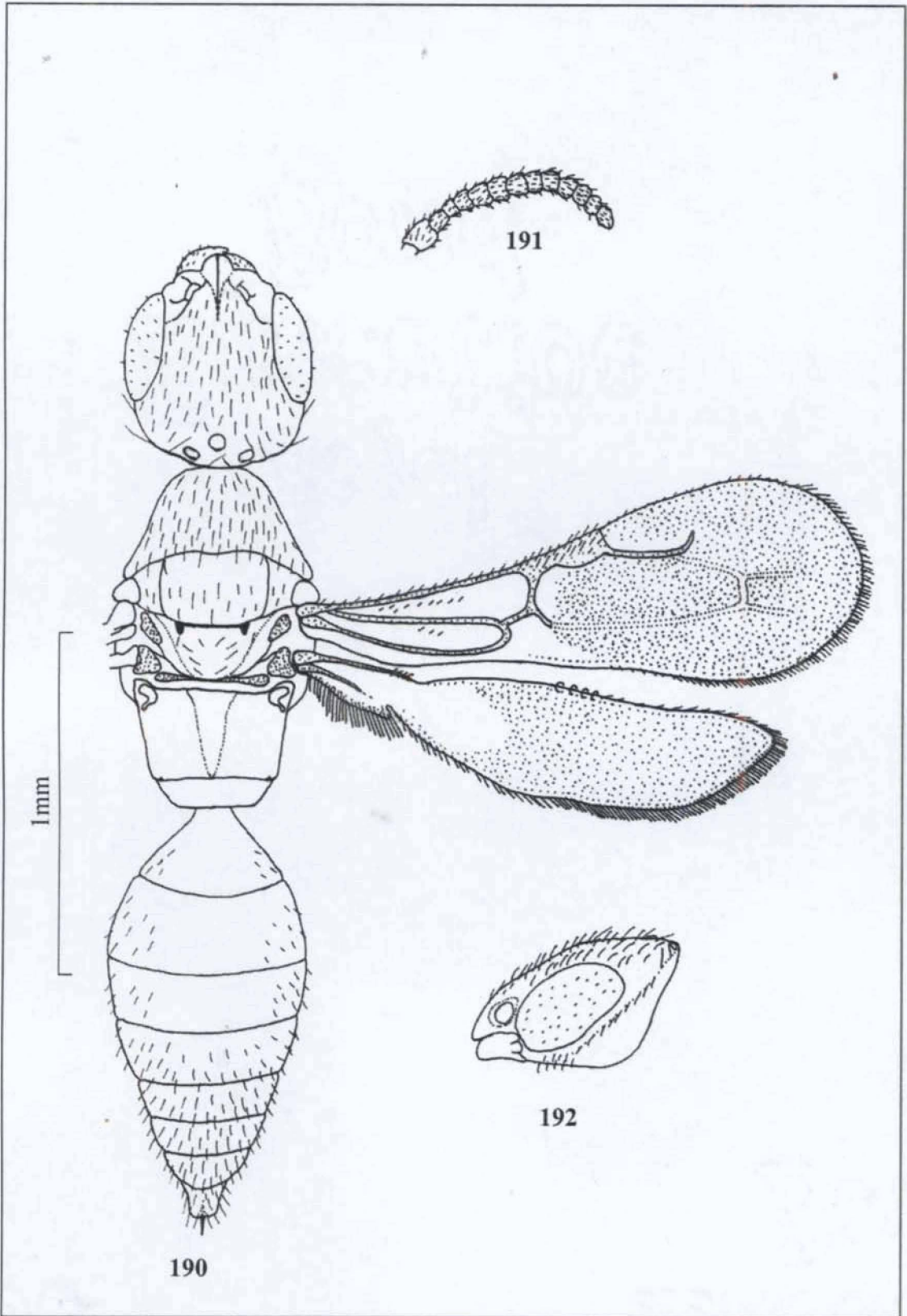
Figs. 178 - 181. *Goniozus antennalis* sp. nov. Female, 178. body, dorsal view; 179. antenna; 180. head, side view; 181. foretibia.



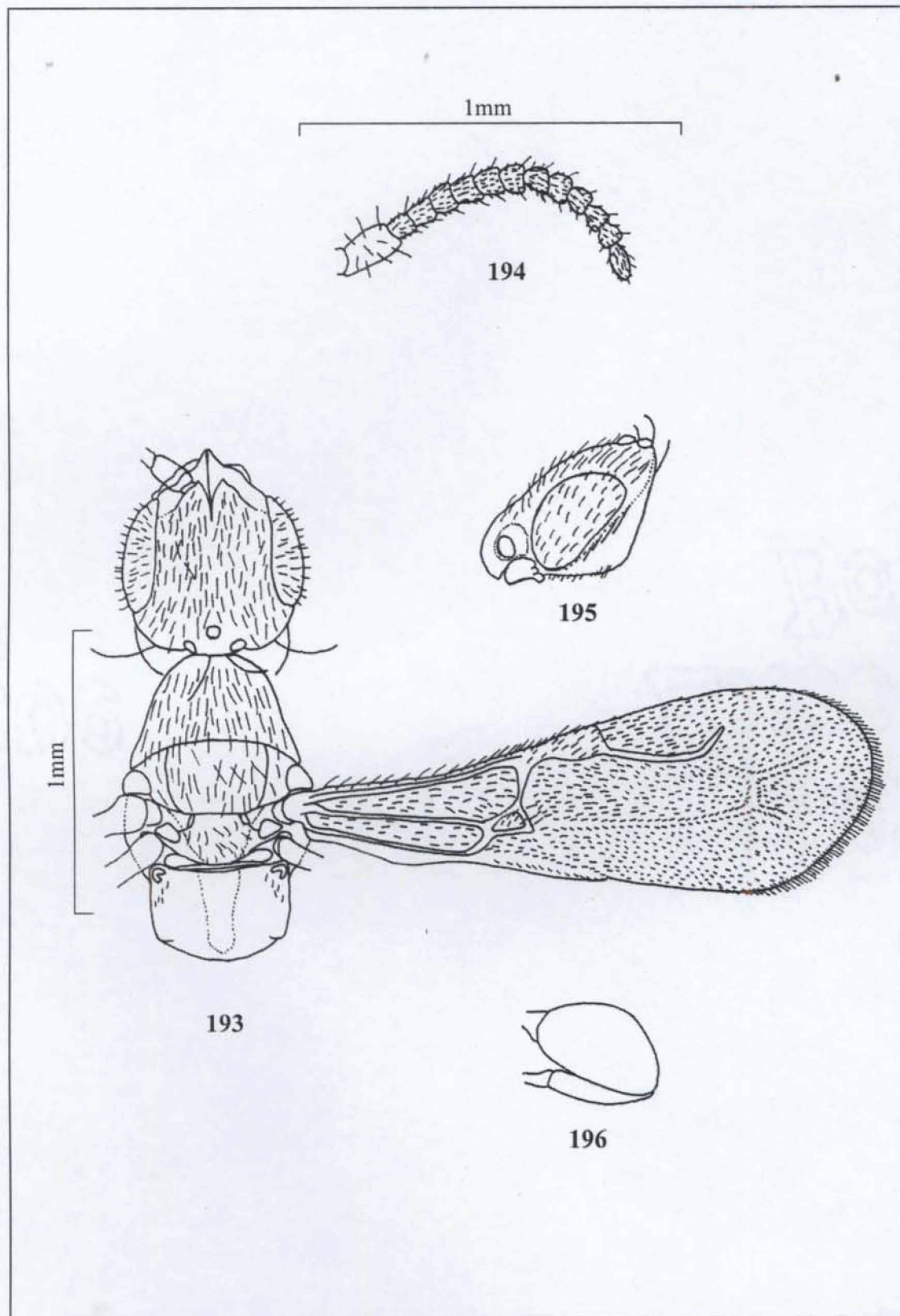
Figs. 182 - 185. *Goniozus aproaeremae* sp. nov. Female, 182. body, dorsal view; 183. antenna; 184. head, side view; 185. foretibia.



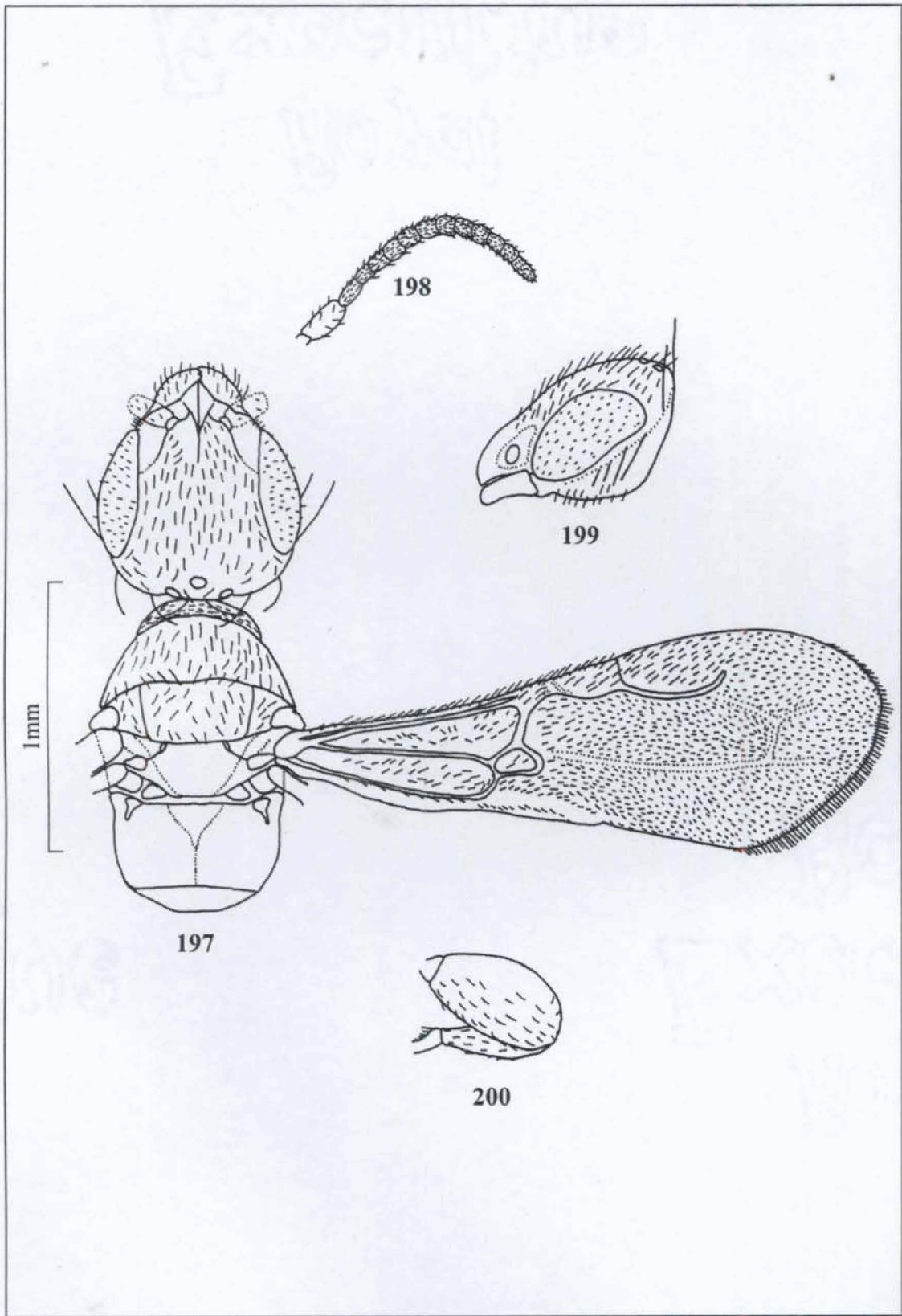
Figs. 186 - 189. *Goniozus armigeræ* Santhosh and Narendran. Female, 186. body, dorsal view; 187. antenna; 188. head, side view; 189. foreleg.



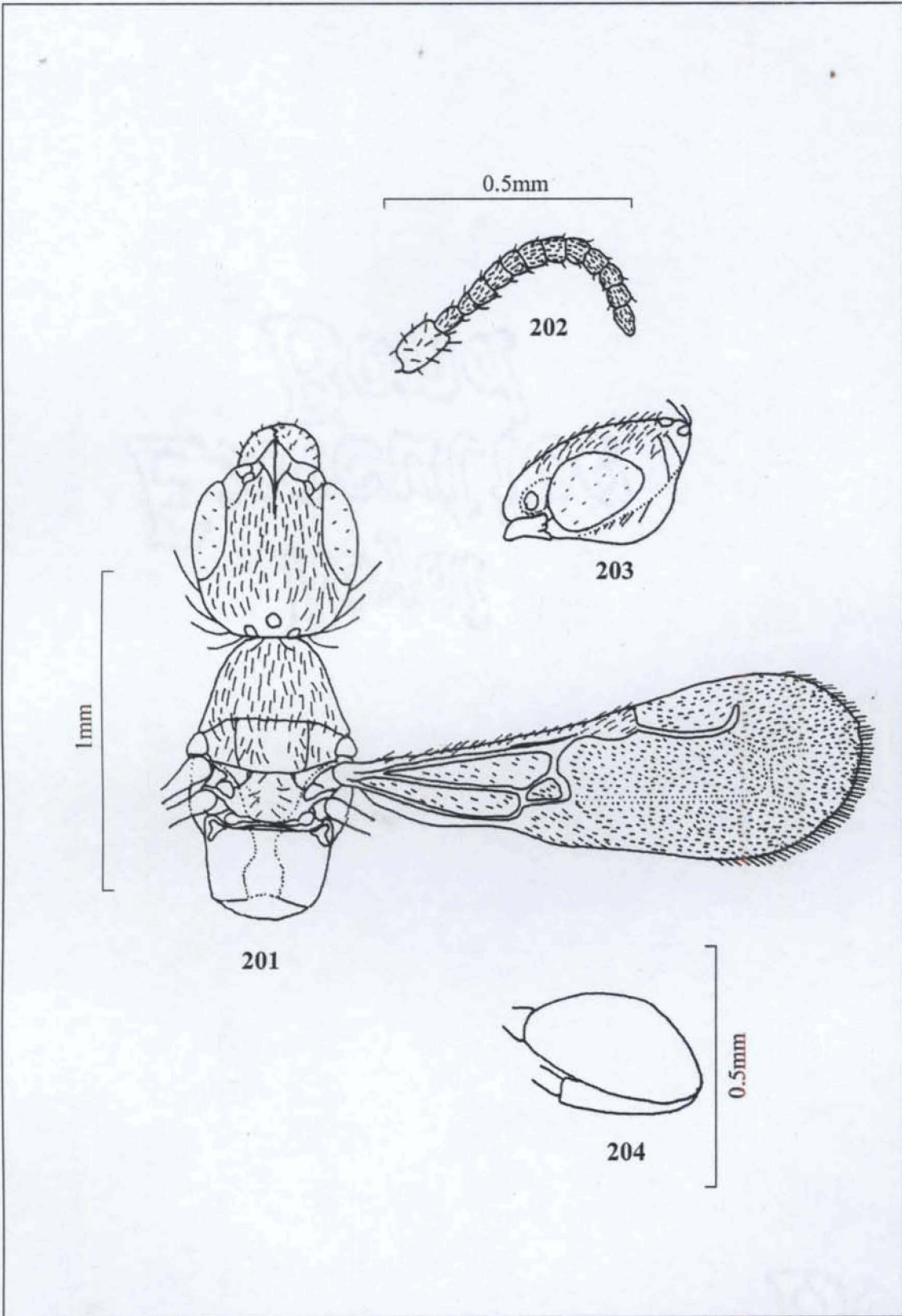
Figs. 190 - 192. *Goniozus buddhai* sp. nov. Female, 190. body, dorsal view; 191. antenna; 192. head, side view.



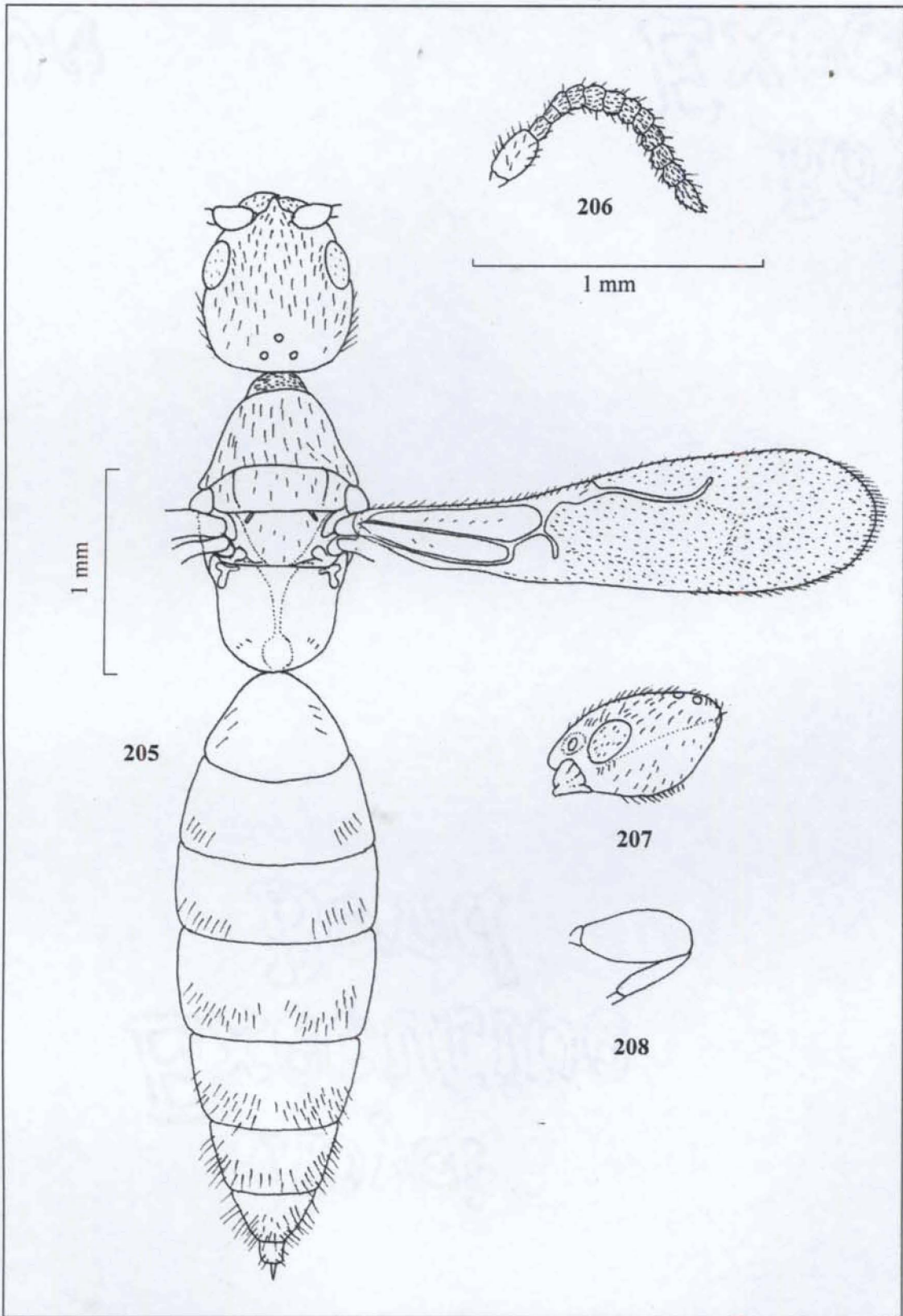
Figs. 193 - 196. *Goniozus clypeatus* sp. nov. Female, 193. body, dorsal view; 194. antenna; 195. head, side view; 196. foretibia.



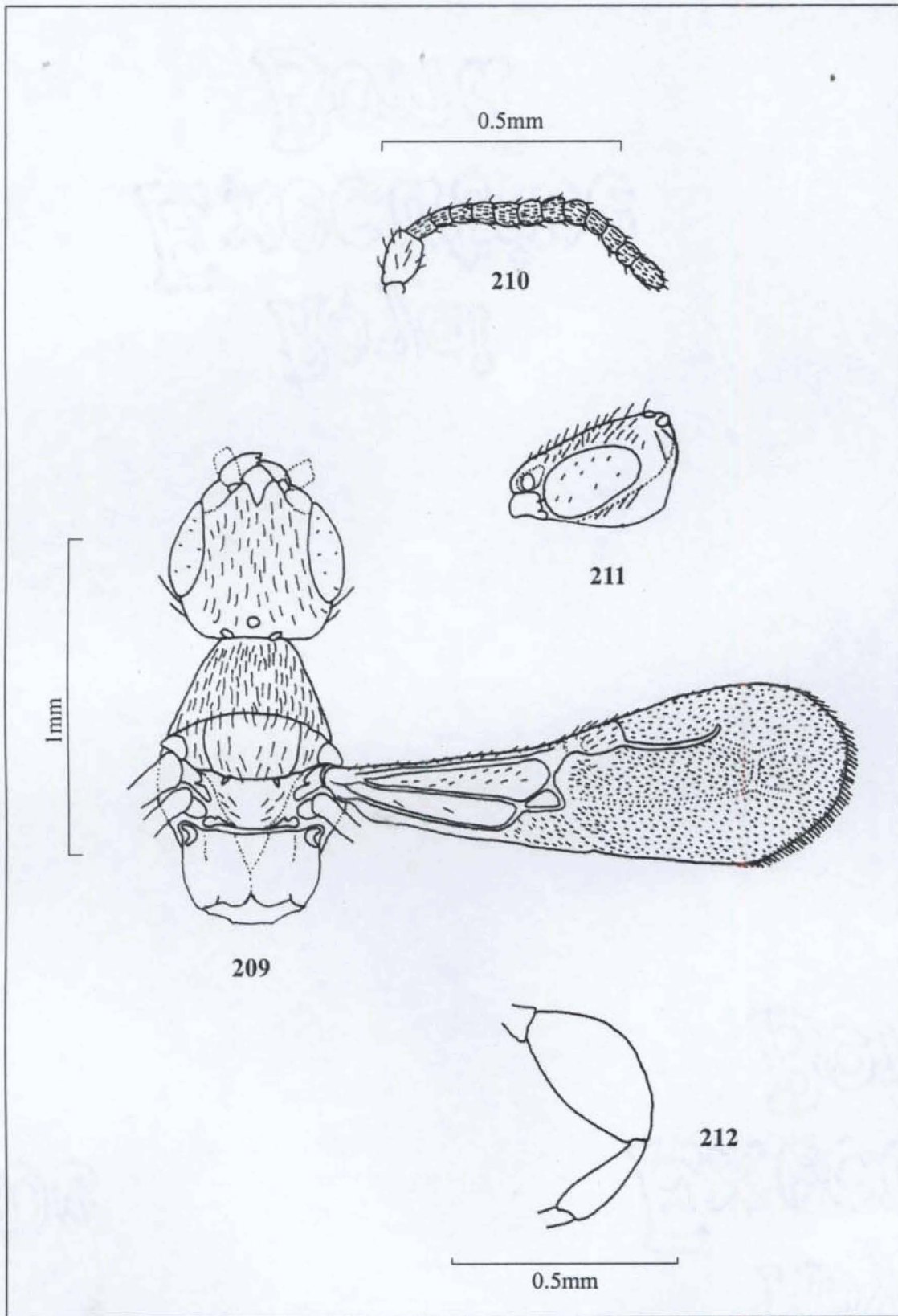
Figs. 197 - 200. *Goniozus cotha* sp. nov. Female, 197. body, dorsal view; 198. antenna; 199. head, side view; 200. foretibia.



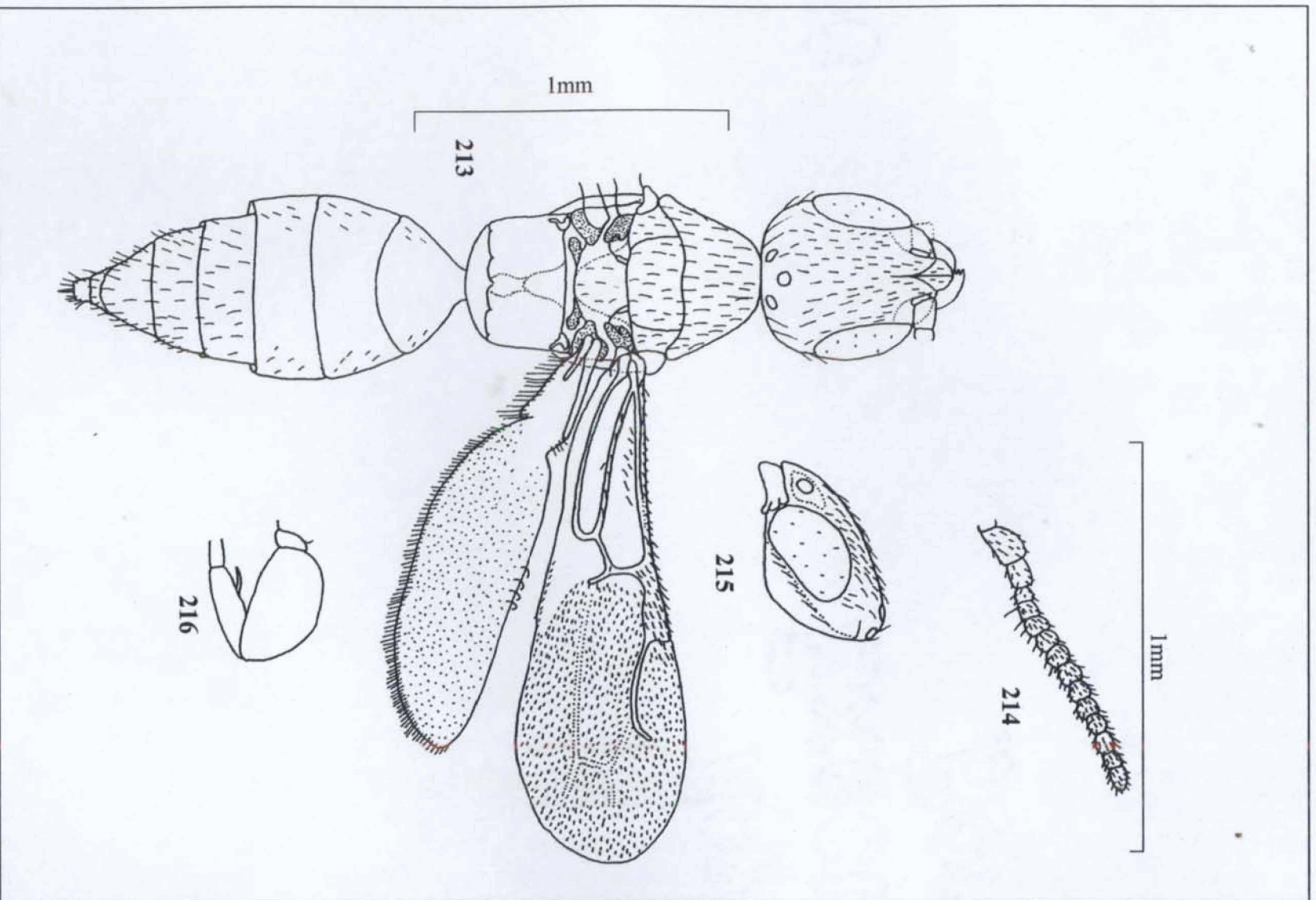
Figs. 201 - 204. *Goniozus inauditus* sp. nov. Female, 201. body, dorsal view; 202. antenna; 203. head, side view; 204. foretibia.



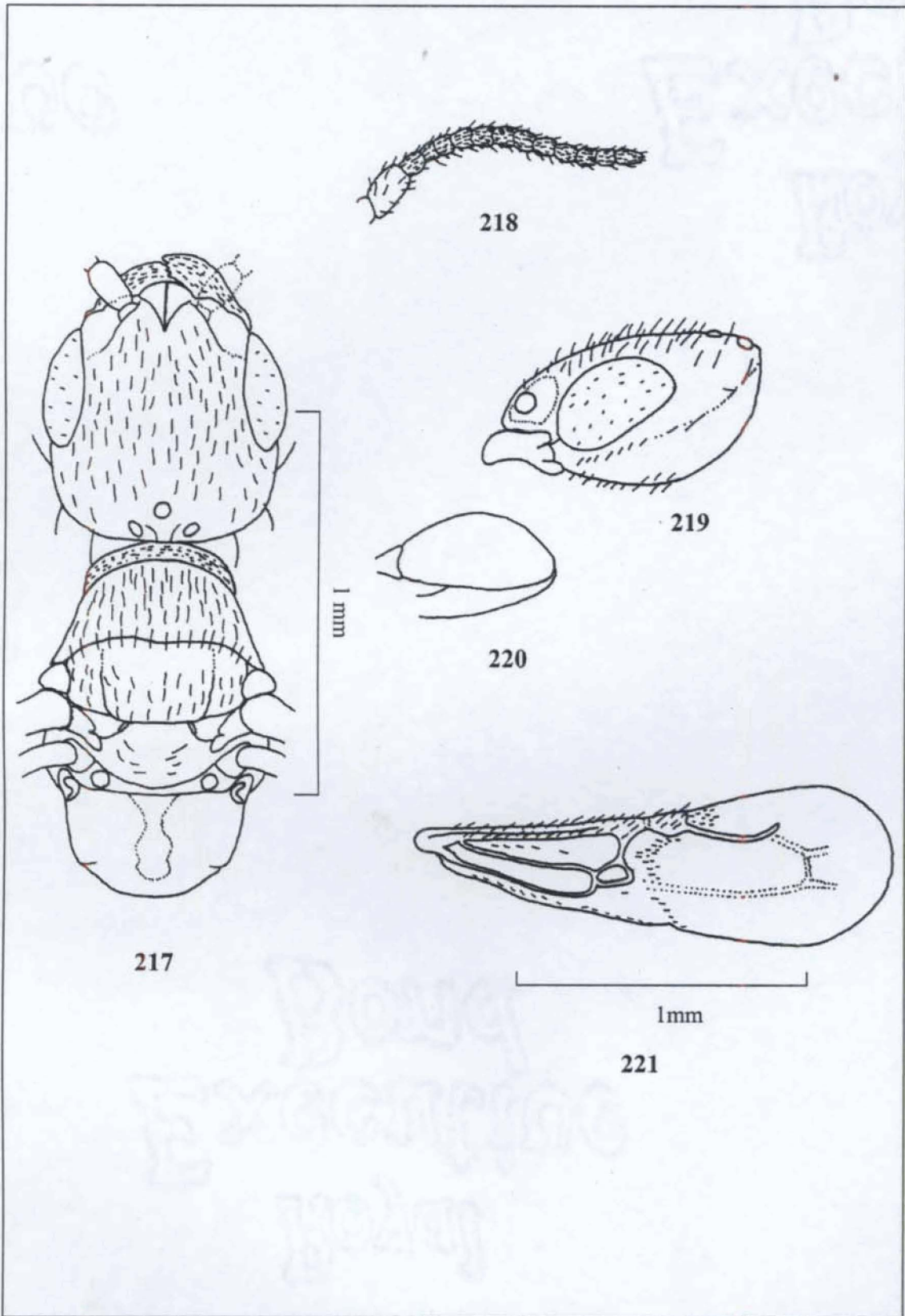
Figs. 205 - 208. *Goniozus indicus* Ashmead. Female, 205. body, dorsal view; 206. antenna; 207. head, side view; 208. foretibia.



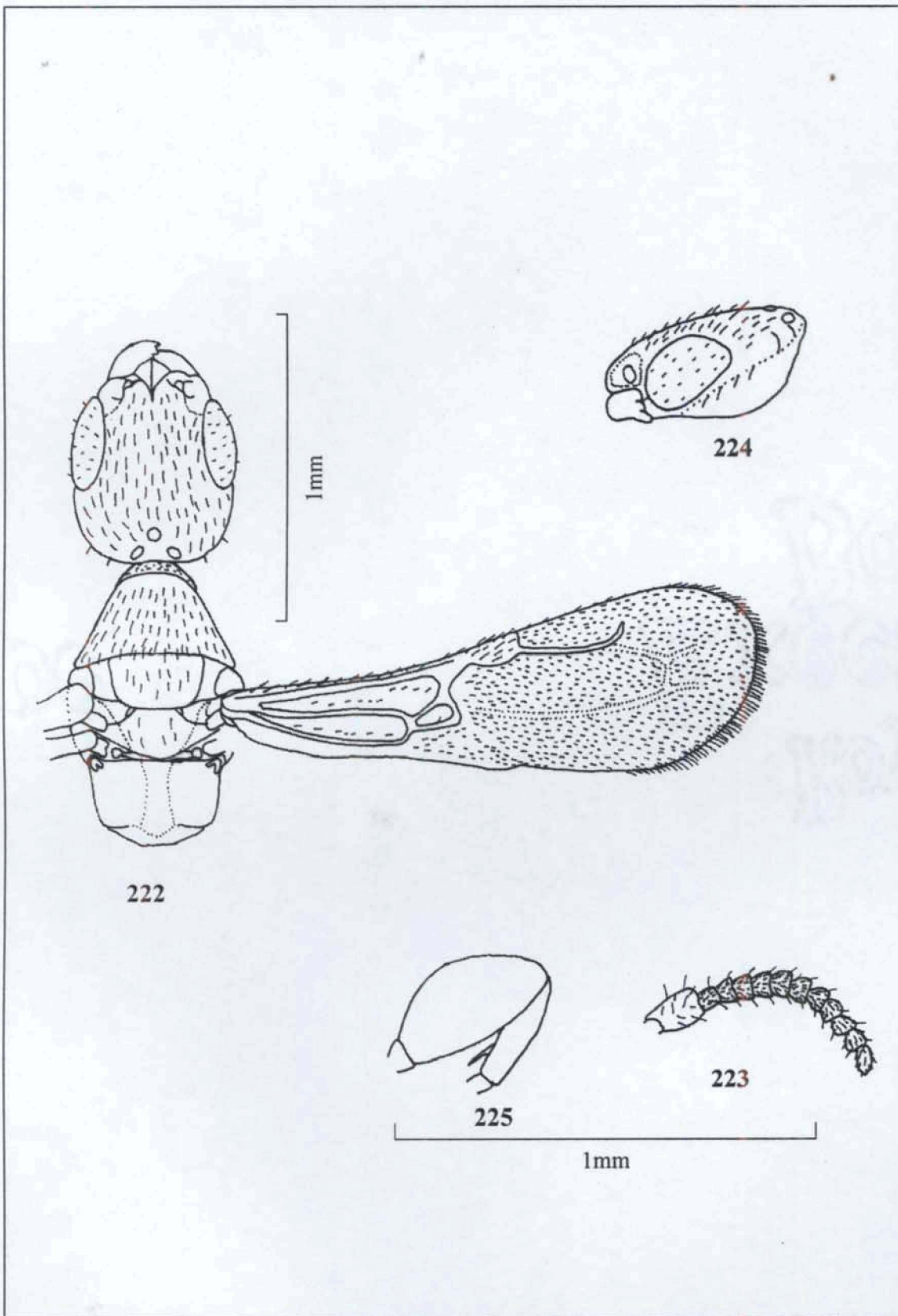
Figs. 209 - 212. *Goniozus jeroeni* sp. nov. Female, 209. body, dorsal view; 210. antenna; 211. head, side view; 212. foretibia.



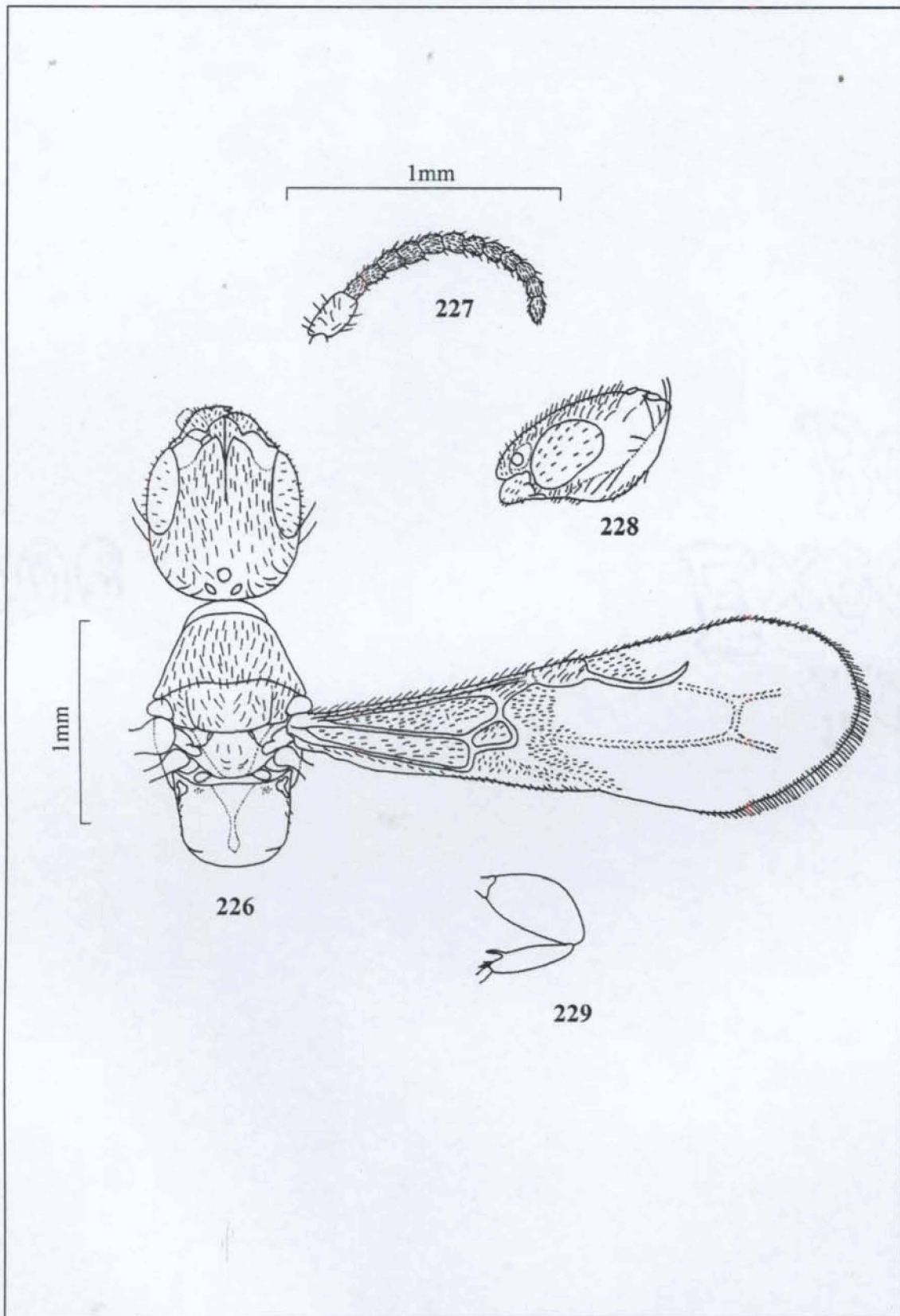
Figs. 213 - 216. *Goniozus kainophanestus* sp. nov. Female, 213. body, dorsal view; 214. antenna; 215. head, side view; 216. foretibia;



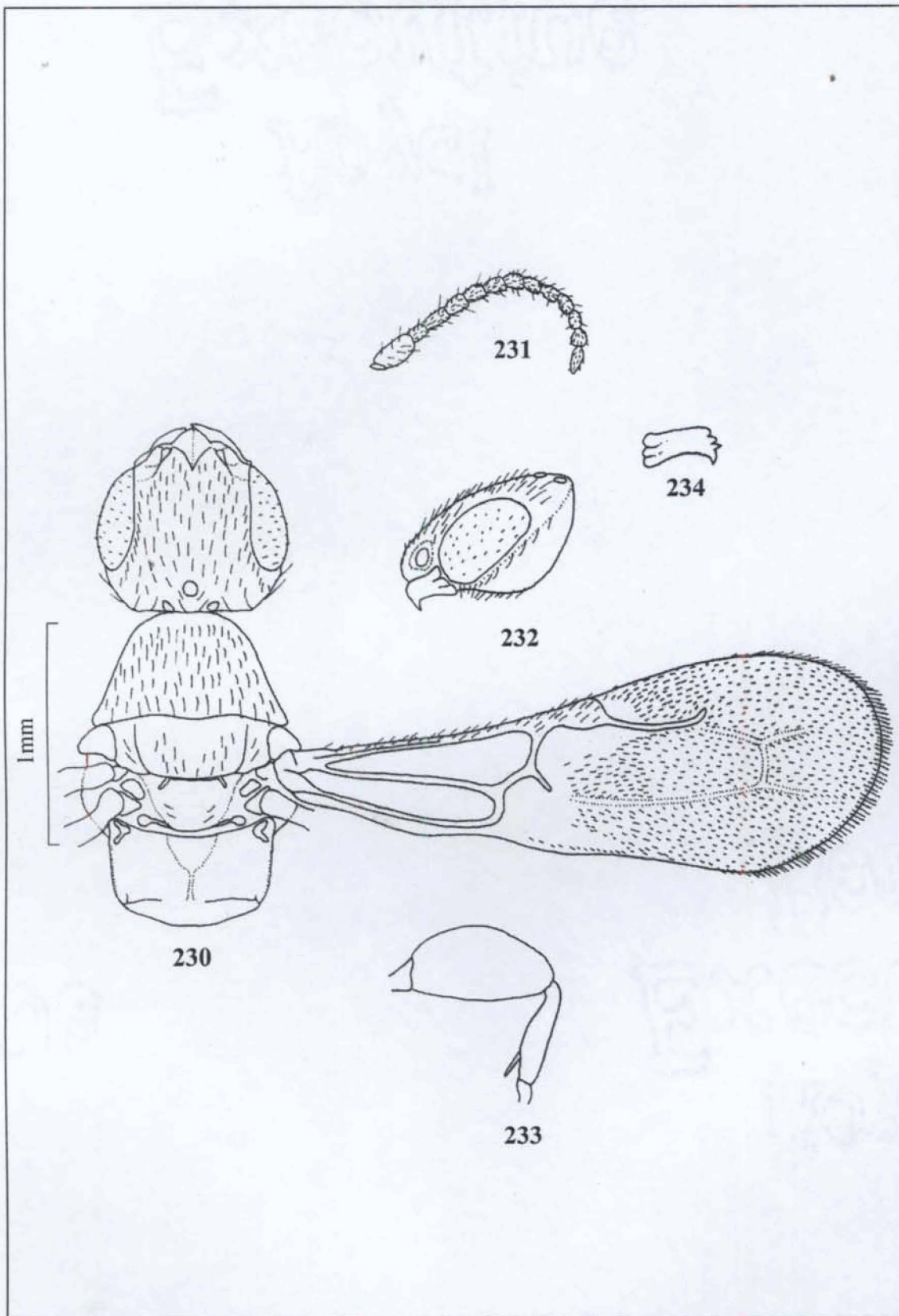
Figs. 217 - 221. *Goniozus kottiyooricus* sp. nov. Female, 217. body, dorsal view; 218. antenna; 219. head, side view; 220. foretibia; 221. forewing.



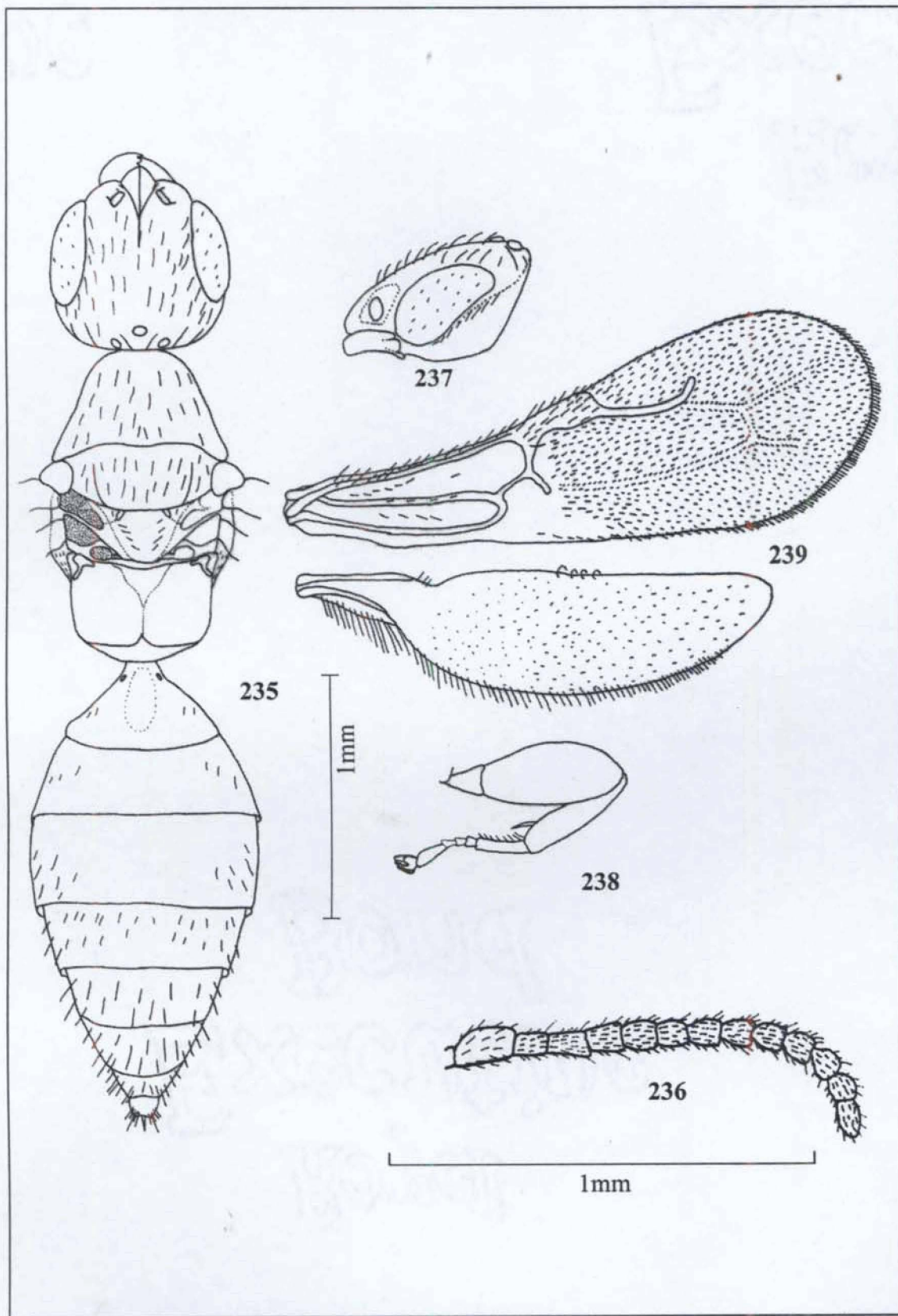
Figs. 222 - 225. *Goniozus kuriani* sp. nov. Female, 222. body, dorsal view; 223. antenna; 224. head, side view; 225. foretibia.



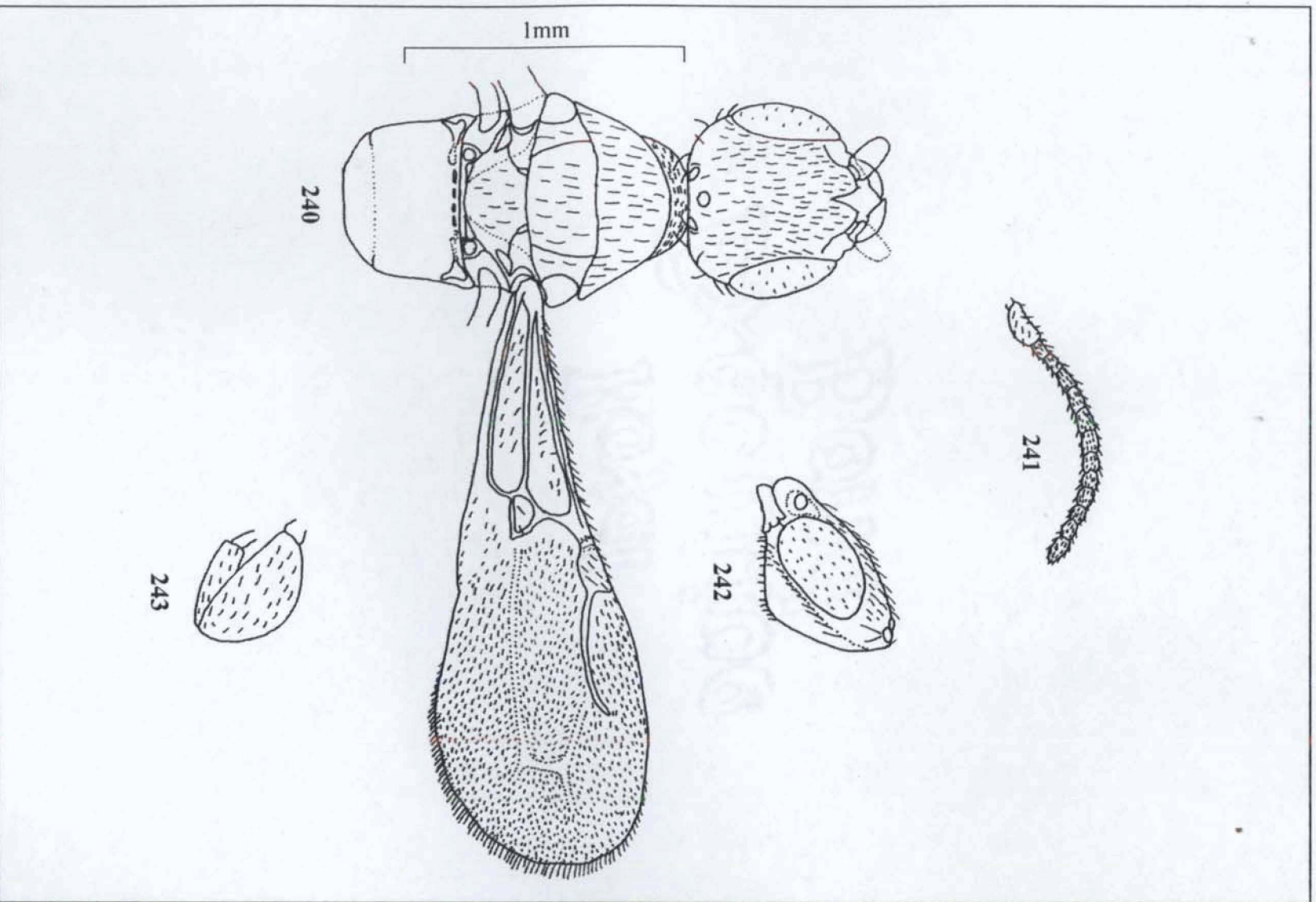
Figs. 226 - 229. *Goniozus longigastralis* sp. nov. Female, 226. body, dorsal view; 227. antenna; 228. head, side view; 229. foretibia.



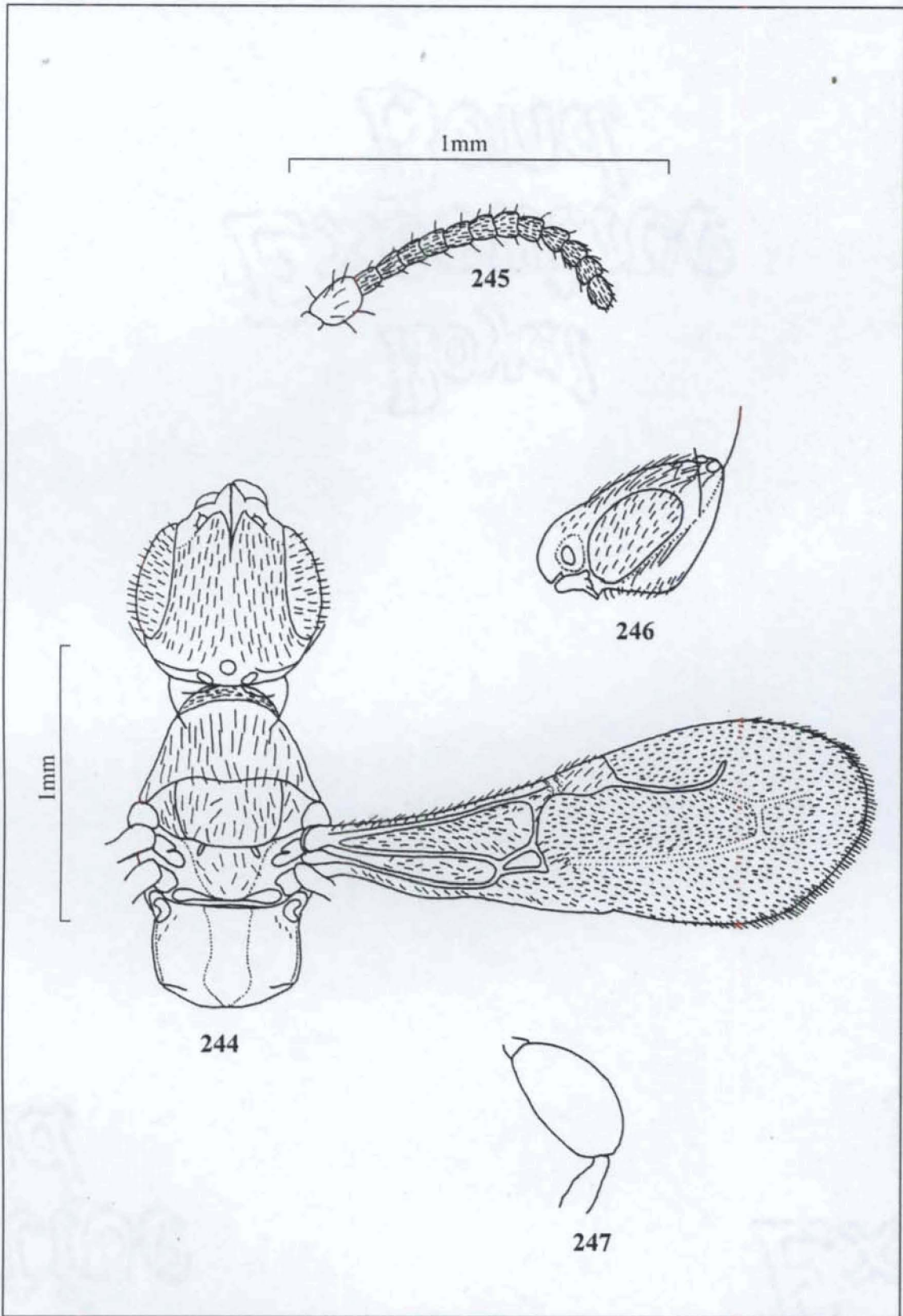
Figs. 230 - 234. *Goniozus malabaricus* sp. nov. Female, 230. body, dorsal view; 231. antenna; 232. head, side view; 233. foretibia; 234. mandible.



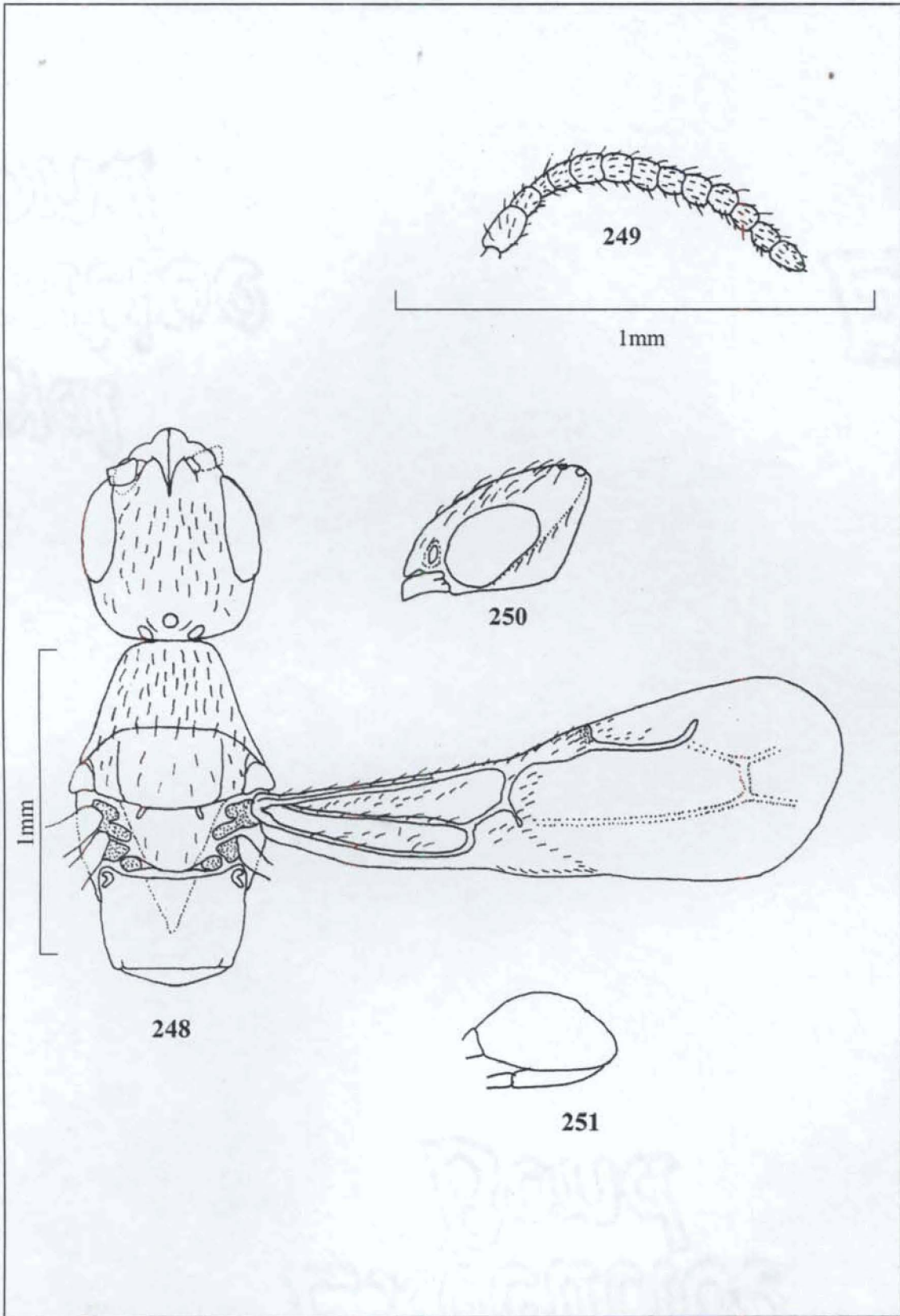
Figs. 235 - 239. *Goniozus mandibularis* sp. nov. Female, 235. body, dorsal view; 236. antenna; 237. head, side view; 238. foretibia; 239. forewing and hindwing.



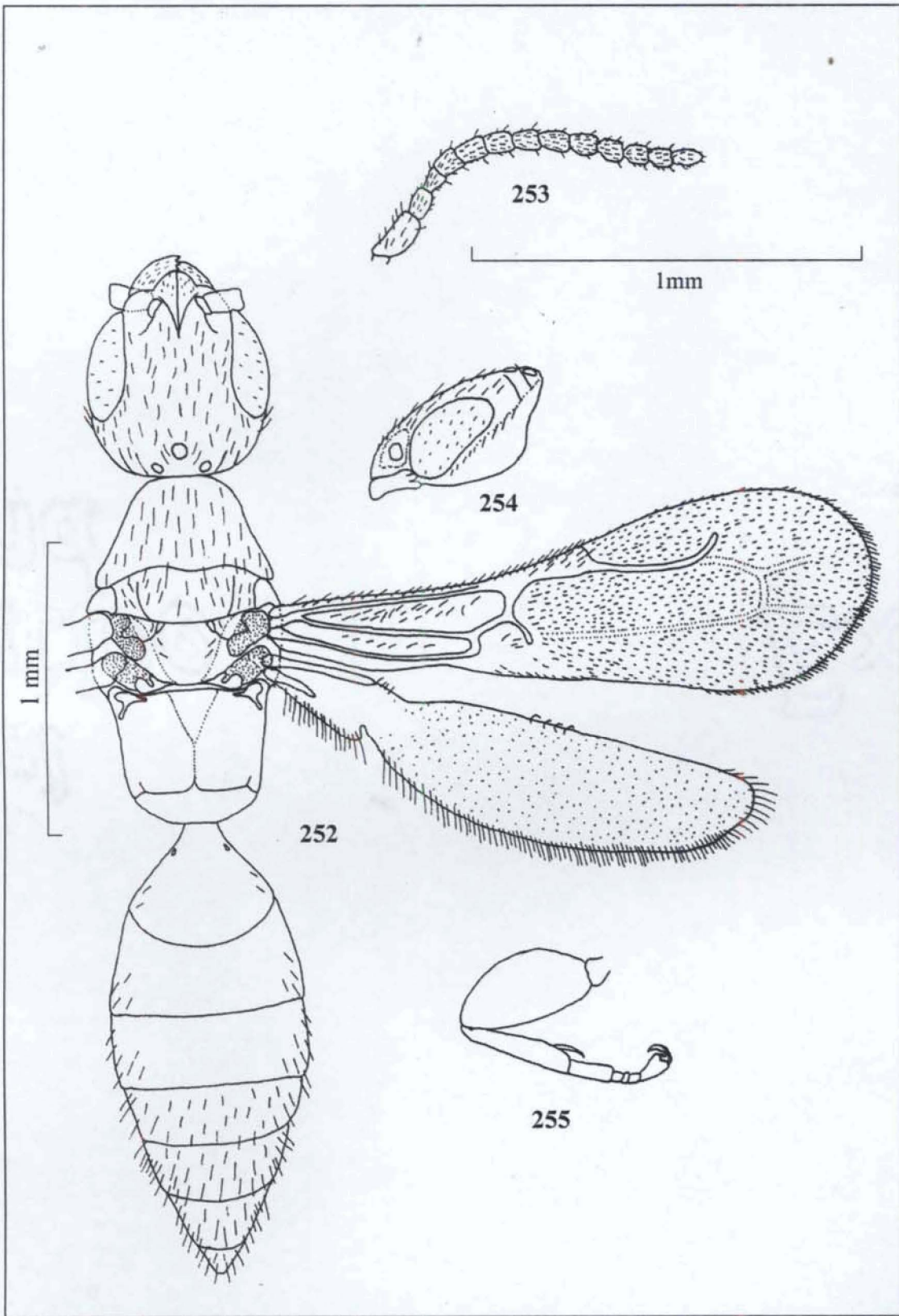
Figs. 240 - 243. *Goniozus mustus* sp. nov. Female, 240. body, dorsal view; 241. antenna; 242. head, side view; 243. foretibia.



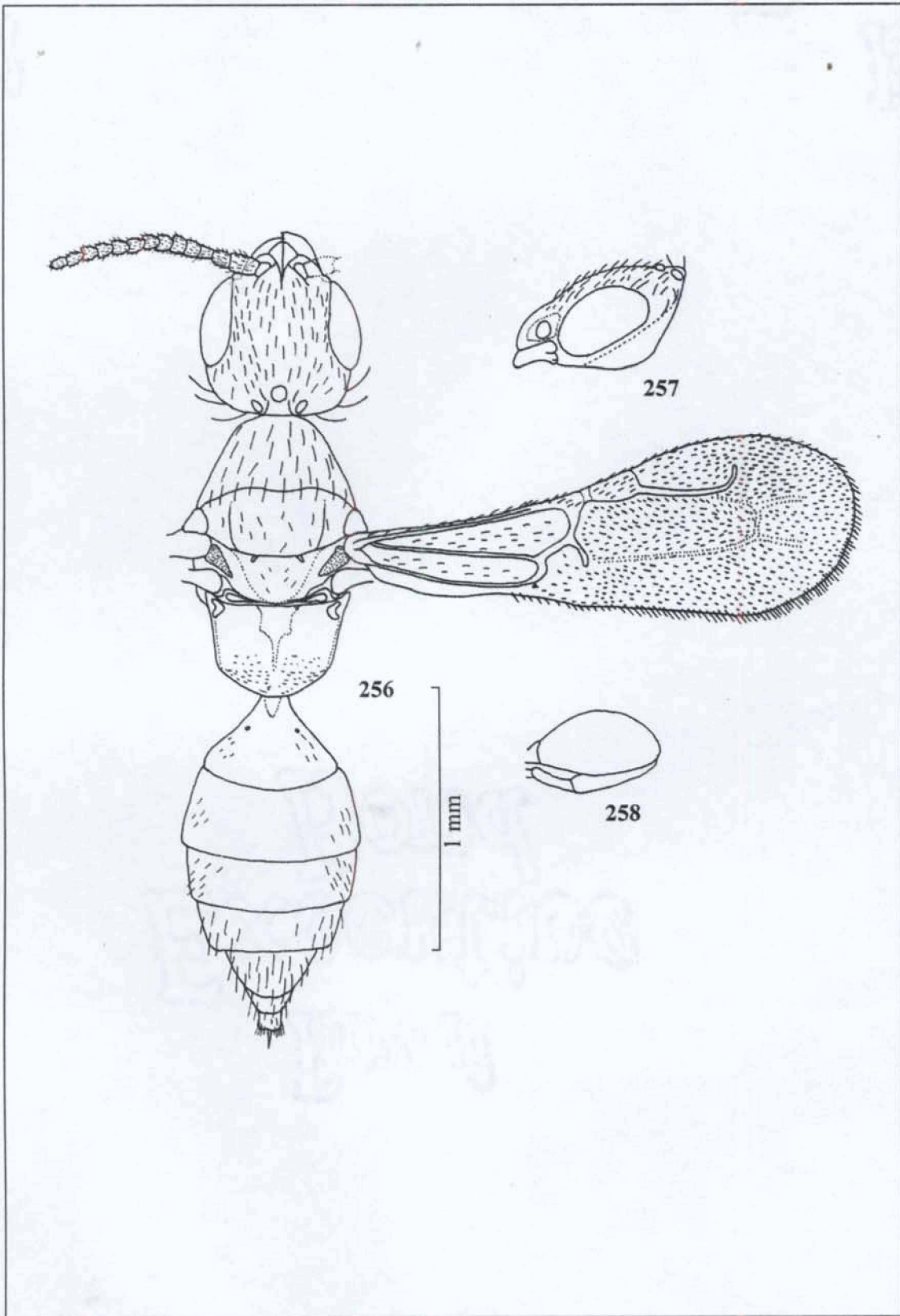
Figs. 244 - 247. *Goniozus neoteropus* sp. nov. Female, 244. body, dorsal view; 245. antenna; 246. head, side view; 247. foretibia.



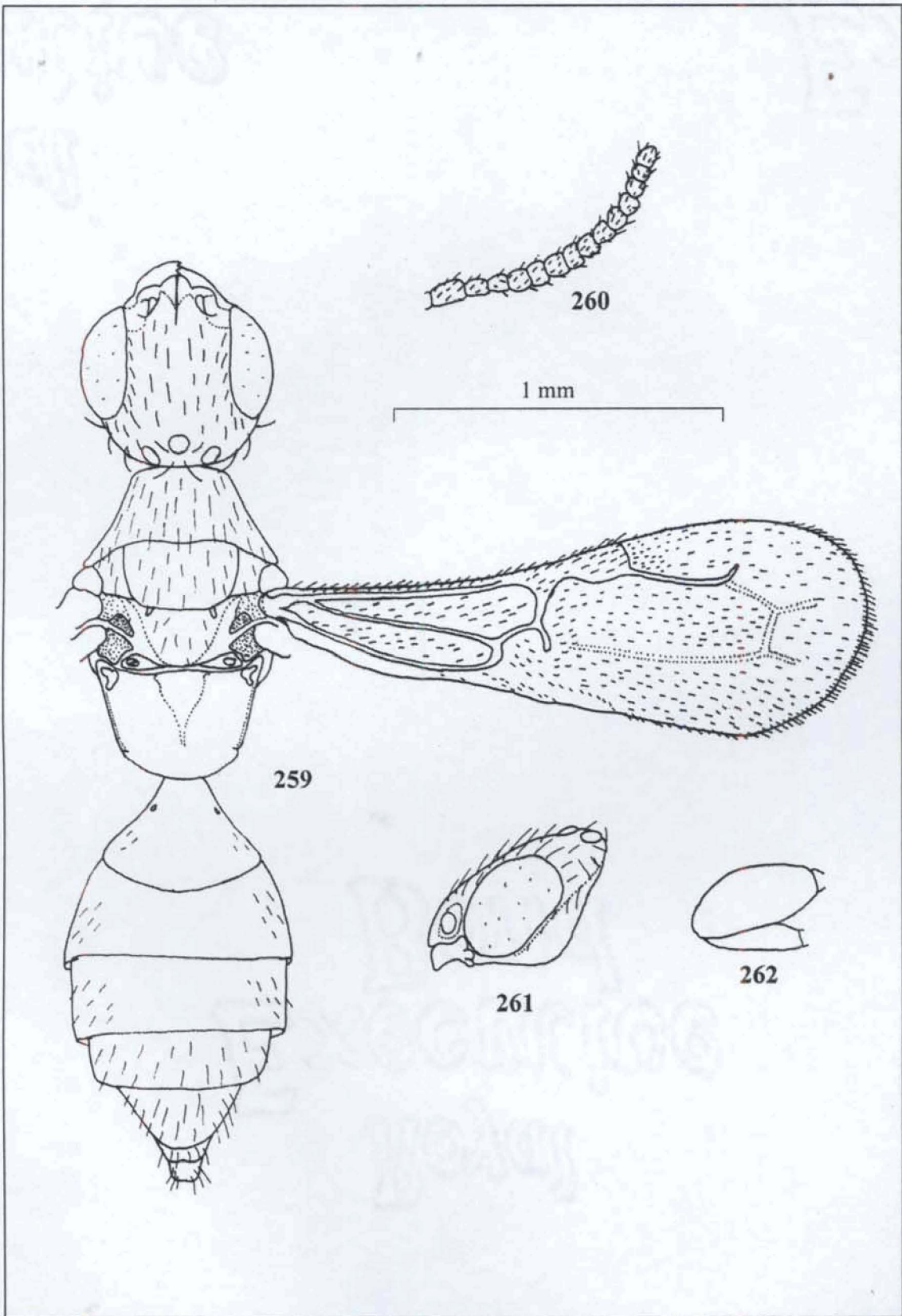
Figs. 248 - 251. *Goniozus novellus* sp. nov. Female, 248. body, dorsal view; 249. antenna; 250. head, side view; 251. foretibia.



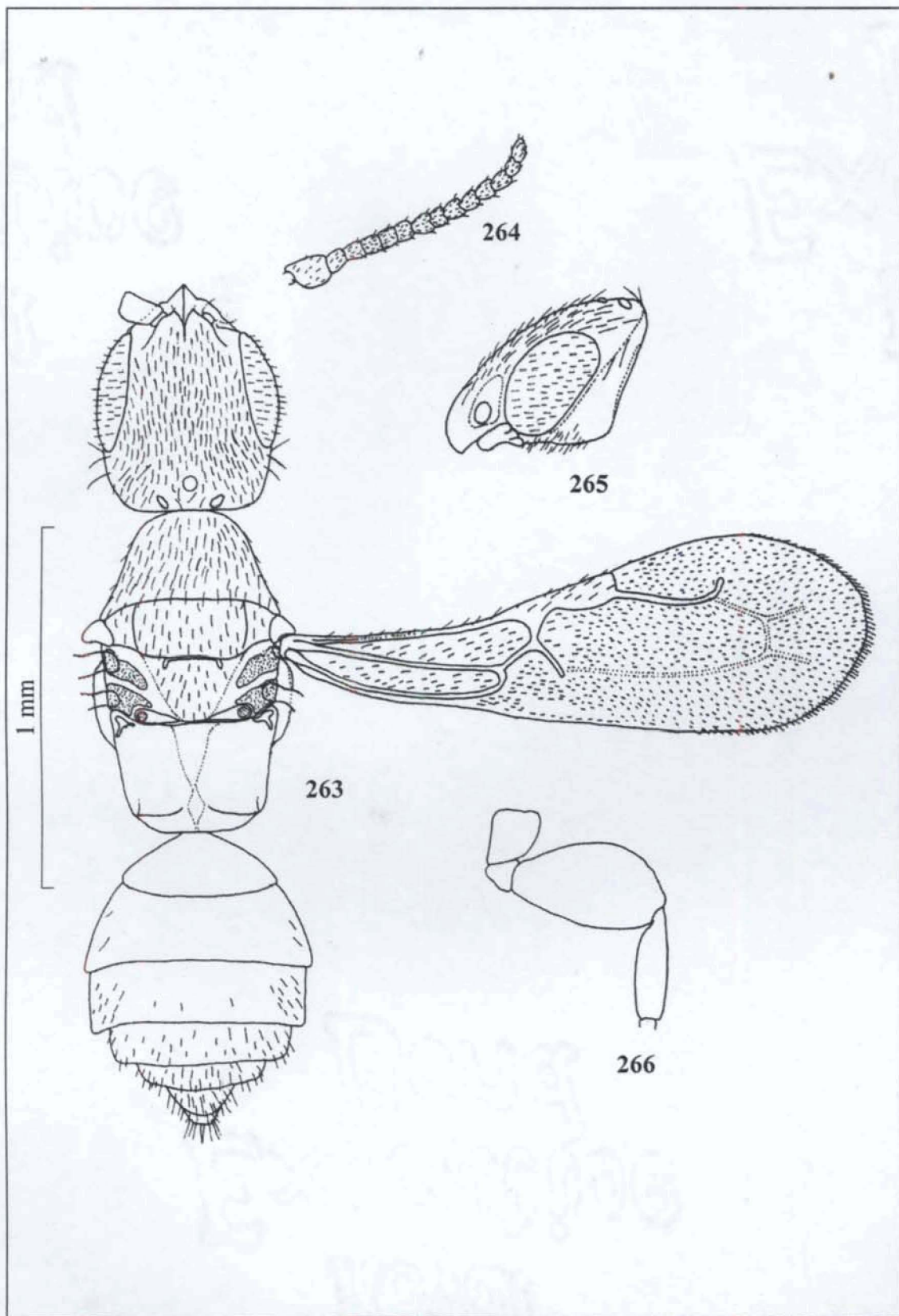
Figs. 252 - 255. *Goniozus nuperus* sp. nov. Female, 252. body, dorsal view; 253. antenna; 254. head, side view; 255. foretibia.



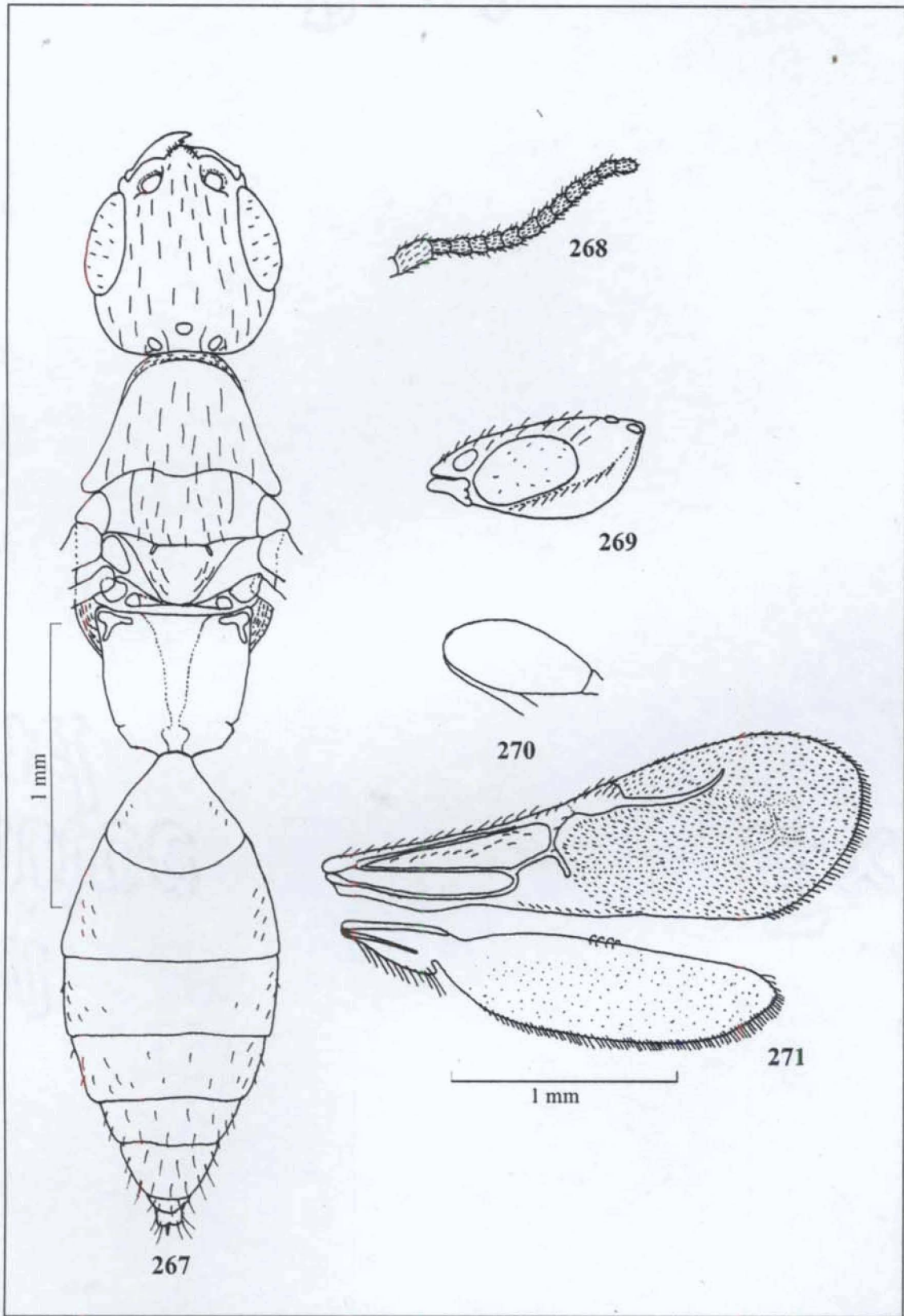
Figs. 256 - 258. *Goniozus orthagae* sp. nov. Female, 256. body, dorsal view; 257. head, side view; 258. foretibia.



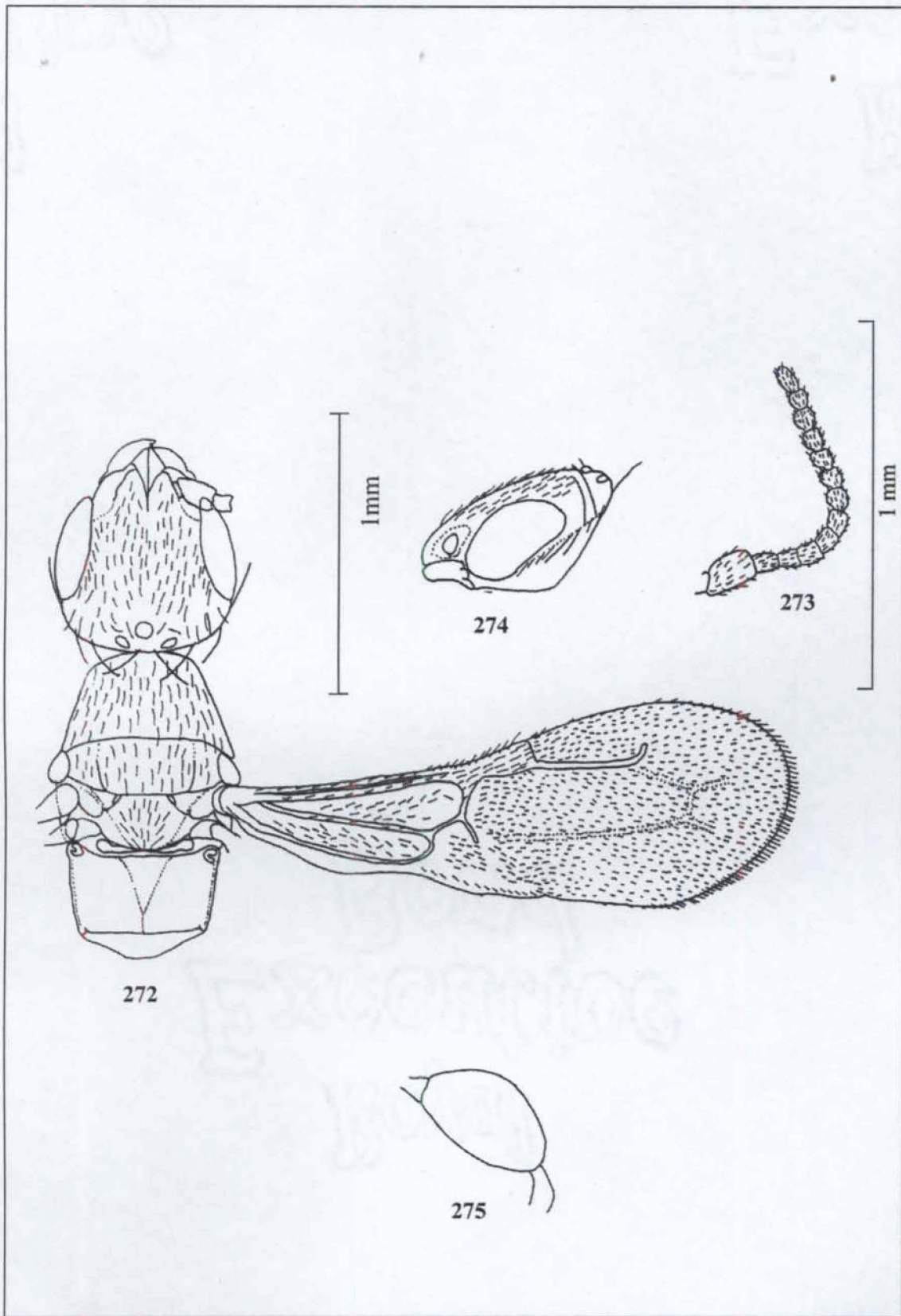
Figs. 259 - 262. *Goniozus orthagae* sp. nov. Male, 259. body, dorsal view; 260. antenna; 261. head, side view; 262. foretibia.



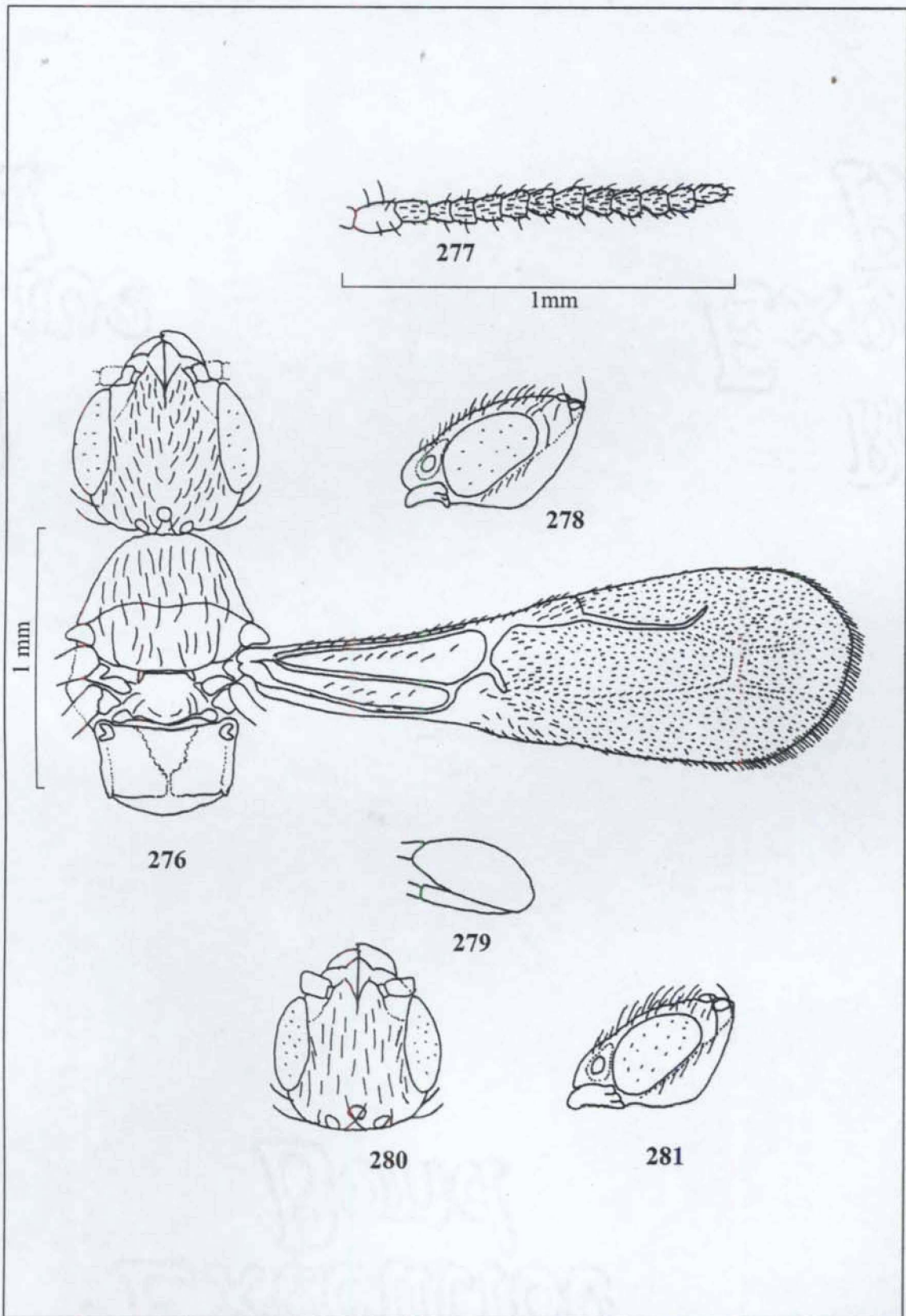
Figs. 263 - 266. *Goniozus palghatensis* sp. nov. Female, 263. body, dorsal view; 264. antenna; 265. head, side view; 266. foretibia.



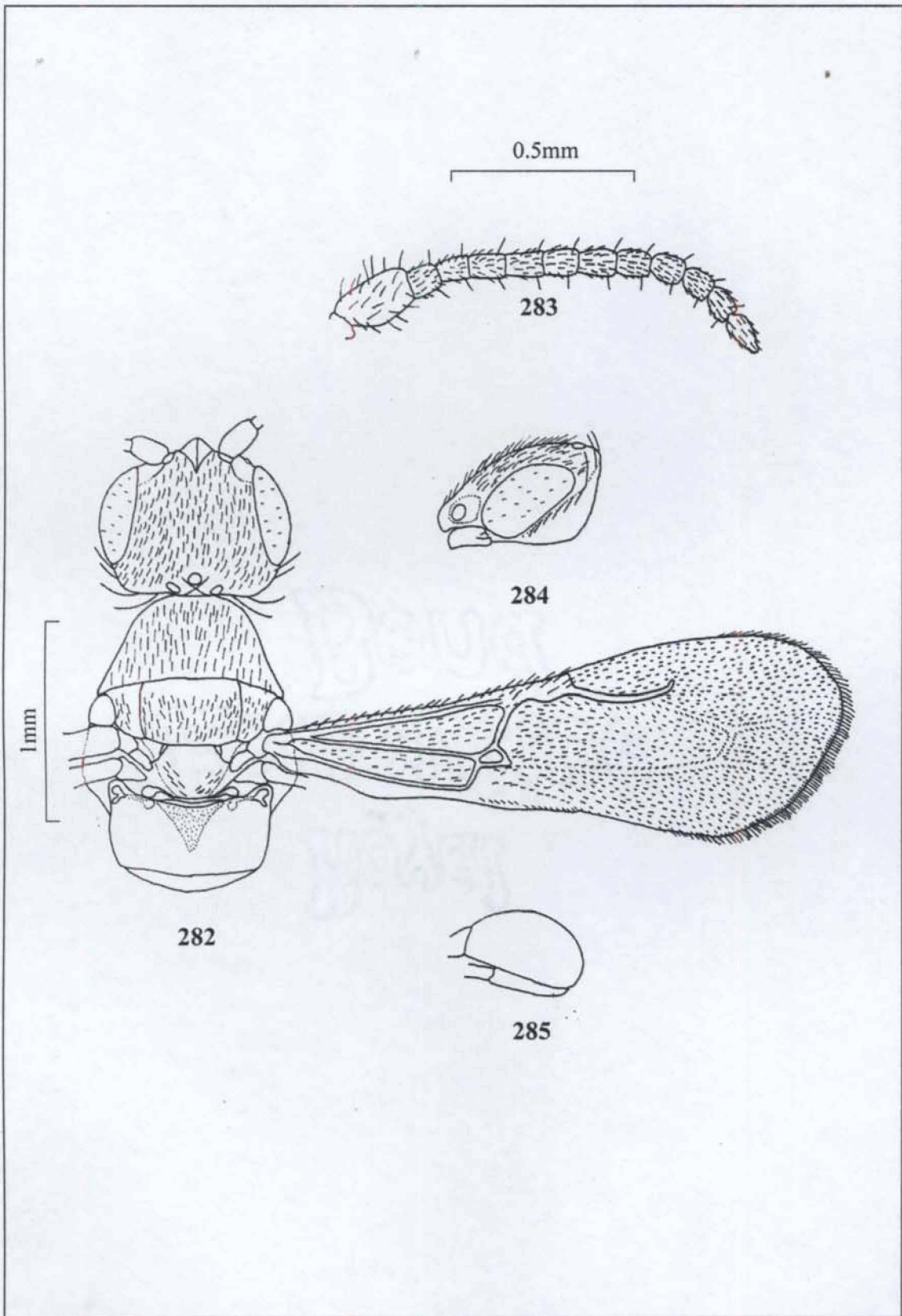
Figs. 267-271 *Goniozus platycephalus* sp. nov. Female, 267. body, dorsal view; 268. antenna; 269. head, side view; 270. foretibia; 271. forewing and hindwing. nov. Male, 280. head, full face view; 281. head, lateral view.



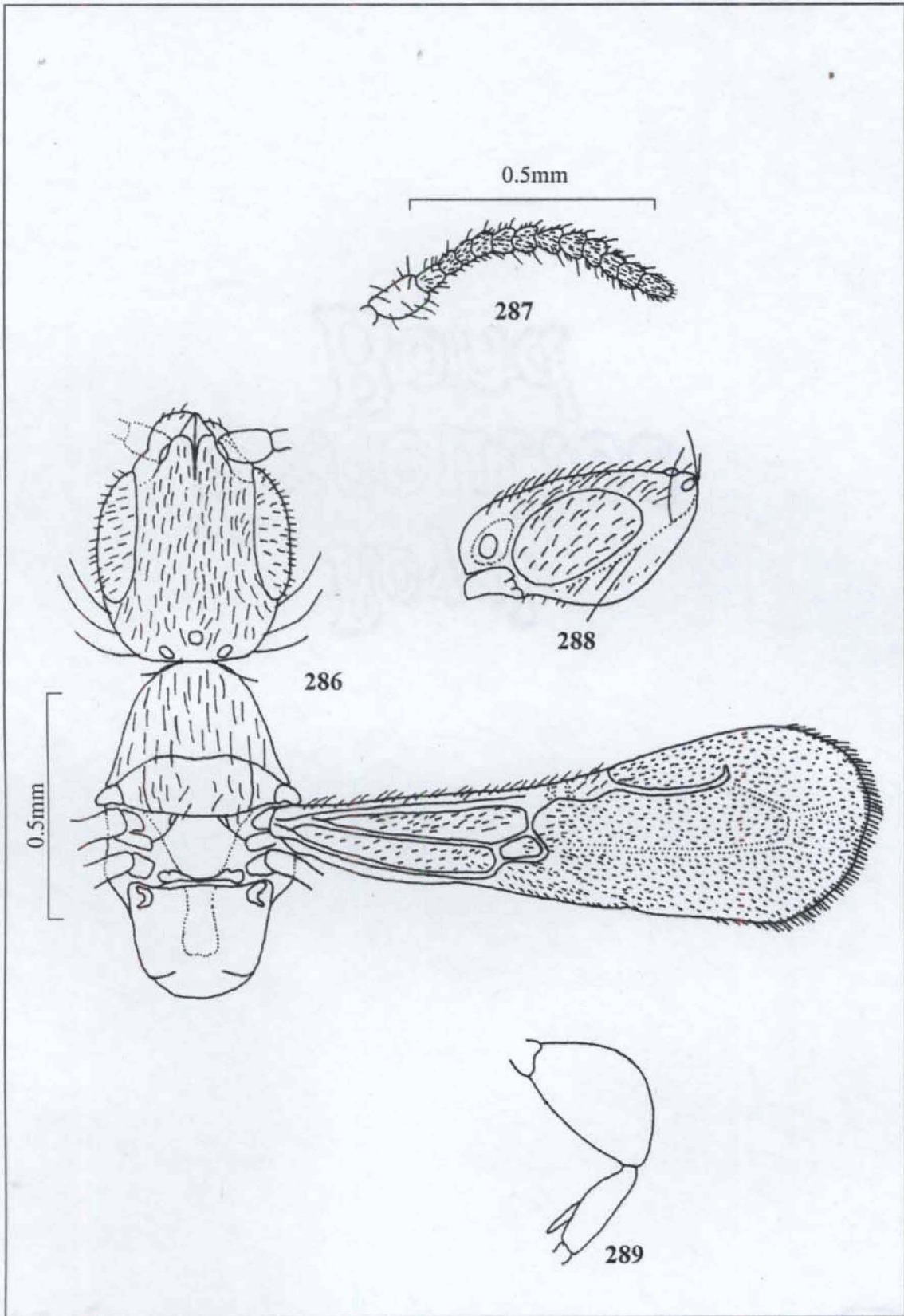
Figs. 272 - 275. *Goniozus propodeatus* sp. nov. Female, 272. body, dorsal view; 273. antenna; 274. head, side view; 275. foretibia.



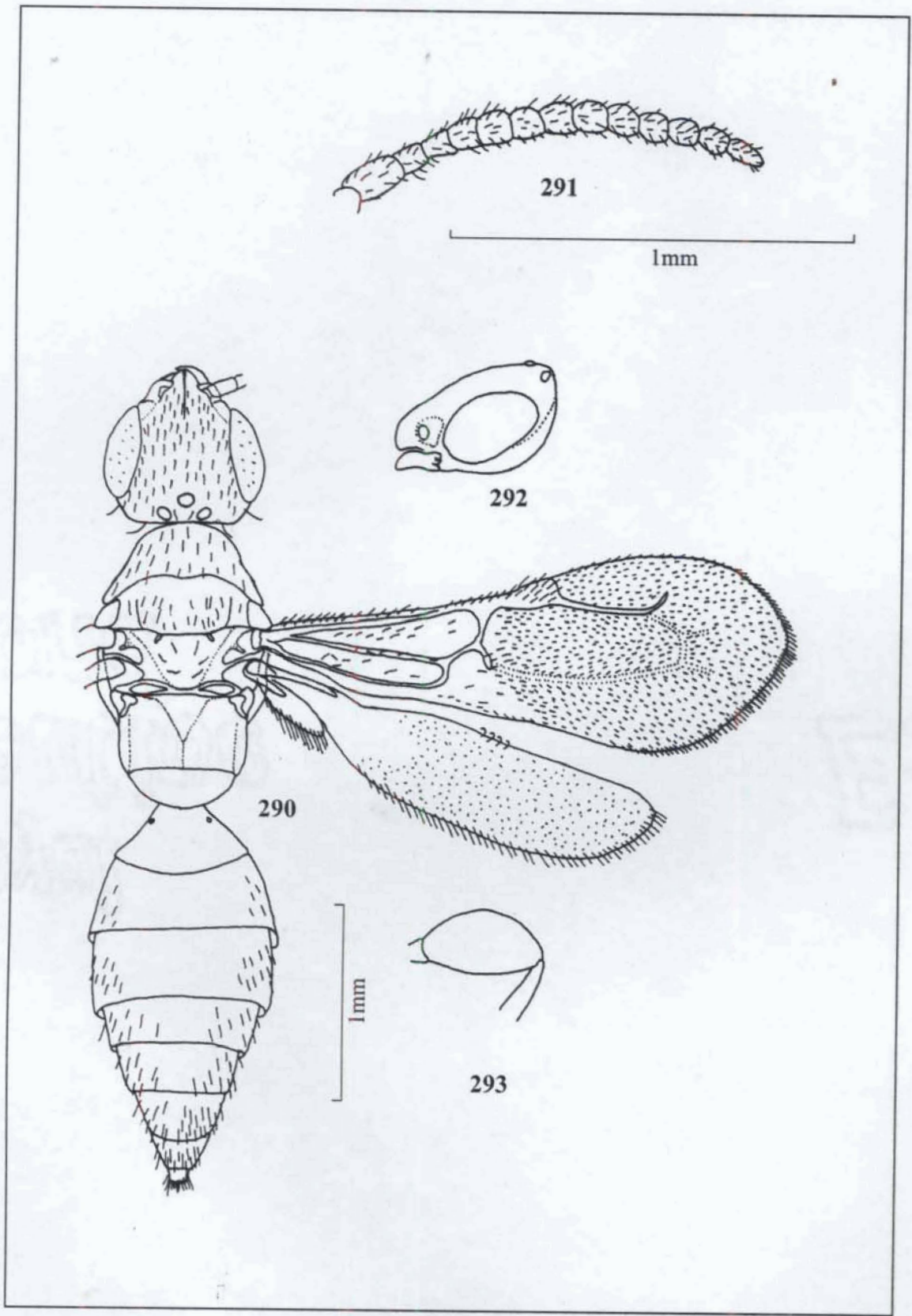
Figs. 276 - 279. *Goniozus proshpatosis* sp. nov. Female, 276. body, dorsal view; 277. antenna; 278. head, side view; 279. foretibia. Figs. 280 - 281. *Goniozus proshpatosis* sp. nov. Male, 280. head, full face view; 281. head, lateral view.



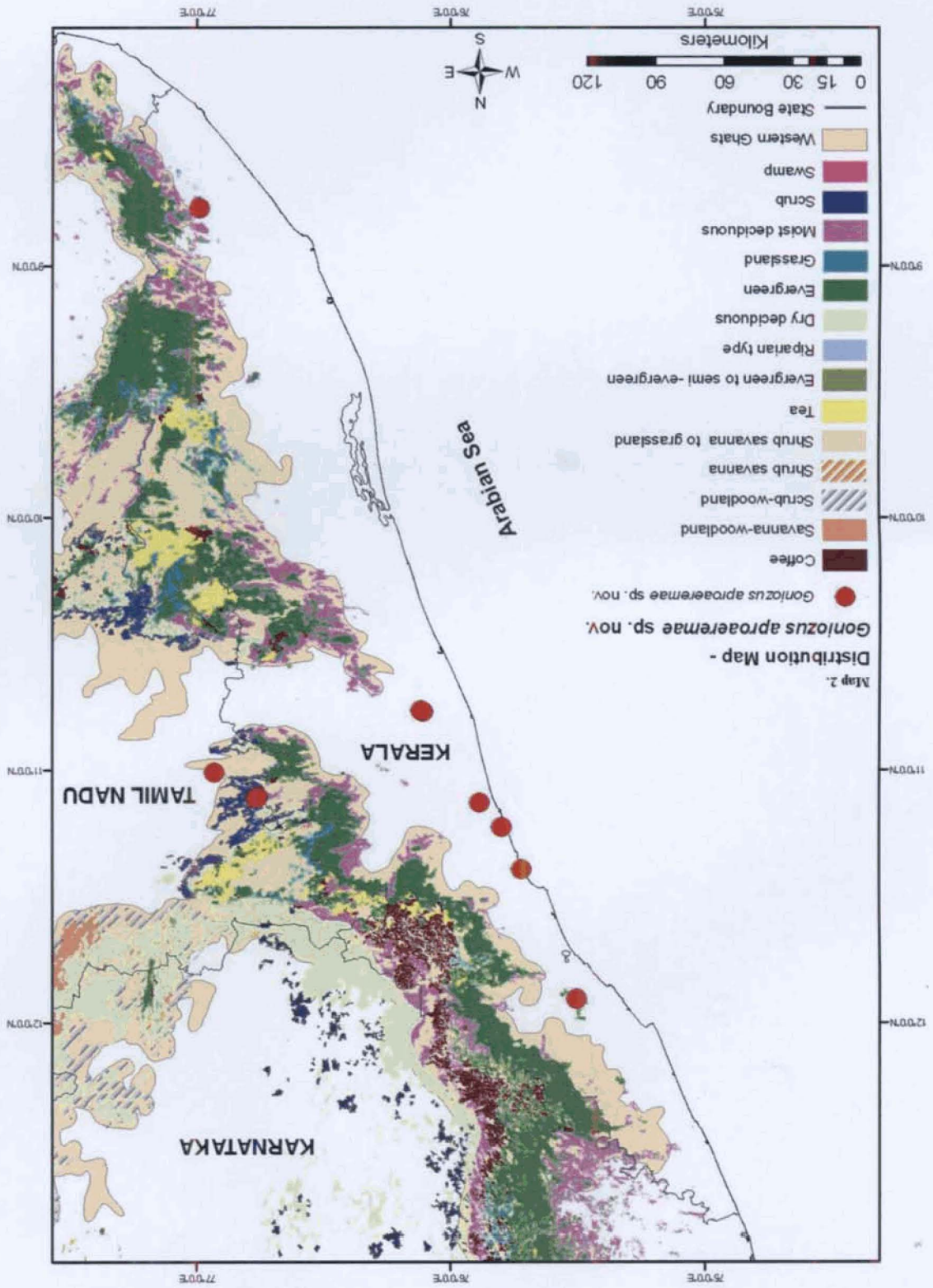
Figs. 282 - 285. *Goniozus recentis* sp. nov. Female, 282. body, dorsal view; 283. antenna; 284. head, side view; 285. foretibia.

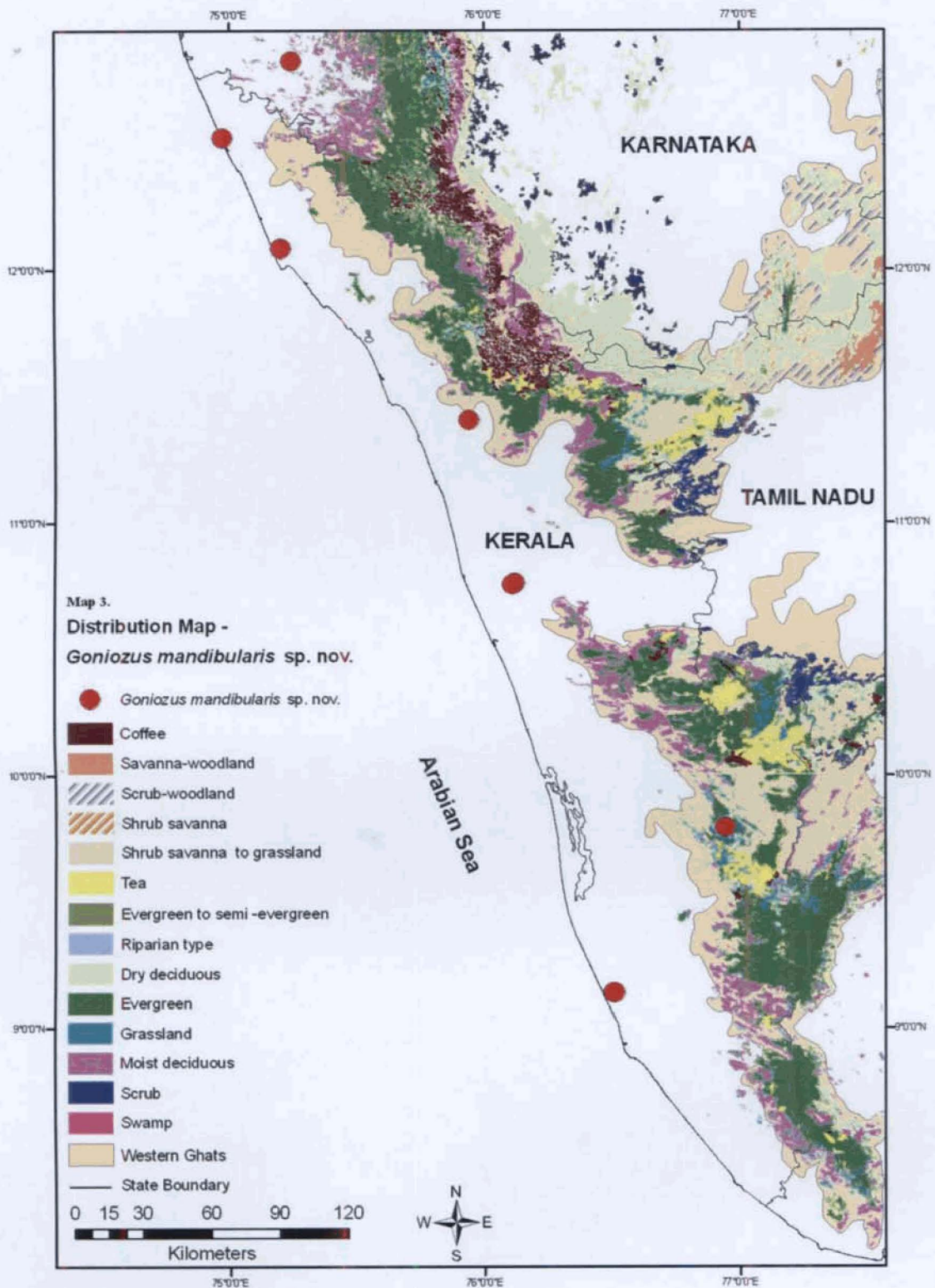


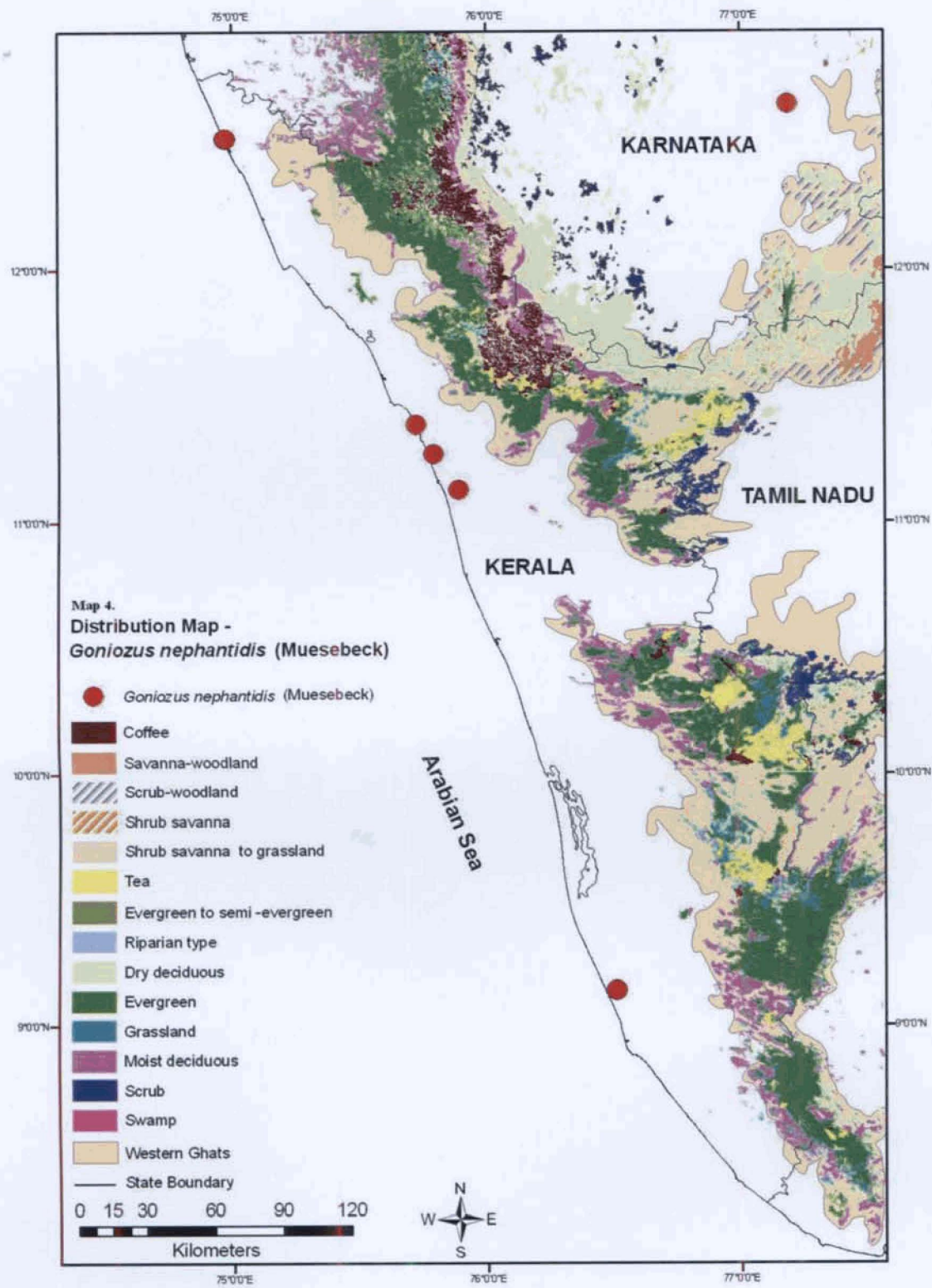
Figs. 286 - 289. *Goniozus setosus* sp. nov. Female, 286. body, dorsal view; 287. antenna; 288. head, side view; 289. foretibia.

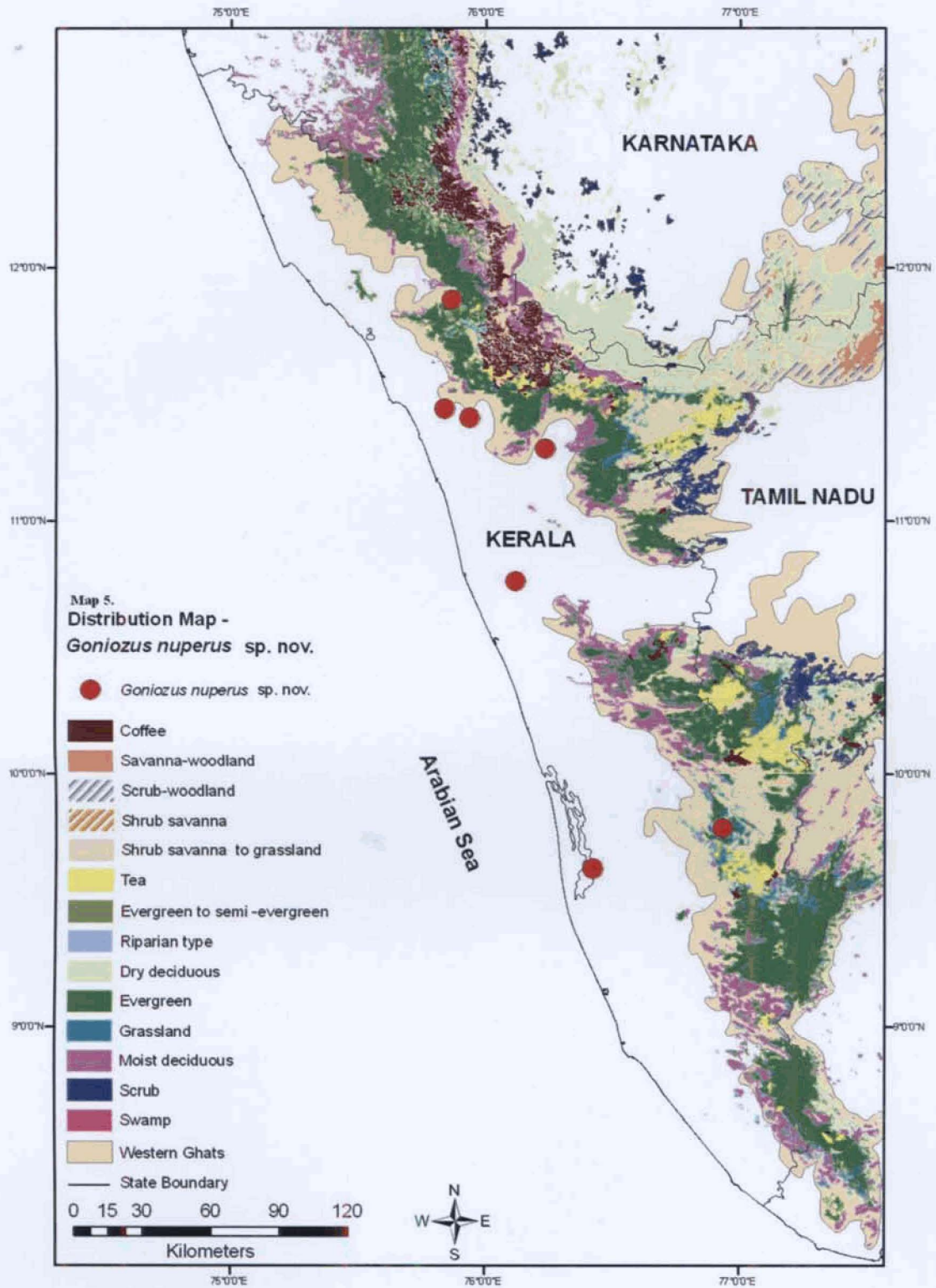


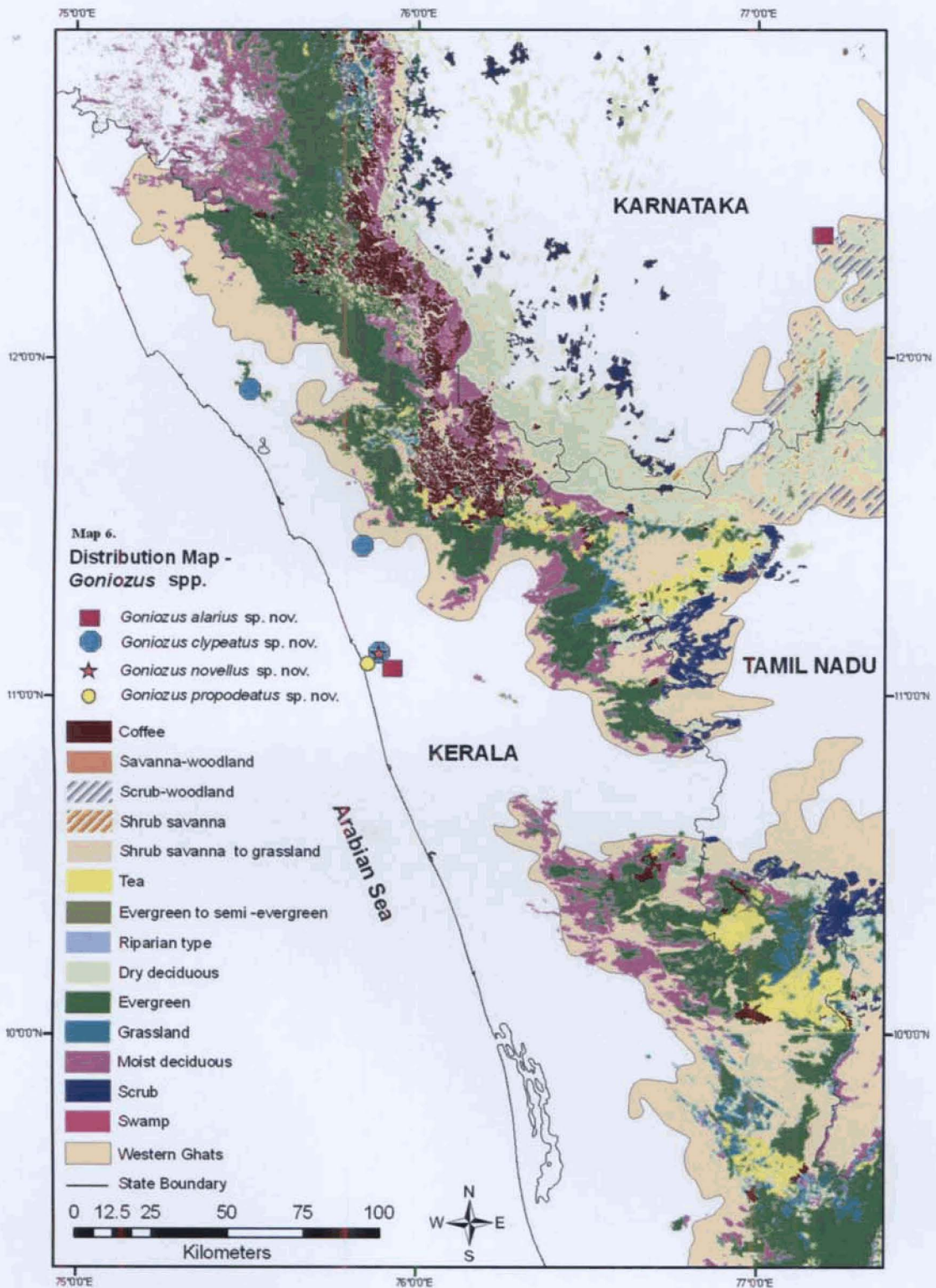
Figs. 290 - 293. *Goniozus sringeriensis* sp. nov. Female, 290. body, dorsal view; 291. antenna; 292. head, side view; 293. foretibia.

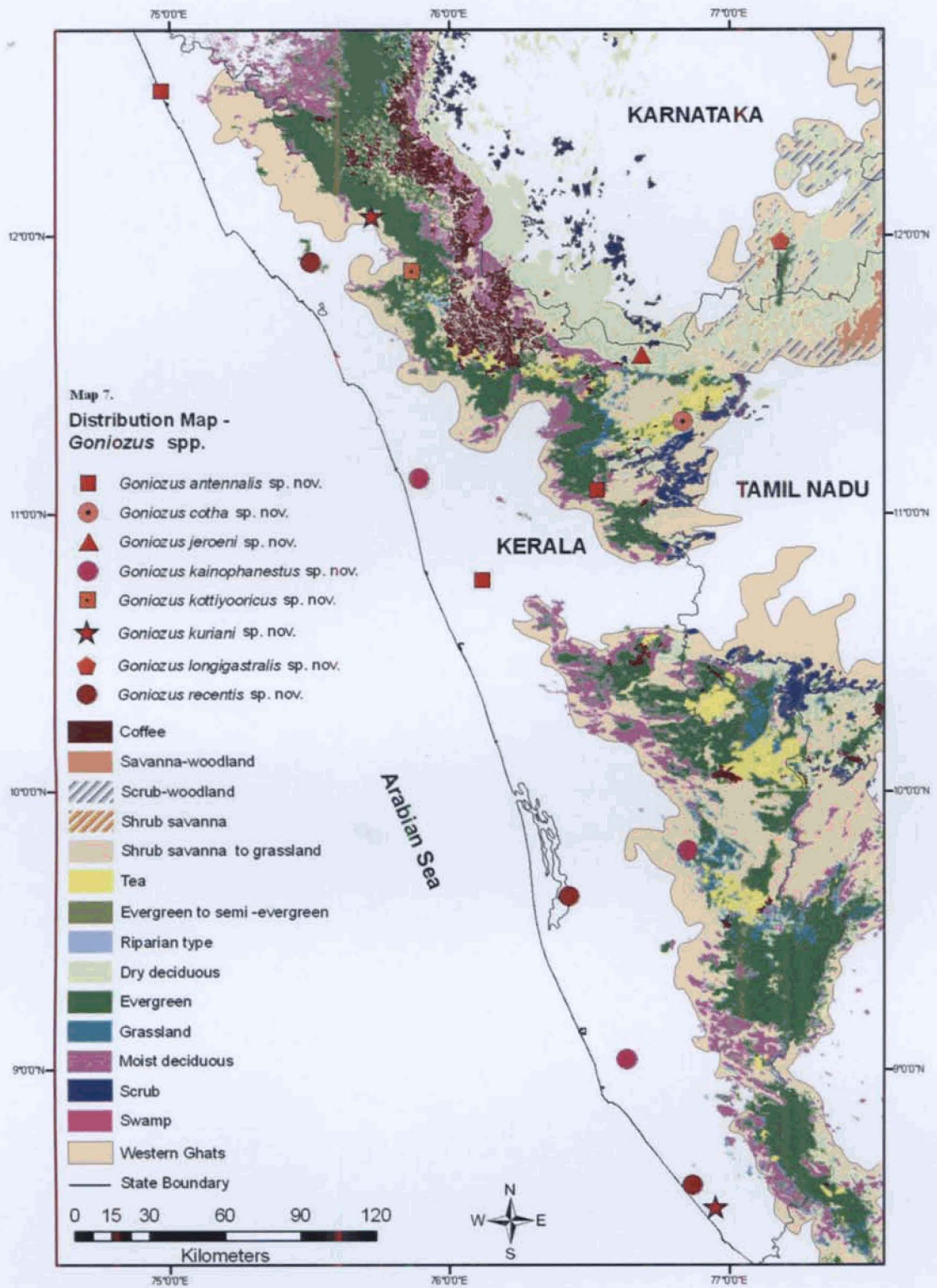


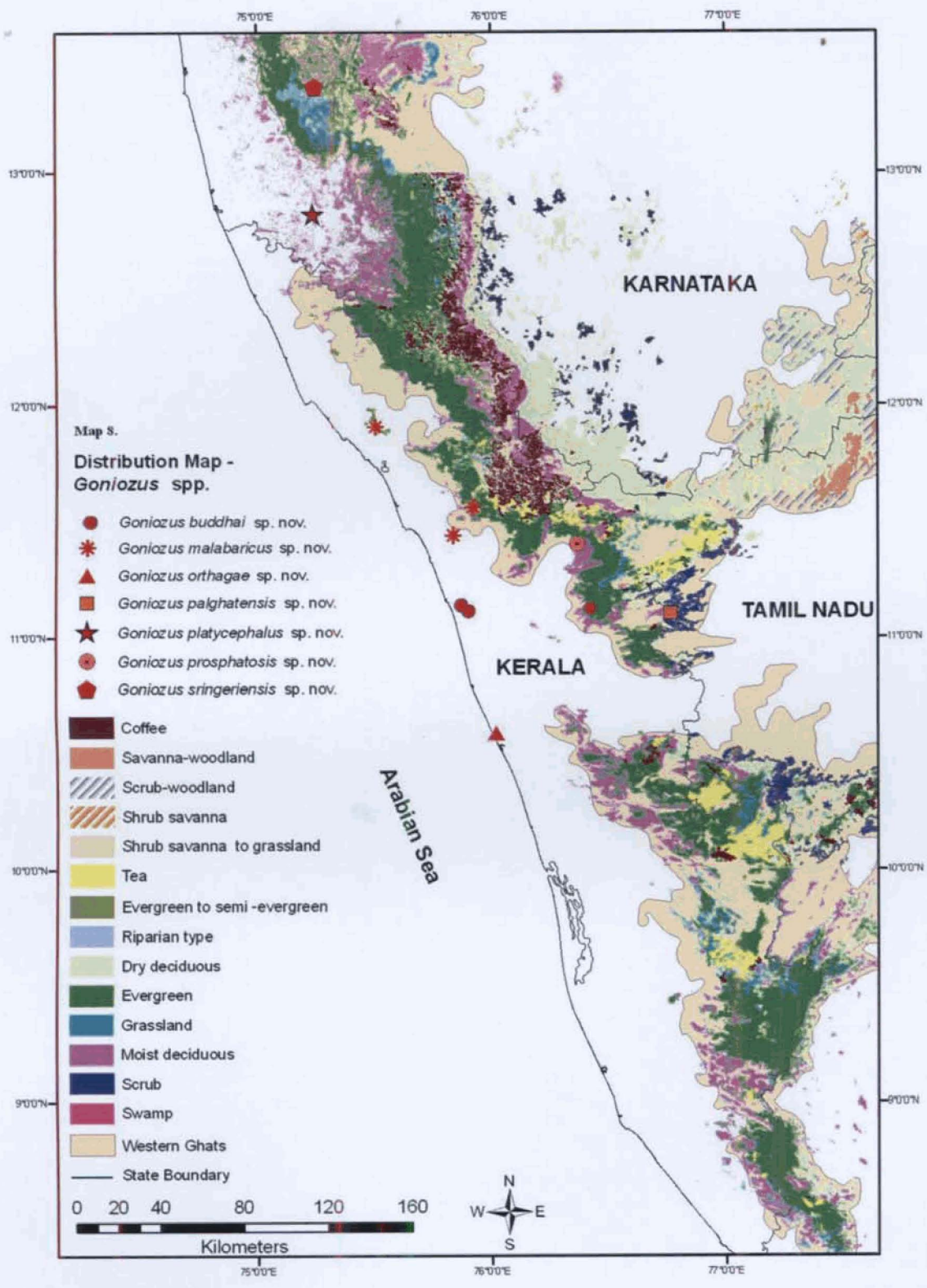


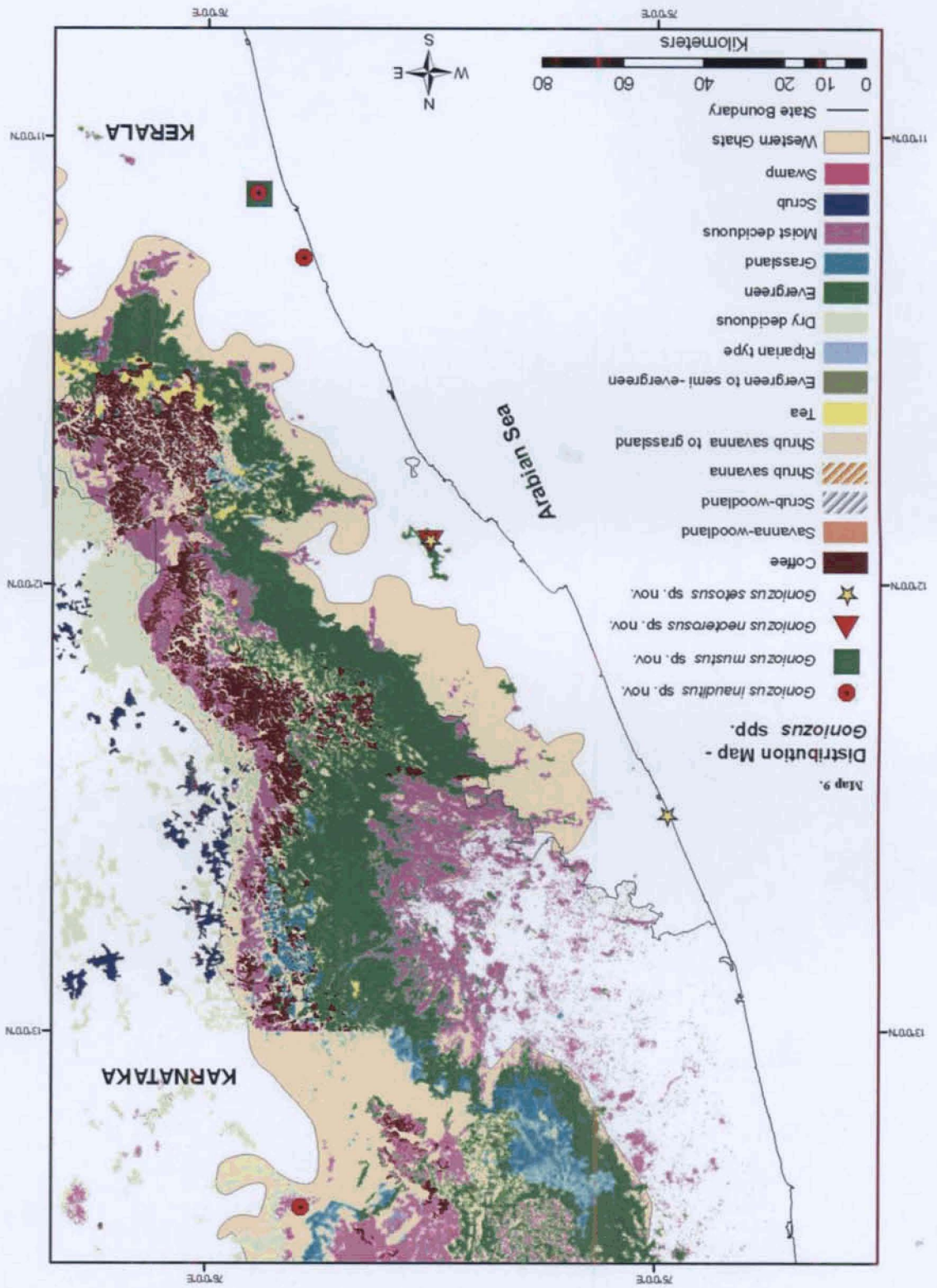


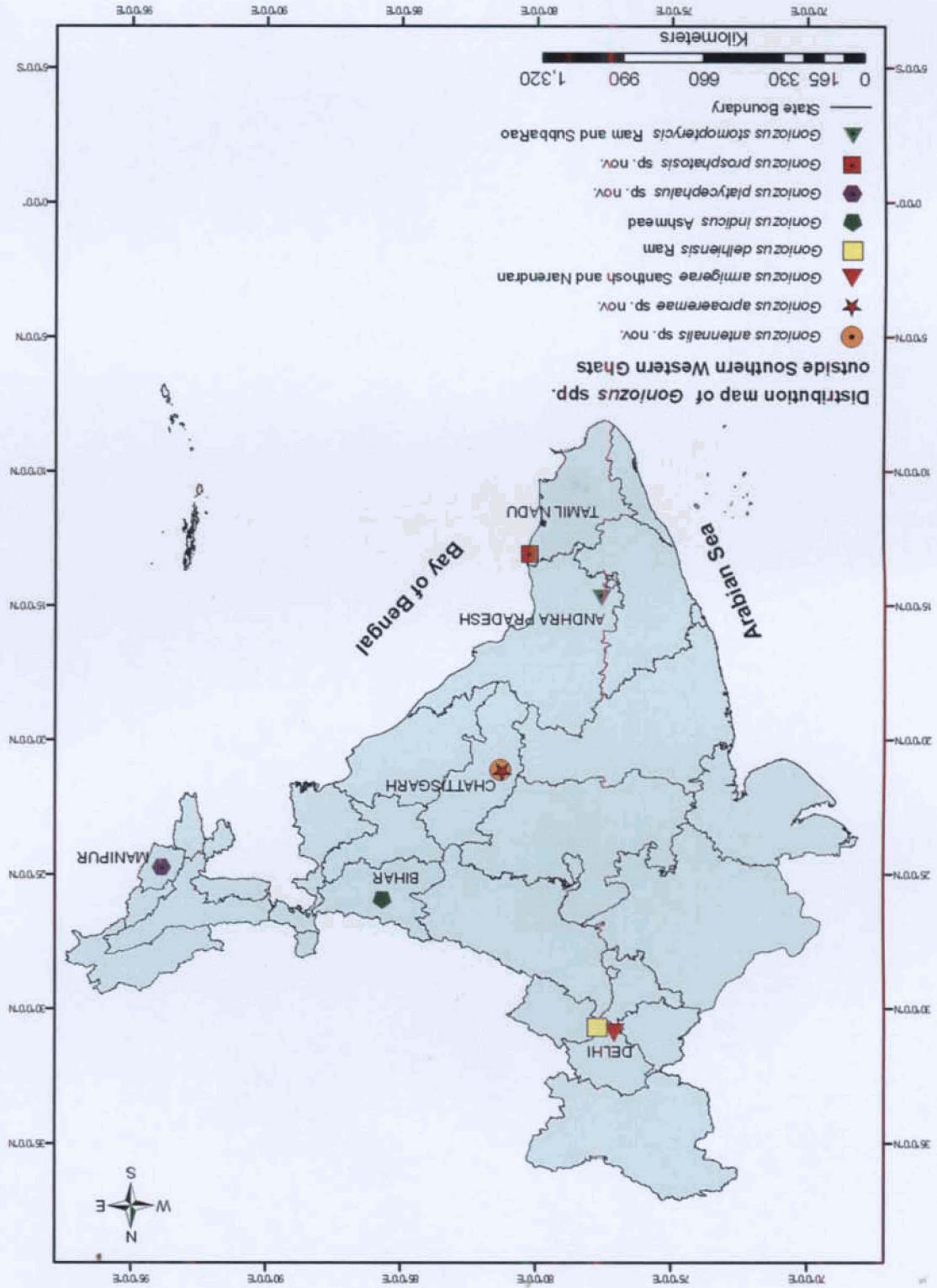












GENUS *ODONTEPYRIS* KIEFFER 1904

Odontepyrus Kieffer 1904c, 1: 378. Type-species: *Odontepyrus flavinervis* Kieffer.

Original Designation. Holotype: female. SUMATRA: Pangherang-Pisang. x. 90, iii. 91 (E. Modigliani) (MCSN). Note- The genus was not characterized until 1905.

Trissomalus Kieffer 1905b 29: 105. Type-species: *Goniozus transvaalensis*

Buysson, 1897: 354 by subsequent designation. Holotype: female. SOUTH AFRICA: Transvaal, Hamman's Kraal, 1893 (E.Simon) (MNHN) synonymized by POLASZEK and KROMBEIN, (1994).

Diagnosis: Maxillary palpi with 5 segments, labial palpi 3; median lobe of clypeus large, anteriorly produced, triangular or subtriangular; median carina of clypeus continues well onto front; narrow, unsculptured, shiny streak extends from proximal end of clypeal carina to front ocellus; antenna with 13 segments. Pronotum short, wider than long; notauli absent; scutellum with a pair of enlarged pits basally; mesopleuron expanded bearing a dentate process developed in varying degrees in some species; propodeal disc with median, lateral and transverse carinae; a pair of pits present near base of propodeal disc. Forewing with pterostigma large; prostigma present and rectangular; marginal cell open; areola present (absent in few species); Rs + m vein is reduced, shorter than Rs vein; radial vein without a sharp angle.

Statistics: The genus *Odontepyrus* Kieffer is represented by 33 species in the world (XU and HE, 2006a; LIM *et al.*, 2009) with four species from Palaearctic region, three species from Ethiopian region, four species from Australian region, and 17 species from Oriental region (POLASZEK and KROMBEIN, 1994; KROMBEIN, 1996; TERAYAMA, 1995a, 1997b; XU *et al.*, 2002a).

Biology: They are parasitoids of microlepidopteran larvae. Host species are from Pyralidae, Noctuidae and Crambidae.

Distribution: The genus *Odontepyris* Kieffer is represented by 33 species in the world and 17 of them are known from Oriental region. Seven species are distributed in India, but none of them in Southern Western Ghats.

Phylogeny: The phylogenetic analysis (POLASZEK and KROMBEIN, 1994) of 11 taxa of Bethylinae for 22 morphological characters provided more stable classification of the subfamily. In this context, the newly described species were manually analyzed and the character coding and data matrix are given in tables (see tables 19 and 20).

The apomorphic characters found in *Odontepyris* are absence of notauli, enlarged scutellar foveae connected by broad transverse groove, expansion of mesopleuron, sometimes with dentate processes, presence of posterior transverse propodeal carina, median longitudinal propodeal carina, and longitudinal discal propodeal carina. The absence of posterior propodeal transverse carina is a plesiomorphic character in Bethylinae and it is shown by *Lytopsenella*, *Eupsenella*, *Sierola* and *Bethylus*, whereas in all studied *Odontepyris* spp. posterior propodeal transverse carina is present.

Remarks: The genus is mostly distributed in the tropics.

Table – 19. Character list and coding of Oriental *Odontepyris*

- #1. Forewing areolet/
 - 0. absent/
 - 1. present/
- #2. Median propodeal carina/
 - 0. incomplete/
 - 1. complete/
- #3. Transverse propodeal carina/
 - 0. complete/
 - 1. interrupted medially/
- #4. Paramedian propodeal carina/
 - 0. absent/
 - 1. weak, incomplete, converging/
 - 2. complete/
 - 3. weak, incomplete, parallel/

- #5. Anterior clypeal margin/
 - 0. obtuse/
 - 1. acute/
 - 2. right angled/
- #6. Clypeal carina/
 - 0. not extending onto front, but only polished streak/
 - 1. extending onto front as carina itself/
- #7. Posterior vertex margin/
 - 0. straight/
 - 1. concave/
- #8. Ocellar triangle/
 - 0. right angled/
 - 1. acute/
- #9. Shape of areolet/
 - 0. ellipsoidal/
 - 1. subtriangular/
 - 2. subrectangular/
- #10. Second sterna/
 - 0. smooth/
 - 1. sparsely punctate/
 - 2. densely punctate/
 - 3. coriaceous/
 - 4. with piliferous tubercles/
- #11. Scrobe/
 - 0. ecarinate/
 - 1. weakly carinate/
 - 2. distinctly carinate/
- #12. Scape/
 - 0. shorter than 2x pedicel/
 - 1. as long as 2x pedicel/
 - 2. longer than 2x pedicel/
- #13. Ocellocular line (OOL)/
 - 0. shorter than 1.11x width of ocellar triangle (WOT)/
 - 1. 1.2 – 1.5x width of ocellar triangle (WOT)/
 - 2. 1.53 – 2x width of ocellar triangle (WOT)/
- #14. Width of frons (WF)/
 - 0. 1.05 – 1.19x height of eye (HE)/
 - 1. 1.2x - 1.41x height of eye (HE)/
- #15. First flagellar segment (F1)/
 - 0. longer than pedicel/
 - 1. as long as pedicel/
 - 2. shorter than pedicel/
- #16. Forefemur/
 - 0. 2.0 – 2.4x as long as wide/
 - 1. 2.45 – 2.87x as long as wide/
 - 2. more than 2.88x as long as wide/

- #17. Length of first flagellar segment (F1)/
 - 0. less than 2x its width/
 - 1. 2x its width/
 - 2. more than 2x its width/
- #18. Length of areolet/
 - 0. 1.6 – 1.9x its width/
 - 1. 2 – 2.9x its width/
 - 2. 3 – 4x its width/
- #19. Pronotal lateral margin/
 - 0. carinate/
 - 1. ecarinate/
- #20. Width of head in full face view/
 - 0. shorter than 1.1x its length/
 - 1. longer than 1.1x its length/
- #21. Maximum distance from top of the eye to posterior margin of vertex (EV)/
 - 0. shorter than 0.45x height of eye (HE)/
 - 1. longer than 0.50x height of eye (HE)/
- #22. Width of head in full face view (WH)/
 - 0. shorter than 1.56x width of frons (WF)/
 - 1. 1.60 – 1.69x width of frons (WF)/
 - 2. longer than 1.70x width of frons (WF)/
- #23. Head/
 - 0. sparsely punctate, punctures separated by distance equal to or more than 2 3x its diameter/
 - 1. moderately punctate, punctures separated by distance equal to its own diameter/
 - 2. densely punctate, punctures separated by distance less than its diameter/
 - 3. not punctate/
- #24. Forewing/
 - 0. hyaline/
 - 1. infumated/

Table – 20. Data matrix of Oriental *Odontepyris*

Taxon	Character coding																									
	1	2	3	4	5	6	7	8	9	0	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	
<i>Odontepyris batrae</i> Kurian	1	1	?	1	1	1	1	0	0	?	?	2	?	?	0	1	2	?	1	?	?	?	0	?		
<i>Odontepyris hypsipylae</i> (Kurian)	1	1	?	1	?	1	1	0	0	?	?	0	?	?	1	1	1	?	1	?	?	?	0	?		
<i>Odontepyris ovatus</i> Xu & He	1	1	?	1	1	1	1	1	0	?	?	2	2	?	0	1	2	?	1	?	?	?	1	1		
<i>Odontepyris rufipedis</i> Xu & He	1	1	?	1	1	1	1	1	0	?	?	2	2	?	0	1	0	?	1	?	?	?	1	1		
<i>Odontepyris ruficrus</i> Krombein	1	1	?	0	?	1	1	1	1	0	2	2	0	1	0	0	?	1	0	0	?	0	1			
<i>Odontepyris taiwanus</i> Terayama	1	?	?	1	1	1	1	1	2	1	?	1	2	?	0	?	1	?	0	1	0	?	2	1		
<i>Odontepyris anamalaicus</i> sp. nov.	1	1	0	1	1	0	1	1	0	4	1	2	2	?	1	1	0	1	0	0	1	1	1	1		
<i>Odontepyris flavinervis</i> Kieffer	1	1	?	1	?	1	1	?	1	?	?	?	?	?	?	1	?	?	0	1	?	0	1			
<i>Odontepyris argyriae</i> Kurian	1	1	?	0	?	1	1	0	0	?	?	1	?	?	0	0	1	?	?	?	?	1	?			
<i>Odontepyris cirphi</i> Kurian	1	1	?	0	1	1	1	0	0	?	?	1	?	?	0	1	0	?	?	?	?	0	?			
<i>Odontepyris muesebecki</i> Krombein	1	1	?	1	?	0	1	1	0	1	0	1	0	1	2	1	0	?	1	0	0	?	0	1		
<i>Odontepyris keystonellus</i> sp. nov.	1	1	0	1	1	1	0	1	1	3	0	2	1	1	1	0	0	2	1	1	1	1	1	1		
<i>Odontepyris hainanus</i> Xiao & Xu	1	1	?	2	1	?	0	1	1	?	?	2	1	0	2	0	0	1	1	0	?	1	0	1		
<i>Odontepyris formosicola</i> Terayama	1	?	1	3	1	1	0	1	1	0	?	0	2	1	2	?	0	0	1	0	1	1	1	1		
<i>Odontepyris quadrifoveatus</i> (Muesebeck)	1	1	?	1	1	1	0	1	1	1	1	0	1	1	2	0	0	2	1	0	1	?	0	0		
<i>Odontepyris cephalopunctatus</i> sp. nov.	1	1	0	2	2	1	0	0	0	0	1	1	1	0	2	0	0	1	0	0	0	1	2	0		
<i>Odontepyris obtusus</i> Xu & He	1	1	?	2	0	1	0	1	0	?	?	2	1	1	1	?	0	2	1	0	?	2	0	1		
<i>Odontepyris terayamai</i> sp. nov.	1	1	0	1	0	0	0	1	0	0	0	2	0	0	0	1	1	2	1	0	0	2	3	1		
<i>Odontepyris fujianus</i> Xu, He & Terayama	0	1	?	1	1	1	1	1	N	3	?	2	2	1	0	?	1	N	?	1	1	?	0	1		
<i>Odontepyris liukueiensis</i> Terayama	0	?	?	1	0	1	0	1	N	0	?	2	?	?	1	?	?	N	0	1	0	0	1	1		
<i>Odontepyris mandibularis</i> Krombein	0	0	?	1	1	1	1	1	N	4	2	2	1	1	1	2	?	N	1	1	1	?	1	1		
<i>Odontepyris koottanadensis</i> sp. nov.	0	1	0	2	1	1	1	1	N	4	1	1	1	1	0	1	0	N	0	1	0	1	1	1		
<i>Odontepyris ventralis</i> Krombein	0	1	?	1	1	1	1	1	N	2	2	2	1	1	1	1	0	N	1	1	0	?	2	1		
<i>Odontepyris indicus</i> (Kurian)	0	1	?	0	1	1	1	?	N	?	?	2	?	?	0	1	2	N	1	1	0	?	?	?		

? - Unknown; N - Not applicable

5.2.1 Key to Oriental species of *Odontepyris* Kieffer

1. Forewing without areolet ----- 2
 -- Forewing with areolet ----- 7
- 2(1). Anterior clypeal margin acute; vertex crest emarginate ----- 3
 -- Anterior clypeal margin obtuse; vertex crest straight -----
 ----- *liukueiensis* Terayama
- 3(2). Median propodeal carina complete; forefemur length shorter than 3x its
 width ----- 4
 -- Median propodeal carina incomplete, absent in basal one-third; forefemur
 length 3.1x its width ----- *mandibularis* Krombein
- 4(3). OOL 1.33 – 1.4x WOT; F₁ 1.4-1.5x as long as wide ----- 5
 -- OOL 1.7 – 1.88x WOT; F₁ 2-2.5x as long as wide ----- 6
- 5(4). Pronotal lateral margin ecarinate; F₁ as long as pedicel; forefemur length
 2.58 - 2.63x its width ----- *ventralis* Krombein
 -- Pronotal lateral margin carinate; F₁ distinctly longer than pedicel; forefemur
 length 2.78x its width ----- *koottanadensis* sp. nov.
- 6(4). EV 0.45x HE; F₁ 2.5x as long as wide; ----- *indicus* (Kurian)
 -- EV 0.56x HE; F₁ 2x as long as wide ----- *fujianus* Xu, He and Terayama
- 7(1). Vertex crest straight ----- 8
 -- Vertex crest emarginate ----- 14
- 8(7). Anterior clypeal margin obtuse or right angled; areolet ellipsoidal ----- 9
 -- Anterior clypeal margin acute; areolet subtriangular ----- 11

- 9(8). Clypeal carina restricted to clypeus, not extending to frons; paramedian carina on propodeum not joining posterior transverse carina; head coriaceous without punctures ----- *terayamai* sp. nov.
- Clypeal carina extending to frons as a low carina beyond posterior scrobal margin; paramedian carina on propodeum joining posterior transverse carina; head coriaceous with punctures ----- 10
- 10(9). Pronotal lateral margin ecarinate; F_1 1.9x as long as wide, equal to pedicel; scape 2.9x as long as wide; propodeal disc 0.62x as long as wide; anterior clypeal margin obtuse; forewing infumated, areolet 3.6x as long as wide head sparsely punctate, separated by $\geq 1x$ its diameter - *obtusus* Xu and He
- Pronotal lateral margin carinate; F_1 1.1x as long as wide, less than pedicel; scape 2x as long as wide; propodeal disc 0.45x as long as wide; anterior clypeal margin right angled; forewing hyaline, areolet 2.3x as long as wide; head densely punctate, separated by 0.5x its diameter -----
-----*cephalopunctatus* sp. nov.
- 11(8). Scape 1.8 - 1.83x pedicel; F_1 1.45 – 1.5x as long as wide ----- 12
- Scape 2.2 - 2.8x pedicel; F_1 1.75 – 1.8x as long as wide ----- 13
- 12(11). OOL 1.4 - 1.5x WOT; propodeal disc 0.53x as long as wide; areolet narrow, no wider than veins enclosing it; transverse propodeal carina complete; paramedian propodeal carina converging posteriorly -----
-----*quadrioveatus* (Muesebeck)
- OOL 1.89x WOT; propodeal disc 0.69x as long as wide; areolet distinctly wider than veins enclosing it; transverse propodeal carina narrowly interrupted medially; paramedian propodeal carina parallel -----
-----*formosicola* Terayama
- 13(11). Antenna uniformly yellow; areolet narrow, 3x as long as wide; F_1 equal to pedicel; scape 2.5 - 2.67x as long as wide ----- *keystonellus* sp. nov.

- Antenna reddish brown; areolet relatively wide, 2x as long as wide; F₁ shorter than pedicel; scape 2.8x as long as wide ----- *hainanus* Xiao and Xu
- 14(7). Clypeal carina not extending to frons----- 15
- Clypeal carina extending to frons ----- 16
- 15(14). Pronotal lateral margin ecarinate; punctures on head separated by 2-3x its diameter; EV 0.29-0.31x HE; OOL 1.06-1.07x WOT; scape 2x pedicel; F₁ shorter than pedicel; scrobe ecarinate----- *muesebecki* Krombein
- Pronotal lateral margin carinate; punctures on head separated by its diameter; EV 0.5-0.57x HE; OOL 1.4-1.67x WOT; scape longer than 2x pedicel; F₁ as long as or longer than pedicel; scrobe strongly carinate -----*anamalaicus* sp. nov.
- 16(14). Head longer than wide in front view; parapsidal furrow absent, if present, very weak and incomplete; F₁ 2x as long as wide; head sparsely punctate; mesosoma narrower than head; eyes with sparse microscopic setae; EV 0.5x HE; small triangular areolet; mesopleuron with dentate process -----
----- *flavinervis* Kieffer
- Head as long as or wider than long in front view; other characters not in above combination, partly or completely different ----- 17
- 17(16). Propodeal paramedian discal carina absent ----- 18
- Propodeal paramedian discal carina present ----- 20
- 18(17). Ocelli arranged in acute triangle; forewing with moderately large subtriangular areolet; F₁ as long as pedicel; scape 2.5x pedicel -----
----- *ruficrus* Krombein
- Ocelli arranged in obtuse triangle; forewing with small ellipsoidal/oval areolet; F₁ longer than pedicel; scape 2x pedicel ----- 19

- 19(18). Mesosoma 2x its width at tegula; forewing length 3x its width; ocellular length 3x the front ocellar length; forefemur 2.86x as long as wide -----
----- *cirphi* Kurian
- Mesosoma more than 2.33x its width at tegula; forewing length more than 3x its width; ocellular length more than 3.5x front ocellar length; forefemur 2x as long as wide ----- *argyriae* Kurian
- 20(17). Pronotal lateral margin carinate; forewing with rectangular areolet; head densely punctate dorsally, punctures separated by 0.5-1.0x their own diameter; anterior clypeal margin narrowly rounded, obtuse -----
----- *taiwanus* Terayama
- Pronotal lateral margin ecarinate; forewing with ellipsoidal or subtriangular areolet; head sparsely punctate dorsally; anterior clypeal margin acute - 21
- 21(20). Scape shorter than 2x pedicel; F1 as long as pedicel --- *hypsipyrae* (Kurian)
- Scape longer than 2x pedicel; F1 longer than pedicel ----- 22
- 22(21). Propodeal paramedian discal carina weak; scape 2.2x as long as pedicel; F₁ 2.67x as long as wide ----- *batrae* Kurian
- Propodeal paramedian discal carina strong; scape 2.4 - 2.56x as long as pedicel; F₁ 1.8 - 2.2x as long as wide ----- 23
- 23(22). Legs fully ferruginous; forewing with veins brown and pterostigma black, areolet 2.8x as long as its width ----- *rufipedis* Xu and He
- Legs black except trochanters, tibiae and tarsi brown reddish; forewing veins testaceous and pterostigma brown; areolet 2.33x as long as its width -
----- *ovatus* Xu and He

***Odontepyris anamalaicus* sp. nov.**

(figs.119-122, 294-297)

Diagnosis. Head coriaceous, moderately punctate, separated by its diameter; anterior clypeal margin acute; clypeal carina not extending onto front; scrobe strongly carinate; vertex crest emarginated; EV 0.5-0.57x HE; WH 1.09- 1.14x LH; eye sparsely setose, setae as long as diameter of single facet; OOL 1.4–1.67x WOT; ocellar triangle acute. Antenna brown; scape longer than 2x pedicel; $F_1 \geq$ pedicel. Pronotal lateral margin carinate; median propodeal carina complete; paramedian propodeal carina incomplete, not joining posterior transverse carina. Forewing infumated with ellipsoidal areolet; areolet 2.5x as long as wide, narrow, but wider than vein enclosing it. Forefemur 2.45-2.6x as long as wide; SI 3.6 – 3.8.

Description: Holotype – Female.

Measurements: Length 6.65mm; LH 1.4 mm; WH 1.55 mm; WF 0.97 mm; LM 2.3 mm; FWL 4 mm; LPD 0.57 mm; WPD 1.14mm.

Colour: Body black, last tergite brown; mandible dark brown; antenna brown; forefemur and forecoxa black, coxa and femur of mid and hind legs dark brown; tibia, trochanter, tarsi brownish yellow; tarsal claw pale brown. Forewing infumated; pterostigma brown, other veins straw coloured.

Head: Head (figs.294, 121) wider than long, WH 1.09x LH; coriaceous with shallow setigerous punctures, separated by their own diameter; vestiture short, sparse, decumbent; head as wide as maximum width of mesosoma; mandible robust with 4 teeth, ventral most tooth being longest, curved downwards; clypeus strongly produced anteriorly, anterior margin acute; clypeal carina restricted to clypeus; smooth line extends from posterior end of clypeal carina to anterior ocellus; scrobe strongly carinate; vertex strongly emarginate in full face view, smoothly curving to occiput, ecarinate; setae on vertex margin not longer than that of frons; gena (fig.120) smooth, polished with scattered setae; eye 0.69mm long, sparsely setose, setae minute, as long as diameter of single facet; ocelli in acute triangle, posterior ocelli away from occipital margin by 1.5x the diameter of posterior ocelli; HE 1.54x

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OOL; OOL 1.63x WOT; EV 0.5x HE (fig.296); WF 1.4x HE; WH 1.61x HE; POL:AOL:DAO = 4:3.5:2. Relative lengths of first five antennal segments (fig.295) 17:8:8:7:6; scape 2.45x as long as wide; scape longer than 2x pedicel length; pedicel 1.78x as long as wide; F1 longer than wide.

Mesosoma: Pronotum (fig.122) strongly coriaceous, vestiture abundant, long suberect; pronotum (fig.294) 0.5x as long as wide with lateral sides carinate in dorsal view, carinae corrugated; mesonotum with shallow setigerous punctures separated from each other by 2x its diameter; vestiture short, sparse, decumbent; parapsidal furrow present, anteriorly incomplete; scutellum smooth, polished, vestiture sparse, decumbent, long; basal pair of scutellar pits slit like, separated at least by 4.5x their maximum diameter, deep wide groove connects two pits; propodeal disc 0.5x as long as its maximum width; propodeal dorsum with three distinct discal carinae, median carina straight reaching posterior, straight, strong, complete transverse carina; paramedian carina distally converging, not joining posterior transverse carina; median area depressed with transverse rugae; sublateral area transversely strigate; declivity coriaceous without median longitudinal carina. Forewing (fig.294) 2.9x as long as wide, with very small ellipsoidal areolet, 2.5x as long as wide; median cell with abundant setae; submedian cells with single row of few setae; area posterior to areolet sparsely setose. Forefemur (fig.297) 2.6x as long as wide; SI 3.4.

Metasoma: Metasoma (fig.119) distinctly longer than mesosoma (92:68); T1 – T3 smooth and polished; T4 – T5 with weakly coriaceous basal band; T6 - T7 smooth and polished. T1- T2 with few setae on lateral sides, others with setae on the dorsal side.

Male: Unknown.

Ecology and Biology: Plant host is *Cinchona* spp. (Rubiaceae).

Etymology: The species epithet is after the type locality, Anamalai Hills.

Material examined: Holotype – Female. INDIA: Tamil Nadu, Anamalai Hills, 10°22'17.40"N 77°9'27.05"E, 1200m, v.1964, TEF, ex. *Cinchona* spp., Susai Nathan leg., VRN 212 (ZMAN). ON LOAN. *Paratypes.* 2 ♀. same data as holotype except VRN 211, VRN 210 (ZMAN). ON LOAN.

Variations. The paratypes are similar to holotype except the variation in morphometric measurements as shown in table - 21.

Remarks. This new species resembles *O. muesebecki* Krombein, but differs in having pronotal lateral margin carinate whereas in *O. muesebecki*, pronotal lateral margin is ecarinate. In this new species, head is moderately punctate, that is punctures separated by their own diameter, whereas in *O. muesebecki* head is sparsely punctate, that is punctures separated by 2-3x their diameter. In this new species, scrobe strongly carinate, whereas in *O. muesebecki* scrobe is ecarinate. In this new species EV 0.5-0.57x HE, OOL 1.4–1.67x WOT, scape longer than 2x pedicel and $F_1 \geq$ pedicel, whereas in *O. muesebecki* EV 0.29-0.31x HE, OOL 1.06-1.07x WOT, scape 2x pedicel and F_1 shorter than pedicel.

Table – 21. Morphometric ratios of *Odontepyris anamalaicus* sp. nov.

VRN	WH/LH	WF/HE	EV/HE	LPD/WPD	OOL/WOT	FFL/FFW	PDL/PDW	LS/PL	SI
212	1.0976	1.4	0.5	0.5	1.625	2.6	0.5142	2.125	3.5986
210	1.1379	1.3809	0.5238	0.5428	1.4444	2.4545	0.4761	2.1666	3.6666
211	1.1064	1.5238	0.5714	0.5789	1.6666	2.5454	0.5	2.1666	3.8024
Mean Values	1.11	1.43	0.53	0.54	1.58	2.53	0.50	2.15	3.69

***Odontepyris cephalopunctatus* sp. nov.**

(figs.123-126, 298-301)

Diagnosis: Head coriaceous, densely punctate, separated by 0.5x its diameter; anterior clypeal margin right angled; clypeal carina extending onto front; scrobe strongly carinate; eye sparsely setose, setae shorter than diameter of single facet;
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OOL 1.22x WOT; ocellar triangle acute; vertex crest straight; EV 0.38x HE; WH 1.05x LH. Antenna yellow, scape at base and terminal 7 flagellar segments brown; scape 2x as long as wide; F₁ 1.1x as long as wide, less than pedicel. Pronotal lateral margin carinate; propodeal disc 0.45x as long as wide; median and paramedian propodeal carina complete, joining posterior transverse carina. Forefemur length 2.2x its width. Forewing hyaline, areolet 2.3x as long as wide.

Description: Holotype – Female.

Measurements: Length 3.89 mm; LH 0.89 mm; WH 0.93 mm; WF 0.56 mm; LM 1.29 mm; FWL 2.4 mm; LPD 0.29 mm; WPD 0.66mm.

Colour: Body black; mandible, teeth black; antenna yellow, scape at base and terminal 7 flagellar segments brown; coxa, femur dark brown; fore trochanter brown; tibia, mid and hind trochanters, tarsi yellow; tarsal claw brownish black. Forewing hyaline; parastigma, pterostigma brown, costa, subcosta yellow, other veins colourless.

Head: Head (figs.125, 298) wider than long, WH 1.05x LH, strongly coriaceous and heavily punctuate, setigerous punctures shallow separated from each other by less than its own diameter; vestiture short, sparse, decumbent; head wider than maximum width of mesosoma; mandible robust with 4 teeth, basal blunt, others pointed; ventral most tooth being longest, straight; clypeus strongly produced anteriorly, anterior margin right angled; clypeal carina extending onto front well beyond posterior scrobal margin; shallow short groove extends from anterior ocellus to frons, not reaching middle of head; scrobe strongly carinate; vertex straight in full face view, smoothly curving to occiput, ecarinate; setae on vertex margin not longer than that of frons; gena (fig.124) coriaceous with scattered setigerous punctures; eye 0.48mm long, sparsely setose; ocular setae minute, as long as diameter of single facet; ocelli in acute triangle, posterior ocelli away from occipital margin by its diameter; HE = OOL; OOL 1.22x WOT; EV 0.38x HE (fig.300); WF 1.17x HE; WH 1.95x HE; POL:AOL:DAO = 4:3.5:2.5; Relative lengths of first five antennal segments (fig.299) 11:5.5:5:4.5:4; scape 2x as long as wide; scape 2x pedicel;

pedicel 1.37x as long as wide; F1, F11 longer than wide, other flagellar segments wider than long.

Mesosoma: Pronotum (fig.126) strongly coriaceous without punctures, vestiture short, sparse, decumbent; pronotum (fig.298) 0.38x as long as wide with carinate lateral sides in dorsal view; mesonotum and scutellum strongly coriaceous with shallow setigerous punctures; vestiture long, sparse, and suberect; parapsidal furrow present, complete; scutellum with 4 foveae anteriorly, lateral ellipsoidal pair separated at least by 3.4x their maximum diameter, median pair shallower, separated on midline by carina; propodeal disc 0.45x as long as its maximum width; propodeal dorsum with three distinct discal carinae, median carina straight reaching posterior strong, concave, complete transverse carina; paramedian carina distally converge and join with posterior transverse carina; median area depressed with transverse rugae; sublateral area transversely strigate; disc and declivity coriaceous. Forewing (fig.298) 3x as long as wide, with small ellipsoidal areolet, 2.3x as long as wide; median and submedian cells with a row of few setae; area posterior to areolet with few sparsely scattered setae. Forefemur (fig.301) 2.2x as long as wide; SI 3.65.

Metasoma: Smooth and polished; T1 – T4 with few setae on lateral sides, others with setae on the dorsal side. Metasoma (fig.123) distinctly longer than mesosoma (75:57).

Male: Unknown.

Ecology and Biology: Unknown.

Etymology: The species epithet is after the densely punctate head.

Material Examined. *Holotype* – Female. INDIA: Tamil Nadu, Nilgiris, Chamrajnagar, Bedaguli, 9.46kms NW Punanjanur, 11°49.61'N 77°10.90'E; 1356m; SEF; WPT; 18. iv. 2007, Mahadesha leg., VRN 203 (DZUC).

Discussion: This new species comes close to *O. obtusus* Xu and He recorded from Fujian province of China. In this new species, pronotal lateral margin is carinate, head is densely punctate dorsally, punctures separated by 0.5x its diameter, anterior
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clypeal margin right angled, forewing is hyaline and areolet is 2.3x as long as wide, F₁ is 1.1x as long as wide, F₁ shorter than pedicel and scape 2x as long wide, whereas in *O. obtusus* it is ecarinate, head sparsely punctate, separated by $\geq 1x$ its diameter, clypeal margin obtuse, forewing is infumated and areolet 3.6x as long as wide, F₁ 1.9x as long as wide, F₁ is equal to pedicel and scape 2.9x as long as wide. In this new species propodeal disc is wider than that of *O. obtusus*.

This new species differs from *O. terayamai* sp. nov. in having dense punctures on head and mesosoma, clypeal carina in extending onto front as a low carina and paramedian propodeal carina is joining posterior transverse carina whereas in *O. terayamai* sp. nov., head and mesosoma are devoid of punctures, clypeal carina is restricted to median lobe of clypeus and paramedian propodeal carina is not joining transverse carina.

***Odontepyris kestonellus* sp. nov.**

(figs.127-131, 302-305)

Diagnosis: Head coriaceous, moderately punctate, separated by its own diameter; anterior clypeal margin acute; clypeal carina extending onto front; scrobe ecarinate; ocellar triangle acute; vertex crest straight; eye sparsely setose, setae as long as diameter of single facet. Antenna uniformly yellow; F₁ equal to pedicel; scape 2.5 - 2.67x as long as wide. Pronotal lateral margin ecarinate; paramedian propodeal carina distally convergent, 0.86x as long as propodeal disc, not joining posterior transverse carina. Forewing infumated with acutely triangular areolet; areolet 3x as long as wide, narrow, not wider than the vein enclosing it. Forefemur 2.2 - 2.3x as long as wide; SI 4.1 - 4.26.

Description: Holotype – Female.

Measurements: Length 5.35mm; LH 1.14mm; WH 1.14mm; WF 0.69mm; LM 1.67 mm; FWL 3.27mm; LPD 0.43mm; WPD 0.84mm.

Colour: Body black; mandible yellow with brownish tinge, teeth brown; antenna uniformly yellow; leg yellow; tarsal claw brownish black. Forewing infumated; parastigma and pterostigma pale brown, other veins straw coloured.

Head: Head (figs.129, 302) as long as wide, $WH = LH$; microreticulate with shallow setigerous punctures, separated from each other by its own diameter; vestiture moderately dense decumbent, thin; head slightly wider than maximum width of mesosoma; mandible with 4 teeth, ventral most being longest, curved downwards; clypeus strongly produced anteriorly, anterior margin acute; clypeal carina extending onto front as low carina slightly beyond the level of posterior margin of scrobe; smooth line extends from posterior end of clypeal carina to anterior ocellus; scrobe ecarinate; vertex smoothly angled to occiput, ecarinate; vertex almost straight in full face view; setae on vertex margin not longer than others; gena (fig.128) weakly coriaceous, sparsely setose; eye 0.53mm long, sparsely setose with minute setae as long as diameter of single facet; ocelli in acute triangle, posterior ocelli away from occipital margin by twice its diameter; $HE\ 1.53x\ OOL$; $OOL\ 1.42x\ WOT$; $EV\ 1.59x\ HE$ (fig.304); $WF\ 1.31x\ HE$; $POL:AOL:DAO = 2.5:2:2$. Relative lengths of first five antennal segments (fig.303) 16:7:7:6:6; scape 2.67x as long as wide; scape longer than 2x pedicel length; pedicel 1.75x as long as wide; F1 1.75x as long as wide.

Mesosoma: Mesosoma (fig.130) microreticulate with shallow setigerous punctures similar to head sculpture, but vestiture sparser; pronotum (fig.302) 0.48x as long as wide with rounded anterolateral corners in dorsal view; lateral margin ecarinate; parapsidal furrow distinct; scutellum with 4 foveae anteriorly, lateral pair ellipsoid pits, separated at least by 2.5x their maximum diameter, median pair shallower, separated on midline by carina; propodeal disc 0.5x as long as its maximum width; propodeal dorsum with distinct three discal carinae, median discal carina straight reaching posterior concave transverse carina; paramedian carina 0.86x as long as LPD, distally convergent, not joining transverse carina; median area depressed with transverse rugae; sublateral area microreticulate with distal irregular rugae; declivity microreticulate; no median longitudinal carina on declivity. Forewing (fig.302) 4x as

long as wide, areolet (fig.131) acutely triangular, 3x as long as wide, wider than the veins enclosing it; median cell with sparsely scattered setae, distal posterior corner clear, submedian cell with a row of setae; area posterior to areolet setose. Forefemur (fig.305) 2.3x as long as wide; SI 4.1.

Metasoma: Tergites smooth and polished. Metasoma (fig.127) longer than mesosoma (62:41)

Male: Unknown.

Ecology and Biology: Unknown

Etymology: The name of the species is technically an arbitrary combination of letters, but the pronunciation of this name is after the name of Keystone Foundation, the institute which led the exploration leading to the collection and discovery of this specimen.

Material Examined: *Holotype* – Female. INDIA: Tamil Nadu, Nilgiris, Chamrajnagar, Kurimandai, 4.78kms NW Punanjanur, 11°81.89'N 77°11.28'E, 1013m, DDF, YPT, 14.iv. 2007; Mahadesha leg., VRN 209 (DZUC). *Paratypes*. 2 ♀. same data of holotype, VRN 208, VRN 207 (DZUC).

Variation: The paratypes resemble holotype in all characters except following morphometric measurements: in both paratypes scape 2.5x as long as wide; forefemur 2.2x as long as wide; SI 4.26; scape 2.14x pedicel; OOL 1.36x WOT. In paratype VRN 207, WF 1.39x HE and in paratype VRN 208, pronotal disc 0.54x as long as wide. See table- 22 for morphometric ratios of all the type materials examined.

Discussion: *Odontepyrus keystonellus* sp. nov. is closely related to *O. hainanus* Xiao and Xu recorded from Hainan province of southern China. In *O. keystonellus* sp. nov. antenna uniformly yellow, areolet is narrow, 3x as long as wide, F1 equal to pedicel and scape 2.5 - 2.67x as long as wide, whereas in *O. hainanus* antenna reddish brown, areolet relatively wide, 2x as long as wide, F1 shorter than pedicel and scape 2.8x as long as wide.

Table – 22. Morphometric ratios of *Odontepyris keystonellus* sp. nov

VRN	WH/LH	WF/HE	EV/HE	LPD/WPD	OOL/WOT	FFL/FFW	PDL/PDW	LS/PL	SI
208	1	1.3	0.46667	0.5	1.357143	2.222222	0.538462	2.1428	4.26036
207	1	1.39286	0.53571	0.48936	1.357143	2.222222	0.481481	2.1428	4.26036
209	1	1.30769	0.65385	0.5122	1.416667	2.3125	0.489362	2.2857	4.11111
Mean Values	1	1.33	0.55	0.50	1.38	2.25	0.50	2.19	4.21

***Odontepyris koottanadensis* sp. nov.**

(figs.132-135, 306-309)

Diagnosis: Head coriaceous, moderately punctate, separated by its own diameter; anterior clypeal margin acute; clypeal carina extending onto front; scrobe strongly carinate; eye sparsely setose, setae shorter than diameter of single facet; OOL 1.4x WOT; ocellar triangle acute; vertex crest emarginated; EV 0.42x HE; WH 1.11x LH. Antenna dark brown, first 3 segments paler; scape 2x pedicel; F₁ is distinctly longer than pedicel; F₁ 1.5x as long as wide. Pronotal lateral margin carinate; median and paramedian propodeal carina complete, joining posterior transverse carina. Forefemur length 2.78x its width. Forewing infumated without areolet.

Description: Holotype – Female.

Measurements: Length 6.3 mm; LH 1.3 mm; WH 1.45 mm; WF 0.86 mm; LM 2.14 mm; FWL 3.4 mm; LPD 0.48 mm; WPD 0.93mm.

Colour: Body black; mandible dark brown; antenna first 3 segments brown with yellow tinge, other segments dark brown; leg pale brown; tarsal claw pale brown. Forewing hyaline and central disc slightly infumated; pterostigma brown, other veins straw coloured.

Head: Head (figs.134, 306) wider than long, WH 1.12x LH; microreticulate with shallow setigerous punctures, separated from each other by its own diameter;

vestiture short, sparse, decumbent; head distinctly wider than maximum width of mesosoma; mandible robust with 4 teeth, ventral most being longest, curved downwards; clypeus strongly produced anteriorly, anterior margin acute; clypeal carina extending onto front as low carina not reaching level of posterior margin of scrobe; no smooth line extends from posterior end of clypeal carina to anterior ocellus; scrobe strongly carinate; vertex smoothly curving to occiput, ecarinate; vertex strongly emarginate in full face view; setae on vertex margin not longer than others on head; gena (fig.133) weakly coriaceous abundantly setose; eye 0.66mm long, sparsely setose, setae minute, shorter than diameter of single facet; ocelli in acute triangle, posterior ocelli away from occipital margin by 2x diameter of posterior ocelli; HE 1.69x OOL; OOL 1.4x WOT; EV 2.1x HE (fig.308); WF 1.3x HE; POL:AOL:DAO = 4.5:3:2. Relative lengths of first five antennal segments (fig.307) 14:7:7.5:7:7; scape 1.54x as long as wide; scape 2x pedicel length; pedicel 1.5x as long as wide; F1 longer than wide.

Mesosoma: Pronotum (fig.135) anteriorly and mesonotum posteriorly strongly coriaceous; scutellum smooth and polished; mesosoma with shallow setigerous punctures separated from each other by 3x its diameter; vestiture short, sparse, and decumbent; pronotum (fig.306) 0.56x as long as wide with carinate lateral sides in dorsal view; parapsidal furrow present, but anteriorly weak; scutellum with 4 foveae anteriorly, lateral pair as rounded pits, separated at least by 3.5x their maximum diameter, median pair shallower, separated on midline by carina; propodeal disc 0.52x as long as its maximum width; propodeal dorsum with distinct three discal carinae, median discal carina straight reaching posterior, straight, strong, complete transverse carina; paramedian carina distally converging, joining posterior transverse carina; median area depressed with transverse rugae; sublateral area transversely strigate; declivity coriaceous; no median longitudinal carina on declivity. Forewing (306) 3x as long as wide, without areolet, only a very short stub from posterior half of basal vein; median and submedian cells with very few setae; area posterior to stub from basal vein clear; area anterior to base of stigmal vein devoid of setae. Forefemur (fig.309) 2.78x as long as wide; SI 4.6.

Metasoma: Metasoma (fig.132) longer than mesosoma (83:61); smooth and polished; T3 with weakly coriaceous in the basal band; T1 to T3 with few setae on lateral sides, others with setae on the dorsal side.

Male: Unknown.

Ecology and Biology: Unknown

Etymology: The species epithet is after the type locality, Koottanad.

Material examined: *Holotype* – Female. INDIA: Kerala, Palghat, Koottanad, 10°45.34'N 76°06.58'E, 48m, 21.xi.2004, sweeping, scrub jungle, S. Santhosh leg., VRN 199 (DZUC).

Remarks: The new species comes close to *O. ventralis* Krombein found in Sri Lanka. In *O. koottanadensis* sp. nov., pronotal lateral margin carinate, F_1 is distinctly longer than pedicel and forefemur length 2.78x its width, whereas in *O. ventralis* pronotal lateral margin ecarinate, F_1 is as long as pedicel and forefemur length 2.58 - 2.63x its width.

***Odontepyris terayamai* sp. nov.**

(figs.136-139, 310-313)

Diagnosis: Head coriaceous, impunctate; anterior clypeal margin obtuse; clypeal carina not extending onto front; scrobe ecarinate; eye sparsely setose, setae as long as diameter of single facet; OOL 0.94-1.23x WOT; ocellar triangle acute; gena smooth, aetose; vertex crest straight; EV 0.28-0.34x HE; WH 0.98-1.39x LH. Antenna reddish brown; scape 2.5x as long as wide; F_1 2x as long as wide, less than pedicel; scape longer than 2x pedicel length; pedicel 1.63x as long as wide. Pronotal lateral margin ecarinate; propodeal disc 0.47-0.60x as long as wide; paramedian propodeal carina incomplete, not joining posterior transverse carina. Forefemur length 2.2-2.57x its width. Forewing hyaline, areolet 3x as long as wide.

Description: *Holotype* – Female

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Measurements: Length 5.8mm; LH 1.22 mm; WH 1.22 mm; WF 0.69 mm; LM 2 mm; FWL 3.3 mm; LPD 0.47 mm; WPD 0.99mm.

Colour: Body black; mandible brown, teeth darker; antenna reddish brown, scape darker at base; coxa black, femur dark brown; trochanter, tibia, tarsi brownish yellow; tarsal claw brownish black. Forewing infumated, especially disc; pterostigma, margin of stigma vein brown, other veins straw coloured.

Head: Head (figs.138, 310) as long as wide, WH 1.09x LH; strongly coriaceous without shallow setigerous punctures; vestiture short, sparse, decumbent; head narrower than maximum width of mesosoma; mandible robust with 4 teeth, basal blunt, others pointed; ventral most tooth being longest, curved downwards; clypeus strongly produced anteriorly, anterior margin obtuse; clypeal carina restricted to clypeus; no smooth line extends from posterior end of clypeal carina to anterior ocellus; scrobe ecarinate; vertex straight in full face view, smoothly curving to occiput, ecarinate; setae on vertex margin not longer than that of frons; gena (fig.137) smooth, polished, aetose; eye 0.65mm long, sparsely setose; ocular setae minute, as long as diameter of single facet; ocelli in acute triangle, posterior ocelli away from occipital margin by its diameter; HE 2.23x OOL; OOL 0.94x WOT; EV 0.34x HE (fig.312) ; WF 1.05x HE; WH 1.87x HE; POL:AOL:DAO = 3.5:3:2.5. Relative lengths of first five antennal segments (fig.311) 14.5:6.5:7.5:7:7; scape 2.5x as long as wide; scape longer than 2x pedicel length; pedicel 1.63x as long as wide; F₁ 2x as long as wide.

Mesosoma: Pronotum, mesonotum and scutellum (fig.139) strongly coriaceous, without shallow setigerous punctures; vestiture of pronotum sparse, moderately long decumbent; mesonotum with short sparse suberect setae; scutellum with few scattered setae; pronotum 0.53x as long as wide with lateral sides ecarinate in dorsal view; parapsidal furrow weak, anteriorly incomplete; scutellum with 4 foveae anteriorly, lateral pair slit like pits, separated at least by 2.8x their maximum diameter, median pair shallower, separated on midline by carina; propodeal disc 0.47x as long as its maximum width; propodeal dorsum with three distinct discal carinae, median carina strong, straight reaching posterior, complete, strong, slightly

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concave transverse carina; paramedian carina distally converging, extending 0.77x the disc length, not joining posterior transverse carina; transverse rugae on inner margin of paramedian carina; sublateral area transversely strigate; sides of median discal carina and declivity coriaceous. Forewing (fig.310) 2.91x as long as wide, with large ellipsoidal areolet, 3x as long as wide; median cell with abundant setae, distal posterior corner clear; submedian cells with a row of few setae; area posterior to areolet sparsely setose. Forefemur (fig.313) 2.5x as long as wide; SI 3.91.

Metasoma: Metasoma (fig.136) distinctly longer than mesosoma (76:58); T1 completely smooth and polished; other tergites with weakly coriaceous basal band. First two tergites with few setae on lateral sides, others with setae on the dorsal side.

Male: Unknown.

Ecology and Biology: collected from scrub jungle. Host is unknown.

Etymology: The species epithet is after M. Terayama, Japanese bethyloid taxonomist.

Material Examined: *Holotype* – Female. INDIA: Kerala, Malappuram, Calicut University Campus, Botanical Garden, Arboretum, 11°07.58'N 75°53.24'E, 80m, 28. iv – 11. v. 2007, MT, S. Santhosh, leg., VRN 200 (DZUC). *Paratypes*: 2 ♀. INDIA: Kerala, Kannur, Panayathanparamba, 3kms W Kannur Airport, 11°54.32'N 75°30.27'E, MT, scrub jungle, S. Santhosh leg., 10-24.ii.2008, VRN 204, VRN 206; 1 ♀. data same as above except 13-27.iii.2008, VRN 205; 1 ♀. data same as above except 7-26.iii.2007, VRN 202; 1 ♀. INDIA: Kerala, Palghat, Koottanad, 9kms W Pattambi, 10°45.34'N 76°06.58'E, 48m, scrub jungle, 16-30.iv.2007, S. Santhosh leg., VRN 201; 1 ♀. INDIA: Kerala, Waynad, Muthanga WLS, 11°40.18'N 76°22.16'E, 879m, sweeping, DDF, 7.v.2000, T. C. Narendran leg., VRN 196 (DZUC).

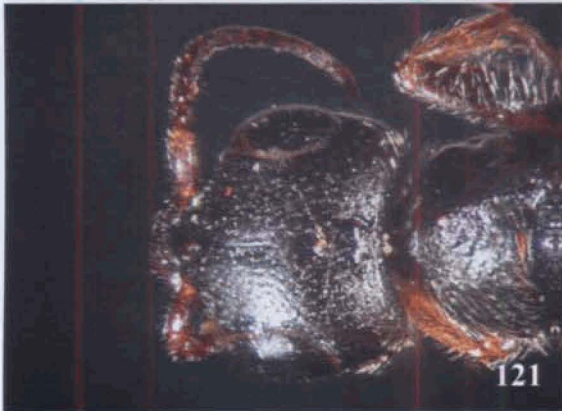
Variation: Paratypes are similar to Holotype except the variation in the morphometric measurements as shown in table - 23.

Discussion: *Odontepyrus terayamai* sp. nov. is related to *O. cephalopunctatus* sp. nov. and *O. obtusus* in having anterior clypeal margin obtuse or right angled; areolet
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ellipsoidal, but it differs in having clypeal carina restricted to clypeus, not extending to frons, paramedian carina on propodeum not joining posterior transverse carina and head coriaceous without punctures, whereas in *O. cephalopunctatus* sp. nov. and *O. obtusus*, clypeal carina extending to frons as a low carina beyond posterior scrobal margin, paramedian carina on propodeum joining posterior transverse carina and head coriaceous with punctures.

Table – 23. Morphometric ratios of *Odontepyris terayamai* sp. nov.

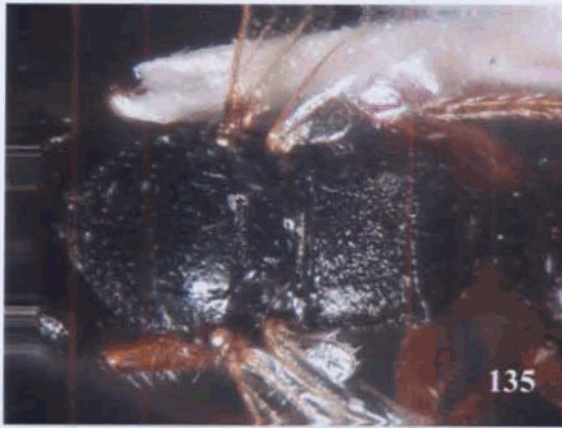
VRN	WH/LH	WF/HE	EV/HE	LPD/WPD	OOL/WOT	FFL/FFW	PDL/PDW	LS/PL	SI
200	1	1.0526	0.3421	0.4736	0.9444	2.5	0.5937	2.2307	3.9062
201	1.0167	1.125	0.3125	0.5681	1.1538	2.315789	0.5652	2	5.8055
202	1.0167	1	0.2941	0.575	1.2307	2.443182	0.56	2	5.2555
204	1.0149	1.0571	0.3428	0.5681	1.1428	2.571429	0.5714	2.0930	5.04
205	1	1.0625	0.3125	0.5	1.1538	2.222222	0.5769	2	5.9504
206	0.9818	1.0714	0.2857	0.6052	1.1666	2.571429	0.5454	2.2857	5.04
196	1.3958	1.1176	0.2941	0.53191	1.2	2.421053	0.5925	2	6.0694
Mean Values	1.06	1.07	0.31	0.55	1.14	2.44	0.57	2.09	5.29



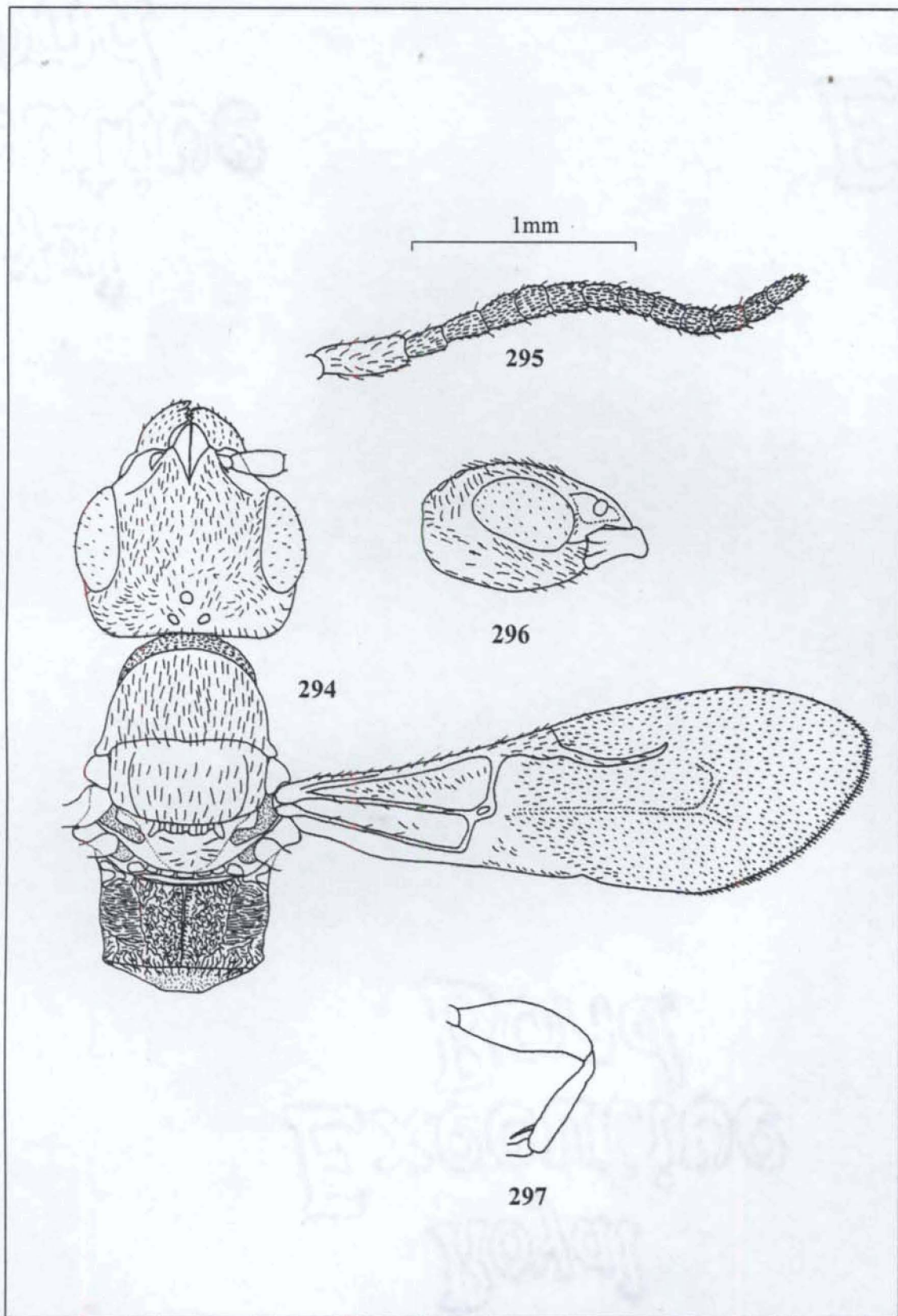
Odontepyris anamalaicus sp. nov., Female. 119. body profile; 120. head, side view; 121. head, full face view; 122. mesosoma, dorsal view. *Odontepyris cephalopunctatus* sp. nov., Female. 123. body profile; 124. head, side view; 125. head, full face view; 126. mesosoma, dorsal view.



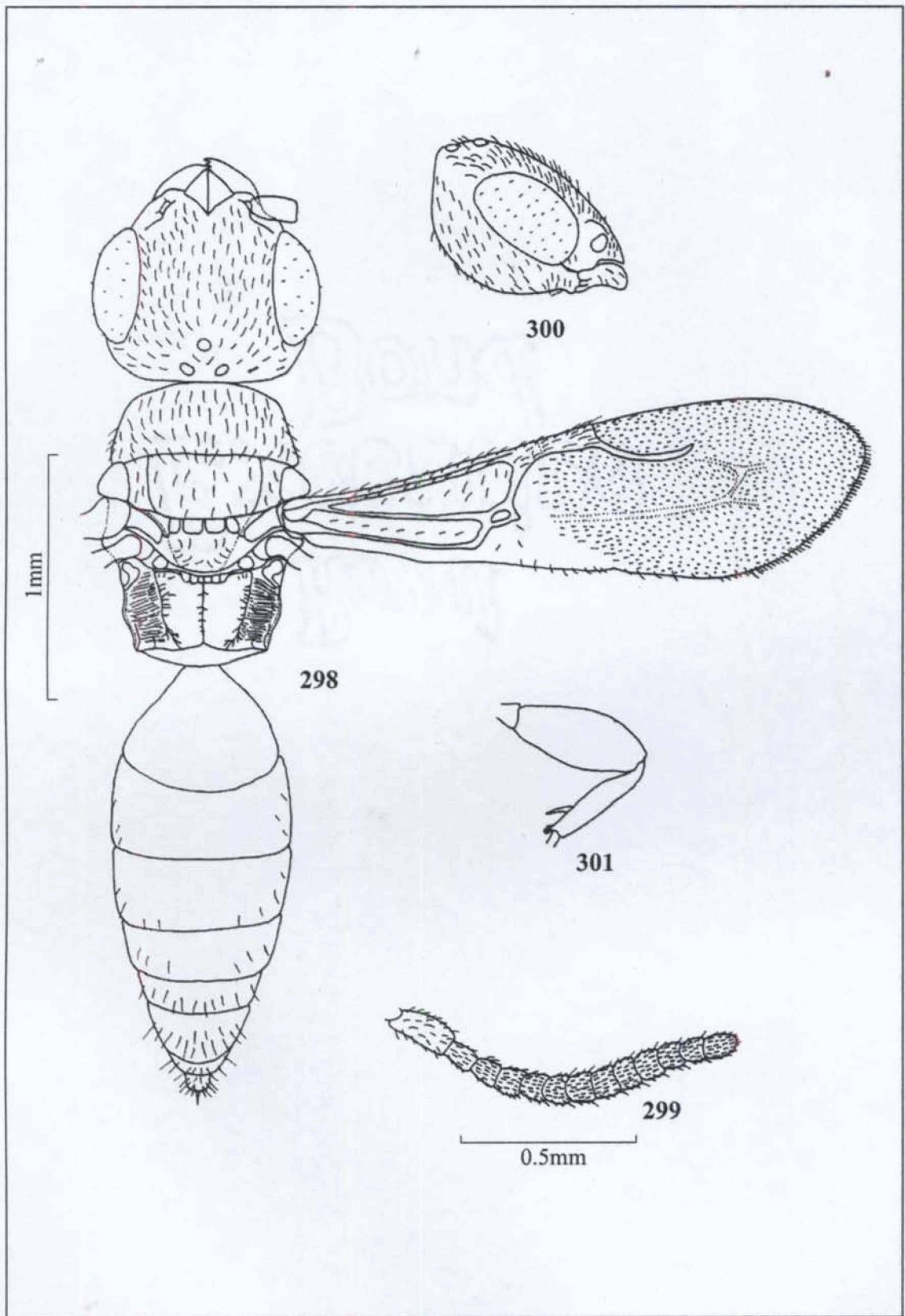
Odontepyris keystonellus sp. nov., Female. 127. body profile; 128. head, side view; 129. head, full face view; 130. mesosoma, dorsal view; 131. forewing. *Odontepyris koottanadensis* sp. nov., Female. 132. body profile; 133. head, side view; 134. head, full face view.



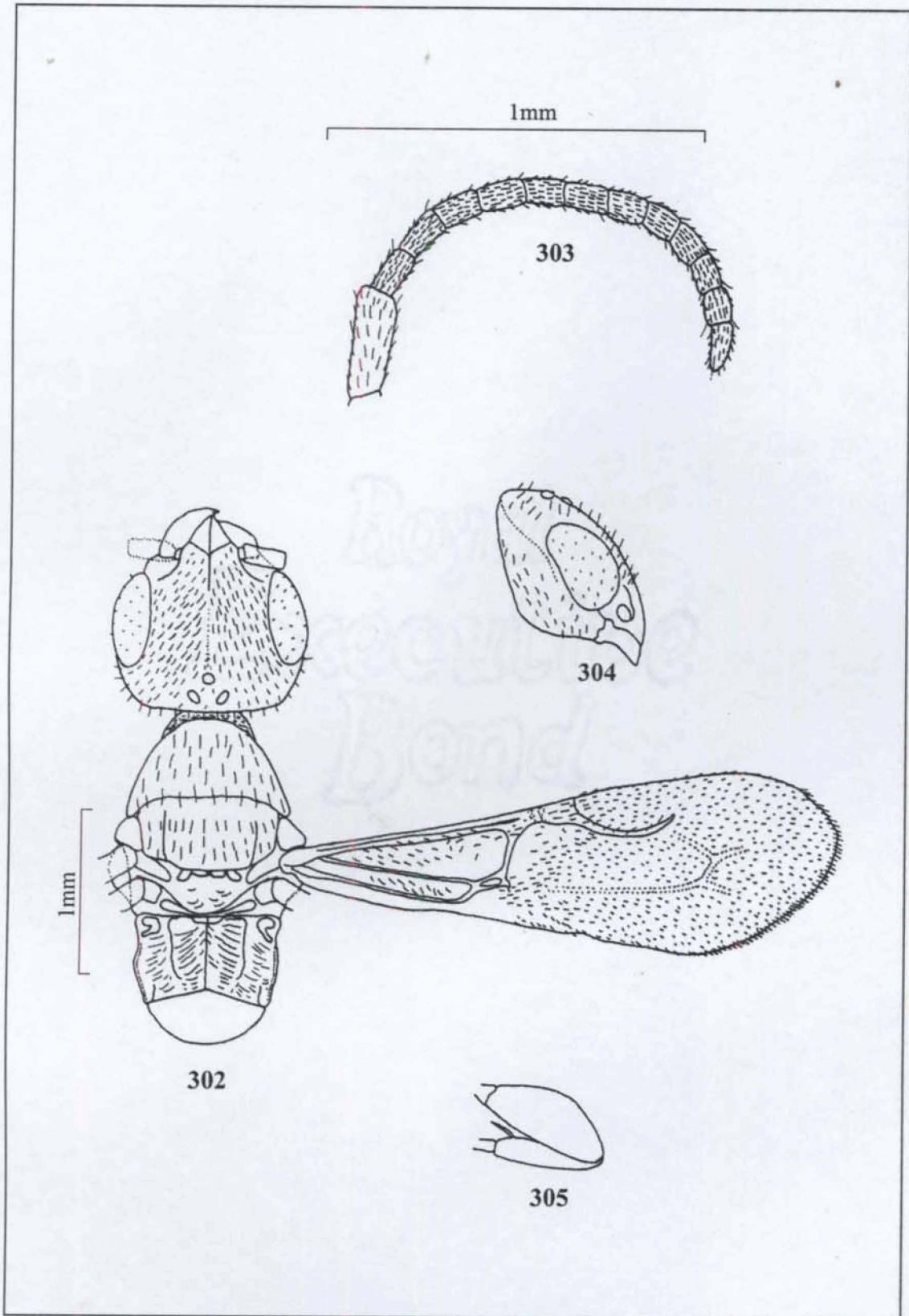
Odontepyris koottanadensis sp. nov., Female. 135. mesosoma, dorsal view. *Odontepyris terayamai* sp. nov., Female. 136. body profile; 137. head, side view; 138. head, full face view; 139. mesosoma, dorsal view.



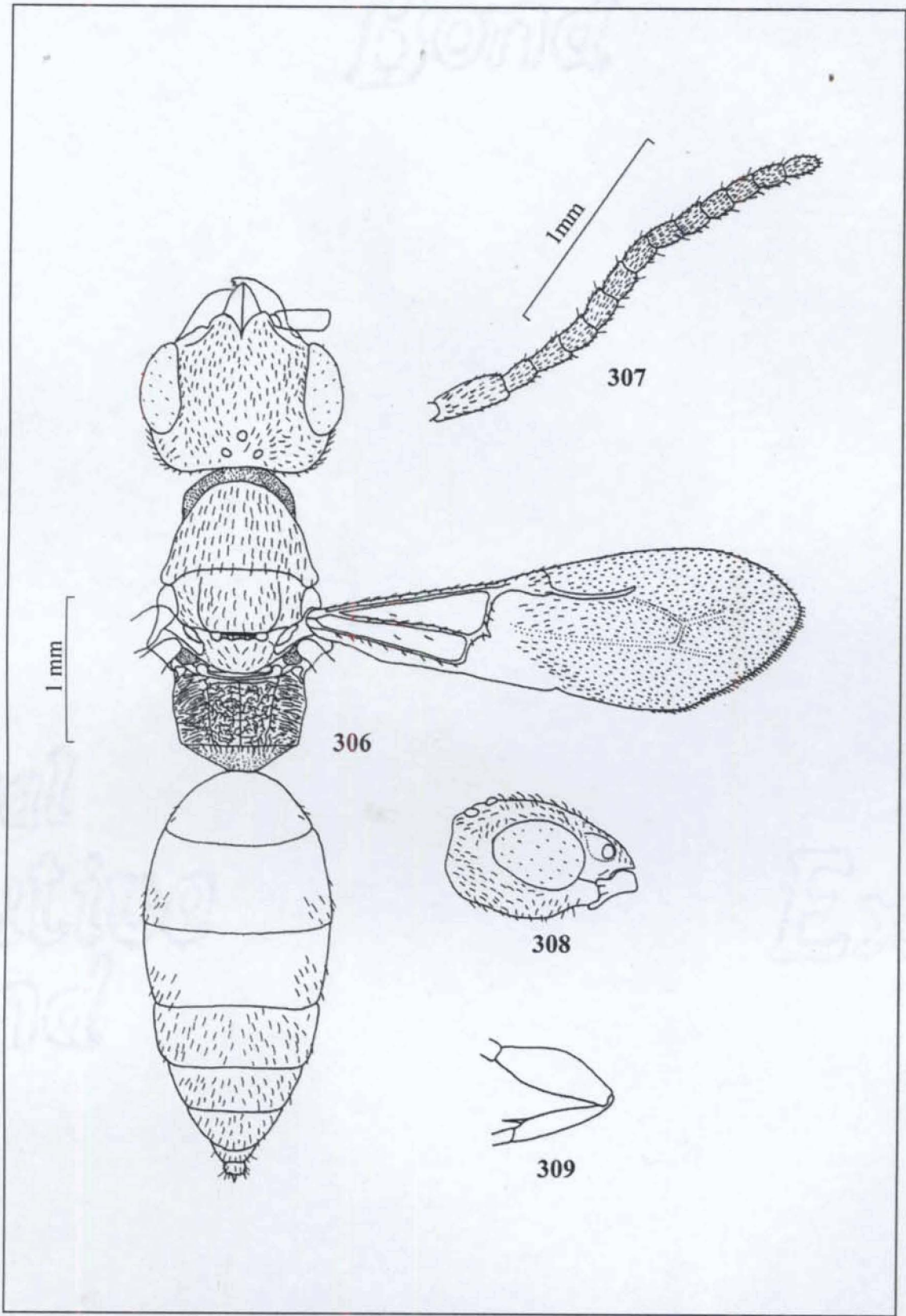
Figs. 294 - 297. *Odontepyris anamalaicus* sp. nov. Female, 294. body, dorsal view; 295. antenna; 296. head, side view; 297. foretibia.



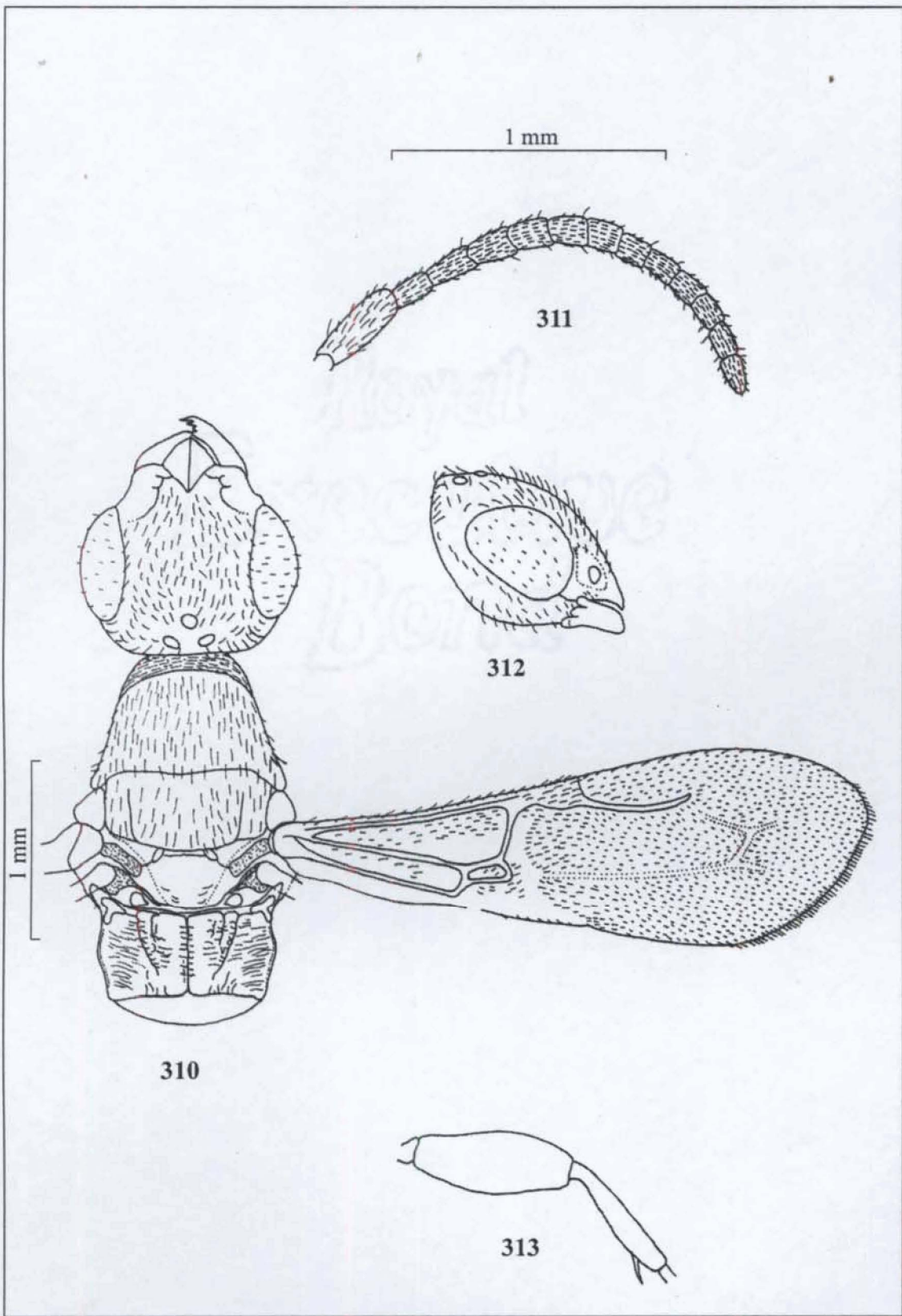
Figs. 298 - 301. *Odontepyris cephalopunctatus* sp. nov. Female, 298. body, dorsal view; 299. antenna; 300. head, side view; 301. foretibia.



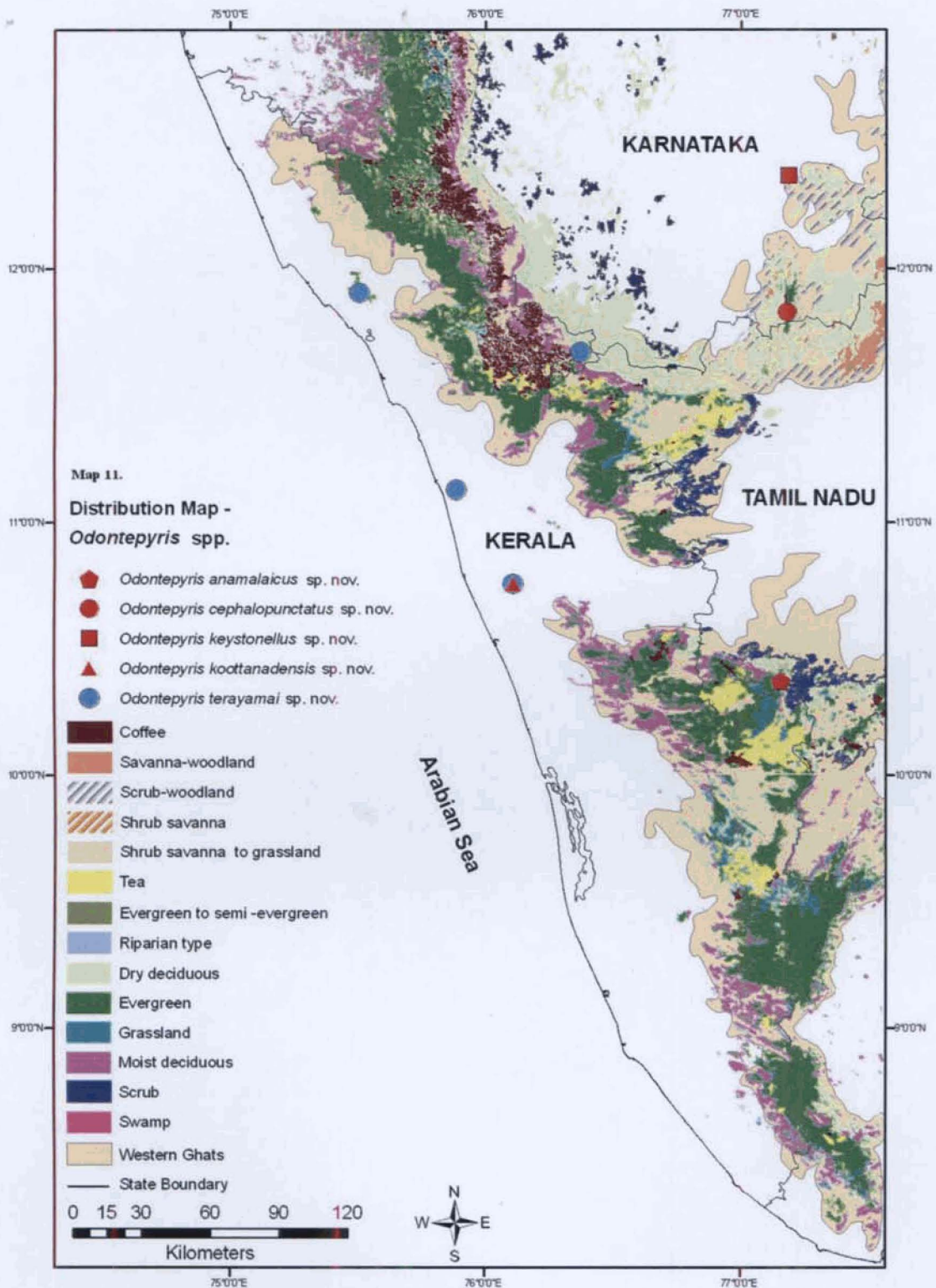
Figs. 302 - 305. *Odontepyris keystonellus* sp. nov. Female, 302. body, dorsal view; 303. antenna; 304. head, side view; 305. foretibia.



Figs. 306 - 309. *Odontepyris koottanadensis* sp. nov. Female, 306. body, dorsal view; 307. antenna; 308. head, side view; 309. foretibia.



Figs. 310 - 313. *Odontepyris terayamai* sp. nov. Female, 310. body, dorsal view; 311. antenna; 312. head, side view; 313. foretibia.



GENUS *SIEROLA* CAMERON 1881

Sierola Cameron 1881, 556. Type species: *Sierola testaceipes* Cameron. Monotypic.

Holotype: female. HAWAII: Sandwich islands (BMNH).

Lelejola Gorbatovsky, 1998, 680. synonymized by TERAYAMA (2006).

Diagnosis: small wasps, 1 – 3 mm in length, fully winged. Maxillary palpi with 4 segments, labial with 2; median lobe of clypeus angulate or rounded, with a median carina or keel; eye glabrous or with sparse, very short setae; antenna short, somewhat moniliform with 13 segments; notauli absent; scutellum with an anterior groove; propodeum slightly elevated medially, with or without a transverse carina margining the disc behind and with lateral carinae, median carina absent. Forewing with areolet and a closed marginal cell; pterostigma large, prostigma developed; radial vein curved upward apically to join the costal vein, which is extending beyond the stigma; m vein shorter than rs vein.

Statistics: Approximately 200 species in the world. There are 196 species from Hawaiian Islands alone (FULLAWAY, 1920). Three species are from Australia and three species from USA. Oriental region has 3 species, one species each from India, Thailand and China. One species is from the Far East and two species are from Japan (TERAYAMA, 2006).

Biology: They are parasitoids of microlepidopteran larvae. Host species are mostly from Pyralidae, Gelechiidae, Tortricidae, Lyonetiidae and Gracillariidae.

Distribution: This genus is distributed mainly in the Nearctic region with around 200 species from Hawaii. It is also recorded from Australian and Oriental regions.

Phylogeny: The phylogenetic analysis (POLASZEK and KROMBEIN, 1994) of 11 taxa of Bethylinae for 22 morphological characters provided more stable classification of the subfamily. In this context, the newly described species were manually analyzed and the character coding and data matrix are given in tables (see tables 24 and 25).

The apomorphic characters found in *Sierola* are 2 segmented labial palpi, 4 segmented maxillary palpi, absence of notauli, absence of unsculptured shiny frontal

streak from the proximal end of the clypeal carina to the frontal ocellus, presence of median longitudinal propodeal carina, presence of prostigma, presence of submarginal cell and radial vein sharply angled. Both the new species described in the present investigation showed the presence of smooth median triangular area and the absence of median longitudinal carina.

Remarks: The genus is regarded as established in North America and may well have been introduced accidentally or in connection with biological control efforts.

Table – 24. Character list and coding of Oriental *Sierola*

- #1. Posterior transverse carina on propodeum/
 - 0. absent/
 - 1. present/
- #2. Width of head/
 - 0. 0.94x as long as length of head/
 - 1. 1.12–1.22x as long as length of head/
 - 2. 1.5x as long as head/
- #3. Vertex margin/
 - 0. straight/
 - 1. concave in full face view/
 - 2. weakly convex in full face view/
- #4. Width of frons (WF)/
 - 0. longer than height of eye (HE)/
 - 1. as long as height of eye (HE)/
 - 2. shorter than height of eye (HE)/
- #5. Mandible/
 - 0. black/
 - 1. orange yellow/
- #6. Ocellocular distance (OOL)/
 - 0. longer than width of ocellar triangle (WOT)/
 - 1. as long as width of ocellar triangle (WOT)/
- #7. Colour of antenna/
 - 0. uniformly yellow/
 - 1. yellow brown, terminal segments fuscous/
- #8. Antenna/
 - 0. distinctly longer than head in full face view/
 - 1. as long as head in full face view/

Table – 25. Data matrix of Oriental *Sierola*

Taxon	Character coding							
	1	2	3	4	5	6	7	8
<i>Sierola mawarajo</i> Terayama	1	1	2	1	0	0	0	?
<i>Sierola indra</i> Terayama	1	1	0	2	0	0	0	?
<i>Sierola nasseri</i> sp. nov.	0	0	1	0	1	0	1	0
<i>Sierola kannurensis</i> sp. nov.	0	1	2	2	0	1	1	1
<i>Sierola sinensis</i> Fullaway	0	2	0	0	0	?	1	1

? - Unknown

5.3.1 Key to Oriental species of *Sierola* Cameron

1. Posterior transverse carinae on propodeum absent 2
 Posterior transverse carinae on propodeum present 4
- 2(1). Vertex concave; antenna distinctly longer than head in full face view;
 mandible orange - yellow *nasseri* sp. nov.
- Vertex weakly convex or straight; antenna as long as head in full face view;
 mandible black 3
- 3 (2). Head 1.12x as long as wide; vertex weakly convex; pedicel 1.75x as long as
 wide *kannurensis* sp. nov.
 Head 1.5x as long as wide; vertex straight; pedicel slightly longer than wide...
 *S. sinensis* Fullaway
- 4(1). Propodeum no smooth area; propodeum posterior margin straight; WF equal to
 HE; vertex margin weakly convex *S. mawarajo* Terayama
 Propodeum with median smooth longitudinal band; propodeum with posterior
 margin weakly concave; WF less than HE; vertex margin almost straight
 *S. indra* Terayama

***Sierola kannurensis* sp. nov.**

(figs.140-143, 314-318)

Diagnosis: Head 1.12x as long as wide; vertex weakly convex; pedicel 1.75x as long as wide. Posterior transverse carinae on propodeum present.

Description: *Holotype* – Female.

Measurements: Length 2.47mm; LH 0.55mm; WH 0.48mm; WF 0.25mm; LM 0.77mm; LP 0.29mm; HE 0.27mm; WPD 0.34mm; FWL 1.42mm.

Colour: Body brownish black; mandible, teeth black; antenna brown-yellow, scape basally and terminal 8 flagellar segments brown; coxa, trochanter, femur brown; tibia and tarsi yellow. Wing hyaline, veins colourless.

Head: Head (figs.142, 314) longer than wide; WH 0.87x LH; WF 0.93x HE; frons and vertex (fig.142) strongly coriaceous; vestiture abundant, short, suberect setae; setae on vertex margin not distinctly longer; vertex straight in full face view; gena (fig.141) weakly coriaceous; mandible (fig.318) with 4 teeth; clypeus with a median carina; eye setose, setae sparse, minute; ocelli in obtuse triangle; POL:AOL = 4.5:2; OOL = WOT. Antenna (fig.317) distinctly longer than head in full face view (43:35); Relative lengths of first four antennal segments 7:3.5:2.2:2.5; scape 1.52x as long as wide; pedicel 1.75x as long as wide; F1 and F2 as long as wide; terminal 8 segments moniliform.

Mesosoma: Pronotal disc (fig.143) strongly coriaceous with sparse, small, decumbent setae; mesonotum, scutellum coriaceous, but weaker than that of pronotum and head. Scutellum with a narrow transverse basal groove widened at both extremities into small pits; propodeum 0.79x as long as maximum width, disc microreticulate except small basal triangular smooth area; posterior transverse carina and discal carina absent; declivity microreticulate. Forewing (fig.315) discal cell sparsely setose.

Metasoma: Smooth and shining.

Ecology and Biology: Unknown.

Etymology: The species epithet is after the type locality, Kannur.

Distribution: India – Kerala.

Material Examined: *Holotype* – Female. INDIA: Kerala, Kannur, Panayathanparamba, 3kms W Kannur Airport, 11°54.32'N 75°30.27'E, 70m, 13-27.iii.2008, MT, scrub jungle, S. Santhosh leg., VRN 214 (DZUC).

Discussion: This new species closely resembles *S. sinensis* Fullaway, but it differs in having head 1.12x as long as wide, vertex weakly convex and pedicel 1.75x as long as wide. In *S. sinensis*, head 1.5x as long as wide, vertex straight and pedicel slightly longer than wide.

***Sierola nasseri* sp. nov.**

(figs.319-320, 360-363)

Diagnosis: Mandible orange – yellow; vertex concave; antenna distinctly longer than head in full face view; no posterior transverse propodeal carina.

Description: *Holotype* – Female.

Measurements: Length 2.86mm; LH 0.67mm; WH 0.63mm; WF 0.36mm; LM 0.88mm; LP 0.33mm; HE 0.32mm; WPD 0.44mm; FWL 1.83mm.

Colour: Body brownish black; mandibles orange; teeth brown; antenna yellow, apical 2 segments dusky; legs yellow. Wing hyaline.

Head: Head (figs.319, 362) longer than broad; WH 0.94x LH; WF 1.12x HE; frons and vertex microreticulate; vestiture sparse; setae short suberect; setae on vertex not distinctly longer than other setae on head; vertex weakly concave in full face view; gena smooth and polished (fig.361); mandible with 4 teeth, ventral most longest and curved downwards; clypeus with a median carina; eye (figs.320, 362) sparsely setose; setae shorter than diameter of single facet; ocelli in obtuse triangle; POL:AOL = 5:3; OOL 1.3x WOT. Relative lengths of first four antennal segments (fig.319) 7:3.5:2.2:2; scape 1.75x as long as wide; pedicel 1.4x as long as wide; F1

length subequal to its width; F2 to F6 slightly wider than long; other terminal segments moniliform.

Mesosoma: Pronotal disc microreticulate with sparse long decumbent setae; mesonotum microreticulate, sculpture on scutellum weaker than that of pronotum and mesonotum. Scutellum with a narrow transverse groove basally widened at both the extremities; propodeum (figs.319, 363) 0.74x as long as wide in dorsal view, microreticulate except basal triangular smooth area and posterior margin; discal and posterior transverse carina absent; declivity weakly microreticulate. Forewing discal cells aetose.

Metasoma: Smooth and shining (fig.360).

Male: Unknown.

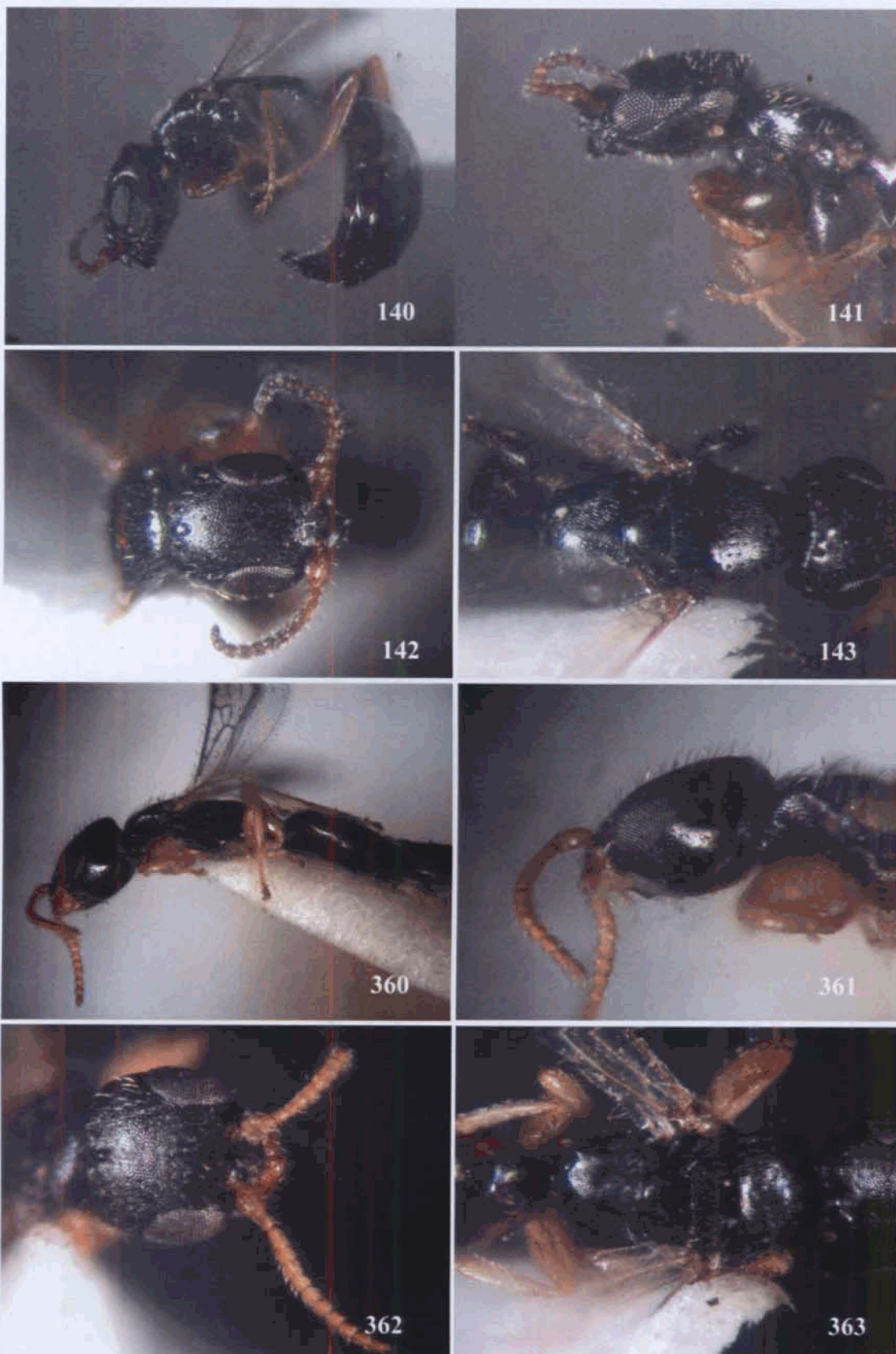
Biology: Ex. leaf galls (fig.144) by unidentified thrips (Thysanoptera: Thripidae) on *Memecylon umbellatum* Brum.f. (Memecylaceae). Co-inhabited in the gall by unidentified rove beetle (Coleoptera: Staphylinidae).

Etymology: The species epithet is after the collector and donator of the specimen, M. Nasser.

Distribution: India – Karnataka.

Material Examined: Holotype – Female. INDIA: Karnataka, Sringeri, Saupnabitta, 13°23.59'N 75°47.30'E, 689m, 27.i.2007, rearing, MDF, Community Managed Forests, M. Nasser, VRN 213 (DZUC).

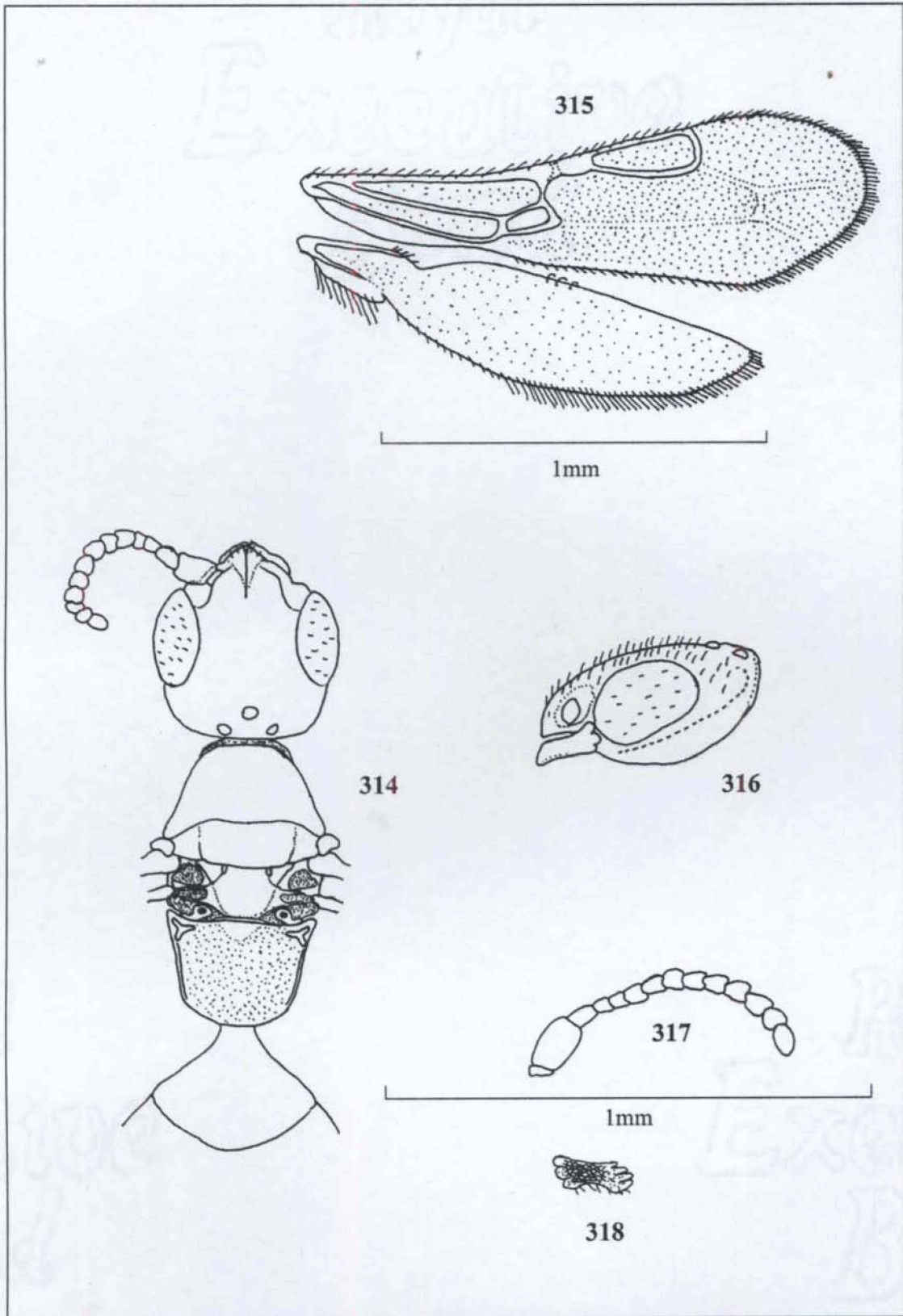
Discussion: This new species is closely similar to *S. kannurensis* and *S. sinensis*, but it differs in having the vertex concave, antenna distinctly longer than head in full face view and mandible orange – yellow. In *S. kannurensis* and *S. sinensis*, vertex is convex or straight, antenna as long as the head in full face view and mandible is black.



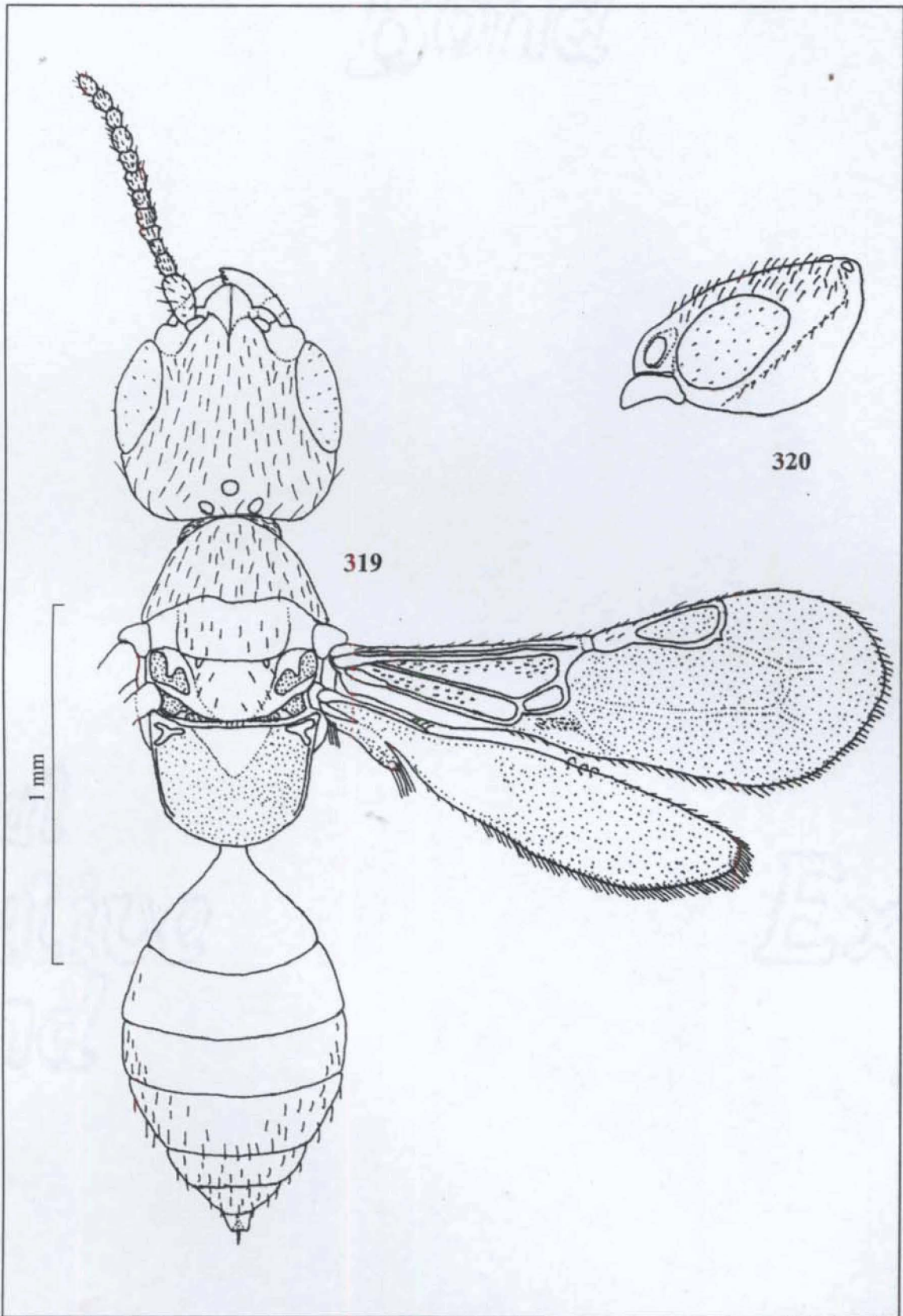
Sierola kannurensis sp. nov., Female. 140. body profile; 141. head, side view; 142. head, full face view; 143. mesosoma, dorsal view. *Sierola nasseri* sp. nov., Female. 360. body profile; 361. head, side view; 362. head, full face view; 363. mesosoma, dorsal view.



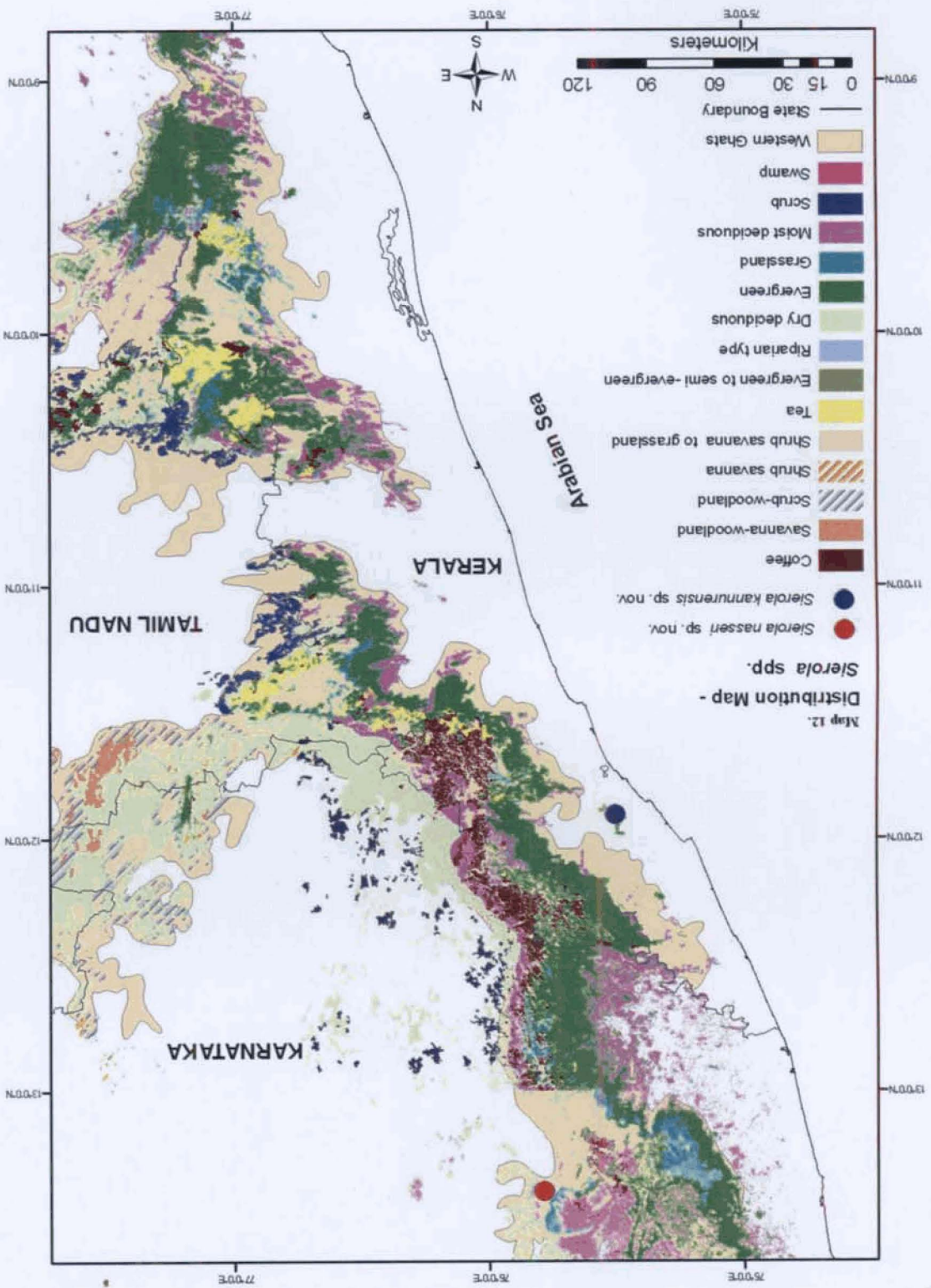
144. leaf gall of *Memecylon umbellatum* Burm. f.



Figs. 314 - 318. *Sierola kannurensis* sp. nov., Female, 314. body, dorsal view; 315. antenna; 316. head, side view; 317. foretibia; 318. mandible



Figs. 319 - 320. *Sierola nasseri* sp. nov., Female, 319. body, dorsal view; 320. head, side view.



GENUS *SCLERODERMUS* LATREILLE 1809

Sclerodermus Latreille 1809, Genera Crust. Et Insect., 4: 118-119. Female. Type species: *Sclerodermus domesticus* Klug in LATREILLE, 1809, Monotypic.

Scleroderma Oken 1817, Isis von Oken, 1: 1178. Unjustified Emendation.

Sclerochroa Förster 1850, Verh. Naturhist. Ver. Rheinlande, 7: 501. Type species: *Sclerochroa (Scleroderma) rufa* Förster, 1850, Monotypic (New name for *Scleroderma*, preoccupied in plants; unnecessary replacement name)

Neoscleroderma Kieffer 1905b, Ann. Soc. Sci. Bruxelles, 29: 106. Synonymy by EVANS, 1964. Type species: *Ateleopterus virginensis* Ashmead (= *carolinense* Ashmead) subsequent designation (designated by KIEFFER, 1914: 41: 270)

Lepidosternopsis Oglobin, 1954 (1953), 3: 101-102. Synonymy by LANES and AZEVEDO, 2008. Type species *Lepidosternopsis kuscheliana* Oglobin, 1954 (1953). Original designation.

Diagnosis: Small wasps (1.5-6mm) with or without wings in either sex. Head longer than wide, its width slightly to considerably exceeding maximum width of thorax. Mandibles with 2 sharp apical teeth, usually with 1-3 small apical teeth basad of these; clypeus with short median lobe which is truncate or emarginated apically; antennae 13 segmented, scape quite long, inserted at base of clypeus, below bottom level of eyes; eye glabrous or with sparse short setae, rather small in apterous forms; HE at least 0.25x WH; ocelli absent in apterous forms, normally developed in alate forms; occipital carina absent. Apterous females with mesoscutum and scutellum fused into a single smooth plate whereas in alate forms scutellum separated from mesoscutum with a narrow transverse groove basally, sometimes widened on each side; propodeum parallel sided or somewhat broadened posteriorly, disc without longitudinal or transverse carinae; mesopleura prominent, forming widest part of thorax; middle tibiae bare or densely covered on upper side with short spines; claws dentate. Forewing with costa absent, subcosta median and basal veins present, anal and transverse median veins present or absent. Subcosta thickened between basal vein and stigma, but not forming a distinct prostigma, stigma minute, not giving rise

to radial vein; abdomen sessile, relatively very long especially in females. Male genitalia with basal ring small; parameres divided into 2 completely separate lobes much as in *Pseudisobrachium*; cuspides broad partially divided into ventral and dorsal arms, ventral portion setose; subgenital plate of male simple, with a long median basal stalk.

Statistics: Currently represented by about 70 species around the world, mainly from the Palaearctic and Oriental regions and Hawaiian Islands (TERAYAMA, 2006). Twelve species are known so far from Oriental region, of which three species each are from India and Sri Lanka. Nine Oriental species are known from apterous females. *S. mori* is based on a alate single male. *Sclerodermus harmandi* and *S. vigilans* are known from alate males and apterous and alate females. *Sclerodermus luteicollis* and *S. hirsutus* are known only from winged females only.

Biology: *Sclerodermus* attacks wood-boring beetle larvae, chiefly Cerambycidae in the case of the American species (EVANS, 1978). Several South American species have been found in association with ant nests, and Hawaiian species are known to attack larvae of wood boring Lepidoptera (BRIDWELL, 1920; EVANS, 1964). A species is found attacking larvae of *Ceratina* bees from Japan.

Distribution: Oriental region (India, Taiwan, Myanmar, Indonesia); Palaearctic region (Japan, Austria, Italy, France, Albania, Algeria); Australian region (Australia); Neotropical region (Brazil, Bolivia, Chile, Argentina); Nearctic region (USA).

Phylogeny: Studies on phylogeny and taxonomy of Scleroderminii by LANES and AZEVEDO (2008) for 72 characters assessed the monophyly of Scleroderminii. In this context, the newly described species were manually analyzed and the character coding and data matrix are given in tables (see tables – 26 and 27).

The apomorphic characters found in *Sclerodermus* are subrectangular or oval shape of head, in lateral view; temple and vertex convex in dorsal view; four or five segmented maxillary palpi; three segmented labial palpi; clypeus with thin median elevation, thirteen segmented antennae; scape slender, width less than 0.3x length;

frontal groove in dorsal view; pronotal collar long, length more than 0.16x pronotal disc length; anterior transverse carina present.

Remarks: Alate females are generally much less common than apterous females, but in the male sex the alate form is the more common. Males are generally much less common than females, and apterous males are very rare indeed. Males are short lived and hence are almost never collected except while rearing them from their hosts.

Table – 26. Character list and coding of Oriental *Sclerodermus*

- #1. Wing and Ocelli/
 - 0. absent/
 - 1. present/
- #2. Scape/
 - 0. 2.1 – 2.69x pedicel/
 - 1. 2.7 – 3.2x pedicel/
- #3. Pedicel/
 - 0. as long as 1.17 – 1.5x its width/
 - 1. as long as 1.6 – 1.8x its width/
 - 2. longer than 1.81x its width/
- #4. Scape length/
 - 0. less than 2.51x pedicel length/
 - 1. 2.55 – 2.95x pedicel length/
 - 2. more than 3x pedicel length/
- #5. Head length in lateral view/
 - 0. shorter than 1.69x its width/
 - 1. longer than 1.72x its width/
- #6. Head width in full face view/
 - 0. 0.70 – 0.89x its length/
 - 1. longer than 0.91x its length/
- #7. Head width in full face view/
 - 0. shorter than 2.7x height of eye (HE)/
 - 1. longer than 2.79x height of eye (HE)/
- #8. Width of frons (WF)/
 - 0. shorter than 1.49x height of eye (HE)/
 - 1. 1.54 - 1.69x height of eye (HE)/
 - 2. longer than 1.7x height of eye (HE)/
- #9. Maximum distance from top of the eye to posterior margin of vertex (EV)/
 - 0. shorter than 2x height of eye (HE)/
 - 1. longer than 2x height of eye (HE)/
- #10. Ocellocular line (OOL)/
 - 0. shorter than 2.45x width of ocellar triangle/

1. longer than 2.5x width of ocellar triangle/
 #11. Forefemur/
 0. shorter than 1.8x its width/
 1. longer than 1.81x its width/
 #12. Mandible/
 0. black/
 1. light brown/
 2. reddish brown/
 #13. Mandibular tooth/
 0. 2 in number/
 1. 3 in number/
 2. 4 in number/
 #14. Eye/
 0. setose, setae equal to or shorter than diameter of single facet/
 1. aetose/
 2. setose, setae longer than diameter of single facet/

Table -27. Data matrix of Oriental *Sclerodermus*

Taxon	Character coding													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
<i>Sclerodermus hirsutus</i> Krombein	1	?	?	?	?	0	?	0	1	0	0	0	3	2
<i>Sclerodermus undulatus</i> (Krombein)	1	1	0	1	0	1	0	0	0	0	1	0	?	?
<i>Sclerodermus harmandi</i> (Buysson)	1	?	?	?	?	1	0	0	?	0	?	0	?	?
<i>Sclerodermus vigilans</i> Westwood	1	?	?	?	?	0	1	1	0	1	1	1	?	?
<i>Sclerodermus luteicollis</i> Kieffer	1	1	?	1	1	0	0	1	0	1	1	1	?	?
<i>Sclerodermus hardwickiae</i> Kurian	1	0	2	0	1	0	0	0	0	0	1	2	2	2
<i>Sclerodermus seenae</i> sp. nov.	1	0	1	0	1	0	0	0	0	0	0	2	?	?
<i>Sclerodermus bicolor</i> Smith	0	0	1	0	1	0	1	2	1	N	1	2	3	1
<i>Sclerodermus vigilans</i> Westwood	0	?	?	?	0	0	?	2	1	N	1	?	?	1
<i>Sclerodermus delhiensis</i> Kurian	0	1	0	1	?	?	?	?	?	N	1	2	3	1
<i>Sclerodermus variegatus</i> Krombein	0	?	?	?	0	0	?	2	1	N	0	2	?	1
<i>Sclerodermus harmandi</i> (Buysson)	0	1	0	2	?	1	1	2	0	N	1	0	4	1
<i>Sclerodermus sumatranus</i> sp. nov.	0	1	1	0	0	0	1	2	1	N	?	1	3	0
<i>Sclerodermus seenae</i> sp. nov.	0	0	0	2	1	0	1	2	1	N	?	0	2	2
<i>Sclerodermus nigrus</i> Kieffer	0	0	0	1	1	0	0	1	0	N	1	0	?	0
<i>Sclerodermus hardwickiae</i> Kurian	0	0	1	0	1	0	1	1	0	N	1	2	2	2
<i>Sclerodermus castaneus</i> Kieffer	0	1	0	2	1	0	1	1	0	N	1	0	4	0
<i>Sclerodermus guani</i> Xiao and Wu	0	?	?	2	?	0	?	1	0	N	?	2	1	1

? - Unknown; N - Not applicable

5.6.1 Key to Oriental species of *Sclerodermus* Latreille (based on females)

1. Ocelli absent (figs.321, 326, 344, 347, 356); wingless..... 2
 -- Ocelli present (figs.331, 339,351); fully winged 11
- 2 (1). Eye bare 3
 -- Eye setose 7
- 3(2). Forefemur 1.74x as long as wide; sides of the head straight; EV 2.1x HE;
 WF 1.7x HE; LH 1.68x depth of head in lateral view; vertex straight;
 propodeum posteriorly 1.07x wider than at spiracles
 *variegatus* Krombein
- Forefemur more than 2x as long as wide; sides of the head weakly convex;
 other characters not in above combination, partly or completely different. 4
- 4(3). Scape as long as or longer than 3x its width..... 5
 -- Scape shorter than 3x its width..... 6
- 5(4). Forefemur 2.5 as long as wide; head and mesosoma castaneous; mandible
 quadridentate; scape 4x as long as pedicel*harmandi* (Buysson)
- Forefemur 2.15 as long as wide; head and mesosoma reddish brown;
 mandible tridentate; scape 2.67x as long as pedicel*delhiensis* Kurian
- 6(4). Propodeum posteriorly 1.12-1.17x wider than at spiracles; WF 1.7-1.86x
 HE; head weakly coriaceous with few tiny scattered punctures.....
 *vigilans* Westwood
- Propodeum posteriorly 1.23x wider than at spiracles; WF 2.1x HE; head
 weakly coriaceous without punctures *bicolor* Smith
- 7(2). EV longer than 2x HE; WH as long as or longer than 3x HE 8
 -- EV shorter than 2x HE; WH shorter than 3x HE..... 9
- 8(7). Scape 3x as long as wide (fig.357); scape 2.25x as long as pedicel; body
 pale brown; mandible tridentate; ocular setae as long as width of single
 facet..... *sumatranus* sp. nov.

- Scape 2.57x as long as wide (fig.348); scape 3x as long as pedicel; body dark brown; mandible bidentate; ocular setae 1.5x as long as width of single facet *seenae* sp. nov.
- 9(7). Pedicel 1.17x as long as wide (fig.322); scape 2.74x as long as wide, 3.29x as long as pedicel; LH 1.88x depth of head in lateral view (fig.323); ocular setae less than width of single facet..... *castaneus* Kieffer
- Pedicel 1.4-1.8x as long as wide (fig.327); scape 2.4 - 2.5x as long as wide, 2 - 2.75x as long as pedicel; LH 1.74 - 1.78x depth of head in lateral view (fig. 328, 345); ocular setae \geq width of single facet 10
- 10(9). EV 1.4x HE (fig.345); body completely brownish black; ocular setae as long as the width of single facet; scape 2.75x as long as pedicel; WH 2.57x HE *nigrus* Kieffer
- EV 1.9x HE (fig.328); body brown, pronotum and propodeum yellow; ocular setae slightly longer than width of single facet; scape 2 - 2.22x as long as pedicel (fig.327); WH 2.8x HE *hardwickiae* Kurian
- 11(1). OOL 3.57x WOT; EV as long as or longer than 2x HE; WH 0.71x LH.....
..... *hirsutus* (Krombein)
- OOL 2.11 - 2.67x WOT; EV shorter than 2x HE; WH 0.81- 0.94x LH.... 12
- 12(11). EV 0.94x HE; WF 0.54x WH; scape 2.89x as long as pedicel; pedicel 1.5x as long as wide..... *undulatus* (Krombein)
- EV 1.58 – 1.91x HE; WF as long as or longer than 0.56x WH; other characters not in above combination, partly or completely different 13
- 13(12). Head, pronotum and propodeum castaneous, mesonotum and metanotum dark brown; WH 0.94x LH *harmandi* (Buysson)
- Body light brown to reddish brown; WH 0.81-0.86x LH..... 14
- 14(13). Forefemur longer than or as long as 2x its width; body light brown; WF 1.54 – 1.64x HE 15

- Forefemur shorter than 2x as long as wide; body reddish brown; WF 1.4 – 1.47x HE 16
- 15(14). OOL 2.11 – 2.25x WOT; EV 1.83 - 1.91x HE; WH 2.85x HE
..... *vigilans* Westwood
- OOL 2.67x WOT; EV 1.62x HE; WH 2.67x HE *luteicollis* Kieffer
- 16(14). Pedicel 2.5x as long as wide (fig.332); forefemur 1.89x as long as wide (fig.334); OOL 2.33x WOT..... *hardwickiae* Kurian
- Pedicel 1.6x as long as wide; forefemur 1.55x as long as wide; OOL 2.42x WOT *seena* sp. nov.

Note: *Sclerodermus guani* Xiao & Wu from China (Xiao and Wu, 1983) is not included in the key for want of type material. However, it is included in the interactive key and character analysis and data matrix.

Sclerodermus bicolor Smith

(figs.364-367)

Sclerodermus bicolor Smith, 1860, 5: 77-78. Female. Examined (OUMNH)

Redescription: Holotype – Female. Apterous.

Measurements: Length 3.22mm. LH 0.56mm; HW 0.49mm; WF 0.30mm; LM 0.92mm; LP 0.37mm; WPD 0.30mm.

Colour: Body dark brown except antenna and propodeum yellow; mandible yellow with terminal ends dark brown, forefemur and pronotum brown; tibia and tarsi yellowish brown.

Head: Head (fig.365) generally smooth and polished, front and vertex weakly coriaceous; 1.14x as long as wide, with subparallel sides, curving inwards posterolaterally to slightly convex vertex in full face view. In lateral view (fig.367), ventral and dorsal margin convex; 1.73x as long as its depth; mandible (fig.366) with 3 teeth, apical 2 long and basal one short; WH 0.87x LH; WF 2.26x HE; WH

3.68x HE; EV 2.3x HE; eye length 2.11x malar space; ocelli absent. scape clavate, 2.55x as long as maximum width.

Mesosoma: Dorsum of mesosoma (fig.364) coriaceous, slightly strong than that of head; pronotal disc slightly wider than long (48:44); mesonotum wider than long, 0.62x as long as wide; propodeum widest near the posterior end, maximum width 1.26x minimum width; posterolateral angles bluntly angulated. Forefemur 2.2x as long as wide.

Metasoma: Weakly coriaceous, stronger than that of head; 1.09x wider than maximum head width; 1.46x as long as head plus mesosoma (fig.364).

Male: Unknown.

Ecology and Biology: Unknown.

Distribution: Indonesia – Sulawesi

Material Examined: INDONESIA: Sulawesi, Makassar (OUMNH)

Discussion: In wingless form of females, *Sclerodermus bicolor* is close to wingless female of *S. vigilans* Westwood in having scape shorter than 3x its width, forefemur more than 2x as long as wide and sides of the head weakly convex. *Sclerodermus bicolor* is having propodeum posteriorly 1.23x wider than at spiracles, WF 2.26x HE and head weakly coriaceous without punctures, whereas *S. vigilans* is having propodeum posteriorly 1.12-1.17x wider than at spiracles, WF 1.7-1.86x HE, head weakly coriaceous with few tiny scattered punctures.

Remarks: Though this species is distributed well outside the study area, their identity is important to bring about clarity and accuracy to the present investigation. Hence, it is also included in the study. Moreover it is assumed that this species might have been transported to other regions for biological control reasons. The type is in a very bad condition and this redescription is based on photographs and the microscopic examination by James Hogan on request. The anterior clypeal margin is obscure as the head is dissected to take the mandibles out.

***Sclerodermus castaneus* Kieffer**

(figs.145-148, 321-325)

Scleroderma castaneum Kieffer, 1904c, 1:373,375-376. Female. Examined (MCSN)

Diagnosis: *Apterous*. Pedicel 1.17x as long as wide; scape 2.74x as long as wide, 3.29x as long as pedicel; LH 1.88x depth of head in lateral view; ocular setae less than width of single facet; EV shorter than 2x HE; WH shorter than 3x HE.

Redescription: *Holotype* – Female. *Apterous*.

Measurements: Length 3.32mm. LH 0.56mm; WH 0.48mm; WF 0.28mm; LM 0.84mm; LP 0.35mm; WPD 0.32mm.

Colour: Body reddish brown; antenna, mandible and tarsi yellow.

Head: Head (fig.147) generally smooth and polished; weakly coriaceous in the front; vestiture almost absent, few short, thin setae present laterally and posteriorly 1.17x as long as wide (fig.321), with subparallel sides, curving inwards posterolaterally to straight vertex in full face view; in lateral view (figs.146, 323), ventral and dorsal margins convex, 1.88x as long as its depth; mandible teeth not visible due to poor card mounting; anterior margin of clypeus transverse, not medially notched; shallow short groove running from posterior margin of clypeus towards front beyond the level of anterior ocular margin; eye 0.17mm long; WH 0.86x LH; WF 1.6x HE; WH 2.8x HE; EV 1.8x HE; eye length 4x malar space; eye sparsely setose, setae minute shorter than the diameter of single facet; ocelli absent. Relative lengths of first five antennal segments (fig.322) 11.5:3.5:1.5:1.5:1.5 in length; scape clavate, 2.74x as long as maximum width; pedicel slightly longer than wide; 3rd to 12th wider than long; apical segment 2x as long as wide;

Mesosoma: Pronotal disc (fig.148, 321) 1.05x as long as wide; mesonotum 0.69x as long as wide; propodeum broadest near posterior margin; maximum width 1.2x its minimum width; posterolateral corners bluntly angulated; dorsum of mesosoma generally polished, very weakly coriaceous. Forefemur (fig.324) 1.73x as long as wide.

Metasoma: Smooth and polished; metasoma (fig.145, 325) 1.3x as long as head plus mesosoma; wider than head (28:32) and thorax.

Male: Unknown.

Ecology and Biology: Unknown.

Distribution: Indonesia – Moluques.

Material Examined. Holotype – Female. Apterous. INDONESIA: Moluques, Ternate, Acqui conora. Beccari leg. xi. 1874 (MCSN).

Discussion: *Sclerodermus castaneus* is related to *S. hardwickiae* Kurian and *S. nigrus* Kieffer in having EV shorter than 2x HE and WH shorter than 3x HE., but it differs in having pedicel 1.17x as long as wide, scape 2.74x as long as wide, 3.29x as long as pedicel, LH 1.88x depth of head in lateral view and ocular setae less than width of single facet, whereas in *S. hardwickiae* and *S. nigrus*, pedicel 1.4-1.8x as long as wide, scape 2.4 - 2.5x as long as wide, 2 - 2.75x as long as pedicel, LH 1.74 - 1.78x depth of head in lateral view and ocular setae \geq width of single facet.

Remarks: Label on the holotype read like *Scleroderma castaneum* J.J.Kieffer, 1904.

Sclerodermus hardwickiae Kurian

(figs.149-156, 326-338)

Sclerodermus hardwickiae Kurian 1955, 4: 78, 79-80.fig.52. Female. Not examined.

Diagnosis: *Apterous* – EV 1.9x HE; body brown, pronotum and propodeum yellow; ocular setae slightly longer than width of single facet; scape 2 - 2.22x as long as pedicel; WH 2.8x HE. *Alate* – Pedicel 2.5x as long as wide; forefemur 1.89x as long as wide; OOL 2.33x WOT; forefemur shorter than 2x as long as wide; body reddish brown; WF 1.4 – 1.47x HE; WH 0.81-0.86x LH.

Description: Female. Apterous.

Measurements: Length 3.1mm. LH 0.54mm; WH 0.45mm; WF 0.26mm; LM 0.84mm; LP 0.33mm; WPD 0.28mm.

Colour. Antenna, tarsi, prothorax and propodeum yellow; rest of legs, mesonotum, head and metasoma brown; metasomal tergites darker; mandibles yellow, teeth brown.

Head: Head (fig.150) weakly coriaceous; vestiture sparse, thin and very short; head (fig.150, 326) 1.2x as long as wide, with subparallel sides, curving inwards posterolaterally to straight vertex in full face view. In lateral view (fig.328), dorsal margin subparallel, ventral margin convex, 1.78x as long as its depth; mandible (fig.330) with 2 apical long teeth; anterior margin of clypeus transverse with shallow median notch; shallow short groove running from posterior margin of clypeus towards front, distinctly extending beyond the level of anterior ocular margin; eye 0.16mm long; WH 0.83x LH; WF 1.67x HE; WH 2.89x HE; EV 1.9x HE; eye length 4.5x malar space; eye sparsely setose, setae slightly longer than diameter of single facet; ocelli absent. Relative lengths of first five antennal segments (fig.327) 10:4.5:1.5:1.5:1.5 in length; scape clavate, 2.5x as long as maximum width; pedicel 1.8x as long as maximum width; antennal segments 3 – 12 wider than long; apical segment 2x as long as wide.

Mesosoma. Pronotal disc 1.1x as long as wide; mesonotum 0.75x as long as wide; propodeum broadst near posterior margin; maximum width 1.14x its minimum width; posterolateral corners smoothly rounded; dorsum of mesosoma weakly coriaceous, relatively stronger than that of head. Forefemur (fig.329) 2.1x as long as wide.

Metasoma. Generally smooth and polished, weakly coriaceous; 1.17x as long as head plus mesosoma (fig.326); wider than head (26:32) and mesosoma.

Material Examined. 5♀. Apterous. INDIA: Karnataka, Bangalore, Malleshwaram, IWST campus, rearing, 20.iii.2006; from decaying log, O.K. Remadevi., VRN 107, 109, 110, 111, 112; 2♀. data same as before except 5.i.2005, VRN 114, 115; 2♀. data same as before except 13.xii.2005, VRN 118, 119 (DZUC).

Description: Female. Alate.

Measurements: Length 2.9mm. LH 0.5mm; WH 0.42mm; WF 0.24mm; LM 0.95mm; LP 0.34mm; WPD 0.3mm.

Colour: Head, mesonotum and metasoma brown except paler basal tergite; pronotum, legs, and basal inverted triangle shaped area of propodeum pale brown; distal half of propodeum, antenna yellow; mandibles yellow teeth brown; wings hyaline, veins brown.

Head: Head (fig.153) weakly coriaceous, relatively stronger than that of apterous female; vestiture sparse and short, setae on outer side of eyes and ventral side of head longer; 1.18x as long as wide (fig.331), with subparallel sides, curving inwards posterolaterally to straight vertex in full face view. In lateral view (fig.333), dorsal margin of head subparallel, ventral margin convex, 1.77x as long as its depth; mandible with 2 apical long teeth; anterior margin of clypeus transverse with shallow median notch; shallow short groove running from posterior margin of clypeus towards front, distinctly extending beyond the level of anterior ocular margin; eye 0.16mm long; WH 0.84x LH; WF 1.47x HE; WH 2.58x HE; EV 1.58x HE; eye sparsely setose, setae slightly longer than diameter of single facet; ocelli in acute triangle; OOL 2.33X WOT; POL: AOL = 3:2; posterior ocelli 1.5x its own diameter from vertex in full face view. Relative lengths of first five antennal segments (fig.332) 10:4:2:1.5:1.5 in length; scape clavate, 2.5x as long as maximum width; pedicel 1.4x as long as maximum width; antennal segments 3 – 12 wider than long; apical segment 2x as long as wide.

Mesosoma: Mesosoma (fig.154) coriaceous, stronger than that of head; vestiture sparse and short; Pronotal disc 0.69x as long as wide; mesonotum without notauli and parapsidal furrows; scutellum shorter than mesonotum, anteriorly with a shallow transverse groove slightly curved backwards at both ends; propodeum broadest near posterior margin; maximum width 1.06x its minimum width; posterolateral corners bluntly angulated. Forewing (fig.331) with anal vein obscure; pterostigma very short restricted to 1/3rd of the forewing. Forefemur (fig.334) 1.9 x as long as wide.

Metasoma: abdomen weakly coriaceous; slightly shorter than head plus mesosoma (fig.152, 331); distinctly wider than head (24:30) and mesosoma.

Material Examined: 5♀. Alate. INDIA: Karnataka, Bangalore, 13°00.37'N 77°34.20'E, 939m, rearing, 13.xii.2005, on decaying log, O.K. Remadevi leg., Vr.No.104, 105, 106, 116, 117 (DZUC).

Description: Male. Alate.

Measurements: Length 2mm. LH 0.4mm; WH 0.36mm; WF 0.22mm; LM 0.83mm; LP 0.31mm; WPD 0.28mm.

Colour: Body, antenna, legs brown; wings hyaline, veins pale yellow.

Head: Head coriaceous; vestiture sparse and short; 1.1x as long as wide (fig.335), with convex sides, curving inwards posterolaterally to convex vertex in full face view. In lateral view (fig.337), dorsal margin subparallel, ventral margin convex; 1.77x as long as its depth; mandible with 3 teeth; anterior margin of clypeus transverse with shallow median notch; shallow short groove running from posterior margin of clypeus towards front, distinctly extending beyond the level of anterior ocular margin; eye 0.16mm long; WH 0.83x LH; WF 1.37x HE; WH 2.2x HE; EV 1.16x HE; eye asetose; ocelli in acute triangle; OOL 1.12x WOT; POL:AOL = 3:2; posterior ocelli very close to vertex in full face view. Relative lengths of first five antennal segments (fig.336) 7:4:2:2:2; scape slightly clavate, 2x as long as maximum width; pedicel 2x as long as maximum width; 3rd to 12th as long as or slightly longer than wide; apical segment 1.8x as long as wide.

Mesosoma: Mesosoma coriaceous; vestiture sparse, thin and short; pronotal disc (fig.335) 0.53x as long as wide; mesonotum without notauli and parapsidal furrows; posterior margin of scutellum separated from propodeum by short metanotum; propodeum broadest near posterior margin; maximum width 1.07x its minimum width; posterolateral corners smoothly curved; very short petiole is present. Forewing (fig.335) with anal vein obscure; pterostigma very short restricted to basal 1/3rd. Forefemur (fig.338) 4.75 x as long as wide.

Metasoma: Metasoma coriaceous; as long as mesosoma (fig.155); wider than head (21:26) and mesosoma.

Ecology and Biology: Parasitoids of *Lyctus* spp. (Coleoptera: Lyctidae) (fig.156) on decaying log.

Distribution: India – Karnataka; Tamil Nadu.

Material Examined. 1♂. Alate. INDIA: Karnataka, Bangalore, Malleshwaram, IWST campus, rearing, 20.iii.2006; from decaying log, O.K. Remadevi., VRN 108; 1♂. data same as before except 5.i.2005, VRN 113 (DZUC).

Discussion: In wingless form of females, *S. hardwickiae* is related to *S. nigrus* in having pedicel 1.4-1.8x as long as wide, scape 2.4 - 2.5x as long as wide, 2- 2.75x as long as pedicel, LH 1.74 - 1.78x depth of head in lateral view and ocular setae \geq width of single facet, but it differs in having EV 1.9x HE, body brown, pronotum and propodeum yellow, ocular setae slightly longer than width of single facet, scape 2 - 2.22x as long as pedicel and WH 2.8x HE, whereas in *S. nigrus* EV 1.4x HE, body completely brownish black, ocular setae as long as the width of single facet, scape 2.75x as long as pedicel and WH 2.57x HE. In winged form of females, *S. hardwickiae* is related to *S. seenae* sp.nov. in having forefemur less than 2x as long as wide, body reddish brown and WF 1.4 – 1.47x HE, but it differs in having pedicel 2.5x as long as wide, forefemur 1.89x as long as wide and OOL 2.33x WOT, whereas in *S. seenae* sp. nov. pedicel 1.6x as long as wide, forefemur 1.55x as long as wide and OOL 2.42x WOT.

Remarks: This is the first record of the winged male and winged female forms of the species. So far, this species was known only from the type locality, Madras. This is the first record of the species from Karnataka.

***Sclerodermus luteicollis* Kieffer**

(figs.157-160, 339-343)

Scleroderma luteicolle Kieffer, 1904c, 1: 373,375. Female. (MCSN)

Diagnosis: *Alate* – OOL 2.67x WOT; EV 1.62x HE; WH 2.67x HE; forefemur longer than or as long as 2x its width; body light brown; WF 1.54 – 1.64x HE; WH 0.81-0.86x LH; WF as long as or longer than 0.56x WH.

Redescription: *Holotype* – Female. *Alate*.

Measurements: Length 3.16mm. LH 0.55mm; WH 0.48mm; WF 0.28mm; LM 1mm; LP 0.4mm; WPD 0.35mm.

Colour: Head and mesosoma pale brown; metasoma dark brown; antenna, mandible, pronotum and legs pale yellow; teeth of mandible red brown; wings hyaline; veins brown; dark brown patch around all ocelli.

Head: Head (fig.157) weakly coriaceous; vestiture erect, short, thin and sparse; 1.14x as long as wide (fig.339), with subparallel sides, curving inwards posterolaterally to convex vertex in full face view. In lateral view, ventral and dorsal margins of head convex (figs.158, 341) 1.72x as long as its depth; anterior margin of clypeus transverse with shallow median notch; shallow short groove running from posterior margin of clypeus towards front beyond level of anterior ocular margin; mandible (fig.343) with 2 apical teeth and one basal small tooth; eye 0.18mm long; WH 0.87x LH; WF 1.54x HE; WH 2.67x HE; EV 1.62x HE; eye length 3.33x malar space; eye sparsely setose, setae minute as long as diameter of single facet; ocelli in acute triangle; OOL 2.67x WOT; POL: AOL = 2.5:2. Relative lengths of first five antennal segments (fig.340) in a ratio of about 11:4:2:2:2 in length; scape clavate, 2.75x as long as maximum width; pedicel 1.52x as long as wide; 3rd to 12th wider than long;

Mesosoma: Mesosoma (fig.160) weakly coriaceous; vestiture erect, short, and sparse; pronotal disc (fig.339) 0.7x as long as wide; mesonotum without notauli and parapsidal furrows; scutellum with a basal shallow transverse groove; propodeum

widest near posterior margin; maximum width 1.1x its minimum width; posterolateral corners smoothly rounded; short petiole present. Forefemur (fig.342) 2.33x as long as wide.

Metasoma: Metasoma (fig.159) weakly coriaceous; 1.14x as long as head plus mesosoma; wider than the width of head (32:39) and mesosoma; vestiture long, moderately profuse in terminal segments.

Male: Unknown.

Ecology and Biology: Unknown.

Distribution: Burma.

Material Examined. Holotype – Female. Alate. BURMA: “Bhamo, Birmania. Fea Coll.” vii.1886 (MCSN).

Discussion: *Sclerodermus luteicollis* and *S. vigilans* Krombein are related in having forefemur $\geq 2x$ as long as wide, body light brown and WF 1.54 – 1.64x HE, but it differs in having OOL 2.67x WOT, EV 1.62x HE and WH 2.67x HE, whereas in *S. vigilans*, OOL 2.11 – 2.25x WOT, EV 1.83 - 1.91x HE and WH 2.85x HE.

Remarks: Label on the holotype read “*Scleroderma luteicolle* J.J. Kieffer, 1904.”

Sclerodermus nigrus Kieffer

(figs.161-164, 344-346)

Scleroderma nigrum Kieffer, 1904c, 1: 373,375. Female. (MCSN)

Diagnosis: *Apterous* – Body completely brownish black; EV 1.4x HE; ocular setae as long as the width of single facet; scape 2.4 - 2.5x as long as wide, 2.75x as long as pedicel; WH 2.57x HE; pedicel 1.4-1.8x as long as wide; LH 1.74 - 1.78x depth of head in lateral view; ocular setae \geq width of single facet.

Redescription: *Holotype* – Female. Apterous.

Measurements: Length 4.64mm. LH 0.81mm; WH 0.72mm; WF 0.43mm; LM 1.34mm; LP 0.65mm; WPD 0.56mm.

Colour: Body dark brown; antenna, mandible, tibia and tarsi yellow; teeth of mandible red brown.

Head: Head (figs.163, 344) weakly coriaceous; vestiture erect, short, thin and sparse; 1.13x as long as wide, with subparallel sides, curving inwards posterolaterally to slightly convex vertex in full face view. In lateral view, ventral margin distinctly and dorsal margin of head slightly convex; 1.74x as long as its depth (fig.162, 345); mandible with 4 teeth, basal tooth very short; anterior margin of clypeus transverse with shallow median notch; shallow short groove running from posterior margin of clypeus towards front beyond level of anterior ocular margin; eye 0.28mm long; WH 0.89x LH; WF 1.54x HE; WH 2.58x HE; EV 1.4x HE; eye length 3x malar space; eye sparsely setose, setae minute as long as diameter of single facet; ocelli absent. Relative lengths of first 5 antennal segments 11:4:2:2:2; scape clavate, 2.44x as long as maximum width; pedicel 1.4x as long as wide; antennal segments 3 – 12 wider than long; apical segment 1.5x as long as wide.

Mesosoma: Mesosoma weakly coriaceous; vestiture erect, short, and sparse; pronotal disc as long as wide; propodeum broadest near posterior margin; maximum width 1.12x its minimum width; posterolateral corners bluntly angulated. Forefemur (fig.346) 2x as long as wide.

Metasoma: Metasoma weakly coriaceous; 1.15x as long as head plus mesosoma; wider than head (31:40) and mesosoma.

Male: Unknown.

Ecology and Biology: Unknown.

Distribution: Indonesia – Mentawai.

Material Examined: Holotype – Female. Apterous. INDONESIA: Iles Mentawai, Sipora, Sereinu; Modigliani leg; v-vi. 1894. (MCSN).

Discussion: *Sclerodermus nigrus* and *S. hardwickiae* are closely related in having pedicel 1.4-1.8x as long as wide, scape 2.4 - 2.5x as long as wide, 2 - 2.75x as long as pedicel, LH 1.74 - 1.78x depth of head in lateral view and ocular setae \geq width of

single facet, but it differs in having EV 1.4x HE, body completely brownish black, ocular setae as long as the width of single facet, scape 2.75x as long as pedicel and WH 2.57x HE, whereas in *S. hardwickiae*, EV 1.9x HE, body brown, pronotum and propodeum yellow, ocular setae slightly longer than width of single facet, scape 2 - 2.22x as long as pedicel and WH 2.8x HE.

Remarks: Label on the Holotype read like *Scleroderma nigrum* J.J. Kieffer, 1904.

***Sclerodermus seenae* sp. nov.**

(figs.165-169, 347-355)

Diagnosis: *Apterous* - Body dark brown; mandible bidentate; scape 2.57x as long as wide, 3x as long as pedicel; ocular setae 1.5x as long as width of single facet; EV longer than 2x HE; WH as long as or longer than 3x HE. *Alate* - Body reddish brown; pedicel 1.6x as long as wide; forefemur 1.55x as long as wide; OOL 2.42x WOT; forefemur length shorter than 2x its width; WF 1.4 – 1.47x HE; WF 1.73x HE; WH 0.94x LH; EV 1.58 – 1.91x HE; WF as long as or longer than 0.56x WH.

Description: *Holotype – Female. Apterous.*

Measurements: Length 2.96mm. LH 0.48mm; WH 0.4mm; WF 0.22mm; LM 0.81mm; LP 0.28mm; WPD 0.26mm.

Colour: Body dark brown, pronotum paler; antenna yellow; scape with brownish tinge; mandible yellow, teeth brown; legs with coxa and femur concolourous with body; all other segments yellow.

Head: Head (figs.166, 347) weakly coriaceous; vestiture erect, sparse, and short, ventral side with long curved setae; 1.2x as long as wide, with subparallel sides, curving inwards posterolaterally to straight vertex in full face view; head in lateral view (fig.349) 1.75x as long as its depth; ventral and dorsal margin subparallel; mandible with 2 apical blunt teeth; anterior margin of clypeus transverse without median notch in full face view; shallow median short groove running from posterior

margin of clypeus towards front, distinctly extending beyond the level of anterior ocular margin; eye 0.13mm long; WH 0.83x LH; WF 1.73x HE; WH 3.1x HE; EV 2.13x HE; Eye length 3.5x malar space; eye sparsely setose, setae 1.5x as long as diameter of single facet; ocelli absent. Relative lengths of first 5 antennal segments 9:3:1.2:1:1.2; scape clavate, 2.57x as long as maximum width; pedicel slightly longer than wide; 3rd to 12th wider than long; apical segment 1.33x as long as wide;.

Mesosoma: Mesosoma (fig.167) weakly coriaceous; vestiture short, erect sparse and thin; pronotal disc (fig.347) 1.13x as long as maximum width; mesonotum without notauli and parapsidal furrows; propodeum broadest near posterior margin; maximum width 1.15x its minimum width; posterolateral corners bluntly angulated. Forefemur 1.86x as long as wide; short petiole present.

Metasoma: Metasoma weakly coriaceous; vestiture short, sparse on basal tergites and long and moderately profuse on terminal segments (fig.165); 1.3x as long as head plus mesosoma (70:53); wider than head (23:28) and mesosoma.

Paratype – Female. Alate.

Measurements: Length 3.02mm. LH 0.53mm; WH 0.43mm; WF 0.24mm; LM 0.97mm; LP 0.35mm; WPD 3mm.

Colour: Body dark brown except pronotum brown; posterior 1/3rd of propodeum yellow; antenna yellow, scape brown at base; mandible yellow, teeth brown; legs with coxa and femur brown, all other segments yellow.

Head: Head weakly coriaceous; vestiture sparse, short and erect, sides subparallel before curving inwards posterolaterally to convex vertex in full face view; head (fig.351) 1.24x as long as wide, 1.72x as long as its depth in lateral view (fig.353), ventral and dorsal margins convex. Anterior margin of clypeus truncated, without median notch; shallow groove running from clypeus onto front beyond anterior level of ocular margin; eye 0.17mm in length; WF 1.4x HE; WH 2.5x HE; EV 1.6x HE; ocelli present, brown in colour, OOL 2.42x WOT, POL: AOL = 2:2; acute triangle; posterior ocelli away from occipital margin by diameter of posterior ocelli. Relative lengths of first five antennal segments (fig.352) 10.5:3.5:1.5:1.5:1.5; scape clavate,

2.63x as long as maximum width, pedicel 1.6x as long as wide; F1 to F10 wider than long, terminal segment 2x as long as wide.

Mesosoma: Mesosoma (fig.169) weakly coriaceous; vestiture sparse, short and erect; pronotal disc 0.77x as long as wide; mesonotum without notauli and parapsidal furrows; scutellum with basal shallow transverse groove; propodeum widest near posterior margin, maximum width 1.03x minimum width at spiracle; posterolateral corner smoothly rounded, short petiole present.

Metasoma: Metasoma weakly coriaceous, vestiture sparse, short on basal tergites and long profuse on distal tergites; metasoma (fig.198) as long as head plus mesosoma; metasoma as wide as mesosoma (27:26) and slightly wider than head (27:25).

Male: Unknown.

Ecology and Biology: Unknown.

Etymology: Species epithet is after the name of the collector and donator of the specimen, K. Seena Narayanan.

Distribution: India – Kerala.

Material Examined. *Holotype* – Female. Apterous. INDIA: Kerala, Panayathanparamba, 3kms W Kannur Airport, 11°54'32"N 75°30'27"E, 80m, 3.iii.2009 – 5.iv.2009, MT, scrub jungle, K. Seena Narayanan leg., VRN 262 (DZUC); *Paratype* – 1♀. Alate. same data of holotype except VRN 263 (DZUC).

Discussion: In winged form of females, *S. seenae* sp. nov. is related to *S. hardwickiae* in having forefemur less than 2x as long as wide, body reddish brown and WF 1.4 – 1.47x HE, but it differs in having pedicel 1.6x as long as wide, forefemur 1.55x as long as wide and OOL 2.42x WOT, whereas in *S. hardwickiae* pedicel 2.5x as long as wide, forefemur 1.89x as long as wide and OOL 2.33x WOT. In wingless form of females, *S. seenae* sp. nov. is related to *S. sumatranus* sp. nov. in having eye setose; EV longer than 2x HE and WH \geq 3x HE, but it differs in having scape 2.57x as long as wide, scape 3x as long as pedicel, body dark brown,

mandible bidentate and ocular setae 1.5x as long as width of single facet. Whereas in *S. sumatranus* sp. nov., scape 3x as long as wide, scape 2.25x as long as pedicel, body pale brown, mandible tridentate and ocular setae as long as width of single facet.

***Sclerodermus sumatranus* sp. nov.**

(figs.170-173, 356-359)

Diagnosis: Body pale brown; mandible tridentate; scape 3x as long as wide; scape 2.25x as long as pedicel; ocular setae as long as width of single facet; EV longer than 2x HE; WH as long as or longer than 3x HE; eye setose.

Description: Holotype – Female. Apterous.

Measurements: Length 3.78mm; LH 0.52mm; HW 0.43mm; WF 0.24mm; LM 0.84mm; LP 0.34mm; WPD 0.26mm.

Colour: Body shining brown except antenna, legs, pronotum, mandible, and propodeum yellow.

Head: Head (figs.172, 356) smooth and polished, front weakly coriaceous; vestiture on dorsal side short thin and sparse, ventrally long and strong; 1.21x as long as wide, with subparallel sides, curving inwards posterolaterally to slightly convex vertex in full face view. In lateral view, ventral and dorsal margin convex; 1.67x as long as its depth (figs.171, 358); mandible with 3 teeth, apical 2 long and basal one short; anterior clypeal margin transverse with shallow median notch; shallow short groove running from posterior margin of clypeus towards front beyond the level of anterior ocular margin; WH 0.83x LH; WF 1.75x HE; WH 3.1x HE; EV 2.25x HE; eye length 2.66x malar space; eye sparsely setose, setae as long as the diameter of single facet; ocelli absent. Relative lengths of first five antennal segments (fig.357) 9:4:1.5:1:1; scape clavate, 3x as long as maximum width; pedicel 1.6x as long as wide; antennal segments 3 – 12 wider than long; apical segment 1.67x as long as wide.

Mesosoma: Dorsum of mesosoma (fig.173) weakly coriaceous, slightly strong than that of head; pronotal disc (fig. 356) slightly wider than long (17:18); mesonotum wider than long, 0.8x as long as wide; propodeum widest near posterior end, maximum width 1.19x minimum width; posterolateral angles bluntly angulated.

Metasoma: Weakly coriaceous, stronger than that of head; 1.2x wider than maximum head width; 1.77x as long as head plus mesosoma (fig.170).

Male: Unknown.

Ecology and Biology: Unknown.

Etymology: The species epithet is after type locality, Sumatra.

Distribution: Indonesia – Sumatra.

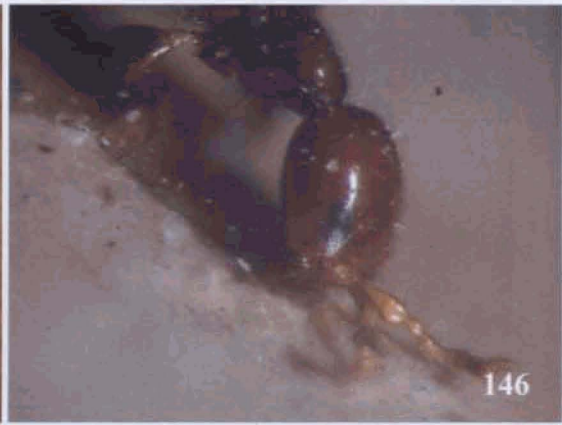
Material Examined: INDONESIA: Sumatra, Padang; E. Modigliani leg. iv. 1894 (MCSN)

Discussion: In wingless form of females, *Sclerodermus sumatranus* sp. nov. is close to wingless female of *S. seenae* sp. nov. in having eye setose; EV longer than 2x HE and $WH \geq 3x HE$. *Sclerodermus sumatranus* sp. nov. is having scape 3x as long as wide; scape 2.25x as long as pedicel; body pale brown; mandible tridentate; ocular setae as long as width of single facet, whereas *S. seenae* sp. nov. is having scape 2.57x as long as wide; scape 3x as long as pedicel; body dark brown; mandible bidentate; ocular setae 1.5x as long as width of single facet.

Remarks: Though this species is distributed well outside the study area, their identity is important to bring about clarity and accuracy to the present investigation. Hence, it is also included in the study.



145



146



147



148

Museo Civico
di Genova

HOLOTYPUS ♀
Scleroderma
castaneum
J.J. Kieffer, 1904

TYPUS

Ternate
Acqui Genova
Beccari 1874 XI

Scleroderma
castaneum
K



149

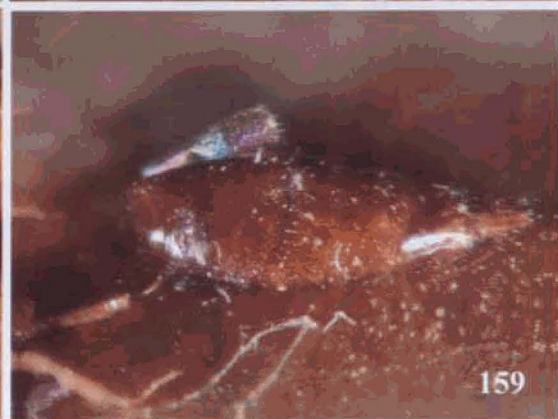
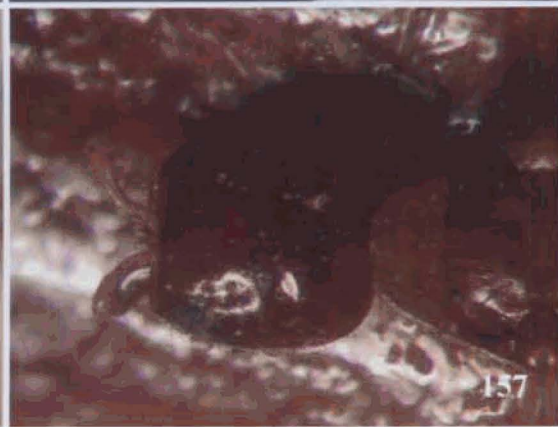
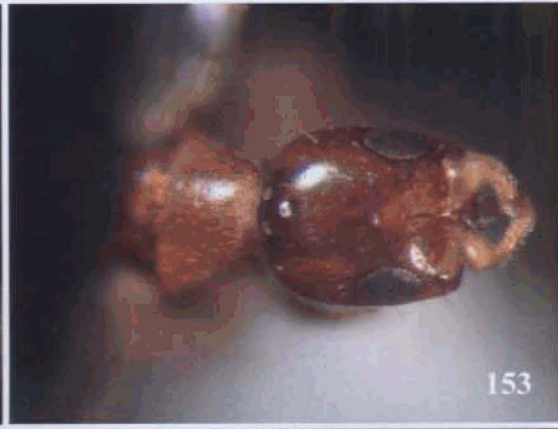


150



151

Scleroderma castaneum Kieffer, Apterous. Female. 145. body, dorsal view; 146. head, side view; 147. head, full face view; 148. mesosoma, dorsal view. *Scleroderma hardwickiae* Kurian, Apterous. Female, 149. body profile; 150. head, full face view; 151. mesosoma, dorsal view.



Sclerodermus hardwickiae Kurian, Alate. Female, 152. body profile; 153. head, full face view; 154. mesosoma, dorsal view. *Sclerodermus hardwickiae* Kurian, Alate. Male, 155. body profile; 156. *Lyctus* spp. *Sclerodermus luteicollis* Kieffer, Alate. Female. 157. head, full face view; 158. head, side view; 159. metasoma, dorsal view.



160



161

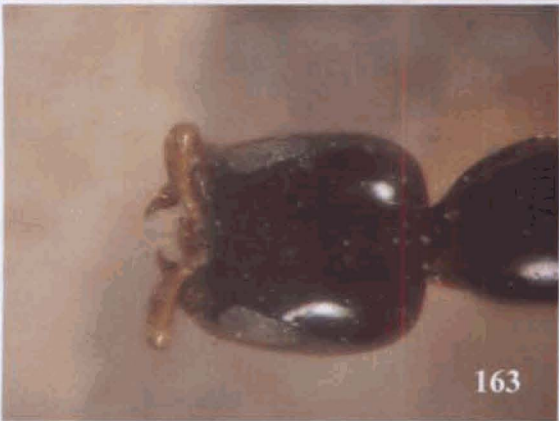


162

Scleroderma luteicollis
♀ K.

Bhamo
Birmaniam
Fea VII 1894

HOLOTYPUS ♀
Scleroderma luteicollis
J.J. Kieffer, 1904



163



164



165

TYPUS

Museo Civico di Genova

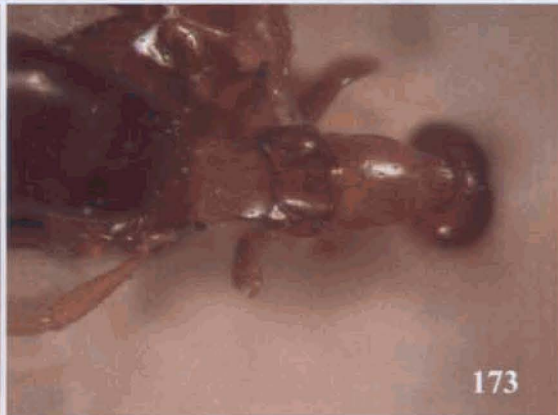
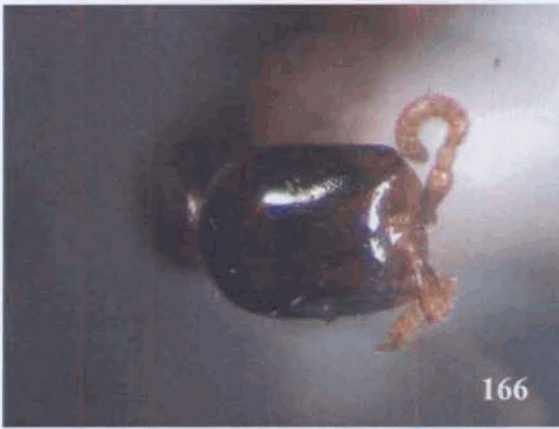
Menawai Sipora
Serinus 1907, 94
Medigliani

HOLOTYPUS ♀
Scleroderma nigrum
J.J. Kieffer, 1904

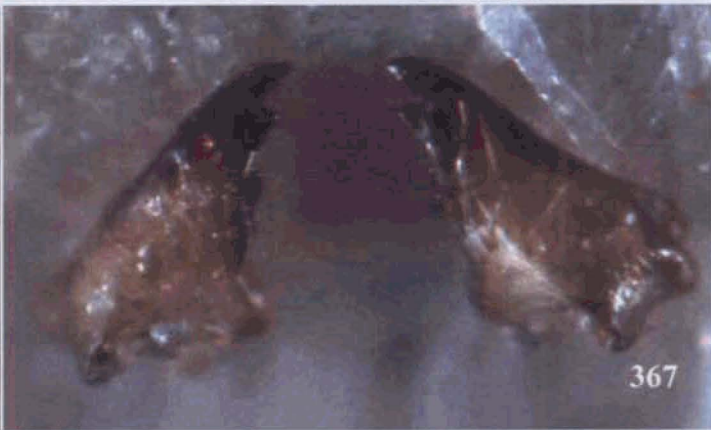
Museo Civico di Genova

Scleroderma nigra K.

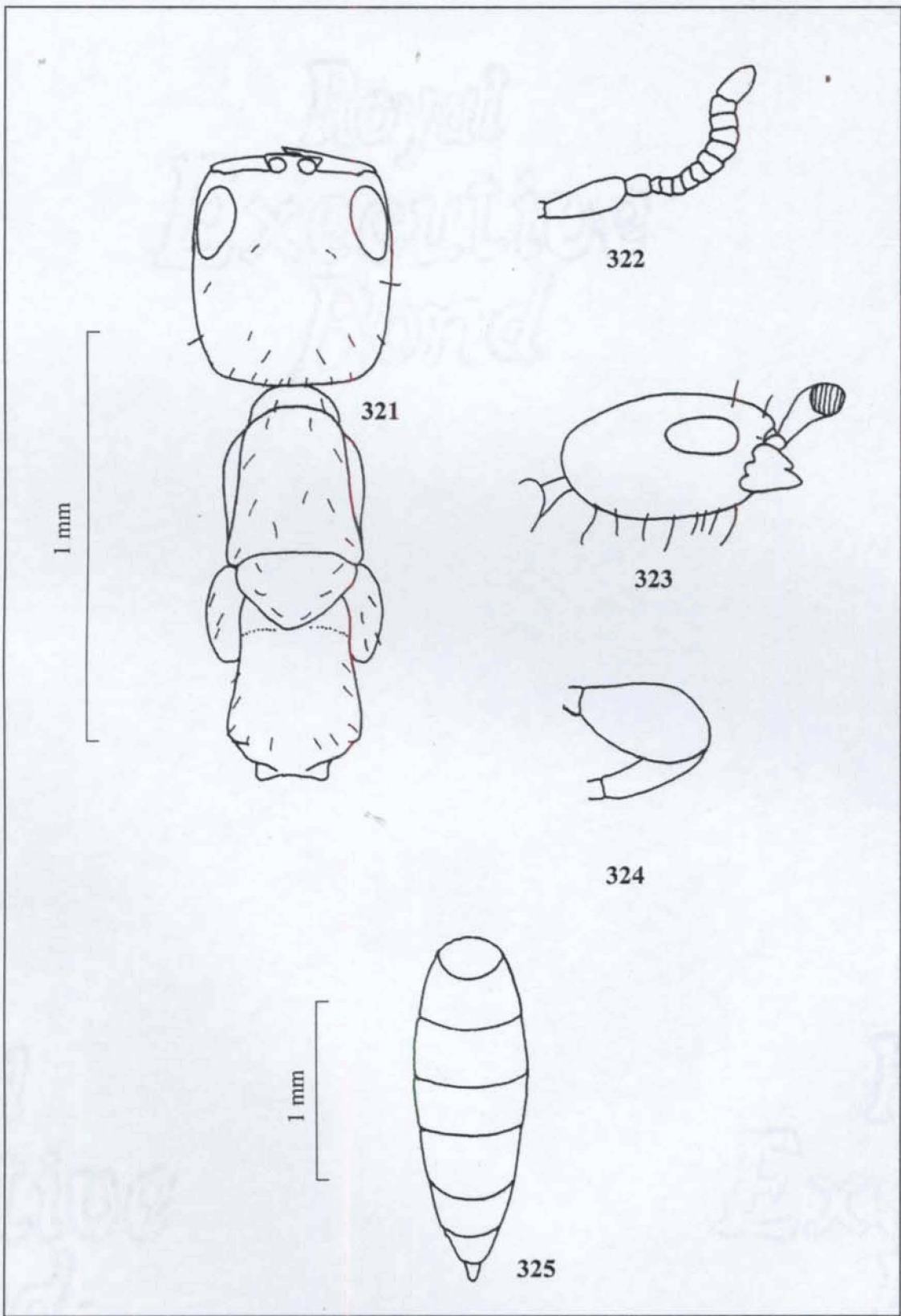
Sclerodermus luteicollis Kieffer, Alate. Female. 160. mesosoma, dorsal view
Sclerodermus nigrus Kieffer, Apterous. Female. 161. body, dorsal view; 162. head, side view; 163. head, full face view; 164. mesosoma, dorsal view. *Sclerodermus seenae* sp. nov. Apterous. Female. 165. body profile.



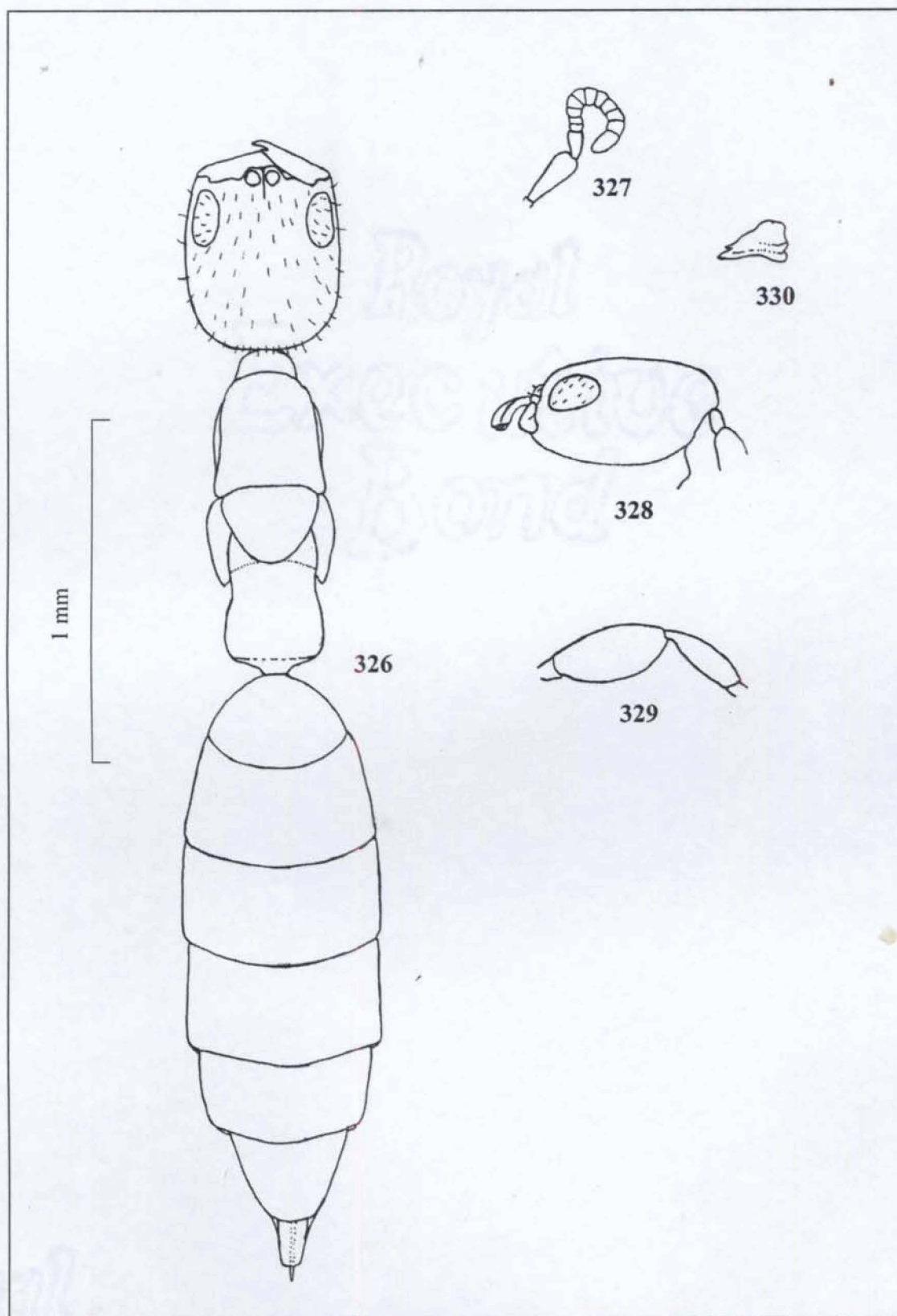
Sclerodermus seenae sp. nov. Apterous. Female. 166. head, full face view; 167. mesosoma, dorsal view; *Sclerodermus seenae* sp. nov. Alate. Female. 168. body profile; 169. mesosoma, dorsal view. *Sclerodermus sumatranus* sp. nov., Apterous. Female. 170. body, dorsal view; 171. head, side view; 172. head, full face view; 173. mesosoma, dorsal view.



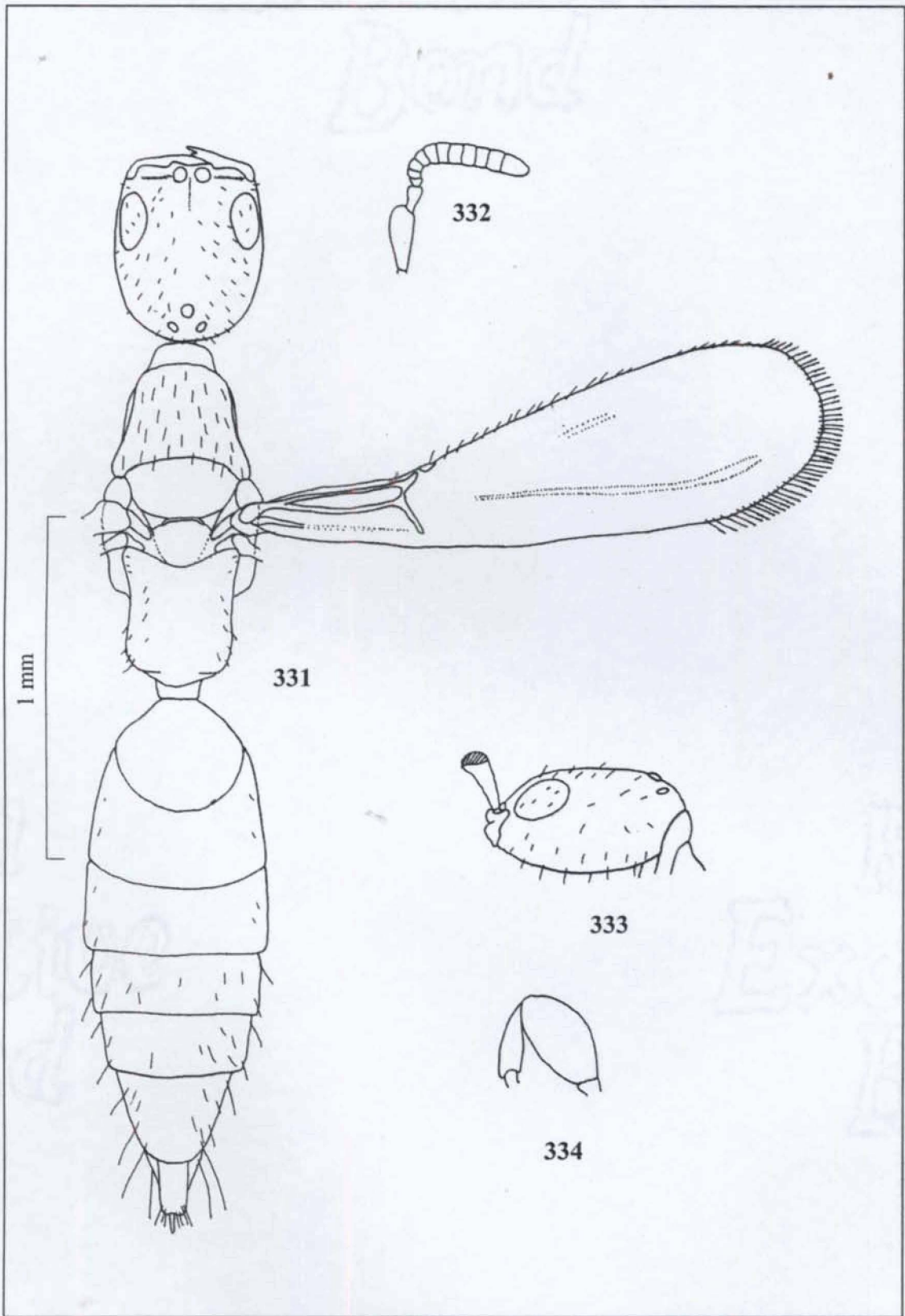
Sclerodermus bicolor Smith, Holotype. Apterous. Female. 364. body; dorsal view; 365. head full face view; 366. body, side view; 367. mandible.



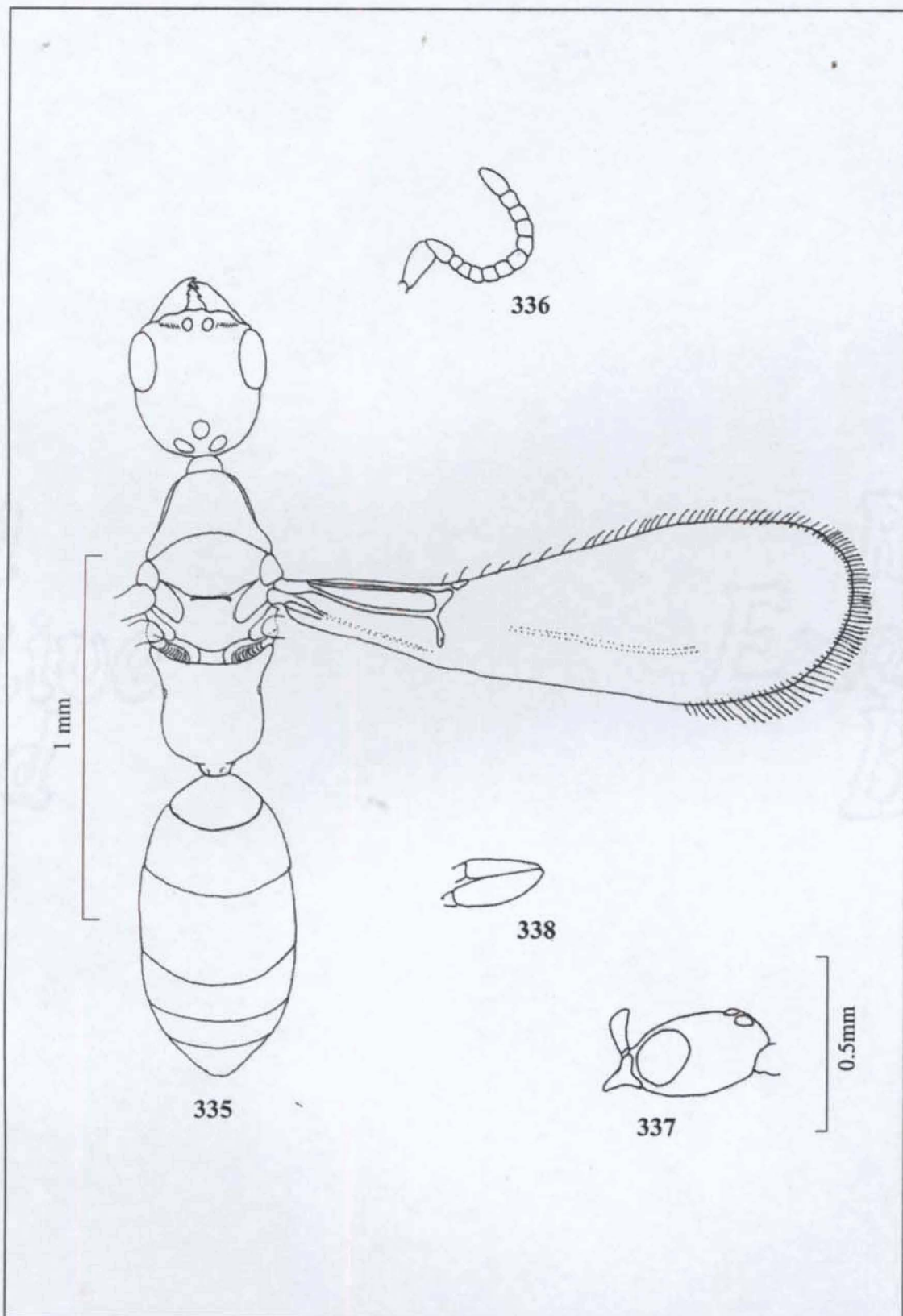
Figs. 321 - 325. *Sclerodermus castaneus* Kieffer. Female, 321. head and mesosoma, dorsal view; 322. antenna; 323. head, side view; 324. foretibia; 325. metasoma.



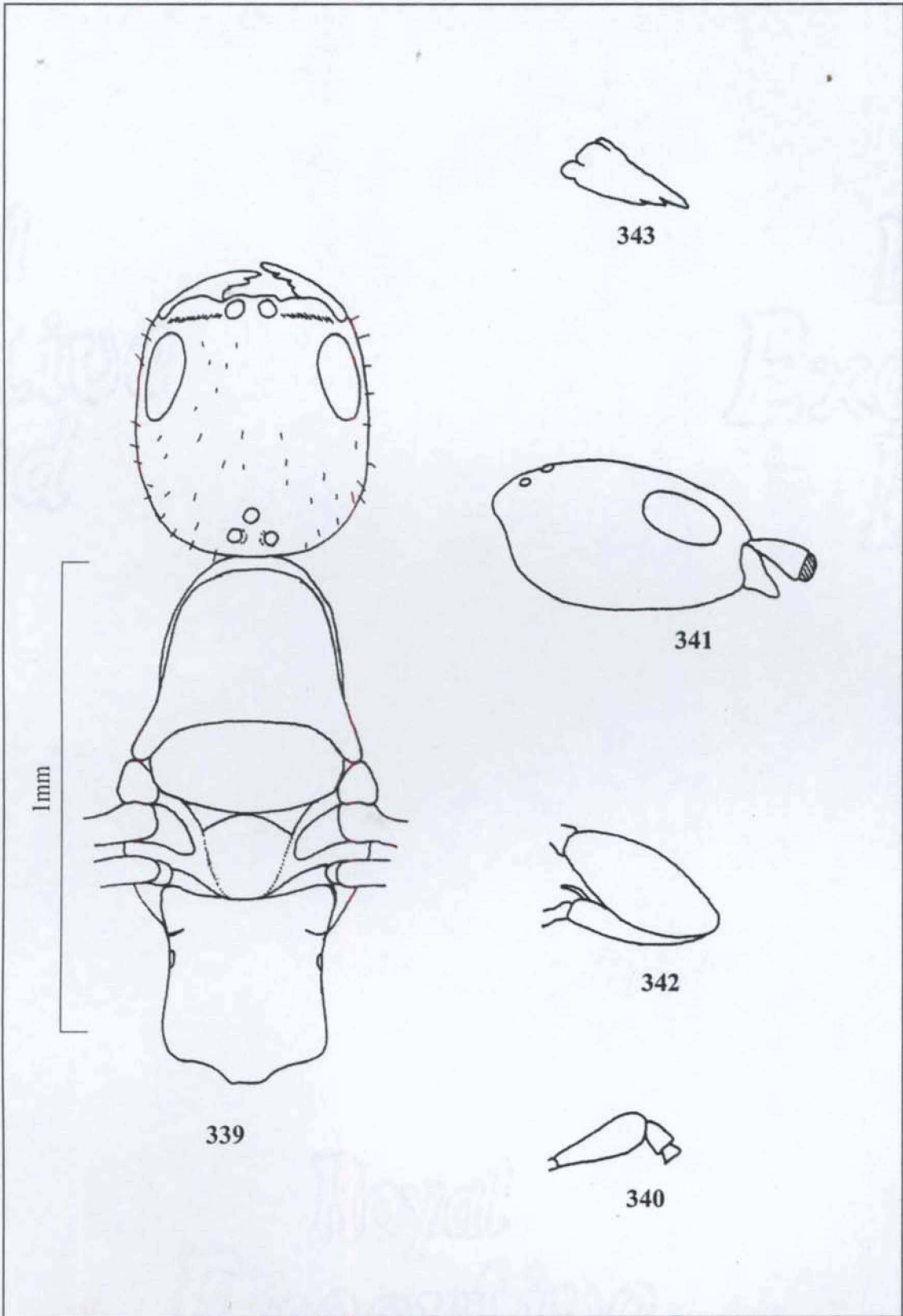
Figs. 326 - 330. *Sclerodermus hardwickiae* Kurian. Apterous. Female, 326. body, dorsal view; 327. antenna; 328. head, side view; 329. foretibia; 330. mandible.



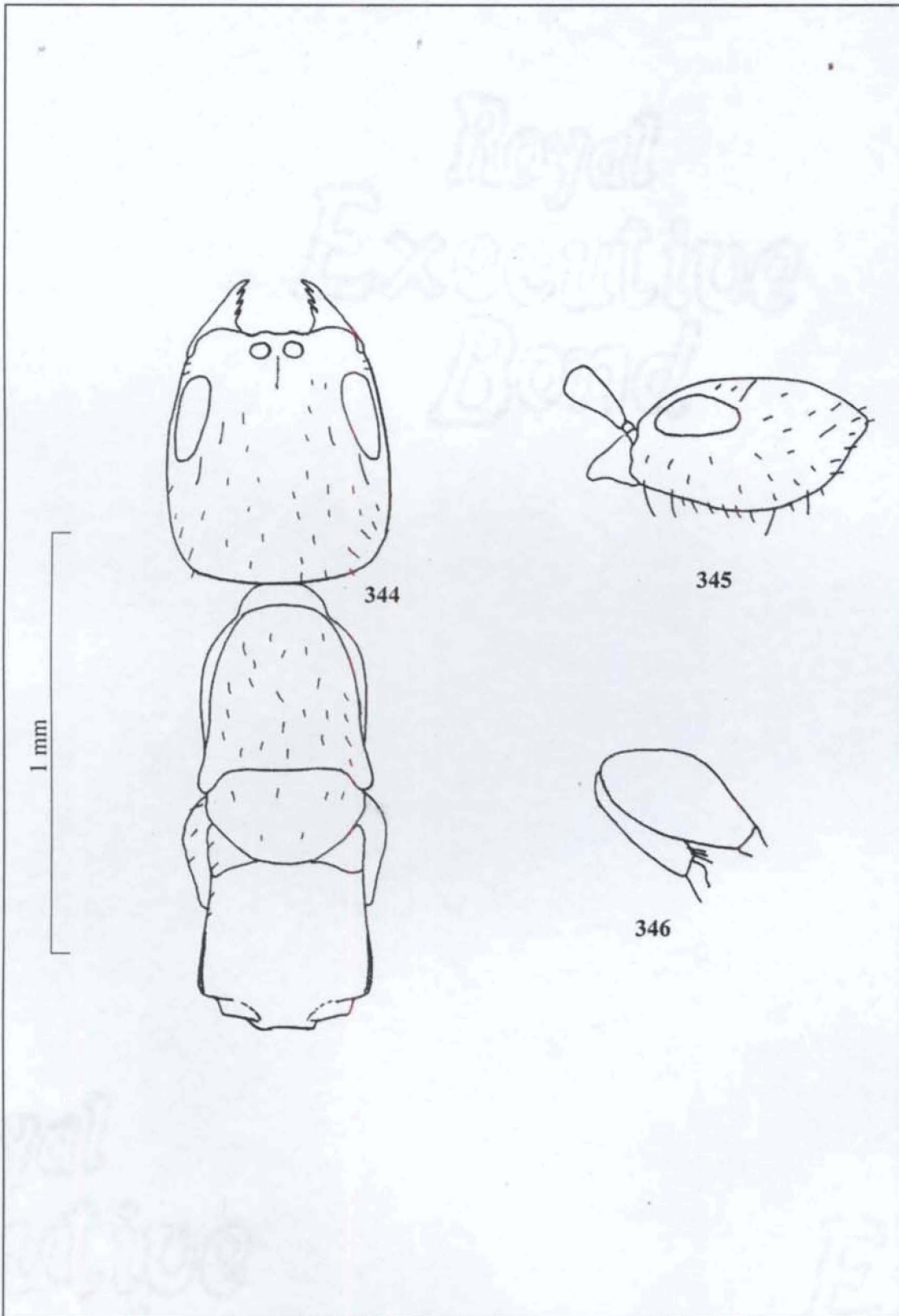
Figs. 331 - 334. *Sclerodermus hardwickiae* Kurian. Alate. Female, 331. body, dorsal view; 332. antenna; 333. head, side view; 334. foretibia.



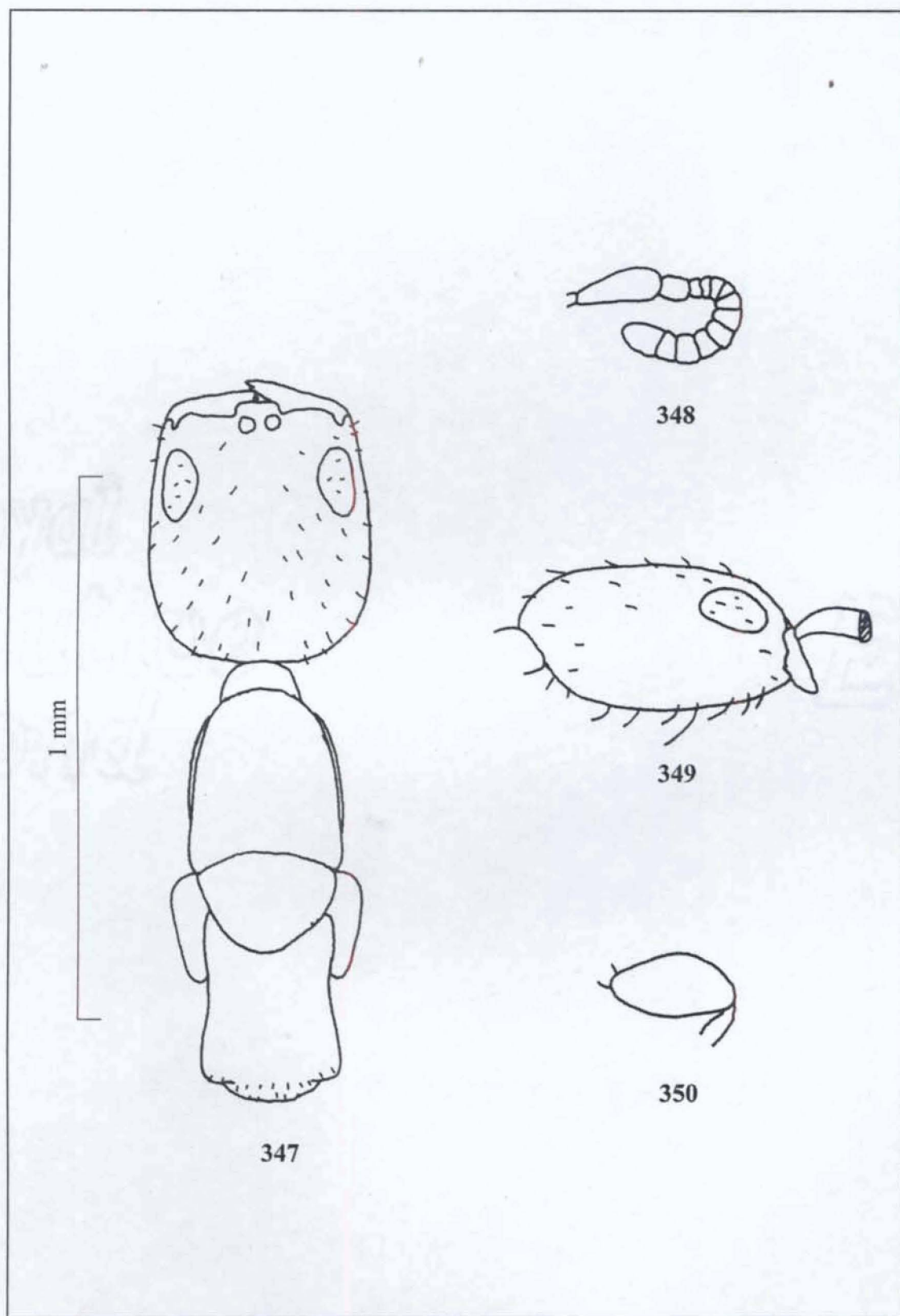
Figs. 335 - 338. *Sclerodermus hardwickiae* Kurian. Alate. Male, 335. body, dorsal view; 336. antenna; 337. head, side view; 338. foretibia.



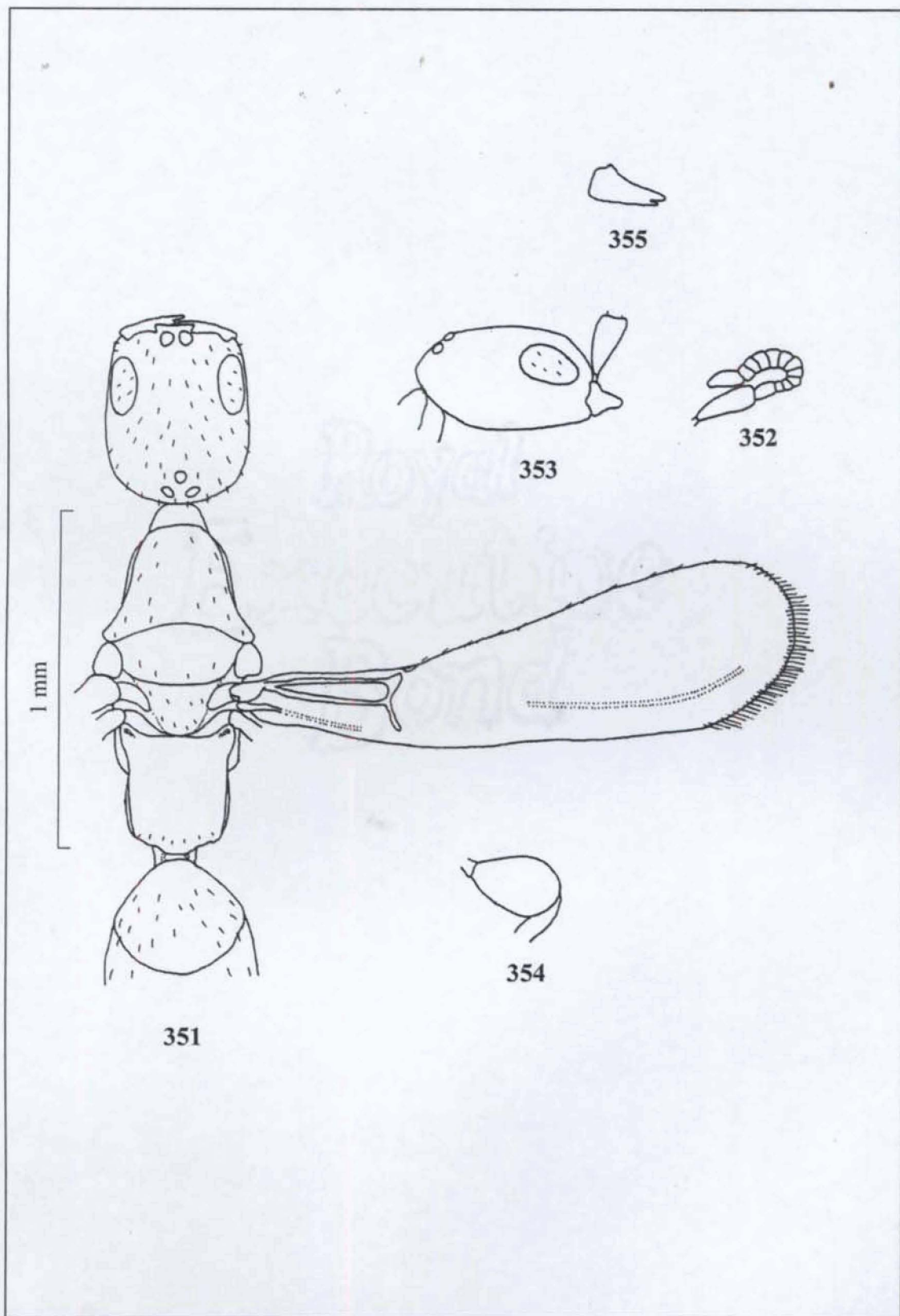
Figs. 339 - 343. *Sclerodermus luteicollis* Kieffer. Alate. Female, 339. body, dorsal view; 340. scape and pedicel; 341. head, side view; 342. foretibia; 343. mandible



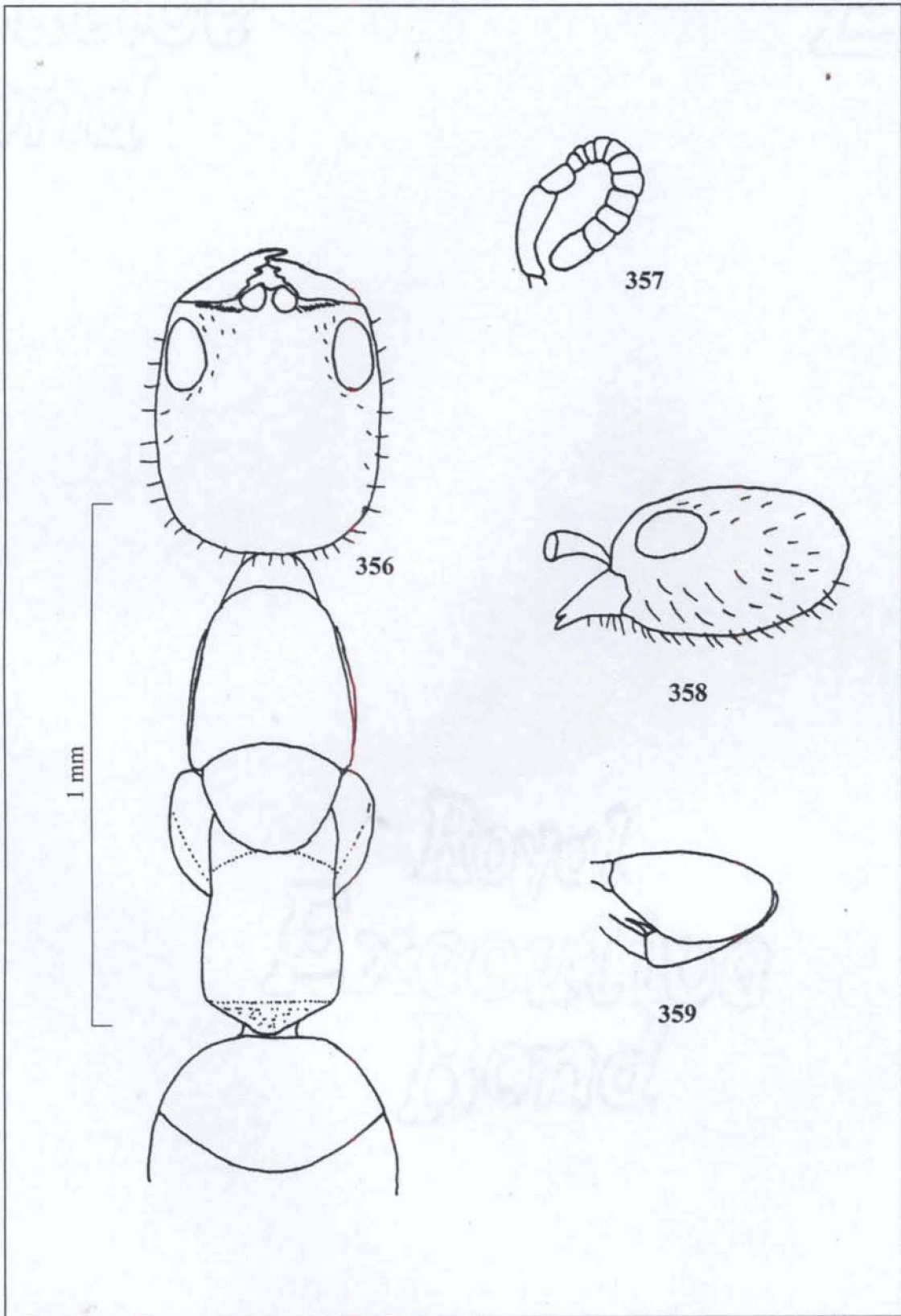
Figs. 344 - 346. *Sclerodermus nigrus* Kieffer. Apterous. Female, 344. body, dorsal view; 345. head, side view; 346. foretibia.



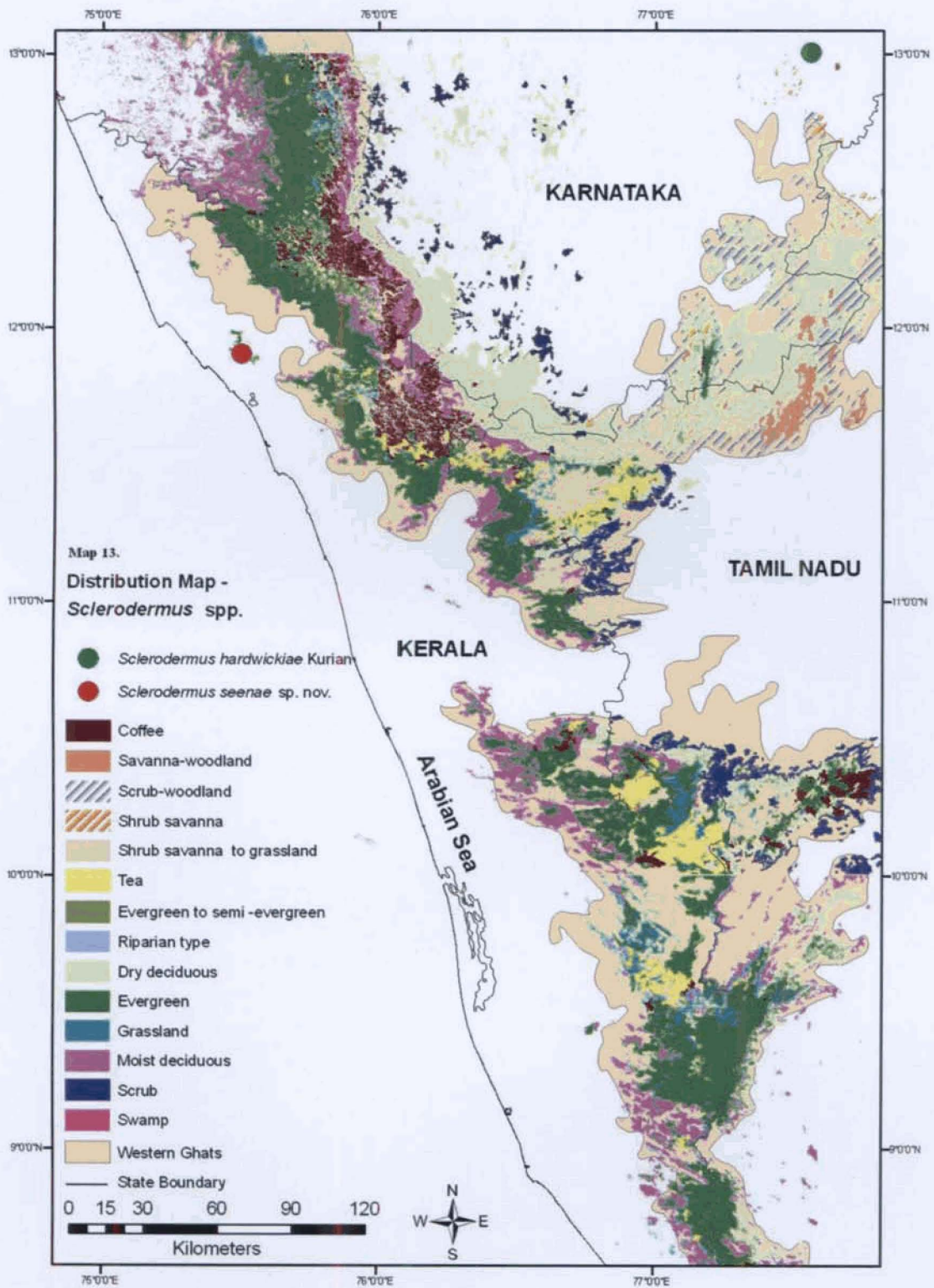
Figs. 347 - 350. *Sclerodermus seenae* sp. nov., Apterous. Female, 347. body, dorsal view; 348. antenna; 349. head, side view; 350. foretibia.



Figs. 351 - 355. *Sclerodermus seenae* sp. nov., Alate. Female. 351. body, dorsal view; 352. antenna; 353. head, side view; 354. foretibia; 355. mandible.



Figs. 356 - 359. *Sclerodermus sumatranus* sp. nov., Female, 356. body, dorsal view; 357. antenna; 358. head, side view; 359. foretibia.



CHAPTER 6

DISCUSSION

Bethylidae is a primitive family of aculeate wasps, lying in the grey zone between the parasitic and predatory wasps. It badly needs a systematic treatment for the Indian region. Obscure and isolated species descriptions without any revisionary work and unavailability of the type material have been the major impediments. Revisionary studies of the economically important and speciose genera like *Goniozus* and *Odontepyris* and the relatively rare *Sierola* and *Sclerodermus* were carried out during this investigation. Taxonomic relationships of the species studied are discussed under the description of the respective taxa.

6.1 Collecting

The collections were made from one of the three biodiversity hotspots in the country, Western Ghats. Southern Western Ghats were chosen as the study area as the wetter southern parts of the Western Ghats is richer in species diversity of the group and is easily accessible from the research centre. Easy access has contributed to intense collection over a long period of time, four years. Moreover, this part of the Western Ghats encompassing the Nilgiri Biosphere reserve is inhabited by great many endemic taxa. Diverse methods of collection were employed to ensure thorough collection in diverse habitats ranging from agricultural fields to scrub, deciduous and evergreen forests, from forest floor to forest canopy, elevations ranging from 7 to 1356 meters above sea level.

Bethylidae study was not carried out in Indian region for good many reasons as mentioned in the introduction of this work. Along with the reasons mentioned, rarity of the specimens in the general museum collections was found to be one of the hurdles in the progress of bethylid taxonomy. Previous studies were mostly based on collections from sweeping and rearing and so the number of individuals for each taxa were limited. The present investigation used the malaise trap for the survey and

the results from the collection survey indicates that malaise trap set in the humus rich soil and decomposing leaf litter could recover upto 59 bethylid specimens in 14 days time during the best collection period from December to February, whereas a sweeping method for the entire day in suitable habitat could recover a maximum of 11 specimens. Malaise trap found more productive in obtaining specimens without the physical labour associated with the active methods. The reason for the good number of bethylids in flight interception traps like malaise trap may be due to their advantage over sweep nets in passively collecting the emerging wasps from host larvae and cocoon living in leaf litter. Some taxa are rarely collected in sweep net method, for instance *Dissomphalus* spp. Since the subfamily Pristocerinae has wingless females, flight interception traps, pan traps or sweep nets are inefficient to collect them. Pitfall traps are good in collecting the wingless taxa. There were occasional instances of Pristocerinae females obtained from sweep net collecting.

6.2 Distribution

Before this investigation, Bethylidae was represented in the Oriental region by 428 species in 44 genera, of which 181 species in 29 genera were known from Indian region (Indian subcontinent) and 23 species in 10 genera from Southern Western Ghats. The present investigation discovered 35 new species in 4 genera of the family. *Goniozus* is the most speciose with 26 new species, followed by *Odontepyris* with five new species, *Sclerodermus* and *Sierola* with two new species each. In the pilot study (SANTHOSH, 2005), ten genera namely *Cephalonomia*, *Glenosema*, *Laelius*, *Rhabdepyris*, *Heterocoelia*, *Acrepyris*, *Dissomphalus*, *Parascleroderma*, *Protisobrachium* and *Pseudisobrachium* are newly recorded from Southern Western Ghats, of which six, namely *Glenosema*, *Heterocoelia*, *Acrepyris*, *Parascleroderma*, *Protisobrachium* and *Pseudisobrachium* are new records to India and three namely *Parascleroderma*, *Protisobrachium* and *Pseudisobrachium* are new records to the subcontinent. Some of the newly recorded genera are not treated at species level as they are either known from single specimens or they are highly speciose to make this study cumbersome. All newly recorded genera are included along with the already known ones in the identification key for accuracy and update. After the

present study, the updated statistics of the family Bethylidae is the following; 463 species in 44 genera from Oriental region, of which 215 species in 32 genera from Indian region (Indian subcontinent) and 57 species in 20 genera from Southern Western Ghats. The updated species statistics of Oriental Bethylidae is given in table – 28.

Distributions maps indicating the habitat types throw light on the geographical and habitat range extensions of the species under study. The information pertaining to the collection localities such as distance from the nearest town or land mark, habitat type, vegetation, geographical coordinates (latitude and longitude), month of collection etc. may be helpful for future collecting and study of the species as many of them may prove to be good biological control agents.

Table – 28. Bethylidae – Updated Species Statistics

SUBFAMILY	GENERA	NUMBER OF SPECIES REPORTED			
		ORIENTAL	INDIAN REGION	INDIA	SWG
Bethylinae		71(104)	49(82)	36(69)	11(44)
	<i>Bethylus</i>	1	1	0	0
	<i>Goniozus</i>	50(76)	37(63)	28(54)	11(37)
	<i>Odontepyris</i>	17(22)	10(15)	7(12)	0(5)
	<i>Sierola</i>	3(5)	1(3)	1(3)	0(2)
Epyrinae		186(187)	69(70)	42(43)	7(8)
	<i>Allobethylus</i>	1	0	0	0
	<i>Calyozina</i>	3	1	0	0
	<i>Cephalonomia</i>	9	3	1	0
	<i>Discleroderma</i>	2	2	1	0
	<i>Disepyris</i>	2	2	2	1
	<i>Epyris</i>	74	22	15	3
	<i>Formosiepyris</i>	4	1	1	0
	<i>Glenosema</i>	5	2	0	0
	<i>Holepyris</i>	30	6	2	1
	<i>Isobrachium</i>	3	1	0	0
	<i>Laelius</i>	3	2	2	0
	<i>Leptepyris</i>	1	0	0	0
	<i>Malanepyris</i>	1	0	0	0
	<i>Neodispyris</i>	5	5	5	0

SUBFAMILY	GENERA	NUMBER OF SPECIES REPORTED			
		ORIENTAL	INDIAN REGION	INDIA	SWG
	<i>Neurepyris</i>	1	0	0	0
	<i>Plastanoxus</i>	2	0	0	0
	<i>Pristepyris</i>	2	1	1	0
	<i>Prosplastanoxus</i>	1	0	0	0
	<i>Prorops</i>	1	1	0	0
	<i>Rhabdepyris</i>	17	9	8	0
	<i>Scaphepyris</i>	1	0	0	0
	<i>Sclerodermus</i>	14(16)	9	3(4)	1(2)
	<i>Trachepyris</i>	2	2	1	1
	<i>Xenepyris</i>	2	0	0	0
Galodoxinae		1	0	0	0
	<i>Galodoxa</i>	1	0	0	0
Mesitiinae		71	38	10	3
	<i>Heterocoelia</i>	8	3	0	0
	<i>Incertosulcus</i>	1	1	1	0
	<i>Metrionotus</i>	4	3	1	0
	<i>Pycnomesitius</i>	3	3	1	1
	<i>Sulcomesitius</i>	55	28	7	2
Pristocerinae		99	25	11	2
	<i>Acrepyris</i>	5	1	0	0
	<i>Apenesia</i>	35	12	4	1
	<i>Caloapenesia</i>	3	0	0	0
	<i>Dissomphalus</i>	14	2	2	0
	<i>Foenobethylus</i>	5	0	0	0
	<i>Neoapenesia</i>	1	0	0	0
	<i>Parascleroderma</i>	4	0	0	0
	<i>Pristocera</i>	19	10	5	1
	<i>Protisobrachium</i>	1	0	0	0
	<i>Pseudisobrachium</i>	11	0	0	0
Total No. of Species		428(463)	181(215)	99(133)	23(57)
Total No of Genera		44	29(32)	22(28)	10(20)

Notes:

1. The figure given in parenthesis is the latest, including the unpublished species reports.
2. During the pilot investigation, ten genera were reported for the first time from Southern Western Ghats of which six are new to India, three are new to Indian Subcontinent

6.3 Taxonomy

6.3.1 Taxonomic Keys (Dichotomous and interactive keys)

The present investigation includes the revision of the four genera *Goniozus*, *Odontepyris*, *Sierola* and *Sclerodermus*; first three falling into subfamily Bethylinae and the fourth into Epyrinae. The morphological character states of all the Oriental species of the three genera viz. *Odontepyris*, *Sierola* and *Sclerodermus* were analysed and Oriental species keys were made for identification of the taxa. Regarding *Goniozus*, the species recorded from the Indian region (Indian subcontinent) were studied and key to species for Indian region is generated. The new taxa in this work were all erected after comparative study with all the taxa from Oriental region. As half a dozen of the Oriental species of the genus *Goniozus* recorded from outside the Indian region are so poorly described with their types in very bad condition to loan out from their depositories, Key to species is restricted Indian taxa.

The dichotomous keys and the computer based interactive keys (in CD) were prepared. Interactive keys made using DELTA software has many advantages over the dichotomous keys. User can choose the sequence of the characters to consider in identification process. The software can also suggest the best order of characters for quick identification. Hence, it provides more flexibility in the key and so specimens with lost parts have certainly a higher chance to get identified using this key. Dichotomous keys were prepared to make it easy and workable with easily observable and reliable characters. More than one character is used in the leads, wherever possible to make it clear and accurate. The leads of two successive couplets are not begun with the same initial word to alleviate any possible chance for confusion.

6.3.2 Character coding and data matrix

Character matrix and coding is given for all the four genera studied. The genus *Goniozus* with 63 species from Indian region, of which six species known only from

males are excluded in the analysis. Forty one characters, with total of 81 character states in 57 female and 18 male species of *Goniozus* are studied. Twenty four Oriental species of *Odontepyris* are analysed using 24 characters. Sixty five character states are studied. Five species of Oriental *Sierola* are analysed using eight characters. Nineteen character states are studied. Thirteen species of Oriental *Sclerodermus* of which 5 species are known from both apterous and alate forms are analysed using 14 characters. Thirty four character states are studied. Some of the characters states are unknown in the species for which descriptions are poor and types unavailable. In total, 199 character states of 87 morphological characters in 99 species of the four genera are analysed in this taxonomic treatment.

While describing the new taxa and re-describing the known taxa from the type materials, all possible and valuable morphometric ratios and reliable character details are recorded and all morphometric ratios from paratypes and their mean values are given in the tabular columns to assess their variability within the species. Significant deviations from the mean values without other reliable supporting characters are considered as only variation to the species and separately recorded.

6.3.3 Reliable versus unreliable characters

The revisionary study of the genera has good many advantages over isolated species descriptions. One of them is the inclusion of reliable characters and omission of the unreliable and inconsistent ones. Oriental *Goniozus* species keys prepared by KURIAN (1955) and RAM and SUBBA RAO (1967) widely used the leg and antennal colouration, which is found to be widely varying within the species and so unreliable. The colouration of the body and appendages are depended on the time elapsed after their emergence. If they are killed shortly after their emergence from their cocoon, they are teneral and so pale coloured compared to the more sclerotized ones killed several hours after their emergence. This is also an important reason for the collapsed body parts, especially the head and mesosoma. For instance, RAM and SUBBA RAO (1967) considered the two shallow depressions on lateral sides of the mesoscutum as diagnostic characters worthy enough to be indicated in their

description of *Goniozus stomopterycis*. Conversely, the type study conducted in the present investigation found that one of their dark coloured paratypes do not show this character and it was nothing but collapsed mesoscutum as they may have been killed soon after their emergence. Thus, shallow lateral depression on mesoscutum mentioned in original description based on the teneral specimen is not of any taxonomic value.

The present investigation has made an attempt to avoid such unreliable characters from diagnostic features and keys, whereas they are indicated in descriptions and remarks for the completeness. Reliable colourations are included in the keys and diagnostic characters. Colouration of the tagma and mandibles are more reliable (GORDH, 1988) and so they are included, but whenever the colouration is used in the couplets in the keys they are in combination with other reliable characters for accuracy. A brief diagnosis is provided for easy and quick confirmation of the species identity.

6.3.4 Introduction of new characters

In addition to the already known, well used and established characters such as the presence or absence of areolet, parapsidal furrows, notauli and shape of smooth elevated antero-median propodeal area, several new characters are found to be diagnostic in species level taxonomic treatment in the four genera studied. Some new terminologies, morphometric ratios and indices are introduced in this study for the first time.

The forefemur in *Goniozus* and many other bethylid genera is flattened and their shape is frequently varying between the species. Forefemur Sphericity Index (SI) previously used in Stephanidae (AGUIAR, 2001) is an index introduced to bethylids taxonomy in the present investigation. It was already used in *Goniozus armigerae* description by SANTHOSH and NARENDRAN (2009). It is calculated using the formula $SI = (\text{forefemur length} \times \text{forefemur width}) / (\text{forefemur height})^2$, to indicate the overall three dimensional shape of the forefemur, where the value “1”

indicates a perfect sphere and the increasingly greater values indicate an elongated flattened or compressed forefemur.

The pattern of forewing vestiture, especially in the median and submedian cells and speculum, a usually hairless region immediately below the short stub arising from the forewing basal vein in *Goniozus* spp are some of the newly introduced diagnostic features. Speculum is a commonly used term in chalcidology and it is introduced to bethylid taxonomy for the first time. The changes in the pattern of distribution of setae in the above mentioned parts of the forewing in *Goniozus* is found to be reliable and used in this work. The relative lengths of the antenna to that of the head in full face view, the ratio of head length to width in lateral aspect, relative length of ocular setae to the diameter of single facet, sculpture of gena, the angle of inclination of propodeal disc towards its lateral edges, ratio of the lengths of pedicel to that of F1, sculpture of metasomal tergites, shape of areolet and its length to width ratio are some of the newly introduced characters in this revisionary work.

6.3.5 Host –Parasitoid Relationships and Habitat Information

Four new host - parasitoid relationships were discovered. *Goniozus orthagae* sp. nov. was emerged from larvae of *Orthaga exvinacea* Hampson, leaf webber on Mango tree, *Mangifera indica* L. (Anacardiaceae). *Goniozus platycephalus* sp. nov. was emerged from larvae of *Cnaphalocrocis medinalis* (Guenee), rice leaf-roller. *Goniozus aproaeremae* sp. nov. was found to parasitize groundnut leaf minor larvae, *Aproaerema modicella* (Deventer). *Goniozus armigerae* Santhosh and Narendran parasitized the larvae of *Helicoverpa armigera* (Hübner).

So far, *Goniozus triangulifer* Kieffer, distributed in Philippines was the only known species of this genus from paddy fields. The present investigation reports six new species viz. *Goniozus antennalis* sp. nov., *Goniozus aproaeremae* sp. nov., *Goniozus mandibularis* sp. nov., *Goniozus nuperus* sp. nov., *Goniozus platycephalus* sp. nov. and *Goniozus recentis* sp. nov. from the rice ecosystem of Southern India. *Goniozus platycephalus* sp. nov. was collected from the rice ecosystem of Karnataka

with their range extended to the Eastern Himalayas, Manipur. *Goniozus aproaeremae* sp. nov. and *Goniozus antennalis* sp. nov. associated with the paddy field have their range extended to the Gangetic plains in the north, Chhattisgarh. *Goniozus nuperus* sp. nov., *Goniozus mandibularis* sp. nov., and *Goniozus aproaeremae* sp. nov. were also reported from mixed vegetable fields. *Goniozus nuperus* sp. nov. was collected from the riparian vegetation and *G. mandibularis* sp. nov. was also collected from the lemon grass fields. *Goniozus setosus* sp. nov. was collected from plantain and coconut plantations. *Goniozus sringeriensis* sp. nov. found emerged from an unknown lepidopteran larvae on *Hibiscus* spp. (Malvaceae). *Odontepyrus anamalaicus* sp. nov. found on its plant host, *Cinchona* spp. (Rubiaceae) from Anamalai hills, 1200m above sea level.

Sierola nasseri sp. nov. and *Goniozus inauditus* sp. nov. were emerged from leaf galls of thrips on *Memecylon umbellatum* Brum.f. (Memecylaceae) with staphylinid beetle as an associate host. This species was also reported from *Opisina arenosella* Walker (Oecophoridae), but this host record must be verified. *Goniozus kuriani* sp. nov. was emerged from unidentified leaf galls of *Syzygium cumini* L. (Myrtaceae). This species was also collected from the plant host, *Dipterocarpus indicus* Bedd. (Dipterocarpaceae).

6.3.6 New Species and New Records

The present study discovered and described 35 new species along with the alate male and alate female forms of *Sclerodermus hardwickiae* Kurian. *Goniozus* was the most speciose with 26 new species namely *Goniozus buddhai* sp. nov., *G. platycephalus* sp. nov., *G. orthogae* sp. nov., *G. sringeriensis* sp. nov., *G. palghatensis* sp. nov., *G. mandibularis* sp. nov., *G. nuperus* sp. nov., *G. kainophanestus* sp. nov., *G. propodeatus* sp. nov., *G. aproaeremae* sp. nov., *G. malabaricus* sp. nov., *G. novellus* sp. nov., *G. prosphatosis* sp. nov., *G. antennalis* sp. nov., *G. recentis* sp. nov., *G. setosus* sp. nov., *G. alarius* sp. nov., *G. clypeatus* sp. nov., *G. kuriani* sp. nov., *G. jeroeni* sp. nov., *G. inauditus* sp. nov., *G. cotha* sp. nov., *G. mustus* sp. nov., *G. neoteropus* sp. nov., *G. longigastralis* sp. nov. and *G.*

kottiyooricus sp. nov. Five species of the genus, *Odontepyris* viz. *O. keystonellus* sp. nov., *O. koottanadensis* sp. nov., *O. anamalaicus* sp. nov., *O. terayamai* sp. nov. and *O. cephalopunctatus* sp. nov. were described new to science. Four new species were described from the genera *Sclerodermus* and *Sierola*. They were *Sclerodermus seenae* sp. nov., *Sclerodermus sumatranus* sp. nov., *Sierola nasseri* sp. nov., and *Sierola kannurensis* sp. nov. *Sclerodermus hardwickiae* Kurian is the new record from Karnataka. It was previously reported from a timber yard in Madras in 1941.

CHECKLIST OF ORIENTAL BETHYLIDAE

No	Taxa	Distribution													
		SWG	IND	SRL	PAK	NEP	BUR	CHI	TAW	SEA	PAL	ETH	NEA	NET	AUS
A Subfamily: Bethylinae															
1	Genus: <i>Bethylus</i> Latreille 1802														
1	<i>Bethylus himalayanus</i> Terayama, 2004						X								
2	Genus: <i>Goniozus</i> Förster 1856														
1	<i>Goniozus ahmeadi</i> Kurian, 1955		X												
2	<i>Goniozus armigeræ</i> Santhosh & Narendran 2009		X												
3	<i>Goniozus baishanzuensis</i> Xu, He & Terayama, 2002							X							
4	<i>Goniozus borneanus</i> Cameron, 1910		X								X				
5	<i>Goniozus chatterjii</i> Kurian, 1955		X												
6	<i>Goniozus chowdhari</i> Kurian, 1955		X												
7	<i>Goniozus comatus</i> Krombein, 1996			X											
8	<i>Goniozus cuttockensis</i> Lal, 1939		X												
9	<i>Goniozus delhiensis</i> Ram, 1969		X												
10	<i>Goniozus depressus</i> Kieffer, 1913										X				
11	<i>Goniozus ecarinatus</i> Krombein, 1996			X											
12	<i>Goniozus fulgidus</i> Krombein, 1996			X											
13	<i>Goniozus fulvicornis</i> (Rohwer), 1915	X	X												
14	<i>Goniozus hualienensis</i> Terayama, 2004									X					
15	<i>Goniozus hyleæ</i> Kurian 1955	X	X												
16	<i>Goniozus indicus</i> Ashmead, 1903	X	X								X				

No	Taxa	Distribution													
		SWG	IND	SRL	PAK	NEP	BUR	CHI	TAW	SEA	PAL	ETH	NEA	NET	AUS
17	<i>Goniozus japonicus</i> Ashmead, 1904								X				X		
18	<i>Goniozus keralensis</i> Gordh, 1988	X	X												
19	<i>Goniozus lamprosemae</i> Xu, He & Terayama, 2002								X						
20	<i>Goniozus lucidulus</i> Krombein, 1996			X											
21	<i>Goniozus lygropiae</i> Kurian, 1955	X	X												
22	<i>Goniozus madrassippattanami</i> Kurian, 1955	X	X												
23	<i>Goniozus manilensis</i> Kieffer, 1922										X				
24	<i>Goniozus marasmi</i> Kurian, 1955		X												
25	<i>Goniozus mellipes</i> (Muesebeck) 1934		X												
26	<i>Goniozus montanus</i> Kieffer, 1908	X	X	X			X								
27	<i>Goniozus mori</i> Kurian, 1955		X												
28	<i>Goniozus morindae</i> Kurian, 1952		X												
29	<i>Goniozus nephantidis</i> (Muesebeck) 1934	X	X	X											
30	<i>Goniozus nephoterycis</i> Kurian, 1952		X												
31	<i>Goniozus nilamburensis</i> Kurian, 1955	X	X												
32	<i>Goniozus pakmanus</i> Gordh, 1984				X								X		
33	<i>Goniozus philippinensis</i> Ashmead, 1904										X				
34	<i>Goniozus pulveriae</i> (Kurian) 1954		X												
35	<i>Goniozus rugosus</i> Samad, 1973				X										
36	<i>Goniozus rutherfordi</i> Krombein, 1996			X											
37	<i>Goniozus salvadorae</i> (Kurian) 1954		X												
38	<i>Goniozus sanctijohannis</i> Kurian, 1955		X												
39	<i>Goniozus sensorius</i> Gordh, 1988	X	X												

No	Taxa	Distribution													
		SWG	IND	SRL	PAK	NEP	BUR	CHI	TAW	SEA	PAL	ETH	NEA	NET	AUS
40	<i>Goniozus sinicus</i> Xiao and Wu, 1987								X						
41	<i>Goniozus stomopterycis</i> Ram and Subba Rao, 1968	X	X												
42	<i>Goniozus thailandensis</i> Gordh & Witethom, 1994									X					
43	<i>Goniozus thalasesodes</i> Kurian, 1955		X												
44	<i>Goniozus triangulifer</i> Kieffer, 1914									X					X
45	<i>Goniozus triangulus</i> Kieffer, 1922		X							X					
46	<i>Goniozus valvolicola</i> Krombein, 1996			X											
47	<i>Goniozus villosus</i> Krombein, 1996			X											
48	<i>Goniozus williamsi</i> Bridwell, 1919									X					
49	<i>Goniozus xiaoi</i> Xu, He & Terayama, 2002								X						
3	Genus: <i>Odontepyris</i> Kieffer 1904														
1	<i>Odontepyris argyriae</i> Kurian, 1954		X												
2	<i>Odontepyris batrae</i> Kurian, 1955		X												
3	<i>Odontepyris cirphi</i> Kurian, 1955		X												
4	<i>Odontepyris flavinervis</i> Kieffer, 1904									X					
5	<i>Odontepyris formosicola</i> Terayama, 1997								X						
6	<i>Odontepyris hypsipylae</i> (Kurian) 1955		X												
7	<i>Odontepyris indicus</i> (Kurian) 1954		X												
8	<i>Odontepyris liukueiensis</i> Terayama, 1997								X						
9	<i>Odontepyris mandibularis</i> Krombein, 1996		X	X											
10	<i>Odontepyris muesebecki</i> Krombein, 1996			X											
11	<i>Odontepyris obtusus</i> Xu & He, 2006								X						
12	<i>Odontepyris ovatus</i> Xu & He, 2006								X						

No	Taxa	Distribution													
		SWG	IND	SRL	PAK	NEP	BUR	CHI	TAW	SEA	PAL	ETH	NEA	NET	AUS
13	<i>Odontepyrus quadriveatus</i> (Muesebeck), 1934		X	X											
14	<i>Odontepyrus ruficrus</i> Krombein, 1996			X											
15	<i>Odontepyrus rufipedis</i> Xu & He, 2006							X							
16	<i>Odontepyrus taiwanus</i> Terayama, 1997								X						
17	<i>Odontepyrus ventralis</i> Krombein, 1996			X											
4	Genus: <i>Sierola</i> Cameron 1881														
1	<i>Sierola indra</i> Terayama, 2004		X												
2	<i>Sierola mawarajo</i> Terayama, 2004									X					
3	<i>Sierola sinensis</i> Fullaway, 1920							X							
C	Subfamily: Epyrinae														
5	Genus: <i>Allobethylus</i> Kieffer 1905														
1	<i>Allobethylus khonkaensis</i> Terayama 2005									X					
6	Genus: <i>Calyozina</i> Enderlein														
1	<i>Calyozina nepalensis</i> Terayama, 2005					X									
2	<i>Calyozina ramicornis</i> Enderlein, 1912								X						
3	<i>Calyozina thaiana</i> Terayama, 2005									X					
7	Genus: <i>Cephalonomia</i> Westwood 1833														
1	<i>Cephalonomia chihpenensis</i> Terayama, 2005								X						
2	<i>Cephalonomia elegantula</i> Terayama, 2005								X						
3	<i>Cephalonomia indica</i> Kieffer, 1907									X					
4	<i>Cephalonomia lignicola</i> Krombein, 1996			X											
5	<i>Cephalonomia peregrina</i> Westwood, 1881			X									X		
6	<i>Cephalonomia rhizoperthae</i> Xu, Weng & He, 1998							X							

No	Taxa	Distribution													
		SWG	IND	SRL	PAK	NEP	BUR	CHI	TAW	SEA	PAL	ETH	NEA	NET	AUS
7	<i>Cephalonomia tarsalis</i> (Ashmead) 1893							X		X	X	X	X	X	X
8	<i>Cephalonomia thaiana</i> Terayama, 2005									X					
9	<i>Cephalonomia tritici</i> Kurian, 1955		X												
8	Genus: <i>Discleroderma</i> Kieffer														
1	<i>Discleroderma indiensis</i> Lanes & Azevedo, 2008		X												
2	<i>Discleroderma tuberculatum</i> (Magretti) 1897							X							
9	Genus: <i>Disepyris</i> Kieffer 1905														
1	<i>Disepyris pallidinervis</i> Cameron 1907		X												
2	<i>Disepyris rufipes</i> Kieffer 1905	X	X												
10	Genus: <i>Epyris</i> Westwood 1832														
1	<i>Epyris acutidens</i> (Kieffer) 1922									X					
2	<i>Epyris aequatorialis</i> Terayama, 2005									X					
3	<i>Epyris agrensis</i> Kurian 1955		X												
4	<i>Epyris albopilosus</i> Cameron 1904		X												
5	<i>Epyris amatorius</i> Cameron 1897		X												
6	<i>Epyris apertus</i> Kieffer 1914									X					
7	<i>Epyris apicalis</i> Smith 1874								X		X				
8	<i>Epyris atayal</i> Terayama, 2005								X						
9	<i>Epyris bidens</i> Kieffer, 1922									X					
10	<i>Epyris budda</i> Terayama, 2005									X					
11	<i>Epyris claripennis</i> Kieffer, 1922									X					
12	<i>Epyris coriaceous</i> Muesebeck 1934	X	X												
13	<i>Epyris delhiensis</i> Kurian 1955		X												

No	Taxa	Distribution													
		SWG	IND	SRL	PAK	NEP	BUR	CHI	TAW	SEA	PAL	ETH	NEA	NET	AUS
14	<i>Epyris despectus</i> Kieffer, 1922									X					
15	<i>Epyris distans</i> Kieffer, 1922									X					
16	<i>Epyris duttai</i> Kurian 1955		X												
17	<i>Epyris feai</i> Kieffer 1904		X												
18	<i>Epyris filiformis</i> Kieffer, 1914									X					
19	<i>Epyris fujianensis</i> Xu, He & Ma 2003							X							
20	<i>Epyris hirtipennis</i> (Cameron) 1909									X					
21	<i>Epyris indicus</i> (Kieffer) 1905		X												
22	<i>Epyris indra</i> Terayama, 2005									X					
23	<i>Epyris karnatakensis</i> Terayama, 2005		X												
24	<i>Epyris kuchingensis</i> Cameron, 1910									X					
25	<i>Epyris laticrus</i> Kieffer, 1911			X											
26	<i>Epyris leyteanus</i> Terayama, 2005									X					
27	<i>Epyris lienfuaensis</i> Terayama, 2005								X						
28	<i>Epyris liukueiensis</i> Terayama, 2005								X						
29	<i>Epyris longicephalus</i> Terayama, 2005								X		X				
30	<i>Epyris luzonicus</i> (Kieffer) 1922									X					
31	<i>Epyris magniceps</i> Kieffer, 1922									X					
32	<i>Epyris malayanus</i> Terayama, 2005									X					
33	<i>Epyris manii</i> Kurian, 1955		X												
34	<i>Epyris maya</i> Terayama, 2005									X					
35	<i>Epyris meifengensis</i> Terayama, 2005								X						
36	<i>Epyris miaoliensis</i> Terayama, 2005								X						

No	Taxa	Distribution													
		SWG	IND	SRL	PAK	NEP	BUR	CHI	TAW	SEA	PAL	ETH	NEA	NET	AUS
37	<i>Epyris montanus</i> (Kieffer) 1905		X												
38	<i>Epyris nanshanchiensis</i> Terayama, 2005								X						
39	<i>Epyris nantohensis</i> Terayama, 2005								X						
40	<i>Epyris nepalensis</i> Terayama, 2005					X									
41	<i>Epyris niger</i> Westwood, 1832		X								X	X			
42	<i>Epyris obliquus</i> Kieffer, 1922									X					
43	<i>Epyris ovatus</i> Xu, He & Ma 2003							X							
44	<i>Epyris parvidens</i> Kieffer, 1922									X					
45	<i>Epyris patnae</i> Kurian, 1955		X												
46	<i>Epyris philippinensis</i> Kieffer, 1913									X					
47	<i>Epyris pleuralis</i> (Kieffer) 1922									X					
48	<i>Epyris politiceps</i> Muesebeck, 1934	X	X												
49	<i>Epyris psilomma</i> Kieffer, 1922									X					
50	<i>Epyris puduma</i> Krombein, 1992			X											
51	<i>Epyris pusillus</i> Kieffer, 1922									X					
52	<i>Epyris quadratus</i> Kieffer, 1922									X					
53	<i>Epyris quaesitor</i> Kieffer, 1922									X					
54	<i>Epyris rejectus</i> Kieffer, 1922									X					
55	<i>Epyris rugicollis</i> Ashmead, 1903				X										
56	<i>Epyris ruficornis</i> (Magretti) 1897						X								
57	<i>Epyris sabahensis</i> Terayama, 2005									X					
58	<i>Epyris sarawakensis</i> Terayama, 2005									X					
59	<i>Epyris sauteri</i> (Enderlein) 1920								X		X				

No	Taxa	Distribution														
		SWG	IND	SRL	PAK	NEP	BUR	CHI	TAW	SEA	PAL	ETH	NEA	NET	AUS	
60	<i>Epyris secundus</i> Brues, 1905	X	X													
61	<i>Epyris shakha</i> Terayama, 2005									X						
62	<i>Epyris shiva</i> Terayama, 2005									X						
63	<i>Epyris striatus</i> Kieffer, 1904						X									
64	<i>Epyris subramosus</i> Kieffer, 1922									X						
65	<i>Epyris sumatranus</i> (Enderlein) 1917									X						
66	<i>Epyris sumatrensis</i> Krombein, 1992									X						
67	<i>Epyris superbus</i> Terayama, 2005								X	X						
68	<i>Epyris thaianus</i> Terayama, 2005									X						
69	<i>Epyris transversarium</i> Xu, He & Ma 2003							X								
70	<i>Epyris tridens</i> Kieffer, 1922									X						
71	<i>Epyris troglodytes</i> Kieffer, 1922									X						
72	<i>Epyris truncatidens</i> (Kieffer) 1922									X						
73	<i>Epyris unicarina</i> Kieffer, 1922									X						
74	<i>Epyris valens</i> Kieffer, 1922			X												
11	Genus: <i>Formosiepyris</i> Terayama 2004															
1	<i>Formosiepyris marishi</i> Terayama, 2004									X						
2	<i>Formosiepyris rugulosus</i> Xu & He, 2005							X								
3	<i>Formosiepyris shiva</i> Terayama, 2004		X													
4	<i>Formosiepyris takasago</i> Terayama, 2004								X							
12	Genus: <i>Glenosema</i> Kieffer 1905															
1	<i>Glenosema Chiangmaiensis</i> Terayama, 1996									X						
2	<i>Glenosema dispersum</i> Krombein, 1996			X												

No	Taxa	Distribution													
		SWG	IND	SRL	PAK	NEP	BUR	CHI	TAW	SEA	PAL	ETH	NEA	NET	AUS
3	<i>Glenosema doiinthanoensis</i> Terayama, 1996									X					
4	<i>Glenosema siamensis</i> Terayama, 1996									X					
5	<i>Glenosema splendidum</i> Krombein, 1996			X											
13	Genus: <i>Holepyris</i> Kieffer														
1	<i>Holepyris aeki</i> Terayama, 2005								X						
2	<i>Holepyris aekoh</i> Terayama, 2005								X						
3	<i>Holepyris amplipennis</i> (Motschulsky) 1863			X											
4	<i>Holepyris andrei</i> Kieffer, 1905	X	X												
5	<i>Holepyris angulatus</i> Xu, HE & Ma, 2003							X							
6	<i>Holepyris atamiensis</i> (Ashmead) 1904							X	X		X				
7	<i>Holepyris daiitoku</i> Terayama, 2005								X						
8	<i>Holepyris dubiosus</i> Kieffer, 1922									X					
9	<i>Holepyris evansi</i> Xu, He & Ma, 2003							X							
10	<i>Holepyris exaratus</i> (Kieffer) 1913									X					
11	<i>Holepyris fulvus</i> Xu, HE & Ma, 2003							X							
12	<i>Holepyris fuscus</i> Xu, HE & Ma, 2003							X							
13	<i>Holepyris gouzanze</i> Terayama, 2005								X						
14	<i>Holepyris grandiceps</i> (Kieffer) 1921									X					
15	<i>Holepyris gundai</i> Terayama, 2005								X						
16	<i>Holepyris gutianshanensis</i> Xu, He & Ma, 2003							X							
17	<i>Holepyris kuchingensis</i> (Cameron) 1910									X					
18	<i>Holepyris longiceps</i> (Kieffer) 1913									X					
19	<i>Holepyris macilentus</i> Xu, He & Ma, 2003							X							

No	Taxa	Distribution														
		SWG	IND	SRL	PAK	NEP	BUR	CHI	TAW	SEA	PAL	ETH	NEA	NET	AUS	
20	<i>Holepyris minimus</i> Magretti, 1897						X									
21	<i>Holepyris opacicollis</i> (Motschulsky) 1863			X												
22	<i>Holepyris parvus</i> (Magretti) 1897						X									
23	<i>Holepyris philippinensis</i> Kieffer, 1922									X						
24	<i>Holepyris seidakka</i> Terayama, 2005								X							
25	<i>Holepyris shamensis</i> Terayama, 2005									X						
26	<i>Holepyris sinensis</i> Xu, He & Ma, 2003							X								
27	<i>Holepyris susanowo</i> Terayama, 1999							X			X					
28	<i>Holepyris sylvanidis</i> (Brethes) 1913		X							X	X	X	X	X	X	
29	<i>Holepyris thailandensis</i> Terayama, 2005									X						
30	<i>Holepyris yambaru</i> Terayama, 1999							X			X					
14	Genus: <i>Isobrachium</i> Forster															
1	<i>Isobrachium bipunctatum</i> Kieffer 1922										X					
2	<i>Isobrachium kongohyasha</i> Terayama, 2005										X					
3	<i>Isobrachium rugicollis</i> Cameron 1906					X										
15	Genus: <i>Laelius</i> Ashmead 1893															
1	<i>Laelius agragensis</i> Kurian, 1955		X													
2	<i>Laelius sinicus</i> Xu, He & Terayama, 2003							X								
3	<i>Laelius voracis</i> Muesebeck, 1939		X										X			
16	Genus: <i>Leptepyris</i> Kieffer															
1	<i>Leptepyris filiformis</i> Kieffer 1914										X					
17	Genus: <i>Melanepyris</i> Kieffer															
1	<i>Melanepyris asiaticus</i> Kieffer 1922										X					

No	Taxa	Distribution													
		SWG	IND	SRL	PAK	NEP	BUR	CHI	TAW	SEA	PAL	ETH	NEA	NET	AUS
18	Genus: <i>Neodispyris</i> Kurian 1955														
1	<i>Neodisepyrus bombayensis</i> Kurian 1955		X												
2	<i>Neodisepyrus duni</i> Kurian 1955		X												
3	<i>Neodisepyrus indicae</i> Kurian 1955		X												
4	<i>Neodisepyrus pusae</i> Kurian 1955		X												
5	<i>Neodisepyrus shishami</i> Kurian 1955		X												
19	Genus: <i>Neurepyris</i> Kieffer 1905														
1	<i>Neurepyris tagalus</i> (Ashmead) 1905									X					
20	Genus: <i>Plastanoxus</i> Kieffer 1905														
1	<i>Plastanoxus konishii</i> Terayama, 2005									X					
2	<i>Plastanoxus thailandensis</i> Terayama, 2005									X					
21	Genus: <i>Pristepyrus</i> Kieffer 1905														
1	<i>Pristepyrus agrensis</i> Kurian 1952		X												
2	<i>Pristepyrus rugicollis</i> Kieffer, 1905									X					
22	Genus: <i>Proplastanoxus</i> Terayama 2005														
1	<i>Proplastanoxus elegans</i> Terayama, 2005									X					
23	Genus: <i>Prorops</i> Waterston 1923														
1	<i>Prorops nasuta</i> Waterston, 1923			X								X	X	X	
24	Genus: <i>Rhabdepyris</i> Kieffer														
1	<i>Rhabdepyris agragensis</i> Kurian 1955		X												
2	<i>Rhabdepyris biharina</i> Kurian 1955		X												
3	<i>Rhabdepyris conjunctus</i> (Kieffer) 1905		X												
4	<i>Rhabdepyris defectus</i> Kieffer 1922									X					

No	Taxa	Distribution													
		SWG	IND	SRL	PAK	NEP	BUR	CHI	TAW	SEA	PAL	ETH	NEA	NET	AUS
5	<i>Rhabdepyris flavipennis</i> (Kieffer) 1914									X					
6	<i>Rhabdepyris foveatus</i> (Cameron) 1905			X											
7	<i>Rhabdepyris fuscinervis</i> (Cameron) 1899		X												
8	<i>Rhabdepyris longiceps</i> Kieffer 1913									X					
9	<i>Rhabdepyris luzonicus</i> Kieffer 1913									X					
10	<i>Rhabdepyris mackenziei</i> Kurian 1955		X												
11	<i>Rhabdepyris pusaena</i> (Kurian) 1955		X												
12	<i>Rhabdepyris raptor</i> (Kieffer) 1922									X					
13	<i>Rhabdepyris raripilus</i> (Kieffer) 1922									X					
14	<i>Rhabdepyris rhizoperthae</i> Menon, Chatterjee & Sarup 1959		X												
15	<i>Rhabdepyris sanctipauli</i> (Kurian) 1954		X												
16	<i>Rhabdepyris similis</i> (Bridwell) 1919									X					
17	<i>Rhabdepyris unidens</i> (Kieffer) 1922									X					
25	Genus: <i>Scaphepyris</i> Kieffer 1905														
1	<i>Scaphepyris rufus</i> Kieffer, 1904									X					
26	Genus: <i>Sclerodermus</i> Latreille 1809														
1	<i>Sclerodermus bicolor</i> Smith, 1860									X					
2	<i>Sclerodermus castaneus</i> Kieffer, 1904									X					
3	<i>Sclerodermus delhiensis</i> Kurian, 1955		X												
4	<i>Sclerodermus guani</i> Xiao & Wu, 1983							X							
5	<i>Sclerodermus hardwickiae</i> Kurian, 1955	X	X												
6	<i>Sclerodermus hirsutus</i> Krombein, 1996			X											
7	<i>Sclerodermus immigrans</i> Bridwell, 1918									X					

No	Taxa	Distribution													
		SWG	IND	SRL	PAK	NEP	BUR	CHI	TAW	SEA	PAL	ETH	NEA	NET	AUS
8	<i>Sclerodermus luteicollis</i> Kieffer, 1904									X					
9	<i>Sclerodermus mori</i> Kurian, 1955		X												
10	<i>Sclerodermus nigrus</i> Kieffer, 1904										X				
11	<i>Sclerodermus thwaitesianus</i> Westwood, 1881			X											
12	<i>Sclerodermus undulatus</i> (Krombein) 1996			X											
13	<i>Sclerodermus variegatus</i> Krombein, 1996			X											
14	<i>Sclerodermus vigilans</i> Westwood, 1881			X											
27	Genus: <i>Trachepyrus</i> Kieffer 1905														
1	<i>Trachepyrus indicus</i> (Muesebeck) 1934	X	X	X							X				
2	<i>Trachepyrus haemorrhoidalis</i> Kieffer 1911			X	X										
28	Genus: <i>Xenepyrus</i> Kieffer 1913														
1	<i>Xenepyrus compressicornis</i> Kieffer 1913										X				
2	<i>Xenepyrus exaratus</i> Kieffer 1922										X				
C	Subfamily: Galodoxinae														
29	Genus: <i>Galodoxa</i> Nagy 1974														
1	<i>Galodoxa torquata</i> Nagy, 1974										X				
D	Subfamily: Mesitiinae														
30	Genus: <i>Heterocoelia</i> Dhalbom 1854														
1	<i>Heterocoelia brevicula</i> Xu, He & Terayama, 2003									X					
2	<i>Heterocoelia granulata</i> Moczar 1984			X											
3	<i>Heterocoelia karunaratnei</i> Moczar 1979			X											
4	<i>Heterocoelia laosensis</i> Moczar 1984										X				
5	<i>Heterocoelia rufa</i> Moczar 1979			X											

No	Taxa	Distribution												
		SWG	IND	SRL	PAK	NEP	BUR	CHI	TAW	SEA	PAL	ETH	NEA	NET
6	<i>Heterocoelia sinensis</i> Xu & He 2006								X					
7	<i>Heterocoelia vietnamensis</i> Moczar 1975									X				
8	<i>Heterocoelia zhai</i> Xu & He 2006								X					
31	Genus: <i>Incertosulcus</i> Moczar 1970													
1	<i>Incertosulcus indicus</i> (Kieffer) 1905			X										
32	Genus: <i>Metrionotus</i> Moczar 1970													
1	<i>Metrionotus biroi</i> (Moczar) 1971			X										
2	<i>Metrionotus hongkongensis</i> Moczar 1974								X					
3	<i>Metrionotus rufohumerus</i> Moczar 1984					X								
4	<i>Metrionotus subminimus</i> Moczar 1984					X								
33	Genus: <i>Pycnomesitius</i> Moczar 1971													
1	<i>Pycnomesitius hirashimai</i> (Moczar) 1981					X								
2	<i>Pycnomesitius krombeini</i> (Nagy) 1968		X	X										
3	<i>Pycnomesitius krombeinicus</i> (Moczar) 1977					X		X						
34	Genus: <i>Sulcomesitius</i> Moczar													
1	<i>Sulcomesitius acutihumerus</i> Moczar 1982					X								
2	<i>Sulcomesitius bahaduri</i> (Kurian) 1955			X										
3	<i>Sulcomesitius bakeri</i> (Fouts 1930)									X				
4	<i>Sulcomesitius bicolor</i> Moczar 1984					X								
5	<i>Sulcomesitius borneoensis</i> Moczar, 1976							X		X				
6	<i>Sulcomesitius brevis</i> Moczar 1984					X								
7	<i>Sulcomesitius brevispinus</i> Moczar 1981									X				
8	<i>Sulcomesitius cambodianus</i> Moczar 1976									X				

No	Taxa	Distribution													
		SWG	IND	SRL	PAK	NEP	BUR	CHI	TAW	SEA	PAL	ETH	NEA	NET	AUS
9	<i>Sulcomesitius ceylonicus</i> Moczar 1979			X											
10	<i>Sulcomesitius crassiantennis</i> Moczar 1976									X					
11	<i>Sulcomesitius crassipunctatus</i> Moczar 1970									X					
12	<i>Sulcomesitius dalatensis</i> Moczar 1977									X					
13	<i>Sulcomesitius discolor</i> (Nagy) 1968		X												
14	<i>Sulcomesitius dudichi</i> Moczar 1982			X											
15	<i>Sulcomesitius duni</i> (Kurian) 1955		X												
16	<i>Sulcomesitius evansi</i> Moczar 1970	X	X												
17	<i>Sulcomesitius godavarensis</i> Moczar 1986					X									
18	<i>Sulcomesitius gressitti</i> Moczar 1977									X					
19	<i>Sulcomesitius gunawardaneae</i> Moczar 1979			X											
20	<i>Sulcomesitius haemorrhoidalis</i> (Magretti) 1897						X	X	X		X				
21	<i>Sulcomesitius impressus</i> Xu, He & Terayama, 2003							X							
22	<i>Sulcomesitius indicus</i> Moczar 1977	X	X	X											
23	<i>Sulcomesitius kibissaensis</i> Moczar 1984			X											
24	<i>Sulcomesitius kucheriai</i> Moczar 1976									X					
25	<i>Sulcomesitius laosensis</i> Moczar 1976							X		X					
26	<i>Sulcomesitius luzonicus</i> (Kieffer) 1914									X					
27	<i>Sulcomesitius luzoniformis</i> Moczar 1981									X					
28	<i>Sulcomesitius maai</i> Moczar 1976									X					
29	<i>Sulcomesitius mahunkai</i> Moczar 1981									X					
30	<i>Sulcomesitius malayensis</i> Moczar 1976									X					
31	<i>Sulcomesitius masneri</i> Moczar 1984			X											

No	Taxa	Distribution													
		SWG	IND	SRL	PAK	NEP	BUR	CHI	TAW	SEA	PAL	ETH	NEA	NET	AUS
32	<i>Sulcomesitius mekei</i> Moczar 1984			X											
33	<i>Sulcomesitius mihalyii</i> Moczar 1982			X											
34	<i>Sulcomesitius moczari</i> Xu, He & Terayama, 2003							X							
35	<i>Sulcomesitius nepalensis</i> Moczar 1986					X									
36	<i>Sulcomesitius nigroalatus</i> Moczar 1984			X											
37	<i>Sulcomesitius orientalis</i> (Fouts) 1930									X					
38	<i>Sulcomesitius persicus</i> Moczar 1970		X								X				
39	<i>Sulcomesitius petersi</i> Moczar 1984			X											
40	<i>Sulcomesitius philippinensis</i> (Kieffer) 1922									X					
41	<i>Sulcomesitius pilosus</i> Moczar, 1984			X											
42	<i>Sulcomesitius pondo</i> (Benoit) 1968		X									X			
43	<i>Sulcomesitius punctaticollis</i> (Fouts) 1930									X					
44	<i>Sulcomesitius punctulatus</i> Xu, He & Terayama, 2003							X							
45	<i>Sulcomesitius quatei</i> Moczar 1977									X					
46	<i>Sulcomesitius rectus</i> Xu, He & Terayama, 2003							X							
47	<i>Sulcomesitius rieki</i> Moczar 1976									X					
48	<i>Sulcomesitius sakaii</i> Moczar 1981			X						X					
49	<i>Sulcomesitius srilankai</i> Moczar 1979			X											
50	<i>Sulcomesitius szentivanyi</i> Moczar 1976			X						X					
51	<i>Sulcomesitius thailandensis</i> Moczar 1977									X					
52	<i>Sulcomesitius townesi</i> Moczar 1977									X					
53	<i>Sulcomesitius vechti</i> Moczar 1979			X				X							
54	<i>Sulcomesitius vietnamensis</i> Moczar 1977									X					

No	Taxa	Distribution													
		SWG	IND	SRL	PAK	NEP	BUR	CHI	TAW	SEA	PAL	ETH	NEA	NET	AUS
55	<i>Sulcomesitius wahisi</i> Moczar 1984			X											
E	Genus: Subfamily: Pristocerinae														
35	Genus: <i>Acrepyris</i> Kieffer 1905														
1	<i>Acrepyris antennatus</i> (Magretti) 1897						X								
2	<i>Acrepyris rugulosus</i> Terayama, Xu & He, 2002								X						
3	<i>Acrepyris sinensis</i> Terayama, Xu & He, 2002								X						
4	<i>Acrepyris tainanensis</i> (Terayama) 1995									X					
5	<i>Acrepyris zhejiangensis</i> Terayama, Xu & He, 2002								X						
36	Genus: <i>Apenesia</i> Westwood 1874														
1	<i>Apenesia carinicollis</i> Terayama, 2004					X									
2	<i>Apenesia chitouensis</i> Terayama, 1996									X					
3	<i>Apenesia clara</i> Xu, Terayama & He, 2002								X						
4	<i>Apenesia consobrina</i> (Kieffer) 1922										X				
5	<i>Apenesia electriphila</i> Cockerell, 1917						X								
6	<i>Apenesia elegans</i> Terayama, 1999							X				X			
7	<i>Apenesia formosimonticola</i> Terayama, 1996									X					
8	<i>Apenesia foutsii</i> Gordh (Fouts) 1930										X				
9	<i>Apenesia interrupta</i> (Kieffer) 1905			X											
10	<i>Apenesia intricate</i> (Kieffer) 1922										X				
11	<i>Apenesia kakaniensis</i> Terayama 2004					X									
12	<i>Apenesia ktmdana</i> Terayama 2004					X									
13	<i>Apenesia lathrobioides</i> (Westwood) 1874			X											
14	<i>Apenesia levicollis</i> (Kieffer), 1905		X												

No	Taxa	Distribution													
		SWG	IND	SRL	PAK	NEP	BUR	CHI	TAW	SEA	PAL	ETH	NEA	NET	AUS
15	<i>Apenesia liukueiensis</i> Terayama, 1996									X					
16	<i>Apenesia luzonica</i> (Fouts), 1930										X				
17	<i>Apenesia meifuiiae</i> Terayama, 1996									X					
18	<i>Apenesia mindanaensis</i> (Fouts), 1930										X				
19	<i>Apenesia minima</i> (Kieffer) 1913										X				
20	<i>Apenesia minor</i> (Kieffer) 1913										X				
21	<i>Apenesia nepalensis</i> Terayama, 2004					X									
22	<i>Apenesia okinawensis</i> Terayama, 1999							X				X			
23	<i>Apenesia percurrens</i> (Kieffer) 1905		X												
24	<i>Apenesia philippinensis</i> (Kieffer) 1913										X				
25	<i>Apenesia pingtungensis</i> Terayama, 1996									X					
26	<i>Apenesia polita</i> (Fouts) 1930										X				
27	<i>Apenesia pulchella</i> Terayama, 2004					X									
28	<i>Apenesia raonis</i> Kurian, 1955		X												
29	<i>Apenesia sahyadrica</i> Azevedo & Waichert, 2006	X	X												
30	<i>Apenesia sarawakensis</i> Terayama & Yamane, 1997										X				
31	<i>Apenesia sinensis</i> Xu, Terayama & He, 2002							X							
32	<i>Apenesia takasago</i> Terayama, 1996									X					
33	<i>Apenesia tianmuensis</i> Xu, Terayama & He, 2002							X							
34	<i>Apenesia unicolor</i> Kieffer, 1904										X		X		
35	<i>Apenesia xanthoptera</i> Kieffer, 1922										X				
37	Genus: <i>Caloapenesia</i> Terayama 1995														
1	<i>Caloapenesia brevis</i> Terayama, 1995										X				

No	Taxa	Distribution													
		SWG	IND	SRL	PAK	NEP	BUR	CHI	TAW	SEA	PAL	ETH	NEA	NET	AUS
2	<i>Caloapenesia thailandiana</i> Terayama, 1995									X					
3	<i>Caloapenesia philippinensis</i> Terayama, 1995									X					
38	Genus: <i>Dissomphalus</i> Ashmead 1893														
1	<i>Dissomphalus brevinervis</i> Kieffer, 1904									X					
2	<i>Dissomphalus browni</i> Terayama, 2001									X					
3	<i>Dissomphalus chiangmaiensis</i> Terayama, 2001									X					
4	<i>Dissomphalus chipenensis</i> Terayama, 1995								X						
5	<i>Dissomphalus fuscus</i> (Kieffer) 1904									X					
6	<i>Dissomphalus khaoyaiensis</i> Terayama, 1995									X					
7	<i>Dissomphalus kinabarensis</i> Terayama, 1995									X					
8	<i>Dissomphalus malaysianus</i> Terayama, 2001									X					
9	<i>Dissomphalus minor</i> Terayama & Yanmane, 1997									X					
10	<i>Dissomphalus nepalensis</i> Terayama, 2001		X			X									
11	<i>Dissomphalus philippinensis</i> Terayama, 2001									X					
12	<i>Dissomphalus thaianus</i> Terayama, 2001		X							X					
13	<i>Dissomphalus tibialis</i> Ashmead, 1904									X					
14	<i>Dissomphalus wusheanus</i> Terayama, 2001								X						
39	Genus: <i>Foenobethylus</i> Kieffer 1913														
1	<i>Foenobethylus bidentatus</i> Várkonyi & Polaszek, 2007									X					
2	<i>Foenobethylus elongatus</i> Várkonyi & Polaszek, 2007									X					
3	<i>Foenobethylus emiliacasellae</i> Várkonyi & Polaszek, 2007									X					
4	<i>Foenobethylus gracilis</i> Kieffer, 1913									X					
5	<i>Foenobethylus thomascokeri</i> Várkonyi & Polaszek, 2007									X					

No	Taxa	Distribution												
		SWG	IND	SRL	PAK	NEP	BUR	CHI	TAW	SEA	PAL	ETH	NEA	NET
40	Genus: <i>Neoapenesia</i> Terayama 1995													
1	<i>Neoapenesia leytensis</i> Terayama, 1995									X				
41	Genus: <i>Parascleroderma</i> Kieffer													
1	<i>Parascleroderma atayal</i> Terayama, 1998								X					
2	<i>Parascleroderma okajimai</i> Terayama, 1998								X					
3	<i>Parascleroderma renaiensis</i> Terayama, 1998								X					
4	<i>Parascleroderma thaiana</i> Terayama, 1998									X				
42	Genus: <i>Pristocera</i> Klug 1808													
1	<i>Pristocera areolata</i> Muesebeck 1934	X	X											
2	<i>Pristocera cariana</i> Magretti 1897							X						
3	<i>Pristocera changmaiensis</i> Terayama & Yamane, 1998									X				
4	<i>Pristocera drewsenii</i> Westwood, 1874			X										
5	<i>Pristocera eironeformis</i> Turner 1914		X											
6	<i>Pristocera formosana</i> Miwa & Sonan 1935								X					
7	<i>Pristocera govindarami</i> Kurian 1952		X											
8	<i>Pristocera huberi</i> Terayama, 2004					X								
9	<i>Pristocera kinabalensis</i> Terayama & Yamane, 1998													
10	<i>Pristocera mieae</i> (Terayama) 1995								X					
11	<i>Pristocera orientalis</i> (Cameron) 1888		X											
12	<i>Pristocera poirieri</i> Terayama 2004					X								
13	<i>Pristocera puncticeps</i> Fouts 1930									X				
14	<i>Pristocera rufa</i> Kieffer 1905		X											X
15	<i>Pristocera sarawakensis</i> Terayama & Yamane, 1998									X				

No	Taxa	Distribution												
		SWG	IND	SRL	PAK	NEP	BUR	CHI	TAW	SEA	PAL	ETH	NEA	NET
16	<i>Pristocera sinhalensis</i> Turner 1928			X										
17	<i>Pristocera sumatrensis</i> Terayama & Yamane, 1998									X				
18	<i>Pristocera tainanensis</i> Terayama 1995								X					
19	<i>Pristocera takasago</i> Terayama 1995								X					
43	Genus: <i>Protisobrachium</i> Benoit													
1	<i>Protisobrachium asianum</i> Terayama, 1995									X				
44	Genus: <i>Pseudisobrachium</i> Kieffer													
1	<i>Pseudisobrachium asianum</i> Terayama, 1995									X				
2	<i>Pseudisobrachium fulleri</i> Terayama, 2004									X				
3	<i>Pseudisobrachium fushanensis</i> Terayama, 2004								X					
4	<i>Pseudisobrachium hongkongense</i> Terayama, 1996						X							
5	<i>Pseudisobrachium lepidum</i> Terayama, 2004									X				
6	<i>Pseudisobrachium lini</i> Terayama, 2004								X					
7	<i>Pseudisobrachium nepalensis</i> Terayama, 2004									X				
8	<i>Pseudisobrachium paotaoanum</i> Terayama, 2004								X					
9	<i>Pseudisobrachium philippinarum</i> Kieffer, 1922									X				
10	<i>Pseudisobrachium silvicolum</i> Terayama, 2004									X				
11	<i>Pseudisobrachium unidens</i> Kieffer, 1922									X				

Abbreviations: SWG - Southern Western Ghats; IND - India; SRL - Sri Lanka; PAK - Pakistan; NEP - Nepal; BUR - Burma; CHI - China; THL Thailand; INA - Indonesia; PHL - Philippines; TAW - Taiwan; SEA - South east Asia; PAL - Palaearctic; ETH - Ethiopian; NEA - Nearctic; NET - Neotropical; AUS - Australian

HOST – PARASITOID INDEX

Subfamily: Bethylinae

Genus: *Goniozus* Förster 1856

<i>Goniozus aproaeremae</i> sp. nov.	GELECHIIDAE <i>Aproaerema modicella</i> (Deventer)
<i>Goniozus armigerae</i> Santhosh & Narendran 2009	NOCTUIDAE <i>Helicoverpa armigera</i> (Hubner)
<i>Goniozus delhiensis</i> Ram, 1969	PYRALIDAE <i>Dichocrosis punctiferalis</i> (Guenee)
<i>Goniozus fulvicornis</i> (Rohwer), 1915	TORTRICIDAE <i>Cryptophlebia carpophaga</i> Walsingham <i>C. illepidia</i> (Butler)
<i>Goniozus hanoiensis</i> Gordh 1993	PYRALIDAE <i>Cnaphalocrocis medinalis</i> (Guenee)
<i>Goniozus hybleae</i> Kurian 1955	HYBLAEIDAE <i>Hyblaea puera</i> (Cramer)
<i>Goniozus indicus</i> Ashmead, 1903	PYRALIDAE <i>Chilo partellus</i> (Swinhoe) <i>Chilo zonellus</i> Swinhoe <i>Chilotraea infuscatellus</i> Snellen <i>Cnaphalocrocis medinalis</i> (Guenee) <i>Corcyra cephalonica</i> (Stainton) <i>Diatraea saccharalis</i> (Fabricius) <i>D. venosata</i> (Walker) <i>D. lineolata</i> (walker) <i>Emmalocera depressella</i> (swinhoe) <i>Eodiatraea centrella</i> (Moeschler) <i>Proceras venosatum</i> (Walker) <i>Proceras indicus</i> Kapur <i>Scirpophaga auriflua</i> Zeller <i>S. chrysorrhoea</i> Zeller <i>S. intacta</i> Snellen <i>S. nivella</i> (Fabricius) <i>S. rhodoproctalis</i> Hampson <i>Tryporyza incertulas</i> (Walker) TORTRICIDAE <i>Cryptophlebia carpophaga</i> (walsingham)

<i>Goniozus japonicus</i> Ashmead, 1904	<p>GELECHIIDAE</p> <p><i>Compsolechia homoplasta</i> Meyrick</p> <p><i>Dactylethrella tegulifera</i> (Meyrick)</p> <p><i>Dichomeris tostella</i> Stringer</p> <p><i>Evippe syricitis</i> (Meyrick)</p> <p><i>Helcystogramma macroscopum</i> (Meyrick)</p> <p>GRACILLARIIDAE</p> <p><i>Caloptilia chrysolampra</i> (meyrick)</p> <p><i>C. elongata</i> (Linnaeus)</p> <p><i>C. soyella</i> (Deventer)</p> <p><i>C. theivora</i> (Walsingham)</p> <p>PYRALIDAE</p> <p><i>Coclebotys coclesalis</i> (Walker)</p> <p><i>Glyphodes pyloalis</i> Walker</p> <p><i>Herpetogramma luctuosalis</i> (Guenee)</p> <p><i>Pleuroptya balteata</i> (Fabricius)</p> <p><i>P. chlorophanta</i> (Butler)</p> <p>TORTRICIDAE</p> <p><i>Adoxophyes orana</i> (Fischer von Roeslerstamm)</p> <p><i>Apotomis geminata</i> (Walsingham)</p> <p><i>Archips fuscocupreanus</i> Walsingham</p> <p><i>A. semistructus</i> (Meyrick)</p> <p><i>A. fasciata</i></p> <p><i>A. semistructa</i></p> <p><i>A. longicellana</i></p> <p><i>Capua vulgana</i> (Froelich)</p> <p><i>Choristoneura diversana</i> (Huber)</p> <p><i>Eucoenogenes ancyrota</i> (Meyrick)</p> <p><i>Eudemis gyrotis</i></p> <p><i>Homona magnanima</i> Diakonoff</p> <p><i>Lobesis aeolopa</i></p> <p><i>Matsumuraeses phaseoli</i> (Matsumura)</p> <p><i>Notarcha derogata</i> (Fabricius)</p> <p><i>Palpita nigropunctalis</i> (Bremer)</p> <p><i>Saliciphaga acharis</i> (Butler)</p> <p>OLETHREUTIDAE</p> <p><i>Epinotia ancyrota</i></p> <p><i>Hystrichosolus spathanum</i></p>
<i>Goniozus keralensis</i> Gordh, 1988	<p>PYRALIDAE</p> <p><i>Lamida moncusalis</i> (Walker)</p>
<i>Goniozus lamprosemae</i> Xu, He & Terayama, 2002	<i>Lamprosema indicata</i> Fabricius
<i>Goniozus lygropiae</i> Kurian, 1955	<p>PYRALIDAE</p> <p><i>Lygropia</i> sp.</p>
<i>Goniozus madrassippattanami</i> Kurian, 1955	<p>PYRALIDAE</p> <p><i>Hapalia machaeralis</i> (Walker)</p>
<i>Goniozus marasmi</i> Kurian, 1955	<p>PYRALIDAE</p> <p><i>Marasmia trapezalis</i> (Guenee)</p>

<i>Goniozus montanus</i> Kieffer, 1908	HYBLAEIDAE <i>Hyblaea puera</i> (Cramer) PYRALIDAE <i>Agrotera basinotata</i> Hampson <i>Haritala quaternalis</i> (Zeller) <i>Mothosalbia straminealis</i> (Guenee) <i>Sylepta crotonalis</i> (Walker) TORTRICIDAE <i>Archips</i> sp. <i>Homona magnanima</i> Diakonoff
<i>Goniozus morindae</i> Kurian, 1952	CECIDOMYIDAE <i>Asphondylia morindae</i> Mani gall (should be verified)
<i>Goniozus nephantidis</i> (Muesebeck) 1934	PYRALIDAE <i>Corcyra cephalonica</i> (Stainton) OECOPHORIDAE <i>Opisina arenosella</i> Walker GALLERIDAE <i>Galleria mellonella</i> (in laboratory)
<i>Goniozus orthagae</i> sp. nov.	PYRALIDAE <i>Orthaga exvinacea</i> Hampson
<i>Goniozus pakmanus</i> Gordh, 1984	GELECHIIDAE <i>Pectinophora gossypiella</i> (Saunders)
<i>Goniozus platycephalus</i> sp. nov.	PYRALIDAE <i>Cnaphalocrocis medinalis</i> (Guenee)
<i>Goniozus pulveriae</i> (Kurian) 1954	BLASTOBASIDAE <i>Holcocera pulvereae</i> (Meyrick) on <i>Laccifer lacca</i>
<i>Goniozus rugosus</i> Samad, 1973	GELECHIIDAE <i>Pectinophora gossypiella</i> (Saunders) PYRALIDAE <i>Nausinoe geometralis</i> Guenee <i>Spilomela perspicata</i> Fabricius <i>Trachylepidia fructicassella</i> Ragonot
<i>Goniozus salvadorae</i> (Kurian) 1954	Psyllid galls
<i>Goniozus sensorius</i> Gordh, 1988	PYRALIDAE <i>Diaphania indica</i> (Saunders)
<i>Goniozus sinicus</i> Xiao and Wu, 1987	SESIIDAE <i>Synanthedon castanvora</i> Yang et Wang
<i>Goniozus stomopterycis</i> Ram and Subba Rao, 1968	GELECHIIDAE <i>Stomopteryx nerteria</i> (Meyrick)
<i>Goniozus thailandensis</i> Gordh & Witethom, 1994	PYRALIDAE <i>Nephopteryx</i> sp. <i>Pseudoceroprepes</i> cf. <i>naga</i>

<i>Goniozus thalassodes</i> Kurian, 1955	GELECHIIDAE <i>Thalassodes vevaria</i> on Litchi leaves
<i>Goniozus triangulifer</i> Kieffer, 1914	PYRALIDAE <i>Cnaphalocrocis medinalis</i> (Guenee) <i>Marasmia patnalis</i> (Bradley) <i>Nacoleia octasema</i> (Meyrick) on <i>Heliconia</i>
<i>Goniozus triangulus</i> Kieffer, 1922	PYRALIDAE <i>Cnaphalocrocis medinalis</i> (Guenee)
Genus: <i>Odontepyrus</i> Kieffer 1904	
<i>Odontepyrus argyriae</i> Kurian, 1954	PYRALIDAE <i>Chilo infuscatellus</i> Snellenhoven
<i>Odontepyrus cirphi</i> Kurian, 1955	NOCTUIDAE <i>Cirphis</i> sp.
<i>Odontepyrus hypsipylae</i> (Kurian) 1955	PYRALIDAE <i>Hypsipyla robusta</i> (Moore)
<i>Odontepyrus mandibularis</i> Krombein, 1996	NOCTUIDAE <i>Mythimna</i> sp.
<i>Odontepyrus quadrioveatus</i> (Muesebeck), 1934	CRAMBIDAE <i>Syllepte</i> sp.
Subfamily: Epyrinae	
Genus: <i>Cephalonomia</i> Westwood 1833	
<i>Cephalonomia peregrina</i> Westwood, 1881	ANOBIIDAE <i>Catorama mexicana</i> Chevrolat
<i>Cephalonomia rhizoperthae</i> Xu, Weng and He, 1998	BOSTRICHIDAE <i>Rhizopertha dominica</i> (Fabricius)
<i>Cephalonomia tarsalis</i> (Ashmead) 1893	CUCUJIDAE <i>Oryzaephilus surinamensis</i> (Linnaeus) <i>Sitophilus grainarius</i> (Linnaeus) <i>S. oryzae</i> (Linnaeus) <i>S. zaemays</i> (Motschulsky) TENEBRIONIDAE <i>Tribolium castaneum</i> (Herbst)
Genus: <i>Discleroderma</i> Kieffer	
<i>Discleroderma indiensis</i> Lanes & Azevedo, 2008	CERAMBYCIDAE <i>Xylotrechus quadripes</i> Chevrolat
Genus: <i>Holepyris</i> Kieffer	
<i>Holepyris grandiceps</i> (Kieffer) 1921	CERAMBYCIDAE <i>Xylotrechus quadripes</i> Chevrolat

<i>Holepyris sylvanidis</i> (Brethes) 1913	CURCULIONIDAE <i>Sitophilus granarius</i> (Linnaeus) CUCUJIDAE <i>Laemophlaeus ferugineus</i> Stephens SILVANIDAE <i>Oryzaephilus surinamensis</i> (Linnaeus) TENEBRIONIDAE <i>Tribolium confusum</i> Duvall <i>T. castaneum</i> Herbst
Genus: <i>Laelius</i> Ashmead 1893	
<i>Laelius voracis</i> Muesebeck, 1939	DERMESTIDAE <i>Anthrenus verbasci</i> (Linnaeus) <i>Anthrenus vorax</i> (Waterhouse) <i>Attagenus</i> sp. (in laboratory)
Genus: <i>Prorops</i> Waterston 1923	
<i>Prorops nasuta</i> Waterston, 1923	SCOLYTIDAE <i>Hypothenemus hampei</i> (Ferrari)
Genus: <i>Rhabdepyris</i> Kieffer	
<i>Rhabdepyris rhizoperthae</i> Menon, Chatterjee & Sarup 1959	BOSTRICHIDAE <i>Rhizopertha dominica</i> Stephens
Genus: <i>Sclerodermus</i> Latreille 1809	
<i>Sclerodermus delhiensis</i> Kurian, 1955	BOSTRICHIDAE
<i>Sclerodermus hardwickiae</i> Kurian, 1955	LYCIDAE
<i>Sclerodermus immigrans</i> Bridwell, 1918	BRUCHIDAE <i>Caryoborus gonagra</i>
<i>Sclerodermus mori</i> Kurian, 1955	ANOBIIDAE <i>Pilinus binodulus</i> Motschulsky
Genus: Subfamily: <i>Pristocerinae</i>	
Genus: <i>Apenesia</i> Westwood 1874	
<i>Apenesia sahyadrica</i> Azevedo & Waichert, 2006	CERAMBYCIDAE <i>Xylotrechus quadripes</i> Chevrolat
Genus: <i>Pristocera</i> Klug 1808	
<i>Pristocera formosana</i> Miwa & Sonan 1935	ELATERIDAE <i>Melanotus tamsuyensis</i> Bates <i>Agonischius obscuripes</i> Gyllenhal
<i>Pristocera rufa</i> Kieffer 1905	CURCULIONIDAE <i>Pantorhytes szentivanyi</i> Marshall

SUMMARY

The aculeate family Bethylidae is a large family of about 2200 described species and an estimated 6000 species, with only less than 30% of them described till now. Bethylids are gregarious ectoparasitoids, the Bethylinae mostly develop on the larval Lepidoptera, whereas the reminders mostly on Coleoptera, although hosts are known only for a small proportion of the family. Bethylids are frequently encountered as parasitoids of crop pests, especially in tropical areas, and several species are used in attempted biological control. Hence, the demand for the correct identification of bethylid wasps is on the rise.

The knowledge lacuna in Indian bethylids, especially of the genus, *Goniozus* was a principal source of motivation to pursue this investigation. This investigation is a study of bethylid fauna of one of the diversity rich regions called Southern Western Ghats falling in the biodiversity hotspot region called Western Ghats and Sri Lanka. In this work, four genera viz. *Goniozus*, *Odontepyris* and *Sierola* of subfamily Bethylinae and *Sclerodermus* of subfamily Epyrinae are revised. Forty five species are studied, described or redescribed with photographic and diagrammatic illustrations. Many type materials are studied and redescrptions are given for those taxa, which were poorly described in the past. Some of the genera newly recorded from Southern Western Ghats are not treated at species level for they are either known from single specimen or they are highly speciose to make this study cumbersome. The thesis is written in six chapters along with dichotomous keys, interactive keys, Oriental check list, host – parasitoid index, literature cited, line diagrams, photographs and distribution maps.

The first chapter gives an introduction to the thesis. In this chapter, the need and scope of the taxonomic treatment of the family is discussed. A brief overview of the importance of bethylids in biological control, the systematics, phylogeny, biology, behaviour, their relationship to man and economic importance of the family are presented. The objectives envisaged in the investigation are also discussed. The

second chapter gives the background knowledge of the World and Oriental species of the family. The third chapter is about the methodology followed for collecting, processing, preserving, identification, distribution maps and interactive keys. The fourth chapter elaborates the terminology, morphological measurements and abbreviations used in the thesis. It also provides the key to subfamilies, tribes and genera of Bethylidae from Southern Western Ghats. The key includes all the previously known and newly recorded genera from the study area. A brief general morphology of the family with illustrations is also included.

The fifth chapter is subdivided into 4 sections, namely, Genus *Goniozus*, Genus *Odontepyris*, Genus *Sierola* and Genus *Sclerodermus*, first three under subfamily Bethylinae and the fourth genus under subfamily Epyrinae. In the first section, genus *Goniozus* is revised and key to species for Indian subcontinent is provided. Descriptions of 31 species are given. The holotype of three species and plesiotype of *G. indicus* are studied and redescribed. Diagnosis to *G. nephantidis* is given. Twenty six new species are discovered and described. In the second section, genus *Odontepyris* is revised with descriptions of five new species and an illustrated key to Oriental species. In the third section, genus *Sierola* is revised with descriptions of two new species and a key to Oriental species. In the fourth section, genus *Sclerodermus* is revised with descriptions of two new species and redescriptions of four species from holotype and one species from plesiotype. Alate male and alate female forms of *Sclerodermus hardwickiae* is described new to science.

The sixth chapter deals with the efficiency of various collection methods used and suitable time and habitat for collecting bethylids. The distribution and range extension of the species under study are also discussed. The advantages of interactive keys over traditional dichotomous keys are given. The character coding and data matrix generated for the four genera studied are discussed. The analysis between reliable characters and unreliable characters are given with examples. The newly introduced characters and morphometric ratios are discussed along with the

four newly discovered and economically important host – parasitoid relationships. The new records and the new species descriptions are listed in the end of the chapter.

The literature review of this investigation is presented with an emphasis to the genera treated here, whereas the checklist and host – parasitoid index are written for the entire family. The check list is with the distribution details of each species within and outside the Oriental region. The host parasitoid index prepared provides an idea of the host preference of Oriental Bethylidae. All the literatures mentioned in the text are cited in the end. The species studied are illustrated in line drawings and photographs. The photographs are prepared by stacking several layers of photographs to avoid the depth of field problem. The distribution and range extensions of the species are studied with the help of GPS generated co-ordinates (latitude and longitude) and digitalized distribution maps with habitat types. The information collected from the field during the collection, such as hosts, habitat type, elevation, plant host etc. are all given in the material examined section of each species to help in the future collection and identification of the same species. A compact disc is attached to the inner side of the back, with the interactive key to species of the four genera treated in this thesis.

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APPENDIX- I

GLOSSARY OF SOME TERMS USED IN THE THESIS

Antennal Funicle: All antennal segments excluding scape and pedicel.

Basal Vein: Short, usually weakly sclerotized vein almost perpendicular or oblique to subcosta.

Clypeus: The area on the front aspect of the head, above the mouth opening and below the face, usually separated from the face by a shallow groove.

Frons: Part of the front aspect of the head, between the eyes, extending from the lower margin of the median ocellus to the lower margins of antennal sockets.

Mandibles: The paired heavily sclerotised biting and chewing lateral appendage of the mouth parts. Mandibular teeth are numbered starting with the outermost (apical) tooth.

Mesonotum: Dorsal sclerite of mesothorax comprising mesoscutum and scutellum.

Mesoscutum: Anterior region of mesonotum between pronotum and scutellum often divided into middle and lateral lobes by notauli.

Mesosoma: The anatomical cluster that is composed of the thorax and the first abdominal segment called propodeum, fused to thorax in hymenopterans.

Metacarpus Vein: Post marginal vein extending from the pterostigma towards wing apex.

Metanotum: Dorsal sclerite of metathorax.

Metapleuron: An oval or subtriangular area on the sides of the thorax, between the mid and the hind coxae and extending up to the propodeum.

Metasoma: The term metasoma is used to mean the functional abdomen (true abdomen minus the propodeum). Abdominal segments in Hymenoptera are numbered from front to rear, with the first apparent segment (morphologically the second segment) termed the first segment as the morphological first segment of abdomen is joined to the thorax as propodeum.

Notauli: A pair of grooves on the mesoscutum, each beginning on the front margin to one side of the midline and extending backward. The notauli divide the mesoscutum into 3 parts: a median lobe between the two notauli and a lateral lobe on each side.

Occipital Carina: A subcircular carina on the hind aspect of the head between the vertex and hind margin of the compound eyes and the foramen magnum.

Parameres: Lateral processes or lobes of the phallobase.

Parapsidal Furrows: Posterior admedian grooves on lateral lobes of mesoscutum.

Pronotal Collar: The anterior, depressed portion of the pronotum is termed the pronotal collar.

Pronotal Disc: Leaving the pronotal collar, the remainder of the dorsal surface of pronotum is the pronotal disc.

Pterostigma: The sclerotised opaque part formed at the junction of costal, subcostal, metacarpus and radial veins near the anterior margin of forewing.

Propleuron: Sides of pronotum.

Propodeum: Apparent segment of mesosoma posterior to metanotum; originally the first abdominal segment.

Prostigma: In many Bethylinae, there is a swelling of the subcosta and basal vein just basad of the stigma, called the prostigma.

Radial Vein: Radial vein is the sclerotised vein distinctly angled from pterostigma

Scutellum: A median, subtriangular, raised part of the mesonotum, behind the mesoscutum.

Speculum: The area immediately posterior to the stub originating from basal vein in forewing. Mostly this area is clear and asetose.

Subcostal Vein: Second vein of forewing next to costa.

Subgenital Plate: The last visible sternite, just in front of the genitalia of the male.

Tegula: A convex scale lying over the base of the fore wing, on the front side.

APPENDIX-II

LIST OF ABBREVIATIONS

1. Abbreviations of Morphological Terms Used in the Thesis

- AN – Antenna
- AO – Anterior ocellus
- AOL – Antero-posterior ocellar line; shortest distance between anterior ocellus and posterior ocellus
- CE – Compound eye
- CL – Clypeus
- D – Declivity
- DAO – Maximum diameter of anterior ocellus
- DC – Discal carina
- EV – Maximum distance from top of the eye to posterior margin of vertex measured in lateral view
- F1-F11 – Antennal flagellar segments 1 to 11
- FFL – Maximum length of forefemur
- FFW – Maximum width of forefemur
- FL – Antennal flagellum
- FR – Frons
- FWL – Maximum length of forewing
- HE – Maximum height or length of eye in lateral view
- LA – Length of antenna
- LC – Lateral carina
- LF1 – Length of first flagellar segment
- LH – Maximum length of head from apex of clypeus to posterior margin of vertex, excluding mandibles in full face view

- LM – Maximum diagonal length of mesosoma excluding pronotal collar, in lateral view
- LP – Length of propodeum measured along the midline including the posterior declivity, in dorsal view
- LPD – Length of propodeal disc measured along the midline excluding the posterior declivity, in dorsal view
- LS – Length of scape
- M – Medial cell in forewing
- m – Medial vein in forewing
- MA – Mandible
- MC – Median carina
- MSC – mesoscutum
- MSN – Mesonotum
- MT – Metanotum
- NT – Notaulus
- OOL – Ocello-ocular line; shortest distance from posterior ocellus to nearest eye margin
- PD – Pedicel
- PDL – Maximum length of pronotal disc, excluding the pronotal collar
- PDW – Maximum width of pronotal disc
- PF – Parapsidal furrow
- PL – Length of pedicel
- PO – Posterior ocellus
- POL – Posterior ocellar line; shortest distance between posterior ocelli
- PRN – Pronotum
- PRP – Propodeum
- rs – Radial sector vein in forewing

- rs+m – Radial sector + medial vein
- S – Spiracle
- SC – scape
- SCP – Scutellar pit
- SCU – Scutellum
- SCU – Scutellum
- SI – Forefemur sphericity index
- SLC – Sublateral carina
- SM – Submedian cell in forewing
- SMC – Submedian carina
- T1-T4 – Abdominal tergites 1 to 4
- TC – Transverse carina
- TE – Tegula
- VE – Vertex
- WF – Minimum width between eyes in full face view
- WH – Maximum width of head including eyes in full face view
- WOT – Width of ocellar triangle; distance across and including posterior ocelli
- WPD – Maximum width of propodeal disc excluding anterior portion from the level of propodeal spiracles, in dorsal view.

2. Abbreviations of Collections/Depositories

BMNH – United Kingdom, London, Natural History Museum.

DZUC – India, Kerala, University of Calicut, Department of Zoology, Systematic Entomology Laboratory, TCN Parasitic Hymenoptera Collections.

INPC – India, New Delhi, Indian Agriculture Research Institute, National Pusa Collections.

MCSN – Italy, Genova, Museo Civico di Storia Naturale "Giacomo Doria".

OUMNH – United Kingdom, Oxford, University Museum of Natural History.

USNM – United States of America, Washington D.C., National Museum of Natural History [formerly, United States National Museum].

ZMAN – Netherlands, Amsterdam, Universiteit van Amsterdam, Instituut voor Taxonomische Zoologie, Zoologisch Museum.

3. Other Abbreviations Used

AUS - Australian

BUR - Burma

CHI - China

CPCRI – Central Plantation Crop Research Institute.

DDF – Dry deciduous forest

ETH - Ethiopian

IND - India

MDF – Moist deciduous forest

NEA - Nearctic

NEP - Nepal

NET - Neotropical

PAK - Pakistan

PAL - Palaearctic

SEA - South east Asia

SEF – Semi - evergreen forest

SRL - Sri Lanka

SWG - Southern Western Ghats

TAW - Taiwan

TEF – Tropical evergreen forest

VRN – Voucher Number of the specimen

WPT – White pan trap

YPT – Yellow pan trap

APPENDIX- III

PUBLICATIONS

Santhosh, S. Narendran, T.C., 2009. A new species of *Goniozus* Förster (Hymenoptera: Chrysidoidea: Bethyilidae) parasitizing *Helicoverpa armigera* (Hübner) from India, Journal of the Entomological Research Society, Turkey, Vol. 11. No. 1, 37-45.

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A New Species of *Goniozus* Förster (Hymenoptera: Chrysoidea: Bethyridae) from India, Parasitizing *Helicoverpa armigera* (Hübner)

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ABSTRACT

Goniozus armigerae Santhosh and Narendran sp. n. is described and illustrated based on specimens reared from *Helicoverpa armigera* (Hübner) (Lepidoptera: Noctuidae) from Himachal Pradesh, India. The new species is compared with other related Oriental species of *Goniozus* Förster. A key to the Oriental species of *Goniozus* with elongate head and no areolet is also provided.

Key words: Chrysoidea, Bethyridae, Himachal Pradesh, taxonomy, key, Oriental region, *Helicoverpa armigera*, Noctuidae.

INTRODUCTION

Goniozus Förster 1856, is a cosmopolitan genus of Bethyridae with the potential of being a biological control agent against various lepidopteran pests (Gordh & Witethom, 1994). Gordh and Móczár (1990) listed 140 nominal species of this genus worldwide and all of them are presumed to be primary external parasitoids of Lepidoptera larvae. *Goniozus* is the most speciose genus of the subfamily Bethyridae, represented by 50 described species from the Oriental region, of which only 36 species are known from the Indian subcontinent.

In this paper, a new species is described with a key to the 15 species of the genus *Goniozus* with elongate head and no areolet in the forewing, known from Oriental region. This is the first record of a described bethyrid species reared from *Helicoverpa armigera*. Vadivelu *et al.* (1975), Divakar & Pawar, (1982), Divakar *et al.* (1983) reported two undescribed species of *Goniozus* as larval parasitoids of *Helicoverpa armigera* (Hübner) from south India. However, the voucher specimens of these reports are lost and have not been available for study. All the specimens studied were obtained

on loan from the National Insect Collections (NPC), Indian Agricultural Research Institute (IARI), New Delhi, India, and subsequently all the types were deposited there.

MATERIAL AND METHODS

Measurements and structural terms used here follow Evans (1964), and Terayama (2006). The terms used for integument sculptures are as per Harris (1979) viz: AOL, antero-posterior ocellar line; EV, post orbital distance measured as distance from top of eye to posterior margin of vertex, measured in lateral view; of eye to posterior margin of vertex, measured in lateral view; F1, F2 and F11, funicular segments 1, 2 and 11 respectively; LFW, maximum length of forewing; HE, maximum length of eye in lateral view; LH, maximum length of head from clypeal margin to vertex in full-face view; LM, maximum length of mesosoma excluding pronotal collar in lateral view; LP, length of propodeum measured along midline including posterior declivity in dorsal view; LPD, length of dorsal propodeum disc excluding declivity in dorsal view; M, median vein; OOL, ocello-ocular line; POL, posterior-ocellar line; Rs, radial sector; TL, total length of outstretched specimen from mandibular apex to metasomal apex excluding ovipositor; WF, minimum distance between the eyes in full-face view; WH, maximum width of head including eyes in full-face view; WOT, width of ocellar triangle; WPD, maximum width of the propodeal disc posterior to level of spiracles; SI, fore femur sphericity index.

Fore femur Sphericity Index is calculated using the formula $SI = (\text{Fore femur Length} \times \text{Fore femur Width}) / (\text{Fore femur Height})^2$ to indicate the overall three-dimensional shape of the fore femur (Aguiar, 2001), where the value 1 indicates a perfect sphere and the increasingly greater values indicate an elongated flattened or compressed fore femur.

The new species is compared with the fourteen described species known from the Oriental region with elongate head (WH equal to or less than $0.91 \times LH$) and a short stub (Rs+M vein) arising from the basal vein, but not forming an areolet.

RESULTS

Goniozus armigerae Santhosh and Narendran sp. n. (Figs. 1-4).

Diagnosis: Eye setose, mandible and antenna brownish yellow, anterior median propodeal carina connected to posterior transverse carina by smooth line, head elongate, WH $0.84-0.89 \times LH$, areolet in forewing absent, clypeal margin obtuse, and scape less than twice pedicel length.

Description: Female (Holotype) TL = 2.79mm; LFW = 2.06mm; LH = 0.70mm; WH = 0.63mm; WF = 0.38mm; LM = 0.84mm; LP = 0.38mm; WPD = 0.49mm; LPD = 0.29mm.

Colour: Body black; leg with coxa, fore femur, and hind femur testaceous, hind femur lighter than fore femur and coxa, other segments yellow; antenna uniformly yellow except single brownish apical segment; mandible brownish yellow, basal, dorsal and ventral margins brownish, teeth red; wings hyaline, stigma and prostigma testaceous, costa and subcosta light brown, other veins unpigmented.

Head (Fig.1): Longer than wide; somewhat flattened 1.5x as long as wide (Fig.2); frons and vertex strongly coriaceous with scattered shallow punctures; gena smooth and polished; pubescence suberect, short and sparse, longest (0.13 mm) hairs on vertex margin; vertex margin straight, ecarinate; antennal scrobe weakly carinate; mandible moderately stout with four teeth; median lobe of clypeus with obtusely angulate terminal margin; clypeal carina strong, arcuate in profile, extending onto front up to level of posterior margin of scrobe; anterior margin of frontal lobe notched in middle; length of clypeal carina 0.68-0.78x HE; WH 0.84-0.89x LH; WF equal to HE; EV 0.41-0.44x HE; ocular setae minute, sparse, as long as single facet; frontal angle of ocellar triangle obtuse, posterior pair separated from crest of vertex by less than their own diameters; OOL 0.84-0.95x WOT; POL 2.0x AOL; antenna (Fig. 3) as long as head; first 4 antennal segments in ratio of length (width) - 8(5.5): 4.2(3.5): 4(3.3): 4 (3.5); third segment 1.14-1.29x as long as wide.

Mesosoma (Fig.1): Short; pronotal disc dull and coriaceous, 0.45x as long as wide, vestiture longer than that of head; mesoscutum rather smooth and shining, only weakly microreticulate with sparse punctures; propodeal disc 0.63x as long as maximum width posterior to spiracles in dorsal view; ratio of maximum width anterior to spiracles to minimum width at posterior margin of dorsal propodeal disc 1.33; complete transverse carina on posterior margin; median basal triangle of propodeal disc smooth and polished, extending beyond mid-level of propodeal disc, connected to posterior transverse carina as a smooth line in microreticulate surface, not elevated as a ridge; other parts of disc and posterior declivity microreticulate; fore femur (Fig.4) length 1.78-1.85x its width. SI = 4.72; mid tibia with a terminal spine slightly longer than half length of basitarsus; forewing (Fig.1) without areolet; median and submedian cells sparsely hairy; Rs+M slightly curved at apex. M:Rs:Rs+M = 9:5:7.

Metasoma (Fig.1): Smooth and polished, as long as mesosoma.

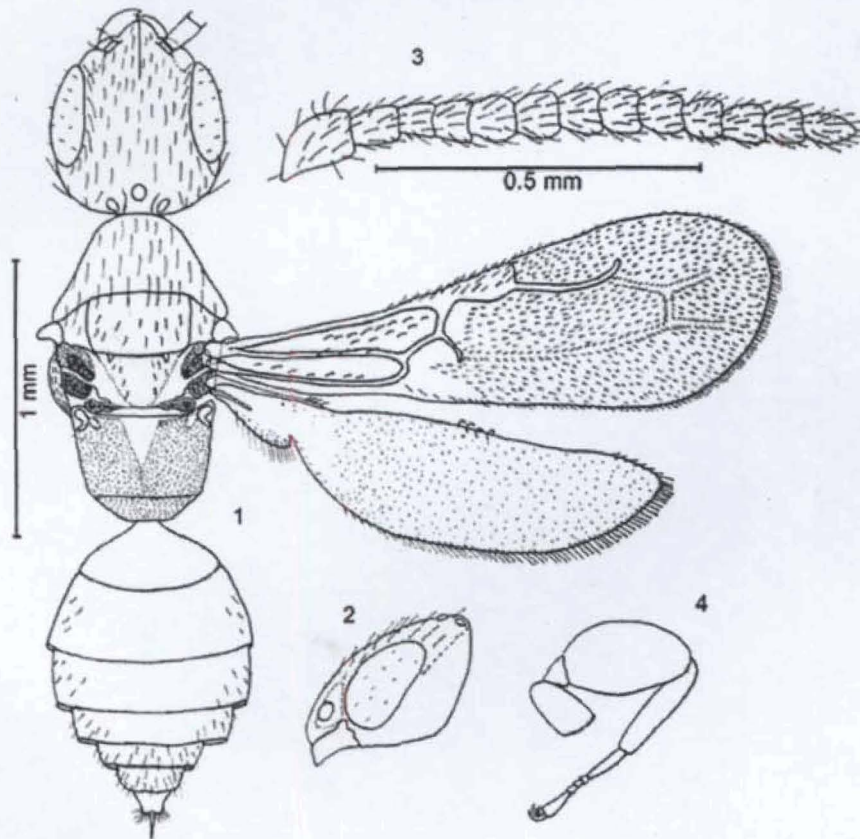
Male: Unknown.

Host: ex. larvae of *Helicoverpa armigera* (Lepidoptera: Noctuidae).

Etymology: Specific epithet is after *armigera*, the host specific epithet.

Distribution: India, Himachal Pradesh.

Material Examined: Holotype. Female, India, Himachal Pradesh, Solan, 30°53'N 77°06'E, 1742 m, 06.02.1995; J. N. Thakur (NPC, Cabinet No. 0116 Tag. No. 4181-85/95). Paratype - 4 females, same data as Holotype (NPC, Cabinet No. 0116 Tag. No. 4181-85/95). All types are deposited at the National Insect Collections (NPC), Indian Agricultural Research Institute (IARI), New Delhi, India.



Figures 1-4. *Goniozus armigeræ* Santhosh and Narendran sp. n.; Female. 1. body in dorsal view; 2. head in lateral view; 3. antenna; 4. foreleg.

Remarks: *Goniozus armigeræ* sp. n. is similar to *G. chatterjii* Kurian, 1955, but in *G. armigeræ* sp. n. the mandible is brownish yellow in colour, EV 0.41-0.44x HE, and the propodeal triangle is connected to the transverse carina by a smooth line, whereas in *G. chatterjii* mandible is reddish brown in colour, EV 0.25x HE, and the anteromedial propodeal smooth triangle is connected to the posterior transverse carina by a raised median carina. This species is also similar to *G. japonicus* Ashmead 1904, but in *G. armigeræ* sp. n. the clypeal margin is obtusely angulated, the posterior transverse carina is complete, eye setose, and the anteromedial smooth propodeal

triangle is connected to the transverse carina by a median smooth line, whereas in *G. japonicus* the clypeal margin is acutely angulated, the posterior transverse carina of propodeum is evanescent in the middle, the eye bare, and the anteromedial smooth propodeal triangle is connected to the posterior margin by a smooth blotch.

Key to species of the genus *Goniozus* with elongate head and no areolet from Oriental region (Female).

- 1. Clypeal carina absent..... *G. fulgidus* Krombein
- Clypeal carina present..... 2
- 2 (1). Length of Rs+M vein equal to or more than M; anterior medial propodeal triangle well developed; head smooth and shiny..... *G. philippinensis* Ashmead
- Length of Rs+M vein shorter than M; other characters not in above combination, partly or completely different..... 3
- 3 (2). Parapsidal furrows absent; clypeal margin obtuse; clypeal carina weak; head in dorsal view coriaceous; scape as long as the Pedicel + F1; Pedicel, F1, and F11 longer than wide, other segments wider than long; propodeal disc shorter than scutellum and mesonotum combined..... *G. borneanus* Cameron
- Parapsidal furrows present; other characters not in above combination, partly or completely different..... 4
- 4 (3). Pedicel shorter than F1..... 5
- Pedicel as long as or longer than F1 8
- 5 (4). Clypeal margin acute; mandible yellow..... *G. keralensis* Gordh
- Clypeal margin obtuse; mandible reddish brown or black..... 6
- 6 (5). Anteromedial propodeal triangle elevated and well developed, connected to posterior margin by a weak short carina..... *G. hanoiensis* Gordh
- Anteromedial propodeal triangle weak or absent; no median short carina on propodeal disc..... 7
- 7 (6). Clypeal carina weak; mandible black; posterior propodeal transverse carina evanescent in middle..... *G. thailandensis* Gordh & Witethom
- Clypeal carina strong and acute; mandible reddish brown; posterior propodeal transverse carina complete..... *G. pakmanus* Gordh
- 8 (4). Length of scape less than 2x pedicel..... 9
- Length of scape equal to or more than 2x pedicel 12

- 9 (8). Mandible reddish brown..... 10
 - Mandible yellow or yellowish brown..... 11
- 10 (9). Head shiny, very weakly coriaceous; body light brown; EV 0.43x HE..... *G. rutherfordi* Krombein
 - Head coriaceous; body black or dark reddish brown; EV 0.25x HE.....
 *G. chatterjii* Kurian
- 11 (9). Clypeal margin obtuse; eye setose; posterior propodeal carina complete
 *G. armigerae* sp. n
 - Clypeal margin acute; eye bare; posterior propodeal carina evanescent in middle..... *G. japonicus* Ashmead
- 12 (8). Anteromedial propodeal triangle absent..... *G. marianensis* Terayama
 - Anteromedial propodeal triangle well developed..... 13
- 13 (12). Mandible reddish brown; OOL nearly twice as long as WOT; pedicel longer than F1..... *G. sinicus* Xiao & Wu
 - Mandible yellow or yellowish brown; OOL subequal to WOT; pedicel as long as F1..... 14
- 14 (13). Clypeal margin obtuse; eye asetose; propodeal disc 0.63x as long as wide, without posterior transverse carina; median and submedian cells with numerous short hairs..... *G. lamprosemae* Xu, He & Terayama
 - Clypeal margin acute; eye with minute erect setae; propodeal disc 0.54x as long as wide, with complete posterior transverse carina; median and submedian cells without hairs..... *G. baishanzuensis* Xu, He & Terayama

DISCUSSION

The bethylid fauna of the Indian subcontinent is interesting, but the current nomenclatural and taxonomic conditions must be improved before reaching a conclusion on either endemicity or relationships with other geographic regions (Gordh, 1986). Among the 50 species of *Goniozus* known from the Oriental region, 34 species are without an areolet in the forewing.

Since *Goniozus ahmeadi* Kurian, 1955 is based on a male specimen and is only known from the type, it is not included in table 1. Though the configuration and concomitant ratios of the head differ between the sexes, the propodeal sculpture remains consistent. *G. ahmeadi* with the long anterior median propodeal triangle reaching the

posterior margin and the absence of a transverse propodeal carina is different from all other related species.

Goniozus species that emerged from *Helicoverpa* (= *Heliothis*) *armigera* have previously been recorded from the regions of Coimbatore, Tamil Nadu (Vadivelu *et al.* 1975), and from the maize fields of Bangalore, Karnataka (Divakar & Pawar, 1982, Divakar *et al.* 1983), but none of them were described. These undescribed species may be conspecific with *G. armigerae* sp. n., but voucher specimens of the previous records were not available for verification.

Table 1. Coding of the diagnostic characters of *Goniozus* species with elongate head and no areolet (based on females).

Taxa	1	2	3	4	5	6	7	8	9	10	11	12
<i>G. chatterjii</i> Kurian, 1955	0	1	0	2	1	1	0	1	0	0	0	0
<i>G. armigerae</i> Santhosh & Narendran sp. n.	0	1	0	0	0	1	1	1	0	0	1	0
<i>G. japonicus</i> Ashmead, 1904b	0	0	0	1	0	1	0	1	0	1	2	0
<i>G. borneanus</i> Cameron, 1910	1	1	0	0	?	?	?	1	0	?	2	0
<i>G. baishanzuensis</i> Xu, He & Terayama, 2002	1	0	0	2	1	0	1	1	0	0	2	0
<i>G. keralensis</i> Gordh, 1986	0	0	0	1	0	0	0	?	0	1	0	0
<i>G. lamprosemae</i> Xu, He & Terayama, 2002	1	1	0	2	1	0	1	1	0	2	2	0
<i>G. marianensis</i> Terayama, 1994	0	1	0	0	?	0	0	1	1	0	2	0
<i>G. sinicus</i> Xiao & Wu, 1987	0	1	0	0	1	0	?	1	0	?	?	0
<i>G. hanoiensis</i> Gordh, 1993	0	1	0	1	1	0	0	1	0	?	0	0
<i>G. fulgidus</i> Krombein, 1996	2	1	1	2	1	1	1	?	?	0	?	0
<i>G. rutherfordi</i> Krombein, 1996	0	?	1	2	1	1	0	?	0	0	3	1
<i>G. pakmanus</i> Gordh, 1984	0	1	1	0	2	0	?	0	1	0	3	0
<i>G. philippinensis</i> Ashmead, 1904a	1	?	1	1	?	?	?	0	0	1	1	0
<i>G. thailandensis</i> Gordh & Witethom, 1994	1	1	1	1	2	0	1	1	2	1	3	0

Characters and their status used in the comparison of *Goniozus* species with elongate head and no areolet (based on females).

1. Clypeal carina. strong and extends caudad between scrobes (0); weak and restricted to clypeus (1); absent (2).

2. Clypeal margin. acute (0); obtuse (1); unknown (?)

3. Head. strongly coriaceous (0); shiny, weakly coriaceous (1).

4. Antenna. uniformly yellow to yellowish brown (0); yellow with apical segments fuscous (1); reddish brown (2).
5. Mandibles. yellow or brownish yellow (0); reddish brown (1); black (2); unknown (?).
6. Scape. as long as or longer than 2x pedicel (0); shorter than 2x pedicel (1); unknown (?).
7. Eyes. bare (0); setose (1); unknown (?).
8. Length of Rs+M vein. as long as or longer than M (0); shorter than M (1); unknown (?).
9. Anterior medial smooth propodeal triangle. well developed (0); weak (1); absent (2); unknown (?).
10. Posterior propodeal carina. complete (0); evanescent in middle (1); absent (2); unknown (?).
11. Connection between propodeal smooth triangle to posterior margin. by median carina (0); by smooth line (1); by smooth blotch (2); absent (3); unknown (?).
12. Body. black or dark reddish brown (0); light brown (1).

ACKNOWLEDGEMENTS

The authors express gratitude to V. V. Ramamurthi, Indian Agricultural Research Institute, New Delhi for the loan of specimens and Celso O. Azevedo; M. Terayama, Stuart Roberts, Zaifu Xu, Anita Varghese and K. Sudheer for their critical review of the manuscript. We thank Zoya Yefremova for the Russian-English translation, Celso O. Azevedo, Jeroen de Rond, Zaifu Xu, Anil Dubey, Anjum Rizvi, Seena Narayanan, Kamran Ahmad and Asha Thomas for the literature. Ministry of Environment and Forests, New Delhi for the financial assistance, and Head of the Department of Zoology, University of Calicut, Kerala, India for the facilities.

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Received: December 17, 2008 Accepted: February 02, 2009

**A TAXONOMIC STUDY OF ANAPROSTOCETUS GRAHAM
(HYMENOPTERA: EULOPHIDAE)**

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ABSTRACT. Three new species of *Anaprostocetus*, viz., *Anaprostocetus keralicus* Narendran & Girish Kumar, *Anaprostocetus areos* Narendran & Fousi, and *Anaprostocetus sringeriensis* Narendran & Santhosh are described. A key to the world species of *Anaprostocetus* is given.

Key words: Taxonomy, Eulophidae, New species, India, Oriental Region, *Anaprostocetus*.

Introduction

Anaprostocetus was erected by Graham (1987) with *Anaprostocetus dehraensis* Graham as the type species from Dehra Dun, India. In the same paper he transferred *Entedon acuminatus* Ratzeburg (parasitic on the Tenthredinid *Euura* spp.) to *Anaprostocetus*. The latter species is widely distributed in the Holarctic Region. LaSalle (1994) redefined the genus while studying the North American genera of Tetrastichinae. Sheng (1995) described *Anaprostocetus cenxiensis* from China. We describe here three new species from India. A key to species of *Anaprostocetus* Graham is included.

All the types are in the T.C.N. Collections of the Department of Zoology, University of Calicut (DZUC) and will be transferred to Zoological Survey of India, Kozikode (ZSIK) in due course of time.

The following abbreviations are used in the text: F₁ to F₃ = Funicular segments 1 to 3; OOL = Ocellocular distance; POL = Postocellar distance; Cl₁ = First claval segment; Cl₂ = Second claval segment; ODP = Posterior ocellar diameter; SMV = Submarginal vein; MV = Marginal vein; PMV = Postmarginal vein; STV = Stigmal vein; BMNH = The Natural History Museum, London; DZUC = Department of Zoology of University of Calicut. ZSIK = Western Ghats Regional Station of Zoological Survey of India, Kozikode.

Key to the species of *Anaprostocetus* Graham

- 1. Clava as long as or longer than combined length of F₁+F₂ 2
- Clava distinctly shorter than combined length of F₁+F₂..... 4
- 2. Clava as long as F₂+F₃; gaster 3.1x as long as broad; fore wing 2.45x as long as broad. China *cenxiensis* Sheng
- Clava distinctly longer than F₂+F₃; other characters partly or completely different 3

3. Clava nearly 3x as long as broad; Cl_1 and Cl_2 not or hardly longer than broad; pedicellus 2.2x as long as broad; malar sulcus slightly curved, 0.66x as long as length of eye; OOL about 2x OD. Holarctic *acuminatus* (Ratzeburg)
- Clava 3.7x as long as broad; Cl_1 and Cl_2 distinctly longer than broad; pedicellus 2.5x as long as broad; malar sulcus not curved, 0.39x as long as length of eye; OOL 1.25x OD. India *sringeriensis*, sp. nov.
4. F_1 distinctly shorter than F_2 ; malar space 0.33x length of eye; pronotum 0.4x as long as mesoscutum; fore wing 2.18x as long as broad; speculum closed behind by cubital line of setae; MV 3.62x STV; gaster 3.32x as long as broad, 1.33x combined length of head plus mesosoma; last tergite 1.22x as long as broad. India *areos*, sp. nov.
- F_1 distinctly longer than or as long as F_2 ; other characters partly or completely different 5
5. Clava 3.5x as long as broad; claval length 0.77x combined length of F_2+F_3 ; pedicellus 0.54x as long as F_1 ; fore wing 2.51x as long as broad; gaster 3.6x as long as broad last tergite 2.8x as long as broad. India *keralicus*, sp. nov.
- Clava 2.8x as long as broad, claval length 0.66x combined length of F_2+F_3 ; pedicellus 0.45x as long as F_1 ; fore wing 2.35x as long as broad; gaster 4.2x as long as broad; last tergite 2x as long as broad *dehraensis* Graham

1. *Anaprostocetus keralicus* Narendran & Girish Kumar, sp. nov. (Figs. 1-5)

Female: Length 3.63 mm. Bright metallic green. Antenna brown with scape, basal part of pedicel and anelli paler; eyes dark red, ocelli black; coxae (except their paler tips) concolorous with mesosoma; fore femur testaceous with outer side of basal part darker; fore tibia and tarsi testaceous; hind femur light brown with apex paler; hind tibia and tarsi pale yellow; all pretarsi dark brown; tegula pale yellow; wings hyaline; fore wing veins yellow with its border brown.

Head: (Figs. 2&3) about as broad as mesoscutum; 2.53x as broad as its maximum length in dorsal view; POL 1.5x OOL; OOL 1.33x ODP; ocellar triangle delimited by grooved lines; each lateral ocellus connected to adjacent eye by a grooved line which expands just outside the ocellus, to form a subtriangular fovea. Head in front view 1.14x its length, sparsely clothed with extremely short pubescence; malar space 0.58x length of eye in profile; sulcus slightly curved; head moderately shiny with extremely fine reticulation. Antenna with scape distinctly shorter than eye, reaching median ocellus, 4.28x as long as broad; pedicellus plus flagellum 1.14x breadth of mesoscutum; pedicellus 2.4x as long as broad; 0.54x as long as F_1 ; anelli 3, distinctly visible; funicular segments decreasing in length; F_1 - 3x, F_2 - 2.85x, F_3 - 2.28x as long as broad, clava 3.5x as long as broad; Cl_1 and Cl_2 little longer than broad; sensillae of flagellum moderately dense.

Mesosoma: (Fig. 1&4) 1.5x as long as broad; pronotum 0.75x length of mesoscutum; mid lobe of mesoscutum as broad as or slightly broader than long, moderately convex, shiny with fine engraved reticulation; median sulcus distinctly strong, slightly broadening towards posterior side; mesoscutum with 9 adnotaular setae on each side; scutellum 1.28x as broad as long; submedian lines slightly nearer to sublateral lines than to each other, enclosing a space 2.62x as long as broad; scutellum 0.55x length of mesoscutum; space between submedian lines nearly equal to the length of a posterior seta of scutellum; anterior pair of setae slightly behind the middle; dorsellum 4.66x as broad as long, moderately shiny, with fine engraved reticulation. Propodeum slightly longer than dorsellum,

very narrowly emarginate before petiole; surface between paraspiracular carinae with strong, raised reticulation; median carina raised, rather thin and slightly expanding posteriorly; paraspiracular carinae strong and curved; areas between these and spiracles moderately shiny with delicate, alutaceous sculpture; spiracle round, separated by their own diameter; callus with 5-6 setae; metapleuron with sculpture slightly raising. Hind coxa 2x as long as its width, with a distinct curved dorsal carina, outer surface with slightly raised reticulation rather finer than that of propodeum; hind femur 4x as long as broad; spur of mid tibia 0.71x length of basitarsus. Fore wing length 2.51x its maximum width, hardly reaching tip of gaster; costal cell distinctly shorter than MV (23:30), about 9x as long as broad; SMV with 7 dorsal setae; MV 4.5x as long as STV, its anterior dorsal side with 32 setae; speculum open below, disc beyond it sparsely setose.

Gaster: (Fig.5) 3.68x as long as broad, 1.4x as long as head plus mesosoma, acute and acuminate posteriorly; last tergite 2.8x as long as broad; tip of hypopygium a little before half of gaster.

Male: Unknown.

Host: Unknown.

Distribution: India: Kerala.

Holotype: Female (on card, Reg. No. MoEF 3712). INDIA: Kerala, Wayanad District, Pookode Lake. (76°3'-6'E, 11°37'-39'N) 8.ii.2003, Coll. T.C.Narendran & Party (DZUC). *Paratypes*: 2 Females (on card, Reg. No. MoEF 4128,4129) INDIA: Kerala, Palaghat District, Parambikulam.(76°38'- 42'E, 10°26'-30'N) 22.xii.1985. Coll. T.C.Narendran & Party (DZUC).

Variation: In paratypes metallic colour is more bluish.

Etymology: The species epithet is after the state, Kerala, where the type locality is situated.

Comments: This new species comes near *A. dehraensis* in general appearance but can be separated by the key characters given above.

2. *Anaprostocetus areos* Narendran & Fousi, sp. nov. (Figs. 6-8)

Female: Length 1.91mm. Dark metallic bluish green. Antenna brown with scape, pedicel and anelli paler; eyes brick red; ocelli reflecting yellowish brown; Fore coxae dark brown with apex paler; fore femur brown on outer side with apex and inner side paler; all tibiae and all tarsi pale yellow; mid femur and hind femur pale yellow with basal half slightly darker; tegula pale yellow. Wings hyaline; fore wing veins pale brownish yellow.

Head: (Fig. 7) as broad as mesoscutum; 3.8x as broad as its maximum length in dorsal view; POL 1.58x OOL; OOL 1.28x ODP; ocellar triangle delimited by a distinct grooved line; each lateral ocellus connected to adjacent eye by a grooved line which expands just outside ocellus to form a subtriangular fovea. Head in front view 1.02x as wide as its length; sparsely clothed with extremely short pubescence; malar space 0.33x length of eye in profile; malar sulcus not curved; head moderately shiny with fine reticulation. Antenna with scape distinctly shorter than eye, reaching front ocellus, 4.3x as long as broad; pedicellus plus flagellum 1.33x breadth of mesoscutum; pedicellus 1.6x as long as broad; 0.61x as long as F₁; anelli 3, quite distinctly visible in certain lights; F₁ shorter

than F_2 ; F_1 - 2.25x, F_2 - 2.5x, F_3 - 1.7x as long as broad; clava 3x as long as broad, distinctly shorter than combined length of F_2+F_3 ; sensillae moderately dense.

Mesosoma: (Fig.6) 1.47x as long as broad; pronotum 0.4x length of mesoscutum; mid lobe of mesoscutum as broad as long, moderately convex, shiny with fine engraved reticulation, median line distinct throughout, strong, 6-7 adnotaular setae on each side. Scutellum 1.33x as broad as its median length, 0.75x length of mesoscutum; submedian lines nearer to sublateral lines than to each other, enclosing a space 2.5x as long as broad; anterior pair of setae slightly behind the middle. Dorsellum 3.5x as broad as long, dull, reticulate; propodeum distinctly longer than dorsellum, slightly emarginate just before petiole; surface between paraspiracular carinae with strong, raised reticulations; median carina raised, not thin, slightly expanding posteriorly; paraspiracular carinae curved, not very strong; space between carina and spiracle smooth but not very shiny; spiracle round, separated from metanotum with a distance lesser than half diameter of spiracle; callus with 3 setae; metapleuron with sculpture slightly raised; hind coxa 1.88x as long as its width, with a distinct curved dorsal carina, outer surface with distinct raised reticulation, rather finer than that of propodeum; hind femur 4.5x as long as broad; spur of mid tibiae 0.75x length of basitarsus; fourth segment of mid and hind tarsi shorter than basitarsus; forewing 2.15x as long as broad; costal cell slightly shorter than MV, 13.5x as long as broad; SMV with 4 dorsal setae; MV 3.6x as long as ST, its front edge with 16-18 dorsal setae; speculum closed behind by cubital line of setae.

Gaster: (fig.8) 3.32x as long as broad; 1.33x as long as head plus mesosoma, acute and acuminate posteriorly; last tergite 1.22x as long as broad; tip of hypopygium a little after middle of gaster.

Male: Unknown.

Host: Unknown.

Distribution: India: Kerala.

Holotype: Female, (on card, Reg. No. MoEF 4130). INDIA: Kerala, Alappuzha District, Kanjikuzhi (76°21'-23'E, 9°39'-41'N), 27.ii.1989, Coll.T.C.Narendran & Party (DZUC). *Paratype*: 1 Female, (on card, Reg. No. MoEF 4131) INDIA: Kerala, Malappuram District, Calicut University Campus (75°50'- 52'E, 11° 7'- 9'N) 8.ix.1986. Coll. T.C.Narendran & Party (DZUC).

Etymology: The specific name is an arbitrary combination of letters.

Comments: This new species differs from all other known species by having F_1 shorter than F_2 and in several other features as mentioned in the key above.

3. *Anaprostocetus sringeriensis* Narendran & Santhosh, sp. nov. (Figs. 9-11)

Female: Length 2.36mm. Metallic blue with violet and green reflections. Antenna brown with scape, pedicel and anelli pale yellowish brown; eyes brick red; ocelli dark brown; coxae except their tips concolorous with mesosoma; fore femur pale yellow with dark brown on outer three fourth from base and half from base on inner side; fore tibiae and tarsi pale yellow; mid femur, tibia and tarsi pale yellow with basal one third of tibia darker; hind femur pale yellow with basal half dark brown; hind tibia and tarsi pale yellow; tegula pale yellow. Wings hyaline; fore wing veins pale brownish yellow.

Head: (Fig.10) as broad as mesoscutum; 2.57x as broad as its maximum length in dorsal view; POL 1.2x OOL; OOL 1.25x ODP; ocellar triangle delimited by a distinct grooved line; each lateral ocellus connected to adjacent eye by a grooved line which expands just outside ocellus to form a subtriangular fovea. Head in front view 1.08x as wide as its length; sparsely clothed with extremely short pubescence; malar space 0.39x length of eye in profile; malar sulcus not curved; head moderately shiny with fine reticulation. Antenna with scape distinctly shorter than eye, reaching front ocellus, 3.22x as long as broad; pedicellus plus flagellum 1.5x breadth of mesoscutum; pedicellus 2.5x as long as broad, 0.75x as long as F₁; anelli 3, distinctly visible; funicular segments decreasing in length, F₁ = 2.83x, F₂ = 2.25x, F₃ = 2x as long as broad; clava 3.7x as long as broad, distinctly longer than combined length of F₂+F₃; sensillae of flagellum dense.

Mesosoma: (Fig.9) 1.66x as long as broad; pronotum 0.5x length of mesoscutum; mid lobe of mesoscutum as broad as long, moderately convex, shiny with fine engraved reticulation, median line distinct throughout, strong, 7 adnotaular setae on each side. Scutellum 1.6x as broad as its median length, 0.6x length of mesoscutum; submedian lines slightly nearer to sublateral lines than to each other, enclosing a space 2.8x as long as broad; space between the submedian lines nearly equal to a posterior seta of scutellum; anterior pair of setae slightly behind the middle. Dorsellum 4x as broad as long, dull, reticulate; propodeum distinctly longer than dorsellum (3:2), distinctly emarginate just before petiole; surface between paraspiracular carinae with strong, raised reticulations; median carina raised, rather thin, sharp and slightly expanding posteriorly; paraspiracular carinae strong and curved; areas between carinae and spiracles moderately shiny with delicate, not raised, alutaceous sculpture; spiracle round, separated from metanotum with less distance than half diameter of spiracle; callus with 3 setae; metapleuron with sculpture slightly raised; hind coxa 1.63x as long as its width, with a distinct curved dorsal carina, outer surface with distinct raised reticulation, rather finer than that of propodeum; hind femur 3.6x as long as broad; spur of mid tibiae 0.71x length of basitarsus; fourth segment of mid and hind tarsi shorter than basitarsus; fore wing length (95:39) 2.43x its maximum width; costal cell (28:33) distinctly shorter than MV, 9x as long as broad; SMV with 4 dorsal setae; MV 5.3x as long as ST, its front edge with 20 dorsal setae; speculum partly closed by cubital line of setae.

Gaster: (Fig. 11) 2.82x as long as broad; 1.08x as long as head plus mesosoma, acute and acuminate posteriorly; last tergite 1.44x as long as broad; tip of hypopygium a little before half of gaster.

Male: Unknown.

Host: Unknown.

Distribution: India: Karnataka.

Holotype: Female, (on card, Reg. No.MoEF 2455). INDIA: Karnataka, Sringeri (75° 13'-15'E, 13°28'-30' N), 28.v.2003, Coll. P.A.Sinu.

Etymology: The specific name is derived from the name of the type locality, Sringeri.

Comments: This new species resembles *A. acuminatus* in having somewhat similar colour but can be separated from that species by the key given above.

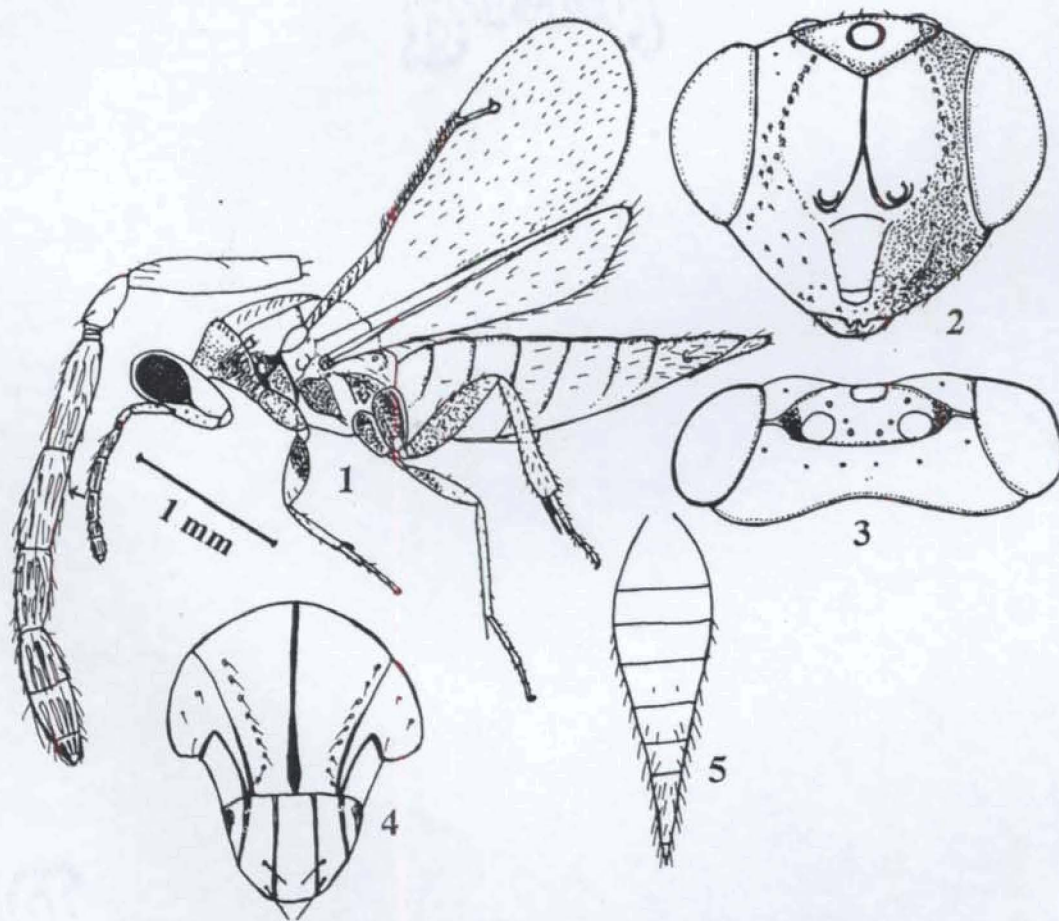
Acknowledgments

We are grateful to the Ministry of Environment and Forests, New Delhi for financial assistance for this research. We thank Dr. John S. Noyes, BMNH, and London for send-

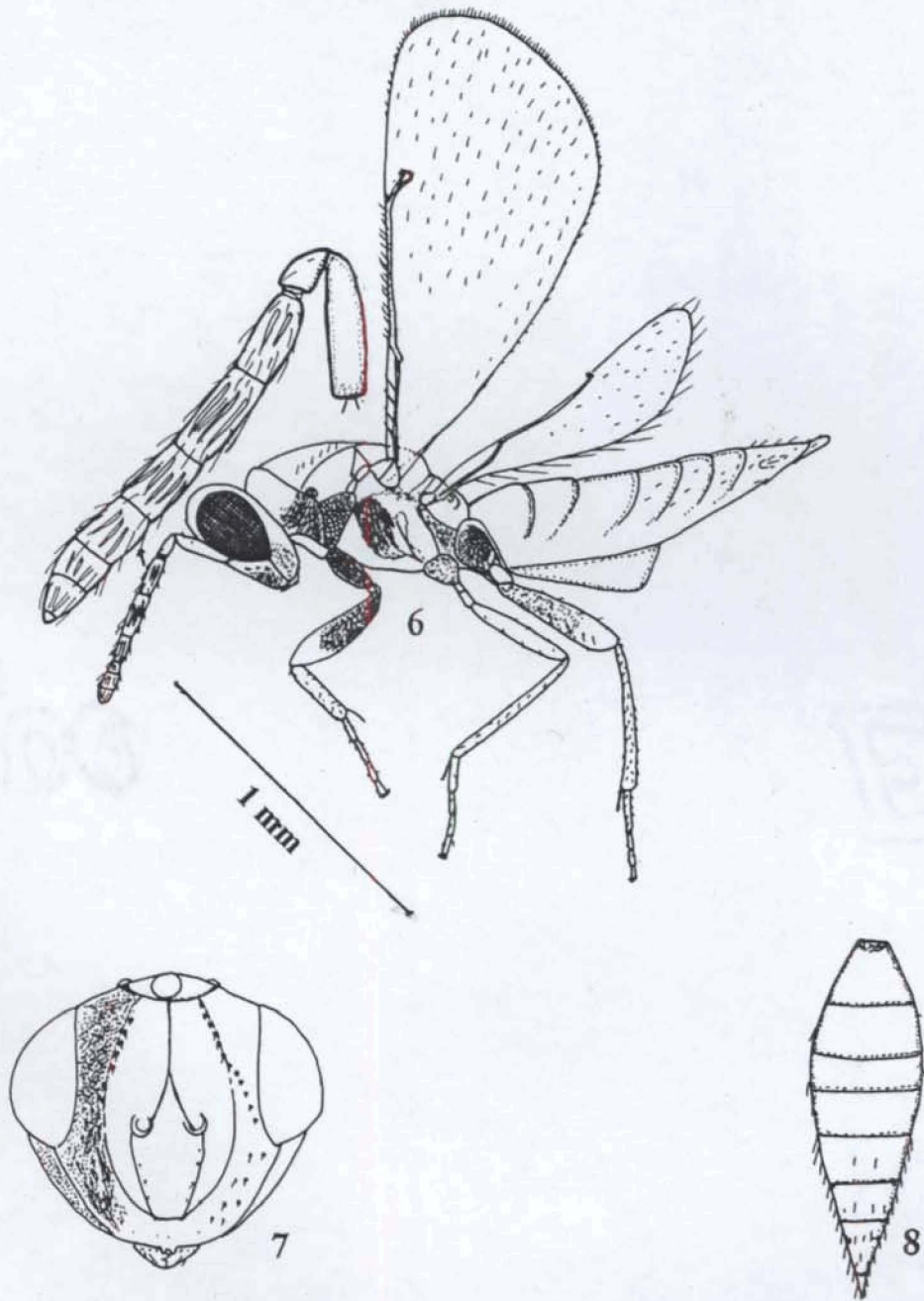
ing relevant reprints and Prof. Mohammad Hayat, Aligarh Muslim University, for reviewing this paper. We also thank the authorities of the University of Calicut for basic facilities.

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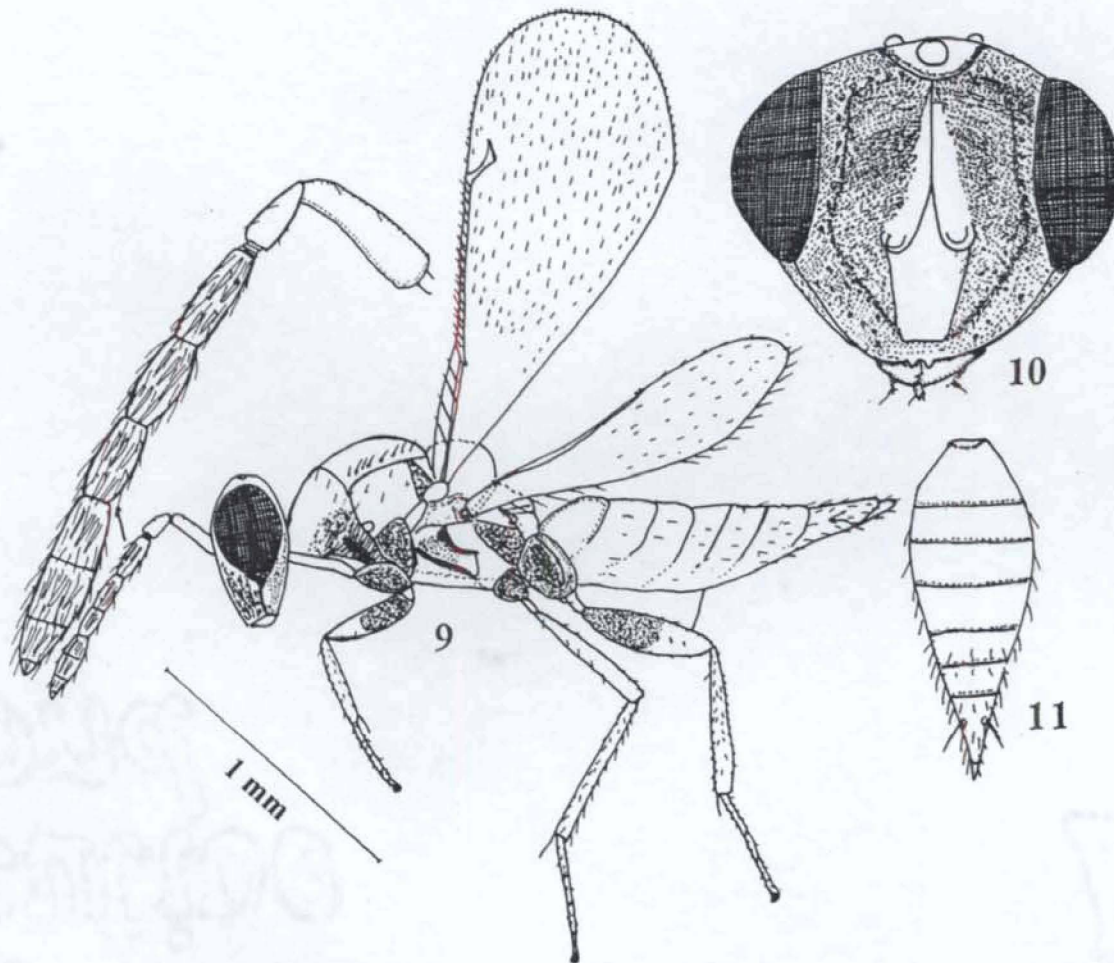
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Figs. 1 - 5. *Anaprostocetus keralicus* Narendran & Girish Kumar, sp. nov., Holotype female: 1, body in profile; 2, head in anterior view; 3, head in dorsal view; 4, mesoscutum and scutellum in dorsal view; 5, gaster in dorsal view.



Figs. 6 - 8. *Anaprostocetus areos* Narendran & Fousi, sp. nov., Holotype female: 6, body in profile; 7, head in anterior view; 8, gaster in dorsal view.



Figs. 9 – 11. *Anaprostocetus sringeriensis* Narendran & Santhosh, sp. nov., Holotype female: 9, body in profile; 10, head in anterior view; 11, gaster in dorsal view.

A New Species of Eulophidae (Hymenoptera: Chalcidoidea) from Kerala, India

T.C. Narendran,^{1,*} S. Santhosh^{1,*} and P. Girish Kumar¹

A new species, *Tamarixia sheebae*, is described and illustrated. *Tamarixia sheebae* differs from *T. bicolor* Mercet and *T. radiata* Waterston in having the apex of gaster tilted upwards. It emerged from leaf galls of *Terminalia arjuna* (Roxb.) Wright & Arn. (Combretaceae), a tree with many medicinal properties in addition to its timber value.

KEY WORDS: Hymenoptera; Chalcidoidea; Eulophidae; Tetrastichinae; *Tamarixia*; *Terminalia arjuna*; new species; India.

INTRODUCTION

The genus *Tamarixia* Mercet, 1924, belonging to the subfamily Tetrastichinae, is represented by about 40 described species including 33 species which are reported from Palaearctic, four species each from Nearctic and Neotropical, three species each from Ethiopian and Australian, and two species from Oriental regions (6). Among the two species known from Oriental regions, namely, *Tamarixia bicolor* Mercet (5) and *Tamarixia radiata* Waterston (8), the latter is widely distributed except in the Australian region. Kostjukov (3) treated *Tamarixia* as a subgenus of *Tetrastichus*, and Bouček (1), Graham (2) and LaSalle (4) treated it as a genus. Graham (2) revised European species. The new species emerged from the leaf galls on *Terminalia arjuna* (Roxb.) Wright & Arn. (Combretaceae), which is a large evergreen tree native to peninsular India and Sri Lanka. In addition to its timber value, it has many medicinal properties. The bark of *T. arjuna* is used in the treatment of polyuria, and skin, heart and blood diseases (7).

MATERIALS AND METHODS

The leaf galls were collected from the host plant and kept in an emergence cage. The specimens were mounted on cards and studied under a Leica MZ6 Stereozoom microscope. The drawings were made with a drawing tube attached to the microscope.

Abbreviations: DZUC = Department of Zoology, University of Calicut; F₁ to F₃ = funicular segments 1 to 3; MV = marginal vein; OOL = ocellocular distance; PMV = postmarginal vein; POL = postocellar distance; SMV = submarginal vein; STV = stigmal vein.

Tamarixia sheebae Narendran sp. nov.

(Figs. 1-3)

Received March 15, 2005; accepted June 23, 2005; <http://www.phytoparasitica.org> posting Aug. 31, 2005.

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Holotype: Female: Length 1.1 mm. Black; eye pale brownish red; ocelli pale brown; antennae pale brownish yellow with scape pale yellow; pedicel dorso-basally brown mandibles dark brown; legs pale yellow with basal half of hind coxa partly black; gaster black dorsally, lateroventrally pale yellow; with a large median yellow patch spreading from base to third tergum. Wings hyaline with veins pale yellow, pubescence on body and wings pale brown.

Head (Fig. 2): Width in dorsal view $1.7\times$ its maximum length; clypeus not delimited, its lower margin entire; occiput with fine reticulations; occipital foramen situated slightly below center of head; mandibles bidentate, inner tooth barely distinct. POL $2.18\times$ OOL; malar sulcus distinct; eye height in profile $2.66\times$ length of malar sulcus. Antennae inserted a little above lower ocular line, antennal formula 11233. Ratio of length to width of antennal segments: scape = 32:8; pedicel = 13:8; $F_1 = 13:9$; $F_2 = 11:9$; $F_3 = 11:13$; clava = 24:12.

Mesosoma: Mesoscutum, scutellum, dorsellum and propodeum lying in the same plane. Pronotum slightly wider than mesonotum in dorsal view, $0.7\times$ as long as mesoscutum, with an exposed spiracle directed upwards on posteriolateral corner; mesoscutum finely reticulate with two pairs of adnotaular setae, one in anterior half and one in posterior half; scutellum almost as long as mesoscutum, the maximum width between sublateral lines, a little more than $1.6\times$ its length, with 2 pairs of setae; scutellum transverse; dorsellum smooth with transverse fovea on either side; spiracle circular and rim fully exposed; submedian areas of propodeum with weaker reticulations than on scutellum. Forewing length $2.36\times$ its maximum width. SMV with one dorsal seta; MV with 8–9 dorsal setae; PMV absent; STV $2.92\times$ as long as MV; costal cell slightly larger than MV; disc moderately pilose; marginal fringe short (Fig. 1); speculum closed behind by cubital line of setae; basal line of setae weak; basal cell otherwise asetose.

Metasoma: Subsessile; slightly longer than mesosoma, petiole slightly distinct from dorsal view, transverse; hypopygium extending over half length of gaster; first tergite larger than any of the remaining tergites; ovipositor exerted, tilted upwards.

Male: Unknown.

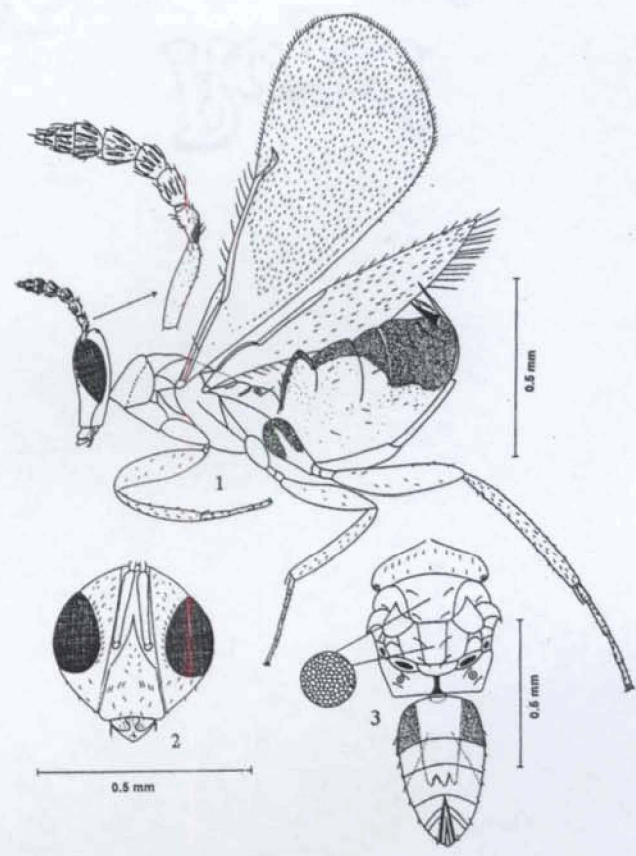
Host: Emerged from leaf galls of *Terminalia arjuna* (Roxb.) Wright & Arn. (Combretaceae). The subglobose galls were 20–25 mm long and 10–15 mm broad. *T. arjuna* found heavily infested with the unknown gall insect, particularly in the rainy season.

Etymology: Named after M. Sheeba, who collected the leaf galls.

Material examined: *Holotype:* Female: India: Kerala, southeastern Malabar, Malappuram District, Manjeri, $11^{\circ}7' N 76^{\circ}7' E$, 02.X.2004. Coll. M. Sheeba, rearing, voucher no. MoEF 4510 (DZUC). *Paratypes:* Three females with same data as holotype. All types deposited in DZUC.

DISCUSSION

Tamarixia sheebae sp. nov. differs from *Tamarixia radiata* Mercet in having: face with 9–11 bristles along each orbit (in *T. radiata*, face with only 7–8 bristles along each orbit); outer and inner propodeum homogeneously with weak reticulations (in *T. radiata*,



Figs. 1-3. *Tamarixia sheebae* Narendran sp. nov. female. Fig. 1. Body profile; Fig. 2. Head anterior view; Fig. 3. Mesosoma and Metasoma in dorsal view.

propodeum smooth near keel but rougher and slightly raised pattern on outer half); head as long as broad (in *T. radiata*, head broader than long); toruli at one-half distance from anterior ocellus to mouth margin (in *T. radiata* toruli at one-third distance from anterior ocellus to mouth margin); scape one-fourth longer than club excluding spur (in *T. radiata*, scape one-fifth longer than club excluding spur); F1 1.4× as long as broad (in *T. radiata*, F1 half as broad as long); apex of gaster tilted upwards (in *T. radiata*, apex of gaster not tilted); ovipositor protruding (in *T. radiata*, ovipositor barely protruding).

Tamarixia sheebae sp. nov. differs from *Tamarixia bicolor* Waterston in having: scape reaching the level of median ocellus (in *T. bicolor*, scape does not reach the level of median ocellus); F1 and pedicellus subequal (in *T. bicolor*, pedicellus longer than F1); club 2× as long as broad (in *T. bicolor*, club 2.5–2.8× as long as broad); club distinctly three-segmented (in *T. bicolor*, club not distinctly segmented); hind femora 4× as long as broad (in *T. bicolor*, hind femora barely 3× as long as broad); costal cell subequal to MV or slightly longer (in *T. bicolor*, costal cell 1.5× as long as MV); front edge of MV with nine setae (in *T. bicolor*, front edge of MV with four or five setae); mesosoma 1.5× as broad as gaster (in *T. bicolor*, gaster as broad as mesosoma); gaster black dorsally with pale yellow



Fig. 4. Photograph of the unknown leaf gall on *Terminalia arjuna* from which *Tamarixia sheebae* were collected.

patch basally around petiole (in *T. bicolor*, gaster pale yellow with brown patch basally around petiole); apex of gaster tilted upwards (in *T. bicolor*, apex of gaster not tilted).

ACKNOWLEDGMENTS

We are grateful to the Ministry of Environment and Forests, New Delhi, Government of India, for financial support for this research; and to the University of Calicut for providing the necessary facilities. We thank Dr. K.P. Rajesh, Department of Botany, University of Calicut, for identification of the host plant. We are grateful to Dr. John LaSalle, CSIRO, Canberra, Australia, and an unknown referee for critically reviewing this paper and offering useful suggestions which we have incorporated in this paper.

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