TAXONOMY, ECOLOGY AND DNA BARCODING OF CARABIDAE (INSECTA: COLEOPTERA) IN MALABAR WILDLIFE SANCTUARY

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Declaration

I do hereby declare that the thesis entitled "Taxonomy, Ecology and DNA Barcoding of Carabidae (Insecta: Coleoptera) in Malabar Wildlife Sanctuary" submitted to the University of Calicut for the award of degree of Doctor of Philosophy in Zoology has not been formed the basis for the award of any other Degree, Diploma, Associateship, Fellowship and represents the original work done by me.

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CONTENTS

	Page No.
Chapter 1: INTRODUCTION	
1.1. Taxonomy of Family Carabidae	2
1.1.1. DNA Barcoding of Carabidae	4
1.2. Ecology of Family Carabidae	5
1.3. Objectives	8
Chapter 2: REVIEW OF LITERATURE	
2.1. Taxonomy of Carabidae from India	9
2.1.1. General status	9
2.1.2. Taxonomy of Carabidae from Malabar Wildlife Sanctuary	15
2.2. Ecology of Carabidae from India	15
2.3. DNA Barcoding of Carabidae from India	16
Chapter 3: MATERIALS & METHODS	
3.1. Study area – Malabar Wildlife Sanctuary	17
3.2. Specimen collection and Analysis	18
3.2.1. Collection of specimens	18
3.2.2. Specimen preservation	19

3.2.3. Identification of specimens 20

3.2.4. Checklist, pictorial key and species descriptions 21

3.3. Ecology 22

3.3.1. Diversity analysis 22

3.3.2. Statistical analysis 23

3.4. DNA Barcoding 24

3.4.1. DNA Extraction and Isolation 24

3.4.2. Assigning primers, DNA Amplification and Sequencing 24

Chapter 4: RESULTS

4.1. Taxonomy 26

4.1.1. Checklist and pictorial keys for the Carabidae collected from Malabar Wildlife sanctuary and surrounding agriculture belts 26

4.1.2. Taxonomic descriptions of species collected from Malabar Wildlife sanctuary and surrounding agriculture belts 42

4.1.3. Taxonomic descriptions and keys to the genera and species of subfamilies Dryptiinae and Panagaeinae 66

4.2. Ecology 146

4.3. DNA Barcoding 150

Chapter 5: DISCUSSION

5.1. Taxonomy 152

5.2. Ecology 153

5.3. DNA Barcoding 154

Chapter 6: CONCLUSION

6.1. Taxonomy 156

6.2. Ecology 156

6.3. DNA Barcoding 157

Chapter 7: REFERENCES 158

LIST OF PLATES, FIGURES AND TABLES **I**

Chapter 1

INTRODUCTION

Family Carabidae also known as Ground beetles, are a large family of Coleoptera which are found in a wide range of terrestrial habitats including forests and woodlands. Carabidae is a prominent fraction of ground beetle assemblage and is a major predator in the soil and litter environment. Ground beetles are nocturnal and usually come out at night. During daytime, they hide under logs of woods, stones, crevices, litter and grass roots. Adults and larvae of most ground beetle species are generalized predators of insects and other invertebrates; however, many species feed as herbivores, omnivores or scavengers (Allen, 1979). Size of the ground beetles range from 2 mm to more than 50 mm. Their body size mainly based on the availability of temperature and water (Homburg *et al.*, 2013). They are present in almost all vegetation and forest types. Moisture determines the distribution of Carabidae beetles, not the composition of vegetation (Boer, 1963).

Family carabidae distributed through all continents except Antartica. In India, about 1,700 species belonging to 285 genera, 48 tribes and 24 subfamilies namely, Anthiinae, Apotominae, Brachininae, Broscinae, Carabinae, Ctenodactylinae, Dryptiinae, Harpalinae, Lebiinae, Licininae, Loricerinae, Melaeninae, Nebriinae, Omophroinae, Orthogoniinae, Panageinae, Patrobinae, Paussinae, Platyninae, Pterostichinae, Rhysodinae, Scaritinae, Siagoninae and Trechinae have been recorded (Andrewes, 1930; Lorenz, 2005, 2018; Anichtchenko, 2018).

1.1. Taxonomy of Family Carabidae

Family Carabidae is coming under the order Coleoptera, the largest order of Kingdom Animalia, consists of more than 4,20,000 species (Slipinski *et al.*, 2011). Family Carabidae is the most speciose family of suborder Adephaga (Insecta: Coleoptera) with approximately 39,000 species (Lorenz, 2018 and Anichtchenko, 2018). Suborder Adephaga is characterized with immobile hind coxae, six abdominal ventrites and presence of pygidial defence glands in adults (Lawrence and Slipinski, 2013). There are three major types of classifications accepted worldwide namely Jeannel (1942–1949), Erwin (1970–2007) and Lorenz (1998–2018). The classifications of Jeannel and Erwin are tough to understand while classification of Lorenz is simple and therefore globally accepted. Currently about 39,000 species belonging to 2088 genera from 88 tribes and 34 subfamilies are recorded from the world (Lorenz, 2018; Anichtchenko, 2018). In India, only about 1,700 species belonging to 48 tribes and 24 subfamilies (Andrewes, 1930; Lorenz, 2005, 2018; Anichtchenko, 2018) have been recorded and which clearly indicates the lack of taxonomic work on Indian Carabidae.

According to Lorenz (2005) and Bouchard *et al*. (2009), the number of Carabidae species has increased from 61 at the time of Linnaeus to approximately 30,000 species by the year 2000. Currently an approximate of 39,000 species has been recorded from the world (Lorenz, 2018). Lorenz (2005) catalogued about 33,000 species from 34 subfamilies with 88 tribes and 1869

genera. Erwin (2007) classified the western Hemisphere Caraboidea into two families Trachypachidae and Carabidae. Family Trachypachidae includes the false Carabidae group with two tribes namely Systolosomatini and Trachypachini and family Carabidae with 11 tribes.

There is no extensive work on taxonomy from India except Andrewes (1929, 1935), the only work compared to that of Ball *et al.* (1979). Also Jedlicka (1928–1969), Chaudoir (1842–1883), Bates (1873–1892), Putzeys (1846–1878), Motschulsky (1844–1866) and Nietner (1856–1858) contributed Carabidae species to the Indian fauna. Andrewes's 'The Fauna of British India' (1929, 1935) has undergone a thorough revision of Indian Carabidae and considered as a comprehensive taxonomic work from India. Only 14 subfamilies were discussed in the 'Fauna of British India' of Andrewes (1929, 1935) out of 24 subfamilies recorded from India (Lorenz, 2005). The remaining 10 lesser known subfamilies were not described in the works of Andrewes 1929 and 1935. After Andrewes (1919, 1920, 1921, 1922, 1923, 1924, 1925, 1926, 1927, 1928, 1929, 1930, 1931, 1932, 1933, 1934, 1935, 1936, 1937, 1938, 1939, 1940, 1941, 1942, 1946 and 1947) and Jedlicka (1928, 1935, 1954, 1955, 1958, 1959, 1960, 1962, 1963, 1964, 1965 and 1969) works, a few occasional papers came from India and that includes works of Saha (1984, 1985, 1986, 1989), Saha and Biswas (1992), Hegde and Kushwaha (2012, 2015), Sabu *et al.* (2008, 2009 and 2010), Shiju *et al.* (2012), Jithmon & Sabu (2018), Chanu and Swaminathan (2018), Straneo (1938, 1961, 1989, 1992, 1994) and Tian and Deuve (2000, 2006, 2007, 2015, 2016).

1.1.1. DNA Barcoding of Carabidae

DNA barcoding is a taxonomic method that uses a short genetic marker from a standard part of the genome of an organism's DNA to identify it as belonging to a particular species (Barcaccia *et al.*, 2015). It designed to provide accurate, fast and automatable species identification by using short and standardized gene regions as internal species tag (Hubert & Hanner, 2015). It could also be used as a tool for understanding the process of speciation deeper. In animals, Mitochondrial Cytochrome Oxidase I (mt COI) gene fragment is used as the standard barcoding region. Mitochondrial genes have properties like lack of recombination, high copy number, high mutation rate and maternal inheritance and are preferred over nuclear genes for barcoding and phylogenetic studies. COI, COII and rRNA genes are the commonly used mitochondrial markers (Simon *et al.*, 1994).

DNA barcoding could be a helpful tool for identify cryptic species (morphologically similar yet different). Family Carabidae is going through many controversies regarding classification which could be solved using DNA barcoding. For example, most of the taxonomists are considering Paussinae and Cicindelinae as subfamilies of family Carabidae (Andrewes, 1930; Lorenz, 2005, 2018; Anichtchenko, 2018) whereas a few others considered it as separate families. Similar controversial opinion can be seen in the case of Rhysodinae. In the case of genus *Omphra*, which is a wingless ground beetle endemic to India and Sri Lanka, it is difficult to differentiate the species as it shares many similar

morphological characters. Subfamilies Brachininae, Panagaeinae, Lebiinae are also having a problem with in the species identification regarding its colour, spots and markings on body parts and that can be solved using molecular methods.

The molecular studies are very limited in oriental regions especially in India. There are 8 species (*Macrocheilus devagiriensis* Shiju 2012, *M. bensoni* Hope 1838, *Omphra pilosa* Klug 1834, *O. hirta* Fabricius 1801, *Pherosophus bimaculatus* Linnaeus 1771, *P. occipitalis* Macleay 1825 and *P. sobrinus* Dejean 1825) has been barcoded as part of DST funded Major project 2014–17 completed by the Dept. of Zoology, St. Joseph's Autonomous college, Devagiri. Present study is trying to solve problems among the Carabidae specimens collected from Malabar Wildlife Sanctuary using barcoding techniques.

1.2. Ecology of Family Carabidae

Family Carabidae (Ground beetles) present in all continents except Antarctica and have the highest species richness in the tropics (Erwin, 1985). Ground beetles are nocturnal and usually come out at night. During daytime, they hide under logs of woods, stones, crevices, litter and grass roots. They are present in almost all vegetation and forest types. Moisture determines the distribution of Carabidae beetles, not the composition of vegetation (Boer, 1963). The morphology of Ground beetles (Carabidae) is specialized for running, climbing, digging, burrowing and swimming (Evans, 1977, 1986; Lovei, 2008). Carabidae beetles present in all major habitats by the help of

structural, behavioural and physiological adaptations and some of the lineages attained dominance with the major structural adaptations being flightlessness and arboreal, fossorial and trogoblitic adaptations (Erwin, 1985). Ground beetles are placed into three main ecological groups namely geophiles or mesophiles, hydrophiles and arboricoles (Darlington, 1971). Size of the ground beetles ranges from 2 mm to more than 50 mm. Their body size mainly based on the availability of temperature and water (Homburg *et al.*, 2013). They also exhibit different body colourations (Loevei and Sunderland, 1996). Majority of Ground beetles are carnivorous, followed by omnivores and phytophagous (Larochelle, 1990). They also considered as polyphagous feeders (consuming carrion and plant materials) (Skuhravy, 1959; Forbes, 1883; Davies, 1987). Ground beetles are holometabolous insects having all the four life stages of development and the larvae are campodeiform (Crowson, 1981). Carabidae beetles have bio-indicator value, (Hilty and Merenlender, 2000; Rainio and Niemela, 2003; Koivula, 2011) as they are sensitive to fine and broad ecosystem alterations (Boer, 1977; Thiele, 1977) in agricultural fields with soil structure (Holland and Luff, 2000; Brandmayr *et al.*, 2005) and use of pesticides (Scalercio *et al.*, 2009; Burgio *et al*., 2015). Apart from these beneficial aspects, Carabidae from genera *Zabrus*, *Harpalus* and *Amara,* which consume large amounts of plant matter, considered as economically significant potential pests (Blunck and Muhlmann, 1954; Dick and Johnson, 1958; Briggs, 1965; Thiele, 1977).

Thiele (1977) has given a detailed work on Carabidae with their ecology and importance. Anderson (2000) studied the origin of Carabidae fauna of dry,

anthropogenic habitats in Western Europe. Brandmayr *et al*. (2003) studied the diversity patterns of Carabids in Alps. Kotze *et al*. (2011) described the basic ecology and biology of Carabidae based on forty years of research in Europe. Holland (2002) studied the ecology of Carabidae and their use in agroecosystems. Vanbergen *et al.* (2010) studied the Carabid beetle responses to habitat and landscape structures in Europe. Tothmeresz *et al*. (2011) studied the responses of carabid beetles to urbanisation in Romania. Maveety *et al.* (2011) studied the Carabidae diversity along an altitudinal gradient in a Peruvian cloud forest. Moraes *et al.* (2013) studied the Carabid beetle assemblages in the Araucaria humid forest of southern Brazil. Worthen and Merriman (2013) studied the relationship between Carabid beetle communities and forest stand parameters. There is no extensive works on ecology of Carabidae from India except Mani (1968, 1974), who worked in Himalayan insects including Carabidae, which is the only work compared to that of Thiele (1977).

No studies exist on the taxonomy, ecology and barcoding of Carabidae from Malabar Wildlife sanctuary. Hence, the present work deals with the taxonomy, ecology and DNA barcoding of Carabidae from Malabar Wildlife Sanctuary and surrounding agrilands.

1.3. Objectives

1. Collection, identification and preparation of faunal inventory with pictorial keys of Carabidae beetles from the Malabar Wildlife Sanctuary.

2. Ecological study of Carabidae beetles leading to the comparison between forest and agriland collections.

3. DNA barcoding of Carabidae beetles from collection to solve problems related to Carabidae systematics.

Chapter 2

REVIEW OF LITERATURE

2.1. Taxonomy of Carabidae from India

2.1.1. General status

First 4 Indian species (*Sphodrus leucophthalmus, Syntomus truncatellus, Bembidion quadrimaculatum* and *Pheropsophus bimaculatus*) of Carabidae was described by Linnaeus in his 'Systema Naturae' with years 1758, 1761 & 1771. Fabricius (1775–1801) described 26 species of Indian Carabidae. In *'Systema entomologiae'*, Fabricius (1775) described his first and largest Carabidae *Anthia sexguttata* from India as *Carabus sexguttata*. Wiedemann in his works, '*Neue Kafer aus Bengalen und Java* 1819', '*Neue exotische Käfer* 1821', and '*Zweihundert neue Kafer von Java, Bengalen und dem Vorgebirge der guten Hoffnung* 1823' described 34 Carabidae species from India. Dejean (1825, 1826, 1828, 1829 and 1831) in his 'Species General des Coleopteres' described 56 Carabidae from India. Macleay (1825) in his work '*Annulosa Javanica*', described the natural affinities and analogies of Carabidae with illustrations. Hope (1831, 1835, 1838 & 1845) described 14 Carabidae species from India. Schmidt-Goebel (1846) described 48 species from India in the work titled '*Faunula Coleopterum Birmanae*'. Motschulsky (1844, 1845, 1847, 1848, 1850, 1854, 1855, 1857, 1858, 1859, 1860, 1861, 1862, 1863, 1864, 1865 and 1866) added 46 species to Indian Carabidae. Laferte-Senectere (1851) described 3 species of Panagaeinae and 9 species of Licininae in his work '*Revision de la tribu des patellimanes de Dejean, coleopteres pentameres de la famille des carabiques*'. Lacordaire (1856) compiled the systems of classification in his

work '*Genera des Coleopteres*' and Schaum (1860) elaborated the system of classification in his paper '*Das system der Carabicinen*'. Chaudoir (1842, 1843, 1844, 1845, 1846, 1847, 1848, 1850, 1852, 1854, 1855, 1856, 1857, 1858, 1859, 1861, 1862, 1863, 1864, 1865, 1866, 1867, 1868, 1869, 1870, 1871, 1872, 1873, 1874, 1875, 1876, 1877, 1878, 1879, 1880, 1882 and 1883) described 184 species from India and he was the greatest of the workers in the field of Carabidae and published 112 papers. Chaudoir (1842–1883) provided simple taxonomic keys to many genera of Carabidae and published Monographs on *Abacetus* (1869), Lebiides (1870), Orthogonides (1871), Pogonoides (1871), Callidides (1872), Brachynides (1876), Chleniens (1876), *Masoreus* (1876), *Tetragonoderus* (1876), Nematotarsus (1876), Siagonides (1876), Panageides (1878), Scaritides (1879) and Oodides (1882). Putzeys (1846, 1863, 1870, 1875 and 1878) described 39 species of Carabidae from India. Nietner (1856, 1857 and 1858) described 20 Carabidae species from India. Bates (1873, 1874, 1876, 1878, 1883, 1886, 1889, 1891 and 1892) described 129 species from India and 79 out of 129 species from the papers published in 1891 and 1892. Horn (1881) provided a monograph '*On Genera of Carabidae with special reference to the fauna of Boreal America*'. Tschitscherine (1894, 1895, 1897, 1898, 1899, 1900, 1901, 1902 and 1903) described 16 species of Carabidae from India. Fairmaire (1849, 1850, 1878, 1881, 1888 and 1901) described 10 Carabidae species and Maindron (1898, 1899, 1905, 1906 and 1909) described 9 Carabidae species from India. In '*the Classification of family Carabidae*' Sloane (1923) provided a key to tribes of family Carabidae and that was the base for further workers. Csiki

(1927, 1929, 1931 and 1932) gave catalogues on Carabidae to world and described 4 species from India.

Andrewes (1919–1946) described 485 Carabidae species from India which is almost one third of the total known Carabidae from India. Andrewes (1921) described genus *Callistomimus* of Oriental region with taxonomic keys. Andrewes (1923) provided detailed papers on the types of Carabidae described by Schmidt-Goebel in *Transactions of the Entomological Society of London*. Andrewes (1925) revised the oriental species of genus *Tachys.* Andrewes (1928, 1933) provided detailed papers on the types of Oriental Carabidae described by Motschulsky. Two volumes of '*Fauna of British India including Burma and Ceylon*' – *Part I Carabinae* (1929) and *Part II Harpalinae* (1935) provided detailed analysis of carabids falling under two subfamilies, namely, Harpalinae and Carabinae with modified version of taxonomic keys of Sloane (1923). *Catalogue of Indian Insects* by Andrewes (1930) provides full details of the carabids described till 1930 including many groups and species not mentioned in Andrewes (1929). Andrewes (1932) provided taxonomic keys to the species of genus *Cymindis*; in 1933 keys to the species of 2 genera *Dioryche*, and *Phloeozeteus*; in 1934 keys to the species of genus *Calathus*; in 1935 keys to the species of 3 genera *Cymindoidea, Platytarus* and *Taridius*; in 1936 keys to the species of *Drypta* and *Desera;* in 1937 keys to the genera and species of Sphodrini group and to other three genera namely *Feronia, Pericalus* and *Catascopus*; in 1940 keys to the species of genus *Oodes* and in 1942 keys to the species of genus *Abacetus*. Jedlicka (1928, 1931, 1933, 1934, 1935, 1936, 1939,

1940, 1947, 1952, 1955, 1956, 1960, 1961, 1963, 1964, 1965, 1966 and 1969) described 29 species to the fauna of Indian Carabidae. Jedlicka (1963) described and provided keys to Palaearctic group of truncatipennes Carabidae in his '*Monographie der Truncatipennen aus* Ostasien'. Straneo (1938, 1961, 1989, 1992 and 1994) described 20 Carabidae species from India. Louwerens (1953) described 10 species of Carabidae from India in the work titled '*The Oriental species of Colpodes*'. Saha and Sengupta (1979) described 3 species of *Chlaenius* from South India namely *Chalenius besucheti*, *Chlaenius loebli* and *Chlaenius mussardi*. Saha (1984) described *Chlaenius puncticephalis* from India. Saha and Biswas (1985) recorded 22 species of Carabidae from Arunachal Pradesh, India. Saha (1986) recorded 16 ground beetle species from Silent Valley with a new species *Oxylobus silenticus*. Saha *et al.* (1992) recorded 73 species belonging to 45 genera of Carabidae from the collections of Zoological Survey of India, Kolkata. Sciaky (1996) described a new subgenus *Pseudethira* and new synonyms among Pterostichinae from Asia including India. Kumar & Rajagopal (1996) recorded 82 species of Carabidae belonging to 23 genera from Karnataka, India. Mateu (1959, 1960, 1963, 1971, 1976, 1978, 1979, 1980, 1981, 1984, 1986 and 1997) described 35 new species from India. Baehr (1988, 1990, 1991, 1996 and 1998) described 6 new species of Dryptiinae from India. Baehr (2010) described 2 new Platyninae species from India. Morvan (1979, 1992, 1996, 1999, 2002, 2004 and 2007) described 23 new species of the subfamily Platyninae from India. Liang *et al.* (2004) gave a new taxonomic status to the genus *Desera* as *Dendrocellus* Schmidt-Göebel. Lorenz (2005)

provided a comprehensive catalogue of World Carabidae in his work titled '*A systematic list of extant ground beetles of the World*'. Deuve (1980, 2012, 2014, 2015 and 2018) described 4 new species of *Crepidogaster* from South India from the Paris Museum collections and also described 10 other new species of Carabidae from India. Tian (2000, 2006, 2007, 2015, 2016 and 2018), worked with Deuve and described 31 new species of Orthogoniinae from India based on the collections at Paris museum. Liang and Kavanaugh (2007) described two new species of *Dendrocellus* from India with a taxonomic key to the species from Asia, Africa and Australia. Schmidt J (2008) described two new species of tribe Platynini from India. Will (2008) reported two *Metabecetus* species from India. Sabu *et al.* (2008) described a new species, *Helluodes devagiriensis*, belonging to the rare genus *Helluodes* from Kerala part of Western Ghats. Abitha *et al.* (2009) described *Orthogonius baconoides* from the Western Ghats. Raj *et al.* (2012) described a new species, *Macrocheilus devagiriensis*, from Kerala part of Western Ghats. Raj *et al.* (2012) worked on the detailed taxonomy of the apterous endemic genus *Omphra* of Indian subcontinent with description of a new species *Omphra drumonti* from the Western Ghats. Kirschenhofer (1987, 1992, 1994, 1996, 2000, 2004, 2007 2010, 2011 and 2012) working on Palaearctic Carabidae described 15 new species from Palaearctic and Oriental regions of India. Jaeger (1997, 2010, 2015 and 2017) and Kataev (1997, 2002, 2003) working on Harpalinae, described 6 new species from India. Balkenohl (2001) provided detailed work on tribe Clivini of Scaritinae in his '*Key and Catalogue of the Tribe Clivinini from the Oriental realm with revisions of the*

genera Thliboclivina Kult and Trilophidius Jeannel'. Kirschenhofer (2011) described *Craspedophorus maharashtraensis* from Maharashtra, India. Hackel and Farkac (2012) gave a world checklist of subfamily Panagaeinae. Hegde *et al.* (2013) provided a checklist of Carabidae from Melghat Tiger reserve of India. Hackel and Farkac (2013) provided a world checklist for subfamily Anthiinae. Hackel & Kirschenhofer (2014 a & b) described 3 new species from India in their work 'A contribution to the knowledge of the subfamily Panagaeinae Hope, 1838 from Asia Part 2'. Fedorenko (2015) described a new genus *Adischussus* of Panagaeini from Oriental region. Kushwaha *et al.* (2015) provided a checklist for the Carabidae collected from Chhattisgarh state of India. Hegde & Kushwaha (2015) recorded 95 species of Carabidae from Utter Pradesh of which 22 species were recorded for the first time from Uttar Pradesh. Hegde & Manthen (2017) recorded 17 species of genus *Chlaenius* from Western Ghats region of Maharashtra, India. Chanu & Swaminathan (2017) described two new species namely *Chlaenius udaipurensis* and *Chlaenius pseudotristis* and recorded 14 species of *Chlaenius* from Rajasthan, India. Unfortunately, Kirschenhofer (2017) synonymised *Chlaenius udaipurensis* with *Chlaenius vulneratus* Dejean 1831 and *Chlaenius pseudotristis* with *Chlaenius variipes* Chaudoir 1856. Hrdlicka (2017) described *Styphlomerus bimaculatus* from Rajasthan, India. Lobl & Lobl (2017) gave a catalogue of Palaearctic carabidae including Carabidae from Palaearctic regions of India. Jithmon & Sabu (2018) described taxonomy of *Euschizomerus* with a new species *Euschizomerus devagiriensis* from India. Manthen & Hegde (2018) recorded species of *Craspedophorus* from

Maharashtra state of India. Akhil *et al.* (2019) described 2 new species (*Macrocheilus bandipurensis* and *M. chinnarensis*) from the south Western Ghats of India. Akhil & Sabu (2019) described two new species of Genus *Styphlomerus* namely *Styphlomerus devagiriensis* and *S. striatus* from southern India with a key to the Indo-Malayan and Palearctic species.

2.1.2. Taxonomy of Carabidae from Malabar Wildlife Sanctuary

As of now, there is no record of Carabidae from Malabar Wildlife Sanctuary itself. Some of the record shows the presence of Carabidae from adjacent areas of Malabar wildlife Sanctuary. Andrewes (1930) catalogue recorded 32 species of Carabidae belonging to various subfamilies from Malabar, Calicut, Mahe and Cannanore. Tian & Deuve (2006) described *Orthogonius indicus* and *Orthogonius latreillei* from Mahe and adjacent areas.

2.2. Ecology of Carabidae from India

Thiele (1977) provided the base for ecology of world Carabidae. From Oriental region, especially from India, only limited works on ecology of Carabidae has been reported. Indian researchers may have to refer the Thiele (1977) works to understand the ecology of Carabidae. Mani (1968, 1974) deals with the general ecology and behaviour of Carabidae beetles in the '*Ecology and Biogeography of High Altitude Insects*' and 'Ecology and Biogeography of India'. Manjunath *et al.* (1969) studied the use of *Pheropsophus sobrinus* Dejean 1826 as the bio-control agent for controlling the larvae of *Rhinoceros* beetle.

Bhat & Rajagopal (1988) gave a basic study on taxonomy and ecology of Ground beetles of Bangalore. Rajagopal & Kumar (1992) studied the use of Carabidae beetles as predators on South Indian crop pests. Vennila & Rajagopal (1999) has given a study of tropical ground beetles using pitfall traps.

2.3. DNA barcoding of Carabidae from India

Maddison *et al.* (2018) carried out barcoding and phylogeny of two species (*Trechodes* sp. and *Paratachys* sp.) of supertribe Trechitae from Karnataka. Lopez *et al.* (2015) studied the phylogeny and divergence time estimation of *Cosmodela* from Southeast Asia. Schmidt *et al*. (2012) did the Phylogeography of the Ground beetle *Ethira* clade of genus *Pterostichus* from Himalayas. Similar to ecological studies, Barcoding and molecular Phylogeny studies of Carabidae is limited in India and Oriental region.

Chapter 3

MATERIALS & METHODS

3.1. Study area – Malabar Wildlife Sanctuary

Malabar Wildlife sanctuary is a part of the Western Ghats biodiversity hotspot. It is the 16th wildlife Sanctuary in Kerala comes under the Nilgiri Biosphere Reserve and a part of the Wayanad Elephant Reserve. It is covering a total area of 74.215015 sq.km and located in Chakkittappara and Koorachundu revenue villages of Quilandy Taluk (Latitude 11˚ 75' and 11˚ 76' North and longitude 76˚ 20' and 75˚ 38' East). Sanctuary is covering the regions of Pannikkottur reserve forests of the Peruvannamoozhi range and Karapara; Kakkayam reserve forest, Olathuki, Shanakaranpuzha and the Attikkode area. The sanctuary lies along the boundary of Kozhikode district with Wayanad district to the north of the Thamarassery – Kalpetta Ghats. Altitude ranges from +90 m to +762 m. Average annual rainfall is 2000 mm and temperature ranges from 16° C to 38° C. The humidity varies from 50% to 100%. The vegetation type includes West-coast tropical evergreen, West-coast Semi Evergreen, Southern moist mixed Deciduous, Southern hill-top Evergreen forests, Grasslands, and Marshy grasslands. Malabar Wildlife Sanctuary is very rich in flora and fauna with more than 680 species of flowering plants including 226 species (about 30%) endemic to southern Western Ghats. More than 200 species of medicinal plants, 52 species of bryophytes including 28 liverworts and 24 mosses and 50 ferns including 3 tree ferns. Forty one species of mammals which includes 6 Western Ghats endemics, 179 species of birds with 10 endemics, 36 species of reptiles with 8 endemics, 38 species of amphibians with 26 Western Ghats endemics, 52 species of fishes including 21 endemics, 143 species of

butterflies including 8 endemics and 51 species of Dragon flies with 11 species of Western Ghats endemics were recorded from the region (Kerala forest website, 2019). The high degree of species diversity and endemism, altitude and vegetation, and lack of studies on Carabidae from the Malabar Wildlife Sanctuary makes it an attractive region for taxonomic and ecological studies.

3.2. Specimen collection and Analysis

3.2.1. Collection of specimens

Specimens were collected using Light traps, Pitfall traps and hand picking from Malabar wildlife sanctuary and surrounding agrifields for a period of two years (2016–2018). Light trap is the first method used for collection of ground beetles as most of them are light attracted and nocturnal. The information on use of light traps for collection of Carabidae beetles is very limited (Frost, 1958; Vanhercke *et al.*, 1981, Ishitani, 1996). As insects can recognize UV lights, a low intensity UV light trap (SAFS Timer Insect LED Light trap, Model SAFS_Itrap_01B) with a tray for holding preservative liquid was used for the study. The traps were randomly placed with an intertrap distance of 750m. Thirty light traps were placed during each sampling year in the forest areas of Malabar Wildlife sanctuary and surrounding agrilands for a period of 12 hours, 18:00 pm–06:00 am. Trapped beetles were collected and washed in clear water and transferred to a specimen container with 70% ethyl alcohol.

Pitfall trap is the second method used for the collection of Carabidae as it is the simplest method for capturing the ground dwelling nocturnally active arthropod taxa (Woodcock, 2005; Sabu & Shiju, 2010). Plastic containers having a diameter of 8 cm and depth of 10 cm were placed sunken in soil with its rim in the level of soil surface for the collection of beetles. The trap was filled with the mixture of salt and soap water up to the mid-level mark to avoid escape of large sized beetles from the trap due to over filling. Soap is added to reduce the surface tension of water and salt act as preservative. The traps were placed in clusters in a straight line with 20 m separation between each trap to avoid the 'digging in' effect (Nyundo and Yaro, 2007; Sabu and Shiju, 2010). Thirty traps were placed during each sampling year in the forest areas of Malabar wild life sanctuary and surrounding agrilands. Traps were set up in the afternoon and collections were done after 48 hours. Similar to light traps, the trapped beetles were collected and washed with fresh water and moved to sample containers having 70% ethyl alcohol as preservative.

Third and final method used for collection of Carabidae was Hand picking. Line transect method was employed in the sampling site with each transect separated by a 500m gap (Buckland and Turnock, 1992). Beetles were collected from under stones, logs, barks of trees, grass patches and leaf litter.

3.2.2. Specimen preservation

Omphra pilosa and *Macrocheilus devagiriensis* collected from Koorachundu and *Macrocheilus bensoni* collected from Walayar (for

phylogenetic analysis) by hand picking were sorted and stored in 95% ethyl alcohol in deep freezer at -20°C (Dillon *et al*., 1996; Janarthanan and Vincent, 2007). It is kept in deep freezer at -20°C to increase the DNA yield which would be otherwise affected by 95% Ethyl alcohol (Jones *et al*., 2013).

3.2.3. Identification of specimens

Specimens from various international museums were analysed for taxonomical studies such as those from British Museum of Natural History, London (BMNH), Natural History Museum, Paris, France (MNHN), Natural History Museum, Berlin, Germany (ZMHB), National Museum of Natural History, Prague, Czech Republic (NMPC) and Natural History Museum Vienna, Austria (NMW). Specimens were identified up to species level with the aid of taxonomic keys in Andrewes (1923, 1929), Hackel & Kirschenhofer (2014 a & b), Fedorenko (2015), Sabu *et al.* (2008, 2009), Shiju *et al*. (2012) and modified and newly prepared taxonomic keys. Identification was done using Leica S8 APO stereo zoom microscope with 8x magnification and images were taken using MC 170 microscope camera attached to Leica Stereozoom Microscope (M 205C). Verified specimens were compared with types from various international museums such as from BMNH, MNHN, ZMHB, NMPC, NMW and ZMUK. Body length was measured from tip of the labrum to apex of the elytra (Lawrence *et al*. 1999). All measurements were given in millimetres. Identified specimens were labelled and deposited in national repository of ZSIC (Zoological Survey of India, Calicut - Western Ghat Regional Centre).

Abbreviations of Measurements

TLB	body length from apex of labrum to apex of elytra.
TW	maximum body width.
PL	length of pronotum along median line.
PW	maximum width of pronotum.
EL	maximum length of closed elytra.

3.2.4. Checklist, pictorial key and species descriptions

Checklist and descriptions of the species from the Malabar Wildlife sanctuary is provided and key to the genera and species of two subfamilies and species descriptions are provided. Checklist of Carabidae beetles of Malabar Wildlife sanctuary region was prepared based on Andrewes (1930), Lorenz (2005), Hackel & Farkac (2012), Shiju & Sabu (2019). Pictorial key was drafted based on Andrewes (1923, 1929), Sabu *et al.* (2008, 2009), Abitha *et al*. (2009), Shiju *et al*. (2012), Hackel & Kirschenhofer (2014 a & b), Fedorenko (2015), Jithmon & Sabu (2018), Akhil & Sabu (2018, 2019). Descriptions of species were collected by translation of the literature collected from various sources, verifying with the types from various museums. Photographs were taken using MC 170 microscope camera attached to a Leica Stereozoom Microscope (M 205C).

3.3. Ecology

Ecological analysis of identified Carabidae from Malabar wildlife sanctuary and surrounding agrilands were done by using the data obtained through light trap method. The ecological data was used to compare the species abundance and richness of both forest and agri ecosystems.

3.3.1. Diversity analysis

To understand the diversity patterns, alpha diversity indices (richness, evenness, diversity) and taxonomic diversity were considered.

For analyzing species richness, Margalef's index (d) (Clifford & Stephenson 1975; Magurran 2004) was calculated by using the following formula.

$$d = S - 1 / \log (N)$$

S = total number of species

N = total number of individuals

Among the diversity indices, Shannon-Weaver diversity index (Shannon & Weaver 1949) is the most commonly used because it incorporates both species richness and evenness components, it can provide heterogeneity of information (Rosenstock 1998; Cheng 1999) and possible to test the differences between two communities using a Shannon *t*-test/ANOVA (Cheng 1999; Magurran 2004).

It is calculated by using the formula,

$$H' = - \Sigma_i P_i (\log (P_i))$$

Where P_i is the proportion of individuals found in the $_i{}^{th}$ species.

Evenness expressed as Simpson's evenness index (1-D or 1/D), addresses equitability of the species (Simpson 1949).

$$E_{1/D} = (1/D)/S$$

Where 1/D is the reciprocal form of the Simpson index (D) and 'S' is the number of species in the sample.

$$D= \Sigma p_i^2$$

Where P_i = the proportion of individuals in the ith species (Magurran 2004)

These three diversity indices are chosen because they are familiar to and readily interpretable for most ecologists.

3.3.2. Statistical analysis

All the data used for statistical analysis were tested for normality with Anderson-Darling test. Since all the data were not normally distributed nonparametric statistics, Kruskal-Wallis H tests was used to test the significant levels in variations (Sachs 1992). Differences with a p-value <0.05 was

compared using Mann-Whitney Test. The data includes the overall abundance of Carabidae species within two habitats. All statistical analyses were performed using PAST software version 2.17c (Hammer *et al.* 2001).

3.4. DNA Barcoding

3.4.1. DNA Extraction and Isolation

Legs were cut using surgical scissors and washed with PBS or nuclease free water for removing the contaminations and to remove traces of alcohol (Serrano *et al.,* 2005). Tissue was scraped off and transferred to a 1.5 ml micro-centrifuge tube after mincing. DNA isolation was carried out using the protocol of Qiagen DNeasy blood and Tissue kit (Qiagen GmbH, Hilden, Germany). Two 50 µl isolates were prepared for obtaining higher concentration of DNA (Janarthanan & Vincent 2007). Isolated DNA was stored at -20°C in a deep freezer (Model no. KEMI KDFVSP-2).

3.4.2. Assigning primers, DNA Amplification and Sequencing

The PCR amplification of a 658 bp mitochondrial cytochrome c oxidase subunit I (COI) gene was carried out using the universal primer LCO490/HCO2198 (Raupach *et al.,* 2011; Andujar *et al.,* 2012). Following the methodology of Simon *et al.* 1994, Emerson *et al.* 1999, Herbert *et al.* 2004 and Raupach *et al.* 2016). Four other primers (LCO1480/HCO2198; C1- J-1718/ C1-N-2191 alias Nancy; C1-J-2092/TK-N-3782; LepF/LepR) were identified as potential primers for Cytochrome Oxidase I. The sequencing of the amplified

DNA fragment from both ends was performed using the Sanger's dideoxy chain termination sequencing method (Sanger and Coulson, 1975) at AgriGenome Labs Pvt. Ltd., Cochin with ABI 3730XL automated sequencer. Sequences were retrieved from electrophorograms using Finch TV. Forward and Reverse sequences of COI gene fragments were multiple aligned using ClustralW programme and Bioedit software (Thompson *et al*., 1994). The FASTA format of 5'-3' contig sequence from both forward and reverse strands was taken for deposition in the public database of NCBI Gen Bank of INSDC and acquiring the accession number for each sequence submission. Basic Local Alignment Search Tool (BLAST) of NCBI was employed for searching sequence similarities (Altschul *et al.*, 1997). Molecular relatedness was inferred using MEGA 6 software.



Plate 1: Map showing A) Malabar Wildlife sanctuary B) Agriculture belts



Plate 2: Traps used for the collection of Carabidae beetles from Malabar Wildlife sanctuary and surrounding agribelts (A) Light trap (B) Pitfall trap

Chapter 4

RESULTS

4.1. Taxonomy

Checklist, pictorial key and descriptions of the Carabidae from the Malabar Wildlife sanctuary and key to the genera and species of two subfamilies with species descriptions are provided.

4.1.1. Checklist and pictorial keys for the Carabidae collected from Malabar Wildlife sanctuary and surrounding agriculture belts

FAMILY CARABIDAE

SUBFAMILY 1. ANTHIINAE BONELLI, 1810

Tribe I. Physocrotaphini CHAUDOIR, 1863

Genus 1. *Helluodes* WESTWOOD, 1847

Westwood, 1847: 279; Chaudoir, 1862: 302; Andrewes, 1930: 178; Moore, 1998: 370; Lorenz, 2005: 510; Abitha *et al.*, 2008: 33.

1. *Helluodes devagiriensis* ABITHA *et al.*, 2008

Abitha *et al.*, 2008: 36.

Distribution: India: Kerala (Kozhikode, Kakkayam, Arakulam, Vazhachal).

Tribe II. Helluonini HOPE, 1838

Hope, 1838: 110; Reiche, 1843: 323; Lacordaire, 1854: 90; Horn, 1881: 125, 160–161; Sloane, 1914: 568; Andrewes, 1920: 40, 46; Csiki, 1932: 1572; Jeannel, 1949: 1041; Basilewsky, 1953: 20, 219; Ball, 1960: 66, 163–164; Basilewsky, 1962: 79–81; Jedlicka, 1963: 280, 467; Darlington, 1968: 228; Lindroth, 1969: 1094–1095; Reichardt, 1974: 220–224; Lorenz, 2005: 510.

= Helluonides Reiche, 1843.

= Helluoninae Basilewsky, 1953.

Genus 1. *Omphra* DEJEAN, 1825

Dejean, 1825: 168, 283; Reiche, 1843: 330; Lacordaire, 1854: 94; Chaudoir, 1872: 140; Sloane, 1914: 570; Andrewes, 1930: 236; Csiki, 1932: 1577; Jedlicka, 1963: 511; Lorenz, 2005: 511; Zhao *et al.*, 2008: 372.

= *Helluo* Latreille and Dejean, 1822: 94.

1. *Omphra pilosa* (KLUG, 1834)

Fabricius, 1801: 214; Klug, 1834: 71; Reiche, 1843: 331; Erichson, 1847: 141; Schaum, 1847: 49; Schaum, 1848: 334; Motschulsky, 1855: 54; Redtenbacher, 1867: 5; Chaudoir, 1872: 141; Putzeys, 1875: 15; Andrewes, 1921: 163; Andrewes, 1923: 460; Andrewes, 1927: 101; Andrewes, 1930: 237; Csiki, 1932: 1578; Jedlicka, 1963: 512; Lorenz, 2005: 511; Zhao *et al.*, 2008: 371; Shiju *et al.*, 2011: 8–9.

= *Helluo pilosus* Klug, 1834

= *Galerita attelaboides* Fabricius, 1801.

Distribution: India (Kerala: Mahe, Chempery, Kuttiyadi, Kozhikode, Malappuram, Chinnar, Karimutti, Arakulam, Thodupuzha; Tamil Nadu: Chennai; Maharashtra: Mumbai; West Bengal; Uttaranchal: Haridwar), Sri Lanka (Hikkaduwa).

Genus 2. *Macrocheilus* HOPE, 1838

Hope, 1838: 166; Reiche, 1843: 334; Schmidt-Goebel, 1846: 64; Lacordaire, 1854: 93; Schaum, 1863: 80; Chaudoir, 1877: 247; Sloane, 1914: 570;

Andrewes, 1920: 493; Andrewes, 1930: 206; Csiki, 1932: 1573; Jeannel, 1949: 1041; Jedlicka, 1963: 468; Lorenz, 2005: 512; Zhao & Tian, 2010: 4.

= *Acanthogenius* Reiche, 1843.

= *Macrochilus* Andrewes, 1920.

= *Macrocheilidius* Jeannel, 1949.

1. *Macrocheilus devagiriensis* SHIJU, 2012

Shiju *et al.*, 2012: 104.

Distribution: India (Kerala: Koorachund, Chelari, Kozhikode, Koduvally, Kannur).

SUBFAMILY 2. BRACHININAE BONELLI, 1810

Tribe I. Brachinini BONELLI, 1810

Genus 1. *Pheropsophus* SOLIER, 1833

Solier, 1833: 461; Lacordaire, 1854: 99; Chaudoir, 1876: 16; Arrow, 1901: 193; Maindron, 1906: 15; Hubenthal, 1911: 547; Hubenthal, 1914: 437; Andrewes, 1924: 55; Andrewes, 1930: 270; Jeannel, 1949: 1091; Jedlicka, 1963: 524; Erwin, 1970: 34; Erwin, 1971: 1.

= *Stenaptinus* Maindron, 1906.

= *Parapheropsophus* Hubenthal, 1914.

= *Aptinomorphus* Jeannel, 1949.

1. *Pheropsophus picicollis* CHAUDOIR, 1876

Chaudoir, 1876: 44; Bates, 1892: 392; Andrewes, 1930: 275.

Distribution: India (Karnataka: Bangalore; Kerala: Thiruvananthapuram, Chelari, Koorachudu; Goa: Mormugao; Arunachal Pradesh And Assam: Dafla

Hills; Mizoram And Tripura: Lushai Hills), Andaman Is; Bhutan; Sri Lanka; Myanmar: Karen Hills. Shan Hills. Bhamo. Palon. Rangoon; Malay Peninsula; Thailand: Siam; Laos.

Genus 2. *Brachinus* WEBER, 1801

Weber, 1801: 22; Latreille, 1810: 104; Dejean, 1825: 297; Hope, 1834: 91; Schmidt-Goebel, 1846: 71; Lacordaire, 1854: 99; Chaudoir, 1876: 49; Wickham, 1893: 330; Wickham, 1894: 39; Porta, 1909: 90; Reitter, 1919: 133; Andrewes, 1924: 56; Lutshnik, 1926: 43; Andrewes, 1930: 48; Csiki, 1933: 1628; Alluaud, 1935: 25; Jeannel, 1949: 1100.

= *Aploa* Hope, 1833.

= *Brachynus* Chaudoir, 1876.

= *Pseudaptinus* Porta, 1909 (not Castelnau).

= *Cnecostolus* Reitter, 1919.

= *Brachynolomus* Reitter, 1919.

= *Brachynidius* Reitter, 1919.

= *Brachinoaptinus* Lutshnik, 1926.

= *Aptinomimus* Alluaud, 1935.

= *Brachynaptinus* Csiki, 1933.

= *Metabrachinus* Jeannel, 1949.

= *Platybrachinus* Jeannel, 1949.

1. *Brachinus devagiriensis* AKHIL & SABU, 2020

Akhil & Sabu, 2020.

Distribution: India: Kerala: Pattambi, Peruvannamoozhi.

SUBFAMILY 3. DRYPTINAE BONELLI, 1810

Tribe I. Zuphiini BONELLI, 1810

Genus 1. *Planetes* MACLAEY, 1825

MacLaey, 1825: 28; Lacordaire, 1854: 94; Bates, 1873: 304; Andrewes, 1924: 52; id. 1930: 278; Lorenz, 2005: 507.

= *Heteroglossa* Nietner, 1857: 141; id. 1857: 279.

1. *Planetes ruficeps* SCHAUM, 1863

Schaum, 1863: 81; Chaudoir, 1872: 139; Heyne-Tasch, 1898: 14; Andrewes, 1924: 53; id. 1930: 279; Lorenz, 2005: 507.

= *bimaculatus* (*Heteroglossa*) Nietner (not Macleay.), 1857: 144; id. 1857: 282; Andrewes, 1927: 106.

Distribution: India (Kerala: Wayanad: Tholpetty, Kozhikode: Koorachundu; Tamil Nadu: Chennai, Nilgiri Hills; Odisha: Surada; Uttarakhand: Dehra Dun), Sri Lanka (Colombo, Hambegannuwa), Myanmar (Tharrawaddy), Bangladesh (Dacca).

Tribe 2. Galeritini LECONTE, 1853

Genus 1. *Galerita* FABRICIUS, 1801

Fabricius, 1801: 214; Latreille & Dejean, 1822: 117; Dejean, 1825: 186; Schmidt-Goebel, 1846: 26; Lacordaire, 1854: 82; Andrewes, 1924: 52; id. 1930: 167; Lorenz, 2005: 508.

1. *Galerita orientalis* SCHMIDT-GOEBEL, 1846

Schmidt-Goebel, 1846: 26; Bates, 1889: 109; Andrewes, 1923: 8; id. 1930: 168; Lorenz, 2005: 509; Kushwaha *et al.* 2015: 22.

Distribution: India (Meghalaya: Khasi Hills; Chattisgarh: Raipur; Kerala: Kozhikode), Myanmar (Patkai hills, Teinzo).

SUBFAMILY 4. HARPALINAE BONELLI, 1810

Tribe I. Stenolophini KIRBY, 1837

Genus 1. *Stenolophus* LATREILLE, 1829

Latreille, 1829: 391; Dejean, 1829: 405; Lacordaire, 1854: 303; Sloane, 1898: 456; Tschitscherine, 1900: 364; id. 1901: 246; Andrewes, 1924: 40; Habu, 1973: 342.

= *Egadroma* Motschulsky, 1855: 43; id. 1864: 201; Tschitscherine, 1900: 364; id. 1901: 246.

1. *Stenolophus smaragdulus* FABRICIUS, 1798

Fabricius, 1798: 60; id. 1801: 209; Dejean, 1829: 418; Hope, 1838: 93; Schaum, 1847: 49; Motschulsky, 1855: 43; id. 1864: 205; Bates, 1886: 80; id. 1891: 333; id. 1892: 349; Bouchard, 1903: 172; Sloane, 1920: 321; Andrewes, 1921: 160; id. 1924: 40.

= *trechoides (Harpalus)* Hope, 1845: 15; Andrewes, 1919: 178.

= *stolidus (Harpalus)* Walker, 1858: 204; Bates, 1886: 80 & 211; Andrewes, 1919: 189.

= *apicalis (Egadroma)* Motschulsky, 1864: 205; Andrewes, 1928: 8.

= *nitens (Egadroma)* Motschulsky, 1864: 205; Andrewes, 1928: 8.

= *transmutans* Bates, 1886: 80; id. 1892: 349.

= *cyanellus* Bates, 1889: 103; id. 1892: 350; Bouchard, 1903: 172; Andrewes, 1928: 8.

= *chaleeus* Lesne, 1904: 76; Andrewes, 1926: 255.

Distribution: Throughout India.

SUBFAMILY 5: LEBIINAE BONELLI, 1810

Tribe I. Perigonini HORN, 1881

Genus 1. *Perigona* CASTELNAU, 1835

Castelnau, 1835: 151; Lacordaire, 1854: 134; Chaudoir, 1871: 281; Putzeys, 1873: 218; Horn, 1876: 248; Bates, 1884: 135; Sloane, 1903: 635; Fauvel, 1907: 97; Andrewes, 1929: 326; id. 1930: 263; Csiki, 1931: 895; Jedlicka, 1935: 17–19; Basilewsky, 1956: 461; Jedlicka, 1964: 267–274; Jeannel, 1942: 580; Blackwelder, 1944: 44; Jeannel, 1948: 734; Darlington, 1968: 6; id. 1970: 29; Gueorguiev & Gueorguiev, 1995: 29 & 210; Lorenz, 2005: 438.

= *Euryperigona* Jeannel, 1941: 138, 149.

= *Nestra* Motschulsky, 1851: 506; id. 1859: 37.

= *Trechicus* Leconte, 1853: 386.

= *Spathinus* Nietner, 1858: 456.

= *Tachynotus* Motschulsky, 1861: 100; Putzeys, 1870: 9; Andrewes, 1928: 6.

= *Pentoplogenius* Morawitz, 1863: 24; Fauvel 1889: 100.

= *Siltopia* Laporte De Castelnau, 1867: 127.

= *Extromus* Peringuey, 1896: 586.

= *Hirtoperigona* Perrault, 1988: 11.

1. *Perigona nigricollis* MOTSCHULSKY, 1851

Andrewes, 1928: 3; id. 1929: 327; id. 1930: 266; Lorenz, 2005: 438.

= *Nestra nigricollis* Motschulsky, 1851: 506; id. 1875: 728.

Distribution: South India; Sri Lanka; Myanmar (Tenasserim); Indonesia (Java, Sumatra, Borneo).

Tribe II. Lebiini BONELLI, 1810

Genus 1. *Lebia* LATREILLE, 1802

Latreille, 1802: 85; Dejean, 1825: 253; Schmidt-Goebel, 1846: 43; Lacordaire, 1854: 127; Chaudoir, 1871: 111-255; id. 1871: 1-87; Horn, 1882: 130; Fowler, 1887: 136; Ganglbauer, 1892: 397; Silvestri, 1904: 68–84; Andrewes, 1930: 191; Alluaud, 1936: 8; Jedlicka, 1933: 144; Jeannel, 1942: 1028; id. 1949: 882 & 902; Jedlicka, 1963: 314; Blackwelder, 1944: 52; Mateu, 1984: 398; Gueorguiev & Gueorguiev, 1995: 31 & 221; Hurka, 1996: 468 & 470; Lorenz, 2005: 481; Park *et al*. 2006: 102.

= *Lia* Eschscholtz, 1829: 7; Blackwelder, 1944: 56.

= *Encrates* Gistel, 1848

= *Callilebia* Crotch, 1870

= *Eulebia* Macleay, 1871: 86; Sloane, 1917: 424.

= *Aphelogenia* Chaudoir, 1871: 156.

= *Dianchomena* Chaudoir, 1871: 156.

= *Metabola* Chaudoir, 1871: 160.

= *Eccoptomesa* Chaudoir, 1871: 156.

= *Ectomomesa* Chaudoir, 1871: 58; Blackwelder, 1944: 56.

= *Astata* Chaudoir, 1871: 157

= *Scythropa* Chaudoir, 1871: 156; Blackwelder, 1944: 56.

= *Morpholebia* Pic, 1922: 25.

1. *Lebia basalis* CHAUDOIR, 1852

Chaudoir, 1852: 43; id. 1871: 149; Andrewes, 1930: 191 (*Lebia*); Lorenz, 2005: 487.

Distribution: India (Tamil Nadu: Rajapalayam; Himachal Pradesh: Shimla; Bihar: Dinapore).

Genus 2. *Lachnoderma* MACLEAY, 1873

Macleay, 1873: 321; Gestro, 1875: 860; Andrewes, 1930: 188; Jedlicka, 1963: 302; Lorenz, 2005: 489.

1. *Lachnoderma biguttatum* BATES, 1892

Bates, 1892: 424; Andrewes, 1930: 188; Jedlicka, 1963: 304; Lorenz, 2005: 489.

= *Lachnoderma rufithorax* Jedlicka, 1964: 315.

= *Lachnoderma rufithorax* Kirschenhofer, 1996: 760.

Distribution: India (Kerala: Koorachundu, Poovathuchola, Muthanga, Cherupuzha, Nedumkayam, Charalmedu; Uttarakhand: Kumaon, Almora, Kousanie, Dehra Dun; Assam: Patkai Hills); Myanmar (Shwegu).

Genus 3. *Anchista* NIETNER, 1857

Nietner, 1857: 523; id. 1857: 374; Chaudoir, 1877: 236; Andrewes, 1926: 346; id. 1930: 22; Csiki, 1932: 1455; Jedlicka, 1963: 449; Habu, 1967: 137; Darlington, 1968: 139; id. 1970: 45; Habu, 1982: 102; Kirschenhofer, 1994: 1006; Lorenz, 2005: 491.

= *Paraphaea* Bates, 1873: 312.

1. *Anchista fenestrata* (SCHIMDT-GOEBEL, 1846)

Andrewes, 1923: 20; id. 1930: 23; Csiki, 1932: 1456; Jedlicka, 1963: 449; Lorenz, 2005: 491; Shi *et al*. 2013: 27.

= *Plochionus fenestrata* Schimdt-Goebel, 1846: 42; Chaudoir, 1872: 168; Bates, 1892: 424.

= *Anchista glabra* Chaudoir, 1877: 237; Andrewes, 1930: 23; Csiki, 1932: 1456; Lorenz, 2005: 491.

= *Anchista nepalensis* Kirschenhofer, 1994: 1005; Lorenz, 2005: 491.

= *Anchista subpubescens* Chaudoir, 1877: 238; Csiki 1932: 1456; Lorenz, 2005: 491.

Distribution: India (Kerala: Thamarassery; Koorachundu, Nedumkayam, Charalmedu, Chinnar-Karimutty; Tamil Nadu: Thambaram, Rajapalayam, Papanasam, Pondicherry; Karnataka: Gundelpet; Rajasthan; Bihar; West Bengal: Singbhum; Uttarakhand: Dehra Dun), Sri Lanka (Horawupatana); Myanamar; Nepal; Pakistan.

SUBFAMILY 5. LICININAE BONELLI, 1810

Tribe I. Chlaeniini BRULLE, 1834

Genus 1. *Chlaenius* BONELLI, 1810

Macleay, 1825: 13; Dejean, 1826: 297, 368; Schmidt-Goebel, 1846: Cover page; Chaudoir, 1850: 407; Laferte-Senectere, 1851: 212, 233, 238, 263, 293; Lacordaire, 1854: 213, 217, 219, 220, 221, 223, 224, 235; Chaudoir, 1856: 192; Motschulsky, 1860: 515; Motschulsky, 1864: 334, 347; Chaudoir, 1876:

10, 11, 12, 16; Bates, 1892: 309; Sloane, 1910: 437; Andrewes, 1919: 91; id. 1923: 58; id. 1924: 24; id. 1930: 82.

= *Lissauchenius* Macleay, 1825: 13.

= *Epomis* Dejean, 1826: 368.

= *Indalma* Schmidt-Goebel, 1846: 154.

= *Diaphoropsophus* Chaudoir, 1850: 407.

= *Barymorphus* Laferte-Senectere, 1851: 235.

= *Amblygenius* Laferte-Senectere, 1851: 263.

= *Ocybatus* Laferte-Senectere, 1851: 293.

= *Ocydromus* Laferte-Senectere, 1851: 230.

= *Homalolachnus* Laferte-Senectere, 1851: 293.

= *Omalotrichus* Laferte-Senectere, 1851: 233.

= *Chlaenites* Motschulsky, 1860: 96.

= *Callistoides* Motschulsky, 1864: 334.

= *Poeciloistus* Motschulsky, 1864: 347.

= *Chlaenioctenus* Bates, 1892: 309.

1. *Chlaenius malachinus* (MOTSCHULSKY, 1865)

Motschulsky, 1865: 335; Chaudoir, 1876: 280; Andrewes, 1928: 12; Andrewes, 1930: 96.

= *Chlaenius pudicus* Chaudoir, 1876: 280.

Distribution: India, Sri Lanka.

2. *Chlaenius kanarae* ANDREWES, 1919

Andrewes, 1919: 3; Andrewes, 1930: 95.

Distribution: India (Karanataka: North Kanara; Goa: Mormugao).

SUBFAMILY 7. ORTHOGONIINAE SCHAUM, 1857

Tribe I. Orthogoniini SCHAUM, 1857

Genus 1. *Orthogonius* MACLEAY, 1825

Macleay, 1825: 26; Dejean, 1825: 169, 269; Schmidt-Goebel, 1846: 55; Chaudoir, 1872: 98; Csiki, 1932: 1586; Jedlicka, 1963: 269; Tian & Deuve, 2000: 2.

1. *Orthogonius baconoides* TIAN & SABU, 2009

Sabu *et al.* 2009: 372.

Distribution: India (Kerala: Mahe, Kozhikode, Wayanad; Tamil Nadu: Nilgiri Hills, Chennai; Karnataka: Shimogga, Mysore).

2. *Orthogonius indicus* TIAN & DEUVE, 2006

Tian & Deuve, 2006: 140–141; Sabu *et al*., 2009: 370.

Distribution: India (Kerala: Mahe, Paithalmala, Kozhikode Medical College, Devagiri, Kizhakoth, Thamarassery, Malapparamba, Chelannoor, Pullorampara, Beypore, Koduvally; Tamil Nadu: Chennai).

3. *Orthogonius indophilus* TIAN & DEUVE, 2006

Tian & Deuve 2006: 130; Sabu *et al*. 2009: 371. 171.

Distribution: India (Kerala: Travancore, Kozhikode, Engapuzha, Thamarassery, Kuruvattor, Koyilandy; Karnataka: Mysore, Coorg).

4. *Orthogonius lucidus* BATES, 1891

Bates, 1891: 324–340; Sabu *et al*., 2009: 372.

Distribution: India (Jharkhand: Chota Nagpur. Konbir, Tetara, Ranchi; Maharashtra: Mumbai; Kerala: Kannur, Kozhikode, Thamarassery, Wayanad, Idukki, Thodupuzha).

SUBFAMILY 8. PANAGAEINAE BONELLI, 1810

Tribe I. Panagaeini BONELLI, 1810

Genus 1. *Craspedophorus* HOPE, 1838

Hope, 1838: 165; Lacordaire, 1854: 210; Chaudoir, 1878: 90; Andrewes, 1919: 126; id. 1924: 22; id. 1930: 133; Lorenz, 2005: 320.

= *Eudema* Castelnau, 1840: 137; Lacordaire, 1854: 210; Chaudoir, 1878: 133.

= *Epicosmus* Chaudoir, 1846: 512; id. 1854: 338; id. 1861: 335; id. 1878: 104.

1. *Craspedophorus mandarinellus* BATES, 1892

Andrewes, 1921: 187; id. 1930: 135; Baehr, 2003: 447; Xie & Yu. 1991: 170; Kirschenhofer, 2000: 324; Lorenz, 2005: 321; Kirschenhofer, 2011: 40, 47; Hackel & Farkac, 2012: 77; Hackel & Kirschenhoffer, 2014: 309; Fedorenko, 2016: 30.

= *Epicosmus mandarinellus* Bates, 1892: 299.

Distribution: India (Maharashtra: Mumbai, Karnataka: Shimoga), Myanmar, Vietnam, China (Guangxi).

Genus 2. *Adischissus* FEDORENKO, 2015

Fedorenko, 2015: 273.

1. *Adischissus notulatus* (FABRICIUS, 1801)

Fedorenko, 2015: 277.

= *Dischissus notulatus* Andrewes, 1921: 162; id. 1930, 153; Lorenz, 2005: 322.

= *Carabus notulatus* Fabricius, 1801: 201; Hope, 1838: 90; Schaum, 1847: 48; id. 1853: 432; Motschulsky, 1855: 70.

= *Craspedophorus longicornis* Schaum, 1863: 84; Chaudoir, 1878: 153; Bates, 1892: 303; Heller, 1916: 276; Andrewes, 1927: 108.

= *Panagaeus sumatranus* Dohrn, 1891: 253–254; Andrewes, 1922: 246.

= *Dischissus phuongensis* Kirschenhofer, 1994.

Distribution: India (Andhra Pradesh; Arunachal Pradesh; Assam; Bihar; Jharkhand; Karnataka; Kerala; Madhyapradesh; Manipur; Meghalaya; Mizoram; Nagaland; Odisha; Tamilnadu: Nilgiri hills; Tripura; Uttarpradesh; Uttarkhand; West Bengal: Kolkata, Almora; Sikkim: Namsoo), Myanmar (Insein, Taungoo, Rangoon, Kawkareik), Malaysia (Kuala Lumpur), Singapore, Hongkong, Bangladesh, Cambodia, China (Shanghai, Anhui, Fujian, Guangdong, Guangxi, Guizhou, Hunan, Xizang, Zhejiang provinces), Laos, Myanmar, Nepal, Sri Lanka, Taiwan, Thailand, Vietnam.

Genus 3. *Euschizomerus* CHAUDOIR, 1850

Chaudoir, 1850: 413; Lacordaire, 1854: 212; Chaudoir, 1878: 157; Andrewes, 1930: 165; Lorenz, 2005: 322.

1. *Euschizomerus indicus* JEDLICKA, 1955

Jedlicka, 1955: 207; Lorenz, 2005: 322; Hackel & Farkac, 2012: 86; Jithmon & Sabu, 2018: 365.

= *Euschizomerus schuhi* Kirschenhofer, 2000: 360; Hackel & Farkac, 2012: 86.

Distribution: India: Mumbai. Lonvala (Maharhastra), Goa: Benaulin Beach, Kerala: Kozhikode - Devagiri & Govindapuram.

SUBFAMILY 9. SCARITINAE BONELLI, 1810

Tribe I. Scaritini BONELLI, 1810

Genus 1. Oxylobus CHAUDOIR, 1855

Chaudoir, 1855: 5; id. 1879: 129; Andrewes, 1924: 8; id. 1929: 292; id. 1930: 252.

1. *Oxylobus follis* ANDREWES, 1929

Andrewes. 1929: 294 & 299; id. 1930: 253.

Distribution: India (Tamil Nadu: Kodaikanal; Andra Pradesh: Horseley Konda, Sirumalai; Kerala: Peerumedu, Wallardi).

Tribe II. Clivini BONELLI, 1810

Genus 1. *Clivina* LATREILLE, 1802

Latreille, 1802: 96; Bonelli, 1813: 480; Dejean. 1825: 411; Putzey, 1846: 523 & 577; Lacordaire. 1854: 204; Putzey. 1863: 29; id. 1867: 107; id. 1868: 10–20; id. 1873: 15-17; Fleischer. 1899: 33; Tschitscherine. 1904: 258; Andrewes. 1924: 11; id. 1926: 372; id. 1929: 344 and 351; id. 1930: 110.

= *Eupalamus* Schmidt-Goebel.1846 (cover); Motschulsky. 1861: 101.

= *Dacca* Putzey. 1863: 68; Andrewes. 1919: 470.

1. *Clivina helferi* PUTZEY, 1866

Putzey, 1866: 126; Andrewes. 1926: 375; id. 1927: 109; id. 1929: 354 and 367; id. 1930: 114.

= *grammica* Putzey. 1877: 41.

= *debilis* Bates, 1892: 278.

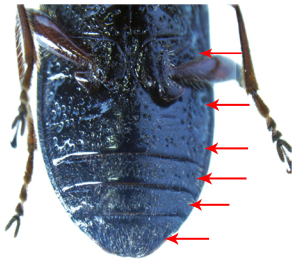
= *invalida* Andrewes, 1919: 470; id. 1924: 12.

Distribution: India (West Bengal: Kolkata; Bihar: Khargpur, Dinapur, Pusa; Odisha: Balugaon, Barkuda Is. (Lake Chilka), Bangladesh (Sunderbans, Parbatipur), Myanmar (Tharrawaddy, Prome, Mandalay, Rangoon, Toungoo, Kondan).

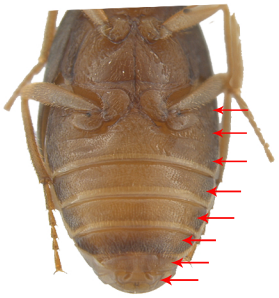
Pictorial key to the Carabidae beetles of Malabar Wildlife sanctuary and surrounding agrilands

Key to the Indian tribes of family Carabidae

1. Venter with six visible segments …….....…… 2



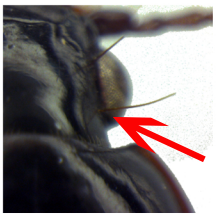
- Venter with seven or eight visible segment
..... BRACHININI (Subfamily Brachininae)



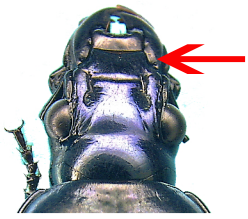
2. Head with one supraorbital seta on each side ……..... 3



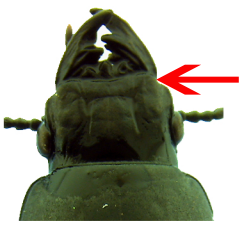
- Head with two supraorbital setae on each side ……..... 5



3. Upper articulation point of the mandible with the head not concealed by the clypeus ……..... 4



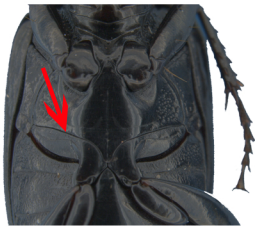
- Upper articulation point of mandible with head concealed by the clypeus, protibiae digitate, body pedunculate. ..... SCARITINI (Subfamily Scaritinae)



4. Outer part of the metacoxae and first ventral segment lying in the same plane .... CHLAENIINI (Subfamily Licininae)



- Outer part of the metacoxae and first ventral segment not lying in the same plane
..... STENOLOPHINI (Subfamily Harpalinae)



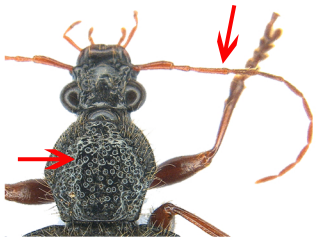
5. Apical joint of the maxillary palpi attached excentrically to the penultimate joint 6



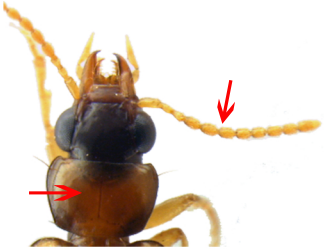
- Apical joint of the maxillary palpi attached normally to the penultimate joint ……..…. 7



6. Upper surface of pronotum punctate and pubescent, middle segments of antennae elongate
..... PANAGAEINI (Subfamily Panagaeinae)



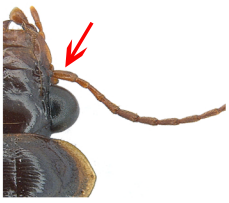
- Upper surface of pronotum glabrous, middle segments of the antennae short and rounded like a string of pearls
..... PERIGONINI (Subfamily Lebiinae)



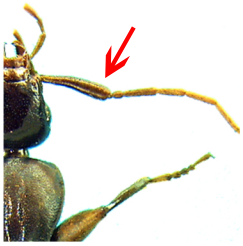
7. Joint 1 of the antennae scapiform ……..…..…… 8



- Joint 1 of the antennae not scapiform …… 10



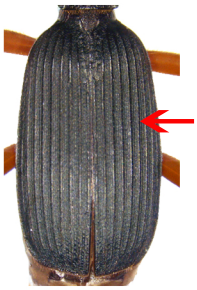
8. Antennae slender, joint 1 as long as the next three taken together ……..…… ZUPHIINI (Subfamily Dryptinae)



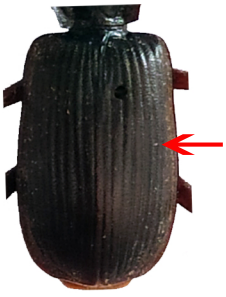
- Antennae fairly stout, joint 1 not longer than the next two taken together …….……. 9



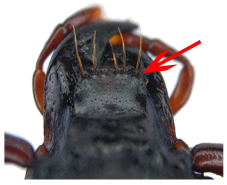
9. Elytra costate, with eight or nine narrow major costae, and usually with a pair of minor costae between each two adjoining major ones ……..…… GALERITINI (Subfamily Dryptinae)



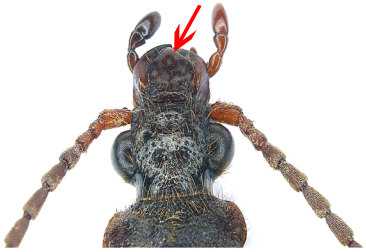
- Elytra normally 9-striate, with moderately convex intervals .....…..…. PHYSOCROTAPHINI (Subfamily Anthiinae)



10. Labrum normal, more or less quadrate ……..…….. 11



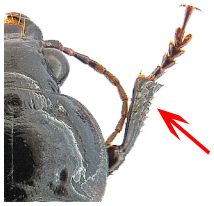
- Labrum large and semicircular, practically concealing the mandibles ……..… HELLUONINI (Subfamily Anthiinae)



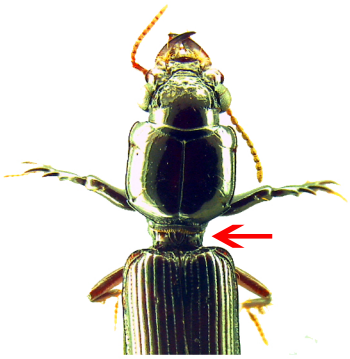
11. Tibiae not serrate ……..…… 12



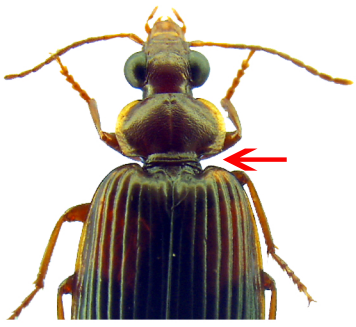
- Tibiae serrate, protibiae dilated at apex; tarsi with joint 4 emarginate and often bilobed, claws pectinate ……. ORTHOGONIINI (Subfamily Orthogoniinae)



12. Body pedunculate ..... CLIVININI (Subfamily Scaritinae)



- Body not pedunculate ….. LEBIINI (Subfamily Lebiinae)



Key to the Genera and species of Indian Tribes

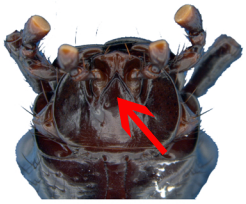
Tribe Physocrotaphini CHAUDOIR, 1863

Ligula prominent and distinctly longer than paraglossae; maxillary palpomere 4 shorter than 3……..... ***Helluodes***

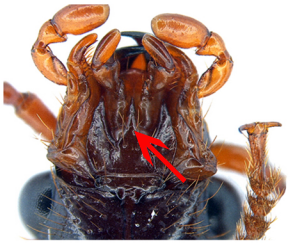


Tribe Helluonini HOPE, 1838

1. Mentum with a strongly developed stout median tooth ……..... ***Omphra***

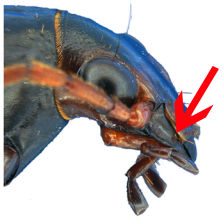


- Mentum with an elongated spiniform median tooth ……..……. ***Macrocheilus***



Tribe Brachinini BONELLI, 1810

1. Mandibular scrobe unisetose ……..... ***Pheropsophus***

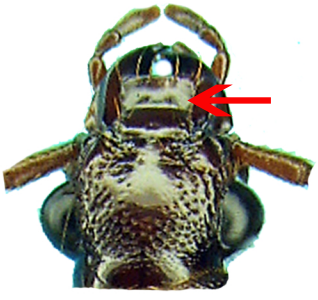


- Mandibular scrobe plurisetose ….....……..….. ***Brachinus***



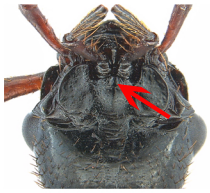
Tribe Zuphini BONELLI, 1810

Labrum square shaped .....….....……. ***Planetes***



Tribe Galeritini LECONTE, 1853

Mentum with bifid median tooth ……..……..... ***Galerita***



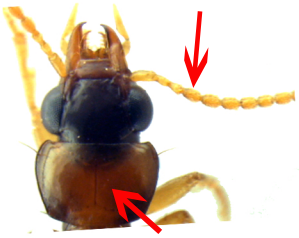
Tribe Stenolophini KIRBY, 1837

Mentum without distinct median tooth ..... ***Stenolophus***



Tribe Perigonini HORN, 1881

Antennae submoniliform and pubescent from 3rd segment,
Pronotum glabrous ……..…… ***Perigona***



Tribe Lebiini BONELLI, 1810

1. Antennae pubescent only from the 3rd segment ..……..… 2



- Antennae pubescent only from the 4th segment …….…… 3



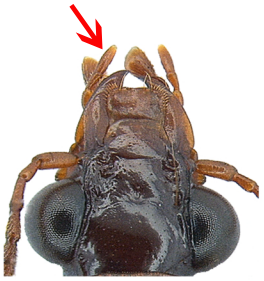
2. Claws simple……..... ***Lebia***



- Claws serrate……..... ***Lachnoderma***

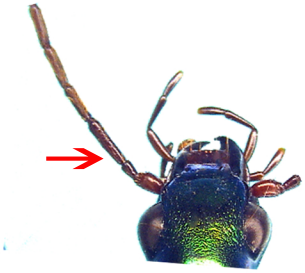


3. Last segment of the maxillary palp oval or elongate oval or cylindrical, fourth tarsomere deeply bilobed ..… ***Anchista***



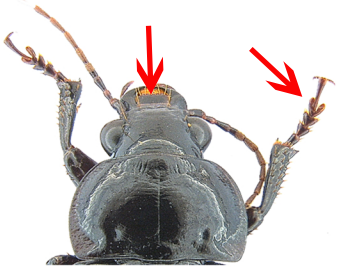
Tribe Chlaeniini BRULLE, 1834

Antennae with segment 3 subequal in length with the subsequent segments …….....….. ***Chlaenius***



Tribe Orthogonini SCHAUM, 1857

Labrum quadrate, 4th segment of all tarsi bilobed; all claws pectinate ..... ***Orthogonius***



Tribe Panagaeini BONELLI, 1810

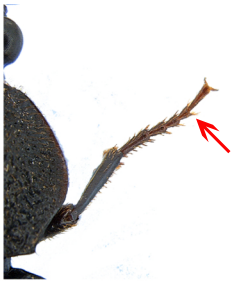
1. Elytra maculate 2



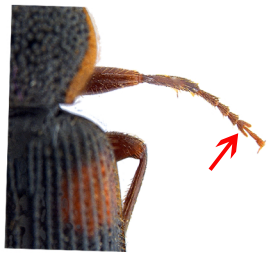
- Elytra immaculate 3



2. Cleft in penultimate protarsomere does not exceed half of protarsomere length ..... ***Craspedophorus***



- Cleft in penultimate protarsomere exceeds half of protarsomere length ……..…… ***Adischissus***

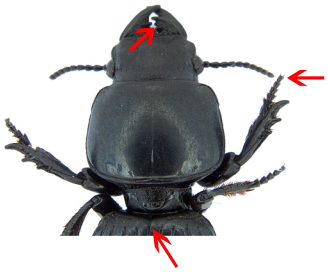


3. 4th Tarsomere deeply bilobed. ..... ***Euschizomerus***



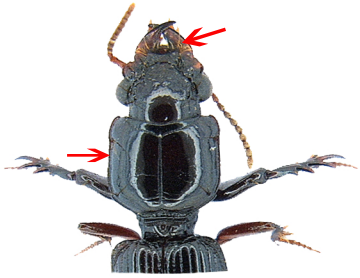
Tribe Scaritini

Glabrous, mandibles stout with 3 or 4 strong teeth, Scutellary striole absent, Claws smooth ……..…… ***Oxylobus***



Tribe Clivinini

Pronotum bordered from apex to peduncle, labrum 6, 7 or 9 setose ..... ***Clivina***



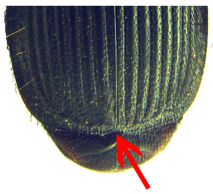
Key to the Species

Genus *Helluodes* WESTWOOD, 1847



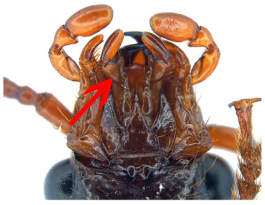
Anterior margin of labrum distinctly crenulate with 4 distinct indentations between anterior angles.... ***devagiriensis***

Genus *Omphra* DEJEAN, 1825



Elytral apex obliquely truncate and emarginated, elytral setae black or brownish red in colour..... ***pilosa***

Genus *Macrocheilus* HOPE, 1838



Penultimate joint of labial palpi strongly dilated inwards, 4th labial palpomere bisetose .....…. ***devagiriensis***

Genus *Pheropsophus* SOLIER, 1833



Pronotum rectangular shaped, lateral ridges narrow; elytra narrow, elongated, with highly serrated median transverse band ……..……..... ***picicollis***

Genus *Planetes* MACLAEY, 1825



Elytra with two median macula, Pronotum dark brown with yellow posterior angles……...…..***ruficeps***

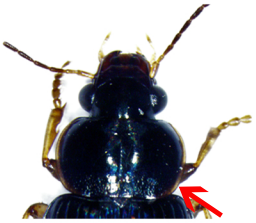
Genus *Galerita* FABRICIUS, 1801



Head reddish brown, Pronotum with posterior angles rectangular but gently rounded, elytra matt black... ***orientalis***

Genus *Stenolophus* LATREILLE, 1829

Pronotum wider than head, rounded, presence of very narrow reddish yellow lateral border ..... ***smaragdulus***



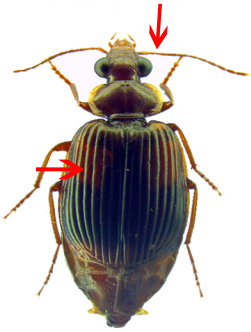
Genus *Perigona* CASTELNAU, 1835

Color dark brownish, Head black, Elytral suture reddish, ……..... ***nigricollis***



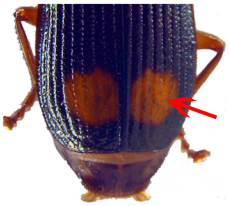
Genus *Lebia* LATREILLE, 1802

Elytral intervals strongly convex, First three segments of antennae ferruginous yellow……..... ***basalis***



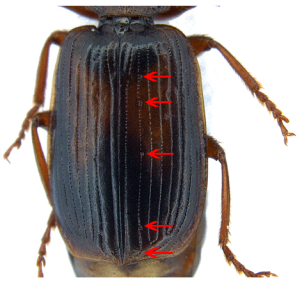
Genus *Lachnoderma* MACLEAY, 1873

Apex of each elytron with one orange-red spot between the 1st and 4th striae.. ..... ***biguttatum***



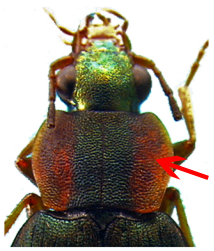
Genus *Anchista* NIETNER, 1857

3rd elytral interval with three to five setigerous pores .....……..…… ***fenestrata***



Genus *Chlaenius* BONELLI, 1810

Pronotal disk black with dark reddish yellow wide lateral border ……..……***malachinus***



- Pronotal disc without dark reddish yellow lateral border ..... ***kanarae***



Genus *Orthogonius* MACLEAY, 1825

1. Labrum straight at the frontal margin ….....…… ***indicus***



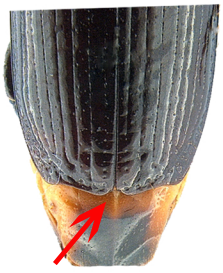
- Labrum emarginated at the frontal margin ……..… 2



2. Elytral apex truncate 3



- Elytral apex deeply emarginated ..... ***indophilus***



3. Pronotum strongly convex with fine punctures, lateral expanded margins smooth and glabrous ..... ***baconoides***

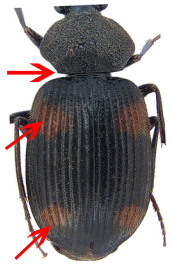


- Pronotum moderately convex with dense and clearly impressed transverse impressions, lateral expanded margins strongly wrinkled and not glabrous ..... ***lucidus***



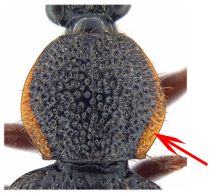
Genus *Craspedophorus* HOPE, 1838

Posterior angles of pronotum with denticulation, humeral macula reaches from 4th interval to margin, preapical margin reaches from 4th to 8th interval ……..…. ***mandarinellus***



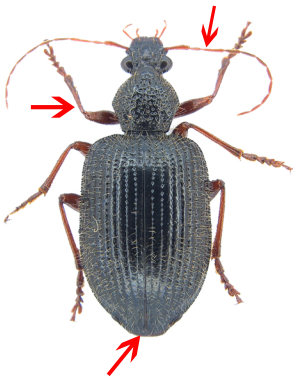
Genus *Adischissus* FEDORENKO, 2015

Pronotum with reddish yellow lateral margin ..... ***notulatus***



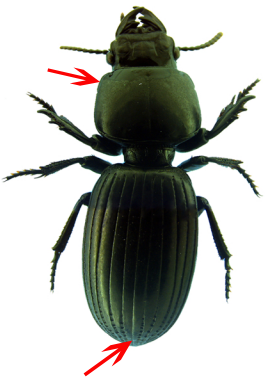
Genus *Euschizomerus* CHAUDOIR, 1850

Elytral apex sinuated and emarginated, Palps, antennae and legs reddish yellow, Anterior half of last labial and maxillary palpomere dark reddish yellow……..…… ***indicus***



Genus *Oxylobus* CHAUDOIR, 1855

Elytral intervals not carinate at apex, sides of pronotum strongly contracted infront …..... ***follis***



Genus *Clivina* LATREILLE, 1802

Mesotibial spurs fairly long at apical third ……..... ***helferi***



Genus Brachinus WEBER, 1801

Body reddish brown to black, Head broad and smooth, Pronotum and elytra shiny, Elytra subparallel and slightly narrowed towards base ..... ***devagiriensis***



4.1.2. Taxonomic descriptions of species collected from Malabar Wildlife Sanctuary and surrounding agriculture belts

Twenty three Carabidae species belonging to 19 genera and 13 tribes from 9 subfamilies were listed. Three species namely, *Helluodes devagiriensis* Abitha 2008, *Macrocheilus devagiriensis* Shiju 2012, *Orthogonius indophilus* Tian & Deuve, 2006 are endemic to the Western Ghats. First reports of *Galerita orientalis* Schmidt-Goebel 1846 and *Clivina helferi* Putzey 1866 from south India. Two new species namely, *Euschizomerus devagiriensis* Jithmon & Sabu, 2018 and *Brachinus devagiriensis* Akhil & Sabu, 2020 have been recorded during identification.

1. *Helluodes devagiriensis* ABITHA *et al.*, 2008

Abitha *et al.,* 2008: 36.

Distribution: India: Kerala (Kozhikode: Kakkayam; Arakulam, Vazhachal).

Specimens examined (n=1). India: Kerala, Kakkyam, 19.XI.2017, Hand picking, Jithmon V.A., 1 ex.

Length: 24 mm.

Black to brownish black. Head large, narrower than pronotum, widest between eyes, wrinkled. Labrum large, subrectangular, anterior margin crenulated with 4 dents, dorsal surface with 6 elongate setae. Mandibles long, weakly arcuate, apex acuminate. Antennae elongate; scape elongate. Palpi glabrous, narrow and elongate, maxillary palpomere 4 curved, labial palpomere

2 with dense long setae. Mentum with bifid median tooth. Submentum with a transverse row of six elongate setae. Ligula slender, elongate. Paraglossae membranous, short and very narrow. Pronotum large and moderately wide, cordiform, widest at anterior third with explanate lateral margins; apical margin moderately sinuate, without marginal border. Elytra elongate, twice as long as pronotum, lateral margins subparalleled, weakly sinuated in anterior third faintly subserrate; humerus rounded, apex obliquely truncated with membranous margins; intervals convex, regularly and densely pilose; all striae well impressed, not extended to apex, sparsely punctate. Legs slender and elongate.

2. *Omphra pilosa* (KLUG, 1834)

Fabricius, 1801: 214; Klug, 1834: 71; Reiche, 1843: 331; Erichson, 1847: 141; Schaum, 1847: 49; Schaum, 1848: 334; Motschulsky, 1855: 54; Redtenbacher, 1867: 5; Chaudoir, 1872: 141; Putzeys, 1875: 15; Andrewes, 1921: 163; Andrewes1923: 460; Andrewes, 1927: 101; Andrewes, 1930: 237; Csiki, 1932: 1578; Jedlicka, 1963: 512; Lorenz, 2005: 511; Zhao *et al.*, 2008: 371; Shiju *et al.*, 2011: 8–9.

= *Helluo pilosus* Klug, 1834

= *Galerita attelaboides* Fabricius, 1801.

Distribution: India (Bengal; Kerala: Mahe, Chempery, Kuttiyadi, Kozhikode, Malappuram, Chinnar, Karimutti, Arakulam, Thodupuzha; Maharashtra: Mumbai; Tamil Nadu: Chennai; Uttaranchal: Haridwar), Sri Lanka (Hikkaduwa).

Specimens examined (n=31): INDIA: Kerala, Koorachundu, 15.IV.2016, Hand picking, Jithmon V.A., 7 exs; Peruvannamoozhi, 02.IX.2016, Hand picking, Jithmon V.A., 4 exs; Koorachundu, 02.II.2017, Hand picking, Jithmon V.A., 11 exs; Koorachundu, 03.II.2017, Hand picking, Jithmon V.A., 3 exs ; Peruvannamoozhi, 10.II.2017, Pitfall, Jithmon V.A., 3 exs; Kakkayam, 22.XI.2018, Hand picking, Jithmon V.A, 3 exs.

Length: 14–17 mm.

Body black; labrum and mentum black or brownish red, coxae and trochanter brownish red, legs black. Setae black in colour. Head with labrum transversely not extended. Clypeus with 6–8 setae. Mentum oval and rectangular, median tooth with 1–1 setae, base with 2–2 setae. Last segment of maxillary and labial palpomere dilated. Last antennal segment elongate, oval. Pronotum strongly convex, entirely rounded, widest in middle. Lateral margins strongly sinuate to base. Base slightly emarginate laterally. Scutellum sparsely or densely punctuate. Elytra elongated oval, widest behind the middle. Humerus not pronounced. Intervals strongly convex, apical margin obliquely truncated with weak emargination.

3. *Macrocheilus devagiriensis* SHIJU, 2012

Shiju *et al.*, 2012: 104.

Distribution: India: Kerala (Kozhikode: Koorachundu, Peruvannamoozhi, Chelari, Koduvally; Kannur).

Specimens Examined: (n=8). INDIA: Kerala, Koorachundu, 15.V.2016, Hand picking, Jithmon V.A., 2 exs; Peruvannamoozhi, 10.II.2017, Light trap, Jithmon V.A., 3 exs; Koorachundu, 27.VIII.2017, Hand picking, Jithmon V.A., 2 exs; Koorachundu, 18.III.2018, Hand picking, Jithmon V.A., 1 ex.

Length: 12.2–13.4 mm.

Body reddish brown; legs, plapi, elytral spots, first antenommere yellow. Head moderately convex; closely punctuate. Clypeus front margin deeply emarginated at middle. Labrum small; apex rounded, strongly convex; sides of base arcuate. Mandibles pointed at apex. 4th maxillary palpomere strongly and flattened dilated, penultimate joint strong and triangularly dilated; 4th labial palpomere flattened dilated, penultimate joint short and strongly dilated inwards, bisetose on apex of dilated part. Mentum glabrous at base; median tooth triangular, pointed, as long as lateral lobes. Pronotum truncate-cordiform, transverse, wider than head, convex, nearly twice as wide as long, widest before middle; slightly sinuate behind; hind angles obtuse, median line distinct, basal foveae deep, surface coarsely punctate. Elytra elongate, parallel at sides, intervals slightly convex, elytron with a median testaceous rounded spot, covering intervals 3–7.

4. *Pheropsophus picicollis* CHAUDOIR, 1876

Chaudoir, 1876: 44; Bates, 1892: 392; Andrewes, 1930: 275.

Distribution: India (Karnataka: Bangalore; Kerala: Thiruvananthapuram, Chelari, Koorachudu; Goa: Mormugao; Arunachal Pradesh; Assam: Dafla Hills;

Mizoram; Tripura: Lushai Hills), Andaman Is; Bhutan; Sri Lanka; Myanmar: Karen Hills, Shan Hills, Palon, Rangoon; Malay Peninsula; Thailand: Siam; Laos.

Specimen examined (n=2): INDIA: Kerala: Koorachundu, Hand picking, 24.VIII.2015, Jithmon V. A., 1ex.; Koorachundu, Hand picking, 04.VI.2016, Jithmon V. A., 1 ex.

Length: 15–17 mm.

Black head with reddish yellow borders; clypeus and labrum reddish yellow; first four antennal segments light yellow red and 5–11 dark brown; pronotum and elytra black. Head narrow with the epistome; neck wrinkled; eyes prominent and protruding. Pronotum smooth, glabrous, barely convex on sides, anterior and posterior margins straight; weak ridge along the lateral margin; two long lateral setae. Elytra subparallel, narrowed towards base; humerus prominent; humeral spot more angular posteriorly, median band narrow, more transverse, extending to the second stria, rather strongly serrated on both edges, not reaching the lateral margin; yellow apical border serrated on the striation, extending between the 2nd and 8th striations; intervals flat, glabrous. Legs with tarsi dark reddish brown; femur and tibia reddish yellow; black spot on the apex of femur present on all legs.

5. *Brachinus devagiriensis* AKHIL & SABU, 2020

Akhil & Sabu, 2020.

Distribution: India: Kerala: Pattambi, Peruvannamoozhi.

Specimens examined (n=1): India: Kerala: Peruvannamoozhi, 02.II.2017, Jithmon V. A., 1 ex.

Length: 5.8–6.13 mm.

Body reddish brown to black. Head wider than long, broad, sparsely pubescent, smooth, with very faint wrinkles. Pronotum shiny, as long as wide, disc punctuated, sparsely pubescent, smooth without wrinkles. Elytra subparallel, slightly narrowed towards base, shiny, densely punctuated and pubescent.

6. *Planetes ruficeps* SCHAUM, 1863

Schaum, 1863: 81; Chaudoir, 1872: 139; Heyne-Tasch, 1898: 14; Andrewes, 1924: 53; id. 1930: 279; Lorenz, 2005: 507.

= *bimaculatus* (*Heteroglossa*) Nietner (not Macleay.), 1857: 144; id. 1857: 282; Andrewes, 1927: 106.

Distribution: India (Uttarakhand: Dehra Dun; Odisha: Surada; Tamil Nadu: Chennai, Nilgiri Hills; Kerala: Wayanad: Tholpetty, Kozhikode: Koorachundu), Sri Lanka (Colombo, Hambegannuwa), Myanmar (Tharrawaddy) Bangladesh (Dacca).

Specimens examined (n=1): INDIA: Koorachundu, Hand pick, 12.XI.2016, Jithmon V.A., 1ex.

Length: 8.5 mm.

Head deeply punctured except forehead, deeply punctured with 2 impressions in front of the eyes, anterior angles of labrum rounded. Pronotum densely and deeply punctured. Dark brown with yellow posterior angles. Elytra slightly pubescent with a round yellow spot at the middle of each elytron. Apical angles rounded. Legs pale reddish.

7. *Galerita orientalis* SCHMIDT-GOEBEL, 1846

Schmidt-Goebel, 1846: 26; Bates, 1889: 109; Andrewes, 1923: 8; id. 1930: 168; Lorenz, 2005: 509; Kushwaha *et al.* 2015: 22.

Distribution: India (Meghalaya: Khasi Hills; Chattisgarh: Raipur; Kerala: Kozhikode: Kakkayam, Chelari), Myanmar (Patkai hills, Teinzo).

Specimens examined (n=1): INDIA: Kakkayam: Hand picking, 26.XI.2017, Jithmon V. A., 1ex.

Length: 17.2–20.7 mm.

Body flat and pretty stretched. Entirely black with reddish brown head and pronotum. Head reddish brown, wrinkled, punctured, almost smooth forehead. Labrum dark reddish-brown. Antennae setaceous, apical third of first antennal segment dark brown (almost black). Head with frontal foveae small but deep, eyes prominent. Pronotum reddish brown with thick black margin, slightly wider than head, much narrower than elytra, flat, wrinkled. Rectangular posterior angles, but gently rounded. Surface with fine and close but superficial punctuation. Elytra elongated, ovate, broadly enlarged at the back, widest in the last third with neat sharp lines. Legs brownish. Yellowish femora, apical third

portion of femora black, tarsi brownish black. The first three tarsomeres of male pulled out very strongly inside to very narrow without setae, on the edge round with long setae, in the middle occupied with a series of short setae, which widen in the end to plates or slices. In female, the first three tarsal segments triangular, ventral side densely hairy.

8. *Stenolophus smaragdulus* FABRICIUS, 1798

Fabricius, 1798: 60; id. 1801: 209; Dejean, 1829: 418; Hope, 1838: 93; Schaum, 1847: 49; Motschulsky, 1855: 43; id. 1864: 205; Bates, 1886: 80; id. 1891: 333; id.1892: 349; Bouchard, 1903: 172; Andrewes, 1921: 160; Sloane, 1920: 321; Andrews, 1924: 40.

= *trechoides (Harpalus)* Hope, 1845: 15; Andrewes, 1919: 178.

= *stolidus (Harpalus)* Walker, 1858: 204; Bates, 1886: 80 & 211; Andrewes, 1919: 189.

= *apicalis (Egadroma)* Motschulsky, 1864: 205; Andrewes, 1928: 8.

= *nitens (Egadroma)* Motschulsky, 1864: 205; Andrewes, 1928: 8.

= *transmutans* Bates, 1886: 80; id. 1892: 349.

= *cyanellus* Bates, 1889: 103; id. 1892: 350; Bouchard, 1903: 172; Andrewes, 1928: 8.

= *chaleeus* Lesne, 1904: 76; Andrewes, 1926: 255.

Distribution: Throughout India.

Specimens examined (n=3): INDIA: Kerala, Kakkayam, 13.III.2016, Light trap, Jithmon V.A., 2 exs; Peruvannamoozhi, 02.II.2017, Light trap, Jithmon V.A., 1 ex.

Length: 6.25 mm.

Body elongated, blackish brown with bluish reflection. Head rounded, barely narrowed posteriorly, smooth, slightly convex. Labrum blackish-brown, with reddish edges. Mandibles blackish. Palps pale yellow. First two segments of antennas light brown; others reddish brown. Eyes prominent. Pronotum wider than head, slightly convex; with narrow lateral border; posterior angles rounded, scarcely marked; base is cut almost completely. Scutellum dark brown, smooth, triangular. Elytra wider than pronotum, elongated, slightly oval, almost parallel, convex; have a narrow lateral border, of a pale yellow-testaceous, which does not extend beyond ninth striae, towards extremity a regular spot of same color, composed of three small elongated spots, placed on 5th, 6th and 7th intervals; middle one smaller, less distinct; striae smooth, strongly marked; intervals almost flat; on third, near second striae, about two-thirds of elytra, a small, quite distinct point, and along outer edge, near eighth striae, deeper and more pronounced depressed points arranged roughly. Legs pale yellow.

9. *Perigona nigricollis* MOTSCHULSKY, 1851

Andrewes, 1928: 3; id. 1929: 327; id. 1930: 266; Lorenz, 2005: 438.

= *Nestra nigricollis* Motschulsky, 1851: 506; id. 1875: 728.

Distribution: South India; Sri Lanka; Myanmar (Tenasserim); Indonesia (Java, Sumatra, Borneo).

Specimens examined (n=11): INDIA: Kerala, Koorachundu, 15.IV.2016, Light trap, Jithmon V.A., 4 exs; Koorachundu, 16.X.2016, Light trap, Jithmon V.A., 2 exs; Peruvannamoozhi, 10.II.2017, Light trap, Jithmon V.A., 5 exs.

Length: 3.0–4.5 mm.

Colour more or less piceous, posterior part of head and a broad transverse band on elytra black. Pronotum black or dark brown. Base of elytra dark, reddish, elytral suture bright red, elytral interval 1 and 2 red. Pronotum transverse, hind end narrowly rounded. Elytra wide meshed, on each elytron four striae clearly printed with embedded punctures, which do not reach the end; a single fovea on 4th striae towards middle of elytra; discal striae of elytra shallow.

10. *Lebia basalis* CHAUDOIR, 1852

Chaudoir, 1852: 43; id. 1871: 149; Andrewes, 1930: 191 (*Lebia*); Lorenz, 2005: 487.

Distribution: India (Kerala: Koorachundu, Peruvannamoozhi; Tamil Nadu: Rajapalayam; Himachal Pradesh: Shimla; Bihar: Dinapore).

Specimens examined (n=2): INDIA: Kerala, Koorachundu, 15.IV.2016, Light trap, Jithmon V.A., 1 ex; Peruvannamoozhi, 10.II.2017, Light trap, Jithmon V.A., 1 ex.

Length: 5.5 mm.

Reddish yellow, head and pronotum more reddish with diaphanous edges, elytra having same colour of the pronotum up to two-thirds of their length, and

black afterwards, black part goes back a little on the suture, wider than the pronotum, this black colour goes up to the first third of their length and on the suture it almost touches scutellum, border remains reddish to the outer posterior angle, first three segments of antennae, palps and legs reddish yellow, end of the first and eyes brown. Pronotum a little more rounded on the sides, striated and punctuated in the same way, very convex intervals.

11. *Lachnoderma biguttatum* BATES, 1892

Bates, 1892: 424; Andrewes, 1930: 188; Jedlicka, 1963: 304; Lorenz, 2005: 489.

= *Lachnoderma rufithorax* Jedlicka, 1964: 315.

= *Lachnoderma rufithorax* Kirschenhofer, 1996: 760.

Distribution: India (Assam: Patkai Hills; Kerala: Koorachundu, Kakkayam, Peruvannamoozhi, Muthanga, Cherupuzha, Nedumkayam, Charalmedu; Uttarakhand: Kumaon, Almora, Kousanie, Dehra Dun); Myanmar (Shwegu).

Specimens examined (n=5): KERALA: Kakkayam, Light trap, 14.II.2016, Jithmon V.A., 2 exs; Koorachundu, Light trap, 11.III.2016, Jithmon V.A., 1 ex; Peruvannamoozhi, Light trap, 11.II.2017, Jithmon V.A., 1 ex; Kakkayam, Light trap, 18.XI.2017, Jithmon V.A., 1 ex.

Length: 10.0 mm.

Convex, not densely punctured. Black, slightly shiny, hairy punctures scattered. Apex of each elytron with one orange-red spot between the 1st and 4th striae. Head behind the eyes prominent, in middle smooth, frontal foveae big and coarsely punctuated, labrum dilated to apex not emarginated. Maxillary palpi

apex dilates obliquely truncate, labial palpi widely dilated, securiform. Mentum strongly toothed. Pronotum squire transverse, sides strongly rounded in the middle, moderately narrowed towards base, but distinctly sinuate to base, lateral margin broad, base wide, but not extended to the base. Elytra long oblong, densely punctuate, pubescent, coarsely punctuate and striate, apex truncate; intervals slightly convex, dorsal side not punctuate; near apex an orange round spot between striae 1–4. Tarsi hairy above, claws much curved and pectinate. Ventral side less densely hairy, abdomen punctuate, striate.

12. *Anchista fenestrate* (SCHIMDT-GOEBEL, 1846)

Anchista fenestrata (Schimdt-Goebel); Andrewes, 1923: 20; id. 1930: 23; Csiki, 1932: 1456; Jedlicka, 1963: 449; Lorenz, 2005: 491; Shi *et al*. 2013: 27.

= *Plochionus fenestrata* Schimdt-Goebel, 1846: 42; Chaudoir, 1872: 168; Bates, 1892: 424.

= *Anchista glabra* Chaudoir, 1877: 237; Andrewes, 1930: 23; Csiki, 1932: 1456; Lorenz, 2005: 491.

= *Anchista nepalensis* Kirschenhofer, 1994: 1005; Lorenz, 2005: 491.

= *Anchista subpubescens* Chaudoir, 1877: 238; Csiki 1932: 1456; Lorenz, 2005: 491.

Distribution: India (Kerala: Thamarassery; Koorachundu, Kakkayam, Nedumkayam, Charalmedu, Chinnar-Karimutty; Tamil Nadu: Thambaram, Rajapalayam, Papanasam; Karnataka: Gundelpet; Bihar; Pondicherry; Rajasthan;

West Bengal: Singbhum; Uttarakhand: Dehra Dun; Sri Lanka (Horawupatana); Myanamar; Nepal; Pakistan.

Specimens examined (n=16): INDIA: Kerala, Kakkayam, 14.II.2016, Light trap, Jithmon V.A., 7 exs; Koorachundu, Light trap, 14.III.2016, Jithmon V.A., 2 ex.; Koorachundu, 16.X.2016, Light trap, Jithmon V.A., 1 exs; Peruvannamoozhi, 10.II.2017, Light trap, Jithmon V.A., 4 exs; Kakkayam, Light trap, 19.XI.2017, Jithmon V.A., 2 ex.

Length 7.7–8.5 mm.

Dorsal side yellowish to reddish yellow, antennae yellowish brown to reddish brown. Elytra with variable bicolored patterns; femora yellow, tarsi and tibiae yellowish brown. Head glabrous, without microsculpture, vertex with a few fine punctures. Pronotum glabrous, cordiform, widest slightly before middle; pronotal base briefly but distinctly lobed, moderately convex, without punctures, front angles with a few moderately long setae, lateral margins slightly angulate in middle, strongly sinuate before hind angles, lateral explanate area wide and even, with a few coarse punctures; hind angles sharp, rectangular or slightly acute; median line distinct. Elytra with striae shallow but distinct, finely punctate, intervals slightly convex, finely and sparsely punctate, 3rd interval with three to five setigerous pores, the basal one usually placed at basal one-third approximately, adjacent to 3rd stria or on middle of interval, the rest adjacent to 2nd stria, 5th interval with two to four setigerous pores, basal one near interval base, the last one usually at middle, all pores usually in center of 5th interval or slightly adjacent to 5th stria, basal margination nearly complete.

13. *Chlaenius malachinus* (MOTSCHULSKY, 1865)

Motschulsky, 1865: 335; Chaudoir, 1876: 280; Andrewes, 1928: 12; Andrewes, 1930: 96.

= *Chlaenius pudicus* Chaudoir, 1876.

Distribution: India. Sri Lanka.

Specimens examined (n=2): INDIA: Kerala, Kakkayam, 14.II.2016, Light trap, Jithmon V.A., 1 ex; Kakkayam, Light trap, 19.XI.2017, Jithmon V.A., 1 ex.

Length: 7.5 mm.

Antennae dark brown, with the first two segments yellow, linear, less elongated. Pronotum short, more transverse, indented at anterior border, with the posterior angles a little obtuse, surface flat, punctuated, rough. Median band of the pronotum narrower with wider yellow lateral border. Elytra slightly elongated, longer than broad, more truncated at the base which is slightly indented, connected clearly to pronotum; striations finer, intervals punctuated. Elytra entirely black with the epipleures only going up to the second striae. Legs reddish brown.

14. *Chlaenius kanarae* ANDREWES, 1919

Andrewes, 1919: 3; Andrewes, 1930: 95.

Distribution: India (Karanataka: North Kanara; Goa: Mormugao; Kerala: Kakkayam).

Specimens examined (n=1): INDIA: Kerala, Kakkayam, 14.II.2016, Hand picking, Jithmon V.A., 1 ex.

Length: 14 mm.

Black. Head metallic green, pronotum dull copper-red on disk, greenish at sides, blue at extreme margin, elytra aeneous black; femora, tibiae; antenna, labium, palpi, trochanters, and tarsi reddish; a yellowish apical spot on each elytron. Pronotum and elytra finely pubescent. Head small, very finely rugose, with a few small punctures; eyes prominent, antennae slender. Pronotum convex, half as wide again as head, more narrowed in front than behind, widest behind middle, sides rather explanate, hind angles obtuse, rounded, surface coarsely punctate, more sparsely towards front angles. Elytra nearly parallel, intervals flat, finely aciculate; yellow spot near apex from middle of interval 3 to stria 9, the colour extending a little forward on intervals 5 and 6 and backwards on 6–8. Underside shiny, iridescent, prosternal process bordered at apex, pro-episterna moderately punctate on inner side, metepisterna longer than wide, moderately punctate, with a groove near outer margin. Front femora (male) without trace of tooth; tarsi glabrous on upper surface.

15. *Orthogonius lucidus* BATES, 1891

Bates, 1891: 324–340; Sabu *et al*., 2009: 372.

Distribution: India (Jharkhand: Chota Nagpur. Konbir, Tetara, Ranchi; Maharashtra: Mumbai; Kerala: Kannur, Kozhikode, Thamarassery, Wayanad, Idukki, Thodupuzha).

Specimens examined (n=3): INDIA: Kerala, Koorachundu, 15.V.2016, Hand picking, Jithmon V.A., 1 ex; Peruvannamoozhi, 10.II.2017, Light trap, Jithmon V.A., 1 exs; Koorachundu, 18.III.2018, Hand picking, Jithmon V.A., 1 ex.

Length: 12–13 mm.

Body black; antennae, mouth parts and leg reddish brown, lower surface black but slightly brownish. Head small, strongly wrinkled and with very fine punctures; labrum emarginated, six setose, clypeus truncate in front, paraglossae longer than ligula; labial palpomere 2 plurisetose; mentum without tooth, bisetose. Pronotum transverse more wider than long, disc moderately convex with dense transversal wrinkles and a few faint punctures; lateral explanate margins gradually wider towards base and strongly wrinkled; apical margin slightly emarginated; basal margin sinuate; median line clear in the middle neither reaches apex nor base; anterior angles more rounded whereas posterior angles more or less rectangular. Elytra elongate twice longer than wide; 8 striate, punctate striate; striae fine and shallow; intervals moderately convex; interval 3 with 3 setigerous punctures; apex obliquely truncate. Prosternal process bordered at apex.

16. *Orthogonius indicus* TIAN & DEUVE, 2006

Tian & Deuve, 2006: 140–141; Sabu *et al*., 2009: 370.

Distribution: India: Tamil Nadu: Madras; Kerala: Mahe, Paithalmala, Kozhikode Medical College, Devagiri, Kizhakoth, Thamarassery, Malapparamba, Chelannoor, Pullorampara, Beypore, Koduvally, Kakkayam.

Specimens examined (n=1): INDIA: Kerala, Kakkayam, Light trap, 19.III.2016, Jithmon V.A., 1 ex.

Length: 13.5–16 mm.

Dark brown, underside and coxae, trochanters and femora of legs lighter. Head with small punctures on vertex, pronotum and elytra glaborous, moderately shining. Head short convex, surface with small punctures, frontal impressions faint, where with coarse wrinkles; labrum straight at frontal margin, clypeus bisetose; ligula small, bisetose at apex, paraglossae adnate; labial palpomere 2 bisetose on inner margin; antennae stout, not extending to base of pronotum. Pronotum transverse, bordered at base and fore margins, lateral expanded margins narrow, gradually widen towards base, slightly reflexed. Elytra elongate ovate, convex, borderedat base, humeri square, paralleled at sides, striae deep, interval 3 with three setiferous pores. Prosternal process bordered at apex. Fore tibia dilated at apex, apical spurs of hind tibia short and broad, fore claws pectinate.

17. *Orthogonius indophilus* TIAN & DEUVE, 2006

Tian & Deuve 2006: 130; Sabu *et al*. 2009: 371.

Distribution: India: Kerala: Travancore, Kozhikode, Engapuzha, Thamarassery, Kuruvattor, Koyilandy; Karnataka: Mysore, Coorg.

Specimens examined (n=4): INDIA: Kerala: Kakkayam, Light trap, 19.III.2016, Jithmon V.A., 1 ex.; Peruvannamoozhi, 10.II.2017, Light trap,

Jithmon V.A., 2 exs; Koorachundu, 27.VIII.2017, Hand picking, Jithmon V.A., 1 ex.

Length: 13 mm.

Body dark brown, labrum, palpi, antennae yellowish brown, tibiae red brown. Strongly shiny, glabrous and smooth on surface, head and pronotun without wrinkles and punctures. Head as wide as long, eye large, neck comparatively long; labrum slightly emarginated at apical margin; clypeus bisetose, ligula bisetose, palpi normal. Pronotum rather convex, widest at one-third of elytra from base, lateral expanded margins narrow and flat, both fore and basal transversal ompressions obvious, basal foveae small, but deep. Elytra narrowly elongate ovate, paralleled at sides, apex deeply emarginated, with obvious rounded outer angle, inner angle nearly rectangular; elytral striae fine and shallow, intervals convex with well-marked tooth like impressions; interval three with three setiferous pores. Legs slender, fore tibia with outer angle very sharp; hind tibial spurs broad, tarsomere 3 longer than tarsomere 4; tarsomere 4 deeply emarginated, claws pectinate. Prosternal process unbordered at apex.

18. *Orthogonius baconoides* TIAN & SABU, 2009

Sabu *et al.* 2009: 372.

Distribution: India: Tamil Nadu: Nilgiri Hills, Madras; Karnataka: Shimogga, Mysore; Kerala: Mahe, Kozhikode, Wayanad.

Specimens examined (n=2): INDIA: Kerala: Kakkayam, Light trap, 19.III.2016, Jithmon V.A., 1 ex.; Peruvannamoozhi, 10.II.2017, Light trap, Jithmon V.A., 1 exs.

Length: 9.0–11.5 mm

Head and elytra dark brown, pronotum, antennae, palpi, underside and legs yellowish to reddish brown. Head and pronotum impunctate, elytra faintly punctured on odd intervals. Head stout, eyes comparatively small, frons and vertex flat; labrum slightly emarginated at front margin, sexsetose, clypeus bisetose; ligula bisetose at apex, labial palpomere 2 bisetose in inner margin. Antennae long. Pronotum strongly transverse widest a little behind middle, lateral expanded margins rather wide, hardly reflexed, both anterior and posterior angles broadly rounded; disc slightly convex, basal foveae small and shallow. Elytra elongate-ovate, well bordered at base, parallel at sides, humerus rather quadrate, apex obliquely and broadly truncate; striae deep, interval 3 with only two setiferous pores. Legs moderate, fore tibia with outer angle nearly rectangular; hind tibia with apical spurs short, pointed at apex, tarsomere 4 deeply bilobed; claws pectinate. Prosternal process with apex well bordered.

19. *Craspedophorus mandarinellus* BATES, 1892

Andrewes, 1921: 187; id. 1930: 135; Baehr, 2003: 447; Xie & Yu. 1991: 170; Kirschenhofer, 2000: 324; Lorenz, 2005: 321; Kirschenhofer, 2011: 40, 47; Hackel & Farkac, 2012: 77; Hackel & Kirschenhoffer, 2014: 309; Fedorenko, 2016: 30.

= *Epicosmus mandarinellus* Bates, 1892: 299.

Distribution: India (Maharashtra: Mumbai, Karnataka: Shimoga), Myanmar, Vietnam, China (Guangxi).

Specimens examined (n=2): INDIA: Kerala: Koorachundu, 16.X.2016, Light trap, Jithmon V.A., 1 exs; Peruvannamoozhi, 10.II.2017, Light trap, Jithmon V.A., 1 ex.

Length: 9.5 mm.

Body winged. Fairly small and slender. Appendages black. Black palps, antennae and legs. Strongly convex eyes. Pronotum Convex, transverse, densely punctured, rather narrow with lateral margin very gently explanate-reflexed. Lateral margins arcuate, narrowing towards anterior angles, widest immediately behind midlength, lateral margins narrowing posteriorly, sinuate in front of posterior angles, which are denticulated. Elytra parallel-sided, convex, deeply striated, intervals convex, weakly glossily, densely punctured; elytral maculae yellowish, marginated (not serrate), humeral macula reaches from 4th interval to margin and even on epipleura, preapical margin reaches from 4th to 8th interval. Legs black, tarsi brownish.

20. *Adischissus notulatus* (FABRICIUS, 1801)

Fedorenko, 2015: 277.

= *Dischissus notulatus* Andrewes, 1921: 162; Andrewes, 1930, 153; Lorenz, 2005: 322.

= *Carabus notulatus* Fabricius, 1801: 201; Hope, 1838: 90; Schaum, 1847: 48; id. 1853: 432; Motschulsky, 1855: 70.

= *Craspedophorus longicornis* Schaum, 1863: 84; Chaudoir, 1878: 153; Bates, 1892: 303; Heller, 1916: 276; Andrewes, 1927: 108.

= *Panagaeus sumatranus* Dohrn, 1891: 253–254; Andrewes, 1922: 246.

= *Dischissus phuongensis* Kirschenhofer, 1994.

Distribution: India (Andhra Pradesh; Arunachal Pradesh; Assam; Bihar; Jharkhand; Karnataka; Kerala; Madhyapradesh; Manipur; Meghalaya; Mizoram; Nagaland; Odisha; Tamilnadu: Nilgiri hills; Tripura; Uttarpradesh; Uttarkhand; West Bengal: Kolkata, Almora; Sikkim: Namsoo), Myanmar (Insein, Taungoo, Rangoon, Kawkareik), Malaysia (Kuala Lumpur), Singapore, Hongkong, Bangladesh, Cambodia, China (Shanghai, Anhui, Fujian, Guangdong, Guangxi, Guizhou, Hunan, Xizang, Zhejiang provinces), Laos, Myanmar, Nepal, Sri Lanka, Taiwan, Thailand, Vietnam.

Specimens Examined (n=1): Peruvannamoozhi, 10.II.2017, Light trap, Jithmon V.A., 1 ex.

Length: 7.2–8.3 mm.

Head and pronotum black to brownish black, posterior pronotal angles reddish yellow. Each elytron with two yellowish-red maculae that reach laterally eighth or ninth interval and often margin, and medially third, fourth or fifth interval; preapical macula does not reach apex. Antennae black or brownish black; tip of terminal palpomere yellowish. Femora yellowish red and tibiae and tarsi brownish. Dorsum smooth and densely covered by semierect setae. Pronotal

and elytral epipleura lighter, yellowish. Eyes large, strongly convex; temples short, together with eyes converging toward neck; Clypeus and neck smooth. Mentum without median tooth. Pronotum wider than long, coarsely rugose nearly throughout, narrowing forward in straight line or obliguely. Posterior angles usually sharp, anterior angles not extending forward. Anterior and basal margins nearly straight. Elytra convex, not widening posteriorly, toward apex evenly rounded. Basal rim incomplete, widening to fifth interval lateral of which merges with basal margin. Humeri distinct, often weakly slanted. Striae deep, coarsely and densely punctured. Intervals convex, punctured and often rugate.

21. *Euschizomerus indicus* JEDLICKA, 1955

Jedlicka, 1955: 207; Lorenz, 2005: 322; Hackel & Farkac, 2012: 86; Jithmon & Sabu, 2018: 365.

= *Euschizomerus schuhi* Kirschenhofer, 2000: 360; Hackel & Farkac, 2012: 86.

Distribution: India: Mumbai. Lonvala (Maharhastra), Goa: Benaulin Beach, Kerala: Kozhikode, Kakkayam.

Specimens examined (n=1): India, Kerala, Kakkayam, 10.II.2017, light trap, Jithmon V. A, 1 ex.

Length: 12.5–14 mm.

Head, Pronotum and Elytra Pure black. Antennae, palps and legs reddish yellow. Head smooth forehead and labrum, shiny, vertex distractly punctured, with strongly bulged eyes, slightly convex in the middle, long and deep furrows. Labrum small, angles weakly rounded, smooth, anterior margin strongly

emarginated. Mandibles fairly short, narrowed to the tip strongly rounded. Frontal furrows reaching about the level of the posterior margin of eye, Genae briefly deposited. Pronotum convex, wider than head, wider than long. Very rough, wrinkled and hairy dorsal side with punctures. Narrowly rounded to the anterior corners, widest and expands behind the middle, posterior corners obtuse. The marginal edge of the pronotum extremely thin.Basal impressions oblong, rectilinear, flat. Elytra highly convex, weakly ovoid, quite long, 3.5 times as long as the pronotum with weakly sloping projected shoulders. Slightly rounded on the sides, largest width just behind the middle, striae moderately deep, roughly punctured, Intervals slightly convex, fine and distracted punctured. First protarsal segment of male non-symmetrical with distal half outwardly enlarged than in female, ventral side of enlarged portion bears adhesive setae. Median lobe of aedeagus long with pointed apex, arcuate downwardly.

22. *Oxylobus follis* ANDREWES, 1929

Andrewes. 1929: 294 and 299; id. 1930: 253.

Distribution: India (Tamil Nadu: Kodaikanal; Andra Pradesh: Horseley Konda. Sirumalai; Kerala: Peerumedu, Wallardi)

Specimens Examined (n=1): Kakkayam, Hand pick, 19.III.2016, Jithmon V.A., 1 ex.

Length: 19–23 mm.

Head smooth, short striae and a few puctures behind eye, eyes small, fairly prominent. Labrum with setae equidistant, clypeus slightly emarginated,

clypeal suture distinct in middle, obsolete st sides, frontal impressions moderately deep, parallel, linear, nearly reaching hind eye level. Pronotum half wider than head, wider than long, strongly contracted infront where the angles are evident, though rounded, sides almost straight, rounded behind front angles, narrowly bordered with 3 setae in the lateral channel infront, fine median line, basal fovea small. Elytra a fourth wider than pronotum and a half as long as wide, 9 striate, striae moderately deep and finely punctate or crenulated, punctures large at apex, intervals narrower and more convex at apex.

23. *Clivina helferi* PUTZEY, 1866

Putzey. 1866: 126; Andrewes. 1926: 375; id. 1927: 109; id. 1929: 354 & 367; id. 1930: 114.

= *grammica* Putzey, 1877: 41.

= *debilis* Bates, 1892: 278.

= *invalida* Andrewes, 1919: 470; id. 1924: 12.

Distribution: India (West Bengal: Kolkata; Bihar: Khargpur, Dinapur, Pusa; Odisha: Balugaon, Barkuda Is. (Lake Chilka), Bangladesh (Sunderbans, Parbatipur), Myanamr (Tharrawaddy, Prome, Mandalay, Rangoon, Toungoo, Kondan).

Specimens examined (n=2): Peruvannamoozhi, Hand picking, 10.II.2017, Jithmon V.A., 2 exs.

Length: 3.5–5 mm.

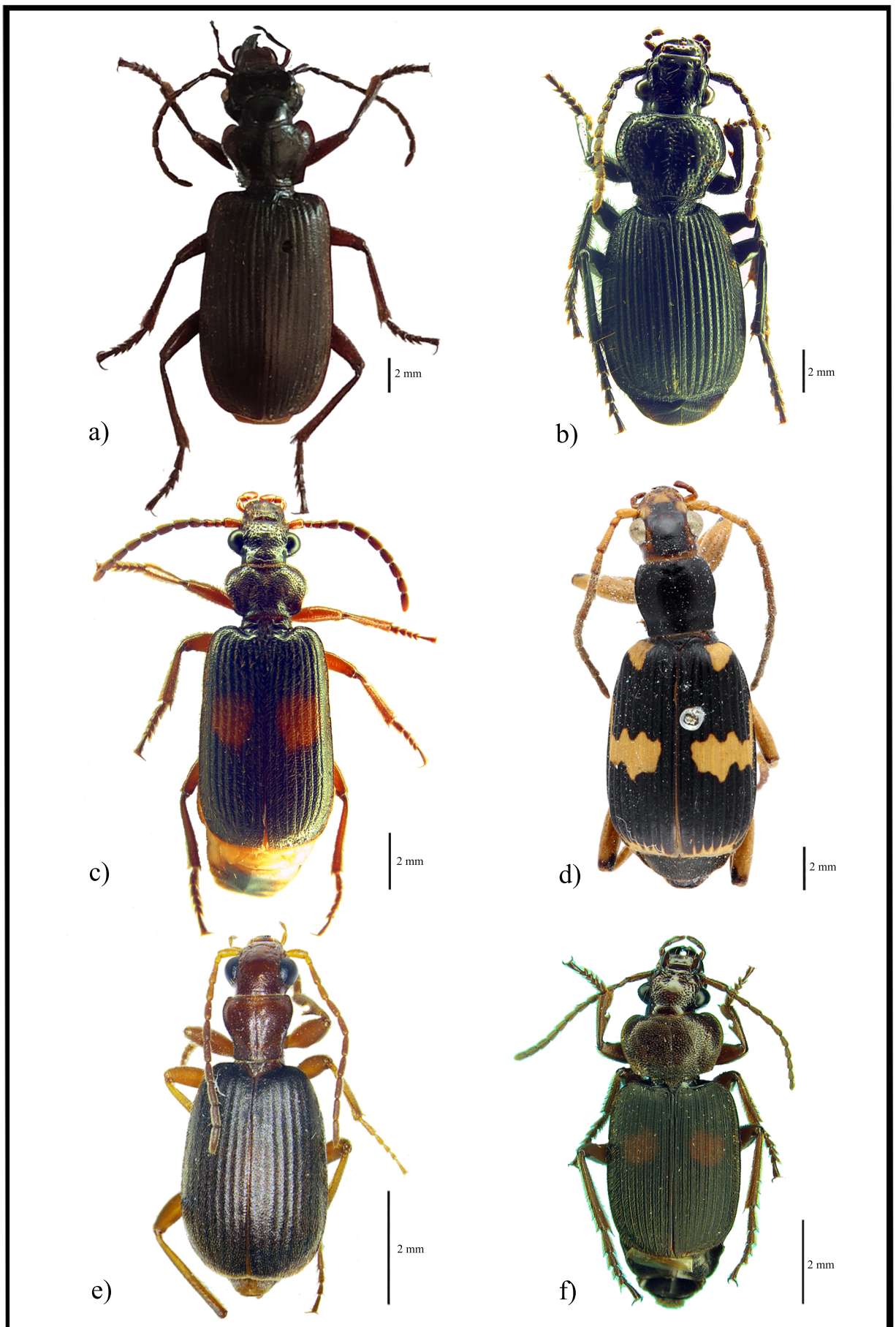


Plate 3: a) *Helluodes devagiriensis* Abitha 2008, b) *Omphra pilosa* Klug 1834, c) *Macrocheilus devagiriensis* Shiju 2012, d) *Pheropsophus picicollis* Chaudoir 1876, e) *Brachinus devagiriensis* Akhil 2020, f) *Planetes ruficeps* Schaum 1863.

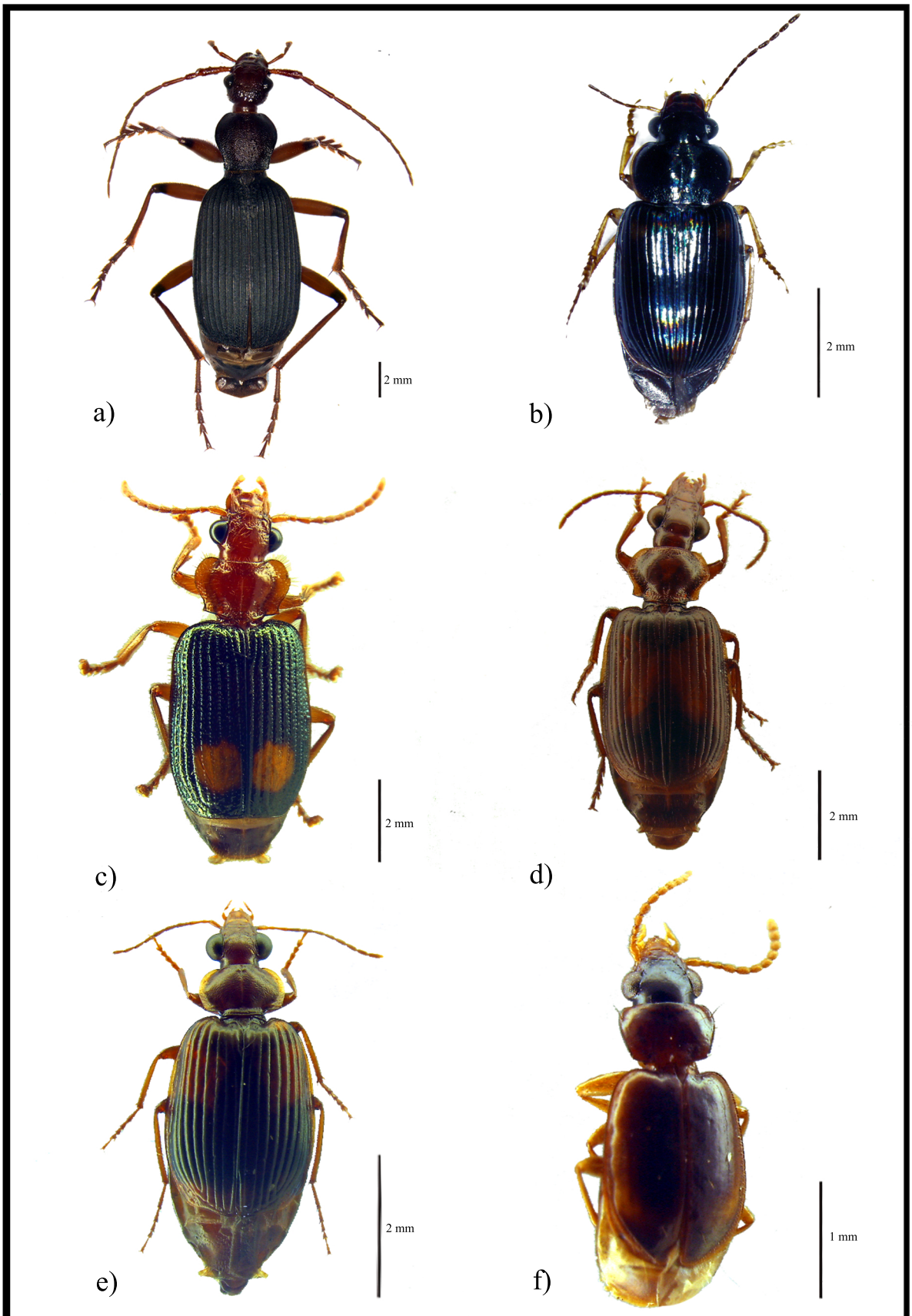


Plate 4: a) *Galerita orientalis* Schmidt-Goebel 1846, b) *Stenolophus smaragdulus* Fabricius 1798, c) *Lachnoderma biguttatus* Bates 1892, d) *Anchista fenestrata* Schmidt-Goebel 1846, e) *Lebia basalis* Chaudoir 1852, f) *Perigona nigricollis* Motschulsky 1851.

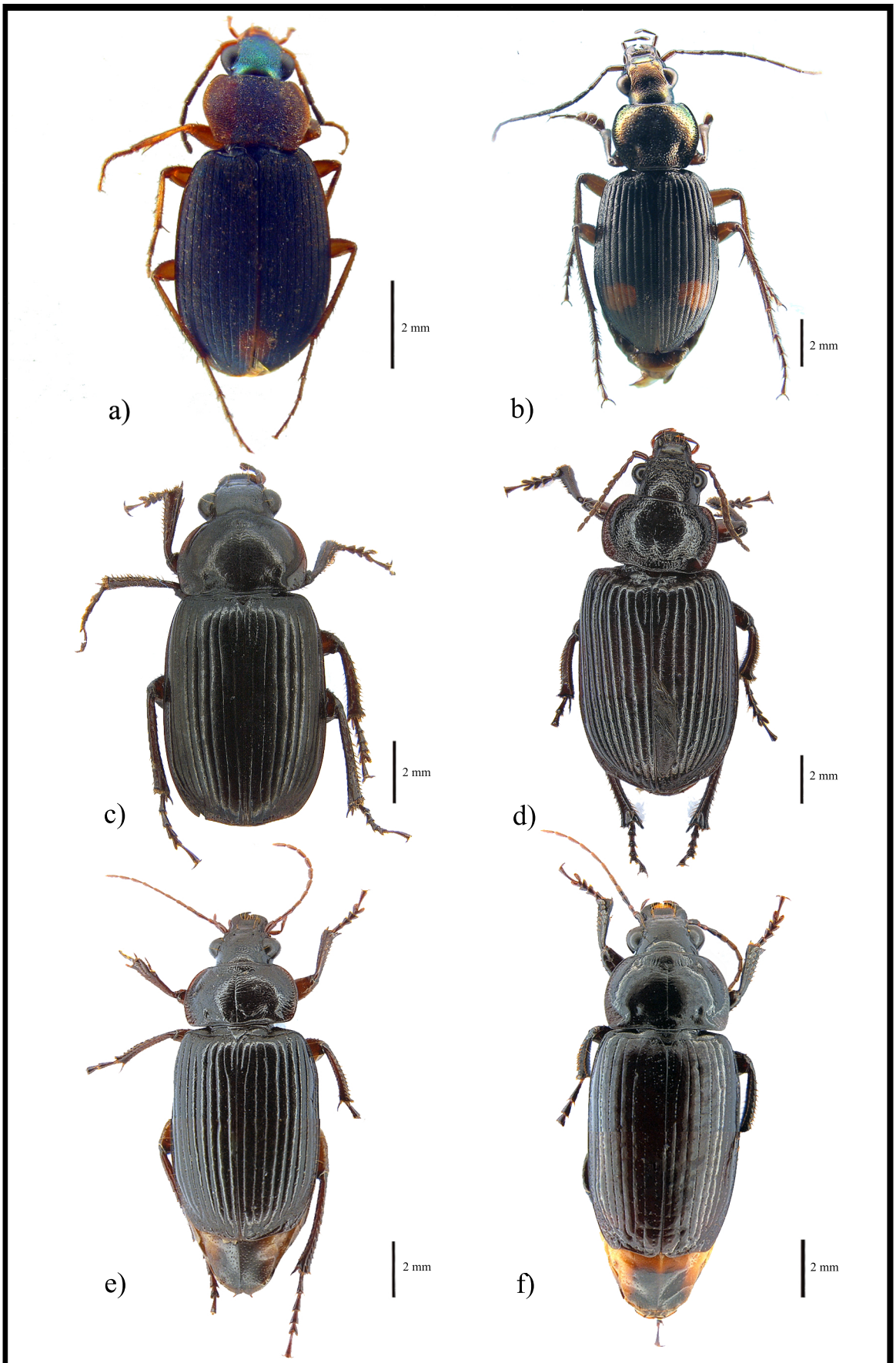


Plate 5: a) *Chlaenius malachinus* Motschulsky 1865, b) *Chlaenius kanarae* Andrewes 1919, c) *Orthogonius bacanoides* Tian & Sabu 2009, d) *O. indicus* Tian & Sabu 2009, e) *O. lucidus* Bates 1891, f) *O. indophilus* Tian & Sabu 2009.

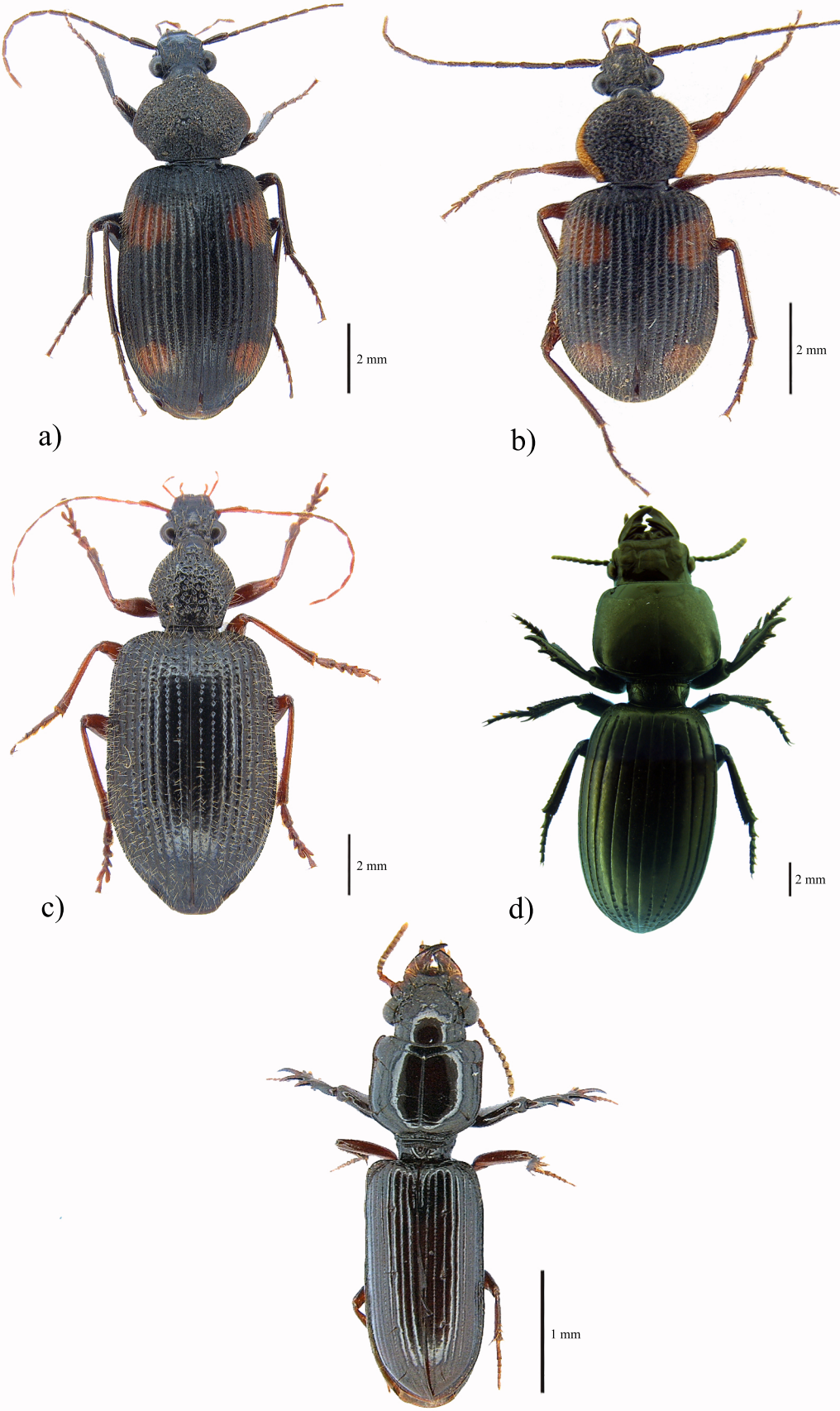


Plate 6: a) *Craspedophorus mandarinellus* Bates 1892, b) *Adischissus notulatus* Fabricius 1801, c) *Euschizomerus indicus* Jedlicka 1955, d) *Oxylobus follis* Andrewes 1929, e) *Clivina helferi* Putzey, 1866.

Reddish brown. Head and pronotum darker than elytra. Median part of clypeus emarginated, hardly bordered with rounded angles. Mentum with parallel sides. Pronotum with a faint Y figure on each side, obsolete. Elytra with striae 3 and 4 free at base, striole short. Venter with last segment punctate, two pores on each side distant. Profemora not dilated beneath, apex of trochanters prominent, mesotibia with a long spur at apical third.

4.1.3. Taxonomic descriptions and keys to the genera and species of subfamilies Dryptiinae and Panagaeinae

Subfamily Dryptinae Bonelli 1810

Subfamily Dryptinae has 3 tribes worldwide namely Dryptini, Zuphini and Galeritini and all the three tribes have been reported from India. Tribe Dryptini is represented by two genera viz., *Drypta* and *Dendrocellus*. Tribe Zuphini is represented by 6 genera (*Paraleleupidia*, *Gunvorita*, *Agastus*, *Zuphium*, *Parazuphium* and *Planetes*) and Tribe Galeritini by a single genus *Galerita*. Altogether 40 species are known from Indian subcontinent with eight species from South India including the four species from the Western Ghats.

Andrewes (1936) provided a key to the species of genera *Drypta* and *Desera* known from India and Southeast Asia. Liang *et. al*. (2004) gave a new taxonomic status to the genus *Desera* as *Dendrocellus* Schmidt-Göbel as the valid name for the species with pectinate tarsal claws formerly included in *Desera* Dejean or Hope). Twenty-two species are recognized in the genus

Dendrocellus Schmidt-Goebel 1846 (Liang & Kavanaugh 2007) and a key to the species from Asia and Australia are provided.

Tribe Zuphini is represented by 21 species belonging to 6 genera (*Paraleleupidia*, *Gunvorita*, *Zuphium*, *Parazuphium*, *Agastus* and *Planetes*) from India and 6 species belonging to 3 genera (*Paraleleupidia, Zuphium, Planetes*) from South India. Matue (1981) described the subtribe Leleupidiina (under tribe Zuphini) from Asia with the genera *Paraleleupidia* and *Gunvorita*. Baehr (1990) described a new species *Paraleleupidia linearis* from south India (Tamil Nadu, Ootacamund). Baehr (1998) gave a revision work on the genus *Gunvorita* from Oriental region, described five *Gunvorita* species and provided a key to the species. Tribe Galeritini is represented by a single genus *Galerita* with 5 species (*G. batesi, G. orientalis, G. nigripennis, G. indicus* and *G. ruficeps*) in India and species key to the genus provided.

Tribe 1. Dryptini Bonelli 1810

Key to the Genera of Tribe Dryptini

1. The tarsal claws are smooth ……...….... ***Drypta***

- Tarsal claws are pectinate ……..… ***Desera***

Genus 1. *Drypta* Latreille, 1796

Latreille, 1796: 75; Fabricius, 1801: 230; Latreille, 1810: 117; Dejean, 1825: 182; Schmidt- Goebel, 1846: 22; Lacordaire, 1854: 79; Andrewes, 1924: 51; id. 1930: 157; Lorenz, 2005: 503.

Body more or less elongated. Head square elongated with a large neck. Eyes rounded, fairly prominent. Extremity of the first segment of antennae and middle of the third blackish. Filiform antenna, shorter than body, scape of antennae as long as next three segments together, scape enlarged towards apex. Last segment of the palps securiform in both sexes, obliquely truncate. Mandibles advanced, almost straight and curved at the tip. Mentum suborbicular, transverse, rather strongly indented, without median tooth. Ligula Linear, elongated, narrow, at the end a little wider and roundly pointed. Paraglossae membranous, free, linear with curvature, much shorter than ligula. Maxillae wide and angular at their base, then straight, and abruptly curved in a very sharp point, pubescent inwards in all their length. Pronotum narrow, more or less elongated and subcylindrical. Elytra with dotted striae; elongated oval, almost parallel, and slightly convex. Truncated and often at the same time slightly rounded at the tip. First three segments of anterior tarsi slightly dilated in the males, triangular, pubescent. Last segment deeply bilobed in both sexes. First segment of all tarsi fairly elongated, the second and third rounded oval in shape.

Key to the species of Genus *Drypta* from Indian mainland

(Modified from Andrewes 1936)

1. Pronotum cordate, not much longer than wide, not constricted at base, with well-marked generally border, clearly visible from above, always dark in colour 2

- Pronotum cylindrical, gently dilated in front and more or less constricted before base, distinctly longer than wide, border slight, at most faintly crenulate, and inconspicuous from above ……..……. 3

2. Eyes projecting laterally beyond genae, tibiae black pronotum gently rounded in front, border crenulated, intervals of elytra convex at base, colour blue black ……....……..……... ***siderea***

- Eyes not projecting laterally beyond genae; border of pronotum crenulated, tibiae ferruginous ….…….……...…… ***crassiuscula***

3. Head, pronotum and elytra uniformly blue, greenish blue or blue black ....… 4

- Head and pronotum red ……...……...……. 6

4. Dark blue, the head and pronotum blue black, elytra barely two thirds longer than wide, intervals strongly convex …….…… ***argillacea***

- Blue or greenish blue, elytra about twice as long as wide, intervals only moderately convex. Length not exceeding 11 mm, blue, knees infuscate, elytral striae fairly deep, intervals moderately convex ……...…...…. 5

5. Head wider than pronotum, the latter two thirds longer than wide and only slightly dilated at middle, the elytral intervals uniformly and fairly closely punctate ……..…….....……... ***aetheria***

- Head as wide as pronotum, the latter only a third longer than wide and distinctly dilated at middle, the elytral intervals very finely and sparsely punctate …….……...…… ***cyanopa***

6. Elytra dark blue with an elongate discal red patch, all the red parts iridescent, femora blue with red base ……..……..…….....….. ***aeneipes***

- Elytra blue black with a red sripe on each, red parts not iridescent, femora ferruginous, black at apex …..……..……..…… ***lineola***

1. *Drypta aenipes* Wiedemann, 1823

Wiedemann, 1823: 60; Heller, 1923: 304; Andrewes, 1921: 173, id. 1930: 157.

Distribution: Bangladesh (Dacca).

Length: 8 mm.

Head, Pronotum, discal patch of elytra reddish, elytral margins and legs bronze coloured. Head more convex, less punctate, genae longer, neck more constricted. Pronotum shiny, shorter, punctate, relatively wider in front and a little more compressed behind. Elytra dark blue with an elongate discal red patch, all the red parts iridescent, brassy green on base and apex, more finely striate, punctuation of intervals finer and more distinct, outer extremity of truncature hardly denae, but forming a sharp angle. Femora blue with red base.

2. *Drypta lineola* MacLeay, 1825

MacLeay, 1825: 27; Dejean, 1825: 184; Redtenbater, 4; Chaudoir, 1877: 262; Bates, 1883: 279; id. 1891: 336; id. 1892: 383; Heyne-Tasch, 1898: 13; Bouchard, 1903: 173; Andrewes, 1919: 167; id. 1924: 469; id. 1923 (1924): 460; id. 1924: 52; id. 1930: 158; Lorenz, 2005: 503.

= *virgate* Chaudoir, 1850: 34; Bates, 1889: 280.

= *philippinensis* Chaudoir, 1877: 263.

Distribution: Throughout India, Java, Sumatra Borneo, Japan, Myanmar, China, Philippines

Length: 9.1 mm.

Body dark blue. Head, pronotum, elytra, antennae and legs reddish brown. Pronotum with shallow punctuation, marked longitudinal line. Elytra striated, finely punctuated. Bluish, with a brownish red longitudinal linear spot. Femora reddish yellow with blackish apical one third. Tibia and tarsi of anterior legs blackish and that of middle and posterior brownish or reddish.

3. *Drypta aetheria* Andrewes, 1936

Andrewes, 1936: 135; Lorenz, 2005: 503.

Distribution: India (Assam).

Length: 10.5 mm.

Body bright blue. Labrum, antennae and legs reddish brown, with the apical third of antennal joint 1 brownish. Body pubescent. Head twice as long as wide, a fourth wider than pronotum, eyes convex and prominent, neck constricted at sides, antennae reaching basal third of elytra, surface closely punctate. Pronotum subcylindrical, two third longer than wide, sides with a distinct border, posterior angles projecting laterally, median line evident, surface closely punctate. Elytra moderately convex, two and a quarter times wider than pronotum, four-fifths longer than wide, moderately dilated behind, apex truncate

with a short sharp tooth on each side at the outer angle, stiae moderately deep and closely punctate, intervals convex, punctate.

4. *Drypta argillacea* Andrewes, 1924

Andrewes, 1924: 106; id. 1930: 157; Lorenz, 2005: 503.

Distribution: India (Tamilnadu: Chennai; Odisha: Ganjam, Surada; Telangana: Bijnor; Utterakhand: Chakrata, Dehra dun, Nainital; Maharashtra: Nagpur; West Bengal: Kolkata), Bangladesh (Dacca).

Length: 12–13 mm.

Body dark bluish black. Palps, basal half of the scape of the antennae, femora and trochanters brownish yellow. Segments 2–11 of antennae, labrum, mandibles, legs and tarsi dark brown. Pubescence grayish. Head twice as long as wide, flattened, collar smooth, prominent eyes. Pronotum longer than broad, cylindrical, widest at middle, middle line rather marked, punctuation strong and confluent. Elytra elongated, slightly convex, rather parallel towards the base, enlarged at first and having their great width to two-thirds, shoulders rounded, extremity quite distinctly truncated, the angles sutural a little acute; deep striations, strongly punctuated, striole, long scutellar, intervals fairly flattened, punctuation tight, but much less strong than that of the head and the pronotum.

5. *Drypta crassiuscula* Chaudoir, 1861

Chaudoir, 1861: 550; Andrewes, 1923: 6; id. 1930: 157.

Distribution: India (Dehradun).

Length: 10.5 mm.

Body black, slightly bluish. Mandibles and labrum brown, palpi and antennae lighter with the tip of the first article slightly brown. Pronotum broader, cylindrical, slightly depressed and fairly raised, which appear to be finely crenulated, the lateral edges are less depressed and less elevated than in the mandibles, the median line less depressed. Elytra shorter, the points at the bottom of the ridges are less wide, so that the intervals are less narrow, and the punctuation which covers them is strong and rather tight. Legs reddish yellow with the brown tips of femora.

6. *Drypta siderea* Bates, 1892

Bates, 1892: 382; Andrewes, 1923: 6; id.1930: 159.

Distribution: India (Garo hills, Dehra Dun, Karen Hills), Laos, China.

Length: 13 mm.

Body bluish black, elytra more shining, Palps and antennae reddish yellow. Apical half of scape blackish bronze coloured. Head widen behind the eyes, punctuated, longitudinally and lift up the middle of the forehead a little, and almost smooth. Pronotum with rounded lateral side explanate and denticulated, punctuated. Elytra with narrow base, posterior enlarged, striated and furrow transversely pointed, with the intervals narrower more convex and smoother down the middle, the sides only having each an irregular row of punctures.

Genus 2. *Dendrocellus* Schmidt Goebel, 1846

Schmidt-Goebel, 1846: 24; Lacordaire, 1854: 80; Chaudoir, 1861: 545; id. 1872: 101; Bates, 1892: 385; Andrewes, 1930: 141; Andrewes, 1939: 133; Jeannel, 1949: 1064; Liang *et al.* 2004: 379; Liang & Kavanaugh, 2007: 3.

= *Desera* Hope, 1838: 105; Dupuis, 1912: 319; Heller, 1923: 303; Csiki, 1932: 1553; Basilewsky, 1960: 177; Jedlicka, 1963: 486; Hansen, 1967: 400; Habu, 1967: 277; Lorenz, 2005: 503.

Body narrow, elongate. Black with blue or green luster, in some species mixed with coppery or purple luster; in some species, pronotum red or brown, sternum brown with blue luster. Head punctate and pubescent. Maxillary and labial apical palpomeres securiform; labrum with medial lobe slightly, moderately, or strongly protruded anteriorly; genae short and oblique, or long and distinctly tumid. Mentum without median tooth. Ligula linear, very elongate, apex bisetose; paraglossae membranous, free, linear, with the curvature, it is much shorter. Palpi with last segment elongate securiform. Pronotum cylindrical, punctate and pubescent, punctures larger than those on head and elytra. Elytra truncate at apex, outer angles more or less round, obtuse, slightly dentate, or strongly dentate and sharply pointed at apex; striae shallow, punctate; intervals flat or slightly convex, punctate and pubescent; in some species, punctures nearly equal in size, quite dense, interspace between two adjacent punctures narrower than diameter of punctures, in other species, punctures unequal in size, sparse, interspace between two adjacent punctures often wider than diameter of punctures. Legs slender, protarsomere 3 strongly or slightly asymmetrical or

symmetrical in male, symmetrical in female, tarsomeres 4 bilobed; tarsal claws slender, more or less pectinate on inner side, very different from those of *Drypta* (claws thick, strongly curved, and smooth on inner side).

Key to the species of Genus *Dendrocellus* from India

(Modified from Liang & Kavanaugh 2007)

1. Head, pronotum and elytra with green or blue or copper luster ……..…… 2

- Head and pronotum with blue; elytra with purple or green luster…. ***nepalensis***

2. Leg completely brownish except the dark brown apical portion of femora... 3

- Leg completely reddish yellow except the black apical portion of femora … 5

3. Outer angles of elytral apex slightly/ strongly dentate…..……. 4

- Outer angles of elytral apex obtuse, not pointed……..…….....… ***rugicollis***

4. Outer angles of elytral apex strongly dentate; Femora brown with apical sixth black; tibiae and tarsi black ……..….... ***unidentatus***

- Outer angles of elytral apex slightly dentate; Femora and Tibiae brown, apical seventh to sixth of femora dark brown …..…….…….. ***inexpectus***

5. Labrum with medial lobe strongly protruded and pointed anteriorly..***confusus***

- Labrum with median lobe slightly protruded anteriorly……..... ***geniculatus***

1. *Dendrocellus confusus* (Hansen, 1967)

Liang and Kavanaugh, 2007: 16.

= *Desera confusa* Hansen, 1967: 406; Lorenz, 2005: 503.

Distribution: India, China, Indonesia, Japan, Laos, Pakistan, Thailand.

Length: 10.2–11.2 mm.

Body black with green luster; Antennal segment 1 with apical fourth blackish brown, basal three fourths yellow; femora yellow, with apical sixth black; tibiae yellow. Head slightly wider than pronotum; labrum with medial lobe strongly protruded anteriorly, eyes large. Pronotum widest at the middle, slightly narrowed anteriorly. Elytra long, lateral margins nearly parallel, outer angles slightly dentate. Protarsomere 3 slightly asymmetrical in male; tarsal claws with 3 or 4 pectinations, length of the longest pectination less than half width of claw base.

2. *Dendrocellus geniculatus* (Klug, 1834)

Schmidt-Goebel, 1846: 25; Liang and Kavanaugh, 2007: 23.

= *Drypta geniculata* Klug, 1834: 52; Schmidt-Goebel, 1846: 25; Chaudoir, 1872: 192; Bates, 1883: 279; id. 1889: 280; id. 1891: 336; Bouchard, 1903: 173; Andrewes, 1921: 173; Heller, 1921: 530; Andrewes, 1923: 8; Heller, 1923: 303; Andrewes, 1924: 469; id. 1930. 142; Lorenz, 2005: 503.

= *Var. rugicollis* (*Dendrocellus*) Chaudoir, 1861: 546; id. 1872: 102; Andrewes, 1919: 170.

= *Desera (Dendrocellus) gilsoni* Dupuis, 1912: 319.

= *Desera gilsoni continentalis* Hansen, 1967: 405.

Distribution: Throughout South East Asia including Japan.

Length 8.0–10.2 mm.

Body black with green or blue luster, mixed with coppery luster; Antennae 1 with apical third dark brown, Antennae 3 with basal two-thirds slightly darker than apical third; femora yellow, with apical sixth or seventh blackish brown; tibiae yellow. Head wider than pronotum, labrum with medial lobe slightly protruded anteriorly; genae short, eyes large. Pronotum widest at middle, slightly narrowed anteriorly Elytra with lateral margins slightly widened to apex, outer angles obtuse or slightly dentate. Protarsomere 3 asymmetrical in male; length of the longest tarsal claw pectinations slightly shorter than width of claw base.

3. *Dendrocellus inexpectus* Liang & Kavanaugh, 2007

Liang and Kavanaugh, 2007: 23.

Distribution: India (Barway, Mumbai).

Length: 9.2–10.5 mm.

Body black with green luster. Head convex, densely punctate; labrum with medial lobe slightly protruded anteriorly; eyes large, apical third of Antennal segment 1 black and rest brown, mandibles and palpi brown. Pronotum densely punctate, widest before middle; apical angles round; strongly narrowed behind, sinuate to basal angles; basal angles obtuse, pointed laterally. Elytra short and wide, intervals nearly flat, densely punctate; outer angles slightly dentate. Protarsomere 3 slightly asymmetrical in male; tarsal claws with 5–6 long pectinations, length of individual pectination subequal to width of

clawbase. Tibia and apical sixth or seventh of femora dark brown, basal two-thirds of femora brown.

4. *Dendrocellus nepalensis* (Hope, 1831)

Liang and Kavanaugh, 2007: 27.

= *Desera nepalensis* Hope, 1831: 21; Chaudoir, 1872: 102; Dohrn, 1879: 457; Andrewes, 1919: 170; Heller, 1923: 303; Andrewes, 1930: 142; Lorenz, 2005: 504.

= *discolour* (*Dendrocellus*) Schmidt-Goebel, 1846: 24; Bates, 1891: 336; Andrewes, 1923: 7; Heller, 1923: 304.

Distribution: India (Assam: Assam valley, Khasi hills, Cachar; Sikkim: Darjiling, Gopaldhara, Pedong; Chota Nagpur: Tetara, Konbir; Tamilnadu: Shembaganur; Manipur). Martaban. Tonkin, China, Bangladesh, Bhutan, Myanmar, Nepal, Vietnam.

Length: 9.8–11.7 mm.

Body black, head and pronotum with blue luster; elytra with purple luster, antennae 1 yellow or with apical fourth brown; femora black with blue luster, tibiae yellowish. Head slightly wider than pronotum; labrum with medial lobe slightly or moderately protruded anteriorly, genae short, eyes large, convex. Pronotum short, widest at apical third. Elytra short, widened to apical fourth and narrowed to apex; outer angles broadly rounded, intervals slightly convex, sparsely punctate. Protarsomere 3 slightly asymmetrical in male; tarsal claws with 4–5 short pectinations.

5. *Dendrocellus rugicollis* Chaudoir, 1861

Chaudoir, 1861: 546; Lorenz, 2005: 504.

= *Dendrocellus flavipes* Schmidt-Goebel, 1846: 24.

Distribution: India, China, Nepal.

Length: 9.4–10.0 mm.

Body black with blue and green luster; palpi, tibia, basal two-thirds of Antennae 1, Antennae 2–11, basal six sevenths of femora yellow; apical third of Antennae 1, apical seventh of femora brown or black. Head slightly convex, labrum with medial lobe moderately protruded anteriorly, genae short, eyes large. Pronotum cylindrical, lateral margins widened from apical angles to middle, then narrowed posteriorly, sinuate before basal angles, basal angles nearly rectangular, middle line very shallow. Elytra with lateral margins slightly widened posteriad from base to apical third, then narrowed to apex, outer angles obtuse, not pointed, striae shallow, intervals densely punctate. Protarsomere 3 slightly asymmetrical in male; tarsal claw with 5–6 long pectinations.

6. *Dendrocellus unidentata* (Macleay, 1825)

Chaudoir, 1861: 545; Liang and Kavanaugh, 2007: 35.

= *Drypta unidentata* Macleay, 1825: 28; Andrewes, 1919: 167; id. 1930: 143; Heller, 1923: 303.

= *Desera unidentata* Andrewes, 1919: 167.

= *Dendrocellus longicollis* Chaudoir, 1861: 45.

= *Desera longicollis* Andrewes, 1936: 136.

= *Desera longicollis* Hansen, 1967: 403.

Distribution: India (Assam: Khasia hills, Andaman Islands), Indonesia (Java), Thailand, Pakistan, Myanmar, China, Vietnam.

Length: 11.5 mm.

Body dark blue, elytra blue black, femora (except apex), palpi, antennae reddish; mandibles and tarsi brown; apex of femora, tibiae, joint 1 of antennae black. Body covered throughout with short grey pubescence. Labrum with medial lobe slightly protruded anteriorly. Head elongate, flat, punctuate, labrum with front margin arcuate, last joint of labial palps securiform and obliquely truncate, eyes prominent. Pronotum twice as long as wide, lateral margins widest at middle, densely and coarsely punctate. Elytra elongate, shoulders strongly rounded, widened towards apex, apex truncate, outer angle with a short strong tooth, sutural angle fairly sharp but not toothed, scutellary striole between striae 1 and suture; intervals closely punctate. Protarsomere 3 slightly asymmetrical in male; Joint 4 of all tarsi strongly bilobed; claws pectinate.

Tribe 2. Zuphiini Bonelli, 1810

Eyes comparatively smaller, together not broader than frons. Antennae slender, joint 1 about as long as the next three taken together. Antennae inserted immediately beneath the pre ocular ridges. Mandibles entire and moderately sharp at apex, basal membrane of labrum not or rarely exposed, clear neck behind the eyes. Neck about a third as wide as the head. Pronotum more or less flattened, always with a clear, sharp and complete border around the sides. The

tips of the elytra are straight or obliquely sheared off. At least the tip of the abdomen is uncovered. Tarsal joint 4 not bilobed. Terminal spur of the hind tibia short.

Key to the genera of Tribe Zuphini from India

1. Neck strongly or moderately constricted …..……..…….. 2

- Neck as wide as the head. .....……..……...…….. ***Planetes***

2. Scape of antennae as long as the length of 2nd, 3rd and 4th segments together; Terminal segment of labial palps slightly widened at apex...……...….. 3

- Scape of antennae as long as only the length of 2nd and 3rd segments together; Terminal segments of labial palps highly securiform and very large 5

3. Segment 3 of antennae much longer than pedicel and more than half of the scape ……...……. 4

- Segment 3 of antennae equal to pedicel and less than half of the scape ……...……...……. ***Agastus***

4. Eyes projected a little …….....……..……..... ***Zuphium***

- Eyes reduced, shorter than temples ……..…….... ***Parazuphium***

5. 3rd segment of Antennae longer among segments 2–11; Frons without circular grooves ……...……..…….....… ***Paraleleupidia***

- Segments 2–11 of antennae having the same length; Frons with a pair of circular or horseshoe-shaped grooves …….. ***Gunvorita***

Genus 1. *Paraleleupidia* Basilewsky, 1951

Basilewsky, 1951: 176; id. 1953: 271; Mateu, 1981: 717; Baehr, 1990: 10; Lorenz, 2005: 504.

Head elongate and narrow. Eyes small, depressed. Mentum with strong unidentate tooth. Labium truncate. Maxillary palpus rather large. Terminal segment of labial palpus large, wide. Moderately short antennae pubescent with the third article a little shorter than the 1st and less than double longer than the 2nd, the others a little except the 8 to 10 which are almost moniliform. Surface with moderately coarse, rather superficial puncturation, but frons almost impunctate. Pronotum narrow, elongate, upper surface slightly convex. Base narrow, straight. Lateral margins with distinct border line. Surface with distinct microreticulation and with dense, moderately coarse, rugose, fairly superficial puncturation. Pilosity rather dense, erect. Elytra elongate, fairly depressed. Microreticulation dense and strong, puncturation dense. Pilosity dense. Legs elongate.

Key to the species of genus *Paraleleupidia* from India

1. Elytral apex truncated and straight; Lateral sides of head posteriorly widened ……... ***loebli***

- Elytral apex truncated and emarginated; Lateral sides of head parallel ..…… 2

2. Elytral Striation strong, intervals convex ……..… ***besucheti***

- Elytral Striation weak, intervals flat ……..…… ***linearis***

1. *Paraleleupidia linearis* Baehr, 1990

Baehr, 1990: 10; Lorenz, 2005: 504.

Distribution: South India (Tamil Nadu: Ootacamund).

Length: 6.5 mm.

Body dark brown. Labrum, palpi, antennae, and legs yellowish. Head elongate and narrow, convex, parallel, posteriorly rounded off, eyes small, depressed, mentum with strong unidentate tooth, maxillary palps large, terminal segment thick, short, obtuse at apex, terminal segment of labial palps large and wide, antennae surpassing middle of pronotum. Pronotum narrow, elongate, surface slightly convex, widest in anterior third, posterior angles rounded off, base narrow and straight, lateral margins with distinct border line, anterior and posterior marginal setae present, surface with distinct microreticulation and with dense puncturation. Elytra elongate, depressed, widened to apex, widest in posterior fifth, apex transverse, shoulders rounded off, striation weak. Series of marginal pores consisting of 8 humeral pores, 2 pores in posterior third, and 6 apical pores. Legs elongate.

2. *Paraleleupidia loebli* Mateu, 1981

Mateu, 1981: 719; Lorenz, 2005: 504.

Distribution: South India (Tamil Nadu: Nilgiri Hills, Chennai).

Length: 5.5 mm.

Body dark brown, head black, appendages and labrum reddish. Moderately shiny and pubescent. Head elongated, slightly convex, antennae pubescent, short, not reaching base of pronotum. Pronotum convex, narrow and elongated, wider than head with moderately rounded sides at the front, posterior angles sub-rounded, median line long and fine, lateral grooves narrow,

punctuation moderately large. Elytra elongated, narrow and parallel, subconvex; very little widened backwards from the humeri which are rounded. Elytra widest towards the posterior part, apex truncated and straight, intervals flat and punctuations small, lateral grooves narrow. Elytral surface with a series of 8 humeral, 2 middle and 6 apical centrally raised punctures.

3. *Paraleleupidia besucheti* Mateu, 1981

Mateu, 1981: 717; Lorenz, 2005: 504.

Distribution: South India (Kerala: Pambanar - Peermedu).

Length: 6.5 mm.

Body dark brown, reddish on labrum and anterior part of the head; margins of pronotum and elytra reddish brown, appendages pale reddish. Body covered with a fine golden pubescence. Head elongate, parallel, eyes flat, not protruding, surface strongly and regularly punctuated, antennae not reaching behind the base of pronotum. Pronotum cordiform, slightly convex, longer than broad, wider than head, long and deep lateral sinuosity, posterior angles obtuse but slightly protruding, deep median furrow, pronotal surface strongly and densely punctuated. Elytra narrow and elongated, apex truncated and barely sinuate in the middle, punctuated, convex intervals. Elytral surface is with a series of 8 humeral, 2 middle and 6 apical centrally raised punctures.

Genus 2. *Gunvorita* Landin, 1955

Landin, 1955: 467; Darlington, 1968: 208; Mateu, 1981: 721; Perrault, 1982: 76; Casale, 1985: 41: Baehr, 1988: 115, Baehr, 1990: 16; id. 1991: 194.

Pilosity elongate, hirsute and dense. Head always posteriorly widened, shape of head either pentagonal or more or less trigonal; eyes small; clypeal suture with a pair of deep grooves; frons with a pair of circular or horseshoe-shaped grooves, puncturation on head smooth. Pronotum narrow and dorsally convex, with inconspicuous lateral margin, puncturation on pronotum smooth. Elytra depressed, posteriorly widened, triangular. Male aedeagus almost always rather elongate, internal sac usually with 2 large sclerotized areas furnished with very elongate sclerotized teeth; Female stylomere 2 always elongate, little curved, with elongate, acute apex, two elongate ventral ensiform setae, 1 elongate dorsal ensiform seta, a well-developed nematiform seta, and stylomere 2 with 1–2 well visible nematiform seta at median rim.

1. *Gunvorita besucheti* Baehr, 1998

Baehr, 1998: 288.

Distribution: India (West Bengal: Darjeeling Dist.: Algarah-Labha).

Length: 4.8–5.3 mm.

Body black, suture of elytra reddish. Labrum, palpi, legs, and antennae yellowish, basal antennomere and femora reddish. Head elongate, oval-shaped, posteriorly widened, distinctly pentagonal, widest in posterior third, surface

convex, eyes small, clypeus anteriorly convex, labrum anteriorly convex, 6-setose, mandibles short, at apex sharply incurved, mentum with short and wide triangular tooth. terminal segment of labial palps large and very elongate, antenna surpassing middle of pronotum. Pronotum elongate, cordiform, longer than wide, wider than head, widest in anterior third, surface convex, lateral margin sinuate in front of posterior angles, apex wide, anterior angles obtuse, base narrow, median line fine, anterior marginal seta elongate, posterior seta slightly shorter. Elytra elongate, triangular, widest in posterior third, surface depressed, apex wide, straight, slightly oblique, striae irregularly marked by rows of punctures, puncturation sparse, fixed setae in third interval.

2. *Gunvorita depressipennis* Baehr, 1998

Baehr, 1998: 295.

Distribution: India (Meghalaya: Khasi hills-Nongpoh).

Length: 4.5–4.6 mm.

Body dark brownish. Labrum, palpi, legs, and antennae yellowish. Head elongate, oval-shaped, posteriorly widened, though neither triagonal nor pentagonal, widest in posterior third, surface convex, eyes comparatively large, clypeus anteriorly convex, frons convex, labrum anteriorly convex, 6-setose, mandibles short, at apex sharply incurved, mentum with short and wide triangular tooth, terminal segment of labial palps large and elongate. Antenna elongate, slightly surpassing middle of pronotum. Pronotum elongate, narrow, cordiform, longer than wide, wider than head, widest in anterior third, surface

moderately convex, lateral margin sinuate in front of posterior angles, base narrow, median line fine, anterior and posterior marginal setae present. Elytra elongate, narrowly triangular, surface depressed, apex wide and straight, markedly oblique, striae irregularly marked by rows of punctures, fixed setae in third interval.

3. *Gunvorita elegans* Landin, 1955

Landin, 1955: 467; Darlington, 1968: 210; Mateu, 1981: 721; Casale, 1985: 41; Baehr, 1998: 269.

Distribution: India (Sikkim), Nepal.

Length: 4 mm.

Body ant-like, convex, dark brown, appendages reddish yellow, surface with moderately long pubescence, surface shining under pubescence. Head long, eyes small, widened posteriorly and rounded, antennae stout, middle segments slightly longer than wide, maxillary palpi small, labial palpi with last segment securiform. Pronotum long, cordate; lateral margins subobsolete, each with one or two strong setae. Elytra narrowed anteriorly to slightly rounded humeri; submarginal umbilicate punctures not closely grouped but more numerous and less widely spaced anteriorly. Lower surface extensively pubescent, but proepisterna not pubescent. Femora rather stout, tibiae moderate, tarsi (especially posterior) slender; middle and hind tibiae each with curved or hooked spur on inner angle, claws simple.

4. *Gunvorita indica* Darlington, 1968

Darlington, 1968: 208; Mateu, 1981: 722; Baehr, 1998: 274.

Distribution: India (West Bengal: Darjeeling: Ghoom).

Length: 5.7–5.9.

Body ant-like, convex, dark brown, appendages reddish yellow; surface with moderately long pubescence; surface shining under pubescence. Head long, eyes small, genae divergent behind eyes, antennae stout, middle segments slightly longer than wide; maxillary palpi small, labial palpi with last segment enlarged. Pronotum long, cordate, lateral margins subobsolete each with one or two strong setae, middle line fine and faint. Elytra narrowed anteriorly to broadly rounded humeri, striae not prominent. Femora stout, tibiae moderate, tarsi (especially posterior) slender; male tarsi not modified, middle and hind tibiae each with curved or hooked spur on inner angle; claws simple.

5. *Gunvorita inermis* Baehr, 1998

Baehr, 1998: 272.

Distribution: India (West Bengal: Darjeeling).

Length: 3.6–3.9 mm.

Body dark brownish, suture of elytra narrowly reddish. Labrum, palpi, legs, and antennae yellowish. Head short, posteriorly widened, triangular, widest near base, surface convex, eyes small, clypeus anteriorly convex, frons convex, labrum anteriorly convex, 6-setose, mandibles short, at apex sharply incurved,

mentum with short and wide, triangular tooth, terminal segment of labial palps large, comparatively elongate, antennae moderately elongate, slightly surpassing middle of pronotum. Pronotum elongate, cordiform, longer than wide, wider than head, widest in anterior third, surface convex, lateral margin sinuate just in front of posterior angles, apex wide, anterior angles obtuse, anterior and posterior marginal setae present, surface without microreticulation, glossy, with fairly dense, coarse puncturation. Elytra elongate, triangular, widest in posterior third, surface moderately convex, odd intervals, apex wide, straight, striae irregularly marked by rows of punctures, fixed setae in third, surface without microreticulation, glossy.

6. *Gunvorita laeviceps* Baehr, 1998

Baehr, 1998: 270.

Distribution: India (West Bengal: Darjeeling, Kalimpong, Algarah, Singla).

Length: 4.0–4.25 mm.

Body dark brownish. Labrum, palpi, legs, and antennae yellowish. Head short, posteriorly widened, triangular, widest near base, surface convex, eyes small, clypeus anteriorly convex, frons convex, labrum anteriorly convex, 6-setose, mandibles short, apex sharply incurved, mentum with short and wide triangular tooth, terminal segment of labial palps large but comparatively short, antenna moderately elongate, slightly surpassing middle of pronotum. Pronotum elongate, cordiform, longer than wide, wider than head, widest in anterior third, surface convex, lateral margin sinuate in front of posterior angles, anterior angles

obtuse, slightly projecting, base narrow, anterior and posterior marginal setae present. Elytra elongate, triangular, widest in posterior third, surface moderately convex, apex wide, faintly sinuate, slightly oblique, striae irregularly marked by rows of punctures, puncturation rather sparse, coarse, fixed setae in third interval, setae elongate. Surface without microreticulation, glossy. Pilosity rather sparse, elongate.

7. *Gunvorita minor* Baehr, 1998

Baehr, 1998: 291.

Distribution: India (Meghalaya: Khasi Hills, Mawsynram).

Length: 4.0 mm.

Body dark brownish. Labrum, palpi, legs, and antennae yellowish. Head elongate, oval, posteriorly widened, though neither triagonal nor pentagonal, surface convex, eyes large, clypeus anteriorly convex, frons convex, labrum anteriorly convex, 6-setose, mandibles short, at apex sharply incurved, mentum with triangular tooth, terminal segment of labial palps large and elongate, antenna surpassing middle of pronotum. Pronotum elongate, cordiform, longer than wide, surface convex, lateral margin sinuate in front of posterior angles, anterior and posterior marginal setae present. Elytra elongate, narrowly triangular, widest in posterior third, surface depressed. apex wide and straight, striae irregularly marked by rows of punctures, puncturation sparse and coarse, fixed setae in third interval, setae very elongate. Surface without microreticulation, glossy. Pilosity rather sparse, moderately elongate.

8. *Gunvorita ovaliceps* Baehr, 1998

Baehr, 1998: 275.

Distribution: India (West Bengal: Darjeeling: Ghoom).

Length: 5.1 mm.

Body brownish black, suture narrowly reddish. Labrum, palpi, legs, and antennae yellowish. Head elongate, oval, posteriorly markedly pentagonal, posteriorly markedly widened, surface convex, eyes small, clypeus convex, frons convex, labrum convex, six setose, mandibles short, apex sharply incurved, mentum with short and wide, triangular tooth, maxillary palps elongate, apex obliquely cut, terminal segment of labial palps large and elongate, antenna surpassing middle of pronotum, puncturation on frons and vertex. Pronotum elongate, cordiform, longer than wide, wider than head, widest in anterior third, surface convex, lateral margin sinuate in front of posterior angles, anterior angles obtuse, slightly projecting, base narrow, lateral margin without distinct border line, anterior marginal seta elongate, posterior setae shorter. Elytra elongate, triangular, widest in posterior third, upper surface depressed, striae irregularly marked by rows of punctures, fixed setae in third interval.

Genus 3. *Agastus* Schmidt-Goebel, 1846

Schmidt-Goebel, 1846: 30; Lacordaire, 87; Andrewes, 1930: 12.

Mentum dentate but moderately blunt, sides narrow, pointed, Mentum with median tooth obtuse; ligula truncate apically; paraglossa membrenous,

laterally connate and apices prominent but short above. Apical segment of labial palpi elongate and fusiformis, maxillary ovate and truncate; labrum transverse, narrowed and truncate; punctures indistinct, base of the antennae testaceous. Brick red in colour. Eyes small and not protruding. Elytra convex with convex striae. Tarsi short and simple.

1. *Agastus lineatus* Schmidt-Goebel, 1846

Schmidt-Goebel, 1846: 31; Gestro, 1875: 867; Bates, 1889: 280; id. 1892: 388; Andrewes, 1923: 10; id. 1930: 13.

Distribution: India (Kolkata), Myanmar, Cochin China, Cambodia, Philippines.

Length: 5.0 mm

Body flat and narrow, punctured, dark brick red (reddish brown), elytral disc dark brownish, six elevated striae, edge of antennae and legs reddish yellow. Head dense and strongly punctured everywhere, with strong yellowish hairs, Labrum, all parts of the mouth, legs reddish-yellow, the latter somewhat darker towards the end. Pronotum scarcely wider than head, longer than broad, narrowed at back, with slightly rounded sides, truncated at base, project outward as a pointed tooth, strongly and densely punctured, occupied with scattered strong hair. Elytra are scarcely twice as wide, more than twice as long, as the pronotum, uniform all over, truncate at back, the outer corners very strongly rounded, with six raised striae, not included in the suture, the intervals being punctured. They scattered and short-haired, blackish brown, whole edge brownish red. Abdomen and legs are brownish yellow.

Genus 3. *Zuphium* Latreille, 1806

Latreille, 1806: 198; Latreille & Dejean: 1822: 121; Dejean, 1825: 192; Chaudoir, 1862: 310; Andrewes, 1930: 358; Lorenz, 2005: 506.

Body very depressed and pubescent. Head rounded, sharply narrowed back into a very narrow and pedunculated neck; small projecting eyes. Antennae long, pubescent from the base, the scape very elongated, without other erect bristle than the long apical bristle. Palps pubescent, last segment slightly dilated, truncated at its end. Labial palps pubescent. Mentum with median tooth. Maxillary and labial palpi similar to one another in size and proportions; 4th maxillary palpomere not markedly dilated. Pronotum elongated cordiform, the lateral parts of the basal edge truncated; Lateral groove very narrow. Marginal bristles present. Elytra wide, depressed, subparallel, with prominent shoulders and apical edge truncated. Obsolete striae; surface pubescent and finely punctuated. Elytra apically truncated and non-sinuous. Male fore-tarsomeres 1–3 with pad-like adhesive vestiture. Legs long, pubescent. 4th tarsal segment simple. Male protarsi with the first three dilated and with double ventral rows of adhesive setae.

Key to the species of genus *Zuphium* from India

1. Head red coloured……..……..……..…….. 2

- Head black or brown coloured ……...…….…….... 4

2. Elytra with anterior or both anterior and posterior spots ……..……. 3

- Elytra without spot ……..……..…..... ***indicum***

3. Elytra with anterior spots only…..……..…….…… ***dabreui***

- Elytra with both anterior and posterior spots…...……. ***erythrocephalum***

4. Head black coloured. Length 8.8 mm …….……..…..……. ***olens***

- Head brown coloured. Length 4.2 mm ……...……..……..… ***modestum***

1. *Zuphium dabreui* Andrewes, 1922

Andrewes, 1922: 168; id. 1930: 359; Lorenz, 2005: 506.

Distribution: India (Karnataka: Belgaum; Tamil Nadu: Kadayam, Chennai; Maharashtra: Nagpur), Sri Lanka (Vauniya, Horawupotana).

Length: 7.5–8.0 mm

Body reddish brown. Head, pronotum, border of elytra, suture near apex, and humeral spots reddish, side-margins and base of pronotum and elytra dark brownish-black. Pubescence short and fine. Head convex behind, flat in front, rather sparsely punctate and very shiny, eyes of moderate size, antennae hardly reaching apex of elytra. Pronotum cordate, slightly convex, a third as wide again as head, and hardly longer than wide again as head, and hardly longer than wide, contracted more behind than in front, lightly rounded in front and sinuate at basal fifth, front angles rounded, but distinct, hind angles right, not very sharp, moderately reflexed and projecting laterally; median line very fine, the surrounding area slightly depressed, surface finely and closely punctate. Elytra flat with oblique shoulders, sides parallel, two thirds as wide as pronotum, intervals convex, surface finely punctate. Red spot covers the shoulder and

extends backwards to a third from base, inwards to about stria 3. Surface moderately glossy.

2. *Zuphium erythrocephalum* Chaudoir, 1862

Chaudoir, 1862: 311; Andrewes, 1930: 359; Lorenz, 2005: 506.

Distribution: India (Madhyapradesh: Neemuch; Maharashtra: Nagpur; Kerala: Malabar; Tamil Nadu: Rajapalayam, Ooty, Chennai, Pondicherry).

Length: 7.5–8.0 mm

The size of the *Z. olens*, from which it differs by the colour of the head which is like that of the pronotum, elytra more shortened, weakly striated, more pubescent, with anterior spot extending on almost all the first third of the elytra and that posterior part of elytra triangular, prolonged in point on the suture and touching the posterior edge; Antennae considerably longer and more slender towards the extremity.

3. *Zuphium indicum* Andrewes, 1922

Andrewes, 1922: 167; id.1930: 359.

Distribution: India (Nagpur).

Length: 11.0 mm.

Body reddish brown. Head, pronotum and border of elytra red, elytra gray black. Pubescence extremely short and fine. Head very convex behind, flat in front, surface shiny, finely punctate, eyes small, antennae slender and reaching to

apex of elytra. Pronotum cordate, slightly convex, half as wide as head and longer than wide, sides gently rounded and sinuate at base, front angles much rounded, hind angles slightly obtuse, fine median line, surface finely and closely punctate. Elytra flat, with oblique but distinct shoulders, sides gently rounded, almost parallel, half as wide as pronotum, striae deeply impressed, finely and closely punctate, intervals flat, surface finely and closely punctate, glossy in appearance and consequently moderately shiny.

4. *Zuphium modestum* Schmidt-Goebel, 1846

Schmidt-Goebel, 1846: 29; Chaudoir, 1862: 312; Gestro, 1875: 864; Bates, 1892: 387; Andrewes, 1923: 10; id. 1930: 359.

Distribution: India (Kolkata, Nagpur, Yenna Valley, Satara), Myanmar (Tharrawaddy, Palon, Penang), Siam, Cambodia, Cochin-China.

Length: 4. 2 mm.

Head brownish, pronotum yellowish red, elytra with elevated striae, margin, suture, antennae and legs brick red. Head brown, forehead fine punctured, segments and antennae brownish-yellow. Pronotum reddish yellow, as broad as e head, as long as broad, broadest in front with gently rounded sides to the posterior, narrowly contracted, posterior corners acute, projecting obliquely forward. Elytra shallow, markedly striated, muddy light brown, fine and dense yellowish setae. The margins and the joints narrow and brownish yellow edged. Legs reddish yellow.

5. *Zuphium olens* (Rossi, 1790)

Rossi, 1790: 217; Chaudoir, 1862: 311; Bates, 1889: 280; id. 1892: 386; Andrewes, 1921: 155; id. 1923: 9; id. 1927: 99.

Distribution: India (Kolkata, Pusa, Chapra, Balugaon), Srilanka, Myanamar (Tharrawaddy, Moulmein, Palon and Tikekee (pegu), Tenasserim, Langkawi I), Siam, Cochin - China, Annam, Java.

Length: 8.8 mm.

Body reddish. Head black, reddish antennae with very long and large primary segment. Palpi reddish. Neck bearing. Pronotum reddish. Elytra brownish black elytra with reddish basal macula, weak striation, each macula at the base rounded, apical angles internally mostly reddish. Ventral side reddish.

Genus 3. *Parazuphium* Jeannel, 1942

Jeannel, 1942: 1094; Lorenz, 2005: 507.

Body wingless. Entirely pale reddish. Head brown (typical shape) or concolorous (unicolor variety). Eyes reduced, shorter than the temples. Antennae long and slender. First segment of antennae pubescent but with several bristles standing on the dorsal border. Posterior frontal bristle inserted laterally on the temple. Pronotum much longer than wide, very narrowed behind, the cut-off sides of the basal margin very oblique. Elytra wide, plain, almost without trace of striae, golden pubescence short and recumbent. Apical truncation of elytra a little sinuated. The genital segment is quadrangular. Median lobe with the basal

part suddenly strangled and bypassed, the middle part with some sort of dead end above the basal part; apical aperture terminal and short, without trace of strips, apex small, triangular, acute.

1. *Parazuphium inconspicuum* (Schmidt-Goebel, 1846)

Schmidt-Goebel, 1846: 30 (*Zuphium*); Bates, 1892: 387; Andrewes, 1923: 10; id. 1930: 359; Jeannel, 1942: 1094; Lorenz, 2005: 507.

Distribution: India (Karnataka: Belgaum), Myanmar, Palon, Siam.

Length: 3.4 mm.

Body brownish yellow, narrow, very flat and still significantly smaller than *Z. Modestum*. Head reddish-brown, vertex dark brown, forehead with few punctures. Entire mouth parts and antennae reddish brown. Second segment of antennae not much shorter than the third and fourth, the others longer, almost equal. Pronotum as wide as the head, wider than long, with gently rounded sides, strongly constricted towards the back, outstretched behind and behind the back, so that they project as a single pointed point and a second pointed point at the end corner is visible. Its fine long line ends at the back in a shallow elongated impression. Elytra long, narrow, slanting outwards obliquely, weakly margined, rounded at the top, extinct striped, very finely punctured, densely hairy, dark brownish, the front and outside pale brownish yellow. The ventral side and legs pale yellow.

Genus 4. *Planetes* Maclaey, 1825

MacLaey, 1825: 28; Lacordaire, 1854: 94; Bates, 1873: 304; Andrewes, 1924: 52; id. 1930: 278; Lorenz, 2005: 507.

= *Heteroglossa* Nietner, 1857: 141; id. 1857: 279.

Body winged. First and fourth segments of antennae equal and as long as second and third segments together. Labrum squared, barely emarginated anterior part. Second segment of maxillary palpi equal to the last two segments together, third segment inversely conical, forth segment elongated, thick, apex obtuse. Labial palpi last segment securiform and third segment barely thick, Last segment of the labial palpi cylindrical. Mentum tridentate. Short truncated labrum and the ligula furnished with very long, narrow paraglossae, strongly curved. ligula short, convex, rounded at apex, and furnished with many long stiff bristles. The tooth of mentum furrowed in the middle and notched at the tip. Pronotum transverse, obtuse posterior angles. Elytra square, moderately elongated, truncated a little obliquely on each side at their extremity, sharp ridges or raised lines, with two smaller raised lines in each interval between them. Fourth segment of the tarsi short, simply indented forward

Key to the species of genus *Planetes* from India

1. Elytra with two median macula……..…...…..…… 2

- Elytra without macula……..……..……..…… 3

2. Pronotum completely black……...…… ***bimaculatus***

- Pronotum dark brown with yellow posterior angles…...……..... ***ruficeps***

3. Pronotum black……..…….…..…….…... ***indicus***

- Pronotum brick red …….…..…. ***ruficollis***

1. *Planetes bimaculatus* Macleay, 1825

MacLeay, 1825: 29; Schaum, 1847: 46; Chaudoir, 1872: 139; Bates, 1892: 388; Heyne-Tasch, 1898: 14; Andrewes, 1919: 169; id. 1930: 278; Lorenz, 2005: 507.

Distribution: India (Assam: Karen Hills), Myanmar, Kuala Lumpur, Siam Indo-China, Java, Sumatra, Japan, Nagasaki; Hiogo, China.

Length: 8.5 mm.

Body subtus dark. Labial palps, antennae, legs and elytra black and median macula reddish brown. Head blackish, transverse, punctured, anterior truncated. Pronotum black, punctured. Lateral edges very finely and narrowly raised. Elytra black depressed furrowed and striated, with median reddish brown macula. Apex truncate with rounded angles. *Planetes bimaculatus*, differs from *P. ruficeps*, Schaum by the lateral edges of the pronotum, very finely and narrowly raised; it is also a little more square and less rounded on the sides, the elytra are more parallel. The apex truncated gracefully, but the angles are rounded as in *P. ruficeps*; the elevated striae of the elytra are wider and more rounded; the head is black with the anterior angles and the chaperon yellow.

2. *Planetes indicus* Andrewes, 1922

Andrewes, 1922: 166.

Distribution: India (Nagpur)

Length: 8.0–8.5 mm.

Black; segment 1 of antennae, femora, and tibiae light reddish, rest of antennae, palpi, clypeus, labrum, and tarsi a little darker. Head rather wide and moderately convex, surface shiny, coarsely punctuate, eyes rather prominent. Pronotum cordate, convex, not wider than head and wider than long, widest at apical fourth, apex emarginated at middle, sides lightly rounded and gently sinuate behind. Elytra flat, a fourth as wide as pronotum, rectangular with rounded corners, base emarginated, border sharply rounded at shoulder; costae fine.

3. *Planetes ruficeps* Schaum, 1863

Schaum, 1863: 81; Chaudoir, 1872: 139; Heyne-Tasch, 1898: 14; Andrewes, 1924: 53; id. 1930: 279; Lorenz, 2005: 507.

= *bimaculatus* (*Heteroglossa*) Nietner (not Macleay.), 1857: 144; id. 1857: 282; Andrewes, 1927: 106.

Distribution: India (Uttarakhand: Dehra Dun; Odisha: Surada; Tamil Nadu: Chennai, Nilgiri Hills; Kerala: Wayanad: Tholpetty, Kozhikode: Koorachundu), Sri Lanka (Colombo, Hambegannuwa), Myanmar (Tharrawaddy) Bangladesh (Dacca).

Length: 8.5 mm.

Head deeply punctured except forehead, deeply punctured with 2 impressions in front of the eyes, anterior angles of labrum rounded. Pronotum densely and deeply punctured. Dark brown with yellow posterior angles. Elytra thinly pubescent with a round yellow spot at the middle of each elytron. Apical angles rounded. Legs pale reddish.

4. *Planetes ruficollis* (Nietner, 1857)

Nietner, 1857: 144; id. 1857: 282; Chaudoir, 1872: 140; Andrewes, 1927: 106.

Distribution: India (Pusa), Bangladesh (Dacca) Sri Lanka (Colombo), Cochin-China, Cambodia.

Length 9.52 mm.

Body blackish brown, pronotum brick red. First 3 segments of antennae black, shape of the body is quite that of the former but the insect is larger. Head is less distinctly punctured than in the forehead. Pronotum deeply punctured, but the divisional furrow is more so than in the preceding species. The anterior tibiae appear somewhat less deeply notched. There is nothing else to add to the description that has not been pointed out already.

Tribe 3. Galeritini Leconte, 1853

(Taken from the keys in Sloane 1923, Jeannel 1949, Lompe 2014)

Antennae fairly stout, hairy, first segment as long as the next two segments taken together. Antennae inserted immediately beneath the pre ocular ridges. Mandibles entire and moderately sharp at apex, basal membrane of the

labrum not or rarely exposed. Elytra costate, with eight or nine narrow major costae, and usually with a pair of minor costae between each two adjoining major ones. Fourth segment of tarsi slightly bilobed.

Genus 1. *Galerita* Fabricius, 1801

Fabricius, 1801: 214; Latreille & Dejean, 1822: 117; Dejean, 1825: 186; Schmidt-Goebel, 1846: 26; Lacordaire, 1854: 82; Andrewes, 1924: 52. id. 1930: 167; Lorenz, 2005:508.

Palpi six segmented, last segment thicker, obliquely truncate. Ligula membranous, between palps acuminate, on both sides supported by sharp pointed seta. Antennae setaceous. Mentum with bifid median tooth. Ligula horny, broad, apex pointed, occupied by two bristles. Paraglossae skin-like, free, line-shaped, inwardly curved and not much shorter than the ligula. Mandibles at the tip occupied with a shortsetae to the outside. The first three tarsomeres of male pulled out very strongly inside to very narrow without setae, on the edge round with long setae, middle occupied with a series of short setae. In female, first three tarsal segments triangular, ventral side densely hairy; 4th tarsal segment deeply bifid in both sexes.

Key to the species of the genus *Galerita* from India

1. Head blood red coloured/ reddish brown..... 2

- Head black .....……..……..... 5

2. Elytra bluish black…….……...……..…. 3

- Elytra matt black…….…..... ***ruficeps***

3. Femora reddish brown with blackish brown apex…….…….... ***indica***

- Femora reddish yellow with blackish brown apex……..…..... ***nigripennis***

5. Pronotum with posterior angles rectangular but gently rounded, elytra black, Eyes prominent …….……..……..…..… ***orientalis***

- Pronotum with posterior angles projecting a little outward, elytra bluish black, Eyes not prominent ……..……..……… ***batesi***

1. *Galerita batesi* Andrewes, 1923

Andrewes, 1923: 9; id. 1930: 168.

= *orientallis* Bates (not Schm. Goeb). 1889: 109; id. 1892: 385.

Distribution: Sylhet (Bangladesh), Myanmar (Karen hills, Teinzo, Palon, Thagata, Tenasserim, Annam).

Length: 17 mm.

Head with frontal foveae rather wide and shallow, interval between them gently raised, area behind mid-eye level coarsely punctate, eyes not prominent. Apical two-thirds of joint 1 of antennae brownish black. Pronotum with hind angles projecting a little outwards, surface closely and confluently punctae, punctures a little smaller than those on the head. Elytra with striae well-marked, the interval between the secondary lines hardly less than that between each of them and the adjoining stria, this latter interval with a single row of fine sharp point like punctures.

2. *Galerita indica* Chaudoir, 1861

Chaudoir, 1861: 557; id. 1877: 255; Bates. 1873: 304; Andrewes. 1930: 168.

Distribution: North India.

Length: 17.5 mm.

Head reddish brown coloured on both dorsal and ventral sides, rounded on the sides and narrowed near anterior extremity, rounded posterior angles. Dorsal side punctuated with smooth forehead and hairy posterior side. Collar smooth and narrow. Eyes prominent. Labrum convex with 6 long setae. Antennae with first segment reddish brown and following segments brown. Palpi and mandibles reddish brown. Pronotum reddish brown with a thick dark margin, as long as broad, not cordate, narrowing from middle to obtuse anterior angles, wider than the head, slightly convex, highly wrinkled. Posterior angles sinuate. Median line well marked, lateral margin narrow and slightly elevated. Elytra bluish black, almost parallel, humerus not pronounced and rounded, twice wider than pronotum, pubescent, rounded behind middle with straight truncated apex. Legs reddish brown with blackish brown apical region. Tibia and tarsi brown, pubescent.

3. *Galerita orientalis* Schmidt-Goebel, 1846

Schmidt-Goebel, 1846: 26; Bates, 1889: 109; Andrewes, 1923: 8; id. 1930: 168; Lorenz, 2005: 509; Kushwaha *et al.* 2015: 22.

= *Galerita nigripennis* Chaudoir, 1861: 557; id. 1877: 255; Andrewes, 1924: 52; id. 1930: 168; Lorenz, 2005: 509.

Distribution: India (Assam: Khasi Hills; Chattisgarh: Raipur; Kerala: Kozhikode), Myanmar (Patkai hills, Teinzo), Taiwan, Japan, China, North Korea, South Korea.

Length: 20.3–24.8 mm.

Body flat and stretched. Head wrinkled, punctured, smooth forehead, labrum dark reddish-brown, apical third of first antennal segment brownish black, eyes rather prominent. Pronotum wider than head, narrower than elytra with hind angles rectangular, but gently rounded, surface with puncturation. Elytra elongated, ovate, broadly enlarged at back, widest in the last third, with neat sharp lines, costae not much raised, interval between each of them and adjoining costa finely and rather irregularly pointed punctures (but there is a single row of punctures on each side of the costae 1 and 7). Femora red, legs brownish-red, the apex black.

4. *Galerita ruficeps* Chaudoir, 1861

Chaudoir, 1861: 556; Andrewes, 1930: 168.

Distribution: India (UP: Harki Dun, Nainital, Almora).

Length: 20 mm.

Head blood red above, brown below; Pronotum black brownish; Elytra matt black; Reddish antennae, palpi and mandibles of a dark red, femora reddish yellow with dark apex, brown legs covered with a strong yellow pubescence. Head Square, rounded posterior angles, punctuated, hairy, eyes not prominent.

Pronotum not wider than head, longer than broad, narrowed posteriorly, anterior angles rounded, straight posterior angles, base squarely cut, covered with fine punctuation, median line not very marked, lateral border narrow. Elytra twice wider than pronotum, twice as long as broad, rounded shoulders, not prominent, parallel sides, rounded behind the middle, truncated end squarely, almost straight. Ventral side of the body punctuated and pubescent.

Subfamily Panagaeinae Bonelli, 1810

It is represented by four tribes at global level and 2 tribes in India (Hackel & Farkac 2012). The subfamily Panagaeinae with 387 species in 29 genera and four tribes (Bascanini, Brachygnathini, Panagaeini and Peliciini) worldwide (Hackel & Farkac 2012 & 2013). Subfamily Panagaeinae is recorded from Indian mainland, with 33 species from two tribes, Peliciini Chaudoir 1880 and Panagaeini Bonelli 1810 (Lorenz 2005, Hackel & Farkac 2012). Tribe peliciini distributed only in South & Central India and Sri Lanka and Tribe Panagaeini distributed throughout India and Sri Lanka from Indian mainland.

Earlier work on Indian Panagaeinae was by Andrewes (1930) and Chaudoir (1878) and later by Straneo & Ball (1989), Hackel and Kirschenhofer (2000, 2014); Hackel and Farkac (2012) and Fedorenko (2016).

Hackel and Farkac (2012) in their checklist of world Panagaeinae provided the synonyms and broad type locality of species and no details of the distribution pattern and references are available. Also after 2012, many species were identified newly and that too included in this checklist.

Tribe Peleciini Chaudoir, 1880: Members of the tribe Peleciini are small to large, rarely encountered apterous carabids. The tribe is fairly small yet widespread in the tropics in the Americas, Africa, and Indian subcontinent. Earlier work on Indian Peleciini was done by Schaum (1864), Chaudoir (1880), Bates (1886) and Andrewes (1923). The tribe Peleciini Chaudoir 1880 was recently monographed (Straneo & Ball 1989). Straneo & Ball (1989) reported one genus and 5 species from India and he has given a key to the genera and species from India.

Tribe Panagaeini Bonelli, 1810: Comprehensive work on the Tribe Panagaeini was written by Chaudoir (1861, 1878). Jedlicka 1965 gave a more comprehensive summary of the species of East Asia. There followed numerous individual descriptions of the species of Tribe Panagaeini (Kasahara 1989; Lorenz 1998; Kirschenhofer, 1996, 2000, 2004, 2010, 2011a,b, 2012a,b; Pang & Tian 2012; Häckel & Kirschenhofer 2014b; Häckel & Anichtchenko 2015). Five genera and 28 species of the Tribe Panagaeini from India are reported.

Kasahara (1989) gave a generic key to the tribe Panagaeini from Japan. Kirschenhofer (1994, 1996 and 2000) had given generic and species level keys of Paleartic and oriental Panagaeinae. Hackel & Kirschenhofer (2014) prepared keys to the species of genera *Craspedophorus* and *Dischissus* from Asian region. Fedorenko (2016) described a new genus *Adischissus* from the Asian region and provided a modified key to the species of genera *Craspedophorus* and *Dischissus* from Asian region. No key for the generic and species level keys to *Microcosmodes*, *Trichisia* and *Euschizomerus* from Indian subcontinent are

available. Also he described a new genus *Adischissus* from the Asian region and a comphrehenisve key to the Indian genera and species are provided in the present effort. The species keys of Kirschenhofer (2000), Hackel & Kirschenhofer (2014) and Fedorenko (2016) includes only the genera *Craspedophorus* and *Dischissus*. No key for the genera *Microcosmodes*, *Trichisia* and *Euschizomerus* from Indian subcontinent.

Descriptions of 33 species belonging to 6 genera with locality and reference details are provided.

Tribe 1. Panagaeini Bonelli, 1810

(Taken from Sloane 1923 & Lompe 2014)

Head with two supra-orbital setae in each side. Labrum with basal membrane concealed. Terminal spur of the hind tibia short. Eyes bulging at the sides of the head as more than semi-circles. Last segment of the maxillary palps attached obliquely to the outer surface of the previous segment. Pronotum without setigerous punctures. Scutellar interneur present, elytra not fused along suture. Dorsal surface more or less punctate and pubescent. Elytral humerus prominent. Elytra with a black cross-shaped marking on a reddish background, rounded at the tip or the elytra together form an evenly rounded tip, or the elytra are more or less pointed, sometimes somewhat bordered towards the end next to the tip. If the terminal spur of the hind tibia is long then the elytra are not sheared off at the tip.

Key to the Genera of tribe Panagaeini from India

1. Elytra black, maculate. Paraglossae of the same length as ligula..... 2

- Elytra immaculate. Paraglossae shorter than ligula……..... 5

2 Penultimate protarsomere not cleft more than other protarsomeres; if cleft more, then cleft does not exceed half of protarsomere length. ***Craspedophorus***

- Cleft in penultimate protarsomere exceeds half of protarsomere length……. 3

3 Scape of antennae as long as the 2nd and 3rd segments together. Cleft in penultimate protarsomere exceeds half of protarsomere length.…. ***Adischissus***

- Scape of antennae not long as the 2nd and 3rd segments together or not exceed the length of eye tubercle. Cleft in penultimate protarsomere does not exceeds half of protarsomere length……..…….……... ***Microcosmodes***

5 4th Tarsomere deeply bilobed. ..... ***Euschizomerus***

- 4th Tarsomere moderately emarginate at apex; not bilobed……..….. ***Trichisia***

Genus 1. *Craspedophorus* Hope, 1838

Hope, 1838: 165; Lacordaire, 1854: 210; Chaudoir, 1878: 90; Andrewes, 1919: 126; id. 1924: 22; id. 1930: 133; Lorenz, 2005: 320.

= *Eudema* Castelnau, 1840: 137; Lacordaire, 1854: 210; Chaudoir, 1878: 133.

= *Epicosmus* Chaudoir, 1846: 512; id. 1854: 338; id. 1861: 335; id. 1878: 104.

Head impressed on both sides. Horny ligula, thick in the middle, hollowed underneath each side to accommodate support of labial palpi, dilated at its extremity, which is obtusely rounded, and carries two piliferous points distant from each other; Narrow paraglossa, lining its lateral border and terminated at

their outer angle by a long, narrow, membranous lobe, emarginated. Palpi to the last segment in the form of very elongated triangle, the outer side forms the base, apex open, rounded, and much nearer to the base than extremity; The anterior side between vertex and apical angle more or less rounded and even sinuous. Labrum widely, but not deeply indented in an arc of circle. Mandibles hooked at their tips. Antennae long, third segment always longer than others, pubescent. Mentum not deeply indented, median tooth fairly large and truncated. Posterior angle sometimes square, sometimes longer than broad, but somewhat transverse. Pronotum fairly raised on its lateral edges. Rounded anteriorly and posterior truncated, depressed, subconcave lateral broad reflecting margins. Elytra elongated oval, deeply striated, more or less convex, free or welded. With eight dotted striae, sinuated apex. Legs long, fairly slender, with a deep longitudinal groove on the outside. Tarsi with fourth segment slightly indented, the fifth segment long, not penetrating in the fourth segment.

Key to the species of genus *Craspedophorus* from India

1. Posterior angles of pronotum with denticulation……..…...…… 2
- Posterior angles of pronotum without denticulation……..... 8
2. Pronotum obliquely hexagonal, elytral humeral macula covers 4th interval to margin, ……..……..…….…… ***hexagonus***
- Pronotum hexagonal, Humeral macula covers 5th interval to elytral margin..... ***microspilotus***
3. Pronotum with lateral margin……...……...……. 4
- Pronotum without lateral margin……..……..……. 5

4. Pronotum obliquely hexagonal……..……..……...…… ***geniculatus***

- Pronotum not obliquely hexagonal …..…..…….……..…. ***mandarinellus***

5. Humeral macula covers 3rd interval to margin……..……..… 6

- Humeral macula covers intervals 5th to 9th ….……..…..…....… ***assamensis***

6. Humeral macula kidney shaped ……..……..…..…… ***hilaris***

- Humeral macula covers interval 3rd to margin…….…….. ***halyi***

7. Humeral macula with serrate margin…….…..…… ***cereus***

- Humeral maculaepartially serrate ……..……..…….…. ***gracilipes***

8. Pronotum cordiform……..…….……..…… 9

- Pronotum not cordiform…….……...…… 10

9. Elytra strongly ovoid with yellow maculae; rounded preapical macula reaching 3rd to 7th interval…….....……..... ***maharashtraensis***

- Elytra parallel sided; preapical macula reduced to two small spots on 6th and 7th interval……..…..……...……..... ***sikkimensis***

10. Lateral sides of pronotum strongly rounded, elytral humeral macula covers 5th interval to margin ……..……...…… ***dehradunensis***

- Lateral sides of pronotum obliquely rounded……....……..... ***pubiger***

11. Elytral humeral macula with serrate margin…….……..... 12

- Elytral humeral macula with partially serrate margin ……...….... 13

12. Humeral macula covers 3rd interval to elytral margin, preapical macula covers 3rd to 8th intervals, body wingless, short metepisterna, elytra highly convex ....……..... ***angulatus***

- Humeral macula covers 2nd interval to elytral margin,coloration of elytra attains cross shape……...……..……....…… 13

13. Preapical macula covers 2nd to 8th intervals, ……..……..…. ***bifasciatus***

- Preapical macula covers 3rd interval to 8th interval…....……..... ***lankaensis***

1. *Craspedophorus angulatus* (Fabricius, 1781)

(*Carabus*) Fabricius, 1781: 302; id. 1787: 197; id. 1792: 148; Oliver, 1795: 38;

= *Carabus reflexus* Fabricius, 1801: 166 (not 1781), *Cychrus reflexus* Fabricius 1801: 166.

= *Panagaeus angulatus* Hope,1838: 92; Chaudoir, 1861: 336; Heyne-Tasch. 1898: 21.

= *Craspedophorus angulatus* Andrewes, 1919: 125; id. 1921: 154; id. 1924: 115; Andrewes. 1924: 462; Andrewes. 1930: 133; Jedlicka, 1965: 3; Kirschenhofer, 2000: 323; Baehr, 2003: 446; Lorenz, 2005: 320; Pang & Tian. 2012: 265; Hackel & Farkac. 2012: 78; Hackel & Kirschenhofer. 2014: 276 & 357; Fedorenko. 2016: 4.

= *Pimelia fasciatus* Fabricius, 1781: 318; id. 1787: 209; id. 1792: 104; Schaum. 1847: 42; Motschulsky. 1855: 69.

= *Panagaeus tomentosus* Vigors, 1825: 537. Dejean. 1826: 284; id. 1831: 598; Schaum. 1847: 42.

= *Panagaeus fabricii* Hope. 1838: 66 (nomen nudum).

= *Pimelia bifasciata* Chaudoir. 1861: 336 (in error).

= *Eudema bifasciatum* Chaudoir. 1878: 133; Alluaud. 1895: 130.

= *Eudema michardi* Fairmaire. 1880: 307; Alluaud. 1895: 130.

Distribution: Southern India (Andhra Pradesh, Tamil Nadu: Pondicheri, Karnataka); Sri Lanka.

Length: 17–23 mm.

Body is wide and very convex, long and densely pubescent. Head attenuate. Pronotum twice wider than head, as long as wide, not too hexagonal, small and hardly explanate laterally. Elytra black, weakly glossy, each elytron with two orangish-yellow maculae. Humeral macula with serrate margin, reaching from outer half of 2nd interval to 9th striae, elytral margin black, preapical macula semilunar, reaching from 2nd to 6th stria, macular spots on two outer intervals distinctly separated from spots on inner intervals and moved toward apex.

2. *Craspedophorus bifasciatus* (Castelnau, 1835)

Andrewes. 1919: 126; id. 1921: 341; id. 1930: 134; Kirschenhofer. 2000: 323; Lorenz, 2005: 320; Häckel & Farkac. 2012: 78; Hackel & Kirschenhofer. 2014: 276 & 346; Fedorenko. 2016: 4.

= *Panagaeus bifasciatus* Castelnau. 1835: 155.

= *Isotarsus bifasciatus* Laferte-Senectere. 1851: 220. Schaum. 1853: 431; Motschulsky. 1855: 69.

= *Epicosmus bifasciatus* Chaudoir. 1861: 336.

= *Eudema bifasciatum* Heyne-Tasch. 1898: 21.

= *Epicosmus castelnaui* Chaudoir. 1878: 112; Bates. 1886: 73; Andrewes. 1919: 126.

Distribution: India (Tamil Nadu: Chennai, Nilgiri Hills, Trichinopoly, Pondicherry; Andhra Pradesh: Udayagiri, Horsely Konda; Madhya Pradesh; Odisha: Barkuda Island: Lake Chilka), Sri Lanka (Colombo, Trincomali, Suriya Ara, Tissa, Maha, Illupalama).

Length: 12.5 mm.

Body black, covered by setae and coarsely punctured. Head densely punctured, narrow and elongated. Pronotum transverse, densely punctured, twice a width of head, narrowing towards neck where almost rounded, posterior angle without denticulation, anterior margin fairly sinuate, lateral margins narrow obliquely toward posterior angles. Elytra wider than pronotum, ovoid, twice longer than wide, narrowing weakly toward base, parallel in middle, each elytron with two yellowish maculae, humeral macula serrate, reaching from 1st stria (2nd interval) to margin and even on epipleura, preapical macula reaches from 2nd to 8th interval, anterior macular margin fairly serrate, posterior margin fairly excavated. Legs black.

3. *Craspedophorus geniculatus* (Wiedemann, 1823)

Andrewes, 1921: 170, 187; id. 1930: 135; Kirschenhofer, 2000: 323; Häckel et Farkac, 2012: 78. Hackel & Kirschenhofer, 2014: 276 & 301.

= *Panagaeus geniculatus* Wiedemann, 1823: 56; Schaum, 1853: 28.

= *Isotarsus rufipalpis* Laferte-Senectere, 1851: 221; Andrewes, 1924: 588; id. 1930: 135; Chaudoir, 1878: 110; Kirschenhofer, 2000: 323; Hackel & Farkac, 2012: 77, 79.

= *Epicosmus geniculatus* Chaudoir, 1861: 351; id. 1869: 351; id. 1878: 112; Andrewes, 1924: 588.

= *Epicosmus hilaris* Chaudoir, 1878: 110; Csiki, 1929: 357.

Distribution: India (West Bengal, Pusa, Bihar).

Length: 11.0 mm

Body black. Palpi pale reddish. Antennae, apex of femora and tarsi brown. Pubescence short and greyish-yellow, but black on elytra. Head small, flat, moderately constricted behind eyes, not narrowed behind, coarsely punctate, clypeus and neck smooth and polished, antennae long and filiform, palpi very long and slender, last joint securiform and obliquely truncate at apex; mentum wide, sinus shallow, lobes short, rounded at sides and apex. Pronotum transverse, moderately convex, explanate at sides, widest at middle, front angles rounded and inconspicuous, widely reflexed before hind angles which obtuse, posterior angle with a small tooth; median line and basal foveae well marked. Elytra moderately convex, parallel, punctate-striate, intervals convex, finely punctate; front spot behind shoulder, extending from margin to stria 3, tapering a little inwards, hind spot smaller, quadrate, covering intervals 4–8. Ventral side of tarsi without hairs.

4. *Craspedophorus gracilipes* Bates, 1892

Andrewes, 1930: 135; Saha & Biswas, 1985: 123; Kirschenhofer, 2000: 323; Hackel & Farkac, 2012: 78; Hackel & Kirschenhofer, 2014: 276 & 370.

= *Epicosmus gracilipes* Bates, 1892: 302.

Distribution: India (Arunachal Pradesh, Assam: Noa Dehing; Sadiya), Myanmar (Kachin), China (Yunnan).

Length: 12 mm.

Body black, covered by black setae. Head squared, frons coarsely punctured, labrum and neck smooth, palps slender, light reddish, antennae black. Pronotum rounded, narrower than elytra, arcuate behind midlength, posterior angles with a small tooth, anterior angles oblique, coarsely punctured. Elytra with four partially serrate yellow maculae. Humeral spot transverse, squared, reaching from 3rd stria (4th interval) to margin and even on epipleura, preapical margin circular-shaped, reaching from 3rd stria (4th interval) to 8th stria. Elytra ovoid, very weakly convex, striated, intervals weakly convex. Tarsi black, distally from 4th segment covered by setae.

5. *Craspedophorus hexagonus* (Chaudoir, 1861)

Andrewes, 1930: 135; Kirschenhofer, 2000: 323; Hackel & Farkac, 2012: 78; Hackel & Kirschenhofer, 2014: 276 & 329.

= *Epicosmus hexagonus* Chaudoir, 1861: 338; id. 1878; 114.

Distribution: India (Uttarakhand: Dehra Dun).

Length: 18.5 mm

Head small, rugate, vertex smooth, eyes strongly convex. Pronotum transverse, obliquely hexagonal, widening at midlength, lateral margins not rounded toward anterior angles, sinuate in front of posterior angles which

indentated; base parallel with anterior margin, covered by yellow setae. Elytra ovoid, elongated, twice wider than pronotum, sinuate near rounded margins, not narrowing towards base, weakly convex, covered by brown setae which yellowish on maculae, with deeply impressed coarsely punctured striae; intervals weakly convex, not densely, each elytron with two large yellow maculae, humeral macula wide, ovoid, reaches lateral margin, macula with serrate margin, preapical macula wide, squared, irregularly bordered, reaching from 4th to 8th interval.

6. *Craspedophorus hilaris* (Laferte-Senectere, 1851)

Andrewes, 1921: 170; id. 1924: 588; id. 1930: 135; Kirschenhofer, 2000: 323; id. 2011: 47; Hackel & Farkac, 2012: 77; Hackel & Kirschenhofer, 2014: 276 & 303.

= *Isotarsus hilaris* Laferte-Senectere, 1851: 221.

= *Epicosmus hilaris* Chaudoir, 1861: 345; id. 1878: 110.

Distribution: India (West Bengal, Maharashtra).

Length: 12–13 mm.

Head, palps yellowish red. Pronotum twice wider than head, longer than wide, narrowing towards fully rounded anterior angles, lateral angles narrowing toward base without sinuation, posterior angles obtuse, each with small tooth on their sides, base parallel and wider than anterior margin, more densely and diffusely punctured. Elytra larger than pronotum, ovoid, not oblique toward base, humeri rounded but distinct. Elytral maculae yellowish, wide, ovoid,

humeral macula reaches from 2nd to 9th interval, preapical macula from 3rd to 9th interval. Tarsi blackish brown.

7. *Craspedophorus incostatus* Kirschenofer, 2000

Kirschenhofer, 2000: 349; Hackel & Farkac, 2012: 78; Hackel & Kirschenhofer, 2014: 276 & 349.

Distribution: India (Utteakhand: Ramgarh).

Length: 18.5 mm.

Body black. Palps, antennae and legs black. Head elongated, mandibles distinctly protruded, eyes strongly convex. Pronotum with arcuate lateral margins narrowing towards neck, narrowing posteriorly, sinuate in front of posterior angles, base parallel with anterior margin. Elytra convex, ovoid, widest behind middle, distinctly rounded, widening posterolaterally. Each elytron with two yellow maculae, humeral macula transverse, reaching from 2nd stria (3rd interval) to margin an even on epipleura, preapical macula transverse, reaching from 3rd (4th interval) stria to 8th interval, striae deeply impressed, not densely punctured, intervals convex and finely punctured.

8. *Craspedophorus mandarinellus* Bates, 1892

Andrewes, 1921: 187; id. 1930: 135; Baehr, 2003: 447; Xie & Yu. 1991: 170; Kirschenhofer, 2000: 324; id. 2011: 40, 47; Lorenz, 2005: 321; Hackel & Farkac, 2012: 77; Hackel & Kirschenhoffer, 2014: 309; Fedorenko, 2016: 30.

= *Epicosmus mandarinellus* Bates, 1892: 299.

Distribution: India (Maharashtra: Mumbai, Karnataka: Shimoga), Myanmar, Vietnam, China (Guangxi).

Length: 9.5 mm.

Body small and slender, black. Head and pronotum without microsculpture. black palps, antennae and legs. Head widest in front of eyes, strongly convex eyes. Pronotum Convex, transverse, densely punctured, rather narrow with lateral margin explanate-reflexed, narrowing towards anterior angles, which rounded, posteriorly directly narrowing toward base, widest immediately behind midlength, lateral margins narrowing posteriorly, sinuate in front of posterior angles and denticulated. Elytra parallel, convex, deeply striated, intervals convex, weakly glossily, densely punctured; elytral maculae yellowish, both squared, regularly marginated (not serrate), humeral macula reaches from 4th interval to margin and even on epipleura, preapical margin reaches from 4th to 8th interval. Legs black, tarsi brownish.

9. *Craspedophorus pubiger* (Chaudoir, 1861)

Epicosmus pubiger Chaudoir, 1861.337.

= *Craspedophorus pubiger* Andrewes. 1930: 136; Kirschenhofer, 2000: 324; Lorenz, 2005: 321; Hackel & Farkac, 2012: 79. Hackel & Kirschenhofer, 2014: 354; Fedorenko, 2016: 4.

Distribution: Indes orientales (India, Myanmar or Bangladesh).

Length: 19 mm.

Head narrower than pronotum. Pronotum strongly rounded on middle and posterior angles much more rounded without an indentation. Elytra not oval as regular, humerus rounded, upper part convex, intervals convex with puncturation, each elytron with two yellowish maculae, humeral macula reaches from margin to striae 3, preapical macula reaches from 4th to 7th interval.

10. *Craspedophorus assamensis* Hackel & Kirschenhofer, 2014

Hackel & Kirschenhofer, 2014: 341.

Distribution: India (Assam)

Length: 18.0 mm

Head, pronotum and elytra black, mandibles, palps, antennae and legs black, both sides densely covered by yellow setae. Head with strongly convex eyes, clypeus and neck smooth. Pronotum wide, lateral margins weakly rounded, narrowing toward anterior angles, which rounded, weakly protruded, margins posteriorly sinuate narrowing toward base, posterior angles obtuse, denticulated, surface densely punctured. Elytra parallel, convex, with four yellowish red maculae; humeral macula reaches from 5th to 9th interval, preapical macula reaches from 4th to 8th interval, margins rounded, humeri rounded and indistinctly oblique, striae deeply impressed and finely punctured, intervals weakly convex and densely punctured.

11. *Craspedophorus sikkimensis* Hackel & Kirschenhofer, 2014

Hackel & Kirschenhofer, 2014: 337.

Distribution: India (Sikkim)

Length: 13.6 mm

Head, pronotum and elytra black, distal parts of mandibles, palps, antennae and tarsi yellowish-red. Base of of legs and mandibular bases darkish. Both sides glossily, covered by short yellowish setae. Head with eyes strongly convex, labrum anteriorly strongly excavated, clypeus smooth, surface densely rugate, punctured. Pronotum wider than long, cordiform, widest behind midlength, margins narrowing obliquely toward neck, little rounded, in front of anterior angles weakly rimmed, margins weakly sinuate, indistinctly rugate in front of base, which parallel with anterior margin in the middle. Elytra weakly convex with four yellowish red maculae; humeral macula reaches from 5th interval to margin, preapical macula reduced to two small spots on 6th and 7th interval, humeri rounded and indistinctly oblique, striae fairly impressed and finely punctured; intervals weakly convex, rugate, densely punctured.

12. *Craspedophorus maharashtraensis* Kirschenhofer, 2011

Kirschenhofer, 2011: 43; Hackel & Farkac, 2012: 77; Hackel & Kirschenhofer, 2014: 308.

Distribution: India (Maharashtra: Panchgani).

Length: 12.4 mm.

Body elongated, covered by yellow setae. Head not coarsely punctured, eyes weakly convex, clypeus punctured, not extended, labrum anteriorly weakly

excavated and convex, internal mandibular margin, anterior margin of labrum and palps brownish. Pronotum narrow, almost as long as wide, cordiform, densely punctured, lateral margins narrowing obliquely towards neck, posteriorly narrowing and distinctly sinuate in front of rectangular posterior angles, base narrower than anterior margin. Elytra with four yellow maculae; humeral macula transverse, ovoid, reaching from 4th interval to margin, Preapical macula reaches from 3rd to 7th interval, distinctly separated from elytral margin and apex, almost ovoid; humeri rounded; striae deeply impressed and finely punctured, intervals weakly convex and densely punctured. Tarsi brownish.

13. *Craspedophorus cereus* (MacLeay, 1825)

MacLeay, 1825: 12; Andrewes, 1919: 135; Andrewes, 1930. 134; Lorenz, 2005: 320; Hackel, 2015: 238; Fedorenko, 2016: 31.

= *buruensis* Hackel & Kirschenhofer, 2014: 295,

= *formosanus* Jedlicka, 1939: 1; 1965: 5; Habu, 1978: 71; Kirschenhofer, 2000: 330; Hackel & Farkac, 2012: 77; Hackel, Kirschenhofer, 2014b: 298.

= *chinensis* Jedlicka, 1965: 5; Kirschenhofer, 2000: 331; Hackel & Kirschenhofer, 2014b: 297.

= *saddlepeakensis* Kirschenhofer, 2011: 4; Hackel & Kirschenhofer, 2014b: 319.

= *laosensis* Kirschenhofer, 2012: 231; Hackel & Kirschenhofer, 2014b: 305.

= *punensis* Hackel & Kirschenhofer, 2014: 318.

= *batesi* Hackel, 2016: 55.

= *maculatus*: Hackel & Kirschenhofer, 2014: 307 (non *maculatus* Kirschenhofer, 2000).

= *philippinus* Jedlicka, 1939: 1.

Distribution: India (Maharashtra: Pune), Vietnam, South China, South Japan, Java, Buru, Philippines, West Flores.

Length: 12.0–12.1 mm.

Head, pronotum and elytra black, mandibles, palps, antennae and legs black. Head with eyes strongly convex, mandibles slender, clypeus smooth, convex, frontal grooves deeply ecavated, neck smooth. Pronotum wide, widest in basal third, lateral margins narrowing obliquely toward anterior angles and rounded, posteriorly narrowing toward base, weakly sinuate in front of posterior angles with denticulation. Elytra parallel-sided, convex, each elytron with two yellowish-red maculae; humeral macula reaches from 4th interval to margin; preapical macula reaches from 4th to 8th interval. Intervals convex, with scattered dense punctuation.

14. *Craspedophorus dehradunensis* (Kirschenhofer, 2000)

Hackel & Kirschenhofer, 2014: 281.

= *Dischissus dehradunensis* Kirschenhofer, 2000: 355; Hackel & Farkac, 2012: 84.

Distribution: India (Uttarakhand: Dehradun)

Length: 13.5 mm.

Body oblong ovoid. Head half portion obliquely incised, Antennae black. Pronotum with strongly rounded sides, posterior corners extremely short, each

with a deep groove like impression which is slightly rounded from the front edge to the base. Elytra black with 4 yellow spots. Humeral spot extends from margin to 4th striae; it reaches epiplures, preapical spot extends from 8th interval to the 4th striae. Legs black.

15. *Craspedophorus microspilotus* Andrewes, 1924

Andrewes, 1924: 131; Hackel& Farkac, 2012: 84; Hackel & Kirschenhofer, 2014:314.

Distribution: Sri Lanka

Length: 10 mm.

Body black, shiny, sparsely pubescent. Head wide and flat, slightly constricted behind eyes, eyes prominent, antennae reaching middle of elytra, surface coarsely and confluently punctate, clypeus and neck smooth, labrum short, emarginate, maxillary palpi long and slender, mentum wide with a short broad tooth. Palpi pale redddish, antennae more or less yellowish. Pronotum slightly convex, more than half as wide as head, a third wider than long, widest at middle, sides finely bordered, posterior angles obtuse and reflexed with a minute indentation, median line distinct. Elytra convex, ovate, pointed at apex, a third as wide as pronotum, with four orange spots, humeral macula from stria 4 to margin, preapical macula from intervals 5–8, intervals convex, surface finely and sparsely punctate. Tarsi pilose on both sides.

16. *Craspedophorus halyi* Andrewes, 1923

Andrewes, 1923: 230; Hackel & Farkac, 2012: 84; Hackel & Kirschenhofer, 2014: 302.

Distribution: Sri Lanka (Niroddumunai).

Length: 12.0–13.0 mm.

Black, elytra with four orange-coloured macula. Palpi, apical joints of antennae and tarsi piceous. Head small and narrow with prominent eyes, neck smooth and polished, strongly constricted behind eye, clypeus and labrum smooth, surface rugosely punctate, antennae filiform, slender and nearly reaching middle of elytra, labrum narrow, emarginate, palpi long and slender, mentum wide with short tooth. Pronotum moderately convex, transverse, much more contracted infront than behind, widest at basal third, extremities truncate, sides explanate behind, with a fine border, from apex to basal third, then sharply rounded and slightly sinuate to base, hind angles in the form of a minute rectangular tooth; median line clearly marked. Elytra convex, oval, widest behind middle, sides gently rounded, sinuate near apex, striae deep and punctate, intervals convex, punctate, pubescent, humeral macula extends from the border to stria 2, apical macula from stria 8 to 3. Tarsi pilose on both sides.

17. *Craspedophorus lankaensis* Hackel & Kirschenhofer, 2014

Hackel & Kirschenhofer, 2014: 351.

Distribution: Sri Lanka.

Length: 14.0 mm.

Head, pronotum and elytra black, glossy, mandibles, antennae and legs black. Head long with eyes strongly convex. Labrum anteriorly distinctly excavated and rimmed. Clypeus smooth, upward convex. Pronotum wider than long widest in basal third, from here lateral margins narrowing directly toward anterior angles, which are rounded, margins posteriorly weakly sinuate in front of posterior angles, which are open and dense. Disc here coarsely and there finelly punctured, densely punctured. Each elytron with two large yellowish-red maculae; humeral macula transverse, reaches from 2nd interval to margin and even on epipleura, narrowing medial, macular spot on 2nd interval about twice shorter than spot on 4th interval, widening out from 8th interval. Preapical macula reaches from 3rd to 8th interval, macular spots of equal length on each interval. Both maculae with regular, not serrate margins. Elytra broadly ovoid, convex near apex, disc more flattened, widest immediately behind midlength, Humeri rounded, weakly obliqued. Striae deeply impressed and punctured.

Genus 2. *Adischissus* Fedorenko, 2015

Fedorenko, 2015: 273.

Body small, slender, and pubescent. Black coloured, lateral margins of pronotum extending outward in a flat form. Elytral macula and legs reddish yellow. Head densely punctate, clypeus and neck smooth and glabrous. Antennae long, scape clearly longer than eye tubercle and slightly longer than antennomere 3. Labrum with apical margin subtruncate. Penultimate labial

palpomere subcylindrical and bisetose at inner margin. Apical labial palpomere securiform. Apical maxillary palpomere securiform in female, rhomboidal in male. Pronotum densely punctate, lateral margins widely explanate, basal angles each with a small tooth. Elytral interval 3 with discal setigerous pores lacking or inconspicuous. Tarsomere 4 bilobed, protarsi similar in both sexes, not dilated in male.

Key to the species of genus *Adischissus* from India

1. Femora reddish yellow, tibiae and tarsi brownish, Humeral macula reaching from 4th interval to elytral margin. ……..……..…..…… ***notulatus***

- Legs pale reddish coloured, Humeral macula reaching from 4th interval to 8th interval……..... ***quadrinotatus***

1. *Adischissus notulatus* (Fabricius, 1801)

Fedorenko, 2015: 277.

Dischissus notulatus Andrewes, 1921: 162; Andrewes, 1930, 153; Lorenz, 2005: 322.

= *Carabus notulatus* Fabricius, 1801: 201; Hope, 1838: 90; Schaum, 1847: 48; id. 1853: 432; Motschulsky, 1855: 70.

= *Craspedophorus longicornis* Schaum, 1863: 84; Chaudoir, 1878: 153; Bates, 1892: 303; Heller, 1916: 276; Andrewes, 1927: 108.

= *Panagaeus sumatranus* Dohrn, 1891: 253–254; Andrewes, 1922: 246.

= *Dischissus phuongensis* Kirschenhofer, 1994.

Distribution: India (Andhrapradesh; Arunachalpradesh; Assam; Bihar; Jharkhand; Karnataka; Kerala; Madhyapradesh; Manipur; Meghalaya; Mizoram; Nagaland; Odisha; Tamil Nadu: Nilgiri hills; Tripura; Uttarpradesh; Uttarakhand; West Bengal: Kolkata, Almora; Sikkim: Namsoo), Myanmar (Insein, Taungoo, Rangoon, Kawkareik), Malaysia (Kuala Lumpur), Singapore, Hongkong, Bangladesh, Cambodia, China (Shanghai, Anhui, Fujian, Guangdong, Guangxi, Guizhou, Hunan, Xizang, Zhejiang provinces), Laos, Nepal, Sri Lanka, Taiwan, Thailand, Vietnam.

Length: 7.2–8.3 mm.

Head and pronotum black to brownish black, posterior pronotal angles reddish yellow. Each elytron with two yellowish-red maculae that reach laterally eighth or ninth interval and often margin, and medially third, fourth or fifth interval; preapical macula does not reach apex. Antennae black or brownish black; tip of terminal palpomere yellowish. Femora yellowish red and tibiae and tarsi brownish. Pronotum wider than long, margins complete but indistinctly rimmed, posterior angles sharp, anterior angles not extending forward, anterior and basal margins nearly straight. Elytra convex, toward apex rounded. Striae deep, coarsely and densely punctured. Scutellary striole rather long and distinct, opening into a large basal pit. Intervals convex, punctured and often rugate. Seventh interval in front of apex elevated into a keel.

2. *Adischissus quadrinotatus* (Motschulsky, 1865)

Fedorenko, 2015: 277.

= *Peranomus* Motschulsky, 1864: 333.

= *Dischissus* Bates, 1873: 244; Chaudoir, 1878: 152; Andrewes, 1928: 22; Andrewes, 1930: 153; Lorenz, 2005: 322.

Distribution: India (Karnataka), Annam, Japan.

Length: 7.3–7.6 mm.

Body black. Head wider, Palps light brown, antennae brownish., Pronotum suboval, transverse, more narrowed anteriorly than behind, with rather produced hind angles, and yellow lateral border, which broadish near the base, and narrows to a point before reaching the anterior angle. Elytra with orange-yellow maculae, elongate, truncated, striae more strongly crenulated, intervals punctuated, Humeral macula reaching from 4th interval to 8th interval. Legs pale reddish.

Genus 3. *Trichisia* Motschulsky, 1865

Motschulsky, 1864: 331; Chaudoir, 1878: 164; Hackel & Farkac, 2012: 98.

Head small, triangular, narrowed back, not punctuated, protruding eyes with long supraorbital setae, Strong antennae of the length half of the body, first 3segments without pubescence, only with a few long setae, following from 4th segment pubescent and cylindrical, Palps with large last segment, depressed, elongated, indentation of mentum with short rounded tooth, 2nd segment of maxillary palpi mediocrely large, labrum slightly indented and short; last segment of labial palpi dilated in males. Pronotum large, strongly transverse,

almost three times wider than head, convex, posterior angles with small dent, straight posterior margin. Elytra wider than pronotum, oval, convex, covered with rough punctuation, truncated at base, fairly short, broad, more or less strongly convex, highly striated and very rough. Legs strong, fairly short tarses, 4th segment not bilobed and scarcely indented, tarsi of male not dilated.

Key to the Indian species of genus *Trichisia*

1. Elytra and pronotum black……...…… ***morio***

- Elytra and Pronotum dark bluish ……..…… ***violacea***

1. *Trichisia morio* (Laferte-Senectere, 1851)

= *Isotarsus* Laferte-Senectere, 1851: 221; Chaudoir, 1861: 348; id. 1878: 165; Gardner, 1927: 66.

= *cyanescens* Motschulsky, 1864: 332; Andrewes, 1928: 24.

Distribution: India (Assam: Jorhat, Uttaraghand: Dehra Dun, Pusa), Bangladesh (Dacca), Pakistan (Rawalpindi), Indonesia (Sumatra).

Length: 9.5 mm.

Head small, antennae black and barely as long as half of body, yellowish pubescence, labrum and mandibles reddish brown. Pronotum twice wider than head, narrowing more towards anterior border, anterior angles rounded, with an acute apex, median line not well marked. Elytra black, wider than pronotum, a third longer than broad, rounded shoulders, apex sinuated and not obtusely

rounded, striae deep and distinctly punctured, convex intervals covered with well-marked and tight dots. Legs entirely red.

2. *Trichisia violacea* Jedlicka, 1935

Jedlicka, 1935: 2; Hackel & Farkac, 2012: 98.

Distribution: India (north east), Philippines (Manila: Luzon Is), China (Yunnan, Xiazang).

Length: 9.0 mm.

Head black, antennae and palps yellowish red, Last segment of labial palps securiform. Pronotum dark blue, strongly transverse, twice as wide as head, widest behind the middle. Lateral margin flat and narrows to the anterior margin. Anterior margin as wide as the neck and truncated. Base twice as wide as the anterior margin, moderately convex, strongly bent down against the anterior corners, in front of the base with a clear longitudinal dimple, flat along the side edge, rough and dense punctuation. Elytra dark blue, wider than pronotum, clearly rounded lateral sides, rounded elytral apex, deeply punctured striae, intervals convex, strongly punctured. Dorsal side pubescent with moderately long black setae. Legs yellowish red.

Genus 4. *Microcosmodes* Strand, 1936

Strand, 1936: 169; Lorenz, 2005: 322.

= *Microshemus* Andewes, 1940: 536; Lorenz, 2005: 322.

= *Microcosmus* Chaudoir, 1878: 139.

Key to the species of Genus *Microcosmodes* from India

1. Reddish brown translucence of lateral pronotal margin not reaching posterior angles, Pronotum as wide as the elytra, Elytra parallel…….. ***elegans***
- Yellowish translucence of lateral Pronotal margin evident throughout length, near posterior angles broadened, Pronotum not as wide as the elytra, elytra widest after the middle ……... ***flavopilosus***

1. *Microcosmodes flavopilosus* (Laferte-Senectere, 1851)

(*Isotarsus*) Laferte-Senectere, 1851: 222; Chaudoir, 1861: 348; id. 1878: 142; Bates, 1873: 243; Andrewes, 1930: 215; Lorenz, 2005: 320.

= *transversus* (*Epicosmus*) Motschulsky, 1864: 332; Andrewes, 1928: 11.

Distribution: India (Pusa, Kolkata, Dehra Dun, Nagpur, Chennai, Mumbai, Coimbatore, Bandra, Minikoi, Gopkuda), Nepal, Bangladesh (Dacca), Sardah, Indonesia (Sumatra), Japan (Formosa), China (Tonkin).

Length: 7.3 mm.

Head black, punctured, clypeus and labrum without punctuation, labrum with slightly emarginated anterior margin, clypeal margin straight. Pronotum transverse, punctured, covered with yellowish setae. Posterior angles with dentation. Yellowish translucence of lateral Pronotal margin evident throughout length, near posterior angles broadened. Elytra black with four yellow spots. striae strongly punctuated, convex intervals, crenate and more punctuated.

2. *Microcosmodes elegans* (Dejean, 1826)

Fedorenko, 2016: 278.

= *Panagaeus elegans* Dejean, 1826: 290.

= *Isotarsus elegans* Laferte-Senectere, 1851: 221; Schaum, 1853: 432.

= *Craspedophorus elegans* Andrewes, 1921: 162; id. 1924: 23; Andrewes, 1930: 134; Kirschenhofer, 2000: 323, 347; Lorenz, 2005: 320; Kirschenhofer, 2011: 47; Hackel & Farkac, 2012: 77; Hackel & Kirschenhofer, 2014: 276 & 284.

Distribution: Throughout India, Bangladesh, Pakistan and Sri Lanka.

Length 8.3–9.5 mm.

Body black, mostly densely covered by long yellowish setae, lateral margin of pronotum usually lighter brownish. Eyes strongly convex, head rugose, punctured, Palps, antennae and legs yellowish red. Pronotum transverse, narrowing forward to rounded anterior angles, posteriorly tapering to briefly indented, unextended posterior angles with outward pointing small, sharp tooth. Lateral margins not elevated, near base weakly but distinctly depressed. Basal impressions widely excavated, indistinctly bordered. Disk coarsely and usually densely punctured, between punctures rugate. Each elytron with two yellowishred maculae; humeral macula reaches from outer half of 3rd interval (where it is only a very short spot) to margin, widening from midline to margin. Preapical macula rectangular with rounded corners, reaching from 3rd to 8th intervals. Elytra widest immediately behind midlength, striae deeply impressed

and strongly punctured, intervals mostly convex with fine indistinct puncturation. Tarsi setose on both sides.

Genus 5. *Euschizomerus* CHAUDOIR, 1850

Chaudoir, 1850: 413; Lacordaire, 1854: 212; Chaudoir, 1878: 157; Andrewes, 1930: 165; Lorenz, 2005: 322.

Indentation of mentum simple, straight, shallow. Labrum indented in an arc of a circle and depressed towards the anterior margin. Antennae longer and larger than in *Panagaeus*. Palpi more elongated; last article less securiform. Legs larger than in *Panagaeus*. Tarsi larger, covered with tight bristles forming a brush underneath; 1st segment elongated, narrowing slightly towards the base; the two following shorter, slightly cordiform, those of the anterior tarsi larger than those of the posterior tarsi; longer than wide in these; the fourth segment deeply bilobed, a little wider and much longer than the preceding one; lobes rather narrow, longer than the nonsplit portion of the segment.

Key to the Indian species of Genus *Euschizomerus*

1. Pronotal antero-lateral margin with wing like expansionin the anterior half……..…….…. ***denticollis***

- Pronotal antero-lateral margin without wing like expansion in the anterior half……..…….. 2

2. Lateral margin of pronotum pointed in the middle. Blackish green pronotum, dark metallic green elytra……..…….……...… ***metallicus***

- Lateral margin of pronotum not pointed in the middle. Black pronotum and elytra……. 3

3. Lateral side or edge of pronotum expanded, antennae brownish black. ***aeneus***

- Lateral sides or edge of Pronotum rounded. Antennae black or reddish yellow……... 4

4. Elytral apexobliquely truncate and not emarginated. Antennae black, palps and legs dark brown, anterior half of last labial and maxillary palpomere black…….. ***devagiriensis***

- Elytral apex sinuated and emarginated, Palps, antennae and legs reddish yellow, Anterior half of last labial and maxillary palpomere dark reddish yellow……. ***indicus***

1. *Euschizomerus devagiriensis* Jithmon & Sabu, 2018

Jithmon & Sabu, 2018: 362.

Distribution: India (Kerala: Kozhikode).

Length 9.5 mm.

Head, pronotum and elytra black; Antennomeres black and palpomeres brownish red, Anterior half of 4th maxillary and labial palpomeres black. Head Small, Shiny. Mentum with subrectangular blunt median tooth. Pronotum transverse, anterior and posterior margins, narrowly rounded to the anterior corners, broadest at centre, expands behind the middle, posterior corners obtuse. The lateral marginal edge of the pronotum extremely thin, anterior corner strongly bent. Lateral margin rounded at the middle and sinuate behind the

middle. Elytra long, highly convex, weakly ovoid, covered with greyish yellow coloured setae, Striae with deep punctures, apex obliquely truncate and weakly emarginated.

2. *Euschizomerus denticollis* (Kollar, 1836)

Kollar, 1836: 334; Chaudoir, 1878: 161; Andrewes, 1930: 105; Lorenz, 2005: 322; Hackel & Farkac, 2012: 86; Jithmon & Sabu, 2018: 363.

Distribution: India (Kerala: Ernakulam, West Bengal: Kolkata), Sri Lanka.

Length: 9.7 mm.

Head small, bluish black, anterior glabrous, shiny, posterior punctured and wrinkled. Labrum small, angles weakly rounded, smooth, anterior margin strongly emarginated. Clypeus smooth. Apical labial and maxillary palpomeres securiform. Mandibles fairly short. Pronotum transverse, wider than head, bluish black, dorsal and ventral side roughly punctured, irregularly arranged large dots, Pronotal antero-lateral margin rounded with wing like expansion in the anterior half on both sides. Elytra convex, long, weakly ovoid, greenish copper coloured; Widest behind the middle; Striae with deep punctures; Intervals weakly convex and punctured, apex obliquely truncate and weakly emarginated; Scutellum triangular, dark bluish, surface glabrous. Legs reddish brown, pubescent.

3. *Euschizomerus aeneus* Chaudoir, 1869

Chaudoir, 1869: 118; id. 1878: 160; Bates, 1892: 303; Andrewes, 1930: 105; Hackel & Farkac, 2012: 86.

Distribution: Myanmar (Taik Kyi, (Pegu); “Deccan” (Probably Bangladesh: Dacca).

Length: 10.0 mm

Head, pronotum and elytra black; Antennomeres brownish black; maxillary and labial palpomeres yellowish red. Head Small, Shiny, slightly convex in the middle, narrower than pronotum, labrum small, angles weakly rounded, anterior margin strongly emarginated, four long setae present on anterior margin, clypeus smooth, with single long setae on either sides, straight margin. Apical labial and maxillary palpomeres moderately expanded apically. Pronotum wider than head, transverse. Dorsal and ventral side roughly punctured and covered by greyish yellow coloured setae, straight anterior and posterior margins, narrowly rounded to the anterior corners, broadest at centre,expands behind the middle, posterior corners obtuse. Elytra Long, convex, weakly ovoid, covered with greyish yellow coloured setae, 2.7 times as long as pronotum, Striae with deep punctures, Intervals weakly convex and punctured, apex obliquely truncate and weakly emarginated. Legs reddish brown, tarsi hairy dorsal and ventral, thick patch of setae covered in ventral side of all tarsal segments.

4. *Euschizomerus metallicus* Harold, 1879

Harold, 1879: 331; Vuillet, 1912: 19; Andrewes, 1927: 109; Andrewes, 1930: 105; Hackel & Farkac, 2012: 86

Distribution: "Indes orientales", Myanmar (Karen Hills, Yangon, Tanintharyi Region), Cambodia.

Length: 14 mm.

Body shiny with yellowish hair. Head black, smooth, antennae blackish brown. Labrum small, anterior margin strongly emarginated. Clypeus smooth, straight margin. Labial and maxillary apical palpomeres securiform. Pronotum strongly punctured, wider than head, blackish green, longer than broad, posteriorly narrower, dorsal and ventral side roughly punctured and covered by yellow coloured setae, forming a fairly sharp angle in the middle of both lateral margins. Elytra dark metallic green coloured, punctured and striated, less pointed towards apex, three times as long as pronotum, Intervals weakly convex and punctured, equal in width, apex highly sinuated and weakly emarginated. Legs black with ore coloured, pubescent.

5. *Euschizomerus indicus* Jedlicka, 1955

Jedlicka, 1955: 207; Lorenz, 2005: 322; Hackel & Farkac, 2012: 86; Jithmon & Sabu, 2018: 365.

= *Euschizomerus schuhi* Kirschenhofer, 2000: 360; Hackel & Farkac, 2012: 86.

Distribution: India (Mumbai. Lonvala (Maharhastra), Goa: Benaulin Beach, Kerala: Kozhikode - Devagiri & Govindapuram).

Length: 12.5–14 mm.

Head, pronotum and elytra black. Antennae, palps and legs reddish yellow. Head smooth forehead and labrum, shiny, strongly bulged eyes, long and deep furrows. Labrum small, angles weakly rounded, smooth, anterior margin strongly emarginated. Mandibles fairly short, narrowed to the tip strongly rounded. Pronotum convex, wider than head, wider than long. Very rough, wrinkled and hairy dorsal side with punctures. Narrowly rounded to the anterior corners, widest and expands behind the middle, posterior corners obtuse. Elytra highly convex, weakly ovoid, quite long, weakly sloping projected shoulders. Slightly rounded on the sides, largest width just behind the middle, striae moderately deep, roughly punctured, Intervals slightly convex, fine and distracted punctured. Distinct sexual dimorphism exists in *Euschizomrus indicus* with the male having enlarged and asymmetrically lobed first protarsal segment and the female with simple symmetrical fore tarsal segment.

Tribe 2. Peliciini Chaudoir, 1880

Body pedunculate. Terminal and penultimate maxillary palpomeres articulated in straight line at apex of penultimate palpomere. Pronotum with one or two pairs of setigerous punctures, globose and constricted to a very narrow short basal stalk. Scutellar interneur short or absent, Elytra fused along suture. Dorsal surface not densely punctate, without fine pubescence. Elytral humerus slightly to markedly constricted.

Genus 1. *Ardistomopsis* Straneo & Ball, 1989

Straneo & Ball, 1989: 123; Lorenz, 2005: 318.

= *Disphaericus* Waterhouse, 1842: 211; Schaum, 1864: 122; Bates, 1886: 73; Lacordaire, 1854: 249; Kolbe, 1895: 346; id. 1898: 64. Csiki, 1929: 400; Andrewes, 1930: 153.

= *Dyschiridium* Chaudoir, 1861: 130; Andrewes, 1930: 153.

= *Spanus* Westwood, 1864: 3; Kolbe, 1895: 347; id. 1898: 65; Andrewes, 1930: 153.

Distribution: Indian subcontinent and Sri Lanka.

Body black. Antennae and legs black, infuscated, or reddish brown. Palpi reddish brown or pale reddish brown. Surface shining to iridescent. Head with one or two pairs of supraorbital setae. Labrum with 6 anterior setae. Labrum with anterior margin deeply notched. Maxillary palpomere 4 in both sexes more or less broadly ovate, apical margin truncate or labial palpomere 3 broadly ovate to sub-triangular, as broad or broader maxillary palpomere 4. Pronotum with proepipleura delimited dorsally by lateral grooves of pronotum, dorsal surface markedly vaulted. With single pair of lateral marginal setae. Basal ridges of elytra not evident. Interneurs deep, punctate or not, intervals slightly to moderately convex. Abdominal sternum VII posteriorly of males with two to six setae, females with eight to 10 setae.

Key to the species of Genus *Ardistomopsis* from India

(Taken from Straneo & Ball 1989)

1. Head with single pair of supraorbital setigerous punctures……..... 2

- Head with two pairs of supraorbital setigerous punctures……..……. 4

2. Front tibia with notch of antennal cleaner near mid-length. Surface of elytra iridescent or not……..…..…….…… 3

- Front tibia with notch of antennal cleaner near base. Surface of elytra shiny, but not iridescent……...… ***andrewesi***

3. Elytron with interneurs deep (including 6 and 7 pre-basally), intervals clearly convex; surface iridescent……..……..……. ***ovicollis***

- Elytron with interneurs shallow (especially basal parts of 6 and 7); intervals nearly flat; surface shining, not iridescent……..... ***batesi***

4. Pronotum orbicular, nearly as long as wide……..……..…..... ***marginicollis***

- Pronotum longer, distinctly longer than wide……..…….... ***myrmex***

1. *Ardistomopsis andrewesi* Straneo & Ball, 1989

Straneo & Ball, 1989: 126; Lorenz, 2005: 318.

Distribution: South India (Shembaganur and Palni Hills).

Length: 6.6–7.18 mm.

Body black. Femora and tibiae reddish. Antennomeres, palpomeres and tarsomeres yellowish red. Head with microlines effaced, surface shining. Maxillary palpomere 4 ovate. Labial palpomere 3 ovate in female, narrowly triangular in male. Head with single pair of supraorbital setae. Pronotum narrow, elongate, surface shining, not iridescent. Elytra ovate, intervals finely punctate. Surface shining. Sternum VII of male posteriorly with four setae, female with 10 setae irregularly distributed. Front tibia with notch of antennal cleaner much

closer to base than to apex. Tarsomeres 2–4 of front, middle and hind legs with adhesive setae.

2. *Ardistomopsis batesi* Straneo & Ball, 1989

Straneo & Ball, 1989: 126.

Distribution: India (Madhyapradesh: Jabalpur).

Length: 3.88 mm.

Body nearly black. Antennae, mouthparts (including mandibles) and legs reddish yellow. Dorsal surface shiny without indication of iridescence. Head with one pair of supraorbital setae, smooth. Pronotum with meshes transverse, microlines effaced toward medial part of disc. Elytra with meshes transverse, intervals only slightly convex and finely punctate. Sternum VII with single pair of setae. Front femur with notch of antennal cleaner.

3. *Ardistomopsis marginicollis* (Schaum, 1864)

Straneo & Ball, 1989: 124; Lorenz, 2005: 318.

= *Disphaericus marginicollis* Schaum, 1864: 122; Andrewes, 1927: 109; Csiki, 1929: 400; Andrewes, 1930: 153.

Distribution: India (Tamil Nadu: Chennai, Tharangambadi, Horseley Konda, Karnataka: Samanahally, Bangalore).

Length: 1.96–8.42 mm.

Body black, legs and antennomeres black; palpomeres reddish yellow. Head shining and with two pairs of supraorbital setae, strongly constricting

behind the eye Terminal maxillary and labial palpomeres subtriangular, apical margins subtruncate. Pronotum wide, slightly longer than broad, highly curved with a deep median line and a delicate margin, Elytra ovate, intervals coarsely punctate, convex, intervals smooth. Front tibia with antennal cleaner notch, setose. Tarsomeres 1–4 of front and middle legs and 2–4 of hind legs with adhesive vestiture ventrally. Sternum VII of female with 10 setae, irregularly distributed.

4. *Ardistomopsis myrmex* (Andrewes, 1923)

Straneo & Ball, 1989: 125; Lorenz, 2005: 318.

= *Disphaericus myrmex* Andrewes, 1923: 228; Csiki, 1929: 400; Andrewes, 1930: 153.

Distribution: India (Tamil Nadu: Anamalai Hills), Sri Lanka (Koggala, Velverry).

Length: 10–11 mm.

Body black. Antennomere 1 reddish brown; femora, tibiae, and antennomeres 2–11 reddish brown or brownish black. Palpomeres reddish brown. Head with two pairs of supraorbital setae, elongate, clypeus bisetose, labrum slightly emarginate, last joint of labial palpi securiform. Pronotum convex, oval, longer than wide, median line very clear and deep. Elytra convex, oval, pedunculate, sides strongly and evenly rounded, slightly sinuate before apex, intervals convex and finely punctate, striations complete. Sternum VII of males posteriorly with four setae, females with 10 setae, irregularly distributed.

Dorsal side of tarsi pubescent, claws simple. Tarsomeres 1-4 of front and middle legs and tarsomeres 1–3 of hind legs with adhesive vestiture.

5. *Ardistomopsis ovicollis* (Bates, 1886)

Straneo & Ball, 1989: 125.

= *Disphericus ovicollis* Bates, 1886: 73; Andrewes, 1923: 229; Csiki, 1929: 400; id. 1930: 153.

Distribution: Sri Lanka (Dikoya)

Length 7.0 mm.

Body black. Femora and tibiae reddish, Antennomeres and palpomeres yellowish red. Head with microlines effaced, surface shining with single pair of supraorbital setae. Terminal maxillary and labial palpomeres broadly ovate. Pronotum with single pair of lateral setae, narrow and elongate. Elytra narrowly ovate, intervals coarsely punctate. Front tibia with notch of antennal cleaner near midlength. Tarsomere 2–4 of front, middle and hind legs ventrally with adhesive setae.

4.2. Ecology

Fifteen species were reported with the Light trap collections. Ten species recorded from the forests and 8 species from agrilands with 3 species (*Anchista fenestrate*, *Lachnoderma biguttatus* and *Orthogonius indophilus*) common to both the habitat types. *Anchista fenestrata*, *Lachnoderma biguttatus* and *Orthogonius indophilus* were the dominant species in forest habitat and *Perigona nigricollis* in agrilands. **Shannon-Weaver diversity index (H')** value of 1.90 and 1.73, **Margalef's richness index (d)** values of 2.62 and 2.17; **Simpson's evenness index ($E_{1/D}$)** value of 0.78 and 0.75 was reported from the forest and agriculture habitats respectively.

Table 1: Diversity, richness, Simpson's evenness of Carabidae in the Malabar WLS and the surrounding agrilands.

Region	Shannon-Weaver diversity index (H')	Margalef s richness index (d)	Simpson's evenness index ($E_{1/D}$)
Forest	1.90	2.62	0.78
Agrilands	1.73	2.17	0.75
	T value = 0.64 P value > 0.05		

Table 2: Abundance of Carabidae collected from Malabar Wildlife sanctuary and the surrounding agrilands.

Sl. No.	Name of Species	Forest habitat		Agriculture habitat	
		(Mean±SD)	Percentage %	(Mean±SD)	Percentage %
1	*Adischussus notulatus*	0.02±0.13	3.2	0	0
2	*Anchista fenestrata*	0.22±0.55	41.9	0.05±0.22	12.0
3	*Brachinus devagiriensis*	0.02±0.13	3.2	0	0
4	*Chlaenius malachinus*	0.03±0.18	6.4	0	0
5	*Craspedophorus mandarinellus*	0	0	0.03±0.18	8.0
6	*Euschizomerus indicus*	0	0	0.03±0.18	8.0
7	*Lachnoderma biguttatus*	0.05±0.22	9.6	0.03±0.18	8.0

8	*Lebia basalis*	0.03±0.18	6.4	0	0
9	*Macrocheilus devagiriensis*	0	0	0.05±0.22	12.0
10	*Orthogonius bacanoides*	0.03±0.18	6.4	0	0
11	*Orthogonius indicus*	0.02±0.13	3.2	0	0
12	*Orthogonius indophilus*	0.05±0.22	9.6	0.02±0.13	4.0
13	*Orthogonius lucidus*	0	0	0.02±0.13	4.0
14	*Perigona nigricollis*	0	0	0.18±0.64	44.0
15	*Stenolophus smaragdulus*	0.05±0.22	9.6	0	0

Table 3: Abundance of Carabidae collected using Pitfall traps from Malabar Wildlife sanctuary and the surrounding agrilands

Sl. No.	Name of Species	Forest	Agrilands	Mean±SD	Percentage %
1.	*Clivina helferi*	2	0	0.03±0.18	33.3
2.	*Omphra pilosa*	0	4	0.07±0.25	66.7

Table 4: Statistical analysis of overall abundance of Carabidae species recorded from the Malabar WLS and the surrounding agrilands

Parameters	Kruskal Wallis Test		Mann-Whitney U Test
	H	P Value	(P value)
Overall abundance	**0.36**	**> 0.05**	**> 0.05**

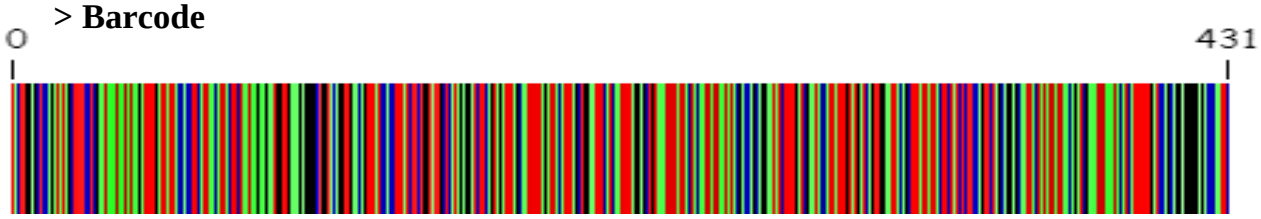
4.3. DNA barcoding

Macrocheilus bensoni collected from the dry deciduous forest in the Walayar region of the Western Ghats was sequenced for comparing its genetic makeup with the Helluonini group (*Omphra pilosa* and *Macrocheilus devagiriensis*) which is present in the Sanctuary. Phylogenetic analysis revealed that *Macrocheilus bensoni* is forming a different clade whereas *Omphra pilosa* and *Macrocheilus devagiriensis* (with distribution is Malabar Wildlife Sanctuary) forms a single clade having two different lineages (Fig. 1).

> *Macrocheilus bensoni* (Isolate MAB-1) (Primer: NANCY) Forward; 432 bp

TACTTGGAGCTCCAGATATAGCTTTTCCTCGAATAAATAATATAAGATT
TTGATTATTACCACCTTCATTAACATTACTTCTAATAAGAAGAATGGTT
GAAAGAGGGGCTGGTACAGGTTGAACAGTTTATCCACCTTTATCTTCT
GGTATTGCTCATAGAGGATCTTCAGTAGATTTAGCAATTTTTAGATTAC
ATTTAGCTGGAATTTCATCAATTTTAGGAGCTGTAAATTTTATTACTAC
AATTATTAATATACGACCAGCAGGAATATCTTTTGATCGAATACCATTA
TTTGTATGATCAGTTGGAATTACAGCTTTATTATTACTTCTATCTCTTCC
AGTTCTAGCAGGAGCAATTACTATATTATTAACAGATCGAAATTTAAAT
ACATCATTTTTTGATCCAGCAGGAGGGGGAGACCCAATTC

> Barcode



> Amino Acid Sequence (143 AAs)

LGAPDMAFPRMNNMSFWLLPPSLTLLLMSSMVESGAGTGWTVYPPLSSGI
AHSGSSVDLAIFSLHLAGISSILGAVNFITTIINMRPAGMSFDRMPLFVWSVG
ITALLLLLSLPVLAGAITMLLTDRNLNTSFFDPAGGGDPI

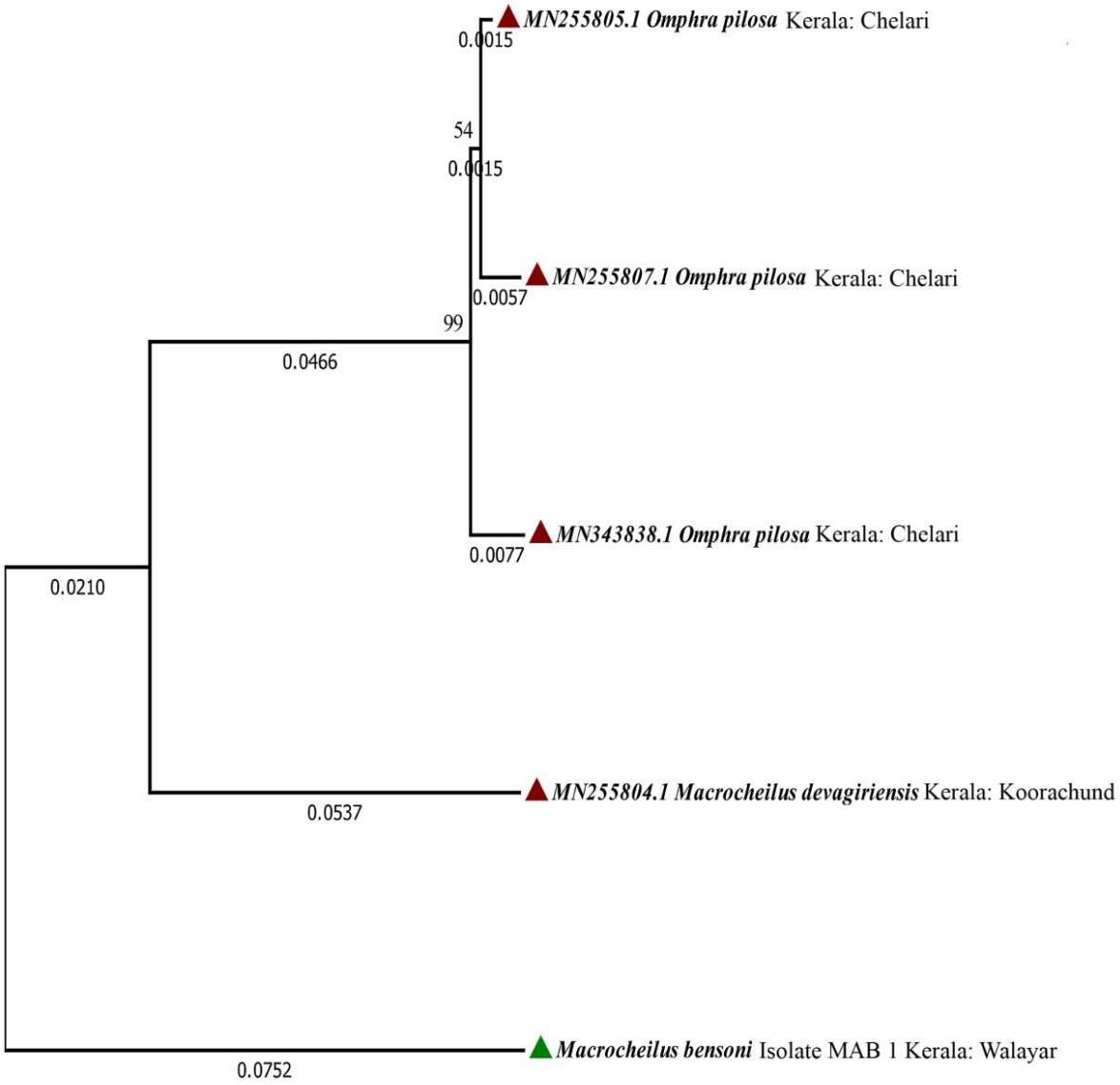


Fig. 1: Phylogenetic relationship (using Neighbour joining method) between the three species of Helluonini of Malabar Wildlife Sanctuary with *Macrocheilus bensoni* collected from outside Malabar Wildlife Sanctuary.

Chapter 5

DISCUSSION

5.1. Taxonomy

Two first reports from south India, G*alerita orientalis* Schmidt-Goebel, 1846 and *Clivina helferi* Putzey, 1866 recorded from Malabar Wildlife sanctuary and a new species namely, *Brachinus devagiriensis* Akhil & Sabu, 2018 indicates that further studies on this region may reveal new additions to the species records from south India. *Galerita orientalis* and *Clivina helferi* were known only from North, North Eastern region of India and Myanmar (Andrewes, 1930; Anichtchenko, 2018). Similarly the record of three species endemic to the Western Ghats namely, *Helluodes devagiriensis* Abitha 2008, *Macrocheilus devagiriensis* Shiju 2012, *Orthogonius indophilus* Tian & Deuve 2006 from the Malabar Wildlife Sanctuary indicates about the importance of regions from the biodiversity view point. The rare and endemic species *Helluodes devagiriensis* was collected from the agrilands differs from another specimen from North Western Ghats with a single trait difference (size and colour) and molecular analysis is necessary to reach at a conclusion.

The prepared checklist along with the pictorial key provides basic information of the Carabidae fauna present in Malabar Wild life sanctuary and surrounding agrilands. Checklist showed that six species namely *Helluodes devagiriensis* Abitha 2008, *Macrocheilus devagiriensis* Shiju 2012, *Orthogonius bacanoides* Tian & Sabu 2009, *O. indicus* Tian & Sabu 2009, *O indophilus* Tian & Sabu 2009 and *Oxylobus follis* Andrewes 1929 were recorded only from south India. Detailed descriptions and keys to the genera and species (73 species, 14 genera) of two subfamilies namely, Dryptiinae Bonelli 1810 and Panagaeinae

Bonelli 1810 provided in the work becomes the first time key to the group from India.

5.2. Ecology

First time on the ecology of Carabidae from Indian mainland and specifically from the Western Ghats is provided. As the ecological data was based on the collections with light traps, only winged species were collected and the present study represents the distribution and diversity of only the winged beetles. Reasons for the failure of pitfall traps in the study region are attributed to the possibility of trapped insects being lifted by insectivorous fauna and the generally wet conditions in the region during the sampling attempts.

Forest Carabids in the studied Malabar Wildlife sanctuary and attracted to the light traps (winged forms) are dominated by tribe Lebiini with *Anchista fenestrata* and *Lachnoderma biguttatus* and reasons for their dominance in the region requires species specific analysis of life biology traits. Dominance of *Orthogonius indophilus* in forest habitat indicates that conditions favourable for the Termitophilous groups exist in the WLS. Seven species namely, *Adischussus quadrinotatus, Brachinus devagiriensis, Chlaenius malachinus, Lebia basalis, Orthogonius bacanoides, Orthogonius indicus* and *Stenolophus smaragdulus* are only recorded from forest regions and known as closed forest specialists.

As this is the first sampled study of the region in Carabidae using light traps, there is no data available for comparison from the oriental region. Overall, little information is available on the value of light trapping as a survey method for carabid surveys and only limited data from light trap collections have been

presented (Frost, 1958; Vanhercke *et al.*, 1981; Ishitani, 1996). All elements affecting dispersal by flight will play an important role in using light trapping as a survey method. Flight of ground beetles is greatly influenced by temperature, rain and wind (Thiele, 1977; van Huizen, 1979; Lovei & Sunderland 1996). McCravy and Willand (2005) and Snyder and Ives (2001) suggested that higher humidity and soil humidity decreased the abundance and diversity of ground beetles.

Agriland Carabids in the studied Malabar Wildlife sanctuary and attracted to the light traps (winged forms) are dominated by tribe Perigonini with *Perigona nigricollis*, tribe Lebiini with *Anchista fenestrata* and tribe Helluonini with *Macrocheilus devagiriensis* and reasons for their dominance in the region requires species specific analysis of life biology traits. Five species namely *Craspedophorus mandarinellus*, *Euschizomerus indicus*, *Macrocheilus devagiriensis*, *Orthogonius lucidus* and *Perigona nigricollis* are only recorded from Agrilands and known as open agriland specialists.

5.3. DNA barcoding

Macrocheilus devagiriensis, a species with distribution in and around Malabar Wildlife Sanctuary only, is having a genetic makeup similar to that of the *Omphra pilosa*, which is present in the Sanctuary and throughout India, that could be attributed to the morphological similarity shared by both the species—small labrum which does not cover the mandibles (Shiju *et al.*, 2012; Akhil *et al.*, 2019). *Macrocheilus bensoni* having larger labrum covering the mandibles, which is a primitive character (Moore, 1998; Ball *et al.*, 2011), is adapted to dry

forests and *Macrocheilus devagiriensis* is derived from ancestral species of the two with adaptive features for living in moist forest belts where it is distributed (Shiju *et al.*, 2012).

Chapter 6

CONCLUSION

6.1. Taxonomy

- Checklist of 23 species from the Malabar Wildlife sanctuary and surrounding agriculture lands.

- Pictorial key to the species from Malabar Wildlife sanctuary and surrounding agriculture lands.

- Record of a very rare enigmatic, termitophilous species, *Helluodes devagiriensis* from Malabar Wildlife sanctuary and a related species from North Western Ghats.

- Presence of a new species (*Brachinus devagiriensis*) from Malabar wildlife sanctuary.

- Taxonomic keys to the genus and species of subfamilies Dryptinae and Panagaeinae in India with species descriptions.

- Deposition of 23 species to the national insect collections of Zoological survey of India (ZSI), Calicut.

6.2. Ecology

- Fifteen species were reported with the Light trap collections.

- Species richness of winged Carabidae higher in forest belt compared to the agriland.

- Three species namely *Anchista fenestrata*, *Lachnoderma biguttatus* and *Orthogonius indophilus* were common to both forest and agrilands.

- Seven species were recorded only from the forests (closed forest specialists)

- Five species were recorded only from the agrilands (open agriland specialists)

- Further study is needed to analyse the reason behind species variations including seasonal variations based on statistical data.

6.3. DNA Barcoding

- *Macrocheilus bensoni* was sequenced for comparing its genetic makeup with *Omphra pilosa* and *Macrocheilus devagiriensis.*

- Phylogenetic Analysis revealed that *Macrocheilus bensoni* is forming a different clade whereas *Omphra pilosa* and *Macrocheilus devagiriensis* forms a single clade having two different lineages.

Chapter 7

REFERENCES

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LIST OF PLATES

Plate 1: Map showing (A) Malabar Wildlife sanctuary (B) Agriculture belts.

Plate 2: Traps used for the collection of Carabidae beetles from Malabar Wildlife sanctuary and surrounding agribelts (A) Light trap (B) Pitfall trap

Plates 3–6: Images of Carabidae beetles collected from the Malabar Wildlife sanctuary and surrounding agribelts.

LIST OF FIGURES

Figure 1. Relationship (using Neighbour joining method) between the three species of Helluonini of Malabar Wildlife Sanctuary with *Macrocheilus bensoni* collected from outside Malabar Wildlife Sanctuary.

LIST OF TABLES

Table 1: Diversity, richness, Simpson's evenness of Carabidae in the Malabar WLS and the surrounding agrilands.

Table 2: Abundance of Carabidae collected from Malabar Wildlife sanctuary and the surrounding agrilands.

Table 3: Abundance of Carabidae collected using Pitfall traps from Malabar Wildlife sanctuary and the surrounding agrilands.

Table 4: Statistical analysis of overall abundance of Carabidae species recorded from the Malabar WLS and the surrounding agrilands.