

**SYSTEMATICS OF THE BEES
(HYMENOPTERA : APOIDEA : APIFORMES)
OF KERALA AT ALPHA LEVEL**

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JOBIRAJ T.

**DEPARTMENT OF ZOOLOGY
UNIVERSITY OF CALICUT
KERALA – 673 635, INDIA**

JANUARY 2002

**DEPARTMENT OF ZOOLOGY
UNIVERSITY OF CALICUT**

Dr. T.C. Narendran
Professor
M.Sc., Ph.D., FASC



Phone: Off: 0494-401144*419
Res: 0494-400302
CALICUT UNIVERSITY P.O.
673 635, KERALA

Date: 14.1.2002

CERTIFICATE

This is to certify that this thesis is an authentic record of the work carried out by Mr. JOBIRAJ T., from May 1998 to January 2002 under my guidance and supervision in partial fulfilment of the requirements of the Degree of Doctor of Philosophy in Zoology, under the Faculty of Science of the University of Calicut. No part of the thesis has been presented before for any other degree.

It is further certified that the candidate has passed the M.Phil examination of the University of Calicut held in 1999.

T. Narendran

Dr. T.C. Narendran

DECLARATION

I do hereby declare that this thesis is an authentic record of the work carried out by me under the supervision of Professor T.C. Narendran, Department of Zoology, University of Calicut and no part of this has previously formed the basis for the award of any degree or diploma as stipulated in the statutes of Calicut University.

Jobiraj T.
14/1/2002

To
My Beloved Parents

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Introduction

INTRODUCTION

Bees occupy a unique role in the world of arthropods. They are entwined into most aspects of human culture, mythology, agriculture, economy and general ecology. Bees are sprightly small creatures that move about on pleasant bright days and visit pretty flowers. Bees are important pollinators of both natural vegetation and crops, and certain kind of bees make useful products, especially honey and wax. There are approximately 20,000 species world wide, with the greatest diversity found in Xeric regions.

What are bees?

In the order Hymenoptera, there is a section called Aculeata (whose females have sting-modifications of the ovipositor of ancestors). The Aculeata include the wasps, ants and bees. Bees are similar to the sphecoid wasps, but are quite unlike from other Aculeata. Bees are usually more robust and hairy than wasps, but some bees (*Hylaeus*, *Nomada*) are slender, sparsely haired, and sometimes wasp like even in colouration. Bees differ from sphecoid wasps in their protein source for their larvae, the former uses pollen (An exception of the genus *Trigona*, which uses carrion instead of pollen), while sphecoid wasp capture spiders or insects to provide food for their larvae.

Bees and sphecoid wasps together constitute the superfamily Apoidea (Michener 1986). The superfamily Apoidea can be recognized by following important characters. (1) the posterior pronotal lobe is distinct but rather small, usually well separated from and below the tegula (2) the pronotum extends ventrally as a pair of processes, one on each side, that encircle or nearly encircle the thorax behind the front coxae (3) Antennae with 10 flagellomeres in female and 11 in male. (4) wing venation well developed, usually 10 or 9 closed cells on

forewing and 2 closed cells in hind wings (sometimes fewer) (5) Hindwing with jugal lobe (6) metasomal sterna 1 and 2 not separated by a constriction and (7) the ovipositor concealed at rest and modified as a sting. Apoidea is a large superfamily consisting of about 10 families with about 28,000 species around the world.

The superfamily Apoidea is divisible into two informal series, the sphecoid wasps or spheciformes and the bees or Apiformes (BROTHERS, 1975). The structural characters of bees that help to distinguish them from sphecoid wasps are (1) the presence of branched, often plumose hairs (2) the hind basitarsi, broader than the succeeding tarsal segments, and (3) metasomal tergum 7 of the female is completely divided into lateral plates (hemitergites) associated with the sting apparatus and sternum 7 of the male is completely invaginated and often elaborately modified, not at all like an apical ventral plate.

An easily visible character that distinguishes nearly all bees from most sphecoid wasps is the presence of golden or silvery hairs on the lower face, causing the face to glitter in the light in the latter. But Bees do not show this feature, because their facial hairs are duller, often erect, plumose, or largely absent. This feature is very useful in distinguishing small wasp like bees such as *Hylaeus* from similar looking sphecoid wasps such as pemphredoninae.

The holophyletic Apiformes is believed to have arisen from the paraphyletic spheciformes. It is likely that bees originated at the very end of the early cretaceous period (125 million years ago).

The Importance of Bees

The bees are the most beneficial group of insects to humans. The important activity of bees, in terms of benefits to human, is their pollination of natural vegetation. Most of the tree species of tropical forests are insect

pollinated, and that usually means bee pollinated (FRANKIE *et al.* 1990). In temperate climate many kinds of bushes, small trees and herbaceous plants including many wild flowers, are bee pollinated. Vegetation of deserts and xeric areas are extremely rich in bee-pollinated plants. Conservation of these plants is essential in preventing erosion and other problems and in providing food and cover for wild life. Conservations of many habitats thus depends upon preservation of bee populations. In addition to this, many cultivated plants, garden flowers, most fruits, most vegetables, many fiber crops like flax and cotton, and the major forage crops such as alfalfa and clover are bee-pollinated. Infact, bees and flowering plants have co-evolved since the cretaceous age, and without the work of the bees the world would be a very different place.

The pollinators are primarily female bees, which collect pollen for their own food and especially to feed their larvae. Flowers produce not only nectar (and sometimes oil) but also excess pollen as bait or reward for the bees. The pollen that may fertilize ovules is that which bees lose inadvertently on floral stigmata as they go about collecting nectar, pollen or other material. Male bees of nearly all species, as well as the female of parasitic species, take nectar from flowers, but carry only the pollen that happens to stick to them. They thus play a role in pollination, but a less important one than that of the females, which actively collect pollen. Parasitic bees are often not hairy and thus play a less significant role in pollination than do males of hairy bees, which are likely to carry abundant pollen.

Honeybees have an important role in agriculture and in preserving wild habitats. They often have highly specialized relationship with native flora, and play a vital role in maintaining natural forest vegetation. Honeybees are suitable for environmental monitoring purpose because of their diverse nesting strategies and specific host plant biochemical relationships. Moreover, plant diversity,

abundance, structure and chemistry are prime determinants of herbivore community structure (MURUGAN *et al.* 1997).

The sting of the bee is the modified ovipositor and therefore found only in the queen and the genetically female worker bee. "Apium virus" prepared from isolated sting and honey sac of freshly killed bee, affords a valuable remedy for rheumatism. Another preparation known as "Specific medicine Apis" is used for the treatment of "Diphtheria, Scarletfever, Erysipeals, Dropy urinary irritation and all kinds of oedema accompanied by swelling and burning.

The royal jelly, which is fed solely to the larvae of the 'queen bee', is secreted from the lateral pharyngeal gland present in the antereodorsal region of the head of the worker bees. The royal jelly is rich in vitamins, especially pantothenic acid and biotin. It also contains w-hydroxy decenoic acid and biopterin which may be a pheromone or ectohormone and thought to produce queen differentiation. Bee royal jelly is popularly used as a "hormone type" ingredient in cosmetic drugs.

Bee-wax secreted through the walls of the body from one celled glands on the under side of the abdomen is commonly used in the manufacture of cosmetics, face creams, paints, ointments, insulators, plastic works, polishes, carbon paper and in laboratory for microtomy. In medicine it is used in the formulation of ointments, plasters, suppositories and surgical dressings.

However, the universally known produce of the honeybees is the honey which since time immemorial has been known in the world of medicine. Honey is medically more popular in the Ayurvedic and Unani systems. It is mildly laxative, antiseptic and sedative. It is quite useful in building up of the haemoglobin content and as a preventive against cough, cold and fever. It is also a blood purifier and a curative for ulcers on tongue and alimentary canal. It is

also found that the typhoid germs are killed by honey within 48 hours, those of Brachio-pneumonia in 4 days and dysentery in 50 hours (KAJAL MATHUR. 1999).

Solitary verses social life

While some female bees are solitary, others live in colonies. A solitary bee constructs her own nest and provides food for her offspring. She gets no help from other bees and usually dies or leaves before the maturation of her offspring. Sometimes such a female feeds and cares their offspring rather than merely storing food for them; such a relationship is called subsocial.

A colony consists of two or more adult females (irrespective of their social relationships), living in a single nest. Usually the females of a colony are divided into (1) one to many workers, which do most of foraging, brood care, guarding etc. and are often unmated; and (2) one queen, who does most or all the egg laying and is usually mated. The queen of most species, larger than her workers, but some times the difference is only in mean size.

The colony of Genera *Apis*, *Trigona* and *Melipona* consists of a Queen. The queen is unable to live alone because she never forages. The workers do forage and form viable colonies. They cannot mate and therefore cannot produce offsprings. These are highly eusocial bees. They always live in colonies and new colonies are established socially by groups or swarms.

Most bumble bees (Bombini) and many sweatbees (Halictinae) and Carpenter bees (Xylocopinae) may live in small colonies. Their colony start with a single female. She performs all necessary functions as nest construction, foraging, provisioning cells, laying eggs and feeding larvae. Later, the daughter emerges out and begins the colonial life and division of labour. These are called primitively eusocial colonies. The term gyne is used to the female who establishes her nest and becomes a queen when the colony develops.

Not all bees that live in colonies are eusocial. Some times a small colony consists of females of the same generation, probably sisters. Among them division of labour develops. One of the female acts as a principal egg layer or queen. Other females act as principal foragers or workers. Such colonies called semisocial. These colonies often arise when the queen of primitively eusocial colony dies. During that time, her daughter mates and become the principal egg layer or replacement queen. In some colonies there is no division of labour and all colony members behave similarly. Such colonies are called communal. In such case two or more females use the same nest, but make her own cells and lays their eggs.

In some rare cases, a few females co-operate in nest building and provisioning the cells. The females lay their eggs, as they built their cells. Here all the females have functional ovaries. Each one can mate and lay an egg. Such a social life is called quasisocial. In certain colonies it is impossible to recognize whether the colony is communal, quasisocial or semisocial. Only observations and dissection will clarify the situation. Such colonies are called parasocial (MICHENER, 2000).

Development and Reproduction

As in all insects that undergo complete metamorphosis, each bee passes through egg, larval, pupal and adult stages. The sex determination is haplodiploid. As in most hymenoptera, eggs of bees that have been fertilized, develop into females and those that are unfertilized develop into males.

During mating female stores sperms in the spermatheca, she usually receives sperms for her life time supply at her first mating. She can then control the sex of each egg by liberating or not liberating sperms from the spermatheca as the egg passes through the oviduct.

The number of eggs laid during life time of a female varies from eight or fewer for some solitary species to more than a million for queen of some highly social bees. The eggs of nearly all bees are elongate and gently curved, whitish with a soft, membraneous chorion. The late embryonic development and hatching of eggs variable among species to species.

Larvae of bees are soft, whitish, legless grubs. They commonly grow rapidly, moulting about four or more times. The last larval stage is called pre pupa.

Mature larvae of many bees spin cocoons, usually at about the time of larval defecation. The cocoons are made up of a framework of silk fiber in a matrix, that is produced as a liquid and then solidifies around the fibers. When conditions are appropriate, pupation occurs. Pupae are delicate, and their development proceeds rapidly. In bees the pupae never survives long unfavourable periods, because they are delicate and usually available for short seasons only.

Adults finally emerges from the cells. Then they leave their nest, fly to flowers or mate. In certain species the female return to their nests or construct new nests elsewhere. Many bees have rather short life span of only few weeks. Some bees pass many unfavourable seasons as adults. This is usually seen in bees with rather long adult life.

Nests and food storage

The nests of bees are the places where their young are reared. It is always made by mother or workers. Nests and especially cells, their provisions, and larval behaviour are full of meaningful details of importance not only for bee survival but also for our understanding of adaptations and of phylogeny. Several bee-nests are burrows in the soil. Others are in pithy or hollow stems, or are

excavated into wood. Some are constructed of resin or mud, often with pebbles. Cell lining are secreted or constructed with leaf fragments, petals, resin and other such materials. Members of Apidae nest in large cavities or some times in exposed situations using secreted wax, often mixed with pollen, resin or mud for construction.

Bee nests consists of brood cells. A cell serves to protect the delicate immature stages, and the food of the growing larva. Most bee nests consist of more than one cells. It consists of burrows in the soil, in wood or in pith. In corbiculate tribes the cells are in cluster or on combs, usually in cavity in a tree or in the ground. In Meliponini, in which the clusters or combs of wax brood cells are surrounded by one or multiple layers of resin or wax involucrum, which is exposed, or hidden in a hollow tree or in the ground. The mixture of wax and resin is called cerumen. The multiple layers of cerumen around the brood chamber are called involucrum, and the layer enclosing the nest are called batumen.

In addition to nest making bees, there are parasitic forms (cleptoparasites and social parasites) that depend on nest-making bees to feed their larvae. The cleptoparasitic female enters the nest of the host and lays an egg in any cell that is in the appropriate stage, often returning to the nest repeatedly to parasitise other cells as they are constructed and provisioned. The host egg or young larva is killed either by the adult parasite, as in *Sphcodes* (Halictidae), or by the young larva of the parasite (as in parasitic Megachilidae and Anthophoridae). The social parasitic female usurps the host nest. The colony becoming in effect the queen of the colony that includes the host workers. The hosts are social bees with a worker caste; the parasites lack a worker caste.

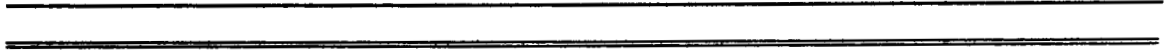
Diversity and Abundance

The bees are the most important of all pollinators and perhaps the most speciose. There are about 20,000 species of bees in the world. Bees appear to attain their greatest abundance, greatest number of species, and probably greatest number of genera and subgenera not in tropics, but in warm temperate, Xeric regions of the world (MICHENER, 1979). The bee fauna is particularly rich in Mediterranean basin and thence eastward to central Asia, and in the Madrean region of North America (= Californian and the desertic regions of the south western United States and northern Mexico). The bee fauna of Mexico, recently analysed (AYALA, GRISWOLD and YANENGA, 1996), supports the idea that bees are more numerous and diverse on xeric temperate areas than in the tropics and they reported 1,800 species. Bee faunas becomes, less in the Arctic regions, in spite of the abundance of flowers in arctic habitats (MICHENER, 2000). The fauna of Java (FRIESE 1914; LIEFTINCK, 1977) contain only about 193 species. This should be viewed from the perspective that it has been studied by persons having special interests in bees and that Java is a large, altitudinally diverse island that was connected with the Asian mainland so recently that it has a rich oriental fauna, not a specialised insular fauna (MICHENER, 2000).

Further Scope of Study

In Kerala we have more or less diverse fauna of series Apiformes and when considering the above mentioned facts the study of the bees is important in applied, academic and economic aspects. Despite the great variety of habits and economic importance, their faunastic studies and taxonomy are poorly done in India, particularly in Kerala, where a wide varieties of Apiformes present. Most of them are poorly described. Hence a detailed systematic study of this group is

needed. Further no research work is meaningful without taxonomy, since all other studies concerning biology, ecology, conservation, genetics etc. rely upon the foundation of good systematics.



Chapter I

REVIEW OF LITERATURE

The bees are probably the most beneficial group of insects to man. They are placed in the series Apiformes within the superfamily Apoidea. Apoidea includes both sphecoid wasps and bees. They are treated as two informal series, Spheciformes and Apiformes respectively, following classification suggested by BROTHERS (1975). Studies on bees mainly centred around certain specialized fields such as behaviour, sociobiology, communication, social parasitism etc. and very little study has been done on their systematics especially in India. The world fauna of Apiformes has at least 20,000 species. Here an attempt has been made to review the literature on the systematics of the family Apidae relevant to the present work, with particular emphasis to the oriental region. Recently MICHENER (2000) divided the series Apiformes into 7 families viz., Stenostictidae, Collectidae, Andrenidae, Halictidae, Melittidae, Megachilidae and Apidae. The family Apidae is divided into three subfamilies viz., Xylocopinae, Nomadinae and Apinae.

The study of bees started with LINNAEUS (1758). He was followed by SCOPOLI (1770), FABRICIUS (1775), LATREILLE (1802), ILLIGER (1802), WESTWOOD (1840), LEPELETIER (1841), SMITH (1854), MICHENER (1944) and many others. In India remarkable works on systematics of bees has been done by BINGHAM (1897).

Studies done by LINNAEUS stood first in the systematics of bees. In his "Systema nature" (1758), he erected the genus *Apis* with the type species *Apis mellifera* Linnaeus (designation of Latreille, 1758). He also described the first anthophorine bee as *Apis retusa*. In 1770, SCOPOLI erected the genus *Nomada* from Europe with the type species *Apis ruficornis* Linnaeus (designated by Curtis

1832). In the same year Scopoli also erected the genus *Eucera* with type species *Apis longicornis* Linnaeus (designated by Latreille 1810). Two oriental species of *Ceratina* had been described by Fabricius (1787, 1798) viz., *C. smaragdula* and *C. aenea* under the generic name *Apis* from 'Tranquebar' and 'India orientali' respectively. LATREILLE (1802a) erected the genera *Anthophora* with the type species *Apis pilipes* Linnaeus and *Xylocopa* (1802b) with the type species *Apis violacea* Linnaeus (Designation of Westwood 1840a).

KIRBY (1802) gave the first major account of the bees of any area (Britain), placed all bees in the two genera, *Melitta* Kirby for short-tongued and *Apis* Latreille for long tongued bees. In the same period he erected the genus *Bombus* with the type species *Apis terrestris* Linnaeus (Monobasic designation). LATREILLE (1802b) recognised the above two groups as families, with certain subgeneric subdivisions. LATREILLE in the year 1805 erected the genus *Ceratina* from Europe with the type species *Ceratina albilabris* Fabricius (based on Monotypy). ILLEGER erected the genus *Melipona* with the type species *Melipona favosa* Fabricius from South-America and oriental region in the year 1806.

PANZER (1806) erected the genus *Nomada* with the type species *Nomada scutellaris* Fabricius. JURINE (1807) described the genera *Pasites* with the type species *Pasites maculata* Jurine (original designation) and *Trigona* with type species *Apis amalthea* Olivier (designation by Latreille 1810). KLUG (1807b) gave a summary listing 32 bee genera. Again LATREILLE in 1809 erected the genus *Ammobates* with the type species *Ammobates rufiventris* Latreille (designation by Latreille 1810).

LEPELETIER (1835, 1841) presented his own classification of bees. He separated the social apinae (*Bombus*, *Melipona*, *Apis*) in a separate account (1835). Other bees (1841) were divided into two major groups, the solitary nesters and the parasites. DAHLBOM (1835) placed *Anthophora* in his tribe Anthophorini.

SMITH from 1840 to 1865 gave important contributions to the systematics of bees. SMITH (1854) erected the genus *Habropoda* with the type species *Habrophora ezonata* Smith (inversed autobasic designation). The first detailed study of the genus *Apis* was done by GERSTACKER (1862), in which he included 3-24 species and treated the four subgenera as distinct genera. SCHENCK (1861, 1869) gave an account of bees of Germany and provided classification. DOURS in 1869 published a monograph of *Anthophora*. THOMSON (1872) prepared a system of classification for bees. SMITH in 1879 described *Ceratina sexmaculata* from Hong Kong.

ASHMEAD (1890) described some new species of Hymenoptera from Colorado. In 1895 MORAWITZ erected a new genus *Tarsalia* with the type species *Tarsalia hirtipes* Morawitz (Monobasic designation). Period from 1895-1949 COCKERELL published several papers pertaining to bee systematics and biology, especially from North America. FRIESE in 1896 published a monograph of *Ceratina*.

In the year 1897 BINGHAM revised the bees of the Indian subcontinent. He gave key to genera and species, with description of each taxon in his 'Fauna of British India'. FRIESE (1897) erected a genus *Amegilla* with the type species *Apis quadrifasciata* Villers (designated by Cockerell). CAMERON in the same year made contributions to systematics of Hymenoptera of the Oriental region. ASHMEAD (1899) modified the classification of the bees and described a new genus *Tetraloniella* with type species *Macrocera graja* Evermann (original designation).

CAMERON (1901) described three new genera and seven new species of Hymenoptera from Eastern Asia and Australia. ASHMEAD (1904b) listed Hymenoptera of Philippine Islands, with the description of a new species. In 1904(a) ASHMEAD revised the genus *Apis*. ROBERTSON (1904) thoughtfully

developed a new classification of bees and his families which was widely accepted by North American hymenopterologists.

MICHENER (1944) revised the classification of the bees of the world. In the same year LIEFTINCK prepared some notes on Malaysian bees of the family Anthophoridae. MICHENER (1944) and SCHWARZ (1948) recognized only two principal genera, *Melipona* and *Trigona* from the tribe Meliponini. RODECK (1945) described two new subgenera of *Nomada* Scopoli viz. *Pachynomada* with the type species *Nomada vincta* Say and *Laminomada* with the type species *Nomada hesperia* Cockerell. RAYMENT (1947) critically revised the species of *Zonata* group of *Anthophora* based on new characters.

POPOV (1950) published a paper on genus *Amegilla* Friese and mentioned the taxonomic position of *Ammobates* Latreille. VAN DER VECHT in 1952 published a preliminary revision of the oriental species of the genus *Ceratina* Latreille. In 1953 MAA revised the classification of the bee genus *Apis*. YU (1954) reported Xylocopine bees from Formosa. LIEFTINCK (1956a) revised some oriental anthophorine bees of the genus *Amegilla* Friese. Again LIEFTINCK in the same year (1956b) revised Xylocopine bees from Moluccan Islands with notes on the other Indo-Australian species. HURD described subgenera of the world carpenter bees of the genus *Xylocopa* Latreille in the year 1956.

MICHENER and MOURE (1957) studied about the classification of the more primitive and non-parasitic Anthophorine bees. LIEFTINCK in 1958 revised the Indo-Australian species of the genus *Thyreus* Panzer. In this paper he prepared a check list for the species. WILLE (1959a) gave comparative morphology and classification of stingless bees and in 1959b he described a new species of fossil stingless bee from Mexico.

ENDERLEIN and BUTTEL-REEPEN (1906) separately revised the genus *Apis*. BROWN in 1906 reported *Trigona biroi* Friese and *Trigona laeviceps* Smith from Philippine Islands. COCKERELL (1908-1937) published the descriptions of about 30 new species of *Ceratina* in more than a dozen different papers. Again COCKERELL (1911c) described two new species along with few subspecies of *Anthophora*. STRAND (1914) erected the genus *Tetralonioidella* with the type species *Tetralonia hoozana* Strand. DOVER (1924) described the blue banded bees of the *Anthophora zonata* group in British Museum.

In 1928 FRISON mentioned the bumble bees of the Philippine Islands. SKORIKOV (1929b) revised the genus *Apis*. POPOV (1931) erected the genus *Parammabatodes* with the type species *Phiarus minutus* Mocsary.

The older classification of bees were based largely on various characters of mouthparts, wings, legs, and scopa. BISCHOFF (1934) was among the first to call attention to various little used characters of the body such as subantennal sutures, episternal groove, as well as jugal and vanal lobes of hind wing etc. MAA (1938) reported Indian species of the genus *Xylocopa* Latreille. SCHWARZ in 1939 described the Indo-Malayan species of *Trigona* Jurine with a key to their identification. In the same year LINSLEY erected some new subgenera and described some species of epeoline and nomadine bees. He again revised the genus *Oreopasites* Cockerell in 1941.

MOURE in the year 1961 erected the genus *Lisotrigona* with the type species *Melipona cacciae* Nurse. He also classified the old world melioponine bees on the same paper. In the same year MILLIRON revised the classification of the bumble bees. HURD on 1961 prepared a synopsis of the carpenter bees belonging to the subgenus *Xylocopoides* Michener.

LIEFTINCK (1962) revised the Indo-Australian species of the *Thyreus* Panzer. In this paper he gave separate identification key to East Asiatic species and Australo-pauan species and prepared a catalogue of Indo-Australian region. Again in 1963 HURD and MOURE modified the classification of the large carpenter bees. LIEFTINCK in 1966 gave notes on some Anthophorine bees, mainly from the old world.

MICHENER (1966b, 1969, 1970, 1975a,b, 1976, 1977a,b) and MICHENER and SCHEIRING (1976) revised the tribe Allodapini at the generic level, as well as the species of Africa, using character of both adults and immature stages. RICHARDS (1968) divided the genus *Bombus* Latreille subgenerically.

MICHENER (1969) erected the genus *Braunsapis* with the type *Apis faciatus* Gerstaecker. Asian species were placed on the genus *Allodapula* Cockerell for a time (Michener, 1966a); Michener (1969, 1975a) recognized *Allodapula* as a strictly African group and proposed the name *Braunsapis*. The only allodapin bee found in the Oriental region is the genus *Brannsapis*. ROZEN (1969) described a new species of African *Thyreus* with life history of two species of *Anthophora*. SHIOKAWA and SAKAGAMI in 1969 published some additional notes on the genus *Pothitis* in the Oriental region, with descriptions of two new species from India such as *Pithitis indica* and *Pithitis waini*.

MAA (1970) revised the subgenus *Ctenoxylocopa* and treated seven species and a subspecies, in two groups. MILLIRON in 1971 published a monograph of the western hemisphere on the bumble bees of the genera *Megabombus* and *Bombus* Latreille in the same period. HIRASHIMA (1971a) made subgeneric classification of the genus *Ceratina* of Asia and West Pacific with comments on remaining subgenera of the world. He recognized eight subgenera from Asia and West Pacific. In the same year HIRASHIMA (1971b) introduced a new genus *Megaceratina* from Africa with the type species *Ceratina bouyssi* Vachal. MOURE

(1971) elevated some of the subgenera of Meliponini to the genus level, making his classification of New World Meliponinae were nearly comparable to that of the Old World.

MILLIRON prepared a monograph of western hemisphere bumble bees of the genera *Megabombus*, subgenus *Megabombus* (1973a) and genus *Pyrobombus* subgenus *Cullumanobombus* (1973b). LIEFTINCK (1974) reviewed Central and East Asiatic *Habropoda* Smith and erected a genus *Habrophorula* with type species *Habropoda nubilipennis* Cockerell from China. WATMOUGH in 1974 studied the biology and behaviour of carpenter bees of Southern Africa.

SAKAGAMI (1975) published a paper on continental South east Asiatic stingless bees. BROTHERS in 1975 gave an account of phylogeny and classification of aculeate hymenoptera, with special reference to the Mutilidae. MICHENER (1975a) made a taxonomic study of African allodapine bees. LIEFTINCK in the same year reported the bees of the genus *Amegilla* Friese from Korea and described the new species *Amegilla parhypate*. TSUNEKI in the year 1975 studied the genus *Nomada* Scopoli of Japan.

MARIKOVSKAYA (1976) gave the systematics of the tribe anthophorini. ZEUNER and MANNING published a monograph of fossil bees on the year 1976 from Baltic amber. KERR and CUNHA (1976) mentioned taxonomic position of two fossil bees, *Meliponorytes devictus* and *Electrapis proava*, by numerical taxonomic methods. WILLE in the same year reported 5 species of *Melopona* Illiger from Costa Rica.

BATRA (1977) reported bees of India and included their behaviour, management and identification key to the genera. MICHENER (1977a) gave the discordant evolution and classification of allodapine bees. Again MICHENER in 1978 revised the allodapine bees of Madagascar and this included keys,

descriptions and illustrations. SAKAGAMI in 1978 described the stingless bee *Tetragonula* Moure from Continental Asia and Sri Lanka. DRESSLER in the year 1978 described and classified *Euglossa* Latreille with notes on some features of special taxonomic importance. He divided *Euglossa* into 12 species groups and 4 subgenera. HURD (1978a) prepared an annotated catalogue of the *Xylocopa* Latreille of the Western hemisphere. He also made a notes on bamboo-nesting carpenter bees of the subgenus *Stenoxylocopa* Hurd and Moure in the same year (1978b).

HIRASHIMA and TADAUCHI in 1979 reported three species of *Colletes* Latreille and two species of *Epeolus* Latreille and described a new species of *Colletes* from Japan. WANG (1979) described three new species of bumble bees from Tibet viz., *Bombus xizangensis*, *Bombus chayaensis* and *Bombus convexus*.

MARIKOVSKAYA (1980) erected a new genus *Solamegilla* with type species *Anthophora prschewalskyi* Morawitz (by original designation). PLOWRIGHT and STEPHEN in the same year re-investigated the taxonomic status of *Bombus franklini*. SAKAGAMI, MATSUMURA and ITO (1980) described *Apis laboriosa* Smith the little known world's largest honey bee from Himalayas and morphologically compared with *Apis dorsata* Fabricius.

SHIOKAWA and HIRASHIMA (1982) made a synopsis of the *Flavipes* group of the bee genus *Ceratina* of eastern Asia. It includes 3 species of which two viz., *Ceratina takasagona* and *Ceratina maai* were described as new from Taiwan and Fukein respectively. WARNCKE in 1982 analysed the systematics of bees of the subfamily Nomadinae. PEKKARINEN (1982) gave the morphology and specific status of *Bombus laponicus* (Fabricius) and *Bombus monticola* Smith.

BROOKS in 1983 gave systematics and bionomics of *Anthophora*, the bomboides group and species groups of the new world. ALPATOV made a

contribution to the study of variation in the honey bees, carnoia and crimean bees and their place among other forms of *Apis mellifera* Linnaeus in the year 1983. CAMARGO and MOURE (1983) erected a genus of Meliponinae the *Trichotrigona* from Amazonas, Brazil with the type species *Trichotrigona extranea* Camargo and Moure, by original designation.

In 1984 LAVERTY, PLOWRIGHT and WILLIAMS erected a new subgenus *Digressobombus* with type species *Megabombus digressus* Milliron by original designation and described the male of the rare *Bombus digressus* from Costa Rica. MARIKOVSKAYA (1985) studied systematics of the genus *Paramegilla* Friese. This article contains a detailed morphological characteristics of the genus *Paramegilla* and 28 included species with data concerning distribution, phenology, tropic links and a conclusion about supposed evolution of the group. SNELLING and BROOKS at the same period reviewed the genera of cleptoparasitic bees of the tribe Ericrocini. WILLIAMS made a preliminary cladistic investigation or relationships among the bumble bees in the same year (1985).

CORREIA and BRANCO (1986) studied biometry and numerical taxonomy of *Apis mellifera* in 1986. WU (1986) described two new species of *Anthomegilla* Marikovskaya from China. WU and KUANG in 1986 studied the genus *Micrapis* Ashmead. MICHENER in 1986 gave family names for all taxa of bees. BROOKS in the year 1986 classified the anthophorine bees.

KIMSEY in 1987 studied the relationships among the englossine genera and arranged it into two natural groups, *Exaerete* + *Euglossa* and *Eufriesea* (*Eulaema* + *Agale*). SCHWARZ (1987a) made contribution to the clarification of some *Nomada* species described by Morawitz and 7 lectotypes were designated. SCHWARZ in the same year (1987b) described five new species from USSR. They were *Nomada ashabadensis*, *N. kocourecki*, *N. margelanica*, *N. pesenkoi* and *N. spinicoxa*.

WU and KUANG (1987) reported two species of small honeybee of genus *Micrapis*.

DALY in 1988 erected a genus *Ctenoceratina* with the type *Ceratina armata* from Africa south of the Sahara. RUTTNER (1988) revised the taxonomy of honey bees. BROOKS (1988) studied systematics and phylogeny of the Anthophorine bees. He reviewed the subgenera and genera of Cosmopolitan tribe Anthophorini. He reported two genera and 14 subgenera, of which seven were new. YAN RUWU described a new species, *Anthophora antennalis* from China in the same year. McEVOY (1988) made a taxonomic history of the Himalayan honeybee *Apis laboriosa*. In this article he reviewed the morphological and biological characters that distinguish *Apis laboriosa* from *Apis dorsata*. BROEMELING (1988) revised the subgenus *Pachynomada* Rodeck of *Nomada* Scopoli, fourteen species were recognised.

SAKAGAMI and INOUE in 1989 described a new species of *Trigona* viz., *Trigona incisa* from Sulawesi. MOURE (1989a) described *Glossuropoda*, a new subgenus of *Euglossa* with the type species *Euglossa intersecta* Latreille. In this paper he also described two new species from Amazonia. LA BERGE in the same year reviewed the bee genus *Pectinapis* La Berge and described a new species *Pectinapis salviae* from London. He also provided a key to species in the above article. MOURE (1989b) described two new species of *Paratrigona* from Amazon region viz., *Paratrigona myrmecopila* and *P. pannosa*. PESENKO *et al.* (1989) described in detail the Chinese wax bee *Apis cerana cerana* in the Soviet Far East. Again MOURE in the same year (1989c) erected a new genus *Sakagamilla* with type species *Sakagamilla affabra* from Brazil. MCGINLEY reviewed the immature Apoidea and prepared a catalog in 1989.

MICHENER (1990a) reviewed the classification of the family Apidae. Here alternative phylogenies for the subfamilies are presented. The Meliponinae is

considered in greatest detail and 21 genera were recognized. Keys were provided for genera and subgenera. REYES in 1990 studied parasitic allodapine bee and its hosts in Java and Malaysia. Again MICHENER in 1990b described a new species *Liotrigona nilssoni*.

REYES revised the Bee genus *Braunsapis* in the Oriental region in the year 1991. 19 species were treated. Eight species were described, as new, namely, *B. flaviventris*, *B. malliki*, *B. clarihirta*, *B. apicalis*, *B. lateralis*, *B. signata*, *B. aurantipes* and *B. indica*. In this work he synonymised many species of *Allodape* with *Braunsapis*. CUNHA (1991) made phenetic review of the taxonomy of some Meliponine bees. CAMARGO and ROUBIK (1991) made a systematic revision and gave biological account of *Trigona hypogea* group, along with descriptions of a new species *Trigona necrophaga* and the *Trigona crassipes* (Fabricius) from Amazon area. ROIG-ALSINA (1991) gave a cladistic analysis of the Nomadinae with description of the new genus *Rhopalolemma* with type species *Rhopalolemma robertsi* Roig-Alsina.

CUNHA (1992) studied the relationship among 42 subgenera of the genus *Xylocopa* using phenetic techniques applied to male and female data sets. SCHOLL *et al.* in 1992 analysed the specific distinctiveness of *Bombus nevadensis* Cresson and *Bombus auricomus* (Robertson) by enzyme electrophoretic data. CAMARGO and PEDRO (1992) revised systematics, phylogeny and biogeography of the Meliponinae. In the same year BRAVO gave the systematics and distribution of *Parapartamona* (Schwarz). In the same paper he recognized two species *P. zonata* (Smith) and *P. brevopilosa* (Schwarz) and *Trigona zonata tungurahua* Schwarz and *T. z. caliensis* Schwarz were considered as synonyms of *P. zonata* (Smith).

ROIG-ALSINA and MICHENER in 1993 studied the phylogeny and classification of long tongued bees proposed for a previously misidentified species (*P. binghami* Cockerell of Shiohawa & Sakagami; *P. comberi* Cockerell of

Hirashima). WANG and YAO studied the Chinese species of the subgenus *Alpigenobombus* Skorikov in the year 1993. This paper dealt 9 species with a new subspecies viz., *Bombus grahami melani*. MICHENER provided morphology, biology, distribution etc. of Apiformes, including classification and diagnosis upto family level in the book on Hymenoptera edited by GOULET and HUBER (1993). In this work Apiformes are arranged in 9 families. MICHENER *et al.* (1994) revised the Bee genera of North and Central America. He also provided identification keys to families. CUNHA (1994) made a phenetic study of the Old World Genera, Trigonini at supra-specific level. Phenetic relationship among 23 genera of Trigonini bees, 13 coming from Oriental and Australian regions and ten coming from Ethiopian region were discussed and proposed. CAMARGO and MOURE (1994) revised Neotropical genera, *Paratrigona* Schwarz and *Aparatrigona* Moure, and described eleven new species and one new subspecies.

TERZO and RASMONT (1996) redescribed *Ceratina gravidula* Gerstaecker and *C. nigraenea* Gerstaecker from West-palaearctic region, with their synonyms and distribution maps. TINGEK *et al.* described a new honey bee *Apis nuluensis* from mountain regions of Borneo in 1996. The differences with *Apis cerana* Fabricius and *Apis koschevnikovi* Buttel-Reepen were also analysed in the above publication.

BAKER in 1997(b) described *Pithitis* Klug species from Indian subcontinent. In this paper *Ceratina comberi* Cockerell was synonymized with *Pithitis smaragdula* (Fabricius); a lectotype was designated for *Ceratina binghami* Cockerell.

MICHENER (1997) designated a neotype *Eucera antennata* Fabricius for the Genus *Tetralonia* Spinola. SHEPPARD *et al.* described a new subspecies of honey bee viz., *Apis mellifera ruttneri* from Malta island in the same year.

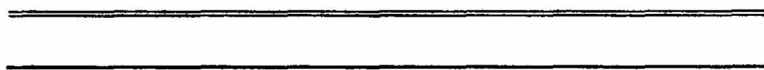
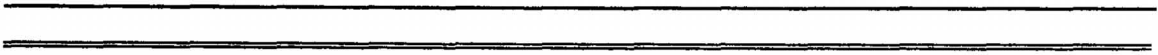
TERZO and RASMONT (1997) revised the carpenter bees of the genera *Copoxyla* Maa and *Xylocopa* Latreille from Mediterranean countries. CHEN and WANG (1997) studied phylogenetic relationships among 28 subgenera of bumble bees using morphological and behavioural characters. BAKER in 1997(a) erected a new genus of Melictini viz., *Sinomelecta* with type species *Sinomelecta oreina* Baker by original designation from Western China. ROUBIK *et al.* described a new stingless bee genus endemic to Central America, *Meliwillea* with type species *Meliwillea bivea* Roubik by original designation. ENGEL *et al.* (1997) analysed the phylogeny and behaviour in honey bees by using morphological and molecular data sets.

ENGEL (1998) published a note on fossil honeybees and evolution in the genus *Apis*. MINCKLEY (1998) did phylogenetic analysis of the genera and subgenera of the tribe Xylocopini by using morphological characters. KOCOUREK and SCHWARZ (1998) described 4 species and one subspecies of the genus *Ceratina* under the authorship of Kocourek from Western palaertic region and Turkistan basin. They are the followings, *C. hakkarica*, *C. hadii*, *C. schwazi*.

ENGEL in 1999a made an attempt to clarify the complicated and error fraught taxonomic history of the honey bees (*Apis*) by cataloguing the numerous names proposed for *Apis*. In this work 178 species and 10 genus group names were brought for the first time into accord with the modern classification of the honey bees. The same author in the same year (1999b) described the first fossil *Euglossa* Latreille and figured from Miocene Dominican amber as *Englossa moronei* new species. The distribution of the euglossines, particularly in the West Indies, and their associations with orchids were briefly considered. TADAUCHI *et al.* described a new species *Epeolus ishikawai* from Japan. REYES *et al.* analysed species phylogeny of the Bee genus *Exoneurella* Michener by using molecular and morphological data sets. JOBIRAJ (1999) made a preliminary revision of the bee genera of Kerala and prepared a key to bee genera of India.

ENGEL reviewed the Indo-Malayan meliponine Genus *Lisotrigona* Moure (2000a). He described two new species from northern Vietnam and Thailand as *L. carpentri* and *L. furva* respectively. The type species *L. cacciae* (Nurse) redescribed and *L. scintillans* (Cockerell) considered to the junior synonym of it. ENGEL (2000b) described the oldest fossil be *Trigona prisca* Michener and Grimaldi in the cretaceous amber from New Jersey, was redescribed and figured. Differences between *T. prisca* and extent *Trigona* were noted and the fossil was transferred into a new genus, *Cretotrigona*. The same author in the same year (2000c) also analysed the relationship between fossils, phylogeny and social bee evolution. MICHENER (2000) published a world revision of Bee Genera in his classical book 'The Bees of the World'. This is the only comprehensive, world wide treatment of all groups of bees - 1,200 genera and subgenera, including more than 16,000 species. The greater part of the work consists of the systematics, with keys (many of them regional) for identification at the sub genus level. For each genus or subgenus, Michener included a brief natural history describing geographical range, number of species, and information pertaining to nesting or floral biology. NARENDRAN, JOBIRAJ and MOHANDAS (2000) described a new species of the genus *Halictus* Latreille viz., *Halictus tectonae* from India.

ENGEL (2001) published a monograph of the Baltic amber bees and Evolution of the Apoidea.



Chapter II

MATERIALS AND METHODS

1. Collection Work

The adult specimens were collected alive from the field. These insects are usually found among the flowers and vegetation. Capturing and preserving specimens is essential for studies on bee ecology, pollination, identification etc. Standard entomological collection techniques include using insect net (Fig. 1). The killing jar or tube with ethyl acetate is used. Many bees are hairy, it is important to keep such a jar or tubes dry; excess moisture or ethyl acetate wets the hairs, thus changing the appearance of specimens and making it difficult to see the important characters. Adult insects were also collected from the hives.

a) Study area

Specimens were collected almost all the districts of the state (Fig. 3). Kerala the extreme south-western state in India, is located between 8°18' and 12°48' latitude 74°52' and 77°22'E longitude. This narrow strip of land extends north-south between the Lakshadweep sea and the main peninsular Indian hill range, the western ghats. Although it is about 580 km in length North-South, its average width varies from 32 kms in the extreme north and south and to over 120 kms in the middle. The state of Tamil Nadu on the east and south and the state of Karnataka on the north and north-east form the state boundaries. The area of the state is 38, 863 sq. kms. and works out to 1.18% of the total area of the country. Bees not only collected from Kerala, but also from neighbouring states are also included in this study, since the bee fauna of Kerala is not isolated from nearby places. The Calicut University campus provide diverse fauna of bees.

According to the geographical features, Kerala can be divided into three regions. (1) The Highlands above 76 m (2) The midlands 7.6 to 76 m and (3) the low lands below 7.6 m.

With an average height of 900 m and a number of peaks well over 1800 m in height, the high land of western ghats includes large forested areas, with major hot spot areas of biodiversity.

The midlands consists of extensive hills and valleys, form an important cultivable area for cashew, coconut, arecanut, tapioca, banana, rice and different kinds of vegetables.

The low lands includes the major coastal areas, were the major 44 rivers of Kerala join to the sea. This area also includes lagoons and backwaters.

b. Climate

Four alternate seasons cover the climate of Kerala. They are hot season (March to May), south west monsoon (June to September), postmonsoon (October to November) and north east monsoon (December to February). The annual temperature range between a maximum of 35.9°C and a minimum of 23.8°C only. The main relative humidity value ranges from 60-90%. The total annual rainfall is excessive with over 3200 mm.

2. Methods of Collection

Collection of bees can be by various methods. These methods are mentioned below.

a) Net sweeping

Bees were usually collected by this method. The type of net most suitable for sweeping is of a particular design. The net used in the present investigation is a modified model designed by NOYES (1982).

The sweep net essentially consists of a net bag attached on a triangular frame which in turn is connected to a cylindrical handle (Fig. 1). The triangular frame of the net is made up of aluminium with sides measuring 48 x 46 x 48 cm. The triangular shape increases the surface area of the net in contact with the ground while sweeping. The net handle is made up of 2.5 cm aluminium tube, about 1 m long. The frame fitted to one end of the handle, enables easy separation of the frame and can be used as far away from the body possible. The long handle makes possible sweeping even underneath long hanging bushes easier and extends the area of each individual sweep. The 60 cm net bag is made up of thin white cotton cloth or strong muslin which allow easy passage of air, the small pore size meshes preventing the escape of minute specimens. The rim of the bag is reinforced with a thick material, preferably, canvas.

For sweeping, it is important to choose an area where the vegetation is as diverse as possible. A grassland with a good variety of flowering plants surrounded by several kinds of bushes and trees form an excellent location for collection. The sweeping is done as described by NOYES (1982). Special attention should be given to the fact that, once the insects are caught inside the net, their escape should be prevented by twisting the net side ways, so that the bag folds over the rim and thus retains the capture. The bees caught into the net are transferred to killing jar or tubes with ethyl acetate or sucked into the aspirator.

b. Aspirator (Fig. 2)

It consists of a glass or plastic vial, fitted with a two-holed cork, holding two thin transparent glass or plastic tubes, acting as a sucker and an entry tube. One end of the entry tube is placed deep down the vial and other end extends well out to be placed against the desired insect. One end of the sucker inside the vial is covered with a piece of fine netting or screening to prevent the suction of insects and the other end is connected air tight to a moderately long rubber tube, to act as sucking device. By sucking, the vacuum created inside the vial draws the desired insect into it through the entry tube. The insects collected are killed by placing a piece of tissue containing a few drops of ethyl acetate in the entry tube.

c. Small hand net

Bees visiting on the flowers were collected by using small hand nets. The small hand net consists of a circular mouth, a handle and a net bag. The circular mouth is made up of aluminium or iron wire with a diameter of 17 cm. The handle is also made up of aluminium and having a length of 30 cm. The netbag measures 35 cm in length and made up of linen or thin cotton or muslin cloth, which allows the easy passage of air. After blowing, the collected specimens were transferred to killing jar or tube with cyanide or ethyl acetate.

d. Malaise trap

A suitable design of Malaise trap has been well described by TOWNES (1972). This tent like device catches insects by chance as they fly into the sides of the trap, they crawl upwards on the cloth to the roof where they enter the killing bottle which contains 70% alcohol. There are several modifications of the original Malaise trap. The latest model of this net made by Messers. Marris House Net's, England is used in the present work. This net has two advantages, it needs to be

visited only once a week for emptying and it can be serviced even by a non-entomologist.

e. Yellow-Pan or Moericke trap

This method is based on the principle that many insects are attracted to yellow colours. The trap consists of a shallow tray, about 60-75 mm deep and about 30 cm square, which is painted bright yellow inside and some neutral colour such as black on the outside. The tray was filled with water to which a few drops of detergent was added to break the surface tension. It was then laid on the ground undisturbed in a suitable habitat (where yellow flowers are not present among the vegetation). The tray was emptied once a day with a small net. Before transferring the specimens to alcohol, they were washed with fresh water to prevent the formation of deposits on the specimens due to contamination from the detergent.

3. Storing and Preservation

a) Unmounted material

Short-haired bees, like most stingless bees (Meliponinae) were put directly from the net into vials of alcohol. They can then be pinned whenever convenient. Long term preservation on alcohol can be improved by freezing. The alcohol was changed periodically so as to prevent the damage.

b) Relaxing

For relaxing, specimens were kept in an atmosphere of acetic acid for at least 6-8 hours. This method was found very suitable for specimens which had been killed using ethyl acetate or other killing agents. Relaxing helped to prevent breakage of specimens when they were being card mounted. In order to achieve best results, a clear plastic sandwich box with a tight fitting lid was taken and

covered the bottom with a thick layer of cotton wool. A few drops of glacial acetic acid added, followed by a second layer of cotton wool. Specimens to be relaxed were placed on top of a piece of tissue in a glass dish and the whole dish, kept in the box, which was then closed.

4. Mounting

Mounting of specimens needs special care in taxonomy. The specimens were mounted in such a way that all characters were visible easily.

a) Mounting on cards

The method followed in the present work is that adopted by BOUCEK and NOYES (NOYES, 1982). The well dried specimens was mounted on a rectangular card. The size of the card altered depending up on the size of the specimens. They were mounted in such a way that one side of their thorax was glued to the card. Thus the specimen was mounted in profile. In another method, they were mounted on a triangular card in such a way that the ventral side of the thorax was glued to the tip of the pointed card, so that the full details of the specimen is observed thoroughly. But the specimens mounted on the tip of pointed card need special care because they are easily subjected to damage. In another method larger specimens were pinned by using standard entomological pins, passing through the thorax from dorsal side.

The materials used for card mounting were (1) Microscope (2) Rectangular or triangular pointed cards (3) Blotting paper (4) A fine zero point brush (5) Entomology pins (6) Water soluble glue (7) Table lamp.

Before mounting, it was made sure that the glue was completely cold-water soluble. First of all, the specimens to be mounted is placed on a piece of blotting paper, so that the blotting paper absorbed the moisture content from the

specimen. It was then dried under the table lamp. The specimen was placed under microscope, and looking through it, its antennae, labial and maxillary palpi, legs and wings were spread and properly positioned, by using brush and pins. The pins of No.3, used here is made by M/s Newey Goodman and Co's (England) Asta pins of size 38 mm x 0.55. Using the tip of a pin a small drop of glue was put on the card. The glue should be fine and water soluble. The tip of the brush was moistened with alcohol. The specimen was picked up using the brush and placed on the gum. Then the specimen was gently and firmly pressed down with the brush for good adhesion. Care was taken to keep antennae, legs, wings etc. free from glue. The wings were kept stretched out and flat on the card. The mounted specimens were held on Asta insect pins. Then the specimens were labelled.

b. Labelling and Registering

Temporary labels were written in the field at the time of collecting specimens. After mounting specimens, permanent labels indicating the name of the country, state, date of collection etc. were added. Registering of specimens were done after the specimens have been identified atleast up to generic level. The registering of entries is as follows. (1) collection number (2) scientific name (3) name of locality (4) date of collection (5) name of the host (6) name of the collector (7) remarks. Serial numbers were also given to each specimen.

The mounted and labelled specimens then kept in insect boxes, for detailed systematic studies. Naphthalene balls were placed in the boxes to protect from insect attacks. Thymol crystals were used as fungicides. 1,2-dichloro benzene can also be used to prevent fungal growth.

C. Mounting on microslides

Microslides of important parts such as antennae, mouth parts, genitalia, legs, stings etc. of paratypes or other specimens were prepared to study the minute details of the specimens. For this purpose the necessary parts were removed from the specimens using needles and forceps. Heavily sclerotised structures were subjected to clearing by solutions such as KOH before mounting. The parts were kept in 10% KOH for 24-48 hours. After clearing they were washed in glacial acetic acid followed by distilled water and then dehydrated by passing through graded series of alcohol. The dehydrated materials were then mounted on glass slides using DPX.

5. Observations

Sorting and mounting were done under Herter and Reuss Optik Kassel Sterezoom (W. Germany) microscope and card mounted specimens were observed under Olympus (Japan made) and M3Z WILD Stereozoom (Switzerland made) microscopes. Slide mounted specimens were observed under LEITZ WETZLAR (German made) microscope.

6. Measurements

All measurements were taken from the LEITZ WETZLAR microscope by using micrometer.

7. Illustrations

The figures were drawn using drawing tube of WILD M3Z stereozoom microscope. Depending on the size of the specimens the figures thus obtained were kept as such and others were enlarged from KB enlarger of the model B2M.

SYSTEMATIC STATUS AND DIAGNOSIS OF FAMILY APIDAE

Family Apidae was erected by LATREILLE in 1802. Apidae was one of the most diverse families of bees containing more tribes than other families of *Apiformes*. Most species are economically important and act as pollinators of many plants.

The family Apidae was revised and modified in the broad sense by MICHENER (1944) who based on traditional systematic methods and intuitional phylogenetic trees. The Apidae is divided into three subfamilies (ROIG-ALSINA and MICHENER, 1993) viz., Xylocopinae, Nomadinae and Apinae. The large and diverse subfamily Apinae appears to be the sister group of other Xylocopinae or the Nomadinae. Xylocopinae is a holophyletic group inspite of the widely different aspects of small, slender species of tribes like Ceratinini and large, robust members of the tribe Xylococoni.

The Nomadinae consist entirely of cleptoparasites. The tribe of non parasitic ancestors are unknown, probably extinct (MICHENER, 2000). MICHENER (2000) excluded three tribes, Isepeolini, Osirini and Protepeolini from Nomadinae and included them under Apinae.

Apinae shows great diversity and they are divided into several tribes. Although the tribes are mostly stable groups, whose members remain together in various analyses, the arrangement of the tribes is different in different analyses (ROIG-ALSINA and MICHENER, 1993; SILVEIRA, 1993b). This diverse group (Apinae) is divided into (1) the corbiculate Apinae (usually called the corbiculate Apidae), for the Euglossini, Bombini, Meliponini and Apini and (2) the non corbiculate Apinae, for all other tribes of Apinae. The noncorbiculate Apinae, which are equivalent to the Anthophoridae or Anthophorinae of some older classifications, united by no synapomorphies, are very diverse morphologically,

and consist of those long tongued bees that do not fall into some other recognized group. These are the reasons why recognition of Anthophoridae is no longer justified (MICHENER, 2000). A group that has been often given family status, is now included in Apidae, subfamily Apinae, is the Ctenoplectrini (MICHENER, 2000).

A revised classification of Bees by MICHENER (2000) is given below:

1. Family : STENOTRITIDAE Cockerell
2. Family : COLLETIDAE Lepeletier
 - Subfamily a : Colletinae Lepeletier
 - Subfamily b : Diphaglossinae Vachal
 - Tribe : Caupolicanini
 - Tribe : Diphaglossini
 - Tribe : Dissoglottini
 - Subfamily c : Xeromelissinae Cockerell
 - Tribe : Chilicolini
 - Tribe : Xeromelissini
 - Subfamily d : Hylaeinae Viereck
 - Subfamily e : Euryglossinae
3. Family : ANDRENIDAE Latreille
 - Subfamily a : Alocandreninae Michener
 - Subfamily b : Andreninae Latreille
 - Subfamily c : Panurginae Leach
 - Tribe : Protandrenini
 - Tribe : Panurgini
 - Tribe : Melitturgini
 - Tribe : Promelitturgini
 - Tribe : Perditini
 - Tribe : Calliopsini
 - Subfamily d : Oxaeinae Ashmead

4. Family : HALICTIDAE Thomson
 - Subfamily a : Rophitinae Schenck
 - Subfamily b : Nomiinae Robertson
 - Subfamily c : Nomiodinae Börner
 - Subfamily d : Halictinae Thomson
 - Tribe : Halictini
 - Tribe : Augochlorini
5. Family : MELITTIDAE Schenck
 - Subfamily a : Dasypodainae Börner
 - Tribe : Dasypodini
 - Tribe : Promelittini
 - Tribe : Sambini
 - Subfamily b : Meganomiinae Michener
 - Subfamily c : Melittinae Schenck
6. Family : MEGACHILIDAE Latreille
 - Subfamily a : Fideliinae Cockerell
 - Tribe : Pararhophitini
 - Tribe : Fideliini
 - Subfamily b : Megachilinae Latreille
 - Tribe : Lithurgini
 - Tribe : Osmiini
 - Tribe : Anthidiini
 - Tribe : Dioxyoni
 - Tribe : Megachilini
7. Family : APIDAE Latreille
 - Subfamily a : Xylocopinae Latreille
 - Tribe : Manueliini
 - Tribe : Xylocopini

Tribe : Ceratinini

Tribe : Allodapini

Subfamily b : Nomadinae Latreille

Tribe : Hexepeolini

Tribe : Brachynomadini

Tribe : Nomadini

Tribe : Epeolini

Tribe : Ammobatoidini

Tribe : Biastini

Tribe : Townsendiellini

Tribe : Neolarrini

Tribe : Ammobatini

Tribe : Caenoprosopidini

Subfamily c : Apinae Latreille

Tribe : Isepeolini

Tribe : Osirini

Tribe : Protepeotini

Tribe : Exomalopsini

Tribe : Ancylini

Tribe : Tapinotaspidini

Tribe : Tetrapedini

Tribe : Ctenoplectini

Tribe : Emphorini

Tribe : Eucerini

Tribe : Anthophorini

Tribe : Centridini

Tribe : Rhathymini

Tribe : Ericrocidini

Tribe : Melectini

Tribe : Euglossini

Tribe : Bombini

Tribe : Meliponini

Tribe : Apini

As it would be beyond the scope of this thesis to include all the above mentioned families and groups, the present study deals only with the systematics aspects of Apidae (Kerala), the most diverse and widely distributed group.

DIAGNOSIS

In most Apidae, glossa long with flabellum; labrum usually broader than long, if not, narrowed to short articulation with clypeus. In most cases, the lower lateral parts of the clypeus and often also the parts of the labrum are bend back. This feature is lost in some apids like *Xylocopa* that have a flat clypeus. There is usually a preapical concavity on the stipes containing a comb, except on most parasitic forms. The episternal groove is absent below the scrobal groove. Apids have only five pairs of ostia in the metasomal part of the dorsal vessel.

KEY TO DIVISIONS OF APOIDEA

1. Body setae simple; metabasitarsus not broader than remaining tarsal segments, frequently with stringil; female T7 not divided into hemitergites ..
.....**Spheciformes**
- At least some setae, particularly those of legs and surrounding propodeal spiracle, branched or plumose; metabasitarsus flattened, wider than remaining tarsal segments, without stringil; female T7 divided into hemitergites **Apiformes**

KEY TO THE FAMILIES OF BEES, BASED ON ADULTS

(Modified from Michener 2000)

1. Labial palpus with first two segments elongate (Fig. 21), flattened, the last two segments small, usually diverging laterally from axis of first two, not flattened, rarely absent; galeal comb absent or rarely weakly indicated; stipial comb and concavity commonly present (Fig. 22); galeal blade elongate, commonly as long as or longer than stipes (Fig. 32) [long tongued bees] 2
- Labial palpus with the first four segments similar to one another (Fig. 23), or first or rarely first two elongate but not much flattened; galeal comb commonly present; stipial comb and concavity absent (Fig. 24); galeal blade usually shorter than stipes (Fig. 24) [short-tongued bees] 3
2. Labrum with basolateral angles enlarged, base forming broad articulation with clypeus, labrum thus widest at base (Fig. 25); labrum at least 0.8 times as long as broad and usually as long as broad or longer; scopa, when present, restricted to metasomal sterna **Megachilidae**

- Labrum with basolateral angles little developed, articulation with clypeus thus narrower than full width of labrum (Fig. 26); labrum usually broader than long, but in some parasitic forms (where scopa is absent) labrum elongate; scopa when present, on hind leg, particularly the tibia, and usually absent on metasomal sterna **Apidae**
- 3. Glossa pointed at apex, sometimes with flabellum 4
- Glossa bluntly rounded, truncate, or bilobed at apex; flabellum absent 7
- 4. Lacinia represented by scale like lobe with hairs near base of galea (Fig. 23); mentum and lorum forming proboscival lobe (Fig. 29, 33, 37); both at least partly sclerotized; lorum not flat 5
- Lacinia inconspicuous or displaced, not a scale like lobe at base of galea (Fig. 38, 39); mentum and lorum not forming proboscival lobe (Fig. 34), mentum sometimes membranous; lorum membranous or nearly flat sclerotized membranes between cardines (Fig. 34, 36) 6
- 5. Lorum more or less plate like but produced in middle for attachment to base of mentum; facial fovea present in females (Fig. 27) and some males, fovea sometimes a groove rather than broad as in figure; subantennal area almost always defined by two subantennal sutures below each antennal socket (Fig. 27) ... [in part] **Andrenidae (Andreninae and Panurginae)**
- Lorum slender, V-shaped or Y-shaped, (Fig. 21); facial fovea absent; a single subantennal suture below each antennal socket (Fig. 28)
..... **Melittidae**
- 6. Lacinia a small, hairless sclerite hidden between expanded stipites; subantennal area defined by two subantennal sutures below each antennal

- socket (Fig. 27); stigma nearly absent; first flagellar segment as long as scape or longer [in part] **Andrenidae (Oxaeinae)**
- Lacinia represented by small, hairy lobe on anterior surface of labio maxillary tube above rest of maxilla (Fig. 38); a single subantennal suture below each antennal socket (Fig. 28); stigma well developed; first flagellar segment much shorter than scape **Halictidae**
7. Apex of glossa bluntly rounded, without preapical fringe or apical glossal lobes; episternal groove absent below scrobal groove; scopa present on hind tibia, but absent on femur **Stenotritidae**
- Apex of glossa truncate to bilobed; episternal groove usually present below scrobal groove; scopa, when present, well developed on hind femur as well as tibia **Colletidae**

STRUCTURES AND TERMINOLOGY OF ADULTS

Morphological terms followed here are those of MICHENER (1944). The important terms may be defined as follows.

1. THE HEAD

Mandibles (Fig. 9): The paired, heavily sclerotized biting and chewing lateral appendage of mouth parts between the labrum and maxilla.

Maxillary palps (Fig. 8): A pair of jointed appendages originating from the maxillae.

Labial palps (Fig. 9): A pair of jointed appendages originating from the labium.

Clypeus (Fig. 4): The medial sclerite of the head immediately above the labrum; often defined dorsally and laterally by the epistomal grooves or sutures.

Antennal socket and toruli (Fig.4): The base of the antenna is set into a small membranous area of the head called the antennal socket (antennal scrobes). The rim of the socket is often strengthened by an internal submarginal ridge called antennal toruli. Subantennal suture extends from each antennal socket down to the epistomal suture.

Antenna (Fig. 7): A paired, segmented sensory appendage of the head between the compound eyes.

Scape (Fig. 7): The first or proximal segment of an antenna called antennal scape.

Pedicel (Fig. 7): The second segment of the antenna, it articulates apically with the flagellum and basally with the scape.

Flagellum (Fig. 7): The third segment of the antenna, it is subdivided into flagellomeres.

Ocelli (Fig. 4): Simple eyes, bead-like eyes located in the central portion of the head, one median and two laterals.

Frons (Fig. 4): The area of the head between the ventral margin of the toruli and the anterior margin of the median ocellus.

Orbit (Fig. 4 & 6): The narrow border around the eyes. The inner orbit for the frontal or facial margin, and outer orbit for the genal margin.

Vertex (Fig.6): The upper surface of the head between eyes, frons and occiput.

Occiput (Fig. 5): The hind part of the dorsal surface of the head.

Malar area (Fig. 5): The space between the eyes and mandibles, its length is the shortest distance from the eye to the mandible.

Foveae (Fig. 4): They are depressions, usually black in colour and therefore conspicuous when the ground colour is pale.

Genal area (Fig. 6): The region behind the eye and in front of the preoccipital ridge.

Preoccipital ridge : A ridge surrounding the concave posterior surface of the head above and laterally.

Proboscival fossa : The deep groove on the underside of the head into which the proboscis folds. The proboscis consists of cardo, stipes, galeae, prementum, galeal blades, labial palpi, paraglossae, glossa etc.

Mentum: (Fig. 8): It is a sclerite basal to prementum, that tapers basally and is thus more or less triangular.

Lorum (Fig. 8): Basal to mentum, there is a sclerite present called lorum.

2. THE THORAX

The bee thorax is compact structure consisting of sclerites of the pro, meso- and meta thoracic segments, which bear the legs and wings, and the first true abdominal segment termed as propodeum (Fig: 12).

Pronotum (Fig. 12): The dorsal sclerite of the prothorax, which extends ventrally at each side as a process that meets or nearly meets its fellow behind the fore coxae. The propleura and prosternum are the front of the pronotum. The dorsolateral angle of the pronotum form the pronotal lobe. The ridge, carina, or elevated zone extends between the dorso-lateral angles along the posterior margin, called pronotal collar.

Scutellum (Fig. 12 & 13): The middle region of the mesonotum or metanotum behind the scutum.

Scutum (Fig. 12 & 13): The anterior sclerite of the notum, in front of the scutellum.

Axilla (Fig. 12): The postero lateral portion of the mesoscutum lateral to the scutellum, usually triangular.

Mesepisternum (Fig. 13): Laterally the mesothorax is represented by the mesepisternum, sometimes referred to as mesopleuron. Mesepisternum sometimes divided by episternal groove.

Scrobal groove (Fig. 13): A horizontal groove on the mesepisternum that may be continuous with the episternal groove anteriorly and ends at the pleural

groove posteriorly. The area above the scrobal groove and behind the episternal groove is often convex and shiny, called hypoepimeral area.

Postnotum (Fig. 12): A posterior sclerite of the mesonotum and metanotum behind the scutellum.

Propodeal pit (Fig. 12): Bees have a pair of impressed lines on the propodeum, which begins near its anterior dorsolateral and meets postero medially that point is called propodeal pit. Thus anterior dorsal margin of the propodeum enclose the propodeal triangle. The horizontal part of propodeum is called basal zone or basal area of propodeum.

The wings (Fig. 14 & 15): The direction towards the costal margin is called anterior and towards wings apex called distal. The wing veins labelled in Figure (Fig. 14 & 15).

Stigma: In forewing a thickly sclerotized and usually darkly pigmented area seen on the apex of the costal vein.

Tegula (Fig.12): A small, scale like sclerite covering the base of the forewing, basal to humeral plate.

Jugal lobe (Fig.15): The posterior area of the wing behind vein 1A. In front of jugal lobe, vanal lobe also seen sometimes. Both are measured from the wing base to the apices.

3. THE METASOMA (Fig. 18)

Tergum: The dorsal sclerites of the body, which may be sub divided into tergites and usually referred to as T₁, T₂, etc.

Sternum: The ventral sclerites of the body, which may be subdivided into sternites and usually referred to as S₁, S₂, etc.

Antecosta: Across the anterior margin, completely hidden intact transverse lines present. It is called antecosta.

Gradulus (Fig. 18): Nearer to the middle of each plate, there is another transverse line seen. It is called the gradulus. The surface basal to the gradulus is called pre-gradular area.

Fasciae (Fig. 18): The terga often provided with transverse bands of pale hair. These are seen on different parts of the terga. These bands are called fasciae.

Pygidial plate (Fig. 18). It is a specialized flat plate on T₆ of females and T₇ of males. It is commonly surrounded laterally and posteriorly by a carina or a line, in some cases, produced as an apical projection. The pre-pygidial fimbria is a band of dense hairs across the apex of T₅ of females. Dense hairs on T₆ of females, on each side of the pygidial plate, constitute the pygidial fimbria.

Volsella : A paired, median inner appendage of the male genitalia.

The Legs (Fig. 19): Fore legs, midlegs and hind legs present.

Tibial spurs: They are movable inferior apical spurs on the tibiae. There is one spur (part of stringils) on front tibia, one on midtibia, and in nearly all bees two on hind tibia.

Tibial spines: They are immovable, sharp, superior apical projections, usually small, often blunt or minute. There are none, one, two or rarely three spines per tibia.

Basitibial plate (Fig. 19): It may be found on the upper or outer side of the base of hind tibia. It is just an elevated plate or surface.

Keirotichia (Fig. 239): On the inner surface of hind tibia of most bees is an area of variable size covered with hairs of uniform length, usually blunt, truncate, or briefly bifid. These hairs, called keirotichia and serve for cleaning the wings.

Arolium (Fig. 20): A pad like structure protruding between the tarsal claws.

Scopa (Fig. 270): A brush like structure of short stiff hairs of equal length used for collecting pollen.

Corbicula (Fig. 278): The concave, smooth region of the metatibia that is margined by a fringe of setae arising from the margins. It forms the pollen basket.

Plantar lobe: A small membranous pad projecting from the ventral apex of tarsomeres 1-4.

ABBREVIATIONS

F ₁ to F ₁₁	Flagellar segments 1 - 10
TL	Total Length (From the apex of mandible to apex of metasoma)
FWL	Forewing length
FWW	Forewing width
HWL	Hindwing length
SL	Scape length
FL	Flagellar length
EL	Eye length
EW	Eye width
T ₁ , T ₂ , etc	Metasomal tergites
S ₁ , S ₂ etc	Metasomal sternites
POL	Length between the lateral ocelli
OOL	Length between margin of eye and lateral ocellus
M	Male
F	Female
OMD	Oculomandibular distance

Chapter III

Observations and Results

OBSERVATIONS AND RESULTS

During the present study, many hundreds of specimens belonging to the various families of Apiformes were collected from different parts of Kerala (Fig. 3). Since it will be beyond the scope of the present thesis to include all the families, only the largest family, viz., Apidae was selected for the present investigation. Under this family about 63 species (one extralimital subspecies also mentioned) belonging to 8 genera were identified. Among these, 19 species are new to science and 1 species is kept as indetermined. All these new species were described in detail. In the case of known species with inadequate descriptions, redescriptions were provided.

A dichotomous key to the Indian genera of Apidae and keys to the species under each genus are presented. In addition a check list of the genera and species of the Apidae dealt with in the present work is also provided.

KEY TO INDIAN GENERA OF APIDAE OF INDIA

(With Subfamilies and Tribes)

1. Submarginal cross veins and second recurrent vein weak compared with other veins, commonly absent (Figs. 243), marginal cell open at apex or closed by weakened vein; hind tibial spur absent ... (Apinae, Meliponini) ...2
- All veins well developed, conspicuous, marginal cell closed by strong vein (Fig. 268) 3
2. Forewing commonly over 4 mm; wing venation usually not greatly reduced, (Fig.: 252) but if minute and with some of the wing reduction characters listed below, then upper margin of hind tibia with plumose hairs intermixed with simple ones (Fig. 252); hindwing commonly with cells R and Cu closed by atleast weakly brownish veins (Fig. 252); forewing with one or two submarginal cross veins usually indicated, first submarginal cell usually recognizable; second Cu of forewing completely indicated atleast by faint veins *Trigona* Jurine
- Forewing length less than 3 mm, wing venation greatly reduced (Fig. 235); hindwing without closed cells (Fig. 235), veins closing cells R and Cu, if visible at all, clear and unpigmented; upper margin of hind tibia without plumose hairs (Fig. 235); forewing with submarginal cross veins almost always completely absent, thus without indication of submarginal cells
.....*Lisotrigona* Moure
3. Scopa of female, when present, forming corbicula on posterior tibia (Fig. 266); inner apical margin of posterior tibia of non parasitic females with row of stiff bristles (rastellum Fig. 270); pygidial and basitibial plates absent 4

- Scopa of female not forming a tibial corbicula, and scopa sometimes absent; inner apical margin of posterior tibiae bare or hairy, without comb; pygidial and basitibial plates frequently present (Fig. 79) 5
- 4. Eyes hairy (Fig. 270); jugal lobe of hindwing present (Fig. 270); hind tibial spurs absent; arolia present (Fig. 266) (Apinae, Apini) .. *Apis* Linnaeus
- Eyes bare; jugal lobe of hind wing absent (Fig. 53); hind tibial spurs present; arolia absent (Apinae, Bombini) *Bombus* Latreille
- 5. Stigma absent (Fig. 50); middle and hind basitarsi longer than tibiae; clypeus nearly flat, lower lateral areas not curved backward (Fig. 40, 41)
..... (Xylocopinae, Xylocopini) *Xylocopa* Latreille
- Stigma present (Fig. 54); middle and hind basitarsi usually shorter than tibiae; clypeus variable but usually more convex with lower lateral parts bent backward (Fig. 42, 43) 6
- 6. Pygidial plate absent, sometimes represented by spine on pygidial fimbriae of female; scopa present (Fig. 125, 126); epistomal suture between lateral extremity and subantennal suture usually bent mesad such that upper part of clypeus is almost parallel-sided; clypeus not or weakly protuberant 7
- Pygidial plate present in females and most males, or if absent in female, then scopa also absent; epistomal suture not or rarely bent mesad such that upper part of clypeus is nearly parallel-sided, clypeus commonly strongly protuberant, lower lateral parts bent strongly posteriorly (Fig. 42, 43) 8
- 7. Submarginal cells two (Fig. 137); clypeus typically slightly constricted at level of tentorial pits (Fig. 138), this level near middle of clypeus
..... (Xylocopinae, Allodapini) *Braunsapis* Michener

- Submarginal cells three (Fig. 103); clypeus not constricted at level of tentorial pits, this level above middle of clypeus (Fig. 104)
..... (Xylocopinae, Ceratinini) *Ceratina* Latreille
- 8. Labrum longer than broad (Fig. 48) or rarely about as long as broad; scopa absent; body rather short-haired, or if with long hairs, then metasoma usually with pattern of white, appressed hair spot or bands 9
- Labrum broader than median length (Fig. 49), longer than broad, in which case scopa present, body with long hairs, and metasoma without spots or bands of appressed white hairs 13
- 9. Distal parts of wings, beyond venation, hairless and coarsely papillate (Fig. 44) (Apinae, Melectini) 10
- Distal parts of wings, beyond venation with hairs (Fig. 45), not or weakly papillate (Fig. 45) (Nomadinae, Ammobatini) 11
- 10. Scutellum flat or nearly so, produced posteriorly over metanotum, propodeum, and in some positions, base of T1, as sharply margined plate, bidentate with broad V or U-shape emargination (Fig. 200) and posterior part of scutellar surface on underside of plate, facing downward; body with areas of appressed plumose hairs forming white, blue, or green spots or broken bands (Fig. 211) *Thyreus* Panzer
- Scutellum convex, biconvex, bifurcate, or bispinose, surface thus downward posteriorly, and posterior part of scutellar surface thus declivous, facing posteriorly; body with or without areas of appressed plumose hairs, but if present, then these hairs white, not at all bluish or greenish *Tetralonioidella* Strand

11. Mandibles in repose directed posteromesally, so that, they cross one another well before their apices, their anterior margins forming angle of 90° to 145° *Parammobatodes* Popov
- Mandibles in repose directed mesally, so that, they overlap one another and cross, if at all, at extremely obtuse angle 12
12. S5 of female with posterior margin unmodified, covered with free hairs; labrum not extending under or posterior to mandibles in repose *Pasites* Jurine
- S5 of female with posterior part not so strongly bent upward, visible from below, preapical concavity more U-shaped and defined by hairy ridge; labrum commonly extending under and sometimes beyond mandibles in repose *Ammobates* Latreille
13. Slender, sparsely haired, wasp like bees; the apex of marginal cell sharply pointed on wing margin (Fig. 58); scopa not developed; three submarginal cells, the first nearly as long as second and third taken together (Fig. 58) ..
..... (Nomadinae, Nomadini) *Nomada* Scopoli
- More hairy and robust bees; the apex of marginal cell not sharply pointed (Fig. 46); scopa usually more or less well developed 14
14. Paraglossa as long as first two segments of labial palpus taken together; jugal lobe of hindwing about half as long as vanal lobe (Fig. 47); antennae of males commonly elongate (Apinae, Eucerini) 15
- Paraglossa much shorter than first segment of labial palpus; jugal lobe of hindwing usually less than half as long as vanal lobe; antennae of males not usually elongate 17

15. Maxillary palpus, three to four segmented or with minute fifth segment, often not longer than width of galeal blade; keirotrichiate area of female apically at least half as wide as hind tibia; scopa consists of sparse, strongly plumose hairs on outer surface of tibia, each arising from tubercle separated from its neighbours by full width of tubercle *Tetralonia* Spinola
- Maxillary palpus five or six segmented, often larger than maximum width of galeal blade; keirotrichiate area and associated finely and closely punctate surface of female usually less than half as wide as hind tibia; scopa consists of denser hairs, often simple, if plumose, then arising from tubercles less widely separated from one another 16
16. Clypeus usually protuberant for more than width of eye or more times length of eye; middle femur of male on undersurface commonly with area of dense, appressed, red-brown hair hiding surface *Eucera* Scopoli
- Clypeus usually protuberant for less than width of eye as seen in lateral view; middle femur of male sometimes with area of sparse, appressed whitish hair not hiding surface, more commonly with unspecialized sloping or erect hair *Tetraloniella* Ashmead
17. Stigma small, usually shorter than prestigma, parallel-sided (Fig. 194), vein arising near it apex; distal parts of wings usually strongly papillate, basal parts usually with large bare area (Fig. 194)
..... (Apinae, Anthophorini)18
- Stigma larger, longer than prestigma, tapering beyond vein r, which arises near the middle of stigma (Fig. 56); distal parts of wings usually only weakly papillate; second abscissa of vein M + Cu of hind wing half as long as vein M or less (Fig. 57) (Apinae, Ancylini) *Tarsalia* Morawitz

18. First recurrent vein joining second submarginal cell near middle; third submarginal cell subquadrate, with front and rear margins of about equal length, and basal and distal margins of about equal length (Fig. 184) 19
- First recurrent vein terminating at or near apex of second submarginal cell (Fig. 54); third submarginal cell with front margin much shorter than rear margin, because of curvature of third submarginal cross vein, the distal margin of the cell is longer than basal margin (Fig. 54) *Habropoda* Smith
19. Arolia present, well developed; hair never metallic
- *Anthophora* Latreille
- Arolia absent (Fig. 186); hair sometimes metallic *Amegilla* Friese

Subfamily a : Xylocopinae

Diagnostic features:

Scopa is reduced and slender than the pollen-collecting non-corbiculate Apinae. The front coxae are considerably wider than long. The basitibial plates often modified. The prepygidial fimbria is absent or evident only at the sides of T₅ of the female. The pygidial plate of female is usually absent or reduced. Hind basitarsus scarcely flattened, and apical process and a panicillus absent. The clypeus not or little protuberant, its lower lateral parts not curved back or small areas curved back. Glossa long and flabellum seen at its apex.

Tribe 1 : Xylocopini

Diagnostic features:

Stigma reduced or absent. Prestigma and marginal cell very long and distal parts strongly papillate. First flagellar segment longer than the second and third taken together. Proboscis short, partly sclerotized and the postpalpal part of the galea black-like. Three submarginal cells present, but the first and second are sometimes partly or wholly fused and in some cases first submarginal cross vein disappears. Arolia absent and the densely hairy plata projects some what between claws.

Genus *XYLOCOPA* Latreille

Xylocopa Latreille, 1802a: *Hist. Nat. des.* 432. Suppressed by Commission opinion 743 (1965).

Xylocopa Latreille, 1802b. *Hist. Nat. des.* 379. Type species: *Apis violacea* Linnaeus, 1758, by designation of Westwood, 1840a: 86.

- Lestis* Lepeletier and Serville, 1828: 799. Type species: *Apis bombylans* Fabricius, 1775 (misidentified as *Apis muscaria* Fabricius, 1775; see Murd and Michener, 1961).
- Mesotrichia* Westwood, 1838: *Tran. Ent. Soc. Lon.* 112. Type species: *Mesotrichia torrida* Westwood, 1838, monobasic.
- Xylocopa (platynopoda)* Westwood, 1840: *Nat. Hist. Bees.* 271. Type species *Apis latipes* Drury, 1773, by designation of Ashmead, 1899a: 71.
- Xylocopa (Audinelia)* Lepeletier, 1841: *Hist. Nat. de Ins. Hym.* 203. *Apis latipes* Drury, 1773, by designation of Sandhouse, 1943: 529.
- Platinopoda* Dalla Torre, 1896: *Cat. Hym.* 202, *Lapsus* for. *Platynopoda* Westwood, 1840.
- Xilocopa (Nyctomelitta)* Cockerell, 1929a: *Ann. Mag. Nat. Hist.* 303. Type species *Bombus tranquebaricus* Fabricius, 1804, by original designation.
- Xylocopa (Biluna)* Maa, 1938. *Rec. Ind. Mus.* 276. Type species: *Xylocopa nasalis* Westwood, 1842, by original designation.
- Xylocopa (Ctenopoda)* Maa, 1938: *Rec. Ind. Mus.* 285 (not McAtee and Malloch, 1933). Type species. *Apis fenestrata* Fabricius, 1798, by original designation.
- Xylocopa (Alloxylocopa)* Maa, 1939. *Lig. Sci. Jour.* 155. Nomen nudum because no characters given, although a type species was not designated.
- Xylocopa (Bomboixylocopa)* Maa, 1939. *Lig. Sci. Jour.* 155. Type speceis: *Xylocopa bomboides* Smith, 1879, by original designation.
- Xylocopa (Ctenoxylocopa)* Michener, 1942a: *Jour. New York: Ent. Soc.* 282, replacement for *Cetenopoda* Maa, 1938. Type species: *Apis fenestrata* Fabricius, 1798, autobasic.
- Xylocopa (Copoxyla)* Maa, 1954: *vid. Med. Dan. Natu. Tor.* 211. Type species. *Apis bombiris* Christ, 1791. = *Xylocopa cyanescens* Brulle, 1832, by original designation.
- Xylocopa (Hoplitocopa)* Lieftinck, 1955: *Verh. der. Nat. Ges.* 27. Type species *Xylocopa assinitis* Ristema, 1880, by original designation.
- Xylocopa (Hoploxylocopa)* Hurd and Moure, 1963: *Univ. Cali. Pub. Ent.* 260. Type species: *Xylocopa acutipennis* Smith, 1854, by original designation.
- Xylocopa (Lieftinckella)* Hurd and Moure, 1963. *Univ. Cali. Pub. Ent.* 286. Type species: *Xylocopa smithii* Ritsema, 1876, by original designation.

Xylocopa (Gnathoxylocopa) Hurd and Moure, 1963: *Univ. Cali. Pub. Ent.* 182. Type species: *Xylocopa sicheli* Vachal, 1898, by original designation.

Xylocopa (Diaxylocopa) Hurd and Moure, 1963: *Uni. Cali Pub. Ent.* 129. Type species. *Xylocopa truxali* Hurd and Moure, 1963, by original designation.

Xylocopa (Dasyxylocopa) Hurd and Moure, 1963: *Uni. Cali. Pub. Ent.* 113. Type species: *Xylocopa bimaculata* Friese, 1903, by original designation.

Xylocopa (Cirroxycopa) Hurd and Moure, 1963. *Uni. Cali. Pub. Ent.* 102. Type speceis: *Xylocopa vestita* Hurd and Moure, 1983, by original designation.

Xylocopa (Mimoxycopa) Hurd and Moure, 1963. *Univ. Cali. Pub. Ent.* 203. Type species: *Xylocopa rufipes* Smith, 1852, by original designation.

Xylocopa (Alloxylocopa) Hurd and Moure, 1963. *Uni. Cali. Pub. Ent.* 239. Type species: *Xylocopa appendiculata* Smith, 1852, by original designation.

Diagnostic Characters:

Robust bees; size ranges from 10-30 mm. Black to metallic blue or green. Male of some species yellow or testaceous. The principal characters of *Xylocopa* are the following: Loss of stigma, the very long prestigma and marginal cell, and the strongly papillate distal parts of the wings. Another distinctive feature is the long first flagellar segment, longer than second and third together. The rather short proboscis distinctive, the parts being strongly sclerotized, the post palpal part of the galea blade like and presumably used to cut into the corollas of tubular flowers to rob the nectar. They have three submarginal cells, but the first and second sometimes partly or wholly fused owing to the disappearance of the posterior part of the whole of the first submarginal cross vein. These bees have no arolia, the densely hairy plate projects somewhat between the claws.

Distribution: INDIA (Throughout INDIA). Sri Lanka, Sunda islands, Japan, Russia, Brazil, S. Africa, Zimbabwe, Namibia, New Guinea, Australia, China, Iran, Argentina, Uruguay, Belina, Chile, Madagascar.

Biology: Male nest in the burrows in wood and smaller species nest in dead stalks of large herbaceous plants; some species, nest on bamboo stalks (Michener, 2000).

Discussion: This genus can be distinguished from all other genera by using wing venation (long, slender, marginal cell, second submarginal cell greatly narrowed costad).

Remarks: Michener (2000) reported 31 subgenera under *Xylocopa*, of these 9 subgenera were reported from Indian subcontinent such as *Biluna* Maa, *Ctenoxylocopa* Michener, *Koptortosoma* Gribodo, *Maafana* Minikley, *Mesotrichia* Westwood, *Nodula* Maa, *Nyctomelitta* Cockerell, *Xylocopa* Latreille S. Str. and *Zonohirsuta* Maa.

The present work recognizes 7 subgenera with 14 species, of which 4 are new to science. A key to the species of Kerala also provided (in this key subgenera also included).

A KEY TO THE XYLOCOPA SPECIES OF KERALA

(Mainly based on Males)

1. Basitibial plate absent, or its apex entire (Fig. 82) 2
- Basitibial plate present, its apex asymmetrically or symmetrically bifid (Fig. 60) 5
2. Dorsal surface of T1 angulately (or subangulately rounded in *Alloxylocopa*) onto anterior surface; lateral line of T₁ transverse 3
- Dorsal surface of T1 sloping or rounding onto declivous anterior surface; lateral line of T1 curved posteriorly, more or less parallel to lateral margin of metasoma 11

3. Ocellus normal, diameter less than twice the width of the scape (Fig. 61); posterior lobe of pronotum prolonged posteriorly well onto mesepisternum (*Ctenoxylocopa*)4
- Ocellus enlarged, diameter greater than twice the width of the scape (Fig. 89); posterior lobe of pronotum not prolonged posteriorly onto mesepisternum (*Nyctomelitta*) *X. tranquebarica* (Fabricius)
4. Wings dark fuscous, with a purple and coppery effulgence, and with obscure hyaline lines between veins at base; TL = 13-17 mm
..... *X. fenestrata* (Fabricius)
- Wings dark brown, without purple or coppery effulgence, and obscure hyaline lines also absent; TL = 22-25 mm *X. anupama* sp. nov.
5. Tegulae elongate, outer margin at least slightly concave (Fig. 69); posterolateral third impunctate, glabrous and shiny (*Mesotrichia*) 6
- Tegulae normal, outer margin convex, rounded behind (Fig. 76); posterolateral third may or may not be impunctate, glabrous and shiny 8
6. Eyes large, meeting or nearly meeting on vertex; anterior tibiae and tarsi flattened and yellow, the tibiae and tarsi modified 7
- Eyes normal, not meeting on vertex; anterior tibiae and tarsi not flattened, the tibiae and tarsi not modified *X. keralensis* sp. nov.
7. Scape of antennae flattened and broad at apex *X. latipes* (Drury)
- Scape of antennae cylindrical and slightly incrassate
..... *X. tenuiscapa* Westwood
8. Dorsal surface of T1 nearly horizontal, abruptly and angularly divided from anterior surface (*Koptortosoma*) 9

- Dorsal surface of T1 sloping forward, subangulately rounding onto anterior surface (Fig. 82) (*Alloxylocopa*) *X. shona* sp. nov.
- 9. Body covered with reddish brown hairs; wings reddish brown; metanotum somewhat enlarged and reddish brown (Fig. 79) *X. nigroscapa* sp. nov.
- Body completely covered with golden hairs, or olive yellow to golden; wings hyaline with golden tints; metanotum dark brown to black and not enlarged 10
- 10. Legs covered with reddish-yellow pubescence *X. verticalis* Lepelletier
- Legs covered with olive pubescence *X. aestuans* (Linnaeus)
- 11. Beginning of thoracic declivity indicated by an abruptly rounded angle in scutellar profile (*Zonohirsuta*) 12
- Beginning of thorax declivity not defined; thorax evenly rounded in profile (*Nodula*) 13
- 12. Mesoscutum more or less closely punctate; labrum rectangular shaped and large (Fig. 80); pubescence on thorax sooty brown to brownish white *X. pictifrons* Smith
- Mesoscutum not very closely punctate; median portion of glabrous or very sparsely punctate (Fig. 67); labrum normal and rounded anteriorly; pubescence on thorax ochraceous *X. collaris* Lepelletier
- 13. Pubescence on mesonotum anteriorly, thorax and anterior tibiae and tarsi pale brown *X. amethystina* Fabricius
- Pubescence dark olive to yellow on mesonotum; thorax and posterior tibiae and tarsi with fuscous to dark brown pilosity *X. bryorum* (Fabricius)

1. *Xylocopa (Koptortosoma) aestuans* (Linnaeus)

Apis aestuans, Linnaeus 1767 *Syst. Nat. i. ed.* x, p. 579, Type: Female.

Xylocopa aestuans Lepeletier. *Hym.* 1835. ii, P. 193, Type F and M; Smith, *Cat. ii*, p. 353; Dall. Torr. Cat. X, p. 202.

Plesiotype : F. TL = 21-23 mm.

Colour. Integument: Usually black, wings dark fuscous with a purple effulgence.

Pubescence: Pubescence black on head and face; on the sides of mesosoma and beneath, and on metasoma black; on mesosoma above bright yellow; mesosoma above densely pubescent.

Head: Head finely punctate; clypeus flat, transverse in the middle anteriorly, sides oblique; clypeus and front not carinate.

Thorax: Thorax finely punctate except the disc of mesonotum smooth and impunctate under the pubescence.

Metasoma: Metasoma also finely punctate.

Male: Male differ from female in having the following important characters: (1) Pubescence olive - yellow, darker or paler according to the locality; (2) posterior tarsi with brown pubescence; (3) wings hyaline.

Distribution: Through out INDIA, Burma, Ceylon, Western Africa, Malaya.

Discussion: This species resembles to *Xylocopa bryorum* (Fabricius) in general appearance, but differ from it on the following characters: 1. Metasoma finely punctate (In. *X. bryorum* more or less closely punctate); 2. Mesosoma with bright yellow pubescence on above it (In. *X. bryorum* yellow pubescence of the

mesosoma spreading on to back of head and gena, and sometimes to basal metasomal segments); 1. Posterior tarsi with brown pubescence (In. *X. bryorum* posterior tarsi with fuscous dark brown pubescence). 2. Wings hyaline (In. *X. bryorum* wings hyaline or fusco-hyaline with a purple effulgence).

Remarks: The specimen is not represented in the present collection and the above description is from that of Bingham (1897).

2. *Xylocopa (Nodula) amethystina* Fabricius

Xylocopa amethystina Fabricius 1798 *Ent. Syst.* ii, p. 325; Dall Torr. *Cat.X*, p. 204.

Xylocopa minuta Lepeletier 1835. *Hym.* ii, p. 190.

Xylocopa ignita Smith 1874. *Trans Ent. Soc.* p. 276.

Plesiotype: F: TL = 13-17 mm

Colour: Integument: Usually black; wings fuscous, with a deep purple lusture.

Pubescence: Metasoma with long, soft thin pubescence on apical three or four segments, pubescence usually black in colour.

Head: Head finely and closely punctate; clypeus medially obscurely carinate; front between antennae with a small but acute and prominent tubercle.

Thorax: Thorax anteriorly, and on sides and apex of mesonotum finely and closely punctate.

Metasoma: Metasoma sparsely punctate.

Male: Male differ from female in having the following important characters: (1) Clypeus and sides of face and apex of labrum yellowish white. (2) Pubescence on mesonotum anteriorly, on the sides of thorax in front, and on

anterior tibiae and tarsi pale brown, almost cinereous on tarsi. (3) Wings paler, in some specimens hyaline at base.

Distribution: INDIA (Maharashtra, Punjab, Kerala), Ceylon.

Discussion: This resembles to *X. bryorum* (Fabricius) in general appearance but differs from it in following characters: 1. Metasoma sparsely punctured (In *X. bryorum* metasoma more closely punctured). 2. Black with black pubescence (In *X. bryorum* pubescence yellow on the thorax and cheeks).

Remarks: The above description is produced from Fauna of British India by Bingham (1897) and the specimen is not represented in this collection.

3. *Xylocopa (Ctenoxylocopa) anupama* sp. nov.

(Fig. 60-62)

Holotype M, TL = 24.8, HW = 6.45, HL = 4.4, SL = 1.95, FL = 5.1, POL = 0.7
OOL = 0.4, EL = 4.6, EW = 2.2, FWL = 20.4, FWL = 6.9, HWL = 11.8.

Colour. Integument: Body usually black, except mouthparts blood red colour, antennae dull brown, eyes yellowish brown to dark brown; wing veins dark brown, membrane fuscous, with base of forewing hyaline, purplish(light violet) tints in certain lights (very poorly developed colour); arolia reddish brown. Depression present on first metasomal segment with reddish colour.

Pubescence: Hairs usually brown and black; pubescence on mandibles light brown; pilosity on labrum and clypeus dark brown and simple, hairs on supra antennal area and vertex lighter than clypeus (longer also) and plumose; hairs on pronotum feathery (much plumose) smoky brown with brownish tints; anterior and lateral areas of scutum as on pronotum, but smaller than pronotal hairs, distinct ivory coloured plumose hairs seen on scutum; scutellum and metanotum with sparse light brown hairs, propodeal area with long plumose and

smoky brown to dull brown pubescence; episternal hairs plumose and brownish black (dull brownish hairs); around the tegulae with plumose and minute brown hairs thickly developed as a band; few brown hairs distributed on the wing margins and wing veins. Fore legs with smoky and dull brown pilosity, which is plumose, femur with few brush like hairs; mid leg and hind leg with brush like dark brown to black hairs, some hairs are plumose; T₁ with plumose smoky brown pubescence on their anterior middle areas and lateral sides; T₂ - T₅ with sparse and minute hairs, smoky brown to black; T₆ thickly pubescent, black bristle like and plumose and thickly developed, long- especially on the lateral areas.

Head: Width in anterior view 1.89x distance between front ocellus and lower margin of clypeus (64.5: 34) (Fig. 61); maximum width of head at the level of posterior margin of eyes 3.3 x distance between front ocellus and occipital margin; relative measurements of POL : OOL = 3.5 : 2; mandible very sparsely and minutely punctate; malar area weakly developed; labrum closely punctate; maxillary palpi-6 segmented (first two large, others small); clypeus and face punctate (punctations are not very closely arranged); Supra antennal area and ocellar area sparsely and deeply punctate; vertex more or less closely punctate, in between areas minutely striated (striato-reticulate also); genal areas also punctate; scape, pedicel and F₁ sparsely and more or less deeply punctate; F₂ - F₁₁ with very minute hairs, relative length: breadth of antennal segment, scape = 19.5 : 2 Pedicel = 3:2.5, F₁ = 6 : 3, F₂ = 5 : 3, F₃ = 4.5:3, F₄ = 5:3, F₅ = 5:3, F₆ = 5 :3, F₇ = 4 : 3, F₈ = 4.5 : 3, F₉ = 4.5:3, F₁₀ = 4 : 3, F₁₁ = 6 : 3 (Fig. 62). Eyes smooth and simple, relative length : breadth of eyes in lateral view = 23 : 11.

Thorax: Maximum width between tegulae to length of thorax = 36 : 43 (Fig. 60); medial area of scutum (mesoscutum) sparsely punctate with well developed punctations) and more closely arranged on the lateral areas; medial line distinct, parapsidal lines weakly represented, in between punctations smooth

and glabrous; scutellum and metanotum punctate as on mesoscutum, but lateral areas more closely punctate; propodeum more closely punctate than the other areas (Fig. 60); episternal punctations not clearly visible due to well developed pubescence.

Legs more or less well developed, sparsely punctate; hairs are well developed and sheet or tuft like on fore tarsal segments, mid and hind tibial spines and spurs well developed, spines pointed and spurs simple and pointed arolia indistinct, claws cleft and symmetrical.

Tegulae glabrous with few punctations; wing venation as in figure (Fig. 60) anterior areas of wing membrane with hyaline streaks (areas) and posterior areas papillate and striated; three submarginal cell, first recurrent nerve meets on 1r-m and second recurrent nerve meets on the middle of third cell. Relative measurements of fore wing length: its maximum width = 102 : 34.5; jugal and vanal lobes of hindwing distinct (Fig. 60), posterior areas of wing membrane striated and papillate, hamuli 40 and above (40-45).

Metasoma: Metasomal tergites with punctations distinct and not very close, punctations represented in the origin of hairs; in between punctations minutely striated and glabrous (Fig. 60); T₁ with a depression on the middle, middle of the depression with a midline or carina, T₂ is largest segment than the other segments; T₃ with two spine like structures on both lateral sides on their basal areas; hairs becomes abundantly on last tarsal segments, but prepygidial and pygidial fimbriae not well developed (Fig. 60); last tarsal segment with two distinct projections. Sternal plates also punctate, punctation not very close.

Female: Unknown.

Materials examined: *Holotype:* M: INDIA, Kerala, Kadalundi, 3.xi - 1999, Jobiraj, T. *Paratype:* M: INDIA, Kerala, Kadalundi, 3-xi-1999, Jobiraj T.

Etymology: The species name is from Sanskrit, meaning unique.

Flower record: Unknown.

Distribution: INDIA (Kerala).

Biology: Unknown.

Habitat: From disturbed habitats (Near Railway Station)

Discussion: This species keys to couplet no. c of the key to species by Bingham (1897). It resembles *X. collaris* Lepeletier, in general appearance, but differs from it mainly in the following characters: 1. Head and mesosoma not closely punctate (In *X. collaris* head and mesosoma closely and finely punctate). 2. Tibial spurs simple and not pectinate (In *X. collaris* tibial spurs pectinate). 3. Hairs on mesoscutum dull white (In *X. collairs* hairs on mesoscutum ochraceous). 4. Scape of antennae dull brown (In *X. collaris* scape of antennae pale yellowish white). 5. Metasoma with smoky brown to black pubescence (In *X. collaris* metasomal segment one or two ochraceous).

4. *Xylocopa (Nodula) bryorum* (Fabricius)

(Figs. 63-65)

Apis bryorum Fabr. 1793 *Syst. Ent.* p. 381.

Xylocopa bryorum Smith, 1874 *Trans. Ent. Soc.* p. 275: Dall.Torr.Cat. X, p. 206.

Plesiotype: F. TL = 27mm, HW = 8.4, HL = 5.8, SL = 2.56, FL = 5.1, EL = 4.2, EW = 2.75, POL = 0.7, OOL = 1.1, FWL = 19.2, FWW = 6.6, HWL = 13.

Colour: Integument: Body usually black except, mouth parts dark brown to black; eyes with dull steel grey markings; wing veins black, membrane fuscous to brownish black; arolia reddish brown. Tegula with brownish tints in certain lights.

Pubescence: Pubescence usually brown and black, on mesosoma yellow; hairs on labrum simple and brownish black; on clypeus brownish black and plumose; hairs on face and supra antennal area black, plumose, intermixed with ivory plumose; vertex with black and yellow, plumose hairs, genal hairs on anterior side plumose and yellow, while on posterior side with silky long and ivory coloured. Median area of mesosoma glabrous without hairs with distinct medial line, other areas of mesosoma with long plumose yellow hairs; tegulae almost covered with yellow plumose pilosity, basal areas of wings with thick plumose tufts of hairs; pronotum with plumose hairs, episternum usually with black plumose pilosity; outer side of fore tibia with few yellow simple hairs, other hairs on legs, brush like and dark brown to brownish black, reflects silver colour on certain lights; anterior areas of tergum with few light yellow plumose hairs, surfaces of all other tarsal segment with minute silver hairs intermixed with dark brown hairs and their sides covered with tufts of dark brown hairs to brownish black hairs; sternum covered with long black bristles.

Head: Width in anterior view $2.27 \times$ distance between front ocellus and lower margin of clypeus (76 : 33.5) (Fig. 63); maximum width of head at the level of posterior margin of eyes $3.7 \times$ distance between front ocellus and occipital margin; relative measurements of POL : OOL = 3.5 : 5.5; mandible sparsely and strongly punctate, in between areas minutely reticulate; malar area distinct and reticulate; posterior side of clypeus with a fascia like structure, minutely reticulate, it extends through the middle of clypeus, other areas, with well developed punctations, in between the punctations minutely punctate and posterior areas reticulate; in between antennal toruli slightly haired with few punctations, other areas striato-reticulate, face, frons and vertex punctate, in between areas reticulate with few minute punctations; gena sparsely punctate, in between areas reticulate; scape, pedicel & F₁ of antennae minutely and sparsely punctate, other areas minutely and sparsely punctate, other areas minutely

reticulate, relative length: breadth of antennal segments scape = 23 : 5, pedicel = 4 : 3, $F_1 = 8 : 2.5$, $F_2 = 4 : 2.5$, $F_3 = 4 : 2.5$, $F_4 = 4 : 2.5$, $F_5 = 4 : 2.5$, $F_6 = 4 : 2.5$, $F_7 = 3.5 : 2$, $F_8 = 3.5 : 3$, $F_9 = 4 : 2$, $F_{10} = 6 : 2$ (Fig. 65). Eyes simple and smooth, coloured areas seen; relative length: breadth of eyes on lateral view = 21:11.

Thorax: Maximum width between tegulae to length of thorax 41:40 (Fig. 63); mesosoma more or less completely covered with plumose hairs; on median area of scutum with medial line distinct, parapsidal lines not clear due to well developed pilosity; scutum glabrous and very minutely and sparsely punctate; median areas of scutellum glabrous and faintly reticulate, other areas sparsely punctate, in between areas faintly striato reticulate.

Legs more or less developed, minutely and sparsely punctate and striato-reticulate; fore tibial and mid tibial spurs and spines present; hind tibial spine not well developed, while spur well developed; hind tibia as long as hind basitarsus, arolia indistinct; claws symmetrical.

Tegulae striated to faintly reticulate and glabrous; wing venation as on figure (Fig. 63) posterior areas of wing membrane striated and papillate; three submarginal cells, first recurrent vein meets on I r-m and second recurrent vein meets on posterior side of third submarginal cell; relative measurements of forewing length: its maximum width = 96 : 33; jugal and vanal lobes of hindwing present (Fig. 63); 43 and more hamuli; hind wing also papillate.

Metasoma: Metasomal tergites glabrous, punctations only on the origin of the hair, in between areas glabrous, impunctate and striato-reticulate; hairs thickly developed on their posterior areas; pre-pygidial and pygidial fimbriae well developed and pygidial area represented by a small slit; T_2 - larger than other segments; sternal plates minutely and sparsely punctate and striated.

Male: Male differs from females in having the following important characters: (1) Pubescence darker olive. (2) Inside of the intermediate and posterior tibiae and tarsi with fuscous dark brown pubescence. (3) Wings hyaline or fusco - hyaline with a purple effulgence.

Materials examined: *Plesiotype:* F, INDIA, Kerala, Muthanga, 6-v-2000, Jobiraj T., *Other materials examined:* 2 F, INDIA, Kerala, Muthanga, 6-v-2000, Jobiraj T.,

Flower Record: Unknown.

Distribution: INDIA (Kerala, Sikkim), Ceylon, South Tenasserim, Malaya, Australia.

Biology: Unknown.

Habitat: Undisturbed forests

Discussion: This species closely resembles *Xylocopa aestuans* Lepeltier in general appearance, but differs from it in the following important characters: 1. The yellow pubescence on the mesosoma spreading on to the back of the head and cheeks, and sometimes to basal metasomal segments (In *X. aestuans* the yellow pubescence on mesosoma not spreads). 2. Metasoma more or less closely punctate (In *X. aestuans* metasoma finely punctate).

Remarks: Male specimen is not represented on the above collection, the above description is based on Bingham (1897).

5. *Xylocopa (Zonohirsuta) collaris* Lepeletier

(Figs. 66-68)

Xylocopa collaris Lepel. *Hym. ii.* p. 189, F; Smith, *cat ii*, p. 353, Dall Torr., at. x p. 208.

Xylocopa defeanii Lepel. *Hym. ii.* p. 209, M.

Plesiotype: F. TL = 21.6, HW = 6.08, HL = 4.04, SL = 0.96, FL = 3.56, POL = 1, OOL = 0.8, FWL = 13.2, FWW = 4.8, HWL = 9.2, EL = 3.4, EW = 1.8.

Colour. Integument: Body usually black except the following parts, mouth parts brown to light brown, ocelli glabrous and reddish brown; eyes steel grey with light brown tints; basitibial plates yellowish brown wings dull fuscous, with a moderate purple effulgence.

Pubescence: Maxillary palpi with golden brown simple pilosity; under the labrum few yellowish white to light yellow hairs, labrum with dull white simple pubescence; clypeus with minute and simple sparse hairs; on the sides of clypeus with a tuft of dull white and simple hairs; paraocular areas with dark brown bristles, intermixed with few dull white hairs; antennal toruli covered with simple white hairs; vertex around the ocellar area with dark brown and long simple hairs intermixed with ivory coloured hairs, anterior areas of pronotum and lateral areas of scutum with few dull white hairs outermixed with few brown hair; other parts of scutum and scutellum not pubescent; episternum with dull brown pubescence to dark brown pubescence, posterior areas of scutellum with sparse white hairs; lateral areas of metanotum and propodeum with a tufts of ivory coloured and dark brown simple hairs; medial areas of metanotum and propodeum not pubescent; legs almost covered with dark brown to black hairs; arolia reddish brown, anterior tergal plates with sparse hairs; lateral areas and posterior area with dark brown to black pubescence, simple and suberect.

Head: Width in anterior view 1.94x distance between front ocellus and lower margin of clypeus (70:36) (Fig. 67); maximum width of head at the level of posterior margin of eyes 6.89 x distance between front ocellus and occipital margin (31: 4.5), relative measurements of POL : OOL = 5:4 (Fig. 66); mandibles sparsely punctate; labrum large, longer than broad, closely punctate; clypeus closely punctate a medial raised have distinct, tenctorial pits distinct; supra antennal area closely and minutely punctate than clypeus, medial vertical carina from the apex of clypeus passes between the base of the antennae, continued as a furrow to the anterior ocellus; vertex, gena, post gena minutely and closely punctate than clypeus, ocelli glabrous, in a triangle on vertex; scape, pedicel F_1 and F_2 minutely and sparsely punctate to striato - reticulate; scape shorter and stouter than F_1 ; relative length: breadth of antennal segments = scape = 11:3, pedicel = 3 :2, F_1 = 9:3, F_2 = 2.5:3, F_3 = 3.5:3, F_4 = 2.5 :3, F_5 = 3:3, F_6 = 3:3, F_7 = 3.5 :3, F_8 = 4:3, F_9 = 3:3, F_{10} = 5.5: 2.5 (Fig. 68); eyes simple and glabrous; relative length: breadth of eyes on lateral view = 17:9.

Thorax: Maximum width between tegulae to length of mesosoma 26:36 (Fig. 66); medial areas of scutum not closely punctate; other areas of scutum closely and uniformly punctate (Fig. 66); scutellum and axillae punctate as on medial areas of scutum; medial and parapsidal lines distinct; scutellum with a raised line in the middle; metanotum and propodeum sparsely and minutely punctate; episternum closely punctate as on scutellum, brown lines visible on metanotum and scutellum.

Tegulae glabrous and minutely punctate; axillary sclerites punctate on tegulae, wing membrane fuscous with brownish to purplish tints; posterior areas of wing membrane papillate and striated, three submarginal cells, first recurrent vein meets 1 r-m and second recurrent vein meets posterior part of third

submarginal cell, marginal cell rounded anteriorly. Hindwing membrane striated and papillate posteriorly; hamuli 26-30 (Fig. 66).

Legs well developed and strong, fore femoral hairs minutely plumose, mid tibial spurs long, pointed and finely pectinate; basitibial plate oval shaped and distinct; hind tibial spurs also pointed and pectinate; hair tufts on legs very long, mid tibial spurs longer than hind tibial spurs; arolia indistinct and symmetrical (Fig. 66).

Metasoma: Metasomal segments sparsely pubescent and sparsely punctate and glabrous; hair tufts on lateral areas of metasoma not thickly developed; pre-pygidial and pygidial fimbriae well developed; sternal plates sparsely and strongly punctate.

Male: Male differs from female in having the following important characters. (1) Frontal carina not coming to the base of the clypeus; (2) Face with yellowish white markings; (3) Pubescence on mesosoma and metasoma ochraceous; (4) Wings sub hyaline, lightly fuscous with purple effulgence.

Materials examined: Plesiotype: F, INDIA, Kerala, Kattikulam, Jobiraj, 12-ix-1998.

Flower Record: Unknown.

Distribution: INDIA (Kerala, Allahabad, Sikkim), Burma, Malaya, Siam, Ceylon.

Biology: Unknown.

Habitat: Disturbed agricultural fields.

Discussion: This species resembles *Xylocopa basalis* Smith on general appearance, but differ in the following characters: 1. Head and metasoma very

finely and closely punctate (In *X. basalis* head and metasoma very finely and sparsely punctate); 2. Black with black and white pubescence (In *X. basalis* Black with cinereous white, pale yellowish white and rufo-fuscous pubescence); 3. Wings dull fuscous, with a moderate purple effulgence (In *X. basalis* wings fuscous with a little purplish lustre, basal half hyaline).

6. *Xylocopa (Ctenoxylocopa) fenestrata* (Fabricius)

Apis fenestrata Fabricius, 1798. *Ent. Syst. Suppl.*, p. 273, Type: male.

Xylocopa serripes Burmeister, 1876. *Stettin. Ent. Ztd.* 37: 156. Type: Male and Female.

Plesiotype: F. TL = 13-17 mm.

Colour. Integument: Usually black; wings dark fuscous, with a purple and coppery effulgence, and with obscure hyaline lines between veins at base.

Pubescence: Pubescence black, ferruginous along apex of anal metasomal segment, sparse except on the intermediate and posterior legs, where it is dense, long and sooty-black; third metasomal segment with, sometimes, a minute spiracular lateral impression near its base covered with short yellow pubescence.

Head: Head finely and closely punctate; clypeus very slightly convex, nearly flat, widely emarginate anteriorly, front not carinate.

Thorax: More sparsely punctate; disc of mesonotum impunctate, with three obscure, parallel longitudinally impressed abbreviated lines.

Metasoma: More or less sparsely punctate.

Male: Male differ from female in having the following important characters: (1) Narrower in shape (2) Wings paler, with hyaline lines more clearly defined.

Distribution: INDIA (Throughout India), Burma, Ceylon.

Remarks: The specimen is not represented in the present collection and the above description is from that of Bingham (1897).

7. *Xylocopa (Mesotrachia) keralensis* sp. nov.

(Fig. 69-72)

Holotype : F. TL = 26, HW = 8.05, HL = 5.4, SL = 2.8, FL = 5.2, POL = 0.9, OOL = 1.2, EL = 4.5, EW = 2, FWL = 23.4, FWW = 7.4, HWL = 15.

Colour. Integument: Body usually black, except mouth parts dark brown to black, eyes dull brown, antennal toruli brown, antennae F₂ - F₁₀ dull brown, ocelli reflects blackish brown; wings dark fuscous with vivid coppery, green and purple effulgence changing as they catch the light; arolia reddish brown to black.

Pubescence: Pubescence on labrum bristle like and brown; hairs on clypeus dark brown and reflects silvery brown in certain lights; on face usually sparse hairs, around antennal toruli few silky light brown plumose hairs, hairs on vertex sparse, dark brown; anterior part of gena with few sparse hairs, on posterior region more or less thickly pubescent, long and dark brown which reflects silvery colour in certain lights; anterior area of pronotum with minute silvery plumose and thin hairs, white on the sides thickly developed black dull blackish brown to black and plumose; medial areas of scutum sparsely pubescent, lateral areas of scutum smoky black, plumose pilosity; scutellum and metanotum sparsely pubescent; pilosity on lateral areas of propodeum smoky brown and plumose; tegulae covered with velvety plumose hairs on its outer surface; wing membrane with silvery white hairs on margins episternum thickly pubescent with black plumose hairs mixed with smoky brown plumose pilosity; legs almost covered with bristle like pilosity, black in colour and reflects greyish white on certain lights; metasomal tergites minutely and sparsely pubescent, lateral sides with

tufts like hair, becomes more on posterior areas, prepygidial and pygidial fimbriae more or less developed; sternites more pubescent than tergites.

Head: Width in anterior view 2.2x distance between front ocellus and lower margins of clypeus (80.5 : 36.5) (Fig. 70); maximum width of head at the level of posterior margin of eyes 4. 698x distance between front ocellus and occipital margin (37.5 : 8); relative measurements of POL : OOL = 4.5 : 6 (Fig. 69); basal areas of mandibles with few well developed punctations, other areas glabrous; malar area distinct and minutely striato-reticulate; labrum with a middle area distinct and minutely striato-reticulate; labrum with a middle projection; clypeus more or less closely punctate, in between punctations striato reticulate, posterior area without punctation and form a band like structure (Fig. 70); frontal line distinct and touches middle of mid ocellus; ocelli glabrous and minutely striato-reticulate, other areas of face and vertex sculptured as on clypeus; genal more or less deeply punctate, in between punctations striated; scape, pedicel and F₁ sparsely, finely punctate (than on face); scape of antenna broadened towards apex; relative length: breadth of antennal segments. Scape = 46:5.5, F₁ = 5:4, F₂ = 20.5:5, F₃ = 6:4.5, F₅ = 5.5:6, F₆ = 6:4.5, F₇ = 7 : 1, F₈ = 7:4, F₉ = 7:4, F₁₀ = 10:4 (Fig. 71). Eyes simple and glabrous, relative length breadth of eyes in lateral view = 22.5 : 10.

Thorax: Maximum width between tegulae to length of mesosoma 33 : 42; anterior areas of scutum (pronotum) closely punctate, lateral areas more or less closely and medial area sparsely punctate and glabrous (Fig. 69); scutellum anteriorly, sparsely and posteriorly and laterally closely punctate; metanotum closely and weakly punctate; propodeum divides into two halves by a carina punctations forms a triangular shape anteriorly on both halves and posteriorly sparsely punctate and glabrous (Fig. 69); episternal sculptures not clearly visible

due to well developed pubescence. Medial line distinct and parapsidal lines weakly represented.

Tegulae punctate on inner halves, other areas glabrous and minutely striato-reticulate, axillary sclerites minutely punctate, wings fuscous and striated and papillate posteriorly, three submarginal cells, second sub-marginal cell almost triangular shaped, third submarginal cell largest one; first recurrent meets I r-m and second meets middle of third submarginal cell; relative measurements of fore wing length: its maximum width = 117 : 37; jugal and vanal lobes of hindwing distinct, posteriorly papillate and striated; hamuli 40 and above (Fig. 69).

Legs more or less well developed and strong; sparsely punctate and striato-reticulate; fore tibial spine well developed and pointed, mid tibial and hind tibial spurs simple and pointed, hind tibia as long as hind basitarsus, arolia indistinct and claws symmetrical.

Metasoma: Metasomal tergites glabrous, punctations only developed in the origin of hair, in between areas minutely striated to striato-reticulate; on the sides of tergum and posterior areas, pilosity forms hair tufts; pre-pygidial and pygidial fimbriae present; sternal plates with few strong punctate, anteriorly and other areas impunctate and glabrous.

Male: Male differs from females in having the following characters: (1) Yellowish facial markings as in figure (Fig. 72); (2) Metanotum uniformly punctate; (3) Longer in body size than females; (4) Hind legs long; (5) T₃ & T₄ with spine like structure on lateral sides.

Materials examined: *Holotype*: F, INDIA, Kerala, Pulppally, Jobiraj, T, 11-IX-1998. *Paratypes* : F Kerala, Pulppally, Jobiraj, 15 - vi - 1998; 2F, 2 - V - 1999; 1 F, Kerala, Pulppally, Koya M., 25 - XII - 1999' 1F, Kerala, Pulppally, Kavitha, P.V., 19-V-1999; 1 F, Kerala, Pulppally, Suneetha, 10 - IV - 1997; 1 F,

Kerala, Pulppally, Smitha . M 15 - IV - 1999; *Allotype*: 1 M, Kerala, Pulppally, Jobiraj. T., 27 - VI - 1999; 1 M, Kerala, Pulppally, Jobiraj T., 15 - VIII - 1999.

Distribution: INDIA (Kerala).

Flower Record: Unknown.

Etymology: The species name is only an arbitrary combination of words.

Habitat: Undisturbed habitats such as agricultural fields, gardens

Discussion: This species resembles *Xylocopa latipes* Fabricius in general appearance, but differs it from following important characters: (1) Scape of antennae more or less cylindrical (In *X. latipes* scape of antennae distinctly flattened); (2) Mid and hind tibial spurs pointed and simple (In *X. latipes* mid and hind tibial spurs finely pectinate); (3) Body size ranges from 22-26 mm (In *X. latipes* body size ranges from 32-35 mm); (4) Propodeum distinctly punctate (In *X. latipes* propodeum impunctate or minutely punctate).

8. *Xylocopa (Mesotrichia) latipes* (Drury)

(Fig. 73-75)

Apis latipes Drury, III. *Exot. Ins.* ii, pl. 48, Fig. 2.

Xylocopa latipes, Fabricius, *Syst. Piez.* p. 337; Smith, *cat*, ii, p. 353; Dalla. *Torr.cat.X*, p. 213.

Apis latipes Drury, 1773, *Illustr. Nat. Hist.*, V-2, p.87, pl. 48, Fig. 2 F Type
Repositing: unknown.

Apis gigas De Gheer, 1773. *Mem. Hist. Ins.*, v-3, p. 576, pl. 28, Fg. 15. F. Type
Repository NRS.

Maestrichia (Platynopoda) Latipes basilopectera Cockerell, 1917. *Philippine Jour. Sci.* 12:
349. Type Repository USNM.

Plesiotype: F (worker) TL = 31, HW = 8.6, HL = 6, SL = 3.2, FL = 6.1, EL = 5, EW = 1.7, POL = 0.8, OOL = 1.2, FWL = 24.4, FWW = 7.8, HWL = 15.

Colour. Integument. Body usually black except antennal toruli dark brown, eyes with dull yellow with steel grey marking; wings dark fuscous with vivid coppery, green and purple effulgence changing as they catch the light; arolia dark brown.

Pubescence: Pubescence usually black; hairs on labrum, face and vertex, simple and greyish black; hairs on posterior part of gena very long thick and black; pubescence on pronotum and scutum velvety, plumose and black; pre episternal hairs longer and thicker than pronotum and scutum; scutellum and metanotum with sparse, greyish, plumose hairs; anterior parts of wing with minute greyish black, simple hairs; pubescence on legs dense and stiff, and thick, black and reflects grey; anterior areas of tergum with space light golden hairs and their sides covered with tufts dark brown to black hairs, simple to plumose; sternal hairs longer and bristle like than tergal hairs, black not thickly developed.

Head: Width an anterior view $2.16 \times$ distance between front ocellus and occipital margin (78:36) (Fig. 73); maximum width of head at the level of posterior margin of eyes $3.6 \times$ distance between front ocellus and occipital margin (39:11) (Fig. 73); relative measurements of POL : OOL = 4:6 (Fig. 73); basal areas of mandible minutely punctate, other areas glabrous; maxillary palpi 6, second one longer than other segments; posterior area of clypeus with a glabrous impunctate area, other areas closely punctate with weakly impressed puncti; punctations on frons and face with few well developed punctations with sparse minute punctations; punctations on vertex not very close, stronger than face, in between areas striato-reticulate gena more or less punctate as on vertex; anterior tentorial pits distinct, frontal line touches the middle of middle ocellus; scape, pedicel and F₁ of antenna minutely and sparsely punctate; scape of the antenna broadened towards the apex; relative length: breadth of antennal segments, scape = 29:4, pedicel = 3:2.5, F₁ = 12:3, F₂ = 3.5 : 3, F₃ = 3.5 : 3, F₄ = 4:3, F₅ = 4:5, F₆ = 5:3, F₇ = 4:3,

$F_8 = 4:3$, $F_9 = 5:3$, $F_{10} = 6:3$ (Fig. 75). Eyes simple and smooth, coloured (greyish streaks) areas seen; relative length : breadth of eyes on lateral view = 45 : 16.

Thorax: Maximum width between tegulae to length of thorax 38 : 42 (Fig. 73), anterior and lateral parts of scutum closely and strongly punctate; median area glabrous and sparsely punctate; scutellum punctate as on scutum, metanotum minutely and closely punctate; propodeum sparsely punctate median line distinct, parapsidal lines weakly represented; punctations on episternum not clearly visible due to well developed pubescence.

Tegulae striated and faintly reticulate and glabrous; wing venation as on figure (Fig. 73), posterior areas of wing membrane striated and papillate; three submarginal cells, first recurrent vein meets 1 r-m and second recurrent vein meets on posterior side of third submarginal cell; relative measurements of fore wing length: its maximum width = 122 : 39; jugal and vanal lobes of hind wing present; hind wing membrane papillate and striated on their posterior end; hamuli 35 or more (Fig. 73).

Legs more or less developed, sparsely punctate, glabrous and minutely striato-reticulate, fore tibial spines curved at apex and pointed, mid tibial and hind tibial spurs well developed and minutely pectinate; hind tibia as long as hind basitarsus, arolia indistinct and claws symmetrical.

Metasoma: Metasomal tergites glabrous, punctations minute and only developed on the origin of the hair; glabrous area minutely striate to striato-reticulate; on the sides and posterior areas of metasoma forming hair tufts; pre-pygidial and pygidial fimbriae weakly developed, pygidial area represented by a small slit; T_2 and T_4 are larger segment than other tergal plates; sternal plates punctate than tergal plates and impunctate areas glabrous.

Male: Male differs from females in having the following important characters: (1) Sulcation on front smaller; (2) Eyes very large and meeting nearly on the vertex (yellowish); (3) Ocelli reflects brownish yellow colour; (4) Anterior tibiae and tarsi flattened and yellow, the tibiae twisted, the tibiae and tarsi fringed anteriorly and posteriorly with long thick and somewhat curled hairs; (5) Mid and hind legs longer than in females; (6) Wings much narrower and apex of fore wing acute.

Materials examined: *Plesiotype:* 1 F: INDIA, Kerala, Calicut University Campus, Girish, 25-xii-1999; *Other materials examined:* 1 M: INDIA, Kerala, Calicut University Campus, Arif, 4-ii-2000; 1 F, INDIA, Kerala, Calicut University Campus, Jobiraj, 10-i-2000; 1 F: INDIA, Kerala, Calicut University Campus, Jobiraj, 14-viii-1998; 1 F: INDIA, Kerala, Calicut University Campus, Sinu A. 25-xii-1999.

Flower record: Unknown.

Distribution: INDIA (Kerala)

Biology: Unknown.

Habitat: Disturbed.

Discussion: This species resembles *X. tenuiscapa* Westwood in general appearance, but differs from it in the following characters: 1. In females sulcation on the front extending up to the ocelli (In *X. tenuiscapa* sulcation on the front of females some what smaller and not extending up to the ocelli); 2. Scape of antenna dialated towards apex (In *X. tenuiscapa* scape of antenna not dialated towards apex). 3. Metasoma more or less closely punctate (In *X. tenuiscapa* metasoma not closely punctate); 3. In males antennal scape not cylindrical (In *X.*

tenuiscapa antennal scape of males cylindrical; 5. Hamuli on hind wing 35 or more (In *X. tenuiscapa* hamuli on hind wing 45 or more).

9. *Xylocopa (Koptortosoma) nigroscaposa* sp. nov.

(Figs. 76-78)

Holotype: M, TL = 21, HW = 5.8, HL = 4.04, Sl = 1.5, FL = 4, POL = 0.4, OOL = 0.3, EW = 2.2, EL = 3.6, FWL = 13.4, FWW = 4.6, HWL = 8.5.

Colour. Integument: Body usually black, except the following parts, mouth parts yellowish brown, maxilla dark brown, labrum with an ivory spot, clypeus entirely ivory colour, supra clypeal spot and paraocular areas ivory colour; F₂ - F₁₁ dull brown, ocelli reflects dull brown to dark brown in certain lights; eyes brown; wing membrane hyaline with brownish tints, wing veins brown to dark brown; arolia reddish brown; mandible brownish red at their apices.

Pubescence: Mandible with few long simple brown hairs; labrum with long very light yellow, simple pilosity; pilosity very sparse on clypeus; paraocular areas with a row of long brown hairs on lateral sides with few light yellow (ivory - with goldern tints). Supra clypeal and supra antennal areas and vertex with sparse bristle like brown hairs intermixed with plumose, feathery, smoky yellow pubescence; genal area thickly covered with long to very long plumose, ivory coloured to light brown hairs; anterior areas of pronotum dull brown plumose and silky hair, which becomes ivory, dull white and thick on their lateral areas; medial areas of scutum sparsely pubescent, lateral and posterior areas with brown, plumose hairs, tegulae covered with plumose dull brown to light brown hairs; scutellar pilosity; ivory coloured and plumose; metanotum and propodeum with smoky brown to dark brown, plumose, long pilosity; wing membrane with few dark brown bristle like, hairs sparsely distributed; fore legs with very long bristle, ivory coloured to dull white on their outer sides and inner sides with dark

short hairs; mid tarsal and hind tarsal segments outwardly with long bristle like light yellow hairs, other segments covered with brownish black to brownish yellow hairs, medial part of T₁ long, plumose and smoky brown pubescence intermixed with light brown hairs, on lateral sides plumose hairs become thick and yellowish brown tufts of long hairs on extreme lateral sides; other tarsal segments covered with long light brown to dark brown hairs with golden tints, which becomes thickly developed on lateral and posterior aspects of tergum; posterior areas intermixed with plumose, shorter smoky brown hairs, sternal plates except last one with ivory to light brown and simple hairs, last sternites with bristles like simple dark brown hairs.

Head: Width in anterior view 1.94x distance between front ocellus and lower margin of clypeus (70:36), maximum width of head at the level of posterior margin of eyes 8X distance between front ocellus and occipital margin (24:3) (Fig. 77); relative measurements of POL : OOL = 2 : 1.5 (Fig. 76); mandibles sparsely punctate; labrum closely and deeply punctate except labral marking, which is smooth and impunctate; clypeus smooth, except few weak and sparse punctures on its lateral sides; supra clypeal area and paraocular marking with sparse and weak punctures, tenctorial pits, distinct; antennal toruli slightly depressed and frontal line slightly raised and touches middle of mid ocellus not extended to clypeus; Supra antennal areas and vertex weakly punctate; ocelli glabrous and triangular on vertex; genal areas thickly pubescent; scape, pedicel and F₁ striato-reticulate with few sparse and weak punctations; F₁ longer and thinner than other antennal segments. Relative length: breadth of antennal segments = scape = 19 : 3.5 pedicel = 3:3, F₁ = 10:3, F₂ = 3 : 3.5, F₃ = 3: 3.5, F₄ = 3: 3.5 , F₅ = 4:4, F₆ = 4:4, F₇ =4:4, F₈ = 4:4, F₉ = 4:4, F₁₀ = 4:4, F₁₁ = 4.5 : 3.5 (Fig. 78). Eyes simple and glabrous; relative length : breadth of eyes in lateral view = 18 : 11.

Thorax: Maximum width between tegulae to length of mesosoma = 29 : 31.5 (Fig. 76), medial areas of scutum glabrous and sparsely punctate, other areas more or less closely punctate; scutellum uniformly punctate, in between areas minutely punctate and glabrous; metanotum minutely reticulate with weak punctations; propodeal reticulations small and strong; episternum thickly pubescent; medial and parapsidal lines distinct.

Tegulae glabrous, reticulate with very few punctations; axillary sclerites more or less closely punctate; wings subhyaline, fuscous on marginal cells, posterior parts of fore wing and hind wing striated and papillate (Fig. 76); three submarginal cells, second submarginal cell square shaped, third submarginal largest, first recurrent meets 1r-m and second meets beyond middle of third submarginal cell, marginal cell pointed and elongated. Relative measurements of fore wing length: its maximum width = 67: 23; jugal and vanal lobes of hindwing distinct; hamuli 28 and more.

Legs well developed and strong; fore tibial spurs and spines pointed; spurs finely pectinate; hair tufts on tibia and tarsal segments very long; inner side of hind femur striated and very sparsely punctate and hairless mid tibial spine curved inner side of hind tibia also hairless smooth and glabrous; hind tibial spurs comparatively small and pointed; arolia indistinct and claws symmetrical (Fig. 76).

Metasoma: Metasomal segments, more or less completely covered with pubescence, anterior segments glabrous; tufts of hairs developed on lateral sides of tergites; pre-pygidial and pygidial fimbriae developed; axilla like structure with hair tuft developed on T₃ and T₄; sternal plates punctate, in between punctations striato-reticulate and glabrous (Fig. 76).

Distribution: INDIA, Kerala, Thrissur (Mannavan Shola).

Female: Unknown.

Material examined: Holotype: M, INDIA, Kerala, Mannvanshola, Mathew & Brijesh, 1-x-1998.

Flower Record: Unknown.

Etymology: Named after the black colour of scape.

Habitat: Undisturbed Forest

Discussion: This species closely resembles *X. collaris* Lepel in general appearance, but differs from it in having: (1) Front below the anterior ocellus, broad line by the eyes over vertex and scape of antennae black or brownish black (In *X. collaris* front below the anterior ocellus, broad line by the eyes over vertex and scape of antennae pale yellowish white); (2) Wings hyaline, light fuscous on marginal cell, without purple effulgence (In *X. collaris* wings sub hyaline, light fuscous with purple effulgence).

10. *Xylocopa (Zonohirsuta) pictifrons* Smith

(Figs: 79-81)

Xylocopa pictifrons Smith, 1852. *Trans. Ent. Soc. s. ii* p. 42, F, Dall Torr. Cat. X. p. 217.

Plesiotype: F: TL = 16-20 (16.6), HW = 5.4, HL = 4, SL = 1.67, FL = 3.08, POL = 0.78, OOL = 0.72, FWL = 12.56, FWW = 4.3, HWL = 9.67, EL = 3.6, EW = 1.8.

Colour: Integument: Body usually black, except mouth parts dark brown to reddish brown; eyes with steel grey markings; scape, pedicel and F₁ of antennae dark brown with reddish tints or certain lights; other flagellar segments dull blackish brown; F₁₀ - reddish brown; arolia reddish brown; wings pinkish violet tints (effluence) in certain lights. Fore leg reddish brown, middle ocellus yellowish brown.

Pubescence: Pubescence usually greyish brown to black; labrum with light brown hairs; clypeus and face with smoky white to white plumose hairs, intermixed with simple dark brown hairs; supra antennal area with silky, smoky white plumose pilosity; plumose dull brown hair intermixed with fine white hairs on vertex, hairs more whitish and plumose on genal area. Pronotum covered with finely plumose and thickly developed smoky brown to black pilosity; scutum and scutellum with sparse and fine hairs; metanotum and propodeum with dull brown, long and plumose pubescence, tegulae with few minute hairs; episternum covered with long plumose black hairs with few smoky white hairs intermixed; legs with brushy hairs dark brown to black, reflects silver colour on certain lights; tergum with minute and sparse hairs and their sides covered with tufts of dark brown hairs, dull brown on the posterior area; sternum covered with minute hairs.

Head: Width an anterior view $1.94 \times$ distance between front ocellus and lower margin of clypeus (65 : 33.5) (Fig. 80); maximum width of head at the level of posterior margin of eyes $3.62 \times$ distance between front ocellus and occipital margin (47 : 12); relative measurements of POL : OOL = 7 : 6.5; mandible glabrous and sparsely and minutely punctate; labrum with triangular mark on the anterior region; clypeus and face sparsely punctate, in between areas striato-reticulate, frontal line slightly raised and touches middle ocellus, around the middle ocellus glabrous and minutely reticulate; vertex punctate (not closely) in between areas minutely reticulate; genal area sparsely punctate, in between areas reticulate; scape, pedicel and F_1 minutely and sparsely punctate, other antennal segments with minute hairs, striato-reticulate. Relative length: breadth of antennal segments, scape = 20 : 2, Pedicel = 3.2, $F_1 = 6 : 2$, $F_2 = 3:3$, $F_3 = 2: 2.5$, $F_4 = 3 : 2.5$, $F_5 = 3 : 2.5$, $F_6 = 4: 2.5$, $F_7 = 4: 2.5$, $F_8 = 3.5 : 2.5$, $F_9 = 3: 2.5$, $F_{10} = 2 : 2.5$ (Fig. 81). Eyes simple and smooth, coloured areas seen (Greyish areas); relative length: breadth of eyes in lateral view = 3.6 : 1.8.

Thorax: Maximum width between tegulae to length of thorax = 47 : 53 (Fig. 79); scutum and scutellum sparsely punctate, in between areas glabrous, metanotum and propodeum with weakly impressed sparse punctations, minutely reticulate; median line weakly represented; episternum sparsely punctate.

Legs more or less developed, minutely and sparsely punctate, in between areas striato-reticulate; fore tibial and mid tibial spurs and spines present, spurs present, spurs not well developed; arolia indistinct, claws symmetrical (Fig. 79).

Tegulae glabrous and striato-reticulate, with only two or three punctations, axillary sclerites minutely punctate; wing venation as in figure (Fig. 79); posterior areas of wing membrane striated and papillate; three submarginal cells; first recurrent vein meets on 1 r-m and second recurrent vein meets on posterior side of third submarginal cell; relative measurements of forewing length: its maximum width = 113:39; jugal and vanal lobes of hindwing present (Fig. 79).

Metasoma: Metasomal tergites glabrous, punctation only on the origin of hair, in between areas minutely reticulate; hair becomes more on the posterior areas; pre pygidial and pygidial fimbriae well developed and pygidial area represented by a small slit; T₂ - largest than other segments; sternal plates minutely and sparsely punctate and striated (Fig. 79).

Male: Male differs from female in having the following important characters: (1) Legs longer; (2) Clypeus narrowly, the face on each side to the level of posterior ocelli, the front below the base of the antennae, and a lunule on each side of the anterior ocellus bright yellow; (3) Pubescence on thorax anteriorly and on sides and back of median segment sooty brown, on side of the thorax anteriorly and on tubercles, brownish white; (4) Wings narrower with more of a greenish brassy lustre.

Materials examined: *Plesiotype*: F, INDIA, Kerala, Trissur, Jobiraj. T, 28-1-2000; **Other materials examined:** 1 F: INDIA, Kerala, Trissur, Jobiraj. T, 28-1-2000.

Distribution : INDIA (Kerala, Sikkim).

Flower record: Unknown.

Habitat: Disturbed habitat including Agricultural fields

Discussion: This species closely resembles to *Xylocopa acutipennis* Smith in having wings fuscous with rich coppery bronze effulgence, not blue or green. But differ from it in the following important characters: (1) Metasoma not so convex, long and narrow, only about two thirds as broad as long. (In *X. acutipennis* metasoma very convex, nearly as broad as long); (2) Anterior and intermediate tibiae and tarsi with black pubescence in males (In males of *X. acutipennis* anterior and intermediate tibiae and tarsi pale golden pubescence); (3) Front between the base of antennae without carina (In *X. acutipennis* front between the base of antennae raised into a broad 'Λ' shaped carina).

Remarks: Male specimen is not represented in the present collection. The above description is taken from Bingham (1897).

11. *Xylocopa (Alloxylocopa) shona* sp. nov.

(Fig. 82-84)

Holotype : M. TL = 32.4; HW = 8.4, HL = 4.95, SL = 2.4, FL = 5.6, POL = 0.8, OOL = 1, FWL = 23.2, FWW = 7.2, HWL = 15.4, EL = 4.1, EW = 2.2.

Colour. Integument: Body usually black, except mouth parts brown, labrum, and posterior parts of clypeus reddish brown, face brown with reddish tints in certain lights; scape of antenna with reddish brown streaks (longitudinal

lines), pedicel reddish brown and flagellomeres dull brown; ocelli reflects reddish brown; tegulae with reddish brown streaks; wings sub-hyaline with light yellow to yellowish brown colour, wing veins reddish brown; fore and mid femur reddish brown; propodeum blood red colour, divided into two by a median carina (black), propodeal pit distinct; tergites, 1-3 with reddish tints in certain lights, arolia brownish red.

Pubescence: Pubescence on mandible sparse and golden brown; pilosity on labrum, clypeus and face more or less simple and golden brown, hairs on supra antennal and ocellar area greatly reduced; pilosity on vertex rather sparse, simple and dark brown; posterior part of gena and postgena with long hairs which is simple (very long) stiff and brownish black to dull black; pronotal hairs thickly developed, plumose feathery and yellowish brown to yellow; pilosity almost absent on medial areas of scutum, lateral area with few plumose brown pilosity; lateral areas of scutellum and metanotum with dull brown and plumose pubescence; propodeal triangle with minute and sparse golden pubescence, lateral areas with long plumose, brown to light brown pilosity; episternal hairs yellowish brown to dark brown and plumose; anterior part of tegulae with velvety plumose hairs, anterior part of wing with few minute and golden hairs; legs almost covered with bristle like hairs, light brown to dark brown; metasomal tergites minutely and sparsely pubescent, lateral side with tufts like hairs become more on posterior areas, prepygidial and pygidial fimbriae more or less developed, these hairs consists of bristle like simple brown intermixed with light yellow plumose pilosity; T₄ and T₅ with triangular gradular area at their posterior sides, with minute yellow hairs forming a particular horn like structure; sternal hairs usually long brown and simple, not thickly developed.

Head: Width in anterior view 2.43x distance between front ocellus and lower margin of clypeus (84 : 34.5) (Fig. 83); maximum width of head at the level

of posterior margin of eyes $6.82 \times$ distance between front ocellus and occipital margin ($37.5 : 5.5$); relative measurements of POL : OOL = 4:5 (Fig. 82); mandible with few distinct punctations on basal area, which becomes sparse on posterior areas, in between punctations glabrous and minutely striato-reticulate; malar area distinct and minutely striato-reticulate; clypeus on anterior surface distinctly punctate, posterior areas impunctate and smooth, supra clypeal areas and face distinctly and closely punctate; frontal line passes in between antennal toruli and touches middle of mid ocelli; on both sides of lateral ocelli with impunctate areas, striato-reticulate (minutely reticulate); vertex more or less punctate, in between punctations minutely reticulate; ocelli glabrous and triangular on vertex ; gena weakly punctate as on vertex and face; scape, pedicel & F₁ of antenna broadened towards apex, striato-reticulate and very sparsely punctate; relative length: breadth of antennal segments. Scape = 25 : 2.5, Pedicel = 3:2.5, F₁ = 4:3, F₂ = 5:3, F₃ = 5:3, F₄ = 5:3, F₅ = 4.5 : 3, F₆ = 4:3, F₇ = 4 : 2.5, F₈ = 4: 2.5, F₉ 4: 2.5, F₁₀ = 4:2, F₁₁ = 4.5 : 2 (Fig. 84). Eyes simple and glabrous ; relative length: breadth of eyes on lateral view = 20.5 : 11.

Thorax: Maximum width between tegulae to length of thorax = 31 : 49; anterior areas of scutum and pronotum closely punctate; medial areas and areas around lateral lines impunctate and smooth, other areas sparsely punctate (triangular area on mesoscutum); medial and lateral lines distinct; scutellum punctate as on lateral areas of mesoscutum; metanotum closely and strongly punctate; Propodeum weakly and sparsely punctate, in between areas hexagonally reticulated; propodeum divides into two halves by a median carina; two lateral black lines seen (Fig. 82); episternum more or less closely and deeply punctate.

Tegulae minutely striato-reticulate with sparse minute punctations, glabrous; axillary sclerites weakly and minutely punctate (Fig. 82); wings sub

hyaline with brown to light brown tints; posterior areas striated and papillate; three submarginal cells, second submarginal triangular shaped, first recurrent meets 1 r-m and second meets beyond middle of third submarginal cell; relative measurements of forewing length: its maximum width = 116:26, jugal and vanal lobes of hindwing distinct, posterior areas papillate, hamuli 35 and more (Fig. 82).

Legs more or less well developed and punctate; foretibial spine pointed; mid and hind tibial spines not well developed; hind tibia as long as hind basitarsus; arolia indistinct and claws symmetrical.

Metasoma: Metasomal tergites glabrous, minutely and sparsely punctate, in between punctations minutely reticulate; axillae like structure with hair tuft (hair band) on both sides of T₄ and T₅ as in fig. (Fig. 82); lateral sides of tergum with hairs tufts, which becomes well developed on posterior aspect, pre pygidial and pygidial fimbriae distinct; sternal plates punctate than tergal plates, in between areas glabrous and minutely striato-reticulate.

Female: Unknown.

Materials examined: *Holotype*: M, INDIA, Kerala, Kollam, P. M. Sureshan, xii-1999.

Distribution: INDIA (Kerala).

Flower record: Unknown.

Etymology: Named after the reddish colour.

Habitat: Disturbed.

Discussion: This species resembles *X. tenuiscapa* Westwood in general appearance; but differs from it in having the following characters: 1. Scape of antennae broadened towards apex (In *X. tenuiscapa* Westwood antennal scape

cylindrical). 2. Propodeum bulged laterally and larger than metanotum and scutellum together (In *X. tenuiscapa* propodeum not bulged laterally). 3. Anterior tibiae and tarsi more or less round and reddish brown (In *X. tenuiscapa* anterior tibiae and tarsi flattened and yellow). 4. Clypeus and face below the antennae reddish brown (In *X. tenuiscapa* clypeus and face below the antennae variegated with yellowish white).

This species also resembles *X. collaris* Lepel in general appearance, but differs from it in the following important characters: 1. Scape of antennae reddish brown. (In *X. collaris* scape of antennae pale yellowish white). 2. Pubescence brown to brownish black (In *X. collaris* pubescence ochraceous). 3. Wings subhyaline without purple effulgence (In *X. collaris* wings light fuscous with purple effulgence).

12. *Xylocopa (Mesotrichia) tenuiscapa* Westwood

(Figs: 85-87)

Xylocopa tenuiscapa Westwood 1840, *Jard. Nat. Lib., Ent.* vii, p-271, pl. 23, Fig. 2M
Smith, cat. ii, p. 353; Dall. Torr. Cat. X, p. 219.

Xylocopa viridipennis Lepel. 1835. *Hym.* ii. p. 205.

Plesiotype: F. TL = 36.6, HW = 9.6, HL = 7.05, SL = 3.2, FL = 6.2, EW = 3, EL = 5.2, POL = 0.8, OOL = 1.6, FWL = 27.8, PWW = 8.2, HWL = 16.8.

Colour: Integument: Body usually black, except antennal toruli dull brown, mouth parts yellowish brown reflection in certain lights; eyes dull yellow with steel grey markings; wings dark fuscous with vivid coppery, green and purple effulgence changing as they catch the light; arolia dark brown.

Pubescence: Pubescence usually black; pubescence on labrum and mandibles light to dull brown; lower areas of clypeus with brown bristles and on face, supra antennal areas dark brown and simple; pubescence on antennal toruli

sparse and minute; posterior part of gena and postgena with tuft like dark brown to black bristles thickly developed. Pilosity on pronotum and scutum velvety, plumose and black greyish reflections in certain lights. Scutellum and metanotum with sparse greyish black plumose hairs; pre-episternal hairs longer and thicker than pronotum and scutum; anterior parts of wings with minute simple and light brown hairs; pubescence on legs long dense and stiff, which is thickly developed, black in colour reflects white or greyish white in certain lights; anterior areas of tergum with sparse light brown hairs and their sides covered with a tufts of dark brown to black hairs, simple to plumose; sternal hairs longer than tergal hairs, black and not thickly developed.

Head: Width in anterior view $2.29 \times$ distance between front ocellus and occipital margin (87:38) (Fig. 86); maximum width of head at the level of posterior margin of eyes $4.27 \times$ distance between front ocellus and occipital margin (47:11) (Fig. 86); relative measurements of POL : OOL = 4:8; basal areas of mandibles minutely punctate and other areas glabrous (Fig. 86); clypeus sparsely punctate with strong and large punctations, in between areas minutely punctate and glabrous; punctations on face sparse and weakly impressed, frontal line touches the middle of middle ocelli, all ocelli placed in a depression; punctations on vertex and gena sparse, in between areas minutely reticulate; malar area distinct; scape, pedicel and F_1 of antenna sparsely punctate, $F_2 - F_{10}$ with minute hairs, scape of the antenna exceeds the middle ocelli, relative length: breadth of antennal segments scape = 29: 3.5 pedicel, 3:3, $F_1 = 13:4$, $F_2 = 3: 3.5$, $F_3 = 4:3.5$, $F_4 = 4:4$, $F_5 = 4:4$, $F_6 = 4:5.4$, $F_7 = 4: 5.4$, $F_8 = 4: 5:4$, $F_9 = 4: 5.4$, $F_{10} = 6.5:4$ (Fig. 87). Eyes simple and smooth, coloured greyish streaks are seen on eyes; relative length : breadth of eyes of lateral view = 26 : 15.

Thorax: Maximum width between tegulae to length of thorax = 46:49 (Fig. 85). Anterior and lateral parts of scutum punctate and medial area impunctate

mostly and glabrous; medial and parapsidal lines distinct; scutellum and axilla uniformly, strongly and sparsely punctate, in between punctations finely reticulate and glabrous; episternal punctations not clearly visible due to well developed pilosity.

Tegulae finely reticulate and glabrous; wing venation as in figure (Fig. 85) posterior areas of wing membrane glabrous and papillate; three submarginal cells; first recurrent vein meets 1 r-m and second meets on posterior side of third submarginal cell; relative measurements of forewing length: its maximum width: 139 : 41; jugal and vanal lobes of hindwing distinct and posterior wing membrane striated and papillate; hamuli 46 or more (Fig. 85).

Legs more or less developed, sparsely punctate, glabrous and finely striato-reticulate; fore tibial spurs paced curved and pointed; mid and hind tibial spurs pectinate, hind tibia as long as hind basitarsus, arolia indistinct and claws symmetrical.

Metasoma: Metasomal tergites glabrous and minutely reticulate; Punctations more or less closely developed and uniform, well developed hair tufts seen on the lateral sides of metasoma; prepygidial and pygidial fimbriae developed and pygidial area represented by a small slit (Fig. 85), T₂ larger than other tergites, sternal plates punctate, lesser than tergal plates, in between punctations minutely reticulate.

Male: The male differs from that of *X. latipes* in the scape of the antennae being cylindrical.

Materials examined: Plesiotype: F, INDIA, Kerala, Calicut University Campus, Sabirabi, 18-xii-1999; *Other materials examined:* 1F, INDIA, Kerala, Calicut University Campus, Sudha. P, 14-vi-1999; INDIA, Kerala, Calicut

University Campus, Reshmi, 6-x-1999; 1F, Lakshmi, H.V., 21-iv-1999; INDIA, Kerala, Calicut University Campus, Jobiraj. T, 20-iv-1999.

Flower record: Unknown.

Distribution: INDIA (Kerala, Tamil Nadu, Assam), Ceylon.

Biology: Unknown.

Habitat: Disturbed.

Discussion: This species closely resembles *Xylocopa latipes* (Drury) in general appearance, but differs from it on having the following characters: 1. In females sulcations on the front smaller and not extending up to ocelli (In *X. latipes* sulcations on the front of females extending up to the ocelli). 2. Scape of antenna not at all dialated towards apex (In *X latipes* scape of antenna dialated towards apex). 3. Metasoma not closely punctate (In *X. latipes* metasoma more or less closely punctate). 4. Parapsidal lines distinct (In *X latipes* parapsidal line weakly represented). 5. Hamuli on hind wing 45 or more (In *X. latipes* hamuli on hind wing 35 or more). 6. In males scape of antennae cylindrical (In males of *X latipes* scape of antennae not cylindrical).

Remarks: Male specimens are not represented in the above collection but characters were taken from Bingham (1897).

13. *Xylocopa (Nyctomelitta) tranquebarica* (Fabricius)

(Figs. 88-90)

Bombus tranquebaricus Fabricius, 1804. *Systema piezatorum*, p 343. 4. Types Repository : UZMC. *Xylocopa rufescens* Smith, 1874. *Ent. Soc. London, Trans* p.271. M & F. Type Repository: Unknown not in BMCNH).

Xylocopa tranquebarica (Fabricius) - Maa, 1940. *Lingnan Sci. Jour.* 19: 578 - 580, Fig. 7 M and F.

Plesiotype: F: HW = 8.22, HL = 6.11, SL = 3.11, FL = 5.6, POL = 1.1, OOL = 0.4 EL = 5.4, EW = 2.8, FWL = 21.2, FWW = 7.2, HWL = 14, TL = 29.

Colour: Integument: Body usually black except the following parts, reddish brown (rufous); antennae rufous brown, flagellum paler beneath, ocelli reflects dull brown in certain lights, tegulae dark brown to reddish brown, leg rufous brown to dark brown; wings fulvo-hyaline, paler along the apical and posterior margins, wing veins reddish brown, gradular areas brown with rufescent tints in certain lights; eyes black with silvery streaks.

Pubescence: Pubescence usually rufo-fuscous with golden-brown; labrum with minute rufo-fuscous hairs which are simple; mandibles consist of few long and simple hairs; posterior parts of clypeus with bristle like and simple hairs (rufo-fuscous) and other areas of clypeus, face and supraantennal areas with fine, plumose, rufo-fuscous hairs; around antennal fossae few bristle like dark brown simple hairs. Gena and postgena covered with long, sub plumose light brown hairs with golden tints; hairs on pronotum, scutum and scutellum closely covered, long, fine and finely plumose, feathery, light yellow to light brown with goldern tints; Episternum also as thorax; hairs on legs thickly developed, bristle like simple and reddish brown; anterior and posterior areas of T₁ minutely plumose and lateral sides of T₁ larger and thickly developed and finely plumose, hairs light yellow with golden tints; remaining parts of tergum with light brown to

golden, simple which is thicker and larger on the sides of tergum and posteriorly it becomes abundant; sternal hairs reddish brown, sub plumose to simple and long.

Head: Width in anterior view a little more than 2.18 x distance between front ocellus and lower margin of clypeus (74:34) (Fig. 89); maximum width of head at the level of posterior margin of eyes 3.73 x distance between front ocellus and occipital margin (41:11); labial palp - 5 segmented, first one is the largest and other segments smaller; mandibles sparsely and minutely punctate, basal areas with well developed punctations other areas striato-reticulate; labrum clypeus and face minutely and sparsely punctate vertex sparsely punctate, not very deep, in between areas minutely reticulate punctations on gena not distinct relative length of POL : OOL = 5.5 : 2 (Fig. 88); ocelli glabrous and large; antenna very sparsely and minutely punctate, scape of antenna long, touches beyond the ocelli, F₁ longer than other flagellar segments, relative length: breadth of antennal segments = Scape = 28 : 3, pedicel = 3 : 3. F₁ = 9 : 3.5, F₂ 3.5 : 3.5, F₃ = 4 : 3.5, F₄ = 4.5 : 3.5, F₅ = 4 : 3.5, F₆ = 4.5 : 3.5, F₇ = 4 : 3.5, F₈ = 3.5 : 3.5, F₉ = 4.5 : 3.5, F₁₀ = 6 : 3.5 (Fig. 90). Eyes simple and glabrous and smooth, relative length: breadth of eyes in lateral view 27 : 14; malar area narrow and small.

Thorax: Maximum width between tegulae to length of thorax 51 : 4; thorax finely and sparsely punctate under the pubescence, which is not clear due to well developed pubescence; median line distinct.

Legs more or less well developed and closely covered with thick pubescence; arolia indistinct; foretibia more or less closely punctate; fore tibial spine pointed; foretibia spurs pointed and simple (not pectinate); mid tibial spurs and spines well developed as that of fore tibia; hind tibia consists of two spines (Fig. 88), one on the middle and other on posterior part, middle spine with two

denticles, posterior one more or less blunt, tibial spines pointed and narrower than the other segments; hind tibia as long as hand basitarsus.

Tegulae glabrous and minutely reticulate, wing venation as in figure (Fig. 88); posterior areas of wing membrane striated and uniformly papillate; three submarginal cells, first and second recurrent veins meets on third submarginal, second submarginal cell triangular shaped; relative measurements of forewing length: Its maximum width = 106 : 36; jugal and vanal lobes of hindwing present, posterior wing membrane striated and minutely, papillate; 33 hamuli present.

Metasoma: Metasoma tergites glabrous and punctate, in between punctations striato-reticulate to minutely reticulate; gradular area distinct on first, second and third tergites; hairs well developed on posterior tergites; prepygidial and pygidial fimbriae well developed and pygidial area represented by a small slit; T₂ largest and broadest than others; sternal plates more punctate than tergal plates (Fig. 88).

Male: Male differs from females in having the following important characteristic features: (1) Pubescence paler but brighter and more dense than metasoma; (2) Pubescence more plumose; (3) Clypeus with yellow colour; (4) Labrum ferruginous red; (5) Terminal five segments of flagellum yellow.

Materials examined: Plesiotype: 1 F : INDIA, Kerala, Calicut University Campus, Jobiraj. T, 23-xii-2000; *Other materials examined:* 1 M, INDIA, Kerala, Calicut University Campus, Jobiraj. T, 5-iv-2000; 3 M, INDIA, Kerala, Calicut University Campus, Jobiraj. T, 2-v-2000.

Distribution: INDIA (Kerala, Sikkim).

Flower Record: Unknown.

Habitat : Disturbed.

Discussion: This species resembles to *X. caerulea* (Fabricius) in general appearance, but differs from it in the following characters: 1. With golden brown, sometimes rufescent pubescence (In *X. caerulea* with blue and black pubescence); 2. Mesonotum punctate (In *X. caerulea* mesonotum smooth); 3. Golden brown pubescence (In *X. caerulea* pubescence blue and black).

14. *Xylocopa (Koptortosoma) verticalis* Lepelletier

(Figs: 91-93)

Xylocopa verticalis Lepel. Hym. ii, p.195, M and F.

Plesiotype: F. TL = 28. HW = 8.42, HL = 6.2, SL = 2.8, FL = 5.5, FWL = 22, FWW = 7.8, EL = 4.8, EW = 2.4, POL = 0.9, OOL = 1.3, HWL = 14.7.

Colour. Integument: Body usually black except, mouth parts reddish brown to yellowish brown, scape of antenna with reddish brown streaks, flagellum dull brown, ocelli glabrous and reflects reddish brown in certain lengths; tegulae dark brown with reddish brown streaks and spots; all posterior tarsal segments brown; gradular areas represented by reddish streaks; wing veins reddish brown colour; wing membrane fuscous, sub hyaline at bases, reddish brown with purple effulgence.

Pubescence: Pubescence usually brown and black and well developed; labrum with simple golden pilosity; mandible with long and thick golden hairs; posterior parts of clypeus with simple, long golden and surface with plumose golden and silvery hairs; face with plumose yellow hairs intermixed with simple dark brown hairs; minute yellow hairs present on vertex; gena covered with light yellow and light brown hairs, which becomes longer and thicker on their posterior areas; pilosity on mesosoma thick, plumose and yellow; tegulae with simple to minutely plumose yellow hairs, basal areas of both with yellow hairs; episternum also covered with plumose yellow pilosity; basal area of first tibia

with yellow hairs; all other segments of legs with brown, sooty brown and silvery hairs; anterior area of tergum with few yellow hairs, surfaces of all other tarsal segment with minute silvery hairs and on their lateral sides with tufts of dark brown hairs.

Head: Width on anterior view $2 \times$ distance between front ocellus and lower margin of clypeus (80:40) (Fig. 92); maximum width of head at the level of posterior margin of eyes $4.56 \times$ (41:9) distance between front ocellus and occipital margin; relative measurements of POL : OOL = 4.5 : 6.5 (Fig. 91); mandibles sparsely punctate, in between areas smooth; labrum triangular shaped with few well developed punctures, clypeus with well developed punctations, in between areas minutely punctate, medial area in punctate, forming a line; face, supra clypeal areas, frons etc. sparsely punctate (less closer than clypeus), in between areas minutely reticulate; frontal line almost touches the middle of ocelli; gena sparsely and strongly punctate, in between areas minutely reticulate; scape reaching after front ocelli, pedicel small, antennae usually thin; relative length : breadth of antennal segments = scape = 27 : 3, pedicel = 2.5 : 3, F1 = 9 : 2.5; F2 = 4 : 2.5; F3 = 4 : 2.5, F4 = 4 : 2.5, F5 = 4.5 : 2.5; F6 = 4.5 : 2.5; F7 = 4.5 : 2.5; F8 = 4.2 : 5; F9 = 4 : 2.5, F10 = 5 : 2.5 (Fig. 93). Eyes simple and smooth, coloured streaks seen; relative length : breadth of eyes on lateral view 24 : 12.

Thorax: Maximum width between tegulae to length of thorax = 38 : 39, thorax more or less completely covered with hairs, so punctations not visible; midline visible and median area glabrous; other area sparsely punctate; scutellum minutely punctate; episterum also covered with thickly developed hairs; surfaces sparsely punctate (Fig. 91).

Legs more or less developed; minutely and sparsely punctate, in between areas striato-reticulate; fore and mid tibial spines present, of which mid tibial

spine well developed; tibial spines are present on all legs, minutely pectinate; tibia 3 as long as basitarsus 3; arolium indistinct, claws symmetrical.

Tegulae glabrous and striato-reticulate, wing venation as in figure (Fig. 91); wings fuscous; posterior areas of wing membrane striated and uniformly papillate; three submarginal cells, first and second recurrent veins meeting posterior end of second submarginal cell and beyond the middle of third submarginal cell; relative measurements of forewing length : its maximum width = 110 : 39; jugal and vanal lobes of hindwing present, numerous hamuli (Fig. 91); posterior areas of hindwings also papillate, not close is in forewing.

Metasoma: Metasomal tergites glabrous and more or less minutely punctate; lateral margin of terga 2-4 with conspicuous pen-like setal tuft; second terga larger (longer and broader) than other tergites; sternum also glabrous and minutely and sparsely punctate (Fig. 91).

Male: Male differs from female in having the following features: (1) Body completely covered with golden hairs, olive yellow to golden; (2) Wings hyaline with golden tints; (3) Ocelli yellow and glabrous; (4) Tegulae brown; (5) Longer than female.

Materials examined. Plesiotype: F: INDIA, Kerala, Thrissur, Jobiraj T., 28.i.2000. *Other materials examined:* 1 F: INDIA, Kerala, Thrissur, Jobiraj T., 28.i.2000; 1 M: INDIA, Kerala, Malappuram, Sherima, 18.ii.2000; 3F: INDIA, Kerala, Muthanga, L. Kishore, 8.v.2000; 2F: INDIA, Kerala, Athirappilly, Jobiraj T., 24.i.1999; 1 F: INDIA, Kerala, Kalpetta, Jobiraj T., 20.xi.2000; 1 F: INDIA, Kerala, Calicut University Campus, Jobiraj T., 20.vi.1998; 1 F: INDIA, Kerala, Calicut University Campus, Bindu S.T., 7.viii.1997.

Flower Record: Unknown.

Distribution: INDIA (Kerala, Barrakpore).

Biology: Unknown.

Habitat : Both from disturbed agricultural fields and undisturbed forested areas.

Discussion: This species closely resembles *X. aestuans* Linnaeus in general appearance, but differs from it in having the following important characters: (1) More compact body (In *X. aestuans* body not so compact), (2) Pubescence on cheek, occiput, sides of thorax and basal metasomal segments, dense and having a velvety appearance in females (In *X. aestuans* pubescence on cheek, occiput, sides of thorax and basal metasomal segments with black in females); (3) Wings fuscous with a purplish effulgence, subhyaline at base (In *Xylocopa aestuans* wings dark fuscous with a purple effulgence); (4) Legs of male covered with a reddish-yellow pubescence (In *X. aestuans* legs with olive pubescence).

Tribe 2 : Ceratinini

Diagnostic features:

Most species have yellow marking at least on face, and some have extensive yellow maculation. In females, there is a vertically elongate yellow bar in the middle of the clypeus. Pygidial fimbria is absent in females. The basal part of S_2 and often of S_3 of females has a semilunar area called a 'wax plate'.

Genus *Ceratina* Latreille

Clavicera Latreille 1802a. *Hist. Nat. de. Four.* 432. Type species: *Hylaeus albilabris* Fabricius, 1793 = *Apis cucurbitina* Rossi, 1792, monobasic.

Ceratina Latreille, 1802b. *Hist. Nat. Gen. Part. Ins.* 380. Type species: *Hylaeus albilabris* Fabricius, 1793 = *Apis cucurbitina* Rassi, 1792, monobasic.

Pithitis Klug, in Illiger, 1807, *Mag. für. Inse.* 698; Klug 1807. *Mag. für. Ins.* 225. Type species *Apis smaragdula* Fabricius, 1787, monobasic.

Ceratina (*Ceratinidia*) Cockerell and Porter, 1899 *Psyche*: 406. Type species: *Ceratina heiroglyphica* Smith, 1854, by original designation.

Zadontomerus Ashmead, 1899. *Trans. Amr. Ent. Soc.* 69. Type species: *Ceratina tejonensis* Cresson, 1864, by original designation.

Zadontomerus Cockerell and Porter, 1899. *Psyche*. 406, unjustified ementation of *Zadontomerus* Ashmead, 1899.

Ceratina (*Crewella*) Cockerell, 1903: *Ann. Mag. Nat. Hist.* 202. Type species *Ceratina titusi* Cockerell, 1903, by original designation.

Neoceratina Perkins, 1912. *Ann. Mag. Nat. Hist.* 117. Type species: *Neoceratina australensis* Perkins, 1912, monobasic.

Ceratina (*Chloroceratina*) Cockerell, 1916: *Phi. Jour. Sci.* 143. Type species: *Ceratina cyanura* Cockerell, 1918, by original designation.

Ceratina (*Calloceratina*) Cockerell, 1924d. *Proc. Ent. Soc. Wash.* 77. Type species *Ceratina amabilis* Cockerell, 1897 = *C. exima* Smith 1862, by original designation.

Ceratinula Moure 1941a. *Arq. do. Mus. Para* 78. Type species: *Ceratina lucidula* Smith, 1854, by original designation.

Ceratina (*Catoceratina*) Vecht 1952. *Zool. Verh.* 30. Type species: *Ceratina perforatrix*, by original designation.

Ceratina (*Lioceratina*) Vecht 1952. *Zool. Verh.* 32. Type species: *Ceratina flavopicta* Smith 1858, by original designation.

Ceratina (*Xanthoceratina*) Vecht, 1952. *Zool. Verh.* 39. Type species: *Ceratina cladura* Cockerell, 1919, by original designation.

Pithitis (*Protopithitis*) Hirashima, 1969: *Pacific Insects.* 651. Type species: *Ceratina aereola* Vachal, 1903, by original designation.

Ceratina (*Euceratina*) Hirashima, Moure and Daly, 1971, in Hirashima, 1971a *Jour. Fac. Agri. Kyu. Uni.* 369. Type species: *Apis callosa* Fabricius, 1794, by original designation.

Ctenoceratina (*Simioceratina*) Daly and Moure, 1988, in Daly, 1988: *Uni. Cal., Pub. Ent.* 42. Type species: *Ceratina moerenhouti* Vachal, 1903, by original designation.

Diagnostic characters:

Minute to moderate sized (body length ranges from 3.0 to 12.5 mm), sparsely haired, shiny, slender bees. Black to weakly blue or green or in tropis varying to brilliant green, some with metasoma coppery or red; prestigma much shorter than distance from base of stigma to vein r; stigma wider than pre-stigma; margins of stigma basal to vein r convergent basally, margin in marginal cell convex except in largest species; middle and hind femora without sharp ventral edges.

Distribution: INDIA (Kerala). It is found on all continents, but rare and limited in distribution in Australia.

Biology: They nest in pitty dead stems or twigs. The cells are unlined, usually cylindrical, and formed merely by partitions in the unbranched burrow; they are not barrel shaped (Michener 2000).

Discussion: *Ceratina* differ from the closely resembling genus *Megaceratina* Hirashima mainly by having apex of the marginal cell bent away from the costa, and there is no sternal scopa. *Ceratina* superficially resembles to augochlorine halitides, but differs as follows: glossa and labial palpi long, basal vein only gently curved, clypeus shaped like thick inverted 'T' and commonly with a yellow or white mark in female, femoral scopa absent. Michener (2000) reported 17 subgenera in *Ceratina*.

Remarks: The present work reports nine species from Kerala, out of which three are new to Science. A key to the species of Kerala is also provided. *Ceratina unimaculata* is reported first time from India.

KEY TO THE *CERATINA* SPECIES OF KERALA

(Mainly based on Females)

1. Propodeum truncate, the steep declivity separated from the very short dorsum by a raised edge. Vertex and temples separated from occiput by carina or sharp edge (Fig. 97) (*Pithitis*) 2
- Junction of propodeal dorsum with declivity rounded or bluntly angular 8
2. Usually brilliant green or blue-green species, with or without brassy or slight purple reflection; tubercles pale yellow or ivory coloured (Fig. 94) 3
- Usually dull blue (dark to bright), dark blue and coppery or coppery species; tubercles often without yellow marking 5
3. Bright blue-green species often with brassy reflection; yellow marking on clypeus well developed, usually with transverse bar apically; punctures on median portions of genal areas usually markedly smaller than those on upper and lower portions (Fig. 97) *C. binghami* Cockerell
- Yellow marking on clypeus without apical bar; punctures on genal areas variable 4
4. Often bright green, hypostomal carinae moderate; punctures very strong (Fig. 106), those on median portions of genal areas quite distinct, slightly smaller than those of upper and lower portion *C. smaragdula* Fabricius
- Dull green with coppery reflection; hypostomal carinae strong, distinctly elevated; punctures on median portions of genal areas distinctly smaller than those of upper and lower portion *C. vechti* (Baker)

5. Punctures on upper portions of genal areas and lateral portions of mesoscutum very strong, often well separated from each other by flat, smooth, shining interspaces; hypostomal carinae rather strong 6
- Punctures on upper portions of genal areas not specially strong, usually close; hypostomal carinae strong 7
6. Body entirely greenish blue; pronotal tubercles white or yellowish white; legs with yellow markings as in figure (Fig. 114)
..... *C. unimaculata javanica* Vander Vecht
- Body dark and dull greenish, with bronzy and purplish reflections, pronotal tubercles dark; yellow markings on legs often reduced or absent (Fig. 117) *C. unimaculata palmerri* Cameron
7. T₄ to T₆ without excavated velvety areas; T₇ with apex slightly broader *C. indica* (Hirashima) comb. nov.
- T₄ to T₆ with excavated velvety areas; T₇ with apex not much broader
..... *C. waini* (Shiokawa and Sakagami) comb. nov.
8. Frons and vertex densely and rather coarsely punctate (Fig. 104); space between ocelli and eye at least with a few distinct punctures (Fig. 104); head distinctly wider than high, more extensively marked with yellow (Fig. 104) (*Certinidia*)..... 9
- Frons and vertex impunctate and striato-reticulate (Fig. 110); space between ocelli and eye impunctate or minutely punctate; head as seen in front, almost circular (Fig. 110); pronotal tubercles and few markings on legs creamy white (*Neoceratina*) ... *Ceratina sasidharani* sp. nov.
9. Metasomal segment 1-6 with yellow transverse bands (Fig. 94); labrum with three brown spots (Fig. 95) 10

- . Metasomal segment 1-5 with yellow transverse bands (Fig. 103); labrum with out brown spots (Fig. 104) *Ceratina hieroglyphica* Smith
- 10. Hind tibia triangularly produced in the middle (Fig. 94); supra clypeal spot with lateral expansions (Fig. 95); supra antennal paired spots almost oval shaped (Fig. 95) *Ceratina anupama* sp. nov.
- . Hind tibia not triangularly produced in the middle (Fig. 101); supra clypeal spot more or less triangular shaped without lateral expansion (Fig. 101); supra antennal spots small and vibrio shaped (Fig. 101)
..... *Ceratina curiosa* sp. nov.

1. *Ceratina (Ceratinidia) anupama* sp. nov.

(Figs. 94-96)

Holotype: F. TL = 7.46, HW = 2.12, HL = 1.74, SL = 0.4, FL = 1.38, POL = 0.33, OOL = 0.315, EL = 1.55, EW = 0.73, FWL = 4.25, FWW = 1.46, HWL = 3.64.

Colour. Integument : Body usually black except, mouth parts dull brown, labrum yellow with three brown spots, clypeus with a '1' yellow marking; supra clypeal marking, supra antennal markings (paired spots), paraocular markings, yellow; scape and pedicel of antenna brownish black, with anterior and posterior yellow spots on scape, rest of flagellomeres brown; ocelli glabrous and reflects dull brown tints in certain lights; genal marking yellow; pronotal band, pronotal tubercles, two parallel longitudinal lines on mesoscutum, a broad squarish mark on scutellum, yellow; coxa, trochanter and anterior parts of femur, all legs reddish brown, rest of the fore legs yellow, mid tibia with light brownish marking and hind tibia with brownish black marking, other parts of legs yellow; tegulae reddish brown to dark brown, axillary sclerites yellow, wing membrane sub hyaline and nerves testaceous, thoracic segments with uninterrupted yellowish marking except the third segment, marking interrupted in the middle.

Pubescence: Pubescence more or less reduced and sparsely distributed; sparse and simple hairs on labrum and mandible hyaline with light yellow tints; face devoid of pilosity except few minute sparse, and hyaline pubescence; vertex and gena pubescent as on labrum, which is longer than hairs on labrum; minute and hyaline hairs distributed whole surface of flagellum. Hairs on pronotum sparse, hyaline, anterior part of scutum with sparse, light yellow pilosity, posteriorly becomes longer; scutellum and metanotum much hairy, hyaline and plumose; episternal hairs more developed than scutum, long and ivory coloured; legs with hyaline to light yellow hairs, weakly and sparsely developed. Sparse,

minute and light golden hairs on tergites, becomes more on posterior aspect; sternal hairs more developed, long and hyaline to golden than tergal hairs.

Head: Width on anterior view a little more than $1.5 \times$ distance between front ocellus and lower margin of clypeus (66:44) (Fig. 95); maximum width of head at level of posterior margin of eyes $7.6 \times$ distance between front ocellus and occipital margin (46:6); relative measurements of POL : OOL = 8:7.5; Mandibles glabrous and impunctate; labrum with few well developed punctations, clypeal marking as in figure (Fig. 95); frons punctate as on clypeus; supraclypeal area above the marking, supra antennal area above the markings and vertex more or less closely and deeply punctate; antennal toruli depressed in middle, frontal line slightly raised and arise from middle of supra clypeal marking and passes on between toruli and not touches the mid ocellus; gena glabrous; weakly and sparsely punctate, scape of antenna not reaching front ocellus; scape and pedicel sparsely and strongly punctate, flagellum covered with minute hairs; relative length: breadth of antennal segments = Scape 20:4, Pedicel = 7:4, $F_1 = 3.5:5$, $F_2 = 4.5:6$, $F_3 = 5:7$, $F_4 = 6:7$, $F_5 = 7:7$, $F_6 = 6:7$, $F_7 = 7:6$, $F_8 = 6:6$, $F_9 = 7:6$, $F_{10} = 11:6$ (Fig. 96). Eyes simple, smooth and glabrous; relative, length : breadth of eyes on lateral view = 17:8.

Thorax: Maximum width between tegulae to length of thorax = 40:46 (Fig. 94); pronotum separated by scutum by a strong carina, pronotum minutely punctate; anterior, posterior, lateral parts of scutum strongly and closely punctate; medial area glabrous, minutely and sparsely punctate; medial and parapsidal lines distinct, scutal markings as in figure (Fig. 94); metanotum and scutellum minutely and weakly punctate; anterior areas of propodeum with weakly developed longitudinal striations followed by coarse punctations; episternum closely and deeply punctate.

Leg moderately long and weakly developed; legs usually devoid of puncti, if punctate, minute; mid and hind femora triangularly bulged in the middle, forefemur normal shaped, mid and hind tibial spur long and minutely pectinate mid tibial spine pointed and well developed (Fig. 94); arolia distinct; hind tibia also bulged after the middle portion.

Tegulae glabrous with basal area weakly punctate; wing venation as in figure (Fig. 94); wings subhyaline; three submarginal cell, middle one small and receives first recurrent vein in its middle and second meets on third submarginal cell. Relative measurements of forewing length: Its maximum width = 102:35 (Fig. 94); jugal and vanal lobes of hindwing present; minute hairs distributed throughout the wing membrane.

Metasoma: T1 minutely punctate, coloured band raised on the middle (Fig. 94), graduli transversely striated to minutely reticulate with few sparse punctations in the middle; T2 - closely and strongly punctate, coloured band raised laterally and continuous, graduli large transversely striated to reticulate and posteriorly more than T1; T3 as on T2, but the band interrupted in the middle, graduli greatly reduced; T4 as on T3, but band continuous; T5 and T6 more or less closely and strongly punctate, coloured band raised in the middle; sternal plates more or less closely and strongly punctate.

Male: Unknown.

Materials examined: *Holotype:* F, INDIA, Kerala, Karumala, Jobiraj, T., 15-vi-1998; *Paratypes* : 2F, INDIA, Kerala, Karumala, Jobiraj, T., 15-vi-1998.

Etymology: The species name is from Sanskrit, meaning unique, feminine gender.

Flower Record: Unknown.

Distribution: INDIA (Kerala).

Biology: Unknown.

Habitat: From disturbed habitats and agricultural fields.

Discussion: This species closely resembles to *Ceratina compacta* Smith in general appearance, but differs from it in the following characters: 1. Supra clypeal area without distinct transverse rim (In *C. compacta* 'L' shaped distinct transverse rim on supra clypeal area), (2) Lateral facial markings extends above antennal fossae (In *C. compacta* lateral facial marking never reaching antennal fossae), (3) Labrum with three brownish black spots (In *C. compacta* labrum with a yellow spot), (4) Surface of clypeus smooth and median carina usually indistinct. (In *C. compacta* surface of clypeus superficially wrinkled, median carina indistinct).

2. *Ceratina (Pithitis) binghami* Cockerell

(Figs. 97-99)

Apis aenea Fabricius, 1798 *Haf., Proft et Storch.* 277: Sex ? ; Habitat in India Orientali Dom. Hybner. (ZMK). [*Ceratina viridissima* Dalla Torre: 1896, *tipsiae*, Gui. Engelmann; 201: misdetermination].

Ceratina binghami Cockerell, 1908, *Ann. Mag. Nat. Hist.* (8) 340; [F & M], Calcutta and Siligiri [USNM].

Pithitis sympatrica Shiokawa & Sakagami, 1969. *Nat. Lif. South east Asia* 1969, 141, 144 (in key), 149, fig. 1, 2; M & F; Poona, India [HUS] synonymised with *binghami* by Hirashima, 1969, *Pacific Insects.* 658.

Plesiotype: M, TL = 8.28, HW = 2.57, HL = 2.04, SL = 0.68, FL = 1.63, FWL = 5.47, FWW = 2.06, HWL = 3.94, EL = 1.61, EW = 0.91, POL = 0.48; OOL = 0.35.

Colour: Integument: Body usually emerald green to bright green with metallic blue tints in certain lights except, mouth parts dull brown, markings on

brownish black, eyes light yellow to dull brown; ocelli glabrous and dull brownish yellow; pronotum dark green to black; pronotal tubercles light yellow; tegulae dark testaceous brown, wings hyaline, veins brown, stigma dark brown; tegulae with yellow spots, medial and parapsidal lines black, middle of mesoscutum with metallic blue tints; legs dark brown to black; tarsi ferruginous, coxae, trochanters and upper side of femora more or less metallic green, line on underside of femora I, posterior part of femur, line on outer side of tibia I, a spot on base of mid tibia, short line on the outer side of tibia III, light yellow to ivory colour; dorsal sides of tergites usually with bluish tints, velvety spot on tergite-2 small and black, all sternites with black fasciae.

Pubescence: Pubescence generally golden to transparent and never obscuring the integument, mandibles and labrum with few moderately long and sparsely distributed golden pubescence; vertex with few minute transparent hairs; eyes with few minute hairs; hairs on postgena minutely plumose, sparse and transparent; pronotal hairs sparse and similar to that of post gena; pronotum consists of minute hairs; lateral areas of scutellum, metanotum, propodeum and posterior part of propodeum with hoary white, plumose pilosity; episternum with sparse, minute, transparent, hoary white hairs, dorsal surface of scutum, scutellum and basal area of propodeum without pubescence. Pubescence on legs, dull white with golden tints and plumose, which are sparse on coxa and trochanter and more or less well developed on femur and tibia, especially on hind femur. Terga with scattered, minute golden and simple hairs becoming more on distal terga and on lateral margins. Sterna with long simple golden hairs on apical margins.

Head: Width in anterior view a little more than 1.76x distance between front ocellus and lower margin of clypeus (67.38) (Fig. 98); maximum width of head at the level of posterior margin of eyes 5.1x distance between front ocellus

and occipital margin (51:10) (Fig. 98); relative measurements of POL : OOL = 7 : 9.5; mandibles glabrous and sparsely punctate; labrum with weakly impressed punctation and lateral mark not seen, circular, as in figure (Fig: 98); clypeal mark triangular and superficially punctate, anterior portion truncate and bases elongated. Supraclypeal area, supra antennal area, vertex, gena and postgena distinctly and deeply punctate; antennal fossae weakly impressed, frontal line slightly raised and visible only in between antennal fossae; scape not reaching front ocellus, striated and sparsely and minutely punctate; relative length : breadth of antennal segments = scape = 26 : 5, pedicel = 6 : 4, F1 = 4.5:4, F2 = 2.5:5, F3 = 3:5.5, F4 = 3:6, F5 = 5:6, F6 = 6:6.5, F7 = 7:7, F8 = 6:7, F9 = 6:7, F10 = 6.5:7, F11 = 7:6 (Fig. 99). Eyes simple and smooth, relative length : breadth of eyes on lateral view = 27.5 : 15.5; ocelli forming triangle in vertex; vertex separated from occiput by a raised edge.

Thorax: Maximum width between tegulae to length of thorax = 37 : 51 (Fig. 97); pronotum separated from scutum by a strong carina, its marginal area consists of minute hairs; pronotal tubercles well developed and distinct; pronotum distinctly punctate; scutum and scutellum distinctly punctate, distal end of axilla pointed; metanotum coarsely punctate, propodeum striated (usually longitudinally); propodeum with a declivity, down sloping on its middle, episternum distinctly and closely punctate.

Legs more or less thin and strong; legs sparsely punctate except fore coxae, mid coxae, mid trochanter, hind trochanter, hind coxae and basal half of hind femur closely and strongly punctate; base of hind femur triangular shaped (Fig. 97). Scopal hairs are absent; hind tibial and mid tibial spurs pointed and pectinate; arolia distinct.

Tegulae smooth and polished, wing venation as in figure (Fig. 97); distal end of marginal cell bend away from wing margin; minute hairs distributed

through wing membrane, three submarginal cells, relative measurements of fore wing length: its maximum width - 93 : 35; jugal and vanal lobes of hindwing present; hamuli 5; wing membrane covered with minute hairs (Fig. 97).

Metasoma: Metasomal tergites distinctly and strongly punctate; basal area of tergite slightly depressed in their middle; transverse impunctate lines on tergites 2 and 3 indistinct and shorter than the space between them. Seventh tergite roundly truncate posteriorly; sternites sparsely punctate and fasciae glabrous and minutely striated.

Female: Female differs from male in having the following important characters: (1) Body bright metallic green with slightly golden green; (2) Sixth metasomal tergite were bluish; (3) Clypeal mark as *Pithitis smaragdula*.

Flower Record: Unknown.

Distribution: INDIA (Kerala, Punjab, Karnataka, Maharashtra).

Biology: The Bees nest in hollow reeds and thatch and excavate tunnels on dried pittu braches of trees. The bee takes from 4 to 5 weeks from egg to imago (egg 3-4, larva 10-13, pupa 11-18 days). At night these bees hide themselves on such hollows as they choose for their nests, the mother bee always confining herself to her own nest. Early in the morning, 5 or 6 of these bees may be found huddled together in the central hollow of a single dried shoot of a bamboo. As a parasite, Dutt noticed a small black chalcid which he bred from the cells (Van der Vecht, 1952).

Habitat: From disturbed habitats.

Material examined: Plesiotype: M: INDIA, Kerala, Bangalore, Jobiraj T., 19-vi-2000.

Discussion: This species closely resembles *Pithitis unimaculata* (Smith) in general appearance, but differs from it on the following characters: 1. Body bright metallic green, partly slightly golden green (In *P. unimaculata* body duller, bluish, greenish blue or bronzy); 2. Hind trochanters and femora bare (In *P. unimaculata* hind trochanters and femora pubescent); 3. The seventh tergite relatively longer, the sides converging towards the narrow apex which is roundly truncate (In *P. unimaculata* the seventh tergite blunt).

Remarks: The female specimen is not represented in this collection and the characters is based on the description of Van der Vecht (1952).

3. *Ceratina (Ceratinidia) curiosa* sp. nov.

(Figs. 100-102)

Holotype: F: HW = 2, HL = 1.6, SL = 0.44, FL = 1.37, POL = 0.29, OOL = 0.38, FWL = 4.71, FWW = 1.71, EL = 1.43, EW = 0.71, HWL = 3.19.

Colour. Integument: Body usually black except, mouth parts dull brown with yellowish tints, labrum, clypeus, supra clypeal marking, paraocular markings and supra antennal spots and genal marking yellow; scape of antenna dark brown, and rest of the segments brown; pronotal line and pronotal tubercles yellow; two paired streak (smaller in size) on scutellum, scutellar marking yellow; forelegs almost completely yellow; mid and hind coxa, trochanter and femora dark brown, other segments yellow; tegulae dark brown, wing membrane hyaline with light brownish tints, veins and stigma brown, except marginal cell veins dark brown. First metasomal segment with uninterrupted yellow marking, T₂, T₃ & T₄ with interrupted yellow markings, T₅ uninterrupted, T₆ with marking represented by a weak streak of brownish yellow.

Pubescence: Pubescence more or less reduced and sparsely distributed; mandible with few suberect, hyaline to white, simple pilosity; pilosity on face

simple and sparse; postgena with sparse hairs, hyaline with light yellow tints, minutely plumose; vertex and pronotum with minute light brown pilosity, which are simple; scutellum with few sparse, large, hyaline, simple to finely plumose hairs; episternal hairs more developed than scutum, moderately long and hyaline; propodeum with few long plumose white pilosity; legs also with minutely plumose and hyaline pubescence; metasomal tergites with sparse and minute hairs arranged in the form of line in certain tergum, becomes longer on their outer surfaces; sternum more plumose than tergum (long and thickly developed metasomal pilosity usually simple).

Head: Width in anterior view a little more than 1.46 x distance between front ocellus and lower margin of clypeus (54:37) (Fig. 101); maximum width of head at the level of posterior margin of eyes 6.57 x distance between front ocellus and occipital margin (46:7) (Fig. 101); relative measurements of POL : OOL = 6:3. Mandibles sparsely punctate; labrum with few punctations, not closely punctate, with three brownish spots (Fig. 101) anterior and lateral parts of clypeus, paraocular areas, largely and more or less closely punctate; supra clypeal spots sparsely punctate, supra antennal areas and vertex closely and strongly punctate; antennal toruli slightly depressed, frontal line slightly raised; anterior genal punctations as on vertex, but not closely arranged, rest of genal area and postgena glabrous and minutely and sparsely punctate; scape and pedicel more or less punctate, flagellum more or less covered with minute pilosity, relative length : breadth of antennal segments = scape = 12:2.5, pedicel = 3.5:2.5, $F_1 = 2:2.5$, $F_2 = 2.5:2$, $F_3 = 4:2.5$, $F_4 = 3.5:4$, $F_5 = 4:4$, $F_6 = 3:4$, $f_7 = 3.5:4$, $F_8 = 4:4$, $F_9 = 4:3.5$, $F_{10} = 5:2.5$ (Fig. 102). Eyes simple, smooth and glabrous; relative length : breadth of eyes on lateral view 10:5.

Thorax: Maximum width between tegulae to length of thorax = 33:46; pronotum separated from scutum by a deep carina, pronotal tubercles bulged,

pronotum weakly punctate; scutum more or less strongly and closely punctate except the medial area; medial and parapsidal lines distinct; mesoscutal markings small and weakly developed; scutellum and metanotum punctate as on scutum, but more fine, scutellar marking with an impression in middle; propodeum minutely punctate and glabrous.

Legs moderately long and weak, glabrous and smooth, hind femur triangularly bulged, hind tibial spur long and minutely pectinate, hairs on legs short and weakly developed, scopa absent, arolia distinct, mid tibial spur small and pointed (Fig. 100).

Anterior areas of tegulae minutely punctate, other areas glabrous and smooth; wing venation as in figure (Fig. 100); middle posterior part of wing membrane almost covered with minute hairs. Relative measurements of forewing length : its maximum width = 99:36; jugal and vanal lobe distinct; hamuli 6.

Metasoma: Metasomal tergites more or less closely punctate; puncture width becomes more on posterior areas; marking on T₁ becomes faint, but not interrupted, marking on T₂ - T₄ also punctate; yellow marking on T₅ faint, but broad; sternal plates strongly and closely punctate (Fig. 100).

Male: Unknown.

Material examined: *Holotype*: 1F; INDIA, Kerala, Calicut University Campus, Jobiraj, T., 27-viii-1998; *Paratypes*: 1F, INDIA, Kerala, Calicut University Campus, Jobiraj, T., 3-vii-1998; 2F; INDIA, Kerala, Calicut University Campus, Jobiraj, T., 30-vi-1998.

Etymology: The species name is taken from latin meaning strange.

Flower record: Unknown.

Distribution: INDIA (Kerala).

Biology: Unknown

Habitat: Disturbed and semidisturbed habitats.

Discussion: This species resembles *Ceratina compacta* Smith in general appearance, but differs from it in the following main characters: 1. Paraocular areas largely and more or less closely punctate (In *C. compacta* paraocular areas irregularly and sparsely punctate); 2. Supra antennal spots small and vibrio shaped (In *C. compacta* supra antennal spots moderate and not vibrio shaped); 3. Labrum with three brown spots (In *C. compacta* labrum with a yellow spot); 4. Yellow band on first tergite uninterrupted (In *C. compacta* yellow band on first tergite enclosing two black spots episternum punctate as on scutum, but very closely and deeply punctate).

4. *Ceratina (Ceratiniidia) heiroglyphica* Smith

(Figs. 103-105)

Ceratina heiroglyphica Smith 1854, *Cat. Hym. Bri. Mus.* II: 226. no. 13, Type: M,F, Northern India, Hongkong and Philippine Islands.

Ceratina morawitzzi Stadelm, *Zool. Jahrb., Syst.* viii (1894) p.233.

Plesiotype: F (Worker): TL = 9, HW = 2.22, HL = 1.9, SL = 0.7, FL = 1.43, FWL = 5.05, FWW = 2, HWL = 3.57, EL = 1.5, EW = 0.79, POL = 0.29, OOL = 0.48.

Colour: Integument: Body usually black except, mouth parts brown, clypeus with '⊥' yellow marking, supra clypeal spots, paraocular and paired supra antennal spots yellow; flagellum dark brown; ocelli reflects golden yellow; eyes light yellow and glabrous; gena with yellow band; pronotal band, pronotal tubercles, two paired patches on mesoscutum, a broad squarish mark on scutellum yellow; fore tibia yellow on outer sides, other tarsal segments and tibiae brown to brownish black; all metasomal segments with fasciae, except last, which

is yellow; tegulae dark brown to black, wings hyaline and veins dull brown; mandibles red brown at their apices.

Pubescence: Pubescence more or less reduced and sparsely distributed; sparse hairs on labrum and mandibles hyaline, simple with golden tints in certain lights; few minute hairs on clypeus, simple and golden; pilosity on vertex larger than clypeus and more simple, light golden, posterior areas of gena with sparse and (distantly distributed hairs), hyaline with very light yellow tints in certain heights; pilosity on pronotum moderately developed, plumose and light golden; very much reduced, minute and hyaline; axillae with few large and distinct silvery plumose hairs; metanotum with few, sparse silvery and plumose pubescence; wing membrane with minute brown hairs; preepisternal hairs more less thickly developed, long, minutely plumose and silvery white; mesepisternum and metepisternum with minute sparse hairs (hyaline); fore leg and midleg with golden pubescence; pubescence on hind leg, larger and thicker than other legs, which are plumose; hairs on tergites sparse, minute and golden; hairs on sternites, longer than tergites, silvery white to light yellow tints in certain lights.

Head: Width in anterior view 1.403x distance between front ocellus and lower margin of eyes (62:44.5) (Fig. 104); maximum width of head at the level of posterior margin of eyes 6.12x distance between front ocellus and occipital margin (52:8.5) (Fig. 104); relative measurements of POL : OOL = (6:10); mandibles sparsely punctate with well developed punctations, between areas, minutely punctate, labrum square shaped, closely and deeply punctate, deeply separated from clypeus; clypeus having few scattered punctures, clypeal mark as in figure (Fig. 104); frons sparsely punctate; antennal toruli slightly depressed; frontal line passes in between antennal toruli, both sides closely and thickly punctate; scape and pedicel sparsely punctate with deep punctations; supra antennal area above the markings and vertex closely and deeply punctate; the triangular area just

below, middle ocellus minutely punctate; gena glabrous with few sparse punctations; scape of antenna reaching front ocellus; flagellum covered with minute hairs; relative length : breadth of antennal segments = scape = 20:4, pedicel = 4:3, F1 = 3:3, F2 = 2:3, F3 = 2:3, F4 = 4:4, F5 = 3.5:4, F6 = 3.5:4, F7 = 4:5, F8 = 4:5, F9 = 4.5:5, F10 = 4.5:5 (Fig. 105). Eyes simple and smooth, relative length : breadth of eyes on lateral view = 10.5 : 5.5.

Thorax: Maximum width between tegulae to length of thorax = 38:58 (Fig. 103); pronotum separated from scutum by a strong carina; pronotum minutely punctate; anterior, posterior and lateral parts of scutum thickly, closely and deeply punctate; medial area glabrous and minutely punctate; medial and parapsidal lines distinct, thoracic and scutellar marking as in figure (Fig. 103); axilla and anterior, posterior areas of scutellum closely punctate, medial area glabrous; metanotum minutely punctate; anterior part of propodeum longitudinally striated, followed by reticulations and more or less closely punctate; episterum, mainly pre and meso closely and deeply punctate, metepisterum minutely punctate.

Legs moderately long and developed; legs sparsely punctate with moderate punctations; forefemur more or less triangularly bulged, hindtibial spurs developed and pectinate; pubescent tufts seen on hind femur and hind tibia; arolia distinct (Fig. 103).

Tegulae glabrous and its basal area punctate and other surfaces impunctate; wing venation as in figure (Fig. 103); wings hyaline, more or less fuscous; marginal cell bend away from wing margin; three submarginal cells, first recurrent vein meeting posterior and second recurrent vein meeting middle of second and third submarginal cells respectively, second submarginal cell smaller than first and third. Relative measurements of fore wing length : Its

maximum width = 106 :42; jugal and vanal lobes of hind wing present; minute hairs distributed over wing membrane; hamuli 5.

Metasoma: Metasomal tergite minutely punctate, the coloured band, fasciae broadened in middle, shape as in figure (Fig. 103) and graduli transversely striated to reticulate and minutely punctate; T2 closely punctate, fasciae laterally attenuated in each side and graduli weakly reticulate and sparsely punctate; T3 - more or less closely punctate and in between areas glabrous; coloured fasciae interrupted in middle and widest laterally; graduli more or less closely punctate; T4, T5 & T6 punctate throughout, punctations sparsely arranged than other segments, fasciae on T4 broadest in middle with a notch in the middle, while in T5 broad and truncate in middle; T6 without any marking; sternal plates more or less closely punctate.

Male: Male differ from females in having the following important characteristic features: 1. The yellow markings broader than the females; 2. Scape of the antennae in front and the anterior femora yellow.

Materials examined: Plesiotype : F: INDIA, Kerala, Kalpetta, Jobiraj, 10-xi-2000; *Other materials examined:* 1F: INDIA, Kerala, Calicut University Campus, Jobiraj, 27-viii-1998; 1F: INDIA, Kerala, Calicut University Campus, Jobiraj, 30-vi-1998; 1F: INDIA, Karnataka, Bangalore, Jobiraj, 14-vi-2000; 1F: INDIA, Karnataka, Bangalore, Srinivasareddy, 2-ix-1996; 1F : INDIA, Karnataka, Bangalore, Srinivasareddy, 1-ix-1996; 1F : INDIA, Kerala, Peechi, Mohandas, 3-vi-2000; 1F : INDIA, Kerala, Calicut University Campus, Sakeer, 18-iv-2000; 1F : INDIA, Kerala, Calicut University Campus, Jobiraj, 27-viii-1998; 1F : INDIA, Kerala, Calicut University Campus, Jobiraj, 6-vii-1998; 3 F: INDIA, Kerala, Trissur, Jobiraj, 28-i-2000; 1F : INDIA, Kerala, Calicut University Campus, Jobiraj, 4-vi-1998; 1F: INDIA, Kerala, Calicut University Campus, Jobiraj, 27-viii-1998; 1F: INDIA, Kerala, Karumala, Jobiraj, 15-vi-1998.

Flower Record: Unknown.

Distribution: INDIA (Kerala, Karnataka, Tamil Nadu, Maharashtra).

Biology: Unknown.

Habitat: Both from Disturbed and disturbed areas.

Discussion: This species resembles to *Ceratina bryanti* Cockerell in general appearance, but differs from it in the following characters: 1. Vertex and mesoscutum densely punctate (In *C. bryanti* vertex and mesoscutum not densely punctate, sparsely punctate); 2. The clypeus has no distinct longitudinal impression, it is rather coarsely, but not closely, punctate, except along the median line which is impunctate (In *C. bryanti* clypeus with a wide median impression, the concave part transversely rugose; lateral margins of median part of clypeus densely punctate).

Remarks: *Ceratina heiroglyphica* Smith is the abundant species of the genus *Ceratina* in Kerala. The male specimens are not represented in the above collection and the characters were taken from Bingham (1897).

5. *Ceratina (Pithitis) indica* (Hirashima) comb. nov.

Pithis indica Hirashima, 1969. *Pacific insects*, 11 (3-4): 649-669.

Holotype: M, Anaimalai Hills, S. India, v.1969. TL = 7-9.

Colour: Integument: Very close to *waini* but colour of integument slightly more bright and shining.

Hypostomal carinae weaker and not distinctly elevated like *waini*.

Female: Closely resembles to males, but distinguishes it from following character: 1. Hypostomal carinae weak; 2. 4th and 6th terga with excavated velvety areas.

Distribution: India (Kerala, Tamil Nadu).

Discussion: Male of *C. indica* is easily separable from *C. waini* by the absence of the velvety black areas on the metasomal segments.

Remarks: This species is not represented in the present collection and the above description is taken from Hirashima (1969). This species is originally described under the genus *Pithitis* Klug which was later synonymized with *Ceratina* Latreille by Michener (2000). Hence the species is transferred to *Ceratina* in the present work (as comb. nov.).

6. *Ceratina (Pithitis) smaragdula* Fabricius

(Figs. 106-108)

Apis smaragdula Fabricius, 1787, *J.C., Mant. Insect.* 91, 305.

Megilla smaragdula Fabricius, 1804, *J.C., Syst. Piez.* (30): 334.

Pithitis smaragdula Klug, 1807, *Magaz. f. Insektenk.* 225. 6: 198.

Ceratina maculata Smith 1854, *Cat. Hym. Br. Mus.* 11: 226, no.14. Type: Male, Java.

Ceratina smaragdula Gerstaecker 1869, *Stett. Ent. Ztz.* xxx: 177, nota, no.2.

Ceratina sexmaculata Smith 1879, *Descr. New Sp. Hym. Br. Mus.*: 92, no.3, Type: Male and Female, Hongkong and Celebes.

Ceratina maculata Saussure 1904, *H. de, Mission Pavie, III, Hymenopteres*: 191, Type: Female and male, Indo-China.

Ceratina sexmaculata, var. *Wallacei* Cockerell 1905, *Trans. Am. Ent. Soc.* XXI: 324, Type from Celebes.

Ceratina sexmaculata, var. *aurata* Friese. 1909b, *Ann. Mus. Nat. Hung.* VII: 208, no:43, Type: Female and male, Kalidupa, Buton Isl.

Ceratina sexmaculata Cockerell, 1911; *Trans. Am. Ent. Soc.* XXXVII: 239.

Ceratina sexmaculata, var. *purpurascens* Cockerell, 1911; *Ann. Mag. Nat. Hist.* (8), VIII: 185. Type from Formosa.

Ceratina smaragdula Alfken. 1926; *Entom. Mitt.* XV: 318.

Ceratina sexmaculata Hedicke 1927. *Deutsch. Ent. Zeitschr.* 1926: 420. Type from Mindoro.

Plesiotype: F, TL = 6.6, HW = 2.3, HL = 1.9, SL = 0.62, FL = 1.15, POL = 0.38, OOL = 0.44, EL = 1.4, EW = 0.68, FWL = 4.6, FWW = 1.6, HWL = 3.05.

Colour. Integument: Body emerald green, rather shiny except, mouthparts yellow to dark brown, labrum and mandibles black, spot on clypeus yellow, outer border of clypeal mark black; antennae dark brown to black; eyes yellow with outer border of lack; ocelli fulvous; pronotal tubercles light yellow, tegulae and axillary sclerites dark brown to black; wings subhyaline, veins dark brown and middle of stigma with yellowish band; median line and two pairs of parapsidal lines black, on the mesoscutum; legs usually dark brown, coxae of fore and hind legs green with yellow line on their anterior part, midcoxae black with yellow line anteriorly; fore femur and tibia with yellow marking or bands, base of fore, mid and hind tibia with a yellow spot; last tarsal segments usually ferruginous or brownish red or reddish brown; base of all tergites black; black paired velvety spots present on terga 3 and 4; wing hyaline, tegulae and axillary sclerites with yellow spots; all sternites consists of black fascia, last sternum more or less black at their apices.

Pubescence: Pubescence usually reduced or scarcely distributed; labrum and mandibles covered with few golden pubescence; hairs on supra antennal area, around antennal toruli and vertex with few sparse, minute golden pilosity; pronotum and scutum separated by a narrow band of minute light yellow pilosity, which extends to pronotal tubercles; posterior part of scutellum and near axilla with light yellow plumose hairs, larger than hairs on pronotum; hairs on episternum sparse and transparent to light yellow; pubescence on legs long, plumose and transparent to light yellow, well developed on hind tibia. Hairs on

terga minute and each one arising from the punctation, transparent to light yellow; sternal hairs transparent and silky and longer than tergal pilosity.

Head: Width in anterior view a little more than $1.49 \times$ distance between front ocellus and lower margin of clypeus; maximum width of head at the level of posterior margin of eyes $6 \times$ distance between front ocellus and occipital margin (36:6) (Fig. 107); relative measurements of PQL : OOL = 3:8.5; mandibles glabrous with few well developed punctations; mouth parts well developed, labial palpi 6, first one longer and stronger than others; labrum large, longer than wide. Median portion of clypeus flattened, spot on clypeus truncate above and impunctate, around the clypeal mark punctate, simple and (mostly single line); in between areas glabrous; paraocular area, frons, face and vertex distinctly and strongly punctate, puncti become smaller on anterior regions (as vertex and other areas), gena and postgena distinctly punctate; frontal line passes in between external toruli and extends upwards and touches the middle ocelli; antennal fossae slightly depressed (Vertex and temples separated from occiput by a carina), antennae small, scape not reaching front ocellus; flagellum thicker than scape, relative length : breadth of antennal segments = scape = 41:8, pedicel = 10:9, $F_1 = 5:8$, $F_2 = 5:8$, $F_3 = 4:8$, $F_4 = 4:8$, $F_5 = 7:9$, $F_6 = 7:10.5$, $F_7 = 8:11$, $F_8 = 7:10$, $F_9 = 9:10$, $F_{10} = 11:9$ (Fig. 108). Eyes simple and smooth, relative length : breadth of eyes in lateral view = 28 : 13.5. Vertex and temples rounded posteriorly.

Thorax: Maximum width between tegulae to length of thorax = 24:33 (Fig. 106); pronotum separated from scutum by the strong carina; pronotal punctation smaller than face and scutum, but with distinctly punctate; mesoscutum, punctate deeply and distinctly with a median line and paired parapsidal lines; scutellum and axillae distinctly punctate; metanotum minutely punctate; propodeum truncate impunctate medially and longitudinally striated, sides minutely punctate; episternum distinctly and strongly punctate (Fig. 106).

Legs moderately long and well developed; coxae strongly punctate other segments of legs minutely punctate; foretibia with well developed spine (Fig. 106); foretibia depressed on their inner surface; mid and hind tibial spurs present; paired hind tibial spur pectinate and pointed, hind femur and tibia covered with long hairs; arolia present.

Tegulae smooth and polished, wing venation as in figure (Fig. 106); distal end of marginal cell bend away from wing margin and rounded; wing membrane hyaline and covered with minute hairs; stigma larger than prestigma; three submarginal cells of which first one larger than second and third, second smaller than first and third, first recurrent veins meets first and second submarginal cells posteriorly; basal vein more or less convex; relative measurements of forewing length : its maximum width = 92:32; hind wings hyaline and minute hairs distributed on wing membrane; vanal and jugal lobe of hind wing present, posterior parts of jugal and vanal lobes striated; hamuli - 6.

Metasoma: Metasomal tergites distinctly and strongly punctate; paired lateral black, velvety markings on tergites 1 & 2; (Fig. 106); last tergite pointed (Fig. 106); sternal plates also distinctly punctate, sternal fasciae (apical margin) glabrous with few punctations, other areas longitudinally striato-reticulate; last sternite with well developed median line; two short transverse, shining black lines on tergites 2 and 3 (Fig. 106).

Male: Male differ from female in the following important characters: 1. The apical margin of the 6th segment crenulate and subdentate in the middle; 2. T-7 with a longer acute tooth medially; 3. Tergites 4, 5 and 6 bear an almost square velvety black spot, on each side of the middle.

Material examined: Plesiotype: F, INDIA, Kerala, Trissur, Jobiraj, T., 28.i.2000; *Other materials examined:* 1F, INDIA, Kerala, Nilambur, T.C.

Narendran, 5.iii.2000; 2F, INDIA, Kerala, Trissur, Jobiraj, T., 28.1.2000; 2F, INDIA, Kerala, Calicut University Campus, Jobiraj, T., 30.vi.1998; 1F, INDIA, Kerala, Trissur, Jobiraj, T., 2.vi.2000; 1F, INDIA, Tamil Nadu, Palayamkottai, Thanasingh, 18-xii-2000; 1F, INDIA, Karnataka, Bangalore, Srinivasareddy, 9.ix.1996; 1F, INDIA, Karnataka, Bangalore, Srinivasareddy, 10.ix.1996; 1F, INDIA, Karnataka, Bangalore, Srinivasareddy, 2.viii.1996; 2M, INDIA, Kerala, Kudiyanmala, Jobiraj, T., 25.xii.1999; 2M, INDIA, Kerala, Muthanga, Jobiraj, T., , 6.v.2000; 2M, INDIA, Karnataka, Calicut University Campus, Jobiraj, T., 30-vi-1996.

Flower Record: *Antigonon*, *Cassia*, *Turnera*, *Melastona*, *Faradaya*, *Gardenia*, *Vinga lutea*, *Lantana camera*, *Wedelia biflora*.

Distribution: India (Kerala, Karnataka, Tamil Nadu, Andra Pradesh).

Biology: Unknown.

Habitat: From both undisturbed and disturbed habitats, including forested areas, agricultural fields, cultivated areas etc.

Discussion: This species closely resembles *Ceratina unimaculata* (Smith) in general appearance, but differs from it in the following characters: 1. Body emerald green, rather shiny (In *C. unimaculata* body duller, bluish, greenish blue or bronzy). 2. Spot on clypeus truncate above, somewhat abruptly widened below, its sides concave. (In *C. unimaculata* spot on clypeus more regularly triangular, rounded above, the sides not concave). 3. Pronotal tubercles white to pale yellow (In *C. unimaculata* pronotal tubercles often dark).

This species also resembles *Ceratina binghami* (Cockerell) in general appearance, but differs from it in the following characters: 1. Body emerald green, rather shiny (In *C. binghami* body bright mettalic green, partly slightly golden green); 2. Under side of hind trochanters and basal fourth of hind femora

with a comb of long, whitish, curved hairs (In *C. binghami* hind trochanters and femora bare); 3. Apex of seventh tergite broadly rounded (In *C. binghami* the seventh tergite relatively longer, the sides converging towards the narrow apex which is roundly truncate).

7. *Ceratina (Neoceratina) sasidharani* sp. nov.

(Figs: 109-111)

Holotype: M. TL = 5.4, HW = 1.33, HL = 1.23, SL = 0.35, FL = 1.71, POL = 0.29, OOL = 0.161, EL = 1, EW = 0.5, FWL = 3.71, FWW = 1.26, HWL = 3.

Colour. Integument: Usually dark brown except the following parts: labrum, clypeus and mandibles yellow; antennae brown with yellow marking on outer side of scape and light yellow streaks on outer side of flagellomeres; ocelli dark brown and glabrous; eyes dull brown to dark brown; pronotal collar and tubercles yellow; tegulae dark brown with a yellowish spot, axillary sclerites brown with yellowish tints; wing hyaline and iridescent, wing veins brown to light yellow, tarsal segments yellow, other parts of legs; tibia anteriorly yellow and posteriorly dark brown; dark brown to black; T1 - T2 with brownish tints, T2 and T3 with paired yellow spots on each side, spot on T3 largest.

Pubescence: Pubescence more or less reduced; hairs on labrum, clypeus and supra clypeal areas and supra antennal areas with moderately long, silvery white to hyaline, plumose, silky hairs; ocellar areas sparsely pubescent; posterior part of vertex, postgena with long silvery, plumose pilosity, genal hairs short and silvery white; hairs on pronotum long, plumose and hyaline to silvery white; scutum and scutellum very sparsely pubescent with very minute hairs; anterior and lateral areas of propodeum as on pronotum; preepisternum and mesepisternum sparsely pubescent, long, irregularly arranged, plumose and hyaline to silvery; metepisternum devoid of pubescence; legs moderately

pubescent with light yellow to hyaline and plumose pilosity; tergum sparsely pubescent with minute light yellow pilosity, posterior and lateral hairs long; sternal hairs larger than the tergal hairs.

Head: Width in anterior view a little more than $1.33 \times$ distance between front ocellus and lower margin of clypeus (68 : 51) (Fig. 110); maximum width of head at the level of posterior margin of eyes $3.33 \times$ distance between front ocellus and occipital margin (40 : 12) (Fig. 110); relative measurements of POL : OOL = 9:5; Mandible, labrum and clypeus smooth, polished and glabrous; supra clypeal area irregularly and sparsely punctate; frontal line visible, posteriorly touches mid ocellus; supra antennal area, vertex impunctate and striato-reticulate, ocelli arranged in a curve on vertex; gena and postgena minutely punctate; scape of antennae very short compared with flagellum, which is long and stout; relative length : breadth of antennal segments = scape = 18:7, pedicel = 4:7 $F_1 = 5:7$, $F_2 = 7:7$, $F_3 = 10:7$, $F_4 = 7:7$, $F_5 = 7:7$, $F_6 = 10:7$, $F_7 = 7:6.5$, $F_8 = 8:6.5$, $F_9 = 7:6.5$, $F_{10} = 6:6.5$, $F_{11} = 9:6$ (Fig. 111). Eyes simple, slightly curved in the middle portion; relative length : breadth of eyes in lateral view = 7:3.5.

Thorax: Maximum width between tegulae to length of mesosoma = 30:56 (Fig. 109); pronotum yellow and separated from scutum by a carina; scutum minutely, more or less strongly reticulate with irregularly arranged sparse punctations; medial and parapsidal lines distinct, scutellum and metanotum as on scutum, but punctations reduced; propodeum impunctate and strongly and largely reticulate than scutum; episternum also minutely punctate with sparse minute punctations.

Legs moderately long and weakly developed (Fig. 112); legs usually devoid of punctations; hair tufts formed on femora; hind tibia usually with minute hairs and few large hairs on their outer and posterior surfaces, hind tibial spurs long and minutely serrate; arolia distinct and developed.

Tegulae minutely and sparsely punctate, axillary sclerites longer than tegulae, wings hyaline and iridescent, posteriorly few minute hairs distributed on the wing membrane (Fig. 109); three submarginal cells, first one largest, first recurrent vein meets on 1r-m and second recurrent vein meets on posterior part of third submarginal cell; first medial cell large and square shaped, jugal and vanal lobes present; hamuli - 6 (Fig. 109).

Metasoma: All tergites minutely striato - reticulate, sparsely and minutely punctate; T2 - T3 with paired spots, spot on T3 larger than T2; metasoma longer than broad. Sternum striato-reticulate, reticulations more developed than tergum.

Female: Unknown.

Materials examined: Holotype: M, INDIA, Tamil Nadu, Sasidharan K.R. 25-xii-1998.

Etymology: This species is named after its collector.

Flower Record: Unknown.

Distribution: INDIA (Kerala)

Biology: Unknown

Habitat: Disturbed areas.

Discussion: This species keys to couplet no.4 and no.5 of the key to species by VAN DER VECHT (1952). It resembles *Ceratina dentipes* Friese in general appearance, but differs from it mainly in the following characters: 1. Clypeus smooth and glabrous (In *C. dentipes* clypeus with few punctures at sides and anterior margin); 2. Punctations less dense and sparse on mesoscutum and scutellum (In *C. dentipes* punctations on anterior part of mesoscutum and on scutellum fine and dense).

It also resembles *Ceratina propinqua* Cameron in the yellow markings on the body, but differs from it mainly in the following characters: 1. Body usually black in colour (In *C. propinqua* body usually metallic blue in colour); 2. Antennal fossae not deep (In *C. propinqua* antennal fossae deep); 3. Mesosoma and metasoma sparsely punctate (In *C. propinqua* mesosoma and metasoma more or less finely and rather densely punctate); 4. Vertex and frons including paraocular areas impunctate and striato-reticulate (In *C. propinqua* vertex and frons including paraocular areas densely and coarsely punctate).

8. *Ceratina (Pithitis) unimaculata javanica* Van der Vecht

(Figs: 113-116)

Ceratina unimaculata javanica Vander Vecht, 1952 [Type F, Mt. Tjampea near Bogor, 5 May 1935] Zoologische verhandelingen [A preliminary revision of the oriental species of the genus *Ceratina* (Hymenoptera: Apidae) 1-85 pp.

Plesiotype: M: TL = 7.6, HW = 2.44, HL = 2.05, SL = 0.55, FL = 1.63, POL = 0.375, OOL = 0.4, EL = 1.4, EW = 0.73, FWL = 4.9, FWW = 1.75, HWL = 3.55.

Colour. Integument: Body entirely bluish green, rather shiny except mouth parts dark brown, mandibles dark brown to black, labrum dark brown with yellowish mark (Fig. 115); spot on clypeus yellow, which is triangular and truncate to rounded above its sides more or less concave, tip of mandibles ferruginous; antennae dark brown; ocelli reflects yellow; eyes dull brown; pronotal tubercles yellow, tegulae and axillary sclerites dull brown with yellow spots, wings hyaline, veins light brown to yellowish brown; stigma honey coloured; parapsidal and median lines black; legs usually brown, all tarsal segments yellowish brown; fore femur and fore tibia with light yellow or ivory-coloured bands or marking; midtibia and femur dark brown, midtibia with light yellow spot on anterior side; outer side of anterior half of tibia ivory coloured, hind tibial spurs ivory coloured; metasoma green with bluish tints; two black

velvety paired spots seen on tergites, second and third; apical margin of sternites black and forming fasciae like structure.

Pubescence: Pubescence usually reduced or sparsely distributed; few bristles on apical part of mandible, which are golden; hairs on labrum minute and transparent to golden; hairs on vertex and in between antennal toruli sparse and transparent; hairs on post gena plumose white with light yellow tints; pronotum with minute silky, white hairs; pilosity on sides of metanotum and propodeum moderately long, plumose and ivory coloured; wing membrane with minute light brown hairs; episternal hairs sparse, light yellow to transparent and minute; legs covered with moderately long white to hyaline pubescence, well developed on hind tibia. Anterior part of T₁ with few sparse, transparent pilosity, it becomes more to posterior part of T₃; other segments, ivory coloured, hairs on outer surface of tergites longer and plumose; hairs on sternites sparse and transparent.

Head: Width in anterior view a little more than 1.51x distance between front ocellus and lower margin of clypeus (75.5 : 50) (Fig. 115); maximum width of head at the level of posterior margin of eyes 4.7x distance between front ocellus and occipital margin (47 : 10); relative measurements of POL : OOL = 7.5 : 8; mandibles glabrous, and depressed in the middle, sparsely punctate, tip is not divided into denticles; labrum square shaped, sparsely and minutely punctate with a semicircular marking (Fig. 115); clypeus flattened and impunctate, yellow coloured marking rounded to truncate, sides concave and widened below; supraclypeal area and paraocular area, deeply, closely and distinctly punctate; frontal line slightly raised and passes in between antennal toruli, not touches middle ocelli; supra antennal area, vertex and gena distinctly and closely punctate; scape not reaching front ocellus, less than half of flagellum, sparsely punctate; flagellum covered with minute hairs; relative length : breadth of antennal segments = scape = 17:4, pedicel = 4:3, F₁ = 2:3, F₂ = 2:3, F₃ = 2:3.5, F₄ =

2:4, F5 = 4.5:5, F6 = 5:6, F7 = 5:6, F8 = 5:6, F9 = 5:6, F10 = 5:5.5, F11 = 7:5 (Fig. 116).

Eyes simple and smooth, relative length : breadth of eyes in lateral view = 29 : 14.5. Vertex and temples separated from occiput a carina.

Thorax: Maximum width between tegulae to length of thorax = 35:58; pronotum separated from scutum by a strong carina; pronotal punctations finer than head; mesoscutum and scutellum strongly and distinctly punctate; axilla punctate and produced in the form of spines (Fig: 113); metanotum coarsely punctate; propodeum longitudinally striated, truncate, a steep separated from very short dorsum by a raised edge, pronotal tubercle punctate; episternum closely and strongly punctate; mesepisternum strongly punctate than preepisternum and metepisternum.

Legs long, thin and developed, all coxae moderately punctate; other segments minutely punctate; apical part of femur modified into a spine (Fig. 114); arolia visible on all legs, fore tibial spurs not well developed; mid tibial spurs developed and pectinate; anterior part of hind femur, somewhat bulged to form a triangular shape (Fig. 114); pubescent tufts seen on hind femur and hind tibia; hind tibial spurs pointed and pectinate.

Tegulae smooth and sparsely punctate, punctations weakly impressed; wing venation as in figure (Fig. 113); wings hyaline and iridescent; marginal cell bend away from wing margin. Three submarginal cells, 1st larger than 2nd and 3rd; first recurrent vein and second recurrent veins joins second and third submarginal cells after their mid line, basal vein convex. Relative measurements of forewing length: its maximum width = 78 : 37.5; jugal and vanal lobes of hindwing present; minute hairs present all over wing membrane; hamuli 5 in number.

Metasoma: Metasomal tergites strongly and distinctly punctate; two short transverse shining black lines present on tergites 2 and 3; T₇ blunt (Fig. 113); sternal plates distinctly punctate; sternal fasciae glabrous with punctations.

Female: Female differ from male in the following important characters: (1) Labrum entirely black; (2) characteristic comb of hairs at the base of hind legs absent; (3) clypeal mark not dilated anteriorly.

Materials examined: *Plesiotype:* M: INDIA, Karnataka, Bangalore, Srinivasareddy, 10-ix-1996; *Other materials examined:* M; INDIA, Karnataka, Bangalore, S. Reddy, 10.ix.1996.

Flower record: *Antigonon, Melastoma malabathricum, Acacia villosa, Rose.*

Distribution: INDIA (Karnataka).

Biology: Unknown.

Habitat: Disturbed areas.

Discussion: This subspecies closely resembles *Ceratina unimaculata palmerii* (Cameron) but differs from it on the following characters: 1. Body entirely greenish blue (In *C. u. palmerri* body dark and dull greenish, with bronzy and purplish reflections); 2. Pronotal tubercles white or yellowish white (In *C. u. palmerri* pronotal tubercles dark); 3. Legs with yellow markings (In *C. u. palmerri* yellow markings on legs often reduced or absent).

Remarks: The male specimen is not represented in the present collection and the characters given above are based on the description of Van der Vecht (1952). This is the first report of this subspecies from Kerala as well as from India. Van der Vecht (1952) originally described it from Java.

9. *Ceratina (Pithitis) unimaculata palmerii* Cameron

(Figs: 117-120)

C. palmerii, Kuching, Borneo (new status), 1908. Cameron, P. *Deutsch. Et. Zeitschr.* 1908: 5661, F.

C. penangensis (M. penang Isl., F. Singapore, new syn). 1919a. Cockerell, T.D.A., *Ann. Mag. Nat. hist.* (9) III: 244, .

Plesiotype: M. TL = 8.42, HW = 2.43, HL = 2.1, SL = 0.53, FL = 1.53, POL = 3.42, OOL = 0.42, FWL = 4.78, FWW = 1.68, HWL = 4, EW = 0.9. EL = 1.63.

Colour. Integument. Mandibles dark brownish red. Body usually dark and dull greenish, with bronzy and purplish reflections; except labrum brownish black with yellow semicircular mark; clypeal spot yellow; scape of antenna, pedicel and F₁ - F₃ brown, rest of the antennal segments yellowish brown; eyes ferruginous brown to dark brown; pronotum dark green; pronotal tubercles yellow dorsally and brownish black on sides; tegulae dull brown with light yellow spots; mesoscutum reflects blue; wings subhyaline with light brown tints in certain lights; parapsidal and medial lines black; last part of metanotum dark green to black; wing veins light yellow to brownish yellow; legs ferruginous brown, white or yellow patches of legs absent; velvety paired spots seen on tergites second and third, sternites brown to ferruginous and fasciae glabrous.

Pubescence: Golden to transparent and never obscuring integument; pubescence usually reduced and sparsely distributed; labrum and mandible consists of few golden hairs, thin and simple; very minute and transparent hairs sparsely seen on face; hairs on gena minute, transparent and plumose; pilosity around tegulae and scutellum ivory to light yellow, transparent and branched; metanotum with sparse, minute transparent hairs; episternal hairs also minute, sparse and transparent; fore and hind legs sparsely pubescent, but hind legs moderately pubescent, pilosity on legs ivory coloured to transparent except the

hind tarsal segments, yellow coloured. Terga with scattered, simple hairs becoming progressively more numerous on distal and lateral margins, minute and transparent; sternal hairs longer than tergal hairs, which are sterna with scattered, simple and transparent becoming longer on apical margins of individual sterma.

Head: Width in anterior view a little more than $1.62 \times$ distance between front ocellus and lower margin clypeus (73:45) (Fig. 119); maximum width of head at the level of posterior margin of eyes $5.17 \times$ distance between front ocellus and occipital margin (44:8.5); relative measurements of POL : OOL = 6.58; mandibles sparsely punctate and pointed at its tip; labrum square shaped and coarsely punctate; clypeal mark triangular, rounded above, sides concave, punctations only superficial; supraclypeal area, paraocular area, supra antennal area, gena distinctly and deeply punctate; frontal line slightly raised, antennal fossae not deeply impressed as *P.u. javanica*; scape not reaching front ocellus; scape smaller than half of the flagellum; relative length; breadth of antennal segments = scape = 23:5, pedicel = 7 : 6; $F_1 = 3:4$, $F_2 = 3:4.5$, $F_3 = 3.5:5$, $F_4 = 4:5$, $F_5 = 6:7$; $F_6 = 7:8$; $F_7 = 7:8$, $F_8 = 7:6$, $F_9 = 7:5$, $F_{10} = 8 : 8.5$; $F_{11} = 9:8.5$ (Fig. 120). Eyes simple and smooth, relative length : breadth of eyes in lateral view 31:17; vertex and temples separated from occiput by a carina.

Thorax: Maximum width between tegulae to length of thorax = 35:58; pronotum separated from scutum by a strong carina; pronotal punctations finer and coarse than head and mesosoma; mesocutum and scutellum distinctly punctate; parapsidal line well developed not straight. Axilla produced in the form of a spine; metanotum coarsely and finely punctate; propodeum longitudinally striate; the steep very short, episternum strongly and closely punctate.

Legs strong, moderately long and minutely punctate; anterior portion of all femur produced in the form of triangle; arolia visible, well developed mid and hind tibial spurs pointed and pectinate; hairs well developed on hind femur and tibia which are plumose (Fig. 117).

Tegulae smooth, polished and punctation very weakly impressed. Wing venation as in figure, (Fig. 117) wings subhyaline, and minute hairs distributed throughout wing membrane; marginal cell bend away from wing margin and rounded at apex, longer than broad and thin; three submarginal cells, first one longer and recurrent veins joins second and third submarginal cells. Relative measurements of forewing length: its maximum width = 91:32; jugal and vanal lobes of hindwing present; hamuli 5 (Fig. 117).

Metasoma: Longer than broad, slender than *javanica*; all metasomal tergites strongly and distinctly punctate; two short transverse black lines present on tergites 2 and 3; first metasomal tergite rounded to blunt (Fig. 117); sternum distinctly punctate, fasciae very sparsely punctate, and minutely striato-reticulate.

Female: Female differ from male in the following important characters:
1. Pronotal tubercle dark; 2. Labrum entirely black; 3. Characteristic comb of hairs at the base of hind legs absent; 4. Clypeal mark not dilated anteriorly.

Materials examined: *Plesiotype*: M, INDIA, Kerala, Kollam, P.M. Sureshan, Xii-1999.

Flower Record: Unknown.

Distribution: INDIA (Kerala).

Biology: Unknown.

Habitat: Disturbed.

Discussion: This subspecies closely resembles *C. unimaculata javanica* (Van der Vecht), but differs from it in the following characters: 1. Flagellum of antennae brown to yellowish brown (In *C. u. javanica* antennae dark brown to black); 2. Pronotum dark green, (In *C. u. javanica* pronotum black); 3. Wings subhyaline (In *C. u. javanica* Wings hyaline); 4. Yellow markings on legs reduced or absent (In *C. u. javanica* legs with distinct yellow markings); and 5. Metasoma slender and long (In *C. u. javanica* metasoma not slender).

Remarks: The female specimen is not represented in the present collection and the above description is based on the description of Van der Vecht (1952). This is the first report of this sub species from Kerala as well as from India. Cameron (1908) originally described it from Borneo.

10. *Ceratina (Pithitis) waini* (Shiokawa and Sakagami) comb. nov.

Pithitis waini Shiokawa and Sakagami, 1969, *Nature and life in South east Asia* 6: 146.

Holotype: M, Sinhagad, W. Ghats (India), 24-iv-1924, F.L. Wain. TL = 7.5 - 9 mm; FWL = 5.5 - 6.5 mm.

Colour. Integument: Body dull metallic blue; clypeal mark yellowish, approximately oval in female, invert 'T' - shaped with truncate apex in male; male labrum media basally yellow with medio basal dark spot; pronotal tubercle black; forefemur and tibia with pale yellowish streaks; whitish yellow basal mark on hind femur reduced or absent. Male with a pair of black depressed area on metasomal terga 4-6.

Head: Clypeal mark truncate above, shows irregular contour at the lower lateral sides, as if indicating a trace of a lateral projection.

Mesosoma: Mesosoma punctate; femoral projection weakly developed.

Metasoma: Metasomal tergum - 7 relatively strongly projecting and narrowly truncate at apex. Apical lobe of metasomal sternum-6 angulate.

Female: Closely resembles to males, but distinguishes it from following characters: 1. Metasomal terga 4-6 with black depressed areas; 2. Clypeal mark truncate above; 3. Femoral projection weakly developed; 4. Femoral hair tuft undifferentiated, with hairs longest at basal one fourth of femur, gradually becoming shorter both basally and apically, poorly developed on trochanter; 5. Metasomal tergum-7 relatively strongly projecting and narrowly truncate at apex.

Distribution: India (Maharashtra, Tamil Nadu, Kerala).

Flower Record: *Pogostemon*, *Randia*, *Coffea*.

Discussion: This species resembles *Ceratina (Pithitis) unimaculata nanensis* (Cockerell) in general appearance, but differ from it in the following character: Black depressed areas on metasomal terga (in *C. (Pithitis) (u.) nanensis* black depressed areas on metasomal terga absent).

Remarks: This species is not represented in the present collection and the above description is taken from that of Shiokawa and Sakagami (1969). This species is originally described under the genus *Pithitis* Klug which was later synonymized with *Ceratina* Latreille by Michener (2000). Hence the species is transferred to *Ceratina* in the present work (as comb. nov.).

11. *Ceratina (Pithitis) vechti* (Baker) comb. nov.

Pithitis binghami Cockerell: Shiokawa and Sakagami, 1969; mis-identification. *Nature and life in Southeast Asia* 6: 148.

Pithitis comberi Cockerell: Hirashima, 1969; mis identification, *Pacific insects* 11(3-4): 659.

Pithitis vechti Baker, 1997; *Reichenbachia Mus. Tierkd. Dresden* 32, WR.14: 88-89.

Holotype: M, W. India, W. Ghats, Lonaula, 7-iv-1997. Length = 6-7 mm.

Colour: Integument: Only slightly darker than on *Ceratina smaragdula* Fabricius and slightly variable, usually dark green with brassy reflections, but sometimes green with blue reflection; ivory markings on clypeus, tubercles and legs very much like *Ceratina smaragdula* Fabricius.

Punctures on median portions of genal areas, median portion of mesoscutum and mesopleura slightly weaker, and hypostomal carinae stronger, more distinctly elevated.

Female: Female resembles the male, but differs from it in the following major characters: 1. Hypostomal carinae strong, distinctly elevated; 2. Punctures on median portions of genal areas distinctly smaller than those on upper or lower portions.

Distribution: INDIA (W. Ghats, Maharashtra, Kerala, Tamil Nadu).

Flower Record: *Eriolaena*, *Leucas*, *Vitex*

Discussion: This species resembles to *Ceratina (Pithitis) smaragdula* Fabricius in general appearance, but differs from it in the following characters: 1. Duller green with coppery reflection (In *C. smaragdula* often bright green); 2. Hypostomal carina strong, distinctly elevated (In *C. smaragdula* hypostomal carinae moderate); 3. Punctures on median portion of genal areas distinctly smaller than those on upper and lower portions (In *C. smaragdula* punctures very strong, those on median portion of genal areas quite distinct, although slightly smaller than those on upper and lower portions).

Remarks: The specimen is not represented in the present collection and the above description is based on the descriptions of Hirashima (1964), Shiokawa and Sakagami (1969) and Baker (1997).

Tribe 3. Allodapini

Diagnostic features

The pubescence is short and inconspicuous. Two submarginal cells (rarely one) present, the second usually much over half as long as the first. The clypeus is rather flat, bend back as a large tooth on each side of the labrum. Upper half of clypeus is not greatly narrower than lower half. Clypeus extends upto the middle of the face. The subantennal sutures much longer than the diameter of antennal socket. The last three metasomal terga of the female somewhat flattened. Basitibial plates are absent or indicated by a carina. The marginal cell is pointed or narrowly rounded, the apex on or close to the wing margin.

Genus *BRAUNSAPIS* Michener

Allodape (*Braunsapis*) Michener, 1969. *Jour. Kan. Ent. Soc.* 42: 290. Type species: *Allodape facialis* Gerstaecker, 1857, by original designation.

Diagnostic characters

Braunsapis is the largest and most widespread genus of Allodapini. They are small (body length ranges from 3 to 9 mm) slender and black bees. Most species of *Braunsapis* are black with ivory or yellow marks on the face and often on the pronotal lobe and tarsi. The hind femur of the male is rather slender, not angulate at its extreme base, but sometimes with a more distal angle.

Distribution: INDIA (Kerala, Karnataka, Tamil Nadu), Africa North to Senegal, Ethiopia, Madagascar to Pakistan, Sri Lanka to China, Taiwan, Philippines, Solomon Islands, Australia.

Biology: Several species of *Braunsapis* are known or probable social parasites of other species of *Braunsapis*.

Discussion: At present, there are 13 genera recognized in the tribe Allodapini (Reyes, 1991). The genus *Braunsapis* is believed to be closely related to *Effractapis*, *Allodape* and *Nasutapis*. Smith described the first Oriental species as *Prosopis mixtus* in 1852, and early author assigned Oriental species either to the genus *Allodape* or *Prosopis*. *Prosopis* is a wholly unrelated collected bee that superficially resembles *Braunsapis*. In 1966 Michener placed Asian species in the genus *Allodapula* for a time; Michener (1969, 1975a) recognized *Allodapula* as a strictly African group and allodapine bees found in Oriental region are on the genus *Braunsapis*.

Remarks: Stephen G. Reyes (1999) reported 19 species from Oriental region. The present work reports 11 species of which three new species from Kerala. Key to Oriental species of males and females are presented along with description of these new species and redescription of known species.

**KEY TO THE ORIENTAL SPECIES OF *BRAUNSAPIA*,
BASED ON FEMALES**
(Modified from Reyes, 1991)

1. T6 scoop shaped; mouth parts reduced (Fig. 123, 124); Scopa reduced (Fig. 126) 2
- T6 rounded; mouth parts normal (Fig. 121, 122); scopa developed (Fig. 125) 3
2. Mandible black; clypeal mark black below, narrowed towards apex (Fig. 131); pronotal collar with yellow mark; tarsi yellow (India) *B. kaliago* Reyes & Sakagami
- Mandible fusco-ferrugineous; clypeal mark entirely yellow, reduced near apex (Fig. 130); tarsi dark (Indonesia, Malaysia) *B. breviceps* (Cockerell)
3. Head as long as broad 4
- Head broader than long 7
4. Mandible and labrum yellow; clypeus partly black below; clypeal mark narrowed towards apex (Fig. 132); scape of antenna not reaching front ocellus; legs orange (Vietnam) *B. aurantipes* Reyes
- Mandible and labrum black; clypeus largely black below; clypeal marking 'T' shaped (Fig. 133); scape of antennae reaching front ocellus; legs yellowish brown to black 5
5. Tegulae transparent; scopa with a patch of dark hairs distally on outer surface of tibia; head width 1.61 mm; head width : head length = 1.01 mm (India) *B. indica* Reyes

- Tegulae transluscently fuscous; scopa with a patch of dark hairs distally, transparent to silvery white; head width = 1.29 mm; head width : head length = 1.06 mm (India) *B. intermedia* sp. nov.
7. Paraocular mark present 8
- Para ocular mark absent or a scarcely noticeable fleck 12
8. Clypeus partly black below; clypeal mark narrowed towards apex (Fig. 135, 136) 9
- Clypeus entirely yellow (Fig. 161) 10
9. Clypeus partly black on upper half; clypeal mark slender, on lower half 'T' shaped (Fig. 135); head width 1.70 - 1.87 mm; scape of antenna reaching front ocellus (Malaysia, Indonesia) *B. lateralis* Reyes
- Clypeus mostly yellow on upper half; clypeal mark broader on lower half; head width 1.47 - 1.87 mm; scape of antenna barely reaching front ocellus (Malaysia, Indonesia) *B. apicalis* Reyes
10. Scape black underneath, if yellow, very much reduced; head width 1.63 - 1.70 mm; longer hairs on T4-6 light brown to fuscous (Malaysia, Indonesia, Philippines, India) *B. palavanica* (Cockerell)
- Scape yellow underneath; head width 1.20 - 1.68; longer hairs on T4-6 transparent to light brown 11
11. Scape of antenna not reaching front ocellus; less orange; Head width: Head length = 1.08 : 1.12; longer hair on T4-6, slanting, simple to blunt (Thailand, Malaysia, Singapore, Indonesia, Phillipines, India) *B. clarihirtha* Reyes
- Scape of antenna reaching front ocellus; legs yellowish brown to brown; Head width : head length = 1.12 : 1.16; longer hairs on T4-6 slanting, finely spiculate (India) *B. micheneri* sp. nov.

12. Metasomal terga mostly yellow (Sri Lanka, thailand, Burma, Malaysia)
 *B. flaviventris* Reyes
- Metasomal terga black or nearly so 13
13. Clypeus entirely yellow; labrum yellow to fusco-ferrugineous 14
- Clypeus partly black below; clypeal mark narrowed towards apex; labrum
 fusco-ferrugineous to black 16
14. Tibia and tarsus orange; scape of antennae barely reaching front ocellus;
 (India) *B. malliki* Reyes
- Tibia and tarsus yellowish or reddish brown to black; scape of antennae
 not reaching front ocellus 15
15. Longer hairs on T4-6 slanting simple (Fig. 138); head width : length = 1.05 :
 1.09 (Vietnam, Burma, Thailand, Malaysia, Indonesia, Philippines, India)
 *B. cupulifera* (Vachal)
- Longer hairs on T4-6 blunt to spiculate as in figure (Fig. 144); head width :
 length ratio 1.09 : 1.16 (Taiwan, Thailand, Malaysia, Indonesia, Philippines,
 India) *B. hewitki* (Cameron)
16. Mandible yellow or with large yellow mark 17
- Mandible fusco-ferrugineous to black, sometimes with small yellow spots
 20
17. Hairs on T4-6 transparent to light yellow, longer hairs slanting and
 spiculate (Fig. 134, 141); shorter hairs subprostrate and spiculate 18
- Hairs on T4-6 light brown to fuscous, longer hairs slanting and simple;
 shorter hairs subprostrate and simple 19

18. Scape yellow underneath; mesepisternum with shallow, oblong punctures containing finer punctures; head width : head length = 116 : 1.19; (Malaysia, Indonesia, Philippines) *B. reducta* (Cockerell)
- Scape with a yellow spot at apex; mesepisternum striato-reticulate with fine, sparse punctures; head width : head length = 1.093 : 1.12 (India) ...
..... *B. engeli* sp. nov.
19. Head width 1.47 - 1.70 mm; outer surface of scopa with patch of golden hairs (Philippines) *B. reversa* (Cockerell)
- Head width 1.69 - 1.91 mm; outer surface of scopa with patch of dark brown hairs (Philippines) *B. signata* Reyes
20. Head width 1.83 - 2.00 mm; hairs on T4-6 light brown to fuscous (Vietnam, Laos, Thailand, Malaysia, Singapore, Indonesia, Philippines, India)
..... *B. philippinensis* (Ashmead)
- Head width 1.73 mm or less; hairs on T4-6 transparent to partly fuscous ...
..... 21
21. Head width 1.20 - 1.57 mm 22
- Head width 1.60 - 1.73 mm (Pakistan, India, Sri Lanka, Laccadive Arch) ..
..... *B. picitarsis* (Cameron)
22. Clypeus largely black below; clypeal mark strongly narrowed to a point (Fig. 173); head width : length = 1.06 : 1.11 (India, Nepal, Vietnam, Laos, Thailand, Malaysia, Hongkong, Indonesia) *B. puangensis* (Cockerell)
- Clypeus partly black below; clypeal mark narrowed towards apex (Fig. 156); head width : length ratio 1.14 : 1.18 (Pakistan, India, Sri Lanka)
..... *B. mixta* (Smith)

KEY TO THE ORIENTAL SPECIES OF *BRAUNSAPIS*, BASED ON MALES

(Males are unknown for *B. malliki*, *B. indica*, *B. micheneri* sp. nov. *B. intermedia* sp. nov. and *B. engeli* sp. nov)

1. Head broad, 1.24 - 1.29 times broader than long; mouth parts reduced (as in Fig. 123, 124) *B. kaliago* Reyes & Sakagami
- Head less broad, 1.23 times or less broader than long; mouth parts normal (as in Figs. 121, 122) 2
2. Hind femur swollen basally, emarginate medially (Figs. 174)
..... *B. puangensis* (Cockerell)
- Hind femur at most slightly swollen basally, not emarginate medially (Fig. 137) 3
3. Mandible completely yellow *B. cupulifera* (Vachal)
- Mandible black 4
4. Paraocular mark altogether absent *B. hewitti* (Cameron)
- Paraocular mark present, sometime very much reduced 5
5. Body length 3.6 - 4.9 mm; head width 1.23 - 1.47 mm *B. mixta* (Smith)
- Body length 5.2 - 7.3 mm; head width 1.60 - 1.97 mm 6
6. Longer hairs on T4-6 transparent to light brown *B. picitarsis* (Cameron)
- Longer hairs on T4-6 fuscous 7
7. Shorter hairs on T4-6 subprostrate, weakly spiculate; hind trochanter notched or bulged *B. philippinensis* (Ashmead)
- Shorter hairs on T4-6 prostrate, simple; hind trochanter simple
..... *B. palavanica* (Cockerell)

1. *Braunsapis cupulifera* (Vachal)

(Figs. 137-139)

Allodape cupulifera Vachal, 1894. *Ann. Mus. civ. Sto. Nat. Genova* (2) 14: 447: Type: male, Carincheba, 900-1100 m Birminia (= Burma) Genona.

Allodape cupulifera bakeri Cockerell, 1916: *Phil. Jour. Sci.* 11: 302. Type: male, Los Banos, Laguna Luzon, Philippines (NMNH) synonymized by Reyes (1991).

Allodape hewetti var *sandacanensis* Cockerell, 1920a *Phil. Jour. Sci.* 17: 226. Type female, Sandakan, Borneo, Malasia (NMNH) Synonimized by Reyes (1991).

Plesiotype: Worker (F). TL = 5.86, FWL = 3.53, FWW = 1.42, HWL = 2.57, HW = 1.4, HL = 1.23, SL = 0.043, FL = 1.107, EL = 1.07, EW = 0.50, OMD = 0.054, POL = 0.21, OOL = 0.19.

Colour: Integument: Black except, mandibles at their apices, labrum, mouth parts brownish yellow, clypeal mark yellow, eyes honey coloured to dark brown; base of scape and ocelli dull brown; tegula transparent, axillary sclerites yellow, pronotal collar with yellow marking; all tarsi yellowish brown; metasomal fasciae dull brown, sting brown.

Pubescence: Facial hairs sparse and transparent; Mesosoma covered with transparent hairs; legs covered by transparent to light brown hairs; metasomal pubescence sparse, hairs on T4-6 transparent to light brown; longer hairs slanting, simple, shorter hairs prostrate simple; sternites with sparse hairs; metanotum and scutellum with plumose, erect, long hairs.

Head: Width in anterior view a little more than 1.353 x distance between front ocellus and lower margin of clypeus (78.5:58) (Fig. 138); maximum width of head at level of posterior margin of eyes 9 x distance between front ocellus and occipital margin (Fig. 138). Relative measurements of POL :OOL = 11:10.5; mandible simple; maxillary palpi 5 segmented; labrum punctate; middle of epistomal suture slightly raised; clypeus entirely yellow, sometimes narrow

towards the base (Fig. 138); clypeal marking with spot like markings, lower area with scattered puncti; scape not reaching front ocellus; malar area small and distinct, genal area striato-reticulate; relative length : breadth of antennal segments scape = 12.3, Pedicel 2:2.5, $F_1 = 3.3$, $F_2 = 3.3$, $F_4 = 2:3.5$, $F_5 = 3:4$, $F_6 = 2.5:4$, $F_7 = 3:3.5$, $F_8 = 3.5:3.5$, $F_9 = 2.5:3$, $F_{10} = 9:3$. Scape with anterior concavity or depressed zone; flagellum covered with minute hairs; eyes simple and smooth, relative length and width of eyes in lateral view = 39.5 : 19; frontal line extends in between antennal toruli.

Thorax: The maximum width between tegulae to length of thorax 17:19; scutum reticulate with sparse punctations; parapsidal lines distinct, scutellum with fine hairs, propodeum hairless and reticulate, pronotal lobe with yellow marking, episternal area sparsely punctate.

Legs well developed; scopal hairs well developed on hind femur; arolia visible, outer side of midtibia reticulate; femoral hairs finely branched, basitibial plate indicated by indistinct carina (Fig. 137).

Tegulae transparent with yellowish tints and punctate; wings hyaline veins light brown; relative measurements of forewing length: its maximum width = 133:53; wing venation as in figure (Fig. 137); two submarginal cells, first recurrent vein meets anterior part of second submarginal cell and second recurrent vein meets posterior apical margin of second submarginal cell; stigma large, wings hairy, minute hairs distributed through out the wing; jugal and vanal lobes present (Fig. 137); hamuli four; 1 r-m of hind wing somewhat produced (Fig. 137).

Metasoma: Metasomal terga glabrous, minutely punctate; T1-T6 fascia well developed; sternites covered with sparse hairs; punctation rather reduced, but finely reticulate; T1 depressed in the middle, T6 - scoop-shaped (Fig. 137).

Male: Male differs from female in having: 1. Length 3.8 - 4.6 mm 2. Labrum and mandible yellow 3. Paraocular mark yellow. 4. Hind trochanter excised medially and lobed distally.

Material examined: Plesiotype: F, INDIA, Kerala, Calicut University Campus, Jobiraj, T. 28-vi-1998; **Other materials examined:** 3F, INDIA, Kerala, Chelavoor, Jobiraj, 15-xi-1999; 1F, INDIA, Kerala, Calicut University Campus, Jobiraj, 27-v-1999; 2F, INDIA, Tamil Nadu, Coimbatore, Sasidharan, 4-x-1997; 2F, INDIA, Kerala, Calicut University Campus, Sakeer, 10-x-1999; 1F, INDIA, Kerala, Calicut University Campus, Jobiraj, T. 4-vi-1996; 1F, INDIA, Kerala, Kodencherry, Jobiraj, 4-xii-2000; 1F, INDIA, Kerala, Kollam, P.M. Sureshan, 10-xi-1999; 1 F, INDIA, Kerala, Kalpetta, 1-xii-2000, Jobiraj, T. xii-2000.

Flower Record: UNKNOWN

Habitat: Disturbed and undisturbed areas including mountains and forests.

Distribution: India (Kerala, Tamil Nadu). Thailand, Vietnam, Burma, Malaysia, Singapore, Indonesia.

Discussion: The females of this species closely resembles to *B. hewitti* (Cameron) in general appearance, but differs from it on the following characters: 1. HW:HL = 1.05 : 1.09 (In *B. hewitti* HW:HL = 1.09 : 1.16); 2. Longer hairs on T4-6 light brown, slanting and simple (In *B. hewitti* longer hairs on T4-6 transparent to light brown, slanting to suberect, blunt to spiculate).

Those females with the clypeal mark reduced on the lower half of clypeus are quite similar to *B. reversa* (Cockerell), but differs from it in having: 1. Relatively smaller head width 1.15 - 1.47 mm (In *B. reversa* the head width

ranges 1.47 - 1.7 mm); 2. Longer hairs on T4-6 light brown (In *B. reversa* longer hairs on T4-6 fuscous).

The males are quite similar to those of *B. reducta*, *B. reversa* and *B. signata* but are smaller.

Remarks: The male specimens are not represented in the above collection and characters and illustrations were taken from Reyes, 1991.

2. *Braunsapis engeli* sp. nov.

(Fig. 140-142)

Holotype: 1 Female (W) : TL = 5.18, FWL = 3.52, FWW = 1.42, HWL = 2.67, HW = 1.41, HL = 1.29, SL = 0.33, FL = 0.98, EL = 0.97, EW = 0.48.

Colour. Integument: Usually black except, maxilla and labrum fuscous-ferruginous to brown; mandible with a distinct yellow spot; clypeal mark yellow, narrowed towards apex, 'T' shaped; paraocular mark absent; flagellum, brownish tints at apices, scape with a distinct yellow spot at apex; ocelli reflects dull brown. Eyes yellow with brownish yellow tints in certain lights. Tegulae transparent to light yellow, axillary sclerites yellow. Pronotal lobe yellow; legs black except distitarsi, brownish yellow; stigma brown with yellow colour in middle, veins light brown, membrane hyaline; metasomal fasciae light brown to steel grey.

Pubescence: Pubescence generally transparent, never obscuring integument; labrum and mandible with long light brown pilosity; transparent, minute pilosity on subantennal and clypeal area; scape of antennae with long suberect, transparent pilosity, flagellum with appressed minute hairs. Pronotal hairs, long, plumose, silvery with brownish tints, minute silvery hairs on scutum and scutellum; metanotal hairs plumose, silvery with brownish tints; moderately long appressed silvery to light yellow hairs on episternum; pubescence on legs

transparent to light yellow, scopal hairs plumose with golden tints; T1-3 with simple, scattered, minute transparent to light brown; hairs on T4-6 transparent to light yellowish brown; longer hairs slanting, weakly spiculate; shorter hairs blunt and spiculate.

Head: Width in anterior view a little more than $1.314 \times$ distance between front ocellus and lower margin of clypeus (71:54) (Fig. 141); maximum width of head at level of posterior margin of eyes $6.4 \times$ distance between front ocellus and occipital margin (16:2.5); relative measurements of POL : OOL = 3:2; clypeal mark as in figure (Fig. 141); mouth parts well developed; maxillary palpi 5-segmented; mandible depressed at base with yellowish projection apically; malar area distinct; labrum deeply punctate, interspaces smooth; middle of epistomal suture slightly raised; paraocular area, supraclypeal area, sparsely punctate, in between areas reticulate; clypeal mark glabrous, impunctate; antennal toruli slightly depressed; frontal line raised, frontal area reticulate; vertex striate-reticulate; scape of antenna not reaching front ocellus; gena longitudinally striate with weak punctations at their extreme ends; relative length : breadth of antennal segments, scape = 17:3, pedicel = 5:3, $F_1 = 3:3$, $F_2 = 3:3$, $F_3 = 3:4$; $F_4 = 4:4.5$, $F_5 = 3.5:4.5$, $F_6 = 4.5:5$, $F_7 = 5:5$, $F_8 = 5.5:5.5$; $F_9 = 6:5$, $F_{10} = 8:4.5$ (Fig. 142). Eyes simple, smooth, glabrous; relative length:width of eyes in lateral view = 32:16.

Thorax: Maximum width between tegulae to length of thorax 31:41; scutum striato-reticulate, weakly and sparsely punctate, in between areas glabrous; parapsidal lines distinct, medial line weak; axilla, scutellum, metanotum, minutely reticulate and punctate; propodeum glabrous, strongly reticulate and impunctate; episternum reticulate to striato-reticulate, sparsely and minutely punctate.

Legs well developed; fore tibial spurs flattened, mid and hind tibial spurs pectinate, arolia distinct, scopa on hind tibia well developed (Fig. 140).

Tegulae transparent and glabrous; relative measurements of forewing length: its maximum width = 116:47; wing venation as in figure (Fig. 140); two submarginal cells, 1-r-m and 2 r-m received by second submarginal cell; stigma large; first submarginal cell longer than second submarginal cell; jugal and vanal lobes of hindwing present (Fig. 140), hamuli - 5; Cu and M very much reduced (Fig. 140).

Metasoma: Terga glabrous, striato-reticulate, weakly punctate; metasomal fascia striate to striato-reticulate; sternum glabrous, reticulate, punctations indistinct (Fig. 140).

Male: Unknown.

Materials examined: Holotype : F: INDIA, Kerala, Calicut University Campus, Jobiraj. T, 20-i-99; **Paratypes:** F: INDIA, Karnataka, Bangalore, Geethabai, 2-v-1996; F: INDIA, Kerala, Calicut University Campus, Jobiraj. T, 8-vi-1998

Etymology: This species is named for Dr. Michael S. Engel of University of Kansas, U.S.A. for his contribution to the knowledge of taxonomy bees.

Flower Record: *Tectona grandis*

Habitat: Undisturbed area

Distribution: INDIA (Kerala)

Biology : Unknown

Discussion: This species resembles *B. signata* Reyes in general appearance, but differs from it in the following characters: 1. Body length 5.18 mm (In *B. signata* body length ranges from 6.0 - 7.0 mm); 2. HW = 1.41 mm (In *B. signata* HW = 1.69 - 1.91 mm); 3. HW:HL = 1.06 (In *B. signata* HW:HL = 1.14 : 1.18 mm); 4.

Scape of antennae not reaching front ocellus (In *B. signata* scape of antennae reaching front ocellus); 5. Outer surface of scopa without dark patch of hairs on distal half of hind tibia (In *B. signata* outer surface of scopa with a dark patch of hairs in distal half).

This species also resembles to *B. reversa* (Cockerell) in general appearance, but differs from it in following characters: 1. Length of body = 5.18 mm (In *B. reversa* length of body = 5.2 - 6.4 mm); 2. HW = 1.41 mm (In *B. reversa* HW = 1.47 - 1.73 mm); 3. HW:HL = 1.06 mm (In *B. reversa* HW:HL = 1.14 : 1.18); 4. Scape of antennae not reaching front ocellus (In *B. reversa* scape of antennae reaching front ocellus); 5. Scopa with dark golden brown patch on distal half of outer surface (In *B. reversa* scopa with golden yellow patch, without dark brown patch on distal half of outer surface).

3. *Braunsapis hewitti* (Cameron)

(Figs. 143-145)

Prosopis hewitti Cameron, 1908: *Deu. Ent. Zeit.* 565. Type: Female, Kuching, Sarawak, Borneo, Malaysia (BMNH); Meade-waldo and Morley, 1914. *Ann. Mag. Nat. Hist.*(8) 14: 403. (Placed under *Allodape*).

Allodape sauteriella Cockerell, 1916: *Phili. Jour. Sci.* 11: 303. Type: female, Formosa (= Taiwan) (NMNH); Cockerell, 1929: *Ann. Mag. Nat. Hist.* (10) 4: (distr. Thailand).

Plesiotype: M, TL = 5.63, HW = 1.61, HL = 1.41, HW/HL = 1.4, FWL = 3.72, FWW = 1.41, HWL = 2.8, SL = 0.45, FL = 1.31, POL = 0.23, OOL = 0.16, EL = 1.21, EW = 0.6.

Colour. Integument: Body usually black except, labrum yellow, mandibles black, mouth parts brown; clypeal mark, paraocular mark yellow, antenna with dark brown reflections, scape yellow underneath; ocelli with dark brown to black reflections. Tegulae transparent to fuscous, axillary sclerites yellow; pronotal

tubercle yellow; all tibiae and tarsal segments yellow to brownish yellow to brown; wing veins brown, membrane hyaline (transparent) and iridescent; stigma with yellow mark in the middle (reflections also); metasomal fasciae brownish grey to steel grey; eyes dark brown.

Pubescence: Pubescence generally transparent to light brown and never obscuring integument, few pilosity on labrum, silvery; pubescence on clypeus, labrum and paraocular areas reduced, very sparse and transparent; scape with few white hairs, flagellum with minute appressed pilosity. Pilosity on vertex fuscous and light brown to yellow; pronotum with silvery white pubescence, with sparse hairs; scutellum few hairs as on scutum; metanotum with long branched pilosity; propodeum glabrous, hairless, episternum with scattered, moderately long plumose pilosity; Hairs on legs transparent to light brown, with yellowish brown tints in certain lights and plumose. T1 with moderately long plumose hairs; T2-T3 with simple scattered light brown pubescence; T4-6 transparent to light brown; longer hairs suberect, simple to blunt, shorter hairs subprostrate, weakly spiculate; sternal hairs sparse, becomes longer and abundant at apical and posterior areas.

Head: Width in anterior view a little more than $1.44 \times$ distance between front ocellus and lower margin of clypeus (69:48) (Fig. 144); maximum width of head at level of posterior margin of eyes $3 \times$ distance between front ocellus and occipital margin (27:9). Relative measurements of POL : OOL = 2:1.1; mouth parts normal, maxillary palp six segmented; mandible glabrous, sparsely punctate; malar area reduced; labrum, clypeus sparsely punctate; frontal line slightly elevated; scape of antenna reaching front ocellus, area around toruli, reticulate to sparsely punctate, vertex with punctations well developed, gena glabrous and striato-reticulate, sparsely punctate; relative length : breadth of antennal segments, scape 26:5, pedicel = 4.5:7, $F_1 = 4:7$, $F_2 = 3:7$, $F_3 = 4:7$, $F_4 = 6:8$, $F_5 = 6:8$, F_5

= 6:8, $F_6 = 7.5:8$, $F_7 = 8:8$, $F_8 = 8:8$, $F_9 = 8.5:8.5$, $F_{10} = 9:8.5$, $F_{11} = 11:8$ (Fig. 145). Eyes simple and smooth, glabrous, relative length and width of eyes in lateral view = 36 : 18.

Thorax: Maximum width between tegulae to length of thorax 51:33; scutum striated with sparse punctations; parapsidal lines distinct; medial line very very faintly marked; integument glabrous; propodeum smooth, glabrous and striato-reticulate; episternum strongly striato-reticulate (Fig. 143).

Arolia present; fore tibial spurs flattened and pectinate; hind tibial spurs pointed and pectinate; scopal hairs poorly developed.

Tegulae transparent, relative measurements of forewing length: its maximum width = 113.5:43; wing venation as in figure (Fig. 143). Second submarginal cell receives both recurrent veins, stigma large and distinct, minute pilosity distributed throughout wing membrane, jugal and vanal lobes of hind wing present, hamuli 5; Cu and M very much reduced (Fig. 143).

Metasoma: Terga glabrous, striato-reticulate, sparsely punctate; fasciae developed on T1-T6; sterna also striato-reticulate (Fig. 143).

Female: Female differs from male in having: 1. Length 4.0 - 6.5 mm; 2. Labrum yellow to fusco-ferrugineous, mandible black, sometimes with yellow mark; 3. Clypeus entirely yellow, sometimes lower half partly black with clypeal mark narrowing towards apex; 4. Scape sometimes with yellow underneath; 5. HW = 1.27 - 1.73; HW : HL = 1.09 : 1.16; 6. Scape either reaching or not reaching front ocellus; 7. Hairs on T4-T6 transparent to light brown, longer hairs slanting to suberect, blunt to spiculate, shorter hairs subprostrate, simple to blunt.

Materials examined: Plesiotype: M: INDIA: Kerala, Calicut University Campus, Jobiraj, T. 11-xii-1999. *Other materials examined:* 2 M: INDIA, Kerala,

Calicut University Campus, Jobiraj T., 11-xii-1999; 2F: INDIA: Kerala, Chelakkadan, Mohandas, 3-ix-1995; 1M: INDIA: Kerala, Calicut University Campus, Girish. 25-vi-2000.

Flower record: *Tectona grandis*.

Distribution: INDIA (Kerala), China, Taiwan, Thailand, Laos, Vietnam, Hongkong, Malaysia, Indonesia, Philippines.

Biology: Studied under the name *B. sauteriella* from Taiwan by Meata *et al.* (1984, 1985), Sakagami (1960) and Shiokawa and Michener (1977).

Habitat: From Disturbed and undisturbed habitats.

Discussion: The females of this species closely resembles to the females of *B. cupulifera* (Vachal) in general appearance, but differs from it in having: 1. Head width : head length = 1.09 : 1.10 (In *B. cupulifera* head width : head length = 1.05 : 1.04); 2. Longer hairs on T4-6 transparent to light brown, slanting to suberect, blunt to spiculate. (In *B. cupulifera* longer hairs on T4-6 light brown, slanting, simple).

The males of *B. mixta* (Smith) are also not easily distinguished from this species except from the following character: 1. Longer hairs on T4-6 simple to blunt (In *B. mixta* longer hairs on T4-6 blunt to spiculate).

Remarks: This is first report of this species from Kerala as well as from India. CAMERON (1908) originally described it from Malaysia under the name *Prosopis hewitti*.

4. *Braunsapis intermedia* sp. nov

(Figs. 146-148)

Holotype: Female (W) TL = 4.96, PWL = 2.88, FWW = 1.16, HWL = 1.93, POL = 0.25, OOL = 0.21, HW = 1.29, HL = 1.20, SL = 0.33, FL = 0.99, EL = 0.97, EW = 0.403.

Colour. Integument: Black except, maxilla and labrum brown; clypeal mark yellow and reduced (narrowed towards apex 'T' shaped), labrum with brownish tints in certain lights, flagellum dark brown, ocelli reflecting light yellow, eyes yellow to brown. Tegulae transparent, axillary sclerites yellow, pronotal lobe yellow; all mediotarsi and distitarsi yellowish brown; wing veins brown, membrane transparent to hyaline; stigma brown with yellow streak in middle; metasomal fasciae light brown to steel grey; sting brownish yellow.

Pubescence: Pubescence generally transparent to light brown, never obscuring integument few long hairs on labrum and mandible transparent, reflecting light yellow in certain lights; clypeus, supraclypeal area with sparse silvery white pilosity; scape of the antenna with few long suberect hairs; flagellum covered with both appressed and suberect minute pilosity, vertex with few plumose hairs. Pronotum with moderately long plumose hairs, silvery with light yellow reflections; scutum, scutellum with sparse and minute pubescence; metanotum with few plumose pilosity; episternum with moderately long silvery hairs, hairs on coxa, trochanters, femur, tibia silvery; white scopal hairs on hind tibia very long, silvery and plumose; tarsal segments with light yellow pubescence. T1 with few moderately long plumose hairs at their base; T2 - T3 with simple scattered minute hairs, transparent to light brown. Hairs on T4-6 transparent to golden yellow (light brownish yellow) longer hairs slanting and weakly spiculate; shorter hairs prostrate, simple.

Head: Width in anterior view a little more than 1.20 x distance between front ocellus and lower margin of clypeus (71:59) (Fig. 147); maximum width of head of the level of posterior margin of eyes 4.7 x distance between front ocellus and occipital margin (23.5:5). Relative measurements of POL : OOL = 14:11.5; mouth parts normal; mandible carinate at their apices and punctate apically; malar area distinct, labrum with well developed deep punctations; clypeal area sparsely punctate; middle of epistomal suture slightly raised; paraocular area with few puncti. Paraocular markings absent; antennal toruli depressed; frontal line slightly raised, passing in between antennal toruli, vertex striato-reticulate with very sparse punctations; the scape of the antenna not reaching front ocellus; gena longitudinally striated and glabrous, reticulations very weak. Relative length : breadth of antennal segments, scape = 18:4, pedicel = 6:3, F₁ = 4:4, F₂ = 3:4, F₃ = 3:4.5, F₄ = 4:4.5, F₅ = 5:5, F₆ = 4:5.5, F₇ = 5.5:6, F₈ = 5:7, F₉ = 4:7, F₁₀ = 9:6. Eyes simple and smooth, relative length: width of eyes in lateral view = 30:12.5.

Thorax: Maximum width between tegulae to length of thorax 17 : 24.5; scutum striato-reticulate and sparsely minutely and weakly punctate integument glabrous; metanotum reticulate, devoid of punctations, propodeum glabrous and reticulate. Parapsidal and medial lines distinct, episternum striato-reticulate (Fig. 146), with very few sparse punctations, interstices glabrous.

Legs well developed, fore femur bulged medially (Fig. 146), depressed in middle; fore tibial spurs flattened, mid tibial spurs pointed, pectinate, arolia present; scopal hairs well developed on hind tibia. Hind basitarsus moderately pilose, basitibial plate and carina indistinct.

Tegulae transparent, relative measurements of forewing length: its maximum width = 91:36; wing venation as in figure (Fig. 146); stigma larger than prestigma, well developed; second submarginal cell small when compared to first submarginal cell; 1m-cu in continuous with 1 r-m; 2-m-cu receive posterior end of

second sub-marginal cell, jugal and vanal lobe of hindwing present; hamuli 5; minute hairs distributed throughout the wing membrane.

Metasoma: Metasoma longer than mesosoma; metasoma longer than broad, terga glabrous and striato-reticulate, metasoma sparsely and minutely punctate, metasomal fasciae distinct and transversely striated; posterior part of metasoma scoop shaped (Fig. 146), sterna, striato-reticulate.

Male: Unknown.

Materials examined: *Holotype:* F, INDIA, Kerala : Trissur (Kerala Forest Research Institute), Mohandas, 12-iv-2000. *Paratypes:* F, INDIA, Kerala, Trissur, Mohandas, 12-iv-2000; F, INDIA, Kerala, Calicut University Campus; Jobiraj, T. 25-x-1999.

Etymology: This species lies in between *B. indica* Reyes and *B. aurantipes* Reyes so it named as intermedia.

Flower Record : *Tectona grandis*

Distribution: INDIA (Kerala)

Biology: Unknown

Habitat: Undisturbed area

Discussion: This species closely resembles to *B. indica* Reyes in general appearance but differs mainly in the following characters: 1. Body length 4.9 mm (In *B. indica* body length 7.3 mm); 2. Tegulae transparent (In *B. indica* tegulae translucently fuscous); 3. HW = 1.29; HW : HL = 1.075 (In *B. indica* HW = 1.61; HW : HL = 1.01); 4. Scopal pilosity transparent to silvery white (In *B. indica* outer surface of scopa with a patch of golden hairs on distal half).

This species also resembles to *B. aurantipes* Reyes in general appearance, but differs mainly in the following characters: 1. Labrum and mandibles black (In *B. aurantipes* Reyes Labrum and mandibles yellow); 2. Paraocular mark absent (In *B. aurantipes* Reyes paraocular mark greatly reduced); 3. HW = 1.29 mm (In *B. aurantipes* HW = 1.23 mm); 4. Legs black to yellowish brown (In *B. aurantipes* Legs orange).

5. *Braunsapis malliki* Reyes

(Figs. 149-151)

Braunsapis malliki Reyes 1991. *Univ. Kan. Sci. Bull.* 54(6): 195; Type: female, Cashew Research Station, Ullal, Mangalore, India, B. Mallik (BMNH).

Plesiotype: Worker (F): TL = 5.72, FWL = 3.96, FWW = 1.55, HWL = 2.93, HW = 1.63, HL = 1.37, SL = 0.45, FL = 1.25, EL = 1.10, EW = 0.48, POL = 0.28, OOL = 0.25.

Colour. Integument: Black except, mandible fusco-ferrugineous to black; mouth parts brownish black, labrum brownish yellow, clypeal mark yellow, scape dark brown with yellowish tints at their apices and bases; ocelli reflecting yellowish to brown; tegulae transparent, axillary sclerites yellow, pronotal collar whitish yellow; All tibiae and tarsal segments yellowish brown with dark brown markings, and wing veins light brown, membrane hyaline, stigma dull brown; metasomal fasciae yellow; sting yellow to brown.

Pubescence: Pubescence generally transparent to light brown, never obscuring integument. Pubescence on labrum transparent to light brown; pubescence on clypeus, supraclypeal area, scape, transparent with golden reflections, flagellum with minute, white appressed pilosity; long light brown hairs on vertex, pronotum with long plumose hairs, scutellum and metanotum with moderate pilosity, which becomes long plumose and silvery white, episternal pilosity silvery; all coxae, trochanters and femur with silvery hairs,

while tibial and tarsal segments golden yellow; T1-T3 with transparent sparse plumose hairs; hairs on T4-T6 light brown, longer hairs slanting, spiculate, shorter hairs prostrate and spiculate; sternal hairs sparse and transparent.

Head: Width in anterior view a little more than $1.42 \times$ distance between front ocellus and lower margin of clypeus (80: 56.5) (Fig. 150), maximum width of head at the level of posterior margin of eyes $7.6 \times$ distance between front ocellus and occipital margin (46:6). Relative measurements of POL : OOL 13.5:12; mouth parts normal; mandible sparsely punctured; malar area distinct and punctate; middle of epistomal suture slightly raised; labrum, clypeus, paraocular area sparsely punctate; anterior area of clypeal mark smooth; antennal toruli depressed; paraocular mark absent; frontal line in between the antennal toruli; scape of antenna reaching front ocelli; punctations in vertex large sparsely distributed, in between areas striated; gena glabrous, minutely and sparsely punctate relative length and breadth of antennal segments = scape = 30:12, pedicel = 9:8, $F_1 = 7:8$, $F_2 = 5.5:8$, $F_3 = 7:10$, $F_4 = 8:10.5$, $F_5 = 8.5:11$, $F_6 = 9.5:11$, $F_7 = 9:11$, $F_8 = 10.5:10.5$, $F_9 = 13:10.5$, $F_{10} = 16:10$ (Fig. 151); eyes simple and smooth; relative length and width of eyes in lateral view 32:13.

Thorax: Maximum width between tegulae to length of thorax = 37:52; scutum, scutellum and metanotum striato-reticulate and sparsely punctate; parapsidal lines distinct; axilla distinct; integument glabrous; propodeum impunctate and hairless, but striato-reticulate, punctations uniformly distributed on episternum, in between areas striated.

Arolia distinct, fore tibial spur modified and pectinate; midtibial spur normal and pectinate; scopal hairs on hind tibia well developed; first tarsal segment of hind leg more or less developed, with long hairs. Tegulae transparent; relative measurements of forewing length: its maximum width = 115:44.5; wing venation as in figure (Fig. 149); Two submarginal cells; submarginal cell receives

first recurrent and second recurrent veins at their bases and apices respectively; stigma large and distinct; jugal and vanal lobes of hindwing present; jugal lobe larger than vanal lobe; hamuli 5 in number and serially arranged; minute hairs distributed throughout wing membrane (Fig. 149).

Metasoma: Terga glabrous, sparsely, punctured and horizontally striated; T1-T6 with fasciae, which also striated; sternal plates also sparsely punctured; T6 reduced when compared to other tarsal segments (small).

Male: Unknown.

Material examined: Plesiotype: F, INDIA, Kerala, Trissur, 12-iv-2000, Mohandas.

Flower Record: *Tectona grandis*

Distribution: India (Karnataka, Delhi).

Habitat: Disturbed and undisturbed habitats.

Discussion: This species is easily separated from other species occurring in India by the yellow clypeus and the orange tibiae and tarsi. It resembles to *B. hewitti* (Cameron) in having yellow clypeus, but differ from it in having: 1. Tibiae and tarsi brownish yellow to orange (In *B. hewitti* tibiae and tarsi black); 2. T4-T6 with light brown hairs (In *B. hewitti* T4-6 with transparent to light brown hairs); 3. Face is slightly convex and glossy (In *B. hewitti* face is not slightly convex and glossy).

Remarks: This is the first report of this species from Kerala. REYES (1991) originally described it from Mangalore.

6. *Braunsapis micheneri* sp. nov.

(Figs.: 152-154)

Holotype: Worker (F): TL = 5.75, FWL = 4.24, FWW = 1.41, HWL = 3.21, HWW = 0.92, SL = 0.375, FL = 1.5, HW = 1.68, HL = 1.47, POL = 0.35, OOL = 0.15, EL = 1.24, EW = 0.63.

Colour. Integument. Black except mandibles brownish yellow at apical margin, mouth parts brownish yellow, labrum, clypeal mark (entire clypeus), para ocular mark whitish yellow to yellow; scape yellow 'underneath', pedicel and flagellum dark brown to black; ocelli dull brown reflections in certain lights. Eyes yellow to brown. Tegulae transparent, axillary sclerites yellow, pronotal collar yellow, base of hind coxae with yellow band or mark, all tibiae brownish yellow and tarsi yellow, both with brown spots. Wing veins light brown, membrane hyaline, stigma yellow in the middle and outer border dark brown. Metasomal fasciae light brown to steel grey.

Pubescence: Pubescence generally transparent to light brown and never obscuring integument. Pubescence on labrum, clypeus, mandible and supra clypeal area sparse, small and transparent; flagellum with minute appressed pilosity, hairs near ocelli and vertex long, plumose, reflecting yellow; Scutum, scutellum and metanotum with moderate pilosity intermixed long, plumose hairs; pronotum and episternum covered with scattered, moderately long plumose pilosity reflecting light brown to transparent; hairs of legs generally transparent to light yellow. T₁ with long plumose hairs, T₂-T₃ with simple scattered light brown hairs, on T₄-T₆ transparent to light brown, slanting, simple to blunt; shorter hairs weakly spiculate, hairs become numerous on apical portion of T₄-T₆; Sterna with scattered simple hairs, becoming longer on apical margin.

Head: Width in anterior view a little more than 1.44 x distance between front ocellus and lower margin of clypeus (66.5 : 45.5) (Fig. 153); maximum width of head at the level of posterior margin of eyes 6.5 x distance between front ocellus and occipital margin. Relative measurements of POL : OOL = 14:6; mouth parts normal; Mandible on anterior half very sparsely punctate, malar area much reduced; clypeus, labrum, paraocular area sparsely punctured; frontal line slightly raised and possess in between antennal toruli; Scape of the antenna reaching front ocellus; gena glabrous and reticulate; antennal segments (relative length : breadth) = scape = 15:5, pedicel = 4:4, F₁ = 3:5, F₂ = 6:4.5, F₃ = 4.5:5, F₄ = 6:6, F₅ = 4:6, F₆ = 5.5:6, F₇ = 6:6, F₈ = 6:6.5, F₉ = 6:7, F₁₀ = 11:6.5 (Punctures on vertex greatly separated, integument smooth) (Fig. 154). Eyes simple and smooth; relative length and width of eyes in lateral view = 26:18.5.

Thorax: Maximum width between tegulae to length of thorax = 55:42; Scutum, Scutellum and metanotum striato - reticulate with sparse punctations; parapsidal lines distinct, integument glabrous; propodeum reticulate. Episternum as on scutum and scutellum, striato-reticulate and glabrous.

Arolia present on legs, fore tibial spur flattened and bifurcated (Fig. 152); femur slightly depressed; mid tibial spur blunt and pectinate; hind tibial spurs, pointed and pectinate; scopal hair poorly developed.

Tegulae transparent, relative measurements of forewing length: its maximum width = 121:41; wing venation as in figure (152); two submarginal cells; second submarginal cell receives the two recurrent veins; stigma large, minute hairs distributed throughout the wing, membrane, 2r-m distad by 2m-cu, first submarginal cell longer than second submarginal cell; jugal and vanal lobes of hindwing present (Fig. 152) hamuli six in number and serially arranged; Cu and M very much reduced.

Metasoma: Terga glabrous, striato-reticulate and sparsely pilose; T1-T6 with fasciae; punctation poorly developed; sterna striato reticulate.

Male: Unknown.

Materials examined: *Holotype* : F: INDIA, Kerala, Thrissur, Mohandas, 3-iv-2000; *Paratypes*: F: INDIA, Kerala, Thrissur, Mohandas, 3-iv-2000; F: INDIA, Kerala, Karnataka, Jobiraj, 20-iv-1999.

Etymology: This species named after Dr. Charles D. Michener, University of Kansas, in honour of his great help in my studies and for his keen interest and great contribution on bee systematics.

Flower Record: *Tectona grandis*

Distribution: INDIA (Kerala)

Biology: Unknown

Habitat: Disturbed

Discussion: This species resembles *B. clarihirtha* Reyes in general appearance, but differs from it in following characters: 1. Scape of antenna reaching front ocellus (In *B. clarihirtha*, scape of antenna not reaching front ocellus); 2. Legs yellowish brown to brown (In *B. clarihirtha* legs orange); 3. HL:HW = 1.14 (In *B. clarihirtha* HL:HW = 1.08 - 1.12); 4. Hairs on T4-6 light brown (In *B. clarihirtha* hairs on T4-6 transparent to clear).

7. *Braunsapis mixta* (Smith)

(Figs. 155-159)

Prosopis mixtus Smith, 1852: *Ann. Mag. Nat. Hist.* (2)9: 50. Type: female, India (BMNH); Meade-waldo, 1923: *Genera Insectorum* 1923. 181: 23 (Placed under *Allodape*).

Allodape marginata Smith, 1854: *Cat. Hym. Ins. Coll. Brit. Mus.* 230. Type female, "East Indies" (BMNH). Synonymized by Reyes (1991).

Allodape parvula Smith, 1879: *Des. Hgm. in . Brit. Mus.* 98: Type: female, Bombay, India (BMNH). Synonymized by Reyes (1991).

Prosopis leucotarsis (Cameron, 1897. Type: female, Ceylon, Cockerell, *Ann. Mag. Nat. Hist.* (9)8: 1921: 363. (Placed under *Allodape*); Meade-Waldo, 1923. *Genera Insectorum* 181: 24 (Placed under synonym of *A. mixta*).

Allodape pumilio Cockerell, 1911: *Ann. Mag. Nat. Hist.* 182. Type: female, Karachi, N.W. India (= Pakistan) (BMNH). Synonimized by Reyes (1991).

Plesiotype: F (Worker). TL = 5.8, FWL = 3.87, FWW = 1.48, HWL = 2.6, POL = 0.27, OOL = 0.218, HW = 1.51, HL = 1.3 (HW/HL = 1.16), SL = 0.43, FL = 1.13, EL = 1.14, EW = 0.51.

Colour. Integument: Black except, labrum with brownish yellow spot; clypeal mark yellow to brownish yellow, paraocular mark absent, antenna dark brown to black, ocelli dull brown to dark brown; eyes dark brown with yellowish markings; tegulae transparent, axillary sclerites yellow; pronotal collar yellow; apical four tarsi rufo-testaceous; metasomal fasciae (apical margins of metasomal segments) rufo-testaceous to steel grey, wing veins pale testaceous, membrane hyaline and iridescent, stigma with yellow tints in middle; sting dark brown.

Pubescence: Pubescence generally transparent to light brown, never obscuring integument. Pubescence on face sparse, silvery to light brown; flagellum with minute silvery appressed pilosity; vertex and occiput with few long hairs; scutum, scutellum with minute, very sparse hairs; metanotum with

long plumose pilosity, silvery to reflecting pale yellow; pronotal tubercle with yellow pubescence; episternum with moderately long transparent, sparse pilosity; Hairs on legs transparent to reflecting light yellow, intermixed with dark brown pubescence; tergal segments up to T3 with simple, scattered sparse hairs light brown, minute; T4-T6 transparent to light brown, longer hairs slanting, spiculate, shorter hairs subprostrate, spiculate.

Head: Width in anterior view a little more than $1.34 \times$ distance between front ocellus and occipital margin (72.5 : 54) (Fig. 156); maximum width of head at the level of posterior margin of eyes $5.83 \times$ distance between front ocellus and occipital margin (7:1.2). Relative measurements of POL : OOL = 13:10.5; mouth parts reduced, mandibles sparsely punctate; malar area reduced, but distinct; labrum deeply punctate; clypeal area, paraocular area sparsely and deeply punctate; frontal line slightly raised and passed in between antennal toruli, toruli area and vertex striato-reticulate; scape of antenna barely reaching front ocellus; gena glabrous, striated and sparsely punctate. Relative length: breadth of antennal segments scape = 21:4.5, pedicel = 5:35, $F_1 = 3:4$, $F_2 = 3.5:3.5$, $F_3 = 5:5.5$, $F_4 = 5:6$, $F_5 = 5:6$, $F_7 = 5:6$, $F_8 = 6:6.5$, $F_9 = 7.5:6.5$, $F_{10} = 7:5$ (Fig. 157). Eyes simple and smooth; Relative length : width of eyes in lateral view 31 : 14.

Thorax: Maximum width between tegulae to length of thorax 9:11; scutum striato-reticulate and minutely and sparsely punctate; medial and parapsidal lines distinct; integument glabrous; scutellum minutely punctate; axilla visible and distinct; propodeum reticulate; episternum striato-reticulate and glabrous legs well developed; fore femur with middle area bulged; fore tibial spurs flattened; arolia distinct; mid tibial spurs long and pectinate, basitibial plate with carina indistinct; scopal hairs well developed on hind tibia, basitibial plate with carina indistinct.

Tegulae transparent; relative measurements of forewing length, maximum width = 104.5 : 40; wing venation as in fig. (Fig. 155); stigma larger than prestigma second submarginal cell smaller than first submarginal cell, which is very long; 1 m - cu not continuous with 1 r-m; 2 m-cu receives posterior end of second submarginal cell, jugal and vanal lobe of hind wing present; hamuli-5; m and Cu reduced very much (Fig. 155).

Metasoma: Terga glabrous, striato-reticulate, striations transversely more distinct; sterna striato-reticulate and minutely punctate; metasomal fasciae distinct and striated; abdomen scoop shaped (Fig. 155).

Flower Record : *Tectona grandis*.

Male: Male differs from females in having: 1. Length 3.6 - 4.9 mm; 2. Labrum yellow to fusco-ferrugineous, mandible black; 3. Clypeus entirely yellow (Fig. 158); 4. Paraocular mark absent; 5. Scape with yellow mark underneath; 6. Tegulae transparent, axillary sclerites yellow; 7. HW = 1.23 - 1.47 mm; HW:HL = 1.16 mm; 8. Hind trochanter simple; 9. Hairs on T4-6 transparent; longer hairs slanting to suberect, blunt to spiculate; shorter hairs prostrate, spiculate.

Materials examined: Plesiotype : F, INDIA, Kerala, Calicut University Campus, Jobiraj, T. 16-viii-2000; *Other materials examined*: 4F , INDIA, Kerala, Calicut University Campus, Jobiraj, T. 16-viii-2000; 1F , INDIA, Kerala, Trissur, Binoy, 16-viii-2000; 3F, INDIA, Kerala, Calicut University Campus, Jobiraj, T. 7-iv-2000; 8M, INDIA, Kerala, Calicut University Campus, Jobiraj, T.7-iv-2000; 1M, INDIA, Kerala, Calicut University Campus, Jobiraj, T. 23-iv-2000; 2M, INDIA, Kerala, Calicut University Campus, Jobiraj, T. 28-iv-2000; 1M, INDIA, Kerala, Calicut University Campus, Jobiraj, T. 16-viii-2000; 1M, INDIA, Kerala, Trissur, Mohandas, 12-iv-2000; 1M, INDIA, Kerala, Balussery, Jobiraj, T. 2-x-1998; 1M, INDIA, Kerala, Calicut University Campus, Jobiraj, T. 8-x-1999.

Flower record: *Tectona grandis*

Distribution: INDIA (W. Bengal, Delhi, Bihar, Maharashtra, Karnataka, Kerala, Punjab, Goa) Sri Lanka, Pakistan.

Biology: Unknown.

Habitat: Disturbed and undisturbed areas.

Discussion: Sympatric populations of *B. mixta* (Smith) and *B. picitarsis* (Cameron) occur in India (Stephan G. Reyes, 1991). The female of this species is distinguished by the following characters: 1. Relatively small size ranges from 3.8 to 6.1 mm (In *B. picitarsis* have relatively large size, ranges from 5.8 - 7.7 mm); 2. HW : HL = 1.14 : 1.18 mm (In *B. picitarsis* HW : HL = 1.09 : 1.14 mm).

The males of this species differs from it in the following characters: 1. HW:HL = 1.14:1.18 mm (In *B. picitarsis* HW:HL = 1.12 : 1.14 mm); 2. Headwidth = 1.23 - 1.47 mm (In *B. picitarsis* Head width = 1.60 - 1.77 mm).

8. *Braunsapis palavanica* (Cockerell)

(Figs: 160-163)

Allodape palavanica Cockerell, 1916: *Phil. Jour. Sci.* 11: 303. Type: female, Puerto princesa, Palawan, Philippines (NMNH).

Plesiotype : Worker (F) TL = 5.42, HW = 1.62, HL = 1.45, (HW/HL = 1.11), SL = 1.48, FL = 0.51, POL = 0.264, OOL = 0.235, EL = 1.06, EW = 0.54, FWL = 3.43, FWW = 1.37, HWL = 2.29.

Colour: Integument: Black except mouth parts brown, labrum yellow, mandible black; clypeus entirely yellow; paraocular mark reduced, yellow; antenna dark brown, ocelli dull yellow to dark brown reflections; eyes brownish yellow to dark brown; tegulae transparent, axillary sclerites yellow to fuscous; pronotal lobe yellow; all tarsi yellow; wing veins dark brown, membrane hyaline,

stigma brown with yellow in the middle; metasomal fasciae light brown to steel grey.

Pubescence: Pubescence generally transparent to light brown, never obscuring the integument. Hairs on face scattered, transparent to golden yellow; scape of antenna with few long plumose hairs, flagellum with appressed, minute, white pilosity; vertex with few minute hairs, light brown, intermixed with plumose, long, light brown pilosity; pronotum with moderately long plumose hairs, silvery with light yellow reflections; scutum with sparse pilosity; scutellum and metanotum with plumose, long, light brown pilosity; episternum with moderately long silvery plumose hairs; pubescence on legs reduced, light yellow to brown with yellowish reflections; T1-T3 with simple scattered brown hairs; hairs on T4-6 light brown to fuscous; longer hairs suberect, simple to blunt, shorter hairs prostrate and simple.

Head: Width in anterior view a little more than 1.36 x distance between front ocellus and occipital margin (76:56) (Fig. 161); maximum width of head at the level of posterior margin of eyes 3.3 x distance between front ocellus and occipital margin (16.5:5); Relative measurements of POL : OOL = 4.5:4; mouth parts normal, maxillary palp six segmented; mandible smooth and glabrous, malar area not well developed; labrum minutely punctured; middle of epistomal suture raised; clypeal area sparsely punctured (punctations not clearly visible); toruli depressed in the middle; frontal line raised in between middle of toruli; toruli area striato-reticulate and minutely punctured (sparse); toruli striato-reticulate; gena striato-reticulate and glabrous. Scape reaching front ocellus. Relative length : breadth of antennal segments: scape 24:4.5, pedicel 4:5, F₁ = 5:6, F₂ = 5:6, F₃ = 5:6, F₄ = 6:6, F₅ = 7:6, F₆ = 6.5:6.5, F₇ = 6.5:7, F₈ = 7:7, F₉ = 8:6.5, F₁₀ = 11:6 (Fig. 162). Eyes simple and smooth, relative length : width of eye in lateral view = 33:5.

Thorax: Maximum width between tegulae to length of thorax = 19:22.5; scutum striato-reticulate and sparsely punctate, integument glabrous, medial line not distinct, parapsidal lines distinct; scutellum striato-reticulate and sparsely punctate; metanotum striato-reticulate; reticulations well developed in the propodeum; episternum striato-reticulate with few sparse punctuations and glabrous (Fig. 160).

Legs developed, fore tibial spurs blunt and flattened, mid tibial spurs serrated and blunt to pointed; arolia well developed, scopa reduced; basitibial plate indistinct. Tegulae transparent. Relative measurements of forewing length: its maximum width = 108 : 43; wing venation as in figure (Fig. 60); stigma larger than prestigma; first and second recurrent veins received by second submarginal cell, first submarginal cell longer than second submarginal, jugal and vanal lobe of hindwing distinct; hamuli 5 in number; minute hairs distributed throughout the wing membrane (Fig. 160).

Metasoma: Metasoma larger than thorax, terga glabrous and striato-reticulate; metasoma sparsely and minutely punctate; metasomal fasciae distinct, fascia transversely striated; metasoma rounded; sterna striato-reticulate.

Materials examined: Plesiotype : F, INDIA, Kerala, Calicut University Campus, Jobiraj, T. 11-xii-1999; **Other materials examined:** 1F, INDIA, Kerala, Calicut University Campus, Jobiraj, T. 25-vi-2000; 1F, INDIA, Kerala, Calicut University Campus, Jobiraj, T. 25-xii-2000.

Flower Record: Teak (*Tectona grandis*)

Distribution: INDIA (Kerala), Malaysia, Indonesia, Philippines.

Male: (Face : Fig. 163). Male differs from female in having: 1. Length 5.5 - 6.4 mm; 2. Labrum yellow, mandible black; 3. Scape yellow underneath,

sometimes absent; 4. HW = 1.63 - 1.7 mm; HW/HL ratio 1.11 - 1.14; 5. Hairs on T4-6 fuscous; longer hairs suberect, simple to blunt; shorter hairs prostrate, simple.

Discussion: The female of this species is readily distinguished by having paraocular facial marks and fuscous hairs on T4-6. The presence of paraocular marks is shared with *B. clarihirta* Reyes, *B. apicalis* Reyes, *B. lateralis* Reyes but differs from them in following characters: 1. Head width 1.63 - 1.77 mm (In *B. clarihirta* the head width relatively smaller 1.32 - 1.60 mm); 2. Longer hairs on T4-6 light brown to fuscous (In *B. clarihirta* longer hairs on T4-6 transparent); 3. Clypeus entirely yellow (In *B. apicalis* and *B. lateralis* have the lower half of clypeus partly black below).

The males of *B. palavanica* have simple trochanters and the longer hairs on T4-6 fuscous. They are quite similar to males of *B. philippinensis* (Ashmead) and *B. picitarsis* (Cameron) but can be separated from the first by their smaller size (HW 1.63 - 1.73 mm) and the yellow clypeus with the clypeal mark not reduced as in *B. philippinensis* and from *B. picitarsis* by having the paraocular mark either reduced or absent.

Remarks: This is the first report of this species from Kerala as well as from India. Cockerell (1916) originally described it from Philippines as *Allodape palavanica*. Males are not represented on the above collection but the characters and illustrations taken from Reyes (1991).

9. *Braunsapis philippinensis* (Ashmead)

(Figs: 164-167)

Prosopis philippinensis Ashmead, 1904b: *Jour. New York. Ent. Soc.* 12: 5 Type, female, Manila Thuzon, Philippines (NMNH); Cockerell, 1916. *Phil. Jour. Sci.* 302. (Placed under *Allodape*); 1919: 191.

Allodape mindanaonis (Cockerell), 1915: *Entomologist.* 48: 109; Type: female, Dapitan, Zamboanga, Mindanao, Philippines (NMNH). Synonymized by Reyes (1911).

Allodape marginata picitarsis Cameron : Cockerell, 1916: *Phil. Jour. Sci.* 14: 302 (distr: Philippines) (Misidentification).

Plesiotype: Worker (F): TL 6.89, FWL = 4.26, FWW = 1.67, HWL = 3.18, POL = 0.32, OOL = 0.24, HW = 1.825, HL = 1.6, HW/HL = 1.14, SL = 0.6, FL = 1.45, EL = 1.3, EW = 0.57.

Colour: Integument: Black except, labrum, mandible black, clypeal mark yellow and narrow towards apex; clypeal mark 'T' shaped, mouth parts brown; paraocular mark absent; flagellum dark brown to black, ocelli reflecting dull brown to light yellow; eyes light yellow with black bands; tegulae transparent to slightly infuscated, axillary sclerites yellow. Legs usually dark brown to black, all mediotarsi and distitarsi yellowish brown; wing veins brown, membrane transparent or hyaline, stigma dark brown with yellow in the middle metasomal fasciae light brown, which reflects steel grey in certain lights, sting ferruginous red.

Pubescence: Pubescence generally transparent to light brown, never obscuring integument; few erect transparent hairs on labrum; sparse hairs distributed over clypeus and face; Scape of the antenna with few light yellow sub appressed pilosity, flagellum with dark appressed pilosity. Vertex with plumose light brown hairs. Pronotum with light yellow, plumose hairs, scutum with very sparse, small pubescence, scutellum with light yellow to brown long plumose

hairs; metanotum smooth; episternum with silvery to transparent plumose hairs; scopal hairs long, plumose and transparent to light brown; T1 with moderately long plumose hairs at their base; T2-T3 with simple scattered, brownish yellow to light yellow hairs, hairs on T4-T6 light brown to fuscous, longer hairs slanting, blunt to spiculate; shorter hairs subprotrate, spiculate.

Head: Width in anterior view a little more than $1.54 \times$ distance between front ocellus and occipital margin (73 : 47) (Fig. 165); maximum width of head at the level of posterior margin of eyes $6.4 \times$ distance between front ocellus and occipital margin (52:8). Relative measurement of POL : OOL = 8:6.5 (Fig. 167); mouth parts normal small; mandible glabrous with few punctations; malar area distinctly punctate, clypeal area with deep and small punctations; middle of epistomal suture raised; antennal toruli depressed, frontal line slightly raised and passed in between antennal toruli and touches middle ocellus; frons punctured and in between punctation striato reticulate; ocellar surface striato-reticulate and glabrous with weakly developed punctation; scape of the antenna reaching front ocellus; gena striato-reticulate with few scattered punctations, relative length:breadth of antennal segments scape = 24:4, Pedicel = 4:4.5, $F_1 = 3:4.5$, $F_2 = 3:4.5$, $F_3 = 4:5$, $F_4 = 5:5$, $F_5 = 6:5$, $F_6 = 6:5$, $F_7 = 5:5$, $F_8 = 7:5$, $F_9 = 7:5$, $F_{10} = 9:4.5$ (Fig. 166). Eyes simple and smooth, relative length: width of eyes in lateral view = 35:15.5.

Thorax: Maximum width between tegulae to length of thorax 18.5:21; scutum striato-reticulate, parapsidal lines distinct, and area in between parapsidal lines punctate; scutellum and metanotum reticulate and finely punctate; propodeum glabrous, reticulate, impunctate; episternum striato-reticulate with very sparse punctations, glabrous.

Legs developed; fore tibial spurs blunt and flattened, mid tibial spurs pointed, pectinate, arolia well developed, basitibial plate with indistinct carina, scopal hairs developed on hind tibia and basitarsus (Fig. 164).

Tegulae transparent to slightly infuscated; relative measurements of fore wing length : its maximum width = 115 : 46; wing venation as in figure (Fig. 164); stigma larger than prestigma; two submarginal cells, second submarginal cell smaller than first submarginal cell, both recurrent nerves meets the second submarginal cell at their bases and apices respectively; jugal and vanal lobes of hindwing present; hamuli 5; minute hairs distributed throughout the wing-membrane (Fig. 164).

Metasoma: Metasoma larger than (mesosoma) terga glabrous and striato reticulate; metasomal fasciae transversly striated metasoma scoop shaped; sterna striato-reticulate.

Male: Face as in figure 129, but differs from females in having: 1. Length 5.6 - 7.3 mm (2) Labium yellow, sometimes reduced, mandibles black (3) Clypeus partly black, clypeal mark some times reduced to longitudinal mark (4) paraocular mark, absent reduced or present (5) HW = 1.77 - 1.97 mm (6) HW:HL = 1.11 : 1.15 mm. (7) Tarsi dark. (8) Hairs on T4-6 fuscous, longer hairs slanting to suberect, blunt, shorter hairs subprostrate, weakly spiculate.

Material examined: *Plesiotype:* F, INDIA, Kerala, Calicut University Campus, 16-viii-2000, Jobiraj, T.; *Other material examined:* F, INDIA, Kerala, Vithuraa, 8-iii-2000, Jobiraj, T.

Flower Record : *Tectona grandis.*

The female type of *B. mindanaonis* has the clypeus mainly black with the clypeal mark T-shaped (Fig. 71), while in *B. philippinensis* the clypeus is partly black below and the clypeal mark narrows towards the apex (Fig. 69).

Distribution: INDIA (Kerala), Vietnam, Thailand, Malaysia, Singapore, Indonesia, Philippines.

Habitat : Disturbed.

Discussion: This species is easily distinguished by its large size and light brown to dark longer hairs on T4-T6.

Remarks: This is the first report of this species from Kerala as well as from India. Ashmead (1904) originally described it from Philippines as *Prosopis philippinensis*. The male specimens are not represented in the above collections but drawings and characters taken from Reyes (1991).

10. *Braunsapis picitarsis* (Cameron)

(Figs: 168-171)

Allodape picitarsis Cameron 1902: 60. Type: Female, Miniko Islands, Laccadive Arch. (BMNH).

Plesiotype: Worker (F): TL = 5.9, FWL = 3.75, FWW = 1.5, HWL = 2.74; POL = 0.235, OOL = 0.235, HW = 1.58, HL = 1.32 (HW:HL = 1.12), SL = 0.41, FL = 1.7, EL = 1.12, EW = 1.12.

Colour. Integument : Black except, mouth parts brownish yellow; clypeal mark yellow, margin of clypeus brownish yellow; scape yellow underneath, flagellum dark brown to black; eyes yellow to brown; ocelli reflecting pale yellow; tegulae transparent, axillary sclerites yellow; pronotal lobe yellow; tarsal segments with brownish tints; wing veins dark brown, membrane hyaline, stigma

yellow in the middle and outer and inner border dark brown; metasomal fasciae brown; stigma ferruginous red.

Pubescence: Pubescence generally transparent to light brown and never obscuring integument. Pubescence on labrum, clypeus, supra clypeal area, mandibles very few, transparent, sometimes reflecting light yellow; scape with fairly long branched pilosity; flagellum covered with appressed pilosity; pubescence on vertex plumose, sparse, transparent to light yellow. Pronotum and episternum with scattered moderately long plumose pilosity, reflecting light yellow to transparent; scutellum and metanotum with long branched transparent hairs, thicker below tegulae; Hairs on legs transparent to light brown, reflects light yellow in certain lights; pilosity on wings dark brown. T1-T3 with transparent, light brown small hairs uniformly distributed. Hairs on T4-T6 transparent to light brown; longer hairs slanting to suberect, simple to weakly spiculate; shorter hairs, subprostrate to simple. Stems with few scattered, long plumose pilosity.

Head: Width in anterior view a little more than $1.28 \times$ between front ocellus and occipital margin (Fig. 170); maximum width of head at the level of posterior margin of eyes $5.7 \times$ distance between front ocellus and lower margin of clypeus (52:9); Relative measurements of POL:OOL 12:12; mouth parts normal, maxillary palpi five segmented, mandible smooth and glabrous, malar area distinct (Fig. 170); labrum deeply punctate, widely separated and evenly distributed; clypeal and supra clypeal area more or less smooth with few scattered punctations, middle of episternal suture raised; antennal toruli not depressed deeply; scape reaching front ocellus; punctations clear above antennal toruli vertex glabrous; gena longitudinally striate to striato-reticulate, with sparse punctations, glabrous; relative length: breadth of antennal segments; scape - 21:4, pedicel = 4:5, $F_1 = 4.5:6$, $F_2 = 3:7$, $F_3 = 3:7$, $F_4 = 4:7$, $F_5 = 6:8$, $F_7 = 6.5:8$, $F_8 = 7:8$, $F_9 =$

7:8, $F_{10} = 8.5:7$, $F_{11} = 11:6.5$ (Fig. 171). Eyes simple and smooth; relative length: width of eyes in lateral view 37:18.

Thorax: Maximum width between tegulae to length of thorax (Fig. 169); scutum striato-reticulate, sparsely and smoothly punctate, integument glabrous, scutellum striato-reticulate and more closely punctate, axilla distinct; metanotum striato-reticulate, propodeum glabrous, reticulations well developed (Fig. 169), parapsidal lines distinct; episternum striato-reticulate with smooth, sparse, punctuations; pronotal collar, pronotal lobe with few punctuations.

Legs developed, basitibial plate indicated by weak carina, coxa, trochanter and femur, striato-reticulate; hind tibial spine blunt and pectinate; arolia distinct; scopal hairs well developed on hind tibia, hind tibial spurs, pectinate.

Tegulae transparent; relative measurements of forewing length: its maximum width = 124:49.5; wing venation as in figure (Fig. 168); stigma longer and broader than prestigma; first submarginal cell longer than second submarginal cell; 1 m - cu inconspicuous with 1 r-m; 2 m-cu receives posterior end of second submarginal cell; jugal and vanal lobes hindwing present; vanal lobes larger than jugal lobe; hamuli 5; minute hairs distributed throughout the wing membrane (Fig. 168).

Metasoma: Metasoma longer than mesosoma; metasoma glabrous, striato-reticulate, sparsely and minutely punctured; metasomal fasciae distinct; T6, scoop shaped, anterior portion of sterna striato-reticulate and glabrous, posterior portion distinctly punctured with well developed punctuations (Fig. 168).

Male: Face as in figure 128. Male differs from female in having: 1. Length 5.2 - 5.8 mm; 2. Labrum yellow, mandible black; 3. Paraocular mark present, sometimes reduced or absent; 4. Scape yellow underneath; 5. HW 1.60 - 1.7 mm; HW:HL = 1.12 - 1.14 mm; 6. Hairs on T4-6 transparent to light brown; longer

hairs slanting to sub erect, simple to weakly spiculate; shorter hairs subprostrate, simple.

Materials examined: *Plesiotype:* F: INDIA, Kerala, Palode, K.C. Koshy, 16-viii-1999; *Other materials examined:* 1F, INDIA, Kerala, Trissur, Mohandas, 12-iv-2000; 1F, INDIA, Kerala, Ponmudi, Jobiraj, T. 9-iii-2000; 1F, INDIA, Tamil Nadu, Coimbatore, Sasidharan, 7-vi-1995.

Flower Record: *Tectona grandis*, *Bamboosa bamboosa*

Distribution: INDIA (Pondichery, Punjab, Uttar Pradesh, Maharashtra, Tamil Nadu, Kerala, Karnataka), Pakistan, Sri Lanka, Laccadive Arch.

Biology: Unknown.

Habitat: Disturbed and Undisturbed areas.

Discussion: The female of *B. picitarsis* is quite similar to that of *B. mixta* (Smith), especially in the facial marking, but differs from it in the following characters: 1. Head width : Head length = 1.09 : 1.14 m (In *B. mixta* Head width : Head length = 1.14 : 1.18).

The males are quite similar to those of *B. mixta* and *B. hewitti* but differ from these two species by their larger size and yellow mandibles.

Remarks: Males are not represented in the above collection and characters and illustrations taken from Reyes (1991).

11. *Braunsapis puangensis* (Cockerell)

(Figs: 172-175)

Allodape puangensis Cockerell, 1929b. *Ann. Mag. Nat. Hist.* (9)8: 149. Type: female, Kum Perang Creek, Thailand (NMNH).

Allodape iwatai Sakagami, 1961: *Nat. life Southeast Asia*. 1: 424. Type: female, Cheng Mai (=Chiang Mai) Thailand (Osaka) (New Synonymy) Holotype lost; neotype, female, Cheng Mai (=Chiang Mai), Thailand (SMUK).

Plesiotype: Worker (F): TL = 6.12, HW = 1.542; HL = 1.45; HW:HL = 1.062, SL = 0.43, FL = 1.13, FWL = 3.85, FWW = 1.32, HWL = 2.67, POL = 0.285, OOL = 0.214, EL = 1.42, EW = 0.460.

Colour: Integument: Black except, mouth parts brown; labrum fuscous-ferruginous to black, clypeal mark yellow, partly black below with clypeal mark narrowing to a point towards apex, paraocular mark absent, scape sometimes yellow underneath; flagellum reflecting brown at their apices, ocelli silvery with light brownish tints in certain lights, eyes yellow to dark brown; Tegulae transparent with dark brown spots, axillary sclerite yellow to dark brown; wing veins brown, membrane hyaline, stigma dull brown with yellowish brown tints in certain lights; pronotal lobe yellow; last four tarsal segments brownish yellow; metasomal fasciae light yellow to steel grey.

Pubescence: Pubescence generally transparent to light brown and never obscuring integument. Pubescence on face small, transparent light yellow tints, very sparsely distributed. Scape of antenna with dull brown, erect to suberect pilosity, flagellum covered with appressed, minute pilosity reflecting silver colour, vertex with sparse medium sized pilosity, transparent to silvery white; Pronotum with long, plumose, transparent hairs, scutum, scutellum with minute sparse hairs; metanotum with few long plumose pilosity. Episternal and sternal hairs reflecting light yellow in certain lights. Hairs on legs long transparent to

light brown; scopal hairs well developed. T1-T3 with minute sparse hairs transparent to whitish yellow; T4-6 transparent to partly fuscous, longer hairs slanting to suberect, simple to spiculate, shorter hairs prostrate, simple to weakly spiculate.

Head: Width in anterior view a little more than $1.263 \times$ distance between front ocellus and lower margin of clypeus (60: 56.5) (Fig. 173); maximum width of head at the level of posterior margin of eyes $5.1 \times$ distance between front ocellus and occipital margin (46:9, 28: 5.5); clypeal mark as in figure (Fig. 173); mouth parts well developed, mandible minutely punctate, malar area distinct, labrum with deep punctations, middle of epistomal suture slightly raised, lower area of clypeus with deep puncti, clypeal mark sparsely punctate, paraocular area with few large and small punctations, subantennal area striato-reticulate with sparse punctations, subantennal suture slightly raised, antennal toruli depressed; scape not reaching front ocellus; vertex striato-reticulate; gena longitudinally striated with few reticulations and glabrous; relative length : width of antennal segments, scape = 22:4, pedicel = 7:3, $F_1 = 6:3$, $F_2 = 3:4$, $F_4 = 4.5$, $F_5 = 5:6$, $F_6 = 4:7$, $F_7 = 6:7$, $F_8 = 5.5:7$, $F_9 = 6:7$, $F_{10} = 6.5:7$, $F_{11} = 7:5.5$ (Fig. 174). Eyes simple and smooth, relative length : width of eyes in lateral view = 32:13.

Thorax: Maximum width between tegulae to length of thorax = 36:53; scutum striato-reticulate and sparsely punctate; medial and parapsidal lines distinct; axilla minutely punctate; scutellum striato-reticulate, weakly and sparsely punctate, propodeum glabrous and reticulate, episternum striato-reticulate, reticulations well-developed.

Legs normal; arolia distinct, basitibial plate with carina indistinct, mid tibial spurs smooth not pectinate; hind tibial spurs as mid tibial spurs; hind tibia with scopa well developed (Fig. 172).

Tegulae smooth with few minute punctations; relative measurements of forewing length: its maximum width = 108:37; wing venation as in figure (Fig. 172); stigma well developed; 1 m - cu and 2 m - cu received anterior and posterior ends of second submarginal cell; jugal and vanal lobes of hindwing present; hamuli 5; minute pilosity throughout wing membrane, posterior margins of wing membranes with numerous minute hairs (Fig. 172).

Metasoma: Metasoma longer than thorax, terga more or less glabrous, striato-reticulate, minutely and sparsely punctate; metasomal fasciae transversely striated; T6 - scope shaped; sterna striato-reticulate.

Male: Male differ from female in having: 1. Length 4.0 - 5.2 mm; 2. Labrum yellow, mandible black; 3. Clypeus entirely yellow; 4. Paraocular mark absent; 5. HW 1.13 - 1.43 mm; HW:HL = 1.10 - 1.3 (Fig. 175); 6. Hind trochanter simple, hind femur emarginate medially, swollen basally; 7. Tarsi dark; 8. Hairs on T4-T6 fuscous; longer hairs suberect, simple, shorter hairs prostrata, simple.

Materials examined: *Plesiotype:* F, INDIA, Kerala, Trissur, Jobiraj, T. 28-i-2000; *Other materials examined:* 3F, Same collection data as of plesiotype; 1F, INDIA, Kerala, Calicut University Campus, Jobiraj, T. 28-iv-2000; 2F, INDIA, Kerala, Kavanoor, Jobiraj, T. 11-iv-2000; 1F, INDIA, Kerala, Tamil Nadu, Sasidharan, 12-iv-1998; 3F, INDIA, Kerala, Karnataka, Bangalore, Geethabai, 2-v-1996; 1F, INDIA, Kerala, Kollom, ZSI xii-2000; 1F, INDIA, Kerala, Calicut University Campus, Sinu, 22-ix-1999; 1 F, INDIA, Kerala, Calicut University Campus, Jobiraj, 25-xii-1992

Flower Record: *Tectona grandis*

Distribution: INDIA (Punjab, Uttar Pradesh, Tamil Nadu, Kerala, Goa, Nepal, China, Thailand, Vietnam, Malaysia, Hongkong.

Biology: Unknown.

Discussion: This species closely resembles *B. cupulifera* (Vachal) on general appearance, but differ from it in having: 1. Mandibles and scape black (In *B. cupulifera* (Vachal) mandibles and scape underneath also yellow); 2. T4-T6 with hairs, transparent to light brown and simple (In *B. cupulifera* T4-T6 transparent to partly fuscous, longer hairs slanting, suberect); HW:HL = 1.06 : 1.11 mm (In *B. cupulifera* HW : HL = 1.05 : 1.09).

This species also resembles to *B. mixta* (Smith) in general appearance, but differs from it in the following characters: 1. HW : HL = 1.14 : 1.18 mm (In *B. mixta* HW : HL = 1.06 : 1.11 mm); 2. Hairs on T4-T6 transparent to partly fuscous; longer hairs slanting to suberect, simple to spiculate; shorter hairs prostrate, simple to weakly spiculate (In *B. mixta* hairs on T4-T6 transparent, longer hairs slanting, spiculate; shorter hairs subprostrate, spiculate).

Remarks: The males are represented the above collection but the characters and illustrations taken from Reyes (1991).

Subfamily b: Apinae

Diagnostic features:

In most cases clypeus protuberant, with the lower lateral parts bend on either side of labrum. Stipial comb present (except in parasitic taxa). Pygidial plate present. The scopa is restricted to the hind tibia and basitarsus. The anterior coxae are usually broader than long.

Tribe 1. Anthophorini

Diagnostic features:

The wings are largely bare. The distal parts beyond the veins strongly papillate. The stigma is small, usually ending at the base of vein r. The marginal cell is slightly shorter than or about as long as the distance from its apex to the wing tip. The first submarginal cell is short, much shorter than the combined lengths of the second and third submarginal cells. The jugal lobe of the hindwing is less than one-half as long as the vanal lobe.

GENUS: AMEGILLA FRIESE

Amegilla Friese, 1897. *Iheil*, 3, *solitare Apiden*, 316 pp. Type species: *Apis quadrifasciata* de Villers, 1789, designated by Cockerell, 1930.

Alfkenella Börner, 1919. *Stam. der. Han.Biol. Zen.* 39: 145-186. Type species: *Apis quadrifasciata* de Villers, 1789, Original designation.

Asaropoda Cockerell, 1926. *Ann. Mag. Nat. Hist.* 18(9): 216-227. Type species: *Saropoda bombiformis* Smith, 1854. original designation.

Aframegilla Popov, 1950. *Ent. obozr.* 31: 257-261. Type species: *Anthophora nubica* Lapeletier, 1841. original designation.

Zonamegilla Popov, 1950. *Ent. Obozr.* 31: 257-261. Type species: *Apis zonata* Linnaeus, 1758. original designation.

Zebramegilla Brooks, 1988. *Univ. Kan. Sci. Bull.* 53(9): 502. Type species: *Anthophora albigena* Lepeltier, 1841.

Dizonamegilla Brooks, 1988. *Univ. Kan. Sci. Bull.* 53(9): 505. Type species: *Megilla sesquicincta* Erichson and Klug 1842.

Megamegilla Brooks, 1988. *Univ. Kan. Sci. Bull.* 53(9): 505. Type species: *Apis acraensis* Fabricius, 1793.

Ackmonopsis Brooks, 1988. *Univ. Kan. Sci. Bull.* 53(9): 508. Type species: *Anthophora mimadrena* Cockerell, 1916.

Micramegilla Brooks, 1988. *Univ. Kan. Sci. Bull.* 53(9): 508. Type species: *Anthophora niveata* Friese, 1905.

Notomegilla Brooks, 1988. *Univ. Kan. Sci. Bull.* 53(9): 511. Type species: *Anthophora acruginosa* Smith, 1854.

Glossamegilla Brooks, 1988. *Univ. Kan. Sci. Bull.* 53(9): 512. Type species: *Saropoda bombiformis* Smith, 1854. Original designation.

Diagnostic characters:

Body length ranges from 8-24 mm; arolia absent (Fig. 177); hind and mid legs of males simple; hairs sometimes metallic; metasoma generally with appressed pubescence (Fig. 177); outer hind tibial spur much isolated from inner tibial spur; mentum with single anterior tooth near basal third; galea with anterior and posterior lumens (Fig. 177); flagellar segment 1 of female equal to combined lengths of next 2.3 - 4.2 flagellomeres; face with yellow to white or reddish yellow to brown markings.

Distribution: INDIA (Kerala), Indo-malayan area, Madagascar, old world continents, Australia.

Biology: In southern and eastern Africa the adults are active from December to April. In the Northern Hemisphere the adults fly from February to October.

Discussion: *Amegilla* Friese segregates from *Anthophora* Latreille by following characters such as arolia absent; basistipial process with one projection; mentum almost always with a single anterior tooth on basal third; gonostylus often greatly reduced to absent and hairs sometimes metallic. Many species of *Amegilla* unlike *Anthophora* are brightly coloured with metallic hues of blue, green and orange hair. These hairs are appressed to integument, flattened with apically converging ridges.

Remarks: Robert W. Brooks (1988) reported 11 subgenera under *Amegilla*. Of these five were reported from India such as *Zonamegilla*, *Dizonamegilla*, *Amegilla* S. str. *Micramegilla* and *Glossomegilla*. The present work recognizes subgenera from above except *Glossomegilla*.

Hitherto reports 4 new species such as *Amegilla* (A) *impunctata*, *Amegilla* (D.) *interrupta*, *Amegilla* (Z.) *malabarensis* and *Amegilla* (Z.) *keralensis* with an undetermined species *Amegilla* (H.) sp. I. The descriptions of *Amegilla* (Z.) *zonata* and *Amegilla* (Z.) *parhypate* also included. Thus altogether 7 species discussed and a key to the species of Kerala is also provided.

KEY TO THE AMEGILLA SPECIES OF KERALA

1. Apex of S₈ narrowed, either bilobed or rounded such that sternum appears triangular from ventral or dorsal aspect (Fig. 176) 2
 - Apex of S₈ wide, apicomediaally emarginate or entire, sometimes apicomediaally produced, sternum appearing rectangular from ventral or dorsal aspect (Fig. 183) (*Micramegilla*) *Amegilla* (*M*) sp.I.
2. Apex of S₈ rounded or very weakly bilobed; body length atleast 12 mm; paraocular marks absent (Fig. 177) or greatly reduced in females
 - (*Amegilla* s.str.) *Amegilla* (*A*) *impunctata* sp. nov.
 - Apex of S₈ strongly bilobed (Fig. 186); body length 8-9 mm; paraocular mark present in females. (Fig. 195) 3
3. Apical margin of S₅ broadly emarginate; metasomal terga usually with mettalic blue colour; length of flagellar segment 1 equal to next 2.3 - 2.8 segments together (*Zonamegilla*) 4
 - Apical margin of S₅ entire; colour of metasomal hair never metallic blue; length of flagellar segment 1 equal to next 3.2 - 3.5 segments together
 - (*Dizonamegilla*) *Amegilla* (*D*) *interrupta* sp. nov.
4. Metasomal hair bands metallic bluish violet; F₁ with reddish brown spot apically (Fig. 190); scutum and scutellum punctate not very closely, in between areas smooth and glabrous (Fig. 190)
 - *Amegilla* (*Z*) *malabarensis* nov.
 - Metasomal hair bands metallic green, blue, bluish-green; F₁ without reddish spot apically; scutum and scutellum closely punctate (Fig. 194) 5

5. Median parts of scutum and scutellum without pilosity (Fig. 194); pubescence on head and thorax reduced (Fig. 194)
 *Amegilla* (Z.) *parhypate* Lieftinck
- Median parts of scutum and scutellum thickly pubescent (Fig. 186); head and thorax thickly pubescent (Fig. 186) 6
6. Scape of antennae with yellowish white spot anteriorly on their outer surface (Fig. 189). Mesosoma with cinereous pubescence mixed with black hairs *Amegilla* (Z.) *keralensis* sp. nov.
- Scape of antennae yellowish white to ivory colour on their outer surface mesosoma with dense rufofulvous mixed with black hairs
 *Amegilla* (Z.) *zonata* Linnaeus

1. *Amegilla* (*Amegilla*) *impunctata* sp. nov.

(Figs. 176-179)

Holotype: M: TL = 14.05, HW = 4.91, HL = 3.27, SL = 0.73, FL = 4.55, FWL = 9.86, FWW = 3, HWL = 4.82, POL = 0.86, OOL = 0.71, EL = 2.77, EW = 1.36.

Colour. Integument: Body usually deep black except, mouth parts brown, labrum creamy white, mandible creamy white with apex black; clypeal marking, paraocular marking and supra clypeal markings creamy white; scape of antennae with white patch on outer surface; ocelli glabrous with reddish brown tints; tegulae brown, wing membrane hyaline, veins dark brown to black; tarsal segments dark brown.

Pubescence: Pubescence on labrum transparent and sparse; pilosity on clypeus sparse, brown and simple; hairs on paraocular, supraclypeal areas and vertex pale white, intermixed with brown; genal hairs white and almost completely covered. Pronotum, scutum and scutellum with very light brownish

yellow, plumose hairs intermixed with plumose brown hairs; episternum as on scutum, but with more white transparent, long and plumose hairs; metanotum covered with long, plumose white hairs; tegulae with light brown to dark brown hairs; outer surface of foreleg and mid leg completely and outer surface of hind tibiae creamy white pubescence, of inner surface with brown hairs. Metasoma clothed with suberect, and deep black hairs not concealing the surface and replaced by lighter ones at extreme sides; metasomal hair bands with appressed white pilosity, on $T_1 - T_5$; surface of T_1 with white hairs almost distributed throughout; posterior tergites with brown bristles; sternal plates with creamy white bristles, forming bands, or uniformly distributed. Under surface of head and mesosoma more or less thickly covered with plumose white hairs.

Head: Width in anterior view a little more than 1.93x distance between front ocellus and lower margin of clypeus (54:28) (Fig. 174); width of head at the level of posterior margin of eyes 5.67x distance between front ocellus and occipital margin (34:6); relative measurements of POL : OOL = 6:5; labral marking as in figure (Fig. 177, 179); weakly punctate; clypeus and paraocular areas weakly punctate and minutely reticulate; supra clypeal areas, supra antennal areas and vertex more or less closely punctate; gena punctate as on vertex; ocelli in a curve on vertex; relative length: breadth of antennal segments, scape = 8:4, pedicel = 3:3, $F_1 = 5.5:3.5$, $F_2 = 8:4$, $F_3 = 4:4$, $F_4 = 5.5:3.5$, $F_5 = 4:3.5$, $F_6 = 4.5:3.5$, $F_7 = 4.5:3.5$, $F_8 = 5:3.5$, $F_9 = 4:3$, $F_{10} = 4.5:3$, $F_{11} = 5:3$ (Fig. 178). Eyes simple and glabrous, relative length: width of eyes in lateral view = 30.5:15.

Thorax: Maximum width between tegulae to length of thorax = 26:28; scutum and scutellum strongly and more or less closely punctate, in between areas glabrous; episternum more closely punctate than scutum and scutellum. Metanotum and propodeum weakly punctate.

Legs long and well developed; arolia absent; hind tibial spur long, pointed and strong; basitibial plate weakly represented (Fig. 176).

Tegulae minutely and sparsely punctate, in between punctations minutely reticulate and glabrous; wing membrane hyaline and iridescent, posterior parts of membrane beyond veins papillate and striated (Fig. 176); wing venation as in figure (Fig. 176); marginal cell length 0.83x more than the distance from apex of marginal cell to wing tip; jugal lobe of hindwing smaller than vanal lobe.

Metasoma: Metasoma glabrous and very minutely reticulate; metasomal hair bands as in figure (Fig. 176); sternal plates sparsely punctate, in between areas reticulate (reticulation more developed than tergum).

Female: Female differs from male in having the following important characters: 1. Facial markings as in the figure (Fig. 179), greatly reduced than in male; 2. Labrum not completely marked with creamy white (Fig. 179); 3. Pubescence on face small and more or less sparsely distributed; 4. Wings with brownish tints (not hyaline); 5. Outer surface of hind tibia with brownish black hair patch on anterior area, just below basitibial plate; outer surface of hind basitarsus also covered with white hairs; 6. Basitibial plate well developed and distinct; 7. Lateral sides of last tergal plates with white hairs.

Materials examined: *Holotype*: M, INDIA, Kerala, Mannavan shola, Mathew & Brijesh, 11-9.1998; *Allotype*: F, INDIA, Kerala, Mannavan shola, Mathew & Brijesh, 17-10.1998.

Etymology: The species name is only an arbitrary combination of words.

Distribution: INDIA (Kerala)

Flower Record: Unknown.

Habitat: Undisturbed forested areas.

Discussion: The above species closely resembles to *Amegilla (A) confusa* (Smith) in general appearance, but differs from it in the following characters: 1. Metasoma impunctate (In *A. (A) confusa* metasoma closely punctate); 2. Mandible almost creamy white in colour with apices black (In *A. (A) confusa* base of the mandibles pale yellowish white); 3. Pubescence on legs usually creamy white on outer and brown on inner surface (In *A.(A) confusa* pubescence on legs usually snow white on outer and black on inner surfaces); 4. Wings hyaline and clear (In *A.(A) confusa* wings fuscohyaline).

2. *Amegilla (Dizanamegilla) interuptta* sp. nov.

(Figs: 180-182)

Holotype: M. TL = 17.2, HW = 5.45, HL = 3.41, SL = 0.82, FL = 4.09, POL = 0.84, OOL = 0.71, FWL = 11.57, FWW = 4.14, HWL = 3, EL = 3.2, EW = 1.8.

Colour. Integument: Body usually black, except mouth parts brown, labrum with white marking as in figure (Fig. 181), mandibles with a white spot; clypeal, supra clypeal and paraocular markings white with light yellow marking; ocelli glabrous, reddish brown with light yellow tints; flagellar segments F₂-F₁₁ dull brownish black; wings fuscous, veins dark brown; tarsal segments reddish brown; posterior areas of tergum brownish black. Anterior part of axilla reddish brown.

Pubescence: Pubescence on labrum transparent, simple, intermixed with few small brown hairs; hairs on clypeus very sparse and brown, paraocular areas with very long brownish black hairs intermixed with plumose, white pilosity; supra clypeal areas and vertex with brownish black and white hairs intermixed; genal area with black hairs; scutum, scutellum and metanotum with dark brown hairs intermixed with plumose white hairs; episternal hairs brown, long and thickly developed; pubescence on tegulae ivory white with dull brown on anterior

areas; axillary sclerites with white pubescence; legs almost covered with dark brown to black bristles; Metasoma brownish black, sparse, suberect pilosity with lateral white spots as in Figure (Fig. 180); spots on T₁ - T₃ small, on T₄ - T₅ more or less developed, but widely interrupted medially; last tarsal segments with a tuft of yellowish brown hairs with golden tints; sternum with brown, silky hairs, lateral spots of white plumose and long hairs of sternites 2, 3 and 4 distinct.

Head: Width in anterior view a little more than 2.07x distance between front ocellus and lower margin of clypeus (60:29) (Fig. 181); width of head at the level of posterior margin of eyes 3.9x distance between front ocellus and occipital margin (39:10); relative measurements of POL : OOL = 6:5; labral marking as in figure (Fig. 181), minutely punctate and glabrous; mandible with a distinct white spot on its middle; clypeus punctate, in between punctations striato-reticulate and glabrous, clypeal marking raised in middle (Fig. 181); supra clypeal marking triangular shaped, paraocular spots band like; supra clypeal areas, frons and vertex punctate as on clypeus, but smaller than clypeus; ocelli in a curve on vertex; relative length : breadth of antennal segments, scape = 9:4, pedicel = 2:3.5, F₁ = 7:3.5, F₂ = 2:4, F₃ = 3:4, F₄ = 4:4, F₅ = 4:4, F₆ = 4:4, F₇ = 4:4, F₈ = 4:4, F₉ = 4:4, F₁₀ = 4:4, F₁₁ = 5:3.5. Eyes simple and glabrous, relative length : width of eyes in lateral view = 16:9.

Mesosoma: Maximum width between tegulae to length of mesosoma 34:36; scutum strongly and more or less closely punctate (Fig. 180); scutellum punctate as on scutum, but sparse, glabrous; axilla with a reddish brown streak; episterum also more or less closely punctate; metanotum weakly punctate.

Legs long and well developed; arolia absent; hairs well developed and long on hind tibia and hind basitarsus, hind tibial spur long, pointed and minutely pectinate, mid tibial spur also long and pointed; basitibial plates weakly represented (Fig. 180).

Tegulae minutely punctate, in between punctations minutely reticulate; posterior parts of wing membrane, beyond veins coarsely papillate (Fig. 180); wing venation as in figure (Fig. 180); marginal cell 4.5 x long as broad, cell length more than the distance from apex of marginal cell to wing tip; first recurrent vein ending almost middle of second submarginal cell and second recurrent vein ending posterior part of third submarginal cell, jugal lobe of hindwing smaller than vanal lobe.

Metasoma: Metasomal terga impunctate, minutely reticulate and glabrous, metasomal spots of hairs as in figure (Fig. 180); sternal plate, also impunctate.

Female: Unknown.

Materials examined: Holotype: M, INDIA, Kerala, Thrissur, Jobiraj, T. 2.i-2000.

Etymology: The species name is only an arbitrary combination of words.

Distribution: INDIA (Kerala).

Flower Record: Unknown.

Habitat: Disturbed area.

Discussion: This species closely resembles to *Amegilla* (*D.*) *sesquicinta* (Erichson and Klug) in general appearance, but differs from it in the following characters: 1. Pubescence on head and mesosoma white intermixed with brownish black (In *A. sesquicinta* white pubescence well developed on head and thorax); 2. Pubescence on legs entirely black (In *A. sesquicinta* anterior legs entirely, the coxae, femora and tibiae of mid and hind legs with white pubescence); 3. Transverse bands on metasoma represented by lateral spots, interrupted medially (In *A. sesquicinta* metasomal bands well developed); 4. Axilla

with reddish brown streak. (In *A. sesquicinta* reddish brown streak on axilla absent).

3. *Amegilla (Micramegilla) Sp. I*

(Fig. 183-185)

Male: TL = 9.6, HW = 3.91, HL = 2.64, SL = 0.72, FL = 3.46, FWL = 7.55, FWW = 2.45, HWL = 5, EL = 2.43, EW = 1.43, POL = 0.64, OOL = 0.55.

Colour. Integument: Body usually black, except mouth parts brown, labrum, mandible, clypeus, paraocular areas, supra clypeal marking, white with light yellowish tints; scape of antenna with white marking on outer surface, rest of segments, brown; ocellus glabrous with brownish tints; tegulae light to dull yellow, wing membrane hyaline, veins dark brown, fore tarsal segments brown. In between $F_1 - F_2$ with a reddish brown area.

Pubescence: Pubescence on labrum transparent to very light yellow; suberect hairs on clypeus brown to black; paraocular areas black with some white intermixed, rest of the face black intermixed with light yellow to white pubescence, genal area with white hairs. Scutum, scutellum and metanotum light yellow to golden with some black intermixed; propodeal area, episternum with plumose very light yellow to white hairs; legs black except white patch on outer surface of fore legs, mid tibia and tarsal segments and hind tibia. Metasoma black with white apical bands on $T_1 - T_5$, some hairs on $T_3 - T_5$ suberect, bristle like and dark brown; band on T_1 , of about uniform width, on $T_2 - T_4$ bands widest submedially and narrower laterally; T_5 almost covered with band; hairs on sternum silky, dull white.

Head: Width in anterior view a little more than 1.84x distance between front ocellus and lower margin of clypeus (43:23) (Fig. 184); maximum width of head at the level of posterior margin of eyes 5.5x distance between front ocellus

and occipital margin (44:8); relative measurements of POL : OOL = 7:6; labrum shiny, weakly and sparsely punctate; clypeus minutely rugose and minutely reticulate; supra clypeal areas and vertex weakly and sparsely punctate; facial markings as in figure (Fig. 184); ocelli in a curve on vertex; relative length: breadth of antennal segments, scape = 20:7, Pedicel = 5.6, $F_1 = 7.5:7$, $F_2 = 6:8$, $F_3 = 8:8$, $F_4 = 8.5:8$, $F_5 = 9:8$, $F_6 = 9:7.5$, $F_7 = 8.5:7.5$, $F_8 = 8:7.5$, $F_9 = 8:7.5$, $F_{10} = 8:7$, $F_{11} = 10:7$ (Fig. 185). Eyes simple and glabrous, relative length: width of eyes in lateral view = 27 : 15.5.

Thorax: Maximum width between tegulae to length of thorax 31:75 (Fig. 183); scutum and scutellum more or less closely punctate, in between areas glabrous; episternum punctate as on scutum, but more closely punctate; metanotum weakly punctate.

Legs of normal, slender form; arolia absent; mid and hind tibial spurs pointed and minutely pectinate; basitibial plate weakly represented (Fig. 183).

Tegulae sparsely and minutely punctate, glabrous; posterior parts of wing membrane striated and papillate (Fig. 183); wing venation as in figure (Fig. 183); marginal cell length more or less equal or less than the distance from apex of marginal cell to wing tip; jugal lobe of hind wing smaller than vanal lobe; cu-v of hindwing 0.33 length of second abscissa of M-cu (Fig. 183).

Metasoma: Metasomal terga very minutely reticulate and glabrous. Sternal punctation minute and sparsely distributed; metasomal bands as in figure (Fig. 183).

Materials examined : Type : M: INDIA, Kerala, Calicut University Campus, 28-iv-2000, Jobiraj, T.

Distribution: INDIA (Kerala).

Flower Record: Unknown.

Habitat: Disturbed habitat.

Discussion: This species resembles *Amegilla (micramegilla) mucorea* (Klug) in the general appearance, but differs from it mainly in the following characters: 1. Scape of antennae with white marking on its outer surface. (In *A. (m). mucorea* scape of antennae black); 2. Pubescence light brown with golden tints (In *A.(m) mucorea* pubescence pure white); 3. Face not densely covered with white hairs (In *A. (M) muconeae* face densely covered with white hairs); 4. First metasomal segment sparsely pubescent, and its apex not broadly emarginate (In *A.(m) mucorea* first metasomal segment pubescent throughout and its apex broadly emarginate).

Remarks: For the time being this is kept as sp. I, because from the available literature it is not possible to confirm the species identification.

4. *Amegilla (Zonamegilla) keralensis* sp. nov.

(Figs: 186-189)

Holotype: F, TL = 8-9; HW = 5.27, HL = 3.27, SL = 0.88, FL = 3.35, FWL = 10.36, FWW = 3.64, HWL = 7, EL = 3.55, EW = 1.91, POL = 0.82, OOL = 0.64.

Colour. Integument: Body usually black except, mouth parts brown; labrum, clypeus, supra clypeal marking, paraocular markings, antennal spots ivory to light yellow; ocelli glabrous and reflects reddish brown; tegulae dark brown to black; sting reddish brown. Wing membrane subhyaline with dull brownish tints, veins dark brown to black.

Pubescence: Labrum with transparent to golden yellow, finely plumose hairs; clypeus as on labrum except with few black bristles; supraclypeal area to vertex with black and white hairs intermixed; black hairs on vertex very long;

gena and postgena with thickly developed ivory to white hairs; scutum and scutellum with small black and white pubescence; metanotum and propodeum with ivory to white coloured hairs, plumose; pronotum, episternum and lateral sides of propodeum with long white to ivory coloured hairs intermixed with few black hairs. Fore leg with white hairs on outer surface of femur, tibia and basitarsus, inner surface and other segments with dark brown to black; mid leg with outer surface of tibiae and basal part of basitarsus with white hairs, other segments with dark brown to black hairs; hind tibia on outer surface, except below basitibial plate, hind femur at their base with white and long, rest of hind leg black. T₁ - T₅ with apical bands of appressed metallic bluish green hairs, bands on T₁ narrower than rest of the bands; T₁ with anterior and posterior areas with subappressed, plumose, ivory pilosity; T₃ - T₅ laterally with less dense, suberect to erect, white hairs intermixed with dark brown to black hairs; sternum with few plumose hairs laterally and dark brown to black hairs on median surface.

Head: Width in anterior view a little more than 2x distance between front ocellus and lower margin of clypeus (58:29) (Fig. 188); maximum width of head at the level of posterior margin of eyes 8.29x distance between front ocellus and occipital margin (58:7) (Fig. 187); relative measurements of POL : OOL = 9:7; labrum shiny, impunctate; clypeus, mandibles and paraocular areas impunctate and minutely reticulate; supra clypeal, supra antennal areas and vertex weakly punctate; ocelli in a triangle on vertex, triangle more or less glabrous and impunctate; scape of antennae small, not reaching front ocellus; relative length: breadth of antennal segments; scape = 15:5.5, pedicel = 3:4.5, F₁ = 13.4.5, F₂ = 4:5, F₃ = 4:5, F₄ = 5:5, F₅ = 5:5, F₆ = 5:5, F₇ = 5:5, F₈ = 5:5, F₉ = 5:5.5, F₁₀ 5:5.5 (Fig. 189). Eyes simple and glabrous, slightly concave not parallel to each other; relative length: width of eyes in lateral view = 39:21.

Thorax: Maximum width between tegulae to length of thorax 47:64 (Fig. 186); scutum and scutellum densely and closely punctate; episternal punctures not clearly visible due to well developed pilosity; metanotum and propodeum weakly punctate, in between areas minutely striato-reticulate.

Legs more or less well developed and long; arolia absent; mid and hind tibial spurs well developed, long and pointed, outer surface pectinate; last tarsal segments smaller than other segments; basitibial plate indistinct (Fig. 186).

Wings subhyaline with brownish tints; posterior parts of wing membrane striated and papillate (Fig. 186), minute hairs distributed throughout wing membrane as in figure (Fig. 186); marginal cell length more or less equal to distance from apex of marginal cell to wing tip; jugal lobe smaller than vanal lobe; cu-v of hind wing 0.44 length of second abscissa of M + Cu.

Metasoma: Metasoma minutely and weakly punctate, in between areas minutely striato-reticulate; sternum more punctate than tergum; metasomal bands of hairs as in figure (Fig. 186).

Male: Male differs from female in having the following important characters: 1. Facial marking more less reduced; 2. Metasomal hairs more black intermixed with light brown; 3. Outer surface of hind tibia completely white; 4. Pubescent fasciae present only in T₁ - T₅.

Materials examined: *Holotype:* F, INDIA, Kerala, Calicut University Campus, T.C. Narendran. 28-v-1999; *Paratypes:* F, INDIA, Kerala, Calicut University Campus, Jobiraj. T. 28-vii-1999; F, INDIA, Kerala, Calicut University Campus, Jobiraj. T. 26-viii-1999; F, INDIA, Kerala, Calicut University Campus, Jobiraj. T. 22-x-1998; F, INDIA, Kerala, Calicut University Campus, Jobiraj. T. 26-x-1998; F, INDIA, Kerala, Calicut University Campus, Ushakumari. 20-vi-1998; 4F & 1M, INDIA, Kerala, Trissur, Jobiraj. T. 20-vi-1998; M, INDIA, Kerala,

Mananthavady, Jobiraj. T. 25-vii-1998; M, INDIA, Kerala, Kodencherry, Jobiraj. T. 23-vii-1999; M, INDIA, Kerala, C.U. Campus, Jobiraj. T. 28-iv-2000; M, INDIA, Kerala, C.U. Campus, Jobiraj. T. 2-vi-1998.

Distribution: INDIA (Kerala)

Flower record: Unknown.

Habitat: Undisturbed and and disturbed habitats.

Discussion: This species resembles *A. (Z.) parhypate* Lieftinck in general appearance, but differs from it mainly in the following characters: 1. Scutum and scutellum thickly pubescent (In *A(Z) parhypate* median part of scutum and scutellum devoid of pilosity); 2. Pubescence on head and mesosoma with thick pubescence (In *A. (Z.) parhypate* pubescence on head and mesosoma reduced); 3. Facial marking yellowish white to ivory coloured (In *A(Z) parhypate* facial markings more yellow).

5. *Amegilla (Zonamegilla) malabarensis* sp. nov.

(Figs: 190-192)

Holotype: F: TL = 10-14 mm, HW = 4.45, HL = 2.91, SL = 0.66, FL = 3.94, POL = 0.68, OOL = 0.55, FWL = 9.45, FWW = 3.55, HWL = 7.18, EL = 2.8, EW = 1.8.

Colour. Integument: Black except integumental fasciae ivory to white as in figure (Fig. 190), mouth parts dull brown to yellowish brown, scape of antennae with white colour on outer side, other segments reddish brown to dark brown; ocelli yellowish brown and glabrous.

Pubescence: Labrum with transparent to white hairs; clypeus with black hairs; supra clypeal area to vertex with white and black hairs intermixed. Scutum, scutellum, episternum with black intermixed with white hairs, rest of mesosoma white; fore leg, with white hairs on outer surface of tibia and basitarsus, inner

surface and other segments with dark brown to black; mid femur black, tibia on outer surface white, outer surface of anterior $\frac{1}{4}$ th of basitarsus with white hairs, rest of mid leg black; hind leg with tibia on outer surface, white to ivory and plumose, rest of hind leg black. $T_1 - T_5$ with apical bands of appressed metallic blue hairs, bands on T_1 and T_2 narrower, on $T_3 - T_5$ blue hair bands over visible portions of terga with few black, long, subappressed, hairs; $T_1 - T_5$ laterally with less dense white hairs intermixed with few black hairs; sternum with plumose white hairs, very few black, simple hairs on lateral areas.

Head: Width in anterior view a little more than $2.23 \times$ distance between front ocellus and lower margin of clypeus (49:22) (Fig. 191); maximum width of head at the level of posterior margin of eyes $5.56 \times$ distance between front ocellus and occipital margin (50:9); relative measurements of POL : OOL = 7.5:6; labrum shiny, impunctate, with few punctations on lateral sides; clypeus, to mandibles and paraocular areas, shiny, impunctate and very minutely reticulate; supra clypeal and supra antennal areas punctate; vertex sparsely and weakly punctate. Ocelli in a triangle on vertex. Scape of antennae very small, not reaching front ocellus; relative length: breadth of antennal segment, scape = 12:4.5, pedicel = 4:4, $F_1 = 8.5:4.5$, $F_2 = 3:5$, $F_3 = 4:5$, $F_4 = 6:5$, $F_5 = 6:5$, $F_6 = 6:5$, $F_7 = 6:5$, $F_8 = 7:5$, $F_9 = 6:5$, $F_{10} = 7:5$, $F_{11} = 7:5$ (Fig. 192). Eyes simple and glabrous, weakly emarginate anteriorly, with very minute and small sparse hairs; relative length: width of eyes in lateral view = 14:9.

Thorax: Maximum width between tegulae to length of thorax = 41:56 (Fig. 190); scutum and scutellum densely punctate, in between punctures micro aereolate; episternum more or less closely punctate (punctations well developed); metanotum and propodeum punctate minutely than scutellum.

Legs more or well developed and long; arolia absent; brush like hairs distributed over the legs; mid and hind tibial spurs well developed, long and

pointed, outer surface not pectinate, smooth; last tarsal segment some what bend and long (Fig. 190).

Wing subhyaline with browish tints, posterior areas of wing membrane striated and papillate, minute hairs distributed on wing membrane, which is sparse on posterior aspect; wing venation as in figure (Fig. 190); marginal cell 1.14 x distance from apex of marginal cell to wing tip; jugal lobe smaller than vanal lobe; vein cu-v of hind wing 0.71 length of second abscissa of M+Cu (Fig. 190).

Metasoma: Metasoma minutely punctate, in between areas minutely striato reticulate; sternum also minutely and weakly punctate; T₇ bidentate, metasomal bands of hairs as in figure (Fig. 191).

Female: Unknown.

Materials examined: *Holotype:* M, INDIA, Kerala, Karumala, Jobiraj, T. 6-viii-2000; *Paratypes:* 2M, INDIA, Kerala, Kalpetta, Jobiraj, T. 20-iii-2001.

Distribution: INDIA (Kerala).

Flower Record: Unknown.

Habitat: Undisturbed and disturbed habitats.

Discussion: This species superficially resembles *A. (Z.) parhypate* Lieftinck in general appearance, but differs from it mainly in the following characters: 1. Metasomal hair bands metallic bluish violet (In *A.(Z) parhypate* metasomal hair bands metallic green or blue); 2. Median part of scutum and scutellum with sparse pubescence (In *A.(Z) parhypate* median part of scutum and scutellum devoid of pubescence); 3. Suberect hairs on clypeus bristle like, dark brown to black (In *A. (Z.) parhypate* hairs on clypeus suberect to appressed, silky and transparent with golden tints); 4. Flagellar segment 1 with a reddish brown spot apically (In *A. (Z.) parhypate* (flagellar segment 1 without spots); 5. Punctations on

scutum and scutellum not very close medially (In *A. (Z) parhypate* scutum and scutellum closely punctate).

6. *Amegilla (Zonamegilla) parhypate* Lieftinck

(Figs: 194-197)

Amegilla parhypate Lieftinck 1975. *Ann. Hist. Nat. Mus. Nat. Hung.*, 67: 279-291.

Type: Male and Female from Korea.

Plesiotype: F: TL = 13.27, HW = 5.23, HL = 3.55, SL = 0.91, FL = 3.55. FWL = 10.27, FWW = 3.78, HWL = 6.73, POL = 0.91, OOL = 0.73, EL = 3.36, EW = 1.82.

Colour: Integument: Body usually black, except mouth parts yellowish brown; mandibles cream, basal tubercles and apical portions blackish brown; labrum, clypeus, supra clypeal markings, paraocular markings, antennal spots, creamy yellow; ocelli glabrous and reflect reddish brown; tegulae dull brown, wings subhyaline, veins dark brown to black.

Pubescence: Pubescence on labrum short, semierect and light golden; erect bristles on clypeus brownish black, hairs golden and suberect; raised pubescence covering frons and vertex pale fulvous mixed with black, long hairs in occipital area dark tipped, remaining pile above and behind eyes light fulvous changing palest yellow on genal area anteriorly. Pubescence on mesosoma pale yellow to ivory mixed with black bristles only on mesonotum and scutellum; medial area of mesoscutum and scutellum without pubescence; episternal pilosity almost light yellow to ivory or white. Fore leg with white hairs to ivory distributed throughout outer faces, inner faces with brownish black to black bristles; apex of mid tibia in addition with ivory external patch of dense, pale ferruginous hairs, outer surface of basitarsus ivory white; tuft at apex of hind femur almost white, partly overlying basitibial plate, which itself is broadly oval. Scopal hairs on outer face of hind tibia throughout pale yellow, except a short triangular black streak just

below the basitibial plate, this spot tapering to a point apically; inner faces with long fringes.

Metasomal dorsum with short, deep black pubescence with colour band, colour bands of gastral tergites 1-4 somewhat broader and light green, brilliant, frequently with distinct coppery reflex; bands successively broader on following tergites, on $T_3 - T_4$ with tiny forward projections in the median line, on T_4 somewhat more expanded in the middle than at sides. Tergite 5 black, but sides carrying a pure white tuft dense and much shorter posterior fringe at middle of posterior margin deep velvet-black. Tergite 6 and pygidial plate dark brown to black.

Head: Width in anterior view a little more than $1.92 \times$ distance between front ocellus and lower margin of clypeus ($57.5:30$) (Fig. 195); maximum width of head at the level of posterior margin of eyes $8.3 \times$ distance between front ocellus and occipital margin ($57:9$); relative measurements of POL : OOL = $10:8$; labrum a little shorter, breadth: its median length as $18.5:14$; labrum superficially punctate; clypeus more coarsely and deeply punctate, supra clypeal area and vertex sparsely and superficially punctate; labral and clypeal markings as in figure (Fig. 195) ocelli in a triangle on vertex; antenna short, relative length : breadth of antennal segments, scape = $10:3$, pedicel = $2:3$, $F_1 = 8:3$, $F_2 = 3:3$, $F_3 = 3:3.5$, $F_4 = 3:3.5$, $F_5 = 3:3.5$, $F_6 = 4:3.5$, $F_7 = 3:3.5$, $F_8 = 3.5:3.5$, $F_9 = 3.5:3.5$, $F_{10} = 4.5:3$ (Fig. 196). Eyes simple and glabrous, relative length : width of eyes in lateral view $7:20$.

Mesosoma: Maximum width between tegulae to length of mesosoma = $47:67$ (Fig. 194); scutum closely and deeply punctate, medial and parapsidal lines distinct; scutellum punctate as on scutum, but not very closely arranged, a medial carina separates scutellum into two halves; episternum more or less closely punctate, weaker than scutum and scutellum; metanotum and propodeum uniformly punctate, more or less closely and finer than scutum and scutellum.

Legs of normal slender form; arolia absent; mid and hind tibial spurs, long, pointed and minutely pectinate at their outer surface; basitibial plate distinct, more or less oval shaped; hind tibial spurs pointed and minutely pectinate; brownish hair streak just below basitibial plates distinct (Fig. 194).

Tegulae sparsely and very superficially punctate; posterior parts of wing membrane striated and papillate (Fig. 194); wing venation as in figure (Fig. 194); marginal cell length more or less equal or more than the distance from apex of marginal cell to wing tip; jugal lobe of hind wing smaller than the vanal lobe; cu-v of hind wing 0.55 length of second abscissa of M+cu (Fig. 194).

Metasoma: Punctuation on metasoma fine and in between areas glabrous and minutely striato reticulate. Sternal punctations more deeper than tergum; metasomal bands as in figure (Fig. 194).

Male: Male differs from female or having the following important characters: 1. Facial markings as in the figure (Fig. 197); 2. Labrum sub-rectangular, distinctly broader than long; 3. Antennal marking larger than female; 4. Outer surface of hind tibia fully covered with very light yellow pubescence; 5. Tergites 1-5 with sharply defined, moderately broad, light metallic green posterior bands not uniting at the extreme lateral margins and composed of elongate scale-like hairs entirely concealing the surface.

Materials examined: Plesiotype: F, INDIA, Kerala, Kattikulam, Jobiraj, T. 12-ix-1998; *Other materials examined:* 1M, INDIA, Kerala, Mananthavady, Jobiraj, T. 25-vii-1998; 3M, INDIA, Kerala, Trissur, Ushakumari, 20-vi-1998; 2M, INDIA, Kerala, Calicut University Campus, Jobiraj, T. 2-vi-1998; 1M, INDIA, Kerala, Kattikulam, Jobiraj, T. 12-ix-1998.

Distribution: INDIA (Kerala)

Flower Record: Unknown.

Habitat: Disturbed and undisturbed habitats such as forests, agricultural fields and gardens.

Discussion: This species resembles *Amegilla* (Z.) *keralensis* sp. nov. in general appearance, but differs from it mainly in the following characters: 1. Median part of scutum and scutellum devoid of pilosity. (In *Amegilla* (Z.) *keralensis* sp. nov., scutum and scutellum with thickly pubescent); 2. Pubescence on head and mesosoma more or less reduced (In *Amegilla* (Z.) *keralensis* sp. nov. head and thorax with thick pubescence); 3. Facial markings more yellow (In *Amegilla* (Z.) *keralensis* sp. nov. facial markings yellowish white to ivory coloured).

7. *Amegilla* (*Zonamegilla*) *zonata* (Linnaeus)

(Fig. 193)

Apis zonata Linnaeus 1758, *Syst. Nat. ed.* 102, i, p.576.

Anthophora zonata Linnaeus, 1897, Bingham, *Fauna. Brit. Ind. Hym.*, i, p.527, pl. iv, Fig. 4.

Anthophora zonata Linnaeus, 1911, Ckll., *Ann. Mag. Nat. Hist.* (8), vii, p.491.

Anthophora comberi Cockerell 1911, ckl. l.c., p.493.

Holotype: TL = 11-13 mm.

Colour: Integument: Black; labrum, base of mandibles, sides and apical margin of clypeus, with a narrow medial line on the same, yellowish white; the labrum with a lateral spot and a line along its base black; a small transverse triangular spot above the base, clypeus and front of scape of antennae pale yellowish white.

Pubescence: Head and mesosoma densely pubescent, clypeus and bases of metasomal segments thinly pubescent; the front and vertex above the base of

antennae, and mesosoma above clothed with dull rufofulvous pubescence mixed with black hairs and with apex of many of other hairs black; legs covered with thin cinereous pubescence; cheeks behind the eyes, head and mesosoma beneath, and posterior tibial above with snow white pubescence; pubescence on metasoma black, apical margins of segments 1-4 with transverse bands of metallic blue scale-like hairs.

Head and mesosoma finely and closely punctured under the pubescence, the bases broadly of metasomal segments finely aciculate. Wings nearly clear hyaline, sometimes with fulvous tint, nerves and tegulae testaceous.

Male: Male differ from female in having the following important character: 1. The clypeus entirely yellowish white with two divergent broad curved spots at base, black.

Flower record: Unknown.

Distribution: INDIA (Kerala, throughout India), Burma, Ceylon, Malay regions to Australia.

Biology: Unknown.

Habitat: From Disturbed and undisturbed areas.

Remarks: This species is not represented in the present collection. Hence the description and illustrations given above are based on the description by Bingham 1897.

Tribe 2. Melectini

Diagnostic features:

Tibial scopa absent in females. The second abscissa of vein M+Cu of the hindwing is shorter than the oblique Cu-V and sometimes absent. Marginal cell rounded apically. The middle tibial spur unmodified. The flabellum is simple and rounded.

Genus *THYREUS* Panzer

Crocisa Jurine. 1801. Type species: *Nomada scutellata* Jurine, 1801. *Intel. der. Litt. Zei.* 1: 160-165.

Thyreus Panzer 1806. Type species: *Nomada scutellaris*. Fabricius 1781, by L.A. Sand house, *Proc U.S. Nat. Mus.* 95: 541 and 604, 1943.

Crocisa Jurine 1807. Type species: *Nomada histrio* Fabricius. *Hym.* p. 239.

Diagnostic characters:

This genus ranges from minute to small bees; head not so wide as mesosoma; labrum bend downwards at an angle to margin of clypeus; mandibles narrow, simple and acute at apex; maxillary palpi two jointed. Face below the bases of antennae and clypeus projected. Thorax shorter than metasoma, scutellum flat, produced into a plate posteriorly and marginate (Fig. 203); legs moderately stout with pubescent spots on tibia, femur, and tarsal segments, wings broad and ample; forewing with cell rounded at the base and apex (Fig. 203); three submarginal cells; metasoma conical, sharply acute at apex; usually white or blue spotting or banding present on metasoma.

Distribution : INDIA (Kerala, Tamilnadu, Karnataka, Bengal, Sikkim, Maharashtra) Cosmopolitan, especially in East Asia and Australia.

Biology : All species of *Thyreus* are considered to be predator inquilines in the nest of Anthophorini and the hosts at present known or suspected all in the genera *Amegilla* and *Asaropoda*, while some *Anthophora* must be added as foster bees in parts of temperate regions (Lieftinck, 1962).

Discussion : The body is less robust than that of most *Melecta*, probably called apiform or euceriform, with a striking pattern often including pale to bright-blue or greenish areas of appressed hairs.

Remarks : Lieftinck (1962) reports 40 species from Indo-Australian region, of these 11 from India.

Hitherto recognizes one species viz. *T. narendrani* as new to science along with two new reports, viz. *T. ceylonicus ceylonicus* (Friese) from Kerala, as well as India and viz. *T. surniculus* Lieftinck from Kerala. In this work, 6 species have been redescribed, 1 species was newly described and description of three species have been added altogether 10 species have been dealt. A key to the species of Indian region is also provided.

KEY TO THE INDIAN SPECIES OF *THYREUS* PANZER

1. Light pubescence pure white; or faintly bluish 2
- Light pubescence various tints of blue, with or without metallic lusture, but not pure white 5
2. Hind tibia outwardly with fringe of long dark bristles along apical margin; Trochanter of hind leg with tuft of long hairs 3
- Hind tibia without fringe of long dark bristles along apical margin; Trochanter of hind leg lacking tuft of long hairs 4
3. White spots on dorsum of mesoscutum extensive; 'ms' extending beyond level of anterior border of 'mls'; 'plsa' linear, occasionally attached to pls; 'pls' conspicuous, usually much larger than 'mls' (Fig. 220)
..... *T. ramosellus* (Cockerell)
- White spots on dorsum of mesoscutum smaller; 'ms' short not reaching level of 'mls'; 'plsa' vestigial or absent altogether; 'pls' subcircular, usually not much larger than 'mls'; colour pattern as in figure (Fig. 230)
..... *T. takaonis* (Cockerell)
4. Light marking white or palest blue. Dorsal thoracic spots all isolated; parascutella entirely black haired; outer faces of middle and hind tibiae white, but abruptly turning black apically. Membrane of forewing dark smoky brown; colour pattern as in figure (Fig. 207) *T. histrio* (Fabricius)
- Light marking snow-white and more extensive. Anterior thoracic spots not sharply outlined, dark areas with white hair intermixed; lateral and posterior mesoscutal spots coalescent; parascutella atleast partly white haired. Whole surface of tibiae and tarsi clothed with white pubescence outwardly. Membrane of forewing pale brownish
..... *T. albolateralis* (Cockerell)

5. Dorsum of scutellum with a pair of conspicuous, subcircular, blue spots, one on each side of the middle (Fig. 224) *T. smithii* (Dalla Torre)
- Dorsum of scutellum without blue spots; wholly covered with black hair ..
..... 6
6. Posterior carina of hind femur strongly raised proximally and terminating abruptly in a robust tooth 7
- Posterior carina of hind femur only slightly raised and terminating some distance from apex in a low, blunt tubercle or simple 8
7. Thoracic spots 'plsa' and 'pls' isolated and lateral patch under the wings is completely divided by black; parascutella black haired (Fig. 200); scutella relatively broader, with more convex side margins (Fig. 200)
..... *T. ceylonicus ceylonicus* (Friese)
- Thoracic spots 'plsa' and 'pls' confluent around tegulae; 'plsa' occasionally linear and isolated and the lateral patch under the wings not completely divided by black; parascutella with blue spots; scutella less broader, with less convex side margins as in figure (Fig. 203)
..... *T. himalayensis* (Radoszkowski)
8. Parascutellar spot with blue or white hairs 9
- Parascutellar spot absent, wholly covered with black hairs 10
9. Tegular marking 't' absent; media lateral spot 'mls' isolated. Metasomal band of three usually divided, forming two isolated spots of unequal size on each side of segment (Fig. 221) *T. narendrani* sp. nov.
- Tegular marking 't' present; mediolateral spot 'mls' confluent with antereolateral 'als' spot. Metasomal band three undivided (Fig. 211)
..... *T. massuri* (Radoszkowski)

10. Tegulae spotted with blue or white hairs 12
 — Tegulae without blue or white hairs 11
11. Forewing dark brown with bronze lusture; hindwing clear; rhinaria crescent shaped and deeply impressed in female antennal segments 4-11 and weakly impressed on 3-12 segments of male *T. praestans* Lieftinck
 — Forewing brownish fuscous without any lusture; hindwing subhyaline; rhinaria present on antennal segments 3-11 of female, linear, extending along full length of segment, and weakly impressed
 *T. surniculus* Lieftinck
12. Hind basitarsus straight, its outer face scarcely hollowed out, punctate all over; in male rhinaria on basal half of 4-12 segments, suboval and feebly indicated; in female on 4-11 segments, all narrowly oval and fairly deeply impressed *T. medius* (Meyer)
 — Hind basitarsus very slightly out bent in male, straight in female, outer face slightly concave, finely punctate; in male rhinaria on 3-12, placed in long axis, elongate-oval and shallowly impressed; in female on 3-11 segments, almost linear and quite sharply indicate
 *T. novaehollandiae signatus* (Meyer)

1. *Thyreus ceylonicus ceylonicus* (Friese)

(Figs: 200-202)

Crocisa ceylonica Friese, 1905, *Zeitschr. Hym. & Dipt.* 5: 2, 428 (key). Type: female, Ceylon.

C. ceylonica Friese, 1909: *Ann. Mus. Nat. Hung.* 7: 261 (Key).

C. ceylonica Friese, Strand 1913, *Archiv f. Naturgesch.* 79 A, 2: 148, (addit. descr.). Type: Female, Ceylon.

C. ceylonica Fabricius. Friese, 1918, *Zool. Jahrb. Abt. Syst.* 41, 5: 496, 511-512 (Pars, Ceylon only). Type M & F, Ceylon.

C. nitidula ceylonica Friese. Meyer 1921, *Archivf. Naturgesch.* 87A, 1: 164 - Type: F. Ceylon. Leifstinck 1958 *Nova Guinea, new ser.*, 9: 25 (list).

Plesiotype: F (worker) TL = 12.71, HW = 3.5, HL = 2.89, SL = 0.9, FL = 3.9, POL = 0.75, OOL = 0.38, FWL = 8.7, FWW = 3.7, HWL = 6.7, EW = 1.43, EL = 2.57.

Colour: Integument: Deep black except, eyes silvery to ash brown, mouth parts ferruginous to black, funicular segments with light brown reflection; forewing membrane with dark smoky tint and with diffuse lighter streaks in largest cells and similar spots bordering submarginal cells; hind wing subhyaline except apically, wing veins dark brown; ocelli with dull brownish white reflections.

Pubescence: Body pubescence deep black, conspicuously variegated with blue hairs; hairs short and dense, mostly decumbant and concealing surface, single blue hair rather slift, 5-9 ramifications; erect black hair and blue hairs more finely branched and feathery. Pubescence on clypeus, light blue, hairs on face light blue, (Fig. 20); a tuft of white hairs on anterior region of antennal toruli; erect hairs on vertex black intermixed with white, black hairs, small and white hairs finely branched and longer than black hairs; scape and pedicel of antennae with minute appressed pilosity. Mesosoma with black plumose hairs variegated with light blue hair patches; episternal hairs light blue to white and much longer and finely branched; thoracic patches of blue hairs as in figure (Fig. 200); of these 'als' larger than 'mls' and 'ms', 'plsa' reduced into small spot; 'ps' larger than 'mls' and 'plsa' semi circular; 'ps' 's' 't' etc. wanting; episternum with black hairs, on which blue patches very much reduced as small rounds; lateral patch under wings completely divided by black patch; outer surface of fore tibia, mid tibia from apex to base and hind tibia on basal three fourth covered with decumbent light blue hairs; outer surfaces of all tarsi with much white pubescence; a tuft of plumose hairs projecting backwards from beneath posterior border of scutellum.

Metasoma covered with decumbant black hairs with blue patches, patches as in figure (Fig. 200); on outer surfaces of metasoma with suberect, long and stiff black pilosity with few long white pubescence; blue patches under sternite reduced or absent in posterior segment.

Head: Width in anterior view a little more than $1.39 \times$ distance between front ocellus and lower margin of clypeus (66.5 : 48) (Fig. 201); maximum width of head at level of posterior margin of eyes $14 \times$ distance between front ocellus and occipital margin (42:3); relative measurements of POL : OOL = 9:4.5; mandible glabrous; malar area much reduced; labrum punctate, with two depression on their lower surfaces. Clypeus deeply and closely punctate; radicle of antennae minutely and closely punctate; frontal line raised in front and touches middle of front ocellus; supra clypeal and supraantennal area deeply and closely punctate; vertex coarsely and superficially punctate, scape of antennae not reaching front ocellus, antenna slender, F_1 shorter than F_2 ; $F_2 - F_{10}$ longer than wide and all of about same length, rhinaria present on segments $F_2 - F_{10}$, and extending along full length, linear and sharply impressed; relative length; breadth of antennal segments; scape = 18:6, pedicel = 3:11, $F_1 = 3:5.5$, $F_2 = 7:6$, $F_3 = 7.5:7$, $F_4 = 7.5:7$, $F_5 = 7.5:7$, $F_6 = 7.5:7$, $F_7 = 7.5:7$, $F_8 = 7:7.5$, $F_9 = 7:6.5$, $F_{10} = 7:5.5$ (Fig. 202). Eyes glabrous, with puncti like impressions small on anterior side, posteriorly it becomes larger and superficial; very minute hairs sparsely distributed; Relative length : width of eyes in lateral view = 18:10.

Thorax: Maximum width between tegulae to length of thorax 38:56; integument of scutum glabrous; episternum deeply and densely punctate, disc of scutum and scutellum superficially and finely punctate; mesoscutum finely punctate; basal scutellar sutures scarcely impressed, dorsal surface of scutellum slightly concave, emargination distinct with sides of posterior border occasionally straight or almost so (Fig. 200).

Legs comparatively short and robust; femora and tibia moderately swollen, posterior ventral carina of hind femur present; hind basi tarsus shorter than tibia, outer face evenly punctate and scarsly pubescent, only a patch of short blue hair on outer surface well developed (Fig. 200).

Whole surface of tegulae moderately, densely punctate, in between punctations reticulate. Relative measurements of forewing length: its maximum width = 104:44; minute hairs distributed over wing membrane and wing vein as in figure (Fig. 200) hairs almost absent in first cubital, second cubital and second medial cell; wing venation as in the figure (Fig. 200); three submarginal cells; posterior parts of wing membrane papillate and striated; jugal and vanal lobes of hindwing distinct; jugal lobe is smaller than vanal lobe; the vein V combines or touches with Cu-v, hamuli 19, posterior part of wing membrane papillate.

Metasoma: Glabrous and covered with black hairs with distinct blue patches or marking as in figure (Fig. 200); punctures on gastral tergites more superficial and much fine; posterior border of gastral tergites impunctate, smooth margins successively broader from before backwards. Sternal plates deeply punctate; paired colour bands of gastral tergites 2-5 widely interrupted, those of 3 (2-3) usually again divided forming two isolated spots of unequal size on each side of segment, latero-ventral spots not visible from above small; spot on T4, smaller than T5. T1 with mid basal semi-circular spot and a longitudinal large patch.

Male: Male differ from female in having the following important characters: 1. Antenna with rhinaria on F2-F11, placed in the long axis, narrowly oval, but feebly indicated; 2. Outer faces of fore and middle tibiae from base to near apex, and with basal half to three-fifth of hinder pair, blue; basitarsus of forelegs (rarely also of middle pair) likewise blue outside.

Materials examined: *Plesiotype* : F, INDIA, Kerala, Athirappilly, Jobiraj, 24-i-1999; **Other material examined:** 1F, INDIA, Kerala, Thrissur, Ushakumari, 10-ix-1998.

Flower record: Unknown.

Distribution: INDIA (Kerala, Tamilnadu, Karnataka, Andaman Islands), Ceylon.

Biology: Unknown.

Habitat: Mainly from undisturbed habitats, also seen in disturbed and semidisturbed areas.

Discussion: This species resembles *T. himalayensis* (Radoszkowski), but differs from it mainly in the following characters: 1. Thoracic spots 'plsa' and 'pls' isolated, and in that the lateral patch under the wings is completely divided by black (In *T. himalayensis* thoracic spots 'plsa' and 'pls' confluent around tegulae, 'plsa' occasionally linear and isolated, and in that the lateral patch under the wings not completely divided by black); 2. Parascutella black-haired (In *T. himalayensis* parascutella usually with blue spot. 3. Scutella relatively broader, with more convex side margins in males (In males of *T. himalayensis*, scutella less broader, with less convex side margins).

Remarks: This is the first report *T. ceylonicus ceylonicus* from Kerala as well as India. Earlier it was originally described by FRIESE (1905) from Ceylon.

2. *Thyreus himalayensis* (Radoszkowski)

(Fig. 203-206)

- Crocisa himalayensis* Radoszkowski, 1893. *Bull. soc. Imp. Nat. Moscou, Annee*, new ser. 7: 171, Type - Male Himalaya.
- C. javanica* Friese, 1905 *Zeitschr. Hym. & Dipt.* 5: 2-3, 8 (include. key). Type: Female Java.
- C. nitidula* var. *tarsalis* Friese, 1905 *ibid.* 4, 9 & 11 (include. key). Type: Male and female India, Burma, Ceylon, Java, Sumatra," Lectotype male Khasi Hills.
- C. pernitida* nom. nor. pro. *C. nitidula* Friese, nec Fabr. Cockerell, 1907, *Bull. Amer. Mus. Nat. Hist.* 23: 233 - lectotype male Khasi Hills.
- C. javanica* Friese + var. *tarsalis* Friese, 1909, *Ann. Mus. Nat. Hung.* 7: 261-263 (Male and Female Key).
- C. decora* Smith + *emarginata* Cockerell, 1910, *Entomologist*, 43: 219.
- C. amata* Cockerell 1911, *Ann. Mag. Nat. Hist.* (8) 7: 312 Type: Male and female Formosa; male holotype Takao, Formosa.
- C. amata* Ckll, Strand 1913, *Supplem. Entom.* 2: 53 (no descr.). Type: male and female, loc. diff.
- C. nitidula* F + *emarginata* Lep. Friese 1914, *Tijdschr. V. Ent.* 27: 8. Type : male and female.
- C. ceylonica* Friese, 1918 *Zool. Jabrab.* 41, 5: 512 (note, erroneous synonymy).
- C. reducta* Cockerell, 1919, *Philipp. J. Sci.* 14: 199. Type female Singapore.
- C. decora* Smith, Cockerell, 1919, *Proc. U.S. Nat. Mus.* 55: 183 (Partim 2)
- C. insulicola* Cockerell, 1919. *Ann. Mag. Nat. Hist.* (9) 3: 240-241. Type Female Penang I.
- C. reducta* Ckll, Cockerell, 1919, *Ibid.* (9) 4:100 - Penang.
- C. nitidula* F. Meyer 1921, *Archiv f. Naturgesch.* 874, I: 160.
- C. nitidula amata* Ckll. Meyer 1921, *Ibid.* 162-163 - Formosa.
- C. pernitida* Ckll. Meyer 1921, *Ibid.* 156-157.

- C. nitidula* F. stammform + *C. nitidula amata* Ckll, Meyer, 1922. *Ann. Mus. Nat. Hung.* 19: 185, note, pars !
- C. amata* ckll, Cockerell, 1927, *Amer. Mus. Novit.* 274: 12 (Key), 13 (note): Type - Male and Female Formosa; China.
- C. reducta fulvicornis*, Cockerell, 1927, *Ibid.* 11 (key), 13. Type: Male, Hongkong *C. niasensis*, Cockerell, 1927. *Ibid.* 11 (key), 13-14. Type: Female Nias I *C. amata* Ckll, Yano, 1932, *Iconogr. Ins. Jap.* 260, Fig. 502 - Honshu to Formosa.
- C. amata* Ckll, Yasumatu & Narisada, 1935, *Mushi*, 8:71 - Dairen : *Kwanfung Prov.*, S. Manchuria.
- C. centrimacula* J. per, Alfken 1936, *Arkiv. f. Zool.* 27A, No.37: 5 - Type male. "S.6. Szeschuan" crect. kiangsu.
- C. amata* Ckll. Yasumatsu, 1946, *Mushi* 17: 22 (no deser.) Type: Male Peking; Japan, S. Manchuria, China & Formosa. Lieftinck 1958, *Nova Guinea*, new ser., 9: 25 (*himalayensis*, *javanica*, *tarsalis*, 26 (*pernitida*), 27 (*amata*; holotype sec. Meyer exerr. Berlin Mus.), 28 (*reducta*, *insulicola*), 298 (*fulvicornis*, *niasensis*) (list).

Plesiotype: M, TL = 12.57, HW = 3.23, HL = 2.6, SL = 0.77, FL = 4.7, POL = 0.6, OOL = 0.4, PWL = 8.17, FWW = 3.1, HWL = 5.17, EL = 2.2, EW = 1.21.

Colour. Integument: Deep black, except eyes brown, antenna reflects dull brown, wing membrane smoky brown, forewing with hyaline streaks in anterior R, in the area posterior 1A and around submarginal cells; hindwing hyaline, subhyaline at their apices, wing veins dark brown.

Pubescence: Body pubescence black, conspicuously variegated with light blue pubescence. Coloured hairs imbricate and form ramified scales, light blue pilosity on face. Plumose, a tuft of white hairs above the antennal toruli, finely branched; scape of antennae with few appressed pilosity; vertex and pronotum covered with long white pilosity; thoracic patches of blue hairs as in figure (Fig. 203); episternum covered with relatively long and plumose white pilosity; 'als' larger than and 'mls' and 'ms', 'ms' very small, 'pls' in continuous with 'plsa', 'ps' represented by a small patch, 't' wanting, sternal patch of blue hairs much

reduced; outer surface of mid tibia from base to apex, hind tibia on anterior $\frac{3}{4}$ th covered with decumbent light blue hairs; all tarsal segments lacking the blue hairs, usually dark brown hairs; metasoma covered with decumbent blue and black hairs, pattern as in figure (Fig. 203); outer surface of metasoma with few suberect and stiff, long, white and black hairs; pilosity on sternites very much reduced, with very small patches of white hairs, other hairs brown, to brownish black.

Head: Width in anterior view a little more than 1.43x distance between front ocellus and lower margin of clypeus (76:53) (Fig. 205); maximum width of head at the level of posterior margin of eyes 7.78x distance between front ocellus and occipital margin (35:4.5). Relative measurements of POL : OOL = 7:4.5; mandible glabrous and punctations sparse; labrum moderately punctate with two depression at their anterior region, malar space much reduced; clypeus closely and deeply punctate, frontal line passes in between anternal toruli, supraantennal area deeply and closely punctate; vertex sparsely punctate. Scape of antenna not reaching front ocellus; antenna somewhat thicker and stronger, rhinaria present as small impressions from 4-12 antennal segments. Relative length: width of antennal segments = scape = 18:5.5, pedicel 3:5, F₁ = 7:8.5, F₂ = 10:7, F₃ 9:7, F₄ = 9:7, F₅ = 9:7, F₆ = 9:6.5, F₇ = 9:6.5, F₈ = 9:6.5, F₉ = 9:6.5, F₁₀ = 9:6.5, F₁₁ = 9:6.5 (Fig. 206). Eyes smooth and glabrous, relative length: width of eyes in lateral view = 15.5 : 8:5.

Thorax: Maximum width between tegulae to length of thorax 26:45; integument of scutum rather glabrous; episternum sparsely and deeply punctate; disc of scutum and scutellum superficially and finely punctate; scutellum flat with slightly upturned lobes, anterior part of scutellum slightly convex on upper part; legs rather thin and short, posterior ventral carina of hind femur present, ending in a robust tooth; mid region of hind femur with an internally projected tooth (Fig.

204); hind basitarsus thinner and shorter than hind tibia; all tarsi very small and thin; tegulae moderately punctate, in between punctations striato-reticulate; wing venation as in figure (Fig. 203); Relative measurements of forewing length : its maximum width = 98:37; hair distribution in wing membrane as in figure (Fig. 203); posterior part of wing membrane papillate; Hamuli in hind wing 16.

Metasoma: Metasoma rather thin and narrow, longer than mesosoma; Black and light blue hair distribution as shown in the figure (Fig. 203); punctures on gastral tergites more superficial and much finer. Sternal plates sparsely punctate.

Female: Female differ from male in having: 1. Rhinaria present on antennal segment 4-11, extending along full length, linear and sharply impressed; 2. Pygidial plate moderately, broadly triangular, sides straight or almost so, lateral margins raised except apically; 3. Sternite 6 somewhat produced apicad, its posterior border smooth and shiny and carrying a minute sharp median carina.

Materials examined: Plesiotype: M, INDIA, Kerala, Silent Valley, Binoy, C.F. 2-xii-1999.

Flower Record: Unknown.

Distribution: INDIA (Kerala, Assam, Sikkim, Bengal, Tamilnadu, Pondichery) Java, Singapore, China, Siam, Indo-China, Combodia, Vietnam, Taiwan, Malaysia, Ceylon, Bhutan.

Biology: Unknown.

Habitat: Both disturbed and indisturbed areas (Hills, Plains, Cultivated areas, gardens etc.).

Discussion: This species resembles *T. ceylonicus* (Fries) in general appearance, but differ from it in the following characters: 1. Apex of gastral

sternite 6 little protuberant and evenly round (In *T. ceylonicus* apex of gastral sternite 6 more markedly projecting and narrowly rounded); 2. Distal half of gastral sternite subcircular in outline (In *T. ceylonicus* distal half of gastral sternite more oval and longer); 3. Parascutella with markings of a lighter tint of blue (In *T. ceylonicus* parascutella invariably black haired); 4. Thoracic 'plsa' in continuous with 'pls', and the lateral patch under the wings is not completely divided by black (In *T. ceylonicus* thoracic 'plsa' and 'pls' isolated and in that the lateral patch under the wings is completely divided by black); 5. Scutella less broader, with less convex side margins (In *T. ceylonicus* scutella relatively broader, with more convex side margins).

Remarks: The female specimen is not represented in this collection and diagnostic characters given above are based on the description of Lieftinck (1962).

3. *Thyreus histrio* (Fabricius)

(Figs: 207-300)

Nomada histrio Fabricius, 1775. *Syst. Ent.* 388-389, sex not stated, Ind. or.

Crocisa minuta n. sp. Radoszkowski 1893. *Bull. Soc. Imp. Nat. Moscou, Annee 1893*, new ser., 7: 168-169, Pl. iv fig. 8, S (F, Scutellum), a-c, i (M, genit.) - M, F, Massuri (Indes Anglaises).

C. minuta Rad: *C. ramosa* Lep. Friese 1909. *Deutsch. Ent. Zeitschr., Beiheft*: 127.

C. chionotricha sp. n. Cockerell 1919. *Ann. Mag. Nat. Hist.* (9)4: 100 - M, Coimbatore, S. India.

C. minuta Rad a synonym of *C. ashabadensis* Rad. Meyer 1921. *Archivf Naturgesch.* 87A, 1: 199, 1921.

Lieftinck 1958. *Nova Guinea*, new ser., 9; 24 (*histrio*, *minuta*), 28 (*rectangula*) (list.)

Lieftinck. 1959. *Trjdschr. V. Ent.* 102: 25-29, 1959 (redescr., Synon. 2 references), Figs. 9-14 (structures F, M) M, F, India, M, F, Ceylon, M, F, Andaman Is.

Plesiotype: F: (Worker): TL = 13, FWL = 10, FWW = 3.71, HWL = 7.29, HWW = 2.4, POL = 0.714, OOL = 0.523, HW = 3.72, HL = 2.89, SL = 1.4, FL = 3.86, EL = 2.428, EW = 1.57.

Colour: Integument: Deep black except, eyes with dull brown streaks, antenna brownish black, wing membrane smoky brown to dark fuscous, with hyaline spots, wing veins dark brown to brownish black; hindwing hyaline, fuscous at apex; ocelli glabrous with greyish white reflections.

Pubescence: Body pubescence brown, conspicuously variegated with white to very light blue hairs, and dark brown erect hairs on outer margins of body; coloured hairs mainly imbricate and form ramified scales (Fig. 210); snow-white hairs on the face as in figure (Fig. 208); pubescence on labrum with light brown reflections vertex with snow white pubescence; episternum with distinct patches of snow white plumose pilosity, other areas covered with dark brown pilosity; scutellum with black hairs except white patch or spot of pubescence at notched area; thorax patch of white hairs as in figure (Fig. 207). Dorsal-thoracic spots all isolated, of these 'als' smaller than 'mls', posterior end of 'ms' entering middle of 'mls', 'plsa' not continuous to 'pls', 'plsa' smaller than 'pls'; 'ps' and 's' wanting; 't' forms distinct spot. Outer surface of fore tibia, mid and hind tibia from base to middle covered with white hairs; all tarsal segment with few white hairs intermixed with brownish black hairs; fore tibia and first tarsal segment with very long brown hairs distributed at their posterior margins; mid femur with spot of white hairs as in figure (Fig. 207); metasoma covered with brown and white decumbent pilosity, few long dark brown suberect and white pubescence on outer margin of metasoma, lateral marks of first gastral tergite 'L' shaped and pattern of patches of hairs as in figure (Fig. 207); white patches of sternites small and much reduced than tergal spots.

Head: Width in anterior view a little more than 1.46 x distance between front ocellus and lower margin of clypeus (67:46) (Fig. 208); maximum width of head at the level of posterior margin of eyes 7.8 x distance between front ocellus and occipital margin (39:5); relative measurements of POL : OOL = 7.5:5.5; mandible glabrous and sparsely punctate; malar area very much reduced; labrum closely punctured with few sparse deep punctations on its anterior half; clypeus deeply and closely punctate; frontal line slightly raised and touches the middle of front ocellus; ocellar area and vertex sparsely punctate. Scape of antenna not reaching front ocellus; antenna somewhat thicker and stronger; rhinaria present on F₂ - F₉, linear and deeply impressed and extending along full length, except F₉, which is reduced (half-length only); Relative length: breadth of antennal segments scape = 20.5:6, Pedicel = 4:5.5, F₁ = 8.5:6, F₂ = 6.5:6, F₃ = 6.5:6.5, F₄ = 6.5:6.5, F₅ = 7:6, F₆ = 7:6, F₇ = 7:6, F₈ = 6.5:6, F₉ = 6.5:6, F₁₀ = 9:6 (Fig. 209). Eyes smooth and glabrous and broader towards the lower margin, relative length: width of eyes on lateral view = 17:11.

Thorax: Maximum width between tegulae to length of thorax 40:49; Integument of mesosoma rather glabrous. Pronotum punctate, disc of scutum and scutellum superficially and finely punctate; episternum sparsely punctate; scutellum flat (Fig.), with slightly upturned lobes and emarginate.

Legs rather short, thick and strong, of simple structure; mid femur swollen and subcylindrical; hind basitarsus shorter than hind tibia, spines pointed and pectinate at their posterior margin; outer face of hind femur slightly depressed.

Tegulae moderately punctate, in between punctations striato-reticulate; wing venation as in figure (Fig. 207); relative measurements of forewing length: its maximum width = 105:39; hairs distributed on radial cell, sparsely on second cubital, first medial and first submarginal cells; three submarginal cells; posterior part of wing membrane papillate and striated; jugal and vanal of hind wing

distinct; jugal lobe rounded and smaller than vanal lobe; vein combines or touches with cu-v, hamuli 20 or more (below 23); posterior part of wing membrane papillate.

Metasoma: Metasoma glabrous and minutely and finely punctate with black hairs and with distinct white patches (Fig. 207); sternal plates deeply punctate.

Male: Male differ from females in having the following important characteristic features: 1. Lateral patches on sixth gastral tergites very much reduced or absent; 2. Antenna thicker than in females; 3. Rhinaria present on - F₁ - F₁₀ in the form of sparsely impressed round areas.

Materials examined: *Plesiotype* : F, INDIA, Kerala, T. Kadavu (Thrissur), R.K. 24-iii-1995; *Other materials examined:* 1 F, INDIA, Kerala, Silent Valley, C.F. Binoy, 12-ix-1995; 1M,3F,INDIA, Kerala, Trissur, Ushakumari, 25-v-1998; 1F, INDIA, Kerala, Silent Valley, C.F. Binoy, 13-x-1995; 1 M, INDIA, Kerala, Wynad, Arif, 30-iv-2000; 1 F, 1 M, INDIA, Kerala, Thrissur, Ushakumari, 25-v-1999; 1M, INDIA, Kerala, Calicut University Campus, Girish. K, 25-v-1999.

Distribution: INDIA (Kerala, Tamilnadu, West Bengal, Karnataka, Orissa, Pondichery); Burma, Ceylon.

Biology: Unknown.

Habitat: Both from disturbed and undisturbed areas.

Discussion: This species resembles to *T. takaonis* (Cockerell) in general appearance, but differs from it in the following characters: 1. Antenna not reaching back to beyond tegula (In *T. takaonis* antenna reaching to beyond tegulae); 2. Thoracic spots as in figure (Fig. 207) (In *T. takaonis* thoracic spots as not in figure).

4. *Thyreus massuri* (Radoszkowski)

(Figs: 201-214)

Crocisa massuri Radoszkowski (1893). *Bull. Soc. Imp. Nat. Moscou*, Annee new ser., 7: 169-170, Type: male, Massuri, Himalaya.

C. massuri Rad., Bingham 1897 ? *Fauna Brit. India, Hym.* I: 517 (Key), 519. N. India.

C. ridleyi Cockerell, 1910. *Entomologist*, 43: 217, 218-219. Type - Female Penanos.

C. sp. near kanshireana Cockerell, 1911. *Ann. Mag. Nat. Hist.* (8)7: 313;

C. surda Cockerell, 1911. *Ann. Mag. Nat. Hist.* (8) 8:770. Type: female Foochow, China.

C. ramakrishnae Cockerell, 1919. *Ann. Mag. Nat. Hist.* (9)3: 192. Type: female Coimbatore, S. India.

C. insulicola Cockerell, 1927. *Amer. Mus. Novit.* 274: 11: Type: Male Koh Tao., Gulf of Siam.

C. insulicola Alfken, 1936. *Arkiv f. zool.* 27A, no: 37: 25- Type male and female Szechuan.

C. surfa Ckll, Hedicke, SB 1946. *Ges. Naturf. Frd. Berlin* 1939 III: 345. Type: female sid-Maudschurec., "China, Tonkon"

C. massuri Lieftinck 1958, *Nova Guinea*, new ser., 9:25 (*massuri*), 27 *crodeleyi* and *Surda*), 28 *ramakrishnae*, 29 (*insulicola*) (list).

Plesiotype: F, TL = 14.6, HW = 3.81, HL = 3.125, SL = 1, FL = 3.81, FWL = 10.1, FWW = 3.8, HWL = 7.1, POL = 0.7, OOL = 0.45, EW = 1.29, EL = 2.5.

Colour. Integument: Deep black except, mouth parts dark brown to brown, labrum with two dull brown spots, eyes light yellow with silvery reflection in certain lights; wing membrane subhyaline, smoky dull brown and generally less obscured subhyaline streaks and spots in basal and posterior spaces and around submarginal cells; hindwing subhyaline and wing veins dark brown; ocelli glabrous and light yellow reflection on certain lights.

Pubescence: Body pubescence deep black, conspicuously variegated with light blue hairs; hair branchlets soft and fine; light blue and minute hairs on labrum, light blue hairs distributed on face as in figure; a tuft of white hairs on anterior part of antennal toruli; vertex covered with small white (light blue) hairs; scape of the antenna covered with minute silky white pubescence. Mesosoma with light blue patches with black hairs; episternal tuft of hairs plumose and white (Fig. 214); scutellum invariably black but parascutellum partly blue; black hairs suberect and finely branched; a fringe of long, plumose white hairs projects from beneath of middle portion of posterior border of scutellum, beneath middle of emargination. Thoracic patch of blue hairs as in figure (Fig. 211); 'als' in continuous with 'plsa' and 'pls', 'ms' extends beyond the middle of 'mls'; 't' and 'ps' distinct; 's' wanting; outer surface of fore tibia, and mid tibia from base to apex, those of hind tibia on basal half with light blue pilosity; all tarsal segments with rich blue colour outwardly; transverse tergal bands interrupted medially; hair pattern in figure (Fig. 211) sternites conspicuously banded with blue on each side of the middle; Pygidial segment black haired.

Head: Width in anterior view a little more than $2.78 \times$ distance between front ocellus and lower margin of clypeus (61:44.5) (Fig. 212); maximum width of head at level of posterior margin of eyes $12.67 \times$ distance between front ocellus and occipital margin. Relative measurements of POL : OOL = 7:4.5; mandible glabrous with few punctations; malar area much reduced; labrum longer than broad, with two distinct brown spots on their anterior half sparsely and deeply punctate. Posterior half of clypeus punctate uniformly; frontal line raised in between antennal toruli; ocellar area and vertex sparsely punctate. Scape of antenna not reaching front ocellus; flagellar segments larger than wide, segment three relatively more slender, fully one fourth longer than wide, remaining segments almost square; rhinaria present segment $F_2 - F_{10}$ narrow, longitudinal and quite strongly impressed. Relative length: breadth of antennal segments,

scape = 16:5, pedicel = 3:5, $F_1 = 9:5$, $F_2 = 6:4.5$, $F_3 = 6:4.5$, $F_4 = 5:4.5$, $F_5 = 5:5$, $F_6 = 5:5$, $F_7 = 5.5:5$, $F_8 = 5.5:5$, $F_9 = 5.5:5$, $F_{10} = 8:5$ (Fig. 213). Eyes smooth and glabrous, relative length: breadth of eyes in lateral view = 17.5:9.

Thorax: Maximum width between tegulae to length of thorax 31.5:47; scutum sparsely and minutely punctate; sides of mesoscutum sparsely and deeply punctate; scutellum, flat and posteriorly emarginate, punctations not clearly visible, episternum more or less well punctate.

Legs strongly developed and of simple structure; tarsal segments of fore leg slender and small compared to tibia; mid tibia subcylindrical and slightly less expanded; hind femur uniformly punctate, hind basitarsus shorter than hind tibia.

Tegulae minutely and superficially punctate, wing venation as in figure (Fig. 211); relative measurements of forewing length : its maximum width = 101 : 38; hair distribution as in figure (Fig. 211); posterior part of wing membrane papillate and striated. Three submarginal cells; jugal and vanal lobes of hind wing distinct; jugal lobe smaller than vanal lobe; the vein 'V' combines or touches with Cu-v; hamuli 19; posterior part of wing membrane papillate and striated.

Metasoma: Metasomal tergites glabrous with distinct patterns of hairs as in figure (Fig. 211); punctures on gastral tergites more superficial and much finer, sternal plates glabrous and sparsely punctate.

Male: Male differ from female in having: 1. Antennae somewhat thick; 2. Rhinaria present on 4-12, oblique and weakly developed; 3. Midtibia not expanded, parallel sided its outer face slightly convex and densely clothed with decumbent pubescence not forming a definite felt like pad, colour light blue subbasally, almost pure white distally; 4. Hind basitarsus very little out curved, parallel-sided; outer face coarsely punctate and basally with scanty hair, the strong dark bristles fringing its ventral border of all about the same length; 5.

Distal portion of tergite 7 somewhat concave, coarsely punctate, sides and apex on each side of the blunt tubercles covered with dark bristles; 6. Apex of sternite 6 produced posteriorly, margin feebly emarginate.

Materials examined: *Plesiotype:* F, INDIA, Kerala, Silent Valley, C.F. Binoy, 12-ix-1995; *Other materials examined:* 1M, INDIA, Kerala, Kodenchery, Jobiraj. T, 12-ix-1995; 1F, INDIA, Kerala, Silent Valley, C.F. Binoy, 11-iii-1995; 1F, INDIA, Kerala, Parambikulam, Suresh, 21-vi-1995; 1M, INDIA, Kerala, Calicut University Campus, Sabirabi, 11-x-1999; 1F, INDIA, Kerala, Trissur, Jobiraj. T, 20-vi-1998.

Flower Record: Unknown.

Distribution: INDIA (Kerala, Tamilnadu, Karnataka, Assam), China, Gulf of Siam.

Biology: Unknown.

Habitat: Disturbed and undisturbed forested areas.

Discussion: This species resembles *T. abdominalis simulator* Lieftinck in general appearance, but differs from it in the following important characters: 1. Wing membrane subhyaline (In *T. a. simulator* wing membrane more fuscous); 2. Pubescence patches more or less well developed (In *T. a. simulator* pubescence patches less developed).

5. *Thyreus medius* (Meyer)

(Figs: 215-218)

Crocisa media Meyer. 1921, *Archiv f. Naturgesch.* 87a, I: 140-143. Type Female Rangoon; Male Hongkong; doubtful.

Male: TL: 11-12 mm; FWL = 8.0 - 9.5 mm.

Colour. Integument: Body deep black except, gastral tergites moderately shiny, black with low metallic purplish and green lusture on basal segments.

Pubescence: Coloured pubescence short and dense, sharply defined, calamine to cendre blue, consisting of branched hairs, longer pile on parts of head and episternum finely plumose. Pattern as in figure (Fig. 215); under surface of mesosoma with patches of blue. Scutellum and parascutella black haired; no blue hair dorsal at apex; a narrow fringe of rather short lighter blue hair projects backward from beneath posterior border of scutellum. Outer faces of fore and middle tibiae from base to near apex, those of hinder pair to about half-way or three-fifth their length, clothed with decumbent coloured hair; blue on fore and hind tibiae, blue and pure white (posteriorly) on middle pair; all tarsal segments black-haired except basitarsi of fore legs, which are blue exteriorly. Metasomal marking as in figure (Fig. 215), tergal bands not constricted or broken laterally. Blue patches on each side of sternites 2 and 3 deep, those on 4 vestigial or absent.

Head: Antennae moderately long, slender, segment 3 scarcely longer than wide, in frontal view distinctly shorter, but seen from behind equal in length or even a little longer than 4, the articulation being oblique; 4-13 all of them a little longer than wide; rhinaria present on basal half of 4-12, sub oval though feebly indicated.

Thorax: Mesoscutum and scutellar areas moderately densely and finely punctate on shining ground, punctures much smaller than distance separating

them and evenly distributed; punctures of tegulae still finer and more superficial but covering whole surface. Basal sutures of scutellar plates scarcely impressed, scutellum flat or even slightly concave as in figure (Fig. 217); emargination V-shaped, lacking apical notch. Mesepisterna coarsely densely punctate, interspaces less than one puncture width.

Legs very slender; inferior margin of femora ridged, posterior carina of hind femur subacute, extending only along its distal three fifth and ending basally in a low rounded tubercle; all tibiae of simple structure, apices truncated; hind tibia moderately widened distally; basitarsi only little shorter than tibiae, hind basitarsus straight and parallel-sided, its outerface barely concave, covered with setigerous punctures.

Forewing brown, except the whole area posterior to M + Cu, and 1A as well as diffuse basal streaks on radial space, and on and around sub marginal cells, subhyaline; hindwing clear, tips gradually somewhat obscured.

Metasoma: Metasomal tergites moderately and densely punctate and glabrous. Tergite 7 closely, finely punctate; surface at first convex, than flat with well pronounced hind angles, free margin impunctate. Posterior border of sternite 5 straight; 6 somewhat produced with rounded apical margin, its surface densely setigerously punctate and hardly noticeably impressed medially.

Female: Female differ from male in having the following characters: 1. Rhinaria well developed, present on 4-11, all narrowly oval and fairly deeply impressed. 2. Pubescence on ventral surface of mesosoma more extensive, the trochanters and base of hind femora being partly blue; bands on metasomal sternites more enlarged (Fig. 216); 3. Outer faces of tarsal segments predominantly blue; 4. Pygidial segment black haired; 5. Length, TL = 13 mm FWL = 11-12 mm.

Flower Record: *Cinchona* sp.

Distribution: INDIA (Kerala, Tamilnadu), Burma.

Biology: Unknown.

Habitat: Disturbed and undisturbed areas (Hills, Mountains, Plains, forests).

Discussions: This species resembles superficially *T. himalayensis* (Radoszkowski), but differs from it the following characters: 1. Hind femur simple without tooth (In *T. himalayensis* hind femur with a tooth); 2. Thoracic spot 'mls' small; 't' present; uninterrupted lateral band on metasomal tergite 3 (In *T. himalayensis* thoracic spot 'mls' large; 't' absent; lateral band on metasomal tergite interrupted).

This species is also resembles to *T. centrimacula* (J. Periz) in general appearance, but differs from it in the colour patterns as in figure (Fig. 215, 216).

Remarks: This species is not represented in the present collection. Hence the description and illustrations is based on the description by Lieftinck (1962).

6. *Thyreus narendrani* sp. nov.

(Figs: 221-223)

Holotype: F (Worker): TL = 14.14, HW = 3.6, HL = 2.8, SL = 1.05, FL = 3.9, EW = 1.43, EL = 2.5, FWL = 10, FWW = 3.7, HWL = 7.4, POL = 1.36, OOL = 0.46.

Colour. Integument: Deep black, except, mouth parts brownish red to black; wing membrane smoky brown, forewing diffusely lighter anteriorly in R, in the area posterior to 1A, and around submarginal cells, hindwing subhyaline and wing veins dark brown; ocelli glabrous with dull white reflections in certain lights.

Pubescence: Body pubescence deep black, conspicuously variegated with light blue hairs; coloured hairs usually ramified and mainly imbricate, anterior part of mandible covered with few white plumose pilosity; white plumose pilosity on posterior part of labrum with unbranched white hairs; anterior part of clypeus and face covered with light blue, plumose pubescence and a tuft of white, long and highly branched hairs arises from anterior part of toruli; on vertex, pubescence sparse and white; genal area thickly covered with plumose white hairs, scape of antenna with few appressed white pilosity. Scutum covered with black hairs variegated with white to light blue small, pilosity; episternum covered with black and white pubescence, white pubescence silky and thick with fine branches. Scutellum covered with black hairs, parascutellum with white spot. Thoracic patches as in figure (Fig. 221); 'als' larger than 'mls', 'ms' enters middle of 'mls', 'plsa' linear and joins with 'pls'; 'pls' distinct and larger than 'mls'; 'ps' forewing distinct spot; 't' wanting; long, plumose whitish hair projects from beneath middle portion of posterior border of scutellum. Fore tibia from base to apex, mid tibia from base to apex and hind tibia on anterior half covered with decumbent light blue hairs all tarsal segments with light blue hairs, much on their outer surfaces; Metasoma covered with decumbent blue and black pilosity, blue to light blue, metasomal patches as in figure (Fig. 221); on outer surfaces or margins of metasoma with few suberect long white and black hairs; blue bands of sternites narrow and thin.

Head: Width in anterior view a little more than 1.14x distance between front ocellus and lower margin of clypeus (72:50) (Fig. 222); Maximum width of head at the level of posterior margin of eyes 10.75 x distance between front ocellus and occipital margin (43:4); Relative measurements of POL : OOL = 9.5:5.5. Mandible, glabrous, anterior portion more or less closely punctate, posteriorly with few deep punctations; malar area much reduced; labrum coarsely punctate with two distinct spots on anterior surface; clypeus closely and deeply punctate;

frontal line slightly elevated in between antennal toruli, not touching the middle of front ocellus; supraantennal area and vertex well punctate; scape of antenna not reaching front ocellus, flagellum long and nearly touching tegula; rhinaria present F4-11 and are linear, more or less oval, deeply impressed and extending along full length of segments. Relative length: breadth of antennal segments, scape = 21:7, pedicel = 4.5:5, $F_1 = 9.5:6$, $F_2 = 9:6.5$, $F_3 = 8:7$, $F_4 = 8:7$, $F_5 = 8:7$, $F_6 = 7:7$, $F_7 = 7:6.5$, $F_8 = 8:6.5$, $F_9 = 6.5:6.5$, $F_{10} = 8:6$ (Fig. 223). Eyes smooth, glabrous and sparsely covered with minute hairs; relative length : width of eyes in lateral view = 17.5:10.

Thorax: Maximum width between tegulae to length of thorax = 41:59. Integument of scutum rather glabrous; scutum evenly punctate, (not closely), in between punctation smooth and glabrous; episternum more or less sparsely punctate; scutellum flat with slightly upturned lobes and emargination distinct; (Fig. 221); scutellum and parascutellum evenly punctate.

Legs more or less strong and simple structure; inner face of hind femur with acute posterior ridge carinate; midtibia slightly swollen and cylindrical; outer surface of mid tibia and hind tibia with few dark coarse spicules; hind tibia with deeply impressed punctations at their posterior part; hind basitarsus shorter and slender than hind tibia.

Tegulae evenly punctate, in between punctations striato-reticulate; wing venation as in figure (Fig. 221); Relative measurements of forewing length: its maximum width = 120:44; minute hairs distributed on anterior part of wing membrane (Fig. 221); three submarginal cells; first submarginal cell more or less square shaped; second and third submarginal cells receives first and second recurrent veins; posterior part of wing membrane papillate and striated; Hind wing with jugal and vanal lobes; jugal lobe smaller than vanal lobe, hamuli - 19-23, posterior part of wing membrane papillate.

Metasoma: Metasoma glabrous and covered with black hairs light blue hairs forms distinct patches; posterior border of gastral tergites normally impunctate, smooth margins successively broader from before backwards; sternal plates punctate deeply, paired colour bands of gastral tergites as in figure (Fig. 221), those of 3 usually again divided, forming two isolated spots of equal size on each side of segment, smallest lateroventral spots not visible from above.

Male: Unknown.

Materials examined: Holotype: F: INDIA, Kerala, Silent Valley, 27-iii-1998, Binoy, C.F.

Etymology: The species is named after Dr. T.C. Narendran, Professor of Zoology, in honour of his expert guidance throughout this work.

Flower Record: Unknown.

Distribution: INDIA (Kerala).

Habitat: Undisturbed forested area.

Discussion: This species superficially resembles *T. massuri* (Radoszkowski) in general appearance, but differs from it in the following characters: 1. Antennal segment 3 slightly longer than broad (9:8) (In *T. massuri* antennal segment 3 relatively more slender, more than one fourth longer than wide); 2. Tegular marking absent (In *T. massuri* tegular marking present); 3. Mediolateral spot 'mls' isolated (In *T. massuri* mediolateral 'mls' confluent with antero-lateral 'als' spot); 4. Metasomal band of 3 usually divided, forming two isolated spots of unequal size on each side of segment, latero-ventral spots very small (In *T. massuri* metasomal band of 3 undivided).

This species also resembles *T. irnea* Lieftinck in general appearance, but differs from it in the following characters: 1. Tegular marking absent (In *T. irnea*

tegular marking present); 2. Outer surface of mid and hind tibiae with coarse spicules (In *T. irnea* outer surface of mid and hind tibiae without coarse spicules); 3. Scutellar spot on emargination absent (In *T. irnea* Scutellar spot on emargination present); 4. Metasomal band of tergite 3 divided into two isolated spots (In *T. irnea* metasomal band of tergite 3 undivided and simple); 5. Median hair fringe under the scutellar emargination long (In *T. irnea* median hair fringe short).

7. *Thyreus ramosellus* (Cockerell)

(Figs. 219-220)

Crocisa ramosella Cockerell 1919; *Ann. Mag. Nat. Hist* (9) 3: 141. Type: Female Chittoor, Madras Pres.

C. macraspis Cockerell, 1919. *Ibid* (9) 4: 99. Type. Male, Saidapet - farm Madras Pres.

Male: TL : 8.9 - 9.0 mm, FWL = 7.5 mm

Colour. Integument: Body deep black, except eyes brown, funicular segments with brown reflections.

Pubescence: Body pubescence deep black, conspicuously variegated with white hairs. White pubescence on mesosoma composed of finely branched decumbent hair; out line of anterior pro and mesonotal spots indistinct, white hair being more sparsely intermixed; posterior spots conspicuous, 'pls' larger than parascutellum; tegulae with anterior and posterior spots; scutellum with broadly triangular spot at apex above notch and with equally broad median fringe of long hair projecting from beneath posterior border; parascutella black haired. Legs with patches of white at coxae, trochanters and near apex of all femora outwardly white; outer faces of fore and middle tibiae from base to apex, of hind tibia on basal three fourth, and streaks along posterior ridges of all tarsal segments. Lateral marks present on gastral tergites 1-6, conspicuous, all transverse extension

broadly rounded inward, basal one absent or barely indicated, the distal one thick, but variable in length; sternal spots 2-4 distinct.

Head : Antennae long, reaching a little beyond tegulae, segment 3 subequal to 4 and all flagellar segments slightly longer than wide; rhinaria well developed on segment 3-12, single and oval on 3, but on next segments there are two rows, each bearing an upper and lower concavity, the former short and oblique, the latter twice as long as upper and placed in the long axis; together they form somewhat hoof-shaped impressions.

Thorax: Body punctation relatively dense and fine, rather superficial, on dorsal thoracic segments not markedly differing from that on gastral tergites. Basal sutures of scutellar plates not impressed, scutellum longer, its surface quite flat, posterior emargination deeper and sides of notch straighter.

Hind femur with distinct posterior convexity (Fig. 220) and outer face of hind tibia with conspicuous comb-like fringe of dark brown hair more than half length of exterior tibial spine; hind basitarsus only little narrowed toward apex, slightly concave outwardly, surface punctate but rather shiny, inner face densely clothed with hair of even length.

Metasoma: Gastral sternite 6 somewhat produced posteriorly, but its apex rounded; apical half with distinct oval impressed median area.

Female: Female differ from male in having the following characters: 1. Length 9.3 - 11.8, FWL = 7.0 - 8.5 mm; 2. Antennae slightly shorter, reaching middle of tegulae; rhinaria present on segment 4-11, all single, narrowly lanceolate and placed in long axis; 3. Hind femur carinate posteriorly; 4. White pubescence on dorsum of mesosoma dense all markings sharply defined and isolated, except 'l_{pn}-als'; 'pl_s' conspicuous, 'ms' long, reaching level of hind margin of 'ml_s', which is circular and of small size, 'pl_{sa}' complete and linear.

Flower Record: Unknown.

Distribution: INDIA (Kerala, Tamilnadu, Maharashtra) Iraq.

Biology: Unknown.

Habitat: Disturbed and undisturbed habitats.

Discussion: This species resembles superficially closely to *T. ramosus* (Lepelletier) but differ from it in the following characters: 1. Body punctation relatively dense and fine, rather superficial, on dorsal thoracic segments (In *T. ramosus* body punctation large, deep and more widely spaced punctures); 2. Outer face of hind tibia with conspicuous comb-like fringe and dark brown hair more than half length of exterior tibial spine. (In *T. ramosus* hind femur simple, no comb like apical fringe).

This species is also very similar to *T. takaonis* (Cockerell) in general appearance, but differs from it in the following characters: 1. White spots on dorsum of mesoscutum extensive; 'ms' extending beyond level of anterior border of 'mls'; 'plsa' linear, bordering tegular along its full length and attached to 'pls'; 'pls' conspicuous, usually much longer than 'mls' (In *T. takaonis* white spots on dorsum of mesoscutum smaller: 'ms' short, not reaching-level of 'mls'; 'plsa' vestigial or absent; 'pls' subcircular, usually not much larger than 'mls'); 2. Apical lobes of 7th gastral sternite broad and abbreviated, sparsely clothed with minute microsetae (In *T. takonis* apical lobes of 7th gastral sternite folded back ventral and densely clothed with long transparent microsetae).

Remarks: This species is not represented in the present collection. Hence the description and illustration is based on the description by Lieftinck (1962).

8. *Thyreus smithi* (Dalla Torre)

(Fig. 224-226)

Crocisa elegans Smith 1879. *Hym. Brit. Mus.* : 107 (Pars!). Type: Female, Bombay, Sumatra, Borneo.

C. smithii Dalla Torre 1896. (nom. nov. Pro *degans* F. Smith 1879 nec Moesary 1878. *Cat. Hym.* 10: 323.

C. emarginata Lep. Bingham 1897. *Fauna Brit. India, Hym.* I: 517-518 (Pars!)

C. quartinae Grib. var. *elegans* Sm; (not seen) Friese 1905. *Zeitschr. Hym. & Dipt.* 5: 3.

C. smithii D.T., Strand 1919. *Societas Ent., Zurich*, 34: 28. Type: Male S. India.

C. smithii D.T., Cockerell 1919. *Ann. Mag. Nat. Hist.* (9) 3: 191, type locality Bombay, fixed - Coorg, S. India.

C. smithii D.T, Meyer 1921, *Archiv f. Naturgesch.* 87 A, I: 140, 143 (Key to female and male), 151, supposed male S. India, Female not seen.

C. smithii Lieftinck 1958, *Nova Guinea, new ser.*, 9:24 *Celegans*, lectotype selected), 25 (*Smithii*, some insect) (list).

Plesiotype: F (Worker): TL = 13.2, FWL = 10.2, FWW = 4.02, HWL = 7.5, POL = 0.79, OOL = 0.5, HW = 3.95, HL = 3.3, SL = 1.05, FL = 3.42, EW = 2.57, EL = 1.57.

Colour: Integument: Deep black, except, eyes brown, funicular segments with brown reflections; wing membrane dark grey brown, forewing diffusely lighter anteriorly in R, area posterior to 1A, and around submarginal cells; hind wing subhyaline; wing veins dark brown to black; ocelli with dull brownish white reflections.

Pubescence: Body pubescence deep black, conspicuously variegated with brilliant blue hairs, coloured hairs mainly imbricate and form ramified scales (Fig: 224); bright blue hairs distributed in face as in figure (Fig. 224); a tuft of white hairs on anterior portion of antennal toruli; erect hairs on vertex white; scape of antenna with dull white hairs, flagellum with appressed pilosity. Pronotum with few black erect hairs; episternum with white, long, plumose hairs; scutellum with

black hairs, except the blue spots; longer hairs, distributed in between patches, thoracic patches of blue hairs as in figure (Fig. 224), of these 'als' larger than 'mls', 'ms' represented by isolated spots, 'plsa' in continuous with 'pls', 't' and 'ps' wanting, 's' forms distinguished rounds; outer surface of fore tibia, midtibia from base to apex, those of hind tibia on basal three fourth, with decumbent blue hairs; all tarsal segments with blue hairs on outer side with long black hairs intermixed on outer borders; metasoma with black decumbent and blue pilosity, blue patches as in figure (Fig. 224); outer side of mesosoma with few suberect, long, white and black hairs; blue hair bands of sternites narrow.

Head: Width in anterior view a little more than 1.52x distance between front ocellus and lower margin of clypeus (79:52) (Fig. 223); maximum width of head at level of posterior margin of eyes 6.4 x distance between front ocellus and occipital margin (16:2.5); relative measurements of POL : OOL = 5.5:3.5; mandible glabrous, minutely punctate at their bases; malar area indistinct; labrum strongly punctate; posterior half of clypeus punctate, other parts of clypeal area obscure due to pubescence; frontal line raised, projected, passes on between antennal toruli and touches middle of front ocellus; ocellar area and vertex more or less closely punctate. Scape of antenna not reaching front ocellus, antenna somewhat thick and strong, rhinaria present on flagellar segments 4-11, linear and deeply impressed and extending along full length of segment. Relative length: breadth of antennal segments, scape = 21:7, pedicel = 3.5:5, F₁ = 7.5:7.5, F₂ = 5:7, F₃ = 5:5.7, F₄ = 6:7.5, F₅ = 6:7.5, F₆ = 6:7.5, F₇ = 6.5:8, F₈ = 6.5:7, F₉ = 6.5:7, F₁₀ = 10:5.5 (Fig. 226). Eyes smooth and glabrous; relative length : width of eyes in lateral view = 18:11.

Thorax: Maximum width between tegulae to length of thorax 39:39; integument scutum rather glabrous. Pronotum well punctate; sides of mesoscutum strongly and densely punctate; disc of scutum and scutellum

superficially and finely punctate. Episternum more or less deeply punctate, scutellum flat with slightly up turned lobes, emargination distinct (Fig. 224).

Legs rather short and strong, of simple structure; inner face of hind femur with a less acute posterior ridge; midtibia slightly swollen and subcylindrical; hind basitarsus shorter than tibia (Fig. 224); legs uniformly, minutely punctate.

Tegular closely and superficially punctate than sides of mesoscutum; wing veins as in figure (Fig. 224); relative measurements of forewing length: its maximum width = 72:28.5, minute hairs distributed throughout wing membrane; three submarginal cells, first submarginal cell longer than second and third; first and second recurrent veins meets second and third submarginal cells in their middle; vein 'V' not strongly developed when compared to other veins. Posterior parts of wing membrane papillate and striated. Jugal and vanal lobes of hind wing distinct, jugal lobe smaller than vanal lobe, vein 'V' combines or touches with Cu-V; hamuli 20 or more (below 23); posterior part of wing membrane papillate.

Metasoma: Metasoma glabrous with black hairs and with distinct patches or markings of blue hairs as in figure (Fig. 224); punctures on gastral tergites more superficial and much fine. Sternal plates striato-reticulate with fine punctures.

Male: Male differ from female in having the following important characters: 1. Antenna somewhat slender; 2. Rhinaria present on 4-12 antennal segments in the form of scarcely impressed elongate oval areas; 3. Dorsum of gastral tergite 7 convex basally, then gradually sloping down and even a little concave apically, closely punctate and covered with depressed dark brown hairs.

Materials examined: Plesiotype: F, INDIA, Kerala, C.U. Campus, Sojan, A, 10-v-2000. *Other materials examined:* 1 F, INDIA, Kerala, Silent Valley, Binoy,

C.F. 20-iv-1995; 1F, INDIA, Kerala, Silent Valley, Binoy, C.F. 16-iii-1999; 1 F, INDIA, Kerala, Silent Valley, Binoy, C.F. 23-i-1995.

Flower Record: *Cinchona* sp.

Distribution: INDIA (Maharashtra, Mahe, Kerala, Tamilnadu).

Biology: Unknown.

Habitat: Found in both disturbed and undisturbed habitats.

Discussion: A conspicuous and easily known species confined to South India (Lieftinck, 1962). Great variation exists in the shape of posterior part of scutellum and emargination.

Remarks: The male specimen is not represent in the collection, the main character taken from the description of LIEFTINCK (1962).

9. *Thyreus surniculus* Lieftinck

(Figs: 227-229)

T. surniculus Lieftinck, 1959. *Tijdschr. V. Ent.*, 102: 30-34, Pl. 2. Fig. 3 (F, Insect). figs 75-20 (F & M structures), F & M India, F & M Ceylon.

Plesiotype: Worker: TL = 14.15, HW = 3.71, HL = 3.09, SL = 1, FL = 4.23, FWL = 9.23, FWW = 3.69, HWW = 7.2 (6.6), POL = 0.692, OOL = 0.384, EL = 2.2, EW = 1.3.

Colour: Integument: Deep black, except, eyes brown, funicular segments with light brown reflections; wing membrane dark brown, forewing diffusely lighter anteriorly in R, in the area posterior to 1A, and around submarginal cells; hindwing subhyaline and wing veins dark brown; ocelli with dull brown reflections in certain lights. Sting ferruginous brown.

Pubescence: Body pubescence dark brown to black reflects light brown in certain lights, conspicuously variegated with blue hairs; coloured hairs mainly

imbricate and form ramified scales (Fig. 227); light and bright hairs distributed over face, a tuft of plumose white hairs above the antennae; antennae covered with dull white (ivory) appressed pilosity; erect and plumose white hairs on vertex. Mesosoma mainly covered with black plumose hairs; Pronotum with black hairs, episternum with thick light brown plumose pilosity; thoracic patches of blue hairs as in figure (Fig. 227) of these 'als' longer than 'ms', 'ms' extends in between 'mls'; 'plsa' extends and touching 'pls'; 'pls' larger than 'mls'; 't', 'ps' and 's' absent; scutellum covered with very black hairs except few blue hairs at region of emargination; tegulae covered with light brown hairs; pubescence on wings dark brown; outer surface of fore tibia, midtibia, from base to apex, those of hind tibia on basal three fourth covered with decumbent blue hairs; apical part of fore femur, basal part of hind femur covered with white to light blue plumose pilosity, all tarsal segment with light blue hairs intermixed with black hairs on their outer surfaces, much reduced towards last tarsal segments. Metasoma with decumbent blue patches of hairs intermixed with light brown to ash coloured pilosity and their outer surfaces with few dark to black suberect hairs (Fig. 227); blue patches of sternites distinct and narrow.

Head: Width in anterior view a little more than $1.418 \times$ distance between front ocellus and lower margin of clypeus (78:55) (Fig. 228); maximum width of head at level of posterior margin of eyes $6.25 \times$ distance between front ocellus and occipital margin (25.4); relative measurements of POL : OOL = 9:5; mandible glabrous, minutely punctate, malar area indistinct; labrum with well developed punctures; clypeus closely punctate with well developed punctations; frontal line raised in between antennal toruli, and not extends backwards and not touches middle of front ocellus; supraantennal area closely and deeply punctated; vertex and ocellar area sparsely punctate; scape of antenna not reaching front ocellus; antenna somewhat thicker and shorter; rhinaria present on $F_3 - F_{10}$, linear and deeply impressed and extending along full length of segment. Relative length:

breadth of antennal segments = Scape = 21:8, pedicel = 3:5.5, $F_1 = 10:8$, $F_2 = 9:8$, $F_3 = 9:8$, $F_4 = 9:8$, $F_5 = 9.8$, $F_6 = 8.5:8$, $F_7 = 9.8$, $F_8 = 9:7$, $F_9 = 8.5:7$, $F_{10} = 9:6$ (Fig. 229). Eyes smooth and glabrous, which are broader to their posterior end. Relative length: width of eyes in lateral view = 11:6.5.

Thorax: Maximum width between tegulae to length of thorax = 48:62; Integument of thoracic scutum glabrous; pronotum minutely punctate; axillae and scutellum punctate sparsely in between areas smooth; episternum more or less deeply punctate; scutellum flat with slightly upturned lobes and emargination distinct (Fig. 227).

Legs strongly developed, simple structure; arolia visible, inner face of mid femur with acute posterior carina or ridge; mid femur swollen and subcylindrical; hind basitarsus shorter than hind tibia (Fig. 227); midtibia with outwardly projected spine like structures (Fig. 227); legs sparsely punctured.

Tegulae sparsely punctate, in between punctations, striato-reticulate; wing veins as in figure (Fig. 227); relative measurements of forewing length: its maximum width = 120:48; hairy distribution restricted to anterior parts of cells; posterior part of wing membrane papillate; three submarginal cells, first larger than second and third submarginal cells; recurrent veins meets second and third submarginal at their middle portion; jugal and vanal lobes of hindwing distinct, jugal lobe is usually smaller than vanal lobe; hamuli 20; posterior part of wing membrane papillate and minutely striated.

Metasoma: Metasoma glabrous, longer than mesosoma; metasomal patches of blue hairs as in figure (Fig. 227); punctures on gastral tergites more superficial and much finer, sternal plates punctate.

Male: Male differ from female in having, the following important characters: 1. Scutellum deeply triangularly excised posteriorly, sides of notch

forming an acute angle; 2. Dorsal thoracic spots all isolated; 3. Parascutella black haired; 4. Coxa and trochanter of hind leg produced posteriorly, both with tooth like intero-apical process; 5. Apex of 7th sternite only slightly emarginate.

Materials examined: Plesiotype: F, INDIA, Kerala, Parambikulam, Sureh, 12-ix-1995.

Distribution: INDIA (Kerala, Bengal, Pondicherry, Maharashtra), Ceylon.

Flower Record: Unknown.

Biology: Unknown.

Habitat: Undisturbed and semi-disturbed areas.

Discussion: This species resembles *T. formosanus* (Meyer) in general appearance, but differ from it in the following characters: 1. Outer face of hind basitarsus streaked with white (In *T. formosanus* all tarsi black haired); 2. Dorsal thoracic spots all isolate (In *T. formosanus* dorsal thoracic spot atleast partly confluent); 3. Parascutella black haired (In *T. formosanus* parascutella with abundant hairs); 4. Posterior carina of hind femur poorly developed and present only on distal half. (In *T. formosanus* posterior carina of hind femur well developed and acute).

Remarks: This is the first report of *T. surniculus* from Kerala. It was originally described by LIEFTINCK (1959) from India and Ceylon. The male of this specimen is not represented in the present collection. Important characters of male given above were taken from description of LIEFTINCK (1962).

10. *Thyreus takaonis* (Cockerell)

(Figs: 230-233)

Crocisa takaonis Cockerell, 1911. *Ann. Mag. Nat. Hist.* (8) 7: 311-312. Type Male and Female Takao, Formosa.

Crocisa subramosa Cockerell, 1911. *Ibid* (8) 8: 770. Type: Female, Foochow, China.

C. takaonis (Kll. strand. 1913. *Supplem. entom.* 2: 52-55 (note on sexual differences). Type: Male and Female Formosa, loc. diff.

C. ramosa var. *reepeni* Friex, 1918. *Zool. Sahr. Abt. Syst.* 41: 512. Type: Male & Female Seenigofa, Ceylon.

C. reductula Cockerell, 1919. *Ann. Mag. Nat. Hist.* (9): 3: 192 - Type: Female Mysore, India.

C. takaonis Ckll. Meyer, 1922. *Ann. Mus. Nat. Hung.* 19: 184, notes. Type Male and Female Formosa; China; INDIA.

C. histrio F., Tomari, 1930. *Ins. Kwantung Prov.* 59.

C. ramosa Lep., Matsumura, 1931. 6000 *illustr. In. Japan Empire*: 6.

C. ramosa Lep., Matsumura, 1931. *Illustr. Common. Ins. Japan*, 4:3.

C. takaonis Ckll, Yan. 1932, *Iconogr. Ins. Jap.*: 260, Fig. 503-Ryukyu, Taiwan.

C. takaonis Ckll, Yasumatsu & Narisada, 1935. *Mushi*, 8: 71 - Dairen: S. Manchuria, Kwantung Prov.

C. takaonis Ckll, Hirashima, 1958. *Mushi*, 32: 75, Tab. 12 (Insect). - Formosa; Amamits.

M: TL = 7.5 - 13 mm; FWL = 6.5 - 11.0 mm.

Colour: Integument: Body deep black, except, eyes brown, funicular segments with brown reflections.

Pubescence: Body pubescence deep black, conspicuously variegated with white hairs. White pubescence on thorax composed of finely branched decumbent hairs; white spots on dorsum of mesoscutum smaller; 'ms' short, not reaching level of 'mls'; 'plsa' vestigial or absent altogether, bordering tegular only

for half its length or less; 'pls' subcircular, usually not much larger than 'mls'. Colour pattern as in figure (Fig. 230); triangular spot, or small tuft, of white at apex above notch of emargination, but it may be also wanting; inner face of hind basitarsus evenly and densely clothed with dark hair.

Head: Antenna long, reaching back to beyond tegula all flagellar segments a little longer than wide, except 3 which is distinctly shorter than 4; rhinaria developed on segment 3-12, single and oval on 3, but on next segments there are two rows, each bearing upper and lower concavity, the former short and oblique, latter twice as long as upper and placed in long axis; together they form some hoof-shaped impressions.

Thorax: Body punctation relatively dense, fine and rather superficial sides of scutellar emargination either practically straight or distinctly bracket-shaped.

Hind basitarsus slightly outcurved, but sides nearly parallel; outer surface distinctly concave, finely superficially punctate around a shiny impunctate and almost hairless area on disk.

Metasoma: Apex of tergite 7 rather narrow, hind margin always more or less convex between prominent, tooth-like hind angles (Fig. 223). Sternite 6 slightly produced medially, rounded or shallowly emarginate; distal portion with distinct, longitudinal, oval, impressed area almost devoid of hair; sternite 8 produced, excised or bluntly pointed, but always with minute setae at margin of emargination. Apical lobes of 7th gastral sternite folded back, densely clothed with long transparent microsetae.

Female: Female differ from male in having the following characters: 1. Antenna hardly surpassing anterior border of tegula; flagellar segment 3 shorter than 4; 2. Rhinaria present on segment 4-11, all single, narrowly lanceolate strongly impressed and placed in long axis; 3. All thoracic spots isolated and

more sharply outlined; 4. Legs modified; hind basitarsus without peculiarities, clothed with white pubescence outwardly; 5. Pygidial plate triangular.

Flower Record: *Cinchona* sp.

Distribution: INDIA (Kerala, Karnataka, Tamilnadu, Dehra Dun, W. Bengal, Orissa) Ceylon, E. China to Manchuria and Japan.

Biology: Unknown.

Habitat: From both disturbed and undisturbed habitats.

Discussion: This species resembles superficially closely to *T. ramosellus* (Cockerell), but differs from it on the following characters: 1. White spots on dorsum of mesoscutum smaller (In *T. ramosellus* white spots on dorsum of mesoscutum extensive); 2. Apical lobes of gastral sternite 7 folded back ventrad and densely clothed with long transparent microsetae (In *T. ramosellus* apical lobes of 7th gastral sternite broad and abbreviated, sparsely clothed with minute microsetae).

Remarks: The species is not represented in the present collection. Hence the description and illustration is based on the description by Lieftinck (1962).

Tribe 3. Meliponini

Diagnostic features:

The claws of females are simple, arolia present. Hind tibial spurs absent. The hind basitarsus slender at base, without an auricle. The wing venation is reduced, the marginal cell often being open apically. Stigma large to moderate-sized, vein 'r' arising near the middle of the stigma. The first and second submarginal cells are often unrecognized and weakly defined. The jugal lobe of hindwing one-third to two-thirds as long as the vanal lobe. The maxillary palpus is minute, one segmented.

GENUS 1 : LISOTRIGONA Moure

Lisotrigona Moure, 1961, *Sudia Entomol.*, 4: 194. Type species: *Melipona cacciae* Nurse, 1907, by original description.

Diagnostic characters:

Length: 2.5 to 4.15 mm. Forewing length less than 3.2 mm; wing venation greatly reduced; upper margin of hind tibia without plumose hairs; hindwing without closed cells, veins closing cells R and cu, if visible at all, clear and unpigmented; forewing with submarginal cross veins almost always completely absent, thus without indication of submarginal cells; atleast distal part of second Cu of forewing undefined or defined by completely unpigmented vein traces; vein M of forewing terminating without bend at about position of anterior end of first recurrent vein which however, is absent (Fig. 235); malar space shorter than flagellar diameter; gonostylus of worker with many minute hairs, in addition to setae along outer and distal margins.

Distribution: India (Kerala, Madhyapradesh), Sri Lanka, Vietnam, Borneo, Sumatra.

Biology: Nothing is presently known about its biology nor have the queen or male ever been captured and described.

Discussion: *Lisotrigona* Moure (1961) is an uncommon genus of the Indian subcontinent. The group is similar to *Pariotrigona* from but differs most notably by the short, linear malar space, the converging inner compound eye margins, the acute base of the marginal cell, and the presence of minute setae on the worker gonostyli. This genus also resembles to *Trigonisca* Moure but it differs from it in the following character: the hind tibia has a much rounded upper apical angle, the hairs on the inner side of the hind basitarsus not in noticeable rows, and the base of the marginal cell acute. Both Moure (1961) and Michener (1990) give useful accounts for the identification of *Lisotrigona*.

Remarks: Engel (2000) reported two new species of *Lisotrigona* from Indo malayan region and gave a key to the presently known species of this genus.

Altogether 3 species have been reported so far with one species from India. The present work reports two species from Kerala, of these one is new to science. This genus is reported for first time from Kerala. A key to the species of the world is also provided.

A REVISED KEY TO THE WORLD SPECIES OF *LISOTRIGONA* MOURE

1. Clypeus entirely yellow; face with yellow markings; mesoscutum black with thin yellow margins bordering tegulae, body size relatively large (4-4.2 mm) *L. carpenteri* Engel
- Clypeus dark brown to black; face without yellow markings; mesoscutum dark brown without lateral yellow markings; body size relatively small (3-3.7 mm) 2
2. Punctures of mesoscutum exceedingly minute and somewhat faint 3
- Punctures of mesoscutum small and strong *L. furva* Engel

3. Integument of head, mesosoma and metasoma generally brown to dark brown; gena impunctate; pubescence on clypeus simple and hypoepimeron without hairs (Fig. 235); metanotum finely imbricate *L. cacciae* (Nurse)
- Integument of head and mesosoma coal black and abdomen brown; Gena sparsely punctate; pubescence on clypeus plumose and hypoepimeron with minute scattered hairs (Fig. 239); metanotum reticulate anteriorly *L. keralensis* sp. nov.

1. *Lisotrigona cacciae* (Nurse)

(Figs: 234-238)

Melipona cacciae Nurse, 1907: *J. Bom. Nat. Hist. Soc.*, 619.

Trigona scintillans Cockerell, 1920a. *Ann. Mag. Nat. Hist.*, (ser. 9) 5: 116. Cockerell, 1920b: 228. Cockerell, 1929: 590. Schwarz. 1937: 307. Synonymized by Engel (2000).

Trigona (Hypotrigona) scintillans Cockerell: Schwarz 1939: *Bull. Amer. Mus. Nat. Hist.*, 76: 130. Sakagami yoshikawe, 1961: 440.

Lisotrigona cacciae (Nurse): Moure, 1961: *Sudia entomol.*, 4: 194.

Lisotrigona scintillans (Cockerell): Moure, 1961: *Sudia Entomol*; 4: 195.

Hypotrigona (Lisotrigona) scintillans (Cockerell): Sakagami, 1975: *J. Fac. Sci. Hokkaido. Univ.*, (Sex. 6, Zool.) 51.

Plesiotype: F (Worker): TL: 3.64, HW = 1.23, HL = 1.11, SL = 0.45, FL = 0.85, FWL = 2.5 FWW = 1.07, HWL = 1.55, POL = 0.33, OOL = 0.16, EL = 0.93, EW = 0.34.

Colour. Integument: Integument generally smooth and shining. Mandible dull yellow (yellowish brown) except apical margin reddish brown and base dark brown. Mouth parts brownish yellow; labrum dark brown. Head dark brown to black; scape yellow except apical quarter sometimes brown; pedicel and flagellum light brown; ocelli glabrous and reflects silvery with light brown tints. Eyes brown. Mesosoma dark brown to black and shining except light brown on

pronotal lobe and yellowish brown on tegula. Wing veins pale yellow to light brown; membrane hyaline. Legs brown except yellow on trochanter, tarsi exclusive of basitarsi and on outer, inner and apical borders of meso- and meta basitarsus. Metasoma light to dark brown.

Pubescence: Pubescence generally silvery or white. Clypeus with minute, silvery, simple hairs scattered over surface. Face along inner margin of compound eye with subappressed, silvery, plumose hairs, hairs not obscuring the integument, such hairs disappear from upper tangent of compound eyes; otherwise face with minute, widely scattered simple hairs, such hairs intermixed with a few longer scattered, light brown, simple hairs on vertex. Hairs of gena like those of face and slightly more numerous. Minute hairs absent on postgena; with widely scattered long, silvery simple hairs. Mesoscutum with minute hairs like those of face except slightly longer. Similar simple, minute hairs on scutellum, becoming progressively longer posteriorly; on apical margin quite longer with a couple of minute branches. Metanotum with minute, simple hairs very widely scattered. Preepisternum with short, plumose, silvery, subappressed hairs, somewhat obscuring integument, such hairs becoming simple on rest of mesepisternum; hypoepimeron without pubescence; metepisternum with silvery hairs on upper third only. Propodeal lateral surface with dense, short, silvery, plumose hairs; posterior surface with a few longer, widely scattered, simple hairs; basal area without pubescence. Metasomal T₁-T₄ virtually without pubescence except widely scattered, simple hairs along apical margins, such hairs progressively more numerous on apical terga, also sparsely present on central discs of T₅-T₆, such hairs widely scattered on sterna.

Head: Width in anterior view a little more than 1.298 x distance between front ocellus and occipital margin (67.5 : 52) (Fig. 236); maximum width of head at the level of posterior margin of eyes 5.16 x distance between front ocellus and

occipital margin (62:12); Relative measurements of POL : OOL = 18:9 (Fig. 234); mandibles sparsely punctate, edentate and rounded along their outer margins, face with widely scattered, minute punctures (separated by three times puncture width), integument between glabrous and inbetween punctures becoming slightly more dense and somewhat faint on vertex. Gena and postgena finely imbricate and impunctate. Scape of antenna not reaching front ocellus; scape less than half of the flagellum. Relative length: maximum width of antennal segments : scape = 25.3, pedicel = 5:4, $F_1 = 4:4$, $F_2 = 3:4$, $F_3 = 4:5$, $F_4 = 3.5:4$, $F_5 = 5:5$, $F_6 = 4:5$, $F_7 = 4:4$, $F_8 = 5:4$, $F_9 = 5:4$, $F_{10} = 7:4$ (Fig. 238); eyes more or less parallel to each other, simple and glabrous; relative length: breadth of eyes in lateral view = 41:15.

Thorax: Maximum width between tegulae to length of thorax 39:51. Mesoscutum with exceedingly minute and faint punctures, separated by two times puncture width; integument between punctures glabrous. Tegmentose bands not developed or present; scutellum similar to mesoscutum except punctures sparse. Metanotum finely imbricate. Pleura glabrous and impunctate except upper half of preepisternum and upper anterior quarter of mesepisternum with faint, minute punctures separated by two times puncture width or less. Propodeum finely reticulatale.

Legs rather long, strong and developed; corbicula glabrous; keirotichia well-developed (Fig. 235); hairs on hind metatarsi bristle like (upper apical angle of hind tibia rounded); arolia distinct, hind tibial spurs pointed and thin.

Tegulae minutely and sparsely punctate, axillary sclerites also minutely punctate; forewing venation as in figure (Fig. 235); relative measurements of fore wing length: its maximum width 110:47; minute hairs distributed throughout the wing membrane, marginal cell acute at apex; submarginal cells not represented; wing venation faintly marked on hindwing; hamuli 5.

Metasoma: Metasoma glabrous and impunctate except apical margins finely imbricate. Anterior terga depressed on the middle (a concavity); sternal plates sparsely and minutely punctate (Fig. 235).

Male: Unknown.

Materials examined: *Plesiotype:* F: INDIA, Kerala, Calicut University Campus, Narendran, T.C., 12-ii-1994. *Other material examined:* 4F, INDIA, Kerala, Nilambur, Narendran T.C., 25-ii-1994.

Flower Record: Unknown.

Distribution: INDIA (Kerala), North Borneo (Malaysia), Northern and Central Thailand, Cambodia, Laos, Southern Vietnam.

Biology: Unknown.

Habitat: Mixed crop area (Partly disturbed by human interference).

Discussion: Engel (2000) compared the type of *L. cacciae* with lectotype of *L. scintillans* (Cockerell) and synonymised. There are almost no differences, outside of lighter coloration, between the two specimens of *L. cacciae* and those of *L. scintillans*; both having the same surface sculpturing, small size etc. Owing to the fact that there was a range of colouration in Nurse's original Series (Nurse, 107) which would easily overlap that of *L. scintillans*, it is difficult to justify the recognition of two species based solely on these minor colour differences. Engel therefore placed these two species under synonymy with *L. cacciae* (Nurse) as the senior synonym.

Remarks: This is the first report of this species from Kerala. Nurse (1907) originally described it from Madhya Pradesh, India.

2. *Lisotrigona keralensis* sp. nov.

(Figs: 239-242)

Holotype: F (w): TL - 3 mm, HW = 1.28, HL = 1.083, SL = 0.389, FL = 0.91, FWL = 2.6, FWW = 0.96, HWL = 1.77, EL = 0.86, EW = 0.35, POL = 0.3, OOL = 0.2

Colour. Integument: Entirely black except the following parts: basal part of mandibles dull brown, rest of the mandibles and glossa dull yellow; labial palpi whitish yellow, labrum dull brown; clypeus dark brown; scape yellowish brown with apical quarter dark brown; pedicel and flagellum light brown; eyes brown; ocelli with dark brown tints in certain lights; tegulae hyaline with brownish black spot anteriorly; axillary sclerites yellow; wing veins pale yellow to light brown, membrane hyaline; legs dark brown except yellow trochanters and tarsal segments; metasoma brown to dark brown.

Pubescence: Pubescence generally silvery or white. Labrum with few long, white hairs. Clypeus with small, simple, white hairs scattered over the surface, and hairs becomes plumose at the margins; facial hairs white and not obscure integument, which is long and plumose; pilosity on ocellar and vertex area minute, white with few scattered long hairs. Antennae covered with minute, suberect hairs over the surface. Anterior part gena with minute, simple, silvery, scattered pilosity; postgena with few hyaline to silvery, long scattered hairs. Labial palpal segments 1 and 2 each with a couple of long, simple, sinous hairs. Pilosity on mesoscutum as on gena, scattered and antereolaterally minutely plumose. Pubescence on scutellum longer than scutum, silvery and becoming progressively longer posteriorly. Metanotum with, minute, simple and transparent hairs very widely scattered. Pre-episternum with short plumose, silvery, appressed hairs not obscuring integument, such hairs becoming simple and longer on rest of mesepisternum; hypoepimeron with minute and scattered hairs; metepisternum with silver hairs on upper part only. Propodeal lateral

surface with moderately long, white plumose hairs; posterior surface with scattered, simple hairs, basal area without pubescence. Pubescence on legs silvery to white except the tarsal segment pilosity reflects brown to golden tints. Metasomal T₁ - T₄ without pubescence except widely scattered, simple hairs along apical margins, such hairs progressively more numerous on apical terga, also sparsely present on central discs of T₅ - T₆; such hairs widely scattered on sterna.

Head: Width in anterior view a little more than 1.33 x distance between front ocellus and lower clypeal margin (84: 63) (Fig. 240); maximum width of head at the level of posterior margin of eyes 6x distance between front ocellus and occipital margin (51:8.5) (Fig. 242). Relative measurements of POL = OOL = 12.8; mandibles sparsely punctate, edentate and rounded along their outer margins; clypeus and face with widely scattered, minute punctures; integument between punctures glabrous; punctures becoming slightly dense and somewhat faint on vertex. Gena and postgena impunctate and glabrous. Scape of antenna not reaching front ocellus; scape less than half of the flagellum. Relative length: maximum width of antennal segments = scape = 2.5: 5.6, Pedicel, 6:5, F₁ = 5:5.5, F₂ = 5:6, F₃ = 5:6, F₄ = 5:6, F₅ = 5:6, F₆ = 4:6, F₇ = 5:6, F₈ = 5.5:6, F₉ = 6:9; F₁₀ = 8:5 (Fig. 241). Eyes more or less parallel to each other, simple and glabrous; relative length: breadth of eyes in lateral view = 34.5:14 (Fig. 239).

Thorax: Maximum width between tegulae to length of thorax = 18:28; mesoscutum with exceedingly minute and faint punctures separated by two times puncture width, integument between glabrous; tomentose bands absent. Punctures on scutellum sparse and more developed than mesoscutum. Metanotum glabrous, reticulate, reticulations well developed on anterior half. Episternum glabrous and impunctate except upper half of pre-episternum; anterior quarter of mesepisternum with faint, minute punctures; propodeum finely reticulate.

Legs rather long, strong and well developed; hind tibia glabrous, posterior marginal hairs simple and moderate, rastrellum not well developed; keirotrichia well developed as in figure (Fig. 239), corbicula glabrous and striato reticulate (more striated); hairs on hind metatarsi bristle like, upper apical angle of hind tibia rounded.

Tegulae and axillary sclerites minutely and sparsely punctate; forewing venation as in figure (Fig. 239). Relative measurements of forewing length : Its maximum width = 104: 38.5; minute hairs distributed throughout the wing membrane; marginal cell acute at apex, submarginal cells not represented; wing venation faintly marked on hind wing; hamuli -5 (Fig. 239).

Metasoma: Metasoma glabrous and impunctate except apical margins finely imbricate, middle terga broader than anterior and posterior tergites. Sternal plates sparsely and minutely punctate.

Male: Unknown.

Materials examined: **Holotype:** F: INDIA, Kerala, KFRI (Peechi), K. Mohandas, 3-IV-2000; **Paratypes:** 2 F: Same data as that of holotype.

Etymology : The species is named after its collection locality.

Flower Record : *Tectona grandis* .

Distribution : INDIA (Kerala).

Biology : Unknown.

Habitat: Undisturbed area.

Discussion: This species closely resembles *L. cacciae* (Nurse) in general characters but differs mainly in the following characters: 1. Integument of head and mesosoma coal black and abdomen brown (In *L. cacciae* integument dark

brown); 2. Mandibles dull yellow to brown (In *L. cacciae* mandibles yellow); 3. Gena sparsely punctate (In *L. cacciae* gena impunctate); 4. Hairs on clypeus plumose (In *L. cacciae* hairs on clypeus simple); 5. Hypoepimeron with pubescence (In *L. cacciae* hypoepimeron without hairs); 6. Metanotum reticulate anteriorly (In *L. cacciae* metanotum finely imbricate).

GENUS 2: *TRIGONA* Jurine

Trigona Jurine, 1807: *Genera*, 320. 245. Type species: *Apis amalthea* Olivier, 1789, by designation of Latreille, 1810: 439.

Amalthea Rafinesque, 1815: *Palermo* 123, unjustified replacement for *Trigona* Jurine. Type species: *Apis amalthea* Olivier, 1798, autobasic.

Trigona (*Tetragona*) Lepeletier and Serville, *Histoire naturelle, Insectes*, Paris. 710. Type species: *Trigona elongata* Lepeletier and Serville, 1828 = *Centris clavipes* Fabricius, 1804, by original description.

Aphaneura Gray, 1832: 575. Type species: *Aphaneura rufesceus* Gray, 1832, = *Apis pallens* Fabricius, 1798, monotypic. [See Michener 1995 a].

Alphaneura Gray, 1832: Pl. III, based on *Aphaneura*. Type species: *Aphaneura rufesceus* Gray, autobasic.

Frieseomelitta Ihering, 1912. *Zeitsch. Wissen. Insekten biol.* 8(1): 5. Type species: *Trigona silvestrii* Friese, 1902, monobasic.

Trigona (*Heterotrigona*) Schwarz, 1939a. *Bull. Amer. Mus. Nat. Hist.* 76: 96. Type species: *Trigona itama* Cockerell, 1918, by original description.

Trigona (*Lepidotrigona*) Schwarz, 1939a. *Bull. Amer. Mus. Nat. Hist.* 76: 132. Type species. *Trigona nitidiventris* Smith, 1857, by original description.

Trigona (*Geotrigona*) Moure, 1943a: *Arq. Mus. Paranaense*, 3: 146. Type species: *Trigona mombuca* Smith, 1863, by original designation.

Duckeola Moure, 1944a. *Javier Prado* 8 (28-29): 71. Type species: *Trigona huberi* Friese, 1901 = *Trigona ghilianii* Spinola, 1853, by original designation.

Tetragonisca Moure, 1946a: *Rev. de Entomol. (Rio)* 17: 438. Type species: *Trigona jaty* Smith, 1863 = *Trigona angustula* Latreille, 1811, by original designation.

- Trigona* (*Ptilotrigona*) Moure, 1951a: *Dusenian*, 2: 47. Type species: *Trigona heideri* Friese, 1900 = *Trigona lurida* Smith, 1854, by original designation.
- Platytrigona* Moure, 1961: *Studia Entomol.*, 4: 203. Type species: *Trigona planifrons* Smith, 1864, by original designation.
- Lophotrigona* Moure, 1961. *Studia Entomol.*, 4: 205. Type species: *Trigona canifrons* Smith 1857, by original designation.
- Tetragonula* Moure, 1961. *Studia Entomol.*, 4: 206. Type species: *Trigona iridipennis* Smith, 1854, by original designation.
- Geniotrigona* Moure, 1962. *Studia Entomol.*, 4: 212. Type species: *Trigona thorasica* Smith, 1857, by original designation.
- Tetragonilla* Moure, 1961: *Studia Entomol.*, 4: 210. Type species: *Trigona atripes* Smith, 1857, by original designation.
- Odontotrigona* Moure, 1961. *Studia Entomol.*, 4: 200. Type species: *Trigona haematoptera* Cockerell, 1919, by original designation.
- Tetrigona* Moure, 1961: *Studia Entomol.*, 4: 215. Type species: *Trigona apicalis* Smith, 1857, by original designation.
- Homotrigona* Moure, 1961: *Studia Entomol.*, 4: 200. Type species. *Trigona fimbriata* Smith, 1857, by original designation.
- Trigonella* Sakagami and Moure, 1975, in Sakagami, *Jour. Fac. Sci. Hok. Kaido, Univ.*, Ser. VI, Zoo, 20: 1957 (not da costa, 1778). type species *Trigona moorei* Schwarz, 1937, monobasic.
- Camargoia* Moure, 1989 a:/72. Type species *Camargoia camargoi* Moure, 1989, by original designation. (New synonymy).
- Trigona* (*Papuatrigona*) Michener and Sakagami, 1990. in Michener, 1990a: 153. Type species: *Trigona genalis* Friese, 1908, by original designation.
- Trigona* (*Sundatrigona*) Inoue and Sakagami, 1993: 769, replacement for *Trigonella* Sakagami and Moure 1975. Type species: *Trigona moorei* Schwary, 1937, by original designation and autobasic.

Diagnostic characters:

This is the largest and most widely distributed genus of meliponini; size ranges from 5-12 mm. Black to largely yellowish or with red metasoma;

trigoniform (metasoma small or slender, body not conspicuously hairy, i.e., hairs short and metasoma usually shining), some species with long parallel sided metasoma. Plumose hairs on posterior margin of hind tibia (Fig. 248), inner surface of hind tibia with longitudinal ridge covered with keirotrichia narrower than or about as wide as shining depressed zone behind ridges (Fig. 248); clypeus entirely impunctate, or punctate like frons, separated from the eye by distance little if any greater than length of malar area (Fig. 248); forewing length commonly (but not always) over 4 mm, wing venation usually not greatly reduced, but if minute and with some of the wing reduction characters listed below, hindwing commonly with cells R and Cu closed by at least weakly brownish veins; forewing with one or two submarginal cross veins usually weakly indicated, first submarginal cell usually recognizable; cell second cu of fore wing completely indicated at least by faint veins; vein M of forewing usually extending at least slightly beyond position of anterior and of first recurrent vein and angulate at end of that vein (Fig. 248), which is usually at least faintly visible.

Distribution: INDIA (Kerala, Tamilnadu, Karnataka), Sri Lanka, Taiwan, Caroline Islands, Soloman Islands, Mexico, Argentina, Indonesia, New Guinea to about latitude 34°s in Australia.

Biology: Highly social, with colonies of hundreds or thousands, nest in cavities in the soil, in hollow trunks or branches, some times in stone walls, in termite nest or exposed on trees (Michener, 1994).

The nests of most species occupy cavities that the bees find, and may limit by walling off unused areas; such walls are part of the batumen that typically surrounds the nest, and are called batumen plates. The cavities used vary from small, abandoned cerambycid beetle burrow, to large hollows in a tree trunk or cavities in the soil. Some species make exposed nests on tree branches or on walls of cliff faces. Nests are made up of wax secreted from metasomal terga mixed

with resins and gums collected by the bees. Some species add mud, faeces, or other materials to certain parts of the construct. The brood cells are mass provisioned and either clustered or arranged in combs that are usually horizontal. The cells open upward and closed after an egg laid. The cells are destroyed after the use and will not be reused. Female caste differentiation is quite different from that familiar in *Apis*, which results from differences in food quality. In most Meliponini, queens produced in small numbers in large cells, often at the margins of combs, and the large quantity of food placed on such cells seems to be the factor responsible for the development of queens in them rather than workers (Michener, 2000).

Discussion: This genus can be distinguished from all other genera (except *Oxytrigona*, *Cephalotrigona*, *Trichotrigona* and *Dactylurina*) from the inner surface of the hind tibia of the worker, which has a longitudinal elevation covered with keirotrichia. Its marginal zone shining and usually about as wide as elevated zone. In *Trigona* the slope separating the keirotrichiate ridge from the smooth one above it is abrupt (except in subgenera *Lepidotrigona* and *papuatrigona*) and extends as a shining channel nearly to the base of tibia.

Remarks: Michener (2000) reported 10 subgenera under *Trigona*, of these two sub genera were reported from India such as *Lepidotrigona* Schwarz and *Heterotrigona* Schwarz.

The genus *Trigona* is represented in Kerala by 5 species viz., *T. (H.) travancorica* sp. nov., *T. (H.) ashokai* sp. nov., *T. (H.) biroi* Friese (new report for Kerala and India), *T. (H.) irridipennis* Smith and *T. (L.) nilamburensis* sp. nov. A key to the species of Kerala is also provided.

KEY TO THE *TRIGONA* Jurine SPECIES OF KERALA

1. Mesoscutum dull with minute, dense punctures; posterior margin of hind tibia of worker without plumose hairs (Fig. 257); propodeal dorsum finely reticulate; bees ranging from 3.5-5.5 mm
..... (*Lepidotrigona*) *T. (L.) nilamburensis* sp. nov.
- Mesoscutum glabrous with minute punctures; posterior margin of hind tibia of worker with plumose hairs (Fig. 252); propodeal dorsum smooth and glabrous; bees ranging from 3-7.5 mm (*Heterotrigona*) 2
2. Pubescence on episternum more or less thick and longer hairs plumose (Fig. 247) 3
- Pubescence on episternum not very thick and moderately long and minutely plumose to simple (Fig. 261) *T. (H.) travancorica* sp. nov.
3. Pubescence on scutellum only at their posterior or border areas; vertex with prominent dark bristles mixed with long silvery plumose pilosity ... 4
- Pubescence on scutellum wholly covered at their surface; vertex with small brown bristles mixed with few small silvery pubescence
..... *T. (H.) ashokai* sp. nov.
4. Hamuli 5 (Fig. 252); malar space obsolete, mesonotum with erect black hairs *T. (H.) irridipennis* variety *irridipennis* Smith
- Hamuli-6 (Fig. 248); malar space less vestigial; mesonotum with suberect silvery grey hairs on mesonotum *T. (H.) biroi* Friese

1. *Trigona (Heterotrigona) ashokai* sp. nov.

(Figs: 243-247)

Holotype: F (Worker): TL = 4.5, HW = 1.74, HL = 1.5, SL = 68, FL = 1.26, FWL = 3.91, FWW = 1.47, HWL = 2.44, EW = 0.44, EL = 1.17, POL = 0.37, OOL = 0.13.

Colour. Integument: Entirely black except without any vestige of yellowish mark; mouth parts yellowish brown, mandible yellow with their apices dark brown; labrum brown; antennae yellowish brown, more reflecting yellow colour; eyes brown; ocelli glabrous and reflects silvery white. Tegulae blackish brown; wings sub hyaline with brownish tints, wing veins brown; last three tarsal segments honey coloured; T₁ and half area of T₂ honey coloured to brown.

Pubescence: Pubescence generally silvery to white; outer layer of mandibles with few simple golden hairs; labrum with minute silvery hairs; clypeus and face covered with minute plumose pilosity; hairs becomes sparse towards vertex, and vertex with few dark bristles; antennae covered with minute appressed pilosity; gena and postgena with minute scattered pilosity. Pronotum with sparse, pubescence, silvery; meso-scutum with light golden, simple pubescence, scattered and weakly forms temantose bands; minute hairs form a line at their antereolateral areas. Scutellum glabrous at middle portion, posterior surface with moderately long plumose, white hairs reflects light brown; metanotum glabrous; preepisternum with short plumose, silvery appressed hair not obscuring integument, such hairs becoming simple and longer and abundant at rest of mesepisternum; metepisternum and sides of propodeum thickly covered with plumose silvery hairs reflects golden colour; pilosity on legs, brown to dark brown and black bristles, except outer surfaces of hind tibia with silvery white and plumose pilosity from anterior to posterior surface. Hairs on T₁ - T₃ almost absent, but other tergal segments with scattered, simple and minute hairs. Sternal hairs similar to tergal hairs except for long bristles like hairs.

Head: Width in anterior view a little more than $1.37 \times$ distance between front ocellus and lower margin of clypeus (66:48) (Fig. 246); maximum width at the level of posterior margin of eyes $4.5 \times$ distance between front ocellus and occipital margin (45:6); relative measurements of POL : OOL = 11:5 (Fig. 244); mandibles sparsely and minutely punctate, one denticle at its apex; labrum impunctate; clypeus and face minutely punctate and interstices glabrous; punctures and pilosity becoming sparse and faint on vertex; gena and postgena extremely minutely punctate and glabrous; malar space more or less reduced; scape of antenna not reaching front ocellus, scape less than half of flagellum; relative length : maximum width of antennal segments = scape = 26:4 Pedicel = 3:3, $F_1 = 3:5$, $F_2 = 4.5:4.5$, $F_3 = 3:5$, $F_4 = 4:4$, $F_5 = 5:5$, $F_6 = 4:5$, $F_7 = 4.5:5$, $F_8 = 5:5$, $F_9 = 5:5$, $F_{10} = 8:5$ (Fig. 247). Eyes more or less parallel to each other, simple and glabrous, relative length : breadth of eyes on lateral view = 35:13.

Thorax: Maximum width between tegulae to length of thorax = 28:38 (Fig. 245); mesoscutum glabrous and very minutely and sparsely punctate; temantose bands weakly developed; scutellum more punctate than mesoscutum; posterior contour evenly rounded with emargination extending beyond base of metanotum; metanotum impunctate and glabrous; episternal punctures weak, minute and punctures not visible on posterior regions due to well developed pilosity.

Legs rather long and strong and well developed; hind tibiae glabrous, rastrellum well developed; keirotrichia as in figure (Fig.243); inner surface of hind metatarsi with basal sericious area, covered with silky hairs.

Tegulae glabrous and minutely punctate; forewing venation as in figure (Fig. 243); relative measurements of forewing length: its maximum width = 117:44; minute hairs distributed all over wing membrane; wings subhyaline with brownish yellow tints; first submarginal cell weakly defined and second

altogether absent; marginal cell 3.8 x longer than broad. Hindwing venation faintly marked; hamuli - 5 (Fig. 243).

Metasoma: Metasoma glabrous and impunctate; contour of basal concavity of first tergum gently rounded; middle terga broader than anterior and posterior terga; sternal plates sparsely and minutely punctate.

Male: Unknown.

Materials examined: *Holotype* : F, INDIA, Kerala, Ponmudi, 4-iii-2000, Jobiraj.T; *Paratype* : 3F, INDIA, Kerala, Ponmudi, 9-iii-2000, Jobiraj. T; 4F, INDIA, Kerala, Vythiri, 2-x-2000, Jobiraj, T.

Etymology: Species name is after Ashoka the wise emperor of India.

Flower Record: Unknown.

Distribution: INDIA (Kerala)

Biology: Unknown

Habitat: Undisturbed areas

Discussion: This species closely resembles to *T. irridipennis* Smith in general appearance but differs from it mainly in the following characters: 1. Erect hairs on vertex sparse and moderately long (In *T. irridipennis* erect hairs on vertex prominent and very long); 2. FWL is equal to 3.25 mm (In *T. irridipennis* FWL equal to 3.78 mm); 3. Pubescence on mesosoma very much reduced (In *T. irridipennis* pubescence on mesosoma more developed).

This species also resembles to *T. (H.) travancorica* sp. nov. but differs from it mainly in the following characters: 1. Scutellum with hairs only at their outer surfaces (In *T. (H.) travancorica* sp. nov. scutellum completely covered with hairs); 2. Mesoscutum glabrous and minutely punctate (In *T. (H.) travancorica* sp. nov.

mesoscutum glabrous and minutely striato reticulate; 3. Episternal hairs not very thick (In *T. (H.) travancorica* sp. nov. episternal hairs more or less thick).

2. *Trigona (Heterotrigona) biroi* Friese

(Figs: 248-251)

Trigona biroi Friese, 1898, *Termes, Fuzetek*, XXI, pp.428, 429.

Trigona biroi Ashmead, 1905, *Proc. U.S. Nat. Mus.* XXVIII, p.957.

Trigona biroi Brown, 1906, *Philippine. Journ. Sci.*, I, p.686.

Trigona biroi Friese, 1909, *Annales Musei Nat. Hingarici*, VII, pp.271-272, 274.

Trigona biroi Cockerell, 1919, *Philippine. Journ. Sci.* XIV, pp.77-78, 79.

Trigona biroi Cockerell, 1925, *Philippine. Journ. Sci.*, XXVII, pp.53, 55.

Plesiotype: F: TL = 4.5, FWL = 3.55, FWW = 1.37, HWL = 2.7, HW = 1.82, HL = 1.48, SL = 0.485, FL = 1.12, EW = 0.46, EL = 1.24, POL = 0.375, OOL = 0.25.

Colour: Integument: Entirely black, without any vestige of yellowish marks except, mouth parts light yellow; mandibles yellowish brown; antennae yellowish brown; eyes silvery to brownish grey; ocelli glabrous, reflects dark brown. Tegulae dark brown. Legs blackish brown, with all tarsi yellowish brown with ferruginous tint; wing veins light brown, stigma honey coloured. T_1 - honey coloured, posterior tergites light brownish black.

Pubescence: Pubescence generally silvery; labrum with intermixed small and large light brown pilosity; Hairs on clypeus small, silvery, plumose; posteriorly tufts of silvery plumose hairs. Hairs on face at level of antennal sockets and above plumose, silvery to light brown tints on certain lights. Vertex with few dark brown bristles intermixed with silvery plumose pilosity. Gena and postgena covered with very minute, silvery, uniformly scattered hairs; flagellum covered with minute silvery pubescence. Black, erect bristles, simple, sparse on

mesoscutum, interstices with few scattered, plumose, silvery hairs. Scutellum posteriorly with plumose, light brown pilosity with few black, erect to suberect hairs; metanotum glabrous; preepisternal hairs, plumose, silvery, sub appressed; mesepisternum and metepisternum with larger plumose and silvery pilosity, somewhat obscuring integument. Pilosity on legs generally silvery to light golden tints, plumose or pectinate, intermixed with a few black, simple, erect to suberect bristles; propodeal laterals with plumose silvery hairs. Metasomal T₁, virtually without pubescence; T₂-T₃ along their apical margins with minute, simple hairs; sternal hairs longer than tergal hairs, silvery to light brown, scattered.

Head: Width in anterior view a little more than 1.425 x distance between front ocellus and lower margin of clypeus (62: 43.5) (Fig. 250); maximum width of head at level of posterior margin of eyes 5.25 x distance between front ocellus and occipital margin (21:4); (Fig. 250) relative measurements of POL : OOL = 3:2. Mandibles minutely and sparsely punctate, edentate along the outer two thirds of its apex, but with two well developed denticles on inner one third; punctures on labrum not clear, dull. Face sparsely and minutely punctate, in between areas glabrous; punctations more sparse, faint on vertex and glabrous. Gena and post gena minutely punctate. Malar space slightly less vestigial, not so wide as scape but nevertheless clearly separating eyes and mandible. Scape of antennae not reaching front ocellus; scape less than half of flagellum. Relative length: breadth of antennal segments : Scape = 33:5, Pedicel = 8:5, F₁ = 5:9, F₂ = 8:9, F₃ = 6:9, F₄ = 8:9, F₅ = 7:9, F₆ = 7:9, F₇ = 7:9, F₈ = 9:8, F₉ = 8:8, F₁₀ = 15:9 (Fig. 251). Eyes more or less parallel to each other, simple and glabrous; relative length : breadth of eyes on lateral view = 47:17.5.

Thorax: Maximum width between tegulae to length of thorax = 37:48 (Fig. 249); mesoscutum glabrous, minutely punctate, 6 temantose bands present;

scutellum similar to mesoscutum except punctures very widely scattered; posterior contour evenly rounded without emargination, extending beyond base of metanotum; metanotum micropunctate and glabrous; episterum minutely punctate, faint.

Legs rather long, strong, well developed; hind tibia glabrous, posterior margin with long plumose pilosity intermixed with simple hairs; rastrellum well developed; hind tibia slender at base and rather broad at apex, outline of tibiae consisting of slight incurved angulation (Fig. 248); hind metatarsi about one half as wide as tibia; corbicula visible, glabrous, slightly concave towards apex; keirotichia well developed, not extends to posterior margin (Fig. 248).

Tegulae and axillary sclerites superficially and minutely punctate; fore wing venation as in figure (Fig. 248). Relative measurements of forewing length: its maximum width : 23.5:52; minute hairs distributed throughout wing membrane; first submarginal cell weakly developed, second cell altogether absent; marginal cell slightly 5.8 x longer than broad. Hindwing venation faintly marked; hamuli = 6.

Metasoma: Metasoma glabrous, impunctate; contour of basal concavity on first tergum gently rounded; mid terga broader than anterior and posterior terga. Sternal plates striatoreticulate.

Male: Unknown.

Materials examined: Plesiotype: F. INDIA, Kerala, Calicut University Campus, Jobiraj T., 25-xi-1999; *Other materials examined:* 1F: INDIA, Kerala, Calicut University Campus, Calicut University Campus, Jobiraj T., 31-v-2000; 1F: INDIA, Kerala, Kerala Forest Research Institute, Peechi, Binoy C.F., 6-viii-2000; 1F: INDIA, Kerala, Calicut University Campus, Jobiraj T., 25-xi-1999; 4F: INDIA, Kerala, Areekode, Sathyan K., 20-v-2000; 3F: INDIA, Kerala, Calicut University

Campus, Jobiraj T., 25-xi-1994; 2F: INDIA, Kerala, Kurumpoyil, Jobiraj T., 30-iv-2000; 1F: INDIA, Kerala, Calicut University Campus, Jobiraj T., 15-viii-1999; 1F: INDIA, Kerala, Karumala, Jobiraj T., 15-vi-1996; 1F: INDIA, Kerala, Muthanga, L. Kishor, 8-v-2000; 3F: INDIA, Kerala, Mananthavady, Biju O.J., 25-vii-2000; 1F: INDIA, Kerala, Pulpally, Jobiraj T., 12-ix-2000; 1F: INDIA, Kerala, Tropical Botanical Garden and Research Institute, Thiruvananthapuram, K.C. Koshy, 25-v-1999; 1F: INDIA, Kerala, Calicut University Campus, Jobiraj T., 15-viii-1999.

Flower Record: *Nipa fruticans*, *Citrus*, *Mimosa pudica*, *Melicopi triphylla*.

Distribution: INDIA (Kerala), Phillipine Islands.

Biology: Unknown.

Habitat: From both disturbed and undisturbed areas.

Discussion: This species resembles to *T. (H.) irridipennis* Smith in General appearance, but differs from it in: 1. malar space not obsolete (In *T.(H.) irridipennis* malar space obsolete); 2. Hamuli 6 (In *T. (H.) irridipennis* hamuli 5); 4. Erect hairs on mesoscutum black (In *T. (H.) irridipennis* erect hairs on mesoscutum usually grey).

Remarks: This is the first report of this species from Kerala as well as from India. Friese (1898) originally described this species from Phillipine islands and New Guinea.

3. *Trigona (Heterotrigona) irridipennis* variety *irridipennis* Smith

(Figs: 252-256)

Trigona irridipennis Smith, 1854, *Catal. Hymen. Brit. Mus.* II, p.413.

? *Trigona laeviceps* Smith, 1857A, *Proc. Entom. Soc. London*, pp.98-99 (Trans. Entom. Soc. London, (2), IV).

- ? *Trigona laeviceps* Smith, 1858, *Journ. Proc. Linn. Soc., Zool.* II, p.51.
- Trigona laeviceps* Smith, 1859, *Journ. Proc. Linn. Soc., Zool.* III, p.135 (in part)
- Trigona praeterita* Walker, 1860. *Annals and Mag. Nat. Hist., (3), V*, p.305.
- ? *Trigona laeviceps* Smith, 1865, *Journ. Proc. Linn. Soc., Zool.* VIII, p.93.
- Trigona laeviceps* Parish, 1866, *Science Gossip*, pp.198-200 (nest)
- Melipona irridipennis* Dalla Torre, 1896, *Catalogus Hymenopterorum*, X, p.579.
- Melipona praeterita* Dalla Torre, 1896, '*Catalogus Hymenopterorum*', X, p.582.
- Trigona bengalensis* Cameron, 1896, *Mem. and Proc. Manchester Lit. and Phil. Soc.*, XLI. pp.143-144.
- Melipona irridipennis* Bingham, 1897, '*Fauna of British India - Hymenoptera*', I, pp.560-561, 563-564.
- ? *Melipona praeterita* Bingham, 1897, '*Fauna of British India - Hymenoptera*', I, pp.560-561, 564.
- ? *Trigona canifrons* Cockerell, 1905, *Annals and Mag. Nat. Hist., (7), XVI*, p.220.
- ? *Melipona laeviceps* Brown, 1906, *Philippine Journ. Sci.*, I, p.686.
- Trigona laeviceps* Schulz, 1907, *Zeitschr. Wissen. Insekten biol.*, III, pp.65-73 (nest, queen, male).
- ? *Trigona erythrostoma* Cameron, 1908, *Entomologist*, XLI, pp.192-193.
- ? *Trigona praeterita* Friese, 1908, '*Nova Guinea*', *Zool.* V, p.355.
- ? *Trigona laeviceps* Friese, 1908, '*Nova Guinea*', *Zool.*, V, p.356.
- Trigona canifrons* Schulz, 1909, *Zeitser. Wissen. Insektenbiol.*, V, pp. 338-341 (nest)'.
(nest).
- Trigona irridipennis* Friese, 1914, *Tijdschr. Voor Entomol.*, LVII, pp.12-13, 43-58 (nest).
- Trigona penangensis* Cockerell, 1919, *Philippine Journ. Sci.* XIV, pp.78-79 (Variety).
- Trigona indipennis* Cockerell, 1919, *Philippine Journ. Sci.*, XIV, p.79.
- Trigona iridepennis* Cockerell, 1919A, *Annals and Mag. Nat. Hist.*, (9) III, p.242.
- ? *Trigona laeviceps* Cockerell, 1923, *Annals and Mag. Nat. Hist.*, (9) XII, p.241.

Trigona dapitanensis Cockerell, 1925B, *Annals and Mag. Nat. Hist.*, (9) XV, p.492 (variety).

Trigona iridipennis Cockerell, 1929A, *Annals and Mag. Nat. Hist.* (10), IV, pp.590, 592.

Trigona iridipennis Friese, 1933, *Naturh. Maandblad*, XXII, p.46.

Melopona iridipennis George, 1933, *Journ. Univ. Bombay*, I, Pt. 5, pp.58-61. (Bionomics, Morphology and metamorphosis).

Melopona irridipennis George, 1934, *Journ Univ. Bombay*, II, Pt. 5, pp.1-16 (Excretion during metamorphosis).

Trigona erythrstoma Schwarz, 1937, *Bul. Amer. Mus. Nat. Hist.*, LXXIII, Art. III, pp.283, 290, 308-310, 316, 328 Pl.III, Fig. H, Pl. IV, Fig. 0.

Plesiotype: F (Worker): TL = 4.2, FWL = 3.78, FWW = 1.4, HWL = 2.32, HW = 1.64, HL = 1.42, SL = 0.5, FL = 1.3, EL = 1.26, EW = 0.46, POL = 0.4, OOL = 0.2.

Colour. Integument: Entirely black, without any vestige of yellowish markings except, mouthparts, labrum and mandibles yellowish brown; scape of antennae yellowish brown, flagellum brown; legs dark brown with silvery streak; all tarsi ferruginous brown; tegulae dark brown; wing veins light brown; stigma honey coloured; wing membrane iridescent, somewhat hyaline; mesosoma more or less tawny coloured except T₁, honey coloured; sclerites yellowish brown to honey coloured.

Pubescence: Pubescence generally silvery white; labrum and mandibles with transparent to white pubescence. Clypeus and face covered with small, silvery, plumose hairs; vertex with few dark brown erect hairs intermixed with few light brown to ferruginous pubescence; gena and postgena with very minute silvery to transparent, uniformly scattered pilosity. Black, erect, bristle like simple hairs, sparsely on mesoscutum, intermixed with silvery white, plumose pilosity, scutellum at their posterior surface covered with plumose silvery hair intermixed with brown bristles; metanotum glabrous, hairless; episternum more or less

covered with thick silvery, plumose pilosity on posterior areas, longer and simple, obscuring the integument. Tegulae with appressed silvery white suberect brownish black hairs; fore femur with minute silvery hairs on outer surface, fore tibia and tarsal segments with brown hairs; outer surface of mid femur with plumose silvery white pilosity intermixed with brown bristles; pubescence on mid tibial and tarsal segments, suberect, long, ferruginous; hind tibia and femur usually with brownish black bristles, plumose, light yellow to creamy brown pilosity on outer surface, tarsal segments with golden yellow. Metasomal T₁ virtually without pubescence, T₂-T₅ with very minute pilosity along their apical margin.

Head: Width in anterior view a little more than 1.29 x distance between front ocellus and lower margin of clypeus (64: 44.5) (Fig. 255); maximum width of head at the level of posterior margin of eyes 12 x distance between front ocellus and occipital margin (48:4); relative measurements of POL : OOL = 11.5:63 (Fig. 253). Mandibles minutely and sparsely punctate, edentate along outer two thirds of its apex, but with two denticles on inner one third. Punctuation on clypeus not visible due to thick pubescence; face sparsely and minutely punctate, in between areas glabrous. Gena and postgena minutely and uniformly punctate; malar space slightly less vestigial. Scape of antenna not reaching front ocellus; scape less than half of flagellum. Relative length: maximum width of antennal segments : Scape = 20:3.5, Pedicel = 5.4, F₁ = 3:4.5, F₂ = 5:4.5, F₃ = 3:4.5, F₄ = 4:4.5, F₅ = 5:4.5, F₆ = 5:4.5, F₇ = 4.5:4.5, F₈ = 4:5, F₉ = 5:5, F₁₀ = 9:5 (Fig. 256). Eyes more or less parallel to each other, simple, glabrous; relative length: breadth of eyes in lateral view = 36:13.

Thorax: Maximum width between tegulae to length of thorax = 39:40 (Fig. 254); mesoscutum glabrous and punctations faintly impressed; 7 temantotic hair bands weakly developed; scutellum glabrous, posterior contour evenly rounded

without emargination, extending beyond base of metanotum; metanotum glabrous impunctate. Episternum with few large punctures sparsely distributed, in between areas minutely punctate and glabrous.

Legs more or less well developed and strong; hind tibia glabrous, with sparse punctations on their anterior surface, plumose pilosity on posterior margins (Fig.254), corbicula well developed on hind tibia; keirotichia not extends to posterior margin (Fig. 252); hind basitarsi with oval shaped bristleless area on its underside. Rastrellum developed, lower area of hind basitarsus with well developed bristles.

Tegulae minutely, uniformly punctate. Forewing venation as in figure (Fig. 252); wings hyaline, uniform clarity throughout the membrane with brownish tint. Relative measurements of forewing length: its maximum width = 108:40; minute hairs distributed throughout the wing membrane, and their outer margins; first submarginal cell weakly defined with minutes hairs; second submarginal cell altogether absent; marginal cell 4.7 x longer than broad, wing venation faintly marked on hind wing; hamuli 5.

Metasoma: Metasoma glabrous and impunctate; contour of basal concavity on first tergum gently rounded; middle terga broader than anterior and posterior terga. Middle portion of sternal plates with sparse, strong punctations.

Male: Essentially similar to female but differ from it in having 1. Wings actually a little longer their tips extending only about to the apex of third tergite. 2. Malar space obsolete, base of mandible and rim of eye in contact. 3. Ocelli almost on a straight line. 4. The mesopleura with semierect silvery - gray hairs and the area to each side of the bare middle region of the propodeum with dense silvery-grey tomentum. 5. Length 4 to 4.25 mm.

Materials examined: *Plesiotype:* F, INDIA, Kerala, Tropical Botanical Garden and Research Institute, Thiruvananthapuram, 27-ii-1997, Maya. C. Nair;
Other materials examined: 3F, INDIA, Kerala, Tropical Botanical Garden and Research Institute, Thiruvananthapuram,, 27-iii-1997; 1F, INDIA, Kerala, Vithura, 20-i-1999, Jobiraj. T; 6F, INDIA, Kerala, Vithura, 8-iii-2000, Jobiraj. T.

Flower Record: *Typha angustifolia*, *Cocos nucifera*.

Distribution: INDIA (Kerala, Maharastra, Karnataka) Ceylon, French Indo-China, Siam, Malaya, Bangk Island, W. Java, N. Java, N. Borneo, W. Borneo, Philippine Islands.

Biology: Unknown.

Habitat: Disturbed.

Discussion: This species closely resembles *T. iridipennis* variety *valdezi* (Cockerell), in general appearance, but differs from it in the following characters:
 1. Length of forewing, including tegula, about 4.25 mm (in variety *valdezi* Length of forewing of about 5.25 mm); 2. Metasoma honey coloured (in *valdezi* metasoma ferruginous).

Remarks: This forms the first report of this species from Kerala.

4. *Trigona (Lepidotrigona) nilamburensis* sp. nov.

(Figs: 257-260)

Holotype: F (Worker): TL = 3.59, FWL = 3.93, FWW = 1.31, HW = 1.37, HL = 1.11, SL = 0.4, FL = 0.87, FW = 0.34, EL = 0.86, POL = 0.31, OOL = 0.15.

Colour. Integument: Entirely black except, mouth parts light yellow; mandibles, labrum light brown; scape of antennae yellow to brownish yellow on their basal part and brown to dark brown at their apices. Eyes dark brown to

black, clypeus with brownish tint in certain lights; ocelli dull yellowish brown and glabrous. Tegulae yellow; wing membrane hyaline with yellowish tint; wing veins brown; all coxa and tarsal segments yellow to yellowish brown. Metasoma dark brown; T₁ at their anterior portion and sternum brown to ferrugineous.

Pubescence: Pubescence generally silvery white and sparse. Pilosity on labrum and face, sparse, minute, plumose, appressed and silvery white; vertex with few dark bristles; funicular segments of antennae covered with subappressed, silvery hairs, reflects golden brown tint in certain lights; gena and postgena without pilosity. Pronotum, scutum and scutellum sparsely minutely, and simply pubescent; metanotum glabrous; pre-episternum and mesepisternum more or less hairless; metepisternum with plumose and light yellow pubescence. Hairs on legs sparse, silvery white to light yellow and simple, but on tibiae plumose. Pubescence absent on metasomal T₁; T₂-T₅ with minute, simple hairs along their apical margin, silvery white in colour; sternal hairs sparse, longer than tergal hairs, silvery white.

Head: Width in anterior view a little more than 1.43 x distance between front ocellus and lower margin of clypeus (52:36.5) (Fig. 259); maximum width of head at level of posterior margin of eyes 4.8 x distance between front ocellus and occipital margin (12:2.5) (Fig. 258). Relative measurements of POL : OOL = 4:2; mandibles sparsely punctate, edentate; labrum and clypeus minutely punctate; face, supraclypeal area uniformly, minutely punctate, interstices glabrous; punctations on vertex larger than face; frontal line clearly visible; gena and post gena sparsely punctate; scape of antennae not reaching front ocellus, less than half of flagellum; relative length : width of antennal segments: scape = 15:3, pedicel = 1.5:2.5, F₁ = 3:2, F₂ = 2:2, F₃ = 3:2, F₄ = 2:2, F₅ = 2.5:2, F₆ = 2:2.5, F₇ = 3:2.5, F₈ = 3:2.5, F₉ = 2.2, F₁₀ = 4.5:2 (Fig. 260). Eyes parallel to each other, simple, relative length : breadth of eyes on lateral view = 25 : 10.

Thorax: Maximum width between tegulae to length of thorax 12 : 15. Mesoscutum striated to striato - reticulate; punctations not clear; posterior contour rounded without emargination, not extending beyond the base of metanotum; episternum impunctate, glabrous, striato reticulate.

Legs moderately long, well developed; hind tibia uniformly punctate, corbicula, rastrellum poorly represented; keirotrichia weakly represented by sparse hairs; posterior hind metatarsi less than half as wide as hind tibia.

Tegulae usually transparent with weakly impressed punctations; forewing venation as in figure (Fig. 257); relative measurements of forewing length: its maximum width = 114:38; wings hyaline, marginal cell 4 x longer than broad.

Metasoma: Metasoma glabrous, minutely punctate; contour of basal concavity of first tergum gently rounded; sternal plates sparsely punctate.

Male: Unknown.

Materials examined: Holotype: F, INDIA, Kerala, Nilambur, T.C. Narendran, 5-iii-1998. **Paratype :** F, same data as that of the holotype.

Etymology: The species is named after its collection locality.

Flower Record: Unknown.

Distribution: INDIA (Kerala).

Biology : Unknown.

Habitat : Undisturbed areas.

Discussion: The species resembles *T. (L.) ventralis* variety *ventralis* Smith in general appearance, but differing from it as follows: 1. Forewing length about 3.93 mm (In *T. (L.) ventralis* variety *ventralis* forewing length about 4.25 mm); 2.

Black spots absent on tergite 1 of metasoma (In *T. (L.) ventralis* variety *ventralis*, black spot on each side of the tergita 1 of metasoma).

5. *Trigona (Heterotrigona) travancorica* sp. nov.

(Figs: 261-265)

Holotype: F (Worker): TL: = 4.88, FWL = 3.8, FWW = 1.4, HWW = 2.44, HW = 1.75, HL = 1.47, SL = 0.55, FL = 1.26, EW = 0.44, EL = 1.25, POL = 0.31, OOL = 0.25.

Colour: Integument: Entirely black except, mouth parts brownish yellow; mandible dark brown; antennae dull brown, with dark bands in certain funicular segments; ocelli reflects yellowish brown; eyes brownish yellow; tegulae brown to black; last four tarsal segments yellow; wing veins light brown, stigma honey coloured; T_1 - dull yellowish brown to dark brown.

Pubescence: Pubescence generally silvery white; labrum covered with white to silvery, small hairs intermixed with few large and suberect hairs. Pilosity on face and labrum with small appressed, plumose and silvery white, vertex with few dark brown bristles intermixed with plumose, long, light yellowish pubescence. Antennae covered with minute appressed hairs; gena and post gena with very minute uniformly scattered silvery hairs. On pronotum light yellow plumose pilosity; dark brown, erect, simple bristles with weakly developed temantose bands on mesoscutum; scutellum posteriorly, moderately, plumose, golden pilose intermixed with light yellow to light brown bristles; metanotum glabrous; tegulae covered with dark brown hairs; pre-episternal hairs large, plumose, silvery white, subappressed; mesepisternum and metepisternum completely covered with plumose silvery hairs, shorter than pre-episternum, somewhat obscuring integument. Pilosity on coxa, trochanter and femur white with light brown reflections, other segments, with dark brown bristles; anterior

and outer part of tibia with golden plumose pilosity. Metasomal T_1 virtually without pubescence. $T_2 - T_5$ with minute, simple hairs along their apical margins (golden pubescence); sternal hairs larger than tergal hairs, which are silvery white.

Head: Width in anterior view a little more than $1.42 \times$ distance between front ocellus and lower clypeal margins (64:45) (Fig. 264); maximum width of head at the level of posterior margin of eyes $6.375 \times$ distance between front ocellus and occipital margin (51:8). Relative measurements of POL : OOL = 7.5:6 (Fig. 263); mandibles sparsely punctate, edentate and rounded along the outer two thirds of its apex but with three well developed denticles in inner one third; punctations on clypeus not visible due to pubescence; face sparsely and minutely punctate, interstices glabrous; punctures and pilosity becoming sparse and faint on vertex, which is glabrous. Gena and postgena glabrous and anterior area of gena slightly depressed, malar space present. Scape of antenna not reaching front ocellus, scape less than half of flagellum. Relative length: maximum width of antennal segments : scape = 20:3, Pedicel = 3:4, $F_1 = 3.5:5$, $F_2 = 3.5:5$, $F_3 = 4.5:5$, $F_4 = 4.5:4.5$, $F_5 = 4.5:4.5$, $F_6 = 4:4.5$, $F_7 = 4:4.5$, $F_8 = 4:4.5$, $F_9 = 5:4.5$, $F_{10} = 7:4$ (Fig. 265). Eyes more or less parallel to each other, simple and glabrous, relative length: breadth of eyes in lateral view 30:105 (Fig. 265).

Thorax: Maximum width between tegulae to length of thorax 30:31.5; mesoscutum glabrous, minutely striato-reticulate, very sparsely punctate, 6 tementose bands present, weak; scutellum also sparsely punctate but more punctate than mesoscutum; posterior contour evenly rounded with emargination, extending beyond base of metanotum, metanotum micropunctate and glabrous; episternal, punctations, minute and obscure due to well developed pilosity.

Legs rather long and strong, well developed, hind tibia glabrous, posterior margin with long hairs, plumose, intermixed with few long bristles; Rastrellum

well developed; keirotrochia well developed (Fig. 261); posterior part of hind metatarsi less than half as wide as hind tibia; corbicula present, glabrous and slightly concave towards apex; inner surface of hind basitarsus with hairless anterior zone followed by bristles; outer surface of hind metatarsi glabrous with bristles on their inner surface.

Tegulae sparsely and moderately punctate; punctations on axillary sclerites not clearly visible. Forewing venation as in figure (Fig. 261). Relative measurements of forewing length: its maximum width = 92:34; minute hairs distributed all over wing membrane; wings hyaline with light brown tints; first submarginal cell weakly defined and second submarginal cell altogether absent; marginal cell 4.75 x longer than broad; wing venation faintly marked on hind wing; hamuli = 5.

Metasoma: Metasoma glabrous and impunctate; contour of basal concavity on first tergum gently rounded; middle terga broader and longer than anterior and posterior terga-sternal plates sparsely punctate.

Male: Unknown.

Materials Examined: *Holotype:* F: INDIA, Kerala, Tropical Botanical Garden and Research Institute, Thiruvananthapuram, K.C. Koshy, 28-vi-1999.

Paratype: F: INDIA, Kerala, Calicut University Campus, Jobiraj, T. 15-viii-1999.

Etymology: This species is named after the collection area.

Flower Record: *Tectona grandis*.

Distribution: INDIA (Keala)

Biology: Unknown

Habitat: Disturbed vegetation

Discussion : This species differs from it in closely resembling *T. canifrons* Smith on following characters: 1. Hindwing consists of 5 hamuli (In *T. canifrons* Smith hind wing consists of 7 hamuli); 2. Mandible with three denticles (In *T. canifrons* Smith mandible with two denticles).

This species also resembles *T. fusco-balteata fusco-balteata* Cameron in General characters, but differs from it in following characters: 1. Pilosity on mesosoma yellowish brown (In *T. fusco-balteata fusco-balteata* Cameron, pilosity on mesosoma silvery); 2. Malar space not obsolete (In *T. fusco-balteata fusco-balteata* Cameron, malar space obsolete).

Tribe 4. Apini

Diagnostic features:

The eyes are hairy. The mandibles of workers lack teeth and carinae. The claws of females are cleft and arolia are present. The hind tibial spurs are absent. The wings have well developed venation. The marginal cell is nearly four times as long as the distance from its apex to the wing tip. Stigma slender, vein r arising near the middle. The prestigma as long as or longer than the stigma. The second and third submarginal cross veins are directed postero-distad and form acute angles with vein M. Jugal and vanal incisions of the hindwing are shallow.

GENUS: APIS LINNAEUS

Apis Linnaeus 1758: *Systema Naturae*, 10, vol.1. *Reformata*. p. 343, 574. Type species: *Apis mellifica* Linnaeus 1761 (= *Apis mellifera* Linnaeus 1758), designation of Latreille (1810). Michener 1944: 292. Maa 1953: 557. Michener 1990: 140.

Apicula Rafinesque 1814: *Principles Fondamentaux de Somnologie*. 29. Unjustified replacement name for *Apis* Linnaeus 1758.

Apiarus Rafinesque 1815: *Analyse de la Nature: on Tableau de l'univers et des corps organises*. 123. unjustified replacement name for *Apis* Linnaeus 1758.

Megapis Ashmead 1904: 120. Type species: *Apis dorsata* Fabricius 1743, original designation. Maa 1953: 552.

Micrapis Ashmead 1904. *Proc. Ent. Soc. Washington* 6: 122. Type species: *Apis florea* Fabricius 1787, monobasic and original designation. Maa 1953: 557.

Apis (synapis) Cockerell 1907: *Entomologist* 40: 229. Type species *Apis (synapis) henshawi* Cockerell 1907, monobasic. Zeuner and Manning 1976: 240.

Hauffapis Armbruster 1938: *Archiv fur Bienenkunde* 19: 37. Unavailable as no type species was originally designated Cl. c.z.N. 1985: Art. 13c).

Apis (sigmatapis) Maa 1953 *Treubia* 21: 556. Type species: *Apis cerana* Fabricius 1793, original designation.

Diagnostic characters:

Moderate size (length 7-19 mm) apiform, in workers body, more robust than adeniform and more slender than euceriform, black, usually with amber or yellowish areas on metasoma; compound eyes with long, fine hairs; metatibial spurs absent, claws cleft; arolia present; inner surface of metabasitarsus with setal comb rows; clypeus elongate, gently convex but scarcely protuberant : Malar space as long as, or longer than basal width of mandible. Mandible without dentition (not so for queens or males) vertex extremely short, much less than ocellar diameter. Scutellum strongly convex and bulging, obscuring metanotum and basal area of propodeum. Basal area of propodeum extremely short and declivious. Mesocoxae nearly meeting medially. Stringils with prong on anterior margin corbicula; rastrellum, and auricle present (workers only). Wing venation strong and complete; marginal cell long, bluntly rounded at apex, not gently tapering over its length; marginal cell about 4 x as long as distance from its apex to wing tip; stigma small and slender; margin within marginal cell straight to concave; 1 r-m and 2 r-m strongly angled respective to M. jugal lobe present, which is little more than half to nearly two third as long as vanal lobe. Jugal and vanal incisions shallow; sting straight (workers only); compound eyes of the drones meet at top of head; metabasitarsal process absent. Mandible usually bidentate weakly. S₈ reduced to transverse bar and spiculum absent. Spatha and volsella absent. In larvae dorsal tubercles on segments 1-4 absent. Mandible weakly sclerotized, bluntly pointed, concavity on inner surface absent.

Distribution: INDIA (Cosmopolitan), Europe, Africa, Madagascar, Arabia, Central and Southern Asia, South East Asian Islands.

Biology: Nests are exposed or in cavities such as hives or hollow trees, sometimes in cavities in the ground. The nests are made primarily of wax secreted by the sternal wax glands of workers. Cells are subhorizontal, forming

vertical combs of two layers of cells opening in opposite directions, their bases constituting a median vertical wax sheet. Food for larvae is provided progressively. Cells are not closed until the larvae has finished feeding. A nest may consist of single exposed comb or multiple combs, usually on a cavity. Brood cells for workers and storage cells for honey or pollen are hexagonal, similar on diameter. Brood cells for males are similar but larger. Queen producing cells are not in combs and tend to hang from brood comb of worker cells (Michener 1990). This is only a group of highly social bees. New colonies are formed by fission, the old Queen and a swarm of workers leaving to find a new site. Colony size ranges from a few thousand to sixty thousand or more workers. There are no parasitic or obligate robber species (Michener, 1990).

Discussion: There is only one genus, *Apis*, in the subfamily Apinae of family Apidae. The relatively few species are so impressively similar that there is no need to reorganize multiple genera. It is important instead to emphasize the similarity among the species. This genus can be distinguished by the following characters such as, hind tibial spurs absent and eyes hairy.

Remarks: Ruttner (1987) followed tradition in recognizing only four or "at most five" modern species of *Apis*. Recently Engel (1999) reported 3 subgenera and four native species from India. The species *A. mellifera* is introduced here for agricultural purposes.

The present work reports three species along with one introduced species from Kerala. Here a key to species of *Apis* of India is also provided.

KEY TO SPECIES OF *APIS* LINNAEUS OF INDIA

1. Worker size variable, moderate to large (13-25 mm), forewing length 7-15 mm (Fig. 226, 270); thumb like process on hind basitarsus of male present; gonobase absent (*Apis* & *Megapis*)
..... 2
- Worker size small (10-15 mm), forewing length 6-7 mm (Fig. 274); thumb like process on hind basitarsus of male absent; gonobase present as distinct ring (*Micrapis*)
..... 3
2. Forewing hyaline; scutellum yellow-brown, rarely black; worker size moderate (12-18 mm), forewing length 7-15 mm; on labrum peg-like setae restricted to apical surfaces and tubercles; male metasomal tergum 8 with vertical arm much longer about the same length; body spicules of almost the same length (*Apis*)
..... 4
- Forewing fuscous; scutellum black, worker size large; forewing length 12-15 mm; drone with dense frond-like setae on meso and metatarsi; male metasomal tergum 8 with 2 long arms of about the same length; on labrum peg-like setae not restricted to apical surface and tubercles body spicules of last two segments larger (*Megapis*) *Apis dorsata* Fabricius
3. Metatibia and dorsolateral margin of metabasitarsus with black setae; metasomal terga 1-2 black, reddish brown tints apically on tergum or basally on tergum 2; drone metabasitarsal process short
..... *A. andreniformis* Smith

- Metatibia and dorsolateral margin of metabasitarsus with white setae; metasomal terga 1-2 reddish brown; drone metabasitarsal process long ...
..... *A. florea* Fabricius
4. Distal abscissa of vein M in hindwing present (Fig. 278); forewing length 7-9 mm; labrum yellow to brown; antenna (outer ring) nearly as wide as antennal palpus; maxillary palpus ventrally preapical
..... *A. cerana* Fabricius
- Distal abscissa of vein M in hindwing absent; forewing length 12-15 mm; labrum dark or dark brown with yellow marking; antenna (outer ring) much more narrow than basal diameter of antennal palpus (inner ring)
..... *A. mellifera* Linnaeus

1. *Apis (Apis) cerana indica* Fabricius

(Figs: 266-269)

The Eastern Honey bee or Asian Honey Bee

Apis cerana Fabricius 1973: *Ent. Syst. Eme. et. Acuta* Vol. 2: 274 (*Cerana* Fabricius)

Apis indica Fabricius 1798: *Suppl. Ent. Syst.* [2] 274 (*indica* Fabricius)

Apis socialis Latreille 1804 a. *Ann. du. Musee Hist. Nat.* 4: 390 (*indica* Fabricius)

Apis peroni Latreille 1804 b. *Ann. du. Musee Hist. Nat.* 4: 173 (*indica* Fabricius: See treatment of *javana* Subspecies)

Apis groonovii Guillou 1841: *Ann. de la soc. ent. de France* 10: 323. [*indica* Fabricius: see treatment of *javana* subspecies)

Apis perrottetti Guerin - Meneville 1844: *Texte explicatif, Insects*, Vol.3, 461. (*indica* Fabricius).

Apis delesserti Querin - Meneville 1844: *Texte Explicatif, Insects*, 3: 461 [*indica* Fabricius].

Apis sinensis Smith 1865: *Ann. Mag. Nat. Hist.*, 3: 380 [*Cerana* Fabricius].

- Apis mellifera* variety *japonica* Radoszkowski 1887: *Horae. Soc. Ento. Rossicae* 21: 436 (*japonica* Radoszkowski).
- Apis delesserti* Buttel - Reepen 1906. *Mitt. aus dem zool. Mue. Berlin* 3: Unjustified emendation. (*indica* Fabricius).
- Apis indica* variety *javana* Erderlein 1906: see *Ent. Zei.* 67: 337. (*javana* Enderlein).
- Apis indrea* Baldensperger 1928: *Bee World* 9: 173.
- Apis johni* Skorikov 1929 b. *Rep. Appl. Ent., Lenin* 4: (Johni Skorikov)
- Apis indica philippina* Skorikov 1929 b: *Rep. Appl. Ent. Leningrad* 4: 252 (*indica* Fabricius).
- Apis indica skorikovi* Maa 1944. *Ent. Shaownana* 1: 4. Nomen nudum. (Skorikovi Engel).
- Apis mellifera gandhiana* Muttoo 1951: *Ind. bee. Jour.* 13: 153. Nomen nudum (*indica* Fabricius).
- Apis (Sigmatapis) lieftincki* Maa 1953: *Truebia* 572 (Johni Skorikov)
- Apis (sigmatapis) samarensis* Maa 1953. *Truebia* 580 (*Indica* Fabricius)
- Apis indica sinensis ussuriensis* Goetze 1964: *Mono. zur. ang. Ent.* 19: 26 Nomen nudum. Refer comments under *A. mellifera*. (*Cerana* Fabricius).
- Apis cerana himalaya* Smith 1991 b. *Div. in the genu Apis, U.S.*, xiv 154. Nomen nudum (Skovikovi Engel).
- Apis cerana* Willis, Winston and Honda 1992: *Mol. Phylo. and Evo.* 1: 169. *Lapsus calami* (*Cerana* Fabricius).
- Apis nulnensis* Tingek, koeniger 1996 (2997) *Senck. bio.* 76: 116. (*nuluensis* Tingek et al).
- Plesiotype:** Worker (F): TL = 13.7, FWL = 7.58, FWW = 2.62, HWL = 4.90, HL = 3.19, HW = 245, SL = 1.08, FL = 2.74, EL = 2.11, EW = 0.88.

Colour: Integument: Black except, mandibles, base of antenna, ocelli and eyes testaceous yellow, antennae reflecting brown in certain lights; scutellum, and tegulae honey coloured; basal metasomal terga testaceous yellow; legs rufofuscous; sterna honey coloured. Pubescence on labrum, mandibles and eyes

white with pale yellow tint, clypeus and vertex dark brown, around antennal socket and face cinereous; finer hairs on mesosoma and metasoma cinereous and erect hairs dark brown, hairs on legs ash coloured anteriorly and apices with brownish tint.

Pubescence: Spare and silvery white hairs on clypeus; these hairs becomes abundant on antennal toruli; genal and postgenal pilosity minute at surfaces and larger on margins; scape of antenna with more or less long pilosity; flagellum with minute appressed pilosity. Thoracic hairs plumose, thickened and reflects light yellow colour on propodeum and metanotum; episternal hairs also similar to mesosoma; scopal hairs on fore legs yellowish white; mid leg and hind leg with appressed hairs, light brown; sparse light brown pubescence on metasomal tergites; sternal hairs white and sparse.

Head: Width in anterior view a little more than 1.3x distance between front ocellus and lower margin of clypeus (58.5: 45) (Fig. 268); maximum width of the head at level of posterior margin of eyes 8 x distance between front ocellus and occipital margin. Relative measurements of POL : OOL = 4:5 (Fig. 267); mandible simple, maxillary palpi single; clypeus slightly elevated and hairs sparse; antennal toruli depressed in pit; in between antennal toruli elevated ridge present; ocelli in a triangle on vertex; malar area distinct; genal area minutely punctate. Antenna 12 segmented. Relative length and width of antennal segments : Scape = 13.5:3.5, Pedicel 3:2, F₁ = 4:3, F₂ = 3:3, F₃ = 4.5:3, F₄ = 4.5L3, F₅ = 4.5:3, F₆ = 5.5:3, F₇ = 5:3, F₈ = 5:3, F₉ = 4:3, F₁₀ = 4:3, F₁₁ = 5.5:3 (Fig. 269); scape not reaching front ocellus; scape minutely striated, flagellum long with minute hairs; eyes hairy. Relative length and width of eye on lateral view = 25.5:10.5.

Thorax: The maximum width between tegulae to length of thorax 28:45 (Fig. 267); scutum smooth with fine punctures and larger hairs are finely branched and thickened near scutellum; scutellum bulbous and distinct with brown spots;

axilla distinct; metanotum and propodeum covered with long branched hairs; episternum minutely punctate.

Legs stronger and well developed; scopa present on femora; fore tibia longer than tarsal segments; tarsi covered with hairs; tibial spurs and tarsal claws with arolia visible; mid tibia and femur somewhat flattened; hind tibia and basitarsus modified (Fig. 266); pollen basket on outer surface of tibia and pollen brush on inner surface of basitarsus developed; mediotarsus and distitarsus very small when compared to basitarsus. Tegulae covered with fine hairs; wings hyaline and veins dark brown. Relative measurement of fore wing length: its maximum width = 97:33.5; forewing venation as in figure (Fig. 266), three submarginal cells present; first recurrent vein meets anterior part of second submarginal cell and second recurrent vein meets posterior part of third submarginal cell; radial cell longer than broad, with darker area on its anterior part; basal vein (vein-M) frequently curved strongly towards the distal end of cu-v (Fig. 266); angle of posterior apical margin of first submarginal cell less than 45°; jugal and vanal of hindwing present (Fig. 266); outer side of radial cell covered with fine hairs; about 18 hamuli serially arranged; distal abscissa of vein M present (Fig. 266).

Metasoma: T₁ - T₆ sparsely punctate. On T₁ with a depression, a raised mid line present on depression; other segments black; sternites covered with sparse hairs.

Male: Male differ from female in having. (1) Compound eyes large, meet at the top of head (2) Clypeus and labrum reduced (3) antennae slender (4) wings hyaline and clear (5) tarsi unmodified and long.

Materials examined: Plesiotype : F, INDIA: Kerala, Calicut University Campus, Jobiraj. T, 9-vi-1998. *Other materials examined:* 1 F, Kudiyan mala, 25-

xii-1999, Jobiraj. T.; 3F, INDIA, Kerala, Palode, 9-iii-2000, Jobiraj. T.; 3 F, INDIA, Kerala, Vithura, 8-iii-2000. Jobiraj. T.; 1F, INDIA, Kerala, Calicut University Campus, 6-vii-1998 Jobiraj. T; 1F, INDIA, Kerala, Calicut University Campus, 15-viii-1998, Jobiraj. T.; 1F, INDIA, Kerala, Calicut University Campus, 30-vi-1998, Jobiraj. T; 1F, INDIA, Kerala, Calicut University Campus, 3-vii-1998 Jobiraj, T; 2F, INDIA, Kerala, Calicut University Campus, 4-vi-1998, Jobiraj, T.; 1F INDIA, Kerala, Calicut University Campus, 9-vi-1998, Jobiraj, T; 5F, INDIA, Kerala, Kartikulam, 12-ix-1998 Jobiraj. T; 1F, INDIA, Kerala, Kodenchery, 14-xii-1998, Jobiraj. T; 1F, INDIA, Kerala, Balussery, 2-x-1998, Jobiraj, T.; 1F, INDIA, Kerala, Kadalundi 3-xi-1999, Jobiraj. T; 1 F, INDIA, Kerala, Chelavoor, 15-xi-199, Jobiraj, T.; 1F, INDIA, Kerala, Trissur, 28-i-2000, Jobiraj, T; 2F, INDIA, Kerala, Nanminda 12-ix-1999, Jobiraj, T.; 1 F, INDIA, Kerala, Calicut University Campus, 22.iv.1997, Kavitha; 3F, INDIA, Kerala, Palode, 23-iv-1999, Koshi.

Flower Record: *Roulfia tetraphylla*, *Portulaca* sp, *Ocimum sanctum*

Distribution: India (Throughout India), Sri Lanka, Burma, Malaya, Madagascar, Afganistan, Himalayan uplift in Tibet, China, Korea, Soviet Union, Vietnam, Japan, Timor, Sumatra, Malaysia, Philippines.

Biology: Highly social.

Habitat: Found in both undisturbed and disturbed habitats, Mountains, plains, and cultivated crop fields.

Discussion: This species resembles *Apis mellifera* Linnaeus in general characters and size, but mainly differs from: 1. Scutellum yellowish brown (In *A. mellifera*, scutellum black); 2. Forewing length 7-9 mm (In *A. mellifera* fore wing length 12-15 mm); 3. Labrum yellow or brown (In *A. mellifera* labrum dark or dark brown with yellow marking); 4. Hamuli on hindwing 18-20 (In *A. mellifera* hindwing with 21 or more hamuli).

This species represents 8 subspecies, but only two subspecies found in India (Engel 1999). *Apis cerana cerana* Fabricius separate from *Apis cerana indica* Fabricius from following characters: 1. Scutellum - testaceous yellow (In *A. cerana cerana* scutellum yellow); 2. T₃ - T₄ - testaceous yellow (In *A. cerana cerana* T₃-T₄ yellow).

Remarks: The male is not represented in this collection and the characters mentioned are based on description of Ruttner (1988). The specimens of *A. cerana cerana* Fabricius is not represented in this collection and diagnostic characters are taken from Engel (1999).

Apis cerana represents 8 subspecies, they are *Apis cerana cerana* Fabricius, *A. c. heimifeng* Engel. *A. c. indica* Fabricius, *A. c. japonica* Fabricius, *A. c. javana* Enderlein, *A. c. johni* Skorikov, *A. c. nuluensis*, Tingek *et al* and *Apis cerana skorikovi* Engel. But only three of them are presently understood from the Indian sub continent. They are *A. c. indica*, *A. c. cerana* and *A. c. skorikovi*. *A. c. indica* and *A. c. skorikovi* are not represented in the collection, notes on them are based on the description of Engel (1999). The followings are the major differences between three species.

<i>A. cerana indica</i>	<i>A. c. cerana</i>	<i>A. c. skorikovi</i>
1. Scutellum - testaceous yellow	1. Scutellum - yellow	1. Scutellum dark
2. T ₃ - T ₄ - testaceous yellow	2. T ₃ - T ₄ yellow	2. T ₄ - entirely black
3. Paired yellow spot on S ₃ present	3. Paired yellow spots on S ₃ absent	3. Paired yellow spots on S ₃ present
4. Finer hairs on tergum cinareous and erect hairs dark	4. Finer hairs on tergum cinareous and erect hairs dark	4. White hairs present on the tergum

2. *Apis (Megapis) dorsata dorsata* Fabricius

(Figs: 270-273)

The Giant Honey bee

Apis dorsata Fabricius 1793: *Ent. Syst. Emen et Acuta*. Vol.2. 328 [*dorsata* Fabricius]

Apis nigripennis Latreille 1804b: *Ann. du Mus. Hist. Nat.* 5: 170 [*dorsata* Fabricius]

Apis bicolor Klug. 1807: *Ann. du. Musee Hist. Nat.* 5: 264. Pre occupied (nec Linnaeus 1758). (*binghami* Cockerell).

Apis laboriosa Smith in Moore et al. 1871. *Jour. Linn. Soc.* 11: 249. [*laboriosa* Smith]

Apis testacca Smith 1871: *Jour. Linn. Soc.* 11: 396. *Lapsis calami*. [*dorsata* Fabricius]

Megapis zonata (Smith); Ashmead 1904; *Proc. Ent. Soc. Washington* 6: 121. [*binghami* Cockerell].

Megapis dorsata (Smith); Ashmead 1904: *Proc. Ent. Soc. Washington* 6: 121. [*dorsata* Fabricius].

Apis dorsata binghami Cockerell 1906: *Canadian Ent.* 38: 166. Replacement name for *Apis zonata* Smith 1859. [*binghami* Cockerell].

Apis binghami sladeni Cockerell 1914: *Ann. Mag. Nat. Hist. Series* 8, 74: 13 [*laboriosa* Smith].

Apis darsata Baldensperger 1928: *Bees world* 9: 173. *Lapsis calami* [*dorsata* Fabricius].

Apis himalayana Maa. 1944: *Ent. Shaowuana* 1: 4 *Nomen nudum claboriosa* Smith)

Megapis breviligula Maa 1953: *Treubia* 21: 563. [*breviligula* (Maa)]

Megapis binghami (Cockerell); Maa 1953: *Treubia* 564. [*binghami* Cockerell]

Megapis laboriosa (Smith); Maa 1953: *Treubia* 570 (*laboriosa* Smith)

Apis dorsata Ruttner 1988: *Biogeography and taxonomy of Honey bees* 118. *Lapsus calami*. [*dorsata* Fabricius]

Apis labortiosa Willis, Winston and Honda 1992: *Molecular Phylogenetics and Evolution* 1: *Lapsus calami*. *Claboriosa* Smith).

Plesiotype: Worker (F): TL = 22.57 mm, FWL = 12.9, FWW = 4.2, HWL = 8.92, HL = 3.6, HW = 4.19, SL = 1.4, FL = 3.4, EL = 3.2, EW = 1.2, OMD = 0.64, POL = 0.6, OOL = 0.4.

Colour: Integument: Black except; Proboscis testaceous yellow; base of antenna and ocelli testaceous yellow; basal three abdominal terga and sterna honey yellow; hind tarsal segments reflects brown; tip of flagellum and base of flagellum and antennae brown.

Pubescence: Head fuscous to rusty brown except the appressed hairs on the face around antennal toruli white. Scutal hairs dark brown (or blackish brown) to cinereous; scutellum, mesoscutum and propodeum pale yellow; basal abdominal segments pale yellow; hind part of metasoma fuscous; anterior part of legs pale yellow and posterior part fuscous.

Head: Width in anterior view a little more than $1.17 \times$ distance between front ocellus and lower margin of clypeus (54.5×46.5) (Fig. 272); maximum width of head at the level of posterior margin of eyes $3.875 \times$ distance between front ocellus and occipital margin. Relative measurements of POL : OOL = 3:2 (75.5) (Fig. 271); mandible simple, sparsely and deeply punctured; labrum and clypeus punctae; clypeus somewhat elevated; antennal toruli depressed in a pit; frontal line distinct and extends to middle ocellus and joins in the form of 'Y' shape; ocelli in a triangle on vertex; malar area distinct and covered with minute hairs; outer margin of genal area with long and branched hairs; antenna 12 segmented; relative length and width of antennal segments : scape = 40.8, pedicel = 75.5, $F_1 = 10:65$, $F_2 = 5.5 : 6.5$, $F_3 = 9.5:6$, $F_4 = 9:6.5$, $F_5 = 10:6$, $F_6 = 9:6$, $F_7 = 9:6$, $F_8 = 9:6$, $F_9 = 5:6$, $F_{10} = 11.5:6$ (Fig. 273); scape not reaching front ocellus; scape sparsely punctured; antennae with appressed and branched hairs. Eyes hairy; relative length and width of eye in lateral view = 23:8.5.

Thorax: The maximum width between tegulae to length of thorax = 24.5 : 46; scutum and scutellum thickly pubescent; scutellum black; pronotum, pre episternum and metepisternum thickly pubescent; mesepisternum with sparse, dark pubescence and minutely punctured; posterior margin of scutum with long branched hairs; metanotum and propodeum covered with relatively small hairs; propodeal spiracle distinct.

Legs well developed; scopa on femora present; scopal hairs well developed on forefemur; hind tibia with corbicula; outer side of hind basitarsus and other tarsal segments with thick, long and bristle like hairs; pollen brush well developed.

Wings pale fuscous or fusco-hyaline; dark smoky tinge on wings; relative measurements of forewing length : its maximum width = 97:32; wing venation as in figure (Fig. 270); with three submarginal cell; first recurrent vein meets second submarginal cell in its anterior middle portion and second recurrent vein meets third submarginal cell; jugal lobe of hind wing present; minute hairs distributed all over the wing surface; 30 hamuli serially arranged; distal abscissa of vein M present (Fig. 270).

Metasoma: T₁ covered with hairs; T₂ -T₃ covered with sparse and minute hairs; a midline in the depression of T₁ extends to propodeal pit; depression in T₁ covered with appressed and minute hairs; sternites also covered with minute hairs.

Male: Male differ from female in having: 1. Compound eyes large, and meet at the top of head; 2. Ocelli closely arranged below the meeting of eyes; 3. Clypeus and labrum reduced; 4. Antennae slender, with steel grey colour 5. Wings hyaline and clear; forewing length = 13.2 mm; 6. Forelegs and midlegs smaller than females; 7. hind leg without corbicula and pollen brush, but the

inner surface of hind basitarsus with thick brush consisting of robust, palm like hairs, tarsal segments, 2, 3 and 4 also with same modification, this brush increases adhesion of the queen's body during copulation.

Materials Examined: *Plesiotype* : F: INDIA, Tamilnadu, Mettupalayam, 26-vii-1998, Jobiraj. **Other materials examined:** 3W: INDIA, Tamilnadu, Mettupalayam, 26-vii-1998, Jobiraj, T; 1W: INDIA, Kerala, Kudiyanmala, 25-xii-1999; 2w: INDIA, Kerala, Palode, 24-iv-199, Koshy; 7 Drones; INDIA, Kerala, Karumala, 16-iv-1998, Jobiraj. T.

Flower Record: *A. dorsata* is an important pollinator of several plants.

Distribution: INDIA (Throughout India), Vietnam, South east Asian islands, Burma, Tenasserim, Ceylon, China, Malaya, Java, Philippine Islands, East of Timor, Pakistan.

Biology: The shape of the comb is more or less semicircular or cuneiform. Queens are reared on the same cells as workers and drones (Buttel - Reepen, 1903, Butler, 1954). Drone brood is irregularly scattered among worker brood. Drones are reared on the same cells as workers, but the capping are elevated. Lindauer (1950) described the process of reproductive swarming, during the "play flight" of young queens a line of bees flying back and forth in a direction is formed while the whole colony becomes agitated. No dances were observed. During the short swarming period small swarms depart every 3-4 days.

The workers sting and is the most painful among the bee species. Much of the wax and honey harvested in India comes under this species (Thakar & Tonapi, 1961; Singh, 1980). This species build their nest in high trees, affixed to the under side of limbs.

Habitat: Undisturbed and disturbed habitats.

Discussion: This species represents 4 sub species (Engel 1999) but only nominal subspecies is found in India. The above subspecies closely resembles to *A. dorsata laboriosa* Smith, other subspecies from Indian subcontinent in general appearance, but differs from it mainly in the following characters: Minute, broad, medioapical extension of the gradulus on S₃ present (In *A(d) laboriosa* minute, broad, medio apical extension of the gradulus on S₃ absent).

3. *Apis (Micrapis) florea* Fabricius

(Figs: 274-277)

The Red Dwarf Honey Bee

Apis florea Fabricius 1787. *Mant. Ins.* i vol. 1: 305.

Apis semirufa hoffmannsegg 1818: *Zool. Mag. von. Wied.* 1(2): 60.

Apis lobata Smith 1854: *Cat. Hym. Ins. Coll. Brit. Mus. Part. 2.*

Apis floralis Horne and Smith 1870: *Trans. Zool. Soc. Lon.* 7: 181. *Lapsus Calami.*

Apis testacea Bingham 1898. *Jour. Bom. Nat. Hist. Soc.* 12: 129. Preoccupied (nec Smith 1858).

Micrapis florea (Fabricius); Ashmead 1904: *Proc. Ent. Soc. Washington.* 6: 122. [See Comments below].

Apis florea variety *rufiventris* Friese in Buttel - Reepen 1906: *Mitt. Zool. Mus. Berlin* 3: 167, 170.

Apis florea florea variety *fuscata* Enderlein 1906. *Apis. Stet. Ent. Zeit.* 67: 338. Unavailable Cl. c. 2N. 1985. Arts. 10c, 23], 506).

Apis nursei Cockerell 1911a: *Ann. Mag. Nat. Hist. Ser. 8, 7.* Replacement name for *Apis testacea* Bingham 1898.

Apis florea nasicana Cockerell 1911b: 241.

Plesiotype: Worker (F): TL = 10.27, FWL = 7, FWW = 2.5, HWL = 4.71, HW = 2.72, SL = 0.857, FL = 1.71, POL = 0.43, OLL = 0.22, EL = 2, EW = 0.78.

Colour: Integument : Black except, proboscis brown, base of antennae and ocelli with cinereous tint, eyes reflects steel grey; tegulae dark brown; wings hyaline and clear, veins testaceous; basal abdominal segment 2-3 reddish brown.

Pubescence: Head covered with white hairs except the vertex, dark to black pubescence; mesosoma, with white pubescence, but certain hairs reflects brown; scopal hairs on fore legs yellowish white, midleg and hind leg with appressed hairs, light brown; sparse light brown pubescence on metasomal tergites; sternal hairs white.

Head: Width in anterior view 1.44 x distance between front ocellus and lower margin of clypeus (73.5: 51); maximum width of head at level of posterior margin of eyes 4.7 x distance between front ocellus and occipital margin. Relative measurements of POL : OOL = 7.7:4 (11.5:6); maxillary palpus single; mandible simple, punctured; malar area wide, with minute and sparse hairs; labrum small, longer than wide; sparse pubescence on clypeus and face; antennal toruli in a depression; supraantennal area striated, ocelli in a triangle on vertex; vertex covered with thick and long pubescence, lower side of genal area long pubescence; antennae 12 segmented; Relative length and width of antennal segments; scape = 21:4.5, pedicel = 4.5:3, F₁ = 4.5:4, F₂ = 3.4.5, F₃ = 3:4.5; F₄ = 4.5:4.5, F₅ = 4.5:4.5, F₆ 4.5:4, F₇ = 4.5:4.5, F₈ = 5:4.5, F₉ = 5:4.5, F₁₀ = 5.5:4 (Fig. 277); scape not reaching front ocellus; scape pubescent; flagellar segment second smaller than first; eyes hairy, sparsely pubescent; relative length and width of eye in lateral view = 3.6: 14 (Fig. 274).

Thorax: Maximum width between tegulae to length of thorax 34:40; scutum striated and minutely punctured; scutellum minutely punctured, long hairs on scutellum branched; propodeum striated covered with minute hairs; mesepisternum sparsely haired and striated; scopa on fore femur long; tarsal

claws with arolia; hind tibia and basitarsus modified (Fig. 274), pollen basket on outer side and pollen brush on inner side.

Tegulae finely punctured; wings hyaline and iridescent, veins testaceous; relative measurements of forewing length: its maximum width = 185:64; fore wing venation as in figure (Fig. 274); three submarginal cells, first recurrent vein meets anterior middle part of second cubital cell and second recurrent vein meets third submarginal cell at their apices; radial cell long, outer vein pointed at tip; wing papillate; basal vein frequently and gently curved, strongly distal Cu-v (Fig. 274); angle of postero apical margin of first submarginal cell less than 45°; jugal and vanal lobe of hindwing present (Fig. 274). Hamuli 11, serially arranged (Fig. 274); distal abscissa of vein-M absent (Fig. 274).

Metasoma: - T₁ - T₆ covered with sparse hairs; depression on T₁ reduced; sternites covered with long hairs.

Male: Male differs from females in having 1. Metatibial process long, more than two-thirds metabasitarsus. 2. Hind basitarsus with thumb-like process 3. Vertical arm of T₈ as long as horizontal arm 4. S₇ and S₈ not fused mesally gonobase represented by isolated fragments ventral gonocoxa sterilized as transverse base; dorsal gonocoxa not reduced, ventral coruna of endophallus not recurved ventrally (Engel, 1999).

Materials Examined: *Plesiotype*: F, INDIA, Kerala, Calicut University Campus, 15-viii-1999, Jobiraj, T.; *Other materials examined*: 2F, INDIA, Kerala, Calicut University Campus, 6-vii-1998, Jobiraj, T. 1F, INDIA, Kerala, Calicut University Campus, 15-viii-1995, 1F, INDIA, Kerala, Nanminda, 12-ix-1999, 1F, INDIA, Kerala, Calicut University Campus, 17-iv-1997, Kavitha, 3F, INDIA, Kerala, Kudiyannala, 25-xii-1999 Jobiraj, T.

Flower Record: Pollinators of field crops in the plains of India and Pakistan : *Brassica campestris*, *Brassica juncea*, *Medicago sativa*.

Distribution: INDIA : (Bengal, Madras, Bangalore, Malabar, Assam, Sikkim) Pakistan, Sri Lanka, Thailand, Indo-China, Malaysia, Sumatra, Java, Borneo, Palawan, Arabian Peninsula, Vietnam, Indonesia, Tennasserim.

Biology: *Apis mellifera* start their nest with a vertical mid-rib, which extends laterally with hexagonal cells. The frequent nesting site is in the thin branch of a bush or a small tree. The disturbance of the bees at the comb elicits a "hissing behaviour" (Ruttner, 1988). The daily egg rate in a good season was found to be 350. The development of *A. florea* colony is solely directed by swarming process, which initiates the dissolution of the colony. Queen cells are constructed at the lower rim of the comb, upto 16 in number. Then bees stops enlarging the comb and rearing new brood. By swarming individual colonies ends.

Habitat: Found in disturbed and undisturbed habitats, such as gardens, forests, vegetable garden, among cultivated crops and mountains.

Discussion: This species resembles *Apis andreniformis* Smith in general appearance, but differs from it mainly in the following characters: 1. Metatibia and dorsolateral margin of metabasitarsus consists of white setae (In *A. andreniformis* metatibia and dorsolateral margin of metabasitarsus with black setae); 2. Metasomal terga 1-2 reddish brown (In *A. andreniformis* metasomal terga 1-2 nearly black); 3. In the drones metabasitarsal process distinct (In the males of *A. andreniformis* metabasitarsal process short).

Remarks: No subspecies is recognized. The male specimen is not represented in this collection and the diagnostic character were taken from Engel (1999).

4. *Apis (Apis) mellifera* Linnaeus

(Figs: 279-281)

The Western Honey Bee

- Apis mellifera* Linnaeus 1758. *Syst. Nat.* 1: 576. [*mellifera* Linnaeus]
- Apis mellifica* Linnaeus 1761. *Syst. Nat.* 1: 421. Unjustified emendation [*mellifera* Linnaeus].
- Apis gregaria* Geoffroy 1762: *Hist. abr.* 2: 407. [*mellifera* Linnaeus]
- Apis cerifera* Scopoli 1770. *Ann. Hist. Nat. Ann.* IV: 16. [*mellifera* Linnaeus]
- Apis unicolor* Latreille 1804b: *Ann. Musee. Hist. Nat.* 5: 168. [*Unicolor* Latreille]
- Apis fasciata* Latreille 1804 b: *Ann. Musee. Hist. Nat.* 5: 171. Pre occupied (*nec* Linnaeus 1767, Scopoli 1770) *lamarckii* Cockerell.
- Apis adansonii* Latreille 1804b: *Ann. Musee. Hist. Nat.* 5: 172. [*adansonii* Latreille]
- Apis ligustica* Spinola 1806: *Ins. Lig. sp. nov. Raviores.* 1: 35. [*linguistica* Spinola]
- Apis capensis* Eschscholtz 1822: *Entomographien.* 1. 97. [*Capensis* Eschscholtz]
- Apis caffra* Lepeletier de saint Fargeau 1836: *Hist. nat. des. sult. Hym.* 1: 402. preoccupied (*nec* Linnaeus 1767). [*Scutellata* Lepeletier de saint Fargeau].
- Apis scutellata* Lepeltier de saint Fargean 1836: *Hist. Nat. des. Suit. Hym.* 1: 404. [*Scutellata* Lepeletier de Saint Fargeau].
- Apis nigritarum* Lepeletier de saint Fargeau 1836: *Hist. Nat. des. suit. Hym.* 1: 406. [*adansonii* Latreille].
- Apis daurica* Fischer von Waldhein 1843. *Mag. Zool. Ana. Com. Paleo.* 5: 1. [*mellifera* Linnaeus].
- Apis mellifica* variety *Cecropia kiesenwetter* 1860. *Ber. Ent. Zeit.* 4: 315. [*Cecropia kiesenwetter*].
- Apis australis* Kiesenwetter 1860: *Ber. Ent. Zeit.* 4: 317. Unjustified replacement name for *Apis ligustica spinola* 1806. [*ligustica spinola*].
- Apis cerifera* Gerstaecker 1862. *Über. geo. verb.* 60. Preoccupied (*nec* Scopoli 1770). [*Sossimai* Engel].

- Apis mellifera* variety *remipes* Gerstaecker 1862. *über. geo verb.* 61. [*remipes* Gerstaecker].
- Apis ligurica* Smith 1861b. *Proc. Ent. Soc. Lon.* 7: 14. *Nomen nudum*. [*ligustica* Spinola].
- Apis mellifica germanica* Pollmann 1879. *Wert. ver. Bei. Germany.* 1. [*mellifera* Linnaeus].
- Apis mellifica carnica* Pollmann 1879: *Wert. Ver. Bei. Germany.* 45. [*Carnia* Pollmann].
- Apis mellifica hymettea* Pollmann 1879. *Wert. Ver. Bei. Germany.* 50. Unjustified replacement name.
- Apis mellifica cypria* Pollmann 1879: *Wert. Ver. bei. Germany.* 52. [*Cypria* Pollmann]
- Apis siciliana* Grassi 1881: *Sag. Mon. Api. Italia. Italy.* 1. [*Siciliana* Grassi]
- Apis mellifica* variety *nigrita* Lucas 1882. *Bull. Sean. Soc. ento. France* 1: 62 [*mellifera* Linnaeus].
- Apis mellifida* Pollmann 1889. *Werth. ver. Bia. Germany,* vii 90. *Lapsus calami* [*mellifera* Linnaeus].
- Apis mellifida* (Sic) variety *Caucasia* Pollmann 1889. *Wert. Ver. Bie. Germany.* VII. 90. [*Caucasia* Pollmann].
- Apis ligurica* Dalla Torre 1896. *Cat. Hym. Sys.* 10. *Apidae.* Germany VIII. 602. *Nomen nudum* (*nec* Tegetmeier 1859, 1860: *Sec. below*). Corrected authorship. [*ligustica* Spinola].
- Apis mellifera carniolica* Koschevnikov 1900. *Izv. Imp. Obs. est. iEt.* 99: 1. Unjustified emendation. [*Cypria* Pollmann].
- Apis mellifica mellifica* variety *Siziliana* Buttel-Reepen 1906: *Mit. Zool. Mus. Berlin* 3: 168. Unjustified emendation [*Siciliana* Grassi].
- Apis mellifica unicolor* variety *syriaca* Buttel-Reepen 1906: *Mit. Zool. Mus. Berlin* 3: 175. Unavailable (I.C.Z.N. 1985: Arts. 10c, 23j, 50c). [*syriaca* Skovikov].
- Apis mellifica mellifica* variety *lehzeni* Buttel-Reepen 1906: *Mit. Zool. Mus. Berlin* 3: 175. Unavailable (I.C.Z.N. 1985: Arts. loc., 23j, 50c). [*mellifera* Linnaeus].
- Apis mellifica unicolor* variety *intermissa* Buttel-Reepen 1906: *Mit. Zool. Mus. Berlin* 3: 187. Unavailable (I.C.Z.N. 1985: Arts. 10c, 23j, 50c). [*intermissa* Maa].

- Apis mellifera unicolor* variety *friesei*. Buttel-Reepen 1906. Mit. Zool. Mus. Berlin 188. Unavailable (I.C.Z.N. 1985: Arts. 10c, 23j, 50c). [*adansonii* Latreille]
- Apis mellifera lamarckii* Cockerell 1906. *Can. Ent.* 38: 166. Replacement name for *Apis fasciata* Latreille 1804b. [*lamarckii* Cockerell].
- Apis mellifica* Enderlein 1906. *Ste. Ent. Zeit.* 67: 331. *Lapsus calami* [*mellifera* Linnaeus].
- Apis mellifica unicolor* variety *friesei* Enderlein 1906: *Ste. Ent. Zeit.* 67: 335. *Lapsus calami*. [*adansonii* Latrille].
- Apis mellifera sicula* Montagano 1911: *Pro. Int. Bee. Con.* 5: 26. [*Siciliana* Grassi].
- Apis adamsoni* Meunier 1915: *Zeit. der. den. geo. geso.* 67: 210. *Lapsus calami*
- Apis fuscata* Meunier 1915: *Zeit. der. den. geo. ges.* 67:210: *Lapsus calami*
- Apis mellifica kaffra* Jack 1916. *Tran. Zool. Soc. London* 7: 397. *Lapsus calami* [*scutellata* Lepeletier de saint Fargeau]
- Apis mellifera caucasica* Gorbachev 1916. *Tifis.* 39. Unjustified emendation. [*Caucasia* Pollmann].
- Apis mellifica* variety *banatica* Grozdanic 1926: *Acta. Soc. Ent. Ser.* 1: 57. [*Carnica* Pollmann].
- Apis fascrata* Baldensperger 1928 *Bee world* 9: 173. *Lapsus calami* [*lamarckii* Cockerell].
- Apis eurasiatica* Skorikov 1929a: *Rep. Appl. ent., Leningrad* 4: 14. Unjustified replacement name for
- Apis mellifera* variety *remipes* Gerstaecker 1962. [*remipes* Gerstaecker]
- Apis mellifera mellifera* natio *tesquorum* skorikov 1929a. *Rep. Appl. Ent. Leningrad* 4: 29. Unavailable (I.C.Z.N. 1985: Arts. 10c, 23j, 50c). [*artemisia* Engel]
- Apis mellifera remipes* natio *absuatna* skorikov 1929a. *Rep. Appl. Ent. Leningrad* 4: 32: unavailable (I.C.Z.N. 1985: Arts. 10c, 23j, 50c). [*remipes* Gerstaecker].
- Apis mellifera remipes* natio *georgica* Skorikov 1929a. *Rep. Appl. Ent. Leningrad* 4: 32. Proposed as new again in skorikov (1929b). Unavailable (I.C.Z.N. 1985: Arts 10c, 23j, 50c). [*remipes* Gerstaecker].
- Apis meda* Skorikov 1929b. *Rep. Appl. Ent. Leningrad* 4: 253. [*meda* skorikov]

- Apis mellifera natio acervorum* skorikov 1929b: *Rep. Appl. Ent. Leningrad* 4: 253. Preoccupied (*nec linnaeus*1758). [*artemisia* Engel].
- Apis remipes transcaucasica* skorikov 1929b. *Rep. Appl. Ent. Leningrad* 4: 254. [*remipes* Gerstaecker].
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- Apis niger* Baldensperger 1932: 5th Con. Int. Ent., Paris. 830. *Nomen nudum*. [*mellifera* Ennaeus].
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- Apis mellifera nubica* Ruttner 1976a: XXV *Con. Int. d' Api. Grenoble*: 359 [*jemenitica* Ruttner].
- Apis mellifera littorea* Ruttner 1976a: XXV *Con. Int. d'Api. Grenoble*: 361. *Lapsus calami* [*litorea* Smith].
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- Apis mellifera carpatica* Barac 1977: *Proc. Int. Bee. Con.* 26: 270 [*Carnica* Pollmann].
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- Apis mellifera macedonica* Ruttner 1988: *Biogeo tax. Honeybees. Germany* xxii 249. [*Macedonica* Ruttner].
- Apis mellifera logustica* Kugler 1988: *The geography of 1st ael*; ix: 268. *Lapsus calami* [*lingustica* Spinola].
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- Apis mellifica capratica* Petrov 1996. *Jour. Ani. Sci. Agni. Aca.* 34: 58. *Lapsus calami* [*carnica* Pollmann].
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- Apis mellifera artemisia* Engel 1999. *Jour. Hym. Res.* 8(2): 165-196. Replacement name for *Apis mellifera acerrorum* skorikov 1929b (*nec* Linnaeus 1758). [*artemisia* Engel].
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- Apis mellifera sossimai* Engel 1999. *Jour. Hym. Res.* 8(2): 165-196. Replacement name for *Apis cerifera* Gerstaecker 1862 (*nec*. Scopoli 1770). [*sossimai* Engel].

Plesiotype: Worker (F): T: = 14.3, FWL = 9.3, FWW = 3.22, HWL = 6.68, HL = 3.6, HW = 4.36, SL = 1.35, FL = 3, EL = 2.68, EW = 1.2, POL = 0.59, OOL = 0.45.

Colour: Integument: Black except, mandibles and labrum dark brown, proboscis yellowish brown, apices of malar space and clypeus dark brown; antennal toruli brown; tegulae dark brown; veins brown; hind tibia and tarsal segments honey coloured; basal abdominal segment faint dull brown.

Pubescence: Face with light yellow tints, except vertex dark brown; anterior thoracic scutum yellowish tint; episternal hairs more light and finely branched; scutum, scutellum reflects light yellow; legs whitish with light yellow tints; metasomal segments except the last with yellowish; last tergite dark brownish black.

Head: Width in anterior view a little more than $1.37 \times$ distance between front ocellus and lower margin of clypeus (48: 35) (Fig. 280); maximum width of head at the level of posterior margin of eyes $11.25 \times$ distance between front ocellus and occipital margin. Relative measurements of POL : OOL = 6.5:5 (Fig. 279); mandible simple, maxillary palpi single; glossa long, feathery, flabellum distinct; antennal toruli in a pit; malar area well developed and distinct; vertex with long, branched hairs; ocelli in a triangle on vertex; antenna 12 segmented. Relative length and width of antennal segments, scape = 23:3, Pedicel = 4:4, $F_1 = 4.5:4$, $F_2 = 3:5$, $F_4 = 5:4$, $F_5 = 4.5:4$, $F_6 = 5:4$, $F_7 = 5:3.5$, $F_8 = 5:3.5$, $F_9 = 5:4$, $F_{10} = 4:4$ (Fig. 281); flagellar segment second shorter than pedicel and other flagellar segments; scape not reaching front ocellus; scape covered with minute hairs; eyes hairy, relative length and width of eye on lateral view = 29.5 : 13.5.

Thorax: Maximum width between tegulae to length of thorax = 38:47 (Fig. 279); scutum, scutellum covered with long hairs; appressed minute hairs also distributed on scutellum; axilla distinct; metanotum and propodeum minutely striated.

Legs stronger and stouter; scopal hairs well developed on femora; scopal hairs branched especially on hind femur; hind femur and basitarsus modified (Fig. 278); pollen basket (corbicula) on outer surface tibiae and pollen brush on inner surface of basitarsus; pollen racket with stiff bristles distinct; arolia present.

Tegulae with minute hairs; wings hyaline; radial cell long, narrow and rounded at apex; three submarginal cells; second submarginal cell sub triangular; first recurrent vein meets second submarginal cell in its anterior end; second recurrent vein meets third submarginal anteriorly: basal vein frequently curved; jugal and vanal lobe of hindwing present; distal abscissa of vein M in hindwing absent (Fig. 278).

Metasoma: T₁ - T₆ covered with minute hairs; tergites broader than other species; depression on T₁ absent; sternites covered with much longer hairs.

Male: Male differ from female in having: 1. Hind basitarsus without thumb like process 2. Vertical arm of T₈ as long as horizontal arm 3. S₇ and S₈ not fused mesally 4. Gonobase absent. 5. eyes large and fused on the top of head.

Plesiotype: 1F: INDIA: Kerala, Kudiyanmala, Jobiraj, T. 25-xii-1999. **Other materials examined:** 1 F: INDIA: Kerala, Kudiyanmala, Jobiraj, T. 25-xii-1999.

Flower Record: Unknown.

Distribution: India (Introduced throughout India). Western Africa, South of Zaire, Turkey, Azerbaijan, Armenia, Georgia, Russia, South Africa, Italy, Yugoslavia, Romania, Europe, Morocco, Saudi Arabia, Somalia, Egypt, Sweden, Malta, Ukraine.

Habitat: Found in disturbed and undisturbed habitats.

Discussion: This species resembles *A. cerana* Linnaeus in general characters, but differs from it: 1. Scutellum brownish black to black (In *A. cerana* scutellum yellow to brown); 2. Forewing length 12-15 mm (In *A. cerana* forewing length 7-9 mm); 3. Hindwing with hamuli 21 or more (In *A. cerana* hindwing with hamuli 18-20).

Remarks: This species has been introduced into India for agricultural purposes. It consist of 28 subspecies, from the available literature, it is not possible to identity up to subspecies. The male specimen is not represented in this collection, the diagnostic characters taken from Engel 1999.

Checklist

**CHECKLIST OF GENERA AND SPECIES OF APIDAE OF INDIA
DEALT WITH THE PRESENT WORK**

SUBFAMILY 1 : Apinae

Genus 1. AMEGILLA Friese

- | | | |
|-----|----------------------------------|----------------------------------|
| 1. | <i>A. calcifera</i> (Cockerell) | India (Assam, Sikkim) |
| 2. | <i>A. confusa</i> (Smith) | India (Sikkim) |
| 3. | <i>A. impunctata</i> sp. nov. | India (Kerala) |
| 4. | <i>A. interrupta</i> sp. nov. | India (Kerala) |
| 5. | <i>A. insularis</i> (Smith) | India (Sikkim) |
| 6. | <i>A. keralensis</i> sp. nov. | India (Tennaserim) |
| 7. | <i>A. malabarensis</i> sp. nov. | India (Kerala) |
| 8. | <i>A. parhypate</i> Lieftinck | India (Kerala) |
| 9. | <i>A. violacea</i> (Lepelletier) | India (Central India) |
| 10. | <i>A. zonata</i> (Linnaeus) | India (Kerala, Throughout India) |
| 11. | <i>A. xerophila</i> (Cockerell) | India (North India) |
| 12. | <i>A.</i> Sp. I | India (Kerala) |

Genus 2. APIS Linnaeus

- | | | |
|----|-------------------------------------|--|
| 1. | <i>A. adreniformis</i> Smith | India (Bengal, Sikkim, Assam) |
| 2. | <i>A. cerana indica</i> Fabricius | India (Throughout India) |
| 3. | <i>A. dorsata dorsata</i> Fabricius | India (Throughout India) |
| 4. | <i>A. florea</i> Fabricius | India (Bengal, Kerala, Karnataka,
Tamilnadu, Assam, Sikkim) |
| 5. | <i>A. mellifera</i> Linnaeus | India (Throughout India) |

Genus 3. LISOTRIGONA Moure

1. *L. cacciae* Nurse India (Kerala)
2. *L. keralensis* sp. nov India (Kerala)

Genus 4. THYREUS Panzer

1. *T. albolateralis* (Cockerell) India (Maharashtra)
2. *T. ceylonicus ceylonicus* (Friese) India (Kerala, Tamilnadu, Karnataka)
3. *T. himalayensis* (Radoszkowski) India (Kerala, Assam, Sikkim, Bengal, Tamilnadu, Pondichery)
4. *T. histrio* (Fabricius) India (Kerala, Tamilnadu, West Bengal, Karnataka, Orissa, Pondichery)
5. *T. massuri* (Radoszkowski) India (Kerala, Karnataka, Tamilnadu, Assam).
6. *T. medius* (Meyer) India (Kerala, Tamilnadu)
7. *T. novaehollandidae signatus* Meyer India (Tennasserim, Bengal)
8. *T. narendrani* sp. nov. India (Kerala)
9. *T. praestans* Lieftinck India (W. Bengal, Tennasserim)
10. *T. ramosellus* (Cockerell) India (Kerala, Tamilnadu, Maharashtra)
11. *T. smithii* Dalla Torre India (Kerala, Maharashtra, Mahe, Tamilnadu)
12. *T. surniculus* Lieftinck India (Kerala, Bengal, Pondichery, Maharashtra)
13. *T. takaonis* (Cockerell) India (Kerala, Karnataka, Tamilnadu).

Genus 5. TRIGONA Jurine

1. *T. ashokai* sp. nov. India (Kerala)
2. *T. biroi* Friese India (Kerala)
3. *T. irridipennis* Smith India (Kerala, Maharashtra, Karnataka)

- | | | |
|----|--|-------------------|
| 4. | <i>T. nilamburensis</i> sp. nov. | India (Kerla) |
| 5. | <i>T. travancorica</i> sp. nov. | India (Kerala) |
| 6. | <i>T. ventralis arcifera</i> Cockerell | India (Himalayas) |

Subfamily 2. Xylocopinae

Genus 1 : BRAUNSAPIS Michener

- | | | |
|-----|--------------------------------------|--|
| 1. | <i>B. cupulifera</i> Vachal | India (Kerala, Tamilnadu) |
| 2. | <i>B. engeli</i> sp. nov. | India (Kerala) |
| 3. | <i>B. hewitti</i> (Cameron) | India (Kerala) |
| 4. | <i>B. intermedia</i> sp. nov. | India (Kerala) |
| 5. | <i>B. indica</i> Reyes | India (Tamilnadu) |
| 6. | <i>B. kaliago</i> Reyes and Sakagami | India (Maharashtra) |
| 7. | <i>B. malliki</i> Reyes | India (Kerala, Karnataka) |
| 8. | <i>B. micheneri</i> sp. nov. | India (Kerala) |
| 9. | <i>B. mixta</i> (Smith) | India (Kerala, Bengal, Bihar,
Maharashtra, Punjab, Goa) |
| 10. | <i>B. palavanica</i> (Cockerell) | India (Kerala) |
| 11. | <i>B. philippinensis</i> (Ashmead) | India (Kerala) |
| 12. | <i>B. picitarsis</i> (Cameron) | India (Kerala, Tamilnadu, Karnataka,
Maharashtra, Punjab, Uttar Pradesh,
Pondichery) |
| 13. | <i>B. puangensis</i> (Cockerell) | India (Kerala, Tamilnadu, Punjab, Uttar
Pradesh, Goa) |

Genus 2. CERATINA Latreille

- | | | |
|----|------------------------------|---|
| 1. | <i>C. anupama</i> sp. nov. | India (Kerala) |
| 2. | <i>C. binghami</i> Cockerell | India (Kerala, Punjab, Karnataka,
Maharashtra) |

3. *C. curiosa* sp. nov. India (Kerala)
4. *C. corinna* Nurse India (North West India, Quetta)
5. *C. canarensis* Cockerell India (South Canara district)
6. *C. engeria* Nurse India (North West India, Quetta)
7. *C. heiroglyphica* Smith India (Kerala, Karnataka, Tamilnadu, Maharashtra)
8. *C. indica* (Hirashima) comb. nov. India (Tamilnadu)
9. *C. ino* Nurse India (Quetta, North West India)
10. *C. lepida* Smith India (North India)
11. *C. perforatrix* Smith India (Assam, Tennasserim)
12. *C. propinga* Cameron India (North India)
13. *C. rufipes* (Hirashima) India (North India)
14. *C. sasidharani* sp. nov. India (Kerala)
15. *C. simillima* Smith India (Maharashtra, Goa)
16. *C. smaragdula* Fabricius India (Kerala, Karnataka, Tamilnadu, Andrapradesh)
17. *C. unimaculata javanica* Vander-
Vecht India (Karnataka)
18. *C. unimaculata palmerri*
Cameron India (Kerala)
19. *C. vechti* (Baker) comb. nov. India (Kerala, Tamilnadu, Maharashtra)
20. *C. waini* (Shiokawa &
Sakagami) comb. nov. India, (Kerala, Maharashtra, Tamilnadu)

Genus : XYLOCOPA Latreille

1. *X. acutipennis* Smith India (Sikkim, Tenasserim)
2. *X. aestuans* (Linnaeus) India (Throughout India)
3. *X. amethystina* Fabricius India (Kerala, Maharashtra, Punjab)

4.	<i>X. anupama</i> sp. nov.	India (Kerala)
5.	<i>X. basalis</i> Smith	India (Northern India)
6.	<i>X. bryorum</i> (Fabricius)	India (Kerala, Sikkim)
7.	<i>X. caerulea</i> Lepeletier	India (Sikkim, Tennasserim)
8.	<i>X. collaris</i> Lepeletier	India (Kerala, Maharashtra, Skikkim)
9.	<i>X. dissimilis</i> Lepeletier	India (Sikkim, West Bengal)
10.	<i>X. fenestrata</i> (Fabricius)	India (Throughout India)
11.	<i>X. irridipennis</i> Lepeletier	India (Karnataka, Tamilnadu, Bengal)
12.	<i>X. keralensis</i> sp. nov.	India (Kerala)
13.	<i>X. latipes</i> (Drury)	India (Kerala)
14.	<i>X. nigroscaposa</i> sp. nov.	India (Kerala)
15.	<i>X. pictifrons</i> Smith	India (Kerala, Sikkim)
16.	<i>X. shona</i> sp. nov.	India (Kerala)
17.	<i>X. tenuiscapa</i> Westwood	India (Kerala, Tamilnadu, Assam)
18.	<i>X. tranquebarica</i> (Fabricius)	India (Kerala, Sikkim)
19.	<i>X. verticalis</i> Lepeletier	India (Kerala, Barrakpore)

The following genera (not dealt in this work) are also found in India.

1. *Nomada* Scopoli
2. *Ammobates* Latreille
3. *Parammobatodes* Popov
4. *Pasites* Jurine
5. *Tarsalia* Morawitz
6. *Eucera* Scopoli
7. *Tetralonia* Spinola
8. *Tetraloniella* Ashmead

9. *Anthophora* Latreille
10. *Habropoda* Smith
11. *Tetralonioidella* Strand
12. *Bombus* Latreille

Summary

SUMMARY

The present systematic study, on one of the families of bees (Apiformes), viz., Apidae reveals the diversity exhibited by the group in Kerala which formed the study area. Apidae of Kerala consists of 8 Genera and 63 species. They have been studied and analysed systematically. Apart from this, one subspecies viz., *Ceratina unimaculata javanica* Van der Vecht has been also included in this work as extralimital species, because it was collected from an area adjacent to the region of present study.

Out of a total of 20 genera reported from India, the present investigation identified 8 genera from Kerala viz., *Xylocopa* Latreille, *Ceratina* Latreille, *Braunsapis* Michener, *Amegilla* Friese, *Thyreus* Panzer, *Lisotrigona* Moure, *Trigona* Jurine and *Apis* Linnaeus. The remaining 12 genera were reported mostly from Central and North India, which is extremely different in climatic conditions when compared to Kerala.

In this study a total of 63 species have been described of which 19 species have been described as new to Science, and one species kept as indetermined. The following table illustrates the total number of species in each genera reported from Kerala and number of new species in each of them.

Genera	No. of species	No. of new species	New Comb.	Species in det.
1. <i>Xylocopa</i> Latreille	14	4	0	0
2. <i>Ceratina</i> Latreille	10	3	3	0
3. <i>Braunsapis</i> Michener	11	3	0	0
4. <i>Amegilla</i> Friese	7	4	0	1
5. <i>Thyreus</i> Panzer	10	1	0	0
6. <i>Lisotrigona</i> Moure	2	1	0	0
7. <i>Trigona</i> Jurine	5	3	0	0
8. <i>Apis</i> Linnaeus	4	0	0	0

The summary of the systematic treatment of the genera and species of Apidae are given below.

Family: APIDAE

Subfamily a: Xylocopinae

Tribe 1: Xylocopini

Genus : *Xylocopa* Latreille

1. *X. (Koptortosoma) aestuans* (Linnaeus)
2. *X. (Nodula) amethystina* Fabricius
3. *X. (Ctenoxylocopa) anupama* sp. nov.
4. *X. (Nodula) bryorum* (Fabricius)
5. *X. (Zonohirsuta) collaris* Lepeletier
6. *X. (Ctenoxylocopa) fenestrata* (Fabricius)
7. *X. (Mesotrichia) keralensis* sp. nov.
8. *X. (Mesotrichia) latipes* (Drury)
9. *X. (Koptortosoma) nirgroscaposa* sp. nov.
10. *X. (Zonohirsuta) pictifrons* Smith

11. X. (*Alloxylocopa*) *shona* sp. nov.
12. X. (*Mesotrichia*) *tenuiscapa* Westwood
13. X. (*Nyctomelitta*) *tranquebarica* (Fabricius)
14. X. (*Koptortosoma*) *verticalis* Lepeletier

Tribe 2: Ceratinini

Genus : *Ceratina* Latreille

1. C. (*Ceratinidia*) *anupama* sp. nov.
2. C. (*Pithitis*) *binghami* Cockerell
3. C. (*Ceratinidia*) *curiosa* sp. nov.
4. C. (*Ceratinidia*) *heiroglyphica* Smith.
5. C. (*Pithitis*) *indica* (Hirashima) Comb. nov.
6. C. (*Pithitis*) *smaragdula* Fabricius
7. C. (*Neoceratina*) *sasidharani* sp. nov.
8. C. (*Pithitis*) *unimaculata javanica* Vander Vecht.
9. C. (*Pithitis*) *unimaculata palmerii* (Cameron)
10. C. (*Pithitis*) *vechti* (Baker) comb. nov.
11. C. (*Pithitis*) *waini* (Shiokawa and Sakagami) Comb. nov.

Tribe 3: Allodapini

Genus : *Braunsapis* Michener

1. B. *cupulifera* Vachal
2. B. *engeli* sp. nov.
3. B. *hewitti* (Cameron)
4. B. *intermedia* sp. nov.
5. B. *malliki* Reyes
6. B. *micheneri* sp. nov.
7. B. *mixta* (Smith)
8. B. *palavanica* (Cockerell)
9. B. *philippinensis* (Ashmead)

10. *B. picitarsis* (Cameron)
11. *B. puangensis* (Cockerell)

Subfamily b: Apinae

Tribe 1. Anthophorini

Genus : *Amegilla* Friese

1. *A. (Amegilla) impunctata* sp. nov.
2. *A. (Dizonamegilla) interuptta* sp. nov.
3. *A. (Micramegilla)* sp. indet.
4. *A. (Zonamegilla) keralensis* sp. nov.
5. *A. (Zonamegilla) malabarensis* sp. nov.
6. *A. (Zonamegilla) parhypate* Lieftinck
7. *A. (Zonamegilla) zonata* (Linnaeus)

Tribe 2 : Melectini

Genus: *Thyreus* Panzer

1. *T. ceylonicus ceylonicus* (Friese)
2. *T. himalayensis* (Radoszkowski)
3. *T. histrio* (Fabricius)
4. *T. massuri* (Radoszkowski)
5. *T. medius* (Meyer)
6. *T. narendrani* sp. nov.
7. *T. ramosellus* (Cockerell)
8. *T. smithii* Dalla Torre
9. *T. surniculus* Lieftinck
10. *T. takaonis* (Cockerell)

Tribe 3: Meliponini

Genus : *Lisotrigona* Moure

1. *L. cacciae* (Nurse)

2. *L. keralensis* sp. nov.

Genus : *Trigona* Jurine

1. *T. (Heterotrigona) ashokai* sp. nov.
2. *T. (Heterotrigona) biroi* Friese
3. *T. (Heterotrigona) irridipennis irridipennis* Smith
4. *T. (Lepidotrigona) nilamburensis* sp. nov.
5. *T. (Heterotrigona) travancorica* sp. nov.

Tribe 4 : Apini

Genus : *Apis* Linnaeus

1. *A. (Apis) cerana indica* Fabricius
2. *A. (Megapis) dorsata dorsata* Fabricius
3. *A. (Micrapis) florea* Fabricius
4. *A. (Apis) mellifera* Linnaeus

In the present study many bees were collected from all over Kerala. Only the taxa belonging to Family Apidae have been studied systematically in this work. All the species were properly identified and described. Redescriptions were given in the case of already known but poorly described species. Apart from this key to the divisions of Apoidea, key to the families of Apiformes, key to the genera with tribes and subfamilies of Apidae of India and various keys to the species under each of the genus found in Kerala also provided. A checklist of Genera and species of Apidae of India, dealt with this work is also provided. All the type materials are kept in the collections of Department of Zoology, University of Calicut.

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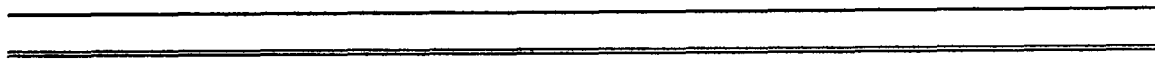
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Plates and Figures

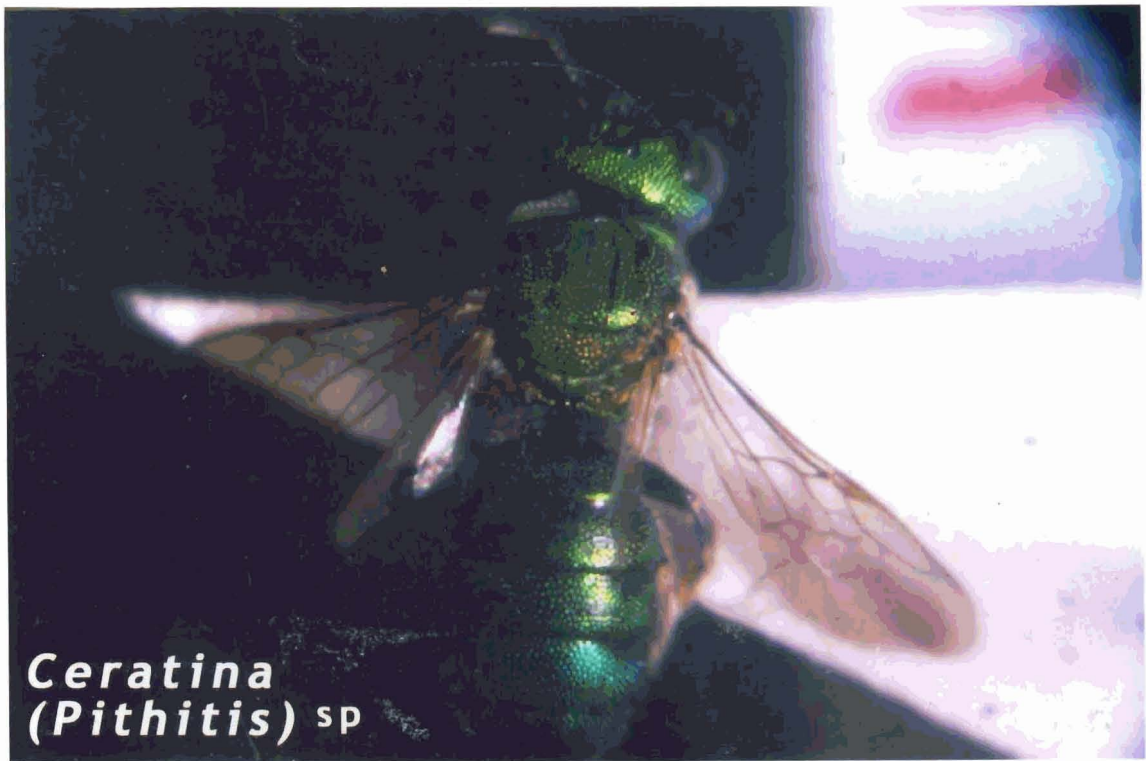
Photographs of *Thyreus* sp., *Amegilla* (*Zonamegilla*) sp. and *Apis cerana* Fabricius were taken from Michener, 2000.

Photographs of Wayanad Shola, Calicut University Campus and Thiruvananthapuram are some of the collection sites.

347 D



Xylocopa sp



Ceratina
(Pithitis) sp

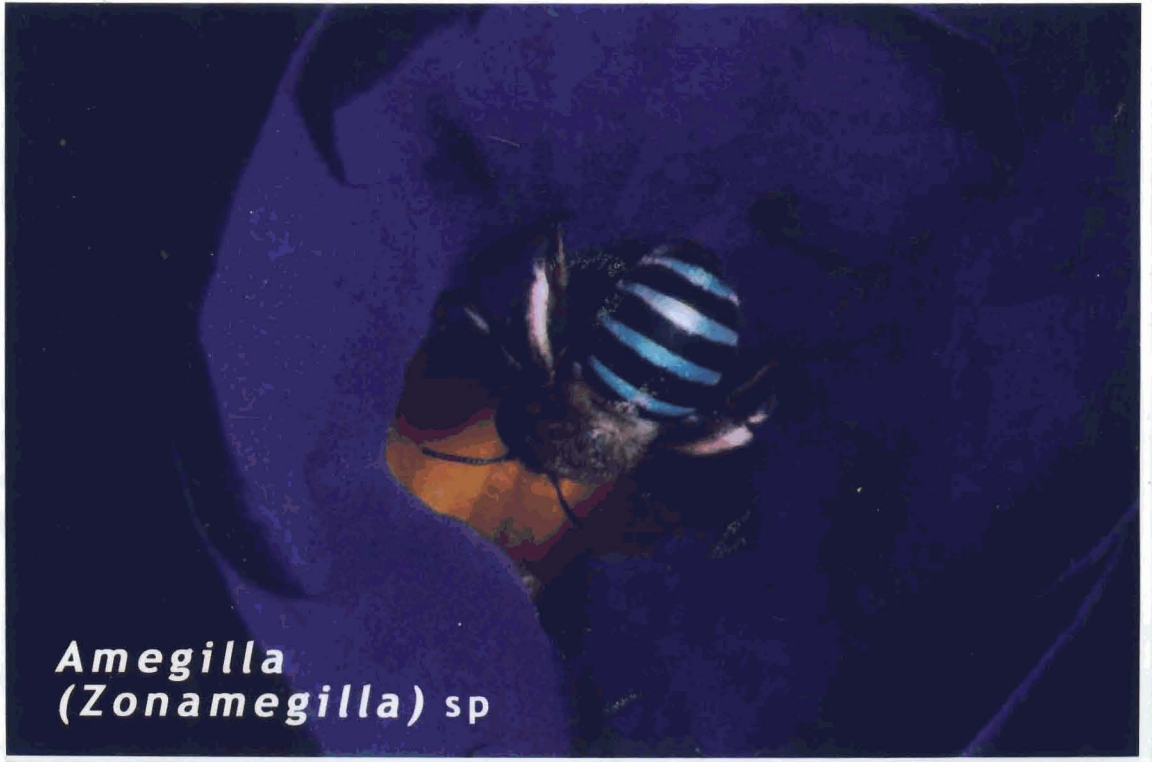
21



Thyreus sp



Thyreus sp



Amegilla
(*Zonamegilla*) sp



Amegilla
(*Amegilla*) sp

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Apis cerena
Fabricius



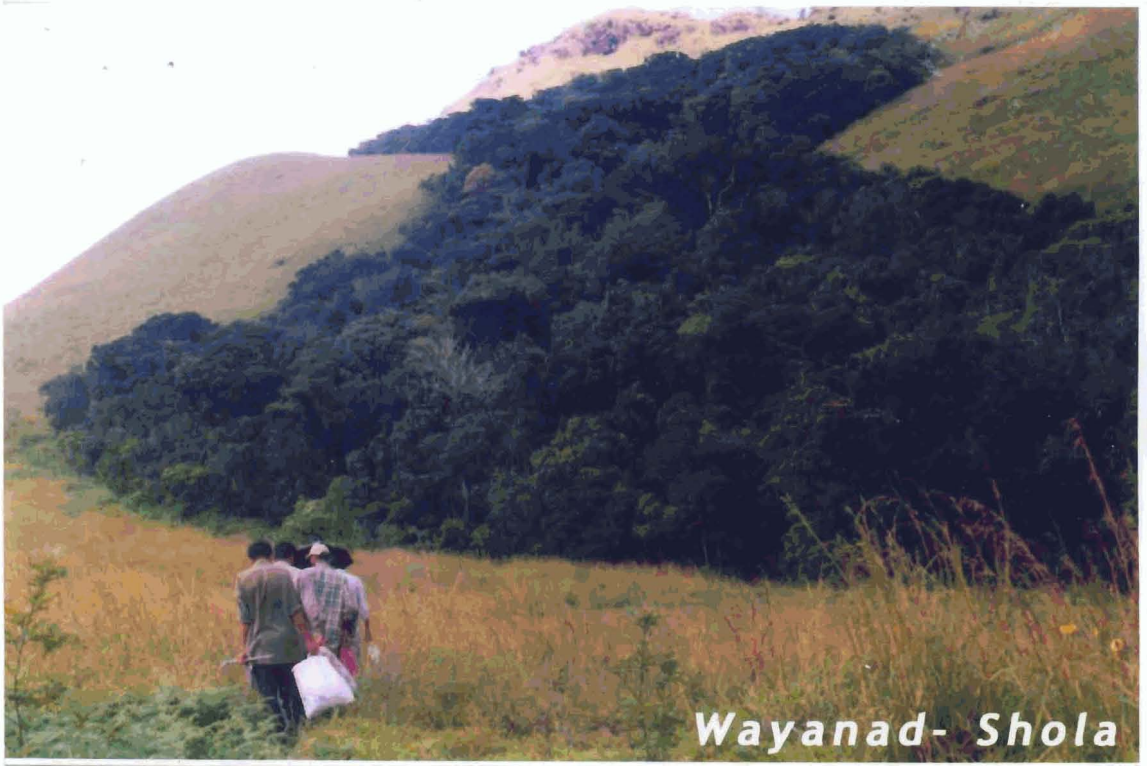
Apis dorsata
Fabricius

24

347 H



Trigona Sp



Wayanad- Shola

347 I



*Calicut
University Campus*



Thiruvananthapuram

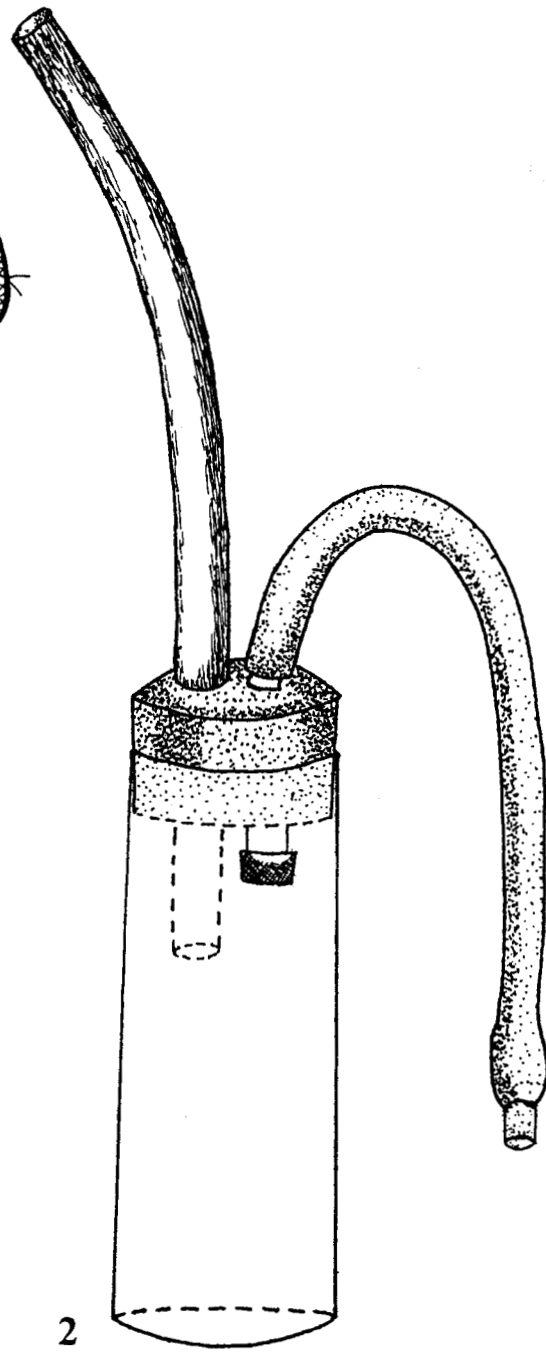
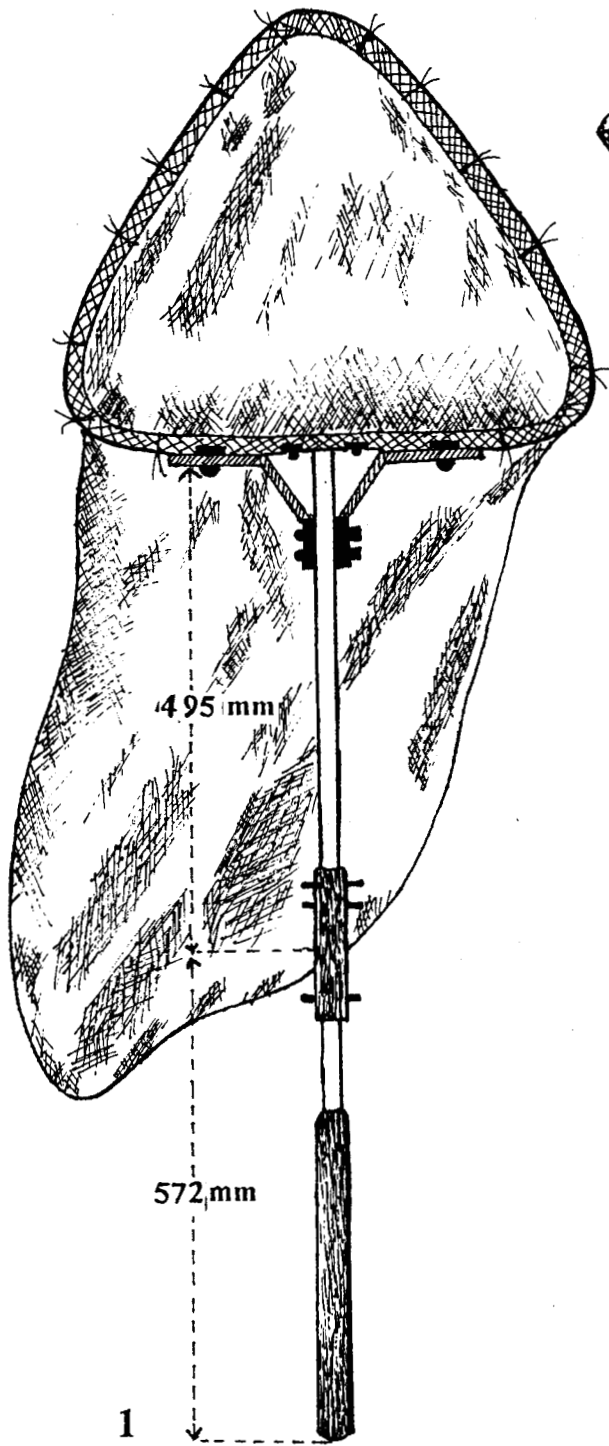


Fig. 1. Sweep net

Fig. 2. Aspirator

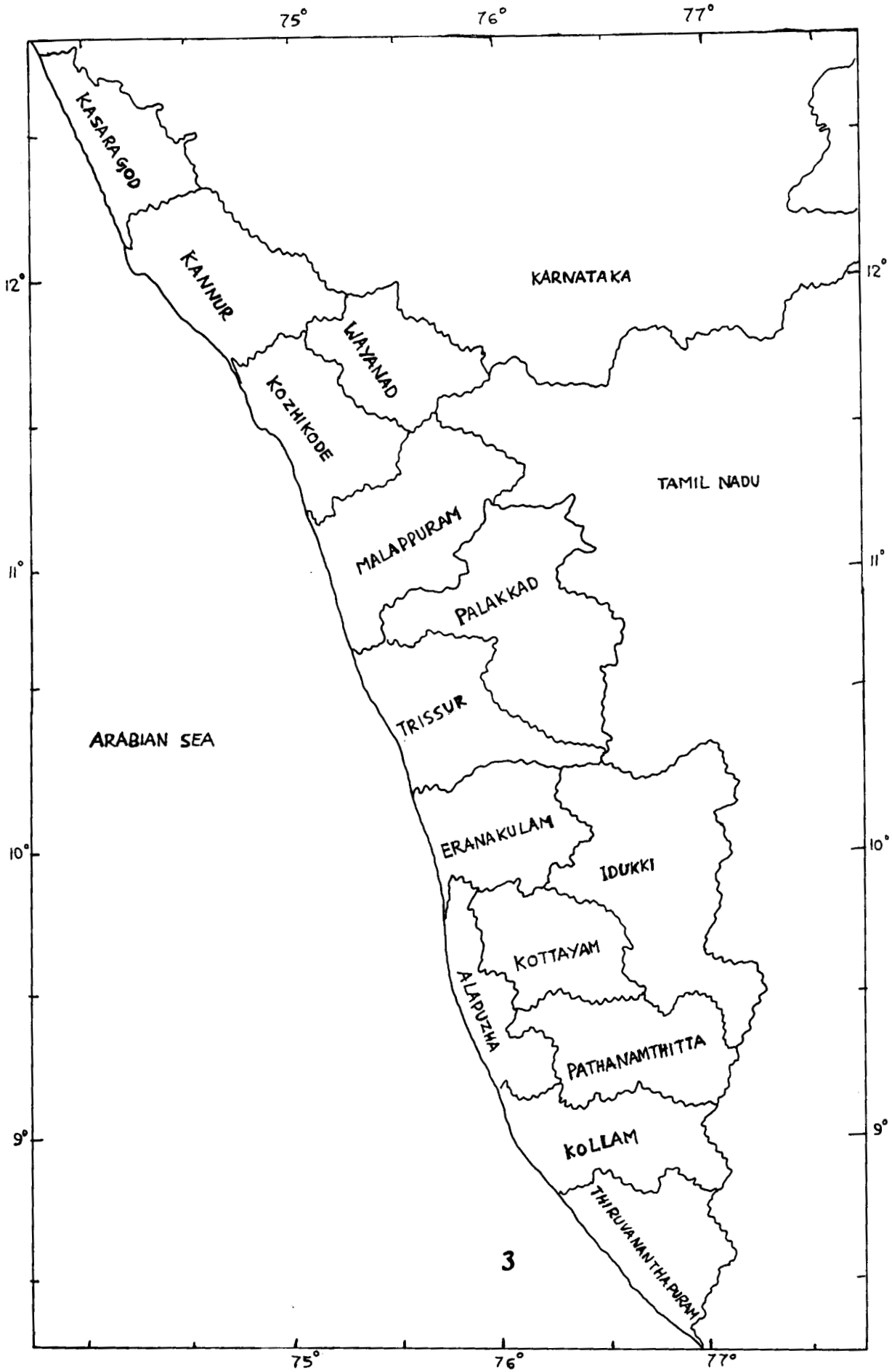


Fig. 3 Kerala Districts

Fig. 4. Frontal view of head of a bee showing major features used in identification

- 1 Vertex
- 2 Supra-antennal area
- 3 Antennal socket
- 4 Sub-antennal suture
- 5 Epistomal suture
- 6 Malar area
- 7 Mandible
- 8 Labrum
- 9 Clypeus
- 10 Anterior tentorial pit
- 11 Paraocular area
- 12 Frontal line
- 13 Facial fovea
- 14 Ocellus
- 15 Supra clypeal area

Fig. 5. Posterior view of head of a bee showing major features used in identification

- 1 Ocellus
- 2 Foramen magnum
- 3 Post occipital suture
- 4 Genal area
- 5 Posterior tentorial pit
- 6 Proboscidal fossa
- 7 Hypostoma
- 8 Labrum
- 9 Mandible
- 10 Post occiput
- 11 Occiput
- 12 Pre-occipital ridge
- 13 Occipital sulcus

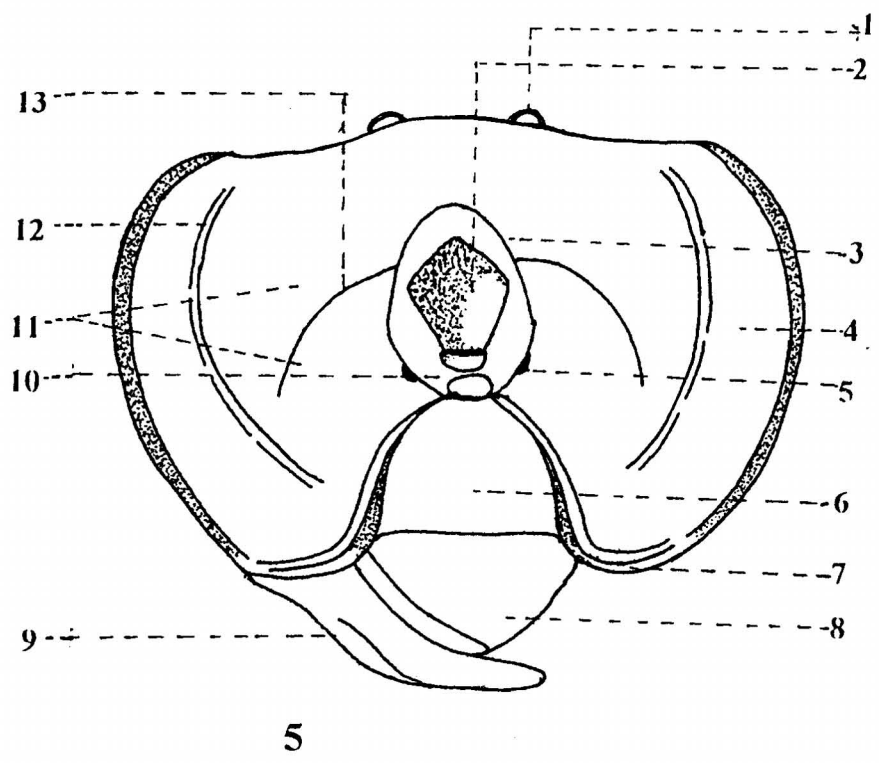
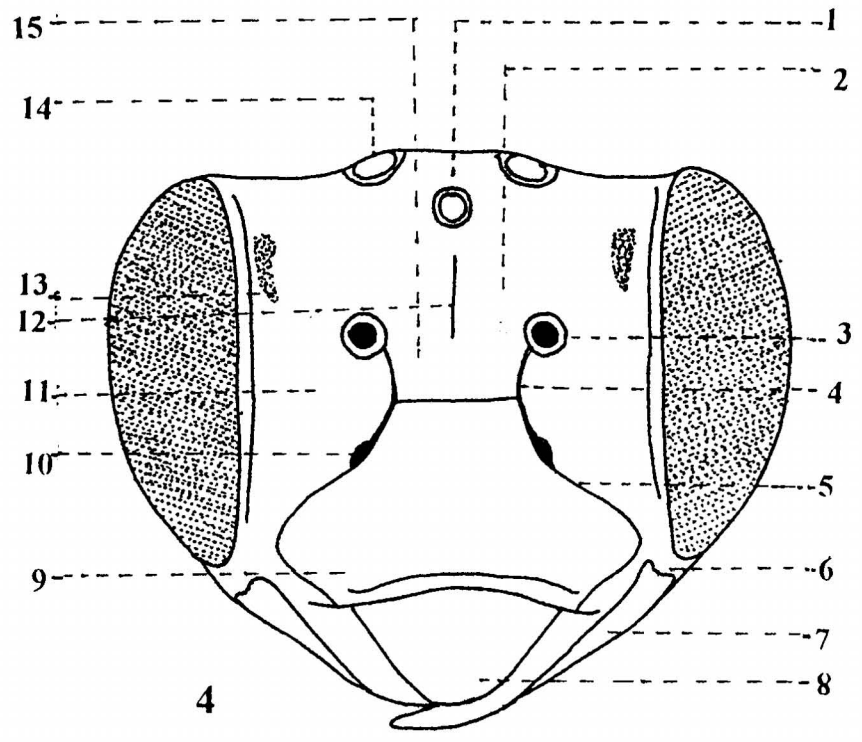


Fig. 6. Lateral view of head of a bee

1. Vertex
2. Compound eye
3. Pre occipital ridge
4. Genal area
5. Length of malar area
6. Mandible
7. Labrum
8. Clypeus
9. Epistomal suture
10. Ocellus

Fig. 7. Diagram of antenna of the female bee

1. Scape
2. Pedicel
3. Flagellum

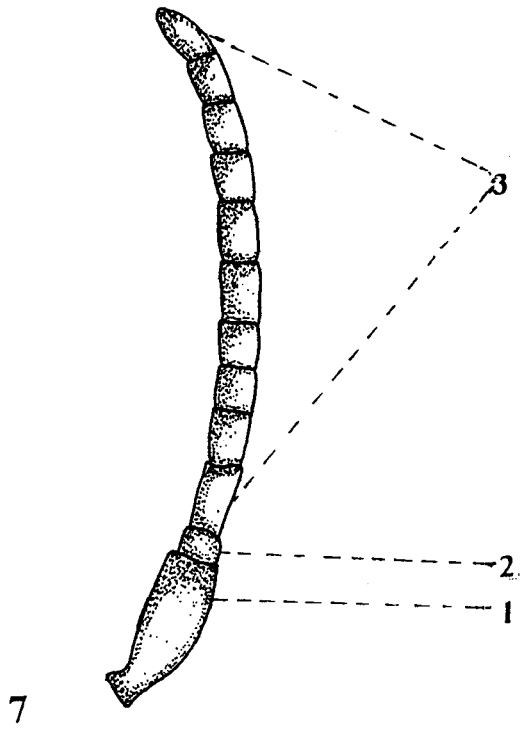
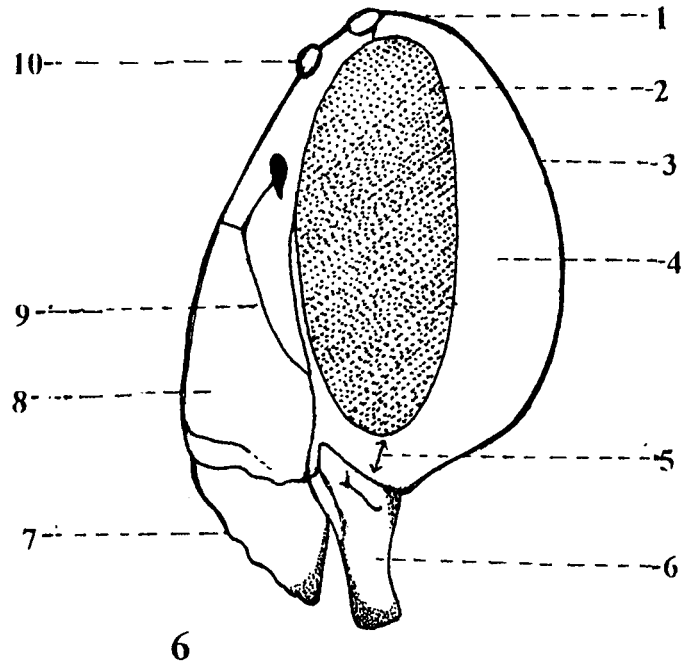


Fig. 8. Diagram of proboscis of an Anthophorid bee, seen in ventral or posterior view

- 1 Mentum
- 2 Pre mentum
- 3 Maxillary palpus
- 4 Galea
- 5 Paraglossa
- 6 Glossa
- 7 Labial palpus
- 8 Stipes
- 9 Cardo
- 10 Lorum

Fig. 9. Lateral view of Maxilla of an Anthophorid bee

- 1 Cardo
- 2 Stipes
- 3 Lacinia
- 4 Maxillary palpus
- 5 Galea

Fig. 10. Diagram of Labium and associated maxillary cardines of a collectid bee, seen in ventral or posterior view

- 1 Lorum
- 2 Cardo
- 3 Mentum
- 4 Pre mentum
- 5 Labial palpus
- 6 Paraglossa
- 7 Glossa

Fig. 11. Lateral view of Maxilla of an collectid bee

- 1 Cardo
- 2 Stipes
- 3 Lacinia
- 4 Maxillary palpus
- 5 Galea

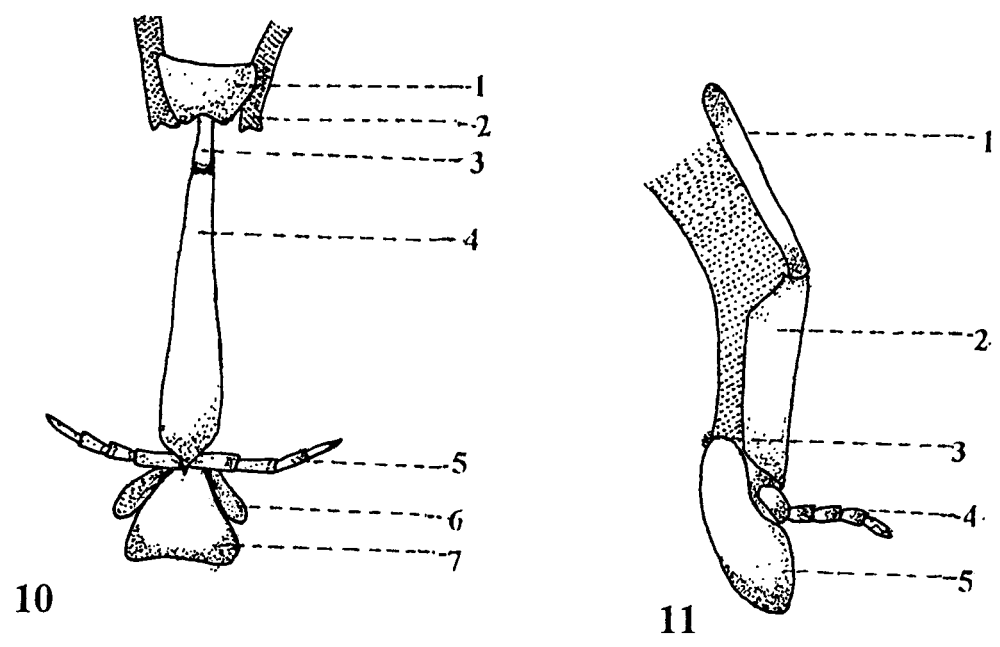
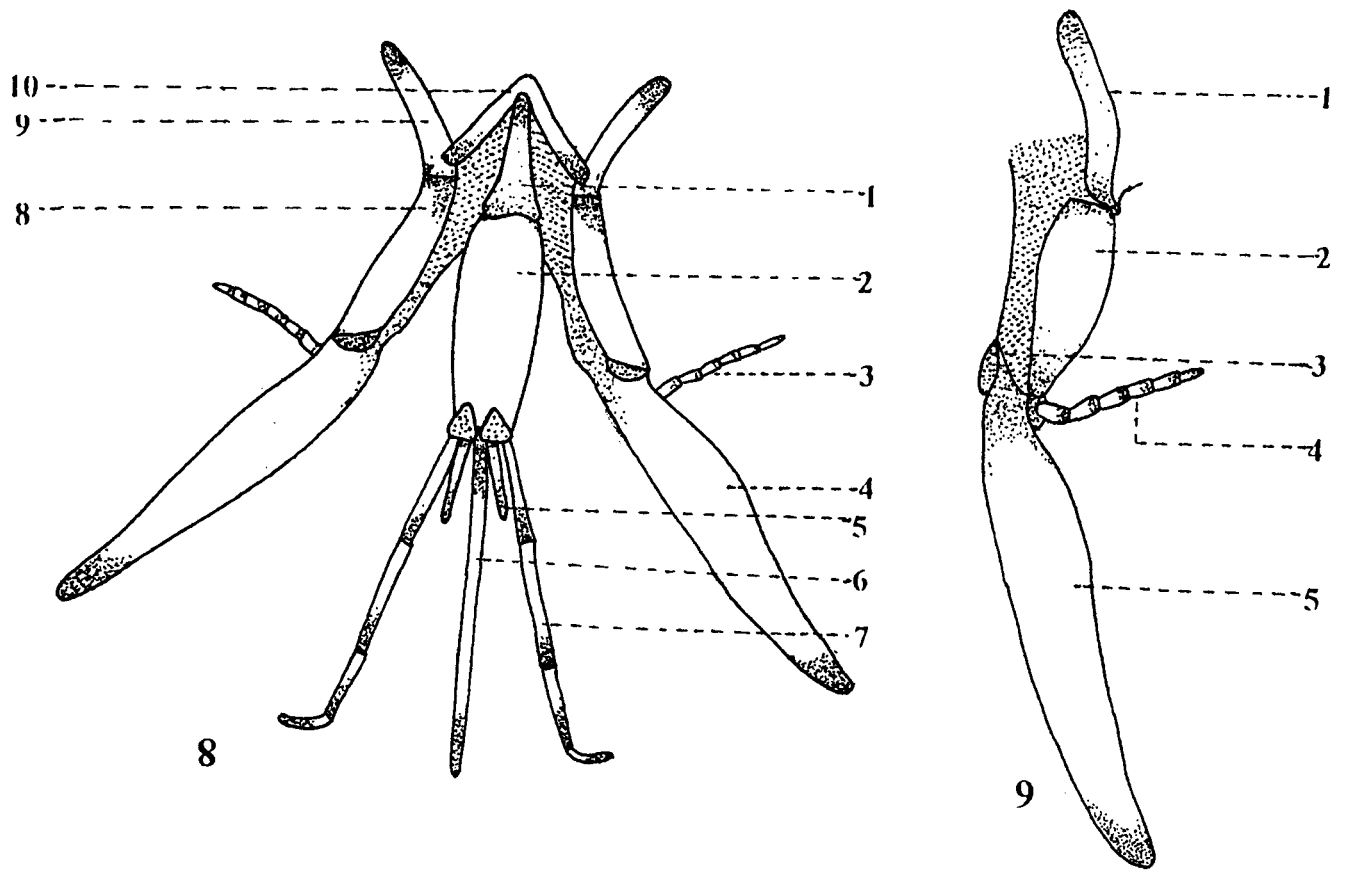


Fig. 12

**Dorsal view of bee thorax :
tegula omitted on the left side**

1. Pronotum
2. Parapsidal line
3. Tegula
4. Mesepisternum
5. Metepisternum
6. Axilla
7. Propodeum
8. Propodeal pit
9. Metanotum
10. Propodeal spiracle
11. Scutellum
12. Hindwing base
13. Forewing base
14. Pre episternum
15. Scutum
16. Notalus

Fig. 13.

**Lateral view of bee thorax :
tegula omitted**

1. Scutellum
2. Metanotum
3. Basal area of propodeum
4. Propodeal spiracle
5. Posterior surface of propodeum
6. Propodeum
7. Metepisternum
8. Coxa 3
9. Coxa 2
10. Scrobal groove
11. Mesepisternum
12. Coxa 1
13. Pre-espiternum
14. Pre-episternal groove
15. Scrobe
16. Pronotum
17. Pronotal lobe
18. Forewing base
19. Parapsidal line
20. Scutum
21. Axilla

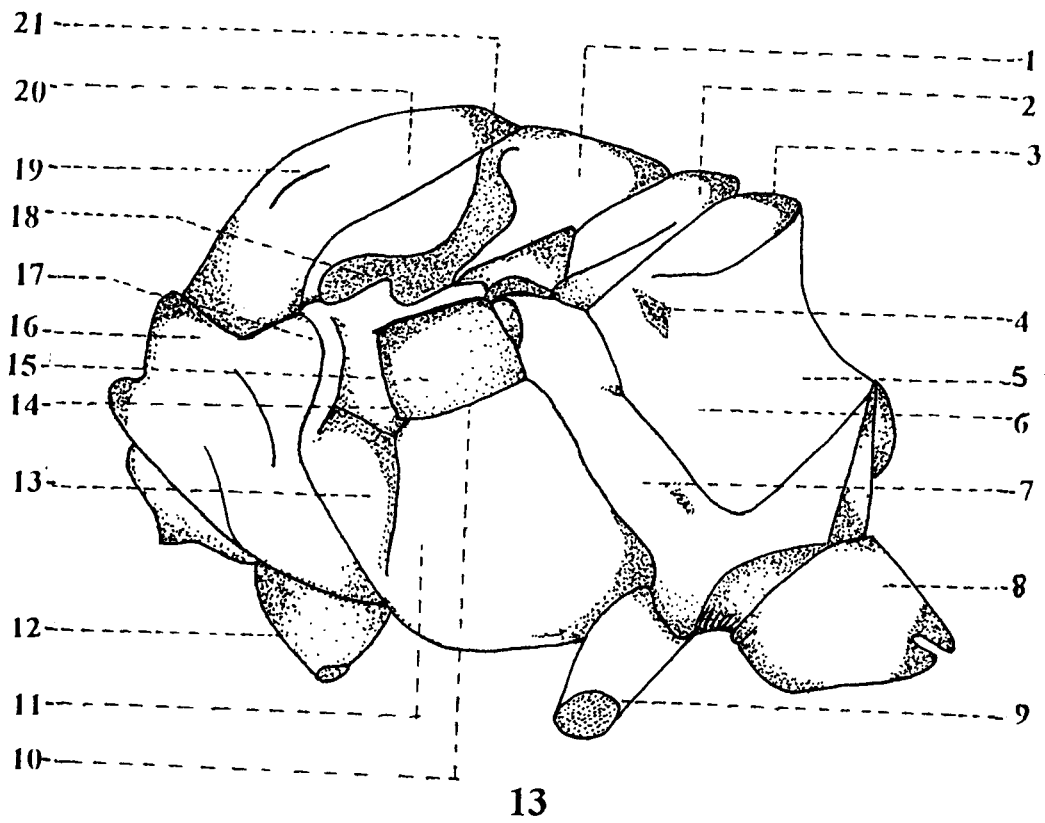
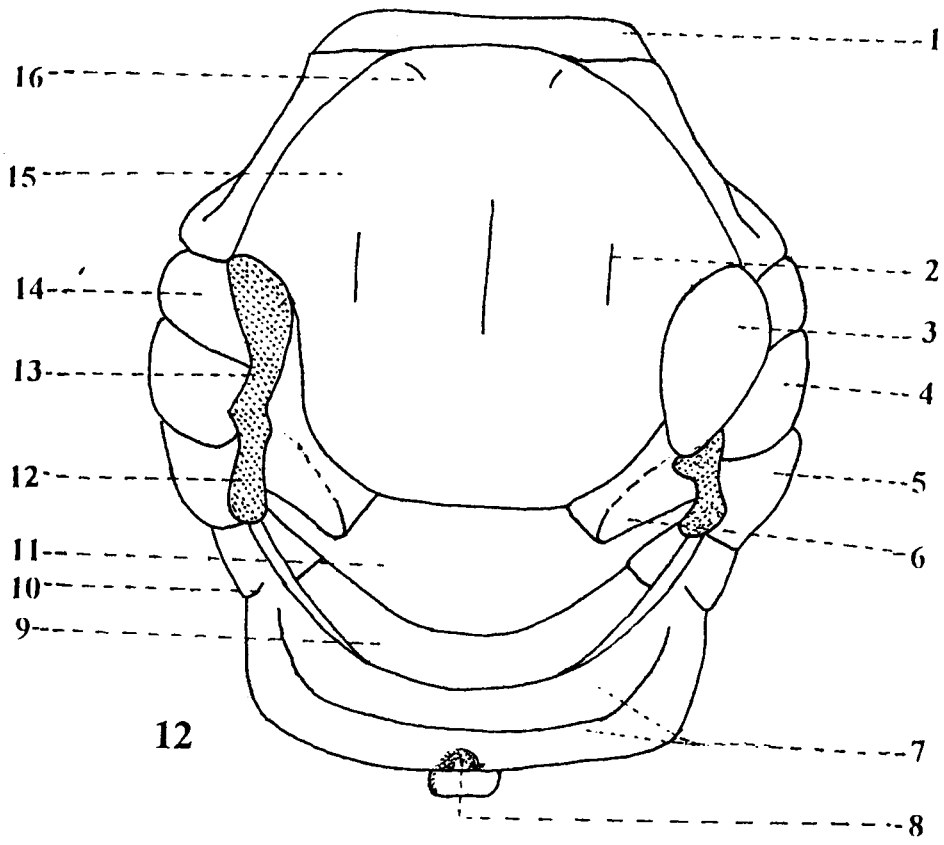


Fig. 14. Diagram of bee forewing, showing veins

- | | |
|---------------|------------------------------------|
| 1. M + Cu | 12. 2r-m |
| 2. R | 13. 1r-m |
| 3. C | 14. 2 nd abscissa of Rs |
| 4. M | 15. 2m-cu |
| 5. Rs | 16. Cu1 |
| 6. Rs + M | 17. 1m-cu |
| 7. Pre stigma | 18. Cu2 |
| 8. Stigma | 19. Cu |
| 9. r | 20. Cu-v |
| 10. Rs | 21. V |
| 11. R1 | |

Fig. 15. Diagram of bee hindwing, showing veins

- | | |
|-----------|---------|
| 1. R | 5. M |
| 2. M + Cu | 6. Cu |
| 3. Rs | 7. Cu-v |
| 4. r-m | 8. V |

Fig. 16. Diagram of bee forewing, showing terminology of cells

- | | |
|---------------------------------------|--|
| 1. Radial cell | 9. 3 rd transverse cubital |
| 2. Basal vein | 10. 2 nd transverse cubital |
| 3. 1 st medial cell | 11. 2 nd recurrent |
| 4. 1 st submarginal | 12. 2 nd medial cell |
| 5. 1 st transverse cubital | 13. 1 st recurrent |
| 6. 2 nd submarginal | 14. 2 nd cubital cell |
| 7. Marginal cell | 15. 1 st cubital cell |
| 8. 3 rd submarginal | |

Fig. 17. Diagram of bee hindwing

- | | |
|----------------|-----------------|
| 1. Radial cell | 4. Jugal lobe |
| 2. Hamuli | 5. Cubital cell |
| 3. Vanal lobe | |

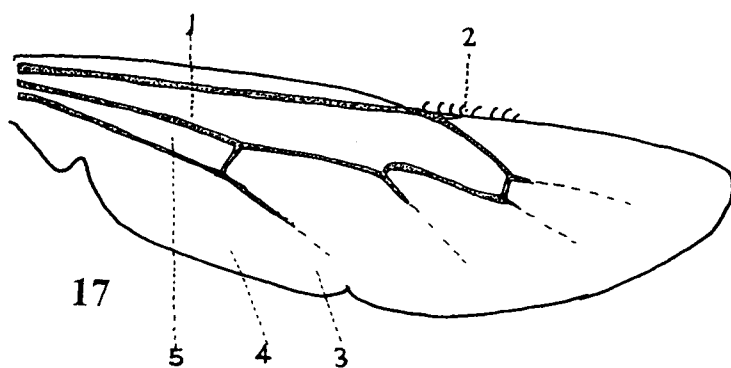
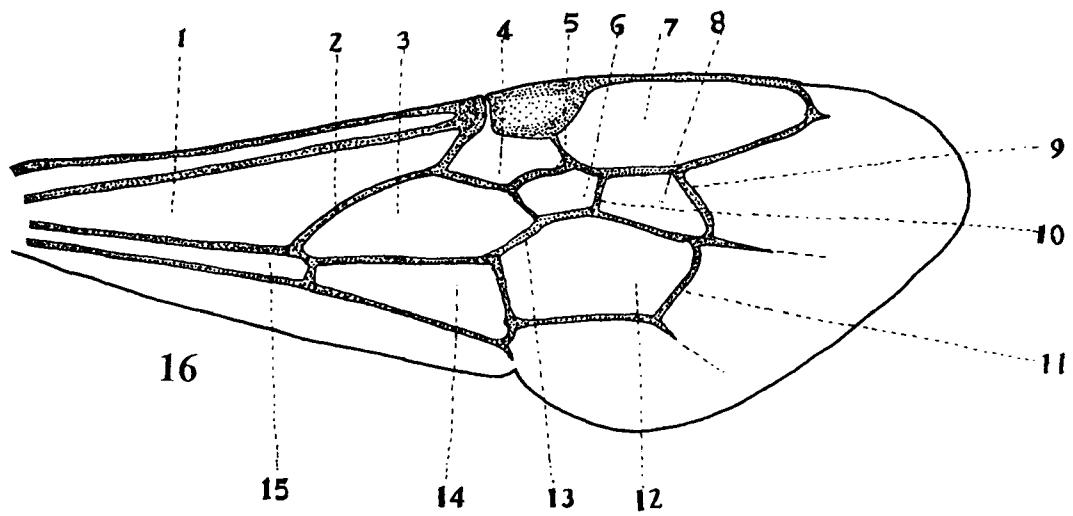
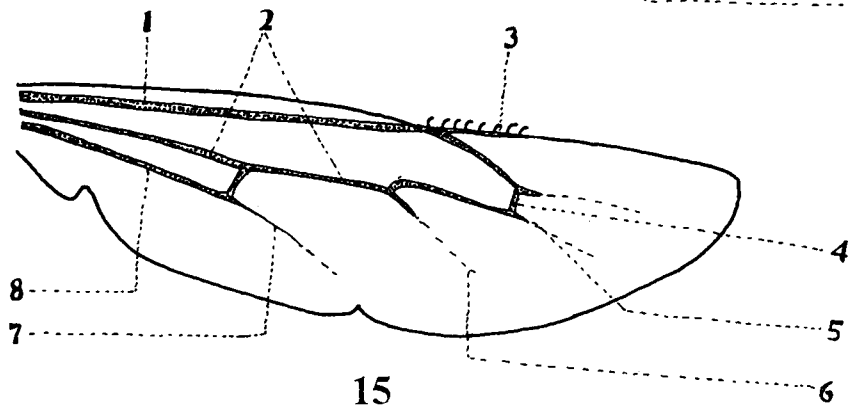
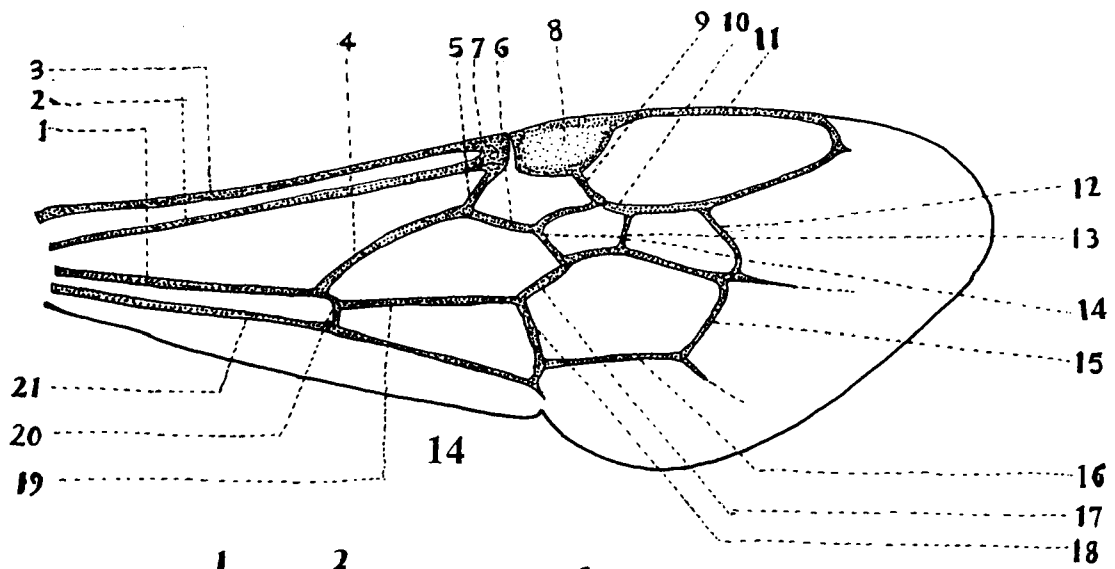


Fig. 18. Dorsal view of female metasoma

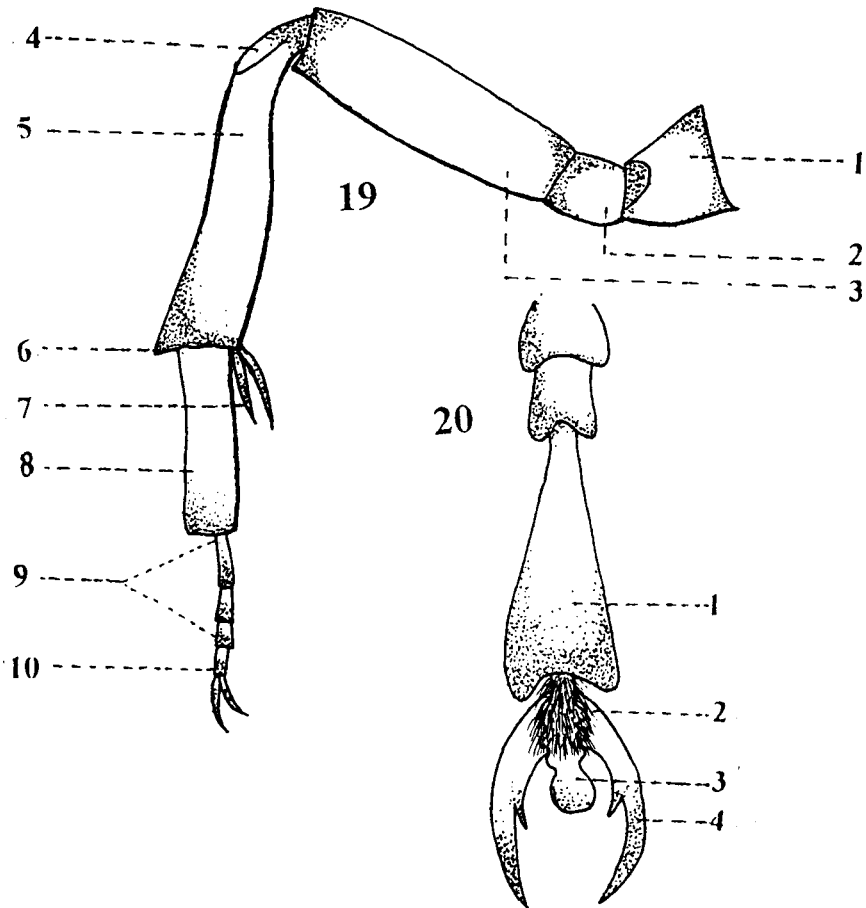
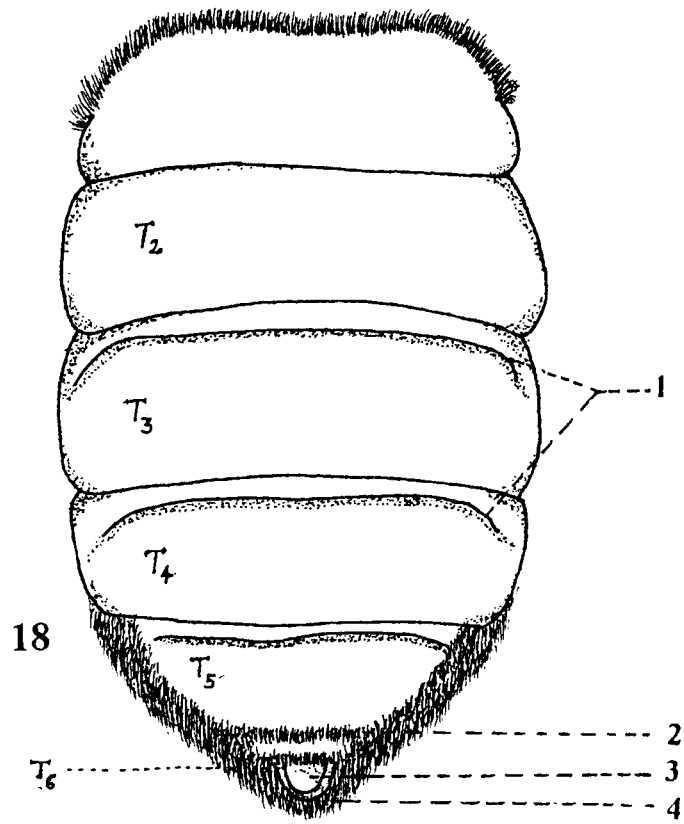
1. Graduli
2. Pre pygidial fimbria
3. Pygidial plate
4. Pygidial fimbria

Fig. 19. Diagram of hind leg of a bee

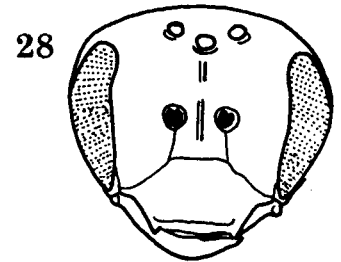
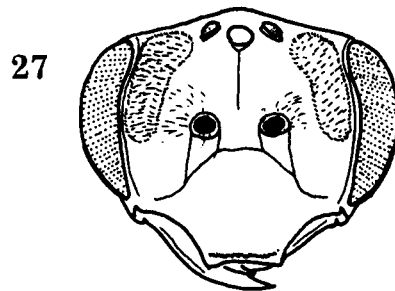
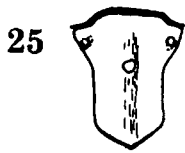
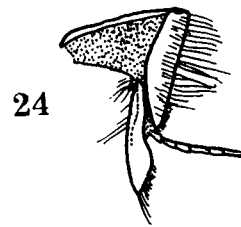
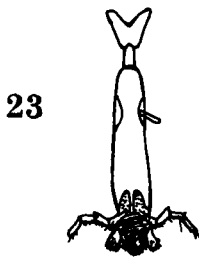
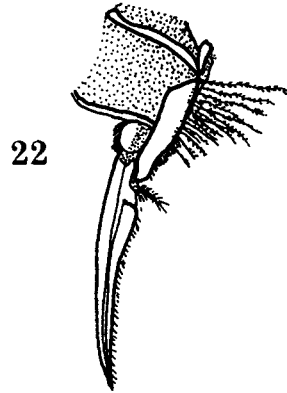
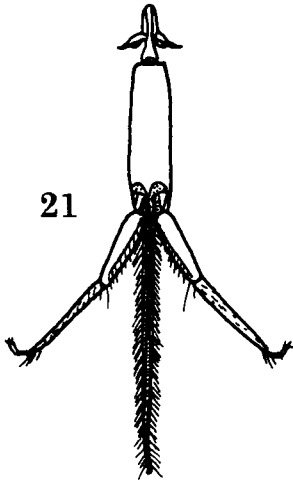
1. Coxa
2. Trochanter
3. Femur
4. Basitibial plate
5. Tibia
6. Tibial spine
7. Tibial spur
8. Basitarsus
9. Mediotarsus
10. Distitarsus

Fig. 20.

1. Distitartus
2. Hairs
3. Arolium
4. Tarsal claw



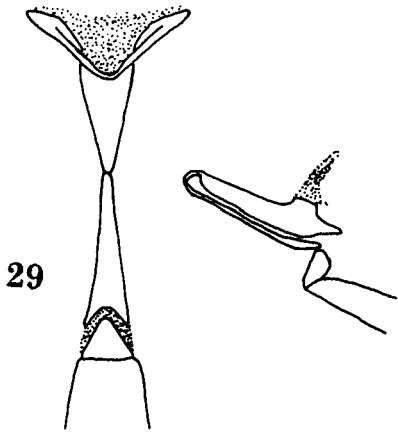
- Figs. 21, 22 :** Labium and maxilla of *Anthidium atripes* Cresson (Megachilidae)
- Figs. 23, 24 :** Labium and maxilla of *Andrena mimetica* (Andrenidae) (from Michener, 1944)
- Fig. 25 :** Labrum of *Heriades apriculus* Griswold (Megachilidae)
- Fig. 26 :** Labrum of *Anthophora edwardsii* Cresson (Apidae)
- Fig. 27 :** Face of *Andrena mimetica* Cockerell (Andrenidae)
- Fig. 28 :** Face of *Halictus farinosus* Smith (Halictidae)
(From Michener, 1944)



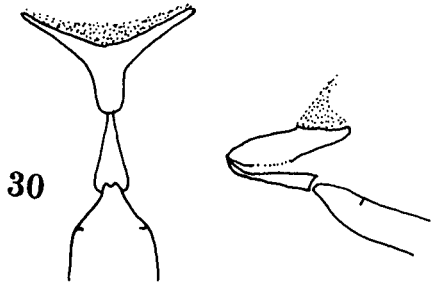
Figs. 29-37: Diagrams of basal sclerites of labium, lorum, mentum and prementum; Posterior and Lateral views

29. *Melitta leporina* (Panzer) Melittidae
30. *Melitturga clavicornis* (Latreille) Andrenidae
31. *Panurgus calcaratus* (Scopoli) Andrenidae
32. *Pseudopanurgus aethiops* (Cresson) Andrenidae
33. *Megandrena enceliae* (Cockerell) Andrenidae
34. *Protoxea gloriosa* (Fox) Andrenidae
35. *Lasioglossum calceatum* (Scopoli) Halictidae
36. *Systropha curvicornis* (Scopoli) Halictidae
37. *Lonchopria herbsti* Vachal Collectidae

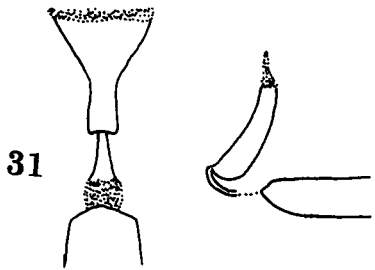
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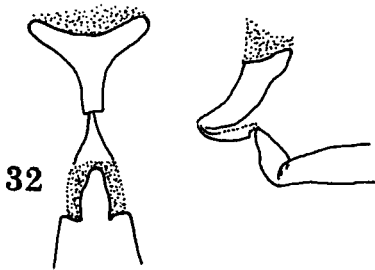
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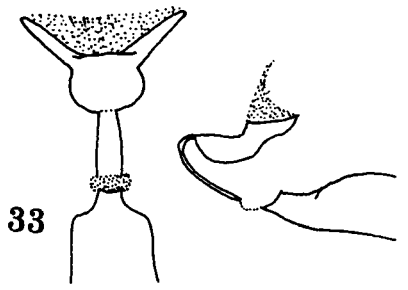
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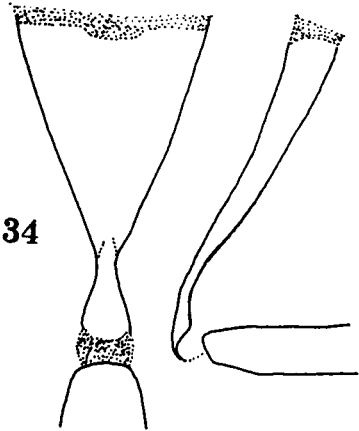
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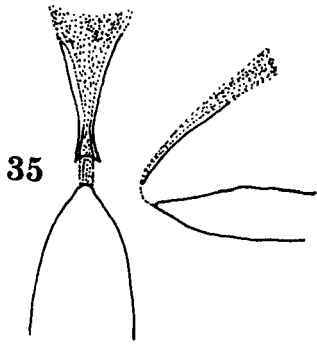
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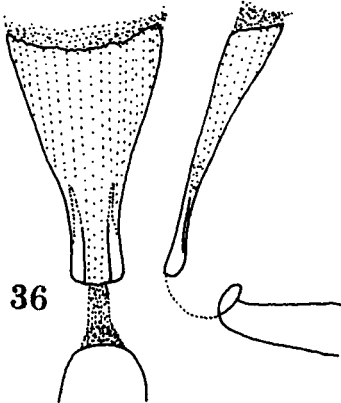
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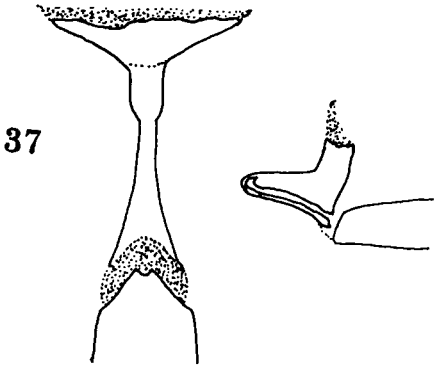
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37

Figs. 38-39: Diagrams of inner views of Maxillae

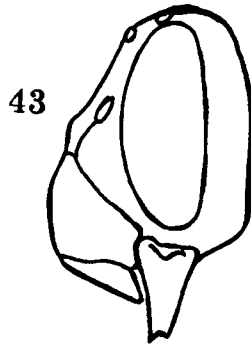
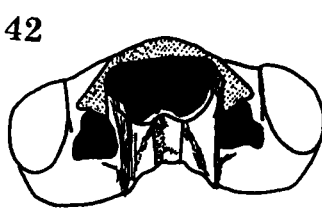
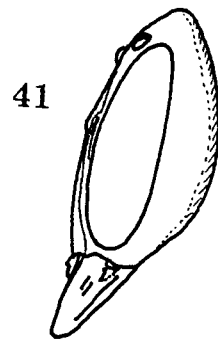
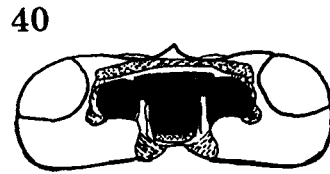
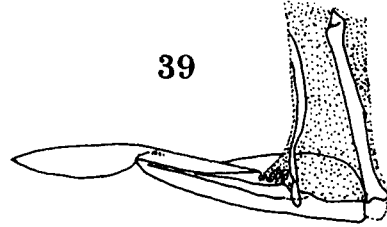
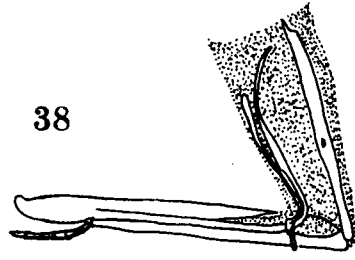
- 38. *Halictus quadricinctus* (Fabricius)
- 39. *Oxaea flavescens* Klug

Figs. 40-41: *Xylocopa tabaniformis orpifex* Smith

- 40. Head : Ventral view
- 41. Head : Lateral view

Figs. 42-43: *Anthophora edwardsii* Cresson

- 42. Head : Ventral view
- 43. Head : Lateral view



Figs. 44-45 : Papillate, hairless wing Vs. nearly uniform hairy wing

- 44. *Xeromelecta californica* (Cresson)
- 45. *Paratetrapedia lugubris* (Cresson)

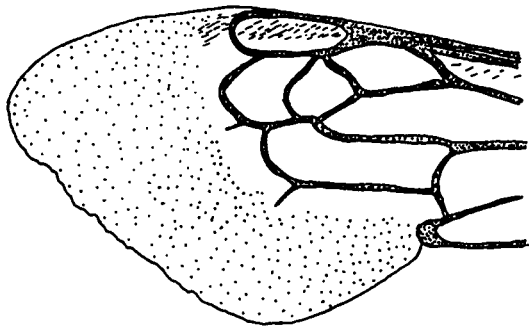
Figs. 46-47 : *Eucera chrysopya* Perez

- 46. Forewing
- 47. Hindwing

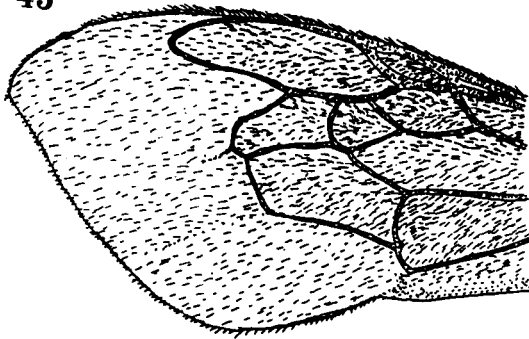
Figs. 48-49 : Head - front view

- 48. *Holcopasites arizonicus* (Linsley)
- 49. *Neopasites* sp.

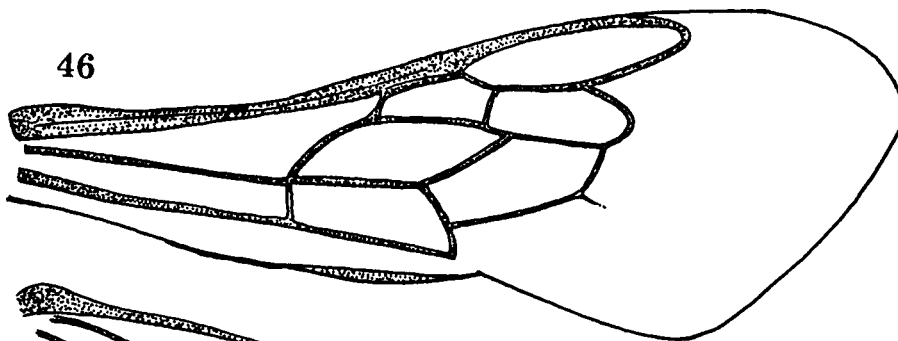
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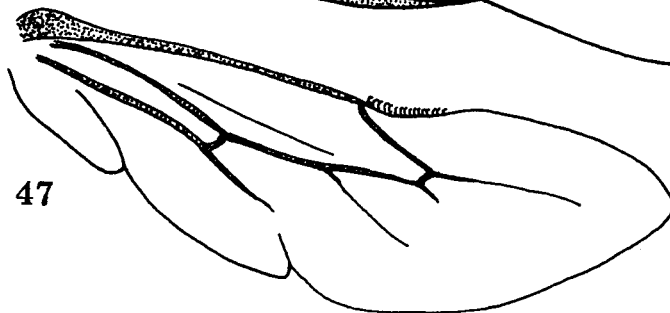
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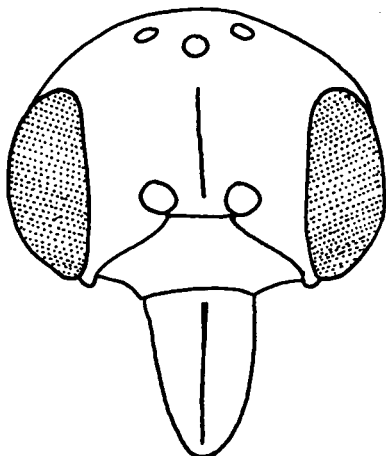
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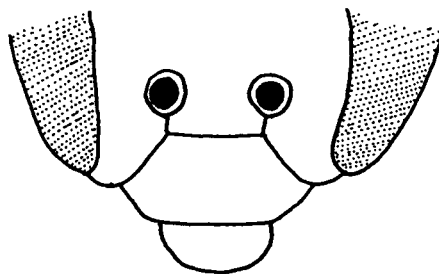
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49



Figs. 50-51 : *Xylocopa tabaniforms orpifex* Smith

- 50. Forewing
- 51. Hindwing

Figs. 52-53 : *Bombus pennsylvanicus* (Degeer)

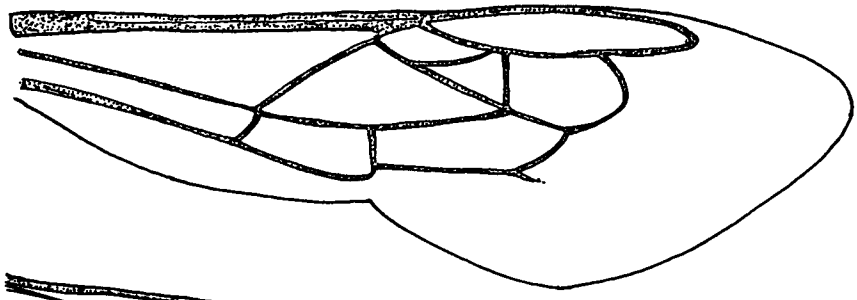
- 52. Forewing
- 53. Hindwing

Figs. 54-55 : *Habropoda* sp.

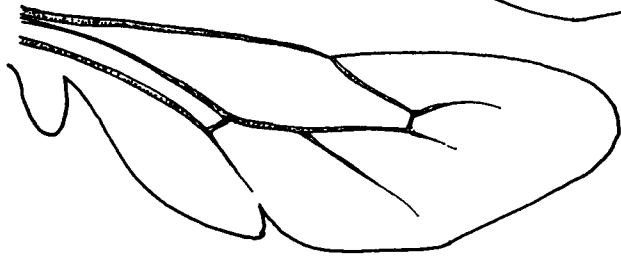
- 54. Forewing
- 55. Hindwing

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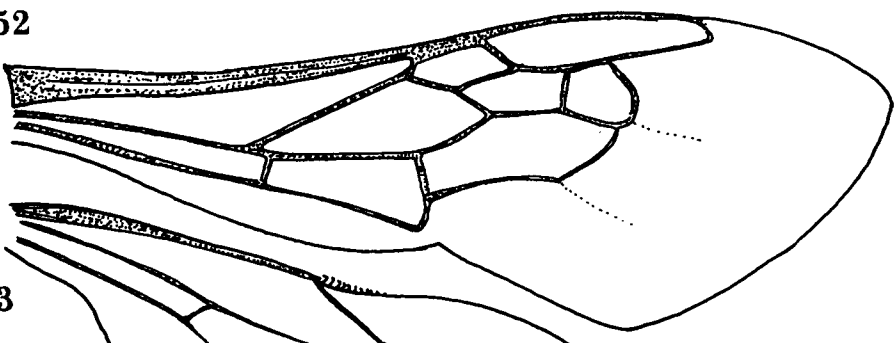
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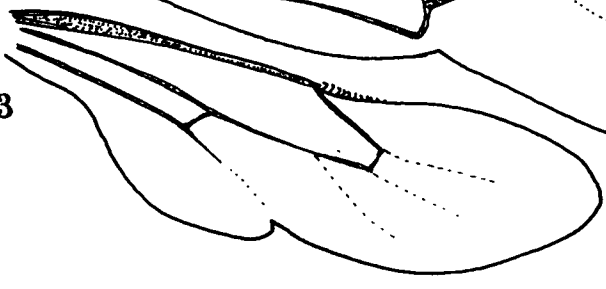
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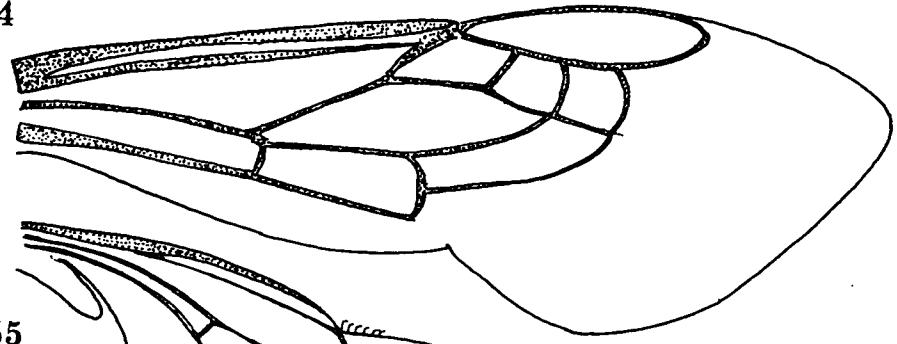
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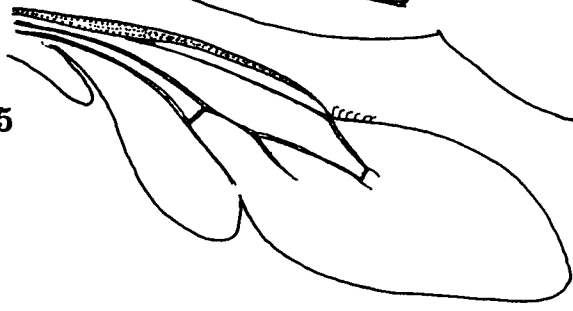
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55



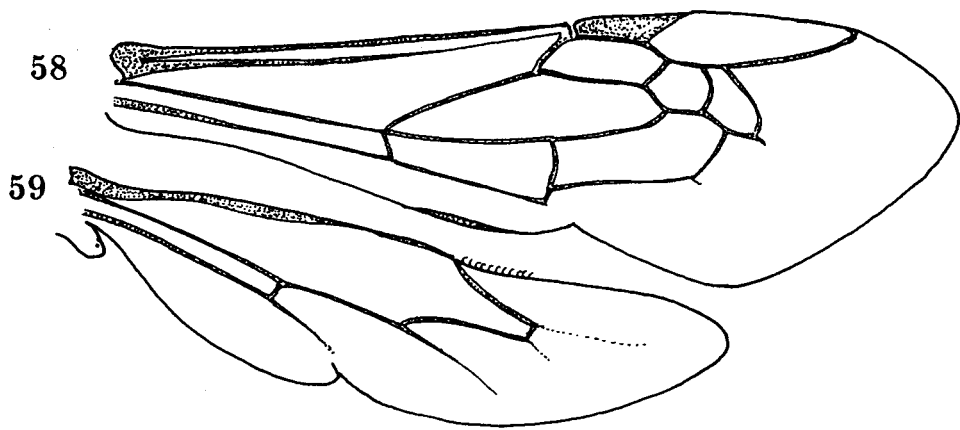
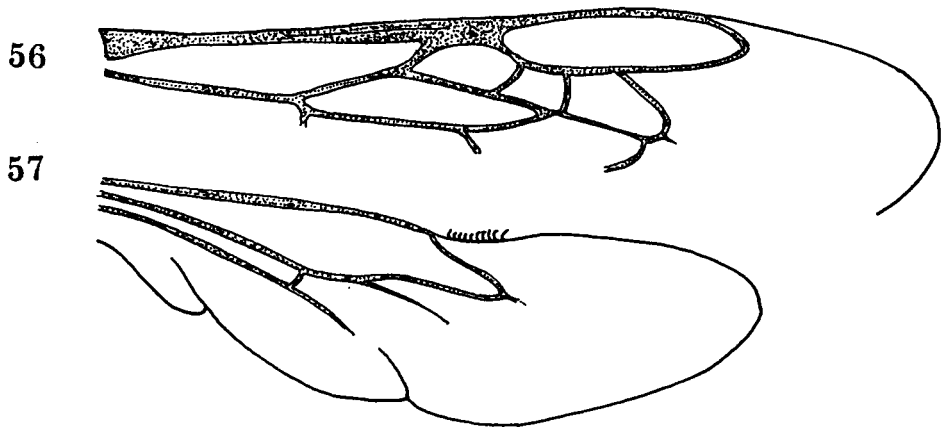
Figs. 56-57 : *Tarsalia ancyliformis mediterranea* Pittioni

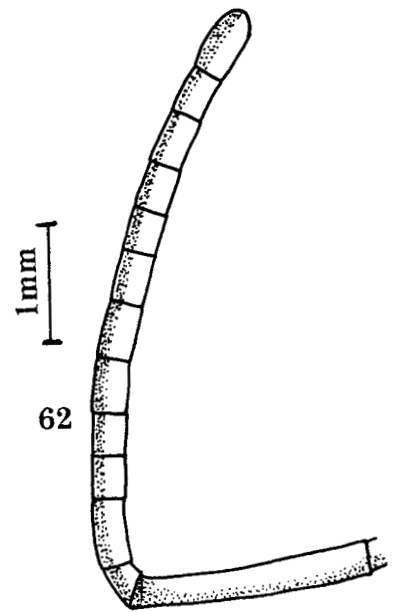
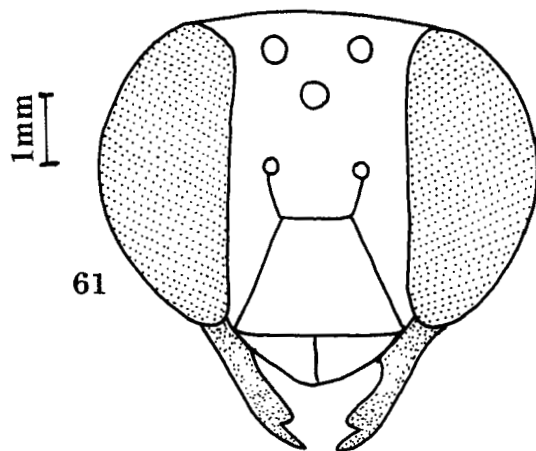
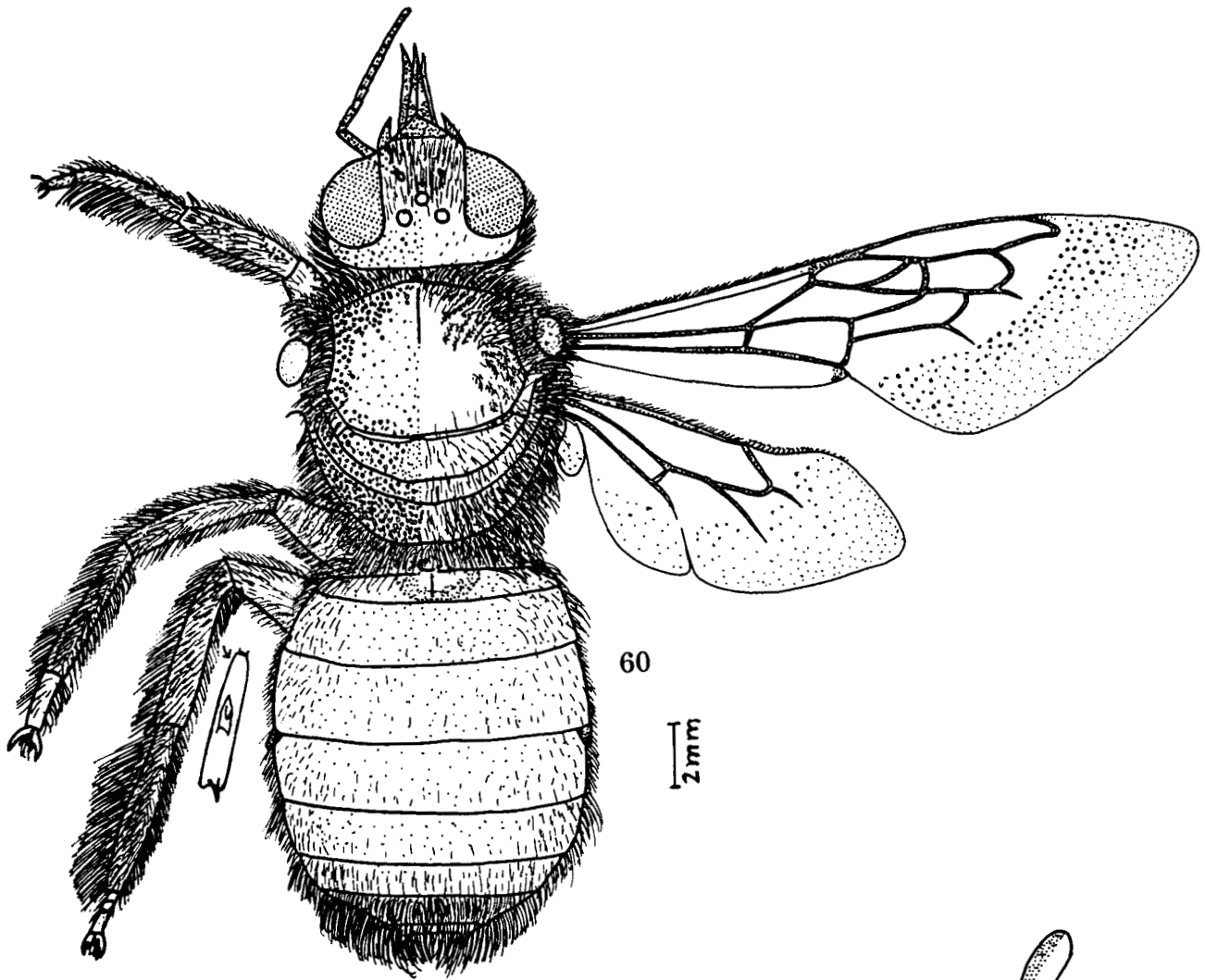
- 56. Forewing
- 57. Hindwing

Figs. 58-59 : *Nomada annulata* Smith

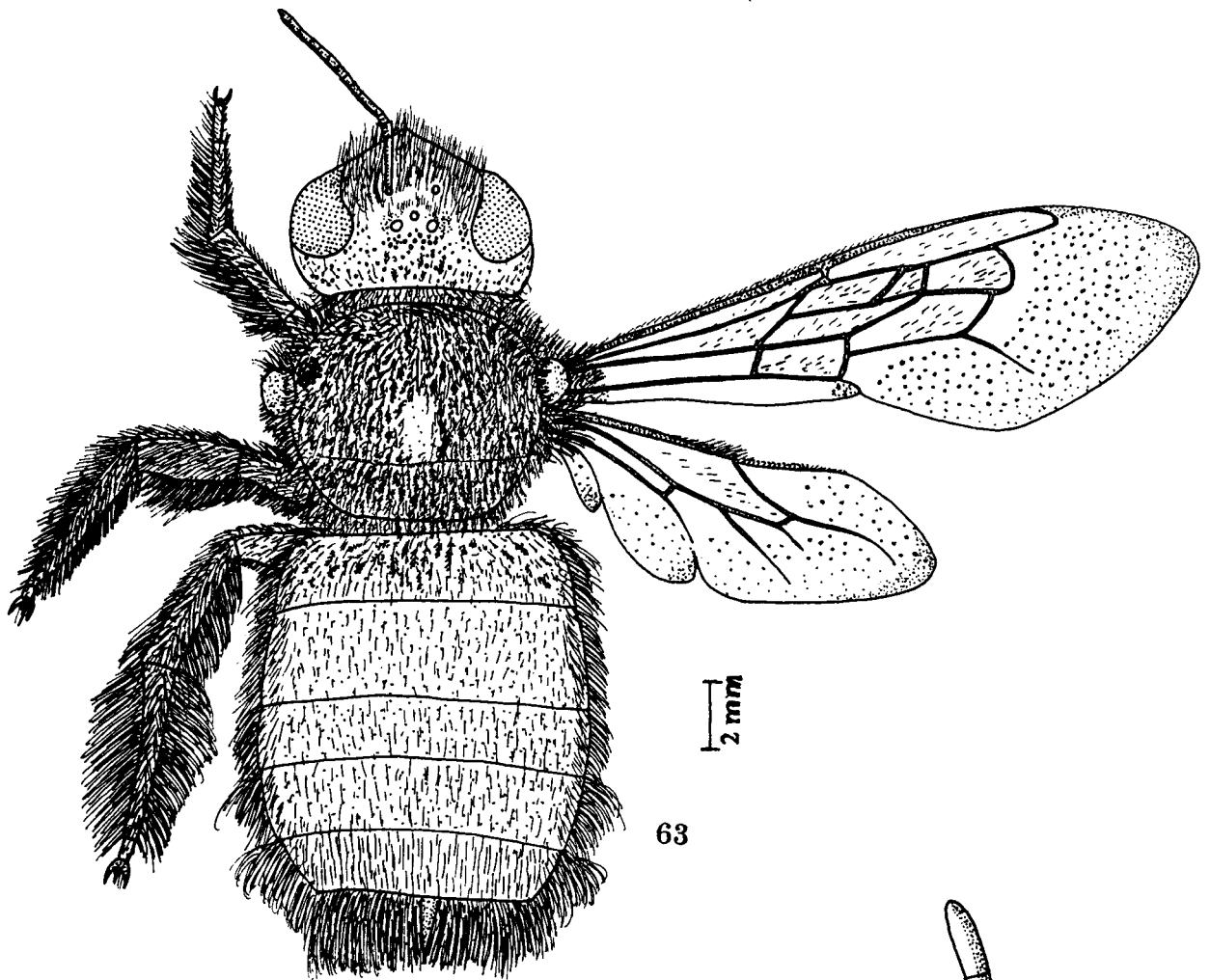
- 58. Forewing
- 59. Hindwing

17

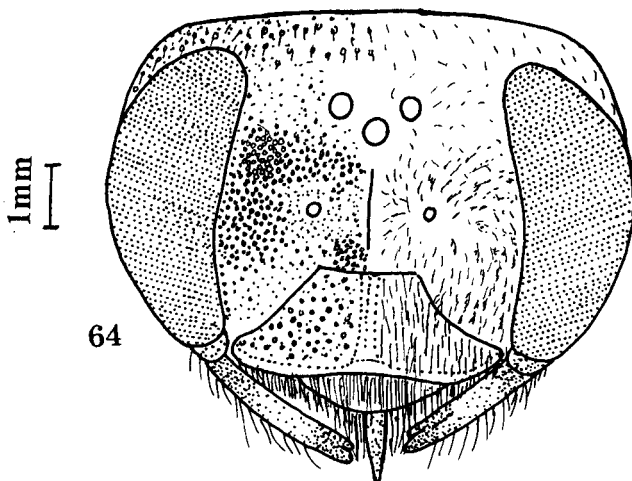




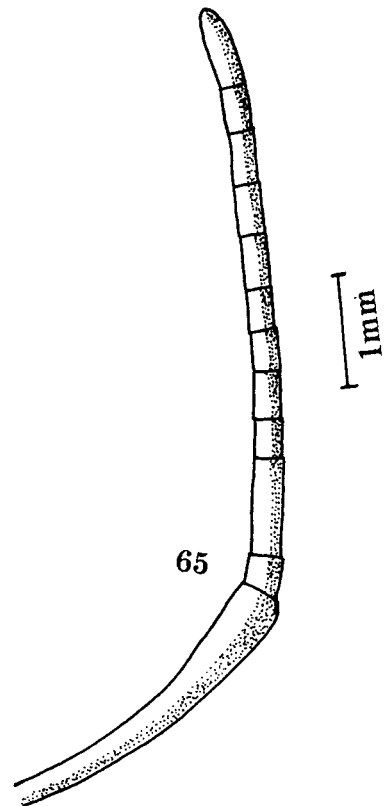
Figs. 60-62: *Xylocopa (koptortosoma) anupama* sp. nov. Male
 60. Body entire : Dorsal view
 61. Head : Front view
 62. Antenna



63



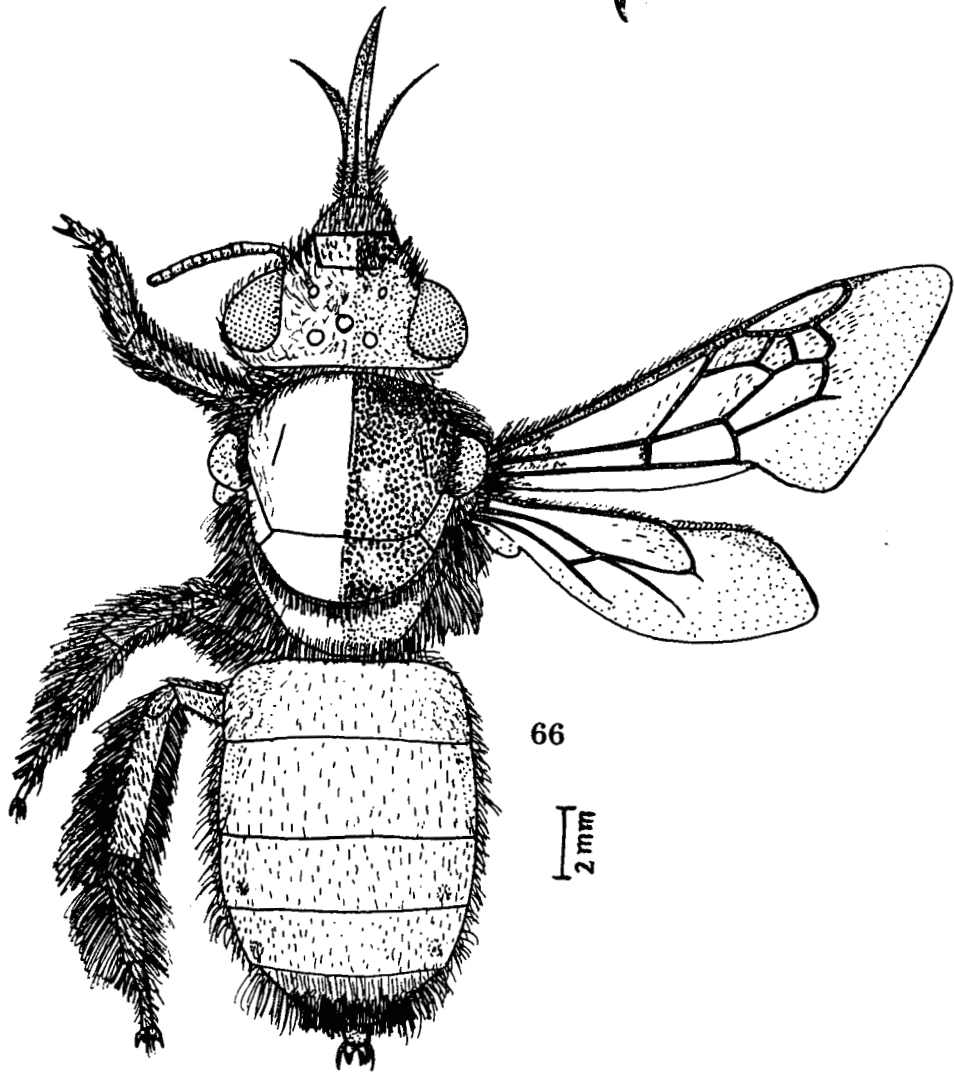
64



65

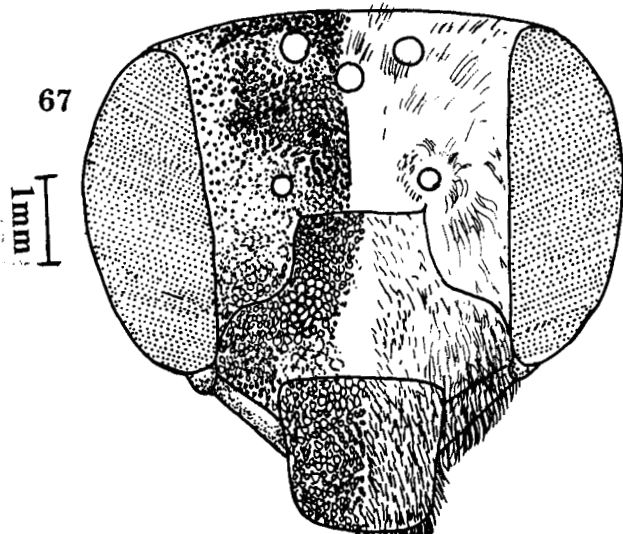
Figs. 63-65 : *Xylocopa (Nodula) bryorum* (Fabricius) Female
 63. Body entire : Dorsal view
 64. Head : Front view
 65. Antenna

012



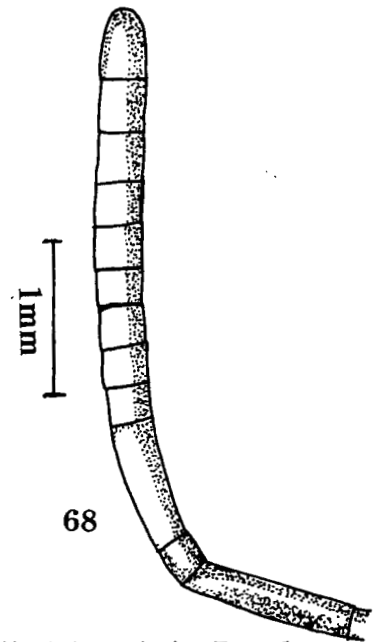
66

2 mm



67

1 mm

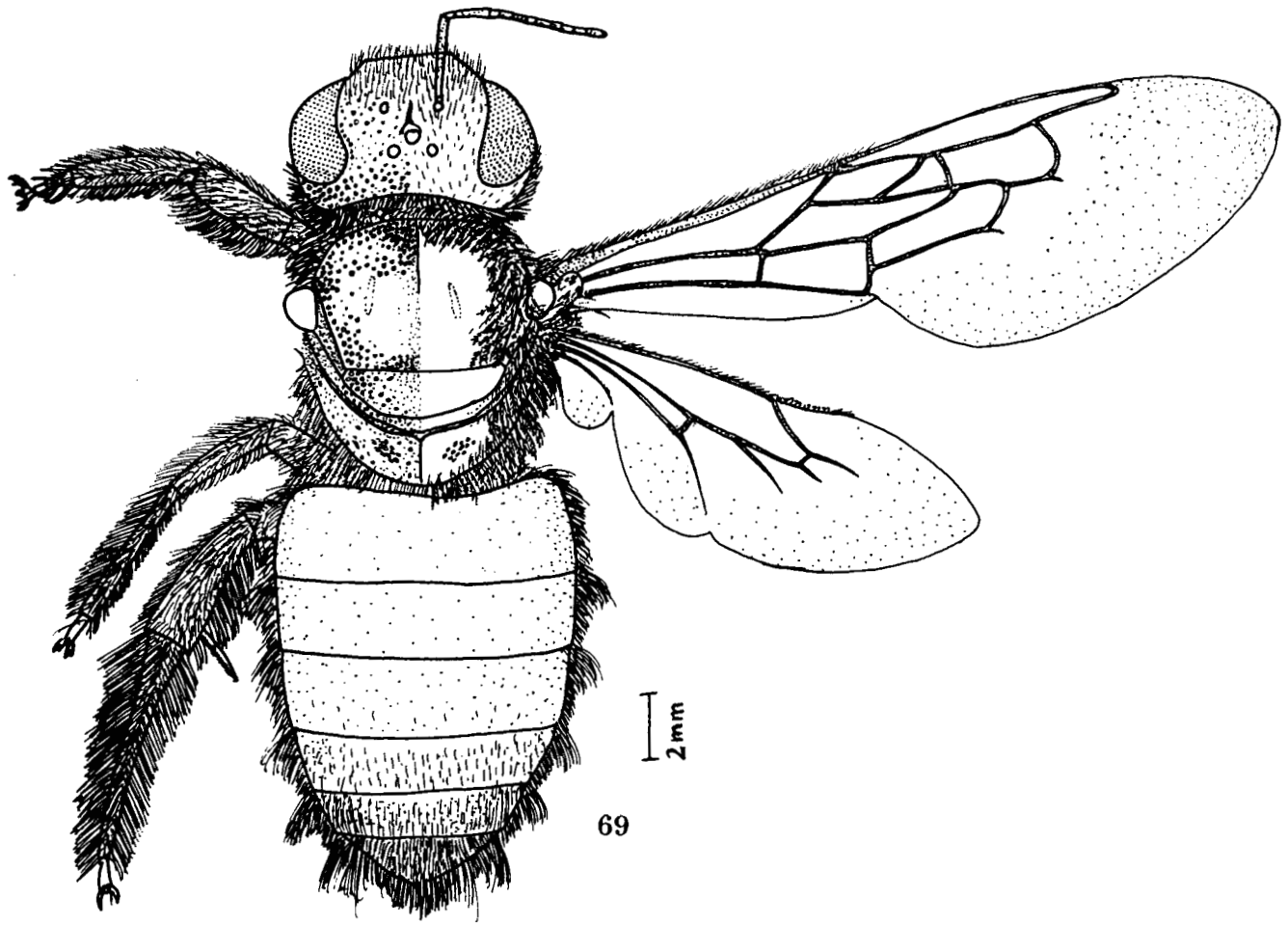


1 mm

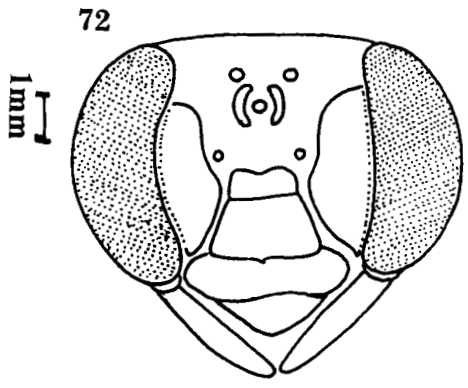
68

Figs. 66-68 : *Xylocopa (Zonohirsuta) collaris* Lepeletier Female
66. Body entire : Dorsal view
67. Head : Front view 68. Antenna

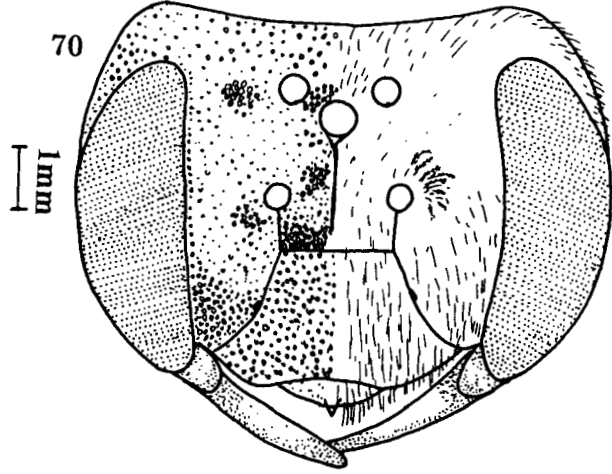
013



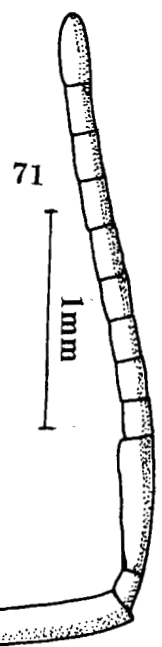
69



72

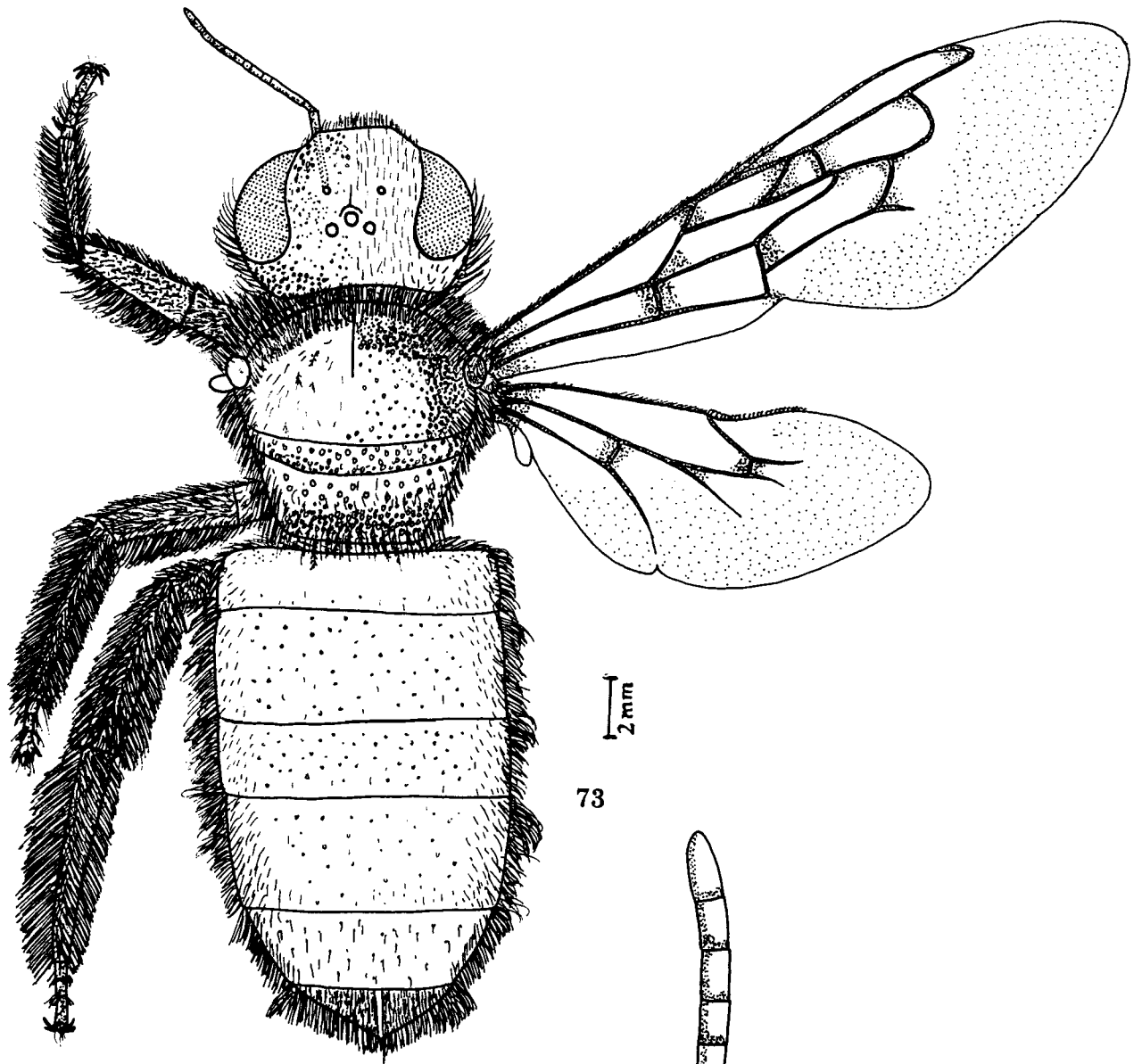


70

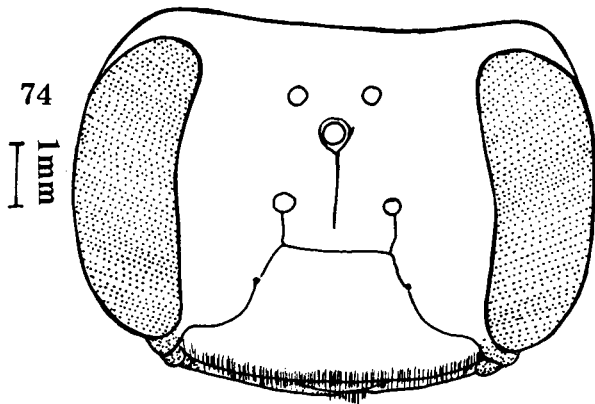


71

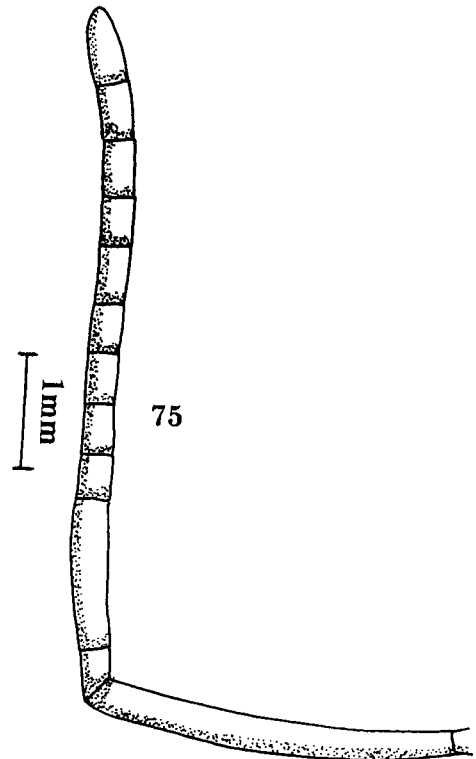
Figs. 69-71 : *Xylocopa (Mesotrichia) keralensis* sp. nov. Female
 69. Body entire : Dorsal view
 70. Head : Front view
 71. Antenna
 Fig. 72. Head : Front view - Male



73

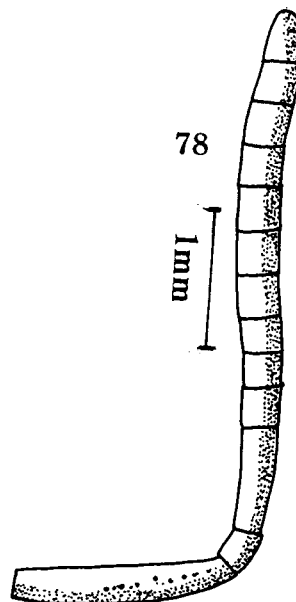
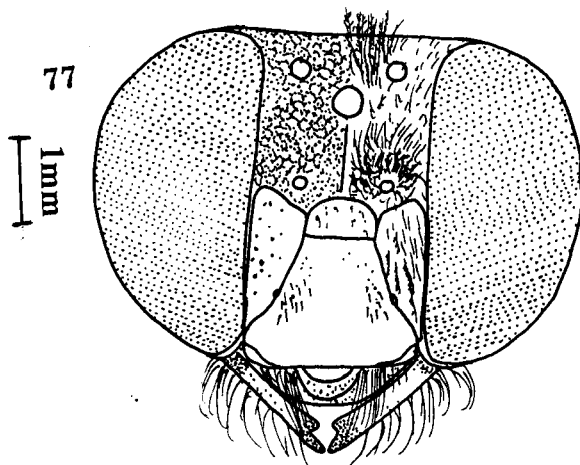
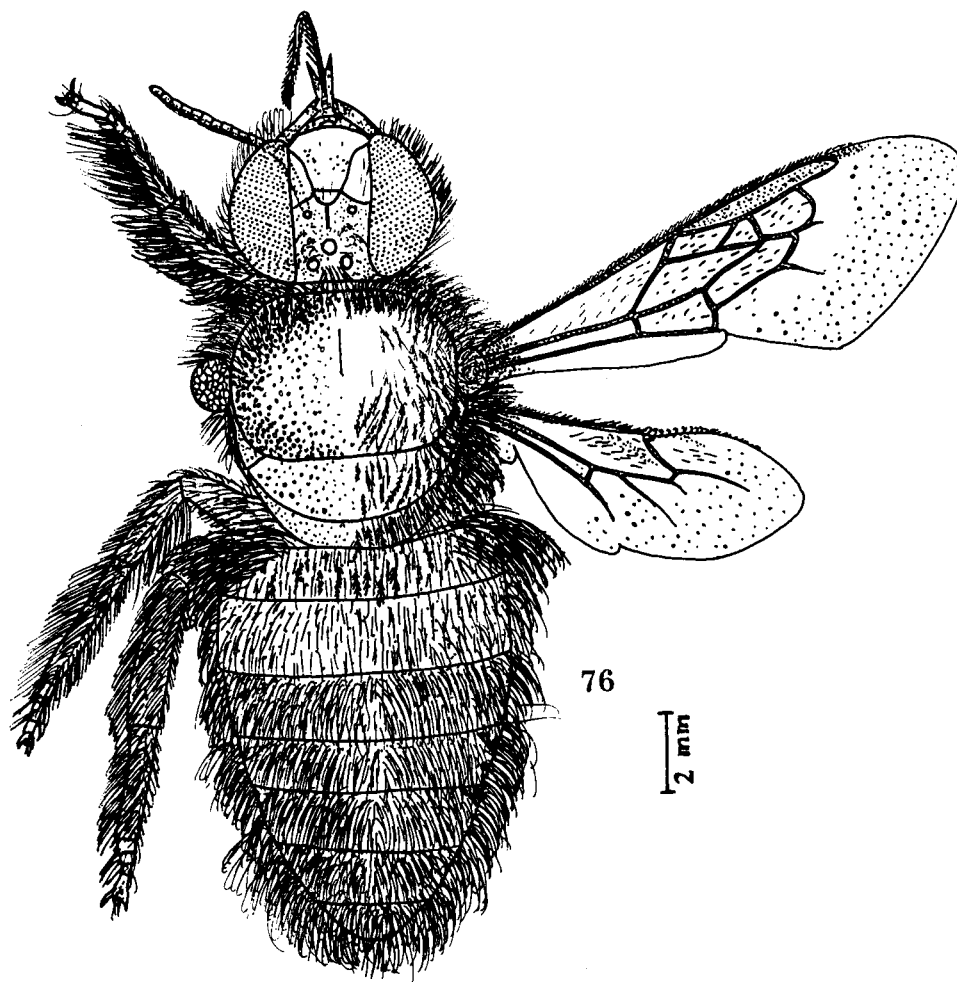


74



75

Figs. 73-75 : *Xylocopa (Mesotrichia) latipes* (Drury) Female
 73. Body entire : Dorsal view
 74. Head : Front view 75. Antenna



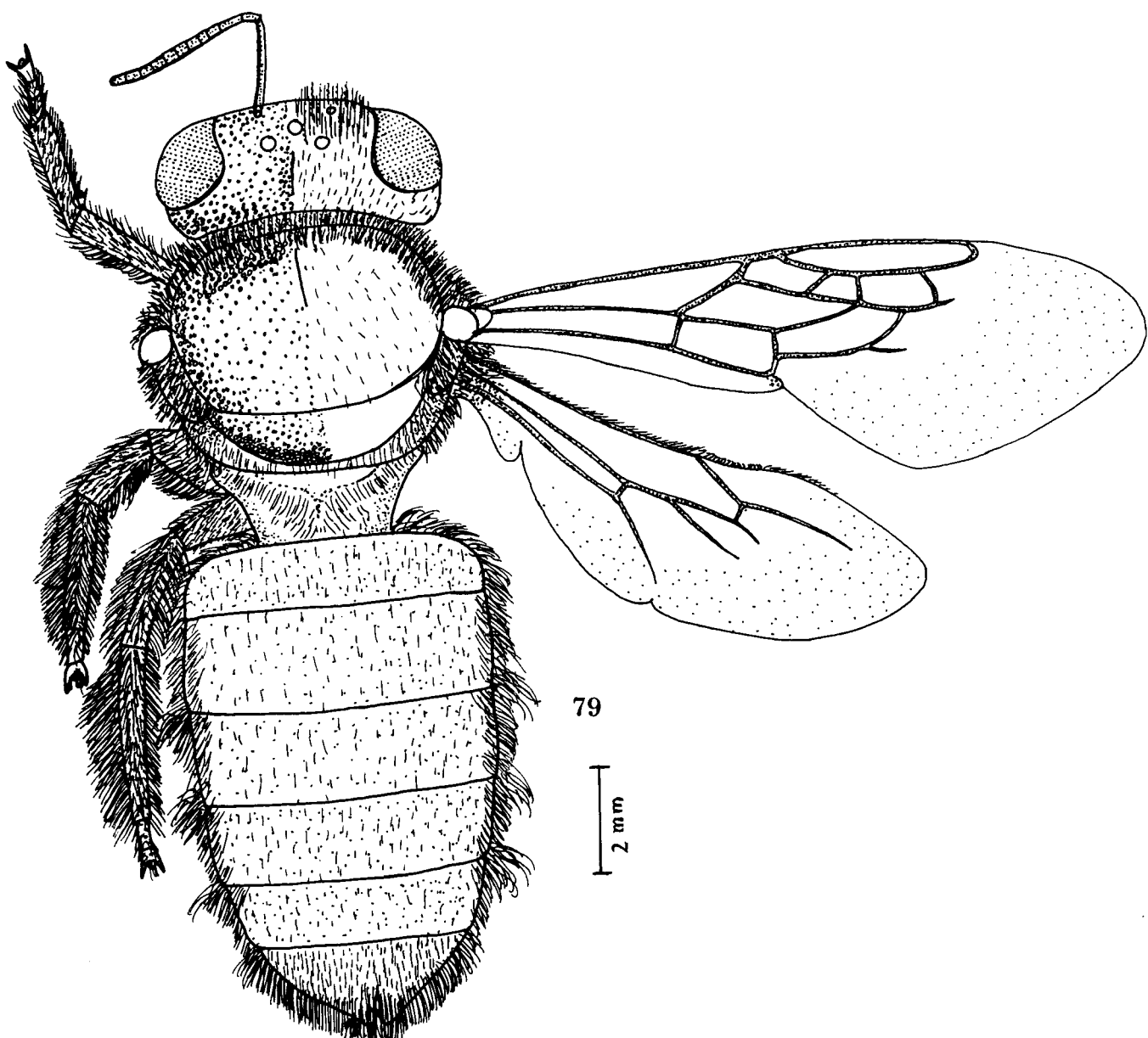
Figs. 76-78 : *Xylocopa (koptortosoma) nigroscaposa* sp. nov. Male

76. Body entire : Dorsal view

77. Head : Front view

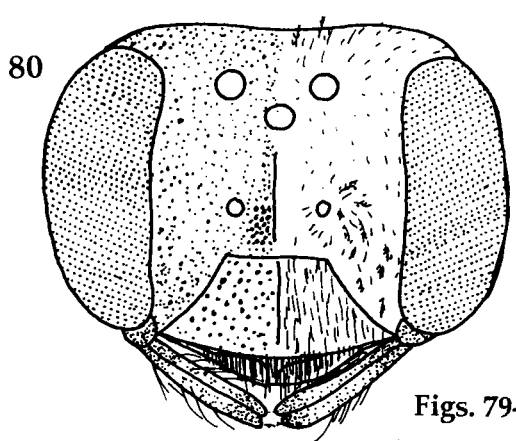
78. Antenna

1216



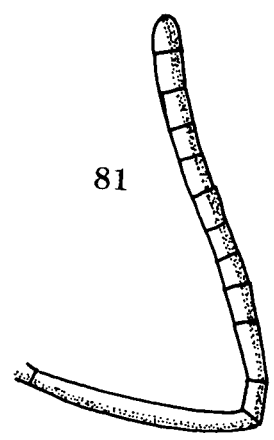
79

2 mm



80

1 mm

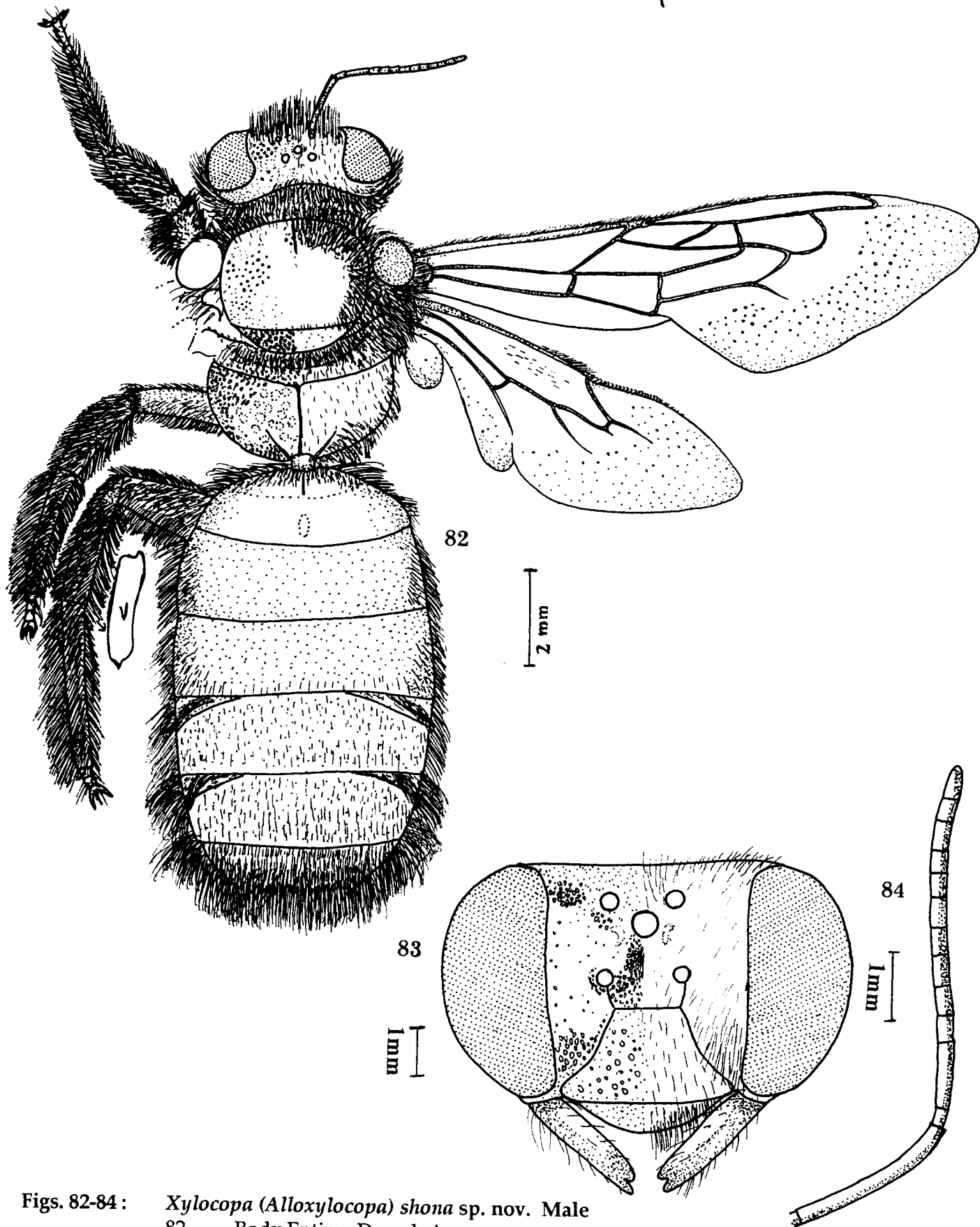


81

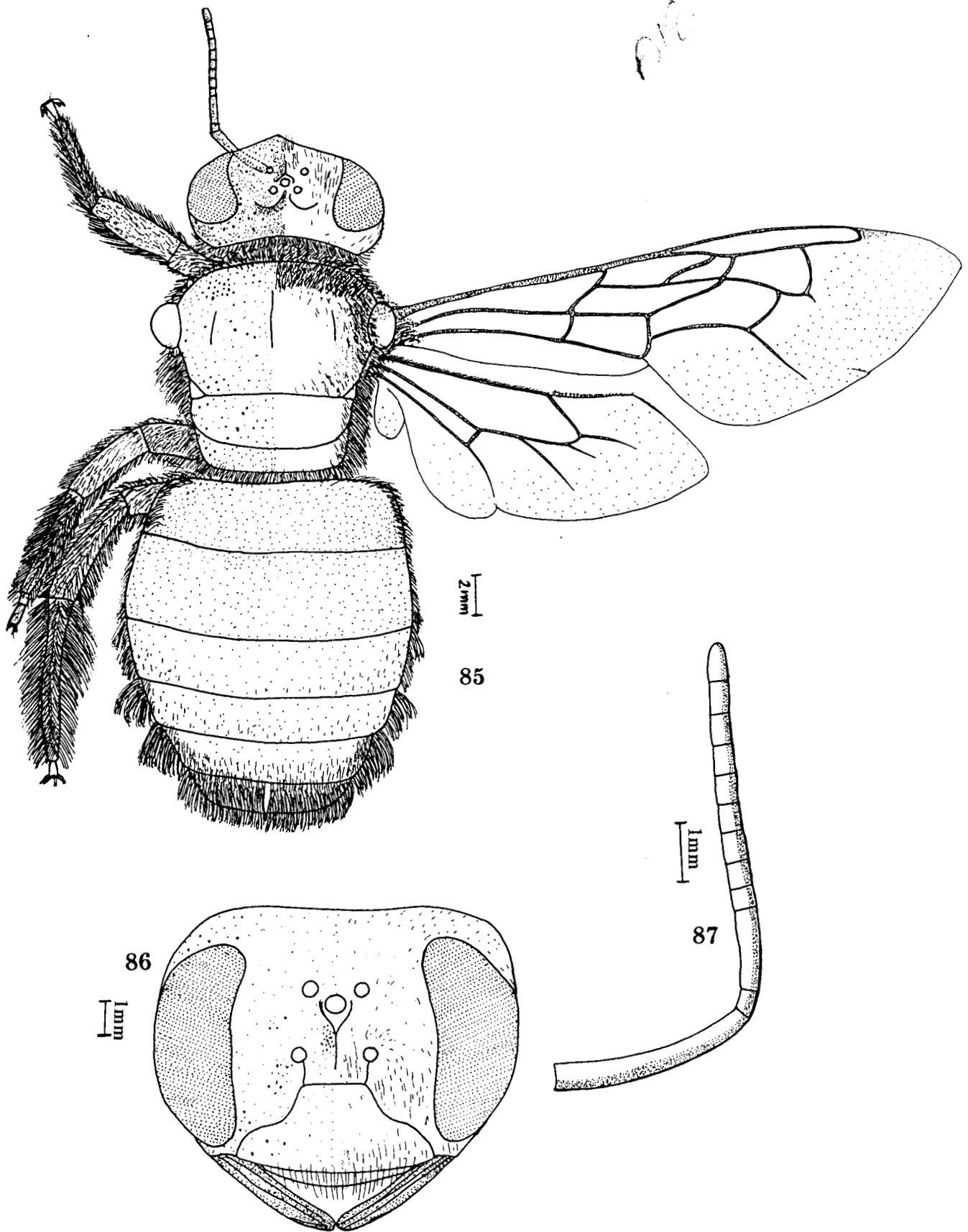
1 mm

Figs. 79-81 : *Xylocopa (Zonohirsuta) pictifrons* Smith Female
 79. Body entire : Dorsal view
 80. Head : Front view
 81. Antenna

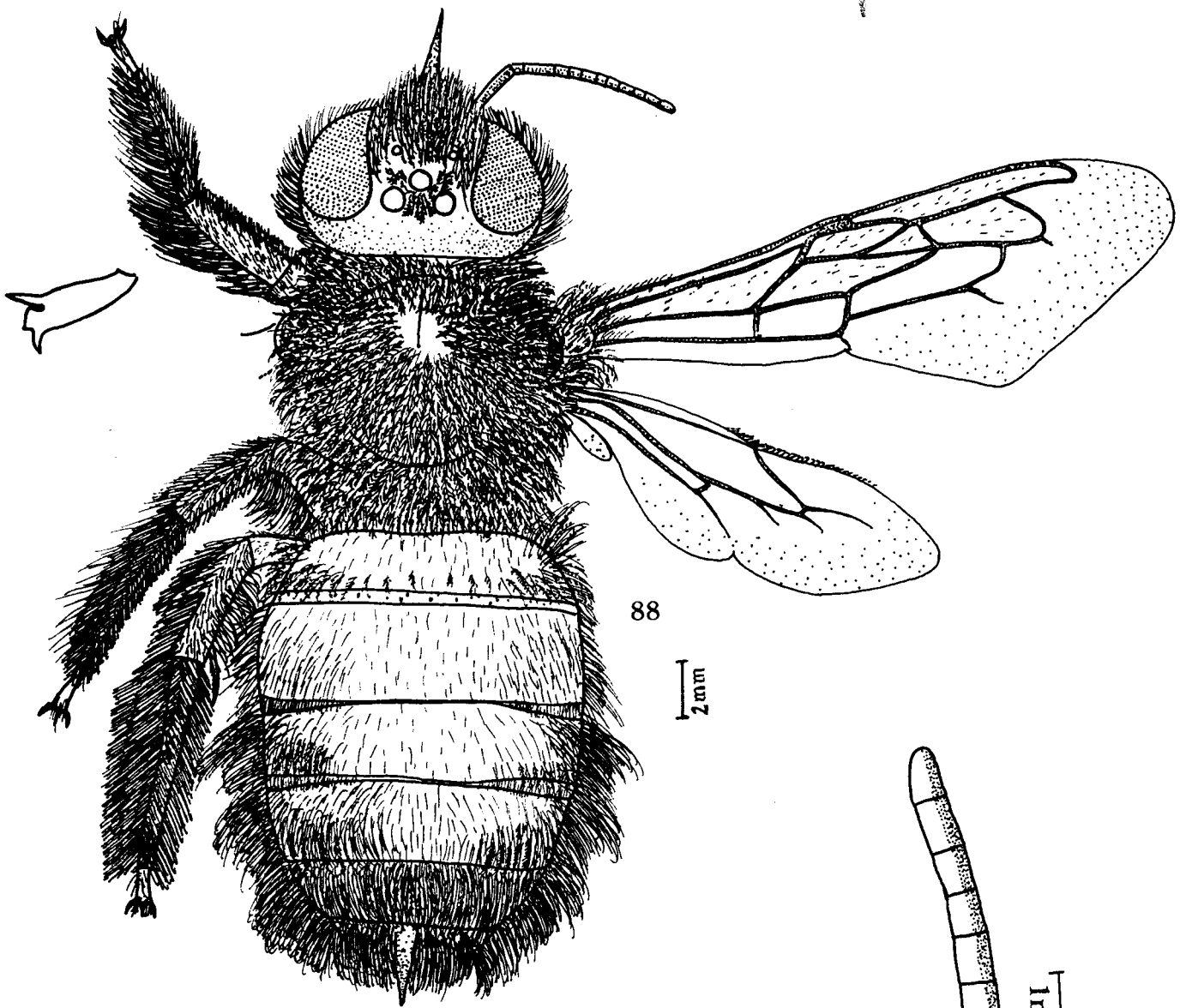
017



Figs. 82-84 : *Xylocopa (Alloxylocopa) shona* sp. nov. Male
 82. Body Entire : Dorsal view
 83. Head : Front view
 84. Antenna

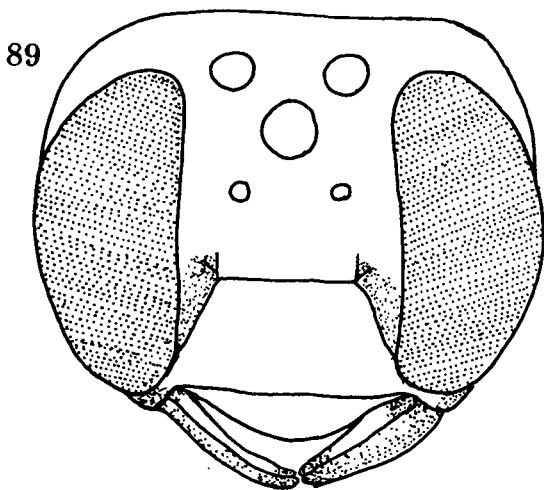


Figs. 85-87: *Xylocopa (Mesotrichia) tenuiscapa* Westwood Female
85. Body Entire : Dorsal view
86. Head : Front view
87. Antenna



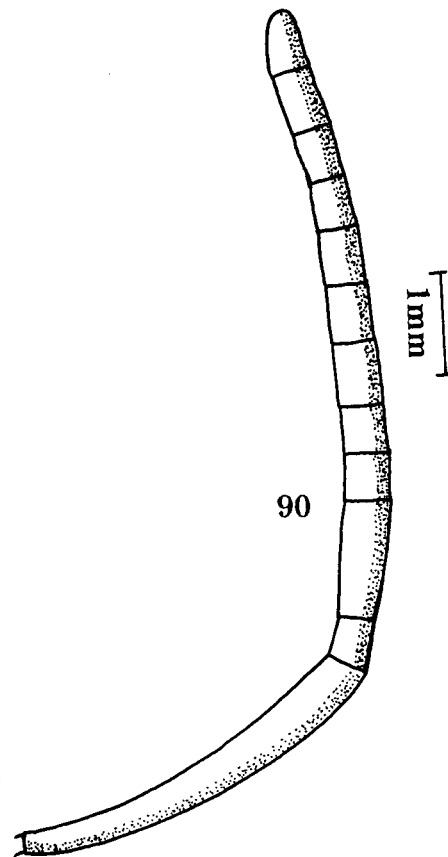
88

2mm



89

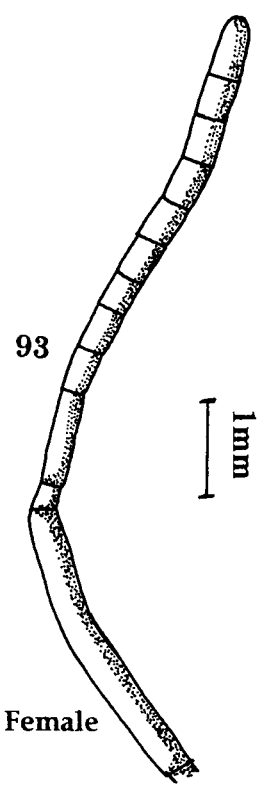
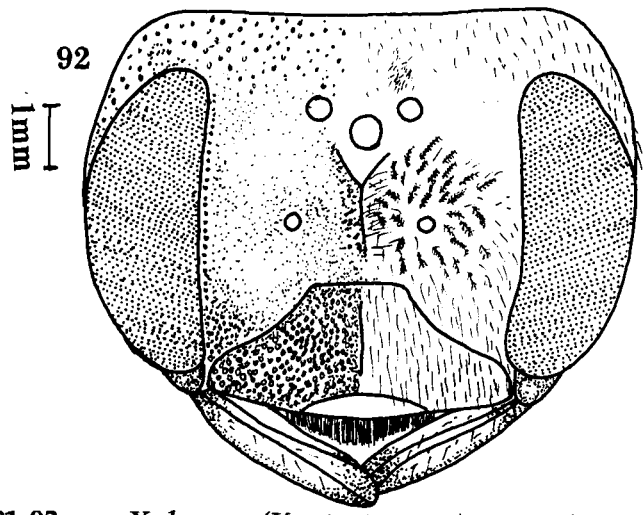
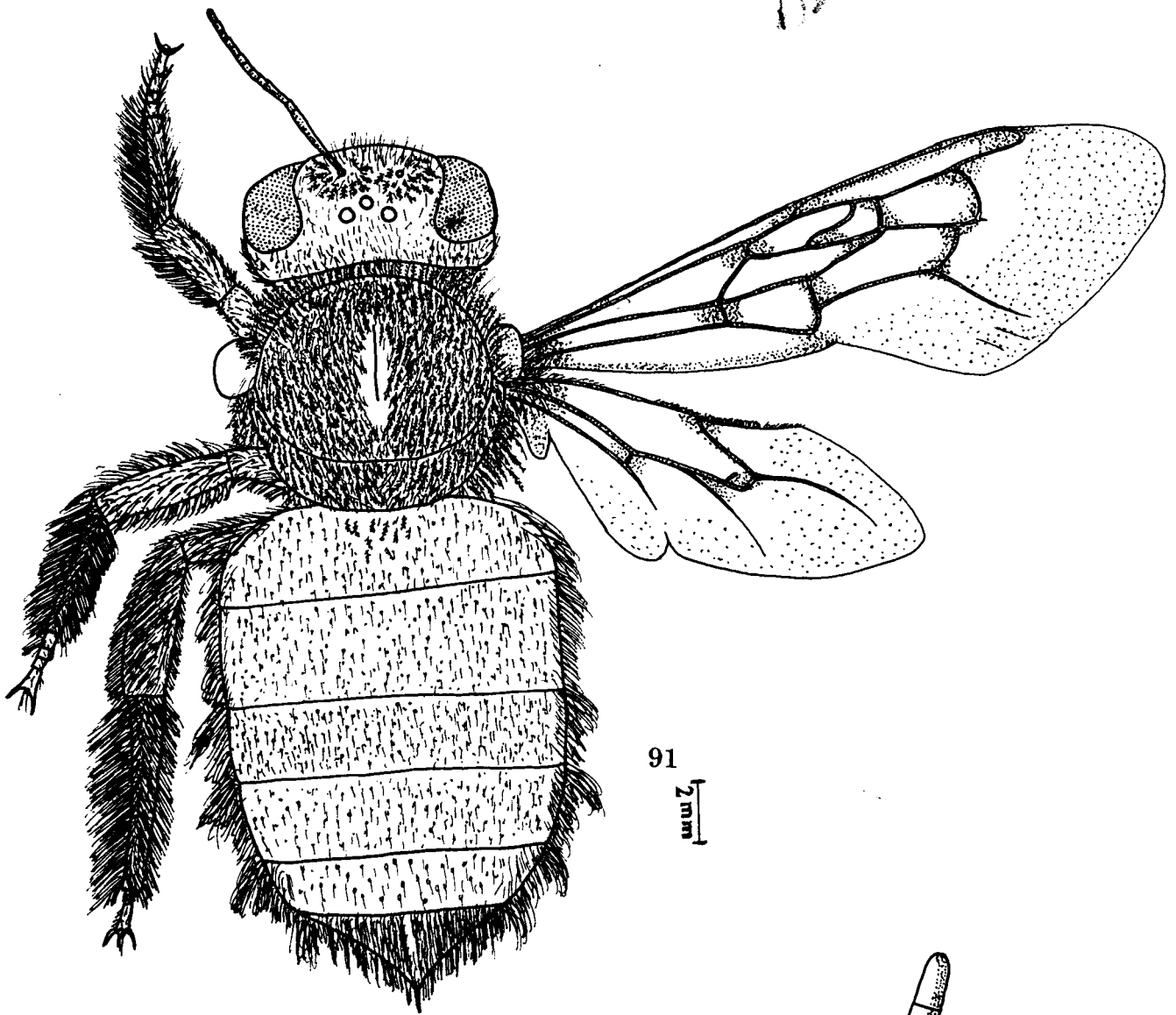
1mm



90

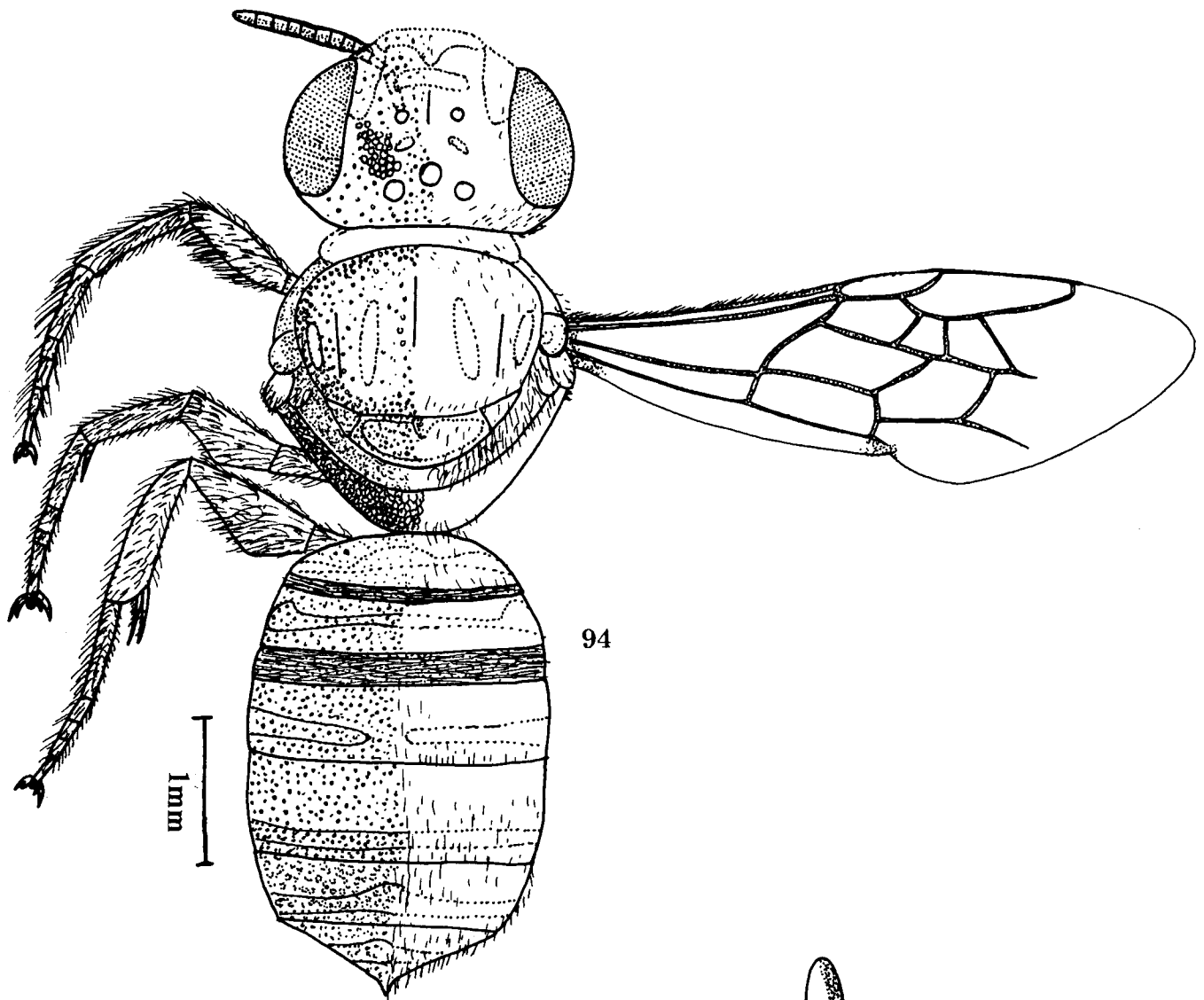
1mm

Figs. 88-90 : *Xylocopa (Nyctomelitta) tranquebarica* (Fabricius) Female
 88. Body Entire : Dorsal view
 89. Head : Front view 90. Antenna

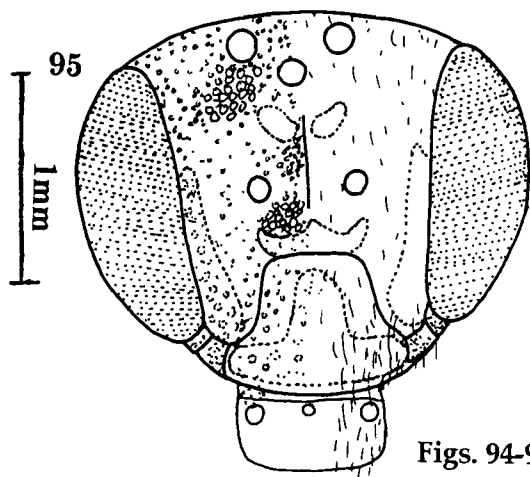


Figs. 91-93: *Xylocopa (Koptortosoma) verticalis* Lepeletier Female
91. Body entire : Dorsal view
92. Head : Front view
93. Antenna

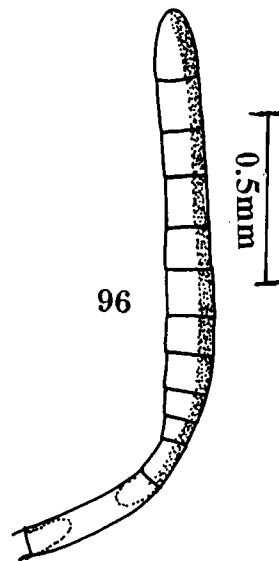
021



94

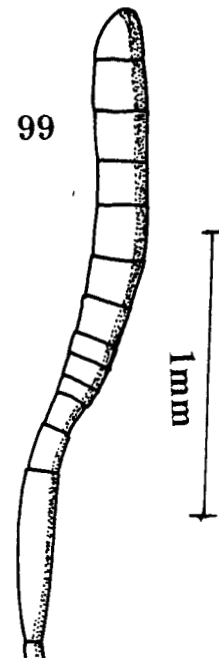
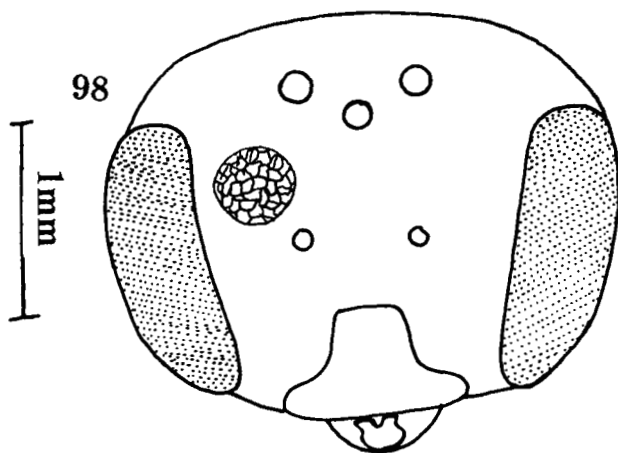
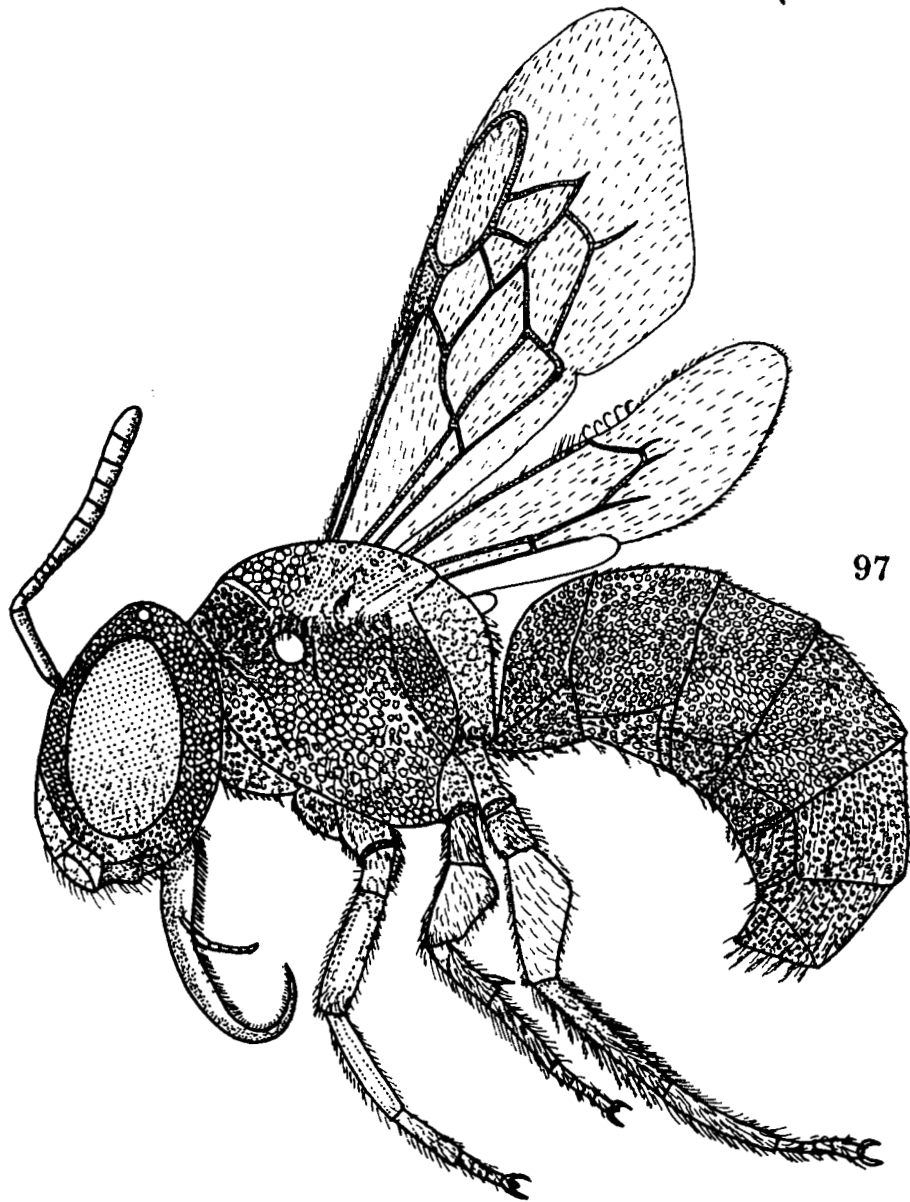


95



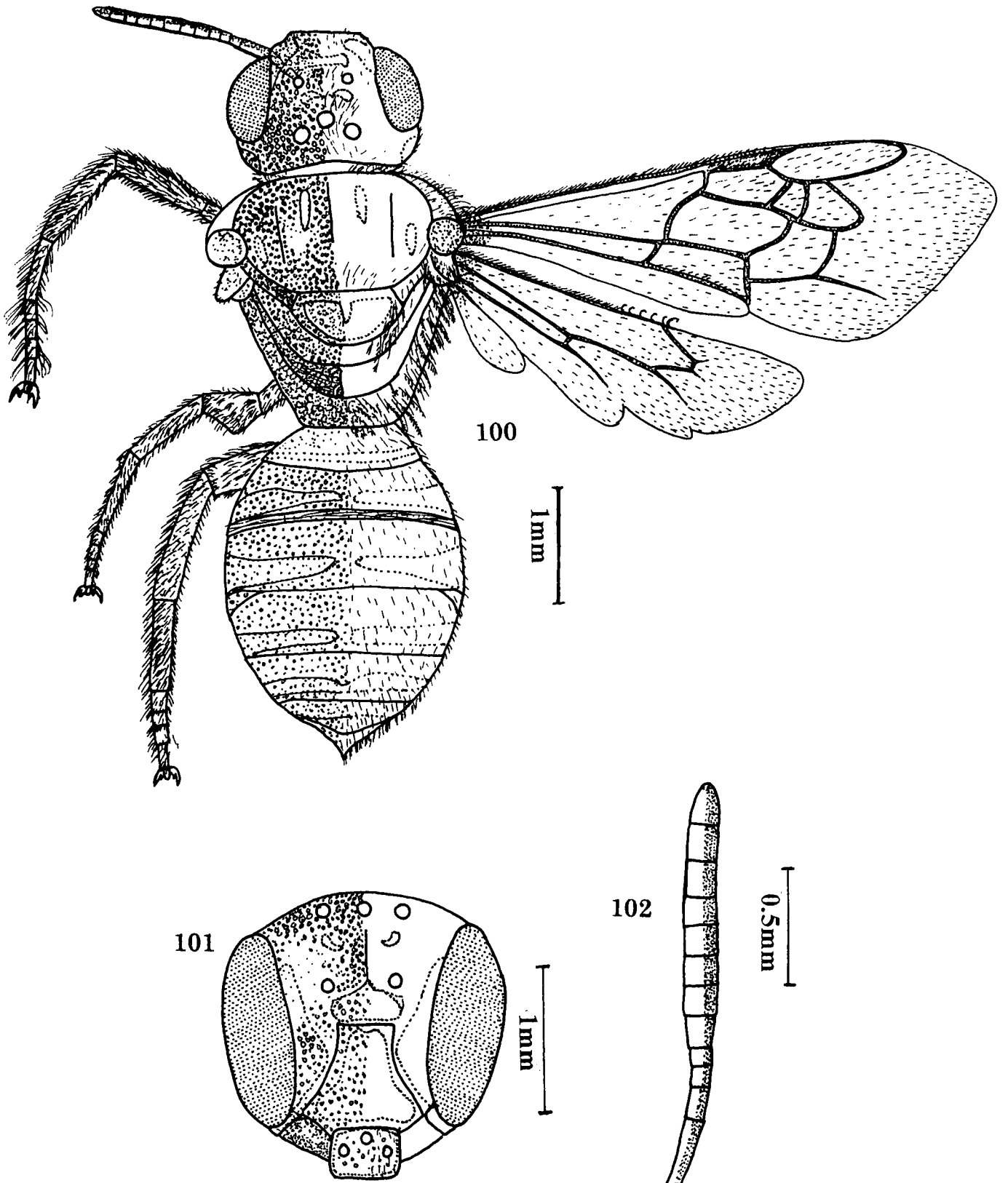
96

Figs. 94-96 : *Ceratina (Ceratinidia) anupama* sp. nov. Female
 94. Body entire : Dorsal view
 95. Head : Front view
 96. Antenna



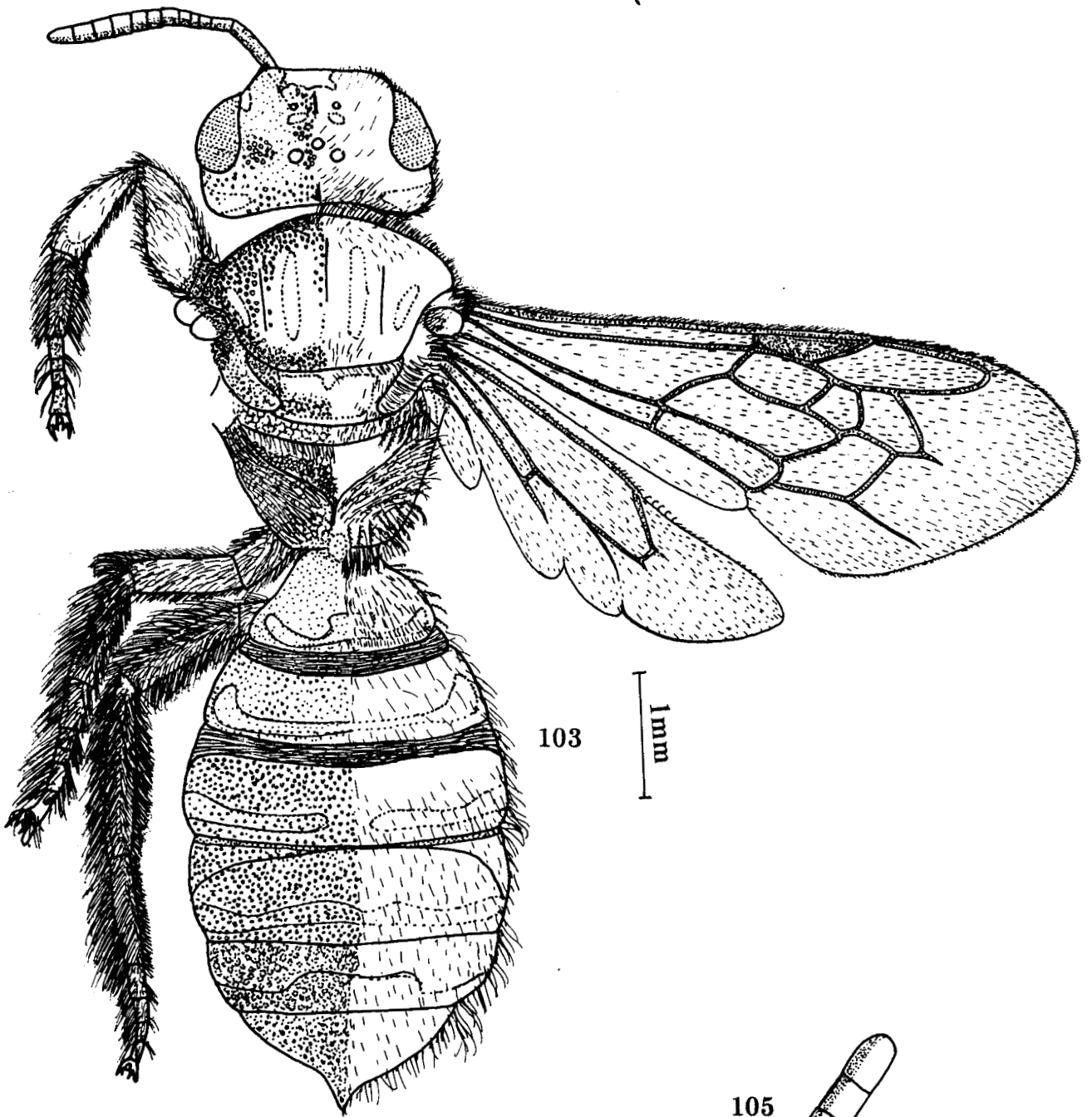
Figs. 97-99 : *Ceratina (Pithitis) binghami* Cockerell
 97. Body (Profile)
 98. Head : Front view
 99. Antenna

1993



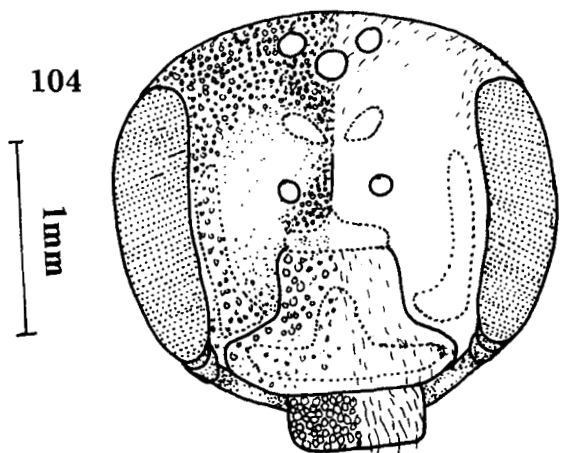
Figs. 100-102 : *Ceratina (Ceratinidia) curiosa* sp. nov. Female
100. Body entire : Dorsal view
101. Head : Front view
102. Antenna

A24



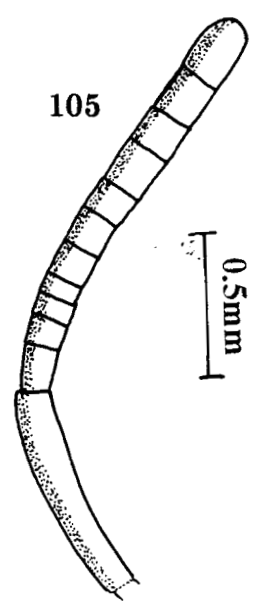
103

1mm



104

1mm

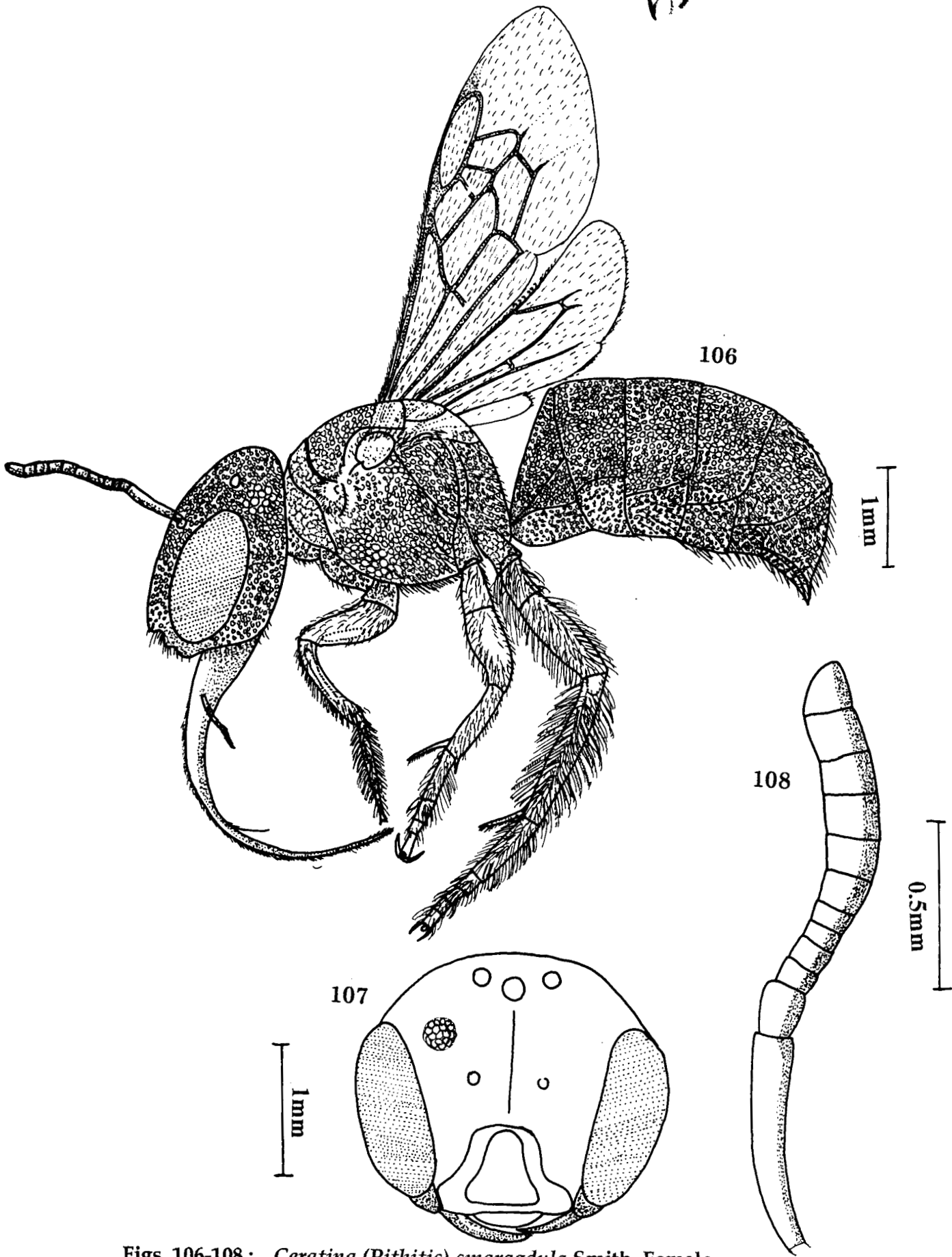


105

0.5mm

Figs. 103-105 : *Ceratina (Ceratinidia) heiroglyphica* Smith
103. Body entire : Dorsal view
104. Head : Front view 105. Antenna

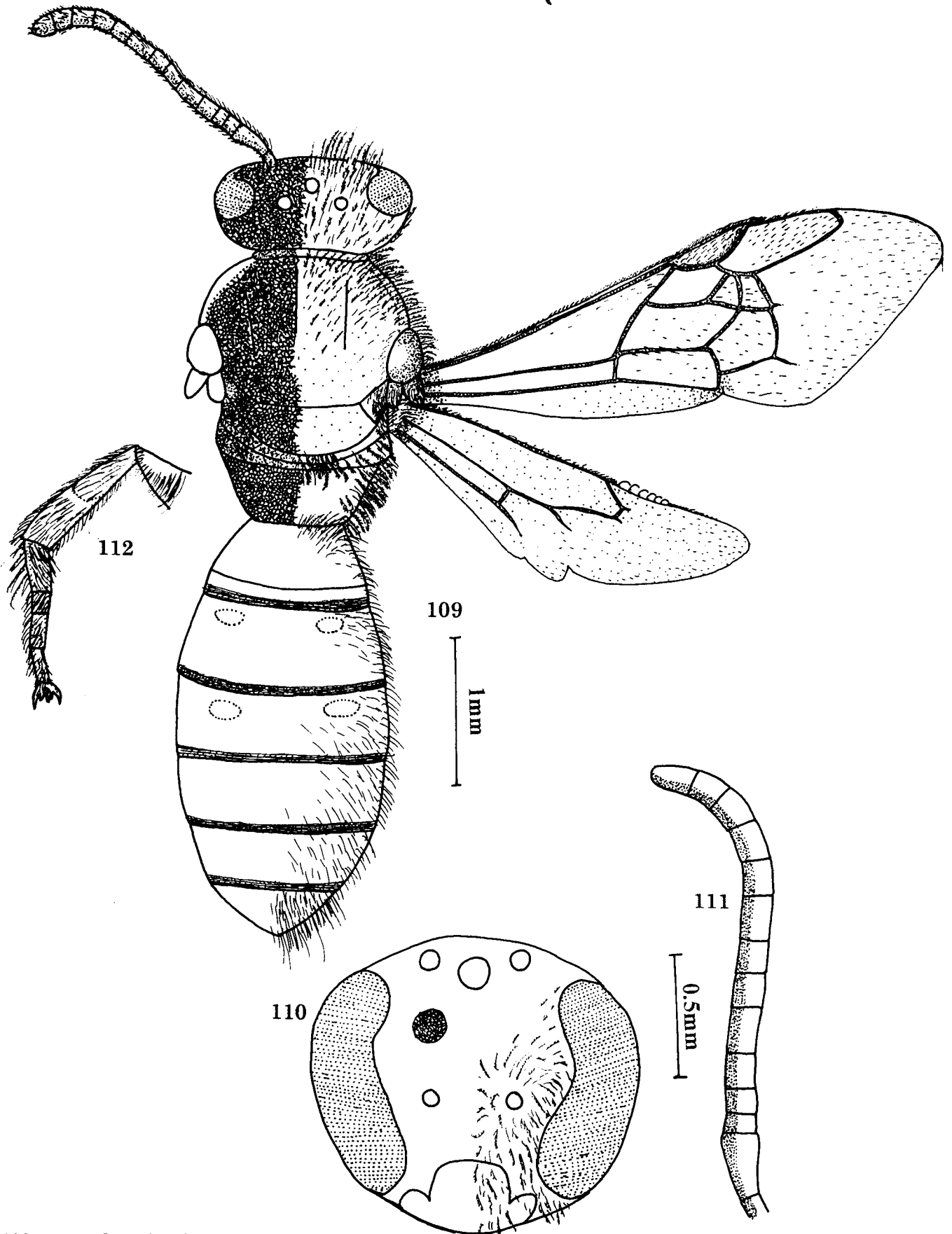
92



Figs. 106-108 : *Ceratina (Pithitis) smaragdula* Smith Female

- 106. Body (Profile)
- 107. Head : Front view
- 108. Antenna

92



Figs. 109-112: *Ceratina (Neoceratina) sasidharani* sp. nov. Male
 109. Body entire : Dorsal view 111. Antenna
 110. Head : Front view 112. Hind leg

024

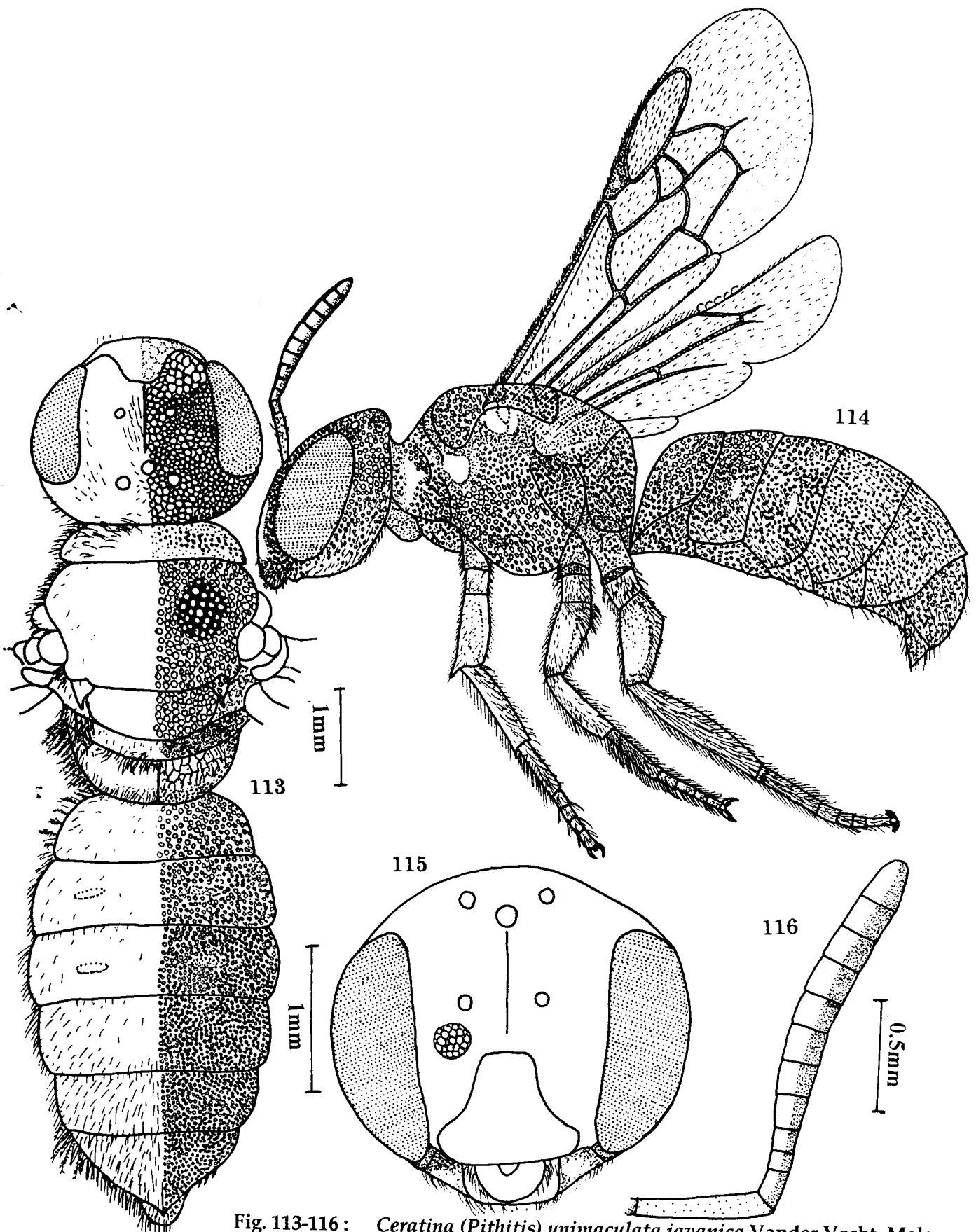
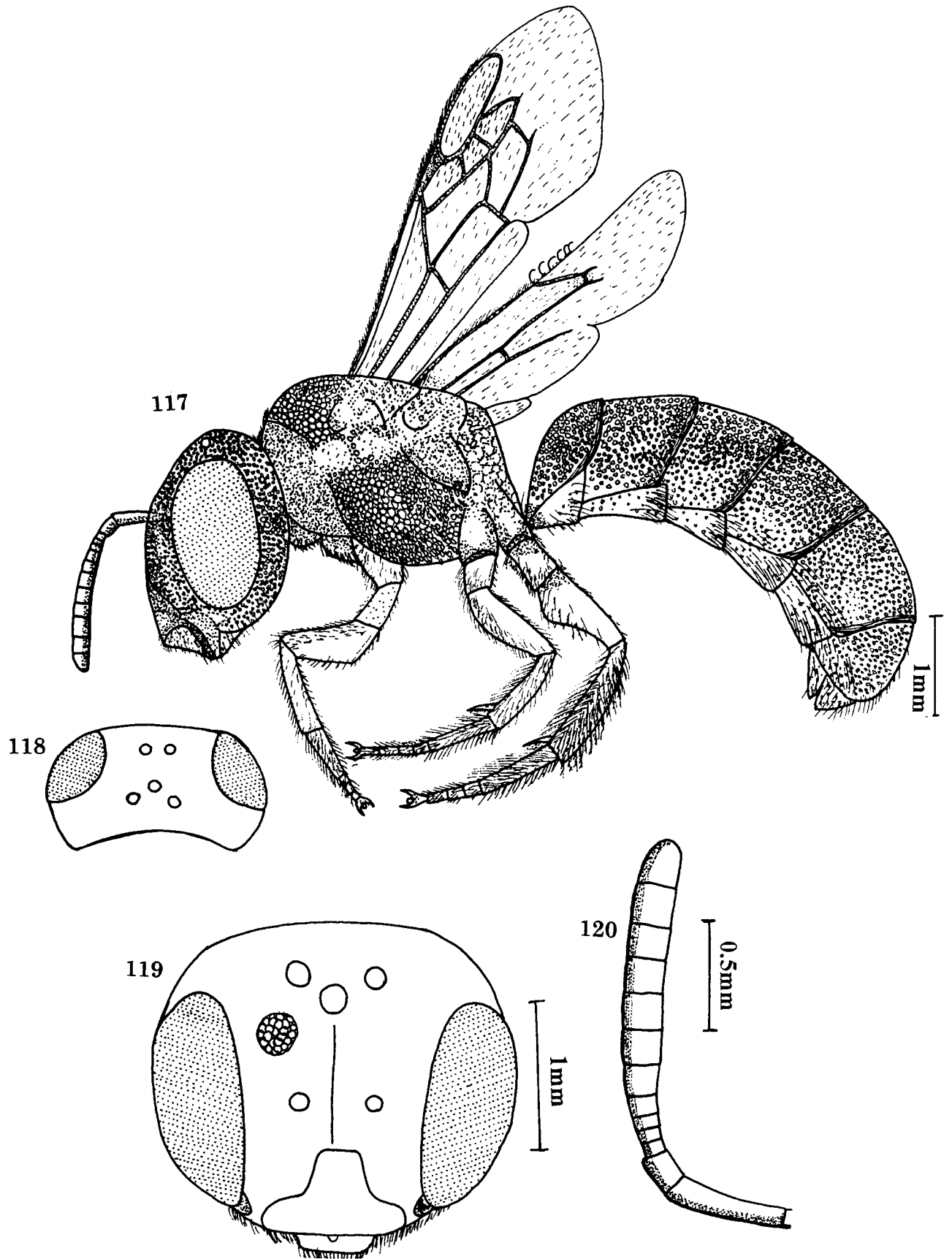


Fig. 113-116 : *Ceratina (Pithitis) unimaculata javanica* Vander Vecht Male
 113. Body (profile) 115. Head : Front view
 114. Body entire : Dorsal view 116. Antenna



Figs. 117-120: *Ceratina (Pithitis) unimaculata palmerii* Cameron Male
 117. Body (Profile) 120. Antenna
 118. Head : Dorsal view
 119. Head : Front view

Figs. 121-122 : *Braunsapis hewiti* (Cameron) Female

121. Labium

122. Maxilla

Figs. 123-125 : *Braunsapis breviceps* Female

123. Labium

124. Maxilla

125. Scopa of hind femur

Fig. 126 : *Braunsapis simillima* (Smith); Scopa

Fig. 127 : *Braunsapis cupulifera* Vachal Male

Head : Front view

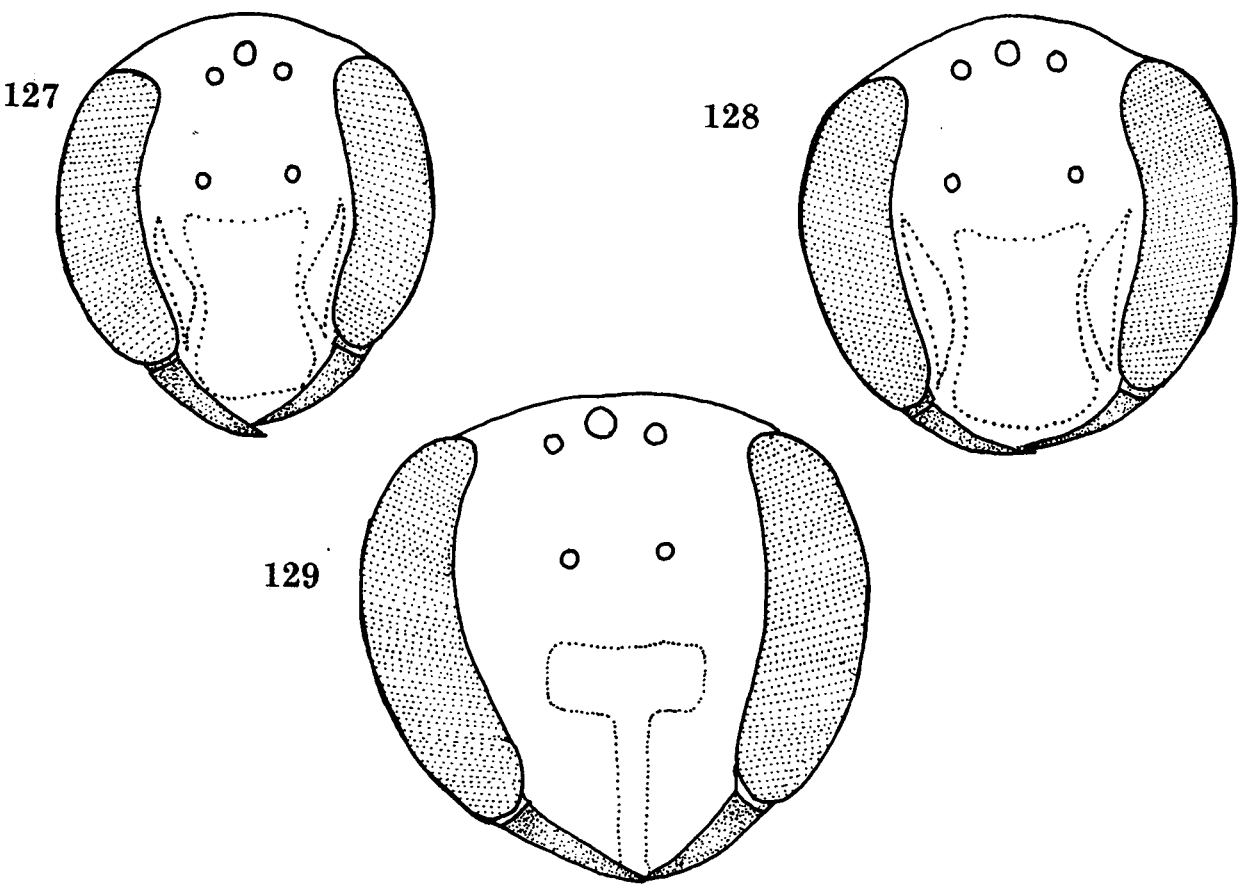
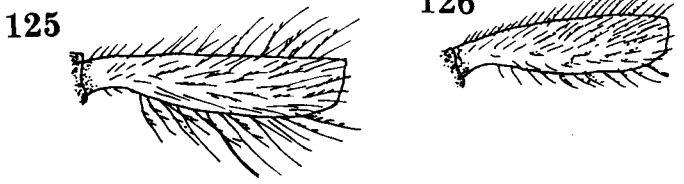
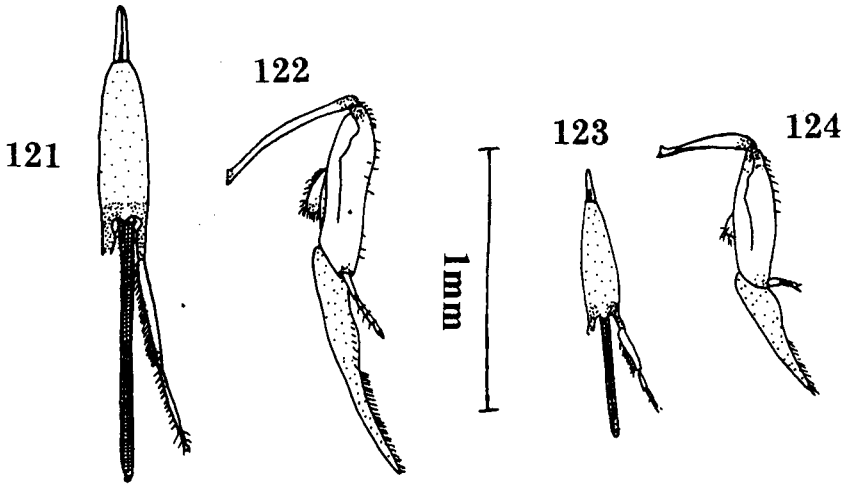
Fig. 128 : *Braunsapis picitarsis* (Cameron) Male

Head : Front view

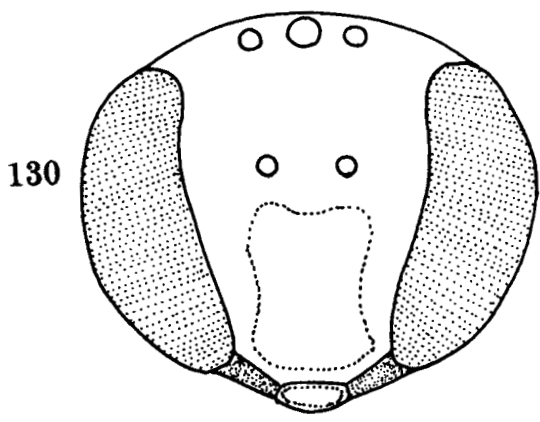
Fig. 129 : *Braunsapis philippinensis* (Ashmead) Male

Head : Front view

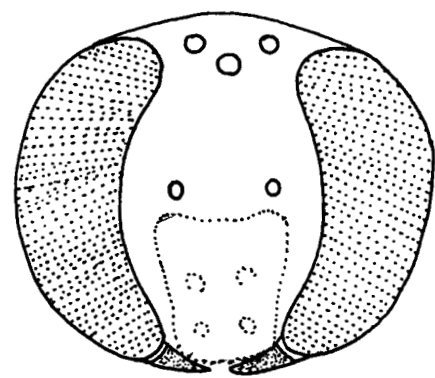
730



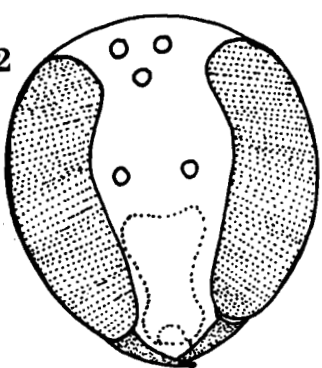
1931



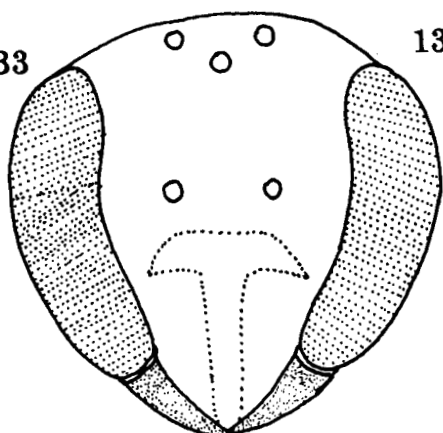
131



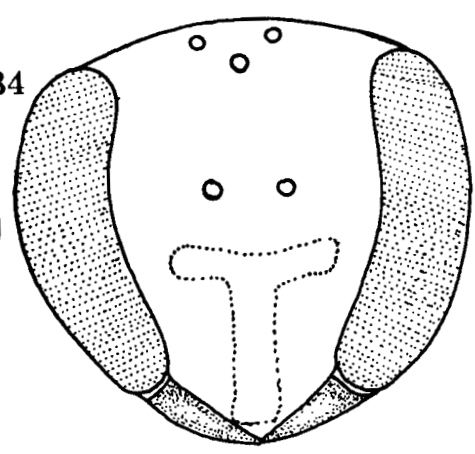
132



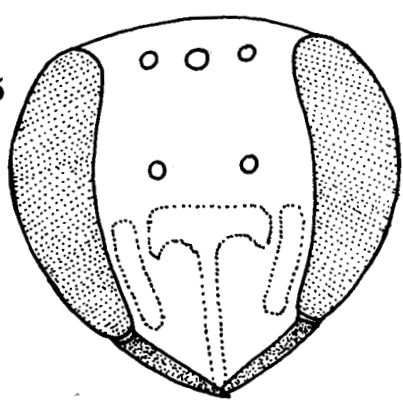
133



134



135



136

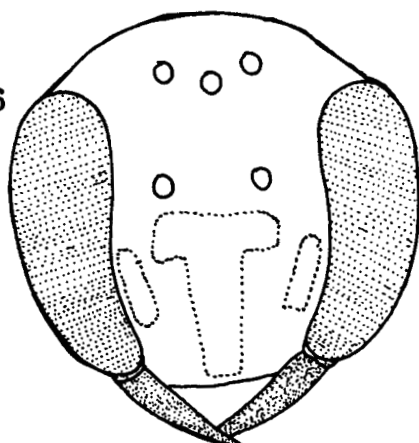
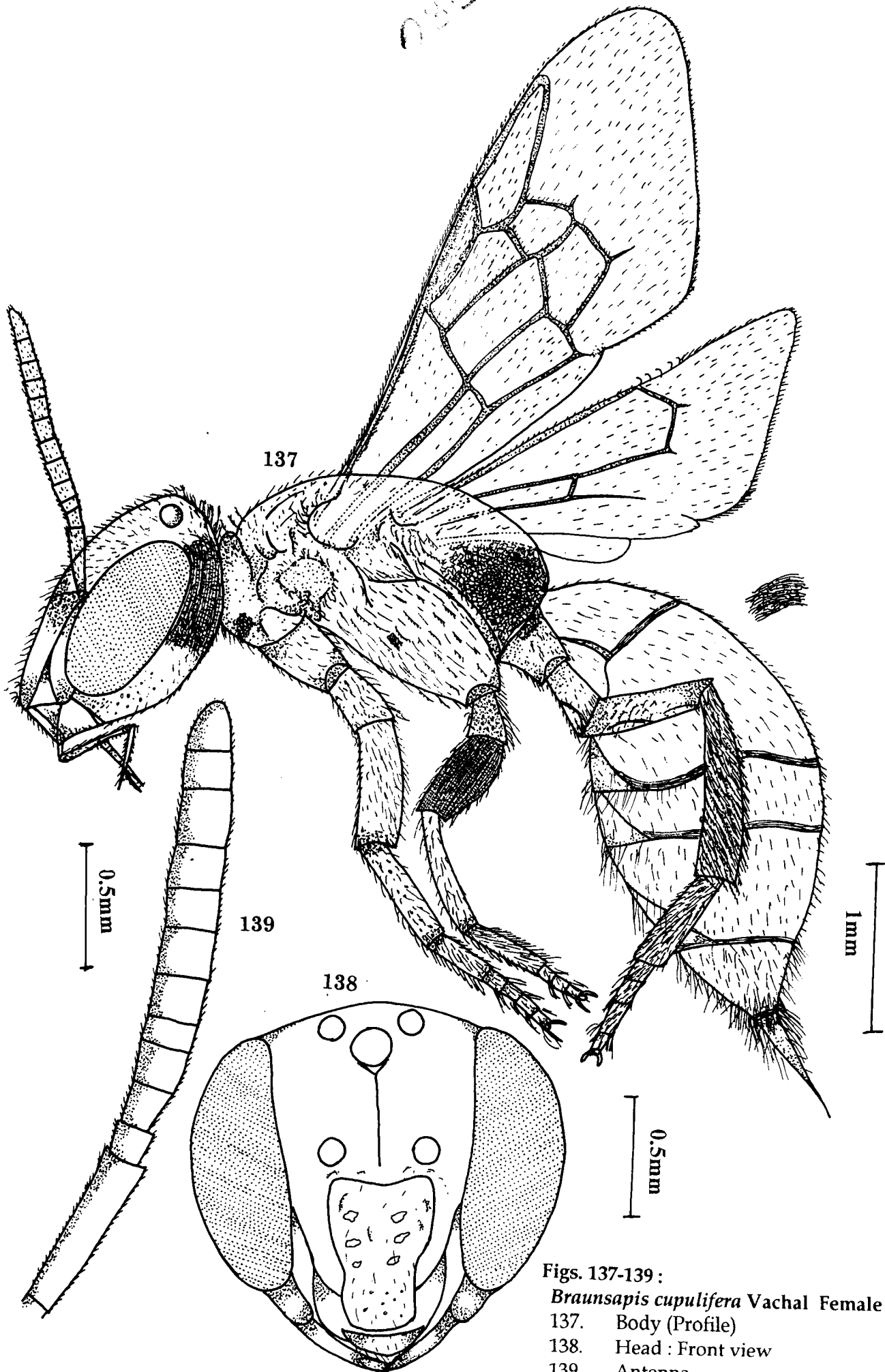
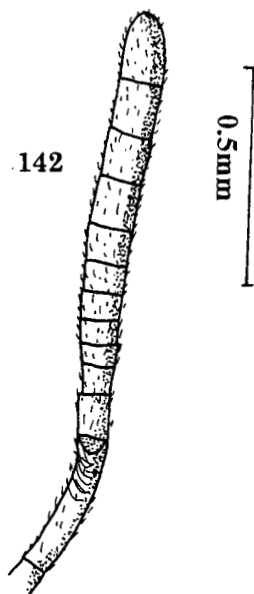
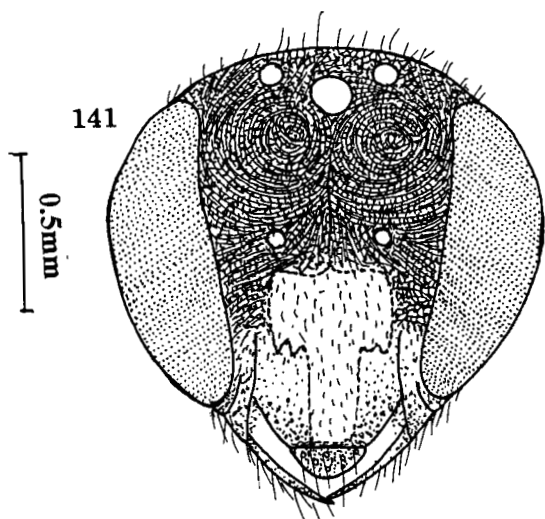
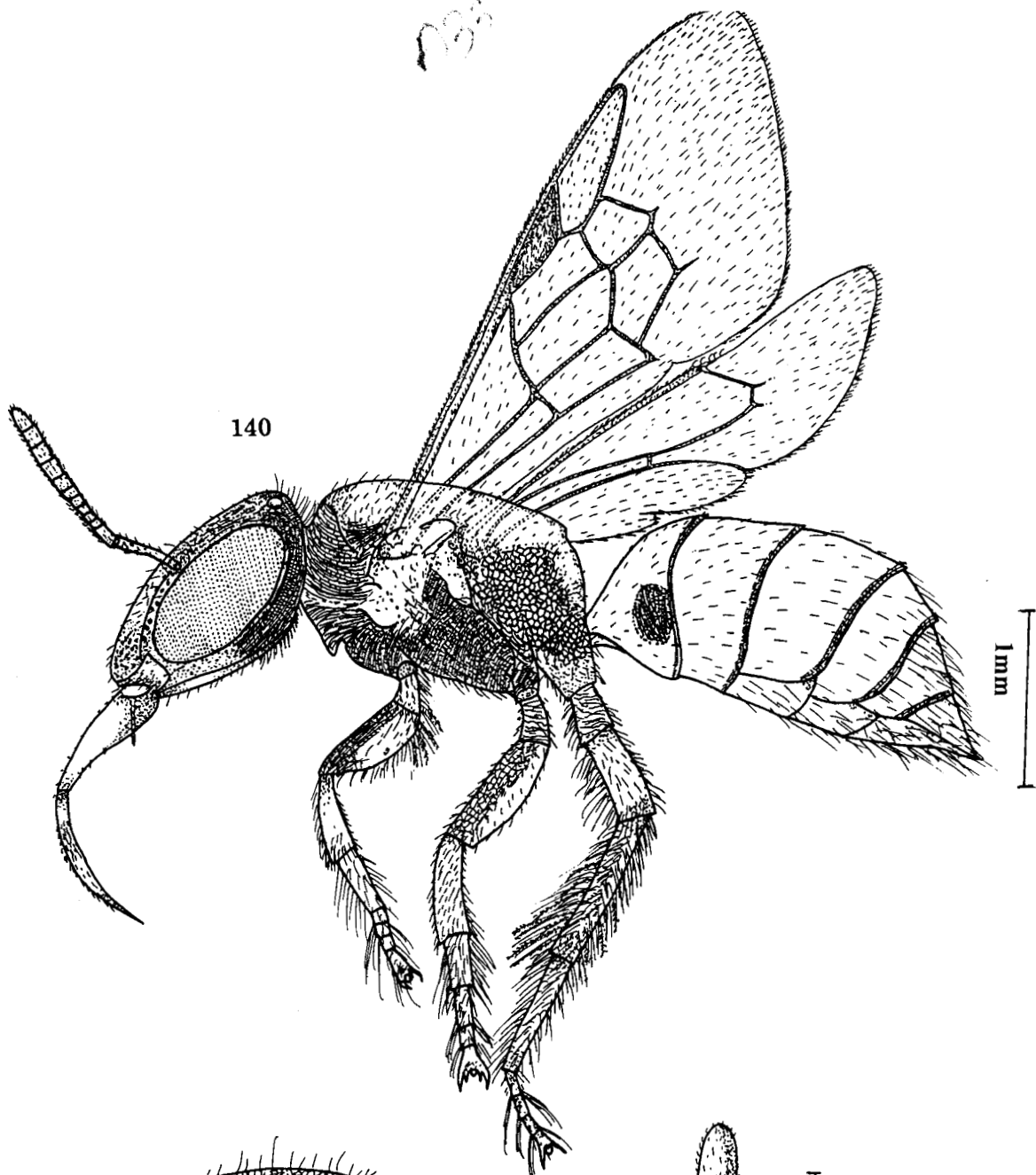


Fig. 130-136: Head: Front view

- 130. *Braunsapis breviceps* Female
- 131. *Braunsapis kaliago* Female
- 132. *Braunsapis aurantipes* Female
- 133. *Braunsapis indica* Female
- 134. *Braunsapis reducta* Female
- 135. *Braunsapis lateralis* Female
- 136. *Braunsapis apicalis* Female

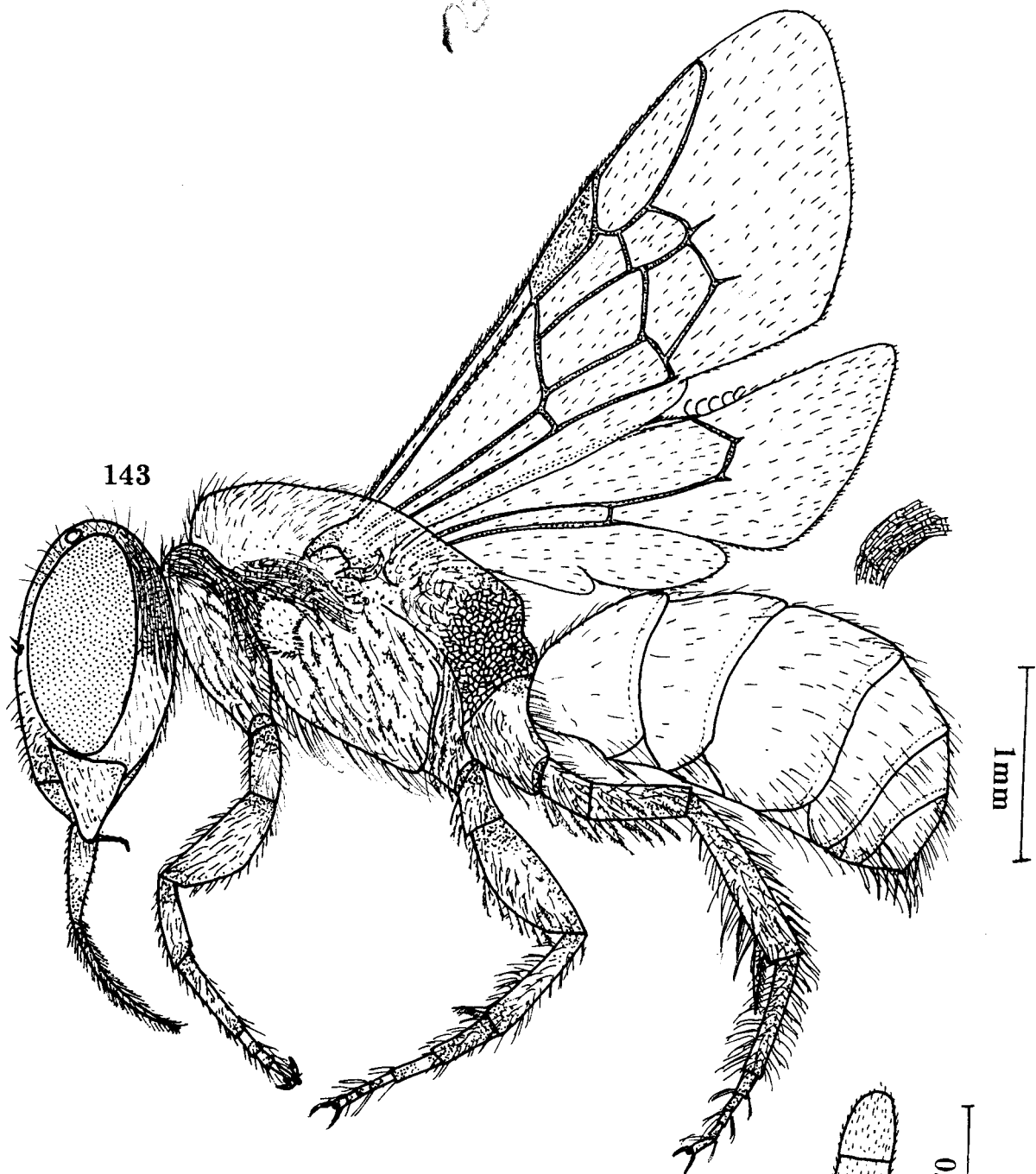


Figs. 137-139 :
Braunsapis cupulifera Vachal Female
 137. Body (Profile)
 138. Head : Front view
 139. Antenna



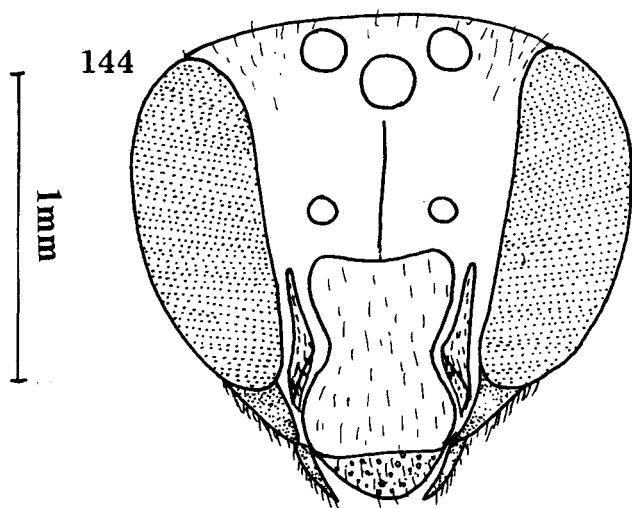
Figs. 140-142: *Braunsapis engeli* sp. nov. Female
140. Body (Profile)
141. Head : Front view
142. Antenna

2049



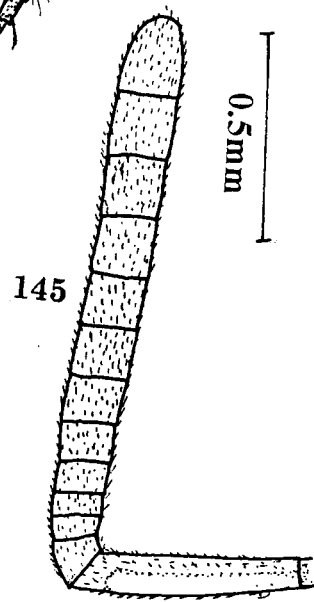
143

1mm



144

1mm



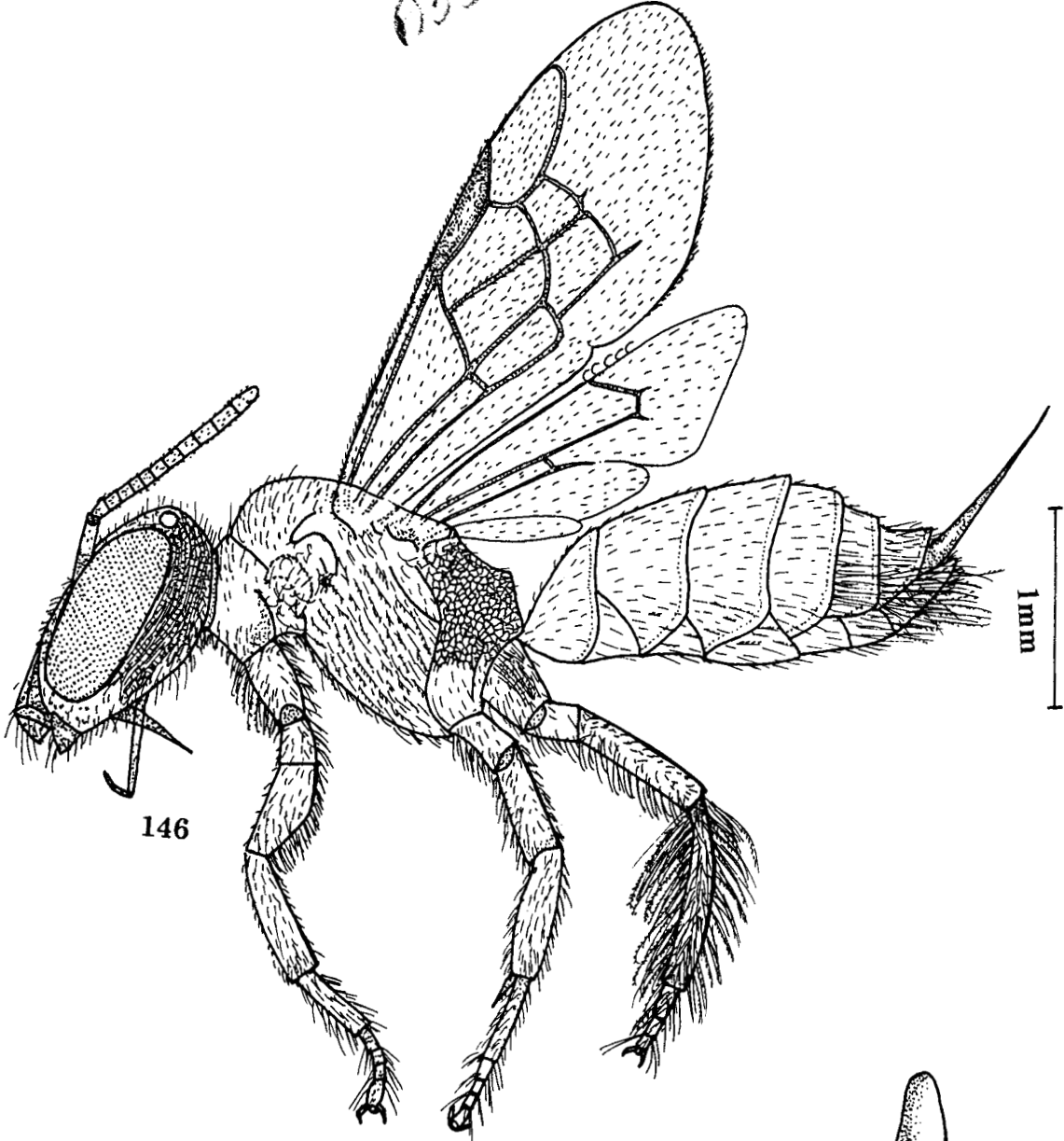
145

0.5mm

Figs. 143-145 : *Brannsapis hewitti* (Cameron) Male
 143. Body (Profile) 145. Antenna
 144. Head : Front view

2049

035

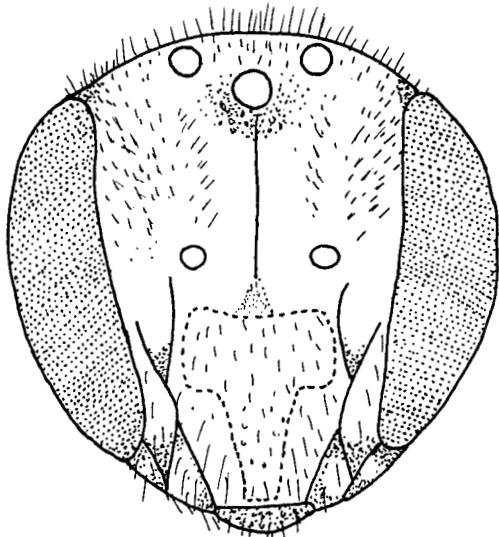


146

1mm

147

0.5mm



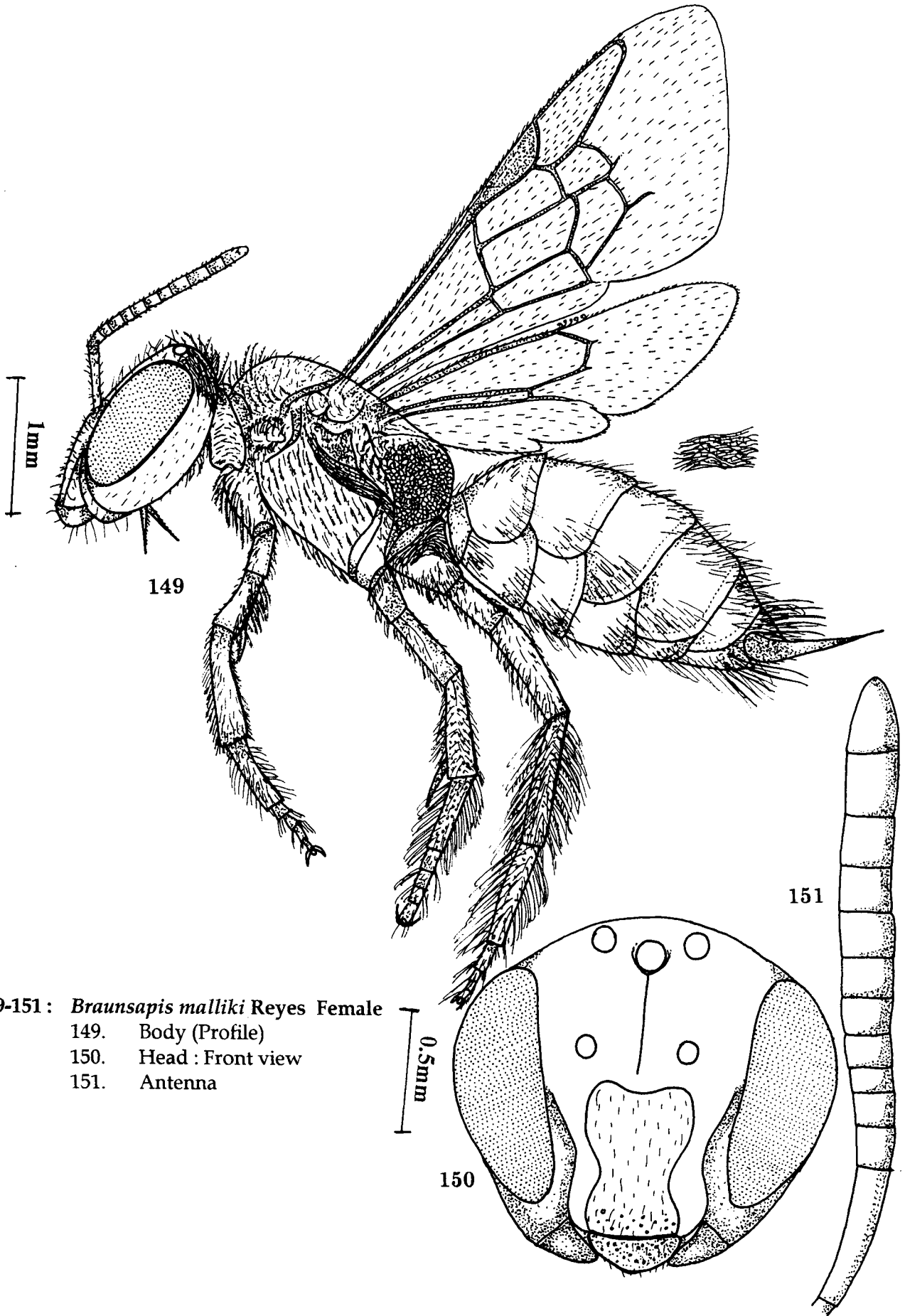
148

0.5mm

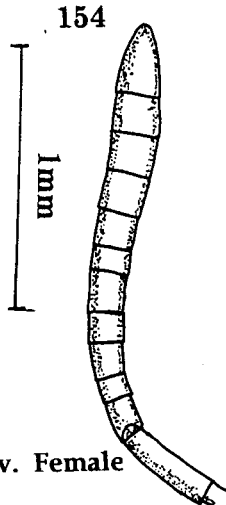
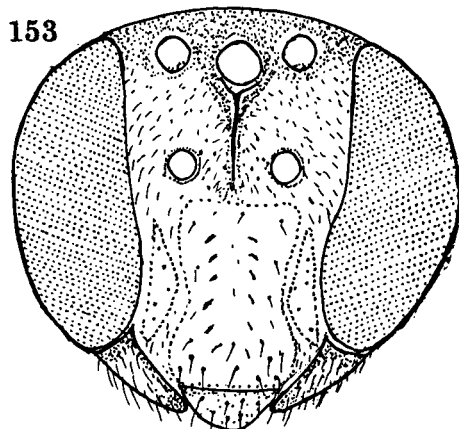
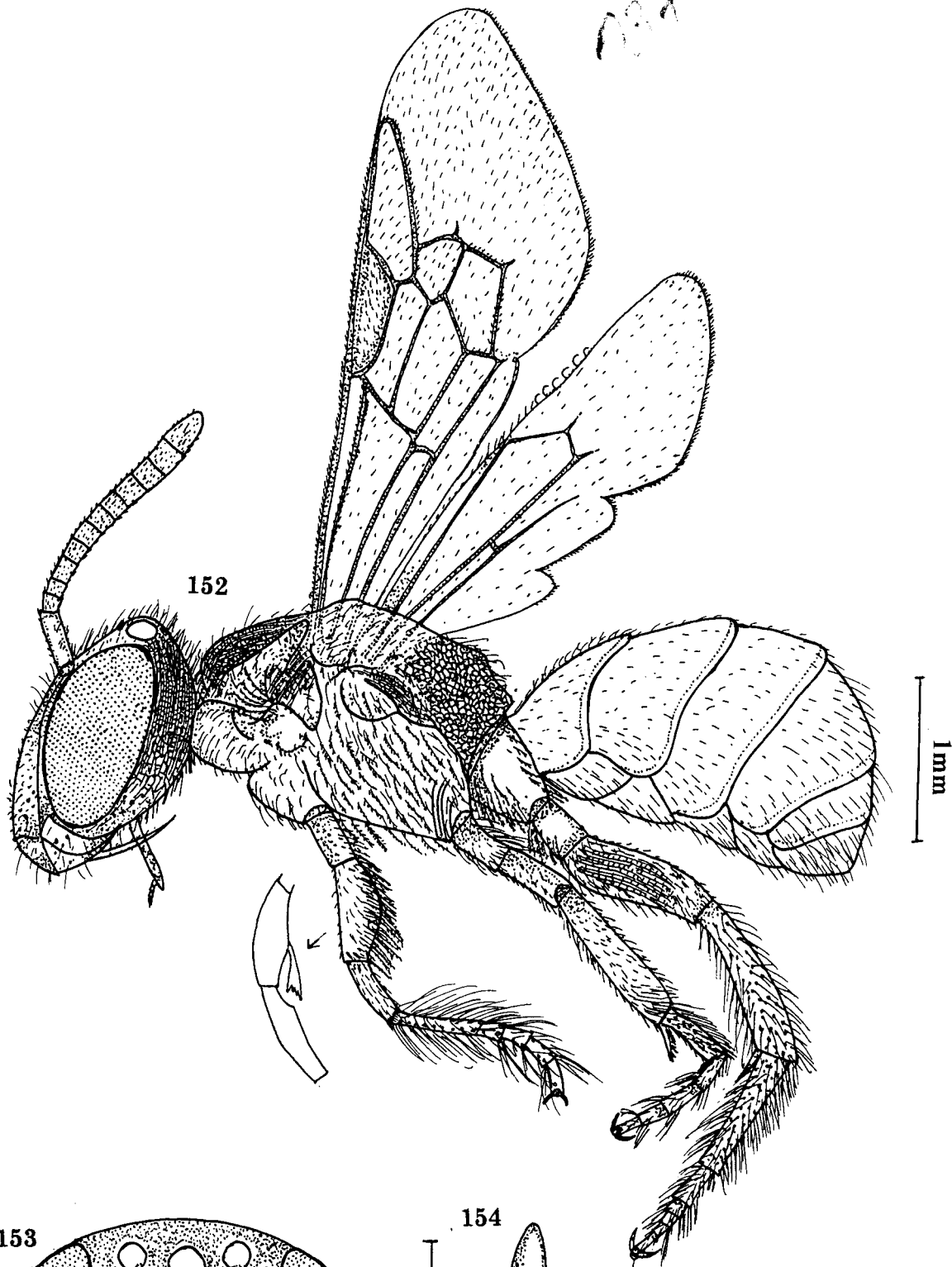


Figs. 146-148: *Braunsapis intermedia* sp. nov. Female

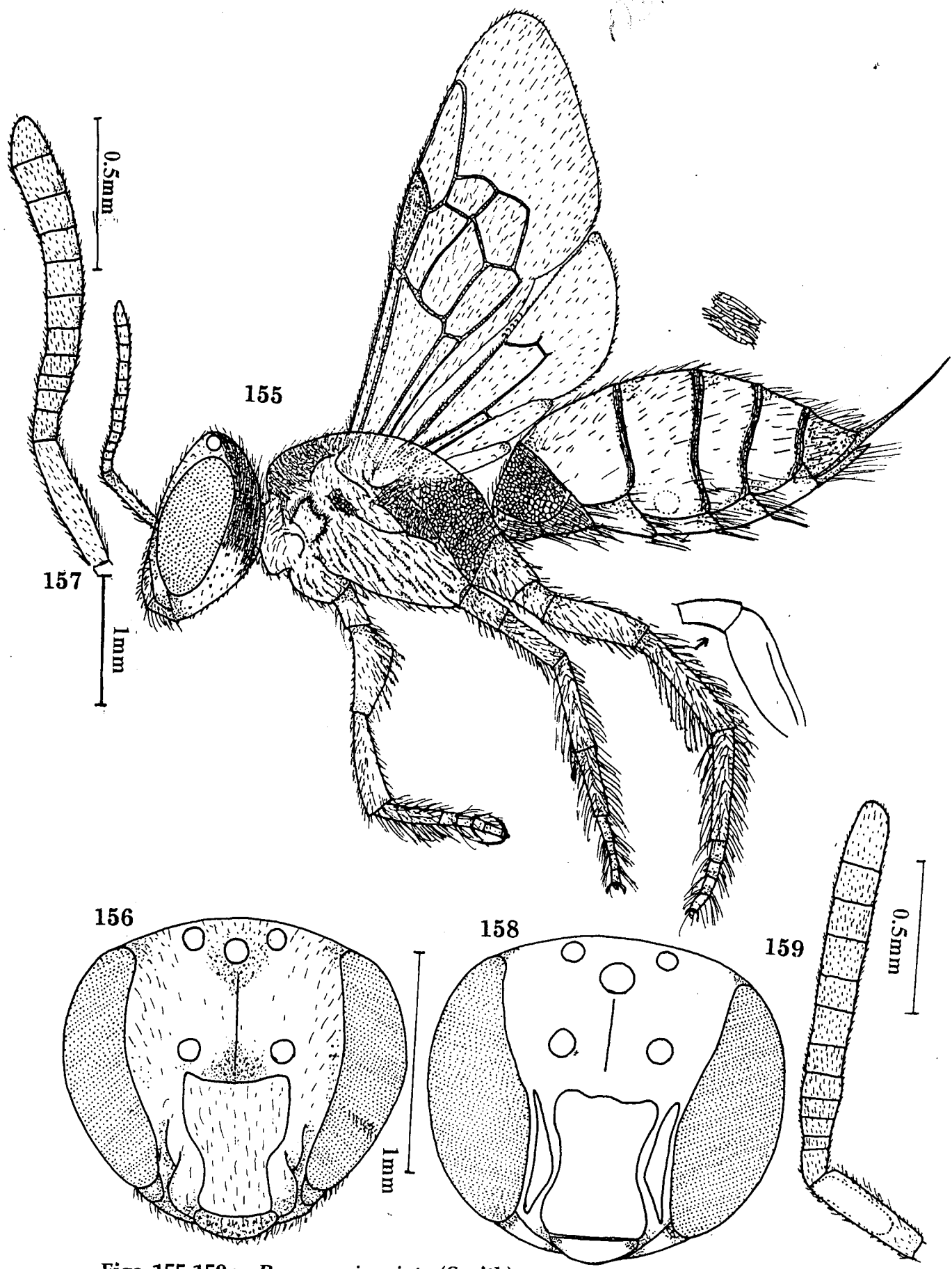
- 146. Body (Profile)
- 147. Head : Front view
- 148. Antenna



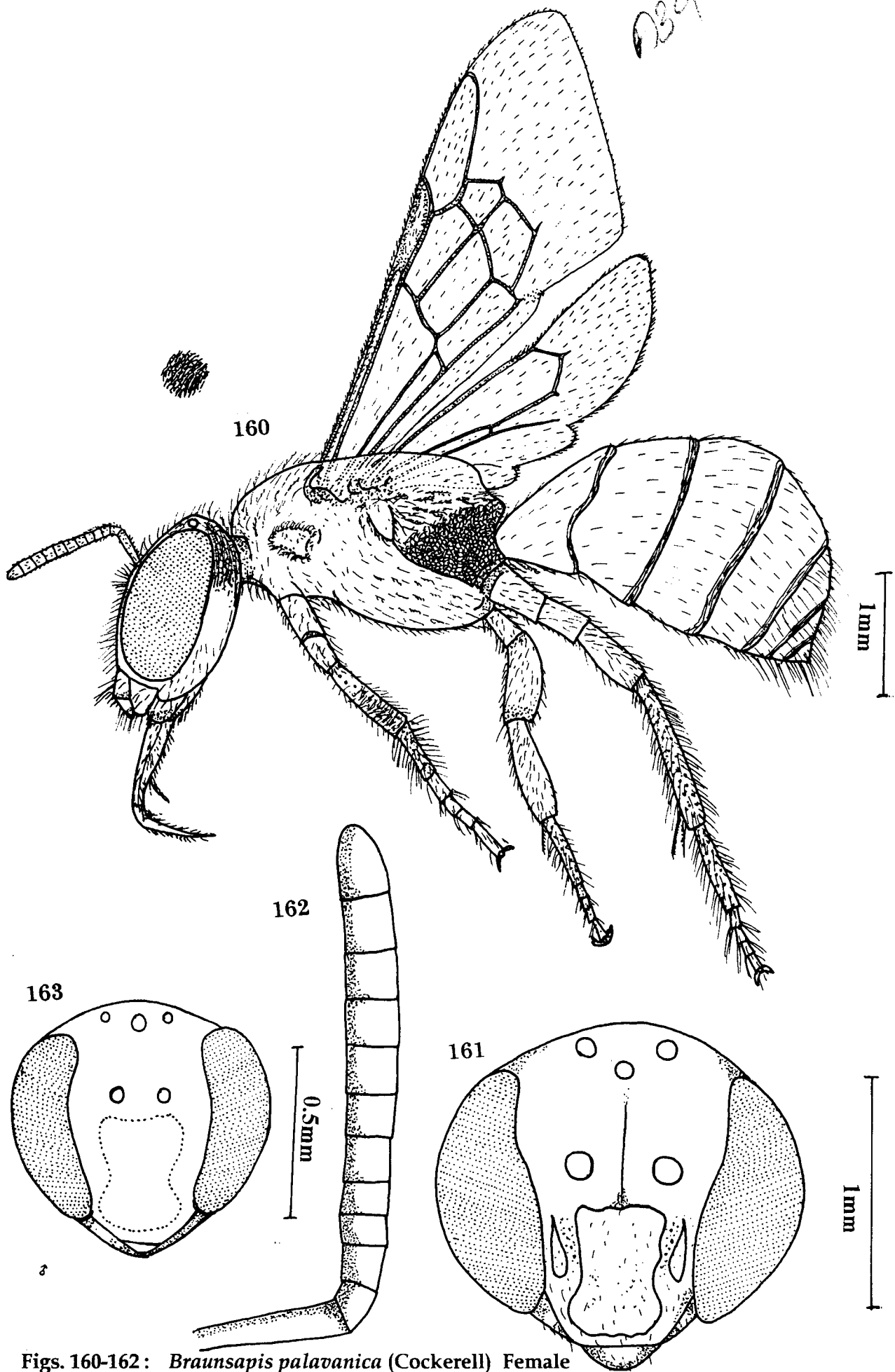
Figs. 149-151 : *Braunsapis malliki* Reyes Female
 149. Body (Profile)
 150. Head : Front view
 151. Antenna



Figs. 152-154: *Braunsapis micheneri* sp. nov. Female
 152. Body (Profile)
 153. Head : Front view
 154. Antenna

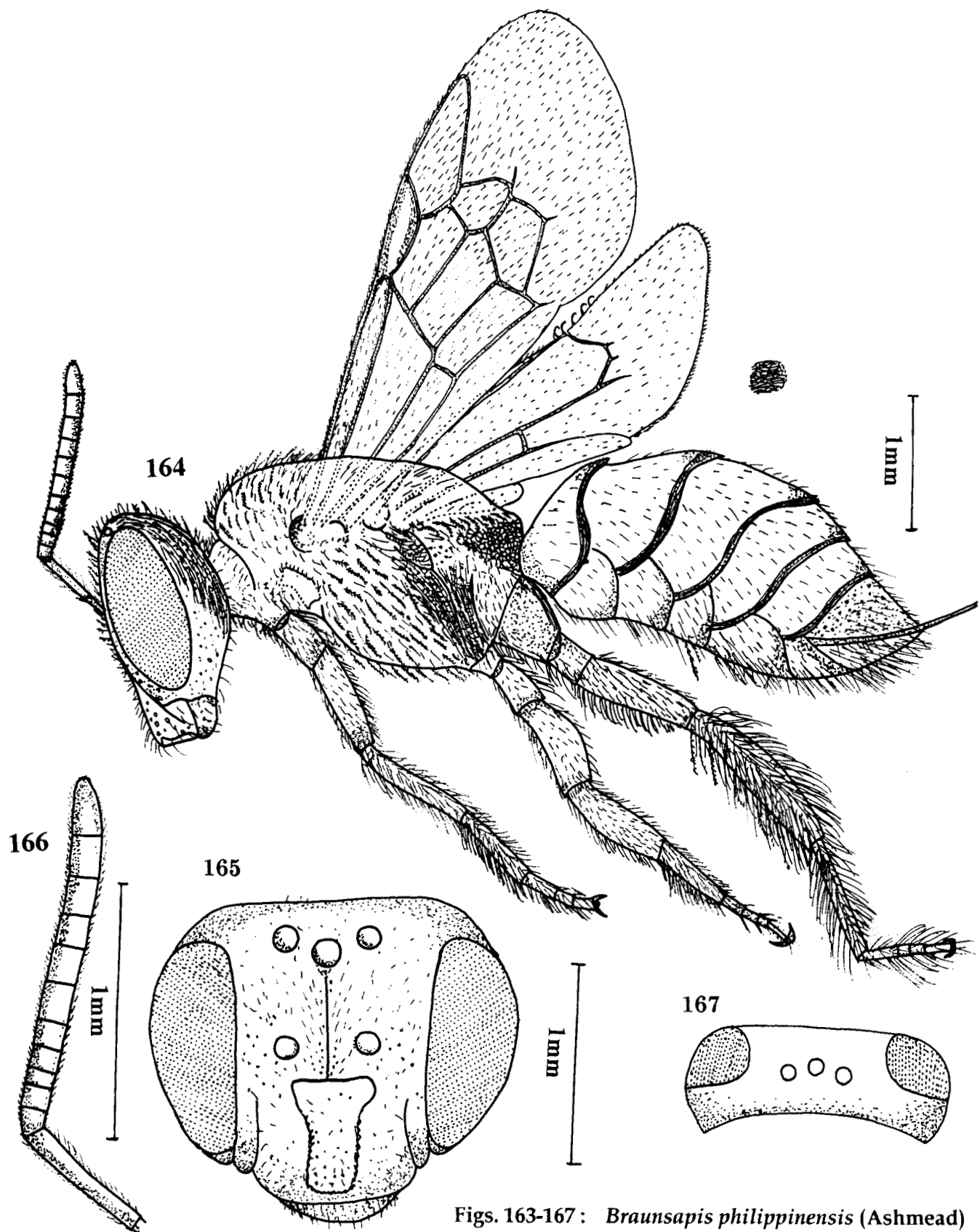


Figs. 155-159: *Braunsapis mixta* (Smith) Female
 155. Body (Profile)
 156. Head : Front view
 157. Antenna
 158. Head : Front view (Male)
 159. Antenna (Male)



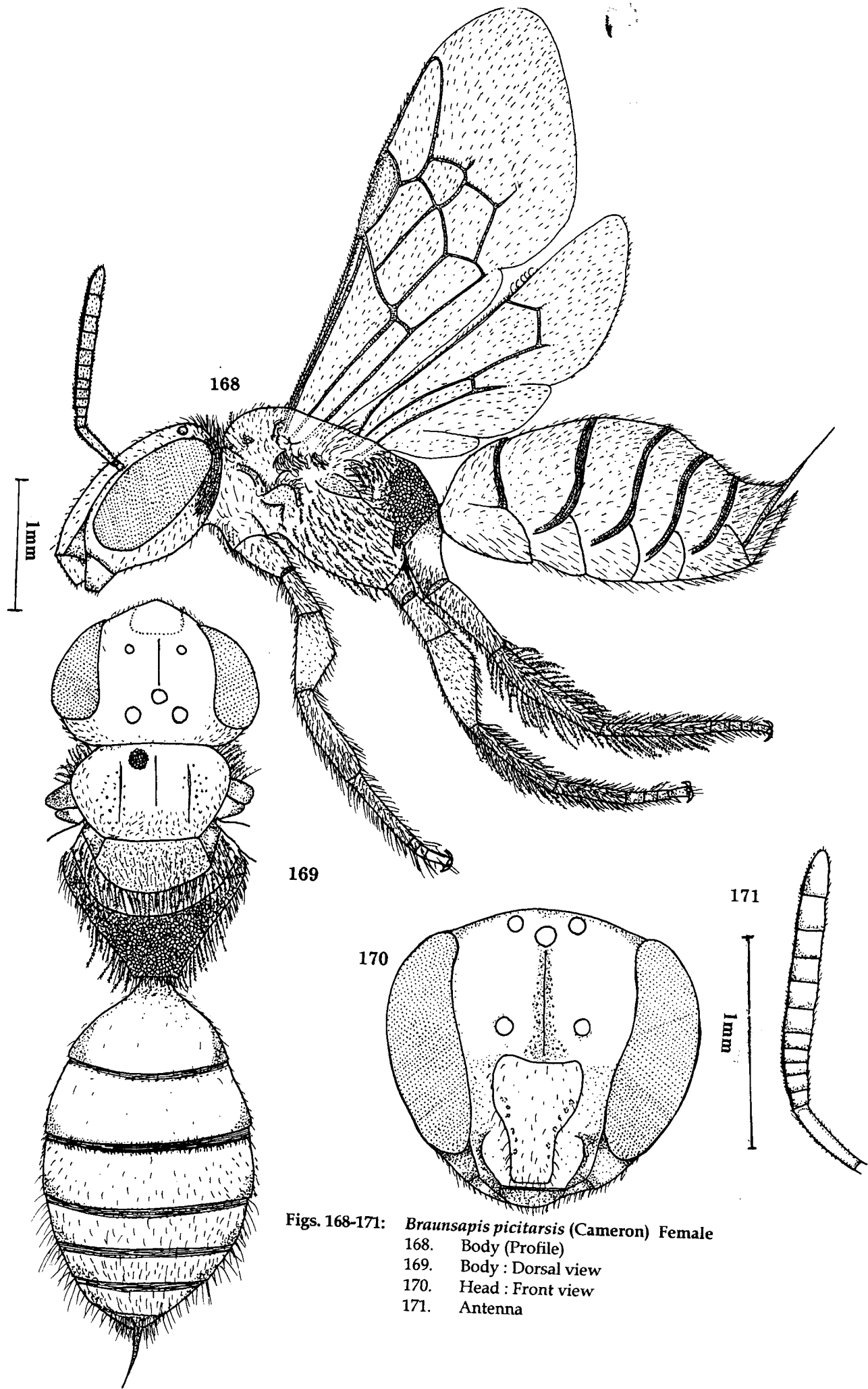
Figs. 160-162: *Braunsapis palavanica* (Cockerell) Female
 160. Body (Profile) Fig. 163: *Braunsapis palavanica* (Cockerell) Male
 161. Head : Front view Head : Front view
 162. Antenna

82



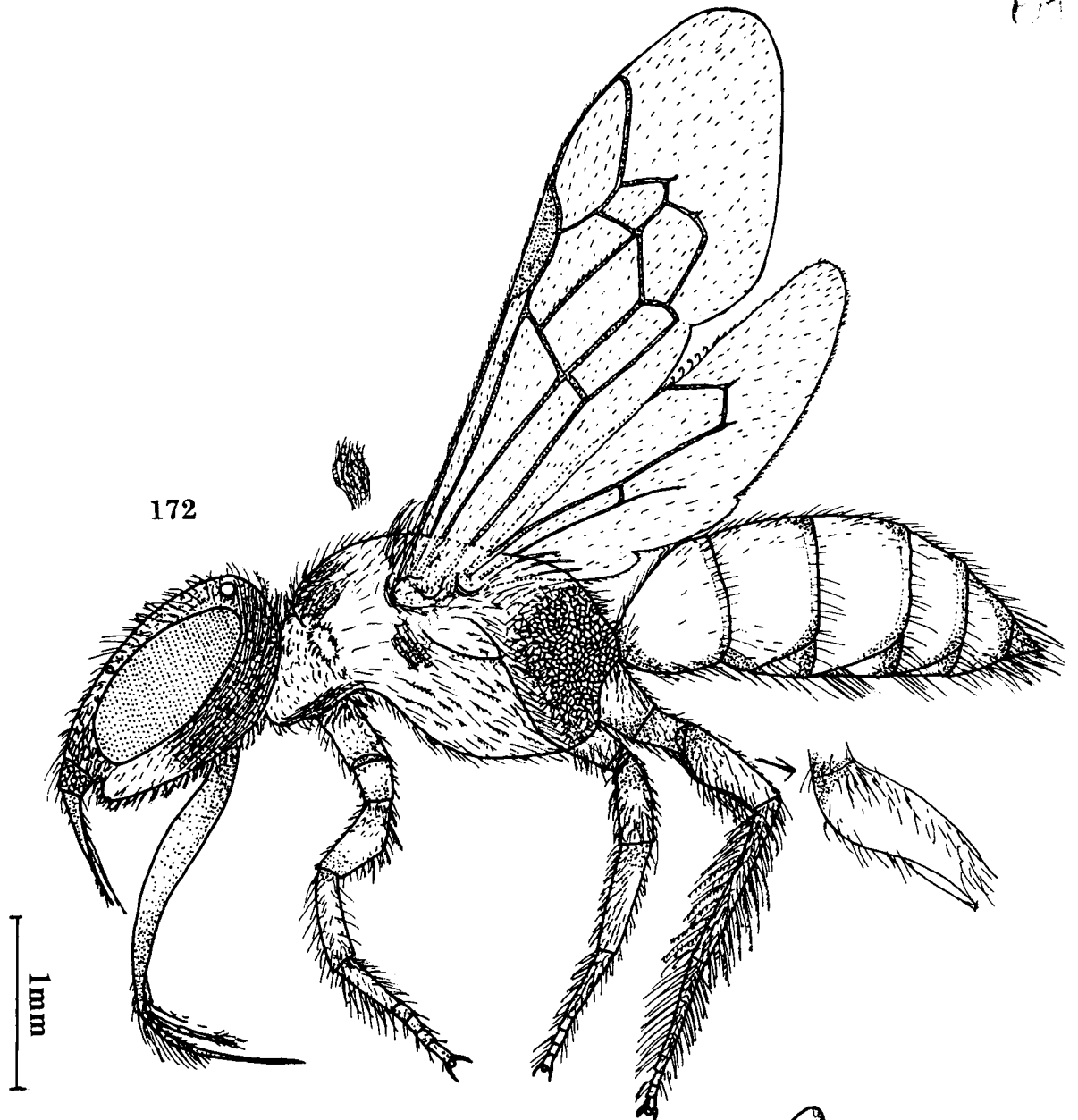
Figs. 163-167: *Braunsapis philippinensis* (Ashmead)

- 164. Body (Profile)
- 165. Head : Front view
- 166. Antenna
- 167. Head (Dorsal view)



Figs. 168-171: *Braunsapis picitarsis* (Cameron) Female
 168. Body (Profile)
 169. Body : Dorsal view
 170. Head : Front view
 171. Antenna

672



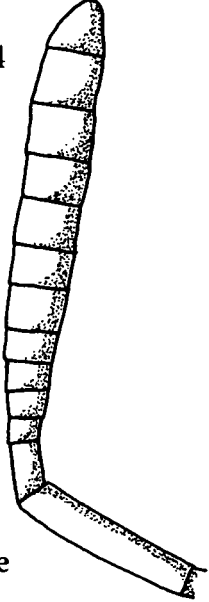
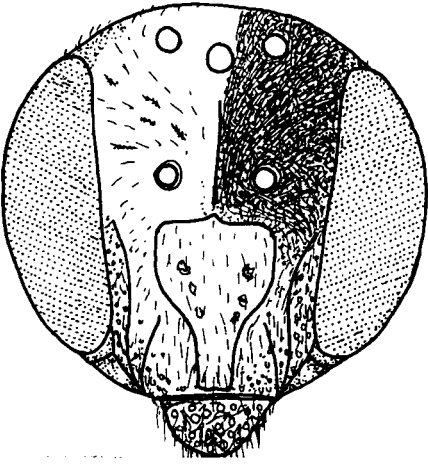
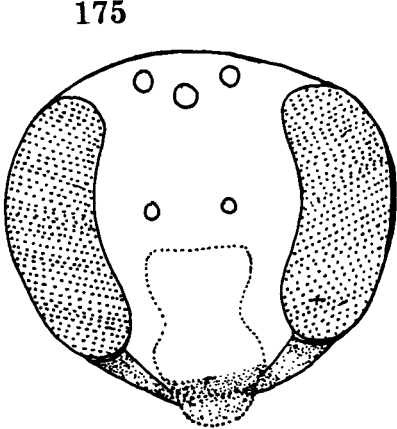
172

1mm

173

174

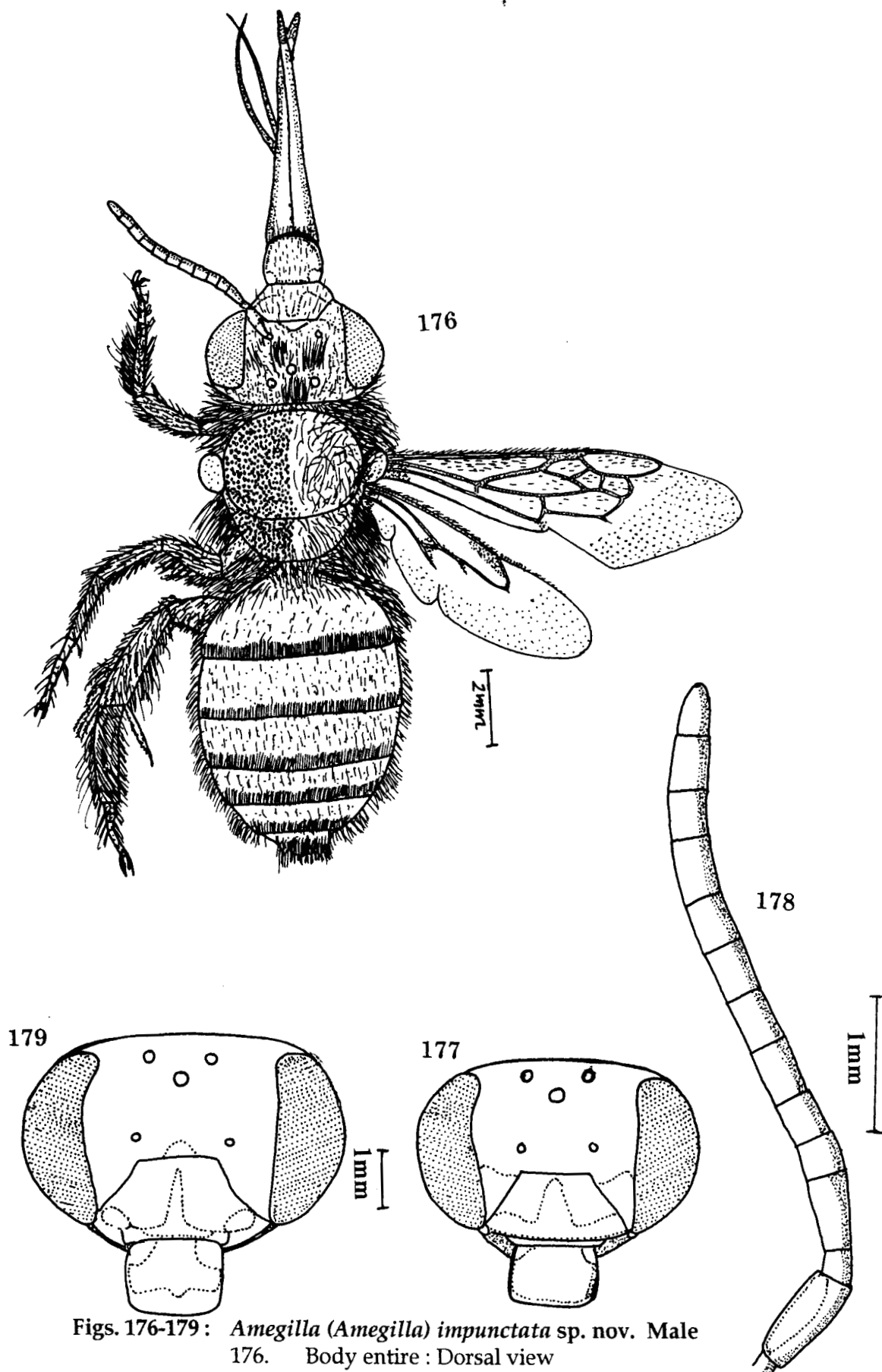
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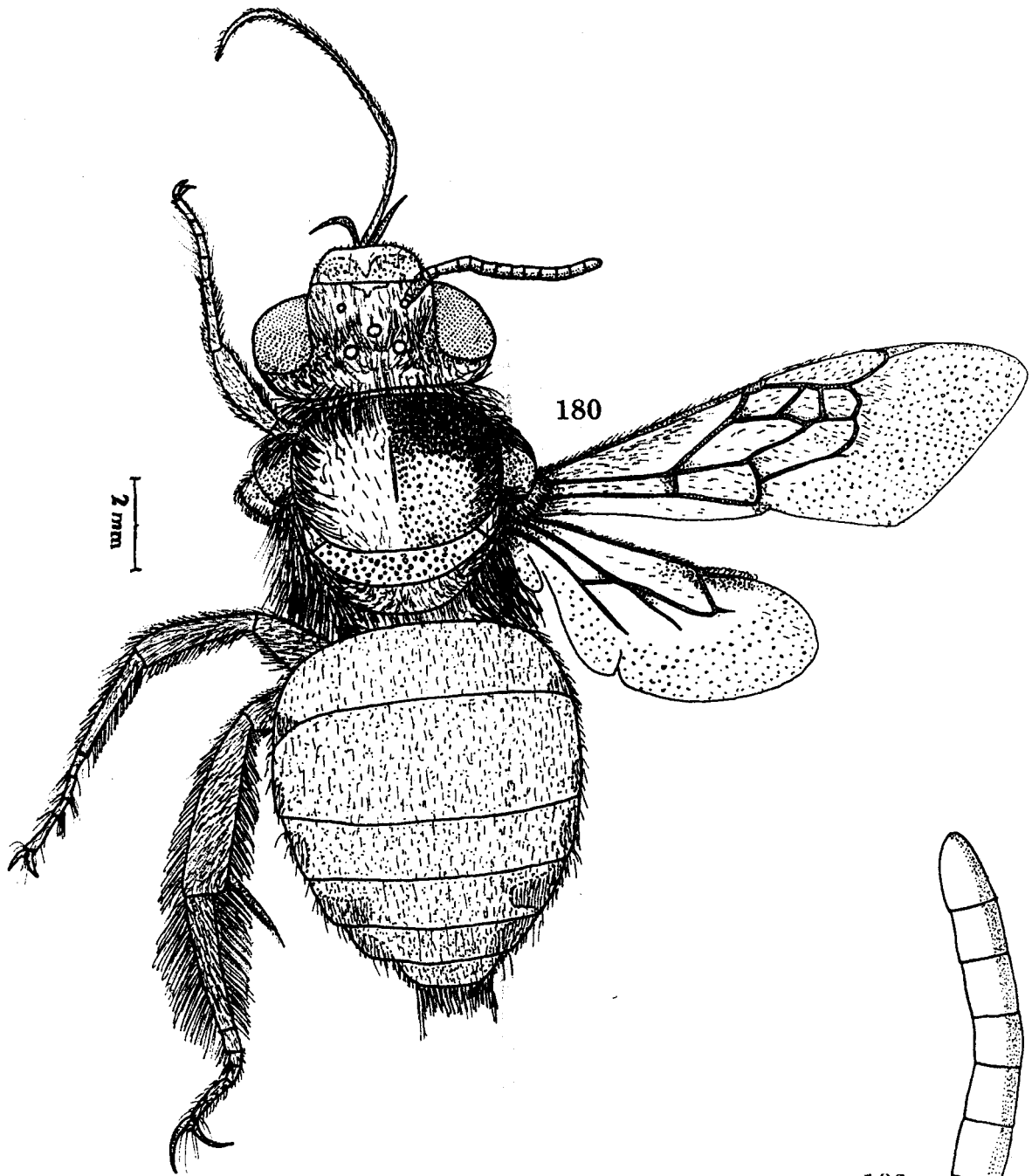
0.5mm

1mm

Figs. 172-175 : *Braunsapis puangensis* (Cockerell) Female
 172. Body (Profile)
 173. Head : Front view
 174. Antenna
 175. Head : Front view (Male)

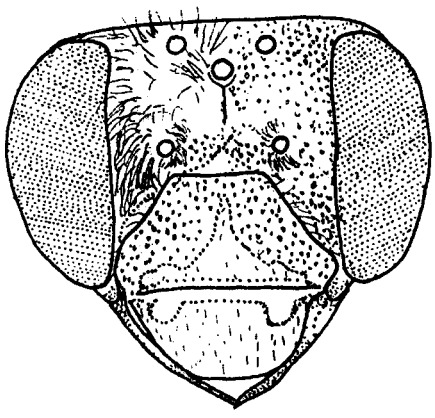


Figs. 176-179: *Amegilla (Amegilla) impunctata* sp. nov. Male
 176. Body entire : Dorsal view
 177. Head : Front view
 178. Antenna
 179. Head : Front view (Female)



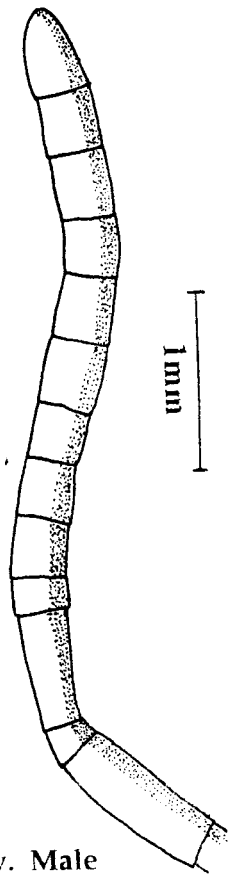
180

2 mm



181

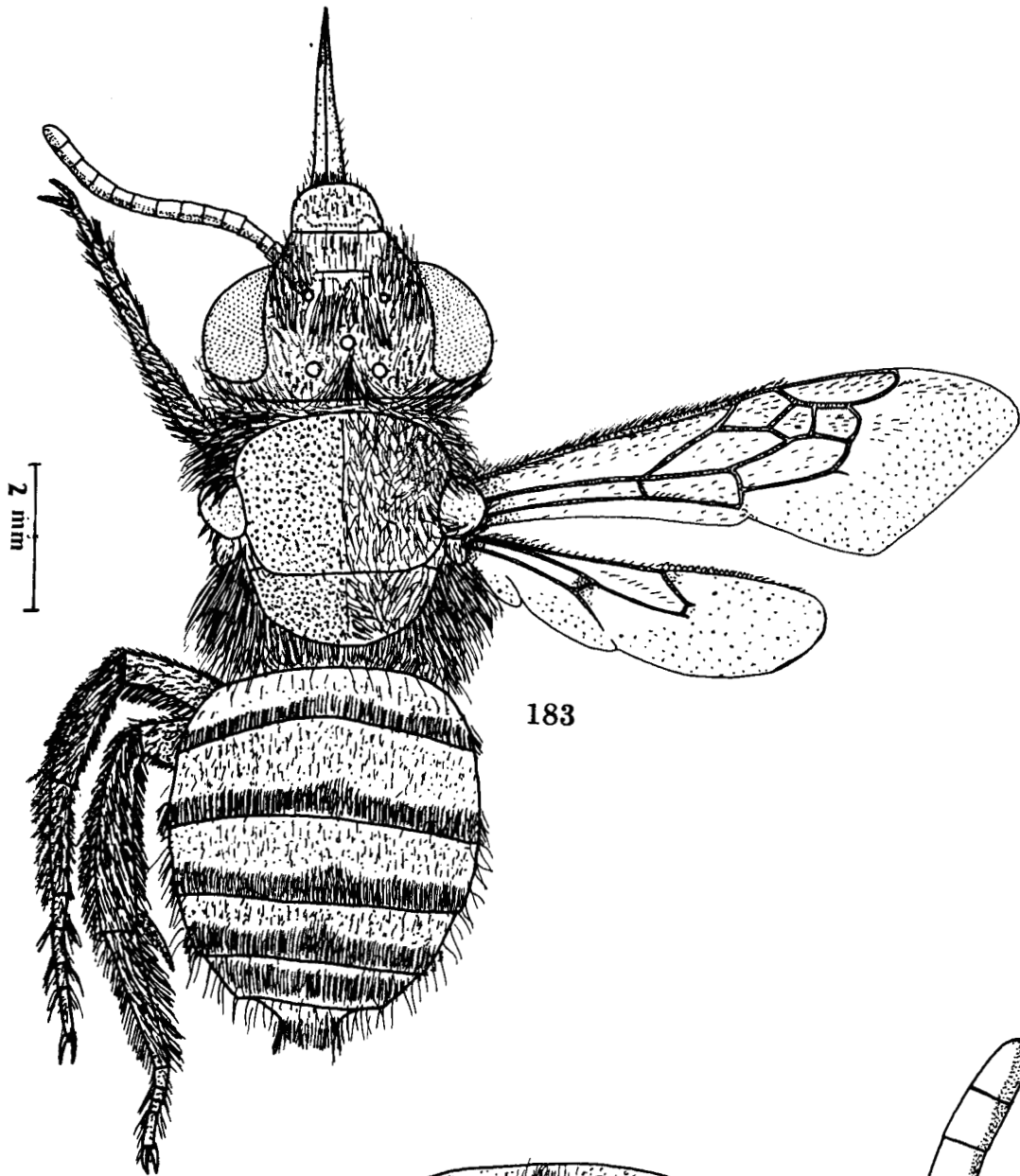
2 mm



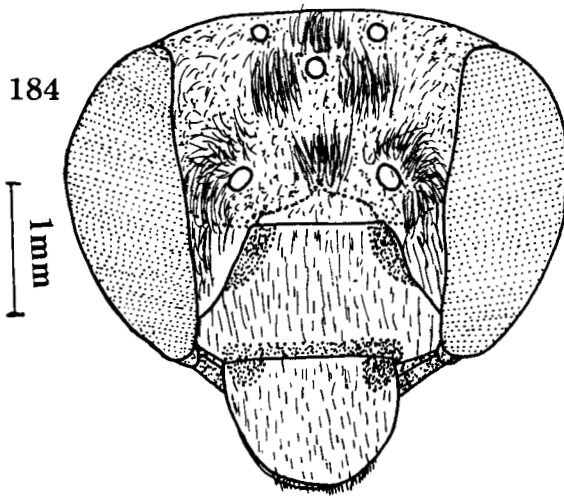
182

1 mm

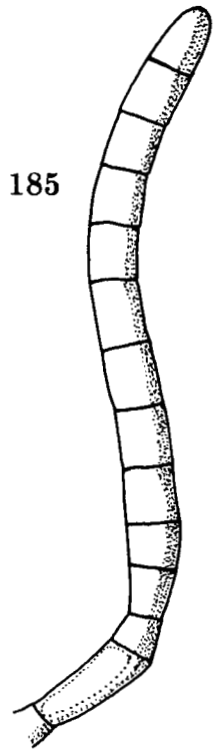
Figs. 180-182: *Amegilla (Dizonamegilla) interupta* sp. nov. Male
 180. Body entire: Dorsal view
 181. Head: Front view
 182. Antenna



183

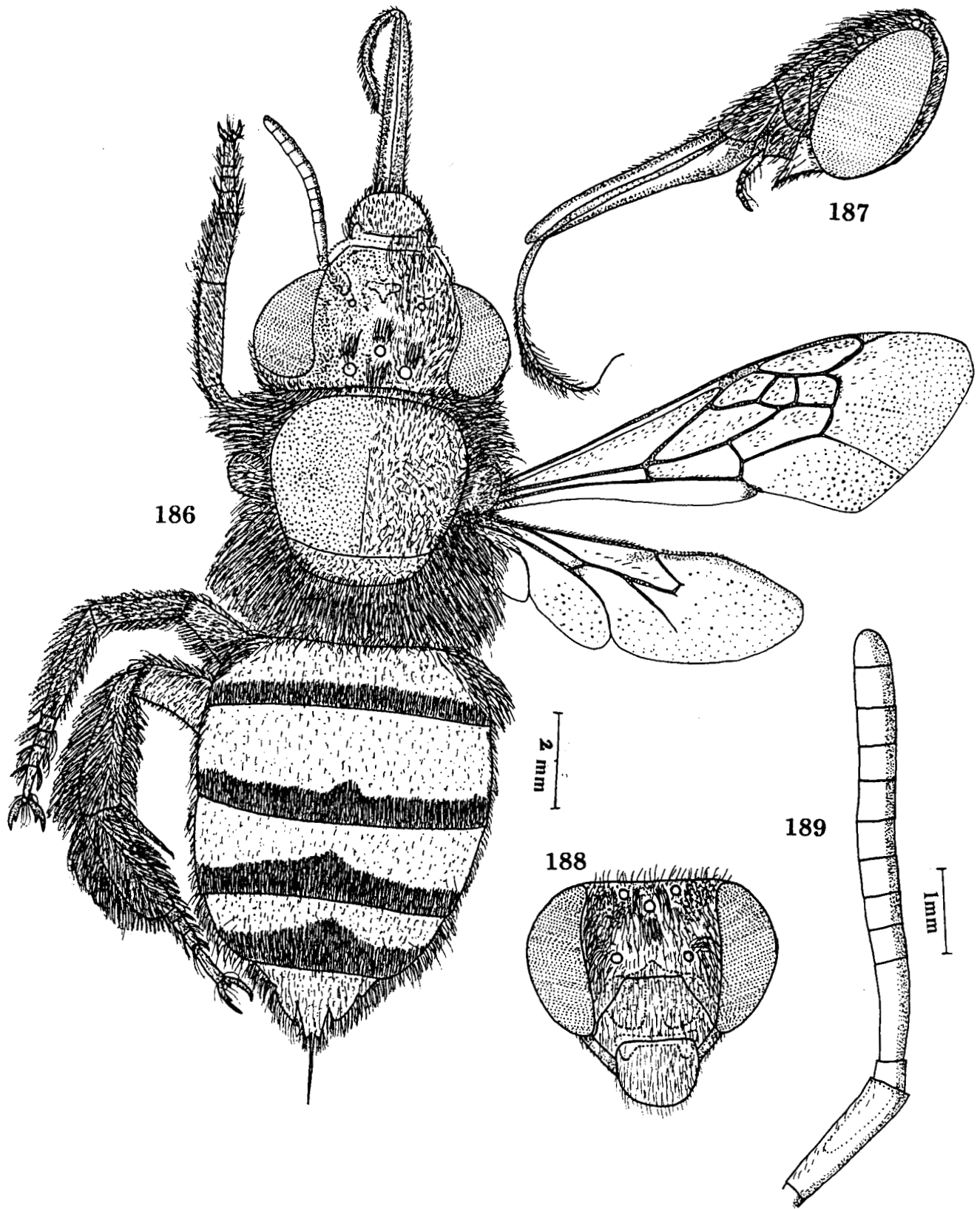


184



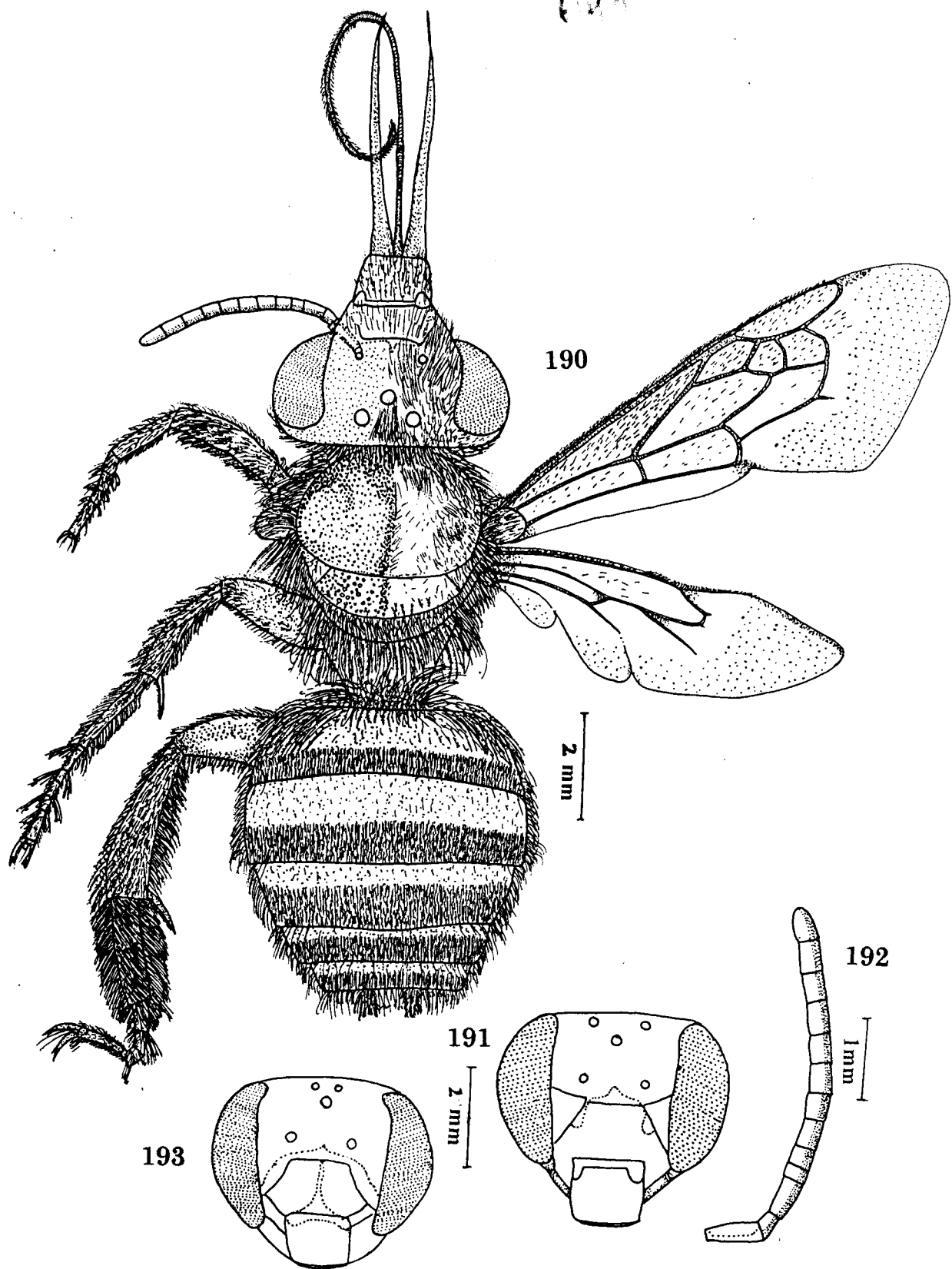
185

Figs. 183-185 : *Amegilla (Micramegilla)* sp. I Male
 183. Body entire (Dorsal view)
 184. Head : Front view
 185. Antenna



Figs. 186-189: *Amegilla (Zonamegilla) keralensis* sp. nov. Female

- 186. Body entire (Dorsal view)
- 187. Head (Profile)
- 188. Head : Front view
- 189. Antenna



Figs. 190-192: *Amegilla (Zonamegilla) malabarensis* sp. nov. Female

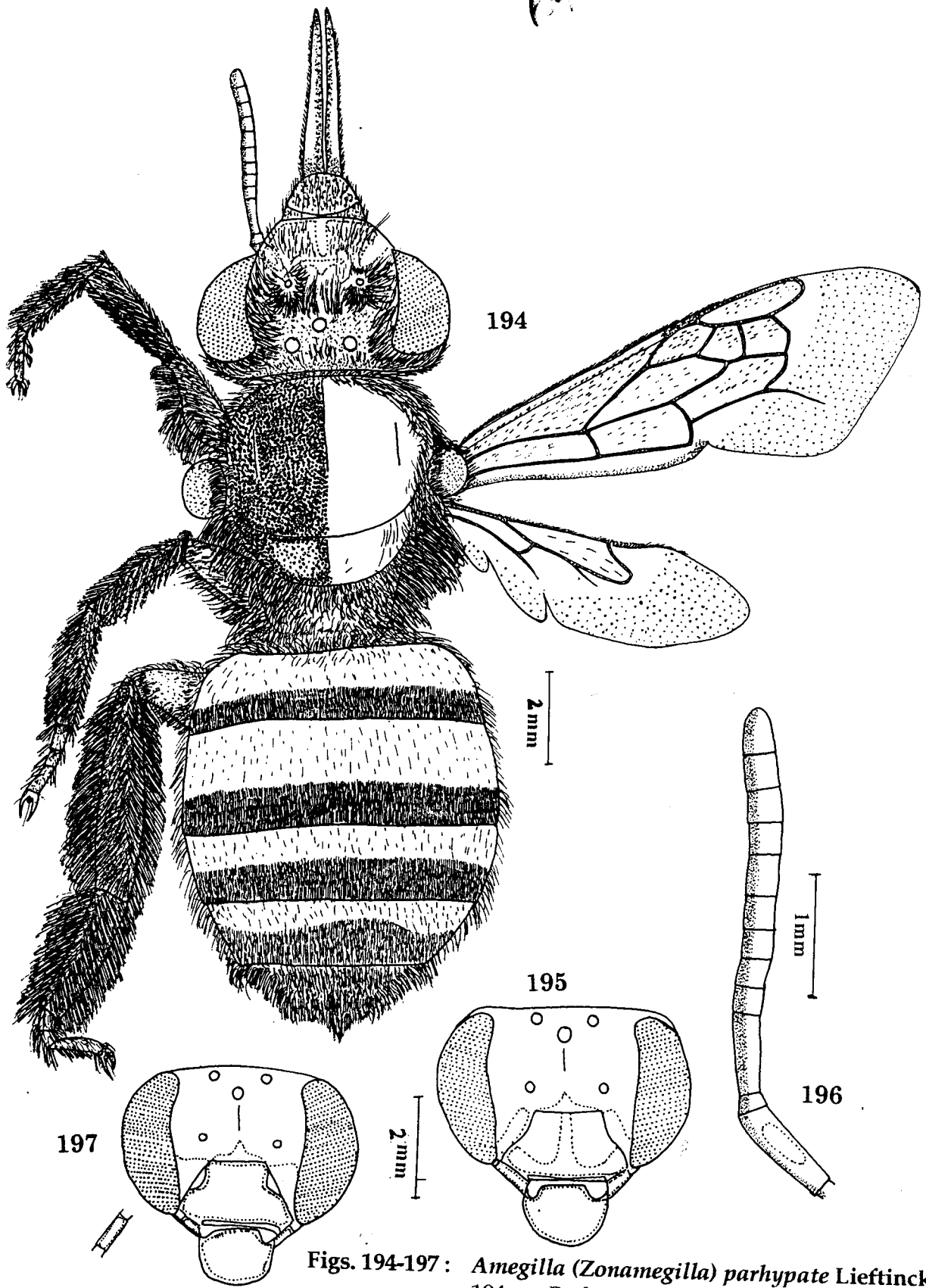
190. Body entire (Dorsal view)

191. Head: Front view

192. Antenna

Fig. 193: *Amegilla (Zonamegilla) zonata* Linnaeus Female
Head: Front view

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Figs. 194-197 : *Amegilla (Zonamegilla) parhypate* Lieftinck Female
 194. Body entire : Dorsal view
 195. Head : Front view
 196. Antenna
 197. Head : Front view (Male)

120

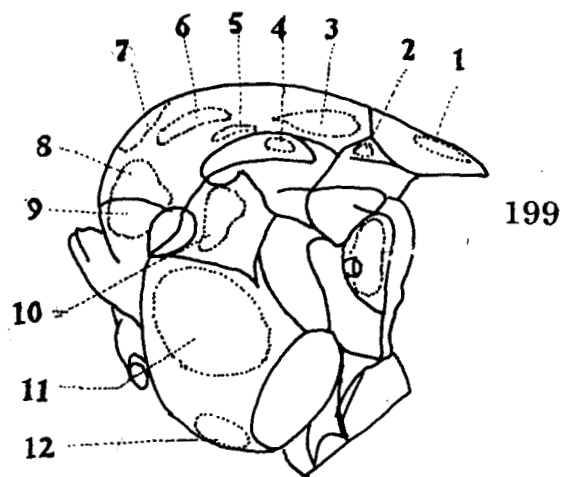
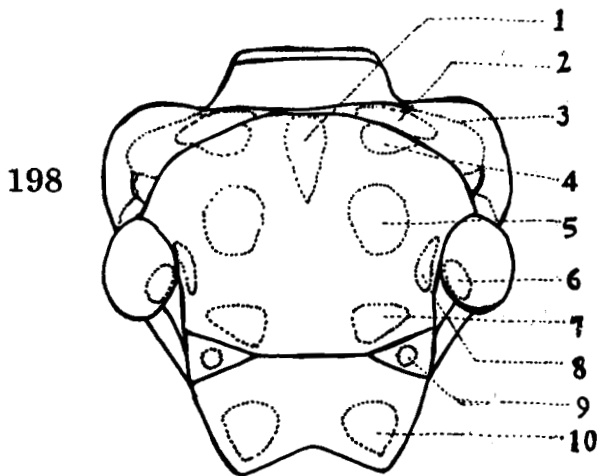


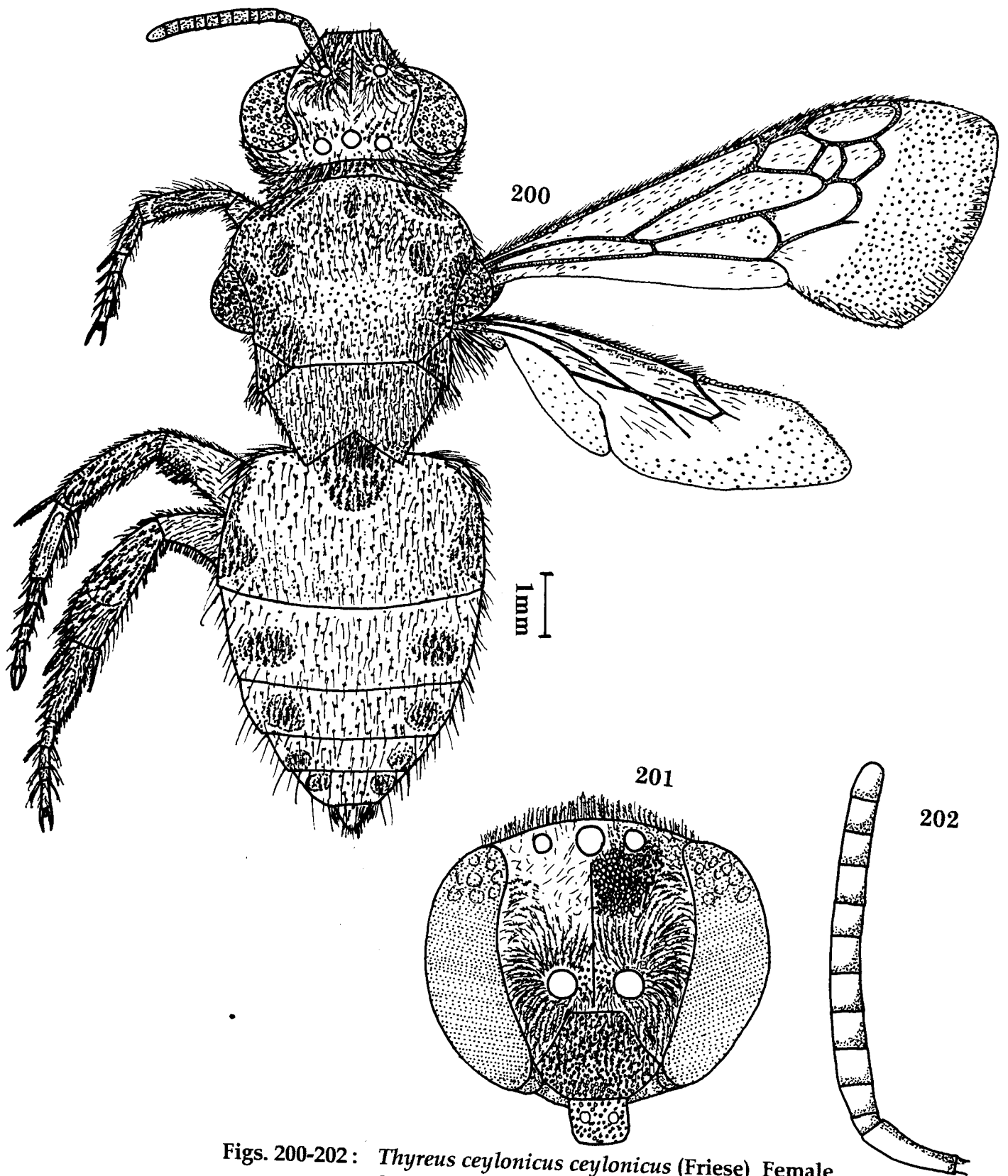
Fig. 198-199: Diagrams of thoracic colour pattern of *Thyreus nitidulus* (F) dorsal and lateral view

Fig. 198. Dorsal view

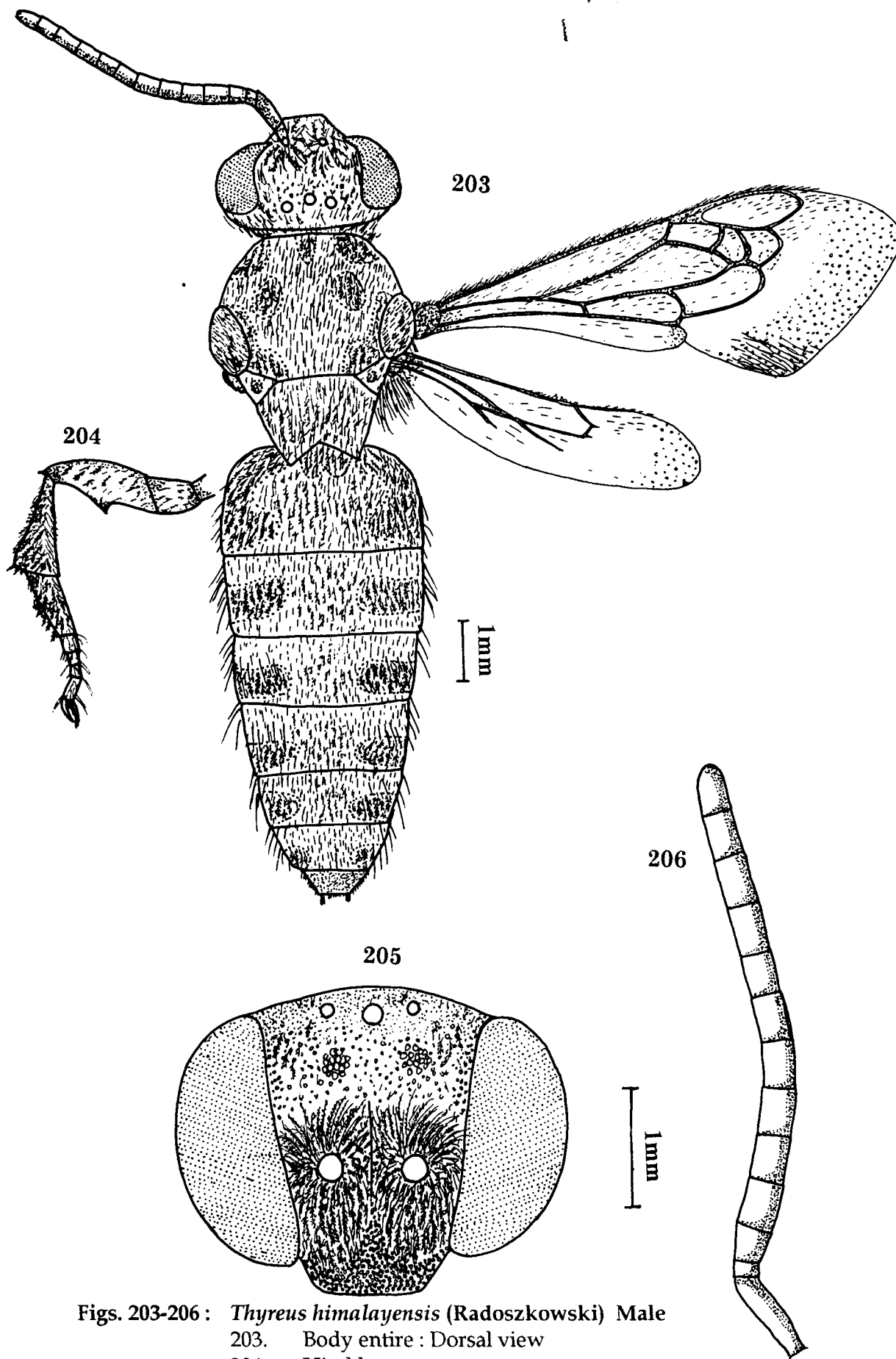
- 1. ms - Mesoscutal
- 2. lpn - Lateral pronotal
- 3. deps - Dorsal episternal
- 4. als - Antero-lateral
- 5. mls - Mediolateral
- 6. t - Tegular
- 7. pls - Postero-lateral
- 8. plsa - Postero-lateral (mesoscutal)
- 9. ps - Parascutellar
- 10. s - Scutellar

Fig. 199. Lateral view

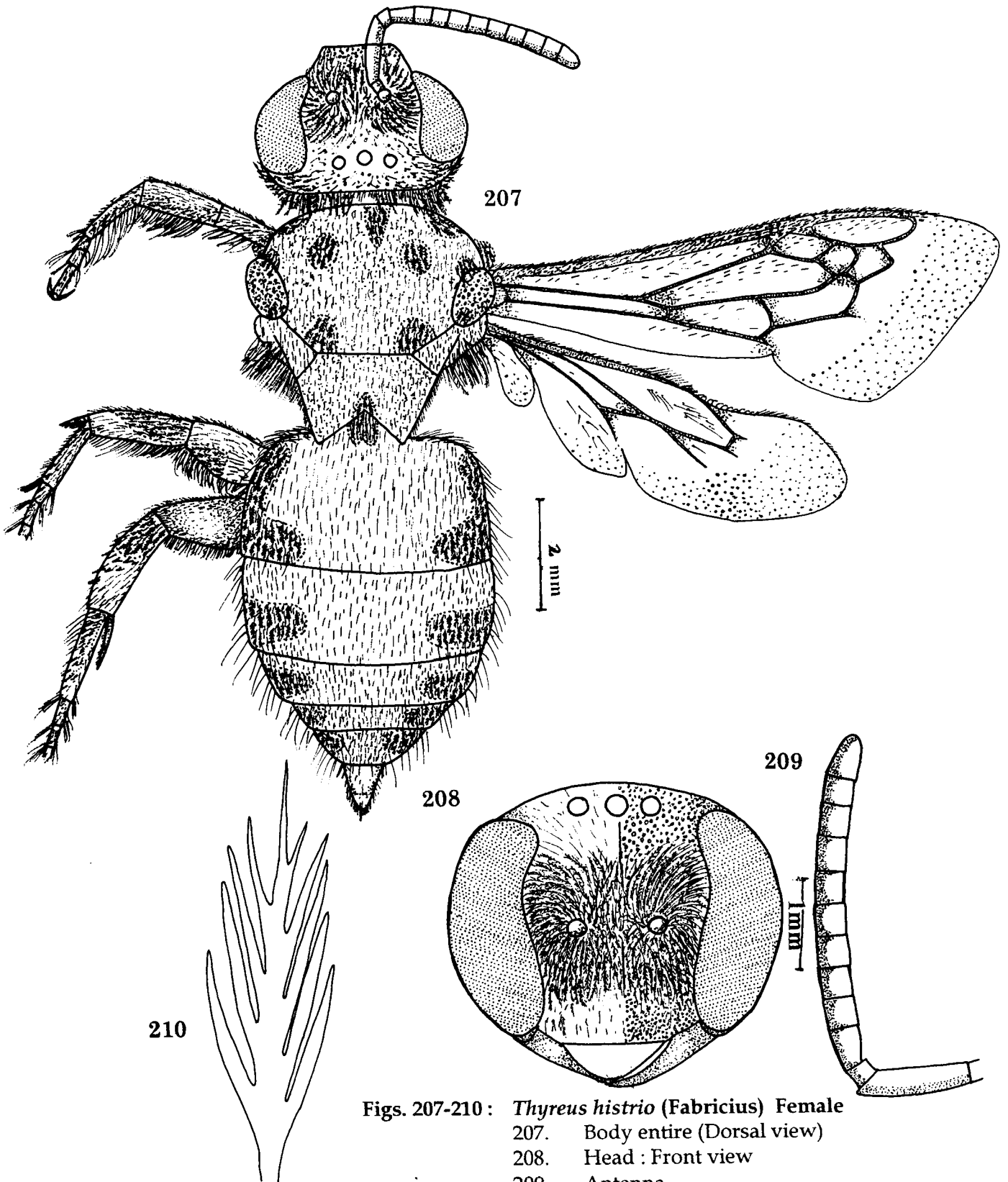
- 1. s - scutellar
- 2. ps - Parascutellar
- 3. pls - Postero-lateral
- 4. t - Tegular
- 5. plsa - Postero-lateral (Mesoscutal)
- 6. mls - Mediolateral
- 7. ms - Mesoscutal
- 8. als - Antero-lateral
- 9. lpn - Lateral pronotal
- 10. hypm - Hypo-epimeral
- 11. deps - Dorsal episternal
- 12. veps - Ventral episternal



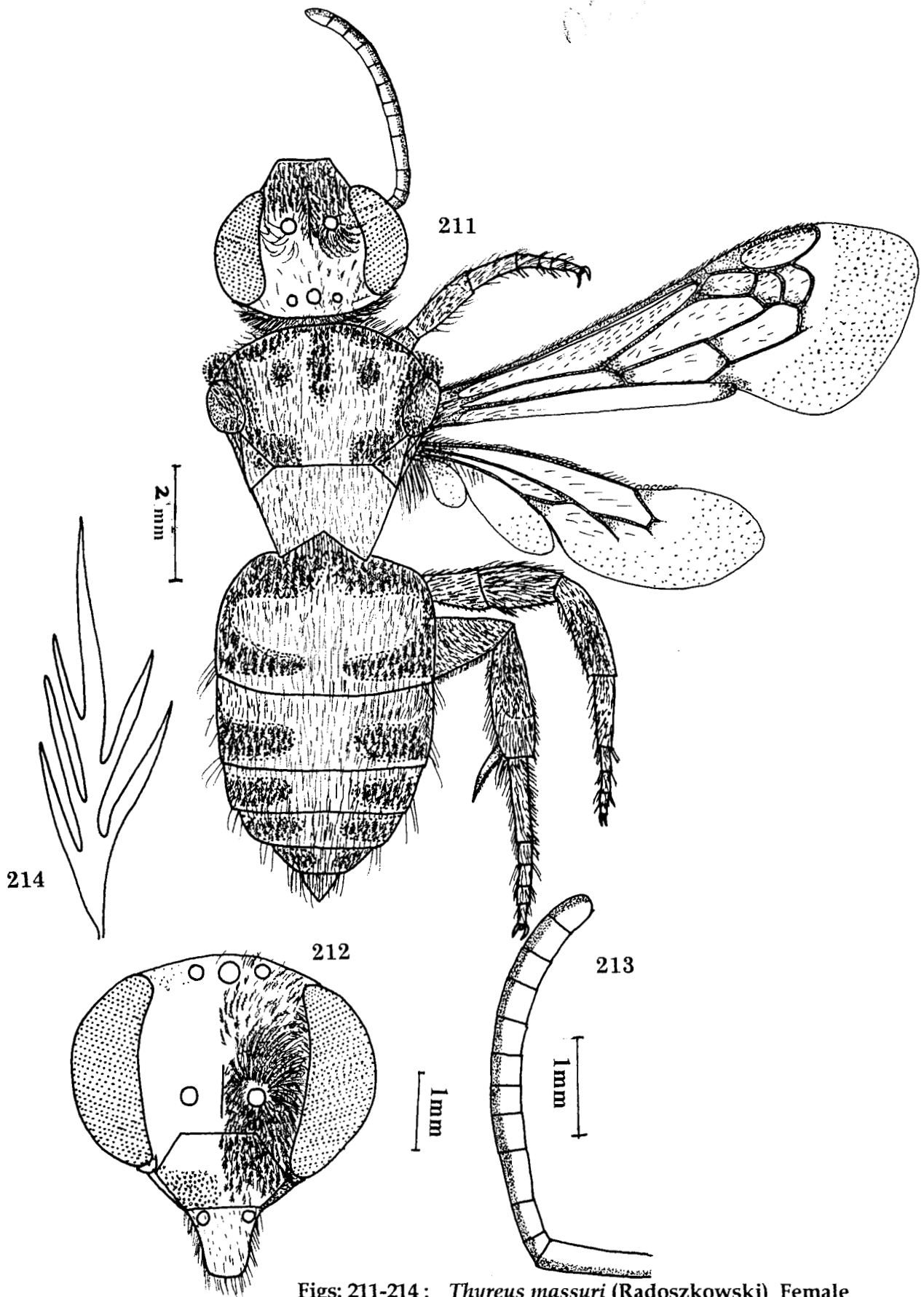
Figs. 200-202: *Thyreus ceylonicus ceylonicus* (Fries) Female
200. Body entire : Dorsal view
201. Head : Front view
202. Antenna



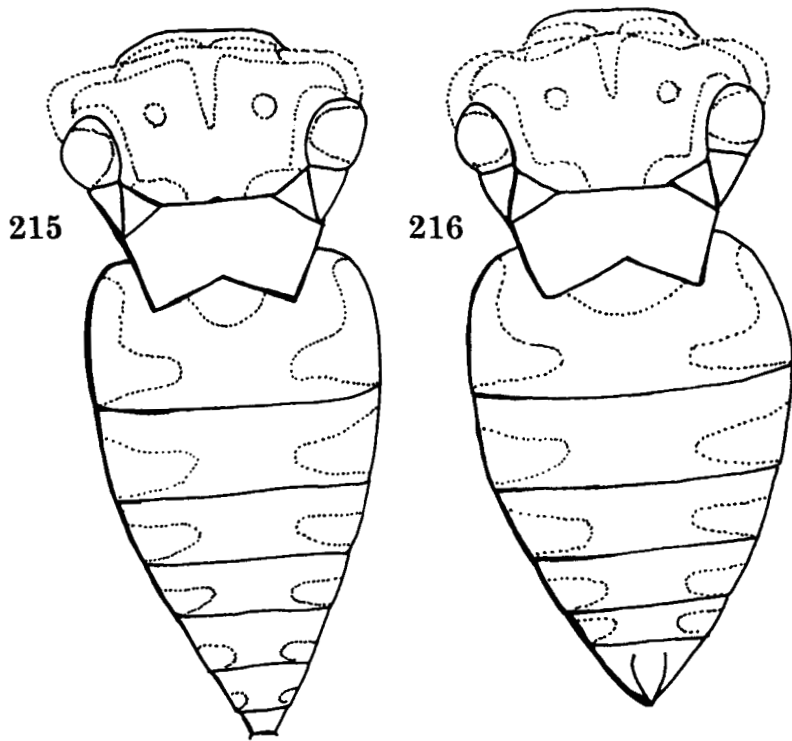
Figs. 203-206 : *Thyreus himalayensis* (Radoszkowski) Male
 203. Body entire : Dorsal view
 204. Hind leg
 205. Head : Front view
 206. Antenna



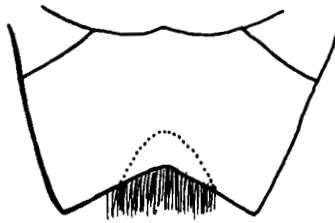
Figs. 207-210 : *Thyreus histrio* (Fabricius) Female
 207. Body entire (Dorsal view)
 208. Head : Front view
 209. Antenna
 210. Single body hair



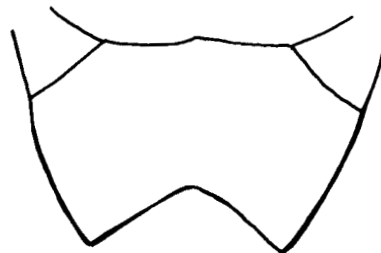
Figs: 211-214: *Thyreus massuri* (Radoszkowski) Female
 211. Body entire (Dorsal view)
 212. Head : Front view
 213. Antenna 214. Single body hair



217



218



219



220



Figs. 215-218 : *Thyreus medius* (Meyer)

215. Body : Dorsal view (Male)

216. Body : Dorsal view (Female)

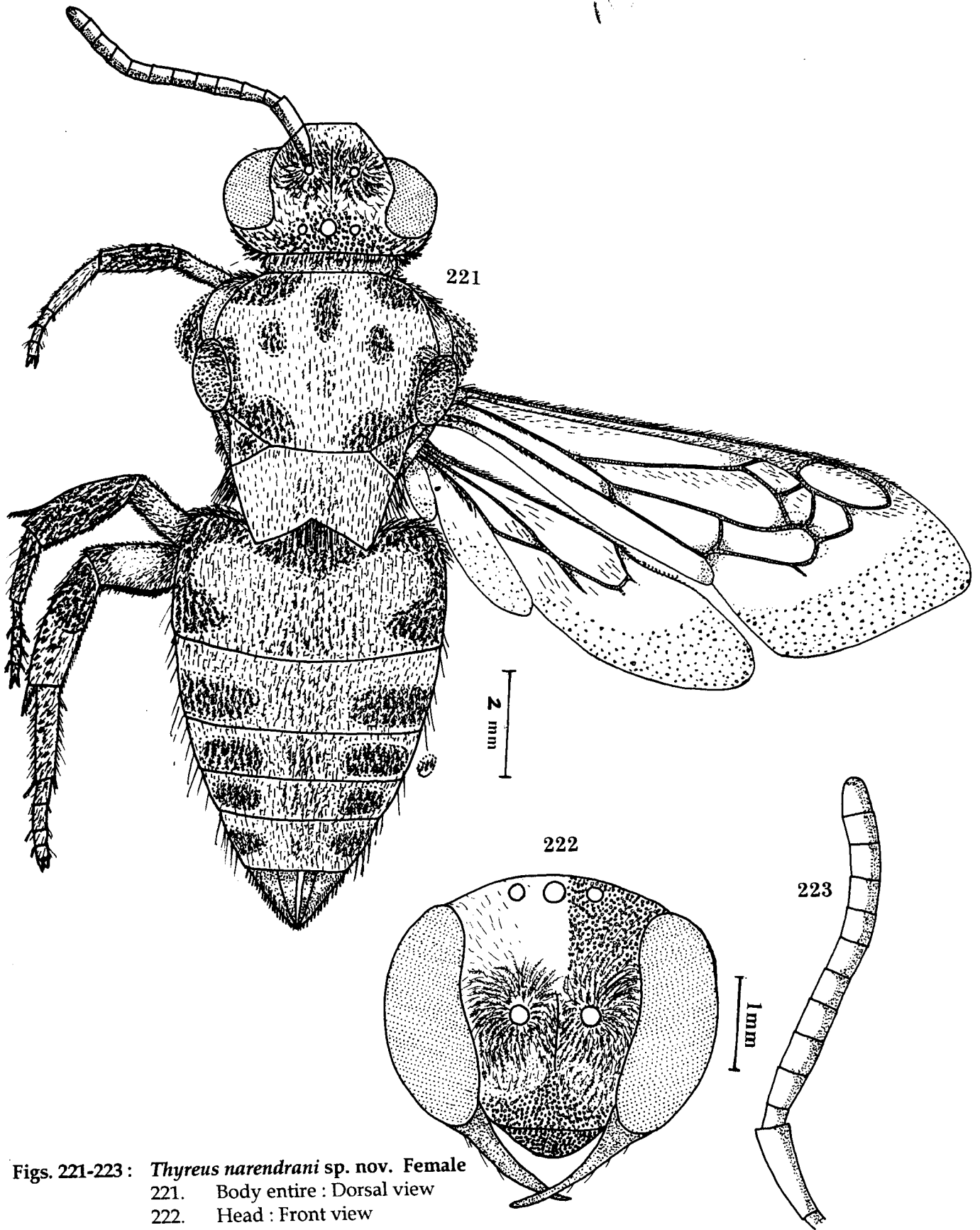
217. Scutellum (Male)

218. Scutellum (Female)

Figs. 219-220 : *Thyreus ramosellus* (Cockerell)

219. Gastral tergite

220. Interoventral view of male hind femur

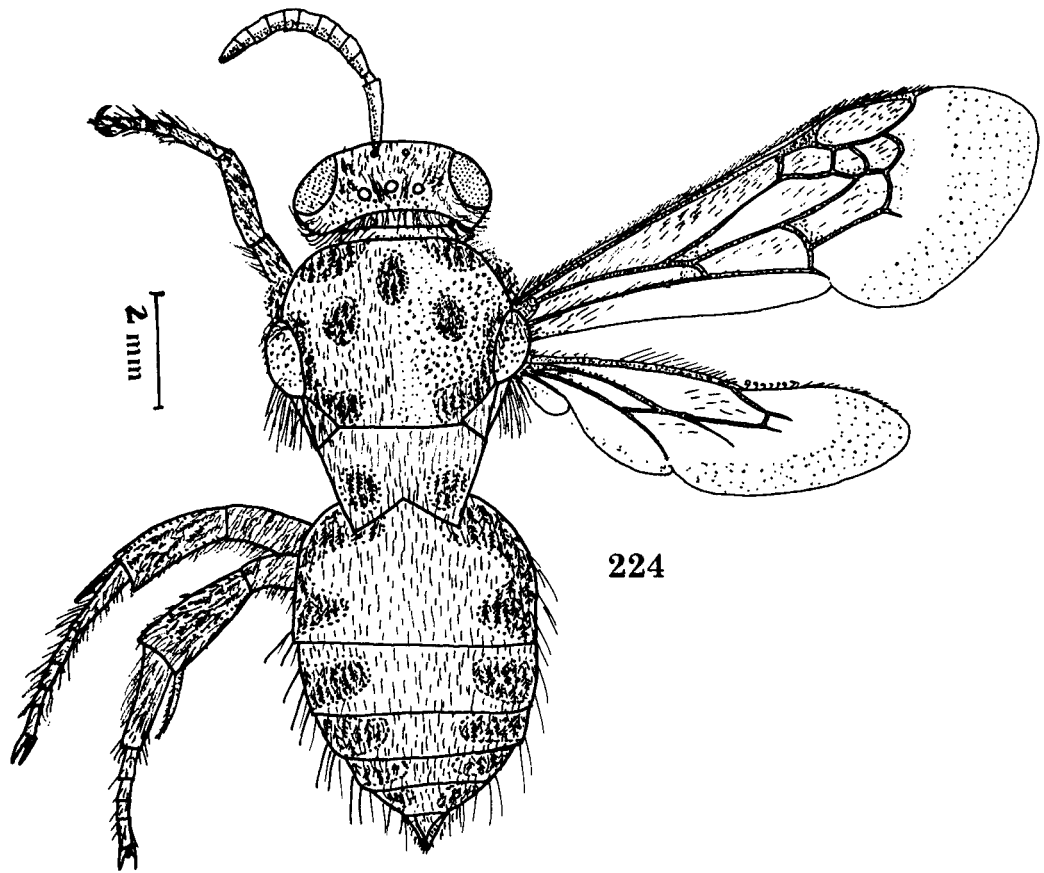


Figs. 221-223: *Thyreus narendrani* sp. nov. Female

221. Body entire : Dorsal view

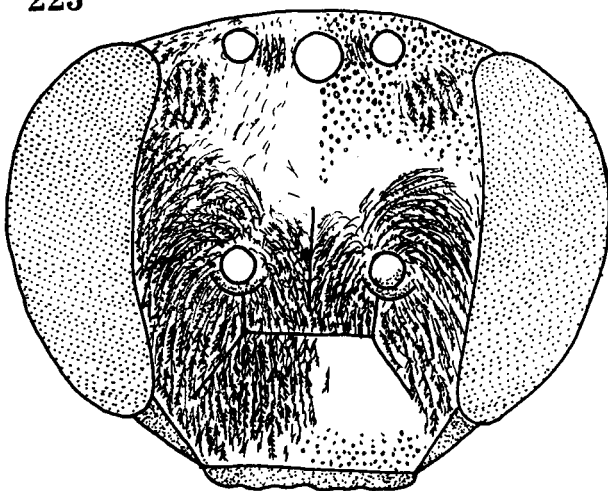
222. Head : Front view

223. Antenna



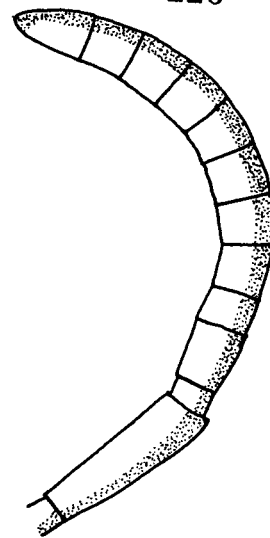
224

225



1 mm

226

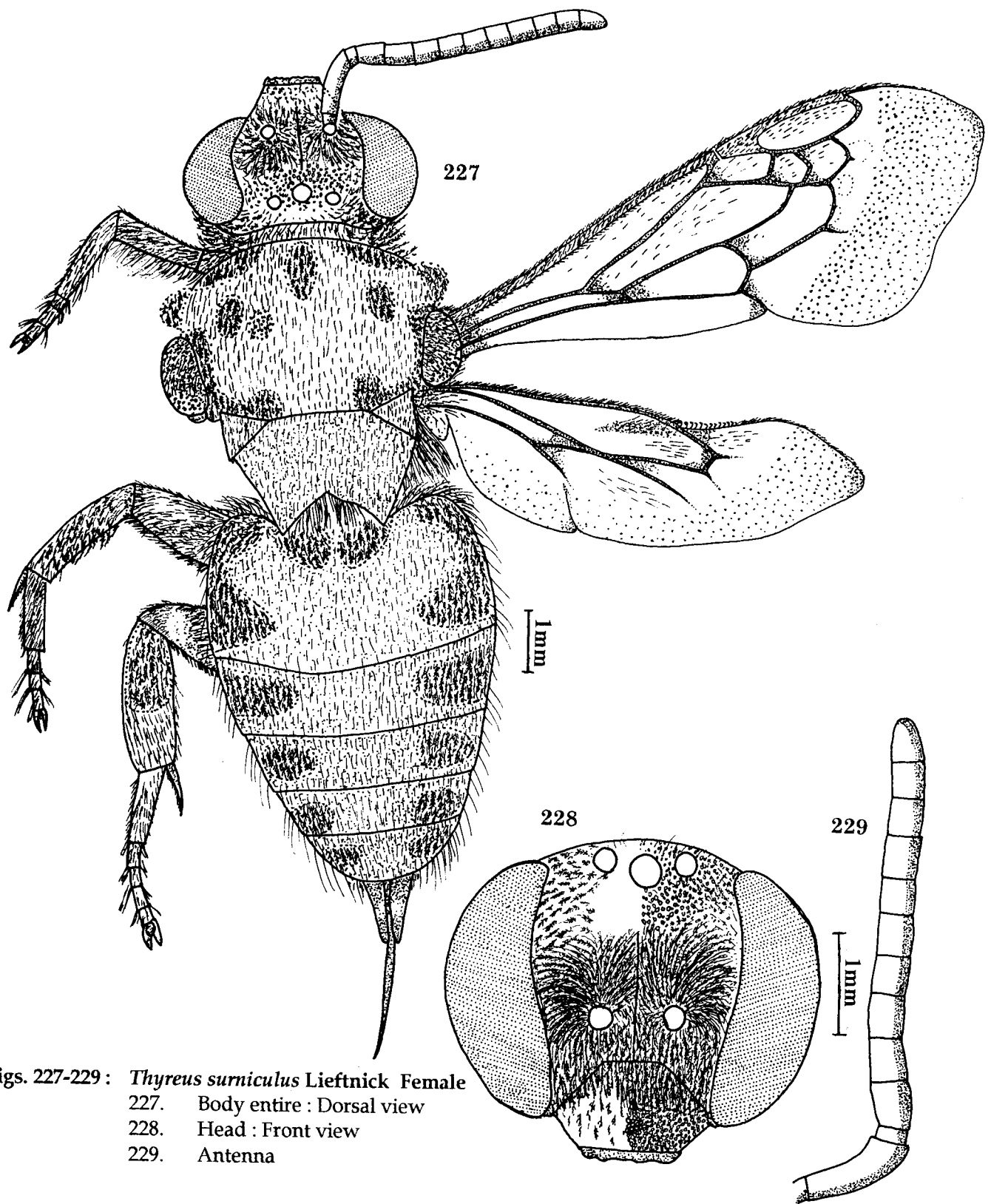


Figs. 224-226: *Thyreus smithii* Dalla Torre Female

224. Body entire : Dorsal view

225. Head : Front view

226. Antenna

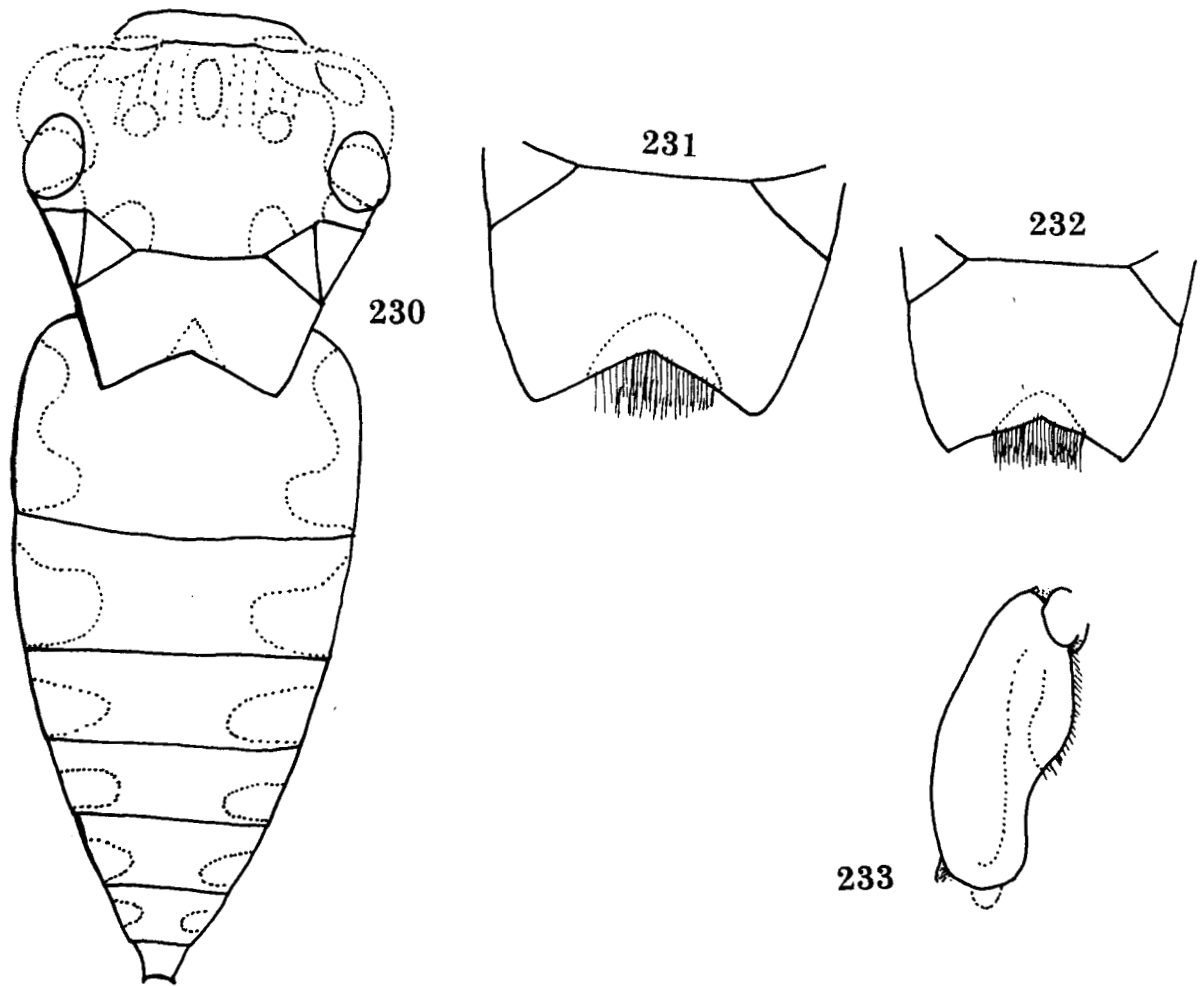


Figs. 227-229 : *Thyreus surniculus* Lieftnick Female

227. Body entire : Dorsal view

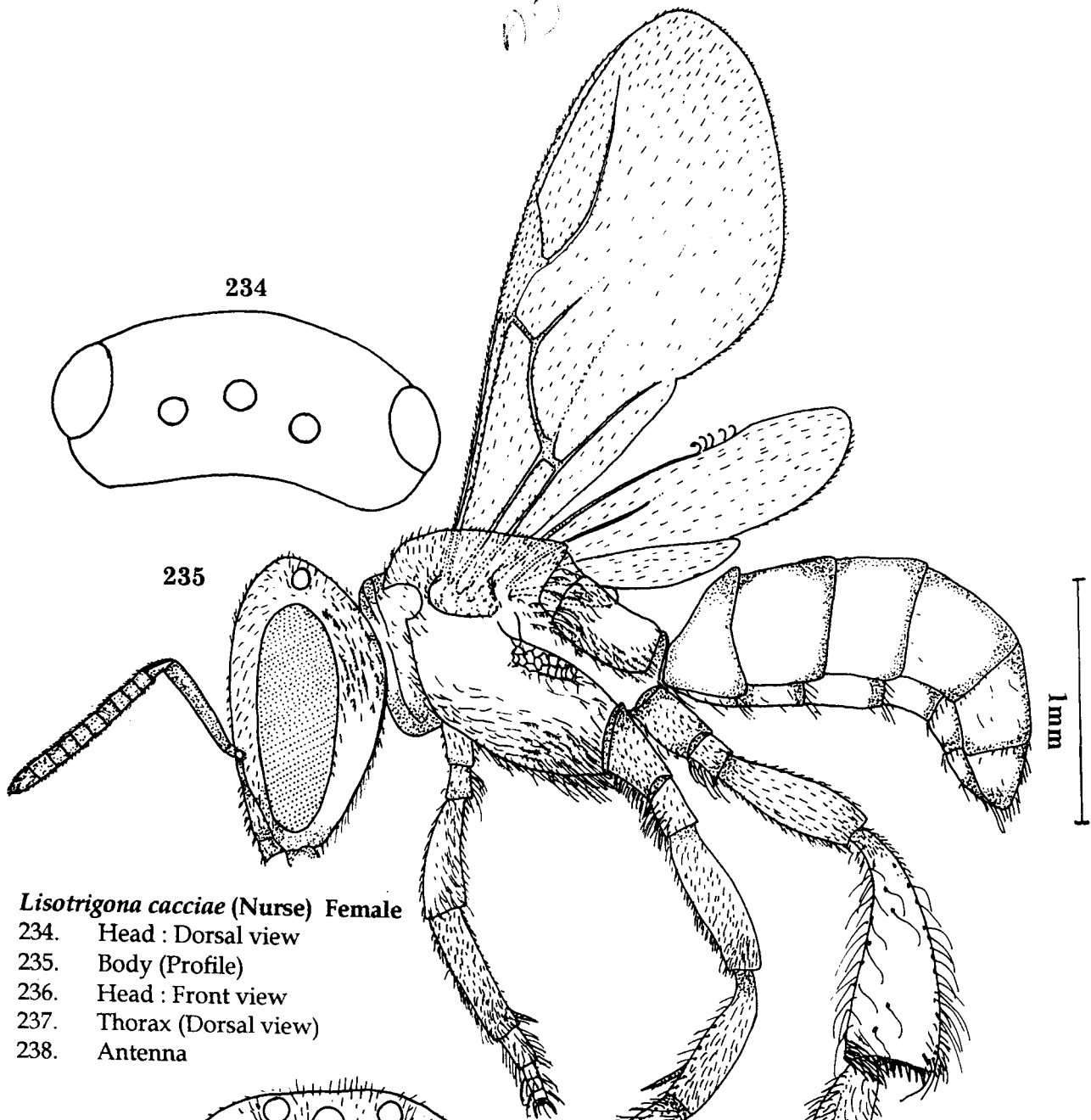
228. Head : Front view

229. Antenna

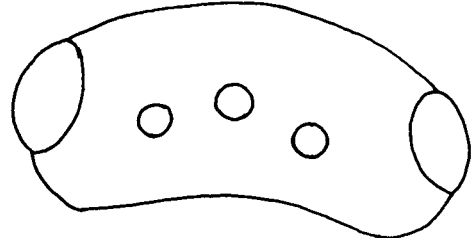


Figs. 230-233: *Thyreus takaonis* (Cockerell) Male
230. Body : Dorsal view
231-232. Scutellum
233. Intereoventral view of hind femur

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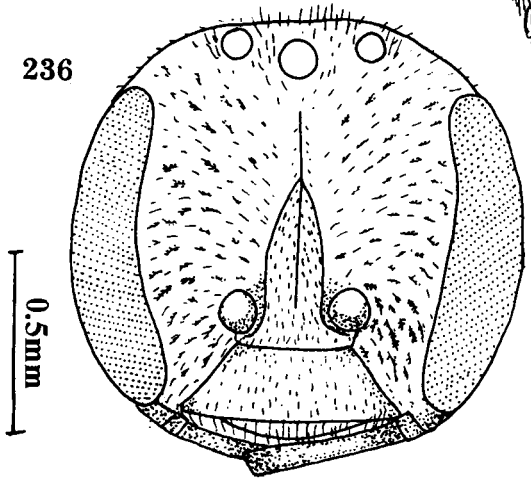


235

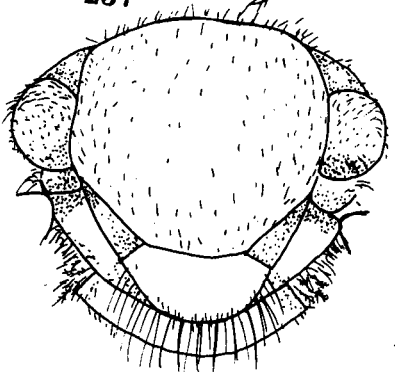
Lisotrigona cacciae (Nurse) Female

- 234. Head : Dorsal view
- 235. Body (Profile)
- 236. Head : Front view
- 237. Thorax (Dorsal view)
- 238. Antenna

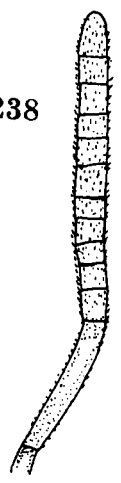
236



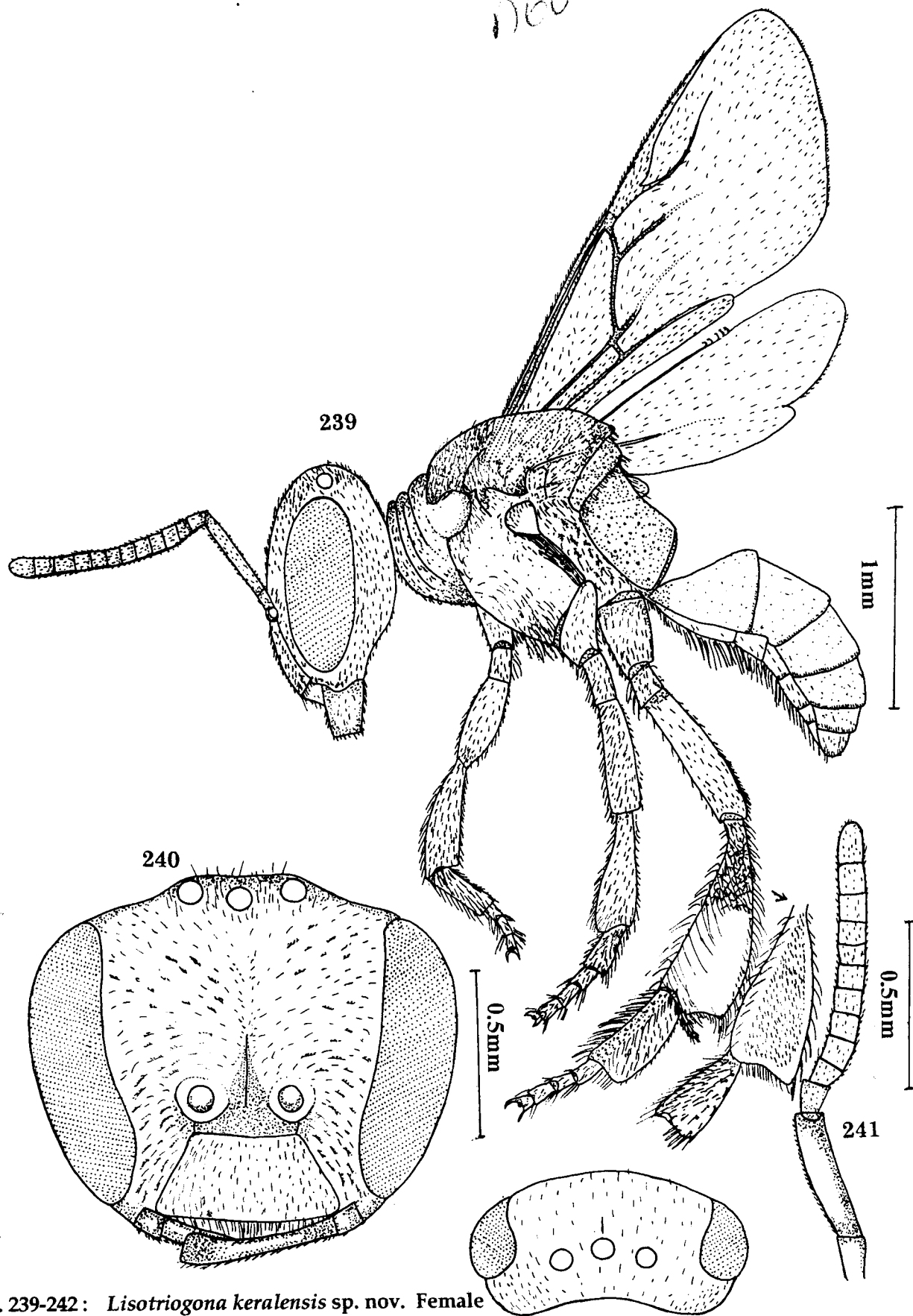
237



238

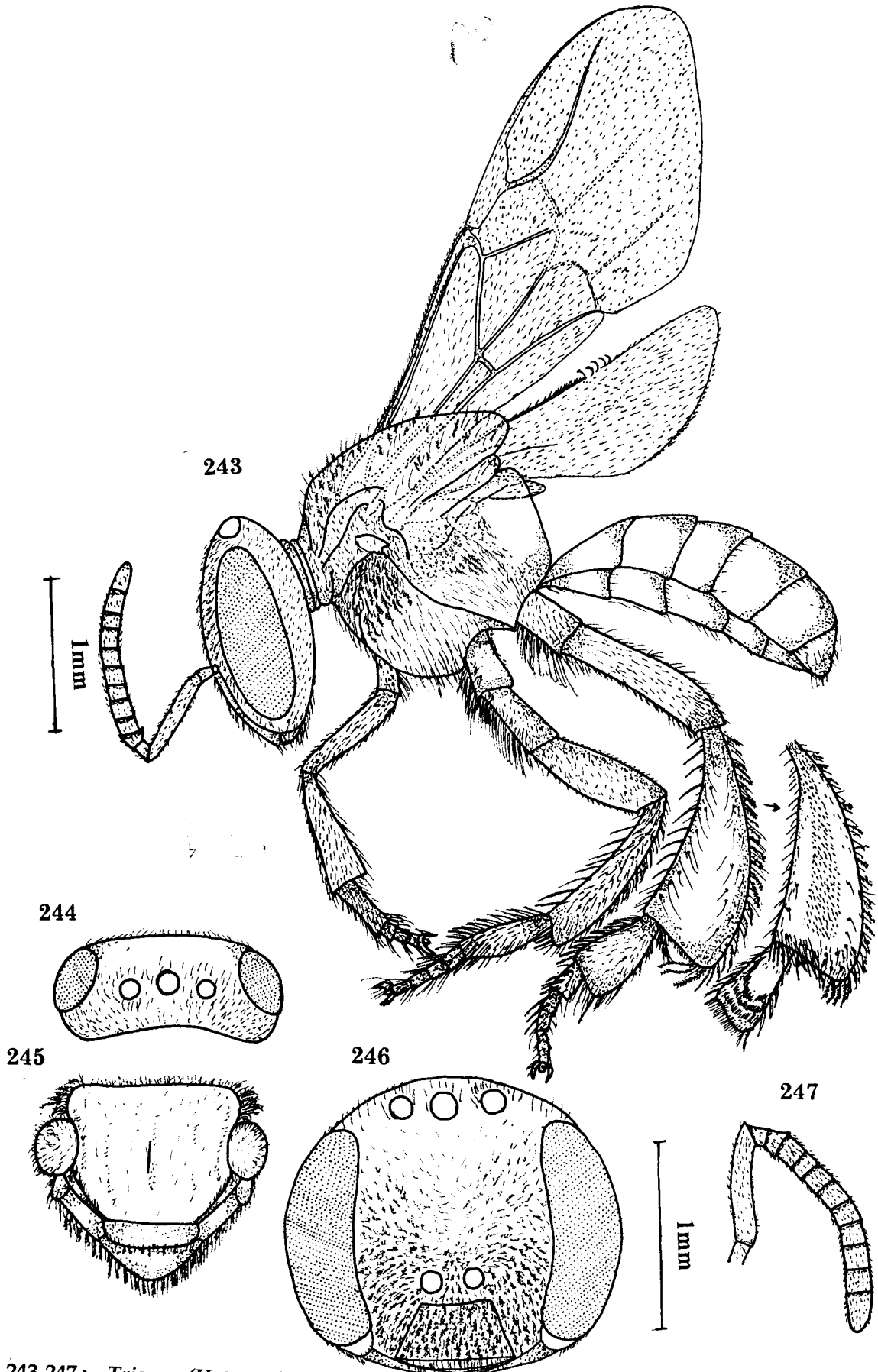


n60



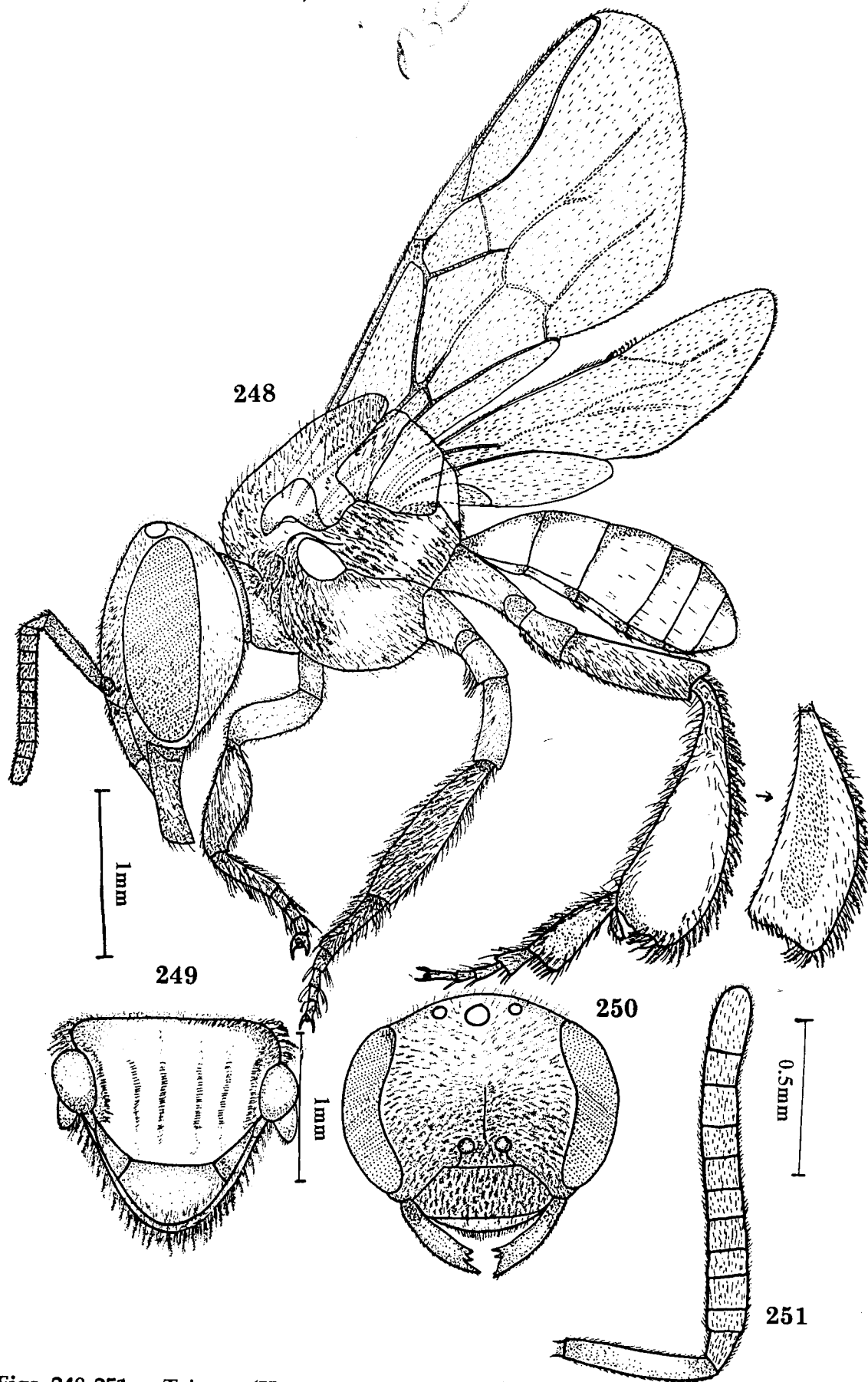
Figs. 239-242: *Lisotriogona keralensis* sp. nov. Female

- 239. Body (Profile)
- 240. Head : Front view
- 241. Antenna
- 242. Head : Dorsal view



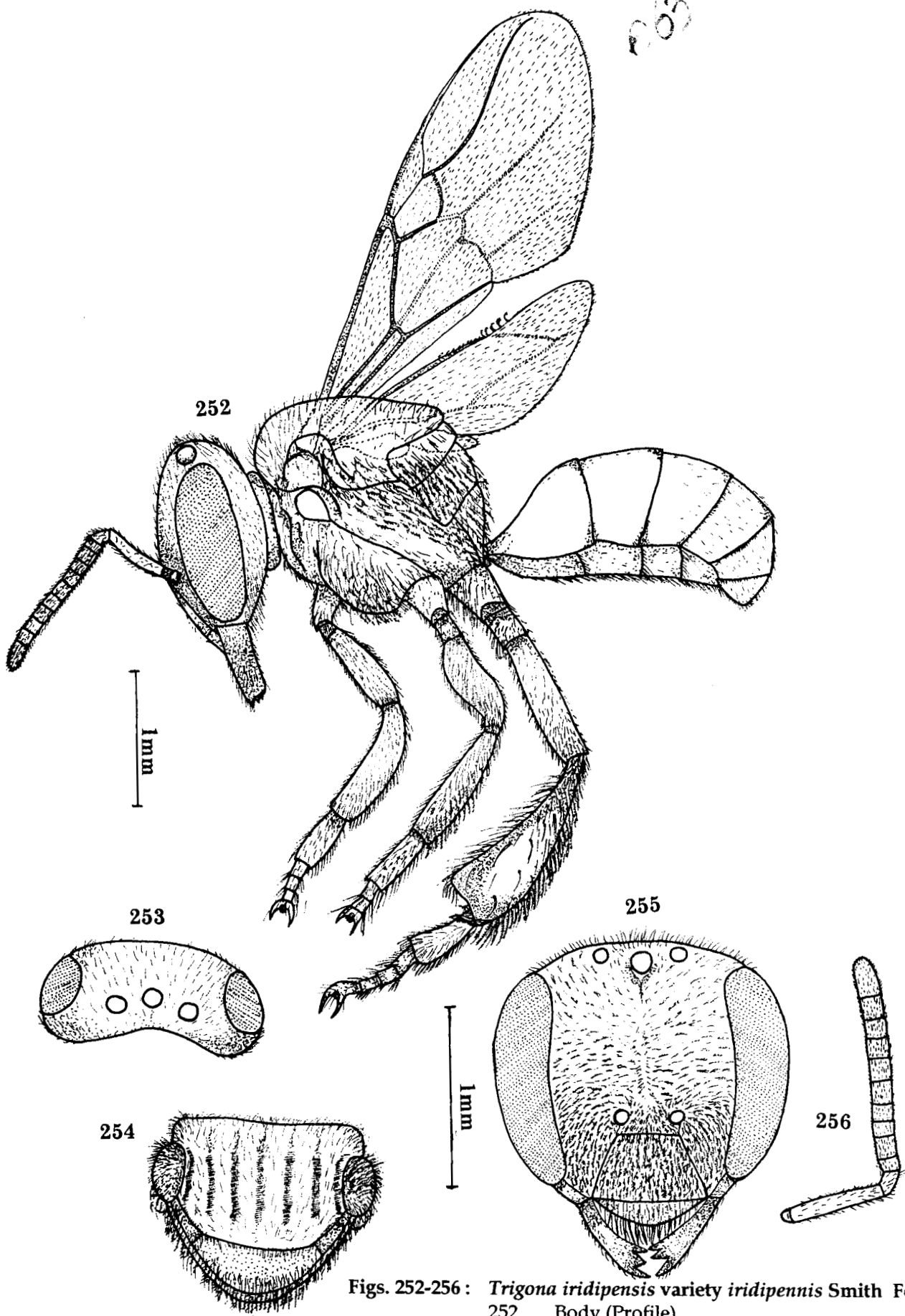
Figs. 243-247 : *Trigona (Heterotrigona) ashokai* sp. nov. 243. Body (Profile) 244. Head : Dorsal view 245. Thorax : Dorsal view 246. Head : Front view 247. Antenna

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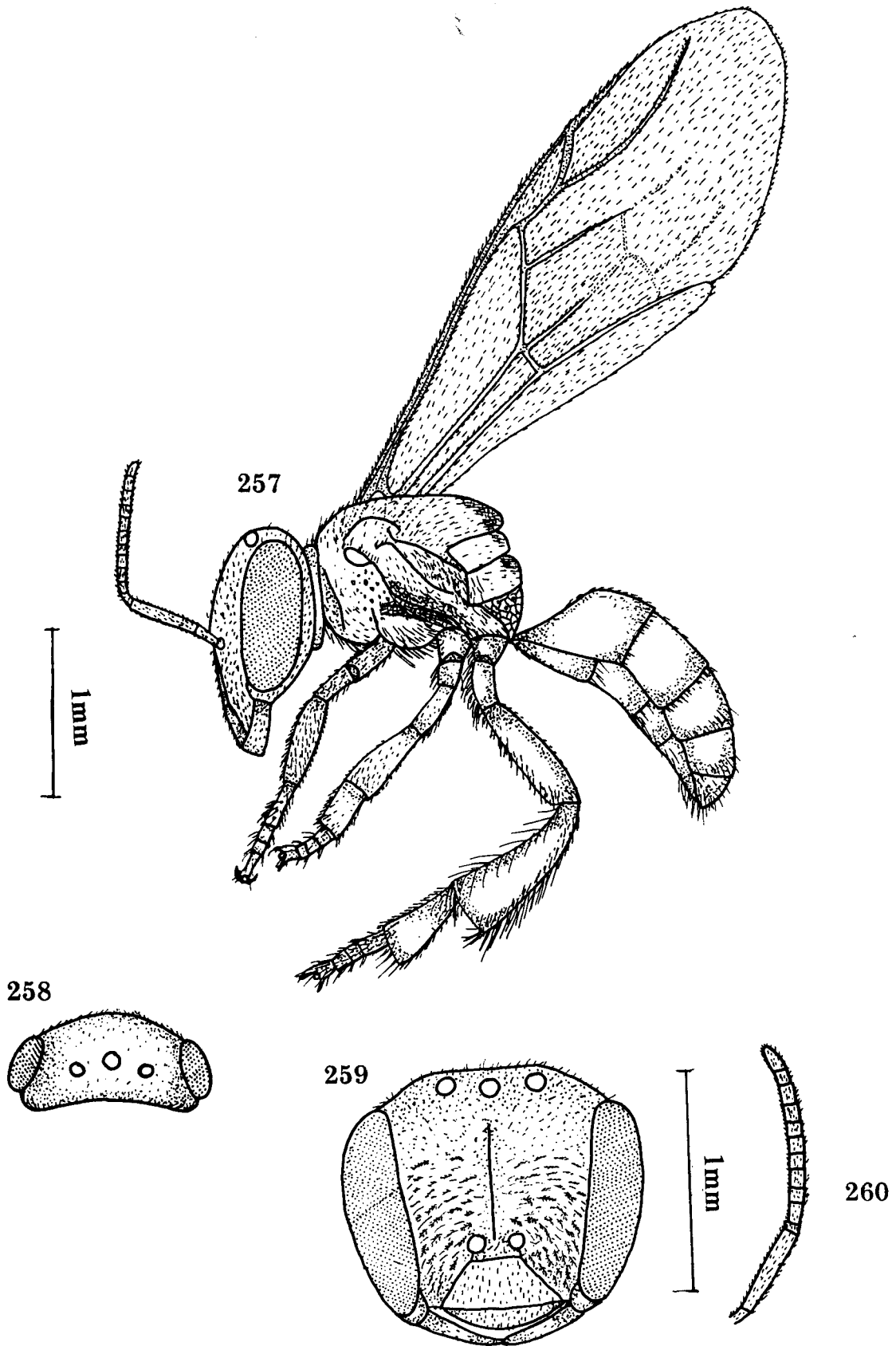
Figs. 248-251 : *Trigona (Heterotrigona) biroi* Friese Female
 248. Body (Profile)
 249. Thorax : Dorsal view
 250. Head : Front view
 251. Antenna

203



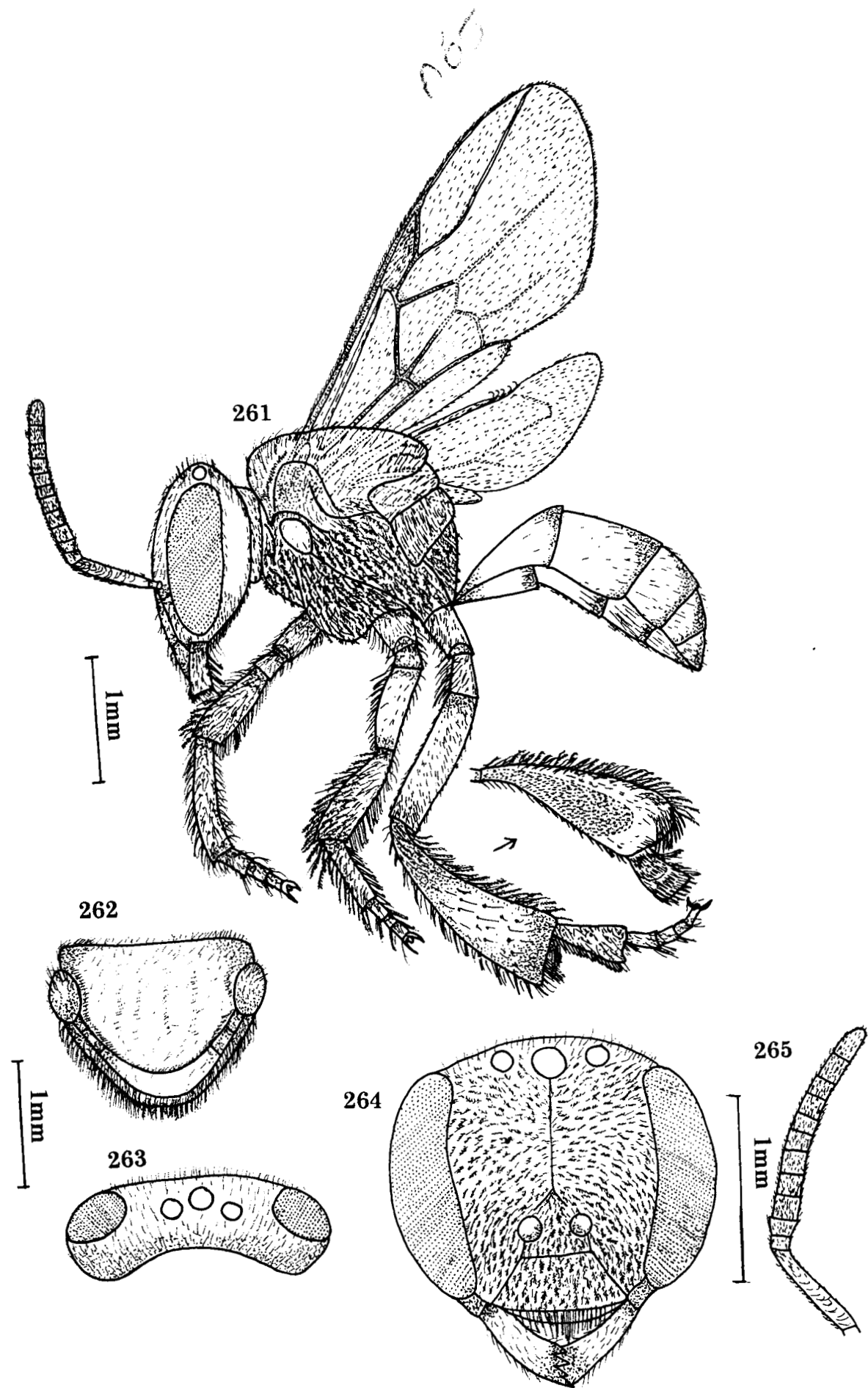
Figs. 252-256 : *Trigona iridipennis* variety *iridipennis* Smith Female
 252. Body (Profile)
 253. Head : Dorsal view 255. Head : Front view
 254. Thorax : Front view 256. Antenna

206



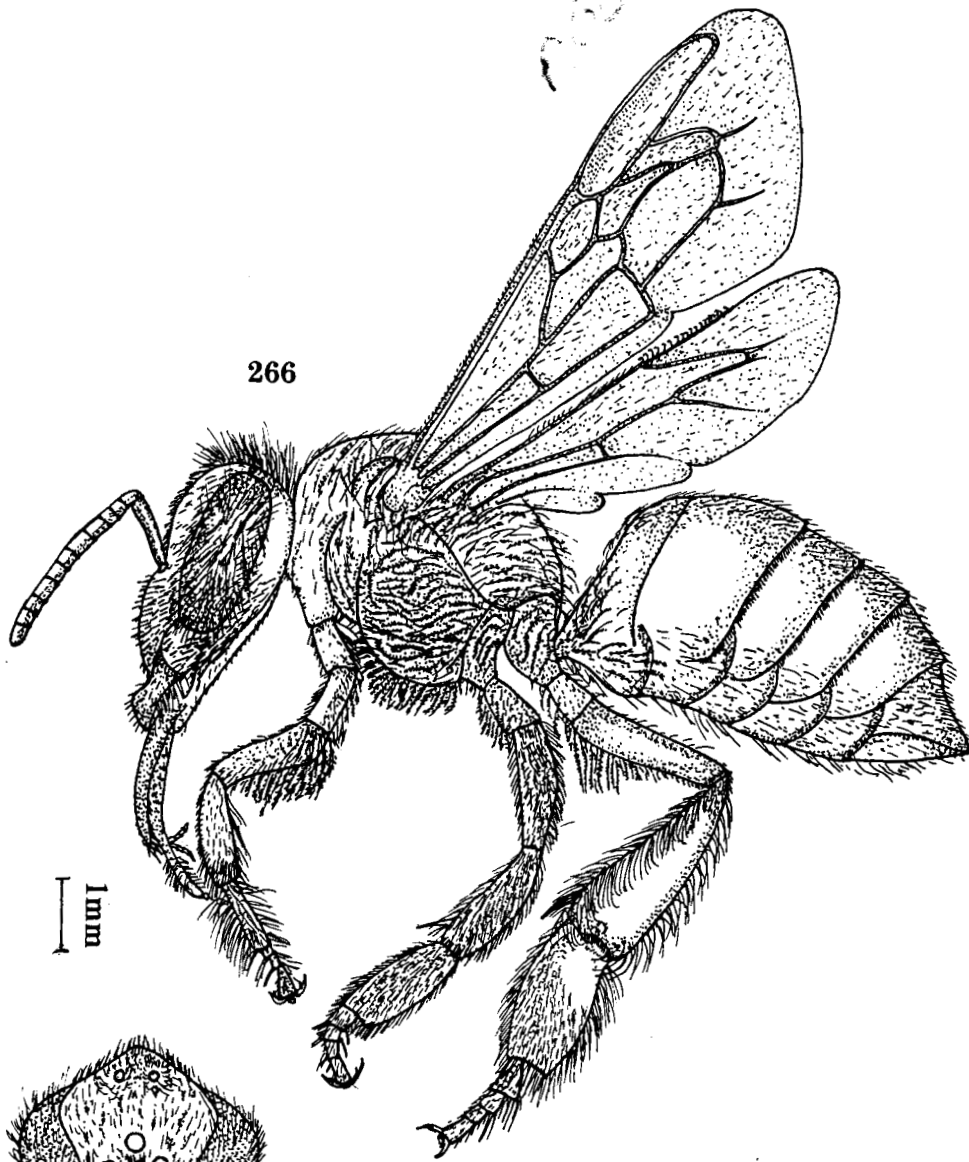
Figs. 257-260 : *Trigona (Lepidotrigona) nilamburensis* sp. nov.

- 257. Body (Profile)
- 258. Head : Dorsal view
- 259. Head : Front view
- 260. Antenna



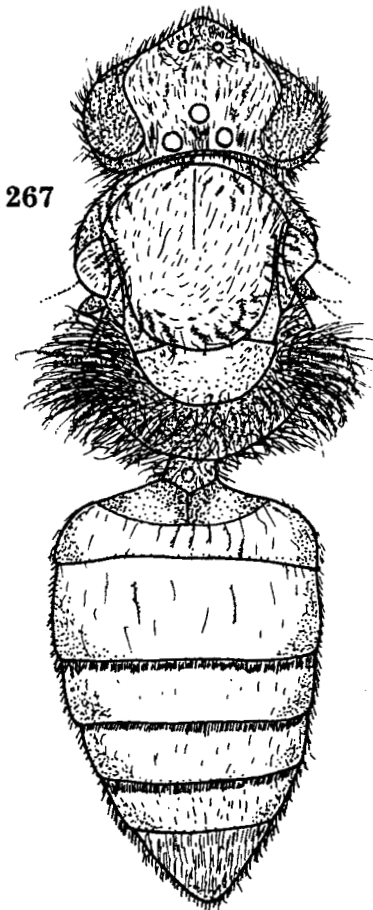
Figs. 261-265 : *Trigona (Heterotrigona) travancorica* sp. nov. Female

- | | | | |
|------|----------------------|------|---------|
| 261. | Body (Profile) | 265. | Antenna |
| 262. | Thorax : Dorsal view | | |
| 263. | Head : Dorsal view | | |
| 264. | Head : Front view | | |



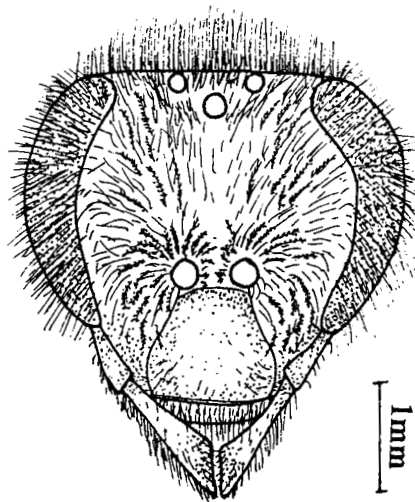
266

1mm

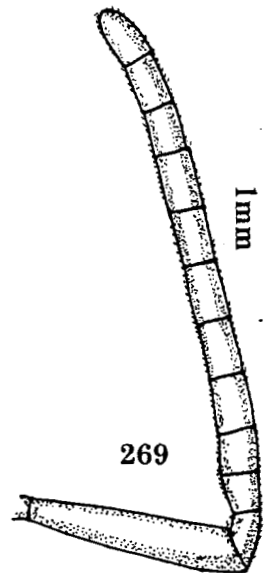


267

268

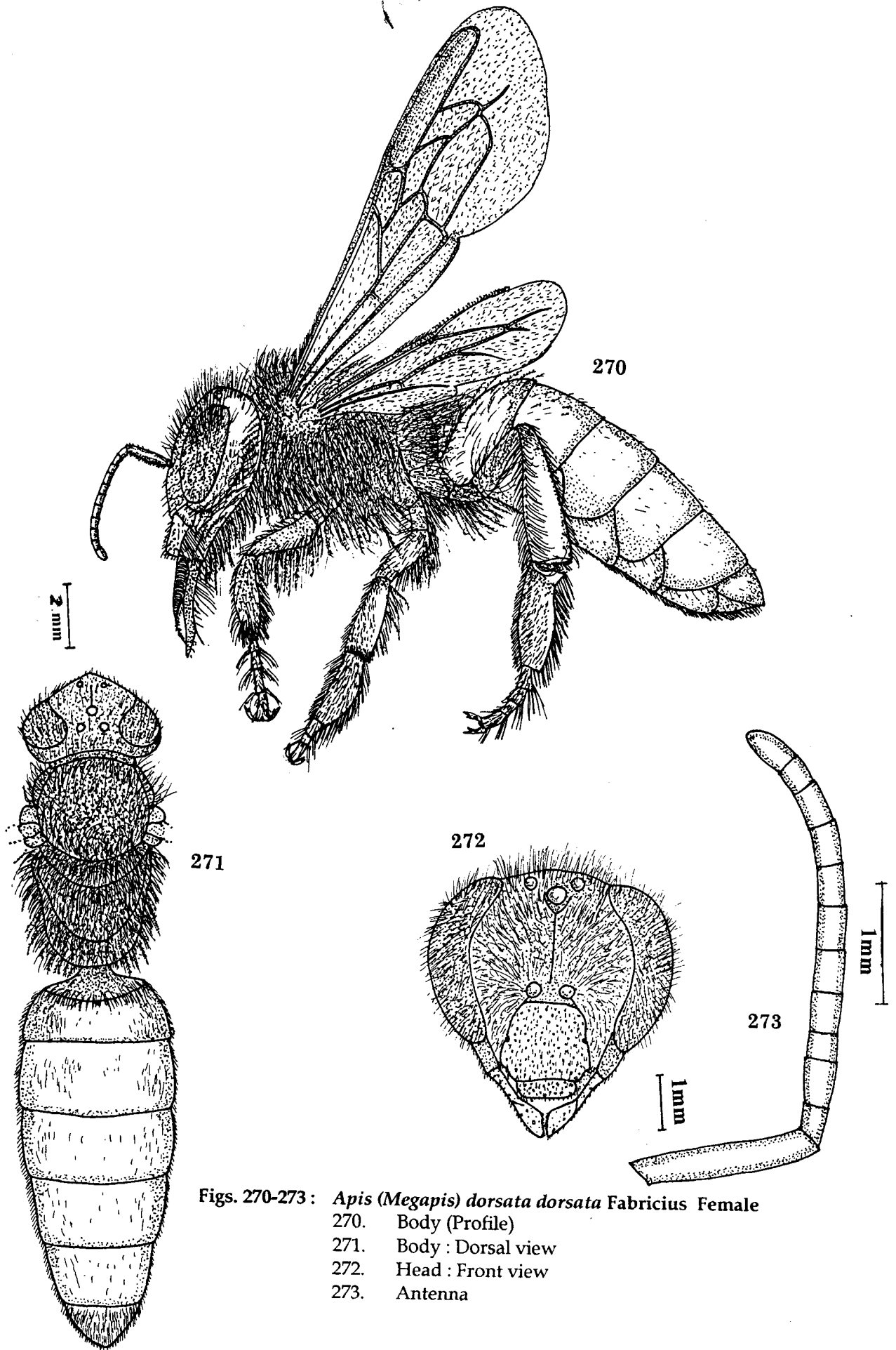


1mm



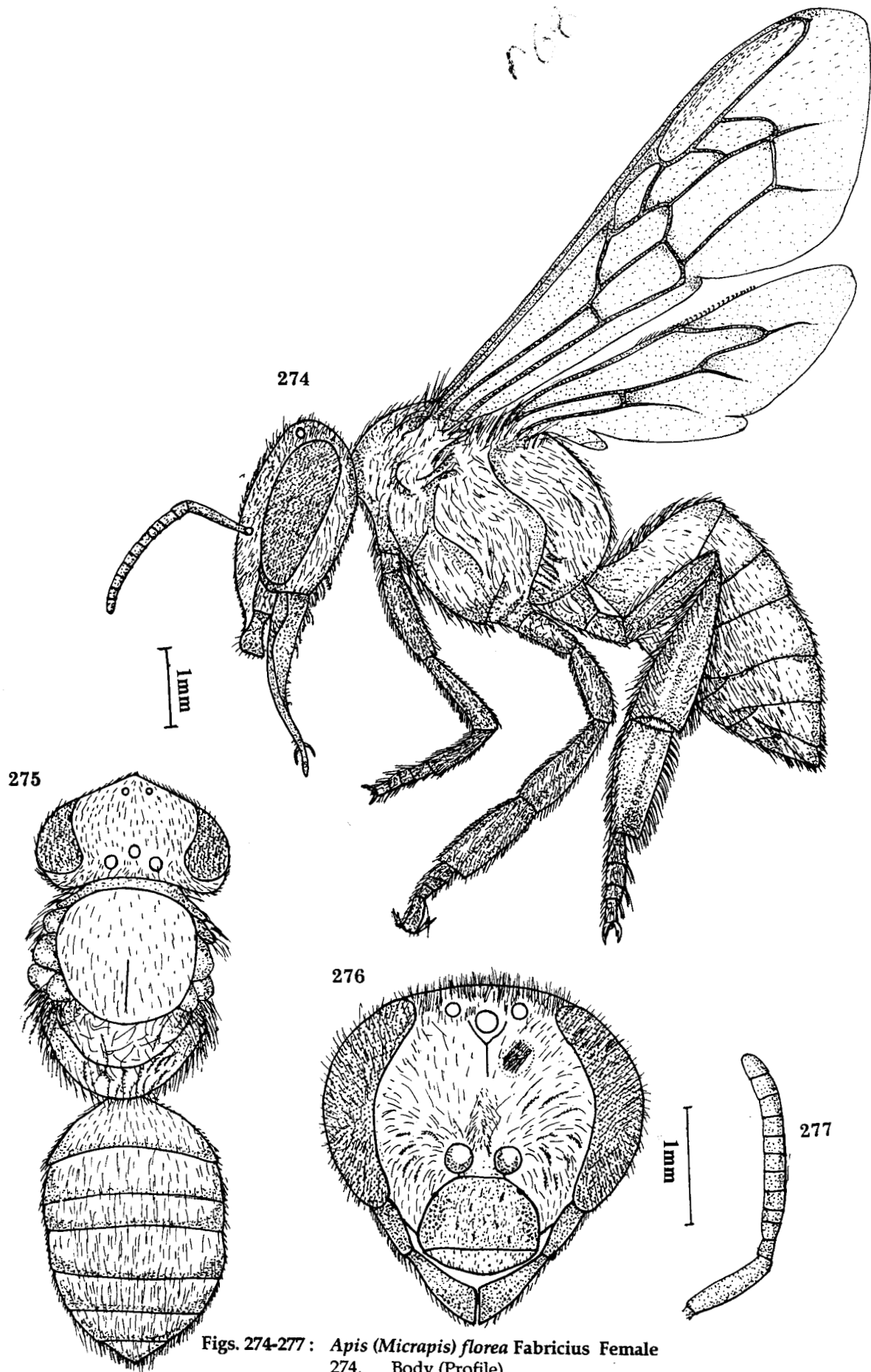
269

Figs. 266-269 : *Apis cerana indica* Fabricius Female
 266. Body (Profile)
 267. Body : Dorsal view
 268. Head : Front view
 269. Antenna

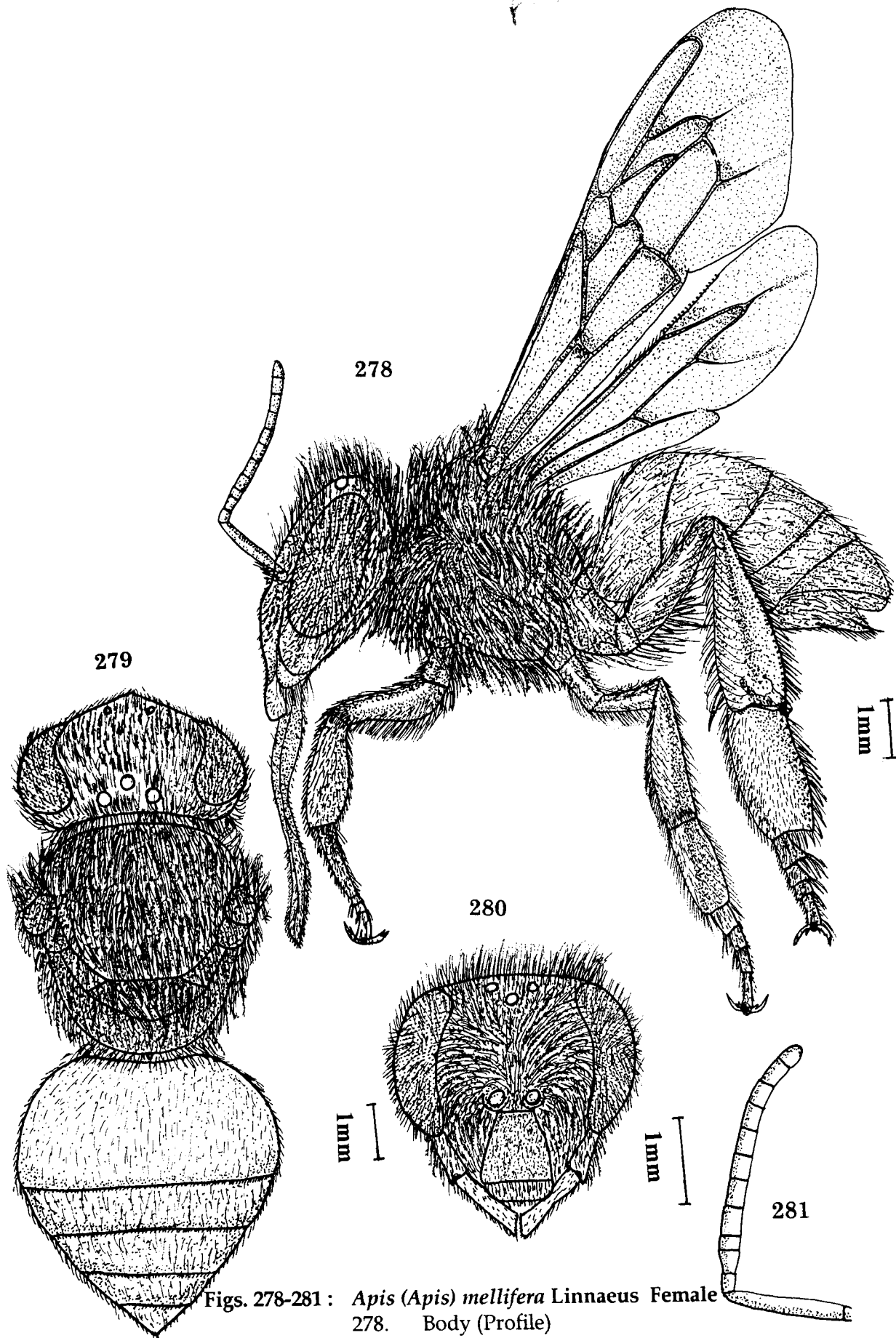


Figs. 270-273 : *Apis (Megapis) dorsata dorsata* Fabricius Female
 270. Body (Profile)
 271. Body : Dorsal view
 272. Head : Front view
 273. Antenna

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Figs. 274-277 : *Apis (Micrapis) florea* Fabricius Female
 274. Body (Profile)
 275. Body : Dorsal view
 276. Head : Front view
 277. Antenna



Figs. 278-281 : *Apis (Apis) mellifera* Linnaeus Female

- 278. Body (Profile)
- 279. Body : Dorsal view
- 280. Head : Front view
- 281. Antenna

Publications

A REMARKABLE NEW SPECIES OF THE BEE GENUS *HALICTUS* LATREILLE (HYMENOPTERA : APOIDEA : HALICTIDAE) FROM INDIA

T. C. Narendran, T. Jobiraj and K. Mohandas*
Systematic Entomology laboratory, Department of Zoology
University of Calicut, Kerala - 673635, INDIA

ABSTRACT : A new species of *Halictus* viz., *H. tectonae* Narendran & Jobiraj sp. nov. is described and its affinities with its closest relatives are discussed. The new species is a pollinator of the flowers of Teak in Kerala.

INTRODUCTION

The genus *Halictus* was erected by Latreille⁶ in 1804. Bingham¹ gave accounts of fifty Indian species of *Halictus*. Cameron⁵ described four new species of *Halictus* from India. Bluthgen^{2,3,4} revised the species of *Halictus* of Indo-Malayan Region. Later Michener⁷ classified Halictine bees. The present species does not come near any of the described species. This interesting species is a pollinator of Teak (*Tectona grandis*).

MATERIALS AND METHODS

Halictus was collected from Teak flowers and curated by methods described by Noyes⁸. The specimen mounted on rectangular card and pinned with Asta pins of size 38mmX 0.53 of No. 3. The observations are made using M3Z Wild Stereozoom (Switzerland) and Letz-Wetzlar (Germany) microscopes. The figures were drawn using the drawing tube of Wild M3Z.

Abbreviations used : F1-F10 = Flagellar segments, OOL = Ocellocular distance, POL = Postocellar distance, DZCU = Department of Zoology, University of Calicut, KFRI = Kerala Forest Research Institute.

Halictus tectonae Narendran & Jobiraj sp. nov.

Holotype Female : Length 8.5mm. Black with following parts otherwise; anterior part of eye with yellowish marking, ocelli brown with ferruginous reflections in certain lights; antennae

reflects brown at their tips; outer parts of tegulae brown, tarsal segments and ovipositor dark brown; apex of metasoma covered with fulvous pubescence; wings hyaline with light brown tint, vein pale testaceous.

Head : Width in anterior view little more than 1.42x distance between front ocellus and lower margin of labrum (73 : 51.5); maximum width of head at the level of posterior margin of eyes 8x distance between front ocellus and occipital margin (40:5). Relative measurements of POL:OOL = 5:4. Dorsal side of head minutely punctured and striated, a long carina begins from middle ocelli and passes in between antennal toruli; area in between lower area of clypeus with pubescence (Fig.-1); below antennal toruli with clear punctae. Clypeus reticulate; scape of antenna larger (Fig-2); last flagellar segments wider than first ones (Fig-2); antennal segments covered with minute hairs; radicle of antennae punctured. Relative length and width of antennal segments, scape = 35:4, pedicel = 6:5.5, F₁ = 4:5, F₂=3:5, F₃=3:5.5, F₄=4.5, F₅=5.5:6, F₆=5:6.5, F₇=5:7, F₈=5.5:7.5, F₁₀=9:7.5.

Mesosoma : The maximum width between the tegulae to length of thorax = 50:34; pronotum sparsely pubescent, mesoscutum striated with sparse minute hairs; scutellum with well developed striations; median carina present, lateral carinae not visible; scutellum minutely punctured between striations; lower parts of scutellum and metanotum with long branched

* Division of Entomology, KFRI, Peechi, 680653.

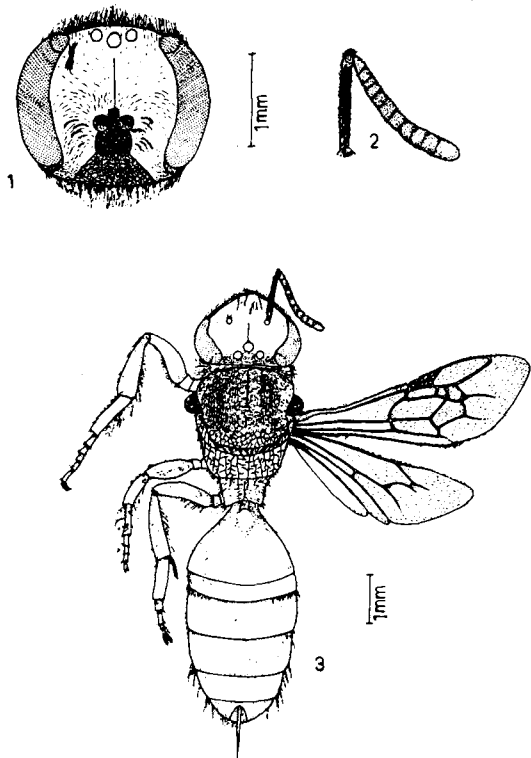


Fig. 1. Head front view. Fig. 2. Antenna Fig. 3. Dorsal view : Entire

hairs. Propodeum reticulate (enclosed space at the base of median segment reticulate), terminal part of propodeum sparsely haired with a median groove. Relative measurements of forewing length: its maximum width = 92:29; three submarginal cells, the first about as long as second and third united, second cell small, subquadrate, receiving the first recurrent vein near its apex, third receiving the second recurrent vein in its apical third (Fig. 3), wing venation as in figure (Fig.3). Legs simple and moderately long, the posterior legs larger than the others and with a floccus of long hair on the coxae and trochanter and a dense polliferous scopa on tibia, hind tibial spur with serration distinct, spine like.

Metasoma : Metasoma elongate to ovate, the basal segment smooth and shining with a distinct fascia, the rest of the segments delicately punctured, and with minute hairs, below the fascia

of the basal segment with lateral patch of white pubescence; apical segment covered with fulvous pubescence; lateral parts of metasoma, especially on hind part with branched hairs.

Male : Unknown.

Biology: This specimen is obtained from Teak flower (a pollinator of Teak). It spent more time on morning around the stamens rather than feeding on the tak flower honey. This resulted the accumulation of lots of pollen grains on the hind legs of the bee.

Specimen examined: Holotype: female, INDIA, Kerala, K. F. R. I (Peechi), 23-04-1999, collected by Anand Gopinath. Depository: DZCU.

Etymology : The name came from *Tectona* (Teak).

Remarks : This species differs from its nearest relative species from India, viz., *Halictus rugolatus* Smith in having head minutely punctured and striated (on *rugolatus* head closely and finely punctures, not striate), mesosoma not punctured but mainly striated (on *rugulatus* mesosoma more strongly punctured than head), the basal segment of metasoma with lateral patch of white hairs (In *rugulatus* basal margin of second and third segments with lateral patch of white pubescence, on the fourth a more or less interrupted fascia).

ACKNOWLEDGEMENTS

We are thankful to authorities of University of Calicut for facilities to do this work. We also thank Dr. Michael S. Engel, American Museum of Natural History and Dr. Achterburg, Rijks Museum of Natural History, (Leiden) for supply of photocopies of some useful relevant literature.

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A NEW SPECIES OF *ORMYRUS* WESTWOOD (HYMENOPTERA:CHALCIDOIDEA:ORMYRIDAE) FROM AUSTRALIA

T. C. Narendran, T. Jobiraj and Sr. K. A. Karmaly
Systematic Entomology Laboratory, Department of Zoology
University of Calicut, Kerala-673 635, INDIA

ABSTRACT : A new species of *Ormyrus marreebensis* Narendran sp. nov. is described and compared with its nearest relative.

INTRODUCTION

After sending the typescript of Indo-Australian Ormyridae (Narendran, 1999) to the printers, the senior author received a set of Australian Ormyrids from Dr. Christopher Burwell of Queensland Museum, South Brisbane of Australia. On closer study it is found to be a new species which is described below. This forms the 12th species from Australia.

MATERIALS AND METHODS

The material for this study was sent by Dr. Christopher Burwell of Australia. They were studied in the laboratory using M3Z WILD Sterozoom (Switzerland make) and Letiz Wetzlar (German make) microscopes. The figures were drawn using drawing tube of WILD M3Z Sterozoom and enlarged using KB enlarger of model B2M. The type is deposited in the Queensland museum, South Brisbane, Australia.

Abbreviations used

EH = Eye height in side view, F - funicular segment MS = malar segment, MV = Marginal vein, MW = Mouth width in anterior view, OOL = Ocellocular line, PMV = Postmarginal vein, POL = Postocellar line SMV = Submarginal vein, T₁-T₅ = Tergite 1 to Tergite 5.

Ormyrus marreebensis Narendran sp. nov.

(Figs. 1-3)

Holotype Female

Length 1.6 mm. Metallic green. Eye reddish yellow; ocelli pale reflecting yellow; antenna

brownish black with basal one third, scape and readicula pale yellow; fore and hind coxae concolorous with body except their apices which are paler; all femora blackish brown with slight metallic reflections, their bases and apices paler; fore and mid tibiae pale yellow, with the middle portion slightly darker hind tibia pale brownish yellow; all tarsi whitish yellow, pretarsi brown; tegula pale yellowish brown; ventral side of gaster mostly pale brown; pubescence silvery; wings hyaline with veins pale brownish yellow; pubescence on wings pale yellowish brown; foveolae of gaster black with metallic tinge.

Head

Width (Fig -1) slightly more than 1.5× distance between front ocellus and lower clypeal margin (90:60); head width in dorsal view 2.75× distance between front ocellus and occipital margin; POL Slightly more than 4.5×OOL; MW 1.09×MS in front view; and occiput cross striate, without any distinct pilosity. Scrobe with margin carinate; front ocellus; area between front ocellus and scrobe cross striate; parascrobal space longitudinally striate with sparse setae; upper clypeal margin hardly distinct; anterior tentorial pits indistinct; lower clypeal margin entire; eye bare; EH in profile a little more than 3×length of MS (30:10); gena striatoreticulate; antennal formula 11263; Relative measurements of L:W of antennal segments :Scape = 29 : 12.5; Pedicel-10.5:6, F₁ = 2.6, F₂ = 1:6, F₃ = 4.5:8, F₄ = 4.5:9, F₅ = 8:10, F₆ = 6:10.5, Clava = 31 : 11.

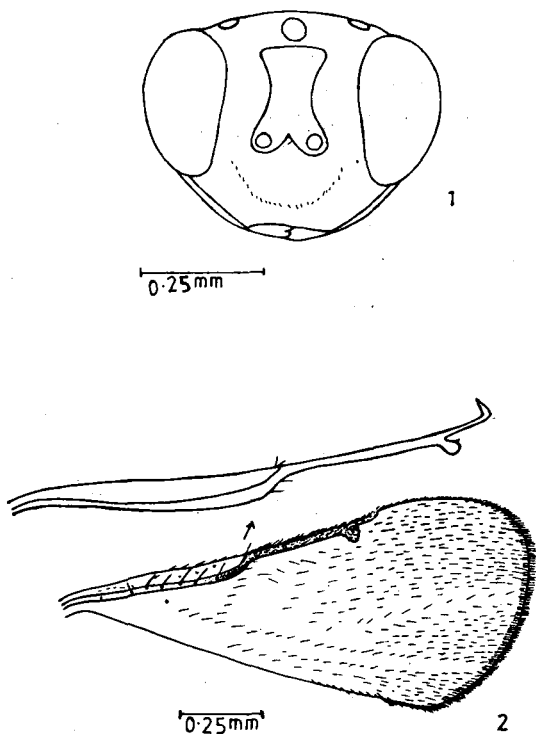


Fig. 1 : Head front view Fig. 2 : Forewing

Mesonoma

Length in dorsal view a little more than $1.25\times$ its maximum width; pronotum and mesonotum with cross striations consisting of fine strips; mesoscutum with moderately dense pilosity without any definite pairs of long setigerous setae; notauli slightly indicated in certain lighting. Scutellum longer than its maximum width ($10.5 : 8$); its apex rounded, anteriorly cross striate, posteriorly semi circularly striate, scutellum with uniformly arranged short pilosity, without distinct pairs of long setigerous setae; apex of scutellum extends a little beyond mesonotum posteriorly. Propodeum with a pair of faint and short submedian carinae on the posterior margin not at all reaching middle of propodeum, (visible in certain lights) propodeum smooth with faint reticulations; callus densely pilose. Forewing length a little more than $2.26\times$ ($14.35 : 63.5$) its maximum width (Fig : 2) ; speculum asetose,

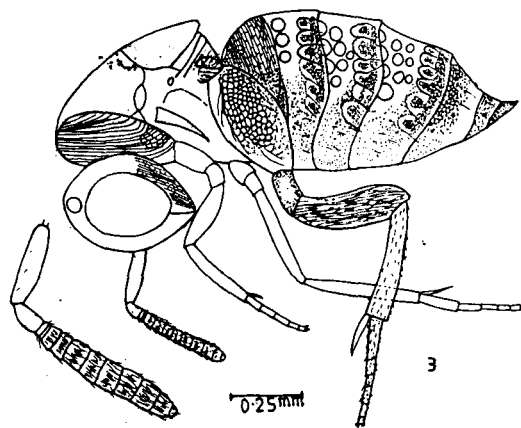


Fig. 3 : Body entire - side view

closed posteriorly by cubital line of setal which does not reach near the base of fore wing; basal line of setae distinct and complete; basal cell with one ventral setae; costal cell with single row of ventral setae. Relative measurements of lengths of forewing veins $SMV = 84$; $MV = 50$; $PMV = 16$; $STV = 4$. Lateral panel of pronotum obliquely cross striato-reticulate; hind coxa on outer dorsal side with relatively large reticulations (Fig : 3); longest spur of hind tibia as long as hind metatarsus.

Gaster (Fig : 3)

Length a little more than $1.7\times$ length of mesosoma ($106:81$), a little more than $1.3\times$ combined length of head and mesosoma in side view; not compressed from side or from dorsal side; median longitudinal ridge present from posterior margin of T_1 to T_5 but not reaching T_6 ; T_1 with a median basal pit, remaining parts of T_1 strongly reticulate; T_2 not visible from dorsal side concealed by T_1 ; T_3 with a cross row of foveolae, followed by crenulate border and cusps space between cusps and portion posterior to cusps of T_3 reticulate to faintly reticulate; T_4 with two cross rows foveolae visible (anterior row partly concealed by posterior margin of T_3), followed by crenulate border and cusps similar to T_3 ; T_5 with three cross rows of foveolae anterior row partly concealed by posterior margin of T_4 ,

followed by crenulate border and cusps similar to T₄; T₆ coarsely reticulate and with scattered minute tubercles bearing setae. Length of epipygium almost half length of T₆ in dorsal view, longer than ovipositor sheath in dorsal view.

Male : Unknown

Host : Unknown

Materials Examined

Holotype : Female; Australia, 3 KMs North East of Mareeba, Coll : C. J. Burwell; 25-28-xi-1997.

Paratypes : 1 female, Australia, Gordonvale, coll. E. C. Dahms and G. Sarens, 16-iv-1987 1 Female : Australia, Mount Mollay, Coll. C. J. Burwell, 22-v-1997.

Remarks:- This species does not fit to the key to the Indo-Australian species of *Ormyrus* by Narendran (1999). This species comes near *Ormyrus burwelli* Narendran and *O. tanus* Narendran in the key but differs from the following characters mentioned below :-

Ormyrus mareebensis sp. nov

1. Fore wing with one ventral seta.
2. Gena striato-reticulate.
3. Costal cell with single row of ventral seta.
4. Longest spur on hind tibia as long as hind metatarsus.
5. T₃ with a cross row of foveolae.
6. T₄ with two and T₅ with three cross rows of foveolae.
7. Propodeum with a pair of very small submedian carinae.

Ormyrus mareebensis sp. nov

1. Fore wing with one ventral seta.
2. Gena striato-reticulate.
3. Longest spur on hind tibia as long as hind metatarsus.
4. T₃ with a cross row of foveolae; T₄ with two and T₅ with three cross rows of foveolae.

Ormyrus burwelli

1. Fore wing with two ventral setae.
2. Gena longitudinally Strait.
3. Costal cell with double row of ventral setae.
4. Longest spur on hind tibia shorter than hind metatarsus.
5. T₃ without cross row of foveolae.
6. T₄ and T₅ with one cross row of foveolae.
7. Submedian carinae absent.

Ormyrus tanus

1. Fore wing with two ventral setae.
2. Gena longitudinally Straite.
3. Largest spur on hind tibia sub equal to length of hind metatarsus.
4. T₃ without cross row of foveolae; T₄ and T₅ with single cross row of foveolae.

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THREE NEW SPECIES OF PTEROMALIDAE (HYMENOPTERA)
FROM KERALA (INDIA)

T.C. NARENDRAN, K. RAJMOHANA AND T. JOBIRAJ
SYSTEMATIC ENTOMOLOGY LABORATORY, DEPARTMENT OF ZOOLOGY,
UNIVERSITY OF CALICUT, CALICUT - 673635, INDIA.
e mail : narendra@unica.ac.in

Three new species of Pteromalidae viz. *Kumarella sandroi* Narendran & Mohana sp. nov., *Callitula bambusae* Narendran & Jobiraj sp. nov. and *C. pceethapada* Narendran & Mohana sp. nov. are described and their affinities discussed with related species.

INTRODUCTION

The genus *Kumarella* Sureshan contain only its type species *Kumarella angulus* Sureshan (Sureshan, 1999) which was collected originally from Parambikulam wild life sanctuary of south Western Ghats of Kerala state. The new species of *Kumarella* described in this paper was collected from Sulthanbatheri of Western Ghats of north Kerala. There are only two species known so far in the genus *Kumarella*. The genus *Callitula* was erected by Spinola (1811) and it is so far represented by only one species in India, viz. *Callitula rugosa* (Waterston). Waterston (1915) described two species viz. *Trigonogastra rugosa* and *T. megacephala* from Ceylon (Sri Lanka) and Boucek *et al.* (1978) transferred *rugosa* to *Callitula* and *megacephala* to *Nigricolana* Boucek. In this paper we described two new species of *Callitula* collected from south Korea.

Abbreviations : MS=Molar sulcus; OOL=Ocellocular distance; POL=Postocellur distance; F=Funicular segment; SMV=Submarginal vein; MV=Marginal vein; PMV=Post marginal vein; STV=Stigmal vein; T=Tergite; DZCU=Department of Zoology; University of Calicut; ZSIC=Zoological Survey of India, Calicut.

Kumarella sandroi Narendran & Mohana sp. nova (Figs. 1- 3)

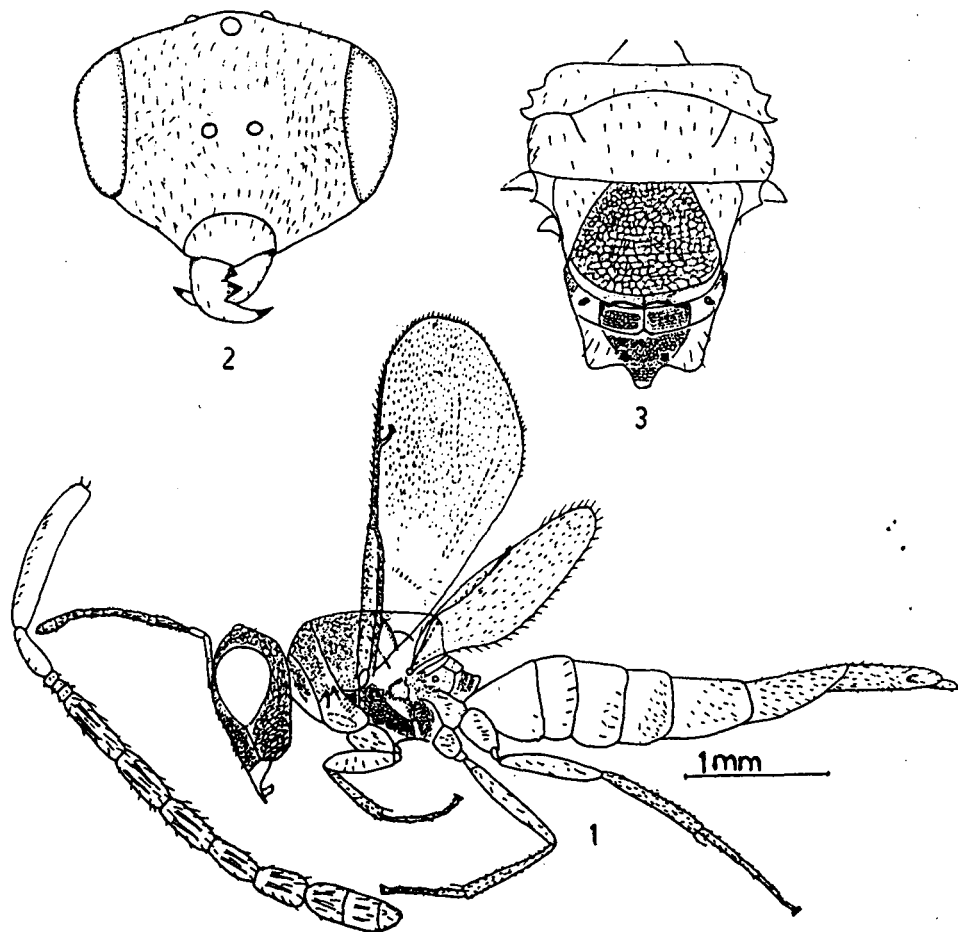
Holotype Female : Length 5.16 mm. Head black with metallic green refringence; mesosoma black with pale brownish yellow reflection on posterior half of pronotum; rest of mesosoma with slight bluish or violet refringence; antenna brown with scape and pedicel pale brownish yellow; mandibles pale brown with apices of teeth darker; eye blackish brown; ocelli pale reflecting reddish brown; tegula pale brownish yellow; legs (except coxae) yellow. Fore and hind coxae concolorous with mesosoma with apices pale brown, midcoxa brown with base darker, all pretarsi black. Gaster black with metallic bluish, greenish and violet reflection. Wings hyaline with veins pale brown and stalk of STV pale yellow; pubescence on body white.

Head (Figs. 1 & 2) : distinctly reticulate, coarser on vertex; frons and face densely pubescent; scrobe shallow, margins indistinct; width of head in anterior view 1.3x its length (excluding mandibles); eye height 1.3x its length; malar space 0.5x eye height in side view; temple 0.33x eye length; POL 0.71x OOL; clypeus distinctly separated from face by a weak line; its lower margin medially pointed; antennal toruli situated middle of head in front view, nearer to front ocellus than to lower margin of clypeus, separated from eye margin about 3x that of distance between them. Antennal formula 11353; scape reaching front ocellus, 0.7x eye height in profile. relative length : width of antennal segments :- scape=42:7; pedicel=15:5; third anellus a little longer than second,

F1=21:6; F2=18:7; F3=17:7; F4=15:7; F5=13:8; clava=26:10.

Mesosoma coarsely reticulate, pubescence moderately dense (not sparse). Mesoscutum width 2.6x its length; axillae normal, not advanced forwards; scutellum with reticulations more pronounced than that of mesoscutum; frenum fairly reticulate with a median raised ridge (absent in *angulus*). Propodeum with a median carina not extending to nucha (Fig. 3); prepectus with deep depression; posteriorly containing reticulation; upper epimeron shiny, remaining areas of mesoepimeron with raised reticulation; hind coxa finely aciculate on dorsal side. Forewing length 2.43x its maximum width; basal line with 7 dorsal setae; speculum narrowly open (or weakly closed) below. Relative lengths of forewing veins :- SMV=39; MV=24; PMV=19; STV=6.

Gaster : sessile; 1.8x as long as head plus mesosoma; T1 a little longer than 1.28x length of T6 dorsally, shorter than T2 and T3 combined; length of epipygium 1.3x length of T5 in dorsal view; relative length of T6 and epipygium in dorsal view 28:26; T6 and epipygium finely transversely striate in dorsal view.



Figs. 1 - 3 : *Kumarella sandroi* Narendran & Monhana sp. nov. Female. 1. Body profile; 2. Head front view; 3. Mesosoma dorsal view.

Male : Unknown

Host : Unknown

Biology : Species of genus *Kumarella* are probably parasitic on insects dwelling in high altitude forest areas.

Etymology : The species name is after Dr. Sandro Pamapallona (Biostatistician, ForMed, Les Chales 1983, Evolene, Switzerland) for his encouragement and keen interest in our research endeavors.

Holotype Female : INDIA, Kerala, Sulthanbathri, 6.v.2000, K. Mohana (ZSIC).

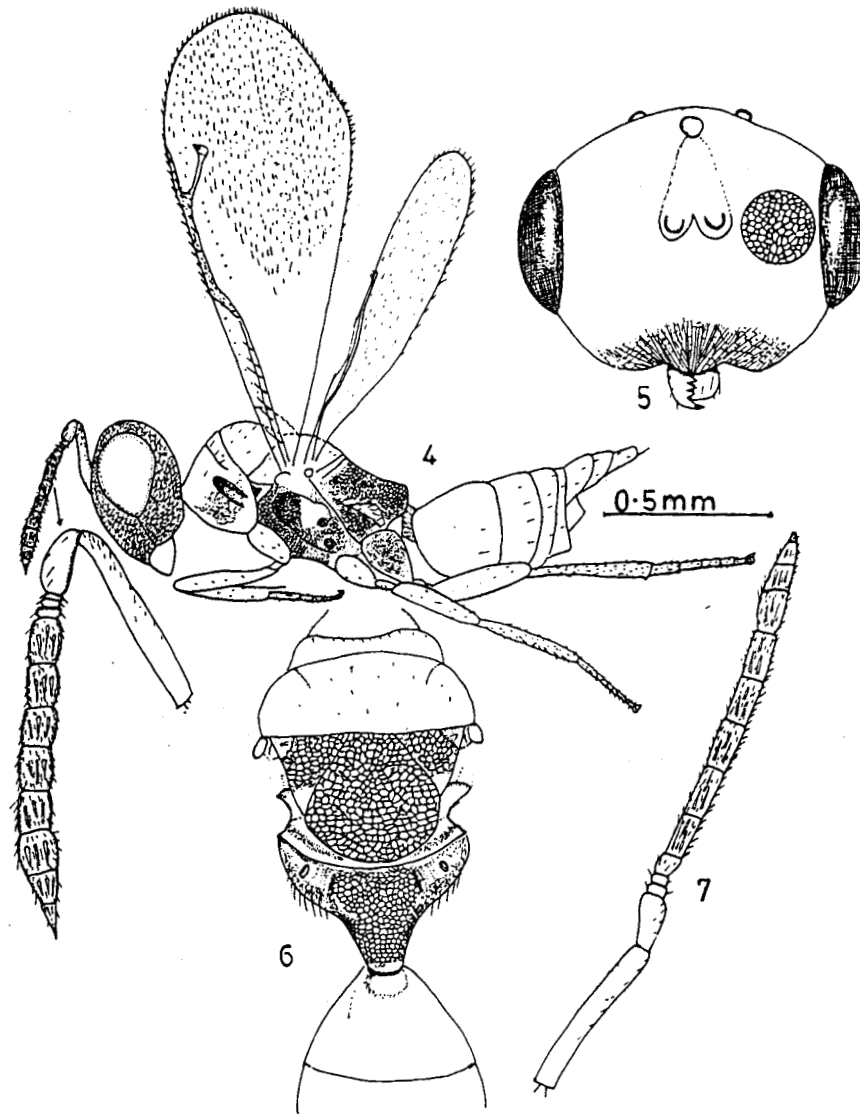
Discussion : The difference between this new species and the only known other species are as follows :

	<i>Kumarella sandroi</i> Narendran & Mohana sp. nov.	<i>Kumarella angulus</i> Sureshan
1.	Mandible tridentate	Mandible bidentate
2.	Gaster 2.45x as long as mesosoma	Gaster 1.78x as long as mesosoma
3.	Frenal area with a distinct median ridge	Frenal area without a median ridge
4.	Propodeum without an extension of median carina on area beyond costular level	Propodeum with median carina extending beyond costular level upto nucha
5.	T6 distinctly longer than T1	T6 subequal in length to T1
6.	Relative lengths of T5 : epipygium : ovipositor sheath in dorsal view=20:28:26	Relative proportion of length of T5 : epipygium : ovipositor sheath in dorsal view=20:18:11
7.	Mesoscutum coarsely reticulate	Mesoscutum more distinctly (not coarsely) reticulate
8.	Pedicel distinctly shorter than F2 (15:18)	Pedicel as long as F2
9.	F3 longer than F4	F3 as long as F4
10.	Head and mesosoma black with metallic green refringence	Head and mesosoma with dark metallic blue refringence
11.	Basal line of forewing with 7 setae	Basal line with 5 setae
12.	Body length 5.16 mm	Body length 3.9-4 mm

Callitula bambusae Narendran & Jobiraj sp. nov. (Figs. 4 - 7)

Holotype Female : Length 1.64mm. Head, mesosoma and gaster dark metallic green; antenna brown with scape and pedicel paler; eye brown; ocelli pale reflecting yellowish brown; tegula pale brownish yellow; legs pale brownish yellow with basal half of fore coxa brown with dark metallic green refringence and hind coxa concolorous with mesosoma except paler apex. Pretarsi blackish brown. Wings hyaline, veins light brown.

Head : with uniform engraved reticulation, meshes broader on frons and vertex; reticulation forming striae radiating from clypeus; gena with less pronounced reticulation than with that of frons; head width in dorsal view a little more than 2x its length, 1.23x width of mesoscutum; in front view head width about 1.3x its length; POL 1.6x OOL; lower margin of clypeus slightly convex anteriorly, not emarginate (Fig. 5), upper margin of clypeus not distinctly demarcated from face; right mandible with 4 teeth; left mandible with 3 teeth; scrobe shallow, margins not quite



Figs. 4 - 7 : *Callitula bambusae* Narendra & Jobraj sp. nov. Female. 4. Female body profile; 5. Female head front view; 6. Mesosoma dorsal view; 7. Male antenna.

distinct; eye height 1.5x its dorsal length; malar sulcus a little more than 0.37x eye height in side view; temples 0.33x eye length; antennal toruli situated middle of face. Antennal formula 11353; scape reaching level of vertex; 0.83x eye height; clava with a spicule like projection; third anellus longer than second anellus. Relative measurement of length : width of antennal segments :- scpae=55:7; pedicel=19:8; F1=12:9; F2=12:9; F3=11:9; F4=12:9; F5=11:9; clava=30:11.

Mesosoma : closely reticulate, its length 1.67x its maximum width; mesoscutum length 2.6x its length; mesoscutum and scutellum distinctly and closely reticulate; pronotum with a submedian

carina; pronotum irregularly reticulate; notauli incomplete; scutellum with 4 pairs of setae. convex, its length subequal to its width (35:36). Propodeum fully reticulate on median part, on sides rugosely reticulate, plicae hardly indicated; callus pubescent, mesopleuron and metapleuron fully reticulate except for a smooth area on upper epimeron; hind coxa weakly aciculate on dorsal side. Forewing length 2.48x its maximum width; with a row of 8 ventral setae below MV, basal half asetose (Fig. 4). Relative lengths of forewing veins; SMV=57; MV=28; PMV=14; STV=13.

Gaster : sessile, petiole hardly distinct; gaster length 0.86x combined length of head and mesosoma; T1 largest; T2 longer than T3; ovipositor sheath subequal to epipygium in dorsal length.

Male : Similar to female except in having third anellus relatively larger (Fig. 7); gaster distinctly shorter than mesosoma; antennal segments differ in size.

Host : Collected from *Bambusa* inflorescence.

Etymology : The species name is after the name of the host plant, namely *Bambusa* sp.

Holotype Female : INDIA, Kerala, Trivandrum, Palode. 10.iii. 2000, Coll. K. Mohana & T. Jobiraj. (ZSIC).

Paratypes : 5 females and 1 male of same collection data as of Holotype (DZCU).

Discussion : *Callitula bambusae* Narendran & Jobiraj sp. nov. differs from *Callitula rugosa* (Waterston) in the following characters.

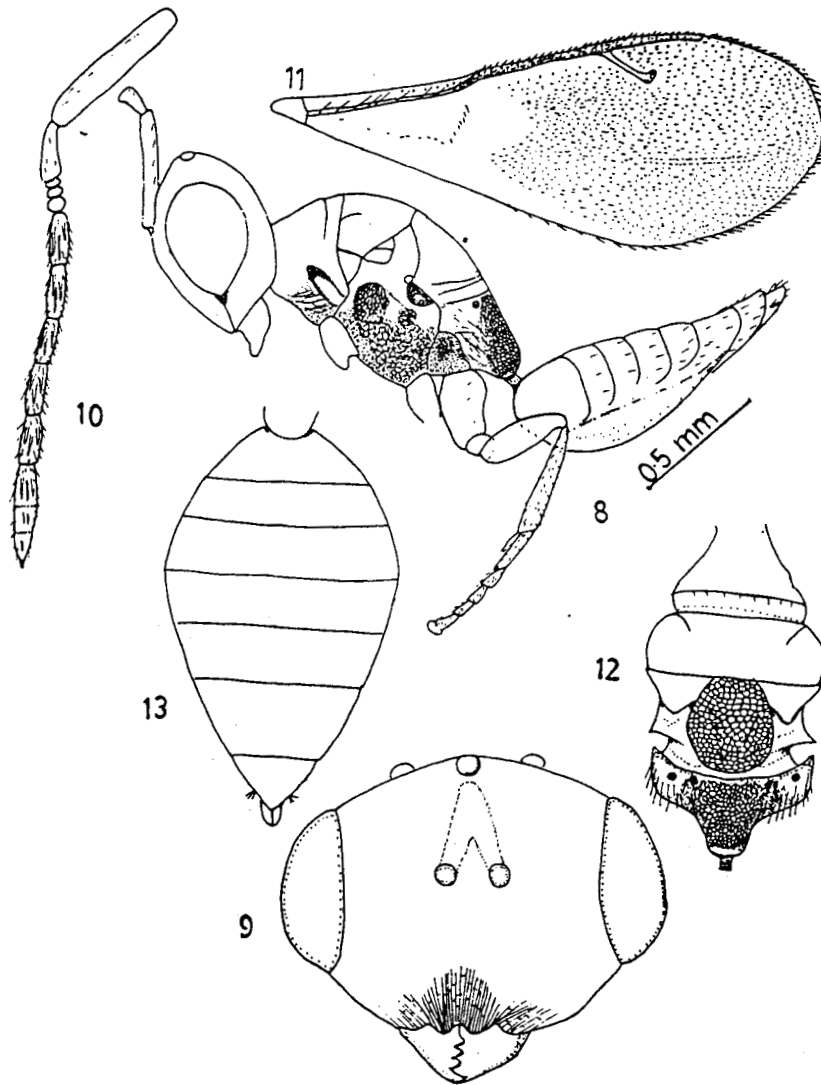
	<i>Callitula bambusae</i> Narendran & Jobiraj sp. nov.	<i>Callitula rugosa</i> (Waterston)
1.	Antenna with 3 anelli	Antenna with 2 anelli
2.	Antennal formula of female 11353	Antennal formula of female 11263
3.	Antennal formula of male 11353	Antennal formula of male 11273
4.	Pedicel of female longer than F1 (19:12)	Pedicel of female equal in length of F1
5.	PMV shorter than MV	PMV longer than MV
6.	Gaster sessile	Gaster petiolate

And in several other features *C. bambusae* differs from *rugosa*. The new species does not fit to key to species by Graham (1969). It differs from all the other species described by Boucek (1964) and Kamijo (1981).

Callitula peethapada Narendran & Mohana sp. nov. (Figs. 8 - 13)

Holotype Female : Length 1.7mm. Head and mesosoma dark metallic green; antenna brown with pedicel, scape and tegula pale yellowish brown; legs (including coxae) pale brownish yellow with slight darker shades on dorsal side of foretarsi and dorsal side of fourth and fifth hind tarsi. Gaster brownish black with pale yellowish brown patch extending from T1 to T5 on dorsal median part, sternites pale brownish yellow. Wings hyaline with veins pale brown. Pubescence silvery.

Head : with uniform distinct engraved reticulation, meshes broader on frons and vertex, face with reticulation forming radiating striae from clypeus; gena with less pronounced reticulations than that of frons; head with 1.3x width of mesosoma, in dorsal view 2.6x its length, in front view



Figs. 8 - 13 : *Callitula peethapada* Narendran & Mohana sp. nov. Female. 8. Body profile; 9. Head front view; 10. Antenna; 11. Forewing; 12. Mesosoma dorsal view; 13. Gaster dorsal view.

1.54x its length. POL 2x OOL; lower margin of clypeus deeply emarginate (Fig. 9); upper margin indistinct, right mandible with 4 teeth and left could not be seen properly since it is covered partly by right mandible. Scrobe shallow, margins indistinct; eye height 1.33x its dorsal length; malar space 0.33x eye height inside view; temples 0.35x as long as eye length; combined length of flagellum and pedicel 1.6x distance that separate eyes in front view; eyes separated by 1.6x eye height; distance between front ocellus and antennal toruli shorter than distance between antennal toruli and lower margins of clypeus; combined length of pedicel and flagellum 1.36x width of head in front view. Antennal formula 11353; scape as long as height of eye, reaching well above

vertex, a little longer than combined length of pedicel, anelli and F1, third anellus longer than preceding ones. Relative measurements of length : width of antennal segments :- scape=43:8; pedicel=16:6; F1=14:6; F2=15:5; F3=12.5:5; F4=14.5; F5=13.6; clava=29:6.

Mesosoma : 1.9x as long as broad; pronotal collar distinctly margined as in Fig. 12; mesoscutum 3x as broad as long, distinctly and closely reticulate; scutellum 1.6x as long as mesoscutum, 1.13x as long as broad, as densely reticulate as that of mesoscutum, with pairs of setae; scutellum length a little more than its width. Propodeum distinctly shorter than scutellum, median area fully reticulate, plicae hardly indicated; callus pubescent; spiracle rounded, separated from metanotum with distance subequal to its diameter; mesopleuron and metapleuron mostly reticulate with a small smooth area on upper epimeron; hind coxa mostly smooth, forewing length 2.6x its width, basal cell mostly asetose but almost closed below of weak setae; speculum open below; basal line with 7 setae; SMV with 9 to 10 setae; costal cell with a distal row of 6 ventral setae below. Relative lengths of forewing veins : SMV=47; MV=37; PMV=25; STV=13.

Gaster : petiolate, petiole reticulate; length of gaster 0.7x combined length of head and mesosoma, 1.06x length of mesosoma; T6 longest; tergites as in Fig. 13.

Male : Unknown

Host : Unknown

Etymology : The species name, *peethapada* in sanskrit means 'yellow legs'.

Holotype Female : INDIA, Kerala, Kayamkulam, 25.v.2000, Coll. K. Mohana (ZSIC).

Discussion : This new species comes very near to the Japanese *Callitula fulvipes* Kamiyo in similar colouration of legs but differs from it in the following features.

	<i>Callitula peethapada</i> Narendran & Mohana sp. nov.	<i>Callitula fulvipes</i> Kamiyo
1.	Scape longer than combined length of pedicel, anelli and F1 together in female	Scape shorter than combined length of pedicel, anelli and F1 together in female
2.	Scape reaching well above level of vertex	Scape reaching slightly above level of vertex
3.	T2 shorter than T3	T2 as long as T3
4.	Face reticulate all over	Face smooth medially
5.	Antennal tortuli nearer to front ocellus	Antennal tortuli equidistant from median ocellus and lower margin of clypeus
6.	Plicae not clearly distinct	Plicae clearly distinct

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