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The anomalous ant-attended mealybugs (Homoptera : Pseudococcidae) of south-east Asia

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Synopsis

The morphology, habits and taxonomy of 12 unusual myrmecophilous mealybugs from south-east Asia are discussed. Unusual characters of some of the species are long antennae, an anal ring without pores, a dense covering of minute setae on the dorsum, long anal lobe setae and large protruding ostioles. The ostioles are unlike any others in the Pseudococcidae and are compared with the siphunculi of aphids. *Allomyrmococcus*, *Hippeococcus*, *Malaicoccus* and *Paramyrmococcus* are aerial genera and are assigned to the subfamily Pseudococcinae. These four genera have many characters in common and a new tribe Allomyrmococcini is erected for them. Two new species of *Malaicoccus* and one new species of *Paramyrmococcus* are described. *Eumyrmococcus* and *Xenococcus* are subterranean and are placed in the subfamily Rhizoecinae.

Introduction

Mealybugs are easy to recognize in life by an elongate-oval body usually covered with mealy or cottony white wax. This wax often extends around the sides to form a series of short filaments but a pair of much longer filaments may be present at the posterior end of the body. Most species have legs which rarely protrude beyond the lateral margins and movement is usually slow. Oviparous females become sedentary and may secrete a noticeable white cottony ovisac.

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In common with all female scale insects, species can be identified only from microscope slide mounts, by the arrangements of body pores and setae. Mealybugs are separated from related groups in possessing at least one of the major characters, cerarii, ostioles, circulus, trilocular pores and tubular ducts which are not cupped at the interior end.

As in all Homoptera, scale insects suck the sap of plants with long stylets and, so far as is known, all mealybug excretion is in the form of honeydew. This substance is excreted in all the families of Coccoidea except the Diaspididae, Conchaspididae, Halimococcidae and certain groups at present assigned to the family Asterolecaniidae. When palatable, honeydew forms an important part of ants' diet and a strong association has been built up between some species of ants and certain Homoptera. The literature discussing this association is extensive and in recent years Nixon (1951), Way (1963) and Wilson (1971) have discussed the subject at some length. Way has defined mutualism as any association beneficial to both the ant and the other insect. Myrmecophilous insects (according to Way) are those which benefit from ants and are more or less adapted to live with them but the relationship need not be obligatory or mutually beneficial.

The majority of myrmecophilous mealybug species having a mutual association with ants are those which a coccidologist would regard as normal and without visible signs of special adaptation. In south-east Asia some myrmecophilous mealybugs have developed most unusual characters and habits and it is the purpose here to describe and discuss this group. At present the group comprises the genera *Allomyrmococcus* Takahashi, *Eumyrmococcus* Silvestri, *Hippeococcus* Reyne, *Malaicoccus* Takahashi, *Paramyrmococcus* Takahashi and *Xenococcus* Silvestri.

Habit

Silvestri (1924) described the first of these mealybugs under the name *Xenococcus annandalei*. It is an elongate-oval species but the abdomen tapers abruptly at the posterior end, and the long antennae are strongly geniculate with a special articulatory mechanism between the first and second segments. One of the most noticeable characters is the dense covering of minute setae on the dorsum which at the time of description had not been seen in mealybugs before. This is a subterranean species found in the nests of the ant *Acropyga acutiventris* Roger. Silvestri described the habit as living on the rootlets of *Ficus* sp. When the soil is damp and warm both ants and mealybugs remain just below the surface under stones but in cold, dry weather they retire deep into the ground. The ants carry away mealybugs in their mandibles when the nest is disturbed and when ants leave the nest, each female carries a female mealybug in her mandibles to new nests elsewhere.

Later Silvestri (1926) described *Eumyrmococcus smithii* from Macao and Shanghai as living under stones with the ant *Acropyga* (*Rhizomyrma*) *sauteri* Forel. Recorded later in Taiwan with the same ant, Takahashi (1934) mentioned that females and workers carry the mealybugs in the mandibles. This species is also densely covered with minute setae and the abdomen is abruptly narrowed but the antennae are short.

Above ground in Thailand were found *Allomyrmococcus acariformis* and *Paramyrmococcus chiengraiensis* described by Takahashi (1941). Both were covered with dense clusters of the ant *Dolichoderus* sp. [= *Hypoclinea*]. *Malaicoccus riouwensis* described by Takahashi (1950) from the Riouw Is (now known as Riau Is) and *M. formicarii* described by Takahashi (1951) from Malaya were both attended by large numbers of *Polyrhachis* sp. This ant carried *M. formicarii* in its mandibles at the constricted part of the thorax. A new species described here as *M. moundi* is also carried at the head or prothorax by the ant *Hypoclinea* sp. (Fig. 1B). Specimens of the mealybug examined in alcohol were firmly grasped in the ants' mandibles which had to be prised apart to release the mealybugs.

Species of *Hippeococcus* described by Reyne (1954) have an even more unusual habit. These species are also aerial, feeding on stems and suckers of various plants, and are covered with ants of the genus *Dolichoderus* (= *Hypoclinea*). Mealybugs of *H. rappardi* Reyne are gleaming without any trace of wax and are very agile. When the ants are disturbed the mealybugs cling to the body, sitting crosswise on the ants' back (Fig. 1A). Immature *H. wegneri* Reyne feeding on young shoots and fruit of *Diospyros kaki* cling to the thorax and other parts of the ant's body. A *Hypoclinea*

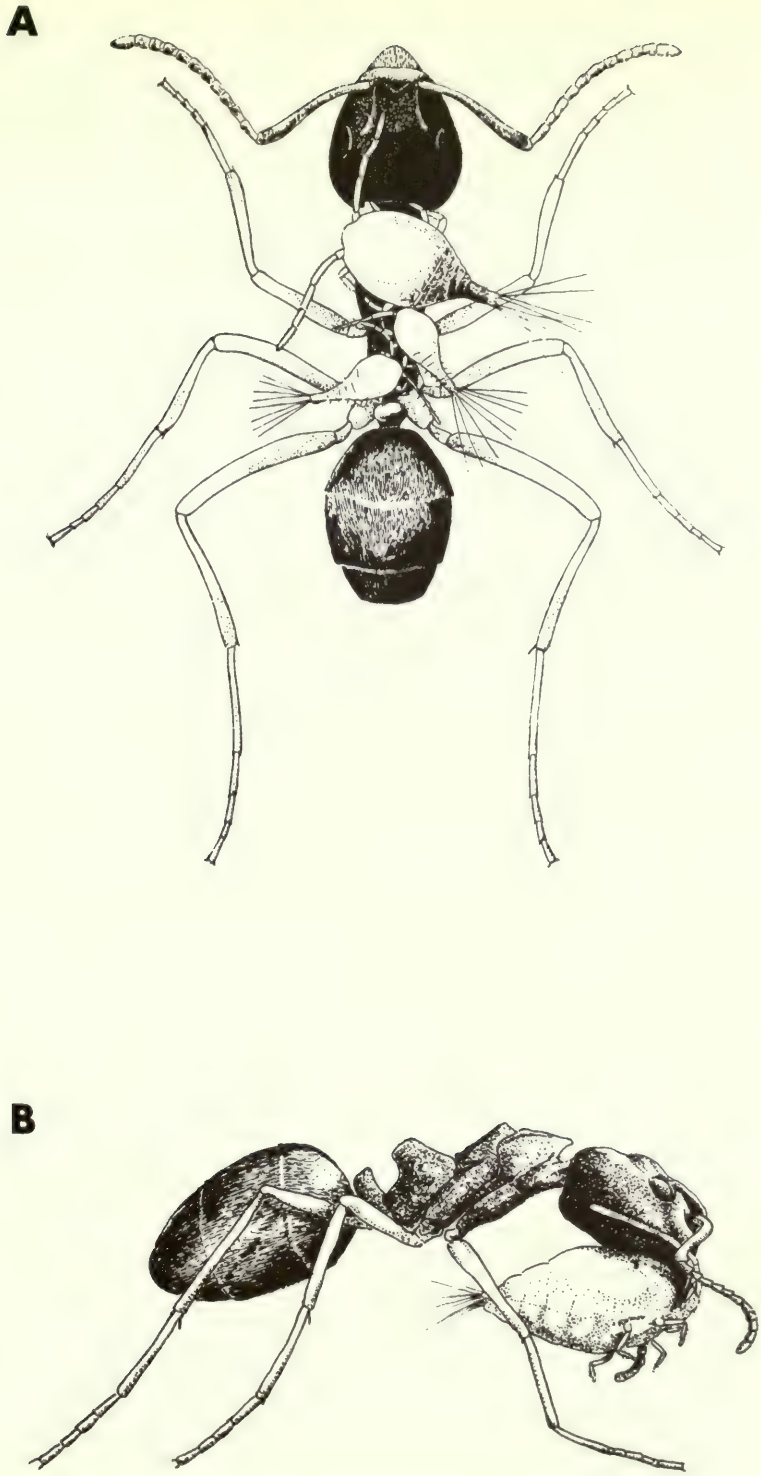

Fig. 1 (A) Ant, *Hypoclinea* sp., carrying *Hippeococcus* sp. on its back. Redrawn from Reyne (1954). (B) Ant, *Hypoclinea* sp., carrying *Malaicoccus khooi* in its mandibles. Drawn specially for this work by Mrs Linda Huddleston of the British Museum (Natural History).

nest is also aerial and sometimes contains numerous mealybugs which, according to Reyne, cling to the ants' bodies when the nest is opened. Ants also drag along swollen adult females and sometimes carry mealybugs in their mandibles. Reyne mentioned that ants were often seen drumming incessantly on a certain spot on the mealybugs and although honeydew was produced as a clear drop at the tip of the abdomen, the ants showed little interest in it. When *H. wegneri*, living on *Cyclanthera explodens*, was disturbed, the ant colony assumed an alarm position and the ants evacuated the mealybugs by first tapping each mealybug with the antennae and then carrying the mealybugs on their backs. Larger mealybugs were often given preference and after the disturbance the ants returned to unload the mealybugs.

These observations reveal an unusual and possibly old association between ant and mealybug but leave many questions unanswered. Broadbent (1951) stated that aphids excreted honeydew only when feeding and if mealybugs excrete in the same manner, it is strange that ants were never seen to take honeydew from *Hippeococcus* on the stems. There were no observations as to whether the mealybugs were feeding inside the nests or whether ants were soliciting them. It is difficult to imagine such a close relationship without ants receiving honeydew at some time and it must be assumed that they take it. No sooty moulds were observed growing on any honeydew falling on plant material. Way (1954) reported that when the ant *Oecophylla longinoda* (Latreille) in Zanzibar was removed from the Coccid *Saissetia zanzibarensis* Williams there was a noticeable fall in the Coccid population because of increased parasitism and suffocation from the Coccid's own honeydew. Das (1959) reported similar suffocation of *Coccus hesperidum* L. on tea in Assam when ants were excluded. The honeydew apparently oozes slowly rather than being ejected for some distance as in *Pulvinaria ribesiae* (Signoret) reported by Newstead (1903). Furthermore, during periods of heavy rainfall in Zanzibar, *O. longinoda* workers were often unable to remain in attendance on the Coccid and the honeydew was washed on to the surrounding leaves. *Hippeococcus* and *Malaicoccus* live in areas where heavy rain beats on ant and mealybug for long periods without any lessening of ant activity. Bünzli (1935) reported that the ant *Rhizomyrma paramariensis* in Surinam carried *Rhizoecus* [=*Neorhizoecus*] *coffeae* Laing and *Geococcus coffeae* Green from wetter to drier areas in underground nests. Way (1954) noted that *Oecophylla longinoda* kept *Saissetia zanzibarensis* numbers at a level which satisfied the honeydew requirements. Flanders (1957), discussing the obligate myrmecophilous mealybug *Chavesia* sp. and the obligate coccidophile *Rhizomyrma fuhrmanni* Forel, stated that the mealybug can feed only on roots exposed by the ant. Furthermore, the worker ant regulates the number of mealybugs feeding at any one time by placing about 70 per cent of the total mealybug population in reserve in a non-feeding position off the roots. How ants remove mealybugs from stems without damaging the stylets has never been observed. In *Hippeococcus* there are apparently numbers of mealybugs on the stems and even greater numbers in ants' nests and one can only speculate that this is a form of regulation by the ant. *Hypoclinea* is not an obligate coccidophile and the question remains whether *Hippeococcus* and the related *Malaicoccus*, *Allomyrmococcus* and *Paramyrmococcus* are obligate myrmecophiles. The answers probably lie in the unusual characters of these mealybugs and these are discussed in the section on morphology.

Distribution

Although Silvestri described *Xenococcus annandalei* from Lake Chilka near the West Bengal border, it has been discovered since in Mysore, southern India and Penang in West Malaysia, northern Vietnam and Hong Kong, always associated with the ant *Acropyga acutiventris* Roger. *Eumyrmococcus smithii* is known from Macao and Shanghai in China and in Japan and Taiwan associated with the ant *Acropyga sauteri*. These two mealybugs are subterranean and probably feed on a wide variety of roots.

Among the aerial species, *Hippeococcus* is known from Java only. *Malaicoccus* is known from Malaya and the Riouw Is in Indonesia but based on the identity of immature stages in this work, a third stage of an apparently new species was mixed with *Allomyrmococcus acariformis* when Takahashi described it from Thailand. *Paramyrmococcus* is discussed here from Thailand and

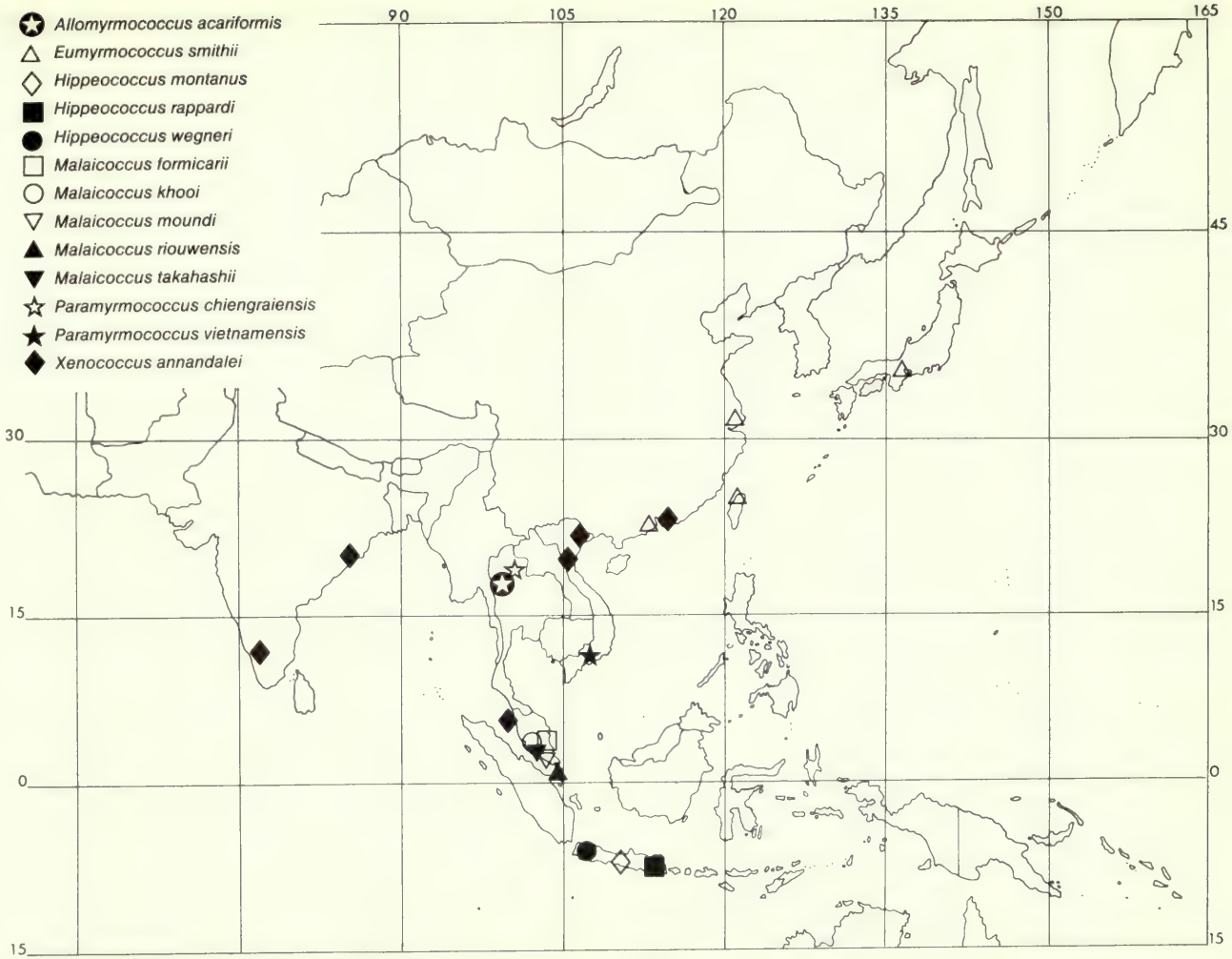

Fig. 2 Distribution of myrmecophilous mealybugs in south-east Asia.

Vietnam. These aerial species seem to be attended only by ants of the genera *Hypoclinea* and *Polyrhachis* which are widespread in south-east Asia. The mealybugs will probably have a distribution throughout the area wherever the ants are present. Since this paper went to press the writer has received a new species of *Malaicoccus* attended by *Hypoclinea* sp. from Sarawak near the border with Sabah.

Morphology

Body

In life the body shape tends to be clavate with the head and thorax dilated and with the abdomen narrowing abruptly at about the third segment. Only in *Malaicoccus* is the abdomen broadly rounded. The body of *Xenococcus* is widest at about the first abdominal segment but the body still has a clavate appearance by the enormous basal segments to the antennae. *Paramyrmococcus* is more turbinate. In South America *Chavesia* has a similar body shape to that of *Eumyrmococcus*. *Chavesia* seems to have developed along similar lines to the genera in south-east Asia and there is strong evidence that *Xenococcus* and *Eumyrmococcus* are closely related to *Chavesia* but that *Allomyrmococcus*, *Paramyrmococcus*, *Malaicoccus* and *Hippeococcus* form a separate group. Coccidologists become used to studying flattened insects on slides, discussing only dorsal and ventral surfaces and forgetting that species have lateral sides. In all the genera from south-east Asia and South America the abdomen curves upwards at the posterior end, as shown by Silvestri (1924; 1926) and by Balachowsky (1957). It is not clear what advantage this gives to the mealybug or the ant. When an ant strokes a mealybug the abruptly narrowed abdomen may resemble an ant petiole and so the mealybug may be more readily accepted. Ants seem to carry these mealybugs near the head and prothorax whereas ants carry mealybugs of more normal shape at about the first abdominal segment. As Bünzli (1935) has remarked, the mandible marks may disappear but sometimes they may persist. *Malaicoccus* has developed heavy sclerotization on the head at the point where they are carried.

Legs

The legs of all species are well developed and reach their greatest length in *Allomyrmococcus* when they are longer than the body. Reyne (1954) has mentioned that *Hippeococcus* moves quickly yet Strickland (1950) stated that in West Africa the mealybugs associated with ants have shorter legs than the active longer legged species that are not associated with ants. The leg setae are well developed on each species and sometimes they are abundant. The claw gives some clue that these mealybugs belong to two distinct groups. In *Xenococcus* and *Eumyrmococcus* the claw is long and slender with a pair of short setose digitules at the base but in the other four genera the claw is stout with a pair of large flattened digitules which are usually twice as long as the claw. Reyne (1954) has suggested that *Hippeococcus* uses the digitules to cling to the ants' bodies and this seems a reasonable deduction. It should be remembered that these large flattened digitules are present in *Allomyrmococcus*, *Paramyrmococcus* and *Malaicoccus* also but these mealybugs apparently do not cling to ants' bodies. The tarsus of each species has a single campaniform sensillum at the outer proximal end, a structure discussed recently by Koteja (1974*b*).

Antennae

Eumyrmococcus has short 2-segmented antennae but in *Xenococcus* the antennae are 4-segmented of a most unusual type. These are long and strongly geniculate with a large basal segment. The articulation between the first and second segments is so well developed that the antennae can bend from a forward position to one lying along the back of the mealybug. Helping in this movement are small teeth on the outer proximal corner of the second segment which fit into grooves on the outer distal corner of the first segment. Long pointed setae are present on all the segments and on the third and fourth segments some setae are as long as the segments. As *Xenococcus* lives underground it is probably advantageous for the mealybug to streamline its body by folding

the antennae along the back but in other circumstances the antennae may be used for recognizing an ant.

The antennae of the other four genera are 6-segmented and are unlike those of any other mealybugs. In each species and in all stages, the second segment is short and does not articulate with the third segment. In the first stage larvae, long setae form whorls mainly at the distal ends of the segments but in *Paramyrmococcus vietnamensis* the fifth and sixth segments have numerous short setae also. Short setae are present on all second instars and they become more numerous and longer on each successive stage so that the adult antennae are densely covered. The antennae in most adult females of this group are about as long as the body. It is difficult to understand why these insects have such long and well-developed antennae. It is usual for an ant to feel or stroke a mealybug before either attending one or carrying one away. Mealybugs of *Hippeococcus* and possibly those of related genera may equally seek out or recognize an ant with their long antennae.

Setae

One of the striking characters of nearly all these mealybugs and the South American genus *Chavesia* is the dense covering of minute setae over the entire body or at least over the dorsum. In many species the setae are short and are so numerous that the distance between the setal bases is much shorter than the length of a single seta. These mealybugs are without the usual protection of mealy or flocculent wax and the numerous setae may act as an alternative protective covering. By trapping air between the setae, the body surface of underground species would be protected from excessive moisture. The aerial species are exposed to heavy rains for long periods and the dense covering of setae may have a waterproofing effect.

Some species do not have such dense coverings. Adult *Hippeococcus* have, in addition to minute pointed setae, small blunt setae of uncertain function. Longer clavate and fleshy setae, which in *H. rappardi* are present in the first stage only, persist in all stages in *H. wegneri*. In many of the immature stages of *Malaicoccus* there are minute setae in varying numbers, each with the seta shorter than the diameter of the setal base. Immature *Paramyrmococcus* have body setae which are short, cylindrical and blunt but these are replaced by numerous short pointed setae in the adult. A few setae which are flat and variously shaped are present on the head and thorax of *Xenococcus*. There is little difference, apart from abundance, in the arrangement of the setae in the stages of *Allomyrmococcus* but immature stages have extra long setae on parts of the body. Adult mealybugs, therefore, usually have some characters such as the addition of special body setae or the loss of long setae, which distinguish them from the immature stages. Ants may be able to recognize these differences by quickly stroking the mealybug's body.

Anal areas

This section includes the anal ring, anal lobes, anal lobe setae and any other structures at the apex of the abdomen. The anal ring is usually sclerotized with 6 setae of various lengths and always without pores except for a few minute pore-like openings in *Malaicoccus*. In the more usual mealybugs, of which *Pseudococcus obscurus* Essig is an example, a short wax tube is secreted from pores around the anal ring. Honeydew droplets are, therefore, excreted a short distance from the body surface. A colony of *P. obscurus* on a potato tuber at times ejected honeydew for a distance of 2–4 cm. This honeydew is clear and sticks to the surrounding foliage, but each droplet of honeydew of the cochineal insect *Dactylopius coccus* Costa is coated with fine wax and falls directly to the ground without sticking to the plant. Broadbent (1951) has mentioned that the aphid *Hayhurstia atriplicis* (L.) excreted globules coated with wax from contact with the wax covering of the aphid. There is always the possibility that wax coating may affect the palatability to ants. No observations have yet been made on the honeydew of the myrmecophilous mealybugs.

Reyne (1954) has stated that *Hippeococcus rappardi* had usually a clear drop of liquid between widely diverging silvery hairs, which are presumably the anal hairs. In *Chavesia*, Beardsley (1970) has described the anal lobes as protuberant and sclerotized on the ventral surface. The anal ring is in a membranous depression on the dorsal surface of the lobes. These lobes also contain

numerous setae and the whole structure forms what Beardsley has called a honeydew basket. A similar structure is present in *Allomyrmococcus* and *Malaicoccus* but the anal ring may be terminal or situated a short distance from the apex. In *Hippeococcus* and *Xenococcus* the anal ring lies at the apex of the dorsum which projects beyond the ventral anal lobes. Wherever the anal ring is placed it is within easy access for the ant and in the absence of pores it seems likely that honeydew remains at the apex of the abdomen until the ant removes it. Broadbent (1951) has described how the aphid *Hyalopterus pruni* (Geoffroy) kicks away globules with the hind legs. Normally the legs of mealybugs are too short to reach the anus but in the absence of ants most of the myrmecophilous mealybugs in this discussion could remove globules with their legs if necessary but this has not been observed.

Long anal lobe setae are present in all genera except *Paramyrmococcus*. Sometimes they are numerous and are longer than the body. Their function is uncertain and their absence in *Paramyrmococcus* does not seem to affect the myrmecophilous habit.

As previously stated, honeydew is probably produced only when the mealybugs are feeding. Furthermore excretion rates may be increased by ants attending mealybugs and removing honeydew. It is usual for an ant to stimulate the mealybug into giving up a drop of honeydew by palpating the abdomen, but the mechanism of this stimulation is not understood. In the Coccidae, Way (1954) and Smith (1942) have discussed how ants solicit species of *Saissetia* by dragging the tips of the antennae back and forth over the caudal end of the body. *Saissetia* and *Udinia* are two related genera often solicited by ants in the tropics but species of both genera have long primary discal setae on the anal plates which when touched may induce the Coccid to open the plates and excrete some honeydew. By stroking the anal ring setae, ants may induce mealybugs to excrete a droplet.

Body pores

An important feature of the myrmecophilous mealybugs is the almost complete absence of pores and ducts. All species have been described without surface wax, and Reyne (1954) described *Hippeococcus* as having a gleaming body. *Eumyrmococcus* and *Xenococcus* are completely without body wax pores and in all the other genera the only pores present in the female stages are trilocular and a few simple pores except in some species of *Malaicoccus* which have a few oral collar ducts in the mid-thorax and anterior abdominal segments. In most species the trilocular pores are quite sparse but in *Hippeococcus* and certain *Malaicoccus* species they are more numerous. It is only the second stage male which has the more usual pores associated with mealybugs. In *H. wegneri* and *M. moundi* the second stage males have multilocular disc pores and oral collar tubular ducts and it is assumed that these secrete the waxy covering for the pupal stage. Nixon (1951) has given a few examples of ants removing wax coverings of mealybugs. For instance, Le Pelley (1943) noted that ants removed wax completely from certain areas of the body of *Pseudococcus* [=*Planococcus*] *lilacinus* (Cockerell) in the Philippines. It is not clear how male mealybug pupae could retain wax coverings in the presence of attending ants. Nevertheless, the gleaming and waxless condition of myrmecophilous mealybugs is probably the result of specialization in the continual presence of ants. Recently Delage-Darchen et al. (1972) have noted an unusual association between Diaspidid scale insects and ants. The scale insects live in tunnels in woody stems and are attended by ants in so far as ants remove the scale coverings. One species of these scale insects is completely without dorsal ducts so that no scale could be secreted anyway. Similar observations with scale insects have also been made by Prins et al. (1975). Although ants may remove wax for food it is also possible that in time species that would normally secrete a wax covering evolve without even any means of producing one. It is difficult to understand how ants benefit from species not producing honeydew.

Labium

The labium of Pseudococcidae is conical and 3-segmented and its morphology has been studied by Koteja (1974*a*) whose terminology is used here. The basal segment is small with a pair of rounded sclerites, often fused medially with the medial segment, and contains 2 pairs of short

setae and one longer pair. On the medial segment there is a basic number of 1 pair of setae. The apical segment has 2 or 3 pairs of posterior setae on the posterior or under surface, a pair of short apical setae, 4 pairs of subapical setae, one pair of lateral setae and 2 pairs of anterior setae situated near the base. In many species there are supernumerary setae anterior to the lateral setae.

Koteja recognized the four subfamilies Trabutininae, Pseudococcinae, Rhizoecinae and Sphaerococcinae. The Trabutininae is separated from the others, using the character of the labium only, in possessing 3 pairs of posterior setae. All the species studied in this work have 2 pairs of posterior setae and the species are separated from the Sphaerococcinae in having a well-developed basal segment not fused totally with the medial segment. The labium of Rhizoecinae, according to Koteja, differs from that of the Pseudococcinae in being small and narrow with the third subapical setae distinctly stouter than the others and with the lateral setae about twice as long as the other labial setae. Williams (1969) has already placed *Eumyrmococcus* in the Rhizoecinae on other grounds but the labium of this genus has a width–length ratio of 1 : 2, there are 14 pairs of setae and the subapical setae become progressively longer towards the base. *Xenococcus* has a labial width–length ratio of 1 : 1·87 when flattened on the slide and 1 : 2·27 when not flattened. The number of setae varies from 12 to 13 and the subapical setae are remarkable in extending more than half way to the base of the apical segment. As in *Eumyrmococcus* these subapical setae become progressively longer towards the base of the segment. For reasons to be given later under classification, *Xenococcus* should be assigned also to the Rhizoecinae.

In the genera *Hippeococcus*, *Malaicoccus* and *Paramyrmococcus* the width–length ratio of the labium varies considerably from 1 : 1·4 in *P. chiengraiensis* to 1 : 1·92 in *Malaicoccus khooi*. Despite this range in size there is reason to believe that these genera with *Allomyrmococcus* belong to the Pseudococcinae. In *Allomyrmococcus* and *Malaicoccus* the total number of setae varies from 20 to 32 pairs in the adult female but in the first and second stages they become reduced to the basic number of 14 pairs.

Circulus

The circulus, when present, is a round or oval sclerotized area, surrounded by a rim, usually lying on venter between the fourth and fifth abdominal segments. Occasionally it may lie within the borders of the fourth segment and some species may have several circuli on different segments. In the Rhizoecinae the circulus is usually small and round but heavily sclerotized, conical and often with an irregular surface. Pesson (1939a) and Lloyd & Martini (1957) have shown that adult females of the genera *Pseudococcus* or *Phenacoccus* use the circulus as an adhesive organ when viewed in profile against a glass surface. The circulus is exserted and then adpressed to the surface allowing the insect to make exploratory leg movements, the body actually pivoting at the circulus. This use seems to be restricted to the adult female because Lloyd & Martini observed that the three nymphal instars were able to ascend or descend with ease by leg actions presumably with the help of the claw digitules.

No similar research has been done on the circulus of the Rhizoecinae but Silvestri (1924), working on alcohol material of *Xenococcus annandalei*, suggested that the circulus of this species secreted some kind of liquid possibly attractive to ants. Whatever its function it does seem that the circulus of the Rhizoecinae has been derived from those of the other groups of the Pseudococcidae.

Ostioles

Among the Coccoidea the Pseudococcidae are unique in usually possessing 2 pairs of transverse slit-like organs on the dorsal surface, commonly named ostioles. In *Allomyrmococcus*, *Hippeococcus*, *Malaicoccus* and *Paramyrmococcus* the ostioles reach an unusual development and this seems an appropriate place to discuss their structure and to compare them with siphunculi or cornicles in aphids.

Occasionally some species of such genera as *Rhodania* Goux and *Ehrhornia* Ferris are without ostioles but they may be present in some of the immature stages where they are limited to the posterior pair only. In adult females of *Antonina*, ostioles may be present as a poorly developed

posterior pair only. The absence or reduction of ostioles is correlated with the amount of external wax secreted from the pores, the term wax being used here in its general sense. Usually those species producing large amounts of dorsal wax or those which become almost enclosed in a felted ovisac, as in *Antonina*, have reduced ostioles.

According to Ferris & Murdock (1936) the anterior pair belong to the pronotum and the posterior pair to the sixth abdominal segment. Pesson (1939b), however, after an overall study of the musculature, concluded that the anterior pair are placed slightly forward to the anterior edge of the prothorax and the posterior pair lie between the fifth and sixth abdominal segments.

Viewed from above each ostiole is composed of two membranous lips which often contain numerous setae and trilocular pores. The inner edges of the lips are usually sclerotized and sometimes these inner edges are the only parts visible.

Šulc (1909) observed in *Phenacoccus farinosus* (de Geer) that blood corpuscles oozed from the ostioles after pressure was applied to the body. He also observed some muscles parallel to and perpendicular to the lips of the ostioles.

In histological studies Ferris & Murdock (1936) found no muscle attachments on these structures and concluded that they led directly into the haemocoele. When the insect was stimulated by an application of violence, a globule of liquid appeared which quickly hardened on exposure to air. The globule, according to Ferris & Murdock, was merely a portion of the body fluids.

In more detailed histological studies, Pesson (1939b) found that in a transverse section, the edges of the slit are continued into the body cavity as a chitinized depression, the median part of which forms an orifice leading directly to the haemocoele. From the lateral inner ends of the depression in each anterior ostiole are inserted two muscles, the anterior or inner muscle inserting itself obliquely to the inner edge of and lateral to the clypeus, and the posterior or outer muscle attached a little anterior to the first leg. There are also two similar muscles in each posterior ostiole which are attached ventrally. If an ostiole is regarded as a valve then normally it should prevent blood loss when at rest but after an application of some body violence near an ostiole the muscles contract and open the lips slightly to emit a droplet of blood or other contents of the haemocoele. This emission, according to Pesson, is nothing more than reflex-bleeding or autohaemorrhage.

Šulc (1909) noted that the expelled wax, on hardening in contact with air, could have a protecting roll by coating the oral parts of an attacker. Pesson never witnessed this in *Pseudococcus adonidum* (L.) [=*P. longispinus* (Targioni-Tozzetti)] and indicated that the liquid expelled is from the free wax occurring in the blood as corpuscles. After repeated excitation of the surrounding cuticle young wax-producing cells may be emitted. Wheeler (1921), in his studies of the myrmecophyte *Tachigalia* and the attending behaviour of beetles of the genus *Coccidotropus* on *Pseudococcus bromeliae* (Bouché) [=*Dysmicoccus brevipes* (Cockerell)], observed that the beetles were interested only in the honeydew excreted and were never immobilized or impeded by any secretion from the ostioles. He stated that the beetles may be attracted by some fascinating aroma secreted by the mealybug but did not actually state that this was emitted from the ostioles.

After Coccoidea are macerated in potash as a first step in the mounting technique there are often observed certain internal wax globules varying in quantity as to the family. It is in the Pseudococcidae that this internal wax is most strikingly abundant and it is apparently this free wax which is expelled through the ostioles.

The posterior ostioles have often been homologized with the cornicles or siphunculi of aphids. Little work has been done so far on ostioles but in recent years work on siphunculi has been extensive. A résumé of recent work on siphunculi in aphids is given here and it is hoped this may stimulate further work on ostioles.

It was shown by Hottes (1928) that cornicles are situated on the dorsolateral surfaces of the sixth abdominal segment. In their most conspicuous form they are cylindrical and longer than wide. Usually the longer cornicles are movable but at the tip of all cornicles there is a slit-like opening which may be opened or closed by a valve moved by a muscle attached near the median-free portion of the valve. The valve is attached at the apex by a flexible hinge. Hottes further indicated that, although cornicles may be movable, the possibility that droplets can be aimed is practically nil. The function of the cornicles, according to Hottes, was not a defence mechanism

but was part of the metabolic processes carried out by the aphid and that the cornicles have an excretionary function. Furthermore, the presence or absence of cornicles may be correlated with the presence or absence of wax pores or a lower reproduction rate. Hottes stated that as aphids have often evolved along with their hosts the change in structure of the cornicles may be the result of the nature of the food consumed.

Despite Hottes' rejection of the defence mechanism function of cornicles, Dixon (1958) observed that if the larva of the coccinelid *Adalia decempunctata* (L.) was smaller than the aphid *Microsiphum evansi* (Theobald) and seized an appendage, the aphid could escape by pulling the appendage free. If the coccinelid larva and aphid were about the same size the aphid could escape if the siphunculus nearest the appendage swung over and placed a drop of oily liquid on the coccinelid's head where the drop would spread over the mouthparts and solidify.

Reflex-bleeding discussed by Hottes was confirmed in aphids by Edwards (1966) who stated that when the cornicle valve is opened, the aphid released material from the haemocoele. As no solvent of the internal material was detected by gas chromatography he explained that the fluid is in a stable liquid–crystalline state within the aphid and changes to the solid crystal phase with a seeding nucleus. He further stated that the rapid crystallization on contact with a solid surface, a hair or duct, suggests that the liquid was in a supercooled state and that foreign material provides a seeding nucleus. The melting point of the waxes of three species of aphids ranged from 37·5 °C to 48 °C so that the waxes should crystallize on seeding at normal summer temperatures. Studying the cornicle area of various species of aphids, Wynn & Boudreaux (1972) found that in *Cinara* and *Longistigma* a multicellular sac possessing a wall, formed from a layer of flat cells with compressed nuclei, extends into the cornicle. This sac is surrounded by vacuolated fat cells and a mass of lipid is found in the sac. All the aphids studied possessed a muscle inserting on the cornicle valve and originating on the venter below the cornicle. The authors suggest that this muscle, in addition to opening the valve at the distal end of the cornicle, may also assist in elevating the cornicle. They also suggest that a dorsoventral muscle just anterior to the cornicle appears to be used in association with other dorsoventral muscles in compressing the body contents causing the emission of a droplet. In each case the cornicle communicates with the haemolymph and blood cells including fat cells escape. The colour of the cornicle droplet corresponds with the colour of the aphid and its haemolymph.

In contrast, Lindsay (1969), studying the cornicles of the pea aphid *Acyrtosiphon pisum* (Harris), stated that the term reflex-bleeding as applied to cornicle exudation is inapplicable since, although a small amount of haemolymph may escape, the primary exudate is the cornicle cells. Analysis of these cornicle cells indicates a close similarity to those of the fat-body cells in composition. Lindsay suggested that the fat-body cells and cornicle cells are homologous, the fat body being a precursor of the cornicle cells and that there is a greater tendency of the cornicle cells to crystallize compared with those of the fat-body cells.

Evidence that haemolymph is not extruded through the cornicles was presented by Strong (1967) who stated that lipids were the principal constituents of the hardened cornicle droplets and were composed solely of triglycerides. Histological preparations by Chen & Edwards (1972) showed that the cornicle secretionary cells are present inside a sac separated by a thin acellular lamina from the haemolymph. The sac is formed by an invagination of the epidermal basal lamina reflected back from the tip of the cornicle. The enclosed secretionary cells are comparable with epidermal gland cells or subepidermal oenocytes. Fluid in the sac differs in composition from the haemolymph and the fluids released through the cornicle are thus not a direct loss of haemolymph but are presumably derived from the haemolymph.

Referring to the triglycerides in the cornicle secretions, Callow et al. (1973) found that the secretions in any one species are the same and that different species of aphids taken from the same host plant have different secretions. The authors found it was easier to obtain droplets from young or small aphids rather than large aphids and they presumed that the larger aphids have less need of a defence mechanism. This is interesting because as already stated ostioles may be present in immature mealybugs and absent in adults although defence mechanisms in mealybugs have not been proved there may be a greater need for ostioles in immatures for different reasons. Analysis by Greenway & Griffiths (1973) of the body triglycerides showed them to contain

the same fatty acid radicles as in the cornicles but in many species there are greater proportions of some triglycerides in the body. When an aphid is overstimulated the composition of the cornicle secretions gradually becomes the same as the body contents.

Speculative suggestions that odours may be emitted by mealybug ostioles have not so far been confirmed but Dahl (1971) reported that odours from crushed aphids repelled other apids. Kislow & Edwards (1972) found that certain aphids are repelled by the odour from cornicle droplets and squashed specimens of the same species. These authors proposed that when there is a slow release of odour it may cause intraspecific spacing of aphids, prevent the influx of other species or even induce aphids to migrate. The alarm pheromone was identified as trans-β-farnesene or TBF in some aphids by Bowers et al. (1972). Nault et al. (1973) showed that the alarm pheromone is known to be interspecific and that the receptor of this repellent odour is the primary sensorium on segment 6 of the antenna. The existence of multiple alarm pheromones was suggested by Nault & Bowers (1974) who found that *Hydaphis erysimi* (Kaltenbach) does not respond to pure TBF and they suggest that the aphid produces one or more other compounds in addition to TBF to produce alarm activity.

Before referring once more to ostioles in mealybugs it is interesting that Dixon & Stewart (1975) after blocking the openings of siphunculi of the sycamore aphid *Drepanosiphum platanoides* (Schrank) found that this occlusion had no adverse effect on the number of offspring produced or on the weight of the aphid. Furthermore, aphids with occluded siphunculi do not space out differently from aphids with normal siphunculi and that the aphid takes most avoiding action when the smell of the pheromone is accompanied by vibrations associated with a struggling aphid.

There is obviously a need for much further research on ostioles. Even a cursory glance at the ostioles of *Allomyrmococcus*, *Paramyrmococcus* and *Hippeococcus* shows that they are much more highly developed than in normal mealybugs. The sclerotized lips have their greatest development in any mealybugs known to the author. Although in the illustrations they are located on the edges, this is due to dorsoventral flattening when specimens are prepared on microscope slides but even in specimens preserved in alcohol they are unusually large and conspicuous with the sclerotized lips protruding on the dorsolateral areas of the body. Their most unusual development is found in *Malaicoccus*. In this genus the anterior pair are often located on the ventral surface on slide preparations. Each ostiole appears to have a fixed anterior sclerotized lip but the posterior lip is a large hinged semicircular flap often containing numerous setae. This flap is often seen completely closed but in some specimens it is open and raised at a right-angle.

In the four genera there is in each ostiole a membrane, easily taking up stain, which completely covers the opening of the lips. It is not certain, working only from microscope preparations, whether there is any opening on this membrane. There is in some specimens a hole or slit on the surface but this may be due to tearing during the mounting technique. The membrane may normally be internal and may be exserted as a result of pressure on the body when flattened.

Why these species should possess such complicated ostioles is still uncertain but the mealybugs, as explained earlier, are transported when the ants are disturbed. Although ants are attracted to excretions of honeydew it is doubtful if honeydew has any odour over long distances but any odour from the ostioles would attract ants and thus help them to transport mealybugs back to the preferred host plants. This is conjecture but any work on pheromones must be done in areas where the mealybugs are common. It is easy to bring aphids into the laboratory for study but much more difficult to experiment with the most interesting of mealybugs which inhabit the tropics. If there is an odour from ostioles of these myrmecophilous mealybugs to attract ants, then there is possibly a similar odour emitted, as suggested by Wheeler, from those mealybugs with a less obligatory association with ants. Any research on this odour could lead to an alteration of the relationship between ants and mealybugs and could possibly help in controlling mealybugs. Mutual association with ants in the Palaearctic Region is common in such mealybugs as *Chnaurococcus subterraneus* (Newstead) and *Euripersia europaea* (Newstead), species which may be useful for research, and in the sugar-cane areas mealybugs living in association with ants are common enough to afford the means for easy research. It is doubtful, for instance, whether alarm pheromones are emitted by mealybugs as in aphids but any work on mealybug ostioles that may determine if their function is different from reflex-bleeding usually propounded would be useful.

Classification

Xenococcus and *Eumyrmococcus* seem to belong to the subfamily Rhizoecinae. Williams (1969) placed *Eumyrmococcus* in this group because it possesses long slender claws with setose digitules and 3 pairs of long anal lobe setae. *Xenococcus* has similar long claws and also 2 circuli which are round, sclerotized and slightly conical. The antennae are not typical of the Rhizoecinae but the reduction in the number of segments suggests a relationship. The long slender labium of both genera each have a width–length ratio of 1 : 2 and the assignment of the genera to the Rhizoecinae agrees with research of the group made by Koteja (1974*a*; 1974*c*). Beardsley (1970) tentatively placed the genus *Chavesia* in the Rhizoecinae and this is probably correct. Some of these species have 4-segmented antennae but of a different shape to those of *Xenococcus*. The labium of *Chavesia* has a width–length ratio varying from 1 : 1·33 to 1 : 2·00 but Beardsley has described it as being 2-segmented only so that the addition of the basal segment would alter the width–length ratio. The labium of *C. trinidadensis* Beardsley has a similar shape to the labium of *Xenococcus*.

The four genera *Allomyrmococcus*, *Hippeococcus*, *Malaicoccus* and *Paramyrmococcus* have many characters in common. The antennae and claws are remarkably similar and so unusual that a new tribe is here erected for the genera within the subfamily Pseudococcinae. In the absence of adult males it is not possible to give the relationship of the tribe.

Separation of the subfamilies Pseudococcinae and Rhizoecinae in this work is based mainly on the shape of the claw and the width–length ratio of the labium but it must be stressed that the species under discussion belong to aberrant genera which are not typical of the subfamilies.

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Abbreviations of the type-depositories mentioned in the text are as follows.

BMNH, London	British Museum (Natural History), London
IEAUN, Portici	Istituto di Entomologia Agraria dell'Università di Napoli, Portici
ITZ, Amsterdam	Instituut voor Taxonomische Zoölogie, Amsterdam
RNH, Leiden	Rijksmuseum van Natuurlijke Historie, Leiden
TARI, Taipeh	Taiwan Agricultural Research Institute, Taipeh
UM, Kuala Lumpur	University of Malaya, Kuala Lumpur
USNM, Washington	United States National Museum, Washington

Taxonomic treatment

An ideal classification of Coccoidea should be based on the taxonomy of adult males but so few males have been studied that identification is possible only with adult females which are neotenic. Female Pseudococcidae usually have three immature instars and males two immature and two pupal instars. There is often little to distinguish immatures from adult females in life apart from size. It is the experience of the writer, who has been engaged in identification of Coccoidea for many years, that identification of immature stages is often just as important to the collector as identification of the adult. When a new species is named, the name applies to all stages, not just to the stage mentioned in the description. In the present work available immature stages are discussed along with adult females.

PSEUDOCOCCINAE

ALLOMYRMOCOCCINI trib. n.

Type-genus: *Allomyrmococcus* Takahashi, 1941.

Pseudococcinae with body of adult female variously shaped, turbinate, or with abdomen rounded or abruptly narrowed at third segment. Head either membranous or heavily sclerotized when there is a deep constriction at about the prothorax. Anal lobes either wanting, in which case the anal lobe setae are short, or well developed with long anal lobe setae about as long as body. Anal ring usually sclerotized, terminal or situated a short distance from apex, with 6 setae but without pores except in one genus with minute pore-like structures. Antennae 6-segmented, stout, well developed and often as long as body, of a distinctive shape. The first segment on dorsum when mounted on slide, often large and wide; second segment short and not articulating with third segment. Remaining segments long, widest at distal end except the last segment, which is often depressed near middle of segment and variously curved. Fourth to sixth segments with abundant short setae, the distance between setal bases shorter than length of a seta. First and second segments with or without abundant setae. Longer and stouter sensory setae present on last segment. Legs well developed, long, the tarsus much shorter than tibia, often with numerous setae. Claw stout, each with a pair of flattened and expanded digitules, these about twice as long as claw and about same width. Labium conical, with 3 segments and with basic number of 14 pairs of setae but sometimes with as many as 32 pairs. Ostioles situated on edges of body when mounted on slide or lying on ventral surface, with an unusual development with heavily sclerotized and wide projecting lips, without setae or with posterior lip in form of sclerotized flap with numerous setae, the inner edges of lips joined by a membrane. Circulus present or absent. Body setae short, often abundant when they may cover the entire body surface except for intersegmental areas. When less abundant they may be accompanied with short blunt setae. Body pores often restricted to trilocular pores and simple pores but occasionally a few oral collar ducts may be present in mid-thoracic and anterior abdominal segments.

Discussion. Based on the characters of the adult female, the tribe is one of the most distinctive in the family Pseudococcidae. As mentioned earlier in the section on classification, no adult males have been studied to give a clue to the relationship of the tribe. The evidence suggests that males exist and there is a pressing need for further observations in the areas where the tribe is known.

Distribution. Thus far the tribe occurs in Thailand, West Malaysia (Malaya), Sarawak, Indonesia and Vietnam but the distribution may be extended after further study is made of nests of the ants *Hypoclinea* and *Polyrhachis*.

Key to genera of Allomyrmococcini (adult females)

1 Body without recognizable anal lobes, posterior end of body rounded, narrow, with short setae in normal positions of lobes. Body setae abundant on dorsal and ventral surfaces ***PARAMYRMOCOCCUS*** (p. 54)

– Body with anal lobes, either poorly or well developed, with anal lobe setae about as long as body 2

2 Head heavily sclerotized and body constricted at prothorax. Long anal lobe setae and marginal setae on at least first preceding segment. Ostioles with posterior lip in form of a sclerotized flap which opens and closes against an apparently fixed sclerotized anterior lip. Anal ring narrow with minute pore-like structures . . . . . ***MALAICOCCUS*** (p. 30)

– Head membranous, body not constricted at prothorax. Long setae on anal lobes only or, if long marginal setae are present they are not on first preceding segment. Ostioles each with two sclerotized lips, the posterior lip similar to anterior lip. Anal ring with broad sclerotized rim without pores 3

3 Anal ring situated a distance about its own length from apex of abdomen, in a membranous depression in middle of sclerotized anal lobes. Body setae all pointed, densely covering dorsal and ventral surfaces, the distance between setal bases shorter than length of one seta. Legs about as long as body with abundant setae . . . ***ALLOMYRMOCOCCUS*** (p. 15)

– Anal ring terminal, at apex of dorsal lobe-like structure between ventral anal lobes. Body setae of two main types, one short and pointed and the other short and blunt, slightly clavate, the distance between setal bases greater than length of single seta. Legs shorter than body length with numerous setae but not densely covered; sometimes these setae are long and fleshy ***HIPPEOCOCCUS*** (p. 20)

Key to genera of Allomyrmococcini (immature instars)

1 Body elongate-turbinate, without recognizable anal lobes, posterior end of body rounded with short setae in normal positions of lobes. Body setae mainly short and cylindrical on dorsum but with longer pointed setae on venter and around margins . ***PARAMYRMOCOCCUS*** (p. 54)

– Anal lobes developed to some extent even though poorly developed in some stages. Long anal lobe setae as long as body 2

2 Head with some sclerotization even if only around the eyes, this sclerotization becoming more extensive in each successive stage. Long marginal setae on at least first preceding segment from anal lobes often as far forward as sixth preceding segment.

Body setae pointed but sometimes there are present also minute setae with the seta shorter than diameter of setal base. Anterior ostioles with posterior lip in form of flap ***MALAICOCCUS*** (p. 30)

– Head always membranous. If long marginal setae are present they are not on first preceding segment from anal lobes 3

3 Anal ring situated at least its own length from apex of body in a small membranous depression in middle of sclerotized anal lobes. Legs about as long as body (first instar not seen) ***ALLOMYRMOCOCCUS*** (p. 15)

– Anal ring terminal at apex of sclerotized dorsal lobe-like structure between sclerotized ventral lobes. Legs long but shorter than body. Body setae pointed or long, fleshy and clavate ***HIPPEOCOCCUS*** (p. 20)

ALLOMYRMOCOCCUS Takahashi, 1941

Allomyrmococcus Takahashi, 1941 : 201. Type-species: *Allomyrmococcus acariformis* Takahashi, by original designation and monotypy.

Only a single species is known so far. The genus has some peculiar characters among which are the unusually long stout legs about as long as the body. The turbinate shape, the well-developed anal lobes and dense covering of minute setae are some of the other most important characters. There is little information on its biology except that colonies are covered with a dense cluster of the ant *Dolichoderus* [=*Hypoclinea*] and the insects feed on young shoots. There is every indication that a honeydew channel or basket is formed between the anal lobes. The anal ring lies some distance from the apex of the abdomen and the space between the lobes is in the form of a concave depression which presumably retains honeydew.

Description. A broadly oval to turbinate body form with well-developed anal lobes each terminating with a group of stout setae about as long as body. Anal ring sclerotized, without pores but with 6 setae lying just outside the ring. Antennae 6-segmented, about as long as body, the second segment short and not articulated with the third; all segments densely covered with slender setae. Legs stout, as long as body or longer, covered with slender setae, tibia about four times as long as tarsus. Claw with a pair of flat expanded digitules, these about as wide as claw at base and twice as long. Body densely covered with minute pointed setae. Ostioles situated laterally, prominent, with well-developed sclerotized lips, without setae or trilocular pores. Labium stout but longer than wide with 30 or more pairs of setae in adult female, ventral or posterior surface with 2 pairs of posterior setae. Eyes present. Trilocular pores present but sparse.

Immature instars similar to adult female in form but smaller and with fewer body setae. No first instar available but second and third instars described here and illustrated.

Distribution. At present the genus is known only from Thailand.

Allomyrmococcus acariformis Takahashi, 1941

Allomyrmococcus acariformis Takahashi, 1941 : 201. Holotype ♀, Thailand: Mt Sutep, near Chiengrai, on plant of family Leguminosae, associated with ant *Dolichoderus* sp. [=*Hyploclinea* sp.] (TARI, Taipeh).

Allomyrmococcus acariformis Takahashi; Takahashi, 1942 : 15.

Adult Female (Fig. 3)

Description. External appearance described originally as 'Dark reddish brown and blackish with no wax.'

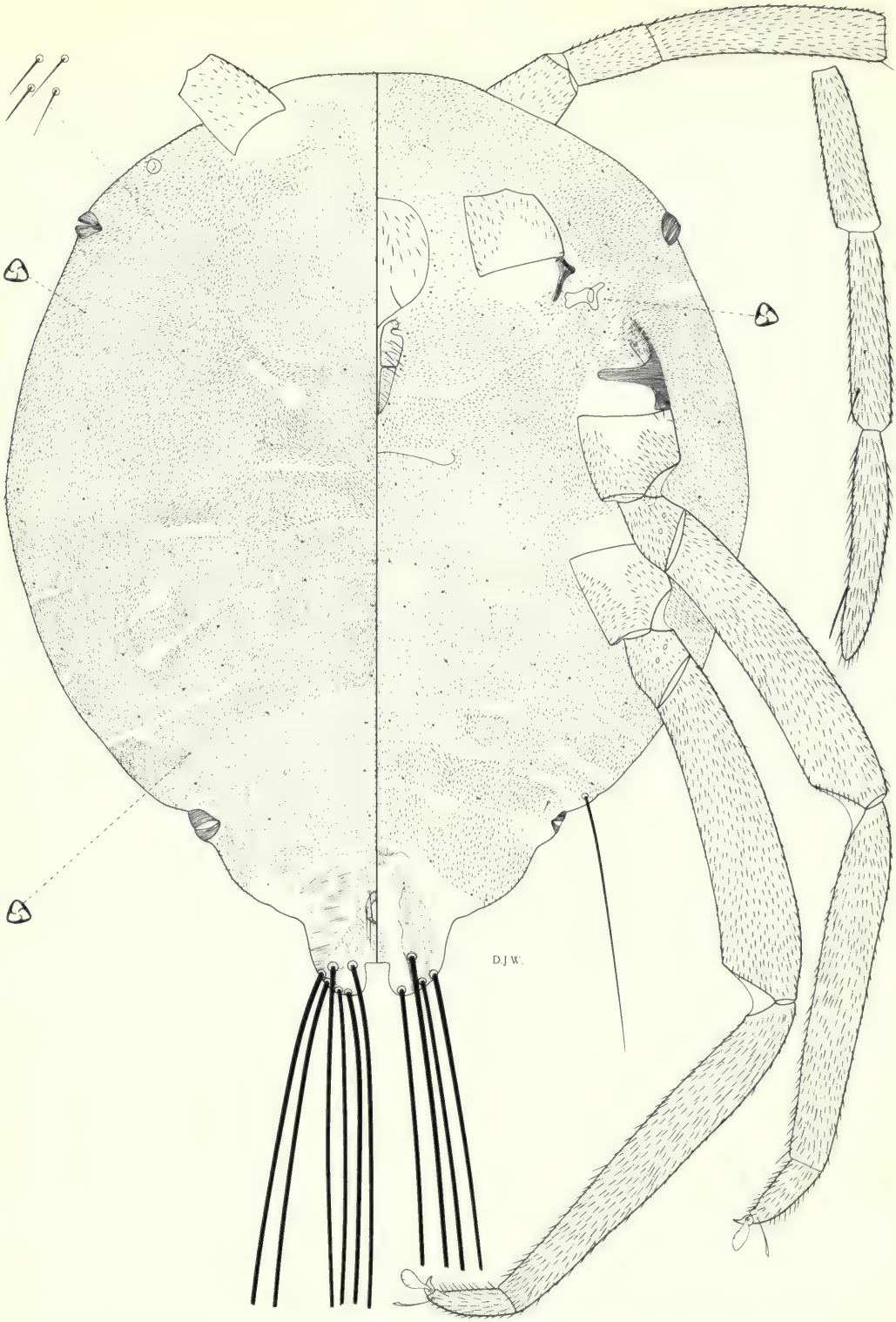

Fig. 3 *Allomyrmococcus acariformis* Takahashi. Adult female. Specimen from Thailand, Mt Sutep.

When mounted on the slide a broadly oval to turbinate species about 1·85 mm long and 1·4 mm wide, broad at anterior end and tapering posteriorly to a well-developed and protruding pair of rounded anal lobes. Antennae 1·81–1·92 mm long thus about as long as body; with 6 segments which on the longest antenna the first segment is 170 μm long, the second 150 μm, third 450 μm, fourth 320 μm, fifth 380 μm and sixth 450 μm, the last segment slightly curved, narrow at base but becoming 65 μm at widest point a quarter of length from base before tapering to apex. Each segment densely covered with slender setae which on first segment are about 32 μm long and commonly 70 μm long on last segment. These setae also accompanied with a few long stout setae on apices of fifth and sixth segments. Legs quite long and well developed. Hind trochanter + femur 800–810 μm long, hind tibia 750–850 μm long and hind tarsus 170–190 μm long, often curved inwards at an angle to tibia. All segments including coxae densely covered with slender setae, those on femur about 20 μm long and on tibia about 48 μm long. Claw stout 44 μm long, each with a pair of stout flat digitules about twice as long as claw. Labium about 200 μm long but width difficult to determine in available specimens. With 30–32 pairs of setae. Apical segment with 2 pairs ventral posterior setae, 1 pair minute apical setae, 4 pairs of subapical setae each 28 μm long, 10 pairs of lateral and anterior setae the longest 40 μm, 10–12 pairs of medial setae the longest 48 μm, 3 pairs of basal setae the longest pair each 40 μm long and 2 pairs each 24–32 μm long. Clypeolabral plate with about 80 setae. Anal ring on dorsal surface about twice its diameter from posterior end of body, without pores but with 6 setae each about 80 μm long. Ostioles large with thick heavily sclerotized and protruding lips, without setae. Circulus absent. Anal lobes sclerotized on both surfaces, this sclerotization extending forwards almost to level of vulva. Median dorsal surface between lobes membranous, depressed and forming a 'honeydew basket'. Each lobe with 6 dorsal and 4 ventral stout apical setae each about 1·5 mm long.

Body surface densely covered with slender pointed setae each about 16–20 μm long, covering almost entire surface except for intersegmental areas. Spaces between setal bases much shorter than length of one seta, the spaces closer on dorsal surface than on ventral surface. The setae lie in various directions giving the surface a wavy appearance. Setal bases of two sizes, the larger size much fewer. A pair of stout setae each about 500 μm long present on lateral edges of sixth abdominal segment. Trilocular pores sparse.

Third Instar Female (Fig. 4)

Similar to adult female but differing mainly in size. Body broadly oval and not so turbinate as in adult, 1·5 mm long and 1·25 mm wide. Anal lobes moderately developed. Antennae 6-segmented 1·35–1·42 mm long, the longest antenna with first segment 150 μm long, second 120 μm, third 300 μm, fourth 220 μm, fifth 270 μm and sixth 360 μm. All segments densely covered with slender setae but not so numerous as in adult, the setae ranging in length from 24 μm on first segment to 60 μm on sixth segment. Legs as in adult but shorter. Hind trochanter + femur 600–630 μm long, hind tibia 550–570 μm long and hind tarsus 150 μm long. Claw stout, 40 μm long with a pair of wide flat digitules about twice as long as claw. Labium 176 μm long and 108 μm wide, with 30–32 pairs of setae, distributed as in adult but differing in size. Lateral setae each about 40 μm long, longest anterior seta 32 μm long, longest medial seta 40 μm long, 3 pairs of basal setae, the longest pair each 40 μm long and the other 2 pairs each 20 μm long. Clypeolabral plate with about 55 setae. Ostioles well developed, as in adult. Anal ring on dorsum about twice diameter from apex of body about 44 μm wide with 6 setae each about 60 μm long. Anal lobes sclerotized on dorsal and ventral surfaces, each lobe with about 9 stout apical and subapical setae 1·55 mm long. Median dorsal area between lobes forming a channel or 'honeydew basket'. Body setae slender, abundant and densely covering almost entire surface except for clear intersegmental areas, about 16–20 μm long, the spaces between setal bases much shorter than length of one seta, dorsal setae tending to be closer together than ventral setae. A pair of lateral marginal setae present on sixth segment each about 400 μm long. Trilocular pores not numerous.

Second Instar Female (Fig. 5)

This instar has similar characters to those of adult and third instar female but can easily be distinguished in possessing a pair of lateral setae on sixth abdominal segment each about 360 μm long, a pair on dorsal lateral edge of fourth segment each about 550 μm long and a submarginal pair on dorsum of prothorax each about 500 μm long, the last 2 pairs with sclerotized areas around setal bases. Body ovoid, about 1·35 mm long and 1·0 mm wide, anal lobes moderately developed. Antennae 0·9 mm long, the first segment 110 μm long, the second 80 μm long, third 180 μm, fourth 130 μm, fifth 160 μm and sixth 240 μm long. Setae ranging from 24 μm long on first segment to 36 μm long on last segment. Legs with hind trochanter + femur 450 μm long, hind tibia 390 μm and hind tarsus 150 μm; all segments densely covered with slender setae, those on disc of femur 16–20 μm long and on disc of tarsus 32 μm long. Claw 32 μm long. Anal ring 40 μm in diameter with 6 setae each 52 μm long; situated about twice diameter

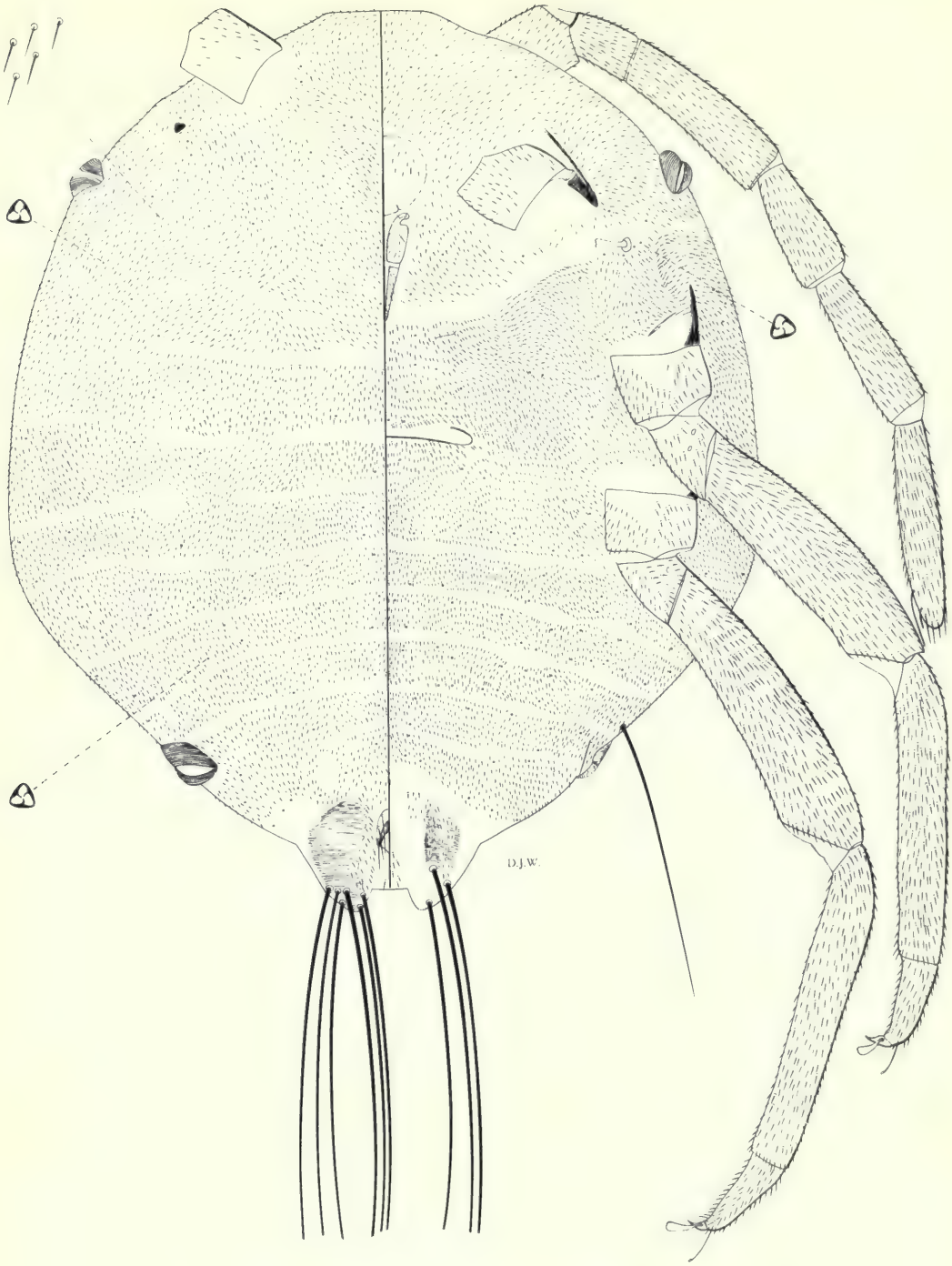

Fig. 4 *Allomyrmococcus acariformis* Takahashi. Third instar female.

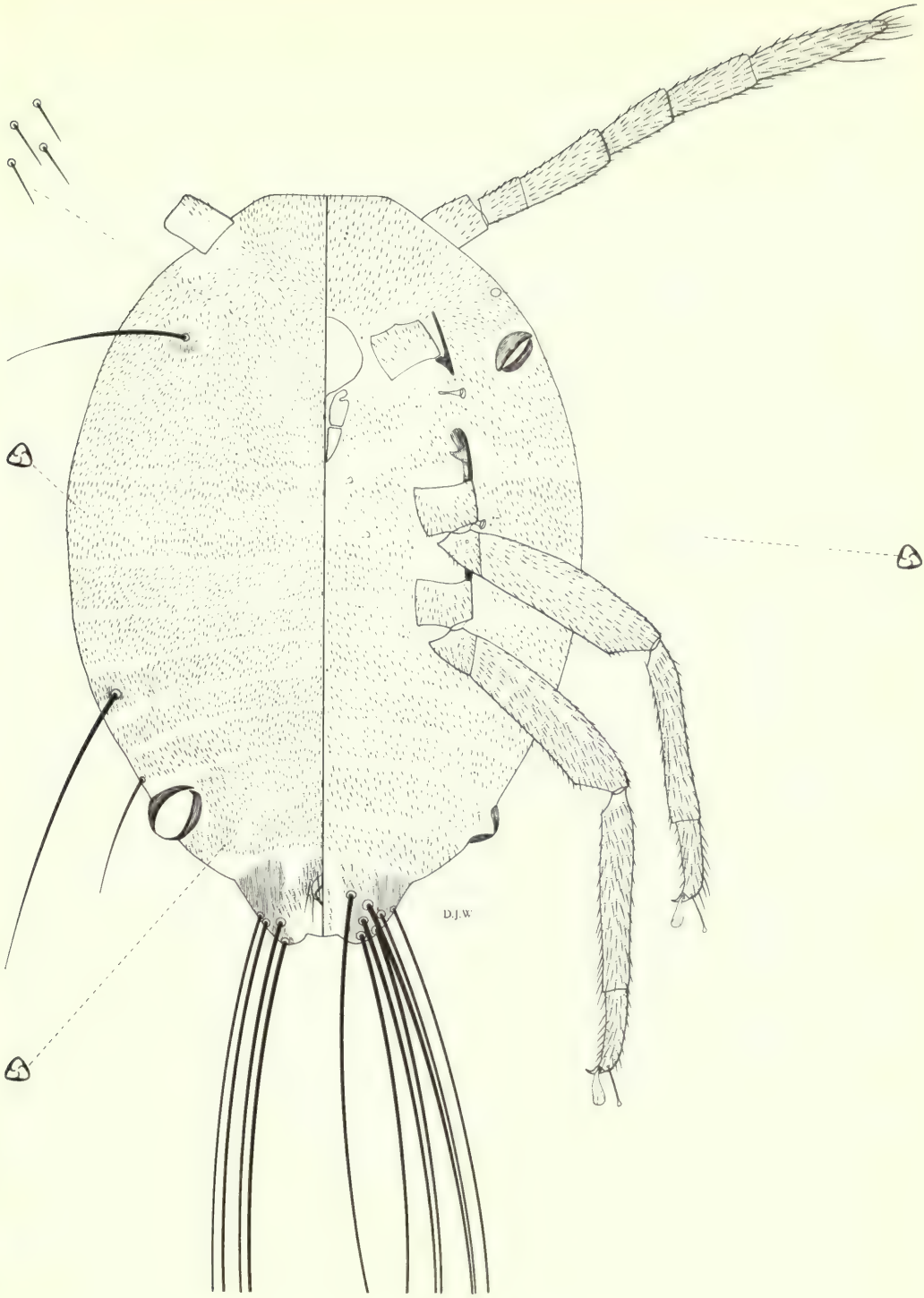

Fig. 5 *Allomyrmococcus acariformis* Takahashi. Second instar female.

from apex of body. Labium 132 μm long and 116 μm wide, with numerous setae as in third and adult instars but obscured in specimen available. Clypeolabral shield with numerous setae but difficult to count in available specimen. Ostioles with well-developed sclerotized lips, the anterior pair lying on ventral surface when mounted on slide. Anal lobes sclerotized, each with 11 apical and subapical setae about 1·5 mm long, their positions varying on dorsal and ventral surfaces but probably with 4 on dorsal surface and 7 on ventral surface. Body setae slender, about 16 μm long, covering almost entire surface except for intersegmental spaces, the distance between setal bases shorter than length of one seta. Trilocular pores few, scattered.

MATERIAL EXAMINED. THAILAND: 2 ♀, 'Siam', Mt Sutep, 5.iv.1940 (*R. Takahashi*; 1 third instar ♀ and 1 second instar ♀, same data as holotype (TARI, Taipeh).

This material has the same data as the holotype and it is assumed it is part of the original. The specimens have been kindly made available for study by Mr Charles Chia-chu Tao of the Taiwan Agricultural Research Institute, Taipeh.

HIPPEOCOCCUS Reyne, 1954

Hippeococcus Reyne, 1954 : 237. Type-species: *Hippeococcus rappardi* Reyne, by original designation.

This genus is known only from Java. It has some peculiar and unusual features connected with its mode of life. According to Reyne the species are invariably associated with ants of the genus *Dolichoderus* (=*Hypoclinea*). They are known to crawl on to ants' backs and are carried away when the ants are disturbed but large individuals may be carried in the ants' jaws. Found on the suckers and stems of the host, colonies are often covered with dense crowds of ants.

Reyne has given detailed descriptions of the species but there has been a pressing need for modern illustrations. The following descriptions, therefore, serve to supplement Reyne's and to accentuate the principal characters.

In common with most mealybugs there are four female instars and all of these are described for *H. wegneri* Reyne. Although Reyne mentioned only three instars it is possible that his descriptions of the second instar may include characters of the third also. Only three female instars are available here for *H. rappardi* Reyne; nevertheless, one or two specimens are at hand of what is presumed to be the second instar male and this is described. Reyne described the adult female before preparation as 'Body gleaming, without a coating of wax'.

DESCRIPTION OF ADULT FEMALE. Body broadly turbinate, seventh and posterior segments narrow. Venter of last segment folded on either side near the mid-line giving it the appearance, when viewed through the stereomicroscope, of forming two parallel tubes, the apices forming the anal lobes containing 5–7 long setae which may be almost as long as the body. The two tube-like parts of the last segment are covered dorsally with a triangular lobe containing setae of various lengths and which bears the anal ring at the apex. This ring is sclerotized, without pores, crescentic and contains 6 setae which increase in length and thickness posteriorly. The anal ring is usually on level with apices of the anal lobes but in one species the anal lobes are produced latero-posteriorly for a distance about same length again as last segment. Antennae 6-segmented, first segment normal, second quite small and usually wider than long, both segments with few setae. Third to sixth segments stout and elongate, containing numerous slender pointed setae, the total length of antenna about half length of body. Ostioles well developed, lying at sides of body, each with heavily sclerotized lips, the sclerotization surrounding anterior lips of first pair also extending around eyes. Without membranous lips, setae or trilocular pores. Setae on both surfaces of body abundant, mainly of two types, one of which is minute, clavate, usually 6–8 μm long, almost transparent, and the other type normal and pointed but short, about 20 μm long. Other setae, present on the posterior abdominal segments and legs, may be stout and long with a blunt tip or swollen apically and of a fleshy appearance. Only the basal part of these setae is sclerotized, the remainder becoming more transparent towards the apex. Claw stout, bearing a pair of quite wide and flat digitules each usually about as wide as the claw and about twice as long. Trilocular pores present. Circulus oval.

DESCRIPTION OF IMMATURE INSTARS. Normally turbinate but becoming wider at each instar. Anal lobes and dorsal triangular lobe containing anal ring present in all stages. Minute transparent clavate setae absent. Short pointed setae absent in first instar but becoming more numerous in each successive stage. Antennae of first instar with thickened long setae only. Second instar with abundant short setae on third to sixth antennal segments and these setae become more numerous in successive instars.

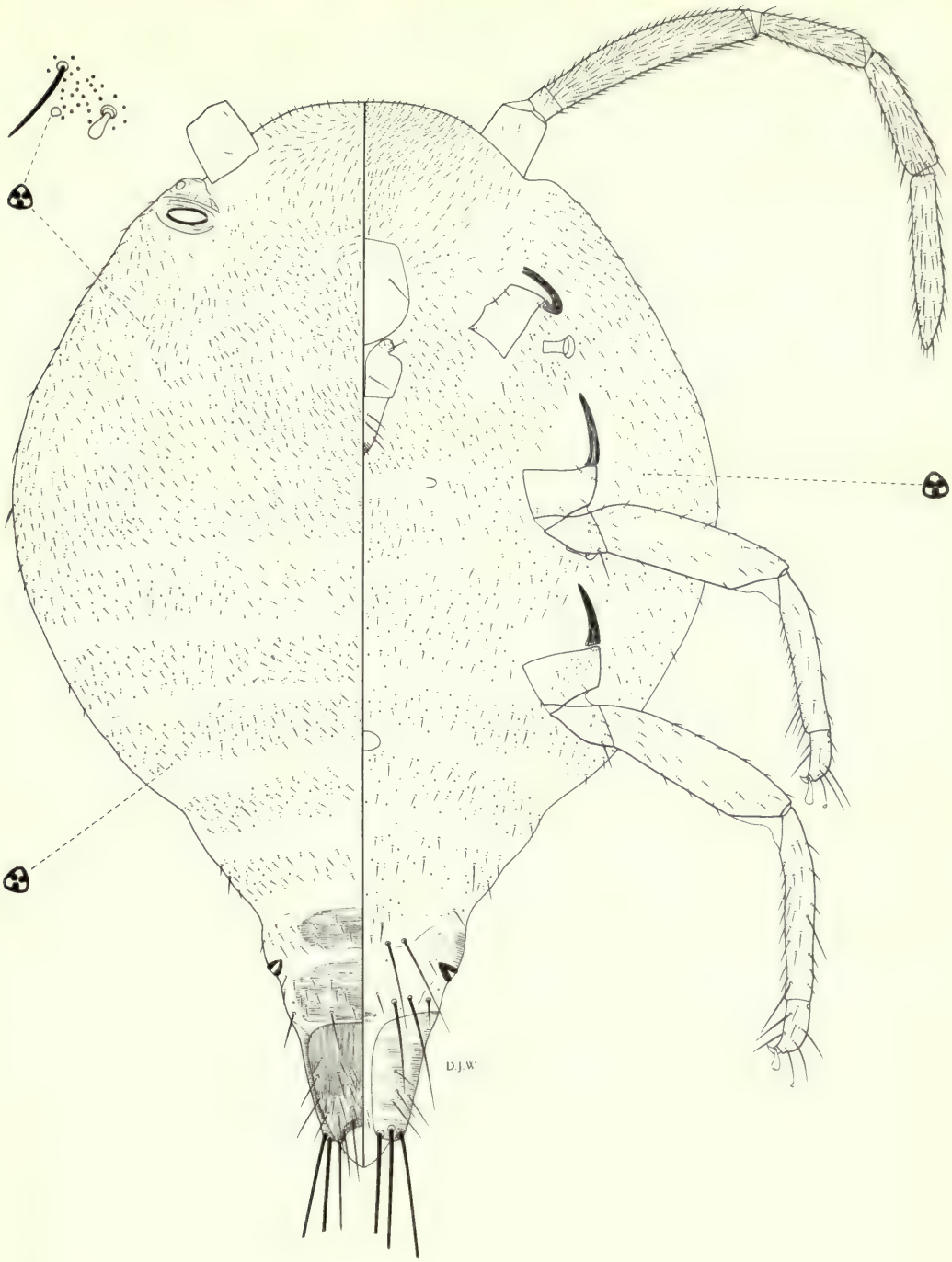

Fig. 6 *Hippeococcus rappardi* Reyne. Adult female. Specimen from Java, Mt Kawai.

Key to species of *Hippeococcus* (adult females)

1 Anal lobes projecting about the length of last segment from level of anal ring ***montanus*** Reyne (p. 22)
– Anal lobes terminating at about same level as anal ring 2
2 Ventral surface of abdomen with numerous stout or expanded setae in addition to long setae on seventh and posterior segments. Anal lobes each with 6 long apical setae ***wegneri*** Reyne (p. 26)
– Ventral surface of abdomen without numerous expanded setae, short pointed setae present only except for long setae on seventh and posterior segments. Anal lobes each with 5 long apical setae . . . . . ***rappardi*** Reyne (p. 22)

Immature instars

A few instars have not been available for study and it is not possible to give a workable key. The first instars of *H. rappardi* and *H. wegneri* have thick, fleshy and clavate setae on the dorsal and ventral surfaces but in *H. rappardi* there are 2 long pointed setae on each side of sixth and seventh segments. In *H. wegneri* there is 1 long seta and 1 short blunt seta in these positions. The thick clavate setae persist in the second and third instars of *H. wegneri* but in *H. rappardi* they are replaced by pointed setae. Instars are mainly distinguished by an increase in antennal and leg lengths. The second instar males are easily recognized by the presence of multilocular disc pores and oral collar tubular ducts.

Hippeococcus montanus Reyne, 1954

Hippeococcus montanus Reyne, 1954 : 250. Holotype ♀, JAVA [lost] (named from drawings in ITZ, Amsterdam).

There are no specimens available of this species as Reyne (1954) named it from certain drawings made by P. van der Goot possibly in 1915. The illustration has the appearance of being accurately executed. Although obviously a *Hippeococcus* species, it differs from *H. rappardi* and *H. wegneri* in having quite long and prominent anal lobes that are set rather wide apart and protrude about the same distance as the length of base or dorsal lobe covering them. In the other two species the anal lobes are about the same length as the dorsal lobe.

Other than living in Java there is no further information on its locality but from the illustration reproduced by Reyne, it should be easy to identify the insect when collected again.

Hippeococcus rappardi Reyne, 1954

Hippeococcus rappardi Reyne, 1954 : 239. Holotype ♀, JAVA: East, Yang Mts, Gondang Plantation, on *Ficus variegata*, 21.vii.1950 (RNH, Leiden) [examined].

Adult Female (Fig. 6)

Body broadly turbinate, about 2·1 mm long and 1·45 mm wide, posterior segments tapering. Anal lobes heavily sclerotized ventrally and with the dorsal surface forming lobe covering median area of last segment, with anal ring at apex. Seventh and eighth segments sclerotized mid-dorsally, and areas of sclerotization present around the well-developed ostioles and around the eyes. Entire surface with minute sclerotized dots that give the body a slightly dark appearance even when not stained. Antennae about 1·55 mm long, the third to sixth segments densely covered with slender setae, those on the third segment 52–60 μm long and those on sixth segment thicker and usually 100 μm long. Legs well developed, hind trochanter + femur 530 μm long, hind tibia + tarsus 540–560 μm long, hind coxa with a few translucent pores. Setae on legs of various sizes, on the hind tarsus they range from stiff pointed setae 40–100 μm long on the inner edge to stout fleshy setae, pointed, 52–160 μm long on the outer edge. Claw about 44 μm long. Labium 180 μm long and 140 μm wide with 14 pairs of setae. Apical segment with two pairs of posterior setae, 1 pair of minute apical setae, 4 pairs of subapical setae each 32 μm long, 1 pair lateral setae each 52 μm long and 2 pairs of anterior setae each 68 μm long. Medial segment with a single pair of medial setae each 60 μm long and basal segment with 3 pairs basal setae, 1 pair 32 μm long and 2 pairs each 20 μm long. Circulus oval, about 74 μm wide. Anal ring at apex of abdomen, about 88 μm wide, with 6 setae, these becoming distinctly longer in a posterior direction, the posteriormost quite thick.

Dorsal setae of two main types. On all segments anterior to eighth there are numerous minute clavate setae with a fleshy appearance, each about 6 μm long. Other dorsal setae pointed, numerous and usually 26 μm long. On the posterior abdominal segments the setae become longer. Trilocular pores not numerous.

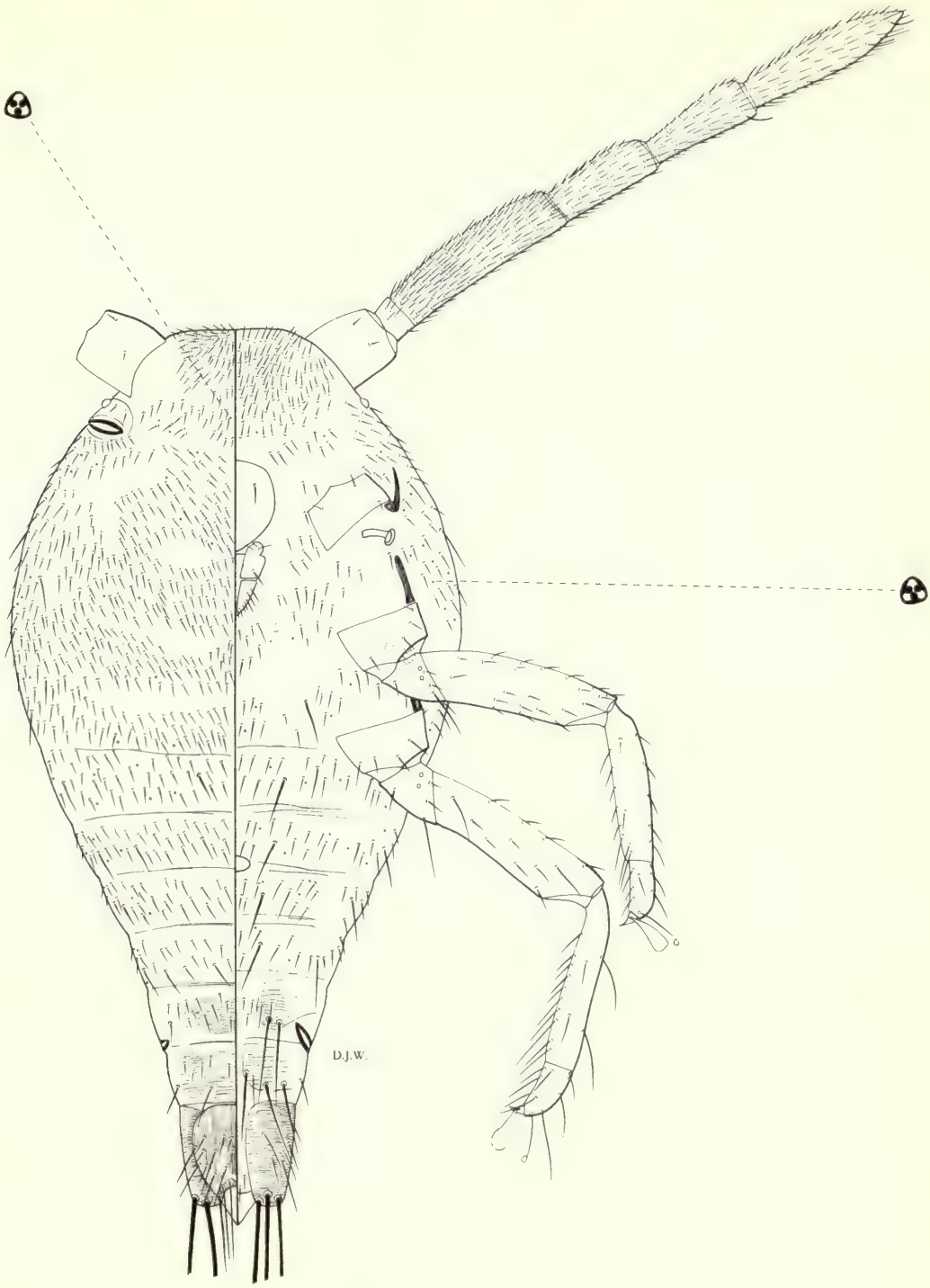

Fig. 7 *Hippeococcus rappardi* Reyne. Third instar female.

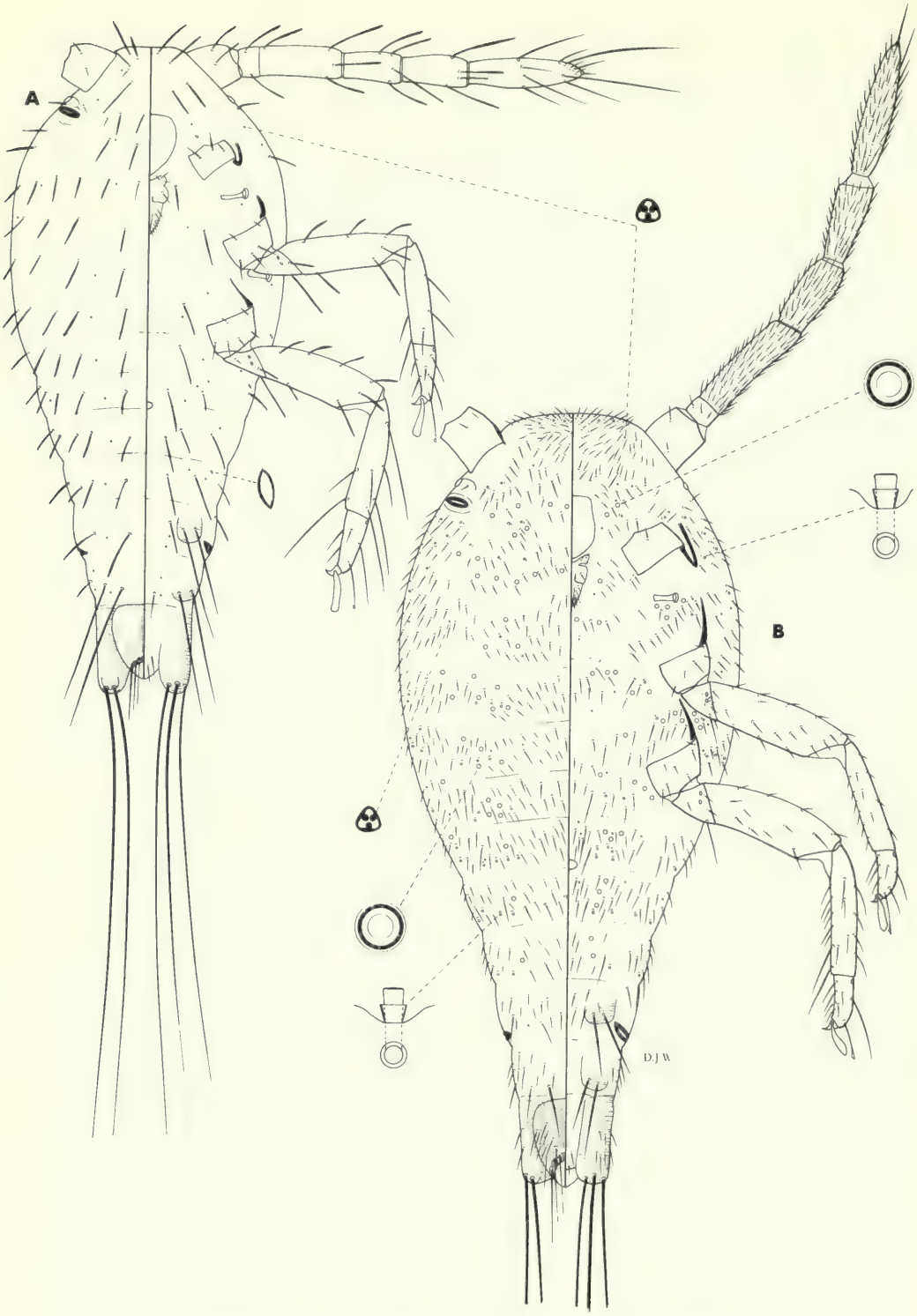

Fig. 8 *Hippeococcus rappardi* Reyne. (A) First instar. (B) Second instar male.

Ventral surface with numerous minute blunt setae as on dorsum but they are absent between antennae and on eighth and posterior segments. Other setae pointed, about 26 μm long except for longer setae near abdominal margins and for long setae 180–200 μm long on the seventh and eighth segments. Trilocular pores tending to be more numerous than on dorsum but absent on head.

Third Instar Female (Fig. 7)

Body about 1·75 mm long and 0·75 mm wide, elongate, widest on thorax, abdomen tapering. Seventh and eighth segments with distinct sclerotization in mid-regions. Anal lobes and dorsal median lobe heavily sclerotized. Antennae 1·2 mm long, third to sixth segments with numerous short setae. Hind trochanter + femur 450 μm long, hind tibia + tarsus 460 μm long. Claw about 36 μm long. Labium 148 μm long and 100 μm wide with same number of setae as in adult and about same size. Circulus oval, 56 μm wide. Ostioles present at edges of body, similar to those of adult but smaller. Body setae short and pointed only, with a similar distribution to those of adult female, but less numerous; mid-dorsal setae about 40 μm long and a typical short ventral seta about 40 μm long. Seventh and eighth segments sclerotized over most of the area. On the seventh segment most of the setae lie in the sclerotized area and on the eighth segment all the setae lie within the sclerotized area. Some long ventral setae on segments 7 and 8 stout and longer than the segments.

Second Instar Male (Fig. 8B)

The writer agrees with Reyne (1954) that this is the second instar male rather than the female because the body has a vestiture of numerous tubular ducts and multilocular disc pores. Although second instar females of other mealybugs may possess similar pores and ducts they usually become more numerous in the third and adult instars. In this species they are absent completely in the third and adult female instars. Numerous pores and ducts in the second instar male are present to secrete the pupal covering.

Body elongate, abdomen tapering, about 1·35 mm long and 0·55 mm wide. Antennae 800 μm long, the third to sixth segments densely covered with short slender setae. Legs well developed, hind trochanter + femur 300 μm long, hind tibia + tarsus 340 μm long. Claw 28 μm long. Labium 120 μm long and 100 μm wide with 14 pairs of setae, common to the species. Dorsal labial setae shorter than those of previous stages, subapical setae each 24 μm long, lateral setae 36 μm long, anterior setae each 40 μm long. Medial segment with medial setae 52 μm long and basal segment with 1 pair basal setae 32 μm long and 2 pairs each 16 μm long. Circulus oval, about 20 μm wide. Ostioles well developed, on edges of body. Anal ring 64 μm wide.

Dorsal setae all pointed, numerous, a mid-dorsal seta usually about 24 μm long. Longer setae present also on the lobe-like structure above anal lobes. Multilocular disc pores present, mainly in submedian areas of thorax and anterior abdominal segments. Oral collar tubular ducts, each with the internal collar flange-shaped and occupying about half length of duct, situated among the multilocular disc pores and extending to margin. Trilocular pores sparse.

Ventral surface with numerous pointed setae tending to be longer than those on dorsum, a common length being about 32 μm. Two pairs of sclerotized areas on seventh and eighth segments each with a pair of long pointed setae. Multilocular disc pores in mid-regions of thorax, anterior abdominal segments and near spiracles. Tubular ducts present near the multiloculars and towards the margins. Trilocular pores few.

First Instar (Fig. 8A)

Body narrowly turbinate, about 1·2 mm long and 0·4 mm wide at the thorax. Anal lobes and dorsal surface forming lobe, heavily sclerotized. Anal ring about 60 μm wide, without pores but with 6 setae at anterior or dorsal half of the ring. These setae become progressively thicker and longer posteriorly, the longest about 160 μm. Anal lobes with 2 long dorsal setae and 3 ventral setae, each about 0·95 mm long. Antennae 6-segmented, about 630 μm long with a few long setae slightly expanded distally, on each segment except last where they are pointed. Legs well developed, hind trochanter + femur 220 μm long, hind tibia + tarsus about 310 μm long. Claw 28 μm long. Labium 120 μm long and 88 μm wide, the dorsal setae tending to be shorter than in previous stage; subapical setae 24 μm long, lateral setae 36 μm long, anterior setae each 32 μm long, medial setae 36 μm long and basal setae with 1 pair 32 μm long and 2 pairs each 12 μm long. Ostioles well developed, without setae but with lips heavily sclerotized. Circulus small and oval about 20 μm wide.

Dorsal setae slightly expanded towards apex, each with a fleshy appearance and about 56 μm long on mid-abdomen where there are about 8 across a segment. Eighth segment with 2 pairs of long pointed setae reaching beyond anal lobes. Trilocular pores few, forming a single submedian row and with one or two around margins.

Ventral surface with setae similar to those on dorsum but tending to be longer, up to 60 μm, except the submarginal setae on seventh and eighth segments which are long and pointed, in pairs, on lightly sclerotized areas. Trilocular pores few, in submedian areas. Simple pores few on submargins, each about same size as a trilocular pore but usually oval in shape.

MATERIAL EXAMINED. *Hippeococcus rappardi* Reyne, holotype ♀, JAVA: East, Yang Mts, Gondang Plantation (RNH, Leiden).

JAVA: Immatures with same data as holotype; immature instars, Mt Kawi, Gaden, on young shoots of *Litsea* sp. (Lauraceae), ii.1951 (*F. W. Rappard*) (RNH, Leiden); 1 ♀ and immatures, same data but labelled from *Litsea* sp., *Eugenia* sp. [Myrtaceae] and *Rubus* sp. [Rosaceae] (BMNH, London).

Recorded also by Reyne (1954) from JAVA: Gondang, on *Ficus variegata*, on suckers of *Eugenia* sp. and *Litsea confusa*; from Gaden, on stems of *Rubus* sp. and *Eupatorium* sp. (Compositae).

Hippeococcus wegneri Reyne, 1954

Hippeococcus wegneri Reyne, 1954: 255. Holotype ♀, JAVA: West, Tjibodas, Botanical Garden, from nest of *Dolichoderus* (= *Hypoclinea*) *gibbifer* Emery, i.1953 (RNH, Leiden) [examined].

Adult Female (Fig. 9)

Body broadly turbinate, attaining a length of 2·75 mm and a width of 2·0 mm, abdomen narrowing abruptly. Anal lobes and dorsal surface of eighth segment heavily sclerotized. Sclerotization also in dorsal median areas of fifth to seventh segments and in ventral submedian areas of seventh and eighth segments. Anal lobe setae comprising three dorsal and four ventral, each about 1·5 mm long. Entire surface with minute sclerotized dots giving the membranous body the appearance of being lightly sclerotized. Antennae about 1·5 mm long with abundant slender setae on third to sixth segments. Setae on third segment about 60 μm long, becoming progressively longer to sixth segment where they are thicker and 90–100 μm long. Legs well developed, hind trochanter + femur 570–590 μm long, hind tibia + tarsus 600–620 μm long. Claw 40 μm long. Setae on legs of different shapes; they are long clavate and thick with a fleshy appearance, or short or long and pointed, the longest on the outer side of tibia and tarsus. On the tarsus the pointed setae are 40–160 μm long and the stout fleshy setae 40–180 μm long. Hind coxae with a few translucent pores. Labium 184 μm long and 120 μm wide, with 14 pairs of setae. Apical segment with 2 pairs of posterior setae, a pair of minute apical setae, 4 pairs of subapical setae each 28 μm long, a pair of slender lateral setae each 48 μm and 2 pairs of thick fleshy anterior setae each 80 μm long. Medial segment with 1 pair of fleshy setae each 92 μm long and basal segment with 2 pairs of short pointed setae each 20 μm long and a pair of fleshy setae each 44 μm long. Circulus about 68 μm wide. Anal ring 84 μm wide, on level with apices of anal lobes, the anterior pair of setae 100 μm long, the median pair 140 μm long and the posterior pair 180 μm long, these setae becoming thicker as they become longer.

Dorsal surface anterior to seventh segment with numerous minute clavate setae each 6–8 μm long, of a fleshy appearance, barely taking up the stain. Short pointed setae each about 20 μm long, evenly distributed. Posterior abdominal segments with a few clavate or thick setae ranging in length from 30 to 120 μm, the dorsal lobe covering anal lobes with a few thick setae about 60 μm long. Trilocular pores in moderate numbers, evenly distributed.

Ventral surface with similar minute clavate and pointed setae as on dorsum, on sixth and anterior segments. Long clavate or thick and bluntly pointed setae present across the abdominal segments ranging in length from about 60 to 90 μm except for some on seventh, eighth and anal lobe segments that may be up to 260 μm long. Trilocular pores numerous with an even distribution.

Third Instar Female (Fig. 10)

Body a similar turbinate shape to that of adult female but narrower, 2·0 mm long and 1·0 mm wide. Sixth and posterior segments sclerotized with the 3 dorsal and 3 ventral anal lobe setae about 1·5 mm long. Antennae 1·13 mm long, the third to sixth segments densely covered with short setae which become longer towards the last segment. Hind legs with trochanter + femur 450 μm long, hind tibia + tarsus 480 μm long. Claw about 30 μm long. Labium 152 μm long and 120 μm wide, with 14 pairs of setae but these shorter than in adult. Subapical setae each 26 μm long, lateral setae each 36 μm long, the 2 pairs of anterior setae each 56 μm long, thick and fleshy. Medial segment with medial setae thick, each 68 μm long and basal segment with 2 pairs of short pointed setae each 16 μm long and 1 pair of thick setae each 56 μm long. Circulus oval, 68 μm wide. Anal ring about 68 μm wide. Body setae of two main types,

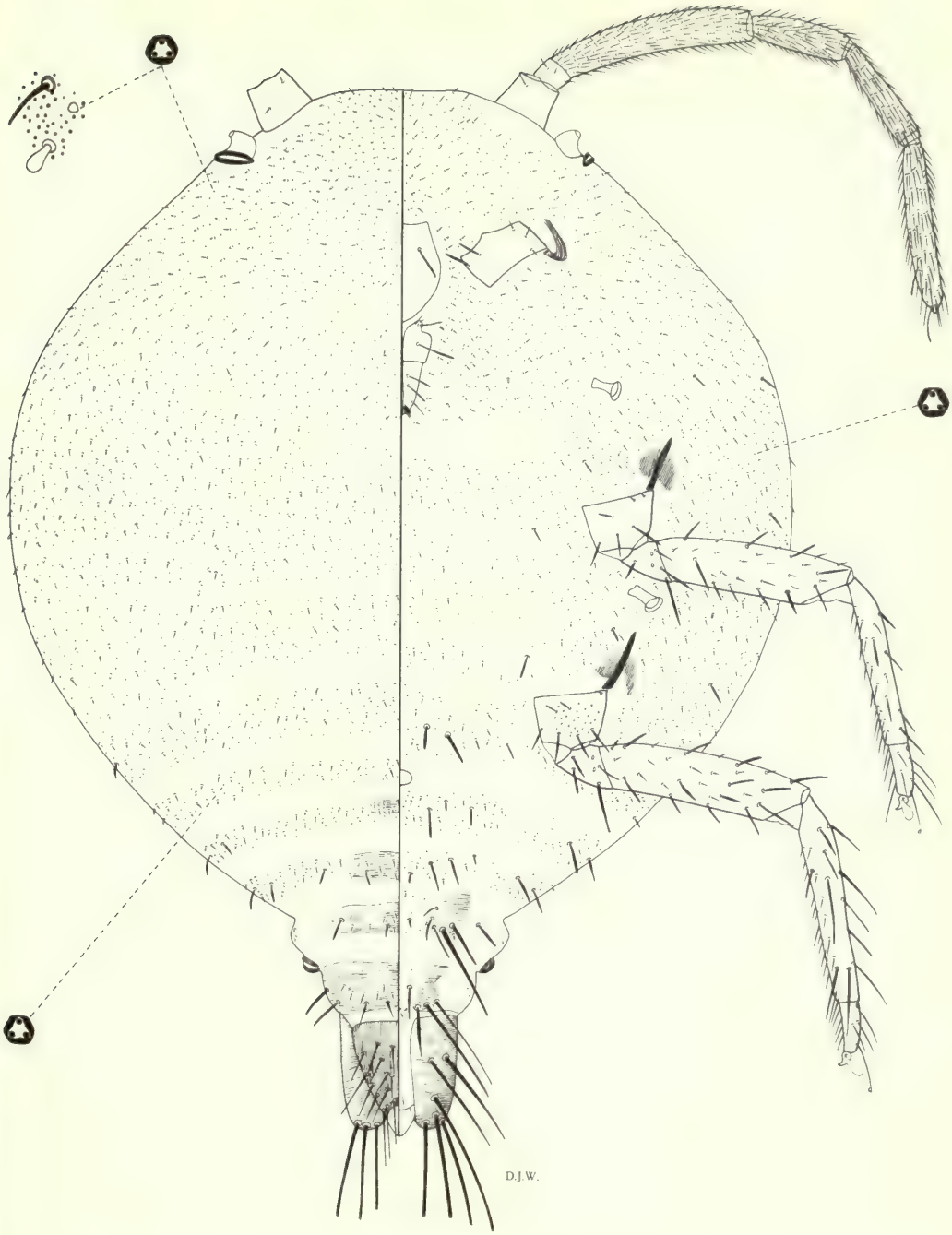

Fig. 9 *Hippeococcus wegneri* Reyne. Adult female. Specimen from Java, Tjibodas.

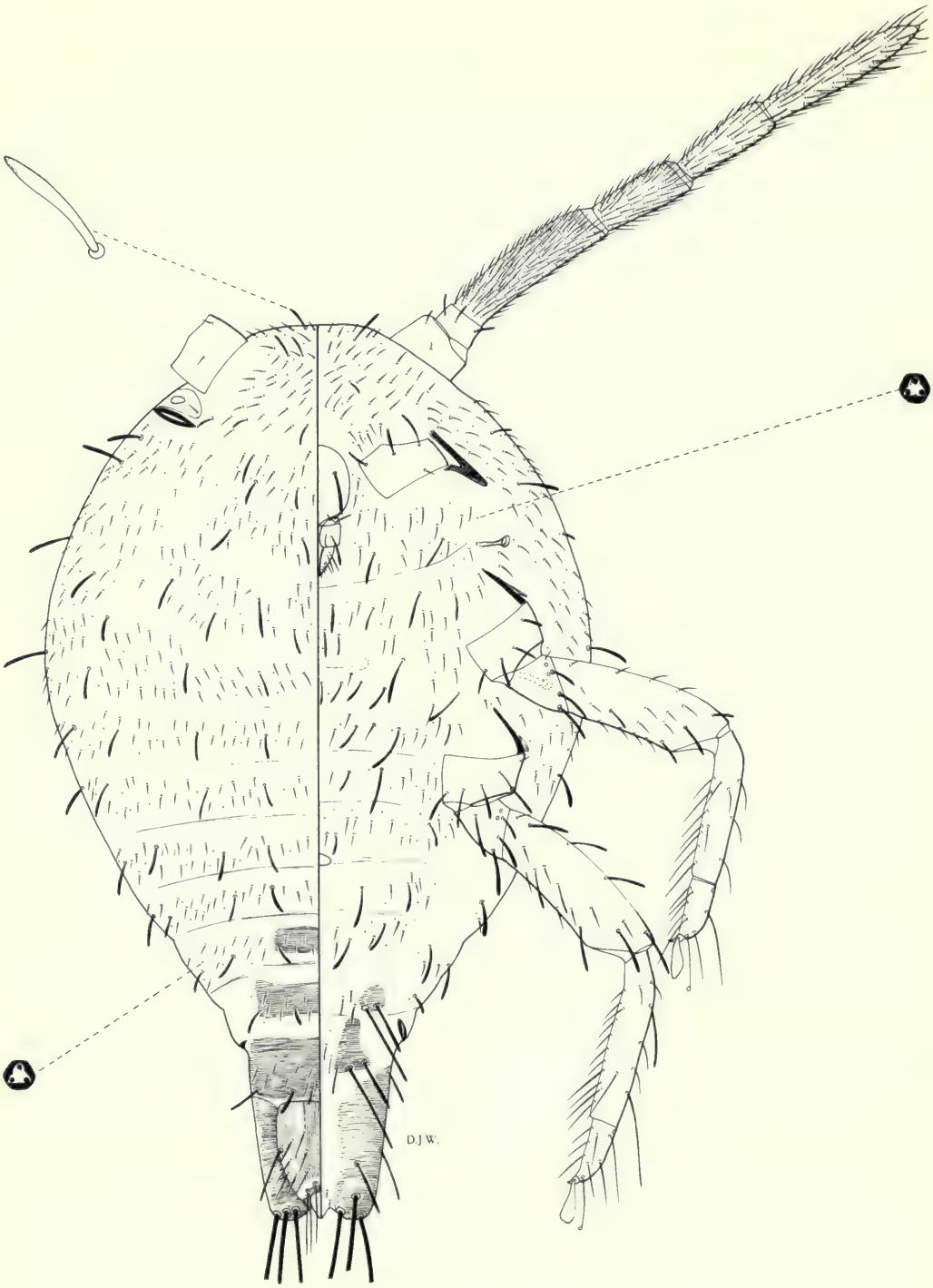

Fig. 10 *Hippeococcus wegneri* Reyne. Third instar female.

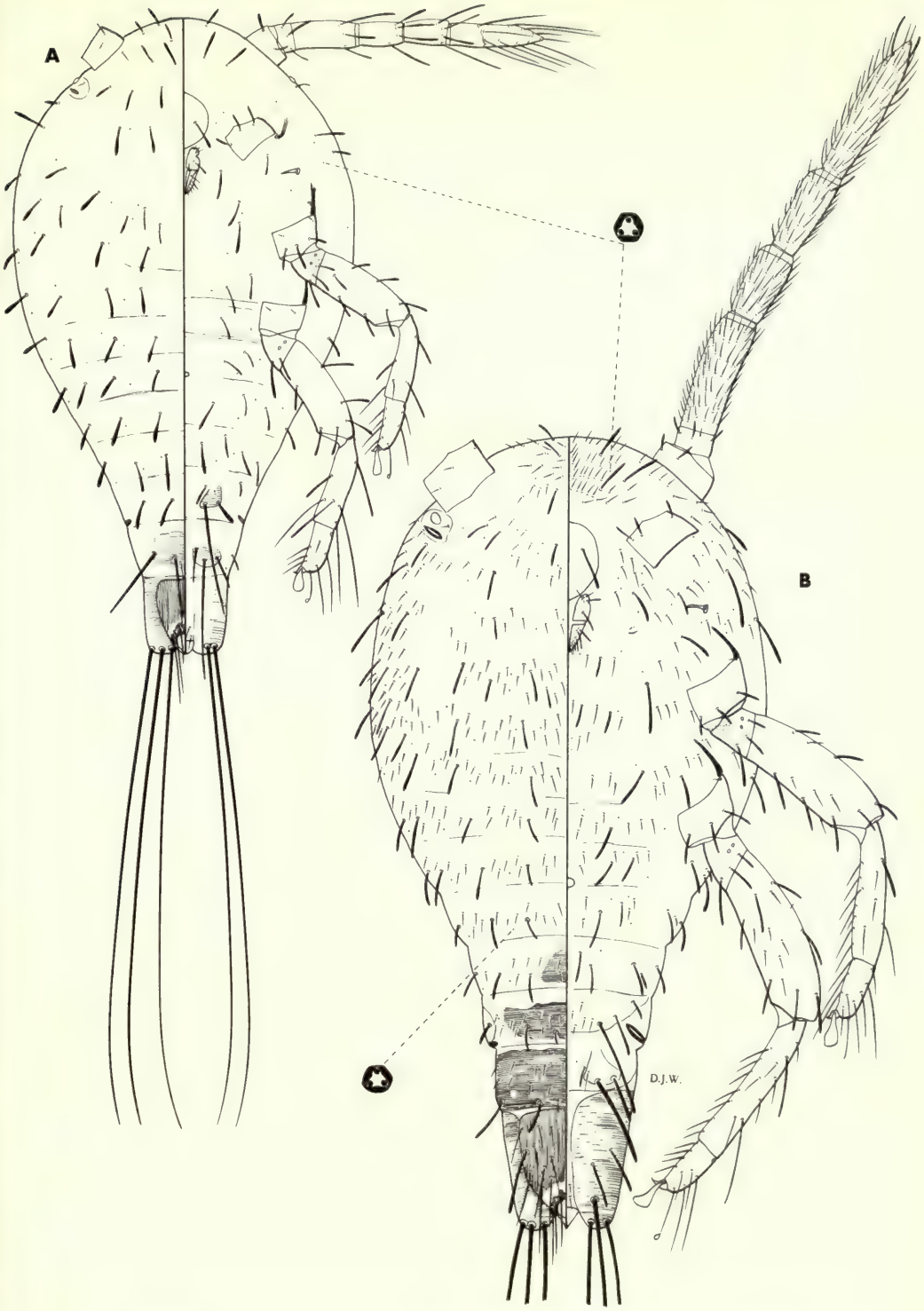

Fig. 11 *Hippeococcus wegneri* Reyne. (A) First instar. (B) Second instar female.

a clavate or expanded type, thick and fleshy, ranging in length from 50 to 100 μm except at posterior end of body where some are longer on ventral surface, and short pointed setae, which are numerous and interspersed among the fleshy setae. The minute clavate setae are absent in this instar. Trilocular pores sparse.

Second Instar Female (Fig. 11B)

Body narrowly turbinate, abdomen tapering, 1·4 mm long and 0·7 mm wide. Sclerotization at posterior end of body on anal lobes, on dorsal surface of eighth segment and in median areas of seventh and sixth segments. Legs with hind trochanter + femur 370 μm long, hind tibia + tarsus 390 μm long. Claw about 28 μm long. Antennae 900 μm long, third to sixth segments with numerous slender setae. Ostioles less developed than in previous stage. Circulus about 40 μm wide. Labium with 14 pairs of setae. Apical segment with 4 pairs of subapical setae each 24 μm long, a pair of slender lateral setae each 36 μm long and 2 pairs of thick fleshy anterior setae each 48 μm long. Medial segment with 1 pair of fleshy setae each 56 μm long and basal segment with 2 pairs of slender setae 12 μm long and a pair of thick setae each 44 μm long. Body setae with similar distribution of clavate type to those in third stage but short pointed setae less numerous especially on head and ventral thorax, the short dorsal setae about 24 μm long and the ventral setae about 32–40 μm long. The clavate setae range in length from 50 to 100 μm long except at posterior end of body where some are 160 μm long. Anal lobe setae difficult to measure but all are over 1·0 mm long. Trilocular pores sparse on both surfaces.

First Instar (Fig. 11A)

Body narrowly turbinate, about 1·35 mm long and 0·7 mm wide, anal lobes each with 3 dorsal and 2 ventral setae at apices, about 1·3 mm long. Anal lobes and dorsal lobe-like structure covering anal lobes heavily sclerotized. Antennae 630 μm long with clavate setae on all segments except last, which has long pointed setae. Legs well developed, hind trochanter + femur 300 μm long, hind tibia + tarsus 320 μm long. Claw 24 μm long. Labium 108 μm long and 80 μm wide, with 14 pairs of setae, all slender except for medial setae which are thick and fleshy. Apical setae each 24 μm long, lateral setae each 28 μm long, anterior setae each 40 μm long. Medial segment with medial setae 56 μm long and basal segment with 2 pairs of basal setae 12 μm long and 1 pair 32 μm long. Ostioles small but with lips heavily sclerotized. Circulus oval, about 20 μm wide. Anal ring 44 μm wide with 6 setae which become progressively longer posteriorly, the second pair twice as long as anterior pair and posterior pair half as long again as median pair.

Dorsal surface without short pointed setae but with long clavate setae ranging in length from 40 to 68 μm. Eighth segment with 4 stout pointed setae as long as anal lobes. Trilocular pores sparse.

Ventral surface with similar clavate setae to those on dorsum but some are longer, approaching 80 μm long. Long stout clavate to pointed setae present also on small sclerotized areas on seventh and eighth segments. Trilocular pores few.

MATERIAL EXAMINED. *Hippeococcus wegneri* Reyne, holotype ♀, JAVA: West, Tjibodas, Botanical Garden, i.1953 (*A. M. R. Wegner*) (RNH, Leiden).

JAVA: immatures, same data as holotype; paratypes and immatures, same data, 1 ♀ on young shoots and fruit of *Diospyros kaki* [Ebenaceae] (RNH, Leiden), 1 ♀ (ITZ, Amsterdam); 6 ♀ and immatures, i.1953 (*A. M. R. Wegner*); 2 ♀, vi.1953 (*A. M. R. Wegner*); 1 ♀ Tjibodas, 22.x.1973 (*B. Bolton*) (BMNH, London).

Recorded also by Reyne (1954) on *Cyclanthera explodens* (Cucurbitaceae).

MALAICOCCUS Takahashi, 1950

Malaicoccus Takahashi, 1950: 65. Type-species: *Malaicoccus riouwensis* Takahashi, by original designation.

This is an unusual genus of the Pseudococcidae in that the known species have the prothorax constricted and most of the head is heavily sclerotized. In life they have a strong resemblance to aphids and may often be mistaken for them. All are associated with ants of the genera *Polyrhachis* and *Hypoclinea* but little is known of their life history or habits. The mealybugs are attended by the ants which often carry them in their mandibles at the constriction on the prothorax.

DESCRIPTION OF ADULT FEMALE. Body form ovoid to globular with a definite constriction on prothorax opposite first coxae. Head heavily sclerotized around antennal bases, the sclerotization often extending to

first pair of ostioles; the front of head on ventral surface almost completely sclerotized forward from clypeus. Antennae 6-segmented, often longer than entire body and densely covered with slender setae; the first segment arising from dorsal surface. Second segment short and not articulating with third segment. Legs well developed, often with numerous setae of different sizes. Claws stout, with flattened digitules which are greater in size than claw itself. Labium conical with 21–32 pairs of setae, always with 2 pairs of posterior setae, a pair of minute apical setae, 4 pairs of subapical setae and 1 pair of lateral setae. The supernumerary setae occur in the anterior and medial groups. Circulus present, usually well developed with deep lateral constrictions. Ostioles of a distinctive type, the anterior pair each with an apparently fixed anterior lip which is arc-shaped. A heavily sclerotized semi-circular lower lip containing a few setae is hinged to close over to the anterior lip. These ostioles often lie on ventral surface on slides due to convexity of body or more often on margins so that they are viewed in lateral aspect. Posterior ostioles with anterior lip apparently fixed and with the posterior lip narrower than in anterior ostiole, with or without small setae. Anal ring terminal, narrow, with a few minute pores and 6 setae. Two crescentic or triangular areas of sclerotization containing setae present at either side of anal ring or just anterior to it. The anal ring is depressed behind the crescentic areas so that apex of abdomen forms a small 'honeydew basket'. Setae on margins of last 2–4 segments about as long as body and often accompanied with 1 or 2 short setae. Body setae minute, always numerous and sometimes densely covering the surface in which case the distance between the setal bases is shorter than the length of a seta. Other setae stout, of various lengths. Posterior end of body with sclerotized areas on both sides of anal lobes and on ventral surface at margin of some preceding segments.

Description of immature instars. Body oval but head angular in first instar and becoming more rounded in successive instars. Prothorax with a slight constriction in first instar but constriction increasingly apparent in second and third instars. Sclerotization on head starting around eyes in first instar and increasing in each instar to around base of antenna and in an area forward from clypeus. Anal lobes always developed to some extent. Antenna 6-segmented, often as long as body. In the first instar long pointed setae form whorls usually at distal end of segments but in the second and third instars the segments become densely covered with short pointed setae. Legs well developed, claw stout, with 2 flat, wide digitules even in the first instar. Labium with 14 basic pairs of setae but this number often increasing in third instar. Ostioles similar in shape to those of adult but without setae. Anal ring usually narrow with a few minute pores. Setae about as long as body on anal lobes and on at least first segment preceding lobes, often present as far forward as second segment or sixth preceding lobes, always on sclerotized areas. Body setae long on first instar but second and third instars with increasing numbers of short setae. In some species there are numerous minute setae with the seta shorter than diameter of setal base. Trilocular pores and simple pores present only except in second instar male which has multilocular disc pores and oral collar tubular ducts also.

Discussion. The genus is probably more closely related to *Allomyrmococcus* than to any other, differing mainly in the sclerotized head, the presence of a circulus and the terminal anal ring.

Distribution. Malaya and the Riouw Is in Indonesia. A third instar female of an undescribed species is known among material of *Allomyrmococcus acariformis* collected by Takahashi in Thailand. See also the record from Sarawak on p. 6.

Key to species of *Malaicoccus* (adult females)

1 A distinct tuft of short slender setae opposite each first spiracle, the space between these setal bases shorter than the length of a seta 2
– Tuft of short setae opposite each first spiracle absent . . ***formicarii*** Takahashi (p. 33)
2 Setae in median area of ventral thorax all short and slender except for an occasional long seta ***khooi*** sp. n. (p. 39)
– Setae in median area of ventral thorax with numerous long stout setae in addition to short slender setae 3
3 Long marginal setae each nearly 1·0 mm long on last 4 segments. Long setae in median areas of anterior ventral abdominal segments absent . . . . . ***moundi*** sp. n. (p. 44)
– Long marginal setae nearly 1·0 mm long on last 2 segments only. Marginal setae on preceding segments much shorter. Long setae present in median areas of all abdominal segments . 4
4 Hind tibia with setae 40–60 μm long, the spaces between setal bases often longer than a seta. A seta 80 μm long on seventh segment in addition to long setae on eighth segment and anal lobes . . . . . ***takahashii*** sp. n. (p. 52)

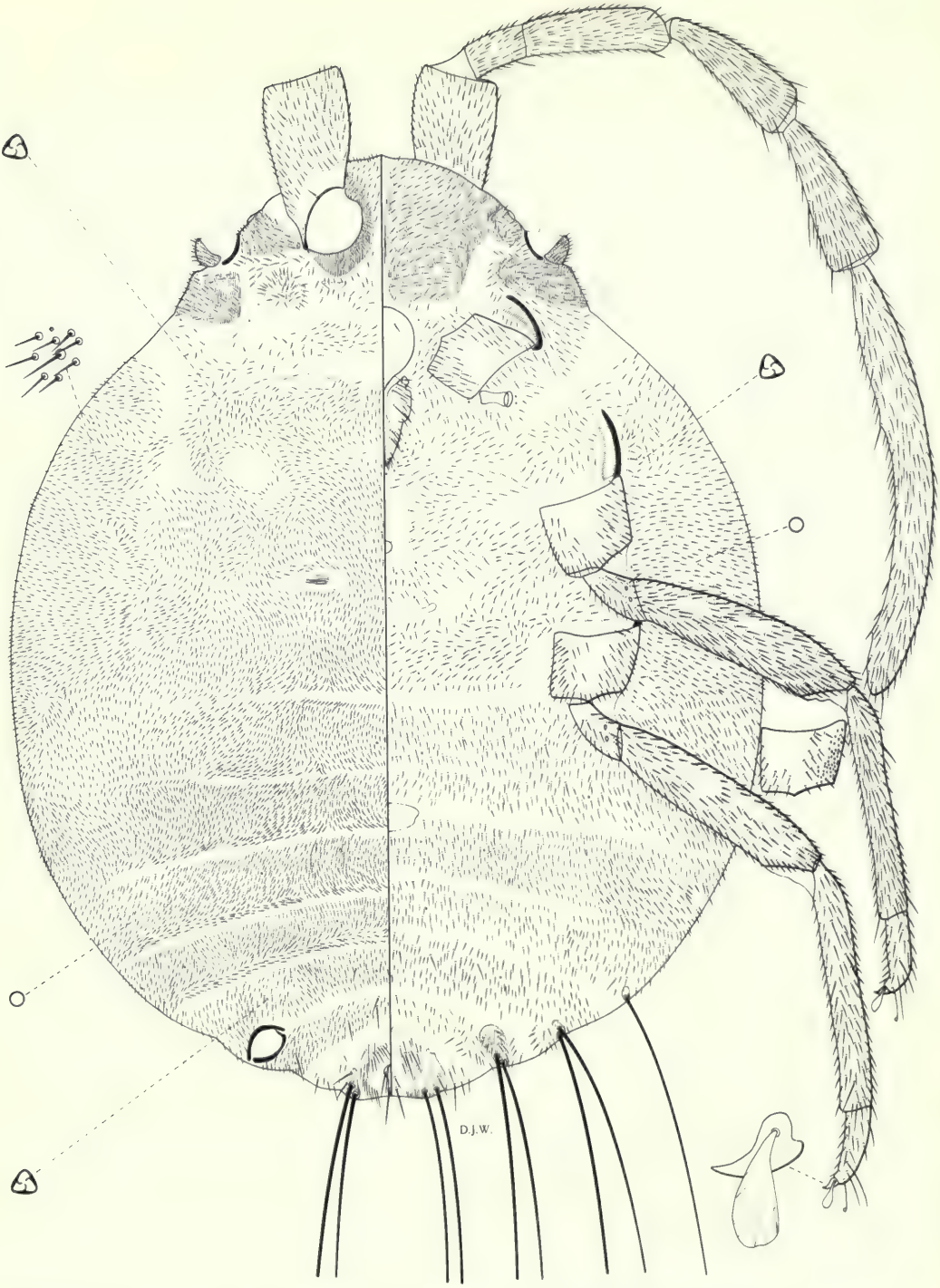

Fig. 12 *Malaicoccus formicarii* Takahashi. Adult female. Specimen from Malaya, Fraser's Hill.

– Hind tibia with numerous setae about 28 μm long, the spaces between setal bases shorter than a seta. Single setae 200–400 μm long on margins of sixth and seventh segments in addition to long setae on eighth segment and anal lobes . . . ***riouwensis*** Takahashi (p. 50)

Immature Instars

It is hoped that the immature instars described here may be recognized easily from the illustrations and descriptions but in the absence of suitable material of some species it is not possible to present a workable key. Some of the following distinguishing characters may prove useful. In *M. takahashii* there are long setae on the anal lobes and margins of the eighth abdominal segment only but in the other species studied, long marginal setae reach as far forward as the second abdominal segment or sixth preceding segment from anal lobes. *M. khooi*, *M. moundi* and *M. takahashii* have unusually short setae in the second and third instars, each seta much shorter than the diameter of the setal bases. The characters of the adult female are reflected in the immature instars. For instance, in *M. khooi* there is a short wide terminal segment on the antenna in the adult, third and second instars and there is an absence of long setae on the ventral surface of thorax in the adult and third instars. The labium of the first and second instars has the basic number of 14 pairs of setae. In *M. moundi* this number persists in the third instar but in the other species studied the number increases to as many as 18 pairs in the third instar. The labium of the second and third instars of *M. khooi* has a primary medial seta which is clavate and digitule-like. Second instar males are easy to recognize by the multilocular disc pores and oral collar tubular ducts on both surfaces.

Malaicoccus formicarii Takahashi, 1951

Malaicoccus formicarii Takahashi, 1951 : 5. LECTOTYPE ♀, West Malaysia: Malaya, Fraser's Hill, 6.vi.1943 (*R. Takahashi*) (BMNH, London), here designated [examined].

Adult Female (Fig. 12)

External appearance described as 'brownish black, without wax'.

On the slide body quite rotund except for a constriction on prothorax. Head and thorax heavily sclerotized around bases of antennae, in a broad band posterior to first pair of ostioles and ventrally in an area forward from clypeus to margins, there being a separate area running from the dorsal to ventral surface enclosing eye. The extent of the sclerotization varies slightly in different specimens. Antennae 2·3–2·5 mm long, the second segment longer than wide and all segments densely covered with slender setae which become longer towards apical segment. In an antenna 2·45 mm long the first segment is 300 μm long, second 140 μm, third 320 μm, fourth 340 μm, fifth 370 μm and sixth 950 μm, the last segment strongly curved. Legs well developed, hind trochanter + femur 610–670 μm long, hind tibia + tarsus 670–760 μm long, always longer than trochanter + femur. Hind coxae with translucent pores towards outer edge. All segments densely covered with short setae. Claw 48 μm long. Circulus 150 μm wide, wider than long with a constriction on either side. Anal ring elongate and becoming quite narrow at the point of constriction, easily distorted, with a few minute pores. Ostioles well developed, the anterior pair each with a narrow sclerotized lip which is apparently fixed, the posterior lip in the form of a hinged plate containing short setae which, when not flat against anterior lip, opens to almost right-angles to body. Posterior pair similar but posterior lip narrower, with a few setae. Labium 210 μm long and 120 μm wide, with 23–30 pairs of setae. Apical segment with 2 pairs of posterior setae, a pair of minute apical setae, 4 pairs of subapical setae each 28 μm long, 1 pair of lateral setae each 72 μm long, 3–7 pairs of anterior setae, the longest 60 μm. Medial segment with 9–12 pairs of setae, the longest 72 μm long. Basal segment with a pair of short setae each 24 μm long and a pair each 32 μm long. Body setae all pointed. Long marginal setae in four distinct groups on either side of abdomen, all about 1·0 mm long. Anal lobe setae comprising a pair on dorsal surface on a small triangular area of sclerotization and a ventral pair on a larger subrectangular sclerotized area. A pair of long setae also present on ventral margin of eighth segment at base of large sclerotized area. A pair also located on margin of seventh segment and a single seta on margin of sixth segment. Dorsal setae abundant, covering most of surface except parts of thorax and head where there are naked areas. The setae lie in definite waves or directions on each segment, a common length being about 16 μm except for longer setae on posterior abdominal segments and on two sclerotized crescentic areas anterior-lateral to anal ring. Ventral setae also abundant but not so numerous as on dorsum, mainly 20 μm long. Trilocular pores very few on both surfaces except for a noticeable concentration near inner edge of first coxa and around the labium. A few minute circular pores also present, each with a diameter much smaller than a trilocular pore or setal base. Tubular ducts absent.

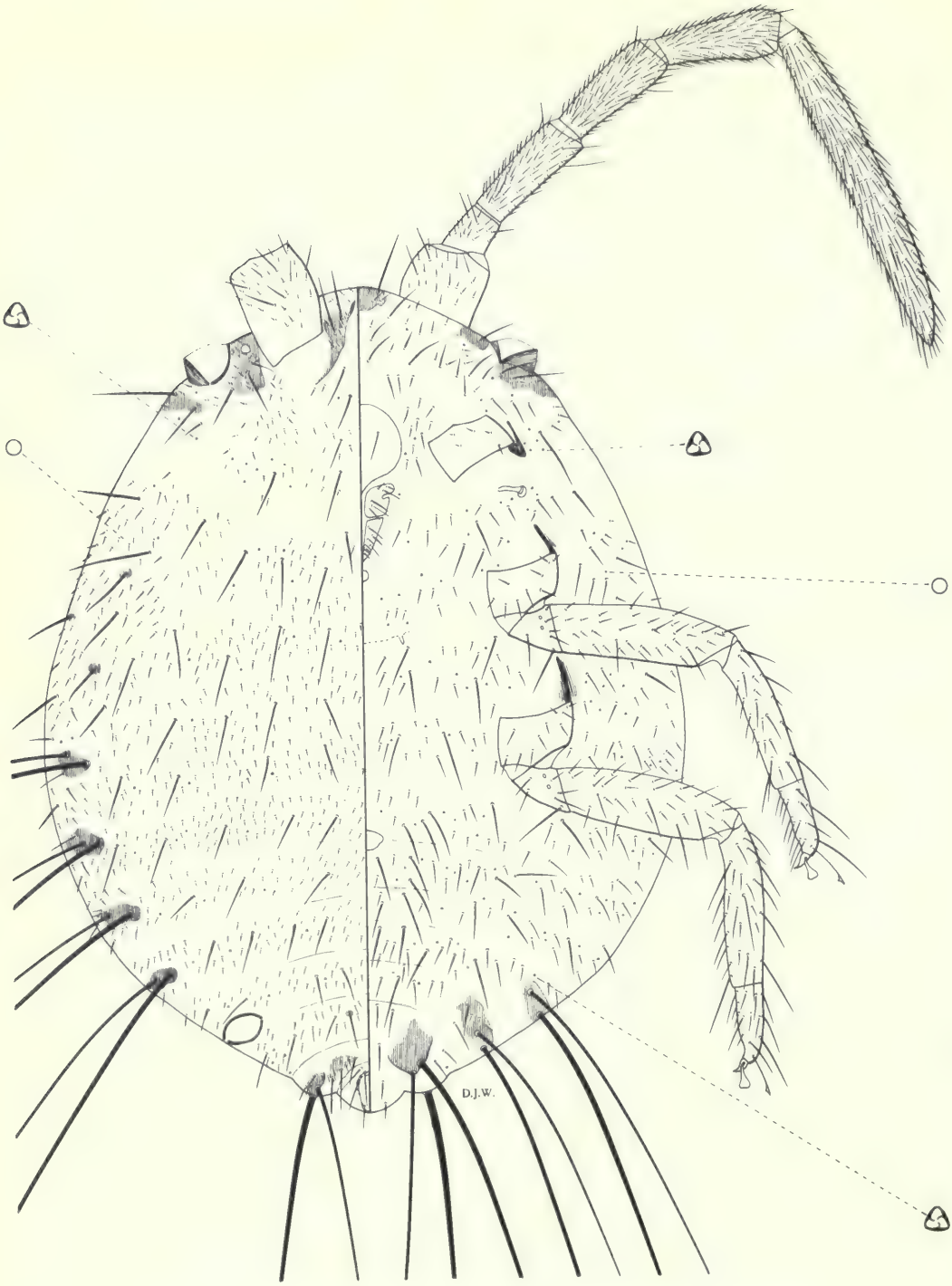

Fig. 13 *Malaicoccus formicarii* Takahashi. Third instar female.

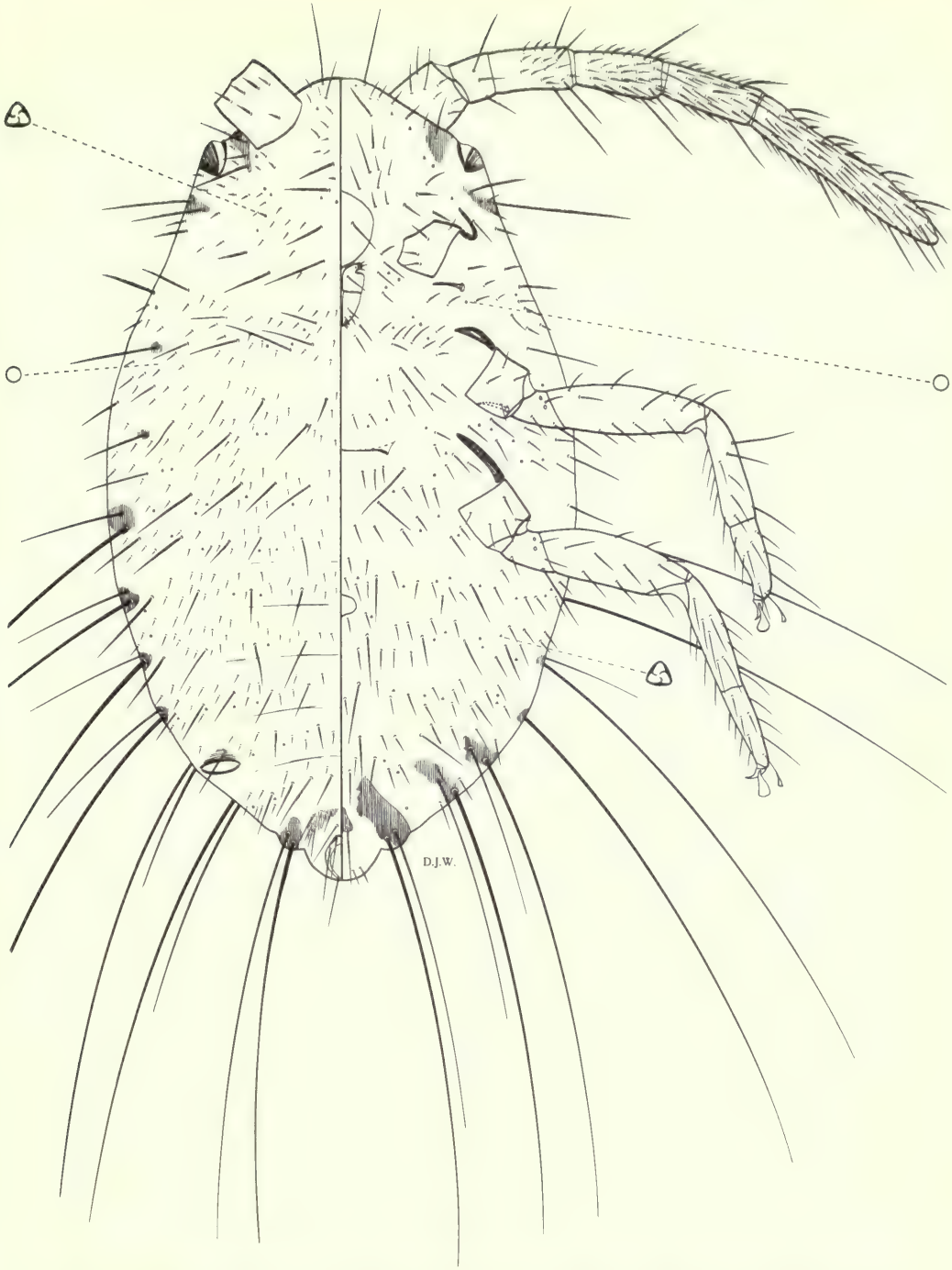

Fig. 14 *Malaicoccus formicarii* Takahashi. Second instar female. Specimen from Selangor, Ula Langat.

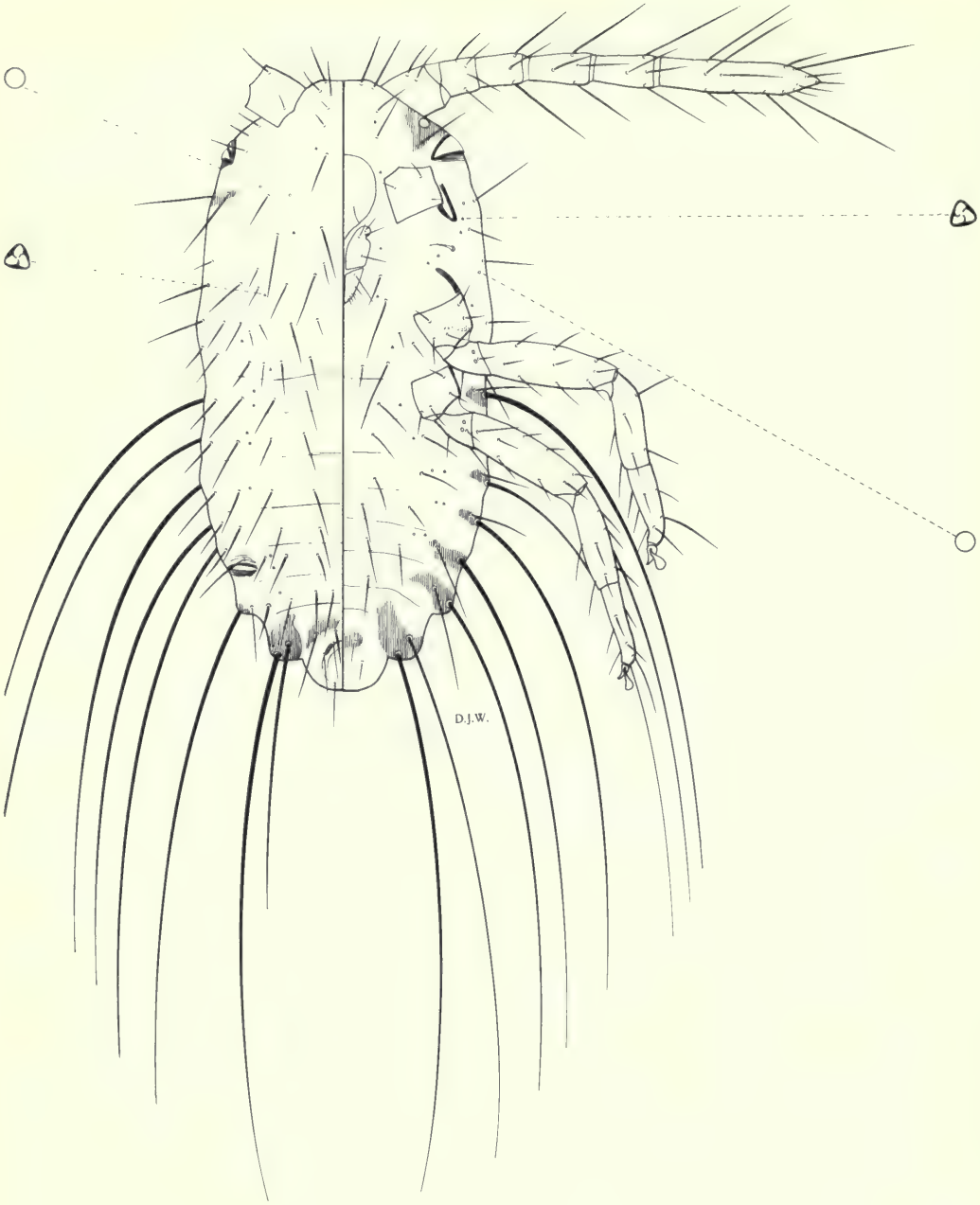

Fig. 15 *Malaicoccus formicarii* Takahashi. First instar.

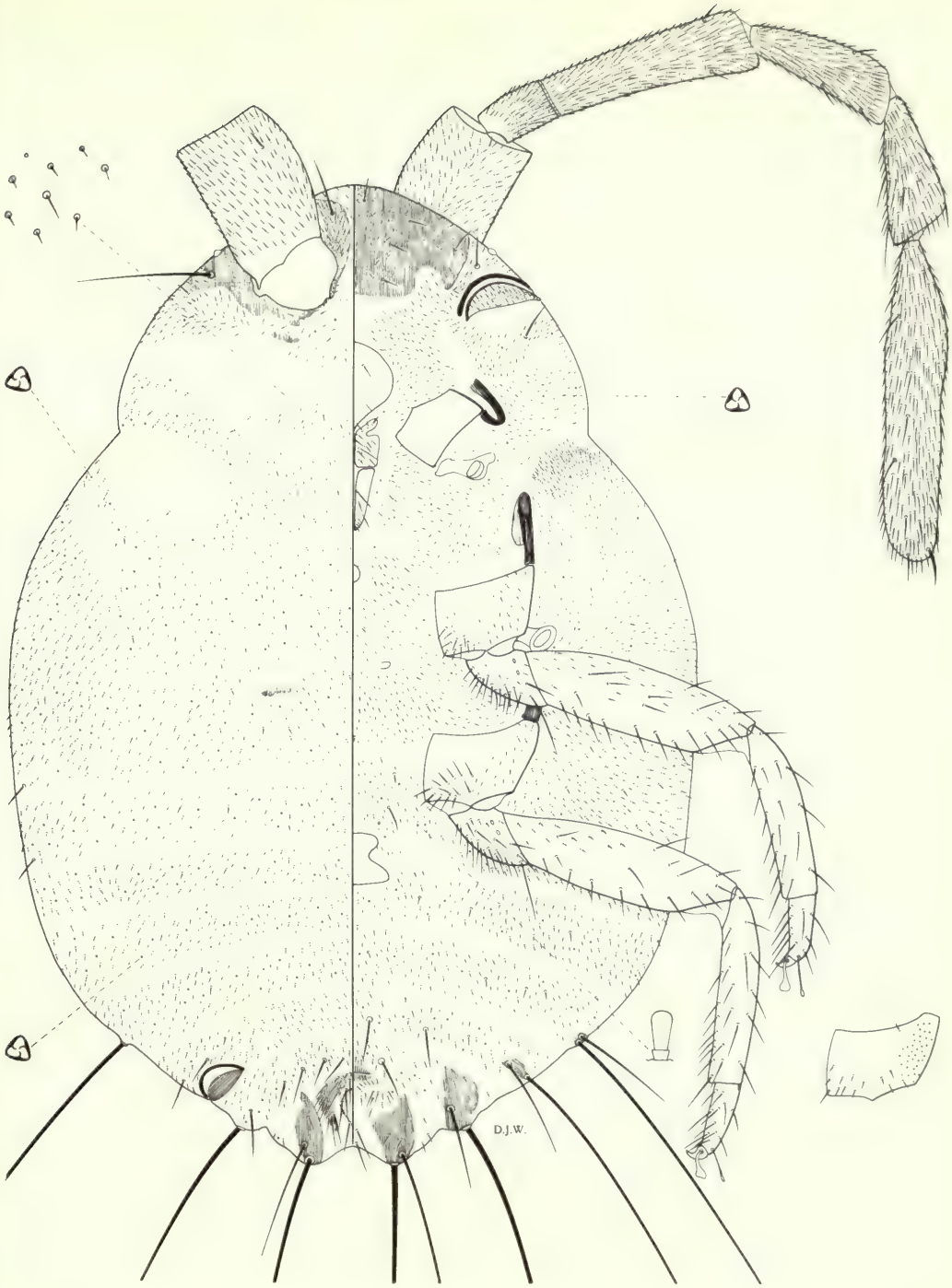

Fig. 16 *Malaicoccus khooi* sp. n. Adult female. Specimen from Malaya, Genting Highlands, on *Poikilospermum cordifolium*.

Third Instar Female (Fig. 13)

This instar has many of the features of the adult female but the body is less broadly oval, 1·75 mm long and 1·2 mm wide and with a smaller constriction opposite first coxae. Antennae 1·70–1·75 mm long, the first two segments with numerous short setae and the third to sixth segments densely covered with slender setae. Long marginal setae on abdomen numbering 6 pairs, about 1·0 mm long on irregular sclerotized areas. Short body setae less numerous than in previous stage, the dorsal setae 20–28 μm long and some of the ventral slightly longer. Other body setae present much longer than the dorsal, ranging from 60 to 150 μm long and ventral setae distributed across the segments 60–180 μm long. Sclerotization not so extensive as in adult. In addition to areas around marginal setae and behind the antennae there is a distinctive sclerotized area just below first pair of ostioles, and two triangular areas between antennal bases on dorsum, these containing setae. Circulus about 88 μm wide with a constriction on either side. Trilocular pores and smaller simple pores present but few. Anal ring narrow with lateral constrictions and becoming distorted during the preparation of the insect on the slide, with a few minute pores. Legs with a few short setae and some long pointed setae, hind trochanter + femur 430–450 μm long, hind tibia + tarsus 500–510 μm long. Claw 44 μm long. Labium 160 μm long and 100 μm wide, with 17–18 pairs of setae. Apical segment with 4 pairs of subapical setae each 28 μm long, a pair of slender lateral setae each 36 μm long and 2–3 pairs anterior setae, the longest 68 μm. Medial segment with 3–4 pairs, the longest 68 μm long, basal segment with 2 pairs basal setae each 24 μm long and a pair each 60 μm long.

Second Instar Female (Fig. 14)

Body oval, about 1·35 mm long and 0·8 mm wide, with anterior end angled and with slight constrictions on the thorax opposite the first coxae. Antennae about 1·0 mm long, with long pointed setae and with a few short slender setae on first segment and numerous such setae on third to sixth segments. Legs with hind trochanter + femur 320 μm long, hind tibia + tarsus 350 μm long. Claw about 36 μm long. Labium 130 μm long and 80 μm wide with 14 pairs of setae. Apical segment with subapical setae each 24 μm long, a pair of slender lateral setae each 32 μm long and 2 pairs of anterior setae, the longest 72 μm long. Medial segment with a single pair of medial setae each 56 μm long and basal segment with 3 pairs of setae, a long pair each 52 μm long and 2 shorter pairs each 20 μm long. Anal ring sclerotized with 6 setae about 80 μm long, with a few minute pores at anterior end and one or two only at sides. Circulus 64 μm wide, oval with a slight notch on either side. Marginal setae on abdomen reaching over 1·0 mm in length. On the anal lobes there are 2 dorsal and 2 ventral setae, the dorsal setae on an irregular-shaped area of sclerotization and the ventral pair on a larger area that extends inwards over most of segment. The anterior long marginal setae either on venter or dorsum when mounted on slide depending on convexity of body. Each long seta accompanied with a much shorter seta, their bases on an irregular-shaped sclerotized area. Other sclerotized areas at bases of shorter setae on thorax, behind the antennae and on either side of anterior end of anal ring, the latter areas crescentic or triangular containing a few setae. Other body setae less numerous than in third stage, thick pointed setae present up to 120 μm long, also short pointed setae which on dorsum are 16–20 μm long and on venter about 40 μm long. Ostioles well developed, the anterior pair with a movable hinged lip.

First Instar (Fig. 15)

Body oval, about 1·05 mm long and 0·6 mm wide. Anal lobes poorly developed, anal ring on apex of abdomen, projecting further than anal lobes. Anal lobes with 2 ventral apical setae about 1·1 mm long, 1 dorsal seta about same length and another about half the length. The five preceding segments each with marginal ventral setae, these also about 1·0 mm long, all of these setae including those on anal lobes, on irregular-shaped sclerotized areas which, anterior to anal lobes, also contain a much shorter seta. Sclerotized areas present on head around the eyes and in a crescentic patch on either side of anal ring. Antennae 620 μm long, with long pointed setae only on each segment. Ostioles prominent with heavily sclerotized lips. Circulus apparently absent. Anal ring sclerotized with 6 setae each about 44 μm long and a few minute pores at anterior edge only. Legs well developed, hind trochanter + femur 220 μm long, hind tibia + tarsus 260 μm long. Labium 110 μm long and 70 μm wide with 14 pairs of setae. Subapical setae each 20 μm long, a single pair of lateral setae each 40 μm long and 2 pairs of anterior setae the longest 60 μm long. Medial setae present as a single pair each 64 μm long. Basal segment with 2 pairs of setae each 20 μm long and a pair 44 μm long. Trilocular pores and simple circular pores in submedian areas, quite sparse.

MATERIAL EXAMINED. *Malaicoccus formicarii* Takahashi, lectotype ♀, WEST MALAYSIA: Malaya, Fraser's Hill, 6.vi.1943 (*R. Takahashi*) (BMNH, London).

West Malaysia: 17 ♀ and immatures, same data as lectotype (BMNH, London); 7 ♀, Selangor, Kepong, on *Bauhinia* sp. [Leguminosae], 29.viii.1943 (*R. Takahashi*); 2 ♀ and immatures, Selangor, Ula Langat, on 'jungle plant', 1928 (*H. T. Pagden*); immatures, Fraser's Hill, on *Languas* sp. [=*Alpinia*] [Zinziberaceae], 6.vi.1943 (*R. Takahashi*) (BMNH, London); 3 ♀, Cameron Highlands, on *Rubus* sp. [Rosaceae], x.1944 (*R. Takahashi*) (UM, Kuala Lumpur); 2 ♀ and immatures, Gombak, on *Mikania scandens* [Compositae], 4.xi.1971 (*Y. P. Tho*) (UM, Kuala Lumpur).

Discussion. The adult female is unlike any other in the genus in lacking a tuft of short setae on the venter opposite the first spiracles and in having the short body setae so densely covered that the distance between setal bases is shorter than the length of a seta.

Malaicoccus khooi sp. n.

Adult Female (Fig. 16)

External appearance not known. Body broadly oval, about 2·35 mm long and 2·17 mm wide with a deep constriction opposite first coxae. Head heavily sclerotized around antennal bases on dorsum and encircling the eyes, this area continuing to ventral surface just above anterior ostioles. Ventral head region anterior to clypeus almost completely sclerotized. Antennae about 1·88 mm long, first segment 250 μm, second 130 μm, third 360 μm, fourth 300 μm, fifth 260 μm and sixth 560 μm long, the last segment rather short and squat compared with that in other species. All segments densely covered with slender setae. Labium 208 μm long and 108 μm wide with 27 pairs of pointed setae. Apical segment with a pair of posterior setae, a pair of minute apical setae about 4 μm long, 4 pairs of subapical setae each 32 μm long, a pair of lateral setae 52 μm long and 2 pairs of anterior setae, the longest 72 μm. Medial segment with 11 pairs of setae, the longest 64 μm long. Basal segment with 3 pairs of setae, the basal pair 16 μm long and the longest 56 μm. Circulus rather large with a deep constriction at either side, about 230 μm at its widest at posterior end. Legs stout, well developed, hind trochanter + femur 520 μm long, hind tibia + tarsus 460 μm long and thus shorter than trochanter + femur. Hind coxa with a few translucent pores on outer dorsal surface, short setae on outer ventral surface and longer pointed setae on inner ventral surface. Long setae also present on outer margin of trochanter and a few present on femur, tibia and tarsus: a few short setae also present on proximal end of femur. Claw 40 μm long. Anal ring reduced to a narrow rim with 6 setae each about 64 μm long, and a few minute pores. Ostioles well developed, the anterior pair lying on ventral surface when mounted on the slide due to convexity of body. Both pairs with edge of anterior lip heavily sclerotized and probably fixed, the posterior lips forming a hinged semi-circular plate which is capable of folding over to anterior lip, this plate with numerous short setae on anterior ostioles but without setae in posterior pair.

Marginal setae on abdomen long, on anal lobes and three preceding segments. Anal lobes with 1 long dorsal and 2 long ventral setae each 850 μm long, the dorsal surface also with a shorter seta about one-third length on an elongate-oval area of sclerotization. Ventral anal lobe setae at apex of a subrectangular sclerotized area. Marginal setae on three preceding segments slightly ventral in position. Eighth segment with a single seta 950 μm long and a much shorter seta on a subrectangular area of sclerotization. Seventh segment with a seta 480–550 μm long and a shorter seta on a small sclerotized patch. Sixth segment with a seta 490–600 μm long and also a short seta on a small sclerotized patch. Dorsal surface of head lateral to each antennal base with a long pointed seta about 32 μm long. A few other setae 12–18 μm long also within the sclerotized areas of head, on abdominal margins and in mid-regions of eighth segment on dorsum and seventh and eighth segments on venter. A few setae present on a sclerotized crescentic area on either side of anal ring. Other body setae numerous, ranging from 8 to 16 μm long on dorsum, the larger setae easily noticeable by the larger setal bases, evenly distributed except on head and thorax where there are a few completely bare areas. Ventral body setae usually longer than dorsal, 12–20 μm long, the longer setae being the most numerous. A distinct tuft of short setae present near margin opposite each first spiracle. Trilocular pores not numerous, evenly distributed but a few concentrated near labium. Minute circular pores sparse, each with a diameter less than a setal base. Tubular ducts each with a diameter smaller than a trilocular pore, represented by one or two on inner side of second and third coxae.

Third Instar Female (Fig. 17)

Body similar in shape to that of adult female with deep constriction opposite first pair of coxae, 1·4 mm long and 0·9 mm wide. Antennae 1·25–1·30 mm long, the longest with first segment 180 μm long and 160 μm wide, second 90 μm long, third 260 μm, fourth 230 μm, fifth 200 μm and sixth 430 μm. All seg-

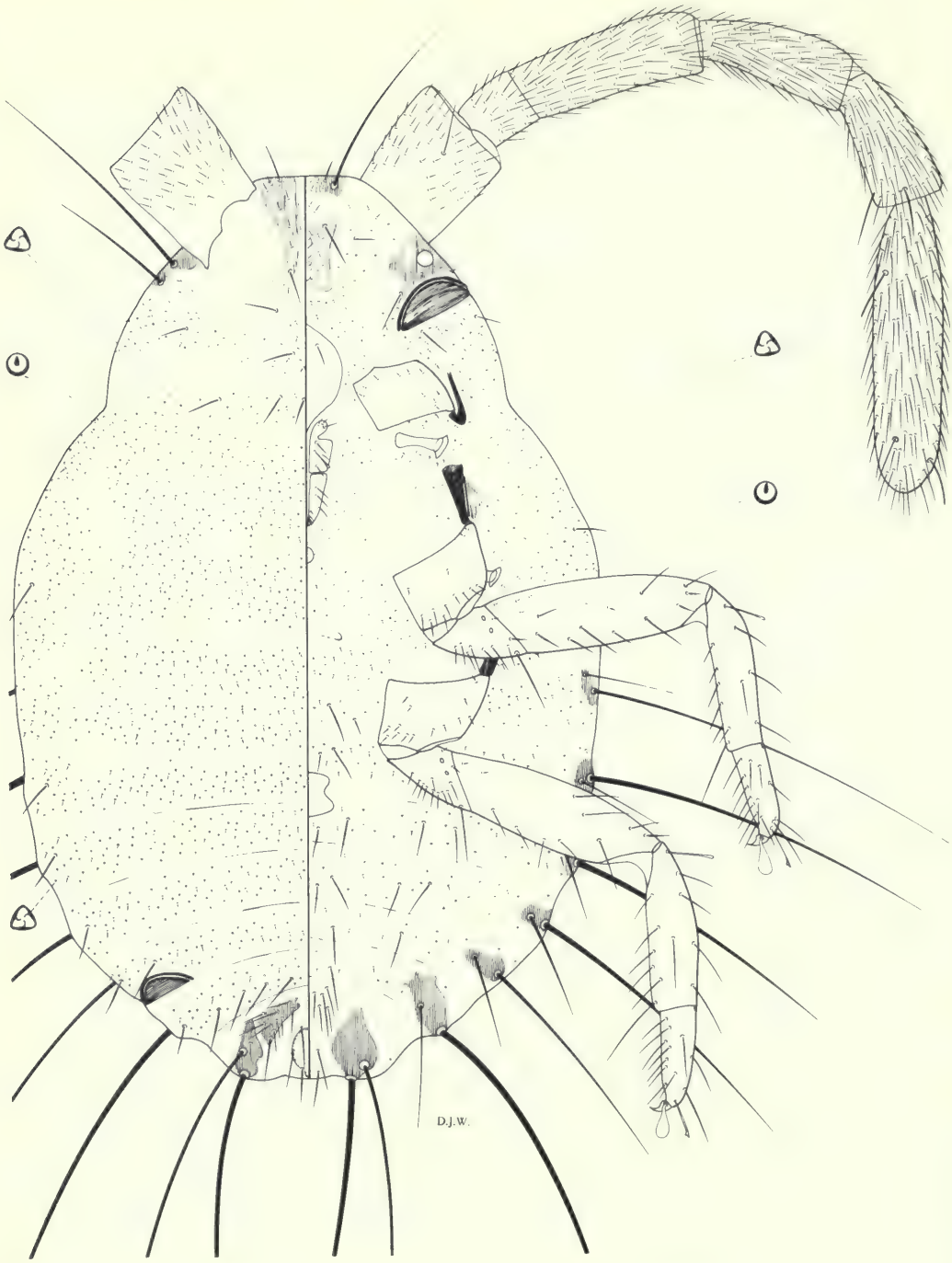

Fig. 17 *Malaicoccus khooi* sp. n. Third instar female.

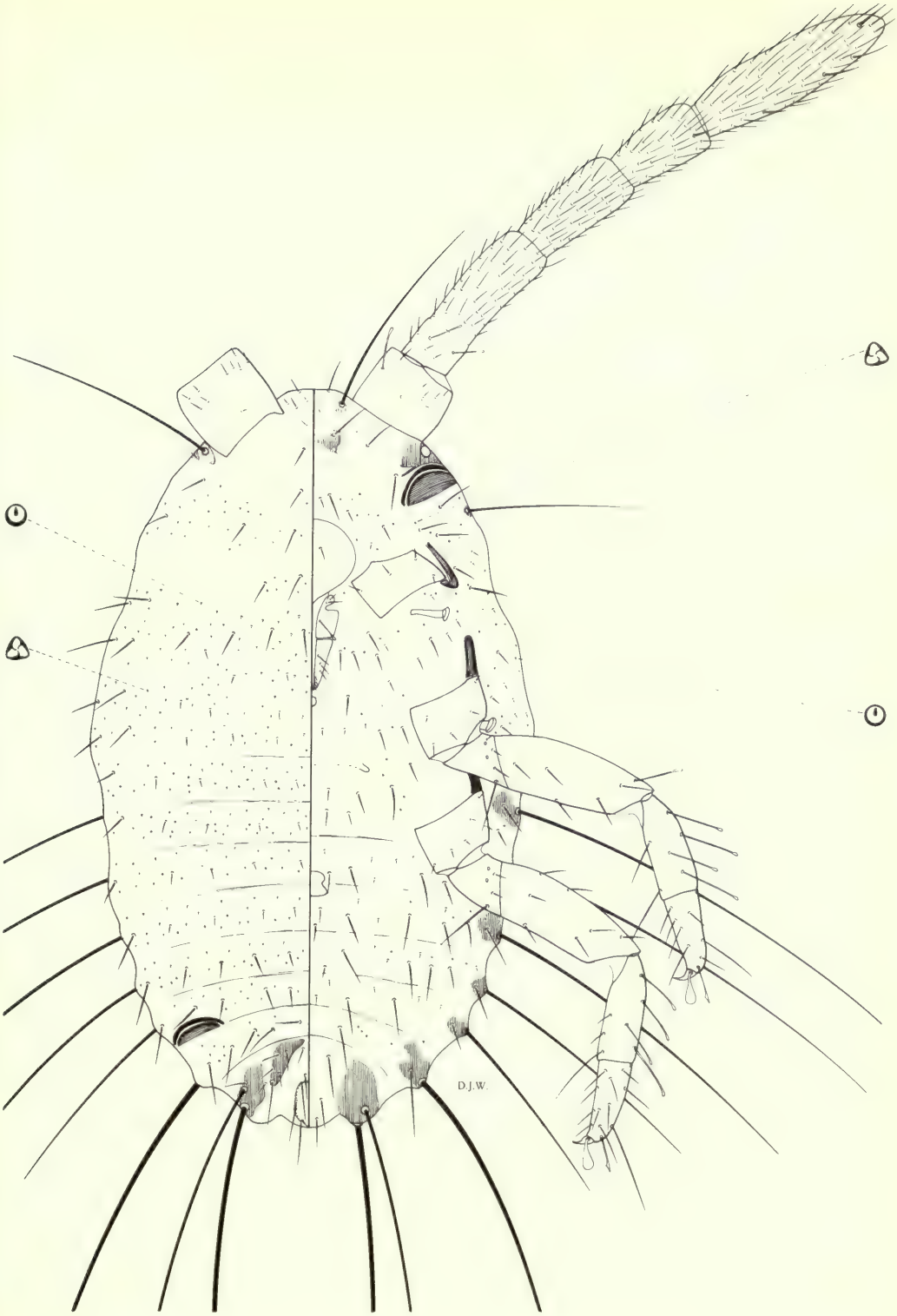

Fig. 18 *Malaicoccus khooi* sp. n. Second instar female.

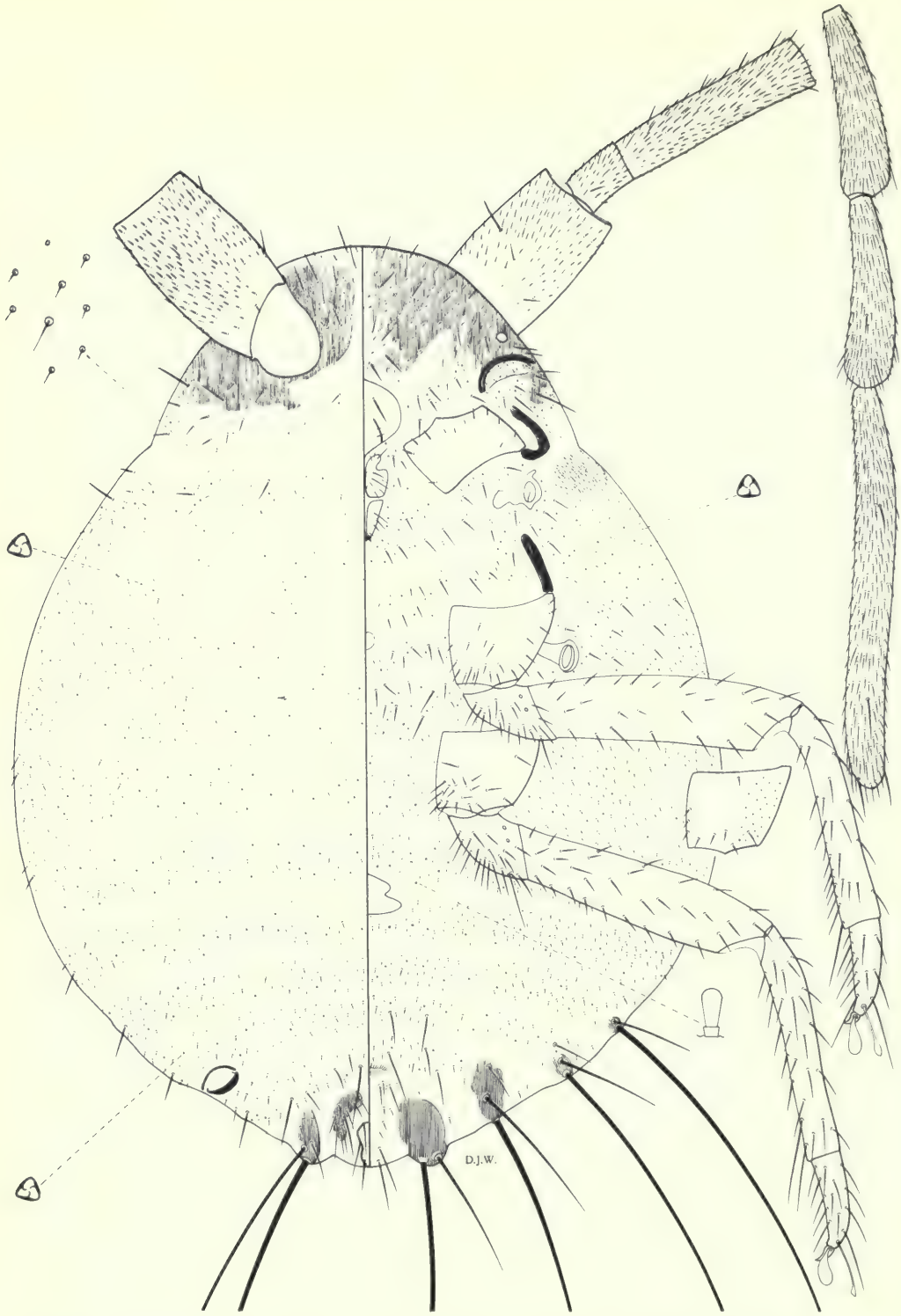

Fig. 19 *Malaicoccus moundi* sp. n. Adult female. Specimen from Malaya, Genting Highlands, on stems of *Uncaria* sp.

ments densely covered with slender setae ranging in length from 30 to 40 μm on first segment to 45 μm on last segment. Legs well developed, stout. Hind trochanter + femur 390–400 μm long, hind tibia + tarsus 360–370 μm long. All legs with pointed setae of different sizes but second and hind legs each with a pair of knobbed digitule-like setae on outer proximal end of tibia, the first legs with similar setae at distal end of femur and along outer edge of tibia. Labium 160 μm long and 100 μm wide, with 17 pairs of setae. Apical segment with a pair of posterior setae, 1 pair of minute apical setae, 4 pairs of subapical setae each 24 μm long, 1 pair of lateral setae each 44 μm long, 2 pairs of anterior setae the longest 68 μm long. Medial segment with 4 pairs of setae, one of the pairs knobbed and digitule-like, 48 μm long. Basal segment with 2 pairs 16 μm long and 1 pair 52 μm long. Circulus constricted, widest at posterior end, 120 μm wide. Anal ring slender with a few minute pores and 6 setae each 64 μm long. Ostioles as in adult female, the anterior pair lying on ventral surface when mounted on slide but these ostioles without setae. Anal lobes sclerotized on both surfaces. Dorsal surface of each lobe with a seta 0·85 mm long and a shorter 330 μm long. Ventral surface of lobe with apical seta 0·85 mm long and another probably shorter but broken in available specimens. Stout marginal setae on 6 anterior segments. On the eighth segment these setae are 0·85 mm long, on the seventh 350 μm, sixth 450 μm, fifth 450 μm, fourth 500 μm and third 550 μm long.

Dorsal surface with setae of different sizes. A pair of stout marginal setae each 350 μm long present just behind first antennal segment. Other setae about 50–60 μm long, few on prothorax, head and last two abdominal segments and singly on margins of most segments. On last segments they are present on two crescentic sclerotized areas anterior-lateral to anal ring. Short slender setae numerous, each 6–8 μm long. Minute setae abundant, each with seta much shorter than setal base. Ventral setae of similar sizes to those on dorsum but a pair 300 μm long on head margin. Other long setae, the longest of which are 85 μm, present in transverse rows on abdomen, head and prothorax. Slender setae 4–12 μm long, few on abdomen but numerous in median areas of head and thorax. Minute setae present in moderate numbers, each much shorter than setal base. Trilocular pores and simple circular pores not numerous, scattered.

Second Instar Female (Fig. 18)

Body oval, about 1·0 mm long and 0·6 mm wide, sclerotized on head around eyes and on a few setal bases. Antennae 840–880 μm long. On longest antenna first segment 110 μm long, second 60 μm, third 160 μm, fourth 150 μm, fifth 120 μm and sixth 280 μm. Slender setae numerous but on each of first and second segments there are one or two knobbed digitule-like setae. Legs well developed with hind trochanter + femur 270–280 μm long, hind tibia + tarsus 270 μm long. Knobbed setae present at distal end of first and second femora and on outer edge of all tibiae. Other leg setae all pointed except for tarsal digitules. Claw stout 28 μm long. Labium 120 μm long and 80 μm wide, with 14 pairs of setae. Apical segment with minute pair of apical setae, 4 pairs of subapical setae each 20 μm long, 1 pair of lateral setae each 32 μm long and 2 pairs of anterior setae, the longest 56 μm long. Medial segment with 1 pair of knobbed setae 52 μm long. Basal segment with 2 pairs of short setae 12 μm long and 1 pair 36 μm long. Circulus constricted, 68 μm wide. Ostioles rather large for size of body, the anterior pair lying behind eye on ventral surface when mounted on slide, without setae. Anal lobes sclerotized, each with a dorsal seta 0·8 mm long, another 270 μm long and a ventral apical seta 0·8 mm long with another 450 μm long. Anterior six segments with long marginal setae, the bases surrounded by sclerotized areas. Eighth segment with marginal setae 0·8 mm long, seventh 250 μm, sixth 350 μm, fifth 490 μm, fourth 550 μm and third 550 μm long. Anal ring with a few minute pores and 6 setae each 60 μm long.

Dorsal surface with stout setae on thorax and posterior abdominal segments 24–50 μm long. On remainder of abdomen the setae are small and slender, about 12 μm long. A pair of long setae behind first antennal segment each about 210 μm long, the area about the setal bases sclerotized. Minute setae numerous, each with seta much shorter than diameter of setal base. Ventral setae of different sizes, the longest about 50 μm accompanied with short slender setae and a few of the minute type. Trilocular pores and simple circular pores sparse.

Holotype ♀, West Malaysia: Malaya, Genting Highlands, on *Poikilospermum cordifolium* [Urticaceae], attended by ant *Hypoclinea* sp., 4.x.1973 (*L. A. Mound*) (BMNH, London).

Paratypes. West Malaysia: 3 ♀ and immatures, same data as holotype; 1 ♀, Genting Highlands, on low herbaceous plant, attended by ant *Hypoclinea* sp., 4.x.1973 (*B. Bolton*) (BMNH, London); 2 ♀, Gombak F. S., on bamboo [Gramineae], 26.x.1971 (*Khoo Soo Ghee*) (UM, Kuala Lumpur).

Discussion. This species is similar to *M. moundi* in having setae about 1·0 mm long on anal lobes and margins of the three preceding segments but it differs in the setae on mid-ventral thorax

which are short and slender, rarely more than 20 μm long whereas in *M. moundi* there are numerous setae up to 130 μm long in this area. The sixth antennal segment in *M. khooi* is about 560 μm long but in *M. moundi* it is more slender and 710 μm long.

Malaicoccus moundi sp. n.

Adult Female (Fig. 19)

Body broadly oval, with a distinct constriction on margins opposite first coxae, about 1·75 mm long and 1·15 mm wide. Head sclerotized around antennal bases on dorsal surface and over entire apex of venter as far as clypeus and almost to constriction on margin. Antennae densely covered with short setae which become longer towards last segment. Total length of antennae 2·12 mm and longer than body in available specimen; first segment 260 μm long, second 120 μm, third 370 μm, fourth and fifth each 330 μm and sixth segment 710 μm long. Legs well developed, hind trochanter + femur 640 μm long, hind tibia + tarsus 630 μm long hence slightly shorter than trochanter + femur. All segments with moderately long setae, hind coxa with a few translucent pores on dorsal outer half. Claw 56 μm long. Labium 212 μm long and 124 μm wide, with 22 pairs of pointed setae. Apical segment with 2 pairs of posterior setae, 1 pair of apical setae about 16 μm long, 4 pairs of subapical setae each about 28 μm long, 1 pair of slender lateral setae each 64 μm long and 2 pairs of anterior setae, the longest 92 μm. Medial segment with 8 pairs of setae, the longest 84 μm. Basal segment with 4 pairs of setae, the shortest 22 μm long and the longest 68 μm long. Circulus large with a deep constriction on either side, the posterior edge wider than anterior edge, 240 μm at widest. Anal ring elongate and narrow, constricted, but distorted in available specimen; with 6 setae, each 72 μm long and a row of minute pores. Ostioles well developed, each with a fixed sclerotized anterior lip and a hinged sclerotized posterior lip which may completely close the ostiole. Anterior pair on ventral margin on slide probably due to convexity of body, the posterior lips with a few setae.

Marginal setae on abdomen, on anal lobes and three preceding segments, the long setae all about 1·2 mm long. Anal lobe setae represented by 2 on dorsum, one thinner than the other, at apex of an elongate area of sclerotization. Ventrally each lobe with a pair of long setae and a large subrectangular area of sclerotization. Sixth to eighth segments with long setae on ventral margins, those on sixth segment accompanied with a shorter seta about 130 μm long, on the seventh segment with a shorter seta about 130 μm long and on the eighth segment with a seta about 400 μm long. Stout setae 50–130 μm long present dorsally on head, prothorax, abdominal margins, median areas of eighth and posterior segments and in a cluster on a sclerotized crescentic area on each side of anal ring. Similar setae present ventrally on head, in median areas of thorax and in mid-region of seventh and posterior segments of abdomen. One or two longer setae 130–300 μm long, in median area of dorsal and ventral eighth abdominal segment. Body setae abundant except on dorsum of head and prothorax where there are extensive bare areas. These setae extremely slender, 6–24 μm long, the majority being the smallest. Ventral surface opposite first spiracles with a distinctive tuft of short setae. Trilocular pores not numerous, evenly distributed but absent on head; there are, however, noticeable concentrations around labium. Simple circular pores, each with a diameter smaller than a trilocular pore, in moderate numbers between second and third coxae.

Third Instar Female (Fig. 20)

Body broadly-oval with a constriction opposite first coxae giving the body a pyriform appearance, about 1·4 mm long and 0·95 mm wide. Head sclerotized on dorsum between antennal bases, on venter between clypeus and anterior margins, and surrounding eyes. Anal lobes moderately developed. Antennae about 1·57–1·58 mm long, the first segment 170 μm long, second 100 μm, third and fourth each 250 μm, fifth 260 μm and sixth 550 μm long, each segment with numerous slender setae which on first segment are about 32 μm long and on sixth segment about 36 μm long. Legs with hind trochanter + femur 460–470 μm long, hind tibia + tarsus about 460 μm long, stout. Labium 160 μm long and 100 μm wide. Apical segment with 2 pairs of posterior setae, a pair of minute apical setae, 4 pairs of subapical setae each 24 μm long, 1 pair of lateral setae each 40 μm long and 2 pairs of anterior setae 60 and 80 μm long. Medial segment with 2 pairs of setae 40 and 60 μm long. Basal segment with 2 pairs of short setae each 24 μm long and a pair of longer setae each 68 μm long. Anal ring slender, easily distorted, with a few minute pores and 6 setae each 88 μm long. Circulus constricted, 130 μm wide. Ostioles as in adult female, the anterior pair often lying on ventral surface when mounted on slide but without setae. Anal lobes sclerotized on dorsal and ventral surfaces, each lobe with a dorsal and ventral seta about 1·3 mm long, a ventral seta 0·8 mm long and a dorsal 0·6 mm long. Ventral margins of third to eighth segments with sclerotized areas each containing one long and one short seta, third and fourth segments with the longer seta 0·7 mm long,

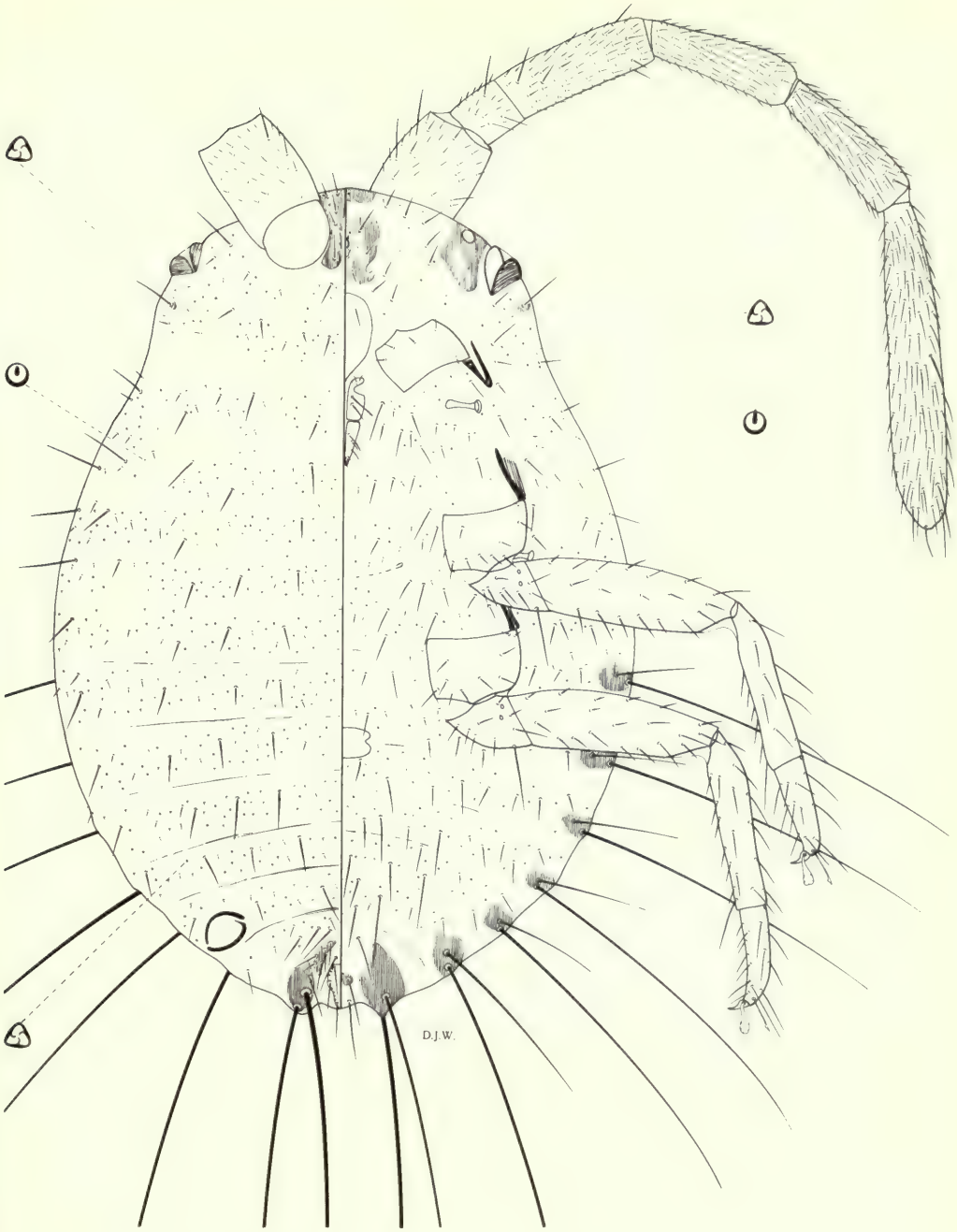

Fig. 20 *Malaicoccus moundi* sp. n. Third instar female.

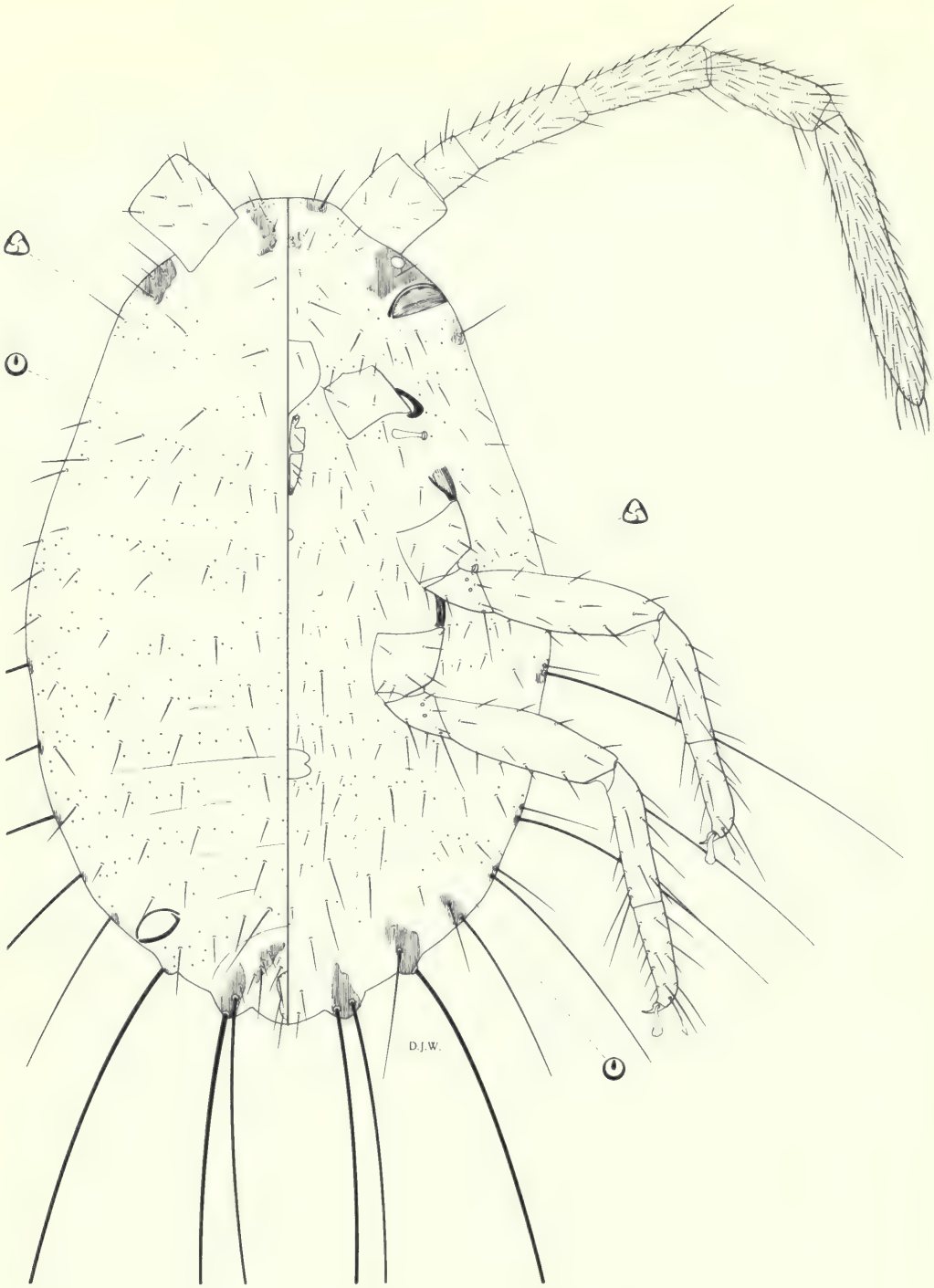

Fig. 21 *Malaicoccus moundi* sp. n. Second instar female.

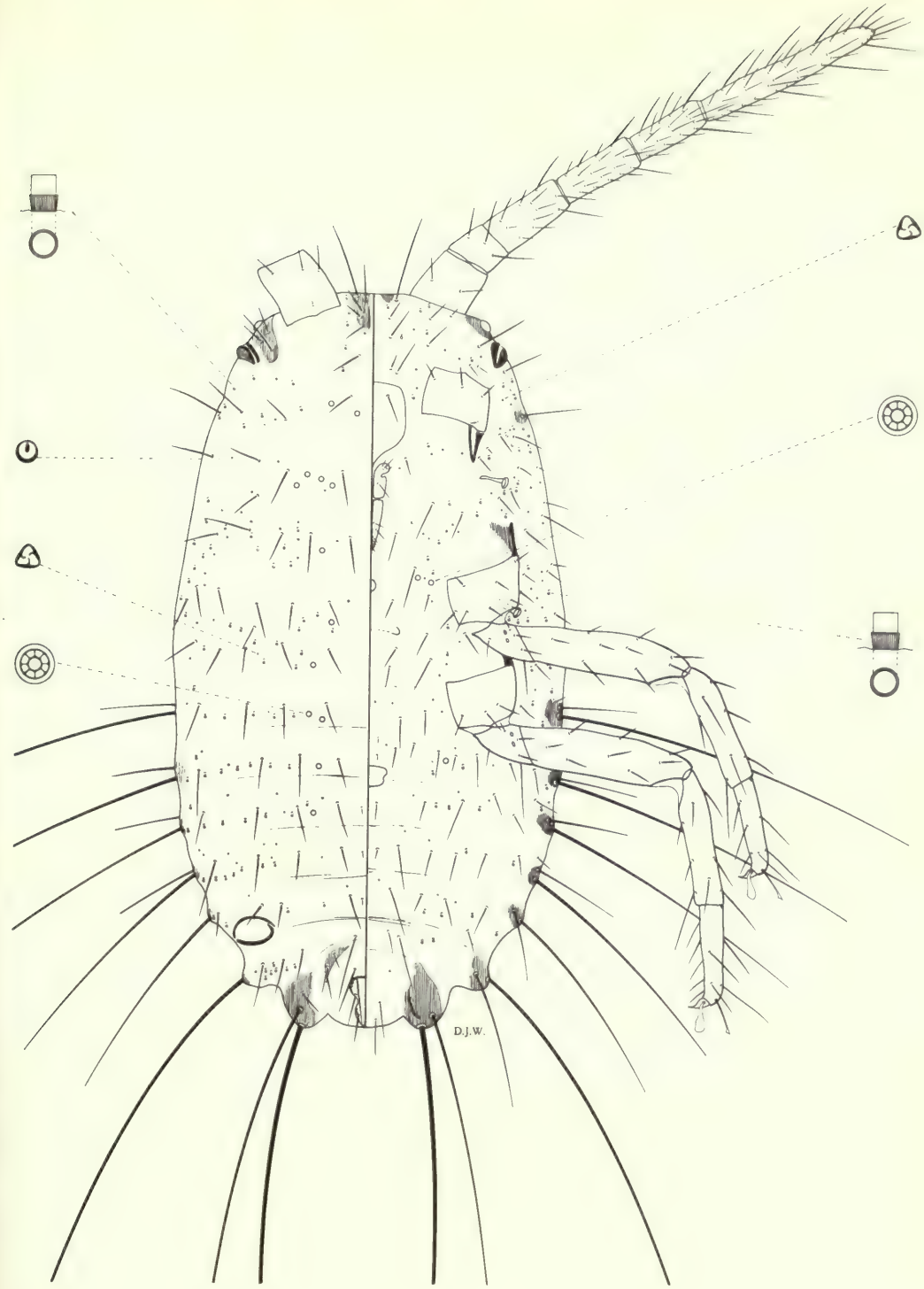

Fig. 22 *Malaicoccus moundi* sp. n. Second instar male.

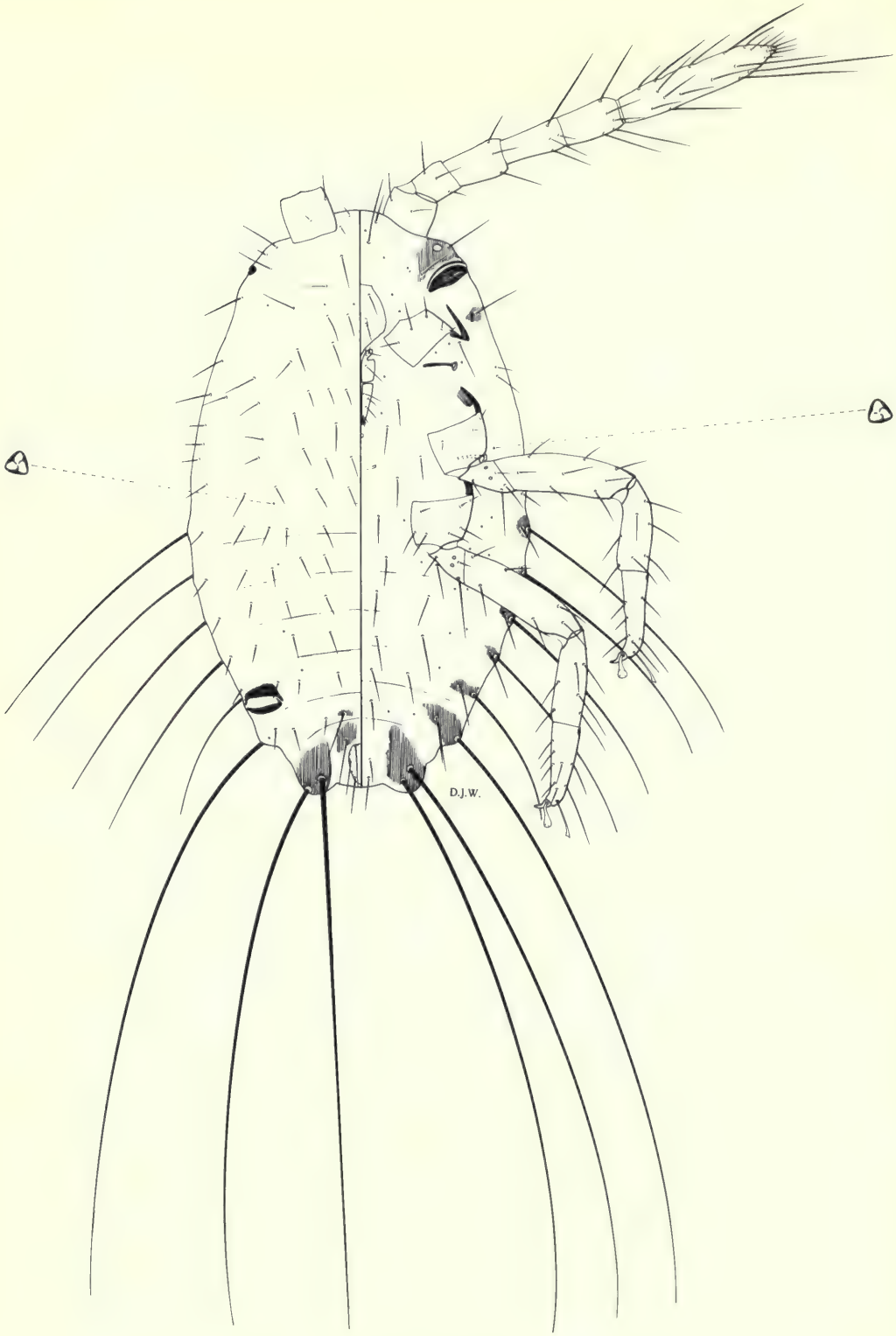

Fig. 23 *Malaicoccus moundi* sp. n. First instar.

fifth 0·6 mm, sixth 0·7 mm, seventh 0·6 mm and eighth 1·3 mm long. The short marginal seta on eighth segment about 330 μm long, the others on anterior segments shorter.

Body setae of different sizes. Dorsum with stout setae, most about 85 μm long, in single transverse rows but a median pair on last segment about 150 μm long. A pair of sclerotized crescentic areas present anterior to anal ring, each with a few setae of different sizes. Stout ventral setae also of different sizes, a common length being about 100 μm. Slender setae scattered on both surfaces, 8–28 μm long. Other minute setae numerous, each shorter than the diameter of its setal base. Trilocular pores not numerous. Simple circular pores smaller than a trilocular pore, scattered.

Second Instar Female (Fig. 21)

This instar differs from previous instars in having shorter and fewer characters. Body about 1·25 mm long and 0·85 mm wide. Head with 2 elongate sclerotized areas between antennae on dorsum. More extensive sclerotization present around eyes and almost reaching anterior ostioles. Antennae 1·12 mm long; first segment 130 μm long, second 60 μm, third 180 μm, fourth 180 μm, fifth 170 μm and sixth 400 μm. All segments with numerous setae. Legs as in previous stage, hind trochanter + femur 330 μm long, hind tibia + tarsus 350 μm long. Claw 36 μm long. Labium 128 μm long and 78 μm wide, with 14 pairs of setae. Apical segment with 2 pairs of posterior setae, a pair of minute apical setae, 4 pairs of subapical setae each 28 μm long, a pair of lateral setae each 36 μm long and 2 pairs of anterior setae 40 and 50 μm long. Medial segment with a single pair of setae 60 μm long. Each lobe of basal segment with a pair of short setae each 20 μm long and 1 long seta 72 μm long. Circulus 80 μm wide. Ostioles as in previous stage, the anterior pair lying on ventral surface when mounted on slide, without setae. Anal ring with 1 or 2 minute pores and 6 setae each about 60 μm long. Anal lobes each with dorsal and ventral elongate areas of sclerotization, with 2 dorsal setae, one 1·0 mm long, the other 550 μm long and 2 ventral setae, one 1·0 mm long and the other 800 μm long. Long marginal setae present on 6 preceding segments, each setal base surrounded by sclerotized areas. Eighth segment with seta 1·0 mm long and a shorter about 180 μm long, seventh with seta 300 μm long, sixth seta 370 μm long, fifth and fourth each 500 μm and third 630 μm long.

Dorsum with stout pointed setae in single transverse rows, usually 44–88 μm long except in mid-region of eighth segment where there is a pair 112 μm long. Similar setae present in a sclerotized crescentic area anterior-lateral to anal ring. Other dorsal setae more numerous and minute, each with seta much shorter than diameter of base. Ventral surface with similar long setae to those on dorsum except on head margin where there is a pair 100 μm long and behind first ostioles where there is a pair each about 120 μm long, these on sclerotized bases. On abdomen there are shorter pointed setae each about 8 μm long and minute setae of two types. One of these is similar to the dorsal minute setae but the other type is longer 2–4 μm but always shorter or same length as setal base. Trilocular pores on both surfaces, not numerous. Simple circular pores present, sparse, smaller than trilocular pores.

Second Instar Male (Fig. 22)

Body elongate, head margin tending to be straight, 1·12 mm long and 0·65 mm wide. Antennae with 6 segments about 745 μm long, the first segment 90 μm long, second 45 μm long, third 120 μm, fourth and fifth each 110 μm long and sixth segment 270 μm long. Fourth to sixth segments with slender setae ranging in length from 36 to 52 μm. Legs with hind trochanter + femur 280 μm long, tibia + tarsus 300 μm long. Claw 28 μm long. Labium 120 μm long and 68 μm wide, with 13 or 14 pairs of setae. Apical segment with 2 pairs of posterior setae, a minute apical pair, 4 pairs of subapical setae each 20 μm long, a lateral pair each 36 μm long, 1 or 2 pairs of anterior setae, the longer 64 μm and the shorter when present 40 μm. Medial segment with 1 pair each 60 μm long and basal segment with 2 pairs 18 μm long and a pair 72 μm long. Anal ring with a few minute pores and 6 setae. Anal lobes sclerotized on both surfaces, the dorsal surface with 1 seta 0·9 mm long and another 500 μm long, the ventral surface with one 0·9 mm long and another 650 μm long. Long marginal setae on 6 anterior segments with bases surrounded by sclerotized areas, on eighth segment these setae 0·9 mm long, on seventh segment 220 μm, on sixth 310 μm, on fifth 400 μm, on fourth 500 μm and on third 550 μm long.

Dorsal and ventral setae similar to those of second instar female but minute setae absent on venter and sparse on dorsum. Trilocular pores few. Simple circular pores quite sparse, each smaller than a trilocular pore. Multilocular disc pores each with 8 loculi, present on dorsum in small submedian groups on fifth abdominal segment and anterior segments to prothorax, an occasional pore also present on anterior abdominal segments and mid-thorax. Oral collar tubular ducts present, each slightly larger in diameter than a trilocular pore and only slightly longer than wide with deep sclerotized internal collar. On dorsum they tend to lie in single transverse rows but on head and thorax they become more scattered. On venter they are present mainly on head and thorax and become sparse on abdomen.

First Instar (Fig. 23)

Body oval, 1·0 mm long and 0·65 mm wide, head sclerotized around eyes. Antennae 565–700 μm long, one of largest with first segment 80 μm long, second 60 μm, third 90 μm, fourth 100 μm, fifth 100 μm and sixth 270 μm long. Each segment with a few long pointed setae at distal end but more numerous setae present on last segment. Legs well developed with hind trochanter + femur 230–250 μm long, hind tibia + tarsus 250–270 μm long. Claw 28 μm long. Circulus apparently absent. Labium 92 μm long and 52 μm wide, with 14 pairs of setae. Apical segment with 2 pairs of posterior setae, a minute pair of apical setae, 4 pairs of subapical setae each 20 μm long, a lateral pair 38 μm long and 2 pairs of anterior setae 20 and 56 μm long. Medial segment with 1 pair of setae 52 μm long and basal segment with 2 pairs 12 μm long and 1 pair 44 μm long. Anal ring slender with a few minute pores and 6 setae each 52 μm long. Anal lobes sclerotized on both surfaces, each with 2 dorsal setae, one 1·0 mm long, the other 460 μm long and 2 ventral setae, one 1·0 mm long and the other 700 μm long. Long marginal setae present on 6 preceding segments, the bases surrounded by sclerotized areas. All of these setae stout, measuring on eighth segment 1·0 mm long, seventh segment 160 μm, sixth segment 220 μm, fifth segment 280 μm, fourth segment 280 μm and on third segment 340 μm.

Body setae 28–44 μm long on dorsum but mid-region of eighth and last segment with pair of setae each 90 μm long on sclerotized patches. Ventral setae usually longer, about 80 μm long. Trilocular pores and simple circular pores sparse.

Holotype ♀, MALAYSIA: Malaya, Genting Highlands, 50 km E. of Kuala Lumpur, on stems of *Uncaria* sp. [Naucleaceae], attended by the ant *Hypoclinea* sp., 28.ix.1973 (*L. A. Mound*) (BMNH, London).

Not included in type-series. MALAYSIA: 2 third instar ♀, 3 second instar ♀, 3 second instar ♂ and 9 first instars, same data as holotype (BMNH, London).

DISCUSSION. The nearest species is *M. khooi* but it differs in the characters given in the discussion of that species. It differs from *M. riouwensis* and *M. takahashii* in having 4 pairs of long marginal setae on the abdomen instead of only 2 pairs. The short dorsal and ventral setae are similar to those of *M. riouwensis* and *M. takahashii* in that the distance between the setal bases is greater than the length of a seta but it differs from *M. formicarii*, which has the distance between the setal bases shorter than the length of a seta.

Malaicoccus riouwensis Takahashi, 1950

Malaicoccus riouwensis Takahashi, 1950 : 66. Holotype, ♀, INDONESIA: Riouw Is, Rempang, in association with ants of genus *Polyrhachis* sp. (probably lost).

Adult Female (Fig. 24)

External appearance described originally as 'Shining blackish brown, with no wax, in life, but dark reddish brown and a little shining when dry.'

Body of adult female pear-shaped with a constriction opposite first coxae. Anal lobes moderately developed. Anterior end of body with extensive sclerotization, which on the dorsal surface, extends around the antennal bases, then laterally and posteriorly around the first pair of ostioles. Ventrally the sclerotization extends over anterior end of head to just above clypeus. Circulus folded in available specimen but described by Takahashi as having deep constrictions at the sides and widest at anterior end. It is possible that Takahashi studied specimens that were distorted and that in reality the circulus is widest at posterior end. Labium 180 μm long, with 21 pairs of setae. Apical segment with 2 pairs of posterior setae, a pair of minute apical setae, 4 pairs of subapical setae each 28 μm long, 1 pair of lateral setae each 60 μm long and 2 pairs of anterior setae, the longest 80 μm long. Basal segment with 2 pairs short setae and 1 pair longer setae. Antennae 6-segmented, 2·33 mm long, thus longer than body; first segment 280 μm long, the second 120 μm, third 390 μm, fourth 370 μm, fifth 320 μm and sixth 850 μm and distinctly curved. Each segment densely covered with short setae ranging from 24 μm long on the proximal segments to about 40 μm towards terminal segment. Other slender setae 120 μm long on second to sixth segments. Thick setae present on all segments, these about the length of the shortest slender setae but much fewer. Legs well developed, hind trochanter + femur 640 μm long, hind tibia + tarsus 650 μm long. Hind coxa with translucent pores on outer dorsal half. Short setae present on all leg segments, those on tibia numerous, about 28 μm long, the distance between setal bases shorter than length of one seta. Claw 48 μm long. Anal ring slender with 6 setae about 56 μm long and a few minute pores. Ostioles well developed, of the type common to the genus, the anterior pair with setae on the lower lips, the posterior pair without setae. Long

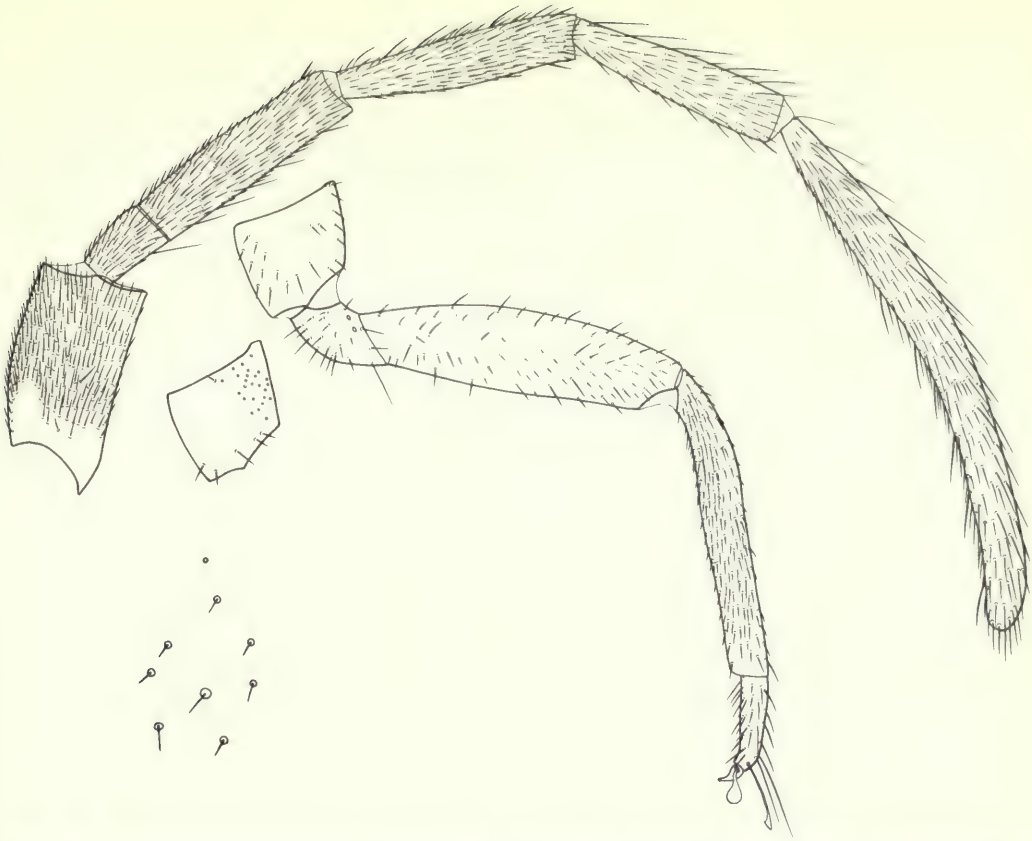

Fig. 24 *Malaicoccus riouwensis* Takahashi. Adult female. Specimen from Riouw Is, Rempang. Antenna, hind leg and dorsal setae.

marginal setae on anal lobes and eighth segment only, the two preceding segments with much shorter setae. Anal lobe setae comprising two long dorsal setae on an elongate area of sclerotization, the long setae about 0·9 mm long and the short setae about 350 μm long. The long ventral setae on eighth segment 0·8 mm long and a short seta 130 μm long on an elongate-oval sclerotized area. Seventh segment with one seta 220–250 μm long and a shorter seta 72 μm long on a round sclerotized area. Sixth segment with a seta 350–400 μm long and a short seta 72 μm long also on a round sclerotized area.

Body setae of various lengths. On the dorsal surface of head some of the stout setae are 30–44 μm long with a few reaching 180 μm. Others on posterior abdominal segments 44–100 μm long, the longest on mid-line. Stout setae on venter 40–68 μm long on all segments especially in median areas. Some setae on posterior abdominal segments 80 μm long. Over the rest of the body there are abundant minute slender setae 5–20 μm long, the larger proportion being the smallest. The setal bases are spaced apart about 1–2 times the length of a single seta. Ventral surface with a distinct tuft of short setae opposite first spiracles, the distance between these setal bases shorter than length of one seta. Trilocular pores present on both surfaces, sparse except for a few between the first spiracles. Minute simple pores few, each with a diameter smaller than a setal base. Tubular ducts represented by one or two on inner side of second and third coxae.

MATERIAL EXAMINED. INDONESIA: 1 ♀ (paratype), Riouw Is [Riau Is], Rempang, i.1946 (*R. Takahashi*) (USNM, Washington).

DISCUSSION. Mr Charles Chia-chu Tao has indicated that there is no type-material of this species in the Taiwan Agricultural Research Institute, Taipeh. Dr Sadao Takagi of the Entomological Institute, Hokkaido University, Sapporo, has informed the writer that there are no specimens in Takahashi's collection there and it must be assumed that the holotype is lost. Dr D. R. Miller of the United States Department of Agriculture, Beltsville, has kindly made available a single

paratype from the collections of the United States National Museum. This specimen is not in good condition and it has not been possible to illustrate it completely here.

The species is closely related to *M. takahashii* in having only 2 pairs of marginal setae nearly 1·0 mm long on abdomen on eighth segment and anal lobes. Anterior marginal setae to these are only 200–400 μm long. The most distinctive character separating this species from *M. takahashii* is the arrangement of the setae on the hind tibiae. These are short, about 28 μm long, and the distance between the setal bases on the disc of tibia is shorter than the length of one seta.

Malaicoccus takahashii sp. n.

Adult Female (Fig. 25)

An oval species, 1·7 mm long and 1·1 mm wide, with a deep constriction opposite first coxae. Anal lobes moderately developed. Anterior end of body heavily sclerotized; on the dorsum this sclerotization encircles antennal base and curves laterally and posteriorly to completely surround anterior ostioles. The sclerotization on ventral surface of head occupies the area immediately in front of clypeus to anterior margin but curves forward laterally before reaching ostiole. Antennae with the first segment 250 μm long, second 150 μm, third 360 μm, fourth 360 μm, fifth 350 μm and sixth 720 μm, the last segment curved. With a total length of 2·19 mm the antennae are longer than body. All antennal segments densely covered with short setae which range in length from 28 μm on the first segment to 48 μm on the last segment. Legs well developed, hind trochanter + femur 560 μm long, hind tibia + tarsus 550 μm long. All segments with quite stout setae in moderate numbers, the smallest on tarsus about 44 μm long with the space between setal bases usually same or greater than length of an average seta. Hind coxa with translucent pores on dorsal outer half. Claw 48 μm long. Circulus notched at either side, 188 μm wide. Labium 200 μm long and 130 μm wide with 20 pairs of setae, many of which are broken but their presence determined by setal bases. Apical segment with 2 pairs of posterior setae, a pair of minute apical setae, 4 pairs of subapical setae, 1 pair of lateral setae and 2 pairs of anterior setae. Medial segment with 7 pairs of setae and basal segment with 2 pairs of short setae and 1 pair of longer setae. Ostioles well developed, the anterior pair each with sclerotized posterior lip containing a few setae. Anal ring rather thin and easily distorted, with a few minute pores on periphery and 6 setae, each about 68 μm long. Long marginal setae each about 780 μm long on anal lobes and eighth segment only. Dorsal surface of anal lobes with an oval sclerotized area. Long marginal setae of eighth segment at apex of an elongate sclerotized area that also contains a seta about 80 μm long, each on a small sclerotized patch. Stout setae on dorsum confined to head, prothorax, eighth and posterior segments. On the head they are present mainly within the sclerotized areas but on the anal lobe segment they are present in two sclerotized crescentic areas anterior-lateral to anal ring. Although most of the stout setae are about 40 μm long some on eighth segment may reach 80 μm and others on head attain a length of 100 μm. Stout setae present on venter on all segments but on abdomen they are present in median areas only. These setae are about 40 μm long and on posterior segments of abdomen they are up to 90 μm long. Other body setae short, slender and numerous, evenly distributed over dorsal and ventral surfaces but absent on dorsal parts of head and thorax. A marginal tuft of short setae present opposite first spiracles, the distance between setal bases shorter than length of one seta. All the short setae range in length from 5 to 24 μm but the shorter setae are most numerous. Trilocular pores few but there is a noticeable concentration between the two first spiracles. Tubular ducts represented by one or two on inner side of second and third coxae. Simple circular pores minute, sparse.

Immature Instars

The three following instars are represented by poor distorted material and it has not been possible to illustrate them. Nevertheless, the long marginal setae are present only on the anal lobes as in the adult.

Third Instar Female

Body oval 1·25 mm long and 0·8 mm wide, constricted opposite first coxae. Head sclerotized around antennal bases, between clypeus and anterior head margin and around eyes on venter. Antennae 1·55 mm long, first segment 180 μm long, second segment 100 μm, third 250 μm, fourth 250 μm, fifth 200 μm and sixth 570 μm long; all segments with numerous slender setae. Legs with hind trochanter + femur 400 μm long, hind tibia + tarsus 410 μm long. Claw 40 μm long. Circulus 128 μm wide. Anal ring with a few

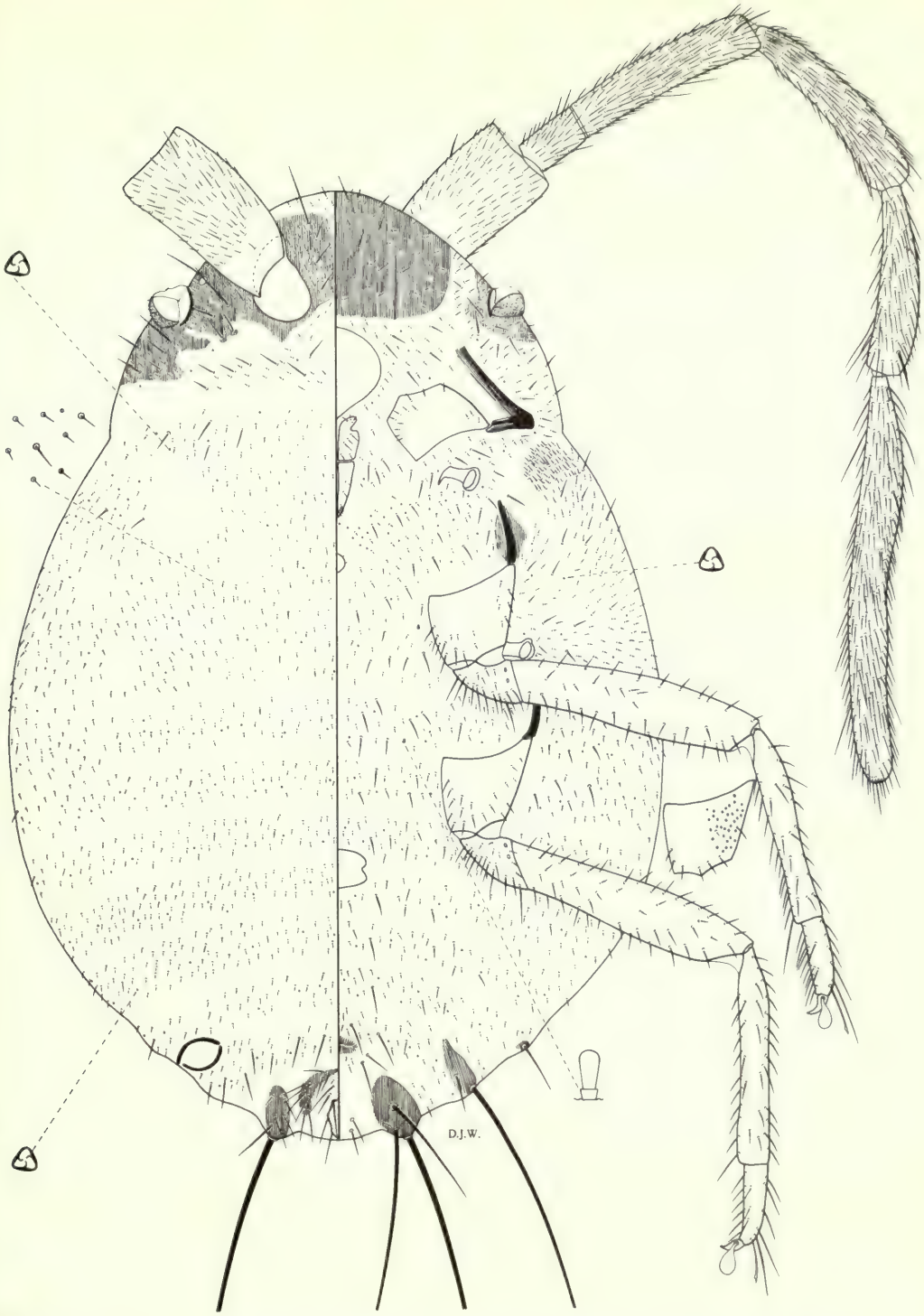

Fig. 25 *Malaicoccus takahashii* sp. n. Adult female. Specimen from Malaya, Kuala Lumpur.

minute pores and 6 setae each 60 μm long. Labium 160 μm long and 90 μm wide, with 16 pairs of setae. Apical segment with 2 pairs of posterior setae, a pair of minute apical setae, 4 pairs of subapical setae each 20 μm long, 1 pair of lateral setae each 56 μm long and 2 pairs of anterior setae, the longest 64 μm long. Medial segment with 3 pairs of setae, the longest 56 μm long. Each lobe of basal segment with a pair of short setae 20 μm long and one seta 44 μm long. Anal lobes sclerotized, each with one dorsal seta 0·8 mm long and a shorter seta 120 μm long, the ventral surface with one seta 0·8 mm long and another 280 μm long. Eighth segment with marginal setae 0·7 mm long and anterior marginal setae much shorter, each about 100 μm long, all on sclerotized areas. Dorsal and ventral setae numerous, of two types, a slender pointed type and a minute type with the seta much shorter than diameter of setal base.

Second Instar Female

Body 1·0 mm long and 0·55 mm wide, sclerotized on head between antennae on dorsum and around eyes on venter. Antennae 1·04 mm long, first segment 120 μm long, second 60 μm, third 170 μm, fourth and fifth each 160 μm and sixth 370 μm long. All segments with numerous slender setae. Hind trochanter + femur 290 μm long, hind tibia + tarsus 320 μm long. Claw 34 μm long. Circulus 80 μm wide. Anal ring slender with a few minute pores and each of the 6 setae 48 μm long. Labium 130 μm long and 70 μm wide, with 14 pairs of setae. Apical segment with 2 pairs of posterior setae, a pair of minute apical setae, 4 pairs of subapical setae each 20 μm long, 1 pair of lateral setae 40 μm long and 2 pairs of anterior setae the longest 56 μm. Medial segment with a single pair of setae 44 μm long. Each lobe of basal segment with a pair of short setae 16 μm long and one seta 36 μm long. Anal lobes each with 4 setae, a dorsal and ventral 0·8 mm long, one dorsal 150 μm long and one ventral seta 270–320 μm long. Eighth segment with marginal setae 0·8 mm long. Anterior marginal setae 100 μm long on sclerotized areas. Trilocular pores, simple circular pores and minute setae very few.

First Instar

Body oval, 0·85 mm long and 0·45 mm wide. Antennae 680 μm long, the first segment 70 μm long, second 40 μm, third 100 μm, fourth 110 μm, fifth 100 μm and sixth 260 μm long. Hind trochanter + femur 220 μm long, hind tibia + tarsus 240 μm long. Claw 28 μm long. Anal ring setae 40 μm long. Anal lobes each with a dorsal and apical seta 0·85 mm long and a short dorsal and ventral seta 220 μm long. Eighth segment with marginal setae 0·85 mm long and anterior marginal setae 100–120 μm long, all on sclerotized areas. Labium 110 μm long and 60 μm wide with 14 pairs of setae. Apical segment with a pair of minute apical setae, 4 pairs of subapical setae each 20 μm long, a pair of lateral setae 32 μm long and 2 pairs of anterior setae, the longest 60 μm long. Medial segment with 1 pair of setae 52 μm long and each lobe of basal segment with a pair of short setae 16 μm long and 1 seta 40 μm long.

Holotype ♀, MALAYSIA: Malaya, Selangor, Kuala Lumpur, 11.viii.1943 (*R. Takahashi*) (BMNH, London).

Not included in type-series. MALAYSIA: 1 third instar ♀, 9 second instar ♀ and 2 first instars, same data as holotype (UM, Kuala Lumpur).

DISCUSSION. This is probably the undescribed species from Kuala Lumpur, on *Palaquium obovatum* (Sapotaceae), mentioned by Takahashi (1951) when discussing *M. formicarii*. Specimens were kindly made available by Dr Khoo Soo Ghee.

The most distinctive features of the adult female are the long pairs of setae present only on the anal lobes and eighth segment. These are about 780 μm long. The only other marginal setae, in addition to the normal body setae, are present on the seventh segment but these are only 80 μm long. A major character separating this species from *M. riouwensis* is the arrangement of the tibial setae, which although longer than those in *M. riouwensis*, are sparser, and on the tibial disc the distances between the setal bases are the same as or longer than the length of one seta.

PARAMYRMOCOCCUS Takahashi, 1941

Paramyrmococcus Takahashi, 1941 : 204. Type-species: *Paramyrmococcus chiengraiensis* Takahashi, by original designation and monotypy.

DESCRIPTION. Adult female with turbinate to oval body, tapering to a rounded posterior end, anal lobes obsolete. Antennae 6-segmented, about as long as body, first and second segments each with 1 or 2 stout setae, third to sixth segments densely covered with slender setae; second segment quite small, either shorter or just slightly longer than wide. Legs well developed, setae varying in size and number, claw

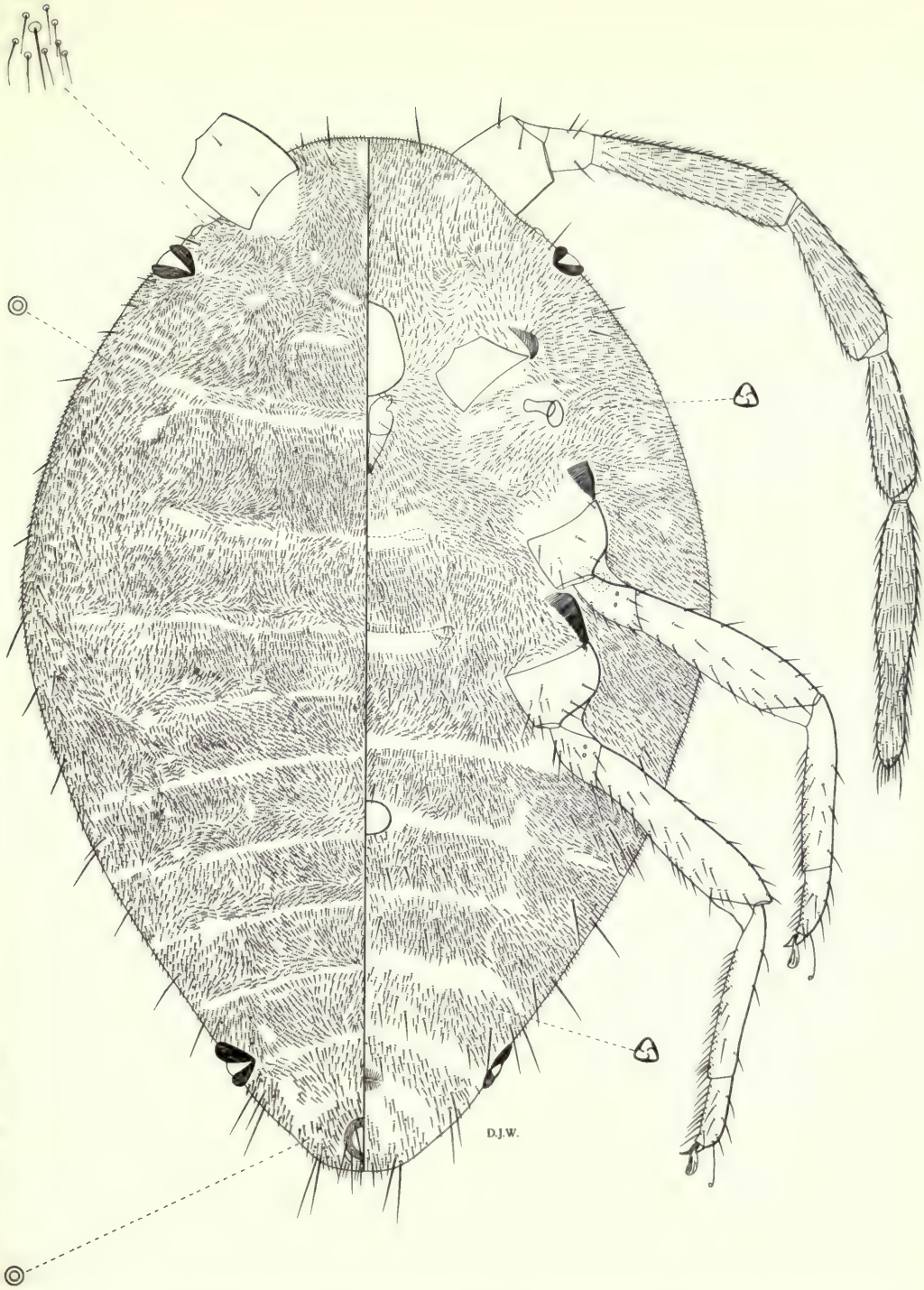

Fig. 26 *Paramyrmococcus chiengraiensis* Takahashi. Adult female. Specimen from Thailand, Chiengrai.

stout with a pair of wide flat digitules. Anal ring sclerotized with 6 setae but without pores. Ostioles situated on margins, of unusual development with large prominent lips that are heavily sclerotized but are devoid of setae. Circulus normal, usually oval. Body setae minute and slender, of unusual abundance, covering almost entire surface except for intersegmental areas, lying in definite directions giving the surface a wavy appearance. Other setae stout, situated mainly around margins; anal lobe setae not much more than twice diameter of anal ring in length. Trilocular pores few.

DISCUSSION. This genus is easily separated from the others in the Allomyrmococcini in being without recognizable anal lobes and in having short setae, only about twice diameter of anal ring in length, in normal positions of lobes. The immature instars are about the same shape as the adult but they tend to be more slender. Distinctive characters of the immature instars, based on *P. vietnamensis*, are short cylindrical and blunt setae on dorsum at least, which are replaced completely in the adult by short pointed setae.

DISTRIBUTION. The genus is known so far from Thailand and Vietnam.

Key to species of *Paramyrmococcus* (adult females)

Setae on hind tibial disc sparse, the distance between setal bases longer than length of a single seta. Marginal stout setae on head and thorax attaining a length of 40 μm ***chiengraiensis*** Takahashi (p. 56)

Setae on hind tibial disc numerous, the distance between setal bases shorter than length of one seta. Marginal stout setae on head and thorax attaining a length of 80 μm ***vietnamensis*** sp. n. (p. 61)

Paramyrmococcus chiengraiensis Takahashi, 1941

(Fig. 26)

Paramyrmococcus chiengraiensis Takahashi, 1941 : 204. Holotype ♀, THAILAND: Chiengrai, Lampang, on undetermined vine, attended by ant *Dolichoderus* sp. [= *Hypoclinea* sp.] (probably lost).
Paramyrmococcus chiengraiensis Takahashi; Takahashi, 1942 : 16.

Adult Female (Fig. 26)

External appearance in life not noted. On the slide, adult female turbinate or broadly oval, widest at mesothorax, posterior end of body tapering, rounded, about 2·0 mm long and 1·25 mm wide. Antennae about 1·78 mm long, first segment 170 μm, second 90 μm, third 430 μm, fourth 320 μm, fifth 270 μm and sixth 500 μm long. Second segment about 80 μm wide and thus slightly longer than wide. Sixth segment widest at proximal half, which then narrows before becoming slightly swollen. The first two segments with 1 or 2 stout setae only, the remaining segments densely covered with slender setae about 32 μm long on third segment and as long as 44 μm on sixth segment. Legs well developed, hind trochanter + femur 520 μm long, femur at its widest about 150 μm; hind tibia + tarsus 450–460 μm long, the tarsus 80 μm at its widest and distinctly shorter than trochanter + femur. Slender setae on dorsal and ventral surfaces of tibia quite sparse, about 40 μm long, the spaces between setal bases much greater than length of one seta. Claw 40 μm long. Labium 160 μm long and 140 μm wide, with 14 pairs of setae. Apical segment with two pairs of posterior setae, a pair of minute apical setae and four pairs of subapical setae each 28 μm long except the second pair, which are more slender and shorter, 20 μm long. Lateral setae and 2 pairs of anterior setae present, each 40 μm long. Medial segment with 1 pair of setae each 40 μm long and each lobe of basal segment with 2 pairs of setae 20 μm long and 1 pair 40 μm long. Circulus oval to subrectangular, 60–104 μm wide. Ostioles well developed, on the margins, with protruding sclerotized lips, without setae. Anal ring 72–80 μm wide with 6 setae 70–80 μm long.

Body setae mainly slender, about 16 μm long but with a smaller proportion of longer setae about 20 μm long evenly distributed among the smaller, covering almost entire surface except for intersegmental areas; the distance between the setal bases much shorter than the length of one seta. On the dorsum the setae are even closer together than on venter. Other setae present are stout, those on margins of head and thorax on both surfaces 40–50 μm long, on margins of abdomen 60–80 μm long except on eighth segment where they are 112 μm long and the two ventral anal lobe setae about 120 μm long. Mid-ventral setae about 40 μm long. Trilocular pores sparse, apparently on venter only. Round pores on dorsal margins few, each slightly smaller than a trilocular pore and with obscure structure.

MATERIAL EXAMINED. THAILAND: 2 ♀, 'Siam', Chiengrai, 16.iv.1940 (*R. Takahashi*) (TARI, Taipeh).

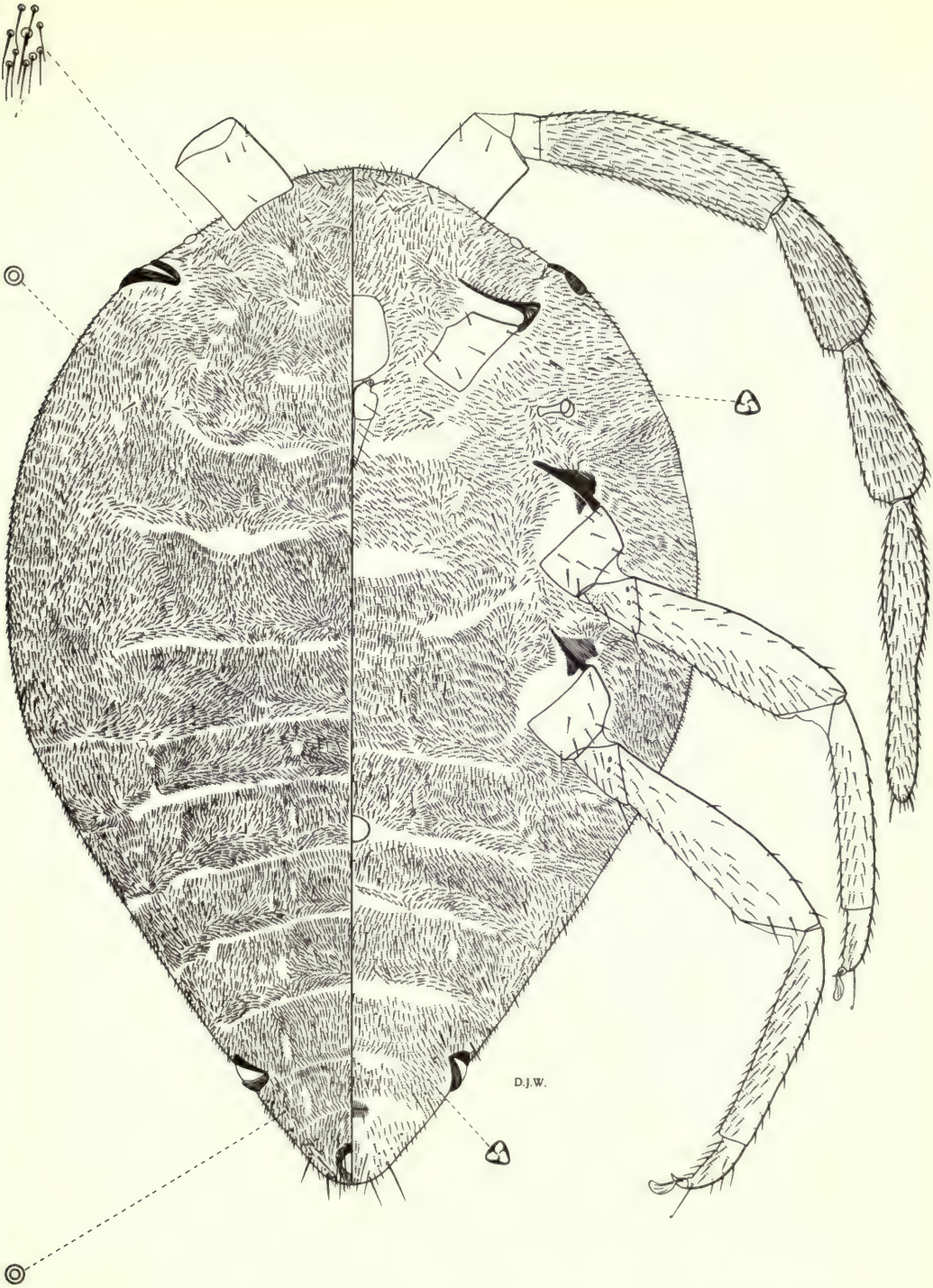

Fig. 27 *Paramyrmococcus vietnamensis* sp. n. Adult female. Specimen from Vietnam, Da Lat.

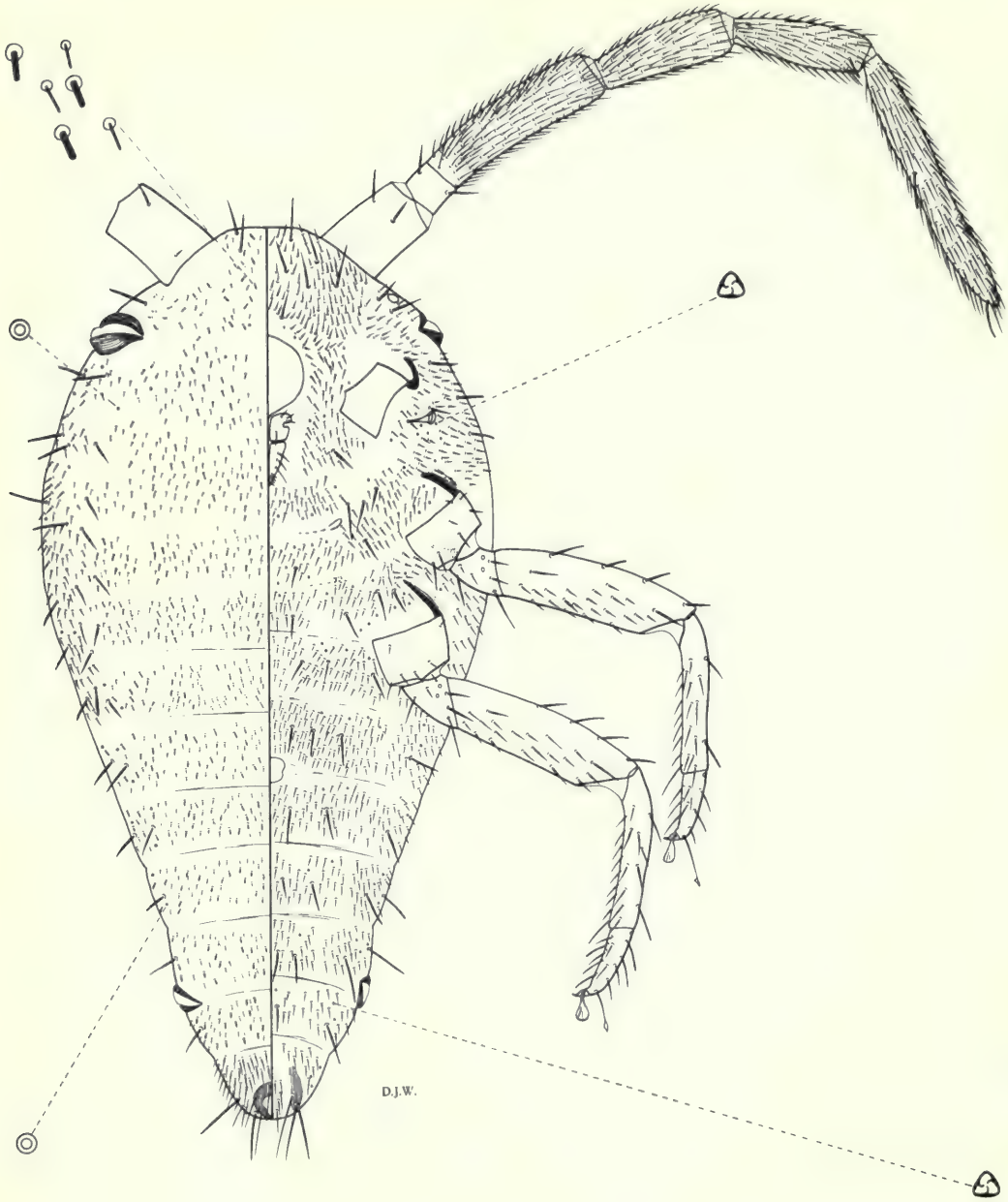

Fig. 28 *Paramyrmococcus vietnamensis* sp. n. Third instar female.

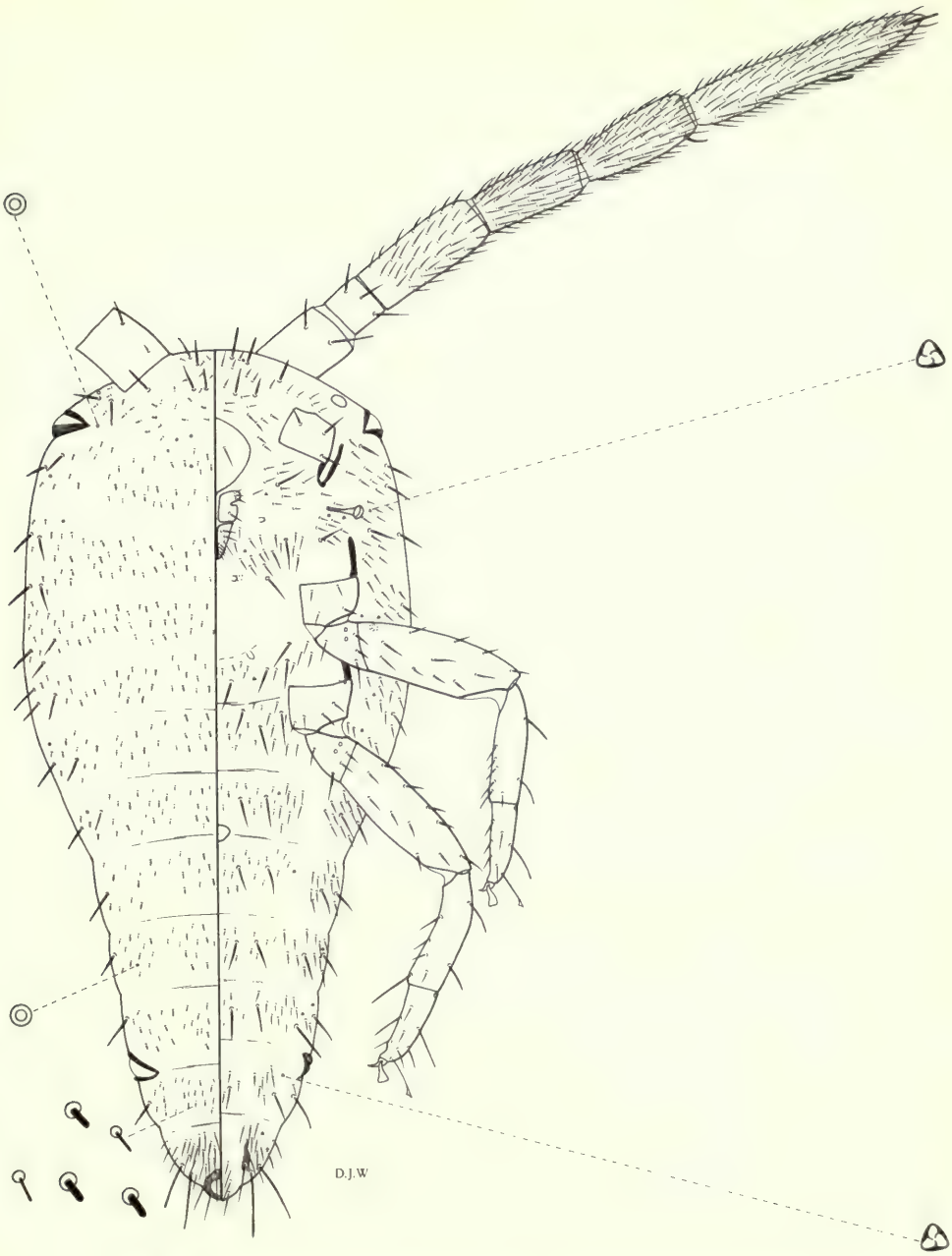

Fig. 29 *Paramyrmococcus vietnamensis* sp. n. Second instar female.

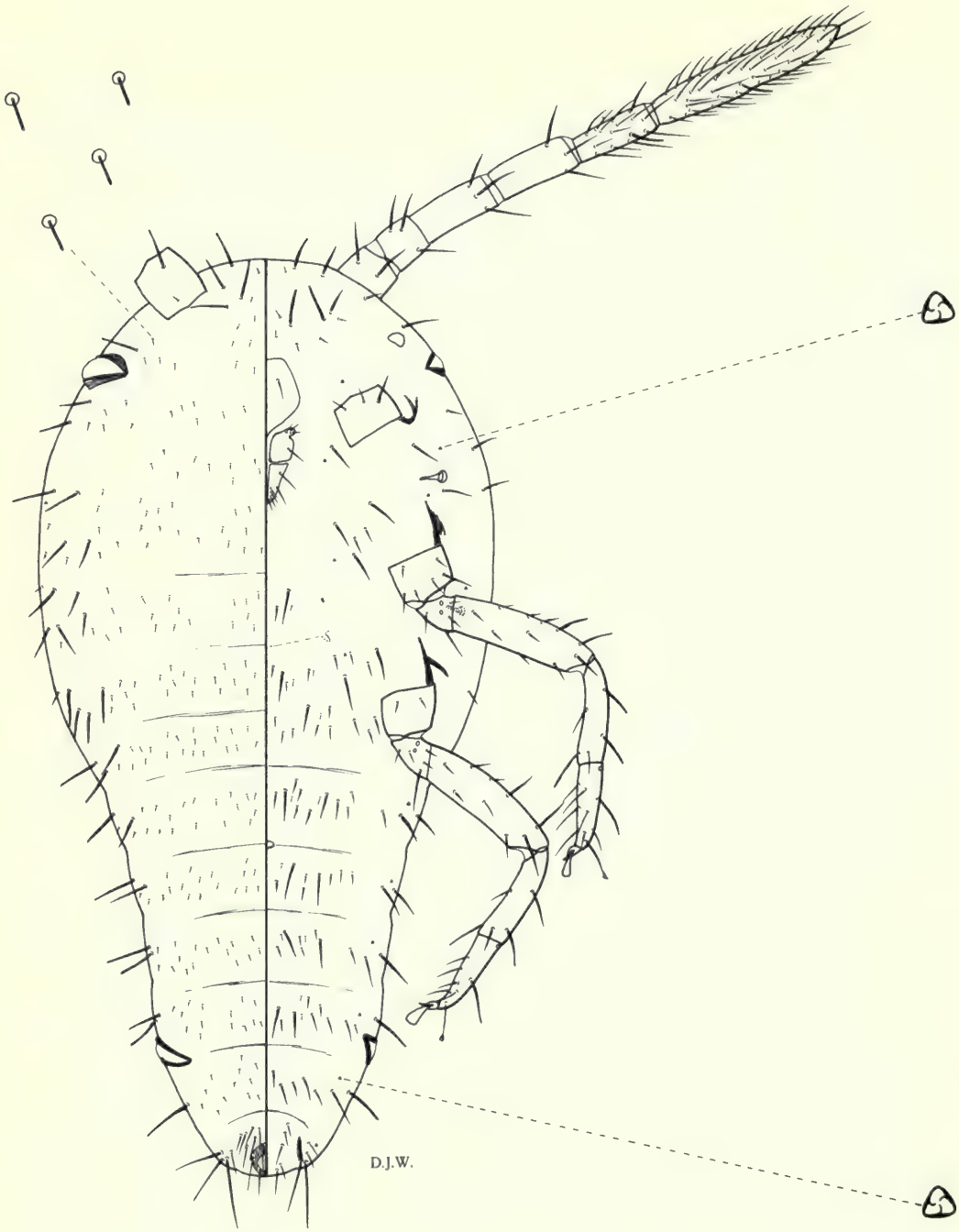

Fig. 30 *Paramyrmococcus vietnamensis* sp. n. First instar.

DISCUSSION. The two specimens examined seem to belong to Takahashi's original type-series. They were kindly made available by Mr Charles Chia-chu Tao of the Taiwan Agricultural Research Institute, Taipeh.

Paramyrmococcus vietnamensis sp. n.

Adult Female (Fig. 27)

External appearance not known. When mounted on the slide, body turbinate, widest at mesothorax, posterior end narrow and rounded, length 2·1 mm, width 1·3 mm. Antennae 1·9–2·0 mm long and thus about as long as body. On an antenna measuring 1·9 mm long the segment lengths are: first 200 μm, second 60 μm, third 470 μm, fourth 290 μm, fifth 290 μm and sixth 590 μm. The second segment 80 μm wide and, therefore, wider than long; sixth segment with a constriction at about middle but basal part wider than terminal part. First and second segments each with one or two stout setae only, remaining segments densely covered with slender setae ranging from about 40 μm long on third segment to 60 μm long on sixth segment. Legs well developed, hind trochanter + femur 560–570 μm long, the widest part of femur about 150 μm at distal end; hind tibia + tarsus 560–590 μm long, thus same length as trochanter + femur or longer, widest part of tarsus 80 μm. Legs with 1 or 2 stout blunt setae and covered with slender setae about 40 μm long, which on the disc of hind tibia are set close together on dorsal and ventral surfaces so that spaces between are shorter than length of one seta. Claw 40 μm long. Ostioles well developed, situated on margins, each with prominent heavily sclerotized lips without setae. Circulus oval, 56–60 μm wide but sometimes with slight constrictions on either side, situated between fourth and fifth segments. Labium 172 μm long and 144 μm wide with 14 pairs of setae. Apical segment with 2 pairs of posterior setae, a pair of minute apical setae, 4 pairs of subapical setae each 28 μm long, 1 pair of lateral setae 40 μm long and 2 pairs of anterior setae, the longest 60 μm. Medial segment with 1 pair of setae each 44 μm long and basal segment with 2 pairs of setae 24 μm long and 1 pair 40 μm long. Anal ring 68–72 μm wide, with 6 setae about 80 μm long. Body setae abundant and covering almost entire surface except for intersegmental spaces. For the most part the setae are slender, about 16 μm long on dorsum and 16–20 μm long on venter, the spaces between the setal bases much shorter than length of one seta but even so these spaces are shorter on dorsum than on venter. Some of the slender setae are a little longer and are easily discernible by the larger setal bases. The directions of the slender setae form definite patterns giving the surface a wavy appearance. Stout setae, easily recognized by the large setal bases, present in small numbers around margins of both surfaces and across ventral abdominal segments, about 25–40 μm long but on the normal positions of the lobes there are usually 2 dorsal and 2 ventral setae about 120 μm long and on margins of eighth segment there are 1 or 2 setae about 100 μm long. Trilocular pores apparently confined to venter where they are sparse. Dorsal marginal and submarginal areas with a few round pores slightly smaller in diameter than a trilocular pore but with an obscure structure.

Third Instar Female (Fig. 28)

Body pyriform, 1·7 mm long and 0·7 mm wide. Antennae 1·57 mm long, the sixth segment with a constriction in the middle. First and second segments with a few stout setae only, third to sixth segments with numerous slender pointed setae but not so numerous as in adult. Labium 160 μm long and 120 μm wide with same number of setae as in adult. Apical segment with 4 pairs of subapical setae each 24 μm long, 1 pair of lateral setae each 32 μm long and 2 pairs of anterior setae 40 μm long. Medial setae 40 μm long and basal setae 20 μm and 36 μm long. Legs with hind trochanter + femur 450 μm long, hind tibia + tarsus 460 μm long. Apart from stout setae 40–55 μm long there are also numerous slender pointed setae 28–32 μm long. Claw 36 μm long. Ostioles prominent with wide sclerotized lips. Circulus about 60 μm wide with a distinct notch at either side. Anal ring 64 μm wide with the 6 setae about 72 μm long.

Dorsal surface with numerous setae of different sizes. Long stout marginal setae present about 60 μm long, each usually with a blunt or irregular apex and often showing a discharge. Shorter pointed setae on margins of head and thorax and on last segment. Evenly distributed over dorsum are two types of minute setae, blunt with parallel sides. One type is extremely thin and about 6 μm long, the other type about twice as thick, about 5 μm long and interspersed with the thin type, both types being present in about equal numbers. Ventral setae only occasionally represented by the minute blunt type, replaced by numerous pointed setae 16–20 μm long, these also accompanied with long thick blunt setae. Trilocular pores few, on ventral surface only but they are more numerous in median areas of thorax. Simple circular pores, sparse, around dorsal margins.

Second Instar Female (Fig. 29)

Similar to third instar but with the following major differences. Body 1·4 mm long and 0·67–0·77 mm wide. Antennae 1·05–1·10 mm long, with long stout setae on first two segments and much more slender setae on third to sixth segments, these quite abundant and ranging in length from 35 to 50 μm. Legs well developed with hind trochanter + femur 320–350 μm long, tibia + tarsus 320–350 μm long. Claw 30–36 μm long. Labium 128 μm long and 88 μm wide, with setae similar to those of third stage but longest basal setae only 32 μm long. Circulus with a small notch on either side, about 36 μm wide. Anal ring 52 μm wide, the anal ring setae about 60 μm long. Body setae less numerous than in previous stage but with the same two types of minute setae on dorsum. The same two types are present also on venter but they are interspersed with long blunt setae and normal pointed setae. Trilocular pores sparse, confined to venter. Simple circular pores present in small numbers around dorsal margins and on prothorax at a point opposite clypeus.

First Instar (Fig. 30)

Body elongate-pyriform, about 1·2 mm long and 0·57 mm wide at thorax, posterior end of body rounded, anal lobes barely perceptible. Antennae 720 μm long, the first four segments each with a few stout setae about 50 μm long, the tips often damaged and each seta having a fleshy appearance. The two terminal segments with much more numerous slender pointed setae, these also 50 μm long; sixth segment with a slight constriction near middle. Legs well developed, hind trochanter + femur 250 μm long, hind tibia + tarsus 260 μm long. Claw 30 μm long. Circulus situated between fourth and fifth segments, small and oval, about 28 μm wide. Anal ring 40 μm wide, without pores but with 6 setae each about 45 μm long. Labium 108 μm long and 80 μm wide, differing from previous stage in that some setae are shorter, the anterior setae 36 μm long, medial setae 36 μm long and basal segment with 2 pairs of setae each 12 μm long and 1 pair 32 μm long. Ostioles on margins with heavily sclerotized lips, without setae.

Body setae of various sizes. Anal lobe setae comprising 3 dorsal and 2 ventral, each about 110 μm long, the bases of the ventral setae at the end of an elongate bar-like area of sclerotization. Margins of dorsum with thick setae usually about 40 μm long, each of which is irregularly blunt at apex and showing what appears to be a discharge. Dorsum with thin type of minute setae only, about 6 μm long. Anal lobe segment without these setae but with pointed setae about 35 μm long. Ventral surface with long setae around margins, some of which attain a length of 50 μm. Other long setae present in median areas of segments, these interspersed with minute setae similar to those on dorsum accompanied with short pointed setae 12–24 μm long. Trilocular pores quite sparse, there being a few around the ventral margins and on thorax.

Holotype ♀, VIETNAM: South, Da Lat (37 km SE.), Chute de Gauhgah, 25.iv.1960 (*R. E. Leech*).

Paratypes and many immatures, VIETNAM: South, Da Lat, same data as holotype (16 ♀, BMNH, London; 2 ♀, USNM, Washington; 2 ♀, TARI, Taipeh; 2 ♀, IEAUN, Portici; 2 ♀, RNH, Leiden).

DISCUSSION. This species is close to *P. chiengraiensis* but differs mainly in the characters given already in the key to species.

RHIZOECINAE

The genera *Eumyrmococcus* and *Xenococcus* are aberrant and are assigned to this subfamily mainly on the bases of the width–length ratio of the labium and the long slender claws with short setose digitules, characters which have been discussed in the section on classification.

Both genera and the South American genus *Chavesia* differ from others in the Rhizoecinae in possessing minute setae densely covering the dorsum. *Chavesia* and *Eumyrmococcus* have the cephalothorax strongly dilated and all three genera have the abdomen tapering or abruptly narrowed. The three genera may be separated by the following key.

Key to adult females of the anomalous ant-attended genera of Rhizoecinae

1 Antennae 2-segmented, not more than 180 μm long. Circulus absent ***EUMYRMOCOCCUS*** (p. 63)
– Antennae 4- or 5-segmented, at least 280 μm long. One or two circuli present . . . 2
2 Antennae well developed, as long as body. Anal ring terminal. Two circuli present ***XENOCOCCUS*** (p. 63)
– Antennae shorter than width of body. Anal ring situated some distance from apex of abdomen, near base of well-developed anal lobes. One circulus present . . . . ***CHAVESIA***

EUMYRMOCOCCUS Silvestri, 1926

Eumyrmococcus Silvestri, 1926 : 271. Type-species: *Eumyrmococcus smithii* Silvestri, by original designation and monotypy.
Eumyrmococcus Silvestri; Williams, 1969 : 336.
Eumyrmococcus Silvestri; Williams, 1970 : 138.

The description of this genus is virtually the same as the type-species given already by Williams (1970). The genus was placed in the tribe Rhizoecini by Williams (1969) and this assignment has been confirmed here by a further study of the labium which has a width–length ratio of about 1 : 2.

Eumyrmococcus smithii Silvestri, 1926

(Fig. 31)

Eumyrmococcus smithii Silvestri, 1926 : 273. LECTOTYPE ♀, CHINA: Macao [on roots of plants, attended by ant *Acropyga* (*Rhizomyrma*) *sauteri* Forel] (IEAUN, Portici), here designated [examined].
Eumyrmococcus smithii Silvestri; Silvestri, 1927 : 254.
Eumyrmococcus smithii Silvestri; Takahashi, 1934 : 2.
Eumyrmococcus smithii Silvestri; Williams, 1970 : 138.

Williams (1970) has described and illustrated this species recently and the illustration from the *Bulletin of Entomological Research* is reproduced with permission but with slight modifications. The labium was too distorted in the material studied at the time but further specimens of the type-series have become available through the kindness of Dr A. Tranfaglia and it is now possible to modify the description of the labium. There is no specimen with a perfect labium and the following description of this structure remains tentative.

Length 156–160 μm and 80 μm wide, apical segment with 2 pairs of posterior setae, 1 pair of minute apical setae, 4 pairs of subapical setae. One pair of lateral setae and 2 pairs of anterior setae. The subapical setae become longer and stouter towards the base. Medial segment with 1 pair of medial setae and basal segment with 2 pairs of short setae and 1 longer pair. Almost all the setae are curled in the specimens examined and the lengths are difficult to determine.

MATERIAL EXAMINED. *Eumyrmococcus smithii* Silvestri, lectotype ♀, CHINA: Macao (IEAUN, Portici).

CHINA: 4 ♀, same data as lectotype (IEAUN, Portici) (1 ♀, BMNH, London); 1 ♀, Shanghai (IEAUN, Portici); 4 ♀, Taipo Market, 26.xii.1924 (*F. Silvestri*) (2 ♀, BMNH, London; 2 ♀, IEAUN, Portici) (mounted from Silvestri's alcohol material). TAIWAN: 4 ♀, Taichu, on sugarcane, 24.ii.1933 (*M. Yangihara*) (TARI, Taipeh).

DISCUSSION. The width–length ratio of 1 : 2 of the labium confirms the assignment of the genus to the Rhizoecinae agreeing also to the definition of the subfamily by Koteja (1974*a*).

XENOCOCCUS Silvestri, 1924

Xenococcus Silvestri, 1924 : 312. Type-species: *Xenococcus annandalei* Silvestri, by original designation and monotypy.
Xenococcus Silvestri; Silvestri, 1926 : 275.
Xenococcus Silvestri; Silvestri, 1927 : 253.

DESCRIPTION. Mealybugs with broadly-oval body, abdomen tapering to narrow sclerotized terminal segment. Apex with dorsal anal ring projecting beyond ventral lobes. Anal ring with 8 setae, the anterior 2 pairs slender and the posterior pair thick and long, the posteriormost often on ventral surface. Anal lobes with numerous long stout setae. Antennae 4-segmented, nearly as long as body, the first segment long and wide, articulating with much narrower second segment containing small teeth at proximal end fitting into grooves at distal end of first segment. All segments with long pointed setae. Legs long and well developed with long slender claw, at base of which are 2 short setose digitules. Labium long and slender with a width–length ratio in excess of 1 : 2. Subapical setae reaching more than half distance to base of apical segment. Two circuli present in adult, circular and slightly conical. Body setae densely covering dorsum. Ventral setae longer and not so numerous. Pores and ducts absent.

Immature instars similar in shape to adult but with fewer setae and with only a single circulus.

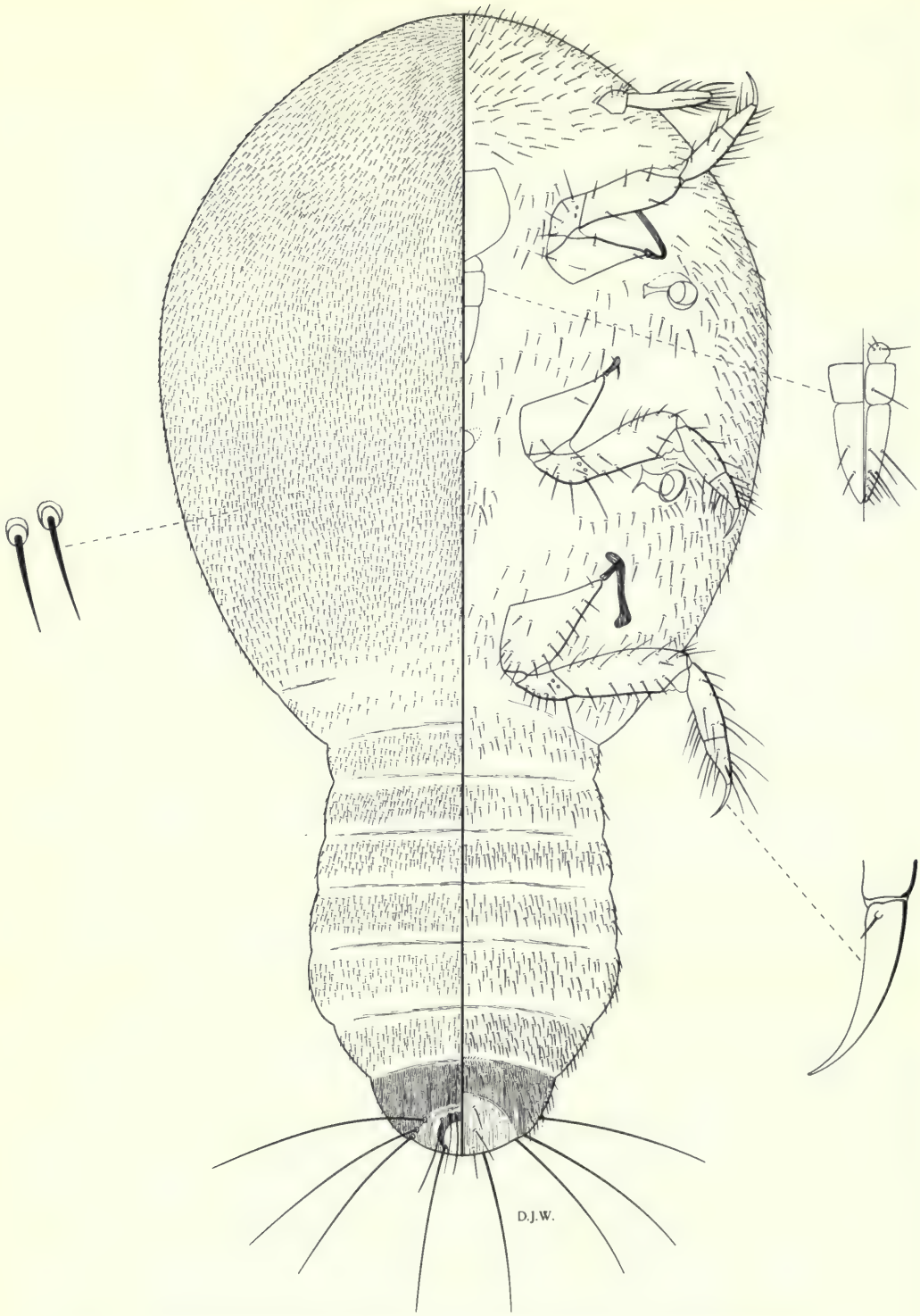

Fig. 31 *Eumyrmococcus smithii* Silvestri. Adult female. Specimen from Japan.

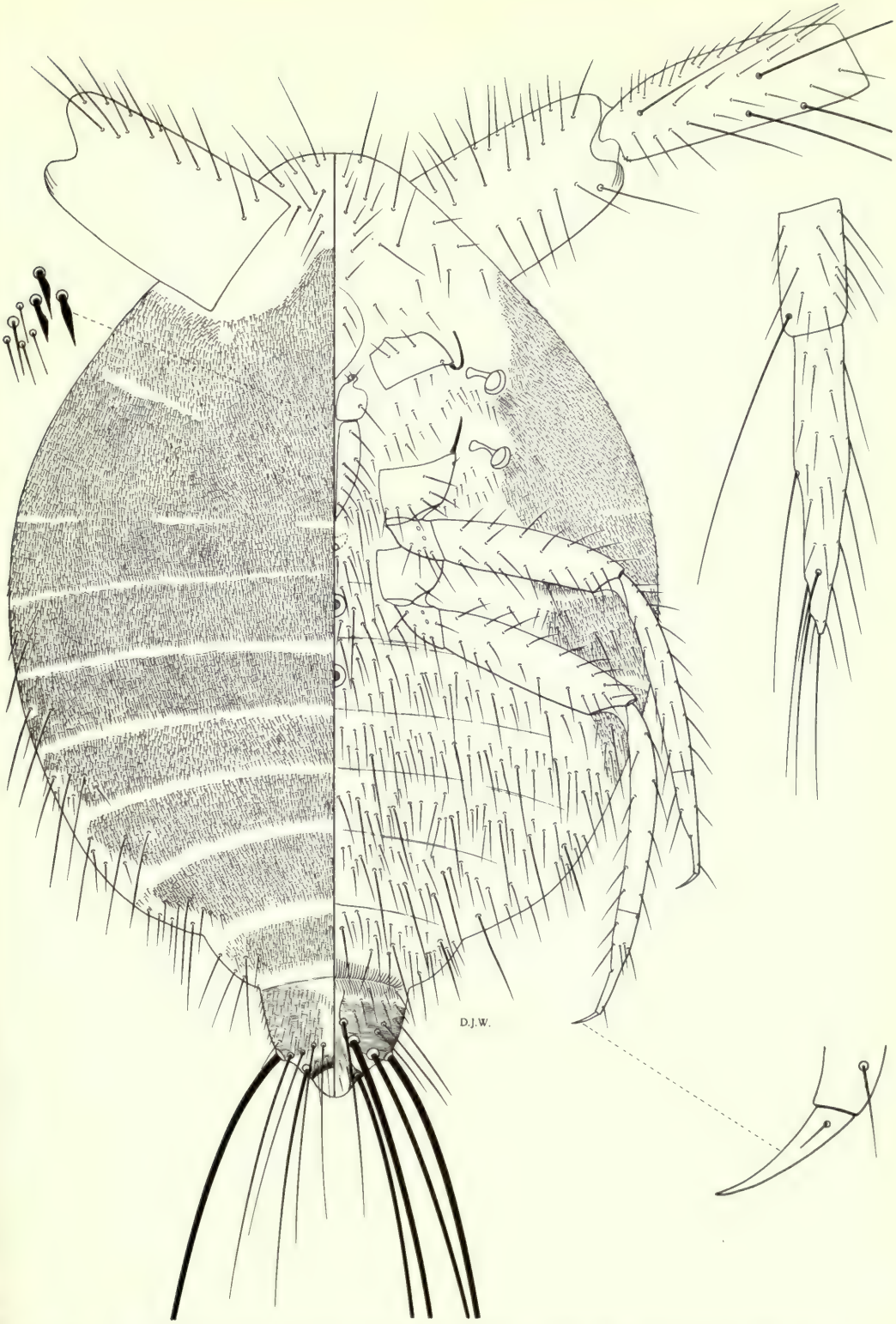

Fig. 32 *Xenococcus annandalei* Silvestri. Adult female. Specimen from India, Barkuda I.

DISCUSSION. The most distinctive character of this genus is the peculiar pair of antennae which are unlike any known in the Pseudococcidae. An anal ring projecting beyond ventral anal lobes, the long stout anal lobe setae and the dense covering of dorsal pointed setae, are characters shared with some of the Allomyrmococcini but the long slender claw with short setose digitules, the round sclerotized circuli and the 4-segmented antennae are characters which seem to belong to the Rhizoecini of the subfamily Rhizoecinae.

De Lotto (1977) has recently described *Xenococcus scorpioides*, an interesting species from South Africa, from the nests of *Acropyga* sp. and the first anomalous species from the African continent. In possessing short 4-segmented antennae, shorter legs with thick claws, it does not seem to be congeneric with *X. annandalei* but probably lies somewhere between *Chavesia* and *Xenococcus*.

DISTRIBUTION. At present the genus is known from India, Malaya, Vietnam and Hong Kong.

Xenococcus annandalei Silvestri, 1924

Xenococcus annandalei Silvestri, 1924 : 312. LECTOTYPE ♀, INDIA: Barkuda I. [Chilka Lake, Madras District (now Orissa Province), on roots of *Ficus obtusa*, with ants *Acropyga acutiventris* Roger] (IEAUN, Portici), here designated [examined].
Xenococcus annandalei Silvestri; Silvestri, 1926 : 275.
Xenococcus annandalei Silvestri; Silvestri, 1927 : 253.

Adult Female (Fig. 32)

Adult female in alcohol ovoid, abdomen tapering, posterior end curved slightly upwards, antennae strongly geniculate, lying in a posterior direction almost parallel to body margins.

On the slide, when flattened, broadly oval, 1·6–1·7 mm long and 1·1–1·4 mm wide, abdomen tapering to a narrow sclerotized last segment almost as long as broad with the anal ring at apex of dorsum projecting beyond a pair of ventral lobes that curve inwards almost to mid-line. Antennae with 4 segments, of a distinctive shape and structure, 1·35–1·54 mm long, attached to dorsal surface of head. One of longest antennae with first segment 380 μm long and 230 μm at widest. Remainder of antenna much narrower, the second segment 440 μm long, the third 200 μm long, and last segment tapering, 520 μm long. All segments with numerous long slender setae of different sizes, the longest on third and fourth segments. Length of longest seta, on third segment 500 μm. Joint between first and second segments distinctive, there being small tooth-like projections on proximal lower corner of second segment which fit into small grooves on posterior distal edge of first segment. Legs well developed, hind trochanter + femur 410–470 μm long, hind tibia + tarsus 470–550 μm long. Tarsus tapering to a distance of about half its length which then becomes narrow and subparallel towards distal end, a small notch also present on inner margin at point between tapering part and narrow extremity. Each leg segment with setae of various lengths but mostly long and slender, the longest on femur about 180 μm long. Claw unusually long and narrow with a length of 40–44 μm and with a pair of setose digitules, each 16 μm long. Two circuli present situated in middle of third and fourth segments. Each circulus round, 40 μm in diameter, with a sclerotized outer rim and with the inner surface forming a cup. Labium unusually elongate; in alcohol specimens 250 μm long and 110 μm wide but, when flattened on slide, about 128 μm wide with 12 or 13 pairs of setae. Apical segment tending to be lanceolate instead of the usual conical shape, with 2 pairs of posterior setae, a pair of apical setae 20 μm long, 4 pairs of subapical setae extending towards base of segment, the distal setae about 20 μm long and the others becoming longer towards the base. Anterior setae represented by a single pair each 100 μm long but a single lateral pair each 80 μm long may be present or absent. Medial segment with a single pair of medial setae each about 75 μm long. Basal segment with a pair of setae each 10 μm long and a single setae 64 μm long on each lobe. Anal ring situated mainly on dorsal surface but often curving to ventral surface, sclerotized, about 120 μm wide at widest point, without pores but apparently with 4 pairs of setae around perimeter, there being 2 pairs of slender anterior setae each about 110 μm long and an outer pair of stouter setae each 400 μm long. A pair of stout setae about 0·8 mm long usually on ventral surface seem to belong to ring. Vulva occupying almost total width of its segment. Posterior setae stout, each about 1·0 mm long, there being 4 such pairs, 1 pair on lateral edges of dorsum anterior to anal ring and 3 pairs on posterior edge of ventral lobes. An anterior pair of setae on inner edges of these lobes much shorter and more slender.

Dorsal setae abundant, covering almost entire surface except for head and intersegmental areas, the spaces between setal bases much shorter than length of one seta. The most abundant are slender, 20–28 μm long but there are some, interspersed with these, about 40 μm long and which may be detected by the

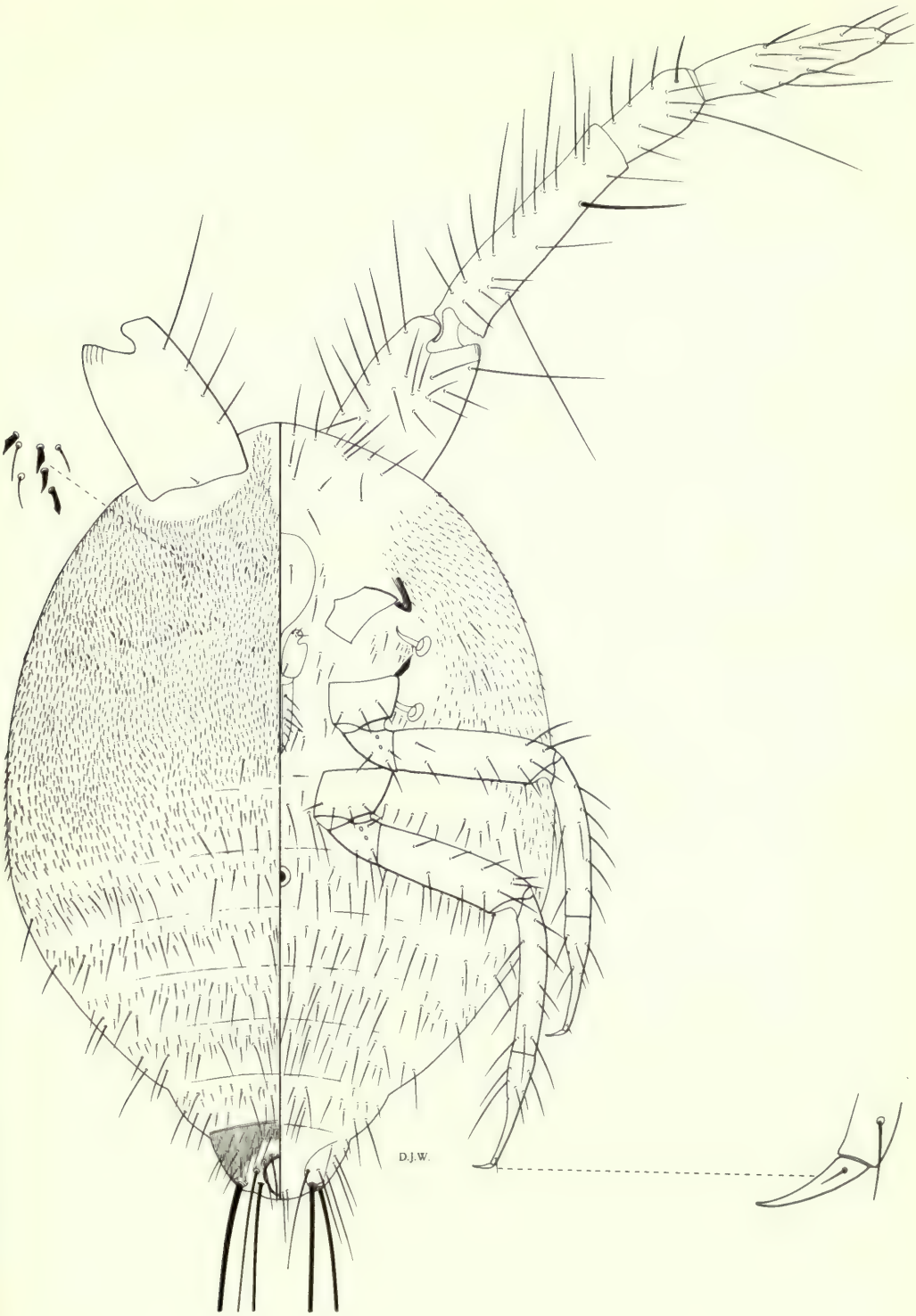

Fig. 33 *Xenococcus annandalei* Silvestri. Third instar female.

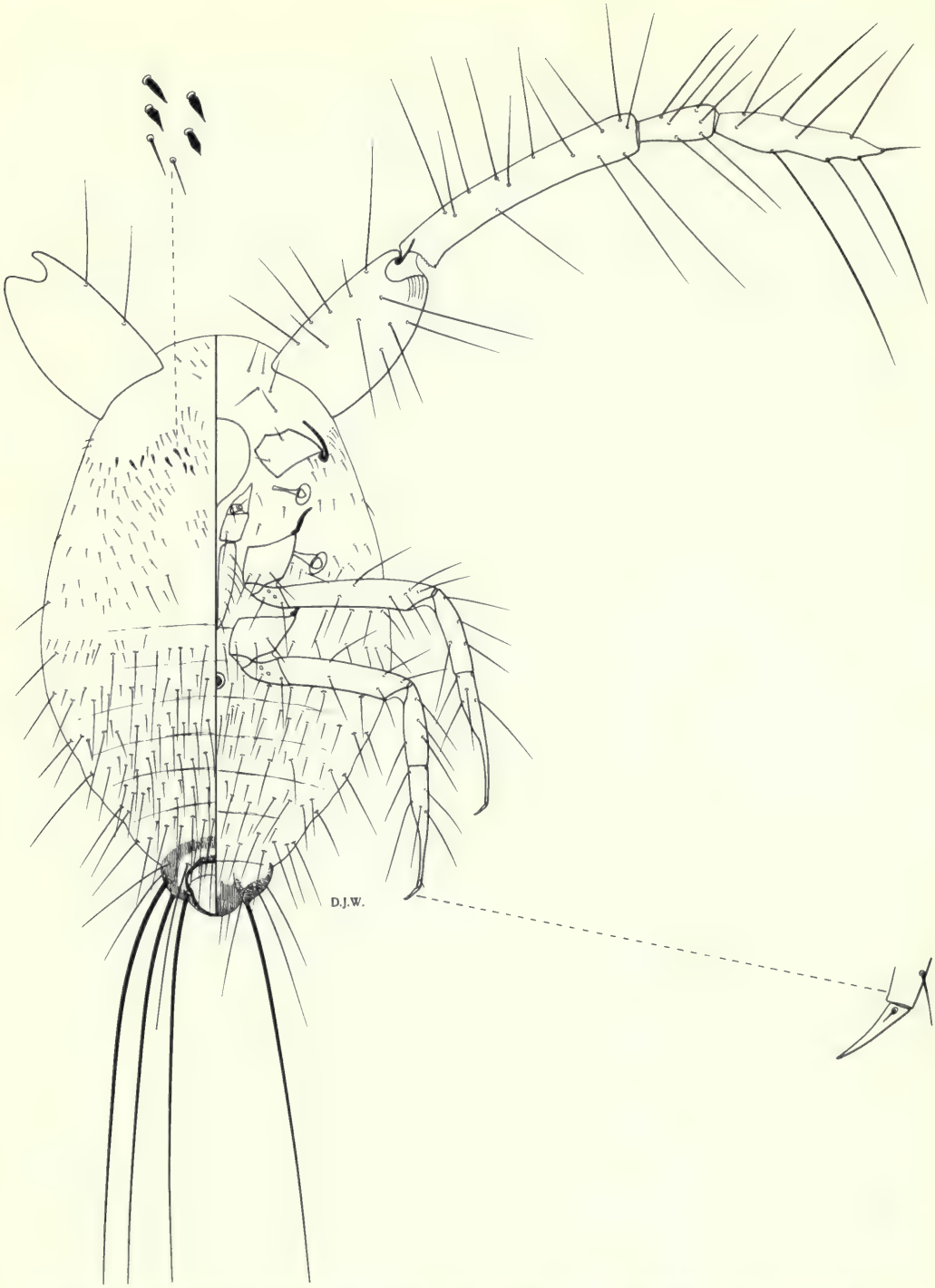

Fig. 34 *Xenococcus annandalei* Silvestri. First instar. Specimen from India, Mysore, on coconut roots.

slightly larger setal bases. On prothorax and mesothorax there are short flat setae in varying numbers but usually few. Each is variously shaped and often peculiarly angled. Setae on last segment longer than usual body setae and just anterior to anal ring a fringe of long setae present comprising 2–3 median pairs each about 480 μm long and a lateral pair usually stouter about 560 μm long. Other long setae, some attaining a length of 240 μm, present on head and around margins of abdomen. Ventral setae numerous, of different sizes, but many are long, the longest about 200 μm. Minute setae present from about fifth segment as far forward as prothorax in a zone extending to spiracles. Body pores and tubular ducts absent.

Third Instar Female (Fig. 33)

Body ovoid, 1·15 mm long, tapering to last segment. Posterior end of body rounded, last segment sclerotized at least on dorsum, the ventral surface curved inwards to form a pair of lobes. Antennae with 4 segments, 1·10–1·23 mm long; on longest antenna, first segment 350 μm long, second 360 μm, third 180 μm and fourth 340 μm, narrower than other segments. Joint between first and second segments similar to that in adult female and with minute teeth on outer posterior angle of second segment fitting into small grooves on outer distal angle of first segment. Each segment with long slender setae of different lengths. Legs similar in shape to those in adult female but shorter, hind trochanter + femur 280–310 μm long, hind tibia + tarsus 350–400 μm long. Labium as in adult but 205 μm long and 88 μm wide, with 13 pairs of setae. Apical segment with 2 pairs of posterior setae, a pair of minute apical setae 12 μm long, 4 pairs of subapical setae set wide apart so that proximal pair at mid-point of segment, the setae ranging in length from 12 μm at apex to 68 μm on mid-segment. Also present 1 pair of lateral setae and 1 pair of anterior setae each 68 μm long. Medial segment with 1 pair of setae 60 μm long. Basal segment with each lobe containing 2 short setae each 8 μm long and 1 seta 36 μm long. One circulus present, circular, about 32 μm in diameter, situated in middle of fourth segment. Anal ring at apex of dorsal surface about 56 μm wide, with narrow sclerotized rim and surrounded by 4 pairs of setae. The anterior median pair are slender and only slightly longer than diameter of ring, outer 2 pairs stouter, the third pair about 210 μm long and the fourth pair 440 μm long. Anal lobes each with one dorsal and two ventral stout setae about 1·0 mm long, there being also a slender seta about 150 μm long on inner margin of lobe.

Dorsal setae abundant anterior to fourth abdominal segment, these mainly slender 12–16 μm long, the distance between setal bases usually shorter than length of one seta or about same length. Minute flat setae with varying distal shape, scattered among slender setae on prothorax and mesothorax. Dorsal setae on fourth and posterior segments fewer and of different sizes, the longest about 180 μm. Ventral setae mainly long and slender on abdomen, the longest about 160 μm but from first segment to prothorax small slender setae, similar to those on anterior dorsum extend inwards from margin to spiracles. Pores and tubular ducts absent.

First Instar (Fig. 34)

Body oval, 0·7–0·9 mm long, membranous except for anal lobe segment which on dorsum is sclerotized on margin extending to a band anterior to anal ring. Anal lobes present ventrally, these also sclerotized. Antennae with 4 segments similar in shape to those of previous stages, 0·85–0·90 mm long, the longest antenna with first segment 240 μm long, the second 320 μm, third 110 μm and fourth 230 μm long. Each segment with slender setae varying in length, the longest about 300 μm. Joint between first and second segments similar to those in other stages. Legs as in previous stages except that tarsus longer than tibia whereas in other stages the tibia is longer than tarsus. Hind trochanter + femur about 220 μm long, hind tibia + tarsus 240–260 μm long. Claw slender, 28 μm long. Labium 180 μm long and 80 μm wide with similar setal distribution to that in previous stages but setae longer than in third stage. Apical segment with a pair of apical setae each 8 μm long, 4 pairs of subapical setae extending to a point more than half length of segment and ranging in length from 12 μm distally to an inner pair 76 μm long. Also present are a lateral pair and an anterior pair each 76 μm long. Medial segment with either 1 or 2 pairs of setae, the longest 72 μm. Basal segment with a pair of setae each 8 μm long and 1 seta 72 μm long on each lobe. Circulus round, about 28 μm in diameter, situated within borders of fourth segment. Anal ring entirely on dorsum, with narrow rim and 4 pairs of setae around outer margin, there being 2 pairs of inner slender setae each about 60 μm long, a third stouter pair about 360 μm long and a stout posterior pair about 750 μm long. The last setae resemble anal lobe setae which are of similar shape and length, there being on each lobe, a pair on dorsal margins and a single seta at apex of lobe on venter.

Dorsal setae mainly short and slender on anterior abdominal segments, thorax and head, each about 12 μm long. A few flat and irregularly shaped setae present on prothorax each about 8 μm long. Abdominal setae all slender, of different lengths, the longest always in transverse rows, about 120 μm long.

Ventral setae on abdomen similar to those on dorsum of abdomen but fewer. Setae sparse on thorax and head. Pores and tubular ducts absent.

MATERIAL EXAMINED. *Xenococcus annandalei* Silvestri, lectotype ♀, INDIA: Barkuda I. (IEAUN, Portici).

INDIA: 7 ♀, same data as lectotype; 2 ♀, 1.x.1922 (IEAUN, Portici), 1 ♀ and 1 third stage ♀ (BMNH, London), 1 ♀ and 1 third stage ♀ (USNM, Washington); 8 ♀, on *Ficus religiosa*, 28.vi.1922 (*N. Annandale*) (7 ♀, on slides and in alcohol, IEAUN, Portici; 1 ♀, BMNH, London); Mysore, on coconut roots (Palmae), 21.vi.1937 (*T. V. Subramaniam*) (3 first stage, BMNH, London). MALAYSIA: Malaya, Penang, 1 ♀ (IEAUN, Portici). VIETNAM: 1 ♀, Than-hoa (IEAUN, Portici). HONG KONG: 1 ♀, Repulse Bay (IEAUN, Portici).

DISCUSSION. This is an unusual species that will probably be found underground throughout south-east Asia, attended by the ant *Acropyga acutiventris*. The peculiar antennae, with the unusual articulation between the first and second segments, are similar in all stages but as yet no second stage has been available.

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Contents

Synopsis

The family-group and genus-group names (including variations in spelling) of the Coleophoridae published since 1973 are listed alphabetically. Citations of type-species are given, together with bibliographical references to the original descriptions and designations of type-species. The recent publications of Căpuşe and Falkovitsh on the classification of the Coleophoridae are discussed. One subtribal, thirty-seven generic and three specific synonymies are newly introduced. The identity of *Phalaena* (*Tinea*) *vestianella* Linnaeus is established and a lectotype is designated. The synonymies of three confused species are discussed and the male genitalia are illustrated.

Introduction

Recently, Căpuşe (1971) and Falkovitsh (1972) proposed a revised classification of the Coleophoridae. The main feature of this classification, which fundamentally differs little from the earlier system (Toll, 1953; 1962), is the application of numerous generic and suprageneric names to what were previously considered to be merely species-groups. In 1974 we discussed this classification and catalogued the family-group and genus-group names of the Coleophoridae. While our catalogue was in press, and after its publication, further genus-group names were proposed (Căpuşe, 1973; 1974; 1975) and, because of the large number of new taxa, we find it necessary to review these subsequent papers. Our earlier criticism can be equally applied to these new taxa and our opinion on the validity of the divisions of the Coleophoridae, which we expressed in detail (Sattler & Tremewan, 1974 : 186–191), remains unchanged.

Each generic name has been checked for homonymy in the catalogues of Neave (1939–66, *Nomencl. zool.* **1–6**). Names that have been proposed expressly to replace junior homonyms are referred to in this catalogue as objective replacement names. Subjective synonymy of the genera is not discussed in detail; however, the present status of each genus is recorded.

All references have been checked personally by the authors. In all instances the original

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publications were examined because reprints sometimes differ in date of publication and in pagination. The printed date of publication in a book or journal is accepted as correct, unless there exists published evidence to the contrary.

The format of this supplement follows that of our previous catalogue. Family-group and genus-group names are listed in separate sections. All names are arranged in alphabetical order; synonyms and unavailable names are cross-referenced. Junior objective synonyms and unavailable names (nomina nuda) are in non-bold italics; unavailable names are marked with a double dagger (‡). The alphabetical entries of all other generic names are in bold italics, as are the names of their type-species.

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The classification of the Coleophoridae by Căpuşe and Falkovitsh

In his major paper on the Coleophoridae, Căpuşe (1971) divided this family into numerous subfamilies, tribes, subtribes, genera and subgenera without providing any keys. However, keys were subsequently provided in a privately published paper (Căpuşe, 1973), in which a subtribe, 28 genera and 8 subgenera were erected. In this paper the short introduction (p. 3) is followed by a key to the subfamilies of the Coleophoridae (pp. 4–5) and a key to the tribes of the subfamily Coleophorinae (pp. 5–6), the other subfamilies being monobasic. Three separate keys to the genera of the tribes Carpochenini (pp. 7–8), Casignetini (pp. 8–12) and Coleophorini (pp. 12–21) are provided. A further key is entitled 'Clé de determination des genres dont nous n'avons pas examiné l'espèce type' (Key for the determination of the genera of which we have not examined the type-species) (pp. 21–23) and is followed by the bibliography (p. 24).

The new genera and subgenera proposed in the keys are accompanied by type-species designations and satisfy the provisions of the *International Code of Zoological Nomenclature*. However, it would have been desirable for them to have been accompanied by detailed descriptions, illustrations, a discussion of the related taxa, an indication of their exact position in Căpuşe's system and a list of further included species. With the exception of one genus all the new genera and subgenera are monotypic, which seems to indicate that they were based either on the study of a small number of species or on a very narrow concept of the genus.

Although Căpuşe placed the new genera and subgenera in their appropriate tribes he did not discuss their affinities with other genera – that two genera key out next to each other is not necessarily an indication of close relationship.

The taxa named in the keys were further described in a subsequent paper (Căpuşe, 1975) where they are again marked as 'nov.'. However, it is wrong and misleading to indicate them as new because they were made nomenclaturally available in 1973. In addition, Căpuşe made no reference to his earlier publication except for a brief mention in the introduction and a citation in the bibliography, and nowhere does he give an indication that any of the taxa were newly proposed in the keys of 1973.

We have already discussed in detail the characters used by Căpuşe and Falkovitsh for separating taxa. These characters were found to be unacceptable at the generic and suprageneric level and, frequently, are merely species differences; their use resulted in poorly defined genera with transitions between each other. Căpuşe's work is based mainly on the papers of Toll (1953; 1962) and this he should have clearly stated. In many instances the groups, sections and subsections of Toll were fully recognized by Căpuşe who merely gave them names and raised them to generic or even suprageneric rank, sometimes rearranging the species-groups and slightly altering the sequence of the species within the groups. The mere application of names to widely recognized species-groups contributes nothing to the advancement of science.

The genus *Cornulivalvulia* Căpuşe, 1973, originally described in the tribe Casignetini Falkovitsh, was subsequently synonymized by Falkovitsh (1974*a* : 194; 1974*b* : 138) with the genus *Multicoloria* Căpuşe, 1973, originally described in the tribe Coleophorini Hübner. This synonymy further emphasizes the weakness of the system proposed by Căpuşe and Falkovitsh.

The division of the Coleophoridae and particularly the genus *Coleophora* into subfamilies, tribes, subtribes, genera and subgenera by Căpuşe (1971) and Falkovitsh (1972) has been ignored by all subsequent authors (e.g. Patzak (1974) in his important paper on the casebearers of East Germany) with the exception of Reznik (1976), who recognized the genus *Multicoloria* Căpuşe. However, it is apparent from Reznik's bibliography that he was unaware of our critical treatment of the Coleophoridae (Sattler & Tremewan, 1974). After the division of the Coleophoridae by Căpuşe (1971) and Falkovitsh (1972), the latter (Falkovitsh, 1973), in a major paper on the casebearers of the Kysyl Kum, in which he described numerous new species, used the name *Coleophora* throughout; however, his paper may have been delayed in press.

As the original works of Căpuşe and Falkovitsh were only based on about 130 of an estimated total of 1000 species, it seemed inevitable to us that the study of further species would result in the erection of more new genera. If the narrow genus-concept of Căpuşe and Falkovitsh is not rejected, the separation of further large numbers of genera (200 or more!) from *Coleophora* is unavoidable. We do not believe that such drastic splitting would serve any useful purpose and suggest that no further attempt is made to divide *Coleophora*.

Check-list of Coleophoridae following Căpuşe (1973; 1975)

The following check-list contains the names of the taxa dealt with by Căpuşe (1973; 1975); the arrangement follows his 1975 paper. The groups, sections and subsections of Toll (1953; 1962) are also indicated. Obvious misspellings and wrong authors have been corrected. The names *atticae*, *herzegoviniensis*, *rectivittella* and *subsimilis*, all attributed to Toll by Căpuşe (1975), originated from Toll but to our knowledge were never made nomenclaturally available. They are not recorded in the British Museum (Natural History) card index or in a manuscript list of the species described by Toll which was compiled by his wife after his death. These names are nomina nuda and are marked with a double dagger (‡). The name *C. subechinella* is used by Toll (1962 : pl. 17S, fig. 183); however, it is not 'accompanied by a statement that purports to give characters differentiating the taxon' (*Int. Code zool. Nom.*, Article 13(a)(i)) and is therefore unavailable.

COLEOPHORIDAE Hübner, 1825

COLEOPHORINAE Hübner, 1825	
CASINI Căpuşe, 1971	
Casas Wallengren, 1881	
C. leucapennella (Hübner)	group 1 (1962)
COLEOPHORINI Hübner, 1825	
HAPLOPTILIINA Barnes & McDunnough, 1917	
Postvinculia Căpuşe, 1973	
P. lutipennella (Zeller)	group 2, section 2 (1962)
Paravalvulia Căpuşe, 1973	
P. spiraeella (Rebel)	group 2, section 2 (1962)
Haploptilia Hübner, 1825	
H. coracipennella (Hübner)	
Zagulajevia Căpuşe, 1971	
Z. tadzhikiella (Danilevski)	group 7, section 2, subsection 2 (1962)
Frederickoenigia Căpuşe, 1971	
F. flavipennella (Herrich-Schäffer)	group 2, section 5 (1962)
Orghidania Căpuşe, 1971	
O. gryphipennella (Bouché)	group 2, section 4 (1962)
Sacculia Căpuşe, 1973	
S. excellens (Toll)	group 6, section 3 (1962)
S. subexcellens (Toll)	group 6, section 3 (1962)

Characia Falkovitsh, 1972	
C. haloxyli (Falkovitsh)	
COLEOPHORINA Hübner, 1825	
Dumitrescumia Căpuşe, 1973	
D. cecidophorella (Oudejans)	group 2, section 8 (1962)
D. trigeminella (Fuchs)	group 2, section 8 (1962)
D. hydrolapathella (Hering)	group 2, section 8 (1962)
Tuberculia Căpuşe, 1973	
T. albitarsella (Zeller)	group 3 (1962)
Globulia Căpuşe, 1973	
G. cornuta (Heinemann & Wocke)	group 2, section 11, subsection 1 (1962)
Quadratia Căpuşe, 1973	
Q. fuscocuprella (Herrich-Schäffer)	group 2, section 11, subsection 2 (1962)
Tollsia Căpuşe, 1973	
T. hornigi (Toll)	group 2, section 14 (1962)
Kasyfia Căpuşe, 1973	
K. binderella (Kollar)	group 2, section 15 (1962)
K. orbitella (Zeller)	group 2, section 15 (1962)
Rhamnia Căpuşe, 1973	
R. ahenella (Heinemann)	group 2, section 15 (1962)
R. subahenella Căpuşe	
Oudejansia Căpuşe, 1973	
O. obviella (Rebel)	group 6, section 2 (1962)
O. moestella (Toll)	group 6, section 2 (1962)
O. pseudoobviella (Toll)	group 6, section 2 (1962)
O. striolatella (Toll)	group 6, section 2 (1962)
O. cribrella (Toll)	group 6, section 2 (1962)
O. dichroella (Toll)	group 6, section 2 (1962)
O. cuencella (Toll)	group 6, section 2 (1962)
O. obtectella (Zeller)	group 6, section 2 (1962)
O. paraobviella (Toll)	group 6, section 2 (1962)
Membrania Căpuşe, 1973	
M. (*M.*) *calycotomella* (Stainton)	group 6, section 4, subsection 1 (1962)
M. (*M.*) *trifisella* (Rebel)	group 6, section 4, subsection 1 (1962)
Longibacillia Căpuşe, 1973	
M. (*L.*) *fergana* (Toll)	group 6, section 4, subsection 2 (1962)
M. (*L.*) *schahkuhensis* (Toll)	group 6, section 4, subsection 2 (1962)
M. (*L.*) *niveopictella* (Toll)	group 6, section 4, subsection 2 (1962)
Baraschia Căpuşe, 1973	
B. (*B.*) *paradoxella* (Toll)	group 6, section 5, subsection 1 (1962)
B. (*B.*) *uralensis* (Toll)	group 6, section 5, subsection 1 (1962)
Abaraschia Căpuşe, 1973	
B. (*A.*) *pagmana* (Toll)	group 6, section 5, subsection 2 (1962)
Kutznetzovvlia Căpuşe, 1973	
K. solidaginella (Staudinger)	group 6, section 1 (1962)
K. conyzae (Zeller)	group 6, section 1 (1962)
K. angustilinea (Toll)	group 6, section 1 (1962)
K. mellechella (Toll)	group 6, section 1 (1962)
K. semistriatella (Toll)	group 6, section 1 (1962)
K. ptarmica (Walsingham)	group 6, section 1 (1962)
K. namangana (Toll)	group 6, section 1 (1962)
K. santolinella (Constant)	group 6, section 1 (1962)
K. jerusalemella (Toll)	group 6, section 1 (1962)
K. parcella (Toll)	group 6, section 1 (1962)
Glaseria Căpuşe, 1971	
G. (*G.*) *biseriatella* (Staudinger)	group 9, section 3 (1962)
G. (*G.*) *microxantha* (Walsingham)	group 9, section 3 (1962)
Proglaseria Căpuşe, 1973	
G. (*P.*) *laticostella* (Mann)	group 9, section 2 (1962)

G. (*P.*) *murciana* (Toll)	group 9, section 2 (1962)
G. (*P.*) *fretella* (Zeller)	group 9, section 2 (1962)
G. (*P.*) *pabulella* (Zeller)	group 9, section 2 (1962)
G. (*P.*) *marianii* (Toll)	group 9, section 2 (1962)
G. (*P.*) *perplexella* (Toll)	group 9, section 2 (1962)
G. (*P.*) *gilveolella* (Toll)	group 9, section 2 (1962)
G. (*P.*) *xanthoptera* (Toll)	group 9, section 2 (1962)
Scleriductia Căpuşe, 1973	
S. ochripennella (Zeller)	group 2, section 3 (1962)
Ascleriductia Căpuşe, 1973	
A. lithargyrinella (Zeller)	group 9, section 1 (1962)
A. fuscatella (Toll)	group 9, section 1 (1962)
Helvalbia Căpuşe, 1973	
H. lineolea (Haworth)	group 6, section 8 (1962)
Latisacculia Căpuşe, 1973	
L. crocinella (Tengström)	group 9, section 1 (1953)
L. arenariella (Zeller)	group 9, section 1 (1953)
L. medelichensis (Krone)	
L. protecta (Walsingham)	
L. pseudoserenella (Toll)	
Klimeschja Căpuşe, 1973	
(*Klimeschjosefia* Căpuşe, 1975)	
K. oriolella (Zeller)	group 23 (1953)
K. vulnerariae (Zeller)	group 23 (1953)
K. semicinerea (Staudinger)	
K. medicaginella (Mann)	
K. defessella (Herrich-Schäffer)	
K. mongetella (Chrétien)	
K. siliquella (Constant)	
K. coarctella (Staudinger)	
K. femorella (Walsingham)	
K. albicosta (Haworth)	
K. supinella (Ortner)	
K. suboriolella (Toll)	
K. hartigi (Toll)	
K. bruneosignata (Toll)	
K. rudella (Toll)	
K. fraudulentella (Toll)	
K. rugulosa (Toll)	
K. turbatella (Toll)	
K. glaseri (Toll)	
Amseliphora Căpuşe, 1971	
A. (*A.*) *niveicostella* (Zeller)	group 9, section 3, subsection B (1953)
A. (*A.*) *albicostella* (Duponchel)	group 9, section 3, subsection C (1953)
A. (*A.*) *squamella* (Constant)	
A. (*A.*) *trifariella* (Zeller)	group 9, section 2 (1953)
A. (*A.*) *bilineella* (Herrich-Schäffer)	
A. (*A.*) *saturatella* (Stainton)	
A. (*A.*) *acrisella* (Millière)	
A. (*A.*) *imbecilla* (Toll)	
A. (*A.*) *discordella* (Zeller)	group 9, section 3, subsection B (1953)
A. (*A.*) *genistae* (Stainton)	group 9, section 2 (1953)
A. (*A.*) *onobrychiella* (Zeller)	
A. (*A.*) *rectilineella* (Fischer von Roeslerstamm)	group 9, section 3, subsection A (1953)
A. (*A.*) *albidorsella* (Toll)	
A. (*A.*) *lineata* (Toll)	
A. (*A.*) *algeriensis* (Toll)	
A. (*A.*) *paragenistae* (Kasy)	

Ardania Căpuşe, 1973	
A. (*A.*) *bilineatella* (Zeller)	group 9, section 2 (1953)
Amselghia Căpuşe, 1973	
A. (*A.*) *fringillella* (Zeller)	group 9, section 3, subsection A (1953)
Calcomarginia Căpuşe, 1973	
C. ballotella (Fischer von Roeslerstamm)	group 14 (1953)
Apista Hübner, 1825	
A. iranella (Toll)	
A. escalerai (Toll)	
A. albostraminata (Toll)	
A. arenicola (Toll)	
A. ochristrigella (Ragonot)	
Apista Hübner, 1825, s. str.	
A. (*A.*) *gallipennella* (Hübner)	group 18, section 1, subsection A (1953)
Metapista Căpuşe, 1973	
A. (*M.*) *stramentella* (Zeller)	group 18, section 1, subsection B (1953)
A. (*M.*) *colutella* (Fabricius)	
A. (*M.*) *rebeli* (Gerasimov)	
A. (*M.*) *wiltshirei* (Toll)	
A. (*M.*) *agnatella* (Toll)	
A. (*M.*) *kasyi* (Toll)	
Multicoloria Căpuşe, 1973	
M. ditella (Zeller)	group 18, section 4 (1953)
M. conspicuella (Zeller)	group 18, section 3 (1953)
M. tristraminata (Toll)	
M. similis (Staudinger)	
M. vibicigerella (Zeller)	group 18, section 4 (1953)
M. partitella (Zeller)	group 18, section 4 (1953)
M. pirizanella (Toll)	
M. andalusiae (Toll)	
M. leucostrigella (Toll)	
M. satellitella (Toll)	
M. medicaginis (Herrich-Schäffer)	group 18, section 4 (1953)
M. zonatella (Toll)	
M. anatolica (Toll)	
M. eucera (Toll)	
M. astragalella (Zeller)	group 18, section 5 (1953)
M. caelebipennella (Zeller)	group 18, section 7 (1953)
M. mandschuriae (Toll)	
M. polonicella (Zeller)	group 18, section 7 (1953)
M. vibicella (Hübner)	group 18, section 7 (1953)
M. didyma (Toll)	
M. stachi (Toll)	
M. paraspumosella (Toll)	
M. spumosella (Toll)	
M. dubiosa (Toll)	
M. xanthoargentea (Toll)	
M. involucrella (Chrétien)	
M. qulikushella (Toll)	
M. paraononidella (Amsel)	
M. ononidella (Millière)	
M. giraudi (Constant)	
M. paragiraudi (Toll)	
M. depauperella (Toll)	
M. perserenella (Rebel)	
M. semistrigata (Toll)	
M. agrianella (Rebel)	
M. canariipennella (Toll)	
M. simillima (Staudinger)	

M. fuscociliella (Zeller)
M. menephilella (Toll)
M. helichrysella (Krone)
M. biskraensis (Toll)
M. radiosella (Toll)
M. dubiella (Baker)
M. minaxella (Toll)
M. praeposita (Toll)
M. atlanticolella (Zerny)
M. argyrella (Herrich-Schäffer)
M. flabelligerella (Rebel)
M. amasiella (Staudinger)
M. sumptuosa (Toll)
M. honestella (Toll)
M. gazella (Toll)
M. gozmanyi (Toll)
M. albarracinica (Toll)
M. medicagivora (Toll)
M. cyrniella (Rebel)
M. praecipua (Walsingham)
M. fuscostraminella (Toll)
M. microeucera (Toll)
M. valesianella (Zeller)
M. echinella (Staudinger)
M. berlandella (Toll)
M. tozeurensis (Toll)
M. ‡*subsimilis* Căpuşe, nomen nudum
M. ‡*rectivittella* Căpuşe, nomen nudum
M. ‡*subechinella* (Toll)
M. cartilaginella (Christoph)
Damophila Curtis, 1832
D. spissicornis (Haworth) — group 13, section 2 (1953)
D. hieronella (Zeller)
D. fuscicornis (Zeller)
D. fuscoaenea (Toll)
D. amethystinella (Ragonot)
D. leucostoma (Gerasimov)
D. ‡*herzegoviniensis* Căpuşe, nomen nudum
D. ‡*atticae* Căpuşe, nomen nudum
D. dannehli (Toll)
Lucidaesia Căpuşe, 1973
L. frischella (Linnaeus) — group 5, section 1 (1962)
L. trifolii (Curtis) — group 5, section 1 (1962)
L. cuprariella (Zeller) — group 5, section 1 (1962)
L. cuprifulgella (Toll) — group 5, section 1 (1962)
L. auronitella (Toll) — group 5, section 1 (1962)
L. argentifimbriata (Walsingham) — group 5, section 1 (1962)
L. basimaculella (Mann) — group 5, section 2 (1962)
CASIGNETINI Falkovitsh, 1972
CASIGNETINA Falkovitsh, 1972
Cornulivalvulia Căpuşe, 1973
C. vicinella (Zeller) — group 18, section 6 (1953)
Aureliania Căpuşe, 1971
A. (*A.*) *flavaginella* (Zeller) — group 30, section 2, subsection E (1953)
A. (*A.*) *virgaureae* (Stainton) — group 30, section 2, subsection A (1953)
A. (*A.*) *halophylella* (Zimmermann) — group 30, section 2, subsection B (1953)
A. (*A.*) *therinella* (Tengström) — group 30, section 2, subsection C (1953)
A. (*A.*) *sternipennella* (Zetterstedt) — group 30, section 2, subsection E (1953)
A. (*A.*) *versurella* (Zeller) — group 30, section 2, subsection E (1953)

A. (*A.*) *pratella* (Zeller)	group 30, section 2, subsection C (1953)
A. (*A.*) *motacillella* (Zeller)	group 30, section 2, subsection E (1953)
A. (*A.*) *erigerella* (Ford)*	group 30, section 2, subsection E (1953)
A. (*A.*) *leucogrammella* (Herrich-Schäffer)	
A. (*A.*) *luteolella* (Staudinger)	
A. (*A.*) *dentiferella* (Toll)	
A. (*A.*) *palumbipennella* (Toll)	
A. (*A.*) *mendosella* (Toll)	
A. (*A.*) *hsiaolingella* (Toll)	
A. (*A.*) *fiorii* (Toll)	
A. (*A.*) *lewandowskii* (Toll)	group 30, section 2, subsection A (1953)
A. (*A.*) *cinerea* (Toll)	
Nosyrislia Căpuşe, 1973	
A. (*N.*) *linosyris* (Hering)	group 30, section 2, subsection D (1953)
A. (*N.*) *asteris* (Mühlig)	group 30, section 2, subsection D (1953)
Ecebalia Căpuşe, 1973	
A. (*E.*) *laripennella* (Zetterstedt)	group 30, section 2, subsection F (1953)
A. (*E.*) *parenthella* (Toll)	
A. (*E.*) *gaviaepennella* (Toll)	
A. (*E.*) *botauripennella* (Toll)	
Hamuliella Căpuşe, 1973	
H. otitae (Zeller)	group 30, section 4, subsection E (1953)
H. granulatella (Zeller sensu Klimesch)	group 30, section 4, subsection C (1953)
H. galatellae (Hering)	group 30, section 4, subsection F (1953)
H. klemensiewiczi (Toll)	group 30, section 4, subsection D (1953)
H. dianthivora (Walsingham)	
H. scabrida (Toll)	
H. agenjoi (Toll)	
H. griseomixta (Toll)	
H. heringi (Toll)	
H. obliterata (Toll)	
H. opacella (Toll)	
H. insulicola (Toll)	
H. gnaphalii (Zeller)	group 30, section 4, subsection C (1953)
H. fischeri (Toll)	
H. tolli (Klimesch)	
H. succursella (Herrich-Schäffer)	group 30, section 4, subsection B (1953)
H. separatella (Benander)	group 30, section 4, subsection A (1953)
H. riffelensis (Rebel)	
H. sabulella (Toll)	
H. granulosella (Staudinger)	
H. artemisicolella (Bruand)	group 30, section 3, subsection D (1953)
Neugenvia Căpuşe, 1973	
N. vlachi (Toll)	group 30, section 6, subsection A (1953)
N. peribenanderi (Toll)	group 30, section 4, subsection G (1953)
N. lineariella (Zeller)	group 30, section 5 (1953)
N. ramosella (Zeller)	
N. troglodytella (Duponchel)	group 30, section 6, subsection B (1953)
N. axana (Hering)	
N. asterifoliella (Klimesch)	
N. gardesanella (Toll)	
Benanderpia Căpuşe, 1973	
B. adspersella (Benander)	group 30, section 10, subsection B (1953)
B. fulvosquamella (Herrich-Schäffer)	group 30, section 10, subsection A (1953)
Patzakia Căpuşe, 1973	
P. silenella (Herrich-Schäffer)	group 30, section 10, subsection D (1953)
P. robustella (Fuchs)	

* *C. erigerella* Ford, 1935, is currently considered to be a synonym of *C. squamosella* Stainton, 1856 (Bradley, 1962: 181).

P. ciconiella (Herrich-Schäffer)	
P. tritici (Lindemann)	
P. graminicolella (Heinemann)	
Lvaria Căpuşe, 1973	
L. lassella (Staudinger)	group 30, section 11 (1953)
Ulna Căpuşe, 1973	
U. saponariella (Heeger)	group 30, section 13 (1953)
GONIODOMINA Căpuşe, 1973	
Goniodoma Zeller, 1849	
G. auroguttella Zeller	
Klinzigedia Căpuşe, 1971	
K. phlomidella (Christoph)	
CARPOCHENINI Căpuşe, 1973	
Carpochena Falkovitsh, 1972	
C. squalorella (Zeller)	group 34 (1953)
Ionescumia Căpuşe, 1971	
I. clypeiferella (Hofmann)	group 34 (1953)
Stollia Căpuşe, 1971	
S. binotapennella (Duponchel)	group 34 (1953)
Bourgogneja Căpuşe, 1971	
B. onosmella (Brahm)	group 29 (1953)

The synonymies of *Coleophora sternipennella* (Zetterstedt, [1839]) and *C. benanderi* Kanerva, 1941

The misidentified type-species of *Aureliania* Căpuşe, 1971, viz. *Coleophora flavaginella* Lienig & Zeller sensu Căpuşe, and the type-species of *Bacescuia* Căpuşe, 1971, viz. *moeniacella* Stainton, are both involved in complicated and confusing synonymy which we attempt to clarify below. The species *Phalaena* (*Tinea*) *vestianella* Linnaeus is also involved (see pp. 84–85). To avoid further confusion we illustrate the ♂ genitalia of the three species concerned. In the synonymies reference is also made to genitalia figures in important papers on Coleophoridae.

Coleophora sternipennella (Zetterstedt, [1839])

(Fig. 1)

Ornix sternipennella Zetterstedt, [1839], *Insecta lapponica* : 1011. Syntypes 1 ♂, 1 ♀, SWEDEN: Västerbotten, Lycksele, 23.vi.1832 (*Zetterstedt*) (Universitetets Zoologiska Institution, Lund) [not examined].

Coleophora flavaginella Lienig & Zeller, 1846, *Isis, Leipzig* **1846** : 295. LECTOTYPE ♂, U.S.S.R.: Latvia ('Lievland'), Kokenhusen near Riga (*Lienig*) (genitalia slide no. 8381; British Museum (Natural History), London), here designated [examined].

Coleophora ‡*flavagipennella* Lienig & Zeller, 1846, *Isis, Leipzig* **1846** : 295. [A manuscript name of Fischer von Roeslerstamm; first published in synonymy under *flavaginella* Lienig & Zeller and therefore unavailable (*Int. Code zool. Nom.*, Article 11(d)).]

Coleophora punctipennella Nylander, 1848, *in* Tengström, *Notis. Sällsk. Faun. Fl. fenn. Förh.* **1** : 142. Syntype(s), FINLAND: Helsinki ('Helsingfors'), vii. (*Nylander*) (Zoological Museum, Helsinki) [not examined].

Coleophora muehligiella Stainton, 1887, *Entomologist's mon. Mag.* **24** : 14. LECTOTYPE ♀, [? GERMANY: Frankfurt/Main] (*Mühlig*) (genitalia slide no. 11093; British Museum (Natural History), London), here designated [examined].

Coleophora moeniacella Stainton, 1887, *Entomologist's mon. Mag.* **24** : 42. [Objective replacement name for *C. muehligiella* Stainton, 1887.]

Coleophora sternipennella (Zetterstedt); Benander, 1939, *Opusc. ent.* **4** : 95, pl. 5, figs 73, 73a (♂), pl. 6, fig. 85 (♀).

Eupista sternipennella (Zetterstedt); Toll, 1953, *Mater. Fizjogr. Kraju* **32** : 177, pl. 14, figs 122, 122a (♂), pl. 29, fig. 278 (♀).

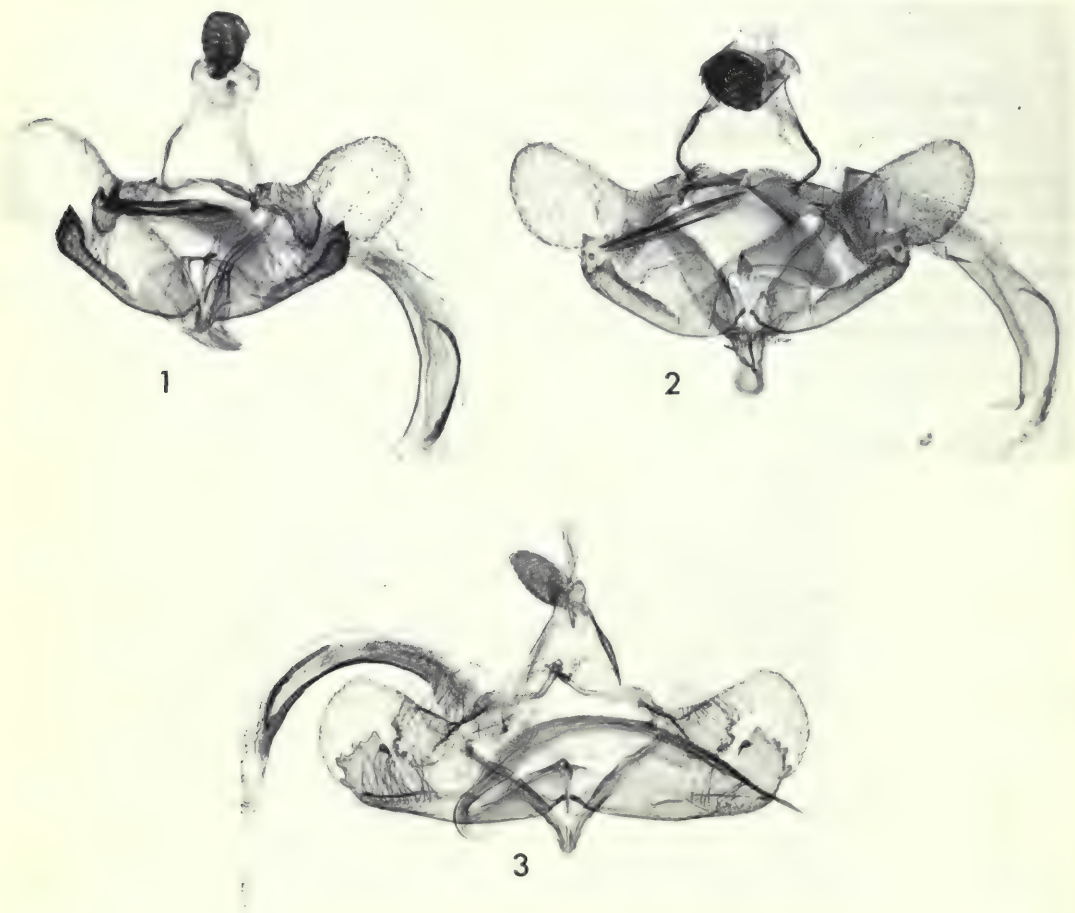
Aureliania sternipennella (Zetterstedt) Căpuşe, 1971, *Recherches morph. syst. Famille Coleophoridae* : pl. 23, fig. E, pl. 38, fig. E.

Coleophora sternipennella (Zetterstedt); Bradley, 1972, *Handbk Ident. Br. Insects* **11** (2) : 16.
Coleophora sternipennella (Zetterstedt); Patzak, 1974, *Beitr. Ent.* **24** : 264, colour fig. 32 (forewing), figs 7 (case), 200 (♂), 332 (♀).
Coleophora sternipennella (Zetterstedt); Karsholt & Nielsen, 1976a, *Syst. Fortegnelse over Danmarks Sommerfugle* : 28.

The syntypes of *sternipennella* were examined by Benander (1938 : 117; 1939 : 95, 99 [explanation of pl. 6, fig. 85], pl. 6, fig. 85; 1940 : 62).

The specimen here designated as the lectotype of *flavaginella* originated from Lienig and came into Stainton's possession via Tengström and Nylander. It bears the label 'Flavaginella Nylander 7/59' indicating the date when Stainton received the specimen from Nylander (Stainton, 1887 : 14). One ♂, two ♀ and one specimen without abdomen from the original series (coll. Zeller; coll. Stainton; British Museum (Natural History), London) have been labelled as paralectotypes.

Pierce & Metcalfe (1938 : 67) stated that they had examined the genitalia of the 'type' of *flavaginella*. In the British Museum (Natural History) there is a specimen bearing several 'Type' labels and a label in Zeller's handwriting 'Flavaginella Lg. Is. 1846, 295.'. It lacks the abdomen and, although it bears no slide number, is probably the specimen referred to by Pierce & Metcalfe;



Figs 1–3 Male genitalia of *Coleophora* species. (1) *C. sternipennella* (Zetterstedt), London, Buckingham Palace Gardens, 26.vii.1974 (*Bradley*) (slide no. 20 402; BMNH). (2) *C. benanderi* Kanerva, Dorset, Swanage, 8.vii.1897 (*Bankes*) (slide no. 4620; BMNH). (3) *C. vestianella* (Linnaeus), [Sweden] (*Linnaeus*) (slide no. 715, Sattler; Linnean Society, London).

however, we have been unable to trace the genitalia slide preparation. This specimen is excluded from the type-material as there is some doubt about its being authentic.

The syntypes of *punctipennella* were examined and the synonymy with *sternipennella* was confirmed by Kanerva (1941 : 120).

In his original description of *muehligiella*, Stainton (1887 : 14) referred to specimens that he had received from Mühlig in February, 1859; however, only a single female is in the Stainton collection and there is no evidence in his notebook that he received more than one specimen.

Stainton proposed the name *moeniacella* (‡*maeniacella* auctorum, incorrect subsequent spelling) as an objective replacement name for *Coleophora muehligiella* Stainton, 1887, which he erroneously considered to be preoccupied by *Coleophora muehligella* Wocke, [1876], *in* Heinemann, *Schmett. Dtl. Schweiz* (2) **2** (2) : 604. Therefore the names *C. muehligiella* Stainton and *C. moeniacella* Stainton must always be placed together; in spite of this the two names have been separated by subsequent authors.

When introducing the name *atriplicis*, Meyrick ([1928] : 763) stated 'This species has been erroneously identified with *C. maeniacella* Staint.', at the same time placing '*muehligiella* Staint., non Wocke' in synonymy of *atriplicis*. It should be noted that the name *C. atriplicis* must be attributed to Meyrick, who made it nomenclaturally available, and not to Durrant from whom it originated as a manuscript name.

Meyrick was followed by Pierce & Metcalfe (1935 : 64) who placed *muehligiella* Stainton in synonymy under *atriplicis* but did not refer to *moeniacella*. In 1938, Pierce & Metcalfe (1938 : 67) placed *moeniacella* [as '*maeniacella*'], together with *annulatella*, in synonymy under *flavaginella* Lienig & Zeller.

Bradley (1972 : 16), in the British list, placed *moeniacella* [=*muehligiella* Stainton] as a senior synonym of *suaedivora* Meyrick; however, Stainton (1887 : 14, *muehligiella*) expressly distinguished it from the species on *Suaeda maritima* (L.) Dumortier (which he erroneously called *flavaginella* Lienig).

Karsholt & Nielsen (1976a : 28) placed *moeniacella* as a synonym of *sternipennella* and *muehligiella* as a synonym of *suaedivora* Meyrick.

Coleophora benanderi Kanerva, 1941

(Fig. 2)

Coleophora benanderi Kanerva, 1941, *Suomen hyönt. Aikak.* **7** : 120. Syntypes ♂, ♀, SWEDEN: Schonen; Blekinge; Småland; Västergötland; Öland; Gotland, vii–viii. (*Benander*) (coll. Benander, Sweden) [not examined].

[*Eupista annulatella* (Nylander); Pierce & Metcalfe, 1935, *Genitalia Tineid Families Lepid. Br. Islands* : 65, pl. 39, figs (♂, ♀). Misidentification.]

[*Eupista flavaginella* (Lienig & Zeller); Pierce & Metcalfe, 1938, *Genitalia Br. Pyrales, Deltoids & Plumes* : 67. Misidentification.]

[*Coleophora annulatella* Nylander; Benander, 1939, *Opusc. ent.* **4** : 96, pl. 5, figs 74, 74a (♂), pl. 6, fig. 84 (♀). Misidentification.]

[*Eupista flavaginella* (Lienig & Zeller); Toll, 1953, *Mater. Fizjogr. Kraju* **32** : 177, pl. 14, figs 120, 120a (♂) (not pl. 29, fig. 277, ♀). Misidentification.]

[*Aureliania flavaginella* (Lienig & Zeller) Căpuşe, 1971, *Recherches morph. syst. Famille Coleophoridae* : 65. Misidentification.]

[*Coleophora annulatella* Nylander; Bradley, 1972, *Handbk Ident. Br. Insects* **11** (2) : 16. Misidentification.]

[*Coleophora annulatella* Nylander; Sattler & Tremewan, 1974, *Bull. Br. Mus. nat. Hist.* (Ent.) **30** : 201. Misidentification.]

[*Coleophora annulatella* Nylander; Patzak, 1974, *Beitr. Ent.* **24** : 263, figs 199 (♂), 331 (♀). Misidentification.]

Coleophora benanderi Kanerva; Karsholt & Nielsen, 1976a, *Syst. Fortegnelse over Danmarks Sommerfugle* : 28.

The name *benanderi* was proposed for *C. annulatella* Nylander sensu Benander (1939 : 96, pl. 5, figs 74, 74a, pl. 6, fig. 84).

The identity of *Phalaena* (*Tinea*) *vestianella* Linnaeus, 1758

Coleophora vestianella (Linnaeus, 1758) **comb. n.**

(Fig. 3)

Phalaena (*Tinea*) *vestianella* Linnaeus, 1758, *Syst. Nat.* (edn 10) **1** : 536. LECTOTYPE ♂, [SWEDEN] (genitalia slide no. 715, Sattler; Linnean Society, London), here designated [examined].

Phalaena (*Tinea*) *vestianella* Linnaeus; Linnaeus, 1761, *Fauna suec.* (edn 2) : 365.

Phalaena (*Tinea*) *vestianella* Linnaeus; Linnaeus, 1767, *Syst. Nat.* (edn 12) **1** (2) : 888.

Ornix laripennella Zetterstedt, [1839], *Insecta lapponica* : 1011. Syntype(s) ♂, NORWAY: Dovrefjell ('alpe Dowre') (*Boheman*) (? Naturhistoriska Riksmuseum, Stockholm) [not examined]. **Syn. n.**

Coleophora annulatella Nylander, 1848, *in* Tengström, *Notis. Sällsk. Faun. Fl. fenn. Förh.* **1** : 143. Syntypes ♂, ♀, FINLAND: Helsinki ('Helsingfors'), vii. (*Nylander*) (Zoological Museum, Helsinki) [not examined]. **Syn. n.**

Coleophora tengstromella Doubleday, 1859, *Zoologist syn. List. Br. Butterfl. & Moths* (edn 2) : 33. [Objective replacement name for *C. annulatella* Nylander, 1848.] **Syn. n.**

Coleophora annulatella Nylander; Wocke, 1861, *in* Staudinger & Wocke, *Cat. Lepid. Eur.* : 123. [With *laripennella* Zetterstedt in synonymy.]

Coleophora laripennella (Zetterstedt); Wocke, 1871, *in* Staudinger & Wocke, *Cat. Lepid. eur. Faunengebiets* : 318. [With *annulatella* Nylander in synonymy.]

Coleophora laripennella (Zetterstedt); Rebel, 1901, *in* Staudinger & Rebel, *Cat. Lepid. palaearctischen Faunengebietes* **2** : 200.

Eupista laripennella (Zetterstedt); Pierce & Metcalfe, 1935, *Genitalia Tineid Families Lepid. Br. Islands* : 66, pl. 40, figs (♂, ♀).

Coleophora laripennella (Zetterstedt); Benander, 1939, *Opusc. ent.* **4** : 94, pl. 5, figs 72, 72a (♂).

Eupista laripennella (Zetterstedt); Toll, 1953, *Mater. Fizjogr. Kraju* **32** : 182, pl. 15, fig. 125 (♂), pl. 29, fig. 281 (♀).

Coleophora laripennella (Zetterstedt); Bradley, 1972, *Handbk Ident. Br. Insects* **11** (2) : 16.

Coleophora laripennella (Zetterstedt); Patzak, 1974, *Beitr. Ent.* **24** : 265, colour fig. 33 (fore wing), figs 203 (♂), 337 (♀).

Coleophora laripennella (Zetterstedt); Karsholt & Nielsen, 1976a, *Syst. Fortegnelse over Danmarks Sommerfugle* : 28.

In 1758 Linnaeus described *Phalaena Tinea vestianella* as follows:

'P. *Tinea* alis cinereis: apicibus adscendentibus plumosis, palpis recurvis. *Habitat in* Vestimentis, *quae destruit.*'

He placed it after *cynosbatella* (Tortricidae) and before *tapetzella*, *pellionella* (Tineidae) and *sarcitrella* (Oecophoridae). In 1761 he placed it after *tapetzella*, *pellionella* and *sarcitrella* and before *pomonella* (Tortricidae), adding a more detailed description which reads as follows:

'PH. TINEA *vestianella* alis cinereis costa albis, apicibus adscendentibus plumosis, palpis recurvatis. Habitat in *Vestimentis*, quae aestate rodit & destruit more praecedentium.

DESCR. Alae superiores lanceolatae, margine crassiore niveo, glaucae atomis nigris. *Inferiores* subulatae, plumbei coloris, omnes latissime ciliatae. *Palpi* prominentes, recurvi. *Antennae* breviores, albo annulatae.'

Linnaeus's description and placement of *vestianella* in 1767 differs little from that of 1761.

In the Linnaean collection there are three identical specimens (1 ♂, 1 ♀; 1 of undetermined sex, without abdomen), the ♂ being associated with the label 'vestianella' in Linnaeus's handwriting. An additional label 'vestianella 888' was subsequently added by Sir James Edward Smith, who acquired the collection after the death of Linnaeus. A detailed examination of these specimens has shown them to be the species hitherto known as *Coleophora laripennella* (Zetterstedt, [1839]).

The specimens agree with the 1758 description by their grey wings and recurved palpi but disagree by their biology and down-turned apices of the wings. Additional descriptive material added by Linnaeus in 1761 and repeated in 1767 clearly applies to the specimens in his collection or would have applied when they were fresh: lanceolate, bluish grey forewings with black specks and white costa; awl-shaped, grey hind wings; long cilia on all wings; prominent, recurved palpi; white-ringed antennae.

If, as we believe, the specimens in the Linnaean collection are authentic and are those upon which the descriptions were based, Linnaeus's account of the biology is incorrect. In his description of the biology in 1761 (slightly more detailed than that of 1758) he stated that it lives in clothing, which it nibbles in summer and destroys in the same way as the preceding species (*tapetzella*, *pellionella*, *sarcitrella*). This description is sufficiently vague that it can be applied to several species of clothes moths and even to the oecophorids *Endrosis sarcitrella* (L.) and *Hofmannophila pseudospretella* (Stainton). It has been suggested that *vestianella* might be the species currently known as *Tineola bisselliella* (Hummel) because the latter is so common that Linnaeus should have known and described it. While the biology might apply to *bisselliella* the brief diagnosis of the moth in 1758 and the more detailed descriptions in 1761 and 1767 clearly do not apply, for example, the grey wings and recurved palpi (1758) and the shape, colour and markings of the wings as well as the ringed antennae (1761; 1767).

All evidence seems to indicate that the descriptions of the moth and of the biology apply to two different species. If *vestianella* is a clothes moth then the descriptions of the moth are incorrect and the specimens in the Linnaean collection are not authentic. However, if it is the species we know as *Coleophora laripennella* (Zetterstedt) then the accounts of the biology are erroneous.

We believe that the identity of this species should, in agreement with normal practice, be based primarily on the description of the moth and on the specimens in the Linnaean collection. Such important evidence cannot be rejected in favour of an account of the biology, the authenticity of which is dubious. It should be noted that erroneous biological data are not uncommon in Linnaeus's works, for example, *Solidago* as food-plant for *Heodes virgaureae*, *Spiraea* for *Zygaena filipendulae* and *Lonicera* for *Plutella xylostella*.

Past authors have interpreted *vestianella* in different ways and its true identity has hitherto remained unknown.

Clerck (1759 : pl. 11, fig. 11) illustrated under the name *vestianella* a species currently known as *Pyrausta cespitalis* ([Denis & Schiffermüller], 1775) (Pyralidae). Stephens (1834 : 344) applied the name *vestianella* to the species currently known as *Monopis rusticella* (Hübner, 1796) (Tineidae) whereas Werneburg (1864 : 232, 273) considered that it might be *lacteella* [Denis & Schiffermüller] [=*Endrosis sarcitrella* (Linnaeus, 1758)] (Oecophoridae). More recently Bradley (1972 : 8) considered that *vestianella* might be conspecific with *Tineola bisselliella* (Hummel, 1823) (Tineidae).

The above designation of the lectotype places *vestianella* as a senior subjective synonym of *Coleophora laripennella* (Zetterstedt, [1839]). Because of the confusion regarding the names *sternipennella*, *flavaginella*, *punctipennella*, *muehligiella*, *moeniacella*, *benanderi*, *laripennella* and *annulatella* (pp. 81–84), the introduction of the name *vestianella* into this group is not disruptive but, on the contrary, introduces an element of stability; being a Linnaean name it cannot in future be affected by any newly discovered synonymy.

The removal of the name *vestianella* from the Tineidae (and Oecophoridae) is also in the interest of stability and ensures that in future it cannot threaten the well-known names of species of economic importance.

The syntypes of *annulatella* were examined and the synonymy with *C. laripennella* (Zetterstedt) was established by Kanerva (1941 : 119).

Doubleday proposed the name *tengstromella* (‡*tengstroemella* auctorum, incorrect subsequent spelling) as an objective replacement name for *Coleophora annulatella* Nylander, 1848, which he erroneously considered to be preoccupied by *Cerostoma annulatella* Curtis, 1832, *Br. Ent.*, **9**, no. 420.

Alphabetical catalogue of the family-group names

‡CASASINI Căpuşe, 1971 (Sattler & Tremewan, 1974 : 198).
Incorrect original formation of the tribe name based on *Casas* Wallengren, 1881.
See also: Casini Căpuşe, 1971.

CASIGNETINA Falkovitsh, 1972; Căpuşe, 1973, *Taxon. Famille Coleophoridae* : 8; 1975, *Fragm. ent.* **11** : 49.

Type-genus: *Casigneta* Wallengren, 1881, nom. praeocc. [= *Casignetella* Strand, 1928].

Originally proposed as a tribe name Casignetini Falkovitsh, 1972, which is invalid as a family-group name as its nominal type-genus is a junior homonym (*Int. Code zool. Nom.*, Article 39) (see Sattler & Tremewan, 1974 : 198). No replacement name was proposed as we considered Casignetini Falkovitsh to be a junior subjective synonym of Coleophoridae Hübner, [1825]. Subsequently used as a subtribe name; again no replacement name is proposed as Casignetina Falkovitsh is currently considered to be a junior subjective synonym of Coleophoridae Hübner, [1825].

CASINI Căpuşe, 1971; Căpuşe, 1973, *Taxon. Famille Coleophoridae* : 6.

Type-genus: *Casas* Wallengren, 1881.

Originally proposed as 'Casasini', which is an incorrect formation of the tribe name based on *Casas* Wallengren, 1881; subsequently emended to Casini (Căpuşe, 1973 : 6; 1975 : 2).

In view of the difficulties we have experienced with regard to the correct formation of the family-group name based on *Casas*, it might be appropriate to comment here on Article 29 of the *Code*. Few taxonomists have a thorough knowledge of the classical languages and in this respect most of us find it difficult or impossible to use the *Code* without seeking advice. In our opinion any taxonomist should be able to use the *Code* without the assistance of classical scholars; we therefore suggest that the relevant rules of the *Code* be amended to recommendations.

COLEOPHORIDAE Hübner, [1825] (Sattler & Tremewan, 1974 : 198).

In 1974 we based the name Coleophoridae on Coleophorae Hübner, [1825], as, in our opinion, Hübner's 'stirps' is the equivalent of the family as understood by current authors. In coming to this decision we were guided by manuscript notes of Durrant in the Walsingham copy of Hübner's *Verzeichniss* and by Hemming (1937 : 19). According to Durrant, Hübner's 'stirps' is the equivalent of the family while Hemming considered it to be the subfamily. However, Hübner's 'stirps' names have not been generally accepted as family-group names, and Franclemont (*in* Hemming, 1957 : 312) stated 'Whatever importance Hübner attached to the category "Stirps" he certainly did not treat it as a taxon belonging to the family-group as currently understood.'

It has also been suggested to us that the family-group name Coleophoridae should not be based on Coleophorae Hübner, [1825] : 426, as the type-genus *Coleophora* Hübner, 1822, is not included in the stirps Coleophorae. The *International Code of Zoological Nomenclature*, Article 11(e), specifies that 'A family-group name must, when first published, be based on the name then valid for a contained genus, . . .'. Our interpretation of Article 11(e) was that the name Coleophorae is clearly based on *Coleophora* which is therefore automatically *contained* in the stirps. We believe that the *Code* would have used the term 'included genus' (rather than 'contained genus') to specify that the type-genus must be included by name.

If our interpretations are rejected the family-group name must be attributed to Bruand, 1850 : 54 (Sattler & Tremewan, 1974 : 198).

‡FALKOVITSHINAE Căpuşe, 1972; Căpuşe, 1973, *Taxon. Famille Coleophoridae* : 5.

Incorrect subsequent formation of the subfamily name based on *Falkovitshia* Căpuşe, 1972 (see Sattler & Tremewan, 1974 : 199).

GONIODOMINA Căpuşe, 1973, *Taxon. Famille Coleophoridae* : 8; 1975, *Fragm. ent.* **11** : 59.

Type-genus: *Goniodoma* Zeller, 1849.

Originally proposed as a subtribe name; currently considered to be a junior subjective synonym **(syn. n.)** of Coleophoridae Hübner, [1825].

HAPLOPTILIINA Barnes & McDunnough, 1917; Căpuşe, 1975, *Fragm. ent.* **11** : 2.

Type-genus: *Haploptilia* Hübner, [1825].

Originally proposed as 'Haploptilidae', which is an incorrect formation of the family name based on *Haploptilia* Hübner, [1825]; subsequently used as a subtribe name (in the incorrect formation Haploptilina) (Căpuşe, 1973 : 12) ; finally emended to Haploptiliina (Căpuşe, 1975 : 2). Currently considered to be a junior subjective synonym of Coleophoridae Hübner, [1825] (see also Sattler & Tremewan, 1974 : 199).

‡HAPLOPTILINA Barnes & McDunnough, 1917; Căpuşe, 1973, *Taxon. Famille Coleophoridae* : 12.

Incorrect formation of the subtribe name based on *Haploptilia* Hübner, [1825]. See also Sattler & Tremewan, 1974 : 199, Haploptilidae.

Alphabetical catalogue of the genus-group names

ABARASCHIA Căpuşe, 1973, *Taxon. Famille Coleophoridae* : 20; 1975, *Fragm. ent.* **11** : 24.

Type-species: ***Coleophora pagmana*** Toll, 1962, *Acta zool. cracov.* **7** : 679, pl. 11K, fig. 119, pl. 7F, fig. 58, pl. 34A, fig. 135, pl. 15M, fig. 102, by original designation and monotypy.

Originally proposed as a subgenus of *Baraschia* Căpuşe, 1973; currently considered to be a junior subjective synonym (**syn. n.**, see pp. 74–75) of *Coleophora* Hübner, 1822.

AMSELGHIA Căpuşe, 1973, *Taxon. Famille Coleophoridae* : 18; 1975, *Fragm. ent.* **11** : 38.

Type-species: ***Coleophora fringillella*** Zeller, 1839, *Isis, Leipzig* **1839** : 208, by original designation and monotypy.

The type-species was cited by Căpuşe as '*fringilella*' which is an incorrect subsequent spelling of *fringillella* Zeller, 1839.

Originally proposed as a subgenus of *Amseliphora* Căpuşe, 1971; currently considered to be a junior subjective synonym (**syn. n.**, see pp. 74–75) of *Coleophora* Hübner, 1822.

AMSELIPHORA Căpuşe, 1971 (Sattler & Tremewan, 1974 : 200).

See also: *Amselghia* Căpuşe, 1973; *Ardania* Căpuşe, 1973.

APISTA Hübner, [1825] (Sattler & Tremewan, 1974 : 200).

See also: *Metapista* Căpuşe, 1973.

ARDANIA Căpuşe, 1973, *Taxon. Famille Coleophoridae* : 18; 1975, *Fragm. ent.* **11** : 38.

Type-species: ***Coleophora bilineatella*** Zeller, 1849, *Linn. ent.* **4** : 198, 272, by original designation and monotypy.

Originally proposed as a subgenus of *Amseliphora* Căpuşe, 1971; currently considered to be a junior subjective synonym (**syn. n.**, see pp. 74–75) of *Coleophora* Hübner, 1822.

ASCLERIDUCTIA Căpuşe, 1973, *Taxon. Famille Coleophoridae* : 19; 1975, *Fragm. ent.* **11** : 30.

Type-species: ***Coleophora lithargyrinella*** Zeller, 1849, *Linn. ent.* **4** : 200, 394, by original designation and monotypy.

Currently considered to be a junior subjective synonym (**syn. n.**, see pp. 74–75) of *Coleophora* Hübner, 1822.

AURELIANIA Căpuşe, 1971, *Recherches morph. syst. Famille Coleophoridae* : 65.

Type-species: *Coleophora flavaginella* Lienig & Zeller sensu Căpuşe, 1971 [= ***Coleophora benanderi*** Kanerva, 1941, *Suomen hyönt. Aikak.* **7** : 120], by original designation.

In our previous catalogue (1974 : 201) we erroneously considered the type-species of *Aureliania*, namely *Coleophora flavaginella* Lienig & Zeller sensu Căpuşe, 1971, to be synonymous with *Coleophora annulatella* Nylander, 1848. The examination of type-material of *annulatella* by Kanerva (1941 : 119) has shown it to be a synonym of *Coleophora laripennella* (Zetterstedt, [1839]). For *annulatella* sensu auctorum Kanerva proposed the name *benanderi*. As noted earlier (Sattler & Tremewan, 1974 : 201) *flavaginella* Lienig & Zeller is a junior subjective synonym of *sternipennella* Zetterstedt. The synonymy is expressed in detail on pp. 81–82.

Under the *Int. Code zool. Nom.*, Article 70(a), the case of a misidentified type-species has to be referred to the International Commission on Zoological Nomenclature. We suggest that the Commission be asked to designate as the type-species of *Aureliania* the nominal species actually involved, namely *Coleophora benanderi* Kanerva, 1941 (*Int. Code zool. Nom.*, Article 70(a)(i)).

The change in the name of the type-species does not affect the synonymy of the genus *Aureliania*, which is still considered to be a junior subjective synonym of *Coleophora* Hübner, 1822.

See also: *Ductispira* Căpuşe, 1974; *Ecebalia* Căpuşe, 1973; *Nosyrislia* Căpuşe, 1973.

BACESCUIA Căpuşe, 1971, *Recherches morph. syst. Famille Coleophoridae* : 65.

Type-species: *Coleophora moeniacella* Stainton sensu Căpuşe, 1971 [= ***Coleophora suaedivora*** Meyrick, [1928], *Revised Handbk Br. Lepid.*: 763], by original designation and monotypy.

Under the *Int. Code zool. Nom.*, Article 70(a), the case of a misidentified type-species has to be referred to the International Commission on Zoological Nomenclature. We suggest that the Commission be asked to designate as the type-species of *Bacescuia* the nominal species actually involved, namely *Coleophora suaedivora* Meyrick, [1928] (*Int. Code zool. Nom.*, Article 70(a)(i)).

C. moeniacella Stainton [= *muehligiella* Stainton] is currently considered to be a junior subjective synonym of *C. sternipennella* (Zetterstedt, [1839]) (see p. 81).

BARASCHIA Căpuşe, 1973, *Taxon. Famille Coleophoridae* : 20; 1975, *Fragm. ent.* **11** : 24.

Type-species: ***Coleophora paradoxella*** Toll, 1961, *Annls zool. Warsz.* **19** : 215, text-figs 14–18, by original designation.

Currently considered to be a junior subjective synonym (**syn. n.**, see pp. 74–75) of *Coleophora* Hübner, 1822.

See also: *Abaraschia* Căpuşe, 1973.

BENANDERPIA Căpuşe, 1973, *Taxon. Famille Coleophoridae* : 10; 1975, *Fragm. ent.* **11** : 54.

Type-species: ***Coleophora adspersella*** Benander, 1939, *Opusc. ent.* **4** : 93, pl. 5, fig. 70, by original designation and monotypy.

The type-species was cited by Căpuşe as '*adspereslla*', which is an incorrect subsequent spelling of *C. adspersella* Benander, 1939.

Currently considered to be a junior subjective synonym (**syn. n.**, see pp. 74–75) of *Coleophora* Hübner, 1822.

‡*CALARITANIA* Mariani, 1943, *G. Sci. nat. econ. Palermo* **42** (3) : 188 (nomen nudum). (Sattler & Tremewan, 1974 : 202, ‡*Calaritania* Grandi.)

‡*Calaritania* Mariani was not accompanied by a description, indication or available nominal species; the only included nominal species, ‡*sardiniella*, is a nomen nudum. Mariani attributed the names *Calaritania* and *sardiniella* to Amsel, who, however, has never made them nomenclaturally available (Amsel, in litt.).

CALCOMARGINIA Căpuşe, 1973, *Taxon. Famille Coleophoridae* : 17; 1975, *Fragm. ent.* **11** : 38.

Type-species: ***Ornix ballotella*** Fischer von Roeslerstamm, 1839, *Abbildungen Bericht. Ergänzung Schmettkde* : 154, pl. 58, figs a–k, by original designation and monotypy.

Currently considered to be a junior subjective synonym (**syn. n.**, see pp. 74–75) of *Coleophora* Hübner, 1822.

‡*CALEOPHORA* Căpuşe, 1973, *Taxon. Famille Coleophoridae* : 11 [under *Hamuliella*]. Incorrect subsequent spelling of *Coleophora* Hübner, 1822.

COLEOPHORA Hübner, 1822 (Sattler & Tremewan, 1974 : 203).

See also: *Abaraschia* Căpuşe, 1973; *Amselghia* Căpuşe, 1973; *Ardania* Căpuşe, 1973, *Ascleriductia* Căpuşe, 1973; *Baraschia* Căpuşe, 1973; *Benanderpia* Căpuşe, 1973; *Calcomarginia* Căpuşe, 1973; ‡*Caleophora* Căpuşe, 1973; ‡*Corothropoea* Căpuşe, 1973; *Cornulivalvulia* Căpuşe, 1973; *Ductispira* Căpuşe, 1974; *Dumitrescumia* Căpuşe, 1973; *Ecebalia* Căpuşe, 1973; *Globulia* Căpuşe, 1973; *Hamuliella* Căpuşe, 1973; *Helvalbia* Căpuşe, 1973; *Kasyfia* Căpuşe, 1973; *Klimeschjosefia* Căpuşe, 1975; *Kuznetzovvlia* Căpuşe, 1973; *Latisacculia* Căpuşe, 1973; *Longibacillia* Căpuşe, 1973; *Lucidaesia* Căpuşe, 1973; *Luzulina* Falkovitsh, 1972; *Lvaria* Căpuşe, 1973; *Membrania* Căpuşe, 1973; *Metapista* Căpuşe, 1973; *Multicoloria* Căpuşe, 1973; *Neugenvia* Căpuşe, 1973; *Nosyrislia* Căpuşe, 1973; ‡*Ortohgraphis* Căpuşe, 1973; *Oudejansia* Căpuşe, 1973; *Paravalvulia* Căpuşe, 1973; *Patzakia* Căpuşe, 1973; *Perygridia* Falkovitsh, 1972; *Postvinculia* Căpuşe, 1973; *Proglaseria* Căpuşe, 1973; *Quadratia* Căpuşe, 1973; *Rhamnia* Căpuşe, 1973; *Sacculia* Căpuşe, 1973; *Scleriductia* Căpuşe, 1973; *Tollsia* Căpuşe, 1973; *Tuberculia* Căpuşe, 1973; *Ulna* Căpuşe, 1973.

CORETHROPOEA Falkovitsh, 1972 (Sattler & Tremewan, 1974 : 203).

See also: ‡*Corothropoea* Căpuşe, 1973.

‡*COROTHROPOEA* Căpuşe, 1973, *Taxon. Famille Coleophoridae* : 20.

Incorrect subsequent spelling of *Corethropoea* Falkovitsh, 1972.

CORNULIVALVULIA Căpuşe, 1973, *Taxon. Famille Coleophoridae* : 9; 1975, *Fragm. ent.* **11** : 49.

Type-species: ***Coleophora vicinella*** Zeller, 1849, *Linn. ent.* **4** : 198, 251, by original designation and monotypy.

Junior subjective synonym of *Multicoloria* Căpuşe, 1973 (Falkovitsh, 1974a : 194); currently considered to be a junior subjective synonym (**syn. n.**, see pp. 74–75) of *Coleophora* Hübner, 1822.

CORYTHANGELA Meyrick, 1897 (Sattler & Tremewan, 1974 : 203).

See also: ‡*Corythangella* Căpuşe, 1973.

‡*CORYTHANGELLA* Căpuşe, 1973, *Taxon. Famille Coleophoridae* : 22.

Incorrect subsequent spelling of *Corythangela* Meyrick, 1897.

DUCTISPIRA Căpuşe, 1974, *Beitr. naturk. Forsch. SüdwDtl.* **33** : 188.

Type-species: ***Coleophora unistriella*** Caradja, 1920, *Dt. ent. Z. Iris* **34** : 152, by original designation and monotypy.

Originally proposed as a subgenus of *Aureliania* Căpuşe, 1971; currently considered to be a junior subjective synonym (**syn. n.**, see pp. 74–75) of *Coleophora* Hübner, 1822.

DUMITRESCUMIA Căpuşe, 1973, *Taxon. Famille Coleophoridae* : 21; 1975, *Fragm. ent.* **11** : 8.

Type-species: ***Coleophora cecidophorella*** Oudejans, 1972, *Ent. Ber., Amst.* **32** : 120, by original designation and monotypy.

Currently considered to be a junior subjective synonym (**syn. n.**, see pp. 74–75) of *Coleophora* Hübner, 1822.

ECEBALIA Căpuşe, 1973, *Taxon. Famille Coleophoridae* : 11; 1975, *Fragm. ent.* **11** : 53.

Type-species: ***Ornix laripennella*** Zetterstedt, [1839], *Insecta lapponica* : 1011, by original designation and monotypy.

For synonymy of *C. laripennella* (Zetterstedt, [1839]) see p. 84.

Originally proposed as a subgenus of *Aureliania* Căpuşe, 1971; currently considered to be a junior subjective synonym (**syn. n.**, see pp. 74–75) of *Coleophora* Hübner, 1822.

GLASERIA Căpuşe, 1971 (Sattler & Tremewan, 1974 : 204).

See also: *Proglaseria* Căpuşe, 1973.

GLOBULIA Căpuşe, 1973, *Taxon. Famille Coleophoridae* : 21; 1975, *Fragm. ent.* **11** : 11.

Type-species: ***Coleophora cornuta*** Heinemann & Wocke, [1876], *in* Heinemann, *Schmett. Dtl. Schweiz* (2) **2** (2) : 539, by original designation and monotypy.

Căpuşe cited the type-species as '*Coleophora cornuta* Stt., 1859', which is a nomen nudum. The species was first made nomenclaturally available by Heinemann & Wocke, [1876]; the synonymy is expressed as follows:

Coleophora cornuta Heinemann & Wocke, [1876], *in* Heinemann, *Schmett. Dtl. Schweiz* (2) **2** (2) : 539.

Coleophora cornuta Stainton, 1859, *Nat. Hist. Tineina* **4** : 14, 15, 32, 33. Nomen nudum.

Coleophora cornuta Wocke, 1861, *in* Staudinger & Wocke, *Cat. Lepid. Eur.* : 121. Nomen nudum.

Coleophora cornuta Wocke, 1871, *in* Staudinger & Wocke, *Cat. Lepid. eur. Faunengebiets* : 313. Nomen nudum.

Currently considered to be a junior subjective synonym (**syn. n.**, see pp. 74–75) of *Coleophora* Hübner, 1822.

HAMULIELLA Căpuşe, 1973, *Taxon. Famille Coleophoridae* : 11; 1975, *Fragm. ent.* **11** : 53.

Type-species: ***Coleophora otitae*** Zeller, 1839, *Isis, Leipzig* **1839** : 207, by original designation and monotypy.

Currently considered to be a junior subjective synonym (**syn. n.**, see pp. 74–75) of *Coleophora* Hübner, 1822.

HELVALBIA Căpuşe, 1973, *Taxon. Famille Coleophoridae* : 19; 1975, *Fragm. ent.* **11** : 32.

Type-species: ***Porrectaria lineolea*** Haworth, 1828, *Lepid. Br.* : 534, by original designation and monotypy.

Currently considered to be a junior subjective synonym (**syn. n.**, see pp. 74–75) of *Coleophora* Hübner, 1822.

KASYFIA Căpuşe, 1973, *Taxon. Famille Coleophoridae* : 21; 1975, *Fragm. ent.* **11** : 16.

Type-species: ***Ornix binderella*** Kollar, 1832, *Beitr. Landesk. Öst. Enns* **2** : 99, by original designation and monotypy.

Currently considered to be a junior subjective synonym (**syn. n.**, see pp. 74–75) of *Coleophora* Hübner, 1822.

KLIMESCHJA Căpuşe, 1971 (Sattler & Tremewan, 1974 : 205).

See also: *Klimeschjosefia* Căpuşe, 1975.

KLIMESCHJOSEFIA Căpuşe, 1975, *Fragm. ent.* **11** : 35 (objective replacement name for *Klimeschja* Căpuşe, 1971).

Type-species: ***Coleophora oriolella*** Zeller, 1849, *Linn. ent.* **4** : 198, 258, by original designation for and monotypy of *Klimeschja* Căpuşe, 1971.

Unnecessary objective replacement name for *Klimeschja* Căpuşe, 1971, which is not a junior homonym of *Klimeschia* Amsel, 1938 (Lepidoptera : Douglasiidae). Căpuşe was aware of the *Code*, Article 56(a) (one-letter difference) and stated: 'Nous pensons que les lettres i–j entrent aussi dans cette règle.' In spite of this he continued: 'Contrairement, nous proposons pour notre genre le nom *Klimeschjosefia*, . . .'. The latter statement is not clear to us. Did Căpuşe propose a replacement name in spite of *Klimeschja* being valid under the *Code* or had he doubts about the one-letter difference i–j and therefore proposed a conditional replacement name? If the former was intended then it is an unnecessary replacement name; if the latter was intended, then it is a conditionally proposed name and unavailable under the *Code*, Article 15.

KUZNETZOVVLIA Căpuşe, 1973, *Taxon. Famille Coleophoridae* : 19; 1975, *Fragm. ent.* **11** : 25.

Type-species: ***Coleophora solidaginella*** Staudinger, 1859, *Stettin. ent. Ztg* **20** : 254, by original designation and monotypy.

Currently considered to be a junior subjective synonym (**syn. n.**, see pp. 74–75) of *Coleophora* Hübner, 1822.

LATISACCULIA Căpuşe, 1973, *Taxon. Famille Coleophoridae* : 18; 1975, *Fragm. ent.* **11** : 32.

Type-species: ***Coleophora crocinella*** Tengström, 1848, *Notis. Sällsk. Faun. Fl. fenn. Förh.* **1** : 140, by original designation and monotypy.

Currently considered to be a junior subjective synonym (**syn. n.**, see pp. 74–75) of *Coleophora* Hübner, 1822.

LONGIBACILLIA Căpuşe, 1973, *Taxon. Famille Coleophoridae* : 20; 1975, *Fragm. ent.* **11** : 23.

Type-species: ***Coleophora fergana*** Toll, 1961, *Annls zool. Warsz.* **19** : 211, text-figs 5–9, by original designation and monotypy.

Originally proposed as a subgenus of *Membrania* Căpuşe, 1973; currently considered to be a junior subjective synonym (**syn. n.**, see pp. 74–75) of *Coleophora* Hübner, 1822.

LUCIDAESIA Căpuşe, 1973, *Taxon. Famille Coleophoridae* : 15; 1975, *Fragm. ent.* **11** : 47.

Type-species: *Phalaena* (*Tinea*) *frischella* Linnaeus sensu Căpuşe, 1973 [= ***Ornix alcyonipennella*** Kollar, 1832, *Beitr. Landesk. Öst. Enns* **2** : 99], by original designation and monotypy.

Under the *Int. Code zool. Nom.*, Article 70(a), the case of a misidentified type-species has to be referred to the International Commission on Zoological Nomenclature. We suggest that the Commission be asked to designate as the type-species of *Lucidaesia* the nominal species actually involved, namely *Coleophora alcyonipennella* (Kollar, 1832) (*Int. Code zool. Nom.*, Article 70(a)(i)).

Currently considered to be a junior subjective synonym (**syn. n.**, see pp. 74–75) of *Coleophora* Hübner, 1822.

LUZULINA Falkovitsh, 1972 (Sattler & Tremewan, 1974 : 205).

Originally proposed as a subgenus of *Perygra* Falkovitsh, 1972; subsequently considered as a genus (Căpuşe, 1973 : 11); currently considered to be a junior subjective synonym of *Coleophora* Hübner, 1822 (Sattler & Tremewan, 1974 : 205).

LVARIA Căpuşe, 1973, *Taxon. Famille Coleophoridae* : 9; 1975, *Fragm. ent.* **11** : 57.

Type-species: ***Coleophora lassella*** Staudinger, 1859, *Stettin. ent. Ztg* **20** : 255, by original designation and monotypy.

Currently considered to be a junior subjective synonym (**syn. n.**, see pp. 74–75) of *Coleophora* Hübner, 1822.

MEMBRANIA Căpuşe, 1973, *Taxon. Famille Coleophoridae* : 19; 1975, *Fragm. ent.* **11** : 22, 23.

Type-species: ***Coleophora calycotomella*** Stainton, 1869, *Tineina sth. Eur.* : 225, by original designation.

Currently considered to be a junior subjective synonym (**syn. n.**, see pp. 74–75) of *Coleophora* Hübner, 1822.

See also: *Longibacillia* Căpuşe, 1973.

METAPISTA Căpuşe, 1973, *Taxon. Famille Coleophoridae* : 17; 1975, *Fragm. ent.* **11** : 41.

Type-species: ***Coleophora stramentella*** Zeller, 1849, *Linn. ent.* **4** : 198, 274, by original designation and monotypy.

Originally proposed as a subgenus of *Apista* Hübner, [1825]; currently considered to be a junior subjective synonym (**syn. n.**, see pp. 74–75) of *Coleophora* Hübner, 1822.

MULTICOLORIA Căpuşe, 1973, *Taxon. Famille Coleophoridae* : 17; 1975, *Fragm. ent.* **11** : 43.

Type-species: ***Coleophora ditella*** Zeller, 1849, *Linn. ent.* **4** : 198, 247, by original designation and monotypy.

Currently considered to be a junior subjective synonym (**syn. n.**, see pp. 74–75) of *Coleophora* Hübner, 1822.

See also: *Cornulivalvulia* Căpuşe, 1973.

NEUGENVIA Căpuşe, 1973, *Taxon. Famille Coleophoridae* : 10; 1975, *Fragm. ent.* **11** : 54.

Type-species: ***Eupista vlachi*** Toll, 1953, *Mater. Fizjogr. Kraju* **32** : 200, pl. 17, fig. 141, pl. 30, fig. 293, pl. 34, fig. 46, by original designation and monotypy.

Currently considered to be a junior subjective synonym (**syn. n.**, see pp. 74–75) of *Coleophora* Hübner, 1822.

NOSYRISLIA Căpuşe, 1973, *Taxon. Famille Coleophoridae* : 11; 1975, *Fragm. ent.* **11** : 52.

Type-species: ***Coleophora linosyris*** Hering, 1937, *Mitt. zool. Mus. Berl.* **22** : 280, text-figs, by original designation and monotypy.

Originally proposed as a subgenus of *Aureliania* Căpuşe, 1971; currently considered to be a junior subjective synonym (**syn. n.**, see pp. 74–75) of *Coleophora* Hübner, 1822.

ORTHOGRAPHIS Falkovitsh, 1972 (Sattler & Tremewan, 1974 : 206).

See also: ‡*Ortohgraphis* Căpuşe, 1973.

‡***ORTOHGRAPHIS*** Căpuşe, 1973, *Taxon. Famille Coleophoridae* : 17.

Incorrect subsequent spelling of *Orthographis* Falkovitsh, 1972.

OUDEJANSIA Căpuşe, 1973, *Taxon. Famille Coleophoridae* : 20; 1975, *Fragm. ent.* **11** : 21.

Type-species: ***Coleophora obviella*** Rebel, 1914, *Verh. zool.-bot. Ges. Wien* **64** : (178), by original designation and monotypy.

Currently considered to be a junior subjective synonym (**syn. n.**, see pp. 74–75) of *Coleophora* Hübner, 1822.

PARAVALVULIA Căpuşe, 1973, *Taxon. Famille Coleophoridae* : 13; 1975, *Fragm. ent.* **11** : 5.

Type-species: ***Coleophora spiraeella*** Rebel, 1916, *Verh. zool.-bot. Ges. Wien* **66** : (15), by original designation and monotypy.

Currently considered to be a junior subjective synonym (**syn. n.**, see pp. 74–75) of *Coleophora* Hübner, 1822.

PATZAKIA Căpuşe, 1973, *Taxon. Famille Coleophoridae* : 10; 1975, *Fragm. ent.* **11** : 56.

Type-species: ***Coleophora silenella*** Herrich-Schäffer, 1855, *Syst. Bearb. Schmett. Eur.* **5** : 227 [key], 252; 1854, *ibidem* **5**, pl. 113, fig. 920d [as *dianthi*, non-binominal; misidentification], by original designation and monotypy.

Currently considered to be a junior subjective synonym (**syn. n.**, see pp. 74–75) of *Coleophora* Hübner, 1822.

PERYGRA Falkovitsh, 1972 (Sattler & Tremewan, 1974 : 206).

See also: *Luzulina* Falkovitsh, 1972; *Perygridia* Falkovitsh, 1972.

PERYGRIDIA Falkovitsh, 1972 (Sattler & Tremewan, 1974 : 206).

Originally proposed as a subgenus of *Perygra* Falkovitsh, 1972; subsequently considered as a genus (Căpuşe, 1973 : 10); currently considered to be a junior subjective synonym of *Coleophora* Hübner, 1822 (Sattler & Tremewan, 1974 : 206).

POSTVINCULIA Căpuşe, 1973, *Taxon. Famille Coleophoridae* : 13; 1975, *Fragm. ent.* **11** : 4.

Type-species: ***Coleophora lutipennella*** Zeller, 1838, *Isis, Leipzig* **1838** : 713, by original designation and monotypy.

Currently considered to be a junior subjective synonym (**syn. n.**, see pp. 74–75) of *Coleophora* Hübner, 1822.

PROGLASERIA Căpuşe, 1973, *Taxon. Famille Coleophoridae* : 18; 1975, *Fragm. ent.* **11** : 27.

Type-species: ***Coleophora laticostella*** Mann, 1859, *Wien. ent. Monatschr.* **3** : 175, by original designation and monotypy.

Originally proposed as a subgenus of *Glaseria* Căpuşe, 1971; currently considered to be a junior subjective synonym (**syn. n.**, see pp. 74–75) of *Coleophora* Hübner, 1822.

QUADRATIA Căpuşe, 1973, *Taxon. Famille Coleophoridae* : 21; 1975, *Fragm. ent.* **11** : 13.

Type-species: ***Coleophora fuscocuprella*** Herrich-Schäffer, 1854, *Syst. Bearb. Schmett. Eur.* **5** : 220 [key]; 1854, *ibidem* **5**, pl. 113, fig. 920f [as '*Fuscocupr.*', non-binominal]; 1855, *ibidem* **5** : 230, by original designation and monotypy.

Currently considered to be a junior subjective synonym (**syn. n.**, see pp. 74–75) of *Coleophora* Hübner, 1822.

RHAMNIA Căpuşe, 1973, *Taxon. Famille Coleophoridae* : 21; 1975, *Fragm. ent.* **11** : 18.

Type-species: ***Coleophora ahenella*** Heinemann, [1876], *Schmett. Dtl. Schweiz* (2) **2** (2) : 546, by original designation and monotypy.

Currently considered to be a junior subjective synonym (**syn. n.**, see pp. 74–75) of *Coleophora* Hübner, 1822.

SACCULIA Căpuşe, 1973, *Taxon. Famille Coleophoridae* : 13; 1975, *Fragm. ent.* **11** : 7.

Type-species: ***Coleophora excellens*** Toll, 1952, *Bull. Soc. ent. Mulhouse* **1952** : 20, pl. 1, fig. 6, by original designation and monotypy.

Currently considered to be a junior subjective synonym (**syn. n.**, see pp. 74–75) of *Coleophora* Hübner, 1822.

SCLERIDUCTIA Căpuşe, 1973, *Taxon. Famille Coleophoridae* : 20; 1975, *Fragm. ent.* **11** : 28.

Type-species: ***Coleophora ochripennella*** Zeller, 1849, *Linn. ent.* **4** : 200, 408, by original designation and monotypy.

Currently considered to be a junior subjective synonym (**syn. n.**, see pp. 74–75) of *Coleophora* Hübner, 1822.

TOLLSIA Căpuşe, 1973, *Taxon. Famille Coleophoridae* : 21; 1975, *Fragm. ent.* **11** : 15.

Type-species: ***Coleophora hornigi*** Toll, 1952, *Bull. Soc. ent. Mulhouse* **1952** : 18, pl. 1, fig. 3, by original designation and monotypy.

Currently considered to be a junior subjective synonym (**syn. n.**, see pp. 74–75) of *Coleophora* Hübner, 1822.

C. hornigi Toll, 1952, is currently considered to be a junior subjective synonym of *Phalaena* (*Tinea*) *violacea* Ström, 1783, *Nye Saml. K. dansk. Vid. Selsk. Skr.* **2** : 88 (Karsholt & Nielsen, 1976*b* : 245).

TUBERCULIA Căpuşe, 1973, *Taxon. Famille Coleophoridae* : 17; 1975, *Fragm. ent.* **11** : 9.

Type-species: ***Coleophora albitarsella*** Zeller, 1849, *Linn. ent.* **4** : 200, 378, by original designation and monotypy.

Currently considered to be a junior subjective synonym (**syn. n.**, see pp. 74–75) of *Coleophora* Hübner, 1822.

ULNA Căpuşe, 1973, *Taxon. Famille Coleophoridae* : 9; 1975, *Fragm. ent.* **11** : 58.

Type-species: *Coleophora saponariella* Heeger, 1848, *Isis, Leipzig* **1848** : 342, pl. 6, figs A–N, by original designation and monotypy.

Currently considered to be a junior subjective synonym (**syn. n.**, see pp. 74–75) of *Coleophora* Hübner, 1822.

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A catalogue of the type-specimens of the Scarabaeinae (Scarabaeidae) and the smaller lamellicorn families (Coleoptera) described by G. J. Arrow

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Contents

Synopsis

A list is given of all the traceable type-specimens of the species and varieties of Scarabaeidae (Scarabaeinae), Lucanidae, Passalidae, Trogidae, Hybosoridae and Geotrupidae described by G. J. Arrow. The current valid name or generic assignment is given where appropriate. Lectotypes are designated where necessary and where this did not require dissection of the specimens to determine the sex.

Introduction

Gilbert Arrow was well aware of the importance of types and always labelled one specimen (occasionally two) from a series as 'type'. However, the vague or ambiguous nature of his published type designations, when any were made at all, renders most of these 'types', except the uniques, unacceptable as holotypes by today's standards. The remainder of the series, which he called 'co-types', were rarely labelled as such. His normal practice was to label very few, if any, of these additional specimens, whether from the collection of the British Museum (Natural History) or borrowed by him from elsewhere.

In the course of evaluating the type status of Arrow material for routine curation of the collection and for an increasing number of inquiries during the past few years, it was found that the data quoted in his descriptions are rarely comprehensive. The localities given are often a précis of the data labels of the series. Instances have been noted of published data, especially bionomic notes, apparently from oral sources or contemporary correspondence, not appearing on the labels. The name of the 'collector' may be the donor of the collection rather than the actual collector. The number and sex of the specimens are usually omitted. These circumstances, together with the fact that a considerable number of syntypes and paratypes must have been given away or exchanged without record, make it impossible in many cases to be certain that the whole of the series is accounted for. This paper, containing details of the type-material of 266 taxa, is the second of a series (cf. Bacchus, 1974) which will catalogue all the traceable type-specimens of species described by G. J. Arrow. Of the total of about 1800 species described

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by Arrow, approximately 760 Scarabaeidae and 650 species of 21 other families remain to be catalogued.

Without access to the collection, museum registers of donations, various journals and lists available only in the museum libraries, and some knowledge of the history of the collection and of the vagaries of Arrow's method, accurate and consistent collation of his type-series is virtually impossible.

All specimens are in the British Museum (Natural History) except where otherwise stated. The original genus of every species is given in parentheses after the specific name, and the current valid name, when it differs from the original, is given at the end of the entry. The number and sex of the original series are given in square brackets whenever possible. The data quoted are not verbatim but have been rationalized for the sake of clarity, brevity and convenience to users. Where possible the present name of the country of origin is used and all available data arranged in a standard form. The museum registration numbers have been omitted as they are of no use without the relevant registers.

The specimens labelled by Arrow as 'types' have, until now, all been regarded as holotypes and all bore the round, red-bordered labels in use in this museum. Where lectotypes are designated they will, except where otherwise stated, be these specimens. Normally when both male and female 'types' were so-labelled by Arrow the male is designated lectotype. In some of the genera included in this catalogue it is not possible to sex accurately the specimens without dissection. In most of these instances lectotypes have not been designated as it is considered that such dissection and subsequent lectotype designation are better left for specialist workers in the future. In the few cases where it was considered expedient to designate lectotypes of unknown sex the reasons for the decision are given in the text.

Every specimen catalogued in this paper will have a round label edged in red (holotype), yellow (paratype), purple (lectotype) or blue (paralectotype or syntype) as appropriate and a label with the name of the taxon written by the cataloguer and with his name printed below.

All cases where Arrow gave details of material in other collections were investigated and much useful information received. Although in some instances the specimens could not be found (and are noted as missing in the catalogue), it is probable that, partly because of Arrow's habit of not labelling many specimens and partly because of the considerable time such searches can take, many of these specimens will eventually be found.

No information is available about material in the Colombo Museum.

Abbreviations

ANIC	Australian National Insect Collection, Canberra.
BMNH	British Museum (Natural History), London.
BPBM	Bernice P. Bishop Museum, Honolulu.
FRI	Forest Research Institute, Dehra Dun.
IP	Institut für Pflanzenschutzforschung, Eberswalde.
IRSNB	Institut Royal des Sciences Naturelles de Belgique, Brussels.
MCSN	Museo Civico di Storia Naturale, Genoa.
MHNH	Muséum National d'Histoire Naturelle, Paris.
MNHU	Museum für Naturkunde der Humboldt Universität, Berlin.
MZUSP	Museu de Zoologia da Universidade de São Paulo, São Paulo.
SMT	Staatliches Museum für Tierkunde, Dresden.
ZSI	Zoological Survey of India, Calcutta.

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I am indebted to Dr C. Costa, Dr R. Damoiseau, Mons. A. Descarpentries, Dr Swaraj Ghai, Dr R. Hertel, Dr F. Hieke, Dr R. Krause, Mons. J. P. Lacroix, Dr H. Lyr, Dr N. C. Pant, Dr R. Poggi, Dr P. Singh, Dr T. Sen Gupta, Dr E. Tortonese and Dr M. Uhlig for searching their collections, providing data and lending specimens. I also thank Mr R. D. Pope for his helpful advice and Miss V. Dick for preparing the index of species described by Gilbert Arrow on which this catalogue is based.

Catalogue of the type-specimens described by G. J. Arrow

SCARABAEINAE

abreui **(*Onthophagus*)**, 1931*b* : 239. LECTOTYPE ♂, INDIA: Betul District, Dharakoh, 2600 ft, 25.iv.1926 (*E. A. d'Abreu*); here designated.

Paralectotypes. INDIA: 1 ♂, same data as lectotype; 1 ♂, 1 ♀, same data as lectotype but 23.iv.1926; 1 ♂, Nagpur District, Pench Valley, Sylari, 1900 ft, 26.iv.1929 (*E. A. d'Abreu*); 1 ♀ Malabar (*Doherty*); 1 [sex unknown], Haldwani, Chakrata, ex dung, 4.v.1930 (*B. M. Bhatia*) (FRI, Dehra Dun).

acuticollis **(*Onthophagus*)**, 1931*b* : 237. LECTOTYPE ♂, INDIA: Chikkaballapura (*T. V. Campbell*); here designated.

Paralectotypes. INDIA: 1 ♀, Cape Comorin, 1888 (*R. P. Castets*).

[Specimen(s) from Madura (*T. V. Campbell*) missing.]

Current valid name: *Onthophagus amphioxus* Arrow (Arrow, 1933*b* : 421).

affinis (Arrow) var. ***capricornis*** **(*Liatongus*)**, see *capricornis*.

affinis **(*Oniticellus*)**, 1908 : 181. LECTOTYPE ♂, BURMA: Tavoy; here designated.

Paralectotypes. INDIA: 1 ♂, Manipur. THAILAND: 2 ♂, 1 ♀, Renong (*Doherty*).

Current valid name: *Liatongus affinis* (Arrow) (Arrow, 1931*b* : 368).

agaricophilus **(*Onthophagus*)**, 1931*b* : 333. LECTOTYPE ♂, INDIA: Kumaon, W. Almora Div., vi.1917 (*H. G. C*[*hampion*]); here designated.

Paralectotypes. INDIA: 1 ♀, same data as lectotype but viii.1917; 1 ♂, same data as lectotype but ix.1920; 1 ♀, Kumaon, C. Almora Div (*H. G. C*[*hampion*]); 1 ♀, Kumaon, Ranikhet Div, on *Agaric*, vi.1921 (*H. G. C*[*hampion*]); 1 ♂, Ranikhet, vi–viii.1916 (*H. G. C*[*hampion*]); 1 [sex unknown], Mussoorie, 600–700 ft, ix.1921 (*Col. Harcourt*) (FRI, Dehra Dun).

amphinasus **(*Onthophagus*)**, 1931*b* : 195. LECTOTYPE ♂, INDIA: Nilgiri Hills (*H. L. Andrewes*); here designated.

Paralectotypes. INDIA: 1 ♂, 3 ♀, same data as lectotype; 1 ♂, same data as lectotype but 4000 ft, vii.1908; 1 ♀, Nilgiri Hills (*A. K. W. Downing*); 1 [sex unknown], N. Kanara, Talewadi, nr Castle Rock, 3.xi.1916 (*S. Kemp*) (ZSI, Calcutta).

andamanus **(*Paraphytus*)**, 1931*b* : 419. Holotype ('probably a ♂'), ANDAMAN ISLANDS (*Roepstorff*).

andrewesi **(*Onthophagus*)**, 1931*b* : 324. LECTOTYPE ♂, INDIA: Nilgiri Hills (*A. K. W. Downing*); here designated.

Paralectotypes. INDIA: 3 ♂, 1 ♀, Nilgiri Hills (*H. L. Andrewes*); 4 ♂, 1 ♀, Kanara; 3 ♂, 2 ♀, Madras, Anamalai Hills, 2400 ft, 6.v.1930 (*J. C. M. Gardner*).

angolensis **(*Coptorrhina*)**, 1906 : 129. LECTOTYPE ♂, ANGOLA; here designated.

Paralectotypes. ANGOLA: 2 ♂.

[Arrow's '♀' was the small male here designated as a paralectotype. The orange labels on all the specimens refer to the register entry 1876-28 where the rest of the data can be found.]

angusticornis **(*Copris*)**, 1933*b* : 427. Holotype ♂, VIETNAM: Tonkin, Chapa, 25.iv.1918 (*Jeanvoine*).

antillarum **(*Onthophagus*)**, 1903 : 510. LECTOTYPE ♂, ST VINCENT: windward side (*H. H. Smith*); here designated.

Paralectotypes. ST VINCENT: 2 ♂, 2 ♀ (*H. H. Smith*); 1 ♀, South End (*H. H. Smith*). GRENADA: 1 ♀, windward side, Mount Gay Estate (*H. H. Smith*); 1 ♀, windward side, Balthazar (*H. H. Smith*); 1 ♀, no other data.

araneolus **(*Sisyphus*)**, 1927*a* : 464 [original series: 2 ♂]. LECTOTYPE ♂, INDIA: Nilgiri Hills, Gudalur, v.1930 (*E. E. Green*); here designated.

Paralectotype. INDIA: 1 ♂ same data as lectotype.

arboreus **(*Onthophagus*)**, 1931*b* : 225. LECTOTYPE ♂, INDIA: Bihar, Pusa, on grass, 28.vii.1922 (*Ram*[rest illegible]); here designated.

Paralectotypes. INDIA: 1 ♀, Bihar, Pusa, 14.ix.1912 (*R.M.P.*); 1 ♂, Dehra Dun, New Forest, 27.ii.1929, on sand (*J. C. M. Gardner*).

[Specimens from INDIA: Sagar, xi; Pusa, viii, missing.]

argentinum **(*Pedarium*)**, 1913*a* : 459. Syntypes, ARGENTINA: 4 ex., Rio Salado, Gran Chaco (*E. Wagner*); 3 ex., Rio Salado, Icano (*E. Wagner*).

assamensis **(*Panelus*)**, 1907*c* : 417 [original series: 3]. Syntypes, INDIA: 2 ex., Assam, Patkai Mts (*Doherty*); 1 ex., Assam, Sudiya (*Doherty*).

***aviculus* (*Onthophagus*)**, 1931*b* : 179. LECTOTYPE ♂, INDIA: Bengal, Darjeeling, Singla, 1500 ft, vi; here designated.

Paralectotypes. INDIA: 4 ♂, 4 ♀ (BMNH, London), 1 [sex unknown] (ZSI, Calcutta), same data as lectotype; 1 ♀, Darjeeling, Tukvar (*E. A. Moller*). BURMA: 3 ♂, 2 ♀, Putao Dist., Sumparbum, vi–vii (*Mrs B. Fischer*).

[Specimen(s) Darjeeling, Tinta Valley, 700 ft, ix (*J. C. M. Gardner*) missing.]

Current valid name: *Onthophagus anguliceps* Boucomont (Arrow, 1933*b* : 421).

***avocetta* (*Onthophagus*)**, 1933*b* : 421 [proposed by Arrow as replacement name for *Onthophagus anguliceps* Boucomont sensu Arrow (1931*b* : 178)]. LECTOTYPE ♂, INDIA: Assam, Garo Hills above Tura, 3500 ft, 15.vii–30.viii.1917 (*S. Kemp*); here designated.

Paralectotypes. INDIA: 3 ♀, same data as lectotype; 1 [sex unknown], same data as lectotype but ix.1917 (*Mrs Kemp*). BURMA: 1 ♂, Karen Hills, Cheba, 900–1100 m, v–xii.1888 (*L. Fea*).

***beesoni* (*Onthophagus*)**, 1931*b* : 319. LECTOTYPE ♂, INDIA: Kumaon, Haldwani Dist. (*H. G. Champion*); here designated.

Paralectotypes. INDIA: 2 ♂ (BMNH, London); 1 [sex unknown] (FRI, Dehra Dun); 2 ♂ Jhaira Range, Dehra Dun, 6.xi.1924 (*C. F. C. Beeson*); 1 ♂, Jhaira, Dehra Dun, ex dung, 14.ii.1929 (*J. C. M. Gardner*).

[Specimen(s) from INDIA: Bengal, Buxar Duars, v (*D. Nowrojee*) missing.]

biharensis*, *Gymnopleurus, 1931*b* : 62. LECTOTYPE ♂, INDIA: Chapra (*Mackenzie*); here designated.

Paralectotypes. INDIA: 1 ♂, 2 ♀, same data as lectotype; 1 ♂, Bengal, Chapra.

[Specimens in the Pusa collection (now Indian Agricultural Research Institute, New Delhi) missing.]

***bisectus*, (*Onthophagus*)**, 1931*b* : 201. LECTOTYPE ♂, INDIA: S. India; here designated.

Paralectotypes. INDIA: 1 ♀, same data as lectotype; 1 ♂, Malabar; 2 ♂, 3 ♀, Nilgiri Hills (*A. K. W. Downing*).

[Specimen(s) from INDIA: Snowdon Peak, 8000 ft, ix (*Y. R. Rao*) missing.]

***bombayensis* (*Gymnopleurus*)**, 1931*b* : 65 [original series: 6]. LECTOTYPE ♂, no locality label, presented by Walter Elliot Esq.; here designated.

Paralectotypes. 1 ♂, same data as lectotype; 1 ♂, 'Quetta Museum'. PAKISTAN: 1 ♀, Baluchistan, 500–800 ft, 26.vii–6.viii.1929 (*J. W. Evans*). INDIA: 1 ♀, Belgaum, Bombay; 1 ♀, Ind. Cent.

***brachialis* (*Uroxys*)**, 1933*a* : 393. Holotype ♂, COLUMBIA: Pichinde, 5000 ft, xi.1891 (*W. Rosenberg*).

***brevicollis* (*Onthophagus*)**, 1907*c* : 422. LECTOTYPE ♂, INDIA: Nilgiri Hills; here designated.

Paralectotypes. INDIA: 1 ♂, 1 ♀, same data as lectotype; 1 ♂, 1 ♀, same data as lectotype but (*G. F. Hampson*); 2 ♂, 2 ♀, same data as lectotype but (*H. L. Andrewes*); 1 ♂, Belgaum, Bombay; 1 ♀, Malabar; 1 ♀, South India.

***bronzeus* (*Onthophagus*)**, 1907*c* : 429. LECTOTYPE ♂, INDIA: S. India; here designated.

Paralectotypes. INDIA: 1 ♀, Nilgiri Hills (*G. F. Hampson*); 1 ♀, S. India, Kanara; 1 ♀, Malabar.

***brutus* (*Onthophagus*)**, 1931*b* : 215. LECTOTYPE ♂, INDIA: Bengal, Sarda (*F. W. C[hampion]*).

Paralectotype. BURMA: 1 ♀, Carin Cheba, 900–1100 m, v–xii.1888 (*L. Fea*).

***bucki* (*Zonocopris*)**, 1932 : 223. Syntypes, BRAZIL: 1 ex., Porto Alegre, Rio Grande do Sul, x.1931 (*P. Buck*); 1 ex., as previous but iv.1931; 6, as previous but dates unknown (MZUSP, São Paulo).

[Although Arrow does not give the precise number of specimens seen by him he does note that there were many examples and that 12 specimens were found inside one snail shell.]

***buffalo* (*Onthophagus*)**, 1907*c* : 437. LECTOTYPE ♂, JAVA: here designated.

Paralectotypes. 1 ♂, 4 ♀, same data as lectotype. BORNEO: 1 ♀, Labuan; 1 ♂, 1 ♀, Borneo [rest of label illegible].

***bufo* (*Onthophagus*)**, 1907*c* : 420. LECTOTYPE ♂, PAKISTAN: Bannu (*Dr Pennell*); here designated.

Paralectotypes. PAKISTAN: 6 ♂, 6 ♀, same data as lectotype; 1 ♂, 2 ♀, same data as lectotype but no collector. INDIA: 1 ♀, Gwalior.

***bufulus* (*Onthophagus*)**, 1941 : 51. Holotype ♂, NEW GUINEA: Papua, Mafulu, 4000 ft, i.1934 (*L. E. Cheesman*).

***calcaratus* (*Pinotus*)**, 1913*a* : 457. Holotype ♂, BRAZIL: Rio Madeira, Madeira-Mamore R[ail] R[oad] Co., Camp 41 (*Mann & Baker*).

***callosipes* (*Sisyphus*)**, 1909*a* : 517. LECTOTYPE ♂, MOZAMBIQUE: Nyassa (*Simons*); here designated [Arrow gives this locality as British Central Africa, Nyassaland (Malawi), apparently not realizing that part of L. Nyasa is, in fact, in Mozambique].

Paralectotypes. MOZAMBIQUE: 1 ♂, same data as lectotype; 1 ♂, 1 ♀, 'Nyassa' [it is not possible to assign these specimens to the Mozambique or the Malawi part of 'Nyassa']. RHODESIA: 1 ♀, Mashonaland, Mt Chirinda, xi.1901 (*G. A. K. Marshall*). TANZANIA: 1 ♂, Massai (sic). ZAIRE: 1 ♂, 1 ♀, 150–200 mls W. of Kambove, 3500–4500 ft, 18.x.1907.

***cancer* (*Mnematium*)**, 1919 : 434. Holotype ♂, no locality label, Nevinson Collection.

capricornis* (*Liatongus affinis (Arrow) var.), 1931*b* : 368 [original series: 4 ♂, unspecified number of ♀]. LECTOTYPE ♂, BURMA: Pegu, Palon, viii–x.1887 (*L. Fea*); here designated.

Paralectotype. BURMA: 1 ♂, Tharawaddy (*G. Q. Corbett*).

Current valid name: *Liatongus capricornis* Arrow (Janssens, 1953, *Explor. Parc natn. Upemba Miss. G. F. de Witte* **11** : 96).

***caucanus* (*Uroxys*)**, 1933*a* : 394. LECTOTYPE ♂, COLOMBIA: Cauca; here designated.

Paralectotypes. COLOMBIA: 1 ♂, 2 ♀, same data as lectotype.

***cheesmanae* (*Onthophagus*)**, 1941 : 52. LECTOTYPE ♂, NEW GUINEA: Papua, Kokoda, 1300 ft, ix.1933 (*L. E. Cheesman*); here designated.

***chrysurus* (*Onthophagus*)**, 1931*b* : 211. LECTOTYPE ♂, INDIA: Chachar, Haflong, 15.v.1925 (*G. D. Bhasin*); here designated.

[This specimen has been designated lectotype because it is uncertain that it is unique.]

***cingalense* (*Phacocosma*)** 1931*b* : 357. Holotype [sex unknown], SRI LANKA: Ohiya, 6500 ft, 9.iv.1928.

***circulifer* (*Onthophagus*)**, 1931*b* : 274. LECTOTYPE ♂, INDIA: Dehra Dun, 7.vii.1925 (*C. F. C. Beeson*); here designated.

Paralectotypes. INDIA: 1 ♀, Darj[eeling], Soom, 400–500 ft, 8.vii.1914; 1 ♂, Bengal, Darjeeling, Singla, 1500 ft, vi; 1 ♀, Siwalik Hills, Mohand Rau, 23.ix.1921 (*Dr Cameron*); 1 ♀, Jummu Prov, Chenab V, Ramban, 2600 ft, 8.v.1928 (*C. F. C. Beeson*); 4 ♂, 2 ♀, Sikkim, Pedong, 6000 ft, 28.iii.1924 (*Maj. R. W. G. Hingston*). BURMA: 1 ♀ (BMNH, London); ? number and sex (FRI, Dehra Dun); Chittagong H[ill] T[racts], Sitaphar R, 5–10.v.1925 (*C. F. C. Beeson*).

In FRI, Dehra Dun, there are also specimens of unknown number and sex from INDIA: Assam, Shillong (*C. F. C. Beeson*); Jhaira Range, Dehra Dun, 6.xi.1925 (*C. F. C. Beeson*).

[Specimens from INDIA: Khinsi Hills, Nagpur, 1500 ft, ix (*E. A. d'Abreu*); Darjeeling District, Lord Carmichael's collector, missing.]

***coeruleicollis* (*Onthophagus*)**, 1907*c* : 430. LECTOTYPE ♀, INDIA: Dhawar; here designated.

Paralectotypes. INDIA: 1 ♂, 1 ♀, Belgaum, Bombay; 1 ♀, India.

***coorgensis* (*Onthophagus*)**, 1931*b* : 202. LECTOTYPE ♂, INDIA: Nilgiri Hills (*H. L. Andrewes*); here designated.

Paralectotypes. INDIA: 5 ♂, 8 ♀, same data as lectotype.

[Specimen(s) from INDIA: Malabar Dist., Sappal, Palghat, 1700 ft, v (*J. C. M. Gardner*) missing.]

***cristatum* (*Trichillum*)**, 1931*a* : 610 ['taken in considerable numbers by Dr. O'haus']. Syntypes, ECUADOR: 1 ex., Mahader Stadt, Loja, 2200 m (*F. O'Haus*); 1 ex., Loja, 1.x.1905 (*F. O'Haus*); 1 ex., Piscobamba (*F. Witt*).

***cryptops* (*Pedarium*)**, 1913*a* : 458. Syntypes, BRAZIL: 2 ex., Goyaz Prov, Jatahy; 1 ex., Natal (*W. M. Mann*).

[One specimen, BRAZIL: Natal (*W. M. Mann*) missing.]

***cupreiceps* (*Onthophagus*)**, 1907*c* : 427. LECTOTYPE ♂, INDIA: Sikkim, Teesta Valley, Tungu, 1300–1400 ft, 1–15.vii.1903; here designated.

Paralectotypes. INDIA: 1 ♂, 3 ♀, same data as lectotype; 1 ♂, 2 ♀, Khamba Jong, 1500–1600 ft, 15–30.vii.1903.

***digitatus* (*Onthophagus*)**, 1931*b* : 177. LECTOTYPE ♂, INDIA: 'Ind. bor.'; here designated.

Paralectotypes. INDIA: 1 ♀, same data as lectotype; 1 ♂, Sikkim (MNHN, Paris).

***draco* (*Copris*)**, 1906 : 127. LECTOTYPE ♂, ANGOLA: Bihe; here designated.

Paralectotypes. ANGOLA: 2 ♀, same data as lectotype.

***delicatus* (*Copris*)**, 1931*b* : 117 [original series: 2]. LECTOTYPE ♂, INDIA: Mishmi Hills, 28°5′ N, 96°15′ E, 2000 ft, 12.iii.1928; here designated.

Paralectotype. INDIA: 1 ♀, Bengal, Darjeeling, Lopchu, 5000 ft, 24.ix.1929 (*J. C. M. Gardner*).

***dynastoides* (*Onthophagus*)**, 1931*b* : 182. Holotype ♂, INDIA: 'Ind. bor.'.

***egregius* (*Onthophagus*)**, 1907*c* : 438. LECTOTYPE ♂, BORNEO: Pontianak, 1893; here designated.

Paralectotypes. BORNEO: 1 ♂, 1 ♀ [not ♂] (BMNH, London), 1 ♀ [not ♂] (MNHN, Paris), same data as lectotype but 1898; 1 ♀ [not ♂] (BMNH, London), 1 ♀ [not ♂] (MNHN, Paris), same data as lectotype but 1900; 1 ♀ (BMNH, London), 1 ♀ (MNHN, Paris) [both described by Arrow as the female of *egregius*], same data as lectotype but 1898.

[The specimens described by Arrow as the female of *Onthophagus egregius* are *Onthophagus aurifex* Harold (Balthasar, 1963, *Monographie der Scarabaeidae und Aphodiidae der Palaearktischen und Orientalischen Region* **2** : 340).]

***elongatus* (*Gyronotus*)**, 1933*b* : 429. LECTOTYPE ♂, SOUTH AFRICA: Natal, N. Zululand; here designated.

Paralectotypes. SOUTH AFRICA: 1 ♂, 2 ♀, same data as lectotype.

Current valid name: *Gyronotus dispar* Felsche (Janssens, 1938, *Expl. Parc natn. Albert Miss. G. F. de Witte* **21** : 16).

***ephippiatus* (*Deronitis*)**, 1933*b* : 422. Holotype ♂, UGANDA: Kasinga Channel, Katunguru, 1931 (*Dr E. B. Worthington*).

***ephippioderus* (*Onthophagus*)**, 1907*c* : 425. LECTOTYPE ♂, INDIA: Bangalore; here designated.

Paralectotypes. INDIA: 5 ♂, 6♀, same data as lectotype; 5 ♂, 3 ♀, Mysore; 2 ♂, Nilgiri Hills (*G. F. Hampson*); 4 ♂, 9 ♀, Nilgiri Hills; 1 ♂, 1 ♀, Belgaum, Bombay; 1 ♂, 1 ♀, Belgaum; 2 ♂, 3 ♀, Kanara.

***excavatus* (*Onitis*)**, 1931*b* : 390. LECTOTYPE ♂, BURMA: Tenasserim; here designated.

***exquisitus* (*Onthophagus*)**, 1931*b* : 225. LECTOTYPE ♂, INDIA: Dehra Dun, 14.vii.1922 (*S. N. Chatterjee*); here designated.

Paralectotype. INDIA: Bengal, Darjeeling, Singla, vi.

***felix* (*Canthon*)**, 1913*a* : 456. LECTOTYPE ♂, BRAZIL: Santarem; here designated.

Paralectotypes. BRAZIL: 1 ♀, same data as lectotype; 1 ♂, 3 ♀, Pernambuco (*A. Fry*); 1 ♂, Para; 1 ♂, Ceara, Baturite Mts (*W. M. Mann*).

[Specimens from BRAZIL: Rio de Janeiro; Ceara, Maranguape Mts missing.]

***felix* (*Onthophagus*)**, 1931*b* : 257. Holotype ♂, INDIA: Chota Nagpur, Nowatoli, x.1897 (*R. P. Cardon*).

Paratypes. INDIA: 4 ♀, same data as holotype.

***fossor* (*Onthophagus*)**, 1931*b* : 300. Holotype ♂, INDIA: Sikkim, Tsuntang, 6000 ft, 24.iv.1924 (*Maj. R. W. G. Hingston*).

Paratypes. INDIA: 1 ♂ 3 ♀, same data as holotype.

***frugivorus* (*Onthophagus*)**, 1931*b* : 336. LECTOTYPE ♂, INDIA: Assam, Garo Hills above Tura, 3500–3900 ft, 15.vii–30.viii.1917 (*S. Kemp*); here designated.

Paralectotypes. INDIA: 1 ♀, same data as lectotype; 4 [sex unknown], same data as lectotype but 15–25.vii.1917, in rotten fruit (ZSI, Calcutta); 1 ♀, same data as lectotype but 3900 ft, 15.vii–15.viii.1917; 2 ♂, 1 ♀, as previous but in rotten fruit.

***fulgens* (*Pedarius*)**, 1913*a* : 458 [original series: 2]. Syntypes, ARGENTINA: 2 ex., Gran Chaco, Rio Salado (*E. Wagner*).

***furcicollis* (*Onthophagus*)**, 1931*b* : 276. LECTOTYPE ♂, INDIA: Gopaldhara, Darjeeling, 3440–4720 ft, 19.ix.1916, on ground (*H. Stevens*); here designated.

Paralectotype. INDIA: 1 ex., Dehra Dun, Nun Nadi, ex carrion, 17.vii.1921 (*Dr Cameron*).

***gallinus* (*Caccobius*)**, 1907*c* : 424. LECTOTYPE ♂, INDIA: Nilgiri Hills (*H. L. Andrewes*); here designated.

Paralectotypes. INDIA: 16 ♂, 17 ♀, same data as lectotype; 1 ♀, same data as lectotype but 600 ft; 7 ♂, 10 ♀, Nilgiri Hills; 1 ♀, Belgaum; 2 ♀, Belgaum, Bombay.

***gazanus* (*Onitis*)**, 1909*a* : 519. LECTOTYPE ♂, RHODESIA: Mashonaland, Chirinda Forest, x.1908 (*G. A. K. Marshall*); here designated.

Paralectotypes. RHODESIA: 7 ♂, 4 ♀, same data as lectotype.

[By modern definition, Chirinda Forest is not in Mashonaland. It is 110 miles south of Umtali.]

***gazanus* (*Sisyphus*)**, 1909*a* : 518. LECTOTYPE ♂, RHODESIA: Mashonaland, Chirinda, x.1905 (*G. A. K. Marshall*); here designated.

Paralectotypes. RHODESIA: 1 ♂, Mashonaland, Mt Chirinda, xi–xii.1901 (*G. A. K. Marshall*); 1 ♂, as previous but xii.1905; 1 ♀, Gazaland, Chirinda, xii.1901 (*G. A. K. Marshall*). MOZAMBIQUE: 2 ♂, Lower Buzi River, Chibababa, xii.1906 (*C. F. M. Swynnerton*).

[The female paralectotype was re-determined as *Sisyphus ocellatus* Reiche by E. Haaf. There is some evidence that the words 'co-type' have been cut from the bottom of Arrow's determination label.]

***geminatus* (*Pinotus*)**, 1913*a* : 457 [original series: 2]. LECTOTYPE ♂, BRAZIL: Natal (*W. M. Mann*); here designated.

***gilleti* (*Pseudopedaria*)**, 1933*b* : 424. LECTOTYPE ♂, RHODESIA: Kashitu, N. of Broken Hill, ii.1915 (*H. C. Dollman*); here designated.

Paralectotypes. RHODESIA: 2 ♀, same data as lectotype but xii.1914; 4 ♀, same data as lectotype but i.1915; 1 ♀, same data as lectotype but iv.1915. TANZANIA: 2 ♀.

***gilleti* (*Synapsis*)**, 1931*b* : 83. LECTOTYPE ♀, INDIA: Bengal, Darjeeling, Singla, 1500 ft, vi; here designated.

Paralectotype. INDIA: 1 ♂ (IRSNB, Brussels).

***gladiator* (*Copris*)**, 1933*b* : 425. Holotype ♂, BURMA: Adung Valley, 6000 ft, 11.v.1931 (*Lord Cranbrook*).

***gladiator* (*Onthophagus*)**, 1907*c* : 418 [original series: 2]. LECTOTYPE ♂, INDIA: here designated.

Paralectotype. INDIA: 1 ♂, same data as lectotype.

***gladiator* (*Sisyphus*)**, 1927*a* : 462. LECTOTYPE ♂, CAMEROUN: Ngpwdar; here designated.

Paralectotypes. CAMEROUN: 4 ♂, 4 ♀, same data as lectotype; 1 ♀, Tazada.

[Specimen(s) from CAMEROUN: Betare missing.]

***globosus* (*Parachorius*)**, 1931*b* : 360. Holotype ♀ ?, INDIA: Darjeeling, 5000 ft, 14.iii.1924 (*Maj. R. W. G. Hingston*).

***gorgon* (*Uroxys*)**, 1933*a* : 397 [original series: 'more than a dozen']. LECTOTYPE ♂, COLOMBIA: Gorgona Island, in hair of three-toed sloth, 3.vii.1924; here designated.

Paralectotypes. COLOMBIA: 2 ♂, 6 ♀, same data as lectotype; 1 ♀, same data as lectotype but (*H. J. K.*).

***gratus* (*Onthophagus*)**, 1931*b* : 212. LECTOTYPE ♂, INDIA: 'Ind. bor.'; here designated.

Paralectotypes. INDIA: 1 ♀ (BMNH, London), 1 [sex unknown], (ZSI, Calcutta), Ranchi (*W. H. Irvine*); 1 ♂, Ranchi.

***griseosetosus* (*Onthophagus*)**, 1931*b* : 192. LECTOTYPE ♂, INDIA: South Mysore (*H. L. Andrewes*); here designated.

Paralectotypes. INDIA: 1 ♂, 2 ♀, same data as lectotype; 2 ♂, Nilgiri Hills (*H. L. Andrewes*); 1 ♂, Kanara; 1 ♂, C[entral] P[rovince], Raigarh R., vii.1927 (*C. F. C. Beeson*).

[Specimen(s) from INDIA: Dehra Dun, vi, missing.]

***gulo* (*Onthophagus*)**, 1931*b* : 164. LECTOTYPE ♂, INDIA: Bombay; here designated.

Paralectotypes. INDIA: 2 ♀, same data as lectotype; 1 ♀, Nagpur (*E. A. D'Abreu*); 1 ♀, Buldana, Purna R, Sagoda, 21.viii.1929 (*N. C. Chatterjee*); 1 ♀, as previous but 7.ix.1929; 1 ♀, as previous but 8.iii.1930; 6 [sex unknown], as previous but 26.vi.1929 [FRI, Dehra Dun]; 1 [sex unknown], as previous but 4–13.x.1921 [FRI, Dehra Dun].

The dates of the paralectotypes in FRI, Dehra Dun, were not listed by Arrow although they are labelled 'Cotypes' and are from the same series as the specimens from the same locality in the BMNH, London. The dates quoted by Arrow are only those of the BMNH specimens and the omission of the data of the FRI specimens is considered to be an accident caused by Arrow's habit of reducing data to an absolute minimum.

***hamaticeps* (*Onthophagus*)**, 1931*b* : 308. LECTOTYPE ♂, INDIA: Siwaliks [hills], Dehra Dun, 24.ix.1922 (*Dr Cameron*); here designated.

Paralectotype. INDIA: 1 ♂, Jhaira Range, Dehra Dun, 6.xi.1924 (*C. F. C. Beeson*).

***hindu* (*Onthophagus*)**, 1931*b* : 289. LECTOTYPE ♂, INDIA: 'India Orient.'; here designated.

Paralectotypes. INDIA: 5 ♀, same data as lectotype. PAKISTAN: 1 ♂, Bannu (*Dr. Pennell*).

[Specimens from INDIA: Nagpur, 1000 ft, viii & ix (*E. A. D'Abreu*) and Bellary Dist., Yemmiganur, viii, missing.]

***hindu* (*Paraphytus*)**, 1913*b* : 193. Holotype ♂, INDIA: Khasia Hills, vii.1894.

Paratypes. INDIA: 2 ♂, same data as holotype; 2 ♀, Upper Rotung, under bark, 6.i.1912 (*Kemp*).

[1 ♂, same data as previous, missing.]

***hingstoni* (*Onthophagus*)**, 1931*b* : 278. LECTOTYPE ♂, INDIA: Sikkim, Lachen, 9000 ft, 26.iv.1924 (*Maj. R. W. G. Hingston*); here designated.

Paralectotypes. INDIA: 1 ♂, same data as lectotype but 8000 ft, 24.iv.1924; 2 ♀, same data as lectotype but 10 000 ft, 25.iv.1924.

[Specimen(s) INDIA: Sikkim, Tsuntang, 7000 ft (*Maj. R. W. G. Hingston*) missing.]

***histeroides* (*Uroxys*)**, 1933*a* : 392. LECTOTYPE ♂, PARAGUAY: here designated. Paralectotypes. PARAGUAY: 2 ♀.

***hookeri* (*Parachorius*)**, 1931*b* : 359. Holotype ♀ ?, INDIA: N. India.

***humeralis* (*Cassolus*)**, 1907*c* : 416. LECTOTYPE ♂, INDIA: Assam, Sudiya (*Doherty*); here designated.
Paralectotypes. INDIA: 1 ♂, 2 ♀, Patkai Mts (*Doherty*); 2 ♀, Valley (*Doherty*).
[One paralectotype, INDIA: Patkai Mts (*Doherty*) lost, empty mount in BMNH, London.]

***hystrix* (*Trichillum*)**, 1931*a* : 609. Syntypes, ARGENTINA: 2 ex., Santa Fé, Rio San Janvier, Estancia la Noria, xii.1911 (*G. E. Bryant*); 1 ex., as previous but 14.xii.1911; 1 ex., as previous but 20.xii.1911; 1 ex., as previous but 23.xii.1911; 1 ex., as previous but 24.xii.1911; 1 ex., as previous but 27.xii.1911; 1 ex., as previous but 3.i.1912.

***indicus* (*Oniticellus*)**, 1908 : 180. LECTOTYPE ♂, INDIA: Nilgiri Hills; here designated.
Paralectotypes. INDIA: 3 ♂, 1 ♀, same data as lectotype; 1 ♂, S. India; 1 ♂, 1 ♀, Anamalais; 1 ♀, Anamalai Hills; 2 ♂, 3 ♀, Malabar.
Current valid name: *Chironitis arrowi* Janssens (Janssens, 1937, *Mém. Mus. r. Hist. nat. Belg.* (2) **11** : 159).

***inermis* (*Caccobius*)**, 1931*b* : 147. LECTOTYPE ♂, INDIA: Fyzabad (*R. W. G. Hingston*); here designated.
Paralectotypes. INDIA: 1 ♂, Nagpur (*E. A. D'Abreu*); 2 ♂, W. Almora, Kumaon (*H. G. C[hampion]*); 1 ♀, Calcutta; 1 ♀, Sikkim, Pedong, 6000 ft, 28.iii.1924 (*R. W. G. Hingston*). SRI LANKA: 1 ♂, Wirawila, 28.vii.1921.

***iyengari* (*Onthophagus*)**, 1931*b* : 323. Holotype ♂, INDIA: Bengal, Rungpur, xi.1924 (*M. O. T. Iyengar*); here designated.
Paratypes. INDIA: 1 ♂, 2 ♀, same data as holotype.

***jucundus* (*Onthophagus*)**, 1931*b* : 188. LECTOTYPE ♂, INDIA: Assam, Manipur (*Doherty*); here designated.
Paralectotype. BURMA: 1 ♀, Momeit [not Momeik] (*Doherty*).

***kanarensis* (*Onthophagus*)**, 1931*b* : 191. LECTOTYPE ♂, INDIA: N. Kanara Dist., Talewadi, nr Castle Rock, 3–10.x.1916 (*S. Kemp*); here designated.
Paralectotype. INDIA: 1 ♀, Kanara.

***kumaonensis* (*Onthophagus*)**, 1931*b* : 272. LECTOTYPE ♂, INDIA: Kumaon, Nainital Div. (*H. G. C[hampion]*); here designated.
Paralectotypes. INDIA: 1 ♂, same data as lectotype; 1 ♀, W. Almora, v–viii.1916 (*H. G. C[hampion]*); 1 ♀, Simla Hills, Theog, 7600 ft, 10.ix.1921 (*S. N. Chatterjee*); 1 ♂, Mussoorie, vii.1926 (*J. C. M. Gardner*); 1 ♀, as previous but vi.1930; 1 ♀, Mussoorie, 6500 ft, 6.vii.1920 (*S. N. Chatterjee*); 1 [sex unknown], Mussoorie, 6000–7000 ft, xi.1921 (*Col. Harcourt*) (FRI, Dehra Dun).

***laborans* (*Onthophagus*)**, 1931*b* : 240. LECTOTYPE ♂, INDIA: Nasik, 31.vii.1911 (*N. B. Kinnear*); here designated.
Paralectotypes. INDIA: 2 ♂, 4 ♀, Chikalda Berars, 3664 ft, 2.xii.1913 (*N. B. Kinnear*); 1 ♂, 3 ♀, Dharwar, x.1909 (*H. Swale*); 2 ♀, as previous but xii.1909; 2 ♀, as previous but 17.i.1910.

***laetum* (*Phacosoma*)**, 1931*b* : 356. Holotype [sex unknown], INDIA: Nilgiri Hills (*H. L. Andrewes*).
Paratypes. INDIA: 4 [sex unknown], same data as holotype.

***laevis* (*Gymnopleurus*)**, 1900 : 23. Holotype ♂, SOMALI REPUBLIC: 'Somaliland', 16.iv–7.viii.1895 or 5.vi–29.x.1897 (*C. V. A. Peel*).
Current valid name: *Garreta nitens* (Olivier) (Janssens, 1940, *Mem. Mus. r. Hist. nat. Belg.* (2) **16** : 32).

laevis Harold var. ***stevensi* (*Onthophagus*)**, see *stevensi*.

***laoticus* (*Sisyphus*)**, 1927*a* : 463. LECTOTYPE ♂, INDO-CHINA: Haut Mekong, Vieng Vien, 24.v.1918 (*R. V. de Salvaza*); here designated.
Paralectotypes. INDO-CHINA: 1 ♂, 2 ♀, same data as lectotype; 1 ♀, Haut Mekong, Vien Vai, 23.v.1918 (*R. V. de Salvaza*).

***lapillus* (*Onthophagus*)**, 1931*b* : 267. LECTOTYPE ♂, INDIA, Sikkim, Pedong, 6000 ft, 28.vii.1924 (*Maj. R. W. G. Hingston*); here designated.
Paralectotypes. INDIA: 2 ♀, same data as lectotype; 1 ♂, 1 ♀, Rungbong Valley, Gopadhara (*H. Stevens*); 1 ♀, Dehra Dun, 18.viii.1915; 1 [sex unknown], Dehra Dun, vi.1918 [FRI, Dehra Dun]; 1 [sex unknown], Dehra Dun, under bark 13.viii.1927 (*S. Badahur*) [FRI, Dehra Dun]; 1 ♂, Mussoorie, vii.1926 (*J. C. M. Gardner*); 1 [sex unknown], Mussoorie, Mackinnon Park, under leaves, 29.viii.1929 (C. F. C. Beeson) [FRI, Dehra Dun]; 1 [sex unknown], Kumaon, Shamkhet, 15.v.1912 [FRI, Dehra Dun]; 1 ♀, Punjab, Simla Hills, Dagshai, 6000 ft, 13.viii.1921 (*O. H. Walters*); 1 ♀, N. India.

***laratinus* (*Onthophagus*)**, 1916 : 494 [original series: 3 ♂, 2 ♀]. Holotype ♂, LARAT I. (Indonesia): (*F. Muir*); here designated.
Paratypes. LARAT I. (Indonesia): 1 ♂, 1 ♀, same data as lectotype.

***latenasutus* (*Onthophagus*)**, 1941 : 50. LECTOTYPE ♂, NEW GUINEA: Papua, Kokoda, 1200 ft, ix.1933 (*L. E. Cheesman*); here designated.
Paralectotypes. NEW GUINEA: 7 ♂, 7 ♀, same data as lectotype; 1 ♂, D[utch] N[ew] Guinea (*Sattelburg*).

***latus* (*Uroxys*)**, 1933*a* : 396. Holotype ♂, BRAZIL: Petropolis, ii.1857 (*H. Clark*).

***lojanus* (*Uroxys*)**, 1933*a* : 395. LECTOTYPE ♂, ECUADOR: Loja Pucara, 8.viii.1905 (*F. Ohaus*); here designated.
Paralectotypes. ECUADOR: 1 ♀, same data as lectotype but 9.viii.1905; 1 ♀, Loja Clavario, 5.viii.1905 (*F. Ohaus*); 1 ♂, as previous but 1.ix.1905; 3 ♂, 3 ♀, Loja (*F. Ohaus*) (IP, Eberswalde).

***madoqua* (*Onthophagus*)**, 1931*c* : 258. Holotype ♂, INDIA: Nilgiri Hills (*H. L. Andrews*).
Paratypes. INDIA: 2 ♂, 2 ♀, same data as holotype.

***manipurensis* (*Onthophagus*)**, 1907*b* : 426. LECTOTYPE ♂, INDIA: Manipur (*Doherty*); here designated.
Paralectotypes. INDIA: 2 ♂, 2 ♀, same data as lectotype.

***manni* (*Canthidium*)**, 1913*a* : 460. LECTOTYPE ♂, BRAZIL: Ceara (*W. M. Mann*); here designated.
Paralectotype. BRAZIL: 1 ♀, same data as lectotype.

***medicus* (*Sisyphus*)**, 1931*b* : 70. Holotype ♂ ?, INDIA: Madras, Anamalai Hills, 2400 ft, 10.v.1930 (*J. C. M. Gardner*).

***metalliceps* (*Onthophagus*)**, 1931*b* : 218. LECTOTYPE ♂, INDIA: Kanara; here designated.
Paralectotype. INDIA: 1 ♀, same data as lectotype.

***minotaurus* (*Onthophagus*)**, 1941 : 53 [original series: 1 ♂, 1 ♀]. Holotype ♂, NEW GUINEA: Papua, Kokoda, 1200 ft, x.1933 (*L. E. Cheesman*).
Paratype. NEW GUINEA: 1 ♀, D[utch] New Guinea, Sattelburg.

***mirandus* (*Onthophagus*)**, 1931*b* : 290. LECTOTYPE ♂, INDIA: W. Almora, Kumaon (*H. G. C*[*hampion*]); here designated.
Paralectotypes. INDIA: 6 ♂, 2 ♀, same data as lectotype; 1 ♂, 2 ♀, Simla, vi. [not vii] 1909 (*H. Chippendale*).

***modestus* (*Oniticellus*)**, 1908 : 182. LECTOTYPE ♂, INDIA: Calicut; here designated.
Paralectotypes. INDIA: 1 ♀ [head and pronotum missing], 7 ♀, same data as lectotype; 1 ♀ Belgaum; 1 ♂, 1 ♀, Belgaum, Bombay; 2 ♂, 2 ♀, Malabar.

***morio* (*Sisyphus*)**, 1909*b* : 93. LECTOTYPE ♂, CHINA: Ai San, 30 mls W. of Chefoo (*M. P. Anderson*); here designated.
Paralectotypes. CHINA: 3 ♀, same data as lectotype; 1 ♀, Shan-hai-Kwan, in mountains, i.1906 (*F. M. Thomson*).
Current valid name; *Sisyphus schaefferi* L. (Haaf, 1955, *Ent. Arb. Mus. Georg. Frey* **6** : 344).

***myrmecophilus* (*Onthophagus*)**, 1907*c* : 431. LECTOTYPE ♂, INDIA: Nilgiri Hills (*H. L. Andrewes*); here designated.
Paralectotypes. INDIA: 4 ♂, 6 ♀, same data as lectotype; 1 ♂, same data as lectotype but 'taken close to nest of *Phidole indica* Mayr whilst I was digging out the nest. Probably lives with the ants'; 6 ♂, 2 ♀, Nilgiri Hills, Barwood Estate, 3500 ft, found with ants in decayed *Ficus* trunk living in galleries of ants (*Phidolegiton* sp., probably *diversus* (Gerdon)), x.1906 (*H. L. Andrewes*).

***nagpurensis* (*Onthophagus*)**, 1931*b* : 342. Holotype ♂, INDIA: Chota Nagpur, x.1897.
Paratypes. INDIA: 2 ♂, 3 ♀, same data as holotype.

***nasalis* (*Onthophagus*)**, 1931*b* : 288. Holotype ♂, INDIA: W. Almora, Kumaon (*H. G. C*[*hampion*]).

***necrophagus* (*Onthophagus*)**, 1931*b* : 196. LECTOTYPE ♂, INDIA: Dehra Dun, Nun Nadi, ex carrion, 17.vii.1921 (*Dr Cameron*); here designated.
Paralectotypes. INDIA: 1 ♂, 1 ♀, Dehra Dun, Jhajra, Sal leaves, 27–29.vi.1912 (*C. N. Chatterjee*).

***nitidicollis* (*Oniticellus*)**, 1908 : 179. Holotype ♂, SARDINIA.

***oculatus* (*Onthophagus*)**, 1931*b* : 168. LECTOTYPE ♂, SRI LANKA: Nilaveli, ix.1914 (*C. F. S. Baker*); here designated.
Paralectotypes. SRI LANKA: 1 ♂, 1 ♀, same data as lectotype. INDIA: 1 ♀, Malabar; 1 ♀, Pondicherry.

***ohausi* (*Trichillum*)**, 1931*a* : 610 [original series: 'considerable numbers']. Syntypes, ECUADOR: 1 ex., Loja Punzara, 7.viii.1905 (*F. Ohaus*); 1 ex., Loja Calvario, 4.viii.1905 (*F. Ohaus*); 1 ex., Loja (*F. Ohaus*); 2 ex., (*F. Ohaus*).

***onthochromus* (*Onthophagus*)**, 1913*a* : 460. LECTOTYPE ♂, BRAZIL: Rio Madeira, Madeira-Mamore R[ail] R[oad] Co. Camp 41 (*Mann & Baker*); here designated.
Paralectotype. BRAZIL: 1 ♀, same data as lectotype.

***orissanus* (*Onthophagus*)**, 1931*b* : 257. LECTOTYPE ♂, INDIA: 'E. Ind.'; here designated.
Paralectotypes. INDIA: 2 ♀, same data as lectotype; 1 ♂, Orissa, Barkul, 0–1000 ft, 1–3.viii.1914 (*Gravely*).

***paliceps* (*Onthophagus*)**, 1931*b* : 287 [original series: 2]. Holotype ♂, INDIA: 'Ind. bor'.
[The paratype was probably from the collection at FRI, Dehra Dun.]

***pantherinus* (*Caccobius*)**, 1931*b* : 154. LECTOTYPE ♂, PAKISTAN: Karachi; here designated.
Paralectotype. INDIA: 1 ♀, Punjab, Multon Div, Gazighat, ex cattle dung, 15.ii.1928 (*B. M. Bhatia*).

***paranense* (*Pedaridium*)**, 1932 : 224 [original series: 4]. Syntypes, BRAZIL: 4 ex., Parana, Castro.

***peninsularis* (*Cassolus*)**, 1907*c* : 437. LECTOTYPE ♂, WEST MALAYSIA: Perak (*Doherty*); here designated.
Paralectotypes. WEST MALAYSIA: 2 ♀, same data as lectotype; 1 ♂, Penang (*Lamb*).

***platalea* (*Onthophagus*)**, 1941 : 49. Holotype ♂, NEW GUINEA: Japen I., R. Manai-Undei, 500 ft, x.1938 (*L. E. Cheesman*).

***porcus* (*Onthophagus*)**, 1931*b* : 325. LECTOTYPE ♂, BANGLADESH: Chittagong H[ill] T[racts], Sitaphar R., 5–10.v.1925 (*C. F. C. Beeson*); here designated.
Paralectotypes. BANGLADESH: 2 ♂ (BMNH, London), 2 ♂ (FRI, Dehra Dun), same data as lectotype.
[The female specimen described by Arrow is missing.]

***prehensilis* (*Macropocopris*)**, 1920 : 436. Holotype ♂, AUSTRALIA: N. Queensland, Kuranda, 19.xi.1909 (*G. E. Bryant*).
Current valid name: *Onthophagus prehensilis* (Arrow) (Matthews, 1972, *Aust. J. Zool.* Suppl. 24 : 42).

***productus* (*Onthophagus*)**, 1907*c* : 423. LECTOTYPE ♂, INDIA: (*Capt. Boys*); here designated.
Paralectotypes. INDIA: 1 ♂; 1 ♂, 'Himalaya O.' (MNHN, Paris); 1 ♀, Sikkim, Chasseurs Indigènes, 1894 (*R. P. Bretandeau*) (MNHN, Paris).

***productus* (*Uroxys*)**, 1933*a* : 389. Holotype ♂, SOUTH AMERICA: 'Amer. aequinoct.'.

***puncticollis* (*Panelus*)**, 1931*b* : 406. Holotype [sex unknown], SRI LANKA: Kandy, vi.1908 (*G. E. Bryant*).
Paratype. SRI LANKA: 1 ex., same data as holotype.

***quadridens* (*Pedaridium*)**, 1932 : 225. Holotype [sex unknown], ARGENTINA: Entre Rios, Santa Elena, 30.i.1912 (*G. E. Bryant*).

***rana* (*Onthophagus*)**, 1931*b* : 268. Holotype ♂, INDIA: Kodai Kanal (*T. V. Campbell*).

***ranunculus* (*Onthophagus*)**, 1913*a* : 461. LECTOTYPE ♂, BRAZIL: Natal (*W. H. Mann*); here designated.
Paralectotypes. BRAZIL: 1 ♂, same data as lectotype; 5 ♀, Ceara, Baturite Mts (*W. H. Mann*); 1 ♂, Para.

***refulgens* (*Onthophagus*)**, 1931*b* : 281. LECTOTYPE ♂, SRI LANKA: Nuwara Eliya, 31.vii.1924; here designated.
Paralectotypes. SRI LANKA: 1 ♂, 1 ♀, same data as lectotype; 1 ♀, Nuwara Eliya, 6234–8000 ft, 8–11.ii.1882 (*G. Lewis*); 2 ♂, 1 ♀, Ohiya, iv.1929. INDIA: 1 ♂, Kodai Kanal (*T. V. Campbell*); 1 ♂, Madura, Shembaganur; 1 ♀, as previous but 1904–5 (*P. de Breuil*).
[Specimens from SRI LANKA: Nuwara Eliya, viii and xii (*G. M. Henry*) missing.]

***regalis* (*Onthophagus*)**, 1907*c* : 431. LECTOTYPE ♂, SRI LANKA: here designated.
Paralectotype. SRI LANKA: 1 ♀, Yerbury.
[Specimen(s) from SRI LANKA: (*E. E. Green*) missing.]

***rhinocerus* (*Liatongus*)**, 1931*b* : 363. LECTOTYPE ♂, INDIA: Kurseong, 4700–5000 ft, 25.vi.1910 (*Annandale*); here designated.
Paralectotype. INDIA: 1 ♂ [not ♀], Himalaya, Simla.

***roberti* (*Pinotus*)**, 1904 : 250 [original series: 2 ♂, 8 ♀]. LECTOTYPE ♂, BRAZIL: Chapada, 2600 ft, xi.1902 (*A. Roberts*); here designated.
Paralectotypes. BRAZIL: 5 ♀, same data as lectotype ; 1 ♂, Para.

***rotundus* (*Pycnopanelus*)**, 1931*b* : 412. Holotype ? ♂, INDIA: Madras.

***rubripennis* (*Onthophagus*)**, 1907*c* : 419. LECTOTYPE ♂, INDIA: Sikkim, environs de Kurseong (*R. P. de Bretandeau*); here designated.

Paralectotypes. INDIA: 1 ♂, 1 ♀ (BMNH, London), 2 ♀ (MNHN, Paris), same data as lectotype; 1 [sex unknown], Kurseong (*R. P. de Bretandeau*) (MNHN, Paris); 1 ♂, Sikkim.

rubripennis Arrow var. ***subcribratus* (*Onthophagus*)**, see *subcribratus*.

***ruficauda* (*Onthophagus*)**, 1931*b* : 295. LECTOTYPE ♂, BURMA: Paungde (*G. Q. Corbett*); here designated.

Paralectotypes. BURMA: 1 ♂, same data as lectotype; 1 ♂, Toungoo (*G. Q. Corbett*); 1 ♀, Tharrawaddy (*G. Q. Corbett*); 3 ♀, Mandalay (*H. L. Andrewes*).

***runicus* (*Drepanocerus*)**, 1909*b* : 93. Holotype ♀, BURMA: Karen Mts, Asciuii Ghecu, 1400–1500 m, iii–iv.1888 (*L. Fea*).

Paratypes. BURMA: 1 ♂ (BMNH), 2 ♂, 1 ♀ (MCSN, Genoa), same data as holotype.

***setosus* (*Panelus*)**, 1931*b* : 406. Holotype [sex unknown], SRI LANKA: Kandy, vi.1905 (*G. E. Bryant*).

***sindensis* (*Gymnopleurus*)**, 1931*b* : 66. Holotype ♀, PAKISTAN: Karachi.

***sladeni* (*Canthidium*)**, 1904 : 249 [original series: 5]. LECTOTYPE ♂, BRAZIL: Chapada, 2600 ft, xi.1902 (*A. Robert*); here designated.

Paralectotypes. BRAZIL: 1 ♂, 2 ♀, same data as lectotype.

***socialis* (*Onthophagus*)**, 1931*b* : 325. LECTOTYPE ♂, INDIA: Nilgiri Hills (*H. L. Andrewes*); here designated.

Paralectotypes. INDIA: 12 ♂, 10 ♀, same data as lectotype ; 1 ♂, Bombay, Belgaum Div., Tavargatti, ex dung, 31.x.1929 (*B. M. Bhatia*).

***solidus* (*Onthophagus*)**, 1931*b* : 265. Holotype ♂, INDIA: Kumaon, Haldwani Dist. (*H. G. Champion*).

Current valid name: *Onthophagus compactus* Arrow (1933*b* : 421).

***sternalis* (*Onthophagus*)**, 1931*b* : 222. LECTOTYPE ♂, INDIA: Berhampore; here designated.

Paralectotypes. INDIA: 1 ♂, 1 ♀, same data as lectotype; 1 ♂, 1 ♀, Fyzabad (*R. W. G. Hingston*).

[Specimens from INDIA: Murshidabad (*E. T. Atkinson*), Bihar, Pusa, vii (*G. Bainbridge-Fletcher*); Chapra (*Mackenzie*); Dehra Dun, x (*G. D. Pant*); Bombay, Surat, vii (*H. Maxwell Lefroy*) missing.]

***stevensi* (*Haroldius*)**, 1931*b* : 416. Holotype [sex unknown], INDIA: Gopaldhara, Darjeeling, 4720–6100 ft, 4.ix.1914 (*H. Stevens*).

stevensi* (*Onthophagus laevis Harold var.), 1931*b* : 172. LECTOTYPE ♂, INDIA: Sikkim, Gopaldhara, Rungbong Valley (*H. Stevens*); here designated.

Paralectotypes. INDIA: 4 ♂, 5 ♀, same data as lectotype.

***striatus* (*Delopleurus*)**, 1931*b* : 411. LECTOTYPE [sex unknown], INDIA: United Prov. Dehra Dun, 2000 ft, vii.1927 (*H. G. Champion*); here designated.

[This specimen has been designated lectotype because it is uncertain that it is unique.]

subcribratus* (*Onthophagus rubripennis Arrow var.), 1907*c* : 420. LECTOTYPE ♂, BURMA: N. Chin Hills; here designated.

Paralectotypes. INDIA: 1 ♀, Khasia Hills; 2 ♂, no locality label (*E. I. C[antor]*). BHUTAN: 1 ♂.

***suillus* (*Onthophagus*)**, 1931*b* : 194. LECTOTYPE ♂, INDIA: South Mysore (*H. L. Andrewes*); here designated.

Paralectotypes. INDIA: 1 ♂, 2 ♀, same data as lectotype.

***surdus* (*Copris*)**, 1931*b* : 132. LECTOTYPE ♂, INDIA: Haldwani, Chakrata, ex dung, 3.v.1930 (*B. M. Bhatia*); here designated.

Paralectotype. INDIA: 1 ♀, Kumaon, Tanakpur (*H. G. C[hampion]*).

***symbioticus* (*Macropocopris*)**, 1920 : 437. Lectotype ♂, AUSTRALIA: N. Queensland, off Wallaby near vent, vii.1919 (*Dr T. F. Illingworth*); designated [as holotype] by Matthews (1972, *Aust. J. Zool.* Suppl. 24 : 257).

Paralectotypes. AUSTRALIA: 13 ♂, 17 ♀, same data as lectotype.

Current valid name: *Onthophagus symbioticus* (Arrow) (Matthews, loc. cit.).

***taprobanus* (*Onthophagus*)**, 1931*b* : 299. LECTOTYPE ♂, SRI LANKA: Bogawantalawa, 4900–5200 ft, 28.ii–12.iii.1882 (*G. Lewis*); here designated.

Paralectotypes. SRI LANKA: 1 ♀, same data as lectotype; 1 ♀ Dikoya, 3800–4200 ft, 6.xii.1881–16.i.1882 (*G. Lewis*); 1 ♀ (*G. Lewis*).

***tarantula* (*Sisyphus*)**, 1909*b* : 92 [original series: 2 ♂]. LECTOTYPE ♂, SRI LANKA; here designated.
Paralectotype. SRI LANKA: 1 ♂, Bogawantalawa, 4900–5200 ft, 21.iii–4.iv.1882 (*G. Lewis*).

***tarsius* (*Onthophagus*)**, 1941 : 54. Holotype ♂, NEW GUINEA: Japen I., R. Manai-Undei, 500 ft, x.1938 (*L. E. Cheesman*).

***tibetanus* (*Onthophagus*)**, 1907*c* : 428. LECTOTYPE ♂, CHINA: Tibet, Brahmapoutra Valley, Chaksam, 12 000 ft, vii.1904 (*H. J. Walton*); here designated.
Paralectotypes. CHINA: 2 ♂, 6 ♀, same data as lectotype; 4 ♂, 3 ♀, Gyangtse, 13 000 ft, vi.1904 (*H. J. Walton*).

***torticornis* (*Caccobius*)**, 1931*b* : 144. LECTOTYPE ♂, INDIA: Dehra Dun, cut grass, 10.vii.1922 (*C. N. Chatterjee*); here designated.
Paralectotype. INDIA: 1 ♀, Dehra Dun, Nun Nadi, ex carrion, 17.vii.1922 (*Dr M. Cameron*).
[Specimen(s) from INDIA: Almora Prov., Kali Valley, 5000 ft, vii (*R. N. Parker*) missing.]

***triceratops* (*Onthophagus*)**, 1913*b* : 195 [original series: 2 ♂]. LECTOTYPE ♂, INDIA; here designated.
[1 ♂ specimen from INDIA: NE. Assam, Sadiya, 23.xi.1911 (*Kemp*) missing.]

***tridenticeps* (*Chaeridium*)**, 1913*a* : 459. Holotype ♂, BRAZIL: Madeira-Mamore Railroad camp 28 (*Mann & Baker*).

***trinitatis* (*Uroxys*)**, 1933*a* : 391. LECTOTYPE ♂, TRINIDAD: iii.1902 (*G. E. Bryant*); here designated.
Paralectotypes. TRINIDAD: 2 ♂, 5 ♀, same data as lectotype; 2 ♂, 2 ♀, 1903 (*G. E. Bryant*).

***triste* (*Phacosoma*)**, 1931*b* : 355 [original series: 2]. Holotype [sex unknown], INDIA: Nilgiri Hills (*H. L. Andrewes*).
Paratype. INDIA: 1 ex., same data as holotype.

***trochilus* (*Onthophagus*)**, 1931*b* : 266. Holotype ♂, BURMA: Tenasserim, Victoria Point (*Doherty*).

***vincentiae* (*Uroxys*)**, 1903 : 510 [original series: 2]. LECTOTYPE ♂, ST VINCENT: Cumberland (*H. H. Smith*); here designated.
Paralectotype. ST VINCENT: 1 ♀, same data as lectotype.

***vividus* (*Onthophagus*)**, 1907*c* : 428. LECTOTYPE ♂, INDIA: S. India, only found in carcases; here designated.
Paralectotypes. INDIA: 2 ♀, S. India; 7 ♂, 7 ♀, Nilgiri Hills; 3 ♂, 1 ♀, Nilgiri Hills (*H. L. Andrewes*); 1 ♂, 1 ♀, Nilgiri Hills (*G. F. Hampson*); 2 ♂, 2 ♀, Bangalore; 2 ♂, Trivandrum; 2 ♀, Malabar; 1 ♀, India.

***vulpinus* (*Onthophagus*)**, 1931*b* : 262. LECTOTYPE ♂, BURMA: Momeit (*Doherty*); here designated.
Paralectotypes. BURMA: 1 ♂, 1 ♀, Patkai Mts (*Doherty*).

***vultur* (*Onthophagus*)**, 1931*b* : 197. LECTOTYPE ♂, INDIA: Bombay, Igatpuri, 2000 ft, 20–30.vi.1904; here designated.
Paralectotype. INDIA: 1 ♀, Belgaum.

***yunnanus* (*Synapsis*)**, 1933*b* : 428. LECTOTYPE ♂, CHINA: Yunnan, Tengyueh, 1909–10 (*J. C. Brown*); here designated.
Paralectotypes. CHINA: 3 ♂, 1 ♀, same data as lectotype; 2 ♂, 1 ♀, Haut Yunnan, Tali.
[Specimen(s) from CHINA: Chien Chuan Chou, 7700 ft, v (*J. W. Gregory*) missing.]

***zebra* (*Onthophagus*)**, 1931*b* : 249. LECTOTYPE ♂, INDIA: Agra, Mhow (*Selous*); here designated.
Paralectotypes. INDIA: 1 ♂, 1 ♀, Belgaum, Bombay.

LUCANIDAE

***acutangulus* (*Dendroblax*)**, 1935 : 122 [original series: 5]. LECTOTYPE ♂, NEW ZEALAND: S. Island, Greymouth (*Helms*); here designated.
Paralectotypes. NEW ZEALAND: 3 ♀, same data as lectotype.
Current valid name: *Dendroblax earlei* White (Holloway, 1961, *Bull. Dom. Mus. Wellington* **20** : 13).

***acutangulus* (*Figulus*)**, 1935 : 120. Syntypes, VIETNAM: 6 ex., Hoa Binh (*A. de Cooman*).

***aratus* (*Figulus*)**, 1935 : 119. Syntypes, INDIA: 1 ex., Nilgiri Hills (*H. L. Andrewes*); 2 ex., Hattikeri, under bark, 3.ii.1909 (*H. L. Andrewes*).

***auritus* (*Aegotypus*)**, 1943 : 142 [original series: 3 ♂]. LECTOTYPE ♂, BORNEO: here designated.
Paralectotypes. BORNEO: 1 ♂, Kinabalu, 1904 (*Rolle*); 1 ♂, Kinabalu.

***auritus* (*Figulus*)**, 1927*c* : 63 [original series: 4]. Syntypes, WESTERN SAMOA: 2 ex., Apia, vi.–ix.1916 (*Dr H. Swale*); 1 ex., as previous but vi.1917; 1 ex., as previous but no date.
Current valid name: *Figulus samoanus* Kriesche (Arrow, 1935 : 119).

***caeca* (*Vinsonella*)**, 1940 : 93 [original series: 12]. LECTOTYPE ♂, MAURITIUS: Mt Cocotte, 26.xi.1938 (*J. Vinsom*), here designated.
Paralectotypes. MAURITIUS: 2 ♂ (BMNH, London), 1 ♀ (MNHN, Paris) same data as lectotype.
[It is possible that there is one more male paralectotype in MNHN, Paris, but it was not possible to check at the time that this catalogue was compiled.]

***carolinensis* (*Dorcus*)**, 1939*a* : 84. LECTOTYPE ♂, CAROLINE ISLANDS: Ponape I., Kolonie, 9.iii.1936 (*Z. Ono*), here designated.
Paralectotypes. CAROLINE ISLANDS: 1 ♂, same data as lectotype but 2.ii.1936 (BPBM, Honolulu); 1 ♀, Ponape I., 29.ii.1936 (*Z. Ono*) (BPBM, Honolulu); 1 ♂, Ponape I., 6.iii.1936 (*Z. Ono*); 1 ♂, 1 ♀, Ponape I., Tamataman-Sakir [not Yamataman], 20.iii.1936 (*S. Otomo*); 1 ♂, Palao I., 8.iv.1936 (*Z. Ono*).

***cheesmani* (*Figulus*)**, 1938 : 61. Holotype [sex unknown], NEW GUINEA: Papua, Kokoda, 1200 ft, viii.1933 (*L. E. Cheesman*).

***concatenatus* (*Figulus*)**, 1938 : 59. Holotype [sex unknown], BORNEO: W. Sarawak, Mt Matang, 1000 ft, 3.xi.1914 (*G. E. Bryant*).

***coomani* (*Figulus*)**, 1935 : 120. Syntypes, VIETNAM: 2 ex., (BMNH, London), 1 ex., (MNHN, Paris), Backau, 1907–8 (*P. Lemée*); 7 ex., (BMNH, London), 1 ex., (MNHN, Paris), Hoa Binh (*A. de Cooman*).

***delicatus* (*Aegus*)**, 1943 : 141 [original series: 2 ♂]. LECTOTYPE ♂, WEST MALAYSIA: Perak (*Doherty*); here designated.
Paralectotype. WEST MALAYSIA: 1 ♂, same data as lectotype.

***dublonensis* (*Dorcus*)**, 1939*b* : 580. Holotype ♂, CAROLINE ISLANDS: Truk Islands, Dublon I., 23.xii.1935 (*Z. Ono*).
Paratype. CAROLINE ISLANDS: 1 ♀, Truk Islands, Dublon I., 5.i.1936 (*Z. Ono*).

***elongatus* (*Penichrolucanus*)**, 1935 : 122. Holotype ♂, WEST MALAYSIA: Selangor, Kuala Lumpur, Gombak Valley, 13.x.1921 (*H. M. Pendlebury*).

***frater* (*Aegus*)**, 1935 : 114. Holotype ♂, MOLUCCAS: Halmahera, Gamkonora, 1200 m, iv.1931 (*G. Heinrich*).

***furcifer* (*Lucanus*)** 1949 : 46. LECTOTYPE ♂, CHINA: Yunnan; here designated.
Paralectotypes. CHINA: 1 ♂, 1 ♀, same data as lectotype; 1 ♂, 1 ♀, Szechuan, ouy Sy, 1911 (*R. P. Mombelg*). INDIA: 1 ♂, Sikkim, Lachen Lochung, viii (MNHN, Paris).
[A lectotype has been designated because although Arrow says that the type is from Yunnan, no specimen was so labelled.]

***henryi* (*Dorcus*)**, 1935 : 110. Holotype ♂, SRI LANKA: Trincomali Dist., Pulmoddai, 10.viii.1934 (*G. M· Henry*).

***histrio* (*Dorcus*)**, 1935 : 109. LECTOTYPE ♂, INDIA: Kumali Hill, 29.ii.1916 (*K. Govindaraj*); here designated.
Paralectotype. INDIA: 1 ♂, Coorg, Periambadi Ghat, 28.v.1917 (*T. R. Rao*).

***humilis* (*Dorcus*)**, 1935 : 111 [original series: 7]. LECTOTYPE ♂, INDIA: Sikkim, Gopaldhara, Rungbong Valley, 1911 (*H. Stevens*); here designated.
Paralectotypes. INDIA: 1 ♀, Sikkim, Gopaldhara, Rungbong Valley, Darjeeling, 1911 (*W. K. Webb*). BHUTAN: 1 ♀, Pedong, 1899 (*L. Durel*); 1 ♂ (BMNH, London), 1 ♂, 1 ♀ (MNHN, Paris), same as previous but 1913.

***immundus* (*Dorcus*)**, 1938 : 56 [original series: 3 ♂, 1 ♀]. Holotype ♂, INDIA: Coimbatore Dist., Camp Valparai, 3500 ft, 1937.
Paratypes. INDIA: 1 ♂ (BMNH, London), 1 ♂ (MNHN, Paris), same data as holotype.
[1 ♀, same data as holotype (MNHN, Paris) missing.]

***leveri* (*Penichrolucanus*)**, 1938 : 61 [original series: 3]. Syntypes, SOLOMON ISLANDS: 1 ex., Mamowa, rotten wood, xi.1931 (*R. A. Lever*); 2 ex., as previous but Guadalcanal, Mamawa.

***marginatus* (*Aegotypus*)**, 1935 : 115. Holotype ♀, BORNEO: ex. coll Parry.

***nageli* (*Dorcus*)**, 1935 : 112. Holotype ♂, INDIA: Assam (*P. Nagel*).

***nicobaricus* (*Penichrolucanus*)**, 1935 : 123. Holotype [sex unknown], NICOBAR ISLANDS: (MNHN, Paris).

***oberthuri* (*Torynognathus*)**, 1935 : 116. LECTOTYPE ♂, SUMATRA: Semangoes Forest (*J. Bouchard*); here designated.

Paralectotypes. SUMATRA: 1 ♂, 3 ♀, 1 [sex unknown, head missing], (BMNH, London), 24 [sex unknown] (MNHN, Paris), 2 [sex unknown] (Coll. M. Bomans), same data as lectotype.

***reticulatus* (*Cardanus*)**, 1943 : 140. Holotype [sex unknown], SUMATRA: Sungei Kumbang, Korinchi, 4500 ft, iv.1914.

***rhodesianus* (*Nigidius*)**, 1935 : 119. Syntypes, RHODESIA: 4 ex. (BMNH, London), 1 ex. (MNHN, Paris), Salisbury (*Marshall*); 1 ex., Mashonaland, Salisbury, xi.1900 (*G. A. K. Marshall*); 1 ex., as previous but iii.1901; 1 ex., Kashitu, N. of Broken Hill, i.1905 (*H. C. Dollman*); 1 ex., as previous but ii.1905.

Current valid name: *Nigidius rhodesianus* Peringuey (Arrow, 1938 : 53).

***scorpio* (*Platyfigulus*)**, 1935 : 117. Holotype ♂, locality unknown ['The unique specimen, which has generously been presented to the British Museum by the authorities of the Colombo Museum, is of unknown origin, but must be assumed to be a native of Ceylon', Arrow (loc. cit.)].

***serratus* (*Figulus*)**, 1938 : 60 [original series: 3]. Syntypes, BORNEO: 1 ex., Sarawak, Retuh, 14.v.1914 (*G. E. Bryant*); 1 ex., Sarawak, Tabehang, 12.v.1914 (*G. E. Bryant*).

***sumatrensis* (*Penichrolucanus*)**, 1935 : 124. Holotype [sex unknown], SUMATRA: Palembang (MNHN, Paris).

***swalei* (*Aegus*)**, 1927*c* : 61 [original series: 2]. LECTOTYPE ♂, WESTERN SAMOA: Apia, vi.–ix.1916 (*Dr H. Swale*); here designated.

Paralectotype. SAMOA: 1 ♀ (*Dr H. Swale*).

[The ♀ paralectotype is 21 mm long, not 11 mm.]

***tutuilensis* (*Aegus*)**, 1927*c* : 62 [original series: 3]. LECTOTYPE ♂, AMERICAN SAMOA: Tutuila, Leone Road, 9.vii.1923 (*Sweezey & Wilder*); here designated (BPBM, Honolulu).

Paralectotypes. AMERICAN SAMOA: 1 ♂ (BMNH, London), 1 ♂ (BPBM, Honolulu), Tutuila, 18.xii. (*H. C. Kellers*).

***upoluensis* (*Aegus*)**, 1927*c* : 60. LECTOTYPE ♂, 'SAMOA': Navigator Is.; here designated.

Paralectotypes. 'SAMOA': 1 ♂ (*S. J. Whitmee*) [collector from BMNH Coleoptera accessions register]. WALLIS ISLANDS: 1 ♀. WESTERN SAMOA: 1 ♂, Lotopa, 29.iv.1917 (*H. Swale*); 1 ♂, as previous but 1.iii.1917; 1 ♂, Apia, vi–ix.1916 (*H. Swale*); 1 ♂, 'Samoa', 20.v.1917 (*H. Swale*); 1 ♂, as previous but no date.

[*Aegus upoluensis* was proposed by Arrow as a 'nom. n.' for *Alcinus dilatatus* Fairmaire sensu Waterhouse (*Trans. ent. Soc. Lond.* **1875** : 163). Waterhouse's description was based on a misidentification and Arrow's note is, therefore, a valid species description.

The lectotype and the specimen collected by Whitmee are the two specimens described by Waterhouse and, although they are not actually mentioned in Arrow's description, it is inferred that he has seen them. Also, the only identification label on the whole syntype series is Arrow's label 'Aegus upoluensis Arrow, Type' on the major male described by Waterhouse. This specimen is therefore designated lectotype.]

***ursulus* (*Dorcus*)**, 1938 : 55. Holotype ♂, BHUTAN: Pedong, 1913.x. (*L. Durel*).

Paratypes. [1 ♂, 1 ♀ in Oberthür Collection (MNHN, Paris) missing.]

***variolosus* (*Cardanus*)**, 1935 : 121 [original series: 2]. Holotype [sex unknown], THAILAND: (*Bates*).

Paratype. INDIA: 1 ex., Assam, Rotung, 1400 ft, ex rotten wood, 23.xii.1911 (*S. W. Kemp*) (ZSI, Calcutta).

***vernicatus* (*Dorcus*)**, 1938 : 58. Holotype ♂, INDIA: Assam, Shillong District, Oberthür Collection (MNHN, Paris) [missing].

***wardi* (*Dorcus*)**, 1943 : 136. LECTOTYPE ♂, CHINA: SE. Tibet, Zayul 1000–1200 ft, vi & vii.1935 (*R. J. H. Kaulback*); here designated.

Paralectotypes. CHINA: 1 ♀, SE. Tibet, Zayul, Di Chu Valley, 11 000 ft, 23.viii.1933 (*F. Kingdon-Ward & R. J. H. Kaulback*). BURMA: 1 ♀, Seinghku Valley, 28°9′ N, 97°25′ E, 6.vi.1926 (*F. Kingdon-Ward*).

PASSALIDAE

***affinis* (*Eumelosomus*)**, 1907*a* : 465. Syntypes. UGANDA: 4 ex., E. Ruwenzori, 600–1200 ft, 1906 (*Hon. G. R. Legge & A. F. R. Wollaston*).

***antillarum* (*Neleides*)**, 1907*a* : 452. Syntypes. GRENADA: 3 ex., Chantilly Estate (windward side) (*H. H. Smith*); 2 ex., Grand Étang (windward side), 1900 ft (*H. H. Smith*); 3 ex., Windsor (*H. H. Smith*); 1 ex., Windsor Estate (windward), 500 ft, 28.iii, wooded ravine, under a rotten log. Found at same place and are probably of the same species [then in different handwriting], i.e. as larvae.

***archidonae* (*Petrejus*)**, 1907*a* : 465. Holotype [sex unknown], ECUADOR: Archidonae.

***borealis* (*Chilomazus*)**, 1907*a* : 467. Holotype [sex unknown], INDIA: Assam, Nagas (*Doherty*).

***centralis* (*Tetraracus*)**, 1907*a* : 458 [original series: 2]. Syntypes, COSTA RICA: 2 ex., Volcan de Barba 1600 m (*P. Biolley*).

***congoensis* (*Didymus*)**, 1907*a* : 463. Syntypes, ANGOLA: 4 ex., San Salvador. ZAIRE: 2 ex., R. Congo, Mayanda.

***crassus* (*Didymus*)**, 1907*a* : 465. Holotype, UGANDA: E. Ruwenzori, 6000–13 000 ft, 1906 (*Hon. G. Legge & A. F. R. Wollaston*).

***curvilineatus* (*Didymus*)**, 1907*a* : 462. Syntypes, UGANDA: 1 ex., Msozi, 4300 ft (*Delme Ratcliffe*); 2 ex., Msozi, ii.1903 (*Delme Radcliffe*). UGANDA: 1 ex., Kavirondo.

***isthmicus* (*Veturius*)**, 1907*a* : 453. Syntypes, COSTA RICA: 1 ex., PANAMA: 1 ex., Bugaba (*Champion*).

***laevisternus* (*Didymus*)**, 1907*a* : 463. Syntypes, KENYA: 5 ex., Kikuyu.

***nasutus* (*Eumelus*)**, 1907*a* : 459. Syntypes, ECUADOR: 1 ex., Cachabe, low c[amp ?], xi.1896 (*Rosenberg*); 2 ex., 1882–3 (*Siemradski*); 1 ex., as previous, no date.
[Specimens collected by Siemradski (MNHN, Paris) missing.]

***peruvianus* (*Petrejus*)**, 1907*a* : 456. Syntypes, PERU: 4 ex.

***peruvianus* (*Veturius*)**, 1907*a* : 455. Syntypes, PERU, 2 ex., Marcapata R. (*J. Kalinowski*); 1 ex., Peru.

***platypleura* (*Erionomus*)**, 1907*a* : 461. Syntypes, KENYA: 6 ex., Kavirondo.

***pulchellus* (*Leptaulacides*)**, 1907*a* : 466. Holotype [sex unknown], NEW GUINEA: Ekeikei, iv.1900 (*Pratt*).

***punctatostriatus* (*Veturius*)**, 1907*a* : 454. Syntypes, GUYANA: 5 ex., Demarara, Georgetown, 1879 (*W. Harper*).

***ruwenzoricus* (*Didymus*)**, 1907*a* : 464. Syntypes, UGANDA: 6 ex., E. Ruwenzori, 6000–13 000 ft, 1906 (*Hon. G. Legge & A. F. R. Wollaston*).

***solidus* (*Triaenurgus*)**, 1907*a* : 452 [original series: 2]. Syntypes, GUATEMALA: 2 ex., Quezaetenango Chuipache (*Richardson*).

***spinosus* (*Petrejus*)**, 1907*a* : 457 [original series: 4]. Syntypes, ECUADOR: 4 ex., Cachabe, Low C[amp ?], 1896 (*Rosenberg*).

TROGIDAE

***acutipes* (*Cloeotus*)**, 1903 : 519. Syntypes, BRAZIL: 9 ex., Rio de Janeirò (*Fry*); 3 ex., Brazil. COSTA RICA: 2 ex., Irazu, 600–700 ft (*H. Rogers*).

***birmanicus* (*Trox*)**, 1927*b* : 467. LECTOTYPE ♂, BURMA: Prome; here designated.
Paralectotypes. BURMA: 1 ex., Pakokku, 180 ft, ix.1915 (*Miss Molesworth*); 1 ex., Burma; 1 ex., Minhla, 1881 (*Comotto*) (MCSN, Genoa).
[Specimen(s) from CAMBODIA: Kompong Kedey, v (*R. V. de Salvaza*) missing.]
[The statement 'type (♂) in coll. British Museum' by Haaf (1954, *Ent. Arb. Mus. Georg Frey* **5** : 389) is incorrect. Although labelled as 'type' by Arrow, the specimen was not designated as the holotype by him. It is this specimen which has been selected as the lectotype.]

***bugabensis* (*Cloeotus*)**, 1903 : 519 [original series: 2]. Syntypes, PANAMA: 2 ex., Bugaba, 800–1500 ft (*Champion*). [One of these syntypes is also a syntype of *Cloeotus viridipennis* Bates (Arrow, loc. cit.).]

***crassicollis* (*Cloeotus*)**, 1093 : 518 [original series: 2]. Syntypes, ST VINCENT: 1 ex., Forest Morne a Garon, 1500 ft, in rotten wood, 27.x; 1 ex., (*H. H. Smith*).

***expansus* (*Trox*)**, 1900 : 22. Holotype, SOMALI REPUBLIC: central & east Somaliland, 5.vi.–29.x.1897 (*C. A. V. Peel*).

***fryi* (*Cryptogenius*)**, 1909*c* : 501. Holotype, BRAZIL: Rio de Janeiro (*Fry*).

***lobicollis* (*Trox*)**, 1927*b* : 466. Syntypes, BURMA: 5 ex. (BMNH, London) 3 ex. (IP, Eberswalde), 2 ex. (MCSN, Genoa) Tenasserim, Moulmein, v.1887 (*Fea*); 1 ex., Burma.
[Specimens from BURMA: Rangoon, vi and x (*Fea*) missing.]

***mollis* (*Trox*)**, 1927*b* : 468. Syntypes, BORNEO: 1 ex., Borneo; 1 ex., Medan (*L. Fulmek*) (IP, Eberswalde); SUMATRA: 1 ex., Palembang, 1900 (*J. Schmitz*).

[Specimen(s) from WEST MALAYSIA: Selangor, Kuala Lumpur, viii. (*H. M. Pendlebury*) missing.]

***rufopiceus* (*Cloeotus*)**, 1903 : 517. Syntypes, ST VINCENT: 2 ex., (*H. H. Smith*); GRENADA: 1 ex., Grand Etang (windward side), 1900 ft (*H. H. Smith*).

***testudo* (*Trox*)**, 1927*b* : 466. LECTOTYPE ♂, PAKISTAN: Karachi; here designated.

Paralectotypes. PAKISTAN: 2 ex., same data as lectotype; 1 ex., 'Ind. bor.'.

[The statement '♂-Typus in coll. British Museum, London' by Haaf, (1954, *Ent. Arb. Mus. Georg Frey* **5** : 365) is incorrect. Although labelled as 'Type' by Arrow, the specimen was not designated as the holotype by him. It is this specimen which has been selected as the lectotype.]

HYBOSORIDAE

***acuticollis* (*Phaeochroops*)**, 1907*c* : 436. Holotype, BORNEO: Kinabalu.

***amplus* (*Phaeochrous*)**, 1909*c* : 499. LECTOTYPE ♂, CAMEROUN: Mundame (*R. Rohde*); here designated.

Paralectotypes. CAMEROUN: 1 ♂, 1 ♀ (BMNH, London), 6 ♂, 1 ♀ (IP, Eberswalde), same data as lectotype.

***arabicus* (*Phaeochrous*)**, 1909*c* : 497. LECTOTYPE ♂, YEMEN: (*Millingen*); here designated.

Paralectotypes. YEMEN: 6 ♂, 1 ♀, same data as lectotype.

***batuensis* (*Phaeochroops*)**, 1909*c* : 495. Syntypes, SULAWESI: 6 ex. (BMNH, London), 1 ex. (MCSN, Genoa), Batu I., 1896–7 (*H. Raap*).

***camerunensis* (*Phaeochrous*)**, 1909*c* : 499. LECTOTYPE ♂, CAMEROUN: Mundame (*R. Rohde*); here designated.

Paralectotypes. CAMEROUN: 1 ♂, 1 ♀ (BMNH, London), 5 ♂, 4 ♀ (IP, Eberswalde), same data as lectotype.

***cinereicollis* (*Phaeochridius*)**, 1942 : 924. LECTOTYPE ♂, BORNEO: Sarawak, foot of Mt Dulit, junction of rivers Tinjar & Lejok, 2.x.1932, trap 2, goat (*B. M. Hobby & A. W. Moore*); here designated.

Paralectotypes. BORNEO: 2 ♂, same data as lectotype; 1 ♂, same data as lectotype but 1.x.1932; 1 ♂, same data as lectotype but 20.ix.1932, trap 1, fish; 2 ♂, same data as lectotype but 22.ix.1932, trap 1, fish; 1 ♂, same data as lectotype but 25.ix.1932, trap 1, fish; 1 ♂, same data as lectotype but 4.x.1932, trap 1, fish; 1 ♂, same data as lectotype but 4.ix.1932, old secondary forest; 1 ♂, same data as lectotype but 24.ix.1932, light-traps 6 & 7.

***crassicollis* (*Liparochrus*)**, 1925 : 329. LECTOTYPE [sex unknown], NEW GUINEA: Kani Mts (*Bennigsen*); here designated.

[Although the sex of the lectotype cannot be determined without dissection, it has been so designated because the syntypes from NEW GUINEA: Mamberano River, Pioneerbivak, vii–viii and xii–i (*W. C. van Heurn*) cannot be found in the collection of IP, Eberswalde.

***dissimilis* (*Phaeochrous*)**, 1909*c* : 496. LECTOTYPE ♂, BURMA: Tenasserim, Moulmein, v.1887 (*Fea*); here designated.

Paralectotypes. BURMA: 1 ♂, 4 ♀ (BMNH, London), 4 ♂, 2 ♀ (MCSN, Genoa), 1 ♂, 1 ♀ (MHNH, Paris), 4 ♂, 2 ♀ (SMT, Dresden), same data as lectotype.

***dux* (*Liparochrus*)**, 1909*c* : 489. LECTOTYPE ♂, NEW GUINEA: Moroka, 1300 m, vii–xi.1892 (*Loria*); here designated.

Paralectotypes. NEW GUINEA: 1 ♂, same data as lectotype (MCSN, Genoa); 1 ♀, Paumomu R. ix–xii.1892 (*Loria*).

***exaratus* (*Chaetodus*)**, 1909*c* : 491. Syntypes, BRAZIL: 1 ex., Rio de Janeiro [Fry collection but doubtfully collected by Fry]; 1 ex., 'Adelops striatus mihi, L in Brasilia (*Dr. Sommer*)'.

***fumipennis* (*Coelodes*)**, 1909*c* : 491. LECTOTYPE ♂, BRAZIL: Ega; here designated.

Paralectotypes. BRAZIL: 1 ♀, same data as lectotype; 2 ♀, Amazon (*Bates*); 1 ♂, 2 ♀, Para.

***gigas* (*Phaeochroops*)**, 1907*c* : 436. Syntypes, BORNEO: 2 ex., Pengaron (*Doherty*).

[Specimens from WEST MALAYSIA: Perak (*Doherty*) missing.]

***indicus* (*Phaeochroops*)**, 1907*c* : 359 [original series: 3]. Syntypes, INDIA: 3 ex., Nigiri Hills (*H. L. Andrewes*).

***laetus* (*Microphaeochroops*)**, 1942 : 926. Holotype, BORNEO: Sarawak, Mt Dulit, 4000 ft, primitive moss forest, 26.x.1932 (*B. M. Hobby & A. W. Moore*).

***lugubris* (*Liparochrus*)**, 1925 : 328. LECTOTYPE ♂, NEW GUINEA: Mamberamo R., Pioneerbivak, xii. 1920 (*W. C. van Heurn*); here designated.

Paralectotype. NEW GUINEA: 1 ♂, same data as lectotype (IP, Eberswalde).

[The female specimen cannot be traced.]

***mashunus* (*Phaeochrous*)**, 1909*c* : 498. LECTOTYPE ♂, RHODESIA: Mashonaland, Salisbury, xi.1900 (*G. A. K. Marshall*), here designated.

Paralectotypes. RHODESIA: 1 ♂, same data as lectotype but xii. 1904: 15 ♂, 10 ♀ (BMNH, London), 3 ♂, 2 ♀ (MCSN, Genoa), 3 (sex unknown) (MNHU, Berlin), 4 ♂, 1 ♀ (SMT, Dresden), same data as lectotype but no date; 1 ♀, Mashonaland. MOZAMBIQUE: 4 ♂, 1 ♀ Nyassa (*Thelwall*).

***mentaweiensis* (*Phaeochroops*)**, 1909*c* : 495. Syntypes, MENTAWEI ISLANDS (Indonesia): 2 ex. (BMNH, London), 3 ex. (MCSN, Genoa), Sipora, Sereinu, v–vi.1894 (*Modigliani*).

Current valid name: *Phaeochroops rattus* Arrow (Arrow, 1942 : 927).

***nanus* (*Phaeochrous*)**, 1942 : 924 [original series: 'over 50']. LECTOTYPE ♂, INDIA: Bihar, Pusa, 24.vi. 1924 (*Mukerjee*); here designated.

Paralectotypes. INDIA: 2 ♂, same data as lectotype; 1 ♀, same data as lectotype but 27.vi.1916 (*Fletcher*); 2 ♀, same data as lectotype but 1.viii.1916 (*D. Nandan*); 1 ♂, as previous but 3.viii.1916; 1 ♀, Bihar, Pusa, 18.vi.1916, at light (*H*[rest illegible]); 1 ♀, as previous but no date; 1 ♂, 6 ♀, Bengal, Chapra (*Mackenzie*).

***niasianus* (*Phaeochroops*)**, 1909*c* : 494. Syntypes, NIAS I. (Indonesia): 3 ex. (BMNH, London), 5 ex. (MCSN, Genoa), 1897–8 (*U.* [not *H.*] *Raap*).

***nigripennis* (*Coelodes*)**, 1903 : 516. LECTOTYPE ♂, ST VINCENT: leeward side (*H. H. Smith*); here designated.

***nitidus* (*Phaeochrous*)**, 1909*c* : 497. LECTOTYPE ♂, TANZANIA: Masai; here designated.

Paralectotypes. TANZANIA: 2 ♂, 2 ♀, same data as lectotype; 2 ♂, 2 ♀, Kilimanjaro; 1 ♀, 'Germ. E. Afr.' (*Rev. A. N. Wood*).

***obscurus* (*Hybochaetodus*)**, 1909*c* : 500 [original series: 2]. LECTOTYPE [sex unknown], PERU: Vilcanota; here designated.

[Although the sex of the lectotype cannot be determined without dissection, it has been so designated because the other syntype cannot be found in the collection of MNHU, Berlin.]

***opacicollis* (*Phaeochroops*)**, 1909*c* : 493. Syntypes, BURMA: 1 ex. (BMNH, London), 1 ex. (MCSN, Genoa), Tenasserim, Plapoo, iv.1887 (*Fea*); 1 ex., Tenasserim, Mt Moolevit, 1000–1 ?00 m, iv.1887 (*Fea*) (MCSN, Genoa).

***pallidus* (*Phaeochrous*)**, 1909*c* : 496. LECTOTYPE ♂, INDIA: South Mysore (*H. L. Andrewes*); here designated.

Paralectotypes. INDIA: 5 ♂, same data as lectotype; 3 ♂, Nilgiri Hills (*G. F. Hampson*). SRI LANKA: 1 ♂, 1 ♀.

***peninsularis* (*Microphaeochroops*)**, 1942 : 925 [original series: 3]. Syntypes, WEST MALAYSIA: 3 ex., Perak, Jor Camp, 2000 ft, 25.viii.1922 (*E. Seimund*).

***peninsularis* (*Phaeochroops*)**, 1909*c* : 492 [original series: 1 ♂, 1 ♀]. LECTOTYPE ♂, WEST MALAYSIA: Perak (*Doherty*); here designated.

Paralectotype. WEST MALAYSIA: 1 ♀, same data as lectotype.

***punctatum* (*Dicraedon*)**, 1911 : 396 [original series: 3 ♀]. LECTOTYPE ♀, GUATEMALA: Zapote (*Champion*), here designated.

Paralectotypes. COLOMBIA: 1 ♀, Cali, ix–xii.1894 (*W. Rosenberg*); 1 ♀, same data as previous but 9–10.i.1894 (SMT, Dresden).

***punctipennis* (*Coelodes*)**, 1909*c* : 491. LECTOTYPE ♂, ECUADOR: Mirador; here designated.

Paralectotypes. ECUADOR: 1 ♂, same data as lectotype; 1 ♀, Canelos (*Buckley*); 1 ♀, Ecuador. PERU: 1 ♀, Amazon, Nauta.

***punctulatus* (*Phaeochroops*)**, 1942 : 926. Syntypes, BORNEO: 1 ex., Sarawak, Matang, 3–13.vii.1909 (*C. J. Brooks*); 1 ex., Sarawak, Mt Merinjak, 2000 ft, 26.v.1914 (*G. E. Bryant*); 1 ex., Sarawak, foot of Mt Dulit, junction of rivers Tinjar & Lejok, trap 1, fish, 25.ix.1932 (*B. M. Hobby & A. W. Moore*); 1 ex., Sarawak, Mt Kulalong, Long Manian, 8.xi.1932 (*B. M. Hobby & A. W. Moore*); 3 ex., Kinabalu.

***pusillus* (*Hapalonychus*)**, 1911 : 396 [original series: 2]. Holotype ♂, PARAGUAY.

Paratype. PARAGUAY: 1 ♂ (*Dr Bohls*) (SMT, Dresden).

***rattus* (*Phaeochroops*)**, 1909*c* : 494. Syntypes, SUMATRA: 2 ex. (BMNH, London), 4 ex. (MCSN, Genoa), Setinjak, 1800 ft, i.1898; 2 ex., Si-Rambé, xii.1890–iii.1991 (*E. Modigliani*).

***thomensis* (*Phaeochrous*)**, 1909*c* : 499. LECTOTYPE ♂, SÃO TOMÉ: Vista Alegre, 200–300 m, x.1900 (*L. Fea*); here designated.

Paralectotypes. SÃO TOMÉ: 1 ♂, 1 ♀, same data as lectotype (MCSN, Genoa).

***timidus* (*Liparochrus*)**, 1909*c* : 490. LECTOTYPE ♂, AUSTRALIA: Alexandria (*W. Stalker*); here designated.

Paralectotypes. AUSTRALIA: 8 ex. (BMNH, London), 1 ex. (ANIC, Canberra), 1 ex. (MCSN, Genoa), same data as lectotype; 6 ex. (BMNH, London), 1 ex. (MCSN, Genoa), same data as lectotype but x.1905; 8 ex. (BMNH, London), 1 ex. (MNHU, Berlin), 2 ex. (MCSN, Genoa) same data as lectotype but 30.xii.1905; 1 ex., same data as lectotype but 25.ii.1906 (MCSN, Genoa); 14 ex. (BMNH, London), 1 ex. (ANIC, Canberra), same data as lectotype but 13–20.iii.1905; 2 ex., same data as lectotype but 20.iii.1906 (MNHU, Berlin).

Current valid name: *Liparochrus dilatifrons* Blackburn (Arrow, 1925 : 328).

***uniformis* (*Phaeochridius*)**, 1925 : 330. LECTOTYPE ♂, BORNEO: Kinabalu; here designated.

Paralectotype. BORNEO: 1 ♀, same data as lectotype (IP, Eberswalde).

***vulpecula* (*Phaeochroops*)**, 1909*c* : 493. Syntypes, MENTAWEI ISLANDS (Indonesia): 2 ex. (BMNH, London), 3 ex. (MCSN, Genoa) Sipora, Sereinu, v–vi.1894 (*Modigliani*).

GEOTRUPIDAE

***bahiae* (*Athyreus*)**,1913*a* : 463. Syntypes, BRAZIL: 2 ex., Bahia; 1 ex., Goyas Prov, Jatahy; 1 ex., Itaparica Is, 28.xii.1906 (*E. G. B. Meade-Waldo*).

***fissicollis* (*Athyreus*)**, 1913*a* : 462. Holotype [sex unknown], BRAZIL: Natal (*W. H. Mann*).

loweri Blackburn var. ***laratinum* (*Bolboceras*)**, see *laratinum*.

laratinum* (*Bolboceras loweri Blackburn var.), 1916 : 493 [original series: 2]. Syntype [sex unknown], LARAT I. (Indonesia) (*F. Muir*).

***parcepunctatum* (*Bolboceras*)**, 1913*a* : 461. Holotype ♂, BRAZIL; Bahia.

Paratypes. BRAZIL: 1 ♂, 4 ♀, same data as holotype; 1 ♀, Ceara-Mirim, Rio Grande de Norte (*W. M. Mann*); 1 ♀, Indepencia, Parahyba (*Mann & Heath*).

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Contents

Synopsis

Keys are provided to the sixteen species of *Trigonopsis* Perty here recognized, of which eight are described as new. Two specific names are newly placed in synonymy. The species are placed in four species-groups, one of which consists entirely of newly described species. Previously published information on biology is summarized, and further biological observations are added where possible.

Introduction

The wasps of the genus *Trigonopsis* are uncommonly encountered inhabitants of the New World tropical forests. They are strikingly elegant creatures, very elongate with a triangular, prognathous head, petiolate gaster, and most parts highly polished. The mandibles are also long and slender, well-adapted to catching and carrying the cockroach prey, which are stored in mud nests. These wasps are scarce in collections, since most collectors have tended to avoid forest habitats with their relatively low yields of insects.

Several species were described by various early authors, notably Smith (1851; 1856; 1873), usually on the basis of single specimens. Kohl (1902) first revised the genus, treating it as a subgenus of *Podium*. Since he did not see Smith's types, misunderstood the descriptions, and in most cases saw no other material assignable to Smith's species, he placed in synonymy several names since regarded as valid. He also confused other species and was misled by inaccurately labelled specimens.

Richards' (1937) revision was more limited in scope, since its main purpose was to provide names for the specimens collected during an expedition to Guyana. However, it also included the material already in the collections of the British Museum (Natural History), where most of Smith's types are housed. Richards, combining this advantage with a more critical approach, clarified much of the previous confusion.

Menke *in* Bohart & Menke (1976), in the context of a revision of sphecid genera, divided *Trigonopsis* into the *rufiventris* and *intermedia* species-groups, and stated that the latter is the more generalized of the two. However, the present study attempts to show that the *intermedia*-group as defined by Menke is more conveniently treated as three distinct groups. Nomenclature in the genus was also updated.

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Examination of recently acquired material in the British Museum (Natural History), using Richards' (1937) paper, indicated that undescribed species were represented. It also became evident that some characters, especially those of the female mandibles and male genitalia, had never received sufficient attention from any author. These facts together stimulated the present work.

Due mainly to lack of material, no previous author was in a position to assess the proximity of species and the extreme variation within some of them. In particular, the absence of the opposite sexes of many species frequently gave rise to misassociations of those present, and to other misidentifications. Considerable efforts were therefore made to gather together all available material, and a very wide range of characters was assessed. In addition, several sex associations were confirmed by reared specimens. As a result, a foundation has been laid for the detailed evaluation of supraspecific relationships here attempted. A high proportion of new species is described within this framework, with very few sexes remaining unknown. The *intermedia*-group of Menke *in* Bohart & Menke (1976) is here divided into three, including a species-group consisting entirely of newly described species.

Certain body measurements, and some ratios derived from them, proved to be of value in separating species. Measurements were made on most specimens with the exception of the numerous specimens of *violascens*, *rufiventris* and *cameronii*, of which samples were subjectively selected.

All measurements in the keys and descriptions are in millimetres, and ratios are expressed as an index derived from the division of one measurement by another. They are abbreviated as follows.

BL	Body length, excluding appendages.
Notch	Female mandible always has a notch of varying size and shape in the inner margin or on the inner side, nearer apex than base.
MBL	Mandibular base length. From notch to base of eye.
MAL	Mandibular apex length. From notch to tip.
MR	Mandibular ratio. MBL divided by MAL. (When the mandible is very worn, the abnormally high MR resulting is given in brackets after the normal range.)
CTW	Clypeal tooth width. In the females the distance between the tips of the outermost clypeal teeth. (Most males have only 2 teeth, or the clypeus is distinct.)
CED	Clypeal emargination depth. Perpendicular distance from the base of the central emargination to the line joining the tips of the teeth (males only).
TOD	Tooth to orbit distance. From the tip of a tooth used to measure CTW, to the nearest point of an orbit.
CR	Clypeal ratio. CTW divided by TOD.
CER	Clypeal emargination ratio. CTW divided by CED (males only).
HW	Head width. Maximum, including eyes.
HL	Head length. From the base of a tooth nearest centre of clypeus, to posterior edge of occipital carina.
HR	Head ratio. HW divided by HL.
LIW	Lower interocular width. Least distance between lower orbits.
MIW	Middle interocular width. Greatest distance between middle orbits.
UIW	Upper interocular width. Least distance between upper orbits.
EL	Eye length.
PDL	Propodeal dorsal length.
PL	Petiole length. Distance from the apex of the propodeal valve to the junction with tergite 1.
PR	Petiole ratio. PL divided by PDL.

Material studied in the present work is deposited in the institutions abbreviated as follows.

AMNH, New York	American Museum of Natural History, New York.
ANS, Philadelphia	Academy of Natural Sciences, Philadelphia.
BMNH	British Museum (Natural History), London.
BPBM, Honolulu	Bernice P. Bishop Museum, Honolulu.
CM, Pittsburgh	Carnegie Museum, Pittsburgh.
CMNH, Los Angeles	County Museum of Natural History, Los Angeles.
CNC, Ottawa	Canadian National Collection, Ottawa.
CU, Davis	California University, Davis.

CU, Ithaca	Cornell University, Ithaca, New York.
Fritz coll.	Personal collection of M. A. Fritz, Instituto Entomológico San Miguel, San Miguel, Province of Buenos Aires.
FSAE, Gembloux	Faculté des Sciences Agronomique de l'État, Gembloux, Belgium.
IML, Tucumán	Instituto Miguel Lillo, Tucumán, Argentina.
IRSNB, Brussels	Institut Royal des Sciences Naturelles de Belgique, Brussels.
IZA, Maracay	Instituto de Zoología Agrícola, Maracay, Venezuela.
MCZ, Harvard	Museum of Comparative Zoology, Harvard.
Menke coll.	Personal collection of Dr A. S. Menke, U.S. Dept of Agriculture, c/o U.S. National Museum, Washington.
MHN, Geneva	Muséum d'Histoire Naturelle, Geneva.
MIZSU, Turin	Museo ed Istituto di Zoología Sistematica dell'Università, Turin.
MNHN, Paris	Muséum National d'Histoire Naturelle, Paris
MNHU, Berlin	Museum für Naturkunde der Humboldt-Universität, Berlin.
MP, Belém	Museu Paraense Emilio Goeldi, Belém, Pará, Brazil.
NM, Rotterdam	Natuurhistorisch Museum, Rotterdam.
NM, Vienna	Naturhistorisches Museum, Vienna.
NR, Stockholm	Naturhistoriska Riksmuseum, Stockholm.
RNH, Leiden	Rijksmuseum van Natuurlijke Historie, Leiden, Netherlands.
TM, Budapest	Természettudományi Múzeum, Budapest.
UM, Oxford	University Museum, Oxford
USNM, Washington	United States National Museum, Washington, D.C.
UZM, Copenhagen	University Zoological Museum, Copenhagen.
ZSBS, Munich	Zoologische Sammlung des Bayerischen Staates, Munich.

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TRIGONOPSIS Perty

Trigonopsis Perty, 1833 : 141, pl. 27, fig. 18. Type-species: *Trigonopsis abdominalis* Perty, 1833 (= *Podium rufiventre* Fabricius, 1804), by monotypy.
Trigonopsis Perty; Smith, 1851 : 31; 1856 : 226, pl. 6, fig. 1; 1873 : 54.
Trigonopsis Perty [as subgenus of *Podium* Fabricius]; Kohl, 1902 : 2.
Trigonopsis Perty; Williams, 1928 : 114.
Trigonopsis Perty; Richards, 1937 : 107.
Trigonopsis Perty; Menke *in* Bohart & Menke, 1976 : 96.

The following description is largely based on that given by Menke *in* Bohart & Menke (1976 : 96–97), with certain modifications.

Highly polished wasps 13–26 mm long, black with red gaster or entirely metallic blue-violet. Forewing hyaline or slightly infuscate with 2 dark, transverse bands towards apex. Head large, ± triangular, strongly prognathous. Occipital carina sometimes expanded into a flange. Mandible long and slender, especially in females, in which its inner margin always has a notch of varying size and shape near the apex, and usually also a basal spine. Some males have a sub-basal tooth on the mandibular inner margin. Female clypeus with 4–7 marginal teeth, male with 2 or structure quite different. Some males have subclypeal tubercles. Antennae cylindrical, sometimes flattened or expanded in males. Pronotum ± elongate, often with a dorsal projection. Mesopleuron with complete episternal sulcus. Propodeum with spiracular groove, its dorsum (= metapostnotum) with a longitudinal groove containing a carina and strong transverse rugae. Remainder of dorsum with or without transverse rugae. Gaster with long petiole.

Among the Sphecinae, *Trigonopsis* is easily distinguished by its elongate shape, prognathous head and typical colour patterns, especially of the wing-bands. These characters are shared by only a few of the species of *Podium* Fabricius and *Penepodium* Menke, its closest relatives (these two genera are hereinafter referred to as *Podium* s.l.). *Trigonopsis* is distinguished from these genera by its propodeal dorsal groove containing a carina and transverse rugae (at most a shallow, simple groove in *Podium* s.l.), the spiracular groove (absent in *Podium* s.l.) and the complete episternal sulcus (incomplete below in *Podium* s.l.). In addition, the female of *Trigonopsis* always has a mandibular notch (although vestigial in one species, it is never absent), and the cuspis of the male genitalia has a basal post (Fig. 70). Both notch and post are lacking in *Podium* s.l.

THE SPECIES-GROUPS. Sixteen species are recognized. Since the key is artificial, it does not reflect the four natural groups in which these are placed. They are characterized and inter-related as follows.

rufiventris-group
- ***violascens*** (Dalla Torre)
  - *violaceus* Smith
  - *resplendens* (Kohl) **syn. n.**
- ***menkei*** **sp. n.**
- ***rufiventris*** (Fabricius)
  - *abdominalis* Perty
  - *haemorrhoidalis* Smith
  - *soror* Mocsary **syn. n.**
  - *frivaldskyi* Mocsary
- ***cameronii*** (Kohl)
- ***howesi*** **sp. n.**
- ***grylloctonus*** Richards

vicina-group
- ***richardsi*** **sp. n.**
- ***vicina*** (Dalla Torre)
  - *affinis* Smith
- ***schunkei*** **sp. n.**

intermedia-group
- ***intermedia*** Saussure
- ***cyclocephalus*** Smith
- ***moraballi*** Richards

neotropica-group
- ***neotropica*** **sp. n.**
- ***succinea*** **sp. n.**
- ***mocoana*** **sp. n.**
- ***cooperi*** **sp. n.**

The ***rufiventris***-group. Propodeal dorsum with, at most, traces of rugae outside central furrow. ♂ sternite 8 bifid, genitalia distinctive, basal post of cuspis round-ended. ♀ clypeus with 5 ± regular teeth, mandible with V-shaped notch. ♂ without subclypeal tubercles, antennae cylindrical.

The ***vicina***-group. Propodeal dorsum with rugae outside central furrow. ♂ sternite 8 entire, basal post of cuspis round-ended. ♀ clypeus with 4–5 regular teeth, mandible with U- to V-shaped notch. ♂ with subclypeal tubercles and flattened, ± expanded antennae.

The ***intermedia***-group. Propodeal dorsum with rugae outside central furrow. ♂ sternite 8 entire, basal post of cuspis round-ended. ♀ clypeus with 6–7 often irregular teeth, mandible with U-shaped notch. ♂ without subclypeal tubercles, with cylindrical antennae.

The ***neotropica***-group. Propodeal dorsum with rugae outside central furrow. ♂ sternite 8 entire, basal post of cuspis square-ended. ♀ clypeus with 5 sometimes irregular teeth, mandible with step-like notch. ♂ sometimes with subclypeal tubercles, and usually slightly flattened antennae.

The *vicina*-group shows certain characters in common with all other groups of the genus. The clypeal and mandibular shape of female *richardsi*, the occipital flange of both its sexes, and the HR of 1·0 of female *richardsi* and all *vicina*-group males, are characters otherwise typical of the *rufiventris*-group.

The females of *vicina* and *schunkei*, the other two species of the *vicina*-group, have the mandibles strongly resembling those of all the *intermedia*-group females. These two groups are further linked by the males of *intermedia* and *schunkei*, the only two in the genus which have a sub-basal tooth on the mandibular inner margin. They are also the largest species of their respective groups.

The subclypeal tubercles found in all *vicina*-group males are also present in the *neotropica*-group, in the male of *neotropica* itself. The strong flattening and partial expansion of the antennae in all *vicina*-group males is paralleled by the slight flattening found in all known *neotropica*-group males except that of *cooperi*. The unusually dense pubescence of the anterior mesoscutum is found in several species of both groups, but not usually in both sexes of any one species. The first two characters are also found in certain species of *Podium* and *Penepodium*, which may indicate that they are ancestral.

Distribution. Most species of this genus are confined to lowland forest, a few ascending to between 600 and 1000 m. The range extends from Mexico to west-coast Ecuador, and everywhere east of the Andes south to Bolivia, the Mato Grosso and Rio de Janeiro.

Variation. The back of the head is sometimes greatly expanded, at times almost quadrate. This appears to be purely individual variation and is found in all species-groups. It occurs mainly in larger specimens and is more common in males than in females.

In addition, various structures show variation along two clines. From the east, one can be traced north-west into the Guianas, the other west along the Amazon. The latter is also accompanied by a colour cline. The Guianas are relatively isolated by high mountains to the south and west. Several species are so far known only from this area. The Andes form the western limit of distribution for all the Amazon Basin species.

The structural clines are most marked in *violascens*, *neotropica* and *cooperi*; details are given under those species.

Colour variation is most easily observed in *rufiventris* as it is the most widespread and commonly collected species of the genus. Almost all the specimens from eastern Brazil and the Guianas are very dark, becoming paler on average westwards along the Amazon. The red colour changes to orange and becomes more extensive, and the wings assume a strong amber tint. West of about 68° W., extreme, pale specimens occur (= *soror* Mocsary). All the females from Chanchamayo, Perené, Tapiche, Pebas, Iquitos and São Paulo de Olivença belong to this form. It is interesting that it seems to occur in isolation, since less extreme forms are unknown from these localities. There are reasonably long series from Mocoa and Pucallpa which show a good range of colour variation, but do not include the extreme form. The phenomenon affects other species in different localities. For example, a female *richardsi* from Satipo represents the extreme, pale form, while a female *rufiventris* from the same locality does not.

The females of all the red-and-black species show the same general tendency to become paler westwards along the Amazon, but to differing degrees. In *cooperi*, for example, the tendency is already strongly evident at 55° W., but not until further west in other species. Although males follow the same general trend, they are darker on average, and extreme, pale forms are unknown.

Biology. Eberhard (1972) noted interactions between individuals of *cameronii* while they were provisioning nests. This is of particular interest in that the behaviour may be described as subsocial. With reference to the same species, Eberhard (1974) gave the most comprehensive account of biology in the genus, including comparisons with certain species of other genera.

So far as is known, all species of *Trigonopsis* prey on cockroaches (apparently usually nymphs) except for *grylloctonus* and *rufiventris*, reported to prey on crickets (Richards, 1937 : 111, and the present study, p. 134). The prey are stored in cells made of mud, several in each cell. Nests consist of one to many cells and are attached to a great variety of forest substrates above ground level, of various degrees of stability. Usually only small nests are found under leaves, so that larger species tend not to choose such places. However, when smaller species choose firmer sites such as rock-faces, they usually make much larger nests than otherwise. On rock-face and tree-trunk sites, large numbers of cells often agglomerate and old ones are frequently renovated for re-use. Variation in the surface structure of mud added after the cells are completed may possibly serve the purpose of camouflage. The cell axes are always parallel and normally horizontal, those recorded by Richards (1937 : 109–110) being exceptional. Up to 4 cells may be placed in a single row but they form a bundle if more numerous. Further collecting is desirable to establish how the size and structure of nests varies according to species, site and region. At least some species belonging to different groups have differently shaped cocoons (Figs 36–39).

FUNCTIONAL MORPHOLOGY. Eberhard (1974 : 304–307) has already suggested how the clypeus and mandibles interact when *cameronii* catches and carries its prey. The sharp sides of the cockroach prey are well gripped during capture by the mandibular notches of the female wasp. Subsequently, these notches oppose the clypeal tooth gaps to grip the palpi of the prey, and prevent it slipping forwards or backwards between the wasp's legs, which hold it during the flight to the nest. A comparison of different species and species-groups reveals interesting compensations. The clypeal teeth of the *intermedia*-group species are usually very blunt and irregular, but the mandibles have broad notches and are the stoutest in the genus. However, most species of the *rufiventris*-group have very long, sharp, clypeal teeth, and mandibles with a strong expansion before a narrow notch, whose effect is further enhanced by the sharp bend of the mandible around it. The clypeal teeth of *violascens* are more variable and often less sharp, but the mandibular expansion is distinctly angulate. Related genera, which never have a mandibular notch, solve the problem of grip in two ways. *Podium* females have slender mandibles but many clypeal teeth, while those of *Penepodium* usually have stouter mandibles, which are angulate below, and only 2 clypeal teeth. (See also *rufiventris*-group notes.)

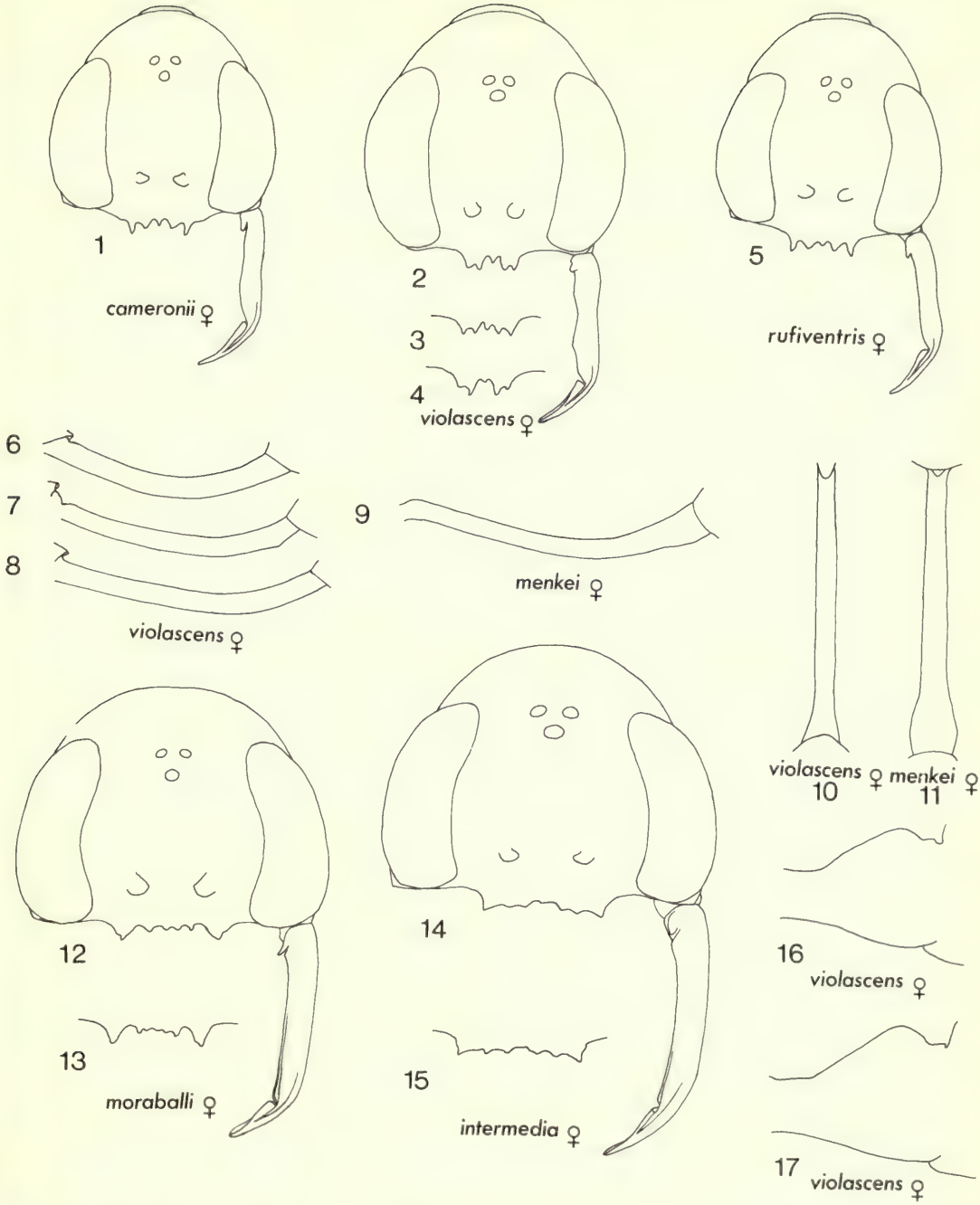
Key to species

It is important to open the mandibles, especially of females. Mandibular expansions are best observed dorsolaterally.

Females

The female of *grylloctonus* is unknown.

1 Body entirely dark, with violet-blue metallic lustre 2
– Head and thorax black, gaster except petiole red (sometimes dark red) 3
2 Pronotal dorsum in profile shallowly, evenly convex. Petiole of even width (Fig. 1). (West of the Andes, north to Mexico) . . . . . ***cameronii*** (Kohl) (p. 136)
– Pronotal dorsum in profile with weak, angular projection posteriorly (Figs 16, 17). Petiole slightly expanded posteriorly (Figs 2–4, 6–8, 10). (Widespread east of the Andes) ***violascens*** (Dalla Torre) (p. 131)
3 Pronotal dorsum in profile shallowly, evenly convex 4
– Pronotal dorsum in profile with sharply angulate projection posteriorly 6
4 Petiole with small but distinct expansion just before junction with tergite 1 (Figs 9, 11) ***menkei*** sp. n. (p. 133)
– Petiole of even width 5
5 Pronotal dorsum with shallow but distinct longitudinal groove . . ***howesi*** sp. n. (p. 138)
– Pronotal dorsum with at most an indistinct longitudinal groove ***rufiventris*** (Fabricius) (p. 133)
6 Clypeus with 6 or more teeth, outermost pair strongly bent forward, those between often weak or irregularly spaced. Mandible stout, evenly tapered, with large notch (Figs 12–15, 22, 23) 7



Figs 1–17 *Trigonopsis* spp. (1–5) heads and clypeal variants. (6–11) petioles. (6–9) left side. (10, 11) dorsal view. (12–15) heads and clypeal variants. (16, 17) pronota, left side.

– Clypeus with 4 or 5 teeth, usually well formed and regularly spaced, outermost pair frequently weakly bent forward or straight. If mandible stout, inner side at least slightly expanded before notch, which is often small 9

7 HW at least 4·4. BL 22–27. Mandibular inner margin without basal spine. CTW at least 1·5 (Figs 14, 15) . . . . . ***intermedia*** Saussure (p. 143)

– HW at most 4·5. BL 13–22. A small, basal spine or tooth present on mandibular inner margin. CTW at most 1·5 8

8 4 smaller teeth of clypeus fairly equal in size and spacing. HW 4·1–4·2. Mandibular notch not overhung by a carina, apical part of mandible much more slender than basal (Figs 12, 13) ***moraballi*** Richards (p. 145)

– 4 smaller teeth of clypeus often irregular, centre pair separated by a wide, shallow gap which is sometimes filled by a blunt, vestigial seventh tooth. HW 4·3–4·5. Mandibular notch partly overhung by a strong carina, apical part of mandible evenly tapered with basal (Figs 22, 23) ***cyclocephalus*** Smith (p. 144)

9 Outermost pair of clypeal teeth equal to or slightly shorter than adjacent pair. Mandible with notch small and step-like, before which the inner margin is moderately expanded (Figs 18–20, 24, 25) 10

– Outermost pair of clypeal teeth distinctly longer than adjacent pair. Mandible often not as above 11

10 BL 22–26. CR 1·8–2·2. PL 3·7–4·4. Propodeal dorsum with coarse rugae outside central groove, which is deep throughout. Small, basal spine on mandibular inner margin rather broad, rounded at tip. Top of pronotal projection very strongly raised, in profile with distinct concavity in front (Fig. 28). Wings strongly amber-tinted, stigma pale. Clypeus with 2 central gaps between teeth deeper than outer ones. HW 3·8–4·6 (Figs 24, 25) ***succinea*** sp. n. (p. 149)

– BL 19–20. CR 2·7–2·9. PL 2·9–3·2. Propodeal dorsum with fine rugae outside central groove, which is shallow anteriorly. Small basal spine on mandibular inner margin narrower, sharply pointed. Top of pronotal projection less strongly raised, scarcely concave in front (Fig. 27). Wings not amber-tinted, stigma dark brown, most veins dark. Clypeus with 2 central gaps equal to or shallower than outer ones. HW 3·7–3·9 (Figs 18–20) ***neotropica*** sp. n. (p. 147)

11 Antennal segment 3 longer than 4 and 5 together. Mandible slender, evenly tapered, rather strongly curved, with distinct, U- to V-shaped notch. MR 1·9–3·2. Clypeus with 2 large teeth and 3 smaller ones between (Figs 21, 26) 12

– Antennal segment 3 not longer than 4 and 5 together. Mandible variously shaped but not as above, notch sometimes small or vestigial. MR at least 2·4. Clypeus not always as above . 13

12 MR 2·7–3·2 (–5·6) MIW 2·2–2·4 times CTW. Antennal segment 3 is 2·5–2·8 times as long as 6. CR 1·3–1·6. Centre tooth of clypeus equal to or slightly longer than adjacent pair. BL 16–19. HW 3·1–3·7 (Fig. 21) . . . . . ***vicina*** (Dalla Torre) (p. 141)

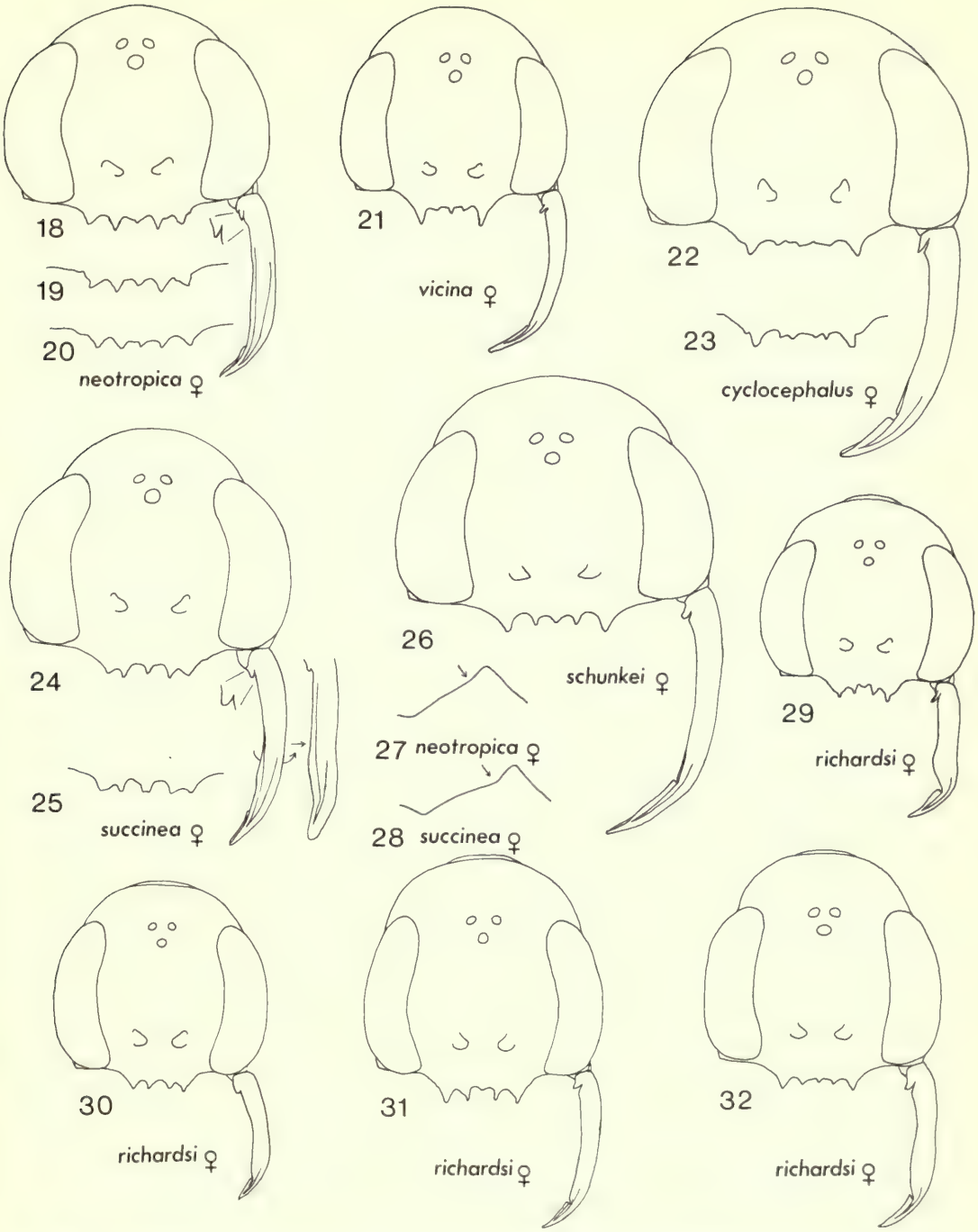
– MR 1·9–2·3. MIW 1·7–2·1 times CTW. Antennal segment 3 is 2·9–3·3 times as long as 6. CR 1·6–2·1. Centre tooth of clypeus equal to or shorter than adjacent pair. BL 18–22. HW 3·7–4·4 (Fig. 26) . . . . . ***schunkei*** sp. n. (p. 142)

13 HW 2·8–3·5, at most 0·1 more than HL. Occipital carina ± expanded into a thin, lamellar flange, often translucent. BL 13–17. Mandibular inner margin ± strongly expanded before V-shaped notch. Mandible usually sharply bent at notch and abruptly tapered after it, upper edge of apex inflexed near notch (Figs 29–32) . . . . . ***richardsi*** sp. n. (p. 140)

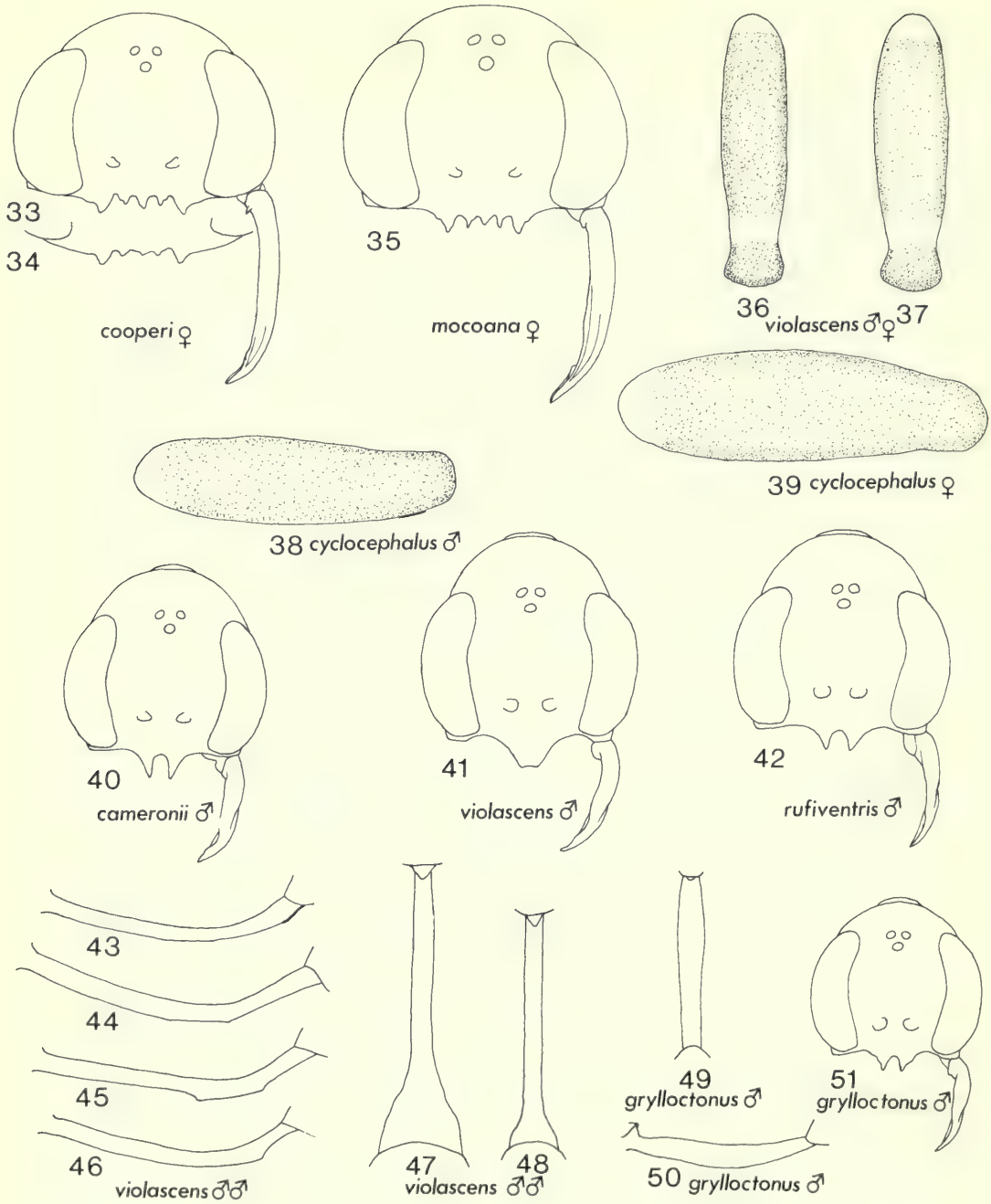
– HW 3·5–4·0, at least 0·66 more than HL. Occipital carina very strong but not forming a flange. BL 17–20. Mandibular inner margin at most moderately expanded before step-like notch. Mandible often shallowly bent at notch, rarely abruptly tapered after it. Upper edge of apex not inflexed 14

14 Mandible stout, inner margin moderately expanded before notch, which is small but distinct. MR 3·4–3·8. EL 2·2–2·3. Toothbearing area of clypeus more projecting, margin outside teeth at steep angle, so that CR is 1·3–1·7; all clypeal teeth bent forward, outermost pair most strongly (Fig. 35) . . . . . ***mocoana*** sp. n. (p. 149)

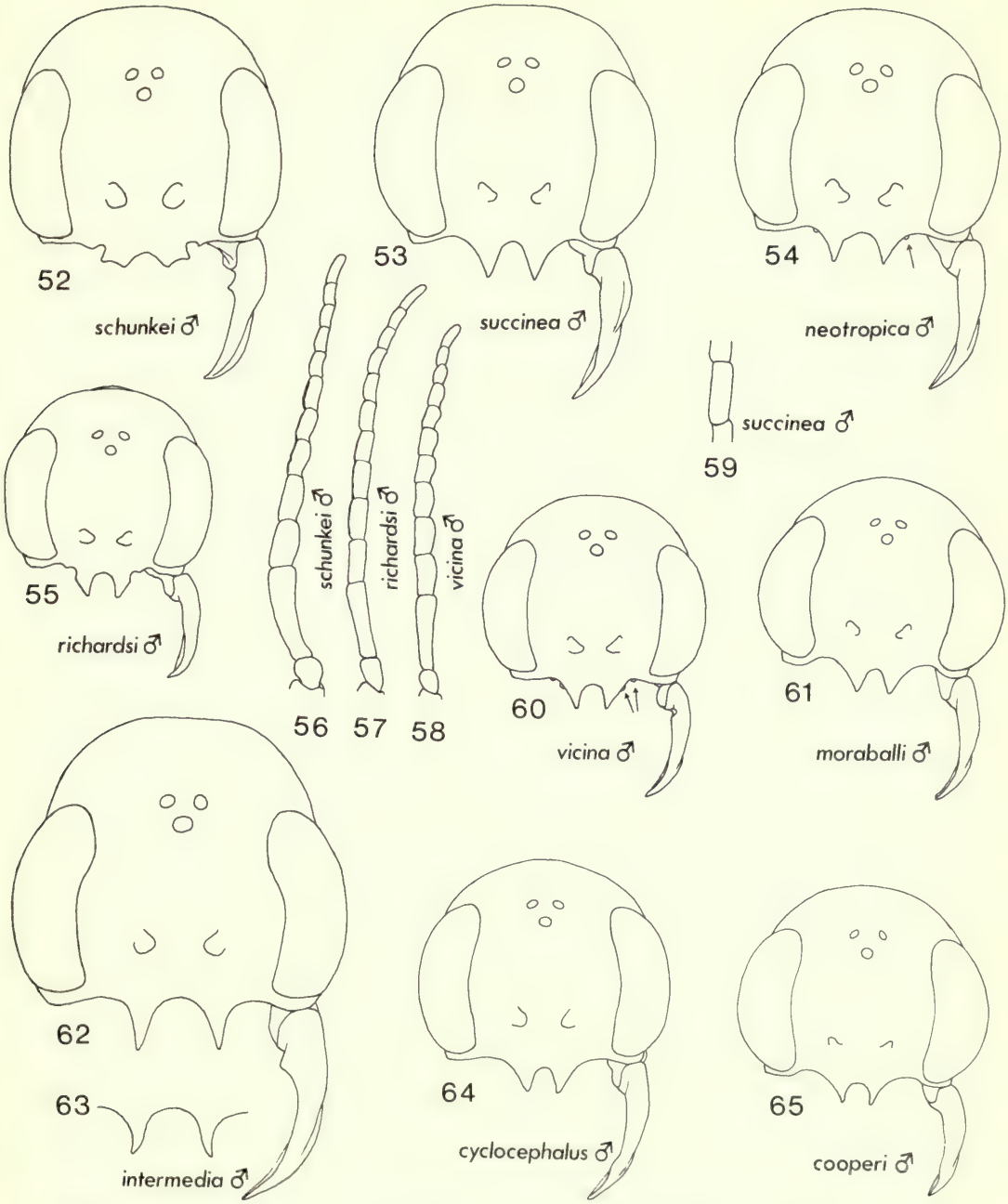
– Mandible slender, evenly tapered, notch vestigial. MR 3·6–5·5 (–7·3). EL 2·0–2·3. Toothbearing area of clypeus less projecting, margin outside teeth at shallower angle (where almost sympatric with *mocoana*, forming a broad, translucent lamella), so that CR is 1·8–2·7; only outermost pair of teeth bent forward, contrasting with others (Figs 33, 34) ***cooperi*** sp. n. (p. 150)



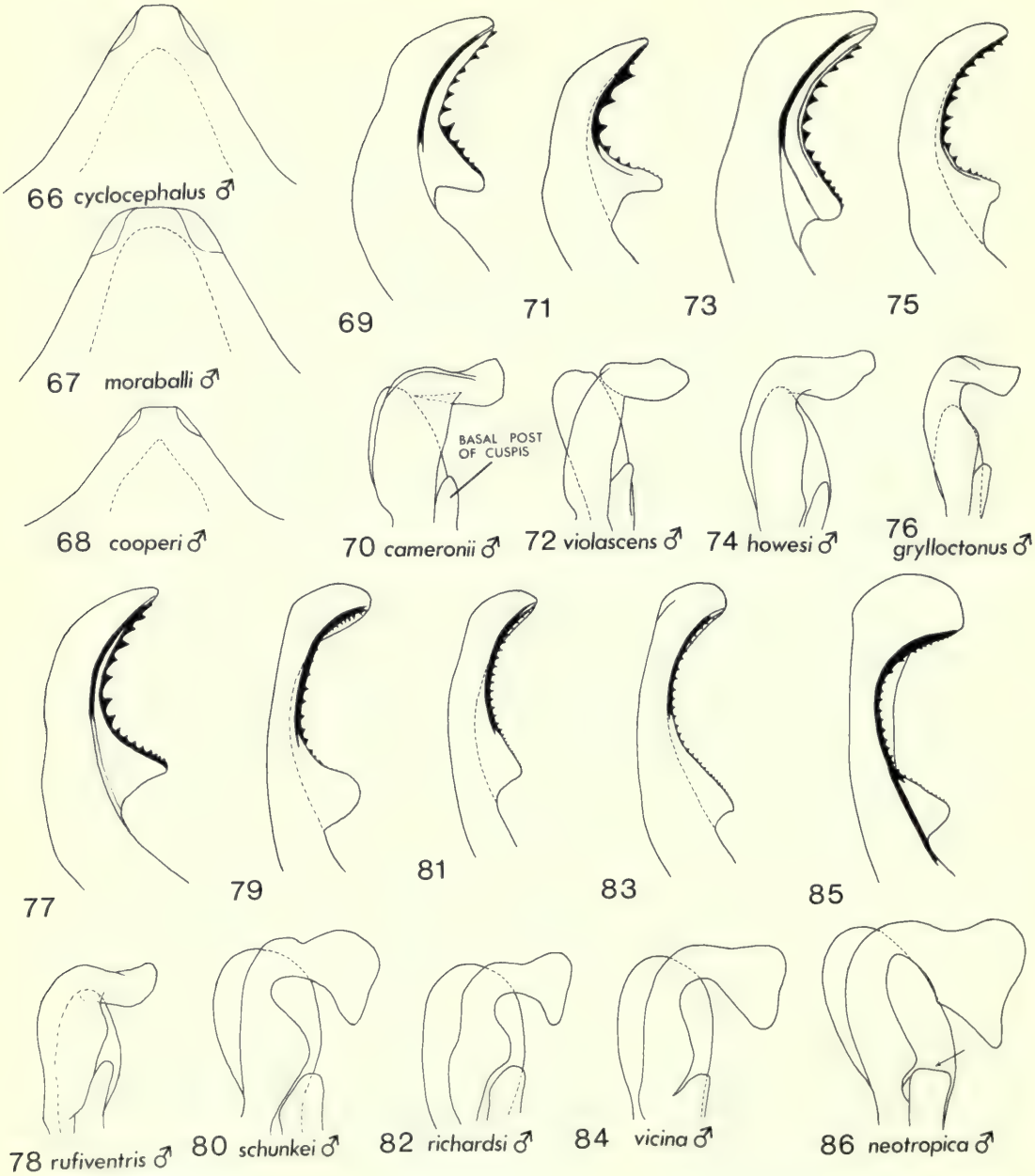
Figs 18–32 *Trigonopsis* spp. (18–26) heads and clypeal variants. (27, 28) pronotal dorsa, left side. (29–32) heads.



Figs 33–51 *Trigonopsis* spp. (33–35) heads and clypeal variants. (36–39) cocoons. (40–42) heads. (43–50) petioles showing (43–46) left side; (47–49) dorsal view; (50) left side. (51) head.



Figs 52–65 *Trigonopsis* spp. (52–55) heads. (56–59) antennae. (60–65) heads and clypeal variants.



Figs 66–86 *Trigonopsis* spp. (66–68) sternites 8. (69–86) aedeagi and volsellae.

Males

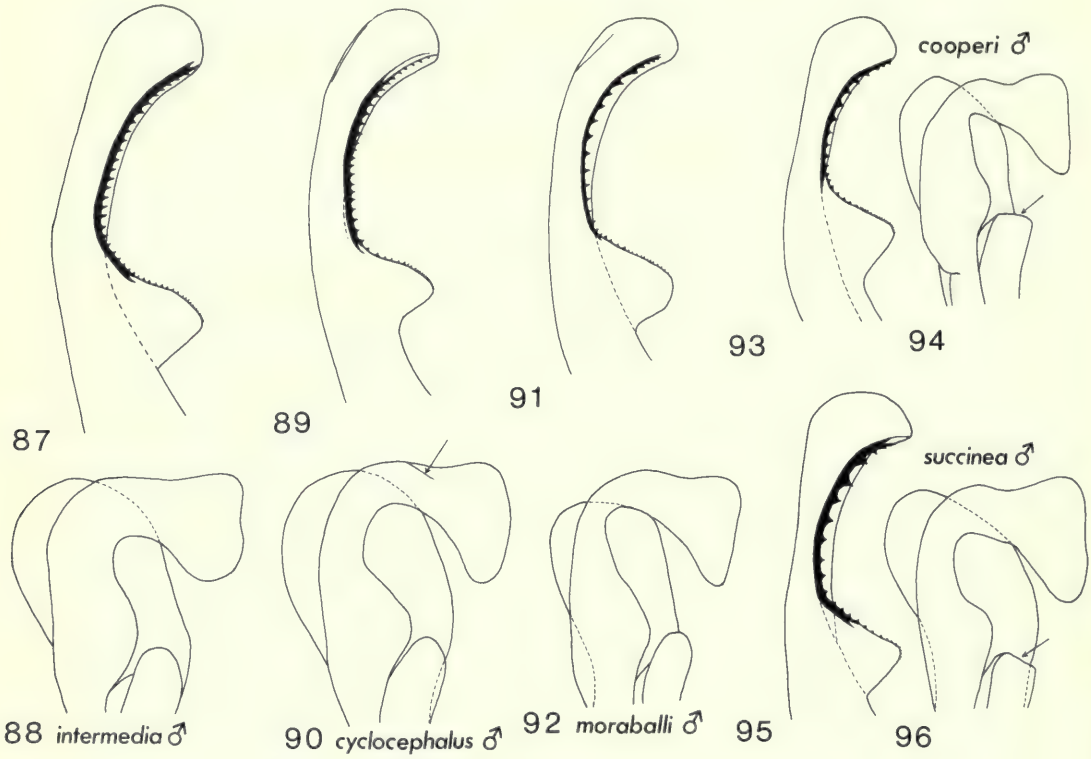
The males of *menkei* and *mocoana* are unknown.

1 Body entirely dark, with violet-blue reflections 2
– Head and thorax black, gaster except petiole red (sometimes dark red) 3
2 Clypeus with 2 large, sharp teeth (Fig. 40). Pronotal dorsum in profile shallowly, evenly convex. Petiole in dorsal view of uniform width throughout. Genitalia as in Figs 69, 70. (West of the Andes, north to Mexico) . . . . . ***cameronii*** (Kohl) (p. 136)
– Clypeus with large, central truncate projection (Fig. 41). Pronotal dorsum in profile, with weakly angular posterior projection (cf. Figs 16, 17). Petiole in dorsal view, strongly expanded at junction with tergite 1 (Figs 43–48). Genitalia as in Figs 71, 72. (Widespread east of the Andes) . . . . . ***violascens*** (Dalla Torre) (p. 131)
3 Pronotal dorsum in profile, shallowly, evenly convex 4
– Pronotal dorsum in profile, with sharply angulate projection posteriorly 6
4 Petiole strongly expanded in middle (Figs 49–51). Genitalia as in Figs 75, 76 ***grylloctonus*** Richards (p. 139)
– Petiole of even width throughout 5
5 Pronotal dorsum with shallow longitudinal groove. Genitalia as in Figs 73, 74 ***howesi*** sp. n. (p. 138)
– Pronotal dorsum without any trace of a longitudinal groove (Fig. 42). Genitalia as in Figs 77, 78 . . . . . ***rufiventris*** (Fabricius) (p. 133)
6 Clypeus with 2 large, rectangular, divergent lobes. Mandibular inner margin with sub-basal tooth (Fig. 52).
Antennae as in Fig. 56. Genitalia as in Figs 79–80 . . . ***schunkei*** sp. n. (p. 143)
– Clypeus with 2 large, sharp teeth, its tooth-to-orbit margin with at most a notch. Mandibular inner margin sometimes with sub-basal tooth 7
7 Antennal segments moderately to strongly dorsoventrally flattened, their junctions offset in lateral view (Fig. 59). Mandibular inner margin without sub-basal tooth 8
– Antennal segments almost perfectly cylindrical, their junctions not or scarcely offset in lateral view. Mandibular inner margin sometimes with sub-basal tooth 11
8 Clypeal tooth-to-orbit margin entire and without any tubercles behind (view from below) (Fig. 53). BL 17–20, HW 3·3–3·8, HL 3·0–3·5, PL 2·7–3·8.
Genitalia as in Figs 95, 96 . . . . . ***succinea*** sp. n. (p. 149)
– Clypeal tooth-to-orbit margin with at least 2 tubercles behind (view from below), sometimes also with a deep notch visible in front view. BL 13–18, HW 2·7–3·6, HL 2·7–3·3, PL 2·3–2·9 9
9 Clypeal tooth-to-orbit margin in front view, with a deep U-shaped notch. Seen from below, sides of notch are tuberculate behind, and outer tubercle is connected to a third one still further back (Fig. 55). Antennal segments 5 and 6 slightly expanded (Fig. 57).
Genitalia as in Figs 81, 82 . . . . . ***richardsi*** sp. n. (p. 140)
– Clypeal tooth-to-orbit margin almost entire in front view but seen from below, base of outer side of each tooth is tuberculate behind. Beyond it, and behind tooth-to-orbit margin but not forming part of it, is another tubercle. The two tubercles together form a deep notch, and tip of second is just visible in front view. Antenna not as above (Figs 54, 60) . . 10
10 Antennal segments 5–10 strongly expanded (Fig. 58). Eyes strongly divergent downwards (Fig. 60). Genitalia as in Figs 83, 84 . . . . . ***vicina*** (Dalla Torre) (p. 141)
– No antennal segments expanded, only flattened. Eyes scarcely divergent downwards (Fig. 54). Genitalia as in Figs 85, 86 . . . . . ***neotropica*** sp. n. (p. 147)
11 Mandibular inner margin with sub-basal tooth. BL 19·5–23·0, HW 3·9–4·5, CTW 0·90–1·05, CDR 1·4–1·7, CR 0·9–1·1 (Figs 62, 63)
Genitalia as in Figs 87, 88 . . . . . ***intermedia*** Saussure (p. 143)
– Mandibular inner margin without sub-basal tooth. BL 15·0–19·0, HW 3·1–3·7, CTW 0·30–0·40, CDR 0·9–1·1, CR 0·40 12
12 TOD 0·85–0·97, PDL 1·8–2·2, third antennal segment 1·1–1·3 long and 1·8–1·9 times as long as the first, eyes slightly divergent below, CED 0·35–0·40, HL 2·8–3·2, HW 3·1–3·7, CTW 0·35–0·40, PL 2·3–3·0 (Fig. 63) (Upper Amazon).
Sternite 8 as in Fig. 66. Genitalia as in Figs 89, 90 . . ***cyclocephalus*** Smith (p. 145)
– TOD 0·70–0·77, PDL 1·7–1·9, antennal segment 3 is 0·9–1·0 long and 1·5–1·6 times as long as the first, eyes parallel or slightly convergent below, CED 0·27–0·32, HL 2·8–2·9, HW 3·1–3·3, CTW 0·30–0·35, PL 2·4–2·6. (Amazon and Guyana) 13
13 MIW 0·35 more than UIW, PDL 1·7–1·8, PL 2·4–2·5, CTW 0·35, CED 0·32 (Fig. 61). Sternite

8 rather sharply keeled, its tip broadly rounded (Fig. 67). Genitalia as in Figs 91, 92 (Guyana) . . . . . ***moraballi*** Richards (p. 146)

MIW 0·15–0·20 more than UIW, PDL 1·8–1·9, PL 2·6, CTW 0·30–0·32, CED 0·27–0·30 (Fig. 65). Sternite 8 obtusely keeled, its tip narrowly truncate (Fig. 68). Genitalia as in Figs 93, 94. (Amazon mainstream from Tena to Piauí, and East Peru) . ***cooperi*** sp. n. (p. 150)

N.B. The last three males are extremely similar externally, although *cooperi* is easily distinguished by its genitalia. The differences between the genitalia of *cyclocephalus* and *moraballi*, although slight, appear to be constant.



Figs 87–96 *Trigonopsis* spp., aedeagi and volsellae.

The *rufiventris*-group

Unique characters are: complete or almost complete lack of transverse rugae outside the central furrow of the propodeal dorsum in both sexes, and bifid sternite 8 and distinctive genitalia of the males. Further characters are: small, slender species with HR of 1·0 or less, very broad occipital flange. Female mandible sharply bent, inner margin with V-shaped notch and strong expansion before it, 5 usually sharp clypeal teeth, sternite 6 sharply keeled. Cuspis of male genitalia with round-ended basal post. Dark parts, at least of legs, ± metallic in all species.

Within the group, *violascens* is distinguished by the dorsal pronotal projection, lacking in the other species. Its male is further distinguished by the unique shape of its clypeus and petiole, and has the most distinct genitalic structure in the group. The female mandibular expansion, rounded in the other species, is angulate and the clypeal variation considerably greater.

This group is by far the most common and widespread of all. It contains the only species found west of the Andes. It includes all the known metallic species, and it is interesting that both of the entirely metallic-coloured species have a greater altitude range than any others of the genus. The

group also includes the only species which lack a pronotal projection, and the single species known to have diverged in its prey choice. Furthermore, it appears that the group may recently have evolved rapidly, since with the exception of *violascens*, the species are very closely related (for example, the head ratios of the species of this group are much more uniform than those of the species of other groups). They are usually separated by small and often single structural characters, although sometimes also by considerable biological ones.

The species *rufiventris*, *cameronii* and *violascens* are apparently more common than any other *Trigonopsis*. Various factors may contribute to their frequency, such as: the unusual shape of the female mandibles and clypeus affording better grip of the prey; small average size reducing the need to find large or numerous prey; greater adaptability in choice of nesting site. Certainly *richardsi*, much the commonest species of the *vicina*-group, is very similar in at least the first two respects (its biology is unknown). The remaining species of the *rufiventris*-group, all of them apparently much less widely distributed, may represent specialized adaptations to certain very localized ecological niches.

Trigonopsis violascens (Dalla Torre)

(Figs 2–4, 6–8, 10, 16, 17, 36, 37, 41, 43–48, 71, 72, 99)

Trigonopsis violaceus Smith, 1851 : 31. Holotype ♂, Brazil (BMNH) [examined]. [Junior secondary homonym in *Sceliphron* Klug, of *Sphex violacea* F., 1775.]
Sceliphron violascens Dalla Torre, 1897 : 392. [Replacement name for *Trigonopsis violaceus* Smith.]
[*Podium* (*Trigonopsis*) *cameronii* Kohl, 1902 : 39, ♀ (part). Misidentification.]
Podium (*Trigonopsis*) *violaceum* Smith; Kohl, 1902 : 39, pl. 1, fig. 3, pl. 5, figs 55, 63 [not pl. 6, fig. 63 as stated in text], pl. 6, figs 70, 80, ♂.
Podium (*Trigonopsis*) *resplendens* Kohl, 1902 : 41, pl. 1, fig. 1, pl. 5, fig. 61, pl. 6, figs 72, 74 [actually an illustration of *violaceum*], pl. 7, fig. 85. Holotype ♀, Brazil (NM, Vienna) [examined]. [Synonymy by Richards, 1937 : 109.]
Trigonopsis violaceus Smith; Richards, 1937 : 109, 112.
Trigonopsis resplendens Kohl; Menke *in* Bohart & Menke, 1976 : 98.
Trigonopsis violascens (Dalla Torre); Menke *in* Bohart & Menke, 1976 : 98.

♀. BL 15·0–19·5 (but see below). Almost entirely dark, with blue-violet reflections, especially on head and gaster. Mandibular base stout, with angulate expansion on inner margin before the notch (Fig. 2). Even in tiny specimens, this angle is still represented by a point. Notch V-shaped, deep and narrow, proximally obtuse-angled, distally right-angled. Apex more slender than base, with upper edge strongly inflexed, especially near the notch. Pronotum with weakly angulate dorsal projection, of a shape different from that found in other species-groups (Figs 16, 17). Petiole slightly expanded at junction with gaster (Fig. 10). HW 2·8–3·4, HL 2·9–3·4, HR 0·9–1·0, EL 1·9–2·3, UIW 1·4–1·7, MIW 1·5–1·9, LIW 1·2–1·5, CTW 0·6–0·8, TOD 0·4–0·6, CR 1·1–1·6, MBL 1·3–1·9, MAL 0·4–0·8, MR 1·8–3·0, PDL 1·8–2·3, PL 2·6–3·3, PR 1·1–1·5. An exceptionally small specimen from the Mato Grosso differs as follows: BL 10·5, HW 2·0, HL 1·9, EL 1·4, UIW 1·0, MIW 1·1, LIW 0·8, CTW 0·4, TOD 0·3, MBL 1·0, MR 3·5, PDL 1·0, PL 1·6.

♂. BL 15·0–22·0. Inner margin of mandible always with middle and pre-apical expansions, the latter stronger (Fig. 41). Clypeus with a large, narrowly truncate projection (Fig. 41). (Because of its unusual shape it was not measured.) Pronotum with a very weakly angular projection (cf. Fig. 16). Petiole strongly expanded at junction with gaster (Figs 47, 48). Genitalia Figs 71, 72. HW 2·6–3·8, EL 1·6–2·2, UIW 1·3–2·1, MIW 1·4–2·3, LIW 1·2–2·1, PDL 1·6–2·6, PL 2·8–3·7, PR 1·4–1·8. Otherwise as ♀.

This species is like *cameronii* in colour, but is nowhere sympatric with it.

Variation. The truncated end of the male clypeal projection is often ± emarginate. In the female clypeus, the centre tooth varies from well-developed (about half the length of the outermost) to vestigial. The adjacent teeth vary considerably in length, from intermediate between the centre and outermost, to much longer than the outermost. As the latter extreme is approached, the outer pair of gaps becomes much shallower so that the clypeus takes the form of two bifid projections with a small tooth between, and also the mandibular expansion becomes more sharply angulate

(Figs 2–4). The projection on the pronotal dorsum, more broadly based than that found in other species-groups, is normally low. On average, it is stronger in the Guianas (Fig. 16) and still more so towards the Andean foothills (Fig. 17). The depth of the cleft in the apex of the projection also varies, but in a less clear pattern. The normally medium-sized punctures of the mesoscutum are occasionally very fine. The gastral petiole, normally rather strongly upcurved distally, is sometimes extremely strongly curved, when it also appears thicker than usual. Ventrally, it has 0–2 rather strong angles in males (Figs 43–46) and sometimes a single weak one in females (Figs 6–8). In a male from Leticia the apex of sternite 8 has a single, central spine instead of being bifid. In all this variation it has not so far been possible to find any consistently coinciding aspects which could indicate the existence of more than a single species.

Distribution. Very widespread east of the Andes, ascending to about 850 m, higher than any other species in that area (map, Fig. 99). This and *neotropica* are the only species so far recorded from the Mato Grosso (see also discussion under *cameronii* distribution).

Biology. Cooper found the following nests. Colombia: Putumayo, Alto Afan near Mocoa, 19.vi.1974: nest with smooth surface, on rock face. Wasp sitting on nest with four empty cells. Indistinguishable from *rufiventris* nest nearby. Amazonas, Leticia, 20.viii.1974: three large nests attached to rootlets of fallen tree. Two nests (preserved in BMNH) measure about 65 mm high, 42 mm along the cells and 30 mm across them with about 9 cells, and 60 × 27 × 30 mm with about three cells. The overall shape is rather like that of a hanging pear, with an upper mass of mud acting as a holdfast, and the cells fixed horizontally below it. The extra mud covering the cells is rough, solid and irregular, overlaid by very many loose pellets. Cockroach prey taken from one of these nests consisted of Blattellidae: 2 nymphs of 1 sp., gen. indet. (det. Gurney). Mocoa, 23.iii.1974, suspended from a rootlet under a bank. It had about five cells and (possibly due to age) a smooth surface. The considerable difference in the form of the final nest-covering used between the two kinds of nesting-site (rock-face and rootlet) would be consistent with its serving the purpose of camouflage.

The cocoons were narrow, black, with two bands of white fibrous material (Figs 36, 37).

Richards (1937 : 109) refers to a Dipterous parasite *Amobia* (as *Pachyophthalmus*) *floridensis antillarum* Richards, bred from a nest of this species in Trinidad.

Material examined. Dates and collectors' names omitted.

Trigonopsis violaceus Smith, holotype ♂, Brazil: Pará, Belém (*Wallace & Bates*) (BMNH). *Podium* (*Trigonopsis*) *resplendens* Kohl, holotype ♀, Brazil: no further data (NM, Vienna).

French Guiana: 1 ♂, Tollinche, River Maroni; 1 ♀, no further data (MNHN, Paris); 1 ♀, no further data (NM, Vienna) (paralectotype of *cameronii*); 1 ♀, no further data (MHN, Geneva). Surinam: 2 ♀, 1 ♂, Malaise trap (RNH, Leiden). Guyana: 1 ♀, Bartica (ANS, Philadelphia); 1 ♀, Essequibo River, Moraballi Creek (*c.* 30 km SE. Bartica) (BMNH). Trinidad: 1 ♀, St Augustine (USNM, Washington); 1 ♀, 9 km N. Arima, 440 m; 3 ♀, no further data (BMNH). Colombia: 1 ♀, 1 ♂, Amazonas, Leticia; 1 ♀, Amazonas, R. Igara Paraná, La Chorrera (mislabelled 'Peru, Putumayo District') (CU, Ithaca); 2 ♀, 1 ♂, Putumayo, Mocoa; 2 ♀, Putumayo, Alto Afan, 7 km NE. Mocoa; 3 ♀, 3 ♂, Meta, Cord. Macarena (BMNH); 1 ♀, further data illegible (UM, Oxford). Peru: 2 ♀, Huánuco, Tingo Maria (BMNH); 1 ♀, same locality (Menke coll.); 1 ♀, same locality (Fritz coll.); 1 ♀, same locality, 620 m (MCZ, Harvard); 1 ♀, Huánuco, Tingo Maria (Rio Huallaga), 700 m (IML, Tucumán); 1 ♀, Huánuco, Cord. Azul, Previsto, 850 m (BMNH); 1 ♀, Huánuco, Pachitea (TM, Budapest); 1 ♂, Huánuco, Monzon (Menke coll.); 1 ♀, Cuzco, Rio Cosñipata Valley, Hacienda Maria, 400 m (IML, Tucumán); 1 ♀, Junín, Chanchamayo (USNM, Washington); 1 ♀, 1 ♂, same data (Menke coll.); 1 ♀, Amazonas, Rio Santiago (AMNH, New York). Bolivia: 1 ♀, La Paz, Coroico (*c.* 500 m) (MNHU, Berlin). Brazil: 2 ♀, Mato Grosso, 12.50 S., 51.47 W., one reared iii.1968 from mud cells, side of shallow pit; the other on mud pit, cerradão, 11.ii.1968 (BMNH); 1 ♀, Pará, Belém (RNH, Leiden); 1 ♀, Pará, R. Arrayolos (MP, Belém); 1 ♀, Amazonas, R. Japurá (MP, Belém); 1 ♂, no further data (UM, Oxford); 2 ♂, no data (USNM, Washington); 1 ♂, no data (NM, Vienna).

Trigonopsis menkei sp. n.

(Figs 9, 11, 99)

♀. BL 22–24. Pronotum without dorsal projection. Gaster red. Petiole with small but distinct lateral expansion just before junction with gaster (Figs 9, 11). HW 3·8–4·1, HL 3·9–4·2, HR 0·9–1·0, EL 2·6–2·7, UIW 1·7–1·8, MIW 2·0–2·2, LIW 1·7–1·9, CTW 0·8–1·0, TOD 0·7–0·85, CR 1·1–1·2, MBL 2·0–2·1, MAL 0·8–1·4, MR 1·5–2·3, PDL 2·7–2·9, PL 3·7–3·9, PR 1·3–1·4. Otherwise as *rufiventris*.

♂. Unknown.

This species differs from its close relatives only in petiole shape.

VARIATION. Mainly in clypeus, as in *rufiventris*.

DISTRIBUTION. Iquitos and near Tena only (map, Fig. 99).

BIOLOGY. Unknown.

MATERIAL EXAMINED. Holotype ♀, ECUADOR: Napo, Río Jatún Yacu (1.04 S., 77.48 W.), 700 m (*MacIntyre*) (MCZ, Harvard).

Paratypes. ECUADOR: 1 ♀, same data as holotype (BMNH). PERU: 1 ♀, Loreto, Iquitos (*Bassler*) (AMNH, New York); 1 ♀, Loreto, Iquitos, 4.viii.1906 (*Ducke*) (MP, Belém).

Trigonopsis rufiventris (Fabricius)

(Figs 5, 42, 77, 78, 97)

Podium rufiventre Fabricius, 1804 : 184. Holotype ♀, SOUTH AMERICA (UZM, Copenhagen) [examined].
Trigonopsis abdominalis Perty, 1833 : 142, pl. 27, fig. 18. Holotype ♀, SOUTH AMERICA (ZSBS, Munich) [examined]. [Synonymy by Smith, 1856 : 226.]
Trigonopsis haemorrhoidalis Smith, 1856 : 226, 479. [Unavailable name, inadvertently published in the synonymy of *Podium rufiventre* F.]
Trigonopsis soror Mocsary, 1883 : 23. Holotype ♀, BRAZIL (TM, Budapest) [examined]. [Synonymy by Kohl, 1902 : 37.]
Trigonopsis frivaldskyi Mocsary, 1883 : 23. Holotype ♀, BRAZIL (TM, Budapest) [examined]. [Synonymy by Kohl, 1902 : 37.]
Trigonopsis rufiventris (Fabricius); Menke *in* Bohart & Menke, 1976 : 98.
Trigonopsis soror Mocsary; Menke *in* Bohart & Menke, 1976 : 98.

♀. BL 15–23. Occipital carina flange-like. Pronotal dorsum without projection and with at most an indistinct longitudinal groove. Gaster red. Petiole of even width. HW 2·7–3·9, HL 2·7–4·2, HR 0·9–1·0, EL 1·9–2·6, UIW 1·3–1·7, MIW 1·5–2·0, LIW 1·2–1·7, CTW 0·65–0·85, TOD 0·50–0·75, CR 1·1–1·6, MBL 1·35–1·90, MAL 0·7–1·3, MR 1·5–1·9 (−2·1), PDL 1·8–2·9, PL 2·5–4·0, PR 1·3–1·6. (Fig. 5.)

♂. BL 13·5–19·0. Clypeus with two large, sharp teeth. Pronotum with at most the slightest trace of a longitudinal groove. Genitalia as in Figs 77, 78. HW 2·6–3·3, HL 2·6–3·5, HR 0·9–1·0, EL 1·8–2·3, UIW 1·3–1·7, MIW 1·4–1·8, LIW 1·2–1·6, CTW 0·25–0·32, CED 0·22–0·35, CER 0·9–1·3, TOD 0·57–0·75, CR 0·4–0·5, PDL 1·6–2·4, PL 2·7–3·7, PR 1·3–1·7. (Fig. 42.) Otherwise as ♀.

This species differs from *cameronii* in colour and distribution, and from other close relatives in its unmodified pronotum and petiole.

VARIATION. The females show much variation. The five clypeal teeth and the gaps between them may be subequal; sometimes the outer two pairs of teeth are longer and the centre one reduced (Fig. 5). The tooth-to-orbit margin is normally straight, but occasionally may be strongly convex near the tooth. The propodeal dorsal and posterior faces normally form an obtuse angle at their junction, but occasionally merge in a shallow curve. The propodeal dorsum of large specimens occasionally bears traces of transverse rugae also outside the central furrow. Only three males of the seventeen examined had the inner mandibular margin with a preapical expansion, and none had a middle expansion (Fig. 42). (Cf. *violascens* Fig. 41.)

(For details of colour variation see general discussion p. 121.)

DISTRIBUTION. Widespread east of the Andes, from Colombia to the Guianas in the north, and south to Peru in the west and Rio de Janeiro in the east (map, Fig. 97).

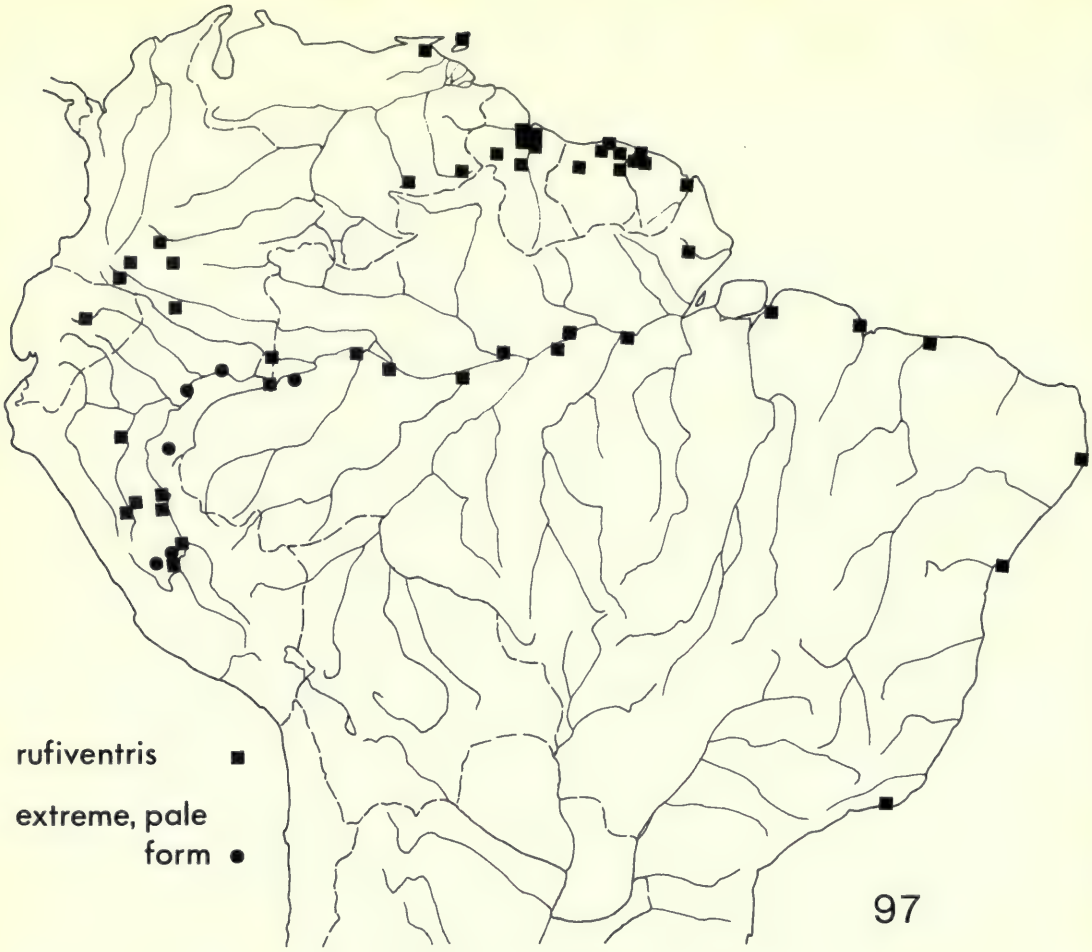


Fig. 97 Collection localities of *T. rufiventris*.

BIOLOGY. Arlé (1933) described nests of 2–12 cells built on rock-faces, just south of Rio de Janeiro. The cells were invariably horizontal, with a rough mud covering. Cockroach nymphs were used as prey. *Photocryptus apicalis* Schmiedeknecht (Ichneumonidae) was a parasite.

Williams (1928 : 115) found two nests near Tena, Ecuador, each fastened to the underside of a palm leaf near the ground. The prey were cockroaches.

Richards (1937 : 109) found two incomplete nests in Guyana, Essequibo River, Moraballi Creek (*c.* 30 km SE. Bartica). One was on a tree branch and had six cells (possibly built by two females), the other was under the roots of a fallen tree and had four cells. Both nests were about 1·3 m from the ground and had the cells 'mouths upwards'. (This is the only record of vertical orientation.) The cell building method was identical to that described by Eberhard (1974) for *cameronii*. Cockroaches, of which at least one was adult, were used as prey.

Cooper found nests in Colombia: Mocoa attached to a vertical tree trunk; to the underside of a fallen tree; and to the underside of a palm leaf. The last nest had only just been begun, but the other two were rather large, with a smooth surface.

Cocoons were similar to those of *violascens* (cf. Figs 36–37).

A female wasp, taken at Mocoa on 1.vi.1976 by Cooper, was walking over and around several old and new nests built on the sides and underside of a boulder on the ground. In one cell in each of two nests was a mixture of cockroach and cricket prey. These were named by Gurney as

follows. First cell: Gryllidae, 2 ♂, 2 ♀ *Anaxipha* sp. nr *peruviana* (Saussure); Blattellidae, 3 nymphs, all of different species, 1 *Chorisoneura* sp., 2 gen. indet. Also 1 adult ♀ *Anaplecta* sp. Second cell: Gryllidae, 1 nymph Eneopterinae, gen. indet.; Blattellidae, 1 ♂ *Calhypnorna* sp. Only *T. grylloctonus* has hitherto been reported as preying on crickets. However, it is not certain that the present wasp was involved with any of the cells near which it was found. Further observation is needed to establish whether *T. rufiventris* also sometimes takes crickets.

MATERIAL EXAMINED. Dates and collectors' names omitted.

Podium rufiventris Fabricius, holotype ♀, GUYANA: Essequibo (*Smidt*) (UZM, Copenhagen). *Trigonopsis abdominalis* Perty, holotype ♀, BRAZIL (ZSBS, Munich). *Trigonopsis soror* Mocsary, holotype ♀, BRAZIL: Amazonas, São Paulo de Olivença (TM, Budapest). *Trigonopsis frivaldskyi* Mocsary, holotype ♀, BRAZIL: 'Massanary' ['Sao Paulo' on label], (TM, Budapest).

PERU: 1 ♀, Junín, Chanchamayo Valley, 800 m (IML, Tucumán); 1 ♀, Junín, Satipo, 750 m (NM, Rotterdam); 2 ♀, Loreto, Col. Perené, El Campamento (CU, Ithaca); 1 ♀, Huánuco, Cayumba, 35 km S. Tingo Maria, 800 m (BMNH); 1 ♀, Loreto, River Pachitea (TM, Budapest); 1 ♀, Loreto, Atalaya, Upper River Ucayali (BMNH); 10 ♀, 2 ♂, Loreto, Pucallpa (BMNH); 1 ♀, Loreto, Pucallpa, 180 m (Menke coll.); 1 ♀, Loreto, Pucallpa, 200 m (CMNH, Los Angeles); 1 ♀, Loreto, Boquerón Abad (BMNH); 1 ♀, Loreto, Chambireyacu, near Yurimaguas, River Huallaga (MNHN, Paris); 2 ♀, Loreto, Rio Tapiche (AMNH, New York); 1 ♂, Loreto, Iquitos (MP, Belém); 2 ♀, Loreto, Iquitos, San Roque (CU, Ithaca); 4 ♀, Loreto, Pebas (3 TM, Budapest; 1 Menke coll.); 1 ♀, no further data (MNHU, Berlin). ECUADOR: 1 ♂, Napo, Tena (BPBM, Honolulu); 1 ♀, Napo, Tena (MNHN, Paris). COLOMBIA: 11 ♀ (incl. 1 reared), 3 ♂ (incl. 1 reared), Putumayo, Mocoa (BMNH); 4 ♀, 2 ♂, Putumayo, Alto Afan near Mocoa (BMNH); 1 ♀, Caqueta, Florencia, 480 m; 4 ♀, 1 ♂, Meta, Cord. Macarena; 1 ♀, Amazonas, Leticia; 1 ♀, Amazonas, Tarapaca; 3 ♀, Amazonas, La Chorrera (BMNH); 1 ♀, 'Bogota'* (MNHN, Paris). VENEZUELA: 1 ♀, Bolívar, Surukum (CU, Ithaca); 1 ♀, Bolívar, Canaracuni, 450 m (IZA, Maracay); 1 ♀, 1 ♂, Monagas, Caripito (MCZ, Harvard). GUYANA: 7 ♀, 1 bred ♂, Essequibo River, Moraballi Creek (*c.* 30 km SE. Bartica); 2 ♀, Mazaruni (*c.* 10 km NW. Bartica), 2nd growth (low forest) (BMNH); 1 ♀, Bartica District (AMNH, New York); 1 ♀, 1 ♂, Kartabo, Bartica District (AMNH, New York); 1 ♀, same data (MCZ, Harvard); 1 ♀, Tumatumari (BPBM, Honolulu); 1 ♀, no further data (BMNH); 1 ♀, Kamakusa (AMNH, New York). TRINIDAD: 1 ♀, Morne Bleu, 2700 ft (CNC, Ottawa). SURINAM: 2 ♀, Coppename River, Raleigh Falls; 1 ♀, Nassau Mts; 1 ♀, Lelydorp, Sumatraweg, Malaise Trap; 1 ♀, Mapane area; 1 ♀, Paramaribo (RNH, Leiden); 1 ♀, Paramaribo (BMNH); 3 ♀, no further data (1 RNH, Leiden; 2 MNHU, Berlin). FRENCH GUIANA: 2 ♀, Mana River (CM, Pittsburgh); 1 ♀, 'Nouveau Chantier'; 1 ♀, St Laurent du Maroni; 1 ♀, Charvein; 1 ♀, 'Haut-Carsevenne'; 1 ♀, St Georges; 1 ♀, St Laurent du Maroni (MCZ, Harvard); 6 ♀, no further data (2 MNHN, Paris; 2 NM, Vienna; 1 UZM, Copenhagen & 1 FSAE, Gembloux). BRAZIL: 1 ♂, São Paulo de Olivença (BMNH); 1 ♀, Amazonas, Tefé (ZSBS, Munich); 1 ♀, 1 ♂, Amazonas, Villa Nova (BMNH); 1 ♀, Amazonas, Manaos (MCZ, Harvard); 1 ♀, 1 ♂, Amazonas (ZSBS, Munich); 1 ♀, Amazonas, Rio Purus (NR, Stockholm); 1 ♂, Amazonas, Fonte Boa (Menke coll.); 1 ♀, Amapá, Serra do Navio (Fritz coll.); 22 ♀, Pará, Belém (4 CU, Ithaca; 6 MP, Belém; 3 ZSBS, Munich; 2 NM, Vienna; 1 MNHU, Berlin; 1 MIZSU, Turin; 1 MNHN, Paris; 3 BMNH & 1 UM, Oxford); 1 ♂, Pará, Belém (MP, Belém); 1 ♀, Pará, Belém, Faz. Velha (MP, Belém); 1 ♀, Pará, Faro (MP, Belém); 1 ♀, Pará, 'Jabaty' (BPBM, Honolulu); 5 ♀, Pará, Santarém (2 Menke coll.; 3 CM, Pittsburgh); 1 ♀, Pará, Maruru near Santarém (CM, Pittsburgh); 1 ♂, same data (Menke coll.); 3 ♀, Amazon, no further data (2 UM, Oxford; 1 NM, Vienna); 1 ♀, 2 ♂, Maranhão, Alcantara (MP, Belém); 2 ♀, Piauí (TM, Budapest); 1 ♀, Pernambuco, Recife (MNHN, Paris); 1 ♀, Bahía, Salvador (NM, Vienna); 1 ♀, Rio de Janeiro, Niteroi (NM, Rotterdam); 1 ♀, near Rio de Janeiro (NM, Vienna); 1 ♀, 'Monat' (USNM, Washington); 2 ♀, no further data (UM, Oxford & TM, Budapest); 1 ♂, no further data (MHN, Geneva); 4 ♀, no data (3 NM, Vienna & 1 UM, Oxford).

* 'Bogota' must here be regarded as an over-generalized locality. The height of this city is well above the upper altitude limit of the genus.

Trigonopsis cameronii (Kohl)

(Figs 1, 40, 69, 70, 98)

[*Trigonopsis violaceus* Smith; Cameron, 1888 : 26, pl. 2, fig. 13. Misidentification.]
Podium (*Trigonopsis*) *abdominale* var. *cameronii* Kohl, 1902 : 29, 37. Lectotype ♀, PANAMA (NM, Vienna), by designation of Menke *in* Bohart & Menke, 1976 : 98 [examined].
Trigonopsis cameronii (Kohl); Richards, 1937 : 107, 112, ♀.

LECTOTYPE. Menke *in* Bohart & Menke (1976 : 98) designated as lectotype of *cameronii* a female specimen from Panama bearing Cameron's label '*Trigonopsis violaceus* Smith ?' and Kohl's label '*Tr. abdominalis* var. *Cameronii*'. It is not known how this specimen came to be in NM, Vienna, but it is part of the original *Biologia Centrali-Americana* material. This is not discussed by Menke, and neither are the three paralectotypes (which I have so labelled): 1, a female labelled 'Bogota', also bearing Kohl's labels '*Trigonopsis abdominalis* var. *Cameronii* K. det. Kohl' and 'cf. *Trigonopsis violaceus* Smith !'; 2, a female from French Guiana bearing Kohl's label '*Trigonopsis abdominalis* var. *Cameronii* K. det. Kohl' and Menke's labels 'Syntype: *Podium abdominale cameronii* Kohl (but not *cameronii*). Desig. A. S. Menke' and '*Trigonopsis violascens* D. T.'; 3, a female from Guatemala which together with the lectotype formed Cameron's original *Biologia* material. It was labelled by him '*Trigonopsis violaceus*' and is the figured specimen, as evidenced by the scale line.

♀. BL 14–18 (but see below). Almost entirely dark, with violet-blue reflections, especially on head and gaster. Pronotum without dorsal projection. (Fig. 1.) HW 2·6–3·1, HL 2·7–3·3, HR 0·9–1·0, EL 1·9–2·2, UIW 1·3–1·5, MIW 1·5–1·7, LIW 1·2–1·4, CTW 0·65–0·80, TOD 0·45–0·60, CR 1·3–1·6, MBL 1·2–1·7, MAL 0·65–0·95, MR 1·5–2·1, PDL 1·6–2·1, PL 2·4–3·2, PR 1·4–1·6. A very large specimen from Colombia, Anchicaya differs as follows: BL 21, HW 3·7, HL 3·7, EL 2·5, UIW 1·8, MIW 2·0, LIW 1·7, MBL 1·9, MAL 1·05, MR 2·4, PL 3·5. Otherwise like *rufiventris* ♀.

♂. BL 14·0–16·0. Colour as ♀. Genitalia as in Figs 69, 70. HW 2·6–2·8, HL 2·6–3·0, HR 0·9–1·0, EL 1·8–2·0, UIW 1·4, MIW 1·5–1·6, LIW 1·2–1·3, CTW 0·25–0·30, CED 0·30–0·32, CER 0·8–1·0, TOD 0·57–0·65, CR 0·4–0·5, PDL 1·7–2·0, PL 3·0–3·4, PR 1·6–1·8. (Fig. 40.) Otherwise as *rufiventris* ♂.

This species resembles *violascens* in colour, but is not sympatric with it. Also, it resembles *rufiventris* in structure. However, the constant colour differences, the different averages of variation as noted below, and their allopatric distribution, added to the fact that only small differences separate other species of the group, all appear to justify treating *cameronii* as a good species.

VARIATION. Rarely, one of the female clypeal teeth may be slightly bifid. Only one of the eight males examined has the inner edge of the mandible with a rather weak preapical expansion, the others entirely lack it (cf. *violascens*). This species exhibits less variation than *rufiventris*, its closest relative, and the ranges of variation only partly overlap. The average size of *cameronii* is smaller and the ranges of clypeal ratio and petiole ratio in the females are not as great. In the males, the ranges of all the ratios except head ratio are smaller. The genitalia are less variable and on average smaller and more heavily pigmented.

DISTRIBUTION. Mexico southwards to the west coast of Ecuador, and eastwards to the Sierra Nevada de Santa Marta on the Caribbean coast of Colombia. It is separated from all other species of the genus by the Andes (map, Fig. 98).

The species inhabits various types of forest which vary considerably in degree of humidity.

Kohl did not see Smith's type of *violaceus* (= *violascens*) (a normal male), which had not been illustrated. He correctly referred to *violascens*, only this type-specimen and an aberrant male. He described an aberrant female as *resplendens*, while referring a normal female (from French Guiana) to *cameronii*. Thus Kohl had confused the two species. Since he was also misled by a true *cameronii* mislabelled 'Bogota', he was unable correctly to state the distribution of the two species.

BIOLOGY. Rau (1933 : 182) (Panama, Barro Colorado Island) records finding a nest of four cells on a tree trunk, 0·35 m from the ground.

Eberhard (1972 ; 1974) has given a comprehensive account of this species' biology, including a primitive kind of sociality, in Colombia, near Cali. The nests consisted of 1–129 cells, often including many old, disused ones, attached to rock-faces. After completion, the cells were incom-

Fig. 98 Collection localities of *T. cameronii.*

pletely covered with rough mud. Cockroaches (*Riatia fulgida* (Saussure), *Chorisoneura translucida* (Saussure) and *Amazonina* n. sp. (det. Gurney)) were used as prey. Parasites were: *Photocryptus* sp. (Ichneumonidae), *Gilvella* sp. (Tachinidae) (possibly on the roaches) and *Macrosiagon lineare* (Le Conte) (Rhipiphoridae).

Cooper found a nest at Colombia, Magdalena, Sierra Nevada de Santa Marta, Rio Don Diego: of two complete cells, measuring about 25 mm high and 25 mm wide, attached to hanging rootlets. A wasp was adding pellets to the outside of the nest, giving it a rough appearance.

Cooper informs me that the cocoon of this species resembles that of *violascens* (Figs 36, 37).

MATERIAL EXAMINED. Dates and collectors' names omitted.

Podium (*Trigonopsis*) *abdominale* var. *cameronii* Kohl, lectotype ♀, PANAMA: Chiriqui, David (NM, Vienna).

MEXICO: 1 ♀, Tabasco, Teapa (BMNH); 1 ♀, Chiapas, Finca Cucalhuitz, 19 km E. Bochil (Menke coll.); 2 ♀, Chiapas, Ruta 190, 21 km E. Cintalapa; 1 ♀, no further data (USNM, Washington). GUATEMALA: 1 ♀, Alta Vera Paz, San Juan (paralectotype of *cameronii*) (BMNH); 1 ♀, Escuintla, El Salto (BPBM, Honolulu); 1 ♀ no further locality, 300 m (AMNH, New York). EL SALVADOR: 1 ♀, Los Chorres (CU, Davis). NICARAGUA: 1 ♀, Managua (Menke coll.). COSTA RICA: 1 ♀, Golfito (CMNH, Los Angeles); 2 ♀, no further data (TM, Budapest). PANAMA: 6 ♀, Taboga Island (3 USNM, Washington; 1 TM, Budapest & 2 UZM, Copenhagen); 1 ♂, same data

(USNM, Washington); 6 ♀, Barro Colorado Island (2 CU, Davis; 1 AMNH, New York; 2 USNM, Washington & 1 Menke coll.); 1 ♀, Chiriqui (TM, Budapest); 1 ♀, Cerro Campana (USNM, Washington). COLOMBIA: 3 ♀, 4 ♂, Valle, Cali, 1000 m (USNM, Washington); 1 ♀, same data (TM, Budapest); 1 ♀, 1 ♂, Valle, Rio Jamundi between Cali and Jamundi, 1000 m (BMNH); 1 ♀, Valle, Cent. Anchicaya, 400 m (BMNH); 2 ♀, same data (USNM, Washington); 8 ♀, Nariño, Barbacoas, 80 m; 2 ♀, Magdalena, N. Sierra Nevada de Santa Marta, Rio Don Diego (BMNH); 1 ♀ [Magdalena ?] Minca (CM, Pittsburgh); 1 ♀, 'Bogota' (see footnote p. 135) (paralectotype of *cameronii*) (MNHU, Berlin); 1 ♀, 'Cananche' (BMNH); 1 ♂, 'Sierra San Lorenzo' (TM, Budapest). ECUADOR: 1 ♂, Guayas, Bucay (*c.* 200 m) (BPBM, Honolulu); 1 ♀, Balzapamba (1.47 S., 79.13 W., *c.* 200 m) (MNHU, Berlin). 1 ♀, no data [mislabelled 'Surinam'] (UZM, Copenhagen).

Trigonopsis howesi **sp. n.**

(Figs 73, 74, 99)

[*Trigonopsis abdominalis* Perty; Howes, 1969 : 36–37, pl. 13b. (Det. Rohwer.) Misidentification.]

♀. BL 19–20. Pronotal dorsum without projection, but with a shallow but distinct longitudinal groove. Gaster red. Petiole of even width. HW 3·4, HL 3·5, HR 1·0, EL 2·4, UIW 1·6, MIW 1·8, LIW 1·6, CTW

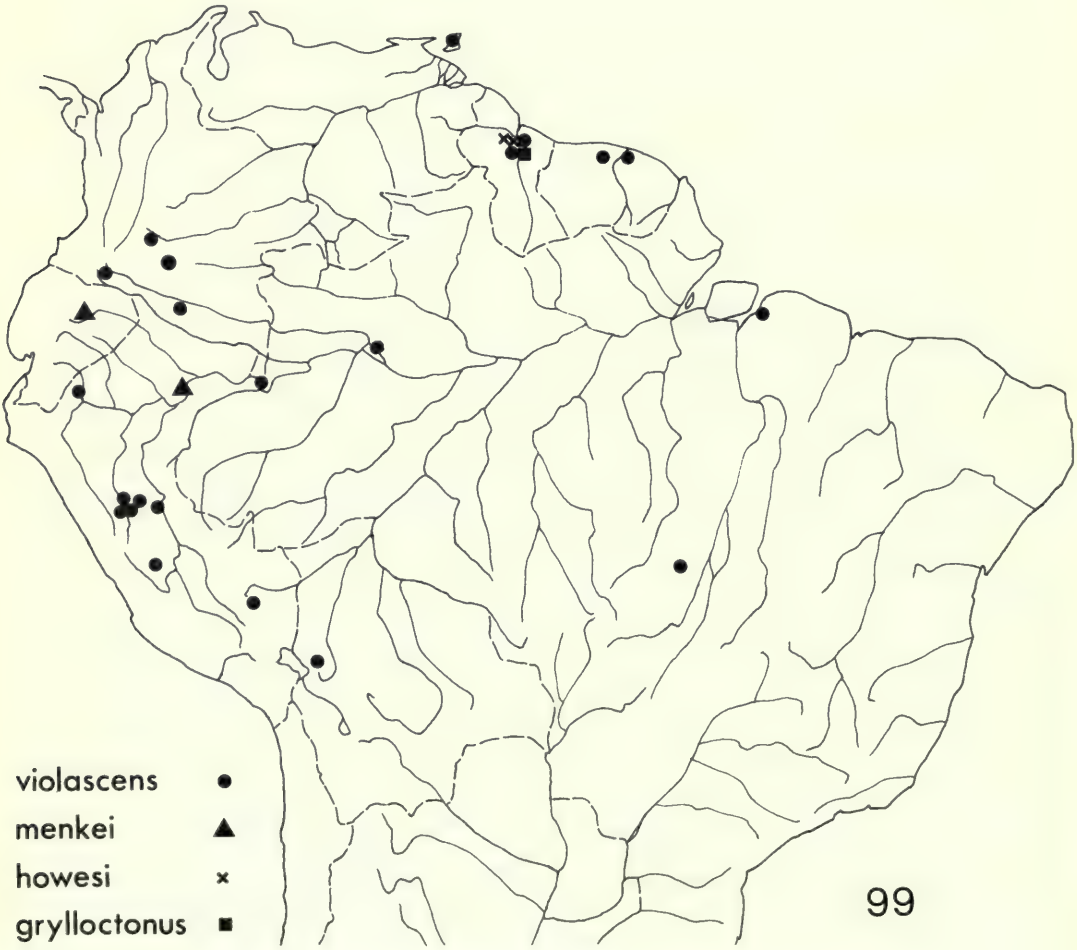


Fig. 99 Collection localities of some *T. rufiventris*-group species.

0·85, TOD 0·80, CR 1·1, MBL 1·8, MAL 1·0, MR 1·8, PDL 2·2, PL 3·3–3·4, PR 1·5. Otherwise as *rufiventris* ♀.

♂. BL 16·5. Pronotal dorsum with moderately distinct longitudinal groove. Genitalia as in Figs 73, 74. HW 3·0, HL 3·2, HR 0·9, EL 2·2, UIW 1·5, MIW 1·6, LIW 1·4, CTW 0·32, CED 0·3, CER 1·1, TOD 0·72, CR 0·4, PDL 2·1, PL 3·4, PR 1·6. Otherwise as *rufiventris* ♂.

This species differs structurally from *rufiventris* only in its pronotal groove and genitalia.

VARIATION. None observed.

DISTRIBUTION. Guyana only (map, Fig. 99).

BIOLOGY. This species builds an extraordinary nest. Howes (1969 : 36–37) states that it was attached to the underside of a palm frond and consisted of 4–5 horizontal cells placed one beside each other. These were enclosed in a thin shell-like globe of clay, surmounted by several half-globes, concave side down, decreasing in size upwards and in contact at least behind. Howes (pl. 13c) gives a good photograph of one such nest (with four half-globes) and told me in correspondence that he found a total of five such nests. The reason for the extremely elaborate additions is obscure. Howes states that cockroaches were used as prey.

MATERIAL EXAMINED. Holotype ♀, GUYANA: Kartabo near Bartica, 26.ii.1922, reared (*Howes*) (*abdominalis* det. Rohwer) (BMNH).

Paratypes. GUYANA: 1 ♂, same data as holotype but 27.ii.1922 (BMNH); 1 ♀, Mazaruni River, Kalacoon, 3 mi. from Bartica, 1961 (*Howes*) (*abdominalis* det. Rohwer) (USNM, Washington).

Trigonopsis grylloctonus Richards

(Figs 49–51, 75, 76, 99)

Trigonopsis grylloctonus Richards, 1937 : 110. Holotype ♂, GUYANA (BMNH) [examined].
Trigonopsis grylloctonus Richards; Menke *in* Bohart & Menke, 1976 : 98.

♀. Unknown.

♂. BL 13·0. Pronotal dorsum without projection and without longitudinal groove. Gaster red. Petiole considerably thickened in middle (Figs 49, 50). Genitalia as in Figs 75, 76. HW 2·3, HL 2·3, HR 1·0, EL 1·6, UIW 1·2, MIW 1·3, LIW 1·0, CTW 0·22, CED 0·20, CER 1·1, TOD 0·50, CR 0·4, PDL 1·4, PL 2·3, PR 1·6, Fig. 51. Otherwise as *rufiventris* ♂.

The male of this species differs from that of *rufiventris* only in petiole shape and genitalia.

VARIATION. Unknown.

DISTRIBUTION. Guyana only (map, Fig. 99).

BIOLOGY. Richards (1937 : 111) describes a mud nest found under a leaf, attached to the midrib near the base. The nest was ovoid, 30 × 20 × 17 mm deep, including the overall mud covering. One cell was still open and contained a cricket. Later, the male wasp emerged from the only other cell.

This is the only species so far known to select prey other than cockroaches.

MATERIAL EXAMINED. Holotype ♂, GUYANA: Essequibo River, Moraballi Creek (*c.* 30 km SE. Bartica), 25.ix.1929, reared (BMNH).

The *vicina*-group

Pronotum with dorsal projection. Propodeum with dorsal rugae also outside the central furrow. Males with strongly flattened antennae, with some segments expanded. The male clypeal structure of the three species represents various degrees of development of a basic pattern. Cuspis of genitalia with basal post round-ended. Female mandible with U- to V-shaped notch, upper edge of apex inflexed. Female clypeus with 5 usually sharp teeth (centre one occasionally reduced or absent). Sternite 6 sharply keeled.

The females of *vicina* and *schunkei* are very similar, having an unusually long third antennal segment, almost identical clypeal teeth and long, slender mandibles. The female of *richardsi* is very different, but its male strongly links it to the other species of the group; in addition, the female has a pronotal projection; mesoscutal pubescence; and HR of 1·0 in common with all males of the group.

Trigonopsis richardsi sp. n.

(Figs 29–32, 55, 57, 81, 82, 100)

[*Trigonopsis affinis* Smith; Richards, 1937 : 107. ♀ variety, ♂. Misidentification.]

♀. BL 13–17. Mandible usually sharply bent at the notch, inner margin ± strongly expanded before it, slender but rather abruptly tapered after it. Upper margin of apex strongly inflexed, especially near notch. Notch V-shaped, narrow but deep, right-angled distally, shallowly rounded proximally. Clypeus with 2 large teeth and 3 smaller ones between, usually all straight, centre one sometimes reduced or absent. HW 2·8–3·5, usually exactly equal to HL (at most 0·1 wider in some larger specimens). Occipital carina ± expanded into a thin, lamellar flange, but not as broadly as in *rufiventris*-group species. (Figs 29–32.) Pubescence usually dense on anterior half of mesoscutum. HL 2·8–3·4, HR always 1·0, EL 1·8–2·2, UIW 1·5–1·8, MIW 1·7–2·0, LIW 1·3–1·8, CTW 0·7–1·1, TOD 0·4–0·6, CR 1·2–2·3, MBL 1·2–2·0, MAL 0·3–0·7, MR 2·4–3·4 (–3·8), PDL 1·7–2·1, PL 2·1–2·7, PR 1·1–1·4.

♂. BL 13–15. Antennal segments 2–6 dorsoventrally flattened, 5 & 6 slightly expanded on outer side. Segment 2 is 1·6–1·7 times longer than wide (Fig. 57). Mandibular inner margin with small but deep basal emargination. Clypeus with 2 large, sharp teeth, its tooth-to-orbit margin interrupted by a deep notch. Sides of notch produced into tubercles behind, outer one connected to a third tubercle still further back (Fig. 55). Genitalia as in Figs 81, 82. HW 2·7–2·8, HL 2·7–2·8, HR always 1·0, EL 1·7–1·9, UIW 1·4–1·5, MIW 1·6–1·7, LIW 1·3–1·5, CTW 0·40, CED 0·32–0·35, CER 1·1–1·2, TOD 0·65–0·70, CR 0·6, PDL 1·5–1·6, PL 2·3–2·4, PR 1·4–1·5. Otherwise as female, except mesoscutal pubescence not very dense.

The smallest red and black species with a pronotal dorsal projection. Both sexes have a rather broad occipital flange. Usually the females are well distinguished by mandibular shape, typically like that of most *rufiventris*-group species, but variants with weak mandibular development are more difficult to identify. However, the HR of 1·0 is still distinctive. The male resembles that of *vicina* but has fewer antennal segments expanded and three subclypeal tubercles instead of two.

Variation. Female variation is complicated and often extreme. The mandibular ratio varies greatly, independently of specimen size. The mandibular expansion varies from slight to very strong with a rounded, obtuse angle. When the expansion is slight, the notch is very small. Most frequently in small specimens, reduction of the centre tooth of the clypeus is accompanied by a narrowing of the gap between the adjacent pair (cf. Figs 29 & 32). Only in some small specimens, the tooth-bearing area is very prominent but strongly emarginate, so that the three centre teeth are effectively much shorter than the outermost pair (Fig. 29). The deeper the clypeal emargination, the broader and more angular is the mandibular expansion. A small female from Venezuela entirely lacks the centre tooth and has the tooth-bearing area prominent, but this is not emarginate and the mandibular expansion is slight (Fig. 30). This specimen is the only one seen which has the clypeal teeth slightly bent forward. A female from Peru, Pucallpa, 22.vi.1960, has the centre tooth very reduced and the other four longer than usual, the head strongly expanded posteriorly, and the mandibular expansion slight (Fig. 31). In this specimen all the interocular widths are abnormally large for the head width: upper 2·0, middle 1·8, lower 2·0, head width 3·2. Even two other specimens with head width 3·3 have all the interocular widths smaller (one has the inner orbits parallel, the other has them slightly divergent downwards). (See also *vicina* variation.)

If there were not so much material available of this species (nineteen females) it would be easy to believe that the striking extremes of variation represented distinct species.

Distribution. This appears to be mainly a western and northern species, less frequent in the east (map, Fig. 100).

Biology. Unknown.

Material examined. Holotype ♀, Peru: Loreto, Pucallpa, 28.vi.1960 (*Schunke*) (BMNH).

Paratypes. Peru: 5 ♀, same data as holotype but 2, 22.vi.1960; 1, 11.i.1961; 1, 24.xi.1962 (BMNH); 1, 180 m, 19.vi.1971 (USNM, Washington); 2 ♂, same data but 5.vii.1951 & 6.i.1962 (BMNH); 1 ♀, Junín, Satipo, 750 m, 15.i.1938 (*Lindemans*) (NM, Rotterdam); 1 ♀, Huánuco, Tingo Maria, Rio Huallaga, 700 m, 15.i.1947 (*Weyrauch*) (IML, Tucumán); 1 ♀, San Martín, Moyobamba region, 8.i.1926 (*Bassler*) (AMNH, New York). Colombia: 1 ♀, Vaupes, Miraflores, 400 m, 31.i–5.ii.1972 (*Cooper*) (BMNH); 2 ♀, Putumayo, Mocoa, 18.iv.1974 & 31.iii.1976 (*Cooper*)

(BMNH). VENEZUELA: 1 ♀, Bolívar, Surukum, xii.1940 (*Anduze*) (CU, Ithaca). GUYANA: 1 ♀, Essequibo River, Moraballi Creek (*c.* 30 km SE. Bartica), 1929 (*Richards*) (BMNH) (Richards' *affinis* variety); 1 ♀, Bartica (NM, Vienna). BRAZIL: 1 ♀, Piauí (TM, Budapest); 1 ♂, Amazonas, São Paulo de Olivença (*Bates*) (BMNH) (Richards' ♂ *affinis*); 1 ♀, Amazonas, Rio Purus, January (*Roman*) (NR, Stockholm). BOLIVIA: 2 ♀, Beni ('Pando' on label), Guayaramerin, xii.1956 (*Fritz*) (Fritz coll.).

Trigonopsis vicina (Dalla Torre)

(Figs 21, 58, 60, 83, 84, 100)

Trigonopsis affinis Smith, 1851 : 31 (part). LECTOTYPE ♀, BRAZIL (BMNH), here designated [examined]. [Junior secondary homonym in *Sceliphron* Klug of *Sphex affinis* F., 1793.]
Sceliphron vicinum Dalla Torre, 1897 : 392. [Replacement name for *Trigonopsis affinis* Smith.]
Trigonopsis affinis Smith; Richards, 1937 : 107, 111, ♀ (part).

LECTOTYPE DESIGNATION. Smith described *affinis* from specimens collected by Wallace and Bates. One syntype in the BMNH collections agrees with Smith's description and locality, and with the current interpretation of the species. A second syntype in the collections of UM, Oxford, does not agree with the description or locality, and is identified as the species here described as *cooperi*. I have labelled, and here designate as lectotype, the female in the collections of the BMNH.

♀. BL 16–19. Mandible slender, evenly curved. Mandibular notch formed by an oblique incision where the inflexed upper margin of the apex is twisted under the upper margin of the basal part, with the basal angle of the notch more shallowly obtuse than the distal. Clypeus with 5 usually well-formed teeth, outermost pair the longest, the centre one equal to or slightly longer than the adjacent pair (Fig. 21). Antennal segment 3 is 2·5–2·8 times as long as 6. MIW 2·2–2·4 times CTW. HW 3·1–3·7, HL 2·9–3·4, HR always 1·1, EL 1·9–2·2, UIW 1·6–1·9, MIW 1·8–2·2, LIW 1·5–1·8, CTW 0·8–0·9, TOD 0·5–0·7, CR 1·3–1·6, MBL 1·7–2·1, MAL 0·3–0·7, MR 2·7–3·2 (–5·6), PDL 1·7–1·9, PL 2·5–2·8, PR 1·4–1·6.

♂. BL 16·5–19·0. Antennal segments 2–12 rather strongly dorsoventrally flattened, segments 5–10 strongly expanded on outer side. Segment 2 about as long as wide (Fig. 58). Extreme base of mandibular inner margin scarcely emarginate. Clypeus with 2 large, sharp teeth. Base of outer side of each tooth tuberculate behind. Behind the tooth-to-orbit margin, but not forming part of it, is another tubercle whose tip is just visible in front view. Together with the other tubercle it forms the sides of a deep notch. There is no third tubercle behind the outer one (Fig. 60). Very similar to male *neotropica* (Fig. 54). Occipital fossa width 1·2 (–1·8). Eyes convergent downwards. Genitalia as in Figs 83, 84. HW 3·0 (–4·1), HL 3·0 (–3·8), HR 1·0 (–1·1), EL 1·9 (–2·4), UIW 1·6 (–2·2), MIW 1·8 (–2·4), LIW 1·4 (–2·2), CTW 0·35 (–0·80), CED 0·35 (–0·60), CER 1·0 (–1·3), TOD 0·75 (–0·90), CR 0·5 (–0·9), PDL 1·8 (–2·3), PL 2·9 (–3·2), PR (1·4–) 1·6. Otherwise as female.

The female is similar to that of *schunkei*, the most obvious difference being the much greater MR of *vicina*. The male is very like that of *neotropica* in clypeal structure, but differs mainly in that some of the antennal segments have lateral expansions.

VARIATION. A large female from Trinidad, although its head width (3·5) is not the largest, has the head posteriorly expanded more than that of any other specimen, and is reminiscent of the Pucallpa specimen of *richardsi* (p. 140). Apart from this and the central clypeal tooth, there is little variation in females.

In the absence of more specimens better to show the range of variation, the male from Marajó is placed here only tentatively. Although its genitalic structure readily distinguishes it from *neotropica*, the structure of the clypeus and antennae of this very large individual are modified such as to make its separation from *richardsi* difficult.

DISTRIBUTION. Sparingly from the Amazon northwards (map, Fig. 100).
BIOLOGY. Unknown. Williams reared a male in 1923 (the only reared specimen of the species-group) but regrettably gave no details in his 1928 paper.

MATERIAL EXAMINED. *Trigonopsis affinis* Smith, lectotype ♀, BRAZIL: Pará, Belém (*Wallace & Bates*) (BMNH).

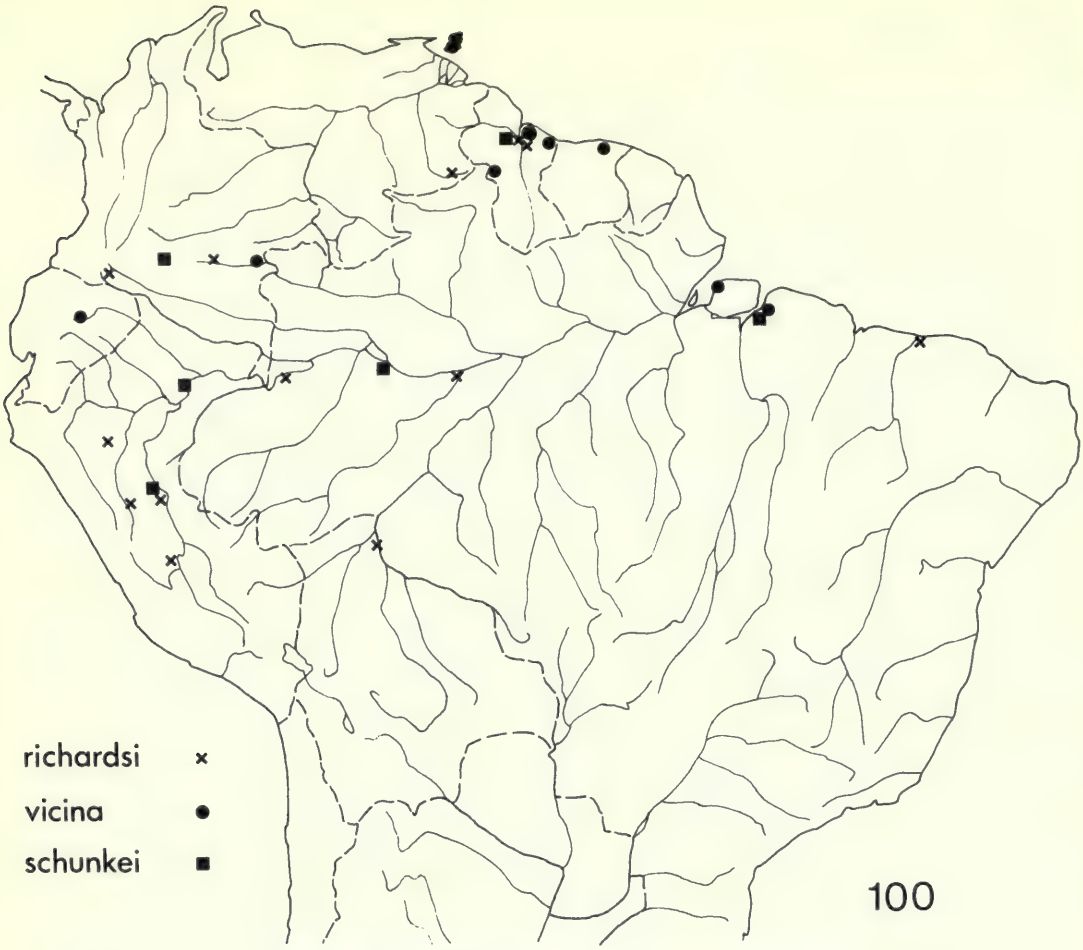


Fig. 100 Collection localities of the *T. vicina*-group.

COLOMBIA: 1 ♀, Vaupes, Mitú, 17.v.1974 (*Cooper*) (BMNH). ECUADOR: 1 ♀, Napo, Napo, viii–ix.1931 (*Benoist*) (MNHN, Paris). TRINIDAD: 1 ♀, Diego Martin, 21.i.1942 (*McC. Callan*) (USNM, Washington); 1 ♀, Arima Valley, 21.vi.1951 (Menke coll.). GUYANA: 1 ♀, ix.1923; 1 ♂, reared 12–13.xi.1923, Blairmont Plantation, Berbice County (*Williams*) (BPBM, Honolulu); 1 ♀, Pakaraima Mts, Upper Ireng River, 1932 (*Myers*) (BMNH); 1 ♀, Demerara (MCZ, Harvard). SURINAM: 1 ♀, Paramaribo, Charlesburg, 16–18.i.1964, Malaise trap (*Geijskes*) (RNH, Leiden). BRAZIL: 1 ♂, Pará, Ilha do Marajó, R. Anajas, 13.vi.1900 (*Ducke*) (MP, Belém).

Trigonopsis schunkei sp. n.

(Figs 26, 52, 56, 79, 80, 100)

♀. BL 18–22. Mandible slender and evenly curved. Mandibular notch only slightly oblique, inflexed upper margin of apex cut off perpendicularly well short of rounded end of upper margin of base, so that a broad, deep notch is formed. Antennal segment 3 is 2·9–3·3 times as long as 6. MIW 1·7–2·1 times CTW. Clypeus with 5 usually well-formed teeth, the outermost pair the longest and the centre one equal to or shorter than the adjacent pair (Fig. 26). HW 3·7–4·4, HL 3·1–3·6, HR 1·1–1·2, EL 2·0–2·4, UIW 1·9–2·2, MIW 2·1–2·5, LIW 1·9–2·3, CTW 1·1–1·2, TOD 0·6–0·7, CR 1·6–2·1, MBL 2·1–2·6, MAL 1·0–1·2, MR 1·9–2·3, PDL 2·0–2·4, PL 3·0–3·3, PR 1·3–1·5.

♂. BL 15·0–16·5. Antennal segments 2–8 strongly flattened dorsoventrally, segments 4–8 moderately expanded on outer side. Segment 2 a little longer than wide (Fig. 56). Inner mandibular margin with a sub-basal tooth. Clypeus produced into two large, rectangular, divergent lobes, with a shallow emargination at the end of each, and a broad, deep one between. Lobe-to-orbit margin with a deep notch, the lobe side of which is strongly carinate behind, with an unconnected tubercle further back (only visible in ventral view) (Fig. 52). Genitalia (Figs 79, 80). HW 3·1–3·5, HL 3·1–3·5, HR 1·0, EL 1·9–2·1, UIW 1·8–2·0, MIW 1·9–2·2, LIW 1·7–2·0, PDL 1·7–1·8, PL 2·3–2·4, PR 1·3. Otherwise as female except pubescence very dense on anterior half of mesoscutum.

The female is very similar to that of *vicina* but has a much smaller mandibular ratio as well as other more detailed differences. The male has a unique clypeal shape.

VARIATION. Apart from the centre tooth of the female clypeus, the back of the head in the Pucallpa 1.v.1959 male is very strongly expanded, that of the other one scarcely so.

DISTRIBUTION. Amazon Basin and Guianas; uncommon (map, Fig. 100).

BIOLOGY. Unknown. Cooper noted an offensive smell produced by the female of this species when caught, although it was less strong than that of *succinea*.

MATERIAL EXAMINED. Holotype ♀, PERU: Loreto, Pucallpa, 3.vii.1960 (*Schunke*) (BMNH).

Paratypes. PERU: 1 ♀, same data as holotype but 20.ii.1963 (BMNH); 2 ♂, same data as holotype but 1.v.1959 (BMNH) and 2.iii.1948 (USNM, Washington); 1 ♀, Loreto, Iquitos, San Roque, iv.1929 (*Klug*) (CU, Ithaca). COLOMBIA: 1 ♀, Meta, La Macarena 29.x–7.xi.1976 (Cooper) (BMNH). GUYANA: 1 ♀, Mazaruni (*c.* 10 km NW. Bartica), 2nd growth (low forest), 27.xi.1937, no. 346 (*Richards & Smart*) (BMNH). BRAZIL: 2 ♀, Amazonas, Tefé (*Bates*) (ZSBS, Munich); 1 ♀, Pará, Belém, 1846 (*Ghiliani*) (MIZSU, Turin); 2 ♀, Pará, Belém, 6.v.1902 & 23.vi.1903 (*Ducke*) (MP, Belém).

The *intermedia*-group

Pronotum with sharply angulate dorsal projection. Propodeum with dorsal rugae also outside central furrow. Female mandible very stout, nearly straight and parallel-sided almost to the U-shaped notch. Notch always large, mandibular outer margin strongly curved around it. Upper margin of apex broadly inflexed, especially near the notch, abruptly tapered. Clypeus with 2 large teeth and 4 or 5 smaller, blunt, often irregular teeth between. Male clypeus with 2 large, sharp, simple teeth, and the tooth-to-orbit margin entire. Antennal segments cylindrical. Cuspis of male genitalia with basal post round-ended.

The females of *intermedia* and *cyclocephalus* are very similar. They are larger than *moraballi*, with the clypeal teeth more numerous and more irregular, the mandible less strongly curved, its apex less slender, the notch overhung by a carina and the upper edge of both base and apex inflexed.

Trigonopsis intermedia Saussure

(Figs 14, 15, 62, 63, 87, 88, 101)

Trigonopsis intermedius Saussure 1867 : 33, pl. 2, fig. 18. Holotype ♀, BRAZIL (NM, Vienna) [examined]. [*Podium* (*Trigonopsis*) *affine* Smith; Kohl, 1902 : 34, part. Misidentification.]

♀. BL 22–27. The largest known species of the genus, and the only species lacking a basal spine on the mandibular inner margin (reduced to an inconspicuous tubercle). Mandible very stout, most of the base slightly curved and parallel-sided, strongly curved from shortly before the notch to beyond it. Near the notch, apical upper margin broadly inflexed, basal very narrowly. Notch large, right-angled distally, obtuse proximally, partly overhung by a strong carina. Clypeus with the outermost pair of teeth fairly large, outwardly directed and strongly bent forward. Between them are 4 much smaller, often irregular, teeth. The central gap (usually the widest) sometimes has a vestigial, blunt, seventh tooth (Figs 14, 15). HW 4·4–5·2. HL 3·4–4·0, HR 1·2–1·3, EL 2·5–3·0, UIW 2·0–2·3, MIW 2·5–2·9, LIW 2·3–2·7, CTW 1·5–1·8, TOD 0·5–0·7, CR 2·6–3·4, MBL 2·4–3·3, MAL 0·7–1·1, MR 2·6–3·4 (–3·9), PDL 2·5–3·1, PL 2·6–3·2, PR 1·0–1·1.

♂. BL 19·5–23·0. Mandibular inner margin with sub-basal tooth. Clypeus with the 2 teeth widely separated, their tips often bent outwards. Head ± strongly expanded posteriorly (Figs 62, 63). Genitalia as

in Figs 87, 88. HW 3·9–4·5, HL 3·5–4·1, HR 1·1, EL 2·4–2·7, UIW 1·9–2·3, MIW 2·3–2·7, LIW 2·2–2·5. CTW 0·90–1·05, CED 0·52–0·67, CER 1·4–1·7, TOD 0·92–1·10, CR 0·9–1·1, PDL 2·2–2·8, PL 2·9–3·6, PR 1·1–1·4. Otherwise as female.

The largest species. The female is very similar to that of *cyclocephalus*, but lacks the mandibular spine. The males of both this species and *schunkei* have a mandibular tooth, but the clypeal shape is quite different.

VARIATION. The temples of the male may be ± strongly expanded, and the tips of the clypeal teeth are sometimes bent outwards. The clypeal teeth of females are irregular as detailed above.

DISTRIBUTION. Fairly common in the Guianas, less so on the eastern coast of Brazil (as far as Rio de Janeiro ?) (map, Fig. 101).

TYPE-LOCALITY. The original description and label both give only Brazil. According to the report of the voyage, the ship *Novara* called in Brazil only at Fernando Noronha Island and Rio de Janeiro. The latter seems the most likely to be the type-locality, especially since at that time the coastal rain-forest was continuous with that further north, where all other specimens were collected.

BIOLOGY. Richards (1937 : 107) states that the female taken at Moraballi Creek on 22.x.1929 was carrying a cockroach up a hollow in a Mora tree.

The following notes were made in Guyana by Professor Richards during the 1937 expedition. They refer to nests examined or collected at Mazaruni (*c.* 10 km NW. Bartica). '2 nests 19.viii.1937, the first on underside of sloping, living tree, 1 ft from ground, in secondary growth. 2 cells, 1 empty, the other with a wasp. The second nest about an inch from the first, 4 cells.'

'Several groups of cells 25.viii.1937 on buttress of old Mora tree. First group very old, occupied by termites. Second group, 2 cells, 1 with a cockroach, with an egg in front of mid coxae, the other with 2 cockroaches and a larva 10 mm long (one prey still intact, constantly moved all its palpi). Third group, 3 cells, one with 4 cockroaches. Preserved. [Now lost.] One cockroach with a larva 4 mm long between fore and mid coxae. All more or less alive, one almost able to walk. Another cell with a larger larva, another with a cocoon. Fourth group, 2 cells. Both with cocoons.'

The above nests produced wasps as detailed in 'Material examined', both sexes from some nests.

MATERIAL EXAMINED. Holotype ♀, BRAZIL (Rio de Janeiro ?) (*Novara Expedition*) (NM, Vienna).

GUYANA: 2 ♀, Essequibo River, Moraballi Creek (*c.* 30 km SE. Bartica), 29.viii & 22.x.1929 (*Oxford University Expedition*) (BMNH); 1 ♀, 2 ♂, Mazaruni (*c.* 10 km NW. Bartica), 2nd growth (low forest), 19.viii.1937, reared (*Richards & Smart*); 3 ♀, 2 ♂, same data but 25.viii.1937, reared (BMNH); 1 ♂, Demerara (*Ballion*) (IRSNB, Brussels); 1 ♀ (*Rodway*); 2 ♀ (*Bartlett*); 1 ♂ (*Cameron*), all without further data (BMNH). SURINAM: 2 ♀ without further data (1, FSAE, Gembloux; 1, TM, Budapest). FRENCH GUIANA: 1 ♀, 1 ♂, Mana River, June 1917 (CM, Pittsburgh); 1 ♀, St Jean de Maroni; 1 ♀, 'Nouveau Chantier'; 1 ♀, Charvein (MNHN, Paris); 1 ♀, Les Hattes, Bas Maroni (*Le Moult*) (Menke coll.); 1 ♂ 'Laiord' [?] (MNHU, Berlin); 1 ♀ (*Ballion*) (IRSNB, Brussels); 1 ♀ without further data (UZM, Copenhagen); 1 ♂ without further data (IRSNB, Brussels). BRAZIL: 1 ♀, Pará, Belém, 1846 (*Ghiliani*) (MIZSU, Turin); 1 ♀, Pará, Belém, 8.vii.1902 (*Ducke*) (MP, Belém); 1 ♀, no locality (*Ballion*) (IRSNB, Brussels); 1 ♀, 1 ♂, without data (NM, Vienna); 2 ♂ without data (FSAE, Gembloux).

Trigonopsis cyclocephalus Smith

(Figs 22, 23, 38, 39, 64, 66, 89, 90, 101)

Trigonopsis cyclocephalus Smith, 1873 : 54. Holotype ♂, BRAZIL (BMNH) [examined].
[*Podium* (*Trigonopsis*) *affine* Smith; Kohl, 1902 : 34, part. Misidentification.]
Trigonopsis cyclocephalus Smith; Menke *in* Bohart & Menke, 1976 : 98.

♀. BL 20–22. Mandible very stout, the base slightly curved and parallel-sided almost to the notch, where it is strongly curved. Near the notch, the upper margin of the base is very narrowly inflexed, that of the

apex broadly. Notch large, right-angled to obtuse distally, more obtuse proximally, and partly overhung by a strong carina. Outermost pair of clypeal teeth large, well-formed, strongly bent forwards, sometimes notched near the base of the outer side, but the tips not bent back. Between them are usually 4 much smaller and often irregular teeth with a wide central gap, but occasionally a short but very broad seventh tooth fills the latter; some teeth may be fused, occasionally asymmetrically. (Figs 22, 23.) Pronotum with sharply angulate dorsal projection. Gaster red. HW 4·3–4·5, HL 3·3–3·6, HR 1·2–1·3, EL 2·4–2·6, UIW 1·9–2·1, MIW 2·4–2·6, LIW 2·2–2·4, CTW 1·4–1·5, TOD 0·6–0·8, CR 1·7–2·5, MBL 2·5–2·8, MAL 0·8–1·1, MR 2·4–3·3, PDL 2·5–2·6, PL 2·4–2·8, PR 1·0–1·1.

♂. BL 15–19. Clypeus with the 2 teeth narrowly spaced (Fig. 64). Third antennal segment 1·1–1·3 long, 1·8–1·9 times as long as the first. Sternite 8 with rather sharp keel near the tip, which is narrowly truncate (Fig. 66). HW 3·1–3·7, HL 2·8–3·2, HR 1·1–1·2, EL 1·8–2·3, UIW 1·6–1·8, MIW 1·9–2·2, LIW 1·6–1·9, CTW 0·35–0·40, CED 0·35–0·40, CER 0·9–1·1, TOD 0·85–0·97, CR 0·4–0·5, PDL 1·8–2·2, PL 2·3–3·0, PR 1·2–1·4. Otherwise as female.

The female is very similar to that of *intermedia*, but has a mandibular spine. The male is extremely similar externally to those of *moraballi* and *cooperi*. However, *cooperi* is easily distinguished by its genitalia, while the differences between those of *moraballi* and *cyclocephalus* are numerous but slight. See keys (p. 129).

THE NON-TYPE SPECIMENS. The males from Leticia reared by Cooper differ from the holotype male in that they are smaller, their temples less expanded and their genitalia slightly different. However, I feel that they are better placed with *cyclocephalus* than with *moraballi*. The identification of female *cyclocephalus* as here treated is based largely on this reared material.

VARIATION. Back of male head ± strongly expanded. Female clypeal teeth irregular as detailed above.

DISTRIBUTION. So far known only from the Upper Amazon (map, Fig. 101).

BIOLOGY. Two mud nests, each of four cells, were found by Cooper at Leticia on 31.viii.1974, 7·6 cm apart, under a flattened liana. One cell of the first was filled with cockroaches (Blaberidae, 1 ♀ *Poroblatta* or gen. near, perhaps n. sp. (det. Gurney)), a second contained a full-grown larva, and the remainder, pupae. The other nest had an entirely smooth surface, i.e. the cells had a complete, overall covering. It measured 750 mm long by 350 mm wide and was roughly oval in shape, but distinctly smaller at one end [perhaps with male cells ?]. Both sexes were reared from these nests. Cooper found two other nests at La Chorrera, Colombia. The first, on 25.viii.1976, consisted of a single cell 270 mm by 170 mm, with a rough surface, under a leaf 2·5 m from the ground. A male wasp was reared. The second nest, on 28.viii.1976, had two cells, measured 40 × 35 × 15 mm, and had a smooth surface. It was under a leaf 2 m from the ground. The first cell contained a larva which failed to develop, the second was still being provisioned by a female, which was captured. The cockroaches were 1 ♂, 1 ♀, of the same species as those from the Leticia nest (det. Gurney).

Cooper informs me that all the cocoons of *cyclocephalus* he found resembled those in Figs 38, 39.

MATERIAL EXAMINED. Holotype ♂, BRAZIL: Amazonas, Tefé (*Bates*) (BMNH).

BRAZIL: 1 ♀, Amazonas, São Paulo de Olivença (UM, Oxford); 1 ♀, same locality (*Bates*) (ZSBS, Munich); 2 ♀, Amazonas, Tabatinga, 7 & 8–9.viii.1974 (*Cooper*) (BMNH). COLOMBIA: 1 ♀, Amazonas, Leticia, 19–20.viii.1974; 3 ♀, 2 ♂, same locality, 31.viii.1974, reared (*Cooper*); 1 ♂, Amazonas, Rio Igara Paraná, La Chorrera, 25.viii.1976, reared (*Cooper*); 1 ♀, same data but not reared; 1 ♀, same data but 28.viii.1976, not reared (BMNH).

Trigonopsis moraballi Richards

(Figs 12, 13, 61, 67, 91, 92, 101)

Trigonopsis moraballi Richards, 1937 : 107, 112. Holotype ♀, GUYANA (BMNH) [examined].

♀. BL 19–21. Mandible very stout, parallel-sided and straight almost to the notch, where it is very strongly curved. Apex very slender, upper margin broadly inflexed, especially near the notch, but that of the base not at all so. Notch large, right-angled or acute distally, rounded proximally, not overhung by a carina.

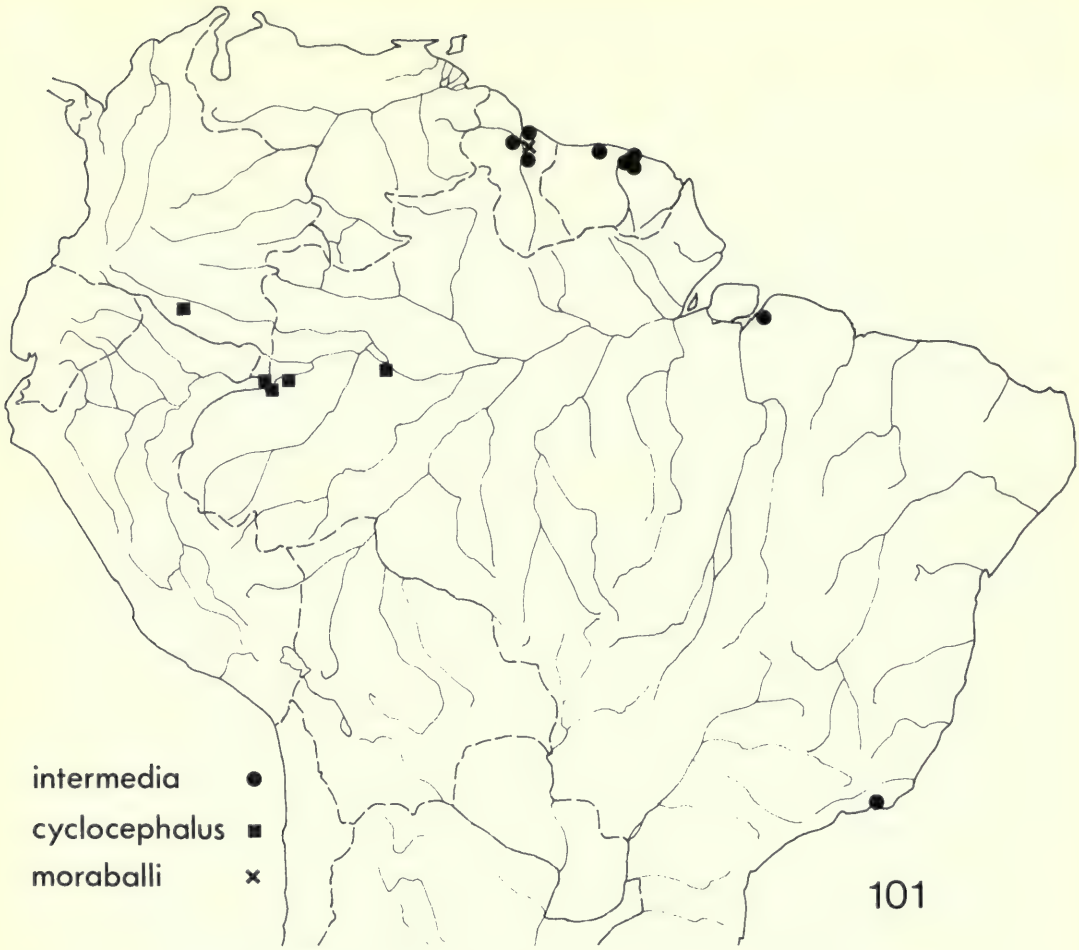


Fig. 101 Collection localities of the *T. intermedia*-group.

The large, outermost pair of clypeal teeth strongly bent forward, tips slightly bent back, notched on outer side near tip. Between them are 4 smaller teeth, fairly regular in height and spacing, but centre pair more obtuse, sometimes slightly shorter and closer together (Fig. 12). HW 4·1–4·2, HL 3·2–3·3, HR 1·2–1·3, EL 2·3–2·4, UIW 1·9–2·0, MIW 2·3–2·5, LIW 2·0–2·1, CTW 1·2–1·3, TOD 0·5–0·6, CR 2·1–2·4, MBL 2·3–2·5, MAL 0·5–0·8, MR 2·9–3·1 (–4·4), PDL 2·1–2·2, PL 2·4–2·6, PR 1·1–1·2.

♂. BL 16. Clypeus with the 2 teeth narrowly spaced (Fig. 61). Third antennal segment 1·0 long, 1·6 times as long as the first, MIW 0·35 more than UIW. Sternite 8 with moderately sharp keel, its tip broadly rounded (Fig. 67). Genitalia as in Figs 91, 92. HW 3·2, HL 2·8, HR 1·1, EL 2·0, UIW 1·6, MIW 2·0, LIW 1·5, CTW 0·35, CED 0·32, CER 1·0, TOD 0·70, CR 0·4, PDL 1·7–1·8, PL 2·4–2·5, PR 1·4. Otherwise as female.

The female is rather like those of *intermedia* and *cyclocephalus*, but its mandibular notch lacks an overhanging carina and the clypeal teeth are less irregular.

The male is extremely similar externally to those of *cooperi* and *cyclocephalus*. However, *cooperi* has distinct genitalia, while the differences between those of *moraballi* and *cyclocephalus* are numerous but slight (see keys p. 130).

Variation. In the single female without locality the 2 centre teeth are much shorter than the adjacent pair, one of them is displaced outwards and the larger gap thus created has a blunt, vestigial seventh tooth (Fig. 13). These differences suggest that this specimen may not belong to

moraballi, but in the absence of other evidence it seems best to regard it as representing variation within the species.

DISTRIBUTION. So far known only from Guyana, but the much paler colour of the specimen without data suggests the possibility of an Upper Amazon origin (map, Fig. 101).

BIOLOGY. Richards (1937 : 108–109) gives a photograph of a 2-celled nest and notes on others. He states that they were found under leaves, 1·2–1·8 m from the ground. Each of the mud cells had one end touching the leaf mid-rib. There was a maximum of 3 cells per nest, the cells being parallel to and in contact with each other. Cockroaches were used as prey, and a wasp was seen to carry one with its 'mouth and forelegs'. A bombyliid fly, *Anthrax leucopyga* Macquart, was also reared.

MATERIAL EXAMINED. Holotype ♀, GUYANA: Essequibo River, Moraballi Creek (*c.* 30 km SE. Bartica), 2.ix.1929, reared (*Oxford University Expedition*) (BMNH).

GUYANA: 1 ♀, same data as holotype; 1 ♀, same data except 3.x.1929, not reared; 2 ♂, same data except 13.viii.1929, not reared, and 20.ix.1929, reared (BMNH) (all paratypes of *moraballi*). 1 ♀ without data (UM, Oxford).

The *neotropica*-group

All species are uniquely characterized by: female mandibular notch formed by a step-like thickening, and cuspis of male genitalia with apex of basal post truncate. Further characters are: pronotum with dorsal projection, propodeum with dorsal rugae also outside central furrow, female clypeus with 5 teeth.

Within the group, *cooperi* is distinguished by: slender female mandible, notch vestigial (never absent), and cylindrical male antennae. The remaining species are further united by: males with antennal segments slightly flattened, and offset at their junctions, females with identical mandibular shape unique to this group: rather stout, slightly curved towards tip, inner margin slightly expanded before notch. The females of two species are still further united by: outermost pair of clypeal teeth equal to or slightly shorter than adjacent pair, another character unique to this species-group.

Rugae outside central furrow of propodeal dorsum often markedly obsolescent anteriorly, especially in *succinea* and *cooperi*.

The evidence so far available suggests that the species of this group, unlike the others in the genus, add no extra mud to the nest after the cells are complete. It is curious that, despite this, extreme mandibular wear is found in an unexpectedly high proportion of females (see also *succinea* biology).

Trigonopsis neotropica sp. n.

(Figs 18–20, 27, 54, 85, 86, 102)

[*Trigonopsis cyclocephalus* Smith; Richards, 1937 : 107, putative ♀. Misidentification.]

♀. BL 19–20. Mandible stout, inner margin of base a little expanded before the step-like notch. Small, basal spine of mandibular inner margin narrow, pointed (Fig. 18). Clypeal teeth ± bent forwards, the outermost pair most strongly, often slightly broader and more blunt than adjacent pair. Centre tooth smaller than others. Centre pair of gaps a little narrower than outer (Figs 18–20). Occipital carina often ± expanded into a brown, translucent lamellar flange. Pronotal dorsal projection scarcely concave anteriorly (Fig. 27). Wings not amber-tinted, stigma and most veins dark brown. HW 3·7–3·9, HL 3·2–3·5, HR 1·1–1·2, EL 2·2–2·4, UIW 1·7–1·8, MIW 2·1–2·3, LIW 1·8–2·0, CTW 1·2–1·4, TOD 0·45–0·50, CR 2·7–2·9, MBL 2·0–2·2, MAL (0·25–) 0·45–0·60, MR 3·3–4·4 (–8·4), PDL 2·2–2·4, PL 2·9–3·2, PR 1·2–1·4.

♂. BL 18. Clypeus with 2 large, sharp teeth. Base of outer side of each tooth is tuberculate behind. Behind tooth-to-orbit margin but not forming part of it, is another tubercle whose tip is just visible in front view. Together with the other, it forms the sides of a deep notch. There is no third tubercle behind the outer one (Fig. 54). Clypeus similar to that of male *vicina* (Fig. 60). Inner orbits parallel. Antennal segments slightly flattened dorsoventrally, their junctions offset in lateral view (cf. Fig. 59). Occipital fossa width 1·5. Genitalia as in Figs 85, 86. HW 3·6, HL 3·3, HR 1·1, EL 2·2, UIW 1·8, MIW 2·1, LIW 1·8, CTW 0·65, CED 0·45, CER 1·4, TOD 0·82, CR 0·8, PDL 2·1, PL 2·9, PR 1·4. Otherwise as female.

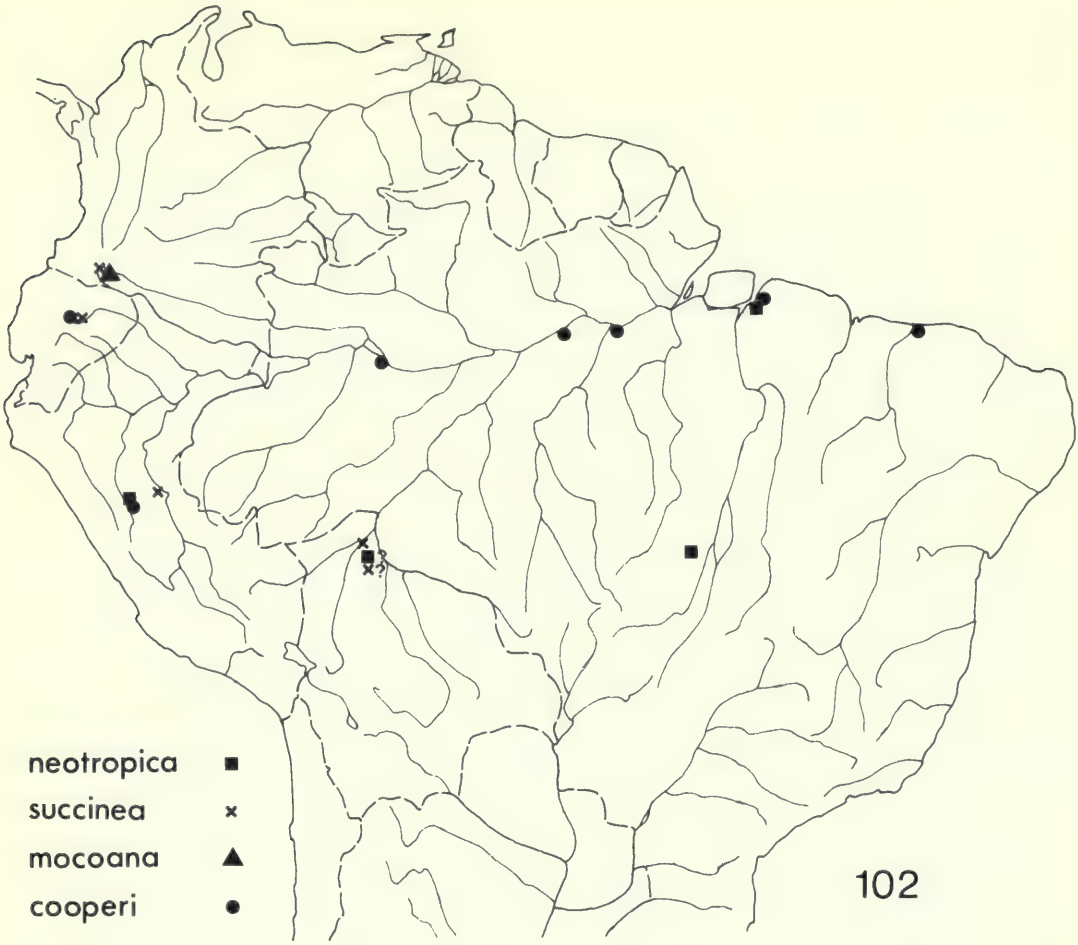


Fig. 102 Collection localities of the *T. neotropica*-group.

The female is similar to that of *succinea*, but is distinguished by its smaller size, the basal spine of the mandibular inner margin pointed instead of rounded, shorter petiole, less coarse propodeal sculpture etc. The male is very like that of *vicina*, but lacks the antennal expansions.

VARIATION. The Belém (i.e. easternmost) specimens differ from the others in the following ways.

The body is altogether darker, in particular the clypeus, legs and wing-bands.

The second abscissa of the radial vein is markedly shorter than the third (roughly equal in the other specimens).

In the females, the central pair of gaps between the clypeal teeth are shallower than the outer pair (Fig. 20), whereas they are roughly equal in the other females (Figs 18,19).

Although all these forms of individual variation are usually found separately in various other species of the genus, it is interesting that they occur together, as well as being geographically correlated, in *neotropica*.

DISTRIBUTION. Widespread but uncommon (map, Fig. 102).

BIOLOGY. The paratype female bears a label 'From one of 3 clay cells fastened side by side under arboreal termites nest. One cell already vacated and one pupa broken in fall.' Hamilton further informs me that the nest was about 5 m from the ground, and that the individual cells were visible.

If this is a typical nesting-site for the species-group (excepting the aberrant species *cooperi*)

they may build their nests at a much greater height than other *Trigonopsis*. This would help to explain why it is much the rarest species-group in collections (see also *succinea* biology).

MATERIAL EXAMINED. Holotype ♀, BOLIVIA (*Steinbach*) (BMNH) (Richards' putative *cyclocephalus* ♀).

Paratypes. PERU: 1 ♀, Huánuco, Tingo Maria, 20–27.i.1968 (*Garcia & Porter*) (MCZ, Harvard). BRAZIL: 1 ♀, Mato Grosso, Serra Roncador, Royal Society Base Camp, 12.50 S., 51.47 W., 11.vi.1968, reared (*Hamilton*) (BMNH); 1 ♀, 1 ♂, Pará, Belém, 6.iii.1900 (*Ducke*) (NM, Vienna); 1 ♀, Pará, Belém, 30.vi.1900 (*Ducke*) (MP, Belém).

Trigonopsis succinea sp. n.

(Figs 24, 25, 28, 53, 59, 95, 96, 102)

♀. BL 22–26. Mandibular base with inner margin a little expanded before the step-like notch. Small basal spine of mandibular inner margin rather broad, rounded at tip. Outermost pair of clypeal teeth scarcely shorter but ± broader and blunter than adjacent pair. Centre tooth equal to or shorter than outermost pair. Teeth ± asymmetrical. Centre pair of gaps wider and deeper than outer pair. Lower part of clypeus and teeth a little bent forward (Figs 24, 25). Occipital carina slightly lamellar flange-like, black, translucent only when seen against the light. Pronotum with dorsal projection strongly transverse, in profile very strong and sharply angulate with distinct concavity in front (Fig. 28). Pubescence of anterior half of mesoscutum ± dense. Wings ± strongly amber-tinted, stigma pale (much paler than infuscation of radial cell). Rugae outside central furrow of propodeal dorsum very coarse, rather widely spaced, and usually strongly obsolescent anteriorly. Central groove very deep throughout. HW 3·8–4·6, HL 3·5–4·0, HR 1·1–1·2, EL 2·3–2·7, UIW 1·8–2·1, MIW 2·2–2·6, LIW 1·9–2·3, CTW 1·1–1·4, TOD 0·6–0·7, CR 1·8–2·2, MBL 2·1–2·5, MAL 0·45–0·80, MR 2·8–4·4 (–4·9), PDL 2·5–3·1, PL 3·7–4·4, PR 1·3–1·5.

♂. BL 17–20. Clypeus with two large, sharp teeth. Tooth-to-orbit margin entire, without tubercles (Fig. 53). Antennal segments slightly dorsoventrally flattened, their junctions offset in lateral view (Fig. 59). Head ± expanded posteriorly. Genitalia Figs 95, 96. HW 3·3–3·8, HL 3·0–3·5, HR 1·1, EL 2·0–2·2, UIW 1·7–2·1, MIW 1·9–2·2, LIW 1·6–1·8, CTW 0·37–0·60, CED 0·30–0·47, CER 1·2–1·3, TOD 0·77–0·87, CR 0·5–0·7, PDL 2·0–2·4, PL 2·7–3·8, PR 1·3–1·6. Otherwise as female, except occipital carina narrower.

The female is similar to that of *neotropica*, but the basal spine of the mandibular inner margin is rounded instead of sharp, the insect is larger, has a longer petiole, coarser propodeal sculpture, etc. At first sight the male much resembles those of several other species, but has slightly flattened antennae. The identification should always be confirmed by genitalia examination (Figs 95, 96).

VARIATION. Female clypeal teeth as detailed above. The back of the head of the male from Tena is very strongly expanded, that of the one from Riberalta scarcely so.

DISTRIBUTION. East Andean foothills from Colombia to Bolivia. Most records are from about 600 m, with isolated ones down to about 200 m (map, Fig. 102).

BIOLOGY. Cooper has observed females collecting various kinds of mud (on one occasion in the company of a *rufiventris* female). All of them flew high into the forest, which strengthens the supposition (discussed under *neotropica*) that most species of this group build their nests far above the ground.

Cooper informs me that the females especially of this species emit an offensive smell when captured.

MATERIAL EXAMINED. Holotype ♀, ECUADOR: Napo, Tena, 14.iv.1976 (*Cooper*) (BMNH).

Paratypes. ECUADOR: 2 ♀, same data as holotype but 16 & 19.iv.1976 (BMNH); 1 ♂, Napo, near Tena, v.1923 (*Williams*) (BPBM, Honolulu). COLOMBIA: 2 ♀, Putumayo, Mocoa, 580 m, 31.iii., 2.vi.1976 (*Cooper*) (BMNH); 1 ♀, same data but 5.vi.1976 (USNM, Washington). PERU: 1 ♀, Loreto, Pucallpa, 14.ii.1952 (*Schunke*) (BMNH). BOLIVIA: 1 ♀, 'Songo' (TM, Budapest); 1 ♂, Beni ('Pando' on label), Riberalta, xi,1956 (*Fritz*) (Fritz coll.).

Trigonopsis mocoana sp. n.

(Figs 35, 102)

♀. BL 18–20. Mandible stout, inner margin of base a little expanded before the notch, which is step-like and very small (but not vestigial as in *cooperi*). Outermost pair of clypeal teeth the longest. Centre tooth

slightly shorter than adjacent pair, and about half height of outermost pair and narrower than them. All teeth bent forward, outermost pair most strongly. All gaps are equally deep but centre pair slightly narrower than outer pair (Fig. 35). Pronotal dorsum with sharply angulate projection. Pubescence moderately dense on anterior half of mesoscutum. Gaster red. HW 3·6–3·8, HL 3·0–3·2, HR 1·2, EL 2·2–2·3, UIW 1·7, MIW 2·1–2·2, LIW 1·7–1·8, CTW 0·9–1·0, TOD 0·6–0·7, CR 1·3–1·7, MBL 1·9–2·0, MAL 0·5–0·6, MR 3·4–3·8, PDL 2·2–2·4, PL 2·5–2·6, PR 1·1.

♂. Unknown.

The female is rather like that of *cooperi*, but is distinguished by the mandible having a larger notch, with the inner margin expanded before it; and by the smaller clypeal ratio.

VARIATION. Slight irregularity in female clypeal teeth.

DISTRIBUTION. Known only from the one locality (map, Fig. 102).

BIOLOGY. Unknown.

MATERIAL EXAMINED. Holotype ♀, COLOMBIA: Putumayo, Mocoa, 24.xii.1974 (*Cooper*) (BMNH). Paratype. 1 ♀, same data as holotype but 6.iv.1976 (BMNH).

Trigonopsis cooperi sp. n.

(Figs 33, 34, 65, 68, 93, 94, 102)

[*Trigonopsis affinis* Smith, 1851 : 31, ♀, part. Misidentification.]
[*Trigonopsis moraballi* Richards, 1937 : 107, ♂, part. Misidentification.]
[*Trigonopsis cyclocephalus* Smith; Richards, 1937 : 107, ♂, part. Misidentification.]

♀. BL 17–19. Mandible rather slender, almost parallel-sided and scarcely curved, more strongly so around the notch. Notch vestigial (never absent), formed by a dent in upper edge of mandible. Below it on the inner side is a small thickening, forming a step in the longitudinal carina present there. Sometimes the two structures join to form a broader step, as in the other species of the group, but smaller. Clypeal teeth well formed and regular, the outermost pair the longest. Three centre teeth often equal, but middle one variable. Tooth-bearing area of clypeus not very projecting, only outermost pair of teeth bent forwards, contrasting with others. A ± broad and translucent lamella connects outermost clypeal tooth with lower orbit. Head very broad, Figs 33, 34. HW 3·5–4·0, HL 2·7–3·1, HR 1·2–1·3, EL 2·0–2·3, UIW 1·7–1·9, MIW 1·9–2·3, LIW 1·7–1·9, CTW 0·9–1·1, TOD 0·4–0·6, CR 1·8–2·7, MBL 2·0–2·3, MAL 0·3–0·6, MR 3·6–5·5 (–7·3), PDL 1·9–2·3, PL 2·4–2·7, PR 1·0–1·4.

♂. BL 16–17. Clypeus with two large, sharp teeth, tooth-to-orbit margin entire (Fig. 65). Antennal segments cylindrical, the third 0·9–1·0 long, 1·5–1·6 times as long as the first, MIW 0·15–0·20 more than UIW. Sternite 8 with obtuse keel, tip narrowly rounded (Fig. 68). Genitalia as in Figs 93, 94. HW 3·1–3·3, HL 2·8–2·9, HR 1·1–1·2, EL 1·9–2·0, UIW 1·6–1·7, MIW 1·8–1·9, LIW 1·4–1·5, CTW 0·30–0·32, CED 0·27–0·30, CER 1·0–1·1, TOD 0·72–0·77, CR 0·4, PDL 1·8–1·9, PL 2·6, PR 1·4. Otherwise as female.

The female is like that of *mocoana*, but distinguished by the mandible having a smaller notch (sometimes vestigial) and lacking an expansion before it; and by the greater clypeal ratio. Externally, the male is extremely similar to those of *cyclocephalus* and *moraballi*, differing mainly in its genitalia.

VARIATION. The female clypeus shows geographical variation. In the east, the teeth tend to be sharper and the lamella less developed (Fig. 33), while in the west, the teeth tend to be more rounded, and the lamella broader and ± translucent. These are most pronounced in the Tena specimens, in which the roundness of the teeth cannot be due to wear since two of the specimens were reared (Fig. 34).

The propodeal dorsal rugae outside the central furrow also vary, in both sexes. They are strongly obsolescent anteriorly in most specimens, but in those from the east they tend to be less coarse, and moderately obsolescent also posteriorly.

DISTRIBUTION. The Amazon, from Tena to Belém; also Piauí and Tingo Maria (map, Fig. 102).

BIOLOGY. Cooper found a nest at Tena, Ecuador under a leaf 1·7 m from the ground. It consisted of 4 mud cells in a row, the sides in contact but without an overall covering, so that the individual cells were plainly visible. The first cell was empty, with an emergence hole. The second was empty but without a hole. The third contained a female wasp about to emerge. Another

female was later taken from cell four. This last cell (preserved in BMNH) measures about 23 mm long × 14 mm across and has a rough surface, showing the outlines of the individual blobs of mud composing it. Also extracted from this cell were the remains of three cockroach nymphs of the family Blaberidae (det. J. A. Marshall). The Tena 17–19.xii female was starting to build a nest under a leaf, about 18 ins from the ground.

MATERIAL EXAMINED. Holotype ♀, ECUADOR: Napo, Tena, 9–14.xii.1971, reared (*Cooper*) (BMNH).

Paratypes. ECUADOR: 1 ♀, same data as holotype; 1 ♀, same data except 17–19.xii.1971 (not reared) (BMNH). PERU: 1 ♀, Huánuco, Tingo Maria, 16.x.1946, 2,200 ft (*Pallister*) (AMNH, New York). BRAZIL: 1 ♀, Pará, Santarém (*Wallace & Bates*) (paralectotype of *affinis*); 1 ♀, Pará, Belém (both UM, Oxford); 1 ♀, Pará, Belém, 1846 (*Ghiliani*) (MIZSU, Turin); 1 ♂, Pará, Belém, ix–x.1959 (*Bianchi*) (BPBM, Honolulu); 1 ♂, Pará, Santarém (*Bates*) (paratype of *moraballi*) (BMNH); 1 ♀, Piauí (TM, Budapest); 1 ♀, Amazonas, Tefé (*Bates*) (ZSBS, Munich); 1 ♂, Amazonas, Villa Nova (*Bates*) (det. as *cyclocephalus* by Richards) (BMNH); 1 ♀, Pará, Belém, Mocambo, 6.viii.1970 (*Pimentel*); 1 ♀, Pará, Ilha das Onças, 30.i.1977 (*Overal*) (both MP, Belém); 1 ♀, Ilha das Onças, 22.i.1977 (*Overal*) (BMNH).

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Junior synonyms and other invalid names are in *italics*.

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Contents

Synopsis

Revisions are given of nine genera with 65 species mainly from the Oriental Region. One of these, *Ecacanthothrips* (6 species), belongs in the Phlaeothripinae; the rest are all Idolothripinae, *Aesthesiothrips* (1 species), *Diaphorothrips* (3 species), *Dinothrips* (5 species), *Elaphrothrips* (17 Oriental species), *Machatothrips* (14 species including 3 from Africa), *Mecynothrips* (13 species), *Meiothrips* (3 species), *Malesiathrips* (3 species). A check-list is provided summarizing the nomenclatorial changes, which include one new genus, six new species, 41 new specific synonyms and 10 new generic synonyms.

Introduction

The thrips species which feed on fungi associated with freshly dead twigs and branches are amongst the largest and most spectacular insects in the order Thysanoptera. Many are large in size, up to 15 mm long, and many exhibit extraordinary patterns of allometric growth and of sexual dimorphism. However, much of the early taxonomic work on these species was carried out before the significance of structural variation and its relationship to body size was fully appreciated.

Recent collections by one of the authors (L. A. Mound) in Malaya and Java have facilitated a reassessment of the species criteria which are current in such complex genera as *Elaphrothrips* and *Ecacanthothrips*. In these two genera in particular, species are variable in structure, widespread in distribution and relatively abundant. In contrast the species of *Machatothrips* are less variable, more localized and relatively infrequent, and these species are peculiarly difficult to define. It seems likely that the different patterns of speciation in these genera are related to different patterns of activity of the individuals, but how a taxonomist should interpret such differences in terms of names is at present very much a matter of opinion.

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The revisions given here concern one genus of Phlaeothripinae and eight genera of Idolothripinae; these include all the common species of large Thysanoptera which are found in this habitat in the Oriental region. It is intended to re-examine the generic classification of the Idolothripinae elsewhere, but such a study must be built on a sound knowledge of the variation within and between species. For example, *Mecynothrips* is used here to include a group of 12 species which have been divided previously between five genera and two subgenera. A study of the variation within and between these species has indicated that large and small males of certain species would be placed in separate genera using traditional criteria, but that it is almost impossible to distinguish between the females at species level. This process of reassessment of taxonomic criteria must needs involve not only recently collected specimens but also the type-material of earlier described species. In this paper all the material which has been studied is detailed, and in the few instances where type-specimens were not available the species concerned are not dealt with in the keys but are merely listed in the text. This approach probably explains the difference in interpretation of certain names, particularly in *Elaphrothrips*, between the present work and that of other recent authors.

Acknowledgements and depository abbreviations

This revisionary study has been carried out with the cooperation of numerous colleagues who are responsible for collections in other institutes and museums. The authors are very grateful to the following for loans of material; depository abbreviations used in the text are given in parentheses. Professor T. N. Ananthakrishnan, Director, Zoological Survey of India, Calcutta (TNA); Paul H. Arnaud, California Academy of Sciences, San Francisco (CAS); E. Dahms, Queensland Museum, Brisbane (QM); C. F. Jacot-Guillarmod, Albany Museum, Grahamstown (JG); A. Kaltenbach, Naturhistorisches Museum, Wien (NM); I. Kudo, Shizuoka Seikogakuin, Oshika, Japan; Madame D. Mathilde-Ferrero, Muséum National d'Histoire Naturelle, Paris (MNHN); Shuji Okajima, Tokyo University of Agriculture (SO, Tokyo); Kellie O'Neill, U.S.D.A., Beltsville, Maryland (USNM); M. Suwa, Faculty of Agriculture, Hokkaido University, Sapporo (HUS); R. zur Strassen, Senckenberg Museum, Frankfurt (SMF).

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Check-list of the species discussed in this paper

Subfamily **PHLAEOTHRIPINAE** Uzel

ECACANTHOTHRIPS Bagnall, 1909
- *Ormothrips* Buffa, 1909
- ***andrei*** **sp. n.**
- ***coniger*** Priesner, 1930
- ***inarmatus*** Kurosawa, 1932
  - *piceae* Ishida, 1936 **syn. n.**
- ***leai*** Moulton, 1947
- ***spinipes*** (Bagnall, 1908)
  - *bagnalli* Priesner, 1930
  - *guineaensis* Moulton, 1947
  - *inermis* (Buffa, 1909)
- ***tibialis*** (Ashmead, 1905) **comb. n.**
  - *bryanti* Bagnall, 1915
  - *coxalis* Bagnall, 1915
  - *coxalis consanguineus* Priesner, 1930
  - *coxalis formosensis* Takahashi, 1936 **syn. n.**
  - *coxalis philippinensis* Priesner, 1930 **syn. n.**
  - *crassiceps* Karny, 1913 **syn. n.**
  - *erythrinus* Ananthakrishnan, 1956
  - *flavipes* Bagnall, 1915
  - *fletcheri* Ramakrishna, 1934
  - *io* Girault, 1930 **syn. n.**
  - *matsumurai* Ishida, 1934 **syn. n.**
  - *priesneri* Hood, 1935
  - *ramakrishnai* Ananthakrishnan, 1952
  - *sanguineus* (Bagnall, 1908) **syn. n.**
  - *steinskyi* (Schmutz, 1913)

Subfamily **IDOLOTHRIPINAE** Bagnall

AESTHESIOTHRIPS Ananthakrishnan, 1961
- ***jatrophae*** Ananthakrishnan, 1961

DIAPHOROTHRIPS Karny, 1920
- *D.* (*Cnemidothrips*) Priesner, 1940
- ***clavipes*** Priesner, 1940
- ***hamipes*** Karny, 1923
- ***unguipes*** Karny, 1920
  - *spinosus* Ananthakrishnan, 1959
  - *thevetii* Ananthakrishnan, 1957 **syn. n.**

DINOTHRIPS Bagnall, 1908
Paxillothrips Ananthakrishnan, 1961 **syn. n.**
juglandis Moulton, 1933
longicauda (Ananthakrishnan, 1961) **comb. n.**
monodon Karny, 1920
spinosus (Schmutz, 1913) **comb. n.**
affinis Bagnall, 1915 **syn. n.**
anodon Karny, 1923 **syn. n.**
celebensis Bagnall, 1934 **syn. n.**
crassiceps (Bagnall, 1921) **syn. n.**
gardneri Moulton, 1928 **syn. n.**
jacobsoni Karny, 1921 **syn. n.**
kemneri Karny, 1923 **syn. n.**
malloti Moulton, 1933 **syn. n.**
sumatrensis Bagnall, 1908
fulmeki Priesner, 1959 **syn. n.**
furcifer Schmutz, 1913
ELAPHROTHRIPS Buffa, 1909
Dicaiothrips Buffa, 1909
E. (*Elaphoxothrips*) Bagnall, 1932
E. (*Cradothrips*) Ananthakrishnan, 1973
amoenus Priesner, 1935
athletes (Karny, 1923)
bakeri (Karny, 1920)
bakeri depokensis Priesner, 1935 **syn. n.**
imitator Priesner, 1935 **syn. n.**
mentaweiensis Priesner, 1929 **syn. n.**
coreanus Woo, 1974
curvipes Priesner, 1929
karnyi Priesner, 1935 **syn. n.**
secus Ananthakrishnan, 1973 **syn. n.**
denticollis (Bagnall, 1909)
beesoni Ramakrishna Ayyar, 1934 **syn. n.**
mucronatus Priesner, 1935
productus Priesner, 1935 **syn. n.**
productus obscuricornis Priesner, 1935 **syn. n.**
sumbanus Priesner, 1935 **syn. n.**
fulmeki Priesner, 1935
greeni (Bagnall, 1914)
bouvieri (Vuillet, 1914)
micidus Ananthakrishnan, 1973 **syn. n.**
insignis Ananthakrishnan, 1973
insularis Priesner, 1928
jacobsoni Priesner, 1935
mahensis (Bagnall, 1921)
hystrix (Bagnall, 1921)
rex (Bagnall, 1921)
malayensis (Bagnall, 1909)
bruneitarsis (Schmutz, 1913) **syn. n.**
bruneitarsis levis (Schmutz, 1913) **syn. n.**
coronatus Bagnall, 1934 **syn. n.**
notabilis Ananthakrishnan, 1973
procer (Schmutz, 1913)
achaetus Bagnall, 1934
approximatus Bagnall, 1934
chandana Ramakrishna Ayyar, 1934
dallatorensis (Schmutz, 1913)
eranthemi Seshadri & Ananthakrishnan, 1954
novus (Schmutz, 1913)
proximus (Bagnall, 1914)
sensitivus Priesner, 1929
seychellensis (Bagnall, 1921)
spiniceps Bagnall, 1932
clarispinis Priesner, 1935 **syn. n.**
graveleyi Bagnall, 1934 **syn. n.**
MACHATOTHRIPS Bagnall, 1908
Adiaphorothrips Bagnall, 1909
Cnestrothrips Priesner, 1939 **syn. n.**
antennatus (Bagnall, 1915)
dammermani (Priesner, 1939) **syn. n.**
artocarpi Moulton, 1928
biuncinatus Bagnall, 1908
montanus Priesner, 1932 **syn. n.**
simplex (Bagnall, 1909)
braueri Karny, 1912
multidens Bagnall, 1934
paucidens Bagnall, 1934
paucidens bicolorisetosus Bagnall, 1934
braueri karnyi Priesner, 1932
celosia Moulton, 1928
corticosus Ananthakrishnan, 1972
decorus **sp. n.**
diabolus Priesner, 1928
haplodon Karny, 1925
braueri buffai Karny, 1925
braueri spatiata Priesner, 1932 **syn. n.**
simplicidens Bagnall, 1934
heveae Karny, 1921
indicus Ananthakrishnan & Jagadish, 1970
lentus **sp. n.**
quadrudentatus Moulton, 1947
silvaticus Ananthakrishnan, 1972
MALESIATHRIPS **gen. n.**
guamensis **sp. n.**
malayensis **sp. n.**
solomoni (Mound, 1970) **comb. n.**
MECYNOTHRIPS Bagnall, 1908
Acrothrips Karny, 1921 **syn. n.**
Dracothrips Bagnall, 1914 **syn. n.**
Kleothrips Schmutz, 1913 **syn. n.**
K. (*Akleothrips*) Priesner, 1935 **syn. n.**
K. (*Synkleothrips*) Priesner, 1935 **syn. n.**
Phoxothrips Karny, 1913 **syn. n.**
acanthus (Hood, 1918) **comb. n.**
gargantua (Girault, 1926)
giganteus (Girault, 1926)
sorex (Karny, 1921)
atratus (Hood, 1919) **comb. n.**
zuluensis (Jacot-Guillarmod, 1939) **syn. n.**
goliath (Priesner, 1935) **comb. n.**
hardyi (Priesner, 1928) **comb. n.**
kanoi (Takahashi, 1937) **comb. n.**
karimonensis (Priesner, 1935) **comb. n.**
karimonensis parvidens (Priesner, 1935) **syn. n.**
kraussi **sp. n.**
lacerta (Priesner, 1935) **comb. n.**
innocens (Priesner, 1935) **syn. n.**

priesneri Mound, 1971
minor Mound, 1971 **syn. n.**
pugilator (Karny, 1913) **comb. n.**
takahashi (Priesner, 1935)
simplex Bagnall, 1912 **comb. rev.**
agama (Priesner, 1935)
ceylonicus (Bagnall, 1914)
gigans (Schmutz, 1913)
snodgrassi Hood, 1952
wallacei Bagnall, 1908
bagnalli Priesner, 1935
bagnalli imbecilla Priesner, 1935 **syn. n.**
magnus Girault, 1929
MEIOTHRIPS Priesner, 1929
M. (*Telothrips*) Kudo & Ananthakrishnan, 1974 (preocc.) **syn. n.**
M. (*Aculeathrips*) Kudo, 1975 **syn. n.**
annulipes (Bagnall, 1914)
annulatus Priesner, 1929 **syn. n.**
menoni Ananthakrishnan, 1964
nepalensis Kudo & Ananthakrishnan, 1974

ECACANTHOTHRIPS Bagnall

Ecacanthothrips Bagnall, 1909*a*: 348. Type-species: *Acanthothrips sanguineus* Bagnall, by monotypy (here regarded as a synonym of *Idolothrips tibialis* Ashmead).

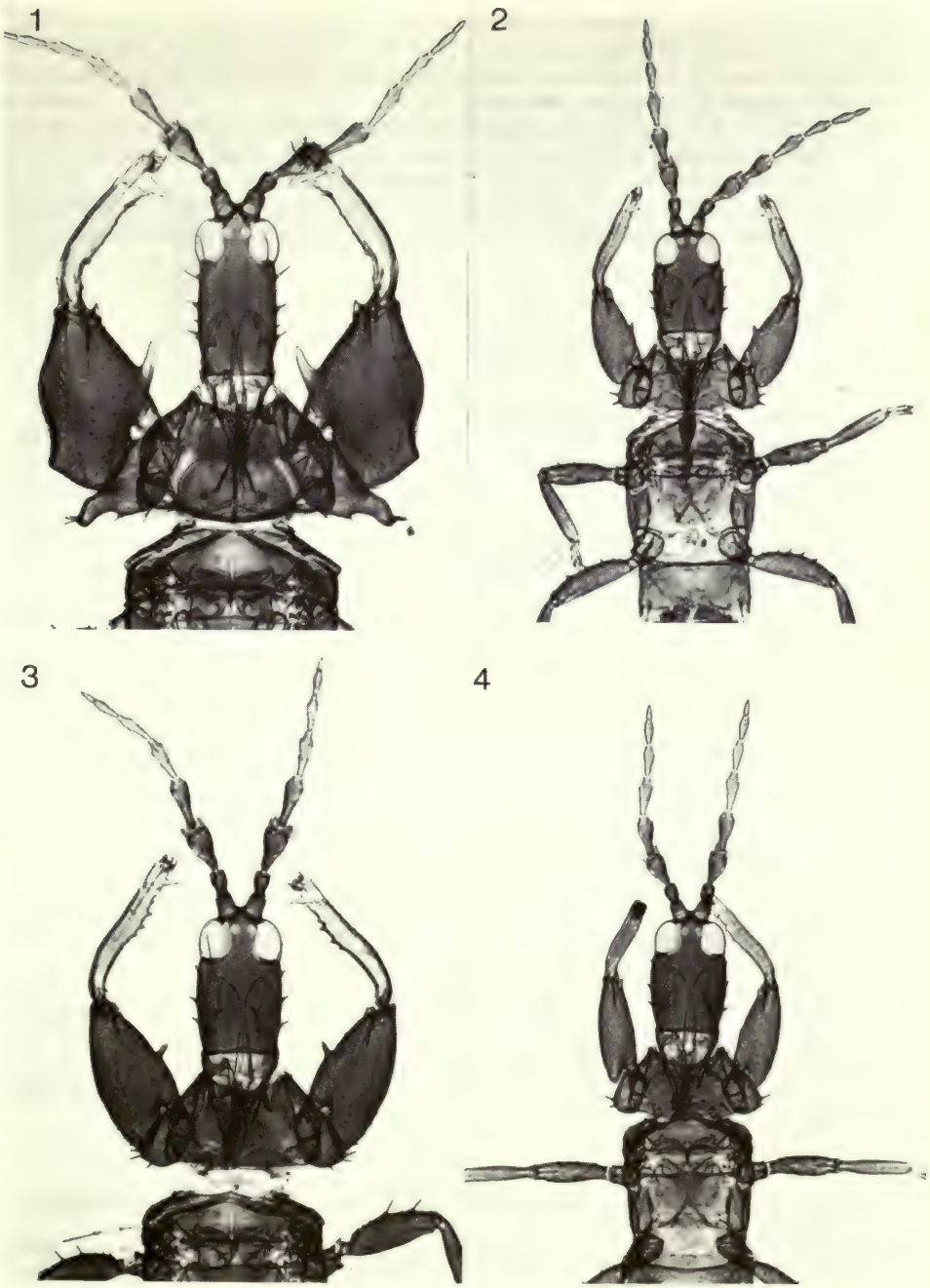
Ormothrips Buffa, 1909: 166. Type-species: *Ormothrips inermis* Buffa, by monotypy (here regarded as a synonym of *Phloeothrips spinipes* Bagnall). [Synonymized by Bagnall, 1911: 464.]

Macropterous, sexually dimorphic Phlaeothripinae. Antennae 8-segmented; segment IV with 4 sense cones, III with enlarged and usually supernumerary sense cones. Head with large eyes, cheeks with at least one pair of setae on small tubercles; stylets retracted almost to eyes, close together in middle of head; mouth cone pointed. Pronotum transverse, epimeral sutures complete; all major setae developed, antero-angulars frequently elongate in ♂; praepectus absent. Fore tarsus usually with a tooth; fore femur of ♂ with a pair of apical tubercles; both sexes sometimes with a median fore femoral tubercle. Mesonotal lateral setae elongate; metanotum reticulate. Fore wing constricted medially, duplicated cilia present. Pelta bell-shaped, rarely almost triangular; tergites II–VII with supernumerary wing retaining setae laterally in addition to the two main pairs; sternite VIII of ♂ without a glandular area.

Although 23 species-group names have been placed in this genus only six species are here accepted as valid. The concept of the genus is usually based on the polymorphic species *tibialis* Ashmead (=*sanguineus* Bagnall), and involves two obvious characters – the large number of enlarged sense cones on the third antennal segment, and the well-developed tubercle on the inner margin of the fore femur. However, only five of the six species here recognized in the genus have the first of these two characters, and only two of the species have the second character. One species, described below as *andrei*, has a well-developed fore femoral tubercle but has only four enlarged sense cones on the third antennal segment (Figs 5–8). This species is thus intermediate between the genera *Ecacanthothrips* and *Hoplandrothrips*. The alternative combination of characters involving four enlarged sense cones and unarmed fore femora is found in *Hoplandrothrips flavipes* Bagnall, and this species could well be treated in *Ecacanthothrips* as a close relative of *andrei*. However, the characteristic of enlarged sense cones on the third antennal segment is not in itself clear-cut in other undescribed species from Malaya and Japan. As a result, *Ecacanthothrips* could well be regarded as an Oriental species-group derived from the world-wide genus *Hoplandrothrips*.

Key to species

1 Fore femur of ♀ and ♂ with a stout median tubercle on inner margin, in very small ♀ this tubercle is scarcely visible; ♂ with a pair of tubercles at apex of fore femur (Figs 6–8) . . 2
– Fore femur of ♀ and ♂ with inner margin smooth or bearing a series of small tuberculate setae; ♂ with a pair of tubercles at apex of fore femur 3
2 Antennal segment III with at least 10 sense cones; pelta triangular; mid and hind femur with 3 stout capitate setae on anterior margin [Widespread] . . . . . ***tibialis*** (p. 161)
– Antennal segment III with 4 sense cones (rarely 5, 3 or 2) (Fig. 5); pelta broadly bell-shaped; anterior margin of mid and hind femur with one stout capitate seta [Malaya] . ***andrei*** (p. 158)
3 Anterior margin of mid and hind femur with a row of 5 or more stout setae with blunt or capitate apices; pelta broadly triangular; inner margin of fore femur with a row of short stout setae on small tubercles [New Guinea, Solomon Is] . . . . ***spinipes*** (p. 161)



Figs 1–4 *Ecacanthothrips tibialis*, (1, 2) ♂; (3, 4) ♀.

– Anterior margin of mid and hind femur with a row of 10 or more fine setae with acute apices; pelta bell-shaped; inner margin of fore femur smooth 4

4 Setae B_1 on tergite IX 1·1 times as long as tube; pronotum with well-developed closely spaced transverse lines of sculpture; sculptured reticles of metanotum and pelta with internal linear markings; posterolateral areas of tergites II–VII with numerous very stout dentate microtrichia; antennal segment III with more than 20 black sense cones which occupy about half of the ventral surface of the segment [Borneo] . . . . . ***coniger*** (p. 160)

– Setae B_1 on tergite IX less than 0·9 times as long as tube; pronotal sculpture weak, without transverse lines; sculptured reticles without internal markings; tergal microtrichia weak, ciliate or absent; antennal segment III with 15 sense cones or less 5

5 Fore wing pale or weakly shaded, but dark brown around sub-basal setae [Japan] ***inarmatus*** (p. 160)

– Fore wing pale or shaded, but not dark at base except on wing scale [Japan to Solomon Is] ***leai*** (p. 160)

Ecacanthothrips andrei sp. n.

(Figs 5–8)

♀ macroptera. Colour brown with some red hypodermal pigment; mid and hind tibiae and apices of femora clear yellow, fore tibiae yellow with faint brown markings; antennal segment III brownish yellow, succeeding segments increasingly dark, IV–VI light brown with yellowish pedicels; major setae of head and thorax dark, of wings and abdomen pale; wings light brown, paler at base, at median constriction and a little paler at apex.

Head reticulate dorsally but reticulation weak medially; cheeks slightly swollen, with one pair of major setae in posterior third. Antennal segment III with 4 sense cones ventrally, less commonly with 5, or 3, or only 2, segment IV with 4 sense cones (Fig. 5). Pronotum sculptured medially; fore femur with hooked median tubercle (Fig. 8); fore tibia with 4 to 5 small tubercles on inner margin; fore tarsal tooth variable in size. Mid and hind femora with 1 stout seta on anterior margin. Pelta broadly bell-shaped; tergites III–VII with a transverse row of 4 setae lateral to wing retaining setae; lateral areas with microtrichia on the lines of sculpture.

Measurements (holotype ♀ in μm). Body, length 3100. Head, length 330; maximum width 230; postocular setae 120; basal cheek setae 26. Pronotum, length 195; median width 370; major setae, anteromarginal 75, anteroangular 90, mid-lateral 80, epimeral 90, posteroangular 130. Width of prothorax across coxae 550. Mesonotal lateral setae 50. Fore wing, length 1150; distal width 80; sub-basal setae 70, 80, 80; number of duplicated cilia 15. Tergite IX setae B_1 130. Tube, length 175. Antennal segments III–VIII length, 90, 115, 100, 68, 55, 40.

♂ macroptera. Colour similar to ♀. Body size variable, large ♂ with elongate head bearing 3 pairs of stout cheek setae, elongate femoral tubercle (Fig. 7), long pointed coxae and large fore tarsal tooth; small ♂ with short head bearing weak cheek setae, very small fore femoral tubercle and fore tarsal tooth (Fig. 6), coxae normal and rounded.

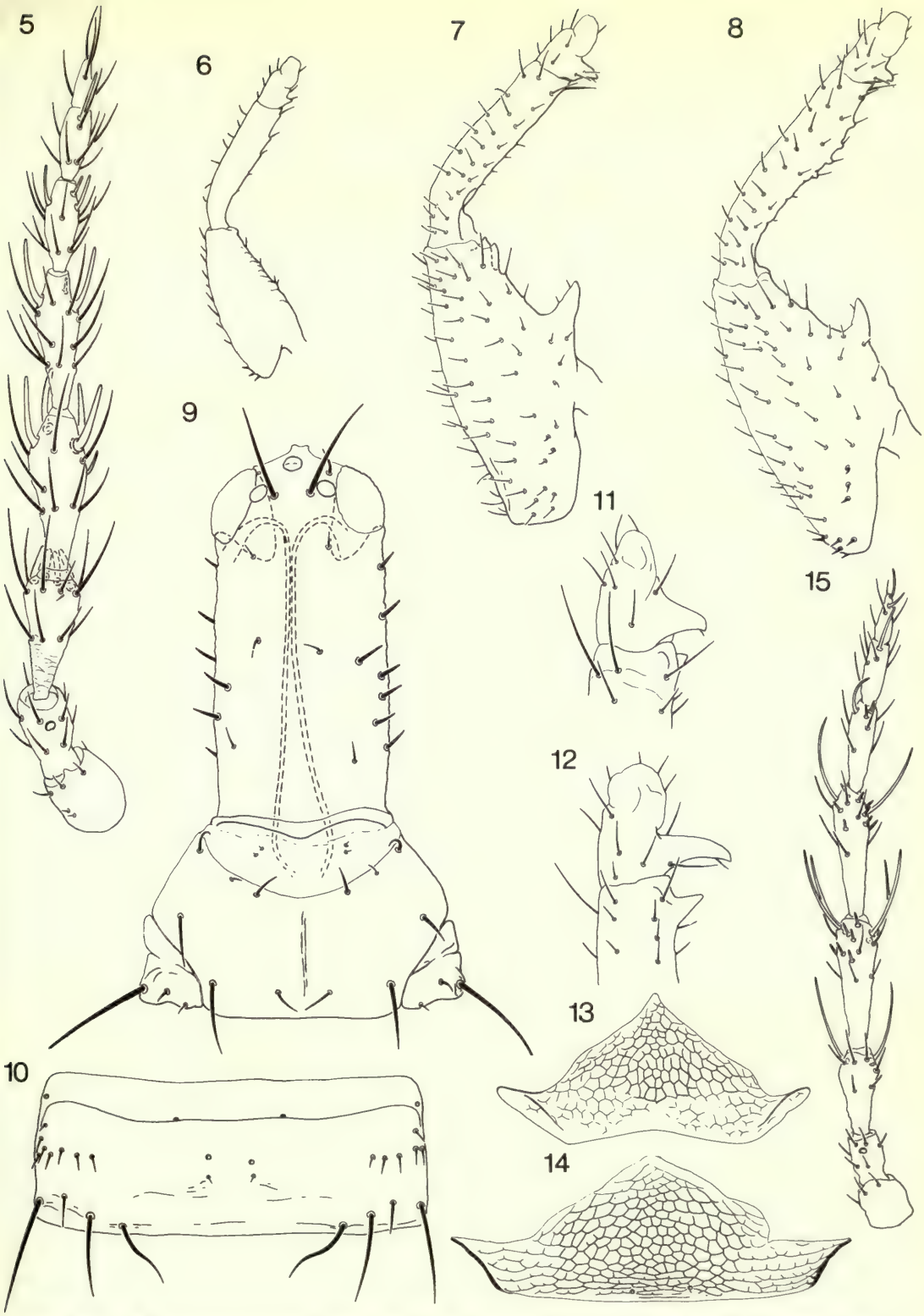
Measurements (largest and smallest ♂ paratypes). Body, length 2800 (1650). Head, length 350 (225); maximum width 190 (165); postocular setae 165 (70); basal cheek setae 35 (16). Pronotum, length 200 (97); median width 320 (210); major setae, anteromarginal 210 (42), anteroangular 115 (50), mid-lateral 115 (38), epimeral 100 (50), posteroangular 130 (65). Width of prothorax across coxae 550 (275). Fore wing, length 1000 (700); number of duplicated cilia 14 (7). Tube, length 160 (115). Antennal segments, III 90 (75); IV 100 (70).

Specimens studied.

Holotype ♀, **Malaya:** Gombak Field Station, 30 km east of Kuala Lumpur, on dead branches, 5.x.1973 (*L. A. Mound*) (BMNH).

Paratypes. **Malaya:** 7 ♀, 7 ♂ with same locality and collector as holotype, 29.ix.1973–7.x.1973; Kuala Lumpur, 3 ♀, 6 ♂ on partly dead branch, 27.xii.1969 (*R. & F. Andre*) (BMNH). **Singapore:** Bukit Timah Reserve, 1 ♀ on dead branch, 3.xi.1973 (*L. A. Mound*) (BMNH).

The head, pronotum and fore legs of the male of *andrei* are very similar to those of *tibialis*, moreover they show the same range of structural variation (Figs 6–8). However, large males have the pronotal anteromarginal setae much longer than the anteroangular setae instead of reduced as in *tibialis*, and the second pair of postocular setae are short and pointed, not elongate and expanded. The females are much less variable than the males. Most of the specimens studied have



Figs 5–15 5–8, *Ecacanthothrips andrei*, (5) ♀ right antenna; (6, 7) ♂ fore leg; (8) ♀ fore leg. 9–11, *Aesthesiothrips jatrophae*, (9) head and pronotum; (10) tergite III; (11) ♀ fore tibia and tarsus. 12 *Diaphorothrips clavipes* ♀, fore tibia and tarsus. 13, 14, peltas, (13) *A. jatrophae;* (14) *D. clavipes*. 15, *A. jatrophae*, right antenna.

4 sense cones on the third antennal segment, but several individuals have one or both antennae with only 3 or 2 sense cones on this segment, and one specimen has 5 sense cones on this segment on one of its antennae. This variation is not related to body size, but when the number of sense cones on a segment is reduced then their own individual size is increased. As discussed in the introduction, *andrei* is intermediate in structure between *Ecacanthothrips* and *Hoplandrothrips*.

Ecacanthothrips coniger Priesner

Ecacanthothrips coniger Priesner, 1930 : 363–364. Syntypes 2 ♀, BORNEO (SMF) [1 ♀ examined].

The only specimen of this species which has been studied is a large female. This specimen is easily recognized from the characters given in the key, but at least some of these characters are probably related to the large body size. If a small female of *coniger* is ever collected it will probably be rather similar to the other members of the *inarmatus*-group.

SPECIMEN STUDIED.

Borneo: Midden, 1 ♀ 'paratype', 16.viii.1925 (*H. C. Siebers* 33) (SMF).

Ecacanthothrips inarmatus Kurosawa

Ecacanthothrips inarmatus Kurosawa, 1932 : 238–242. Holotype ♀, JAPAN (Nat. Inst. Agric. Sci. Tokyo) [examined].
Ecacanthothrips piceae Ishida, 1936 : 154–156. Holotype ♂, JAPAN (? lost) [not examined]. **Syn. n.**

This species appears to be confined to the Japanese mainland. It is similar to, but considerably larger than, *leai* from Malaya and Java. The pattern of intraspecific variation in the *inarmatus* species-group requires further study based on new collections. Haga (1972) states that *piceae* may be the male form of *inarmatus*. The unique holotype of *piceae* is not in the Ishida collection at Sapporo and there is nothing in the description to distinguish it from *inarmatus*.

The smallest specimen listed below has a head rather similar to *leai*, but the other specimens are larger with a relatively long head. The pronotal anteromarginal setae of the males are elongate, about two-thirds as long as the anteroangulars, and the males have 2 pairs of long stout setae laterally on the posterior half of the head. The colour of the legs and antennal segments appears to be variable from yellow to brown, but even in the palest specimen the tibiae are dark.

SPECIMENS STUDIED.

Japan: Sizuoka, lida-mura, holotype ♀ of *inarmatus* in hole of citrus tree, 24.xi.1930 (*T. Noguti*) (SO, Tokyo); Kanagawa Prefecture, Atsugi, 1 ♂, 1 ♀ on dead leaves, 18.iii.1975; Kawada, Mikura-jima I., 2 ♀ (1 ♀ BMNH) on dead leaves, 9.vi.1973 (SO, Tokyo), 1 ♀, 11.vi.1973 (BMNH); Ohdaru spa, 1 ♂ on dead leaves, 27.vi.1972 (SO, Tokyo).

Ecacanthothrips leai Moulton

Ecacanthothrips leai Moulton, 1947 : 176. Holotype ♀, MALAYA (CAS) [examined].

This species was described from a single damaged female, but further specimens of both sexes have now been collected in both Malaya and Java. Moreover two females from New Guinea, referred to as *spinipes* by Mound (1970), are here regarded as *leai* as well as two specimens from the Ryuku Islands and four specimens from the Solomon Is. In Malaya *leai* was collected with both *tibialis* and *andrei*, and *tibialis* is also known from the Ryuku Is.

The differences between *leai* and *spinipes* are referred to under the latter species. Unfortunately all of the differences could be a function of size, that is *leai* may represent a small form of *spinipes*. Similarly the differences between *leai* and *inarmatus* are of the same order as the geographical variation in colour noted in *tibialis*. The male and female listed below from Amami-ohshima (Ryuku Is) are larger than the *leai* specimens from Malaya and Java with the head relatively long and slender and the pronotal anteromarginal setae of the male as long as the anteroangular

setae. Major males of *leai* from Malaya have the anteromarginal setae reduced. One of the females listed below from New Guinea has brown hind tibiae, whereas all the other specimens of *leai* have yellow tibiae. Delimitation of species in the *inarmatus*-group is still far from clear, and the description of further species needs to be avoided until more material is collected.

SPECIMENS STUDIED.

Malaya: Kuala Lumpur, ♀ holotype (*A. M. Lea*) (CAS); Kuala Lumpur, 11 ♀, 2 ♂ on dead branches xii.1969 (*R. & F. Andre*) (BMNH); Gombak, 30 km east of Kuala Lumpur, 5 ♀, 2 ♂ on dead wood, ix–x.1973 (*L. A. Mound*) (BMNH). **Java:** Tjibodas Botanic Garden, 5 ♀, 2 ♂ on dead leafy twigs, x.1973 (*L. A. Mound*) (BMNH). **New Guinea:** Wau, Bulolo Gorge, 900 m, 1 ♀ from bark of fallen log, 4.vi.1968 (*R. Rice*); Aiyura, 5400 ft [1800 m], 1 ♀ on grasses, 22.ii.1962 (*J. H. Barrett*) (BMNH). **Solomon Is:** Rendova, 2 ♂, 2 ♀ on dead leaves, xi.1972 (*Krauss*) (BMNH). **Japan:** Amami-ohshima Is, Nishinakama, 1 ♀, 1 ♂, 30.vi.1972 (*M. Kuboki*) (SO, Tokyo).

Ecacanthothrips spinipes (Bagnall)

Phloeothrips spinipes Bagnall, 1908*b* : 195–196. Holotype ♀, NEW GUINEA (BMNH) [examined].
Ecacanthothrips spinipes (Bagnall) Mound, 1968 : 90.
Ormothrips inermis Buffa, 1909 : 168. Holotype ?, NEW GUINEA (? lost) [not examined]. [Synonymized by Mound, 1970 : 96.]
Ecacanthothrips bagnalli Priesner, 1930: 364–365. Holotype ♂, KEI IS (SMF) [examined]. [Synonymized by Mound, 1970 : 96.]
Ecacanthothrips guineaensis Moulton, 1947 : 176–177. Holotype ♀, NEW GUINEA (CAS) [examined]. [Synonymized by Mound, 1970 : 96.]

Mound (1970) listed material of this species from the Solomon Islands and New Guinea and discussed variation in the shape of the pelta which appeared to be dependent on body size. However, the two small females from New Guinea (1 ♀ Aiyura, 1 ♀ Wau) which have a bell-shaped pelta also lack capitate setae on the mid and hind femora. These specimens are here regarded as *leai* despite the fact that one of them was collected with 11 ♀, 1 ♂ of *spinipes*. Unfortunately all of the known *spinipes* specimens are considerably larger than any of the known *leai* specimens. Therefore it is impossible to be certain that the obvious differences in head shape, pelta and femoral setae are not a function of size rather than real species differences. In contrast to *leai* the inner margin of the fore femur bears a series of small tuberculate setae, the mid and hind femora bear a row of stout capitate setae, the head is relatively short and narrowed to the base with three or more pairs of stout tuberculate setae in the female and four or more pairs of long stout setae in the male. The colour of the tibiae and third antennal segment appears to be variable. No further material has been studied apart from that listed by Mound (1970 : 97) from New Guinea and the Solomon Is.

Ecacanthothrips tibialis (Ashmead) **comb. n.**

(Figs 1–4)

Idolothrips tibialis Ashmead, 1905 : 20. Holotype ♀, PHILIPPINES (USNM) [examined].
Acanthothrips sanguineus Bagnall, 1908*a* : 362. Holotype ♀, NEW GUINEA (BMNH) [examined]. **Syn. n.**
Ecacanthothrips sanguineus (Bagnall) Bagnall, 1909*a* : 348.
Ormothrips sanguineus (Bagnall) Buffa, 1909 : 166.
Ecacanthothrips crassiceps Karny, 1913 : 134–136. Holotype ? ♀, NEW GUINEA (? lost) [not examined]. **Syn. n.**
Ormothrips Steinskyi Schmutz, 1913 : 1028–1030. Syntypes ♂, ♀, SRI LANKA (Ceylon) (NM) [2 ♀ examined]. [Synonymized with *sanguineus* by Ananthakrishnan, 1961*b* : 275.]
Ecacanthothrips bryanti Bagnall, 1915*a* : 320–321. Lectotype ♂, SARAWAK (BMNH) [examined]. [Synonymized with *sanguineus* by Ananthakrishnan, 1961*b* : 275.]
Ecacanthothrips coxalis Bagnall, 1915*b* : 597. Lectotype ♂, SARAWAK (BMNH) [examined]. [Synonymized with *sanguineus* by Ananthakrishnan, 1961*b* : 275.]
Ecacanthothrips flavipes Bagnall, 1915*b* : 597. Lectotype ♂, SARAWAK (BMNH) [examined]. [Synonymized with *sanguineus* by Ananthakrishnan, 1961*b* : 275.]

Ecacanthothrips coxalis var. *consanguineus* Priesner, 1930 : 367–368. Syntypes ♂, ♀, MALAYA & BORNEO (SMF & BMNH) [examined]. [Synonymized with *sanguineus* by Mound, 1968 : 89.]

Ecacanthothrips coxalis var. *philippinensis* Priesner, 1930 : 368. Syntypes ?, PHILIPPINES (? SMF) [not examined]. **Syn. n.**

Ecacanthothrips io Girault, 1930 : 1. Holotype ♂, AUSTRALIA (QM) [examined]. **Syn. n.**

Ecacanthothrips matsumurai Ishida, 1934 : 149–151. Holotype ♂, TAIWAN (? lost) [not examined]. **Syn. n.**

Ecacanthothrips fletcheri Ramakrishna, 1934 : 495–496. Holotype ♀, INDIA (? TNA) [not examined]. [Synonymized with *sanguineus* by Ananthakrishnan, 1961*b* : 275.]

Ecacanthothrips priesneri Hood, 1935 : 196–199. Holotype ♀, TANZANIA (USNM) [examined]. [Synonymized with *sanguineus* by Ananthakrishnan, 1961*b* : 275.]

Ecacanthothrips coxalis var. *formosensis* Takahashi, 1936 : 454–456. Holotype ♂, TAIWAN (? Dept. Agric. Res. Taiwan) [not examined]. **Syn. n.**

Ecacanthothrips ramakrishnai Ananthakrishnan, 1952 : 38–41. Holotype ♂, INDIA (TNA) [not examined]. [Synonymized with *sanguineus* by Ananthakrishnan, 1961*b* : 275.]

Ecacanthothrips erythrinus Ananthakrishnan, 1956 : 134–136. Holotype ♂, INDIA (TNA) [not examined]. [Synonymized with *sanguineus* by Ananthakrishnan, 1961*b* : 275.]

Ashmead described *tibialis* from a single specimen which at that time was mounted dry on a card point. This female was subsequently placed in balsam on a slide and is a typical member of the species usually known as *sanguineus*. Karny described *crassiceps* from a single specimen from New Guinea. This specimen is not available but the description defines satisfactorily an extreme gynaecoid male of *tibialis*, particularly when it is remembered that both Karny and Priesner measured 'head length' from the anterior margin of the eyes instead of the extreme anterior margin of the head. The specimen described as *io* by Girault is a typical male of *tibialis*. Moreover, although type-specimens have not been studied there is nothing in the descriptions of *philippinensis*, *matsumurai* nor *formosensis* to distinguish these from the species *tibialis* which is known to be common in both the Philippines and also Formosa.

This species is exceptionally variable. Structural variation associated with allometric growth is found throughout the geographical range of the species and has been discussed and illustrated by Hood (1935) and Ananthakrishnan (1961). Variation in colour of the tibiae and also the median antennal segments does not seem to be associated with body size, but there is a tendency for specimens from the western end of the range to have darker appendages than specimens from the eastern end. Thus the specimens from the Philippines and many of those from Borneo have the pedicels of antennal segments V and VI yellow, and the hind tibiae vary from yellow washed with brown medially to dark brown with paler ends. Most of the specimens studied from Malaya, Sri Lanka, India, Mauritius and Tanzania have the antennal pedicels brown and the hind tibiae frequently black. However, the specimens listed below from Japan and Taiwan are also dark. These colour variations, together with the structural variation associated with allometric growth patterns (Figs 1–4), account for the large number of names by which this species has been known.

SPECIMENS STUDIED.

Japan: Okinawa-jima Is, 3 ♂, 1 ♀ (SO, Tokyo; 1 ♀ BMNH); Amami-ohshima Is, 1 ♀, vii.1972 (SO, Tokyo; 1 ♂ BMNH). **Taiwan:** Nansanchi, 2 ♀, 2 ♂, vi.1972 (SO, Tokyo); Heito, 1 ♀ from bark of *Artocarpus*, 25.iii.1933 (*M. Ishida* 1685) (HUS) [det. *sanguineus* by Haga, 1972, and labelled 'M. Ishida's E. matsumurai']. **China:** Chengtu, 1 ♀, viii.1930 (BMNH). **Vietnam:** Tonkin, 4 ♀, 3 ♂ (BMNH). **Philippines:** Manilla; holotype ♀ of *tibialis* (*Robt Brown*) (USNM); 17 ♀, 8 ♂, vii.1931 (BMNH). **Borneo:** Midden, 1 ♂, 1 ♀ syntypes of *consanguineus*, viii.1925; Sarawak, Mt Matang, ♂ lectotypes of *bryanti*, *coxalis* and *flavipes*, xii.1913–ii.1914; Hii Siew, 3 ♀, 2 ♂ on Cacao (BMNH). **New Guinea:** Dorey, holotype ♀ of *sanguineus;* Wau, 2 ♀, 2 ♂, vi.1968 (BMNH). **Australia:** Queensland, holotype ♂ of *io* (QM). **Indonesia:** Isle of Nias, 1 ♀, 7 ♂; Java, Bogor, 31 ♀, 21 ♂ 10 instar II, x.1973 (*Mound*) (BMNH). **Singapore:** Bukit Timor, 7 ♀, 12 ♂, xi.1973–i.1974 (BMNH). **Malaya:** near Kuala Lumpur, 48 ♀, 41 ♂, x.1973; Ringlet, Cameron Highlands, 4 ♀, 5 ♂, x.1973 (*Mound*); Trengannu, 9 ♀, 2 ♂, iii.1974 (BMNH). **India:** Madras, 4 ♀, 5 ♂ (*Ananthakrishnan*) (BMNH). **Sri Lanka:** Peradeniya, 7 ♀, 6 ♂ (*Green & Rutherford*) (BMNH); 2 ♀ syntypes of *Steinskyi* on bark, 24–25.v.1902 (*Uzel* 193, 194) (NM). **Mauritius:** 1 ♀, v.1970; 1 ♂, xii.1971; 1 ♂, vi.1971 (BMNH). **Rodrigues:** 1 ♂ (BMNH). **Tanzania:** Amani, holotype ♀ of *priesneri*, i.1928 (USNM).

AESTHESIOTHRIPS Ananthakrishnan

Aesthesiothrips Ananthakrishnan, 1961*a*: 253. Type-species: *Aesthesiothrips jatrophae* Ananthakrishnan, by monotypy.

Large, dark, macropterous species of Cryptothripini. Head elongate, eyes relatively small but slightly prolonged ventrally; stylets retracted to eyes, close together in middle of head; postocellar setae reaching to apex of antennal segment I; mouth cone broadly rounded. Antennae 8-segmented, III about two-thirds as long as IV; sense cones on III and IV longer than their segment, 2 on III, 4 on IV. Pronotum transverse, epimeral sutures complete, setae in normal position; posteroangular setae scarcely two-thirds as long as epimerals; praepectus present. Both sexes with stout fore tarsal tooth, apex of fore tibia flattened and bearing a small tubercle. Metanotum weakly reticulate, median setae less than 50 μm long. Fore wing relatively slender, sub-basal setae not elongate. Pelta irregularly triangular (Fig. 13); tergites II–VII with 1 pair of wing-retaining setae, and laterally with a transverse row of 2 to 5 short setae; tergite IX setae almost as long as tube; ♀ with tube slightly longer than head, margins weakly convex; ♂ with tube shorter than head.

This genus was erected for a single species described from two damaged females. The original description referred to the elongate sense cones on the third and fourth antennal segments, but did not mention the remarkable maxillary stylets and long postocellar setae (Fig. 9). The form of the head is similar to *Phaulothrips* Hood from Australia (Mound, 1974), but the structure of the antennae and sense cones is quite different (Fig. 15). *Celidothrips* Priesner is also related but has long postocular setae and short sense cones, and one ommatidium is isolated behind each eye on the cheeks.

Aesthesiothrips jatrophae Ananthakrishnan
(Figs 9–11, 13, 15)

Aesthesiothrips jatrophae Ananthakrishnan, 1961*a*: 253–254. Holotype ♀, India (TNA) [examined].

This species was based on two damaged females collected in northern India. The specimens listed below from Malaya cannot be distinguished at present from *jatrophae*, although the holotype has fewer setae laterally on each tergite. The males are very similar to the females although a little smaller with a shorter tube. However, the length of the tube is apparently subject to allometric growth in this species. The short third antennal segment is mainly yellow in contrast to the dark brown of the rest of the body.

Specimens studied.

India: Dehra Dun, Nakronda, holotype ♀ on *Jatropha curcus* fruits, 23.iii.1934 (*Bahadur*) (TNA). **Malaya:** Kuala Lumpur, 13 ♀, 4 ♂ on dead branch, 26.xii.1969 (*R. G. & F. Andre*) (BMNH).

DIAPHOROTHRIPS Karny

Diaphorothrips Karny, 1920*a*: 186. Type-species: *Diaphorothrips unguipes* Karny, by monotypy.
Diaphorothrips (*Cnemidothrips*) Priesner, 1940: 403. Type-species: *Diaphorothrips hamipes* Karny, by original designation.

Medium sized, dark brown members of Cryptothripini. Head rectangular, longer than broad; cheeks with at least 8 pairs of setae; 1 pair of ocellar setae frequently elongate; maxillary stylets retracted almost to postocular setae, not close together in midline; mouth cone appears pointed. Antennae 8-segmented, VIII lanceolate in shape; 2 sense cones on III, 5 on IV. Pronotum with anterior margin thickened, at least in large specimens, anteromarginal setae reduced; both sexes with fore tarsal tooth well developed and fore tibia with subapical projection (Fig. 12); praepectus well developed, mesopraesternum boat-shaped. Fore wings broad with numerous duplicated cilia. Pelta hat-shaped with lateral margins curving forwards away from tergite II (Fig. 14). Tergites with 1 pair of wing-retaining setae; setae on IX shorter than tube; tube heavy, margins slightly convex.

The three species now recognized in *Diaphorothrips* are *unguipes* from Sri Lanka and southern India, *hamipes* from Java, Sumatra and Malaya, and *clavipes* from both Singapore and the adjoining Riau Is. However, none of these species appears to occur in large numbers, each having been

collected infrequently from dead twigs or under bark. The genus is a typical member of the Cryptothripini and is intermediate in structure between certain species of *Scotothrips* or *Dichaetothrips* and the Oriental genus *Uredothrips*. The subgenus *Cnemidothrips* does not seem to be a useful category in view of the many similarities between the three species indicated below.

Key to species

1 Antennal segment III yellow to yellowish brown in basal half, relatively short and conical, less than 2·2 times as long as maximum width; relatively small species with tube 1·2 times as long as head [Malaya to Sumatra] . . . . . ***hamipes*** (p. 164)

– Antennal segment III dark brown with extreme base pale, more than 2·5 times as long as wide; relatively large species with tube 1·4 times as long as head 2

2 Postocellar setae more than 3·0 times as long as anteocellar setae; cheeks with 10–12 pairs of relatively weak setae, longest cheek seta less than 26 μm; fore wing clear or weakly shaded in distal half [India, Sri Lanka] . . . . . ***unguipes*** (p. 164)

– Postocellar setae less than 0·8 times as long as anteocellar setae; cheeks with 8 pairs of stout dark setae, longest cheek seta more than 30 μm; fore wing deeply shaded in distal half [Riau Is, Singapore] . . . . . ***clavipes*** (p. 164)

Diaphorothrips clavipes Priesner

(Figs 12–14)

Diaphorothrips (*Cnemidothrips*) *clavipes* Priesner, 1940 : 403–405. Holotype ♀, Riau Is (SMF) [examined].

The cheek setae of this species are larger and darker than in the other two species. The antennae are similar to *unguipes* but the ocellar setae are similar to *hamipes*.

Specimens studied.

Riau (Riouw) Is: Doerian, ♀ holotype, xi.1923 (*Dammerman*) (SMF). **Singapore:** 3 ♀ on dead twigs, 4.xi.1973 (*L. A. Mound*) (BMNH).

Diaphorothrips hamipes Karny

Diaphorothrips hamipes Karny, 1923 : 296–299. Syntypes 1 ♀, 2 ♂ (sic) Java: (SMF) [2 ♀ examined].

The original description refers to one female and two males. However, the only specimens bearing the original data which have been found are both females although one was labelled as male by Karny. The species is smaller than both *clavipes* and *unguipes*, although the head length varies from 280 to 350 μm in the available specimens. Even in the largest specimen the cheek setae are pale and slender. The external sense cone on the sixth antennal segment is exceptionally large, whereas it is small in *clavipes* and only moderately large in *unguipes*.

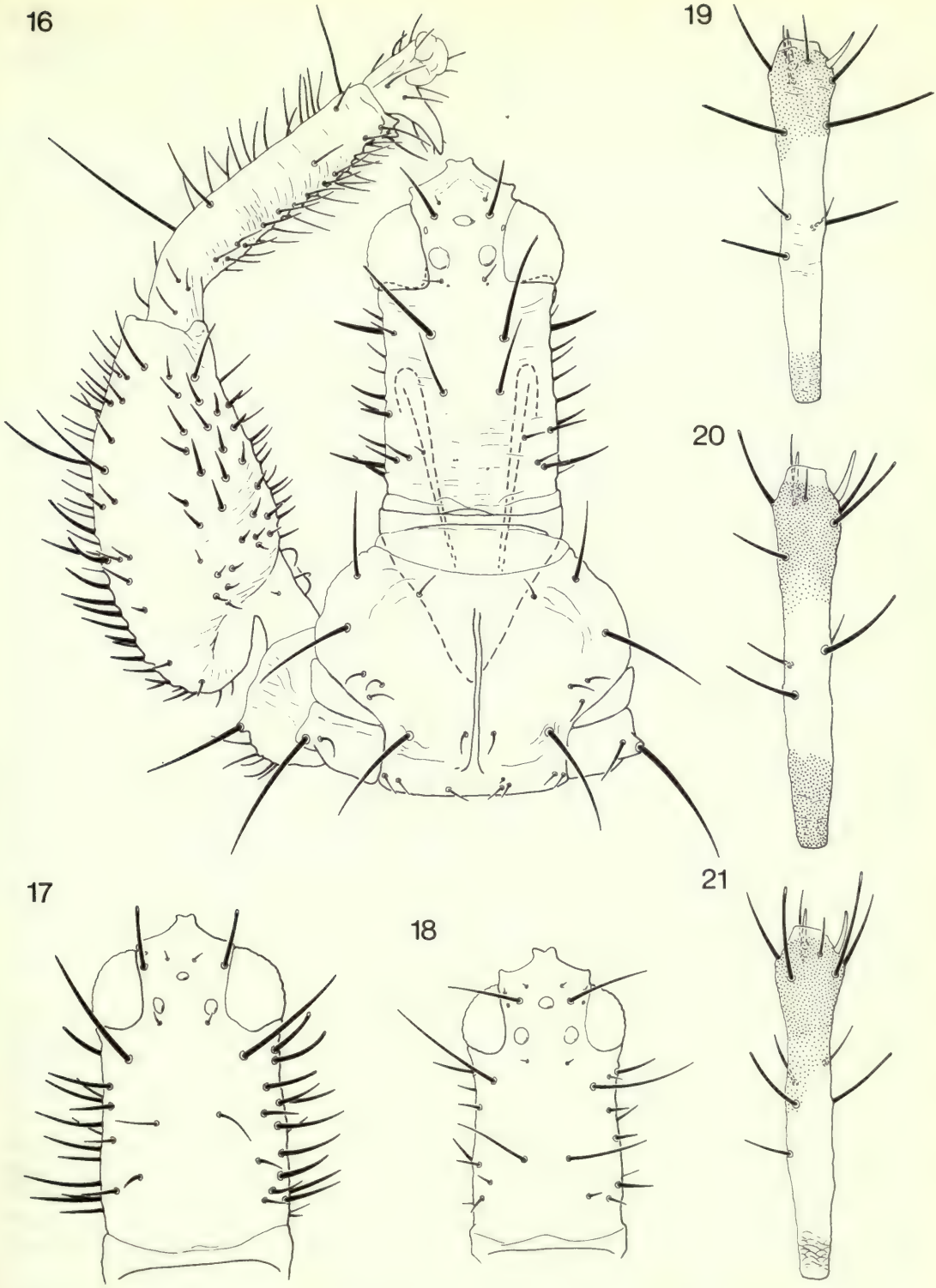
Specimens studied.

Java: Buitenzorg [Bogor]; 2 ♀ syntypes under citrus bark, 11.ii.1921 (*Kemner*) (SMF); 1 ♀ on dead twigs, 18.x.1973 (*L. A. Mound*) (BMNH). **Sumatra:** Medan, 1 ♀ in dry *Caesalpinia* pods, 15.v.1922 (*Fulmek*) (SMF). **Malaya:** Kuala Lumpur, 3 ♀, 3 ♂ on dead branches, 26–29.xii.1969 (*R. G. & F. Andre*) (BMNH).

Diaphorothrips unguipes Karny

Diaphorothrips unguipes Karny, 1920*a* : 186–189. Syntypes 2 ♀, Sri Lanka (Ceylon) (SMF) [1 ♀ examined].
Diaphorothrips thevetii Ananthakrishnan, 1957 : 101–102. Holotype ♀, India (TNA) [examined]. **Syn. n.**
Diaphorothrips spinosus Ananthakrishnan, 1959 : 321–322. Holotype ♀, India (TNA) [examined]. [Synonymized by Ananthakrishnan & Jagadish, 1970 : 275.]

The original description of *unguipes* refers to one winged and one wingless specimen from Sri Lanka, but only the winged individual has been studied. *D. thevetii* was based on a rather small, damaged female and the original description did not compare this specimen with other members of the genus. The differences quoted by Ananthakrishnan (1973*b* : 87) are interpreted here as being related to body size. *D. spinosus* was based on a male and female with a longer head and



Figs 16–21 Males of *Dinothrips* species. 16, *D. spinosus*. 17, *D. juglandis*. 18, *D. longicauda*. 19–21, antennal segment III, (19) *D. spinosus;* (20) *D. sumatrensis;* (21) *D. juglandis*.

with longer setae than the *thevetii* holotype. However, none of these specimens differs significantly from the syntype listed below. The date of collection and the collector's number on the holotype slide of *spinosus* differ from those given in the original description.

SPECIMENS STUDIED.

Sri Lanka (Ceylon): Bentotta, 1 ♀ syntype of *unguipes* (*W. Horn* 99) (SMF). **India:** Madras; ♀ holotype of *thevetii*, on *Thevetia*, 19.xi.1955 (*Ananthakrishnan*); ♀ holotype of *spinosus* from inside dry twigs of *Thevetia*, iii.1957 (*Ananthakrishnan*); 1 ♀ on *Sesbania* twigs, 2.iv.1963 (BMNH); 3 ♀ on *Erythrina* twig, 20.ix.1965 (1 ♀ SMF, 2 ♀ BMNH).

DINOTHRIPS Bagnall

Dinothrips Bagnall, 1908*b*: 190. Type-species: *Dinothrips sumatrensis* Bagnall, by monotypy.
Dinothrips Bagnall; Priesner, 1959: 52.
Paxillothrips Ananthakrishnan, 1961*a*: 250. Type-species: *Paxillothrips longicauda* Ananthakrishnan, by monotypy. **Syn. n.**
Dinothrips Bagnall; Ananthakrishnan, 1964: 88; 1973*b*: 91.

Large, dark, macropterous species of Idolothripini. Head rectangular, about twice as long as broad, projecting slightly in front of eyes; eyes large and equally developed on dorsal and ventral surfaces; head with 1 pair of anteocellar setae, 1 pair of postocular setae and 1 pair of long setae on the vertex (postocular setae pair II); cheeks set with stout spine-like setae. Antennae 8-segmented; segment III about 5·0 to 5·5 times as long as broad, with 2 sense cones, IV with 4 sense cones. Pronotum shorter than head, almost twice as broad as long, usually with 5 pairs of major setae but sometimes with an additional pair of posteroangulars (Fig. 24). Fore tarsal tooth present in ♂ and ♀, but much larger in ♂; fore femora of ♂ enlarged with numerous spine-like setae at base (Fig. 16). Mesothoracic anterior angles of ♂ with spiracles produced into a laterally projecting, usually bifurcate, process; this process not developed in ♀ and some small ♂. Pelta triangular, lateral lobes separated (Fig. 30). Tergites II–VII with 2 pairs of sigmoid wing-retaining setae, those on VII much reduced, tergal accessory setae straight (Fig. 31); sternite IX of ♂ with a pair of large spines (Fig. 33). Tube with straight sides evenly narrowing to apex, about 4 times as long as broad and about as long as head.

Although *Dinothrips* is a small genus, only five species now being recognized, the individuals are frequently large. They are found on dead branches in the area between northern India, Sri Lanka, New Guinea and the Philippines, and they frequently constitute the dominant element in the thrips fauna of this habitat. In both Malaya and Java *D. sumatrensis* and *D. spinosus* have been found together on recently fallen tree trunks where they were coexisting in large numbers with *Ecacanthothrips* species. Each *Dinothrips* species is sexually dimorphic, the males having a pair of enlarged mesothoracic spiracular processes (Figs 22, 26–29) which are not developed in females. However, the males are subject to allometric growth patterns such that these processes are large in large individuals but small or absent in small individuals. This sexual dimorphism and allometry is the cause of the large number of names which have been applied to the two common species.

The monobasic genus *Paxillothrips* was distinguished from *Dinothrips* by the small peg-like mesothoracic processes, and by the form of the pelta. However, the pelta of the two male and one female paratypes of *longicauda* which have been studied is similar to that of *Dinothrips* species and not like that given in the illustration which accompanied the original description. Moreover, the mesothoracic process is so variable in *Dinothrips*, even being absent in some males, that it is of little practical value as a generic characteristic. *Dinothrips* is related to both *Elaphrothrips* and the monobasic African genus *Lamillothrips*. In the latter genus the anterior angles of the pronotum are produced into tubercles in the male, and the lateral lobes of the pelta are not separated. In Oriental *Elaphrothrips* species the tergites bear accessory sigmoid setae anterolateral to the major wing-retaining setae, and the first ocellus is situated anterior to the ocellar setae, on the head prolongation.

Key to species

1 Antennal segment III with base pale (Fig. 21); mesothoracic spiracular process of ♂ small (Figs 27, 28) 2

– Antennal segment III with base dark (Figs 19, 20); mesothoracic spiracular process of ♂ frequently large (Figs 22, 29) 3

2 Pronotal anteromarginal setae longer than the distance between their bases (Fig. 25); median pair of setae on vertex small, no longer than cheek setae and about 0·3 times as long as postocular setae (Fig. 17); cheek setae long and pale (♂ 160–170 μm; ♀ 95–100 μm) [India, Burma] . . . . . ***juglandis*** (p. 167)

– Pronotal anteromarginal setae shorter than distance between their bases; median pair of setae on vertex about 0·75 times as long as postoculars (Fig. 18); cheek setae short and pale (50–90 μm) [India] . . . . . ***longicauda*** (p. 167)

3 Mesothoracic spiracular process of ♂ not bifurcate but with dentate margin (Fig. 29); cheek setae less than 100 μm long [Philippines] . . . . . ***monodon*** (p. 167)

– Mesothoracic process of ♂ bifurcate or reduced (Figs 22, 26) 4

4 Antennal segment III usually less than 3·5 times as long as the apical dark band on this segment (♂ 2·2–3·2; ♀ 2·8–3·9) (Fig. 20); cheek setae long and pale in ♂ (110–180 μm) but shorter and sometimes dark in ♀ (60–100 μm); anteocellar setae long (♂ 140–180 μm; ♀ 120–160 μm); ♂ usually, ♀ sometimes with more than one pair of major posteroangular pronotal setae (Fig. 24); epimeral tubercles often well developed; antecostal ridge of sternite II in ♀ often interrupted medially [Malaya to Borneo] . . . . . ***sumatrensis*** (p. 170)

– Antennal segment III usually more than 3·5 times as long as apical dark band on this segment (♂ 3·5–4·9; ♀ 3·4–5·3) (Fig. 19); cheek setae shorter and darker (♂ 70–140 μm; ♀ 50–90 μm); anteocellar setae shorter (90–150 μm); only one pair of posteroangular pronotal setae (Fig. 16); epimeral tubercles weak even in large ♂; antecostal ridge of sternite II in ♀ not interrupted medially [India to Solomon Is] . . . . . ***spinosus*** (p. 169)

Dinothrips juglandis Moulton

(Figs 17, 21, 25, 28)

Dinothrips juglandis Moulton, 1933 : 6. Holotype ♂, India (BMNH) [examined].

This species is readily distinguishable from the others in this genus by having the pronotal anteromarginal setae longer than the distance between their bases. In the specimens listed below the cheek setae are long and pale and the mesothoracic spiracular processes are not well developed (Fig. 28).

Specimens studied.

India: Bengal, Lopchu, holotype ♂, paratype ♀ (also 3 ♂ 1 ♀ with identical data) under bark of *Juglans regia*, 26.ix.1929 (*J. C. M. Gardner*) (BMNH). **Burma:** Mishmi Hills, 2 ♂, iii.1935 (*M. Steel*) (BMNH).

Dinothrips longicauda (Ananthakrishnan) **comb. n.**

(Figs 18, 27, 32)

Paxillothrips longicauda Ananthakrishnan, 1961*a* : 250. Holotype ♀, India (TNA) [not examined].

Two male and one female paratypes of this species have been studied out of an original series of 4 ♀, 2 ♂. These specimens resemble the other species in *Dinothrips* in most characters, but have rather paler wings and small peg-like mesothoracic spiracular processes. The available specimens are small, the head appears to be slightly more concave behind the eyes, and the metanotal sculpture of the male is developed into a U-shaped ridge (Fig. 32).

Specimens studied.

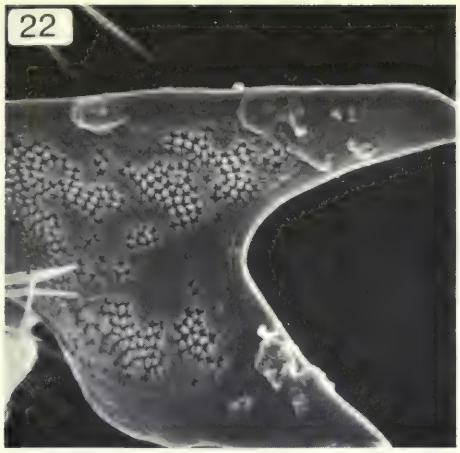
India: Bombay, Ramangulli, 2 ♂, 1 ♀ paratypes in hollow of bamboo, 28.i.1949 (TNA).

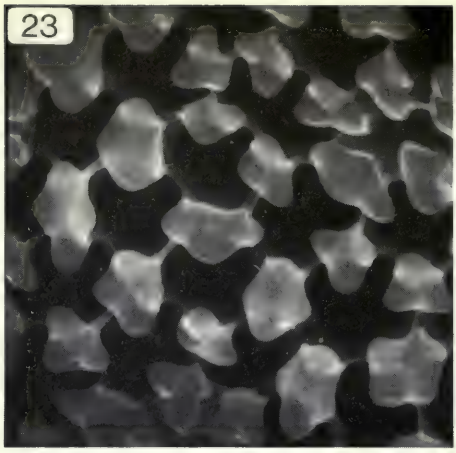
Dinothrips monodon Karny

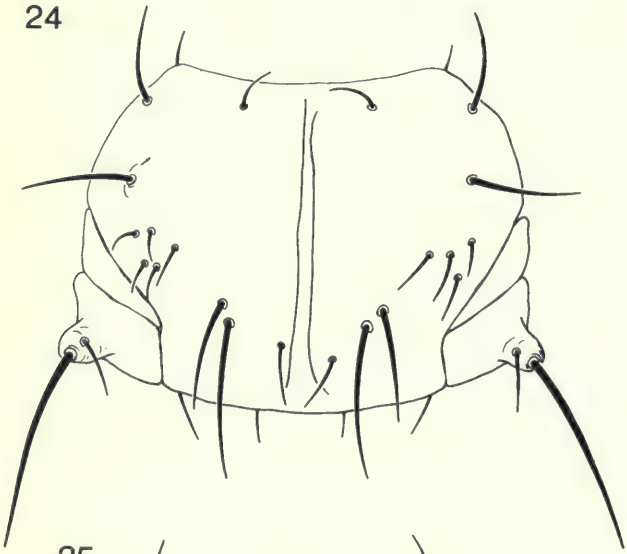
(Fig. 29)

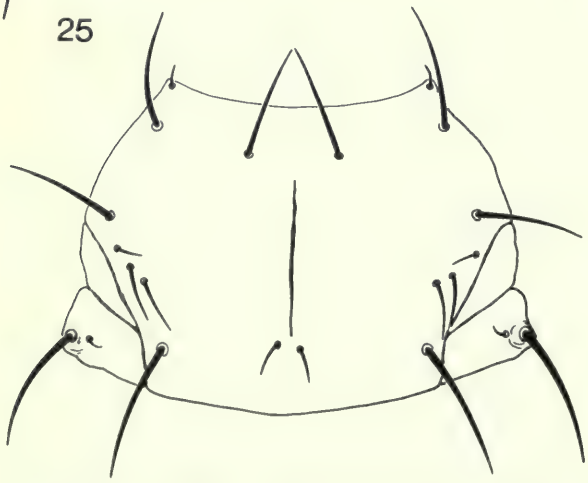
Dinothrips monodon Karny, 1920*b* : 204. Holotype ♂, Philippines (SMF) [examined].

The male of this species is recognized easily by the unforked, toothed spiracular process (Fig. 29).









Figs 22–29 Males of *Dinothrips* species. 22–24, *D. sumatrensis*, (22, 23) mesothoracic spiracular process. 25, *D. juglandis*. 26–29, mesothoracic spiracular processes, (26) small *D. spinosus;* (27) *D. longicauda;* (28) *D. juglandis;* (29) *D. monodon.*

Moulton (1943) records 6 ♂, 1 ♀ of *monodon* from the Philippines, but the original description was based on a single male.

SPECIMEN STUDIED.

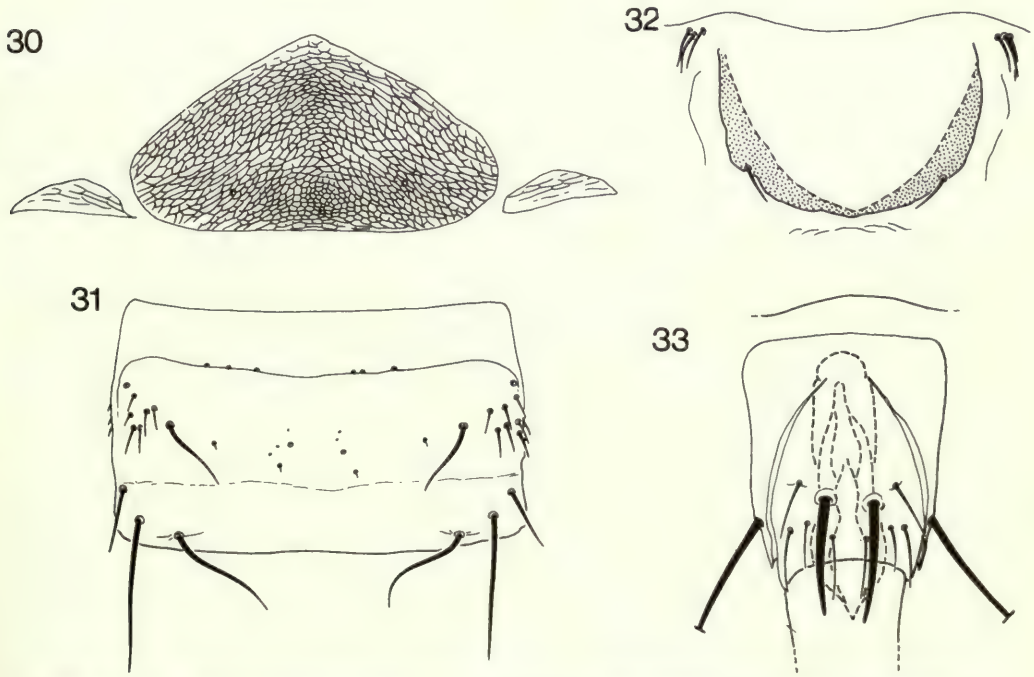
Philippines: Mindanao, Butuan, holotype ♂ (*Baker*) (SMF).

Dinothrips spinosus (Schmutz) **comb. n.**

(Figs 16, 19, 26, 33)

Ischyrothrips spinosus Schmutz, 1913 : 88. Holotype ♀, SRI LANKA (Ceylon) (NM) [examined].
Dinothrips affinis Bagnall, 1915*c* : 270. LECTOTYPE ♂, BORNEO (BMNH), here designated [examined]. **Syn. n.**
Dicaiothrips crassiceps Bagnall, 1921*b* : 399. Holotype ♀, BURMA (BMNH) [examined]. **Syn. n.**
Dinothrips jacobsoni Karny, 1921*a* : 283. Holotype ♂, JAVA (SMF) [examined]. **Syn. n.**
Dinothrips kemneri Karny, 1923 : 294. LECTOTYPE ♂, JAVA (SMF), here designated [examined]. **Syn. n.**
Dinothrips anodon Karny, 1923 : 295. Syntypes 1 ♂, 1 ♀, JAVA (depository unknown) [not examined]. **Syn. n.**
Dinothrips gardneri Moulton, 1928*b* : 290. Holotype ♂, INDIA (CAS) [examined]. **Syn. n.**
Dinothrips malloti Moulton, 1933 : 6. Holotype ♂, INDIA (BMNH) [examined]. **Syn. n.**
Dinothrips celebensis Bagnall, 1934*a* : 485. Holotype ♂, SULAWESI (Celebes) (MNHN) [examined]. **Syn. n.**
[*Dinothrips sumatrensis* Bagnall; Priesner, 1959 : 52. Misidentification.]

D. spinosus is the most commonly collected species in the genus, with an extensive distribution in tropical rain forest between northern India, Sri Lanka, Sulawesi and New Guinea. However, throughout much of this range it is often found in company with a second closely related species, *sumatrensis*, with which it has previously been confused.



Figs 30–33 Males of *Dinothrips* species. 30, 31, *D. sumatrensis*, (30) pelta; (31) tergite IV. 32. *D. longicauda*, metathorax. 33, *D. spinosus*, sternite IX.

The unique holotype female of *spinosus* was labelled subsequently by Dr H. Priesner '*Dinothrips sumatrensis* Bagn'. This specimen is evidently a member of the genus *Dinothrips*, but it is indistinguishable from the female paralectotypes of *affinis* and, like them, differs from *sumatrensis* in having the third antennal segment longer, more slender and paler, in having shorter darker cheek setae and shorter anteocellar setae, and in having only one pair of posteroangular pronotal setae. The synonymy of *affinis* with *sumatrensis* by Mound (1968) is therefore here refuted.

Bagnall (1915*c*) states that the *Dinothrips* collected by G. E. Bryant from dead bark and trees on Mt Matang in December 1913 comprised both *sumatrensis* and *affinis*. He distinguished the second species by having the third antennal segment 'more slender' and 'distinctly longer than in *sumatrensis* . . . rarely darker basally and only narrowly blackish-brown at apex'. The series of specimens remaining in Bagnall's collection and bearing the above data comprises 2 ♀, 5 ♂ which agree with the description of *sumatrensis*, and 8 ♀, 8 ♂ which agree with the description of *affinis*. One of these male syntypes is here designated lectotype of *affinis*.

Bagnall (1921*b*) described *crassiceps* from a unique female, but this specimen cannot be distinguished from females of *spinosus*. The remaining six nominal species listed above in the synonymy of *spinosus* were all established for different variants of the male mesothoracic spiracular processes. The holotypes of *gardneri* and *jacobsoni*, as well as the lectotype of *kemneri* designated here, are merely small individuals with small processes, and the 'heavy, blunt tips' of these processes in *malloti* described by Moulton are due to the tips being broken. Moreover, *celebensis* lies within the range of variation of *spinosus* (not of *sumatrensis*, cf. Mound, 1968), and judging from the description, this is also true of *anodon*.

SPECIMENS STUDIED.

Sri Lanka (Ceylon): holotype ♀ of *spinosus*, No. 54, stuck to sap of fallen tree, between wood and bark, 2.i.1902 (*Uzel*) (NM). **India:** Malabar, 8 ♀ (BMNH); Taliparamba, 1 ♀ (BMNH), 1 ♀ (SMF); Kumaon, 1 ♀; Kiruvatti, 4 ♂, 2 ♀; Aryankaru, 1 ♀; Dehra Dun, 1 ♂, 1 ♀ (BMNH); holotype ♂ of *gardneri*, Golatappar, 14.xi.1922 (*N. C. Chatterjee*) (CAS); holotype ♂ of *malloti*, Lachiwala, on log of *Mallotus philippensis*, 6.i.1929 (BMNH). **Burma:** holotype ♀ of *crassiceps*, Myawadi, 900 ft [270 m], 24–26.xi.1911 (*F. H. Gravely*) (BMNH). **Vietnam:** North, 1 ♂, 1 ♀ (BMNH). **Malaya:** Kuala Lumpur, 13 ♂, 12 ♀; Perak, 1 ♂, 1 ♀; Ringlet, 2 ♂; Kuala Trengganu, 1 ♀ (BMNH); Bentong, 1 ♂; Serdang 1 ♂, 1 ♀ (SMF). **Singapore:** 4 ♂, 1 ♀ (BMNH). **Riau (Riouw) Is**: 1 ♀ (SMF). **Sumatra:** 18 ♂, 23 ♀ (BMNH), 17 ♂, 19 ♀ (SMF). **Mentawei Is**: 3 ♂, 1 ♀ (SMF). **Java:** holotype ♂ of *jacobsoni*, Semerang, under bark, 1905 (*F. Jacobson*) (SMF); lectotype ♂ of *kemneri*, Bogor (Buitenzorg), under *Albizzia* bark, 10.xii.1920 (*N. A. Kemner*) (SMF); Bogor, 24 ♂, 6 ♀ (BMNH), 2 ♂, 3 ♀ (SMF); Jasinga, 1 ♂, 2 ♀ (BMNH); Sindanglaja, 2 ♂, 1 ♀ (SMF). **Borneo:** 1 ♀ (SMF); Sarawak, 4 ♂, 5 ♀; lectotype ♂, paralectotypes 7 ♂, 7 ♀ of *affinis*, Mt Matang 1000 ft [300 m], on dead tree, 16.xii.1913 (*G. E. Bryant*) (BMNH). **Sulawesi** (Celebes): 7 ♂, 1 ♀ (BMNH); holotype ♂ of *celebensis* (*de la Savinière*) (MNHN). **Philippines:** 1 ♂, 5 ♀ (SMF). **New Guinea:** 2 ♀ (BMNH), 1 ♂ (SMF). **Solomon Is:** 1 ♀ (BMNH).

Dinothrips sumatrensis Bagnall

(Figs 20, 22–24, 30, 31)

Dinothrips sumatrensis Bagnall, 1908*b* : 191. LECTOTYPE ♂, SUMATRA (BMNH) [examined].
Dinothrips furcifer Schmutz, 1913 : 36. Holotype ♂, SRI LANKA (Ceylon) (lost) [not examined]. [Synonymized by Karny 1920*b* : 203.]
Dinothrips fulmeki Priesner, 1959 : 55. Holotype ♂, SUMATRA (SMF) [examined]. **Syn. n.**

The published data for the original material of *sumatrensis* were 'Several examples of both sexes and in all stages, SUMATRA, Amsterdam Museum', also 'Three carded males in the Paris Museum, Benghalis, Sumatra (*Maindron* 1885)'. The specimens from Amsterdam were stated to have been sent by J. C. H. Meyere, but recent correspondence with the Zoological Museum, University of Amsterdam, has established that there are no specimens preserved there from the type-series. It would have been out of character for Bagnall, in 1908, to return material to a correspondent. However, Karny (1920*b*) states that Bagnall sent to him some specimens of *sumatrensis* from the type locality 'Nias' – an island off the western coast of Sumatra. This is interesting because the introduction to Bagnall's paper (1908*b*: 183) suggests that the type-series was in alcohol,

and an old tube has recently been found in Bagnall's collection labelled by him 'Nias/K. Jordan'. Despite the lack of connection between K. Jordan and J. C. H. Meyere this tube may contain the type-series of *sumatrensis*. The specimens have now been mounted onto slides and represent two species, *sumatrensis* and *spinosus*. This mixture is probably the cause of subsequent confusion over the identity of these species. The description of *fulmeki* by Priesner (1959), for example, involves a comparison with specimens of '*sumatrensis*' which were evidently misidentified *spinosus*. The lectotype of *sumatrensis* designated here is one of the 'three carded males', now mounted onto a slide, from Sumatra, Benghalis. The antennae are lost but the cheek setae are long and pale and there are 2 pairs of posteroangular pronotal setae.

SPECIMENS STUDIED.

Malaya: 3 ♂, 10 ♀ Kuala Lumpur (BMNH); 1 ♂, 9 ♀ Pahang (SMF); 1 ♀ Ringlet; 1 ♂, 1 ♀ Perak; 1 ♀, Kuala Trengganu (BMNH). **Riau (Riouw) Is**: 2 ♀ (SMF). **Sumatra:** lectotype ♂ of *sumatrensis* Benghalis, 1885 (*Maindron*) 7004 85; 14 ♂, 14 ♀ (BMNH); holotype ♂ of *fulmeki* Medan, Rimboen, under bark of a cut-down tree, v.1925 (*L. Fulmek*), 2 ♂ paratypes of *fulmeki*, 2 ♂, 3 ♀ with type-data (SMF). **Java:** 1 ♂, 1 ♀ (BMNH). **Borneo:** Sarawak, 6 ♂, 3 ♀ (BMNH), 6 ♂, 2 ♀ (SMF).

ELAPHROTHRIPS Buffa

Elaphrothrips Buffa, 1909 : 162–163. Type-species: *Idolothrips coniferarum* Pergande, 1896, designated by Andre, 1940.

Dicaiothrips Buffa, 1909 : 169–170. Type-species: *Thrips schotti* Heeger, 1852, designated by Bagnall, 1910. [Synonymized by Hood, 1927 : 238–9.]

Elaphrothrips (*Elaphoxothrips*) Bagnall, 1932 : 516–517. Type-species: *Kleothrips athletes* Karny, by monotypy.

Elaphrothrips (*Cradothrips*) Ananthakrishnan, 1973*a* : 273. Type-species: *Elaphrothrips* (*Cradothrips*) *insignis* Ananthakrishnan, by monotypy.

Macropterous species of Idolothripini; very variable in size, longest individual 4 or 5 times as long as smallest individual. Head usually elongate, 2·0 to 4·0 times as long as broad, usually with a long projection in front of eyes; eyes large and equally developed on dorsal and ventral surfaces; head with 1 pair of long ocellar setae, often as long as the postoculars, situated posterolateral to the first ocellus, 1 pair of small postocellar setae, 1 pair of postocular setae and 1 pair of long setae on the vertex; some species have a second smaller pair of setae on the vertex behind the first pair of postocular setae; cheeks set with stout spine-like setae, particularly in males. Antennae 8-segmented; segment III about 4 to 7 times as long as broad, with 2 sense cones, IV with 4 sense cones. Pronotum about half as long as head, about 1·5 times as broad as long, with 5 pairs of major setae. Fore femora of ♂ enlarged, usually with a stout sickle-shaped seta at apex; fore tarsal tooth well developed in ♂, very reduced or absent in ♀. Fore wings pale or shaded, slightly broadened in the apical half with 25 to 60 duplicated cilia. Pelta broadly triangular or with lateral lobes which are sometimes separate. Tergites II–VII with 2 pairs of sigmoid wing-retaining setae and several pairs of usually sigmoid accessory setae, but posteromarginal setae of VII straight; sternites II–VIII with several small accessory setae, sometimes arranged in a row; sternite IX of males with a pair of large spines (cf. *Dinothrips*). Tube with straight sides evenly narrowing to apex, shorter than total head length and not bearing any obvious lateral setae.

Elaphrothrips is a large pantropical genus in which many species show confusing patterns of structural variation, both between sexes and also between different-sized individuals of the same sex. At present it is not possible to distinguish between differences due to allometric growth and differences due to geographical isolation with any great certainty. In the present account only 17 species from the Oriental Region are recognized and 15 new synonyms are established. Several of these species are widespread, e.g. *denticollis*, *malayensis* and *spiniceps* (Map 1), and detailed studies may eventually demonstrate that these are actually species-groups. However, in view of the intraspecific variation found in some populations, and in view of the few populations which have ever been sampled and studied satisfactorily, the species concepts adopted here are considered to be of greater practical value than those adopted in previous studies. Even with the present analysis it is remarkable how several species have been found to coexist at some sites, e.g. *bakeri*, *curvipes*, *denticollis* and *sensitivus* in Malaya and Java (Table 1).

Table 1 *Elaphrothrips* species from (a) Malaya and (b) Java

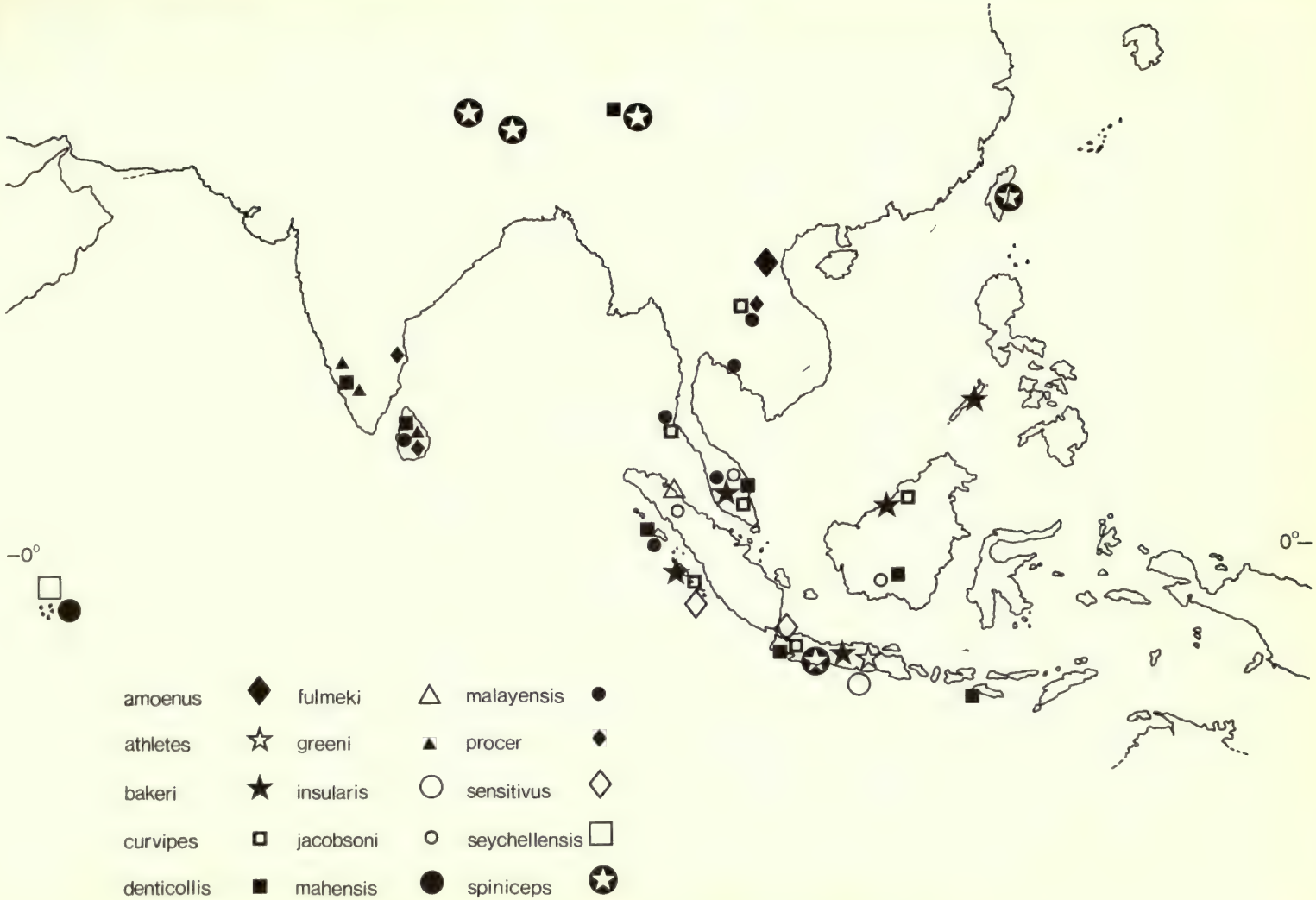
(a)	Malaya										
L. A. Mound Collection Nos.	9	39	42	51	81	83	90	104	106	110	111
bakeri	–	–	–	1♀	3♂, 1♀	3♂, 2♀	–	–	1♀	1♀	–
curvipes	–	2♂	–	–	–	1♂	1♀	–	1♀	1♂	1♂
denticollis	1	–	–	–	2♂, 2♀	11♂, 8♀	–	–	–	1♂, 2♀	–
jacobsoni	–	–	–	–	–	–	–	1♂	1♀	1♂	–
malayensis	1♂, 1♀	–	1♀	–	2♂, 1♀	–	–	–	–	–	–
sensitivus	–	–	–	–	–	–	–	–	–	–	–

(b)	Java							
L. A. Mound Collection Nos.	119	126	162	166	177	185	192	193
bakeri	–	–	–	–	–	–	–	1♂, 3♀
curvipes	–	–	–	1♂	–	1♂	–	–
denticollis	–	–	–	1♂	1♀	–	–	3♂, 5♀
jacobsoni	–	–	–	–	–	–	–	–
malayensis	–	–	–	–	–	–	–	–
sensitivus	1♂	7♂, 6♀	1♀	4♂	17♂, 11♀	–	3♂, 6♀	4♂, 1♀

Buffa distinguished *Elaphrothrips* from *Idolothrips* by the head being slightly produced in front of the eyes. He removed *coniferarum* Pergande and *flavipes* Hood from *Idolothrips* and included them in his new genus. He also erected the genus *Dicaiothrips* for *schotti* Heeger and the African species *bottegii* which have a long head production and a large sickle-shaped seta on the male fore femur.

In the Austro-Oriental region *Elaphrothrips* is related to the genus *Mecynothrips* which has three pairs of sigmoid wing-retaining setae on tergites III to V; *Dinothrips* which has straight tergal accessory setae; *Pyrgothrips* in which the eyes are prolonged ventrally, and the monotypic *Tiarothrips* which has a distinctive head shape with a very long production in front of the eyes. The first ocellus and anteocellar setae of this latter genus, however, are situated between the anterior margin of the eyes and not on the prolongation as they are in the other related genera. The African genus *Derothrips* is also similar to *Elaphrothrips* but, as in *Pyrgothrips*, it has the eyes prolonged ventrally. At the eastern end of its range (Map 1) *Elaphrothrips* appears to be replaced by the closely related genus *Mecynothrips*.

Elaphrothrips apertus Girault from Queensland, Australia, was transferred to *Bolothrips* and synonymized with *badius* (Hood) by Mound (1974). *Elaphrothrips crassiceps* Bagnall from Burma is transferred above to *Dinothrips* (p. 169) and synonymized with *spinosus* (Schmutz). Ananthakrishnan (1973*a* : 282) synonymized *Elaphridia agasthya* (Ramakrishna) with *crassiceps* which he then designated as the type-species of his genus *Elaphridia*. However, the unique holotype female of *crassiceps* differs from a syntype female of *agasthya* which has been studied in the shape of the pelta and the number of pairs of sigmoid wing-retaining setae on the tergites. *E. crassiceps* has a pelta with small, separate lateral lobes and tergites with 2 pairs of sigmoid wing-retaining setae. *E. agasthya* has an entire pelta without separate lateral lobes and tergites with only 1 pair of sigmoid wing-retaining setae which are situated on the posterior margin. *E. agasthya*, the type-species of *Elaphridia*, is therefore regarded as a different species from *Elaphrothrips crassiceps*, indeed it should be placed in a different tribe. *Elaphrothrips thoreauini* Girault (1929*a*) was described from an unspecified number of syntypes of unspecified sex from Queensland, Australia.



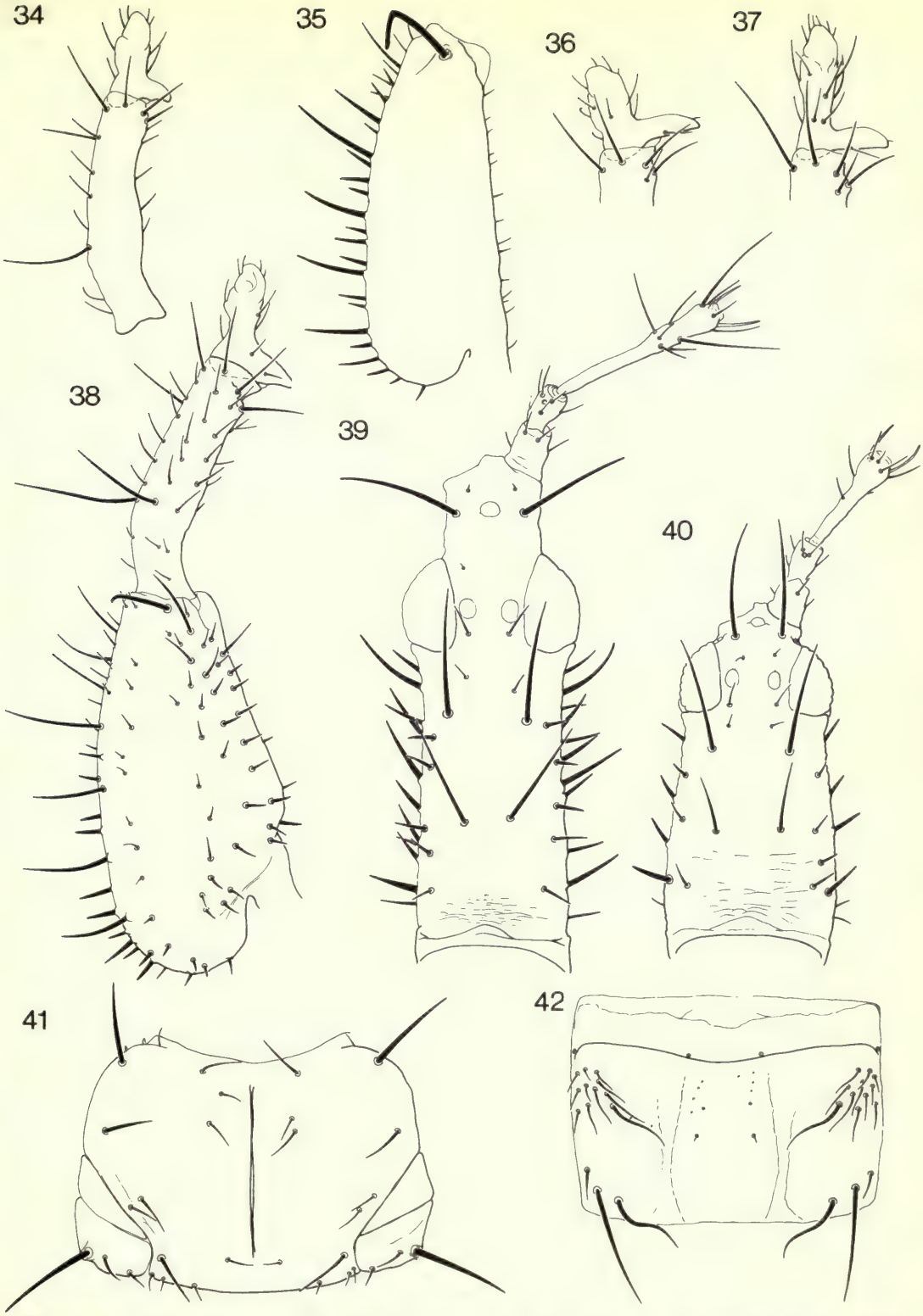
Map 1 Distribution of *Elaphrothrips* species in the Oriental Region.

There is a slide in the Queensland Museum labelled by Girault '*Elaphrothrips thoreau- / ini* Girault Type ♀ / (outer) Taringa, 26th. Jany. 1929 / under bark living gum / trees / *Horistothrips* / *corticis* Girault / Types'. This slide bears 3 ♀, 1 ♂ under one cover slip and 1 ♀ under another. The 2 ♀, 1 ♂ grouped together have dark legs with pale knees and tarsi which correspond to the description of *H. corticis*. The smallest ♀ with these and the ♀ under the separate cover slip have completely pale legs and represent the second species *thoreauini*. The ♀ under the separate cover slip is here designated as LECTOTYPE and the species should now be referred to as *Horistothrips thoreauini* (Girault) **comb. n.**

The length of the head prolongation is measured laterally from the base of the antenna to the anterior margin of the eye, and the breadth is measured across the base anterior to the eyes.

Key to the Oriental species

1 Cheek setae shaded, pale to dark 2
– Cheek setae colourless, with no trace of pigment 8
2 Head prolongation very short, 8 times as broad as long; antennal segment III less than 5 times as long as broad; all tibiae dark; basal stem of antennal segments IV and V pale; ♀ fore femur with a dark tubercle on inner margin . . . . . ***insignis*** (p. 181)
– Head prolongation 4 or less times as broad as long; ♀ fore femur without a tubercle . . 3
3 Antennal segment III 6 times as long as broad; head prolongation 4 times as broad as long; all tibiae dark; antennal segment III pale with a narrow dark apical ring, basal stem of IV and V pale . . . . . ***mahensis*** (p. 182)
– Antennal segment III less than 5·2 times as long as broad; head prolongation less than 3·5 times as broad as long 4
4 Head prolongation 1·8 times as broad as long; antennal segment III with small area of apical dark shading, basal stem of IV–VI pale, length of III and IV subequal; apices of tibiae and tarsi pale, ♂ foretarsal tooth slim; pelta (Fig. 49). . . . . ***amoenus*** (p. 176)
– Head prolongation more than 2 times as broad as long; antennal segment IV–VI with darker basal stems 5
5 Hind tibiae with apical half, other tibiae with apices and tarsi pale; antennal segment III pale with a slightly shaded apex, segments IV and V with patchy shading in basal stem; major and minor ♂ with concave inner margin of fore tibiae (Fig. 34) 6
– All tibiae completely dark; basal stem of antennal segments IV and V evenly dark . . 7
6 Antennal segment III equal to or shorter than IV; distance between base of left ocellar seta and left postocular seta greater than the length of either of these setae; pelta (Fig. 47) ***curvipes*** (p. 178)
– Antennal segment III longer than IV; distance between base of left ocellar seta and left postocular seta less than the length of either of these setae . . . . . ***notabilis*** (p. 182)
7 Dark apex of antennal segment III extending beyond apical bulge, about one-third length of segment; head prolongation 2·1 times as broad as long; pelta with lateral lobes separate or only narrowly joined to centre (Fig. 43); anteroangulars of ♂ longer and stouter than small mid-lateral setae, ♀ with posteroangular setae short, little more than 0·5 times total median length of pronotum (Fig. 41) . . . . . ***jacobsoni*** (p. 181)
– Dark apex of antennal segment III not extending beyond apical bulge, about one-quarter length of segment; head prolongation 2·4–3·4 times as broad as long; pelta with lateral lobes more broadly joined to centre (Fig. 52); anteroangulars of ♂ shorter than well-developed mid-laterals, ♀ with posteroangular setae long, more than 0·75 times total median length of pronotum . . . . . ***bakeri*** (p. 176)
8 Head prolongation 3·0 to 5·0 times as broad as long; antennal segment III 5·1 or less times as long as broad; all tibiae completely dark 9
– Head prolongation 1·0 to 3·0 times as broad as long; antennal segment III often longer; tibiae sometimes partly pale 11
9 Head prolongation 4·0 to 5·0 times as broad as long (Fig. 40); dark apex of antennal segment III broad, more than one-third length of segment, IV and V sometimes with paler basal stem; lateral lobes of pelta narrowly joined to centre (Fig. 44) . . ***spiniceps*** (p. 184)
– Head prolongation 3·0 to 4·0 times as broad as long; dark apex of antennal segment III not as extensive 10
10 Antennal segments IV and V usually with paler base; lateral lobes of pelta narrowly joined to centre (Fig. cf. *bakeri*) . . . . . ***procer*** (p. 183)



Figs 34–42 *Elaphrothrips* species. 34, *E. curvipes*, ♂ fore tibia and tarsus. 35, *E. denticollis* (*mucronatus* holotype), ♂ fore femur. 36, 37, ♂ fore tibiae and tarsi, (36) *E. sensitivus* holotype ♂; (37) *E. denticollis* (*sumbanus* holotype ♂). 38, *E. denticollis* (*productus* holotype ♂). 39, *E. greeni* (*bouvieri* holotype ♂). 40, *E. spiniceps* ♀. 41, *E. jacobsoni* ♂. 42, *E. bakeri* ♂, tergite III.

– Antennal segments IV and V completely dark; pelta entire (Fig. 48), small species from Seychelles . . . . . ***seychellensis*** (p. 184)

11 All tibiae with apical half pale; antennal segment III more than 6 times as long as broad, basal stem of antennal segments IV and V usually slightly paler; head prolongation 1·0 to 1·5 times as broad as long (Fig. 39) . . . . . ***greeni*** (p. 180)

– At least mid tibiae completely dark; antennal segment III usually less than 6 times as long as broad, if more than 6 times as long as broad, then antennal segments IV and V with dark basal stem 12

12 Basal stem of antennal segments IV and V pale, yellowish, distinctly paler than apex of segment 13

– Basal stem of antennal segments IV and V as dark as apex of segment, or light brown, only slightly paler than apex of segment 14

13 Basal one-fifth of antennal segment VI clear yellow, distinctly paler than distal part of segment, antennal segment III distinctly longer than IV; pelta (Fig. 45) . . . . ***fulmeki*** (p. 180)

– Antennal segment VI completely dark, antennal segments III and IV subequal in length ***malayensis*** (p. 182)

14 Antennal segment III uniformly brown . . . . . ***athletes*** (p. 176)

– Basal stem of antennal segment III distinctly paler than apex 15

15 Hind tibiae long, equal to or longer than median head length including the head production; antennal segment III longer than IV and 4·7 to 6·2 times as long as broad; major pair of median head setae usually long and stout, four-fifths or more times length of postocular setae; basal wing setae B_2 long, B_1 1·0 to 1·3 times as long as B_2; ♂ fore tarsi almost 3 times as long as broad (Figs 37, 38); pelta (Fig. 46) . . . . . ***denticollis*** (p. 179)

– Hind tibiae short, equal to or shorter than median head length; antennal segment III equal to or shorter than IV and 4·0 to 5·5 times as long as broad; major pair median head setae usually short, two-thirds or less times length of postocular setae; basal wing setae B_2 short, B_1 1·3 to 2·0 times as long as B_2; ♂ fore tarsi less than 2 times as long as broad (Fig. 36); pelta (Fig. 50) . . . . . ***sensitivus*** (p. 183)

Elaphrothrips amoenus Priesner

(Fig. 49)

Elaphrothrips amoenus Priesner, 1935*a* : 174. Holotype ♂, VIETNAM (NORTH) (SMF) [examined].

This species is known only from the holotype. It has a long head production, dark cheek setae and pale yellow basal stems of antennal segments III–VI. It is similar only to the stouter *fulmeki* which differs in having pale cheek setae.

SPECIMEN STUDIED.

Vietnam (North): Langson, holotype ♂, 6.ii.1925 (SMF).

Elaphrothrips athletes (Karny)

Kleothrips athletes Karny, 1923 : 355. Holotype ♂, JAVA (SMF) [examined].
Elaphrothrips (*Elaphoxothrips*) *athletes* Karny; Bagnall, 1932 : 516–517.

This species is known only from the holotype. It is a major male with a stout fore tarsal claw, pale cheek setae and a long head production. It is most similar to *denticollis* but may be distinguished by the colour of the third antennal segment. The antennae of the *athletes* holotype are poorly preserved but segment III appears to be uniformly pale brown.

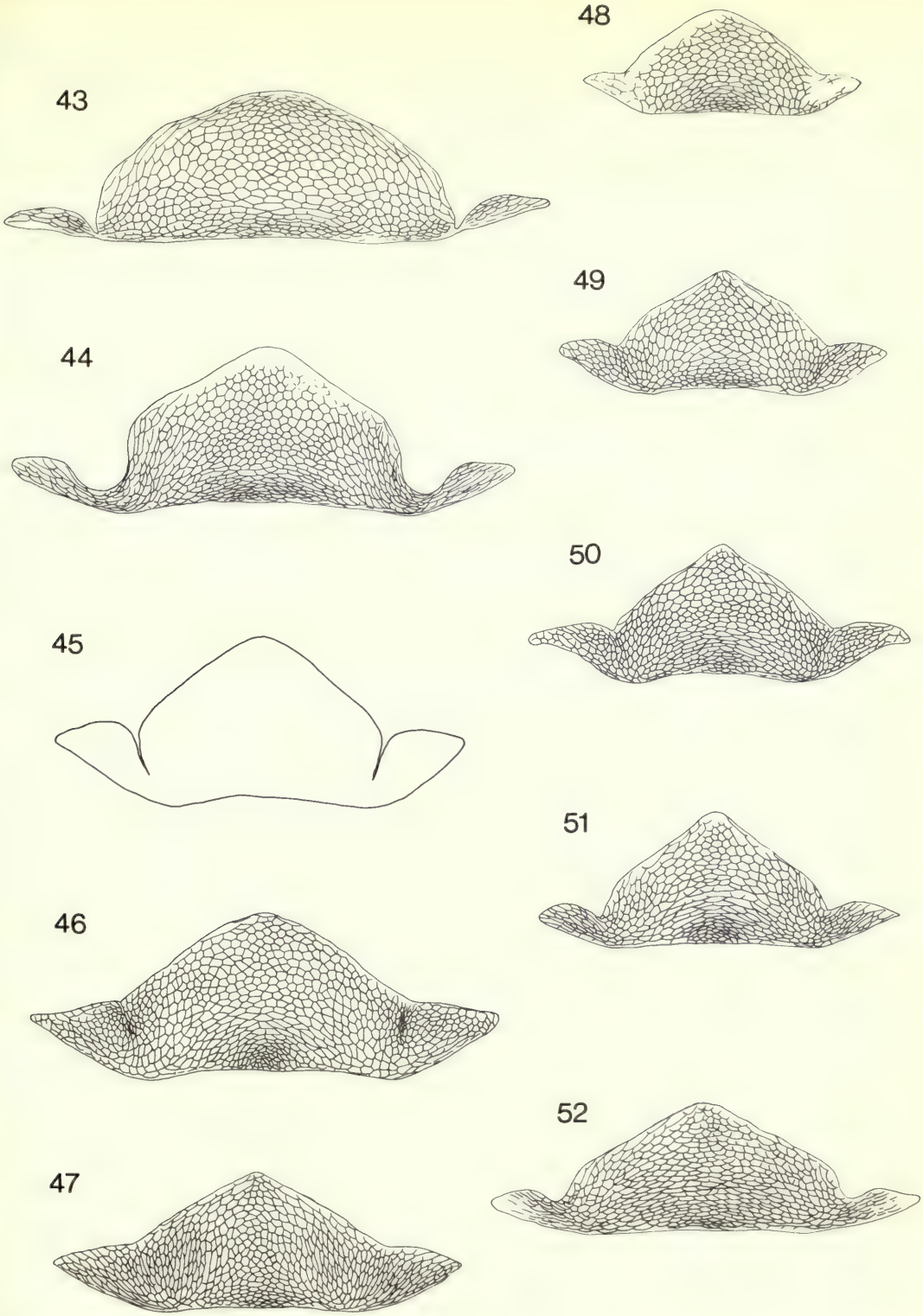
SPECIMEN STUDIED.

Java: Semarang, holotype ♂, ix.1909 (*E. Jacobson*) (SMF).

Elaphrothrips bakeri (Karny)

(Figs 42, 51, 52)

Dicaiothrips bakeri Karny, 1920*b* : 206. Holotype ♂, PHILIPPINES (SMF) [examined].
Elaphrothrips mentaweiensis Priesner, 1929*b* : 201. Holotype ♂, MENTAWEI IS (SMF) [examined]. **Syn. n.**



Figs 43–52 Male peltas of *Elaphrothrips* species. 43, *E. jacobsoni;* 44, *E. spiniceps;* 45, *E. fulmeki;* 46, *E. denticollis;* 47, *E. curvipes;* 48, *E. seychellensis;* 49, *E. amoenus;* 50, *E. sensitivus;* 51, *E. bakeri;* 52, *E. bakeri* (v. *depokensis* syntype).

Elaphrothrips bakeri var. *depokensis* Priesner, 1935*a* : 159. 10 syntype ♂, ♀, JAVA (SMF) [1 ♂, 1 ♀ examined]. **Syn. n.**
Elaphrothrips imitator Priesner, 1935*b* : 249. Holotype ♂, JAVA (SMF) [examined]. **Syn. n.**

This species is dark brown except for antennal segment III which is pale yellow with a small brown patch at the extreme apex. The head has a relatively short prolongation in front of the eyes, and the cheek setae are dark.

The holotype of *bakeri* is a major male with an enlarged fore femur and a stout fore tarsal tooth. The holotype of *mentaweiensis* is a minor male with a slim fore tarsal tooth but is otherwise inseparable from *bakeri*.

E. bakeri var. *depokensis* was described from 10 male and female syntypes differing from *bakeri* in the relative lengths of antennal segments IV and V. One major male and one female with type-data and labelled 'type' by Priesner have been examined and are indistinguishable from *bakeri*.

The holotype major male and female paratype of *imitator* which were apparently collected together have also been examined. They are rather poorly preserved specimens which differ from *bakeri* in the diffuse colour of antennal segment III, and in the slightly shorter segment IV and head prolongation. These characters, however, are not regarded as sufficient to distinguish the specimens as a separate species.

E. bakeri is most similar to *procer*. The latter species, from Sri Lanka and India, differs in having pale cheek setae and pale basal stems of antennal segments IV and V. It may also be distinguished from the dark brown species *jacobsoni* by the extent of the apical dark patch on antennal segment III, the shape of the pelta and the lengths of the pronotal posteroangular setae.

SPECIMENS STUDIED.

Malaya: Negeri, 2 ♂ on *Dryobalanops aromatica*, 24.vii.1970; Damansara Forest Reserve, 1 ♀ on dead branches and leaves, 3.x.1973 (*L. A. Mound*); Gombak, 2 ♀ 3 ♂ on dead leaves on branches, 7.x.1973, 1 ♀ on dead branch, 13.x.1973 (*L. A. Mound*); Genting Highlands 3000 ft [1000 m], 2 ♀, 1 ♂ on dead leaves 14.x.1963, Tea Estate, 3500 ft [1150 m], 1 ♀, 3 ♂ on dead leaves on branch, 6.x.1973 (*L. A. Mound*) (BMNH). **Mentawei Is:** Siberoet, holotype ♂ of *mentaweiensis* from dried leaves, 24.ix.1924 (*H. H. Karny* 101) (SMF); Sipora, 2 ♀, 2 ♂ paratypes of *mentaweiensis* (*H. H. Karny* 221) (BMNH), 1 ♀ paratype of *mentaweiensis* 9.x.1924 (*H. H. Karny*) (SMF). **Java:** Jasinga Forest Reserve, 3 ♀, 1 ♂ on dead leafy branch, 30.x.1973 (*L. A. Mound*) (BMNH); Depok, 1 ♀, 1 ♂ syntypes of *depokensis* on bushes of fresh and dried leaves, 14.v.1929 (*H. H. Karny*); Halte Dawoean, holotype ♂ with 1 ♀ paratype of *imitator* on *Hevea*, xi.1906 (*De Vos van Nic.*) (SMF). **Borneo:** Sarawak, 1 ♂ (*C. R. Wallace*) (BMNH); 6 ♂, 5 ♀ on dead leaves, viii.1972 (*Kizasawa & Sohma*) (SO, Tokyo). **Philippines:** Palawan, Puerto Princesa, holotype ♂ of *bakeri* (*Baker*) (SMF).

Elaphrothrips coreanus Woo

Elaphrothrips coreanus Woo, 1974 : 69. Holotype ♀, KOREA (Dept. Agric. Biol., Seoul Nat. Univ., Suweon) [not examined].

The holotype of this species and the specimen referred to as *Elaphrothrips antennalis* Bagnall by Woo (1974) have not been available for study. The descriptions and illustrations, however, would indicate that neither specimen belongs in this genus.

Elaphrothrips curvipes Priesner

(Figs 34, 47)

Elaphrothrips curvipes Priesner, 1929*b* : 206. 2 syntype ♂, MENTAWEI IS (SMF) [1 ♂ examined].
Elaphrothrips karnyi Priesner, 1935*b* : 246. Holotype ♀, SUMATRA (SMF) [examined]. **Syn. n.**
Elaphrothrips secus Ananthakrishnan, 1973*a* : 278. Holotype ♀, INDIA (TNA) [examined]. **Syn. n.**

This species has lightly shaded cheek setae, characteristically patchy shading in the basal stems of antennal segments IV and V and both major and minor males have a concave inner margin to the fore tibiae. It is most similar to *notabilis* which differs in having much longer major head and pronotal setae.

SPECIMENS STUDIED.

India: West Bengal, Kalimpong, holotype ♀, paratype ♂ of *secus*, on dry twigs, 20.iv.1969 (*T. N. Ananthakrishnan*) (TNA). **Laos:** Vang-Viong, 1 ♂, 1 ♀ on dead leaves, 21.iii.1975 (*S. Yamaguchi*) (SO, Tokyo). **Thailand:** Ban lung tong, Phuket Is, 2 ♂ on dead leaves, 11.i.1975 (*S. Yamaguchi*) (SO, Tokyo). **Malaya:** Negri Sembilan, 2 ♀, 1 ♂ on oil palms (*Chemara Research Station*); Gombak, on dead branches, 3 ♂, 2 ♀, 30.ix.–13.x.1973 (*L. A. Mound*); Genting Highlands 3000 ft [1000 m], 1 ♂ on dead leaves, 14.x.1973 (*L. A. Mound*); Kuala Lumpur Agricultural University, 1 ♂ on rolled leaves of *Pittosporum ferrugineum*, 15.x.1973 (*L. A. Mound*) (BMNH). **Sumatra:** Fort de Kock, 920 m, ♀ holotype of *karnyi* from a deserted larval borehole in a plant stem, xi.1920 (*E. Jacobson*) (SMF). **Mentawei Is:** Sipora, Sioban, 1 ♂ syntype of *curvipes* from dried leaves, 29.x.1924 (*H. H. Karny* 221) (SMF). **Java:** Bogor Gardens, 1 ♂ on dead leaves, 25.x.1973, 1 ♂ on dead creepers, 28.x.1973 (*L. A. Mound*) (BMNH).

Elaphrothrips denticollis (Bagnall)

(Figs 35, 37, 38, 46)

Dicaiothrips denticollis Bagnall, 1909*b* : 527. Holotype ♀, NIAS (BMNH) [examined].
Elaphrothrips beesoni Ramakrishna, 1934 : 7. Syntypes ♂, ♀, INDIA (TNA) [2 ♂ examined]. **Syn. n.**
Elaphrothrips mucronatus Priesner, 1935*a* : 167. Holotype ♂, JAVA (SMF) [examined]. [Synonymized with *beesoni* by Ananthakrishnan, 1973 : 278.]
Elaphrothrips sumbanus Priesner, 1935*a* : 169. Holotype ♂, SUMBA (SMF) [examined]. **Syn. n.**
Elaphrothrips productus Priesner, 1935*a* : 170. Holotype ♂, SUMBA (SMF) [examined]. **Syn. n.**
Elaphrothrips productus f. *obscuricornis* Priesner, 1935*a* : 171. Syntypes ♂, ♀, SUMBA (SMF) [1 ♂ ? syntype examined]. **Syn. n.**

From recent material collected in Malaya and Java it appears that the males of this species are very variable. The large males from this material have a slim fore tarsal tooth, a slim fore femur with a large, pale sickle-shaped seta at the apex and a pair of well-developed median setae on the vertex. This form corresponds with the holotype male of *mucronatus*.

A male labelled by Priesner *E. productus* f. *obscuricornis* has been examined. It is not labelled 'type', but it has the same data as the *productus* holotype. Since the type-data for f. *obscuricornis* was not indicated by Priesner, this specimen is assumed to be a syntype. It has a slim fore tarsal claw, a slim fore femur with a smaller, darker, sickle-shaped seta at the apex, and a pair of well-developed median setae on the vertex. This specimen is indistinguishable from the smaller males in the recently collected series of this species.

The holotype male of *sumbanus* differs from the previous form in having finer median setae on the vertex and a longer third antennal segment. This segment is 6·2 times as long as broad in the holotype, whereas in the other specimens it is only 4·7 to 5·7 times as long as broad.

The holotype male of *productus* is a large major male with a stout fore tarsal claw, a greatly enlarged fore femur with a small dark sickle-shaped seta at the apex and fine median setae on the vertex as in *sumbanus*. Ananthakrishnan (1973*a*) regarded *productus* as a distinct species, differing mainly in its colouring. The long series of specimens in the British Museum (Natural History), however, shows this variation in antennal and fore tibial colour.

The holotype of *denticollis* is a unique female. It is in poor condition with most of the head setae missing but it has one complete antenna and six legs. It is indistinguishable from the females associated with the male holotypes of *mucronatus*, *productus* and *sumbanus*, and also from recently collected females from Malaya and Java.

E. beesoni was described from numerous specimens collected by the Sandal Insect Survey at Fraserpet, Coorg, 1930. Ramakrishna compares his species with *greeni* which differs in colour and the relative lengths of antennal segments III and IV. In *greeni* they are subequal in length and in *beesoni* segment III is longer than IV. The tibiae of *beesoni* are also dark and differ from those of *greeni*, which are distinctly bicoloured. The two male syntypes of *beesoni* which have been examined lack antennae but in the shape of the head and fore legs and the colour of the tibiae they are inseparable from the *mucronatus*-type males. Ananthakrishnan (1973*a*) synonymized *greeni* with *beesoni* but for the above reasons *greeni* is kept here as a distinct species.

However, it is possible that *beesoni* was based on a mixed series, especially as it was collected with *chandana* (see *procer*).

The characters distinguishing the two males of *sumbanus* and *productus* are not regarded as sufficient to separate these from the remaining material listed below. This is here interpreted as representing one variable species which is widespread between Sri Lanka and Borneo.

SPECIMENS STUDIED.

Sri Lanka (Ceylon): Peradeniya, 1 ♂, 25.vii.1913 (*A. Rutherford*) (BMNH). **India:** Coorg, 2 ♂ syntypes of *beesoni* on Sandal, 24.x.1930 (TNA). **Burma:** Mishmi Hills, Delei River 1700 ft [570 m], 1 ♂, iii.1935 (*M. Steele*) (BMNH). **Malaya:** Selangor, 1 ♀, iii.1898 (*Biro*); 1 ♂, on *Flindersia brayliana* leaves, 3.xii.1956 (Forest Research Institute); Kuala Lumpur, 1 ♀ on *Citrus medica* v. *acida*, 7.ix.1928 (*G. H. Corbett*); Gombak, 8 ♀, 11 ♂ on dead leaves on branches, 7.x.1973 (*L. A. Mound*); Genting Highlands 3000 ft [1000 m], 2 ♀, 1 ♂ on dead leaves, 14.x.1973 (*L. A. Mound*); Genting Tea Estate 3500 ft [1150 m], 2 ♀, 2 ♂ on dead leaves on branch, 6.x.1973 (*L. A. Mound*) (BMNH). **Java:** Bogor Gardens, 1 ♂ on dead leaves, 25.x.1973, 1 ♀ on large dead leaves on tree, 26.x.1973 (*L. A. Mound*); Jasinga Forest Reserve, 5 ♀, 3 ♂ on dead leafy branch, 30.x.1973 (*L. A. Mound*) (BMNH); Depok, holotype ♂ and paratype ♀ of *mucronatus* on bushes of fresh and dried leaves, 14.v.1929 (*H. H. Karny*) (SMF). **Nias:** holotype ♀ of *denticollis* (*K. Jordan*) (BMNH). **Sumba:** Kambera, holotype ♂ and paratype ♀ of *productus*, 1 ♂ ? syntype of *productus* f. *obscuricornis* (SMF), 3 ♀, iii.1925, 1 ♀, 2 ♂, 6.iii.1925, 1 ♂, 12.iii.1925 (*Dammerman*); Kananggar, 700 m, 1 ♂, v.1925 (*Dammerman*) (BMNH); Laora 100 m, holotype ♂ and paratype ♀ of *sumbanus*, v.1925 (*Dammerman* 89) (SMF). **Borneo:** 3 ♂ on dead leaves, viii.1972 (*Mizusawa & Soma*) (SO, Tokyo).

Elaphrothrips fulmeki Priesner

(Fig. 45)

Elaphrothrips fulmeki Priesner, 1935*b*: 242. Holotype ♂, SUMATRA (SMF) [examined].

This species is known only from the holotype which is a major male. It has a broad fore tarsal claw, pale cheek setae and pale basal stems to antennal segments III–VI. It is distinguished from *amoenus* by the pale cheek setae and segment III being longer than IV. It is most similar to *malayensis* and differs only by having a pale base to antennal segment VI which in *malayensis* is completely dark. All the males of *malayensis* that have been examined, however, are small and it is possible that *fulmeki* represents the major form of this species. It is also possible that *sensitivus* is a larger darker form of *malayensis*, but these major males differ from *fulmeki* in having dark antennal segments IV–VI, a longer more slender fore tarsal claw and a differently shaped pelta. If *malayensis* and *sensitivus* are one species then *fulmeki* must represent a second species.

SPECIMEN STUDIED.

Holotype ♂, **Sumatra:** Medan (*L. Fulmek* 24) (SMF).

Elaphrothrips greeni (Bagnall)

(Fig. 39)

Dicaiothrips greeni Bagnall, 1914: 289. Holotype ♂, SRI LANKA (Ceylon) (BMNH) [examined].
Dicaiothrips bouvieri Vuillet, 1914: 276. Holotype ♂, INDIA (BMNH) [examined]. [Synonymized by Mound, 1968: 96.]
Elaphrothrips micidus Ananthakrishnan, 1973*a*: 275. Holotype ♀, INDIA (TNA) [not examined]. **Syn. n.**

The holotype of *greeni* lacks antennae and has only one fore leg which is without tarsi. Abdominal segment VII is missing and the detached segments VIII–X are from a female. The fore femur, however, is enlarged as in males and it would appear that the detached abdominal segments are from another specimen. One unidentified male in the British Museum (Natural History), mounted and labelled by Bagnall 'CEYLON / E. E. Green 2821' appears to be the same species. This, also, is without antennae but does have two complete fore and hind legs and one complete mid leg. The tarsi and apical half of all tibiae are pale. The original description would suggest that antennal segments IV and V have a slightly paler stem. Three other specimens in the British Museum (Natural History), two males and one female from India, have all tibiae and antennal

segments III–VI distinctly bicoloured. The holotype of *bouvieri* has bicoloured tibiae but the basal stems of antennal segments IV–VI are dark. The ♂ paratype of *bouvieri* has darker fore tibiae and tarsi but antennal segments IV and V have patchy, somewhat paler shading on the basal stem. Mound (1968), recognizing this variability in colour, synonymized *bouvieri* with *greeni*. The male and female paratypes of *micidus* which have been examined have all tibiae bicoloured and pale basal stems to antennal segments III–V. They are therefore here synonymized with *greeni*. The relationship of this species to *beesoni* (cf. Ananthakrishnan, 1973*a*) is discussed under *denticollis*.

SPECIMENS STUDIED.

Sri Lanka (Ceylon): Peradeniya, holotype ♂ of *greeni* on decayed *Phaseolus* pods (*E. E. Green* 3023); 1 ♂, 'CEYLON' (*E. E. Green* 2821), no further data (BMNH). **India:** Nilgiri Hills, holotype and paratype ♂ of *bouvieri*, Coonoor 2000 m, 14–31.vii.1901 (*M. Maindron*), 1 ♂, Mysore (*Campbell*); Kiruvatti, 1 ♀ on dry leaves and twigs, 17.ix.1969 (*T. N. Ananthakrishnan*); Trichur, 1 ♂ on *Areca* sheath, 17.viii.1966 (*T. N. Ananthakrishnan*) (BMNH); Yelagiri, 1 ♂, 1 ♀ paratypes of *micidus* on dry leaves, 8.x.1970 (*T. N. Ananthakrishnan*) (TNA).

Elaphrothrips insignis Ananthakrishnan

Elaphrothrips (*Cradothrips*) *insignis* Ananthakrishnan, 1973*a*: 273. Holotype ♀, INDIA (TNA) [not examined].

Ananthakrishnan erected a subgenus for this new species described for two females and two males. It is characterized by the presence of a tooth on the inner margin of the female fore femur. The head prolongation is very short, about 8 times as broad as long, antennal segment III is less than 5 times as long as broad and longer than IV, antennal segments III–V have pale basal stems and all tibiae are dark brown. The two specimens examined are assumed to be paratypes although the published date of collection was 19.xi.1970.

SPECIMENS STUDIED.

India: Almora, U.P., 1 ♂, 1 ♀ paratypes on dry twigs, 19.x.1970 (TNA).

Elaphrothrips insularis Priesner

Elaphrothrips insularis Priesner, 1928*a*: 57. Holotype ♂, JAVA (Hamburg Museum, destroyed).

This species was described from a unique male which was destroyed in the Hamburg Museum. It was not illustrated and the original description is insufficient to distinguish it from, or synonymize it with, other species in the genus from the Oriental Region. However, it would appear to resemble most closely *fulmeki* with the head prolongation 1·9 times as broad as long, antennal segments III–VI with pale basal stems, segment III longer than IV, and a stout fore tarsal claw. The name *insularis* is best regarded as a nomen dubium at present.

Elaphrothrips jacobsoni Priesner

(Figs 41, 43)

Elaphrothrips jacobsoni Priesner, 1935*b*: 243. Holotype ♂, SUMATRA (SMF) [examined].

This is a very large black species, similar to *bakeri*, with dark cheek setae. It may be distinguished mainly by the more extensive dark apex of antennal segment III, the slightly shorter head prolongation and the lateral lobes of the pelta being separate or only narrowly joined to the centre.

SPECIMENS STUDIED.

Malaya: Ringlet, 1 ♂ on dead branch, 12.x.1973; Gombak, 1 ♀ on dead branch, 13.x.1973; Genting Highlands, 3000 ft [1000 m], 1 ♂ on dead leaves, 14.x.1973 (*L. A. Mound*) (BMNH). **Sumatra:** Fort de Kock, 920 m, holotype ♂ and 1 ♀ paratype on plant detritus, vii.1922 (*E. Jacobson*) (SMF). **Borneo:** 1 ♂ under bark, 1973 (*T. Kubayashi*) (SO, Tokyo).

Elaphrothrips mahensis (Bagnall)

Dicaiothrips mahensis Bagnall, 1921*a*: 283. Holotype ♂, SEYCHELLES (BMNH) [examined].
Dicaiothrips rex Bagnall, 1921*a*: 281. Holotype ♂, SEYCHELLES (BMNH) [examined]. [Synonymized by Mound, 1968: 97.]
Dicaiothrips hystrix Bagnall, 1921*a*: 284. Holotype ♀, SEYCHELLES (BMNH) [examined]. [Synonymized by Mound, 1968: 97.]

This species has a short head prolongation, a long antennal segment III and a distinctive antennal colour. Segment III is very pale with a thin dark apical ring and segments IV and V have pale basal stems with a thin dark basal ring. The holotypes of *mahensis* and *rex* represent the major male form and *hystrix* represents the female form of this species. It is most similar to *procer* which differs in having pale cheek setae and not so distinctly bicoloured antennal segments IV and V.

SPECIMENS STUDIED.

Seychelles: Mahé, nr Morne Blanc, holotype ♂, 1 ♂ paratype of *mahensis*, ix–x.1908 (*H. Scott*); Cascade Estate, 1000 ft [300 m], 1 ♀, 1 ♂, ii–iii.1909 (*H. Scott*); Silhouette [Mare-aux-Cochons], holotype ♀ of *hystrix*, holotype ♂ of *rex* [6.ix.1908 (*H. Scott*)], 1 ♂ paratype of *hystrix*, 1908 (*Seychelles Expedition*), Mare-aux-Cochons, 1 ♀, ix.1908 (*H. Scott*) (BMNH).

Elaphrothrips malayensis (Bagnall)

Dicaiothrips malayensis Bagnall, 1909*b*: 525. Holotype ♂, NIAS (BMNH) [examined].
Dicaiothrips bruneitarsis Schmutz, 1913: 80. Holotype ♂, SRI LANKA (Ceylon) (NM) [examined]. **Syn. n.**
Dicaiothrips bruneitarsis var. *levis* Schmutz, 1913: 82. ? Holotype ♀, SRI LANKA (Ceylon) (NM) [examined]. **Syn. n.**
Elaphrothrips coronatus Bagnall, 1934*b*: 631. Holotype ♀, SRI LANKA (Ceylon) (BMNH) [examined]. **Syn. n.**

The ♀ holotypes of *bruneitarsis* var. *levis* and *coronatus* from Sri Lanka are indistinguishable from a series of females collected in Malaya. These females were collected with males indistinguishable from the holotype ♂ of *malayensis* from the Isle of Nias, Java, and the holotype ♂ of *bruneitarsis* from Sri Lanka. Both sexes have antennal segment III and the basal stems of IV and V pale yellow, and the legs are dark except for the tarsi. The females have a small fore tarsal tooth and a slightly enlarged fore femur with a rugose inner margin. These three species are, therefore, here synonymized.

E. malayensis is most similar to the larger darker species *sensitivus* in which the basal stems of antennal segments IV and V are as dark as, or only slightly paler than, the apex of those segments.

SPECIMENS STUDIED.

Sri Lanka (Ceylon): Peradeniya, holotype ♂ of *bruneitarsis*, Nr 64 from the upper side of a banana leaf in the Botanic Gardens of Peradeniya, 4.i.1902 (*Uzel*); ? holotype ♀ of *bruneitarsis* var. *levis*, Nr 83, 10.i.1902 (*Uzel*) (NM); holotype ♀ of *coronatus*, on banana 2.vi.1913 (*A. Rutherford*); 2 ♀, 1 ♂ on dead *Hevea* leaves, 6.v.1914 (*A. Rutherford*) (BMNH); Deniyaya, 1 ♂, 1 ♀ on dead leaves, 7.xi.1974 (*S. Yamaguchi*) (SO, Tokyo). **Laos:** Van-Viong, 2 ♂, 1 ♀ on dead leaves, 21.iii.1975 (*S. Yamaguchi*) (SO, Tokyo). **Thailand:** East, Chanta buri, 1 ♂, 1 ♀ on dead leaves, 30.iii.1975; South, Ban lung tong, Phuket Is, 1 ♂ on dead leaves, 11.i.1975 (*S. Yamaguchi*) (SO, Tokyo). **Malaya:** Negri Sembilan, 1 ♀ on oil palms (*Chamara Research Station*); 11 miles (17 km] Genting Highlands, 1 ♀, 1 ♂ on dead leaves, 27.ix.1973 (*L. A. Mound*); 5000 ft [1700 m] Genting Highlands, 1 ♀ on dead branch, 1.x.1973 (*L. A. Mound*); 3500 ft [1200 m] Genting Tea Estate, 1 ♀, 2 ♂ on dead leaves on branch, 6.x.1973 (*L. A. Mound*). **Nias:** holotype and 2 paratype ♂ of *malayensis* (*K. Jordan*) (BMNH).

Elaphrothrips notabilis Ananthakrishnan

Elaphrothrips notabilis Ananthakrishnan, 1973*a*: 276. Holotype ♀, INDIA (TNA) [examined].

This species has pale shaded cheek setae and the fore tibiae of the males have a concave inner margin. It is very similar to *curvipes* but can be distinguished from the latter species by its unusually long major head and pronotal setae.

SPECIMENS STUDIED.

India: Mysore, Kiruvatti Forest, holotype ♀, paratype ♂ on decaying bark, 6.ix.1967 (*T. N. Ananthakrishnan*) (TNA).

Elaphrothrips procer (Schmutz)

Dicaiothrips procer Schmutz, 1913 : 73. Holotype ♂, SRI LANKA (Ceylon) (NM) [examined].
Dicaiothrips novus Schmutz, 1913 : 76. Holotype ♀, SRI LANKA (Ceylon) (NM) [examined]. [Synonymized by Ananthakrishnan, 1973*a* : 281.]
Dicaiothrips dallatorensis Schmutz, 1913 : 77. Holotype ♂, SRI LANKA (Ceylon) (NM) [examined]. [Synonymized by Ananthakrishnan, 1973*a* : 281.]
Dicaiothrips proximus Bagnall, 1914 : 289. Holotype ♂, SRI LANKA (Ceylon) (BMNH) [examined]. [Synonymized by Mound, 1968 : 98.]
Elaphrothrips achaetus Bagnall, 1934*b* : 633. Holotype ♀, SRI LANKA (Ceylon) (BMNH) [examined]. [Synonymized by Mound, 1968 : 98.]
Elaphrothrips approximatus Bagnall, 1934*b* : 635. Holotype ♂, SRI LANKA (Ceylon) (BMNH) [examined]. [Synonymized by Mound, 1968 : 98.]
Elaphrothrips chandana Ramakrishna, 1934 : 9. Holotype ♂, INDIA (unknown) [not examined]. [Synonymized by Ananthakrishnan, 1973*a* : 28.]
Elaphrothrips eranthemi Seshadri & Ananthakrishnan, 1954 : 224. Holotype ♂, INDIA (TNA) [1 ♂ paratype examined]. [Synonymized by Ananthakrishnan, 1973*a* : 281.]

This species has a relatively short head prolongation in front of the eyes, paler basal stems to antennal segments IV and V and distinct lateral lobes to the pelta.

The major males of this species have an enlarged fore femur and a stout fore tarsal tooth. The minor males have a slim fore femur and a slender fore tarsal tooth. Mound (1968) synonymized the major male *proximus*, the minor male *approximatus* and the female *achaetus* with *procer* which was based on a major male. The holotype female of *novus*, the holotype minor male of *dallatorensis* and a paratype major male of *eranthemi* are indistinguishable from *achaetus*, *approximatus* and *proximus* respectively. They are here, therefore, all regarded as synonyms of *procer*. *E. chandana* was described from a few males and females collected with *beesoni*. They are smaller and darker and, according to Ananthakrishnan, are synonymous with the '*dallatorensis*' form.

This species from Sri Lanka and India is similar to *bakeri* from Malaya apart from the pale cheek setae and paler basal stems to antennal segments IV and V. The female and minor male from Laos, however, have almost uniformly dark basal stems to segments IV and V.

SPECIMENS STUDIED.

Sri Lanka (Ceylon): holotype ♂ of *procer*, holotype ♀ of *novus*, Nr. 34, on a bush 19.xii.1901 (*Uzel*) (NM); Peradeniya, holotype ♂ of *dallatorensis*, Nr. 83, 10.i.1902 (*Uzel*) (NM), holotype ♂ of *proximus*, holotype ♀ of *achaetus*, 1 ♀, 1 ♂, on pods of *Crotalaria*, xi.1912 (*E. E. Green* 3180), holotype ♂ of *approximatus* on dead *Hevea* leaves, 6.v.1914 (*A. Rutherford* 321), 1 ♂, 21.vii.1913 (*A. Rutherford*), 1 ♀ without data (BMNH). **India:** Madras, 1 paratype ♂ of *eranthemi*, Teynampet Botanical Gardens, on *Eranthemum*, 17.i.1953 (*T. N. Ananthakrishnan* 150) (TNA), 1 ♀ on *Cassia* twig, 23.x.1966, 1 ♀, 1 ♂ on dry twigs, 4.iii.1967, 3 ♀, 3 ♂ on *Sesbania* twigs 3.iv.1963; Adichanallur, 1 ♀ on *Areca* sheath, 29.viii.1966 (*T. N. Ananthakrishnan*) (BMNH). **Laos:** Vang-Viong, 1 ♂, 1 ♀ on dead leaves, 21.iii.1975 (*S. Yamaguchi*) (SO, Tokyo).

Elaphrothrips sensitivus Priesner

(Figs 36, 50)

Elaphrothrips sensitivus Priesner, 1929*b* : 204. Holotype ♂, MENTAWEI IS (SMF) [examined].

The holotype of *sensitivus* is a major male. This species has pale cheek setae and a long head production, and the males have a well-developed but slim fore tarsal tooth. It is very similar to *malayensis* which may be distinguished by the pale basal stems of antennal segments IV and V.

SPECIMENS STUDIED.

Mentawei Is: Sipora, Sioban, holotype ♂, from dead leaves, 9.x.1924 (*H. H. Karny* 164) (SMF). **Java:** Bogor, 1 ♀ (labelled by Priesner, allotype of *sensitivus*, but not referred to in the original description) on dried leaves, 22.ix.1922 (*Soerijat*) (SMF); Bogor Gardens, 1 ♂ on dead leaves of *Brownea* sp. tree, 18.x.1973, 6 ♀, 7 ♂ on dead leaves on tree 19.x.1973, 1 ♀, 24.x.1973, 4 ♂ on dead leaves, 25.x.1973, 12 ♀, 18 ♂ on large dead leaves on tree, 26.x.1973, 6 ♀, 3 ♂ on dead leafy branch, 29.x.1973 (*L. A. Mound*); Jasinga Forest Reserve, 1 ♀, 4 ♂ on dead leafy branch, 30.x.1973 (*L. A. Mound*) (BMNH).

Elaphrothrips seychellensis (Bagnall)

(Fig. 48)

Dicaiothrips seychellensis Bagnall, 1921*a* : 280. Holotype ♀, SEYCHELLES (BMNH) [examined].

This is a small dark species from the Seychelles with pale cheek setae. The males have a well-developed fore femur with a large sickle-shaped seta and a well-developed fore tarsal tooth.

SPECIMENS STUDIED.

Seychelles: holotype ♀, Mahé [above Port Glaud, 500–1000 ft [200–300 m], 5.xi.1908 (*H. Scott*)], 1 ♂ paratype (*Seychelles Expedition* 1908–1909), above Port Glaud 500–1000 ft [200–300 m], 1 ♀ paratype, 5.xi.1908 (*H. Scott*), Cascade Estate, 800–1000 ft [270–300 m], 1 ♀, i.1909 (*H. Scott*); Silhouette nr Mont Pot-a-Eau, 1500 ft [500 m], 1 ♂, viii.1908 (*H. Scott*) (BMNH).

Elaphrothrips spiniceps Bagnall

(Figs 40, 44)

Elaphrothrips spiniceps Bagnall, 1932 : 514. Holotype ♀, INDIA (BMNH) [examined].
Elaphrothrips graveleyi Bagnall, 1934*b* : 628. Holotype ♀, INDIA (BMNH) [examined]. **Syn. n.**
Elaphrothrips clarispinis Priesner, 1935*b* : 247. Holotype ♂, JAVA (SMF) [examined]. **Syn. n.**

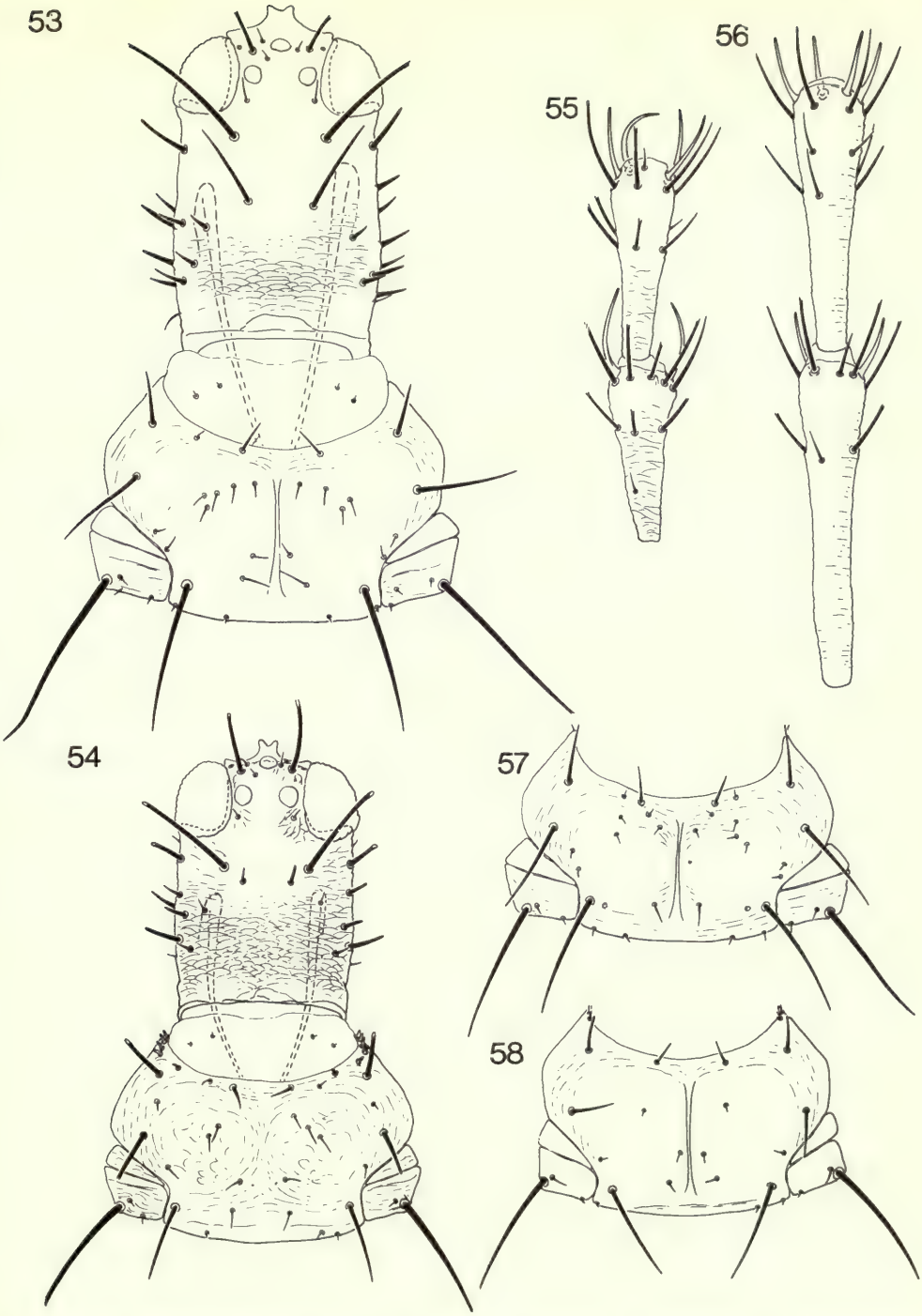
This is a large, stout, black species with a broad head, only about twice as long as broad, pale cheek setae and a short prolongation in front of the eyes. The small lateral lobes of the pelta are narrowly joined to the centre. The holotype of *spiniceps*, although described and labelled as a female, is, in fact, a male with enlarged fore femora and a well-developed fore tarsal tooth. Both antennae are unfortunately missing distal to the second segment.

The holotype of *graveleyi* is a female with the head and pelta shape as in *spiniceps*. The basal stem of antennal segment III is clear pale yellow and segments IV and V have a slightly paler basal stem. An additional male and female in the British Museum (Natural History) collection from Burma and two males and two females from Nepal (SO, Tokyo) all have pale basal stems to segments III–V. The sickle-shaped seta on the fore femur of even the largest of these males is small.

The male holotype of *clarispinis* is indistinguishable from the holotype of *spiniceps* in the shape of the head and pelta. Both antennae of *clarispinis* are complete, however, and the basal stem of segment III has patchy dark shading and the basal stem of IV is hardly paler than the apex. The fore femur also bears a well-developed sickle-shaped seta. Four males and one female from Taiwan also have this antennal colouration, and a large sickle-shaped seta in the males, but this is considered to be no more than regional variation and all these specimens are here regarded as *spiniceps*. Ananthakrishnan (1973*a*) records two males and two females of *clarispinis* from India. However, from the redescription and illustrations it is apparent that these specimens have been misidentified and most closely resemble *denticollis* which is found in India.

SPECIMENS STUDIED.

India: Sikkim, Gangtok, holotype ♀ of *spiniceps* (*Lt. Col. F. M. Bailey*), holotype ♀ of *graveleyi*, Kurs[e]ong 4700 ft [1800 m] with *Neoheegeria fumipennis* Bagnall, 26.iii.1910 (*F. H. Graveley*) (BMNH). **Nepal:** Ghasa, 2 ♂, 2 ♀ on dead leaves, 4.vi.1974 (*S. Yamaguchi*) (SO, Tokyo). **Burma:** Mishmi Hills, 1 ♂, Delei River, 4700 ft [1800 m] iii.1935; 1 ♂, Monodon (*M. Steele*) (BMNH). **Taiwan:** Nanshanchi, 4 ♂, 1 ♀ on dead leaves, 1.vi.1972 (*S. Okajima*) (SO, Tokyo). **Java:** Kamodjan, above Garoet, 1200 m, holotype ♂ of *clarispinis*, 30.v.1923 (*Siebers*) (SMF).



Figs 53–58 *Machatothrips* species. (53) *M. biuncinatus;* (54) *M. antennatus.* 55, 56, antennal segments III and IV, (55) *M. quadrudentatus;* (56) *M. biuncinatus.* (57) *M. braueri;* (58) *M. heveae.*

MACHATOTHRIPS Bagnall

Machatothrips Bagnall, 1908*b* : 189. Type-species: *Machatothrips biuncinatus* Bagnall, by monotypy.
Adiaphorothrips Bagnall, 1909*b* : 536. Type-species: *Adiaphorothrips simplex* Bagnall, by original designation. [Synonymized by Priesner 1939 : 75.]
Cnestrothrips Priesner, 1932 : 344 (1939 : 75). Type-species: *Cnestrothrips dammermani* Priesner, by original designation. **Syn. n.**

Large, dark, macropterous species of Cryptothripini. Head rectangular, about 1·5 times as long as broad, projecting only slightly in front of eyes; eyes equally developed on dorsal and ventral surfaces; head with 1 pair of elongate ocellar setae situated posterolaterally to anterior ocellus and outside ocellar triangle, also 1 pair of postocular setae and 1 median pair of setae on vertex (postocular pair II); cheeks with stout spine-like setae. Antennae 8-segmented, segment III 2·5 to 5·0 times as long as broad with 2 sense cones, IV with 4 sense cones. Pronotum shorter than head, twice as broad as long with 5 pairs of major setae. Fore femora of males and females enlarged, females always and males rarely with a row of teeth on inner margin; fore tarsal tooth present in ♂ and ♀, larger in ♂. Wings broad, slightly broader in apical half, pale or dusky, with numerous duplicated cilia. Pelta broadly triangular. Tergites II–VII with 1 pair of wing-retaining setae; sternites II–VIII with a row of small accessory setae; sternite IX of males with a pair of long stout setae. Tube with straight sides evenly narrowing to apex, 3·0 to 3·5 times as long as broad, about as long as head.

Twelve species are here recognized in this genus and a further two nominal species were not available for study, but the patterns of inter- and intraspecific variation are difficult to interpret (Table 2). The species are distinguished on the lengths of the setae on the head and pronotum, the length and colour of the third antennal segment, and the form and number of tubercles on the fore femora of the females. Unfortunately none of these characters appears to be stable, and since it is not unusual for two or more species to be collected together the possibility of hybridization must be considered in future studies in the field. The species are not infrequently collected but apparently do not usually exist in large populations. This widespread dispersion in low numbers suggests a high vagility, and this biological characteristic would contribute to taxonomic problems. Certainly the taxonomic conclusions which have been reached in this genus, for example only two new synonyms are established, are in marked contrast to the conclusions reached in *Elaphrothrips* and *Dinothrips*. In both of these genera it is not unusual for each species to form large populations and, despite the problems associated with allometric growth, there is less overlap in the ranges of structural variation between species.

Machatothrips species are widespread between West Africa and Guam throughout the Old World tropics. The genus is unusual in that it is the females, not males, which bear the obvious sexually dimorphic characters on which species are defined. However, in both of the new species described below, *decorus* and *lentus*, one or more males are known which have female-like fore legs.

Adiaphorothrips pallicornis Karny (1924) from Queensland is not a member of *Machatothrips*. The holotype has slender maxillary stylets and is a member of the Phlaeothripinae. This species is here transferred to the genus *Akainothrips* Mound (1971*a*) and should be referred to as *Akainothrips pallicornis* (Karny) **comb. n.** The holotype female of *Machatothrips isshikii* Ishida (1932 : 7–9) (HUS) has been examined. The specimen has been remounted and relabelled by Dr Haga as *Acanthothrips nodicornis* (Reuter) although this synonymy does not appear to have been published.

The monotypic genus *Cnestrothrips* was erected by Priesner for his species *dammermani* which is here shown to be a synonym of *Machatothrips antennatus*. It differs from the other species of *Machatothrips* in the presence of a group of spines on the fore angles of the pronotum, and also in having a series of small tubercles, without any large teeth, on the inner margin of the female fore femora. The arrangement of these teeth in *M. decorus* is intermediate between that of *antennatus* and the other species in the genus in having one larger basal tooth and a row of 12 to 14 almost uniform small teeth.

Machatothrips is closely related to *Macrothrips* from New Guinea although the females of the latter do not have a row of teeth on the fore femora. Both males and females of *Macrothrips* have a hook on the ventral surface of the fore angles of the pronotum. Larger specimens of this

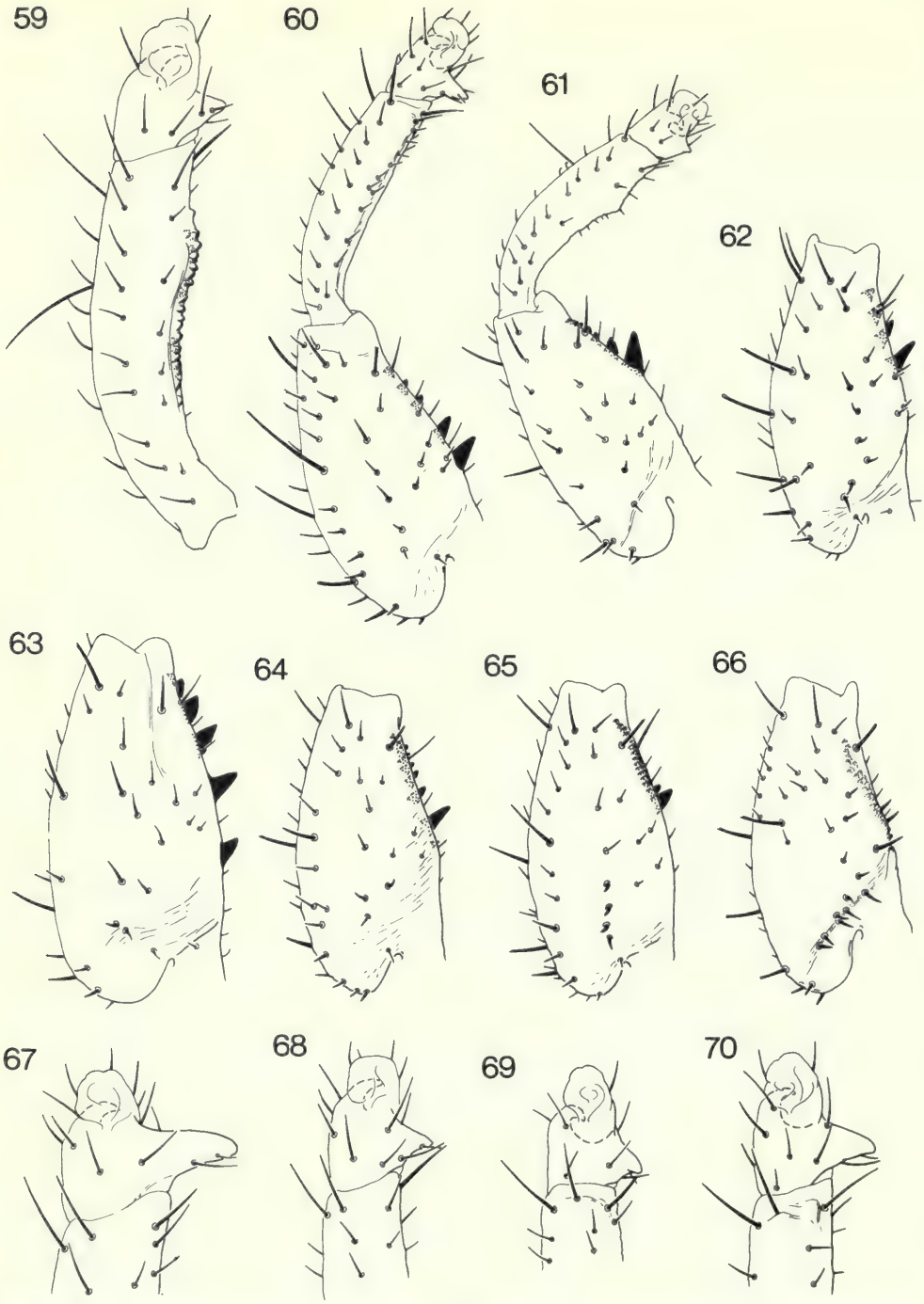
Table 2 Variation in the length of antennal segment III and the postocular setae of *Machatothrips* species

Species	Antennal segment III length/breadth	Postocular setae pair I length/pair II length	Distribution
sylvaticus	2·4 to 2·7	3·4 to 5·0	India
quadrudentatus	2·5	10·0	New Guinea
antennatus	2·8 to 3·6	7·0 to 9·3	Malaya
indicus	3·0	4·8	India
haplodon	3·2 to 3·6	5·0 to 10·0	Africa
lentus	3·2 to 3·8	3·0 to 6·5	Malaya
decorus	3·2 to 3·8	2·8 to 3·3	Malaya
heveae	3·5 to 4·0	2·0 to 2·2	Malaya
artocarpi	3·5 to 4·4	1·9 to 3·7	Japan to Solomon Is
braueri	3·0 to 4·5	1·9 to 3·2	Africa
celosiae	4·7	2·4	Taiwan
biuncinatus	4·1 to 5·0	1·4 to 2·8	Malaya to New Guinea

genus have a nodular swelling on the inner margin of the fore femora near the base, they also have large coxal and epimeral tubercles, and the fore tibiae have from one to three teeth on the inner margin near the apex. The pronotum of *Machatothrips* lacks the hook and tubercles, and only in males of *antennatus* is a small tooth visible at the apex of the fore tibiae. The tube of *Macrothrips* is longer than in *Machatothrips* being more than four times as long as broad and the pores on the pelta are situated further forward (Figs 71–78). Partial revisions of *Machatothrips* have been published by Mound (1968; 1970).

Key to species

1 Postocular setae pair I 5 to 10 times as long as postocular setae pair II 2
– Postocular setae pair I 1 to 5 times as long as postocular setae pair II 5
2 Antennal segment III yellow, 2·5 times as long as broad (Fig. 55); anteromarginal setae equal in length to anteroangulars [New Guinea] . . . . . ***quadrudentatus*** (p. 195)
– Antennal segment III as dark as IV, 2·8 to 3·8 times as long as broad 3
3 Fore angles of pronotum with a group of spine-like setae (Fig. 54); fore femora of ♀ with a complete row of small tubercles (Fig. 66); anteromarginal setae 0·4 to 0·7 times as long as anteroangulars [Malaya, Borneo] . . . . . ***antennatus*** (p. 189)
– Fore angles of pronotum without spine-like setae; fore femora of ♀ with a row of 4 to 8 stout teeth; anteromarginal setae 0·6 to 1·1 times as long as anteroangulars 4
4 Fore tibiae of ♀ with a distinct hump, fore tarsal claw small, fore femora with teeth restricted to distal half (Fig. 61) [Malaya] . . . . . ***lentus*** (part) (p. 194)
– Fore tibiae of ♀ without a hump, fore tarsal claw well developed and sharply pointed, fore femora with row of teeth extending into basal half (Fig. 60) [Africa] . ***haplodon*** (p. 193)
5 Antennal segment III 2·4 to 3·0 times as long as broad at apex 6
– Antennal segment III more than 3·0 times as long as broad 7
6 Antennal segment III slightly paler than IV; fore tibiae of ♀ without hump [India] ***silvaticus*** (p. 195)
– Basal stem of antennal segments III–VI slightly paler than apical half; fore tibiae of ♀ with a distinct hump bearing spinules (Fig. 59) [India] . . . . . ***indicus*** (p. 194)
7 Pronotal anteromarginal setae short, less than 0·5 times as long as anteroangulars; postocular setae pair II long, pair I 1·4 to 2·8 times as long as pair II (Fig. 53); antennal segment III long, 4·1 to 5·0 times as long as broad (Fig. 56); distal teeth on fore femora of ♀ usually fused into a ridge (2+3 to 4+5) (cf. Fig. 61) [Malaya to New Guinea] . ***biuncinatus*** (p. 190)
– Pronotal anteromarginal setae longer, more than 0·5 times as long as anteroangulars; antennal segment III shorter, usually less than 4·5 times as long as broad; teeth on ♀ fore femora usually separate 8
8 Pronotal anteromarginal setae longer than anteroangulars; antennal segment III 4·7 times as long as broad [Taiwan] . . . . . ***celosiae*** (p. 192)



Figs 59–70 *Machatothrips* species. 59, *M. indicus* ♀, fore tibia and tarsus. 60, *M. haplodon* ♀. 61, *M. lentus* ♀. 62–66, ♀ fore femora, (62) *M. artocarpi;* (63) *M. heveae;* (64) *M. braueri;* (65) *M. decorus;* (66) *M. antennatus*. 67–70, ♂ fore tarsi, (67) *M. artocarpi;* (68) *M. decorus;* (69,70) *M. lentus* (69 gynaecoid ♂).

– Pronotal anteromarginal setae 0·5 to 1·0 times as long as anteroangulars; antennal segment III 4·5 or less times as long as broad 9

9 Postocular setae pair I 3·0 to 6·5 times as long as pair II; antennal segment III 3·2 to 3·8 times as long as broad; fore tibiae of ♀ with a distinct hump, arrangement of teeth on fore femora similar to *biuncinatus* (2+3 to 4+6) (Fig. 61) [Malaya] . . . . ***lentus*** (part) (p. 194)

– Postocular setae pair I usually less than 3·2 times as long as pair II, if more than 3·2 times as long as pair II then antennal segment III 3·5 or more times as long as broad; fore tibiae of ♀ without a distinct hump. 10

10 Pronotal posteroangular setae short, median pronotal length 1·8 to 3·0 times as long as these setae (Fig. 58); antennal segment III 3·5 to 4·0 times as long as broad; fore femora of ♀ with 5 to 10 teeth throughout its length, first tooth in basal half smaller than second (Fig. 63) [Malaya, Java] . . . . . ***heveae*** (p. 194)

– Pronotal posteroangular setae longer (Fig. 57), median pronotal length usually 1·1 to 2·0 times as long as these setae, if more than 2·0 then antennal segment III only 3·2 times as long as broad 11

11 Tube short, 2·8 to 3·3 times as long as basal breadth; fore femora of ♀ with 5 to 10 closely set teeth evenly decreasing in size, rarely with a smaller tooth or tubercle in basal half (Fig. 64) [Africa] . . . . . ***braueri*** (p. 190)

– Tube longer, 3·3 or more times as long as basal breadth 12

12 Fore femora of ♀ with a distinctive row of 12 to 14 teeth in distal half (Fig. 65); pronotal anteromarginal setae 0·5 times as long as anteroangulars; antennal segment III 3·2 to 3·8 times as long as broad [Malaya] . . . . . ***decorus*** (p. 193)

– Fore femora of ♀ with 3 to 5 separate teeth in distal half (Fig. 62); pronotal anteromarginal setae 0·6 to 0·9 times as long as anteroangulars; antennal segment III 3·5 to 4·4 times as long as broad [Japan to Solomon Is] . . . . . ***artocarpi*** (p. 189)

Machatothrips antennatus (Bagnall)

(Figs 54, 66, 74)

Adiaphorothrips antennatus Bagnall, 1915*b*: 594. Lectotype ♀, Borneo (BMNH) [examined].

Cnestrothrips dammermani Priesner, 1932: 344 (1939: 76). Holotype ♀, Riau (Riouw) Is (SMF) [examined]. **Syn. n.**

This is a distinctive species, both males and females having a group of spine-like setae on the fore angles of the pronotum and short postocular setae pair II. The females have a complete row of 12 to 20 small tubercles on the fore femora, and the tergal accessory setae of both ♂ and ♀ are rather robust. The holotype of *dammermani* has these characteristics and is indistinguishable from *antennatus* with which it is here synonymized. This species is most similar to *decorus* which may be distinguished by having much longer postocular setae pair II.

Specimens studied.

Malaya: Gombak, dead branch, 2 ♀, 1 ♂, 30.ix.1973; 1 ♂, 7.x.1973; Damansara Forest Reserve, 8 miles [13 km] north of Kuala Lumpur, 1 ♀, 3.x.1973 (*L. A. Mound*) (BMNH). **Singapore:** Bukit Timah, 2 ♀, 1 ♂ on dead branches, 3.xi.1973 (*L. A. Mound*); 2 ♂ on *Dialium wallichii* fallen tree, 16.xi.1973 (*D. H. Murphy*) (BMNH). **Riau (Riouw) Is:** Doerian, holotype ♀ of *dammermani*, caught in low herbage, vi.1923 (*Dammerman* 33) (SMF). **Borneo:** West Sarawak, lectotype ♀ of *antennatus*, Mt Matang, 1000 ft [300 m], under bark of dead tree, 7.xii.1913; Quop, 1 ♂, 28.iii.1914 (*G. E. Bryant*) (BMNH).

Machatothrips artocarpi Moulton

(Figs 62, 67, 71)

Machatothrips artocarpi Moulton, 1928*a*: 322. Holotype ♀, Taiwan (CAS) [examined].

This dark but otherwise unremarkable species is recorded from Japan, Formosa, Guam, Philippines, New Guinea and the Solomon Is, but not, as yet, from further west.

Specimens studied.

Japan: Ishigaki-jima I., Mt Banna, 2 ♀, 2 ♂ on dead twigs, 16.vi.1972 (*S. Okajima*) (SO, Tokyo). **Taiwan** (Formosa): Kagi, holotype ♀, paratype ♂, on *Artocarpus*, 10.viii.1927 (*R. Takahashi*) (CAS). **Guam:** 1 ♂

under dead bark (*Swezey*); Upi, 4 ♀, 1 ♂ (2 ♀, 4 ♂ CAS) under bark of *Pariti tiliaceum*, 5.v.1936 (*Swezey*); Apra, 9 ♀, 2 ♂ under dead bark, 15.vi.1936; Machaneo, 2 ♀ (3 ♀, 2 ♂ CAS) on *Elaeocarpus joga* bark, 30.vi.1936 (*Swezey*); Piti, 1 ♀, 3 ♂ (4 ♀, 3 ♂ CAS) under *Heritiera littoralis* bark, 7.x.1936 (*Swezey*); Yigo, 1 ♀ (1 ♂ CAS) under dead bark, 1 ♀ (1 ♀ CAS) under *Elaeocarpus joga* bark, 18.x.1936 (*Swezey*); 1 ♀, 2 ♂ ? Guam [unlabelled from Floyd Andre Collection] (BMNH). [? **Philippines]:** Occ. Negros, 1 ♀ on *Papaya*, 1.9.1929 (*W. D. Pierce*) (CAS). **New Guinea:** Maffin Bay, 1 ♀, vii.1944; 7 ♀, 1 ♂, viii.1944; 1 ♀, 1 ♂, ix.1944; 1 ♀, 2 ♂, 3.x.1944; 12 ♀, 7 ♂ on bark, ix.1944 (*E. S. Ross*) (CAS). **Solomon Is:** 5 ♀, 4 ♂, 1965 (*J. A. Grant*); Guadalcanal, Umasani River, 2 ♀, 1 ♂ on *Areca macrocalyx*, 1–9.vii.1965 (*P. N. Lawrence*); Kakum, 1 ♀, 3 ♂ in arable soil, 1962 (*P. Greenslade*); Oreke, 1 ♂, 14.xii.1934 (*R. A. Lever*); North Guadalcanal, 2 ♀, 2 ♂ on dried calyx of shrivelled coconut, x.1931 (*R. A. Lever*); Rendova, 1 ♀ on *Cocos* trunk, 28.iii.1935 (*R. A. Lever*) (BMNH).

Machatothrips biuncinatus Bagnall

(Figs 53, 56, 72)

Machatothrips biuncinata Bagnall, 1908*b* : 189. Holotype ♀ (fore leg only), New Guinea (BMNH) [examined].

Adiaphorothrips simplex Bagnall, 1909*b* : 537. Lectotype ♂, Borneo (BMNH) [examined]. [Synonymized by Mound, 1968 : 134.]

Machatothrips montanus Priesner, 1932 : 344. Holotype ♀, Sarawak (SMF) [examined]. **Syn. n.**

Bagnall described *Adiaphorothrips simplex* from two males collected together, and Mound (1968) designated one of these as lectotype. The holotype of *montanus* has the anteromarginal setae missing, but the small setal bases indicate that they were probably short as in typical *biuncinatus*. The original description states that the fore femora have only three teeth, but three extra small humps are visible in the position of the typical fused comb of *biuncinatus*. This is a variable species with very short anteromarginal setae, long postocular setae pair II, long anteroangulars, long antennal segment III and a rounded pelta. It is similar to *artocarpi*, but that species has longer anteromarginals, shorter anteroangulars and postocular setae pair II, and a pointed pelta (Fig. 71).

Specimens studied.

Malaya: Lenggong, 1 ♀ (*A. M. Lea*) (CAS); Damansara Forest Reserve, 8 miles [13 km] north of Kuala Lumpur, 1 ♂ on dead branches and leaves, 3.x.1973; Gombak Field Station, 16 miles [26 km] east of Kuala Lumpur, 1 ♀, 2 ♂ on dead wood, 25.ix.1973; Gombak, on dead branches, 1 ♀, 30.ix.1973, 1 ♀, 4 ♂, 5.x.1973, 1 ♂, 8.x.1973; Ringlet, 2 ♀ on a dead branch, 12.x.1973 (*L. A. Mound*) (BMNH). **Singapore:** Bukit Timah Forest, 1 ♀, 3 ♂ on fallen *Dialium wallichii* tree, 16.xi.1973 (*D. H. Murphy*) (BMNH). **Mentawai Is:** Siberut, 1 ♂, 13.ix.1927 (BMNH). **Java:** Jasinga Forest Reserve, 1 ♀, 4 ♂ on a dead leafy branch, 30.x.1973 (*L. A. Mound*) (BMNH); Marywattie near ? Lindanglaja Menzel, 2 ♀ under bark, vii.1924 (SMF). **Borneo:** Sambas, lectotype ♂ and paralectotype ♂ of *simplex*, v.1890 (*Th. F. Lucassen*); Sarawak, Lawas, 1 ♀ (*C. R. Wallace*); West Sarawak, Quop, 1 ♂, iii.1914 (*G. E. Bryant*); Sarawak, Matang, 1 ♂ on dead bark, 8.xii.1913; 1 ♀, 1 ♂ on dead tree, 17.xii.1913 (*G. E. Bryant*) (BMNH); Sarawak, Mt Dulit, 3000 ft [1000 m], holotype ♀ of *montanus* (*Mjoberg*) (SMF). **Sulawesi** (Celebes): 1 ♀ (*de la Savinière*) (BMNH); 1 ♀ without data from the Bagnall Collection (BMNH). **New Guinea:** holotype ♀ of *biuncinatus* (Netherlands' New Guinea Expedition, 1904–5); Bulolo Gorge, north of Wau, 2 ♂ on bark of fallen log, 4.vi.1968 (*R. Rice*) (BMNH); Finschhafen, 5 ♀, 1 ♂ on bark, 16.iv.1944; Maffin Bay, 1 ♀ on bark, ix.1944 (*E. S. Ross*) (CAS).

Machatothrips braueri Karny

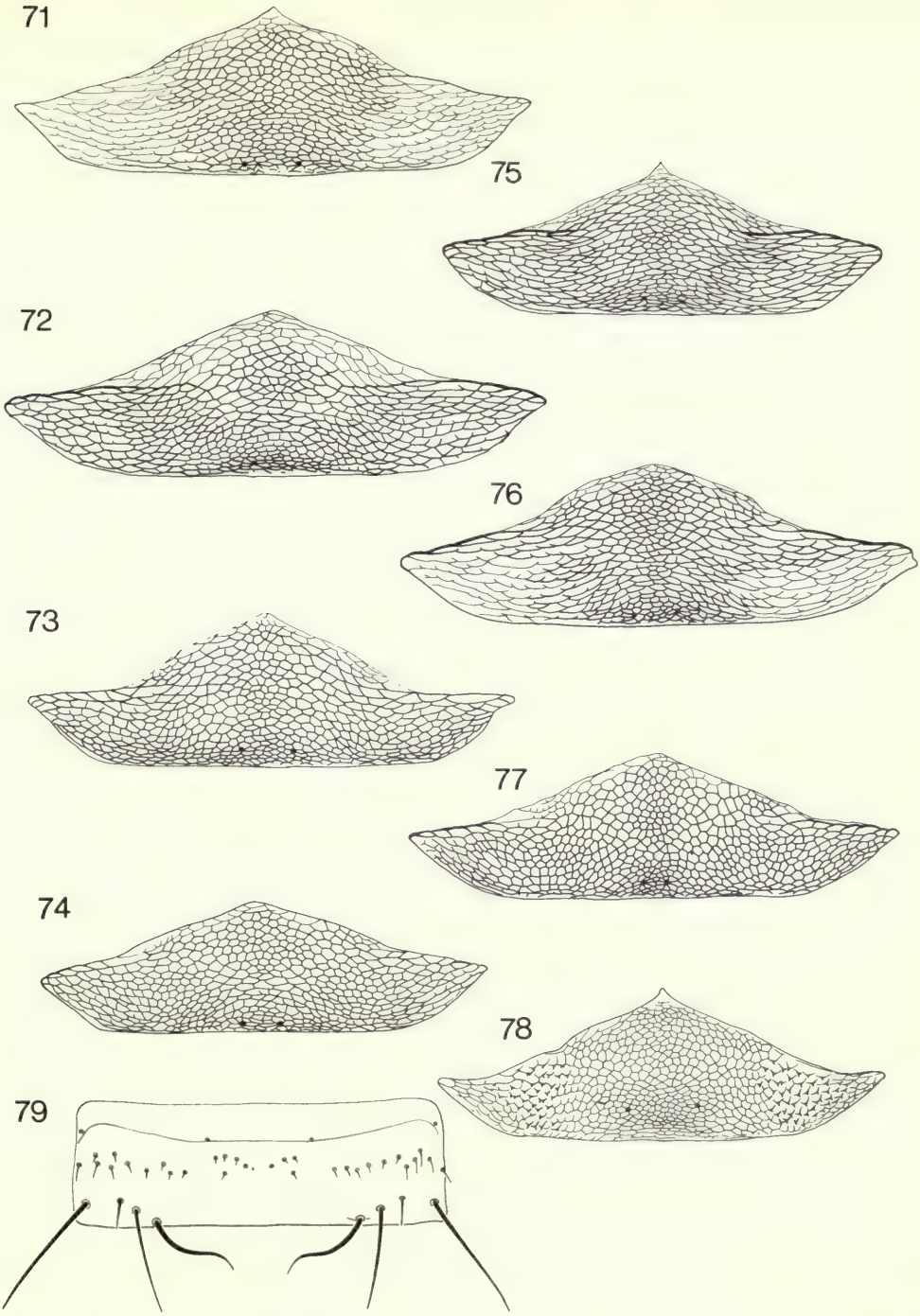
(Figs 57, 64, 73)

Machatothrips braueri Karny, 1912 : 23. Holotype ♀, Cameroun (MNHU) [examined].

Machatothrips multidens Bagnall, 1934*a* : 487. Lectotype ♀, Ghana (BMNH) [examined]. [Synonymized by Mound, 1968 : 134.]

Machatothrips paucidens Bagnall, 1934*a* : 489. Lectotype ♀, Ghana (BMNH) [examined]. [Synonymized by Mound, 1968 : 134.]

Machatothrips paucidens var. *bicolorisetosus* Bagnall, 1934*a* : 489. Lectotype ♀, Sierra Leone (BMNH) [examined]. [Synonymized by Mound, 1968 : 134.]



Figs 71–79 *Machatothrips* and *Macrothrips* species. 71–78 peltas, (71) *Machatothrips artocarpi;* (72) *M. biuncinatus;* (73) *M. braueri;* (74) *M. antennatus;* (75) *M. lentus;* (76) *M. heveae;* (77) *M. haplodon;* (78) *Macrothrips* species. 79, *Machatothrips lentus*, tergite III.

Machatothrips braueri is very similar to *heveae* from Malaya. Both species have well-developed postocular setae pair II, these setae being more than one-third as long as pair I, and the measurements of antennal segment III as well as the anteromarginal setae lie within the same ranges. The row of teeth on the fore femora of the females is also variable. Usually *braueri* has a row of 5 to 9 separate teeth, the most basal being the largest, whereas *heveae* has 4 to 7 separate teeth, the most basal being smaller than the second (Fig. 63). There are, however, some *braueri* with a small basal tubercle or tooth, but usually the two species may be separated on the length of the posteroangular setae. These setae in *braueri* are long, more than half as long as the pronotum, whereas those of *heveae* are short, seldom more than half and usually only one-half to one-third as long as the pronotum. There are some specimens of *braueri* in the BMNH labelled *paucidens* or *bicolorisetosus* which are smaller and have shorter, darker setae. The third antennal segment of some of these is also very short, being only 3·0 to 3·5 times as long as broad.

Machatothrips braueri may be distinguished from *haplodon*, the only other species from Africa, by its much longer postocular setae pair II, those of *haplodon* being less than 0·2 times as long as pair I, and those of *braueri* being more than 0·3 times as long as pair I.

SPECIMENS STUDIED.

Sierra Leone: 1 ♀ on coconut (*E. Hargreaves*); Njala, lectotype ♀, paralectotype ♀ of *bicolorisetosus*, also 1 ♀ with identical data, in tunnels of coffee twig borer, 7.i.1927 (*E. Hargreaves*); 1 ♀, 1 ♂ in twigs of *Bauhinia tomentosa*, 1933 (*E. Hargreaves*); 2 ♀ in cassava stem (*E. Hargreaves*); 1 ♀, 1 ♂ on coffee, 16.x.1963 (CIE 19548); Petema, 1 ♂ under bark of *Kola*, 19.ii.1925 (*E. Hargreaves*) (BMNH). **Ghana:** on cocoa, 2 ♂, vi.1972, 22 ♀, 7 ♂, 1972 (*J. D. Majer*); Kade, on cocoa, 1 ♀, 27.i.1971, 25 ♀, 13 ♂, i–ii.1972 (*J. D. Majer*); Aburi, in tunnels of cocoa stem moth borer, lectotype ♀ of *paucidens*, lectotype ♀ and paralectotype ♂ of *multidens*, 29.x.1915; 5 ♀ paralectotypes, 15.xi.1915; 3 ♀, 1 ♂ in tunnels of *Cacao* shot hole borer, 20.xi.1915 (*W. H. Patterson*); on *Tapinanthus bangwensis* on cocoa 1 ♀, 1 ♂, 1969, 8 ♀, 1 ♂, 1970 (*P. M. Room*) (BMNH). **Nigeria:** Ibadan, 2 ♀ on dead wood, 16.ix.1964; Ibadan, Moor Plantation, 3 ♀, 3 ♂ on yam leaves, 7.vii.1964 (*B. A. Okwakpam*) (BMNH). **Zaire:** 1 ♂ on *Cacao* (*R. Mayne*) (BMNH); Kasai, Ngombe, 1 ♀, 8.xi.1921 (*H. Schouteden*) (SMF). **Cameroun:** Bascho, holotype ♀ of *braueri*, iv.1909 (*Oberlt. Bartsch. S.V.*) (MNHU).

Machatothrips braueri f. *karnyi* Priesner

Machatothrips braueri f. *karnyi* Priesner, 1932 : 340. Holotype ♀, CONGO (BRAZZAVILLE) (unknown) [not examined].

This form was described from a unique female with three large and three small spines on the fore femur. Unfortunately the type has not been traced and the original description is insufficient to assign it to any one species.

Machatothrips celosia Moulton

Machatothrips celosia Moulton, 1928*a* : 325. Holotype ♀, TAIWAN (Formosa) (CAS) [examined].

This species is known only from the holotype which is very similar to *artocarpi*. It may be distinguished by the anteromarginal setae being longer than the anteroangulars and by the longer third antennal segment. The second specimen mentioned in the original description is indistinguishable from typical *artocarpi*.

SPECIMEN STUDIED.

Taiwan: Kagi, holotype ♀ on *Celosia argenta*, i.1928 (*K. Toyota*) (CAS).

Machatothrips corticosus Ananthakrishnan

Machatothrips corticosus Ananthakrishnan, 1972*b* : 443. Holotype ♀, INDIA (TNA) [not examined].

Type-material of this species was not available for study but from the original description it would appear to be most similar to *indicus* Ananthakrishnan. Both species were collected from Kerala, India.

Machatothrips decorus sp. n.

(Figs 65, 68)

♀ macroptera. Colour uniformly brown, basal three-fifths of tube dark brown to black; wings pale with dark median longitudinal line in basal half; abdominal setae pale, yellowish, wing-retaining setae slightly darker.

Head 1·5 times as long as broad, postocular setae pair I 2·8 times as long as postocular setae pair II; antennal segment III 3·6 times as long as broad. Pronotum twice as broad as long, anterior angles with a row of three small spine-like setae; anteroangular setae twice as long as anteromarginals; median length of pronotum 1·2 times as long as posteroangular setae. Fore femora enlarged with a row of 12 to 14 small teeth in apical half of inner margin; inner margin of fore tibiae weakly convex, fore tarsal claw small. Tube evenly narrowing to apex, 3·3 times as long as basal breadth.

Measurements (holotype ♀ in μm). Body, length 5420. Head, length 500; maximum breadth across cheeks 355. Postocular setae pair I 220; pair II 76. Antennal segments, III length 220, breadth 62; length, IV 210; V 176; VI 134; VII 80; VIII 76. Pronotum, median length 270; maximum breadth 548; anteromarginal setae 58; anteroangular setae 119; mid-lateral setae 128; posteroangular setae 214; epimeral setae 286. Fore wing, length 2208; maximum breadth 240; number of duplicated cilia 63; length basal setae, 1, 142; 2, 190; 3, 334. Dorsal setae tergite IX 600. Tube, length 670; maximum breadth 200.

♂ macroptera. Colour and structure similar to ♀. Posteroangular setae shorter than in ♀, pronotum 2·4 times as long as these setae. Fore femora aberrant, with two well-developed and two small teeth on inner margin; fore tarsal tooth sharply pointed, as long as its basal breadth (Fig. 68).

Measurements (paratype ♂ in μm). Body, length 4675. Head, length 470; maximum breadth across cheeks 316. Postocular setae pair I 190; pair II 58. Antennal segments, III length 180, breadth 58; length, IV 176; V 162; VI 120; VII 70; VIII 70. Pronotum, median length 270; maximum breadth 524; anteromarginal setae 48; anteroangulars 95; mid-laterals 100; posteroangulars 114; epimerals 200. Fore wing, length 2016; maximum breadth 190; duplicated cilia 54; basal setae, 1, 90; 2, 124; 3, 152. Dorsal setae tergite IX 476. Tube, length 546; maximum breadth 152.

SPECIMENS STUDIED.

Holotype ♀, **Malaya:** Gombak, 16 miles [26 km] west of Kuala Lumpur, on dead branches, 8.x.1973 (*L. A. Mound*) (BMNH).

Paratype. 1 ♂, same data as holotype.

This species is most similar to *antennatus* in the shape of the third antennal segment, the small spine-like setae on the fore angles of the pronotum and the long row of small tubercles on the female fore femora. It may be distinguished mainly by the much longer postocular setae pair II. It is also not easily distinguishable from the African species *braueri*, apart from the arrangement of the fore femoral teeth of the female and slightly shorter anteromarginal setae. The male is unusual in having teeth on the fore femora.

The two specimens on which this species is based were collected with a male of *biuncinatus*.

Machatothrips diabolus (Priesner)

Adiaphorothrips diabolus Priesner, 1928*a* : 56. Holotype ♀, EAST AFRICA (Hamburg Museum, destroyed). This species was described from a unique female which was destroyed in the Hamburg Museum. It was not illustrated and the original description is insufficient even to assign it to the genus *Machatothrips*. Priesner (1928*a*) states that it most closely resembles *elephas* Karny which he subsequently transferred to the genus *Scotothrips*. The name *diabolus* is best regarded as a nomen dubium at present.

Machatothrips haplodon Karny

(Figs 60, 77)

Machatothrips braueri var. *haplodon* Karny, 1925 : 141. Holotype ♀, UGANDA (BMNH) [examined].

Machatothrips braueri var. *buffai* Karny, 1925 : 142. Holotype ♂, UGANDA (BMNH) [examined]. [Synonymized by Mound, 1968 : 135.]

Machatotothrips simplicidens Bagnall, 1934*a* : 490. Holotype ♀, CONGO (BRAZZAVILLE) (MNHN) [not examined]. [Synonymized by Mound, 1968 : 135.]

Machatothrips braueri f. *spatiata* Priesner, 1932 : 341. LECTOTYPE ♀, ZAIRE (SMF), here designated [examined]. **Syn. n.**
Machatothrips haplodon Karny; Mound, 1968 : 135.

Machatothrips braueri f. *spatiata* was described for an unspecified number of female syntypes from various localities in the Belgian Congo. Three females labelled 'paratype' have been studied. One, from Kasai, Ngombe, 8.xi.1921 (*Dr H. Schouteden*), has postocular setae pair II 0·3 times as long as pair I, antennal segment III 4·0 times as long as broad, and a short blunt fore tarsal claw. The fore femoral teeth are variable in form and the presence of a small tooth at the base is not sufficient to separate this specimen from typical *braueri*. The two other 'paratypes', one from Haut Uelé, Moto, 1920 (*L. Burgeon*), and the other from Barumbu here designated as lectotype, have postocular setae pair II 0·1 times as long as pair I, antennal segment III 3·2 to 3·5 times as long as broad and a long and sharply pointed fore tarsal claw. The presence of the small spine at the base of the femora of these two specimens is not sufficient to separate them from typical *haplodon*. *Machatothrips braueri* var. *buffai* was described from specimens without fore femoral teeth. The holotype is a male which, in common with most males of this genus, has no fore femoral teeth. It has short postocular setae pair II and is indistinguishable from typical *haplodon*.

SPECIMENS STUDIED.

Ghana: 1 ♀ on *Tapinanthus banguensis* on cocoa, 1970 (*P. M. Room*) (BMNH). **Zaire:** lectotype ♀ of *spatiata*, Barumbu, viii.1925 (*J. Ghesquière*), paralectotype ♀ of *spatiata*, Haut Uelé, Moto, 1920 (*L. Burgeon*) (SMF). **Uganda:** Kampala, holotype ♀ of *haplodon*, holotype ♂ of *buffai* and 2 ♀ in Scolytid galleries in bark of *Ficus ovata*, 8.viii.1921 (*H. Hargreaves*) (BMNH).

Machatothrips heveae Karny

(Figs 58, 63, 76)

Machatothrips heveae Karny, 1921*b* : 61. Holotype ♀, JAVA (SMF) [examined].

This species is very similar to the African species *braueri* but may usually be distinguished by its shorter posteroangular setae.

SPECIMENS STUDIED.

Malaya: Kuala Lumpur, 2 ♀ (*A. M. Lea*) (CAS), 2 ♀, 3 ♂ on dead branches, 29.xii.1969 (*R. G. & F. Andre*); Gombak, 2 ♂ on dead branches 29.ix.1973, 1 ♀ on *Cassia* leaves, 2.x.1973 (*L. A. Mound*) (BMNH). **Java:** Halte Dawoean, holotype ♀ on *Hevea* xi.1906 (*De Vos V.N.C.*) (SMF).

Machatothrips indicus Ananthakrishnan & Jagadish

(Fig. 59)

Machatothrips indicus Ananthakrishnan & Jagadish, 1970 : 279. Holotype ♀, INDIA (TNA) [examined].

This species, described from two females and two males, may be distinguished easily from the others in the genus by the inner margin of the fore tibiae being set with small spinules in both sexes and the fore tibiae of the females having a distinct hump.

SPECIMENS STUDIED.

India: Aryankavu, holotype ♀ and paratype ♂ on dry twigs, 18.vii.1969 (TNA).

Machatothrips lentus **sp. n.**

(Figs 61, 69, 70, 75, 79)

♀ macroptera. Colour dark brown to black, basal stem of antennal segment III, tarsi and extreme apex of tube slightly paler. Wings dusky with a dark median longitudinal line in basal half. Wing-retaining setae dark brown, the two pairs of tergal posteroangular setae pale, colourless to yellow.

Head about 1·5 times as long as broad, postocular setae pair I 3·0 to 6·5 times as long as pair II. Antennal segment III 3·2 to 3·8 times as long as broad. Pronotum twice as broad as long, anteroangular

setae 1·5 to twice as long as anteromarginals, median length of pronotum 1·7 to 2·5 times as long as the short posteroangulars. Fore femora enlarged with 2 to 4 separate teeth plus a ridge of 3 to 6 in the distal half of the inner margin; inner margin of fore tibiae with a distinct hump opposing the basal, largest, femoral tooth; fore tarsal claw small. Tube evenly narrowing to apex, about 3·5 times as long as broad.

Measurements (holotype ♀, also largest and smallest ♀ paratypes, in μm). Body, length 5328 (5874, 5106). Head, length 520 (546, 500); maximum breadth across cheeks 326 (344, 316). Postocular setae, pair I 200 (209, 186), pair II 66 (62, 52). Antennal segments, III length 200 (214, 190), breadth 62 (62, 58); length, IV 186 (204, 180); V 156 (170, 158); VI 120 (128, 120); VII 76 (76, 76); VIII 76 (80, 76). Pronotum, median length 266 (314, 268); maximum breadth 530 (540, 510); anteromarginal setae 42 (62, 42); anteroangulars 66 (80, 62); mid-laterals 90 (95, 86); posteroangulars 120 (132, 110); epimerals 228 (248, 214). Fore wing, length 2160 (2400, 2062); maximum breadth 220 (240, 200); duplicated cilia 57 (67, 60); basal setae, 1, 90 (120, 90); 2, 148 (200, 148); 3, 248 (286, 238). Dorsal setae tergite IX 575 (592, 564). Tube, length 632 (710, 632); maximum breadth 180 (190, 180).

♂ macroptera. Colour and structure similar to ♀. Inner margin of fore femora normally without teeth; inner margin of fore tibiae without hump; fore tarsi with well-developed, rounded claw. Some males have a tendency to produce fore femoral spines; these specimens have shorter, more sharply pointed, fore tarsal claws.

Measurements (largest and smallest ♂ paratypes in μm). Body, length 4942, 4800. Head, length 490, 480; maximum breadth across cheeks 306, 306. Postocular setae, pair I 190, 186; pair II 28, 42. Antennal segments, III length 200, 194, breadth 58, 58; length, IV 186, 180; V 162, 156; VI 122, 120; VII 70, 70; VIII 70, 70. Pronotum, median length 366, 304; maximum breadth 592, 528; anteromarginal setae 52, 40; anteroangulars 80, 80; mid-laterals 114, 104; posteroangulars 134, 114; epimerals 238, 224. Fore wing, length 2160, 2015; maximum breadth 214, 200; duplicated cilia 74, 63; basal setae, 1, 90, 86; 2, 142, 138; 3, 228, 214. Dorsal setae tergite IX 466, 472. Tube, length 584, 536; maximum breadth 162, 162.

SPECIMENS STUDIED.

Holotype ♀, **Malaya:** Genting Highlands, 4500 ft [1500 km], 30 miles [48 km] east of Kuala Lumpur, dead wood and leaves, 28.ix.1973 (*L. A. Mound*) (BMNH).

Paratypes. **Malaya:** Damansara Forest Reserve, 8 miles [13 km] north of Kuala Lumpur, 1 ♀, 3 ♂ on dead branches and leaves, 3.x.1973; Tanah Rata, 3 ♀, 1 ♂ on dead branch, 12.x.1973; Ringlet, 1 ♀, 1 ♂ on dead branch, 12.x.1973; Gombak, on dead branch, 1 ♀, 5.x.1973, 1 ♂, 13.x.1973 (*L. A. Mound*); Cameron Highlands, 1 ♀ under bark of *Citrus*, 8.xi.1974 (*J. A. Whellan*) (BMNH); Kuala Lumpur 1 ♂; Fraser's Hill, Gap, 2 ♀ (*A. M. Lea*) (CAS). **Singapore:** 1 ♀ (*A. M. Lea & C. T. McN.*) (CAS).

This species is most similar in colour and form to *artocarpi* but it may usually be distinguished by the shorter third antennal segment, posteroangular setae and postocular setae pair II. The females, however, are distinctive in having a hump on the inner margin of the fore tibiae. The teeth on the fore femora are arranged similarly to *biuncinatus* with the smaller apical teeth sometimes fused at the bases to form a ridge. This species appears twice in the key due to the variation in length of the postocular setae pair II, pair I being 3·0 to 6·5 times as long as these setae.

Machatothrips quadrudentatus Moulton

(Fig. 55)

Machatothrips quadrudentatus Moulton, 1947 : 179. Holotype ♀, NEW GUINEA (CAS) [examined].

This species is known only from the holotype which, although described as a male, is, in fact, a female. It is distinct in having a short pale, third antennal segment 2·5 times as long as broad, very short postocular setae pair II, which are only 0·1 times as long as pair I, and long anteromarginal setae equal in length to the anteroangulars. The fore femora bear four simple separate teeth in the distal half.

SPECIMEN STUDIED.

New Guinea: Finschhafen, holotype ♀, v.1944 (*E. Ross*) (CAS).

Machatothrips silvaticus Ananthakrishnan

Machatothrips silvaticus Ananthakrishnan, 1972*a* : 436. Holotype ♀, INDIA (TNA) [paratypes examined].

This species is known from 21 male and 35 female paratypes, in addition to the holotype, from

India. It has a short, third antennal segment, slightly paler than the fourth and may be distinguished from *indicus* mainly by the lack of tubercles on the fore tibiae.

SPECIMENS STUDIED.

India: Madhya Pradesh, Kanha forest, 2 ♂, 1 ♀ paratypes on dry twigs, 21.i.1970 (TNA).

MALESIATHRIPS gen. n.

Type-species: *Malesiathrips malayensis* sp. n.

Small, dark or bicoloured species of Idolothripinae. Head longer than wide, dorsal surface sculptured, bearing several pairs of broadly blunt, pale setae which arise from tubercles, maxillary stylets V-shaped. Antennae 8-segmented, III–IV less than twice as long as wide; 2 sense cones on III, 4 sense cones on IV. Pronotum with epimeral sutures complete; 5 pairs of major setae present, anteroangular and midlateral setae relatively close together on a slight ridge, epimeral setae elongate on a small tubercle; praepectal plate broad, parallel to probasisternum. Fore tarsus with or without a tooth; all femora with one or more stout pale setae. Mesonotal lateral setae small; metanotum reticulate, median setae stout. Fore wings slightly angled before middle, parallel-sided distally, without duplicated cilia; sub-basal setae B_3 stout. Pelta broad; abdominal tergites with anterior pair of wing-retaining setae small or absent; posterior margin of tergites with 4 pairs of setae; tergite IX setae B_1 and B_2 stout, B_3 finely acute; tube less than 4 times as long as tergite IX, terminal setae short.

This new genus is erected for three species from the Malesian phytogeographic region. One of these species, *solomoni* Mound, was described in the genus *Atractothrips* but the type-species of that genus, from Florida, has the following characteristics: antennal segment III more than 4 times as long as wide, sense cones less than 0·25 times as long as segment; praepectus absent; pronotal midlateral setae reduced; sub-basal wing setae not developed; tergites with 2 pairs of sigmoid wing-retaining setae; posterior margin of tergites with 3 pairs of setae; tergites sculptured in front of antecostal ridge; tube more than 5 times as long as tergite IX.

Malesiathrips appears to be similar to the monobasic Hawaiian genus *Dermothrips* which has very reduced setae and the terminal antennal segments condensed. However, the tribal relationships of these genera, together with *Emprosthiothrips* from Australia, are at present uncertain.

Key to species

1 Antennal segment II bearing 1 large seta, with expanded apex, which extends beyond mid-point of III (Fig. 82); head prolongation in front of eyes shorter than diameter of one ocellus; head with 1 pair of postocular setae (Fig. 80); sub-basal setae shorter than half basal width of fore wing; median metanotal setae short, about as long as one sculptured reticle [Guam] ***guamensis*** (p. 196)

– Antennal segment II with 2 short broad setae at apex (Fig. 83); head prolongation as long as diameter of one ocellus; head with 2 pairs of postocular setae (Fig. 81); sub-basal setae longer than half basal width of fore wing; median metanotal setae longer than the diameter of 2 reticles 2

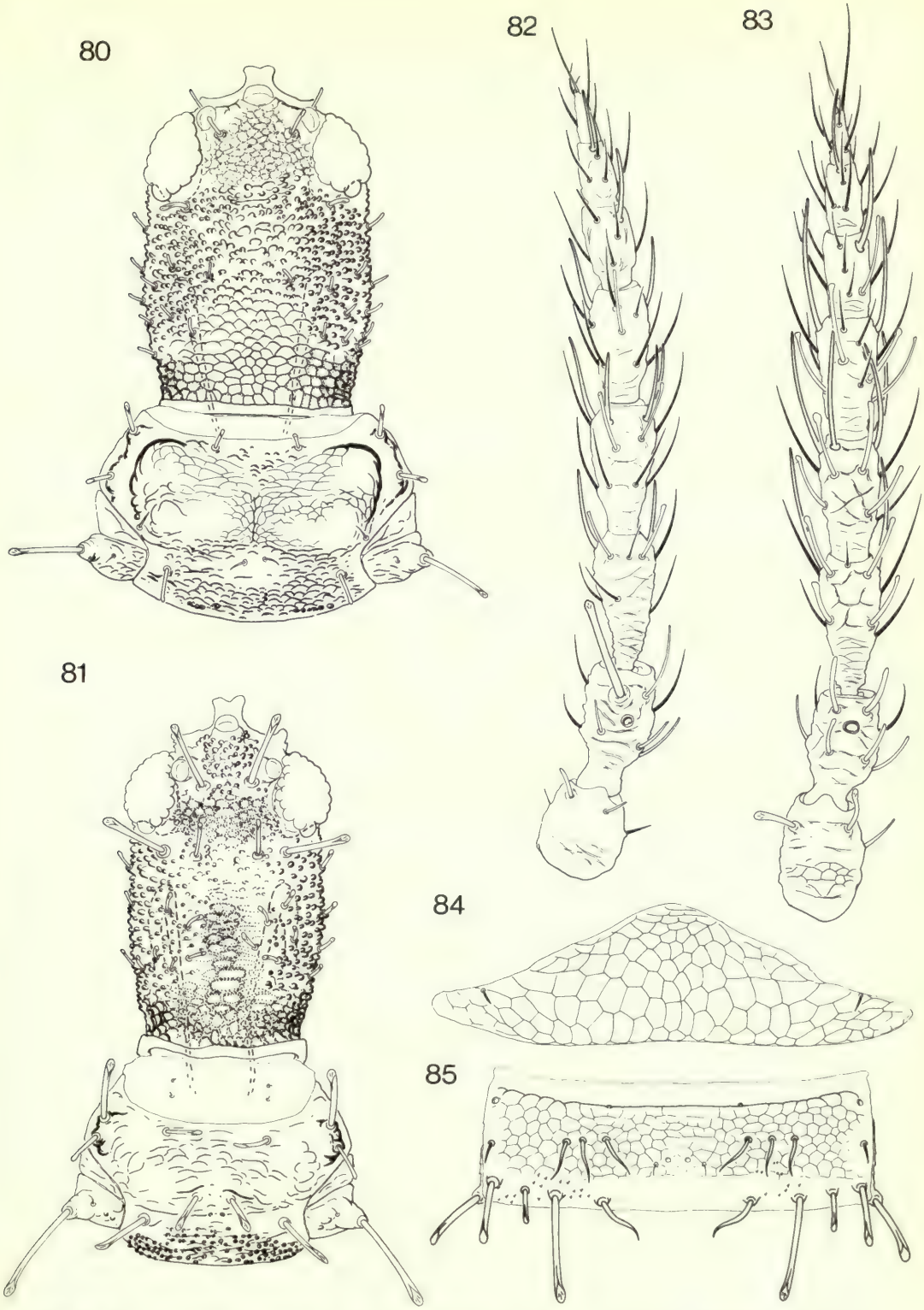
2 Head with 1 pair of setae on vertex behind and equal in length to postocular setae; median area of vertex tuberculate; pronotal posteromedian discal setae short and acute; fore wing with 2 long sub-basal setae; ♀ with small fore tarsal tooth; head dark laterally, antennal segments III–IV light brown, legs bicoloured, tube as dark as abdomen [Solomon Is] ***solomoni*** (p. 199)

– Head with 2 or 3 pairs of short broad setae behind postoculars (Fig. 81); median area of vertex with large, transverse reticles; pronotal posteromedian discal setae as long as anteromarginals; fore wing with 1 long sub-basal seta; ♀ without a fore tarsal tooth; head with 2 longitudinal pale stripes, antennae blackish brown except pedicel of III, legs uniformly dark, tube much paler than abdomen [Malaya, Java] . . . . . ***malayensis*** (p. 198)

Malesiathrips guamensis sp. n.

(Figs 80, 82)

Macropterous ♀. Colour brown; abdomen and tube, pronotum and sides of pterothorax dark brown; head, median area of pterothorax and pelta light brown, legs dark, tarsi yellow; antennal segments,



Figs 80–85 *Malesiathrips* species. (80) *M. guamensis;* (81) *M. malayensis;* (82) *M. guamensis;* (83) *M. maiayensis;* (84) *M. malayensis*, pelta; (85) *M. malayensis*, tergite IV.

I–II, VI–VIII dark, III–IV mainly yellow, V yellow to brown; fore wing weakly shaded medially; major setae pale, but large dorsal seta on antennal segment II dark.

Head with irregular tubercles medially, reticulate between eyes and at posterior margin; eyes rather small; postocular and postocellar setae little larger than cheek setae. Antennal segment II with median dorsal seta long and spatulate; III–IV with dorsal setae expanded at apex; pedicel of VI broad. Pronotum sculptured; major setae almost tubular. Metanotum strongly reticulate, median setae small. Pelta reticulate, broad, close to anterior margin of tergite II; tergites similar to *malayensis* (Fig. 85); tergite IX with setae B_1 and B_2 broadly rounded at apex, B_3 finely acute; tube margins weakly convex, with longitudinal ridges basally.

Measurements (holotype ♀ in μm). Body, length (contracted) 2000. Head, length 325; median width 220; postocellar and postocular setae 25. Pronotum, length 180; median width 300; major setae, anteromarginal 15, anteroangular 30, mid-lateral 17, epimeral 70, posteroangular ? 30. Metanotal median setae 15. Fore wing, length 1000; distal width 80; sub-basal setae 12, 15, 30. Tergite IX setae, B_1, 75; B_2, 75; B_3, 90. Tube, length 300; terminal setae 150. Antennal segments, length, 45, 70, 75, 72, 60, 45, 40, 30.

SPECIMEN STUDIED.

Holotype ♀, **Guam:** Upi, under bark of *Pariti tiliaceum*, 5.v.1936 (*Swezey*) (BMNH).

The eyes of *guamensis* appear to be more reduced than in the other two species of the genus. The pedicillate antennal segments are similar to *solomoni*, but there is a large seta on segment II. The tergites appear to be similar to *malayensis*, but the abdomen of the unique holotype is contracted and difficult to study.

Malesiathrips malayensis sp. n.

(Figs 81, 83–85)

Macropterous ♀. Colour yellow to blackish brown; head pale between the eyes and with two submedian pale stripes, rest of head dark; antennal segments II–VIII dark except base of III; thorax and legs brown, tarsi paler; abdominal segments II–VIII blackish brown, slightly paler submedially, IX pale, tube reddish brown; fore wings shaded, particularly at base, with a longitudinal dark stripe.

Head projecting in front of large eyes; dorsal surface reticulate medially, tuberculate laterally (Fig. 81); postocellar and lateral postocular setae sometimes longer than median postocular setae. Antennal segments IV–VI with broad pedicels; dorsal setae on I–V flattened or apically blunt. Pronotum with posteromedian discal setae similar in structure to the 5 pairs of major setae. Tergites with median pores close together, III–VIII with anterior pair of wing-retaining setae weakly sigmoidal, II–VII with posterior pair of wing-retaining setae sigmoid and flattened (Fig. 85); sternal marginal setae very small; tube parallel-sided, ridged near base, constricted at apex.

Measurements (holotype ♀ in μm). Body, length (extended) 2400. Head, length 345; median width 185; postocellar setae 65; postocular setae 30, 65. Pronotum, length 135; median width 255; major setae, anteromarginal 35, anteroangular 54, mid-lateral 30, epimeral 105, posteroangular 54. Metanotal median setae 54. Fore wing, length 1000; distal width 75; sub-basal setae 2, 10, 65. Tergite IX setae, B_1, 110; B_2, 95; B_3, 80. Tube, length 330; terminal setae 90. Antennal segments, length 50, 60, 75, 68, 68, 50, 40, 30.

Apterous ♂. Similar in colour and structure to ♀; head without ocelli; fore tarsus with a small, broad-based tooth; tergites with 2 pairs of large posteromarginal setae and 2 pairs of minute setae; tergal posteroangular setae small but thorn-like.

Measurements (paratype ♂ from Java, in μm). Body, length 1800. Head, length 270; median width 165; postocellar setae 50; postocular setae 30, 48. Pronotum, length 125; median width 225; epimeral setae 60. Tube, length 210. Antennal segments, length, 50, 50, 65, 50, 50, 40, 35, 25.

SPECIMENS STUDIED.

Holotype ♀, **Malaya:** 16 ml [26 km] east of Kuala Lumpur, Gombak Field Station, on dead wood, 26.ix.1973 (*L. A. Mound*) (BMNH).

Paratypes. **Malaya:** Kuala Lumpur, 3 ♀ on dead leaves and branches, 23–27.xii.1969 (*R. G. & F. Andre*) (BMNH). **Java:** Bogor Botanic Gardens; 30 ♀, 8 ♂ from dead palm fronds, 24.x.1973 (*L. A. Mound*); 4 ♀ from dead leaves, 25.x.1973 (*L. A. Mound*) (BMNH).

The head of *malayensis* is similar in shape to that of *solomoni*, but the antennal segments are more condensed, and the fore tarsal tooth is smaller. Moreover, *malayensis* has 2 pairs of wing-retaining setae whereas the anterior pair is not developed in *solomoni*. The paratypes from Java and Malaya have shorter setae on the head than the holotype.

Malesiathrips solomoni (Mound) **comb. n.**

Atractothrips solomoni Mound, 1970 : 116–118. Holotype ♀, SOLOMON IS (BMNH) [examined].

This species is discussed under *guamensis* and *malayensis*. The male has the tergal posteroangular setae short but stout and thorn-like.

SPECIMENS STUDIED.

Solomon Is: Choiseul I., Vasu River, holotype ♀ with 2 ♀, 1 ♂ paratypes from forest litter, 16.xi.1965 (*Greenslade*) (BMNH).

MECYNOTHRIPS Bagnall

Mecynothrips Bagnall, 1908*a* : 356. Type-species: *Mecynothrips wallacei* Bagnall, by original designation and monotypy.

Phoxothrips Karny, 1913 : 132. Type-species: *Phoxothrips pugilator* Karny, by monotypy. **Syn. n.**

Kleothrips Schmutz, 1913 : 1057. Type-species: *Kleothrips gigans* Schmutz, by monotypy, here regarded as a synonym of *Mecynothrips simplex* Bagnall, 1912. **Syn. n.**

Dracothrips Bagnall, 1914 : 290. Type-species: *Dracothrips ceylonicus* Bagnall, by monotypy, here regarded as a synonym of *Mecynothrips simplex* Bagnall, 1912. **Syn. n.**

Acrothrips Karny, 1921*b* : 43. Type-species: *Acrothrips sorex* Karny, by monotypy, emended from *serex* by Karny, 1924 : 37, here regarded as a synonym of *Kleothrips acanthus* Hood, 1918. **Syn. n.**

Kleothrips (*Synkleothrips*) Priesner, 1935*c* : 330. Type-species: *Kleothrips* (*Synkleothrips*) *innocens* Priesner, by monotypy, here regarded as a synonym of *Kleothrips lacerta* Priesner, 1935*c*. **Syn. n.**

Kleothrips (*Akleothrips*) Priesner, 1935*c* : 332. Type-species: *Kleothrips* (*Akleothrips*) *karimonensis* Priesner, by original designation. **Syn. n.**

Mecynothrips Bagnall; Mound, 1971*b* : 279–283.

Phoxothrips Karny; Haga & Okajima, 1974 : 375–384.

Large, macropterous species of Idolothripini. Head elongate, 2 to 3 times as long as greatest breadth, prolongation in front of eyes also elongate, 2 to 3 times as long as broad; eyes sometimes slightly longer on the dorsal surface; head with 2 pairs of elongate ocellar setae, pair I near first ocellus, pair II posterior to ocellar triangle; 1 pair of postocular setae and 1 pair of median setae on vertex; cheeks with at least 3 (usually more than 6) pairs of pale, stout spine-like setae arising from tubercles. Antennae 8-segmented, segment III 6·0 to 11·5 times as long as broad with 2 sense cones, IV with 4 sense cones. Pronotum about one-third as long as total head length, 1·5 times as broad as long to slightly longer than broad, usually with 5 pairs of major setae; anteromarginals, anteroangulars and mid-laterals sometimes reduced to minor setae, and the second pair of epimerals sometimes well developed; fore angles of some males bearing large recurved horns; epimeral sutures sometimes not developed in larger males. Fore femora of males and females enlarged, rectangular or bulbous in males, usually with an apical tooth and with or without a median or basal tubercle. Fore tibiae of males sometimes with a seta-bearing tubercle at apex; fore tarsal claw well developed in most males, absent in females and some gynaecoid males. Wings broad, slightly broader in apical half, pale or dusky with numerous duplicated cilia. Pelta broad with lateral lobes. Tergite II with at least 2 pairs of wing-retaining setae, tergites III–V with 3 pairs of sigmoid wing-retaining setae and numerous sigmoid accessory setae. Sternite IX of males with a pair of stout setae. Median pair of setae on tergite IX 0·40 to 1·25 times as long as tube. Tube with straight sides evenly narrowing to apex, 4 to 5 times as long as broad, 1·10 to 3·75 times as long as head prolongation, with a few small setae laterally.

The length of the head prolongation is measured laterally from the base of the antenna to the anterior margin of the eye, and the breadth is measured across the base anterior to the eyes. The 'head length from behind eyes' is also measured laterally between the posterior margin of the eyes and the posterior margin of the vertex.

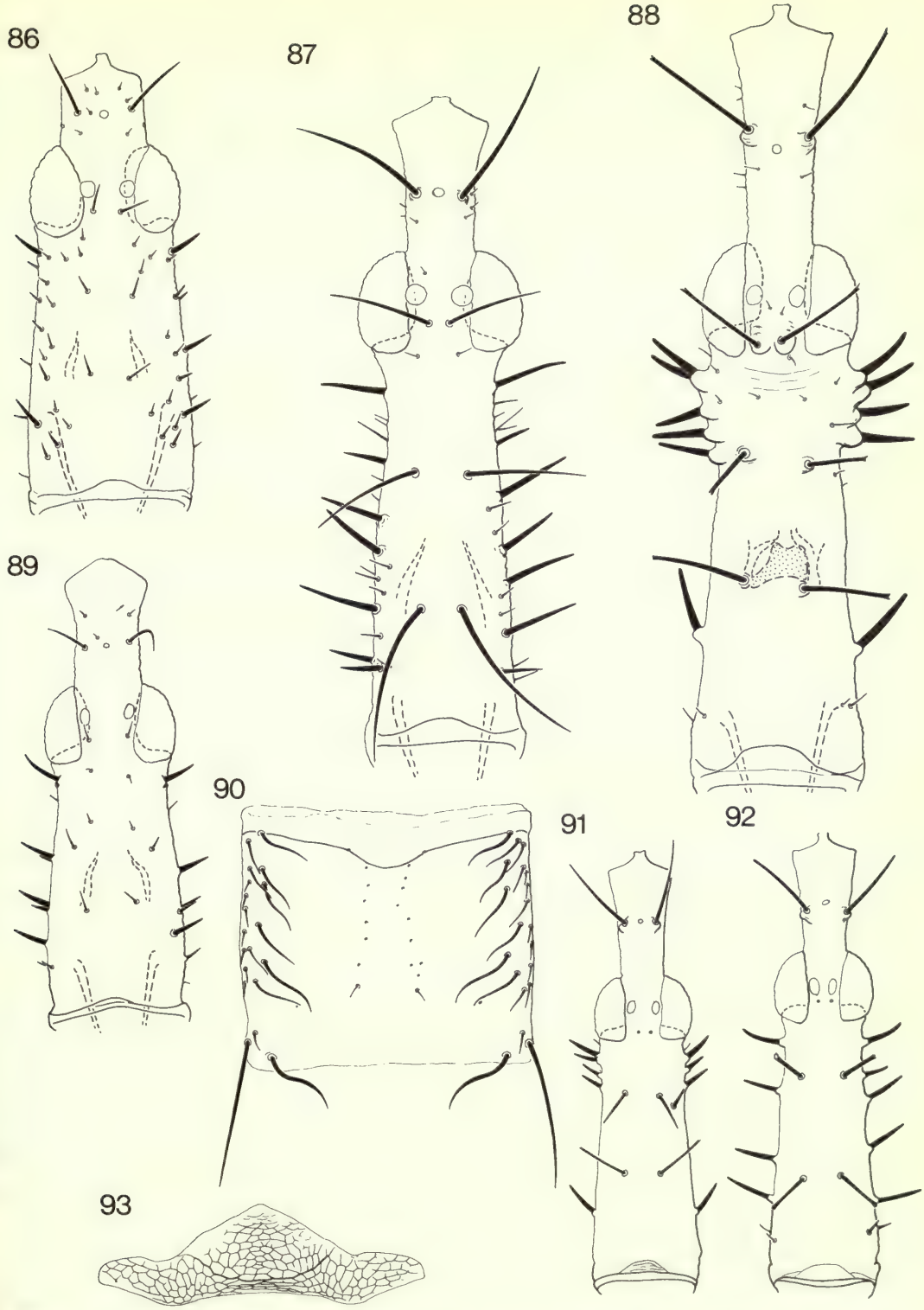
The monotypic genus *Dracothrips* was erected by Bagnall for *ceylonicus*, but he later synonymized this with *Kleothrips gigans*. The monotypic genus *Acrothrips* was erected by Karny for *sorex*, but Bagnall later synonymized this with *Kleothrips acanthus*. Priesner erected two subgenera of *Kleothrips; Synkleothrips* for his species *innocens* which has unarmed fore femora and *Akleothrips* for his species *karimonensis* which has an apical tooth and a basal tubercle on the fore femora. Haga & Okajima (1974) indicated that the two genera *Phoxothrips* and *Kleothrips* could not be separated and that *Phoxothrips* was the oldest name. Moreover, they illustrated clearly the range in form of the male fore femur of the type-species *pugilator* which varies from being slender, unarmed and female-like to being enlarged, with a median hump and apical tubercle. Despite this variation within one species, they retained the subgeneric names *Synkleothrips* and *Akleothrips* with the resulting anomaly that large and small males of *pugilator* would be placed in separate subgenera. Similar variation in the fore femora occurs in *hardyi* Priesner (Mound, 1974) and it appears that only one generic name is useful for this group of species.

The genus *Mecynothrips* was erected by Bagnall for *wallacei* which was based on one large male. The distinguishing characteristics of this genus appear to be the long head prolongation, the horns on the fore angles of the pronotum and the relatively short tube. The fore femora of the males have an apical tooth and a median tubercle. The pronotal horns, even in small males, are well developed and all the male specimens examined have at least a small median tubercle on the fore femora. However, *acanthus* is intermediate between *Phoxothrips* and *Mecynothrips* in the form of the fore angles of the pronotum, and the species assigned to *Mecynothrips* appear to represent the more extreme oedymerous forms of *Phoxothrips*. The present authors do not regard these differences as sufficient to segregate two genera in which, moreover, the females are not easily distinguishable even at species level. Therefore *Phoxothrips* and *Mecynothrips* are here synonymized.

Within *Mecynothrips* three species-groups can be distinguished on characters which are available in both sexes. In the *simplex*-group, which includes *atratus*, *goliath* and *pugilator*, the median setae on tergite IX are shorter than the tube. In the *acanthus*-group, which includes *hardyi*, *karimonensis* and *lacerta*, the median setae on tergite IX are longer than the tube and the pronotal anteromarginal setae are well developed. In the *wallacei*-group, which includes *kraussi*, *priesneri* and *snodgrassi*, the median setae on tergite IX are longer than the tube but the pronotal anteromarginals are small, minor setae. These species-groups appear to be correlated with the geographical distribution of the species each includes. The *simplex*-group is the most northern: East Africa, Sri Lanka, Java, Sarawak, Philippines, Taiwan, Japan. The *wallacei*-group is the most eastern: New Guinea, Australia, Solomon Is. The *acanthus*-group is the most southern: Java, Sumba, Australia. The genus *Mecynothrips* appears to be the Austro-Oriental equivalent of the otherwise pantropical genus *Elaphrothrips* (Mound, 1974). In both sexes it may be distinguished by the presence of 3 pairs of wing-retaining setae on tergites III–V whereas species of *Elaphrothrips* have only 2 pairs.

Key to species

1 Median pair of setae on tergite IX (B_1) shorter than tube, 0·4 to 0·8 times as long . . 2
– Median pair of setae on tergite IX (B_1) longer than tube, 1·05 to 1·25 times as long . . 5
2 Median length of pronotum of ♀ 1·7 to 2·5, of ♂ 2·4 to 2·7 times as long as anteroangular setae; legs bicoloured; fore femur of large ♂ without any development of the inner margin, apart from a black apical spine 3
– Median length of pronotum of ♀ 3·0 to 3·3, of ♂ 3·9 to 7·7 times as long as anteroangular setae; legs usually dark; fore femur of large ♂ with a black apical spine and a basal bulge or median tubercle 4
3 Antennal segment III with a dusky basal stem, IV and V with a darker stem and pale median band, VI dark; fore wings with a dark median longitudinal bar at the base; ♂ with a slim, curved fore tarsal tooth and simple fore tibia (Fig. 103) [Sumba] . . . ***goliath*** (p. 203)
– Antennal segments III–IV with a pale or slightly dusky basal stem; fore wings with a pale basal half and dark margins in the apical half; ♂ with long, slim, straight fore tarsal tooth; small ♂ with simple fore tibia, larger ♂ with two protruding points at the base (Fig. 99) [India to Philippines] . . . . . ***simplex*** (p. 207)



Figs 86–93 *Mecynothrips* species. 86, *M. pugilator;* 87, *M. acanthus;* 88, *M. kraussi;* 89, *M. atratus* (*zuluensis* paratype); 90, *M. simplex*, tergite IV. 91, 92, smallest males; (91) *M. kraussi;* (92) *M. snodgrassi*. 93, *M. atratus*, pelta.

4 Setae B_1 on tergite IX short, no longer than 0·5 times as long as tube; all legs and tarsi dark; antennal segments III–V with a pale basal stem, segment VI completely dark; ♂ with a slim fore tarsal tooth, fore femur with a black apical spine and median tubercle (Fig. 102). Head length from behind eyes 2·4 to 2·7 times as long as the prolongation (Fig. 89) [East and South Africa] . . . . . ***atratus*** (p. 203)

– Setae B_1 on tergite IX longer, 0·5 to 0·7 times as long as tube, all legs dark, tarsi paler, antennal segment III–VI with a pale basal stem. Large ♂ with a slim fore tarsal tooth, fore femur with a black apical spine and basal bulge, small ♂ with only a small fore tarsal tooth and fore femur without a basal bulge. Head length from behind eyes 3·5 to 4·4 (5·5 in *takahashii*) times as long as the prolongation (Fig. 86) [Japan, Taiwan] . . . ***pugilator*** (p. 207)

5 Anteromarginal setae well developed, 0·75 to 1·0 of anteroangular setae (Fig. 113); tendency to relatively longer tube and shorter head prolongation; ♂ with tube more than 2·5 times length of head prolongation; ♂ without process over tentorial pits on ventral surface of head 6

– Anteromarginal setae small, hardly more developed than other minor pronotal setae; tendency to relatively shorter tube and longer head prolongation; ♂ with tube less than 2·5 times length of head prolongation; ♂ with process over tentorial pits on ventral surface of head (Figs 88, 106, 107) 9

6 Antennal segment III dark, only slightly paler at extreme base, segments IV and V with a pale basal stem and dark basal ring; head prolongation about 0·25 times length of head from behind eyes. Major ♂ with a small fore tarsal tooth, also fore femur with a black apical spine and a basal tubercle, small ♂ with unarmed fore legs [Australia] . . ***hardyi*** (p. 203)

– At least antennal segments III–V with a pale yellow basal stem; head prolongation about 0·33 times length of head from behind eyes. 7

7 Mid and hind tibiae not distinctly bicoloured; basal stem of antennal segment III paler than IV–VI; ♂ with a small, slim fore tarsal tooth and unarmed fore femur (Fig. 101) [Sumba] ***lacerta*** (p. 206)

– Mid and hind tibiae distinctly bicoloured; basal stem of antennal segment III concolourous with IV and V. 8

8 Basal stem of antennal segments III–VI pale yellow; ♂ with a well-developed, slim fore tarsal tooth, fore femur with an apical spine and basal tubercle (Fig. 100) [Java] ***karimonensis*** (p. 205)

– Antennal segments III–V with a dusky basal stem and a paler median band; male with a stout fore tarsal tooth, fore femur with two apical spines but without any basal tubercle (Fig. 98) [Australia] . . . . . ***acanthus*** (p. 202)

9 Cheeks with only 1 pair of spine-like setae in basal two-thirds (Figs 88, 91); median sub-basal wing seta usually longer than the most basal; ♂ with cluster of 3 to 5 pairs of spine-like setae on cheeks just posterior to eyes, fore tarsus with a long retroussé claw 3 to 4 times as long as its basal breadth (Fig. 94); process over tentorial pits bilobed (Fig. 106) [Solomon Is] ***kraussi*** (p. 205)

– Cheeks set with numerous spine-like setae throughout entire length (Fig. 92); sub-basal wing setae 1 and 2 subequal, or 2 shorter than 1; fore tibia of ♂ with straight fore tarsal claw, usually only 2 to 3 times as long as basal breadth (Figs 95, 96) 10

10 Male fore tarsus with a stout claw about 2·5 times as long as basal breadth; fore ocellus situated anterior to ocellar setae (Fig. 92); process over tentorial pits bilobed [Solomon Is] ***snodgrassi*** (p. 208)

– Male fore ocellus situated lateral or posterior to ocellar setae; process over tentorial pits with 1 lobe 11

11 Male fore tarsal claw stout, only about twice as long as basal breadth; seta bearing tubercle at apex of fore tibia not so distinct (Fig. 96) [New Guinea, New Britain] . ***priesneri*** (p. 207)

– Male fore tarsal claw more slender, more than 3 times as long as basal breadth; seta-bearing tubercle at apex of fore tibia distinct (Fig. 95) [New Guinea, Australia] . ***wallacei*** (p. 208)

Mecynothrips acanthus (Hood) **comb. n.**

(Figs 87, 98)

Kleothrips acanthus Hood, 1918 : 77. Holotype ♂, AUSTRALIA (USNM) [not examined].

Acrothrips serex Karny, 1920*c* : 43. Lectotype ♂, AUSTRALIA (SMF) [examined]. [Synonymized by Bagnall, 1932 : 520.]

Acrothrips gargantua Girault, 1926 : 1. Lectotype ♂, AUSTRALIA (QM) [not examined]. [Synonymized by Mound, 1974 : 65.]

Phoxothrips giganteus Girault, 1926 : 4. Holotype ♂, AUSTRALIA (QM) [not examined]. [Synonymized by Mound, 1974 : 65.]

This species belongs to the group with the median setae on tergite IX longer than the tube, well-developed anteromarginal setae and males with bulbous fore femur with a spine only at the apex. The males may be distinguished by the presence of small horns on the fore angles of the pronotum and a second tooth on the ventral surface of the fore femora at the apex. The females are difficult to distinguish from *karimonensis* but tend to have shorter anteroangular setae and a longer head production.

SPECIMENS STUDIED.

Australia: [Queensland] Atherton, ♂ lectotype, 2 ♀ paralectotypes of *sorex*, v.1913 (*Mjöberg* 2) (SMF); Kuranda 1100 ft [330 m], 2 ♂, 2 ♀, v.vi.1913, 1 ♂, 21.vi.–24.vii.1913 (*R. E. Turner*); Kuranda–Mareeba, Clohesy River, 1 ♀, 17.i.1962 (*E. Britten*) (BMNH).

Mecynothrips atratus (Hood) **comb. n.**

(Figs 89, 93, 102, 114)

Kleothrips atratus Hood, 1919 : 69. Holotype ♀, EAST AFRICA (USNM) [examined].
Kleothrips (*Akleothrips*) *zuluensis* Jacot-Guillarmod, 1939 : 70. Holotype ♂, SOUTH AFRICA (JG) [examined]. **Syn. n.**

This species is the only representative of *Mecynothrips* in Africa and belongs to the group with the median setae on tergite IX shorter than the tube. It has a distinctively shaped head and pelta (Figs 89, 93), rather short antennal segments, incomplete epimeral sutures, pale wings and completely dark legs. The anterior pair of wing-retaining setae on tergites III–V are sometimes weakly developed, particularly in the female. The males have an enlarged fore femur with an apical tooth and a well-developed median tubercle, and a slim fore tarsal claw. *Kleothrips atratus* was described from one female only and *zuluensis* from two males. Jacot-Guillarmod distinguished them on the shape of the head and its prolongation, also the relative lengths of antennal segments VII and VIII and abdominal segments VIII and XI. These differences are so small that they are here regarded as sexual variation and the two species synonymized.

SPECIMENS STUDIED.

East Africa [Tanzania]: Rufigi River, ♀ holotype of *atratus*, 1.vi.1917 (*A. W. Robbins-Pomeroy*) (USNM). **South Africa** (Zululand): ♂ holotype of *zuluensis*, Hluhluwe, Hhabisa, 24.i.1937 (*Jacot-Guillarmod*), ♂ paratype of *zuluensis*, White Umfolosi, 1922 (*R. H. T. P. Harris*) (JG).

Mecynothrips goliath (Priesner) **comb. n.**

(Fig. 103)

Kleothrips goliath Priesner, 1935*c* : 327. Holotype ♂, SUMBA (SMF) [examined].

This species is very similar to *simplex* in having short setae on tergite IX and unarmed, bulbous fore femora. It may be distinguished by the darker basal stem of antennal segments III–VI, the dark median bar at the base of the fore wings, the dark postocular setae, also the slim curved fore tarsal claw and the unarmed fore tibiae of the males.

SPECIMENS STUDIED.

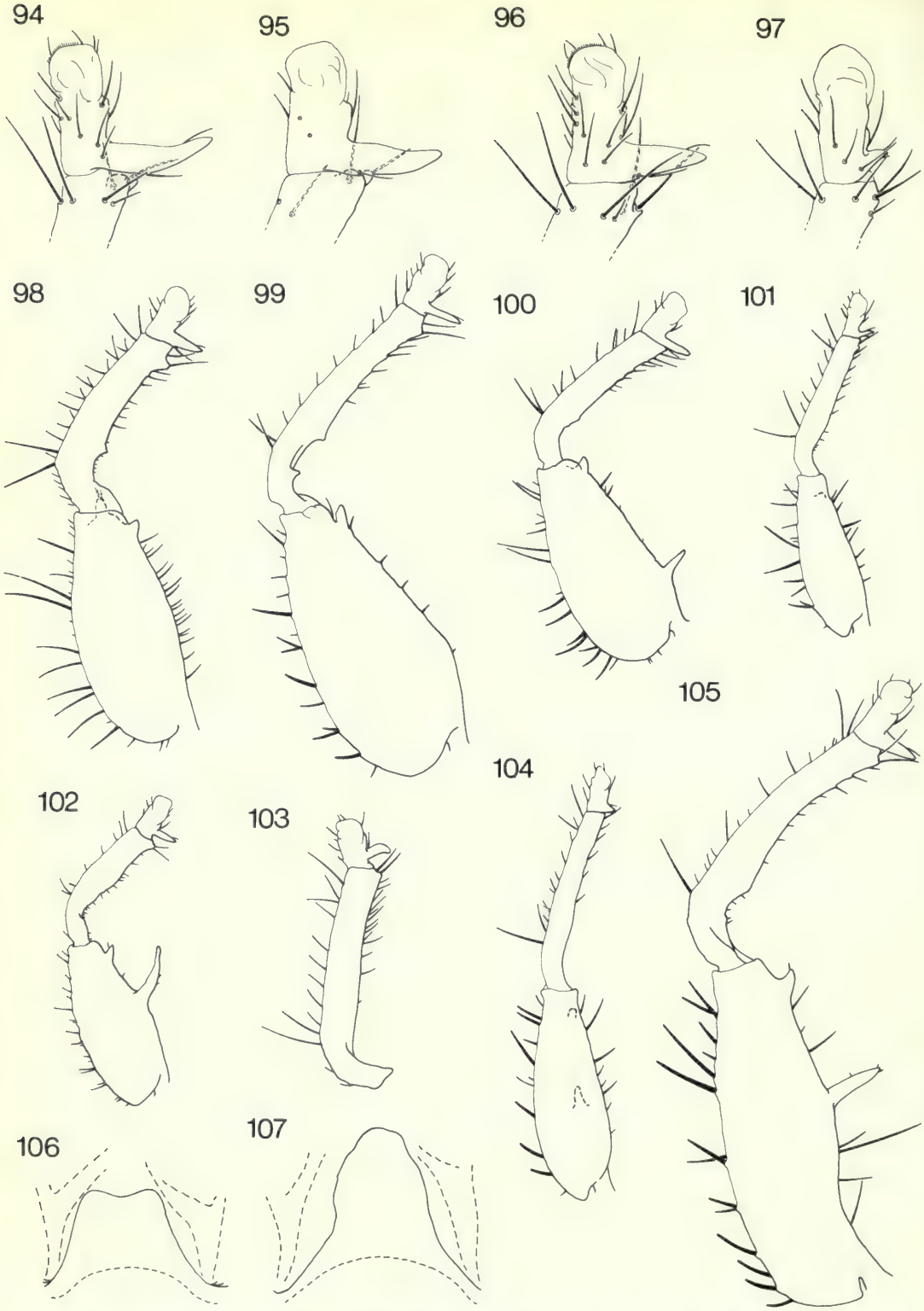
Sumba: Kananggar, 700 m, holotype ♂, paratype ♀, v.1925 (*Dammerman* 224) (SMF).

Mecynothrips hardyi (Priesner) **comb. n.**

(Figs 97, 113)

Kleothrips hardyi Priesner, 1928*b* : 657. Holotype ♀, AUSTRALIA (SMF) [examined].
Kleothrips hardyi Priesner; Mound, 1974: 65–66.

This is a dark species belonging to the group which has the median setae on tergite IX longer



Figs 94–107 Males of *Mecynothrips* species. 94–97, fore tibiae and tarsi, (94) *M. kraussi;* (95) *M. wallacei;* (96) *M. priesneri;* (97) *M. hardyi.* 98–105, fore legs, (98) *M. acanthus;* (99) *M. simplex;* (100) *M. karimonensis;* (101) *M. lacerta* (*innocens* holotype); (102) *M. atratus* (*zuluensis* paratype); (103) *M. goliath;* (104, 105) *M. priesneri* (104, *minor* paratype). 106, 107, tentorial pit covers, (106) *M. kraussi;* (107) *M. priesneri.*

than the tube and well-developed pronotal anteromarginal setae. Large males have bulbous fore femora with an apical tooth as well as a basal tubercle and a small fore tarsal claw. Small males, however, have completely unarmed fore legs. This species is distinct in having a dark antennal segment III, dark legs and dark wings in both sexes.

SPECIMENS STUDIED.

Australia: [Queensland] Brisbane Bot[anical] Gardens, holotype ♀ (*Hardy*) (SMF); 30 ml [48 km], N. Biloela, 4 ♂, 2 ♀ on dead *Eucalyptus* leaves, 18.vii.1968 (*L. A. Mound*) (BMNH).

Mecynothrips kanoi Takahashi **comb. n.**

Kleothrips kanoi Takahashi, 1937 : 343. Syntypes 2 ♀, TAIWAN (depositary unknown) [not examined].

This species was described from two female syntypes but has not been recognized since. From the original description it can be established that *kanoi* belongs to the group which has the median setae on tergite IX shorter than the tube. It has a shorter head prolongation than *simplex*, dark legs and antennal segments III–VI with a pale base. Takahashi states that it differs from *takahashii* in the leg colour, the head prolongation and the shorter anteroangulars. It is likely, however, that these characteristics fall within the variation of *pugilator* of which it is probably a synonym.

Mecynothrips karimonensis (Priesner) **comb. n.**

(Fig. 100)

Kleothrips (*Akleothrips*) *karimonensis* Priesner, 1935*c* : 332. Holotype ♂, JAVA (SMF) [examined].
Kleothrips (*Akleothrips*) *karimonensis* f. *parvidens* Priesner, 1935*c* : 334. LECTOTYPE ♂, JAVA (SMF), here designated [examined]. **Syn. n.**

This is the type-species of Priesner's subgenus *Akleothrips* to which he also assigned *hardyi* and *lacerta*. These three and also *acanthus* comprise the group of species with the median setae on tergite IX longer than the tube and well-developed anteromarginal setae. The larger males have bulbous fore femora with an apical tooth and a basal tubercle, also a slim fore tarsal claw. The smaller males have a smaller basal tubercle on the fore femur, and a longer tube as do the females. An unspecified number of these small males were named f. *parvidens* by Priesner. The lectotype designated here is the specimen labelled as holotype by Priesner.

SPECIMENS STUDIED.

Java: Karimon, holotype ♂, paratype ♀ of *karimonensis*, lectotype ♂ of f. *parvidens*, v.1926 (*Dammerman* 10) (SMF).

Mecynothrips kraussi **sp. n.**

(Figs 88, 91, 94, 106, 115)

♂ macroptera. Colour dark brown to black, basal stems of antennal segments III–V, apices of mid and hind tibiae, tarsi and cheek spines pale yellow, wings dusky at the base with a dark, median longitudinal line in the basal half.

Head from behind eyes about 3 times as long as broad, and head prolongation also about 3 times as long as broad; ocellar setae situated anterior to first ocellus, postocellar setae situated on a pair of tubercles between the eyes near their posterior margin; 3 to 5 pairs of cheek setae arranged on a cluster of tubercles immediately behind eyes, 1 pair of cheek setae situated on tubercles in the basal half of head; tentorial pits on ventral surface of head covered by a bilobed tubercle. Antennal segment III 9·7 to 11·4 times as long as broad and 1·4 times as long as IV. Pronotum slightly longer than broad, anterior angles produced into upwardly curved horns, anteromarginal and anteroangular setae reduced to minor setae, mid-laterals small, posteroangular and one pair of epimeral setae well developed. Fore femora enlarged, rectangular with a dark seta-bearing spine on inner margin at apex, also a tubercle medially and a small rugose hump at the base; fore tibiae L-shaped with 2 major setae on outer angle, apex slightly produced inwards under the well-developed, retroussé fore tarsal claw. Median pair of setae on tergite IX about 1·2 times as long as tube. Tube evenly narrowing to apex, about 4·5 times as long as broad, set with a few small setae.

Measurements (holotype ♂, with largest and smallest ♂ paratypes, in μm). Body, length 10100 (10945, 9985). Head, length from behind eyes 865 (890, 710); basal breadth 335 (385, 315). Head prolongation, lateral length 400 (450, 315); basal breadth 125 (135, 125). Anteocellar setae 230/250 (268, 220), postocellar setae 180 (–, –). Postocular setae, pair I 115 (115, 115/135), pair II 180 (169/190, 155). Antennal segments, III, length 655 (780, 545); breadth 65 (65, 55); length, IV 480 (545, 415); V 395 (430, –); VI 240 (270, –); VII 115 (125, –); VIII 95 (115, –). Pronotum, median length 565 (650, 422); maximum breadth 545 (605, 490); posteroangular setae 120 (160, 110); epimeral setae 142 (170, 135). Fore wing, length 2975 (3455, 2685); maximum breadth 250 (325, 240); duplicated cilia 59 (67, 52); basal setae, 1, 126 (125, 105); 2, 142 (160, 110); 3, 225 (240, 185). Dorsal setae tergite IX 660 (–, –). Tube, length 545 (615, 545); maximum breadth 125 (135, 125).

♀ macroptera. Colour similar to the males.

Head and prolongation not as elongate as the male, only twice as long as broad; ocellar setae situated lateral or posterior to first ocellus; cheeks set with at most 3 pairs of stout setae in apical half, not in a cluster, and 1 pair in basal half. Pronotum about 1·4 times as broad as long without horns at anterior angles; anteromarginal setae small but anteroangulars, mid-laterals, posteroangulars and 2 pairs of epimerals well developed. Fore femora not enlarged, unarmed, fore tarsi without a tooth. Tube about 4 times as long as broad.

Measurements (largest and smallest ♀ paratypes in μm). Body, length 8065, 7485. Head, length from behind eyes 620, 530; basal breadth 315, 325. Head prolongation, lateral length 240, 190; basal breadth 125, 115. Anteocellar setae 260, –; postocellar setae 190/210, –. Postocular setae, pair I 95/105, 95/115, pair II 230, –. Antennal segments, III, length 480, –, breadth 45, –; length, IV 375, –; V 305, –; VI 200, –; VII 95, –; VIII 85, –. Pronotum, median length 385, 325; maximum breadth 500, 480, –; anteroangular setae 85/95, 40/65; mid-laterals 135, –; posteroangulars –, –; epimerals, outer 115/145, 105; inner –, 85/95. Fore wing, length 2880, 2305; maximum breadth 250, 190; duplicated cilia 54, 45; basal setae, 1, –, 220; 2, –, –; 3, –; 385. Dorsal setae tergite IX –, –. Tube, length 700, 605; maximum breadth 150, 135.

SPECIMENS STUDIED.

Holotype ♂, **Solomon Is:** Gizo, Titania, 0–20 m, 10.xi.1970 (*N. L. H. Krauss*) (BMNH).

Paratypes. **Solomon Is:** 2 ♂, 2 ♀, same data as holotype; 3 ♂, 1 ♀, same data but 9.xi.1970 (BMNH).

This species is most similar to *snodgrassi* from which the males may be distinguished by the arrangement of the cheek setae and the position of the first ocellus. Of this group of species with median setae on tergite IX longer than the tube and small pronotal anteromarginal setae, the only females known are 1 of *priesneri*, 3 of *wallacei* and 3 of *kraussi*. The females of *wallacei* have not been examined but those of *kraussi* may be distinguished from *priesneri* on the lengths of the postocular setae and pronotal mid-lateral setae. The median head setae of *kraussi* are 2·5 times as long as the postoculars, whereas those of *priesneri* are subequal, and the mid-laterals of *kraussi* are less than 1·5 times as long as the anteroangulars, whereas those of *priesneri* are more than twice as long.

Mecynothrips lacerta (Priesner) **comb. n.**

(Fig. 101)

Kleothrips lacerta Priesner, 1935*c*: 329. LECTOTYPE ♀, SUMBA (SMF), here designated [examined].
Kleothrips (*Synkleothrips*) *innocens* Priesner, 1935*c*: 331. Holotype ♂, SUMBA (SMF) [examined]. **Syn. n.**

Kleothrips lacerta was described from a series of female syntypes. The lectotype designated here is the specimen labelled as holotype by Priesner.

This species belongs to the group with the median setae on tergite IX longer than the tube and well-developed pronotal anteromarginal setae. *K. innocens* was described as the type-species of the subgenus *Synkleothrips* because of the unarmed fore femora. The holotype is a small male with a slim fore tarsal claw.

This species is most similar to *karimonensis* from Java but it may be distinguished mainly by the more uniform colour of the mid and hind tibiae.

SPECIMENS STUDIED.

Sumba: Kambera, lectotype ♀ of *lacerta*, iii.1925 (*Dammerman* 6); Laora, 100 m, holotype ♂ of *innocens*, iv.1925 (*Dammerman* 89) (SMF).

Mecynothrips priesneri Mound

(Figs 96, 104, 105, 107)

Mecynothrips priesneri Mound, 1971*b* : 281. Holotype ♂, New Guinea (BPBM) [1 ♂ paratype examined].
Mecynothrips minor Mound, 1971*b* : 282. Holotype ♂, New Guinea (BPBM) [1 ♂ paratype examined]. **Syn. n.**

This species belongs to the group with the median pair of setae on tergite IX longer than the tube and small pronotal anteromarginal setae. Males have large horns on the fore angles of the pronotum, rectangular fore femora with an apical tooth and a median tubercle, and a stout fore tarsal claw. The cover over the tentorial pits on the ventral surface of the head is of one lobe as in *wallacei*.

Mound (1971) distinguished the small male, *minor*, from *priesneri* by the position of the first ocellus which is variable, and the major setae on antennal segments III and IV not being at right angles to the segment. However, these characters are typical of females and small males throughout the genus.

Specimens studied.

New Guinea: Manus I., Rossur, 150 m, 1 ♂ paratype of *priesneri*, 30.vi.1959 (*J. L. Gressitt*); Wau, 1200 m, 1 ♂, 1 ♀, 9.xii.1961 (*J. H. Sedlacek*) (BMNH). **New Britain:** Gazelle Peninsula, Bainings, St Paul's, 350 m, 1 ♂, 7.ix.1955; Kerawat, 60 m, 1 ♂ paratype of *minor*, 2.xi.1955 (*J. L. Gressitt*) (BMNH).

Mecynothrips pugilator (Karny) **comb. n.**

(Fig. 86)

Phoxothrips pugilator Karny, 1913 : 132. Holotype ♂, Taiwan (depositary unknown) [not examined].
Elaphrothrips takahashii Priesner, 1935*d* : 372. Holotype ♀, Japan (SMF) [examined]. [Synonymized by Haga & Okajima 1974 : 379.]
Phoxothrips pugilator Karny; Haga & Okajima, 1974 : 376.

This species belongs to the group with the median setae on tergite IX shorter than the tube. The large males are distinct in having the inner margin of the fore femur developed into a distinct bulge. This, however, varies with size and in small males it is indiscernible. Both males and females of the species may be distinguished from the others in this group, *atratus*, *goliath* and *simplex*, by the distinctly bicoloured antennae and dark legs. The head is also not so constricted behind the eyes.

This is the type-species of the monotypic genus *Phoxothrips*. It was probably described from a unique male which, according to Haga & Okajima (1974), is not with Karny's specimens at Eberswalde. They redescribed the species from a large series of males and females from the Ryuku Is.

The unique female holotype of *takahashii* is similar to *pugilator* although it has a shorter head prolongation.

Specimens studied.

Japan: Amami Ooŝima, Gusuku, Loochoo, holotype ♀ of *takahashii*, 27.vii.1932 (*S. Minoua*) (SMF); Arakawa, Ishigaki-jima, Ryûkyûs, 2 ♂, 1 ♀ on dead *Phoenix* (*S. Okajima*) (BMNH).

Mecynothrips simplex Bagnall **comb. rev.**

(Figs 90, 99)

Mecynothrips simplex Bagnall, 1912 : 216. Holotype ♂, Philippines (BMNH) [examined].
Kleothrips gigans Schmutz, 1913 : 1058. Syntypes ♂♀, Sri Lanka (Ceylon) [1 ♂ examined]. [Synonymized by Ananthakrishnan, 1969 : 130.]
Dracothrips ceylonicus Bagnall, 1914 : 290. Syntypes 2 ♂, Sri Lanka (Ceylon) (lost). [Synonymized with *gigans* by Bagnall, 1918 : 219.]
Kleothrips agama Priesner, 1935*c* : 323. Holotype ♂, Java (SMF) [examined]. [Synonymized by Ananthakrishnan, 1969 : 130.]
Kleothrips simplex Bagnall; Mound, 1968 : 130.

This species belongs to the group in which the median setae on tergite IX are shorter than the tube. It is most similar to *goliath* from Sumba except for the slightly paler bases of the antennal segments.

The unique holotype of *simplex* is a large male with square fore angles to the pronotum but without horns, and with an enlarged, bulbous fore femur which bears only an apical spine. The fore tibia has two small teeth at the base and the fore tarsus has a well-developed but slim claw. The mid and hind tibiae are distinctly bicoloured.

Schmutz (1913) described *gigans* as the type-species of his genus *Kleothrips*, differing from *Mecynothrips* in lacking horns on the fore angles of the pronotum. The syntype male examined corresponds to the original illustration in having a large bulbous fore femur with only an apical tooth, a tooth at the base of the fore tibia and a well-developed slim fore tarsal claw. It is in these characteristics inseparable from *simplex*.

The specific synonymy of *ceylonicus* with *gigans* was not stated but implied. In March 1918 Bagnall synonymized his monotypic genus *Dracothrips* with the, at that time, monotypic *Kleothrips*. There were no other species in *Kleothrips* until Hood described *acanthus* in October 1918.

Priesner (1935) described *agama* from a large series of males and females from Java. They differ from *simplex* only in the lack of any small teeth at the base of the fore tibia. From the material examined this character would appear to vary according to the stoutness of the specimen.

Ananthakrishnan (1969) discussed and illustrated the structural variation in the head and fore legs of this species, but unfortunately used the name *gigans* rather than the older name *simplex*.

SPECIMENS STUDIED.

Sri Lanka (Ceylon): 1 ♂ (*E. E. Green*); 1 ♂, 8.iv.1907 (*B. Fletcher*); 1 ♂ (*Thwaites*); Peradeniya, 1 ♀ (*E. E. Green*), 1 ♂ on dead *Hevea* leaves, 10.v.1914; ? Ceylon: 1 ♂ (BMNH). **India:** Adichanallur, 1 ♂, 1 ♀ on *Areca* sheath, 25.vi.1967 (*TNA*); Uyithri, 2 ♂, 4 ♀ on dry twig, 15.viii.1969 (*TNA*) (BMNH). **Malaya:** Penang, 1 ♀, 20.xi.1945 (*H. T. Pagden*) (BMNH). **Java:** Karimon, holotype ♂, paratype ♀ (+ 2 ♂ paratypes, 2 ♀ BMNH) v.1926 (*Dammerman* 10) (SMF); Bogor, 2 ♂, 2 ♀ on dead leaves, 25.x.1973 (*L. A. Mound*); Jasinga Forest Reserve, 2 ♂ on dead leafy branch, 30.x.1973 (*L. A. Mound*) (BMNH). **Borneo:** W. Sarawak, Quop, 1 ♂, iii.1914 (*G. E. Bryant*) (BMNH). **Philippines:** holotype ♂ of *simplex* (*E. Simon*) (BMNH).

Mecynothrips snodgrassi Hood

(Fig. 92)

Mecynothrips snodgrassi Hood, 1952 : 294. Holotype ♂, SOLOMON IS (USNM) [not examined].

This species belongs to the group which has the median setae on tergite IX longer than the tube, and small pronotal anteromarginal setae. The males have large horns at the fore angles of the pronotum, and rectangular rather than bulbous fore femora with an apical tooth and a median tubercle on the inner margin. The fore tarsal claw is well developed and there is a bilobed cover over the tentorial pits on the ventral surface of the head. The original illustration of the large holotype male shows the irregular arrangement of cheek spines and the bilobed process on the head. In these characteristics this species closely resembles the new species *kraussi*, also from the Solomon Is, but it may be distinguished by the more numerous cheek setae in the basal half, *kraussi* having only 1 pair, and the stouter fore tarsal claw. The position of the first ocellus, although variable, is apparently anterior to the ocellar setae in *snodgrassi* and usually posterior in *kraussi*.

SPECIMEN STUDIED.

Solomon Is: Florida Group, Tulagi, 1 ♂, 2.ix.1960 (*C. W. O'Brien*) (BMNH).

Mecynothrips wallacei Bagnall

(Fig. 95)

Mecynothrips wallacei Bagnall, 1908*a* : 357. Holotype ♂, NEW GUINEA (BMNH) [examined].
Mecynothrips magnus Girault, 1929*b* : 1. Syntypes ♂, AUSTRALIA (QM) [not examined]. [Synonymized by Mound, 1971 : 283.]

Mecynothrips bagnalli Priesner, 1935*c*: 335. Holotype ♀, Kei Is (? SMF) [not examined]. [Synonymized by Mound, 1971: 283.]

Mecynothrips bagnalli f. *imbecilla* Priesner, 1935*c*: 338. Syntypes ♂♀, Kei Is (? SMF) [not examined]. **Syn. n.**

This is the type-species of the genus *Mecynothrips*. It belongs to the group of species with small anteromarginal prothoracic setae and the median setae on tergite IX longer than the tube.

The holotype of *wallacei* is a large male with well-developed pronotal horns, rectangular fore femora with an apical spine and a tubercle on the inner margin just in the apical half. The fore tibiae have a slight bulge at the base and are drawn out into a tubercle at the apex. The fore tarsal claw is stout and well developed. The fore wings are pale apart from a dark horizontal median band in the basal half. There is a cover over the tentorial pits on the ventral surface of the head which is of one lobe, as in *priesneri*.

Priesner described the form *imbecilla* from small males which have shorter pronotal horns as well as smaller fore femoral spines and a smaller fore tibial apical tubercle. There is a small male possibly of *wallacei* in the BMNH from New Guinea which has a small slim fore tarsal claw and only an apical spine on the fore femur. The female which was apparently collected with this male, however, has well-developed anteromarginal prothoracic setae.

Specimens studied.

West Malaysia ('Malayischen Archipel.'): 1 ♂ (? *Karny*) (BMNH). **New Guinea:** Dorey, holotype ♂ of *wallacei* (*Wallace*); Port Moresby, Waigani, 1 ♂, 1 ♀, leaf litter, 28.ix.1969 (BMNH).

MEIOTHRIPS Priesner

Idolothrips (*Meiothrips*) Priesner, 1929*b*: 197. Type-species: *Idolothrips* (*Meiothrips*) *annulatus* Priesner (here regarded as a synonym of *Acanthinothrips annulipes* Bagnall), by monotypy.

Meiothrips Priesner; Bagnall, 1934*a*: 494.

Meiothrips (*Telothrips*) Kudo & Ananthakrishnan, 1974: 385. Type-species: *Meiothrips* (*Telothrips*) *nepalensis* Kudo & Ananthakrishnan, by monotypy. [Junior homonym of *Telothrips* Priesner, 1929*a*.] **Syn. n.**

Meiothrips (*Aculeathrips*) Kudo, 1975: 421. Replacement name for *Telothrips* Kudo & Ananthakrishnan. **Syn. n.**

Large, elongate species of Idolothripini. Head long, projecting in front of eyes; first ocellus between bases of antennae; inter- and postocellar setae well developed; vertex with 1 pair of postocular setae close together, well behind eyes; cheeks with at least 2 pairs of short stout setae. Antennae 8-segmented, exceptionally elongate, III as long as fore tibia; III with 2 sense cones, IV with 4 sense cones. Pronotum with epimeral sutures not complete; praepectal plates weakly developed, lateral to mouth cone. Fore tarsi unarmed; femora slender but irregularly swollen distally, bearing 4 pairs of stout capitate setae. Mesonotal lateral setae, metanotal median setae and metepimeral setae stout and elongate. Fore wing with or without duplicated cilia; sub-basal setae relatively small, II shortest, III longest. Pelta pointed medially, with broad lateral wings. Tergites III–VI with antecostal ridge recurved medially; tergites with 2 pairs of sigmoid wing-retaining setae and several accessory setae laterally, one or more pairs of these setae sometimes on or anterior to antecostal ridge; setae on IX short; tube with numerous erect setae, with or without tubercles or denticles in ♂.

This genus is closely related to *Bactridothrips* and *Idolothrips*. In all three genera the species have numerous erect setae on the tube, and the metanotum and metepimera bear a pair of stout setae. The females of *Meiothrips* species can be distinguished from females of species in the other two genera mainly by the longer antennae and more slender head. The males of *M. annulipes*, like the males of *Idolothrips* species, have the posteroangular setae of the abdominal tergites stout and thorn-like. Moreover, in both *M. nepalensis* and *I. dissimilis* the dorsal surface of the tube bears two rows of stout tubercles, whereas in *M. annulipes* the dorsal surface of the tube bears numerous small denticles. The subgenus *Aculeathrips* is thus intermediate between *Meiothrips* and *Idolothrips*, and it is possible that only one genus is needed for this whole group of species. The species of *Meiothrips* have been collected infrequently, but the genus is widespread between Nepal, southern India and Borneo. In contrast *Idolothrips* is still known only from Australia.

Key to species

1 Fore wing without duplicated cilia; pelta with numerous dentate microtrichia on lines of sculpture in posterior half (Fig. 111); mid-femora uniformly dark brown; ♂ with 1 pair of posteroangular setae short and thorn-like on tergites VII–VIII; tube of ♂ with numerous small denticles on dorsal surface [Malaya, Sumatra, Borneo] . . . ***annulipes*** (p. 210)

– Fore wing with at least 12 duplicated cilia; sculpture on pelta not bearing microtrichia; mid-femora yellow in part; ♂ without thorn-like tergal posteroangular setae 2

2 Tube of ♂ with 2 longitudinal rows of pointed tubercles dorsally; setae B_1 on tergite IX of ♂ shorter than width of tergite; antennal segments VI–VII with a short apical, ventral prolongation (Fig. 110); femoral major setae yellow [Nepal, Thailand]. . ***nepalensis*** (p. 212)

– Tube of ♂ without dorsal tubercles or denticles; setae B_1 on tergite IX of ♂ longer than width of tergite; antennal segments VI–VII not prolonged ventrally (Fig. 109); femoral major setae brown to dark brown [India, Thailand, Malaya] . . . . . ***menoni*** (p. 210)

Meiothrips annulipes (Bagnall)

(Figs 108, 111–112)

Acanthinothrips annulipes Bagnall, 1914 : 378–379. Lectotype ♂, SARAWAK (BMNH) [examined].
Idolothrips (*Meiothrips*) *annulatus* Priesner, 1929*b* : 197–201. Syntypes ♀♂, SUMATRA (SMF) [1 ♂ BMNH examined]. **Syn. n.**
Meiothrips annulipes (Bagnall) Bagnall, 1934*a* : 494.

The specimens in the type-series of *annulipes* are larger and more brightly coloured than the small teneral male syntype of *annulatus* which has been studied. The degree of development of the thorn-like setae on the posterior angles of the tergites is variable as in *Idolothrips* (Mound, 1974). Priesner pointed out in the original description of *annulatus* that on tergite V it is not unusual for the seta on one side to be long and 'female-like', but on the other side to be short and stout. This, however, is not true of larger males and it can be inferred that on smaller males both setae on tergite V will be slender.

SPECIMENS STUDIED.

Borneo: Sarawak, Mt Matang, lectotype ♂ of *annulipes* on dead wood at 1000 ft (30 m], 13.xii.1913 (*G. E. Bryant*) (BMNH); 6 ♂, 1 ♀ paralectotypes with similar data, xii.1913–i.1914 (BMNH). **Sumatra:** Mentawei, Siberat, syntype ♂ of *annulatus*, 10.ix.1924 (*Karny*, 25) (BMNH). **Malaya:** Tapah, 1 ♂, 1 ♀ on dead leaves, 30.vii.1976 (*Okajima*) (SO, Tokyo).

Meiothrips menoni Ananthakrishnan

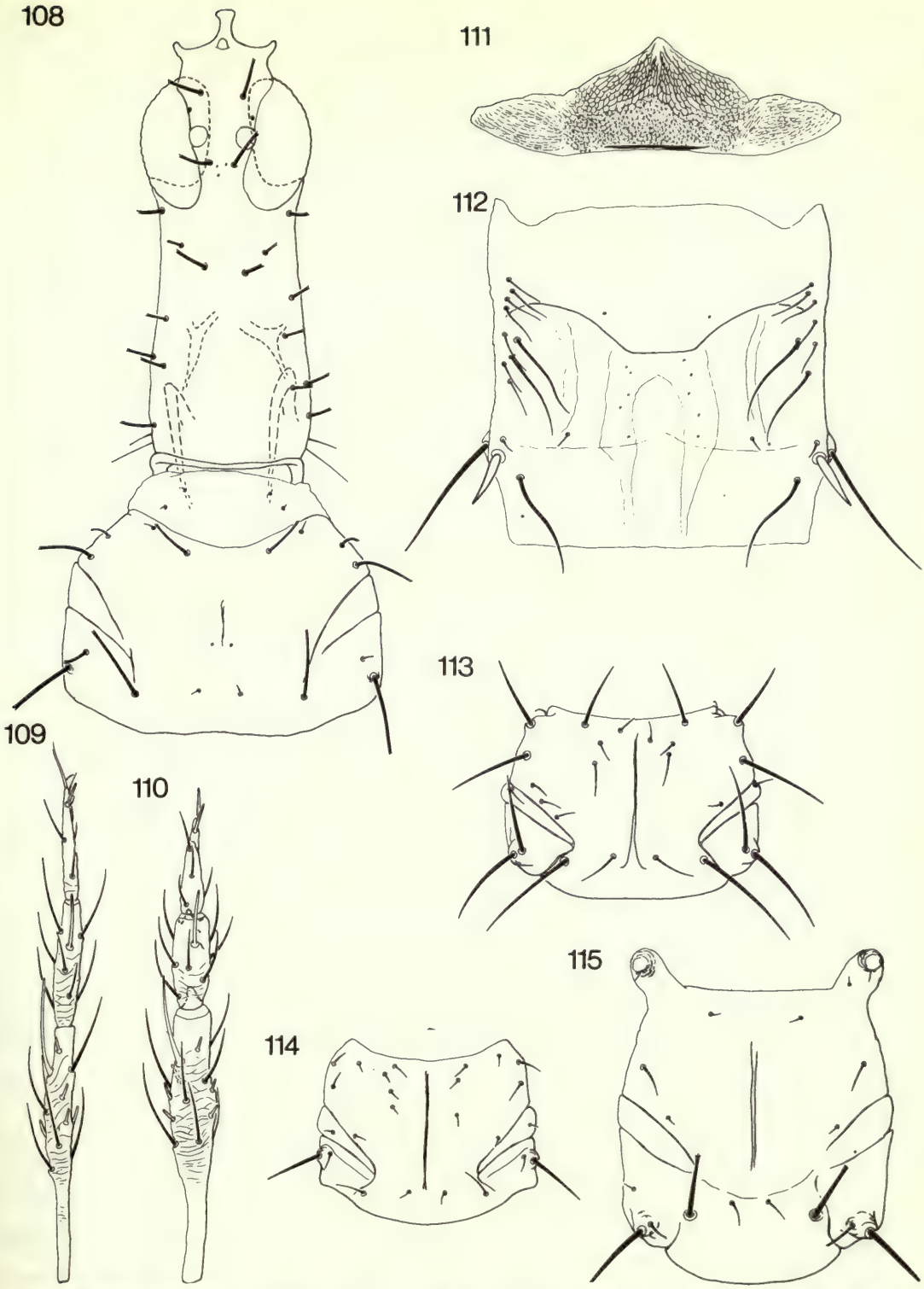
(Fig. 109)

Meiothrips menoni Ananthakrishnan, 1964 : 99–101. Holotype ♀, INDIA (TNA) [not examined].

This species was described from a single female collected at Trichur in southern India. That specimen and the three specimens from India listed below have the tibiae largely yellow except for a pale brown mark near the base and an even fainter mark near the apex. In contrast, the specimens listed below from Malaya have an extensive dark brown sub-basal area on the tibiae, and a narrow dark brown area subapically. Moreover, these specimens have short, dark pronotal posteroangular and anteromarginal setae, and the setae on the vertex and ocellar region are also short and dark, whereas the Indian specimens have longer and paler setae. If only these two samples were available then the Malayan specimens would undoubtedly be regarded as a distinct species. However, the two specimens listed below from Thailand have the tibiae intermediate in colour between the Indian and Malayan specimens, and moreover the pronotal setae are long and pale whereas the head setae are short and dark. These specimens suggest that *menoni* exists as a cline between southern India and Malaya; therefore no attempt is made here to distinguish between these populations by the use of formal names.

SPECIMENS STUDIED.

India: Trichur [Kerala], 1 ♂, beating logs, 7.xi.1963; Kallar [? Mysore], 1 ♂, 1 ♀ on *Areca* leaf, 9.ix.1967



Figs 108–115 108–112, *Meiothrips* species. (108) *M. annulipes*. 109, 110, antennal segments VI–VIII, (109) *M. menoni;* (110) *M. nepalensis*. 111–112, *M. annulipes*, (111) pelta; (112) tergite V. 113–115, *Mecynothrips* species pronota, (113) *M. hardyi;* (114) *M. atratus* (*zuluensis* holotype); (115) *M. kraussi*.

(TNA). **Thailand:** Doi Suthep, 1 ♂, 1 ♀ from dead leaves, 1100 m, 11.viii.1976 (*Okajima*) (SO, Tokyo). **Malaya:** Tapah, 1 ♂ from dead leaves, 28.vii.1976 (*Okajima*) (SO, Tokyo); Kuala Lumpur, 13 ♀, 7 ♂ from dead branches, 23–26.xii.1969 (*Andre*) (BMNH).

Meiothrips nepalensis Kudo & Ananthakrishnan

(Fig. 110)

Meiothrips (*Telothrips*) *nepalensis* Kudo & Ananthakrishnan, 1974 : 385–387. Syntypes ♂♀, NEPAL (2 ♂ syntypes BMNH) [examined].
Meiothrips (*Aculeathrips*) *nepalensis* Kudo & Ananthakrishnan; Kudo, 1975 : 421.

As discussed above, the remarkable dentate structure of the tube in this species is not unique but also occurs in *Idolothrips dissimilis* Girault from Australia. One of the males listed below from Thailand is exceptionally small. This specimen differs from the other *nepalensis* males in having no long metanotal setae, and in having few small denticles near the base of the tube although the dorsal tubercles are well developed. It is not possible to know if this is normal variation, aberration or another new species. The pronotal anteromarginal setae are shorter than the mid-lateral setae in one of the four syntypes which have been studied, but this is not so in the other three syntypes.

SPECIMENS STUDIED.

Nepal: Dhunche, 4 ♂ syntypes on dry leaf, 19.x.1973 (*Kudo*) (2, BMNH). **Thailand:** Doi Suthep, Chiengmai, 4 ♀, 2 ♂ on dead leaves, 22.iv.1976 (*Suzuki*) (BMNH); Doi Suthep, 1100 m, 1 ♂, 11.viii.1976 (*Okajima*) (SO, Tokyo).

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The phlebotomine sandflies (Diptera : Psychodidae) of the Oriental Region

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Bull. Br. Mus. nat. Hist. (Ent.) **37**(6) : 217–343 Issued 30 November 1978

Synopsis

A key is given for the 122 species and two subspecies of Phlebotominae known from the Oriental Region, which are grouped in two genera. Taxonomic citations include all those necessary for reference to early works. Seventeen new species and one subspecies are described and named, and three species are described and given vernacular names. Many existing descriptions are amplified.

Detailed study showed the significance of some structures not normally used in taxonomy, including features of the stylets and sculpture of the pigment patch. Long-standing problems of *Phlebotomus argentipes*, the *Sergentomyia babu* complex, *S. malabarica* and *S. perturbans* were investigated. Variation in *P. argentipes* is associated with biological differences in host choice and disease transmission. Many new localities are recorded and the distribution of each species is mapped. Aspects of biology are reviewed with special reference to general distribution, biting habits and seasonal distribution. Medical importance is summarized.

Introduction

Only three species of Phlebotominae were known in the world in 1905 when impetus was given to their study by their suspected association with sandfly fever and leishmaniasis. By 1925 47 more species were known, 14 of them from the Orient, including nine from India and two from Sri Lanka. In 1926 Adler and Theodor discovered the taxonomic value of cibarial teeth and spermathecae, giving further impetus to sandfly taxonomy, and by 1970 649 taxonomic names had been proposed. Devastating epidemics of kala-azar, discussed in a later section, had led to intensive research during which J. A. Sinton published a long series of important taxonomic papers, mainly on India and Pakistan, from 1921 to 1933. Raynal and Gaschen investigated Indo-Chinese species, a few other workers studied some Oriental species, and Quate recently made important contributions from south-east Asia. Otherwise, interest waned because kala-azar came under control, and was not present in south-east Asia to stimulate research. Recently, however, several factors have rekindled interest in Oriental Phlebotominae and necessitated a taxonomic review. Reduction in anti-malarial house-spraying has led to some recrudescence of kala-azar. Several viruses have been found in sandflies, and the modern interest in zoonoses, animal reservoirs of leishmaniasis, and possible additional vectors has led to much collecting in outdoor habitats. Improved trapping methods have yielded large collections for study.

In the present work 17 species and one subspecies are described as new, some by D. J. L. & J. Jeffery and the others by D. J. L. Several existing descriptions are amplified and the males of some species are described for the first time. The 124 taxa now known from the Region comprise 122 species and two subspecies. More species may exist, for Quate & Fairchild (1961) expected more to be found in West (Peninsular) Malaysia and Borneo, and Quate (1965) trebled the number of known Philippine species, and estimated that a hundred might exist.

In the section on biology several aspects are summarized, including seasonal occurrence which is important for planning future surveys.

The data of specimens critically examined for the descriptions and measurements, including the type-specimens of new species and subspecies, are listed under 'Material examined'; all such specimens are in the BMNH unless otherwise stated. The data of type-specimens of previously described species are given in the synonymies and not repeated under 'Material examined'.

Under the heading 'Distribution' are listed data from several sources which can be distinguished by the form of annotation. Localities of specimens routinely identified for distribution records (but not used for the descriptions and measurements) are indicated by '(BMNH)' or by the collector's name in parentheses; in the latter case at least some of the specimens seen are also in the BMNH unless otherwise indicated. Published records are indicated by a reference to the published source. Records taken from the manuscript notes of J. A. Sinton are indicated by '(Sinton's notes)'. Localities of specimens already listed under 'Material examined' are marked '(as above)'. Dates of collection and other data are added only when thought to be of particular interest.

The length of the scale lines on the figures is given in millimetres.

Explanation of terms

Abbreviations and some terms are explained below

Antenna 3 etc.	Antennal segment 3 etc.
BMNH	British Museum (Natural History)
BPBM	Bernice P. Bishop Museum, Honolulu
Complex	A group of closely similar species or infraspecific forms
ICZN	International Code of Zoological Nomenclature
R_2 etc.	Wing veins: radius branch 2 etc.
Series	A group of species within a subgenus or species-group
Species-group	A group equivalent to a subgenus
TC	Theodor collection, Hadassah-Hebrew University Medical School, Jerusalem (location of types shown by personal communication, 1977)
ZMA	Zoological Museum, Amsterdam University

Methods

Many mounting media have been used for sandflies, and for the present work a variant of Berlese's medium (Lewis, 1973*b*) was employed which can be filtered through previously wetted filter paper during preparation. The medium is useful for rapid processing of large numbers of flies. To allow for shrinkage through evaporation, either specimens were left for some hours before addition of a cover glass, or mounts were topped up with mounting fluid after a few hours or a day. Slides were kept at about 37 °C, usually for about five weeks, till the peripheral mountant was brittle and no movement in thick mounts was noticed, but not long enough for cover glasses to become loose. Excess mountant was then removed with a needle, and cover glasses were ringed with Euparal which is more secure than the commonly used nail varnish.

Drying alters the refractive index and reduces the initial clarity of some ascoids and spermathecae, but this can be restored by re-wetting. If mounts are insufficiently dried Euparal may mix with the mountant, so that preparations become grey and specimens fragile. This process can take 20 years or more; it is a warning against adopting new methods without careful consideration.

Caustic potash (10 per cent) was not used for maceration, but the head of one old pinned fly was put in hot potash for one minute because dried tissues had distorted the cibarium.

It is often necessary to remount a sandfly, for reorientation, for examining spermathecae, or for studying such structures as the cibarial teeth of *S. cheongi* and the lower parameral lobes of *P. philippinensis*. For recovering a specimen from a sealed mount, a slide was briefly immersed in water, and Euparal was chipped away. A small square of cover glass above the specimen was isolated by thrusting a needle, plough-like, beneath the glass, and the water and debris were washed away and replaced by Berlese's medium. A fresh cover glass was added to keep the mount wet till it softened in a few hours or over-night. Water could be dropped on, or pipetted in, for rapid soaking, but might form an inconvenient precipitate or wash away small objects. Mounts, used thus for recovering specimens, serve as storage capsules which are better than vials of alcohol, for space-saving, upkeep, retrieval and inspection.

When sandflies in a collection are being mounted time can be saved if one or a group of species can be isolated provisionally from the others by means of external features. This can occasionally be done by observing size (large, medium or small), labrum length, dark or pale scutum or abdomen, and broad or narrow wings. Species provisionally separable in this way include *S. gombaki*, *S. iyengari* and *S. malayae*.

Identification of sandflies is often difficult for several reasons. For example, the appearance of internal taxonomic features may be affected by the condition of a fly, method of mounting, or degree of illumination. It is often difficult to associate the sexes, and the problem of finding larvae limits their use.

Measurements were made from Berlese mounts and did not alter appreciably with drying. Wing measurements could be slightly different if flies were examined in water.

If eyes were unusually large or small, their length, parallel to the head axis, was measured and divided by the head length measured from the clypeus tip to the level of the postero-lateral margins.

The cibarial teeth were counted in heads not subject to pressure. Compression may reveal a few more lateral teeth or spicules but spoils a specimen. Cibarial teeth numbering more than 60, often seen in subgenus *Parrotomyia*, are difficult to count unless they are magnified about 300 times and ticked on a camera lucida image. In some species with about 90 teeth the width of one was estimated by examining the median ones at about ×2000 and counting the number in a length of 0·008 mm.

If the inter-arcal area is dark or refractive it is occasionally necessary to separate the pigment patch from the ventral wall of the cibarium. This can be done by mounting the relevant part of the cibarium upside down in Berlese's medium and sliding the armature forward.

It is sometimes useful to examine a cibarium in longitudinal or transverse optical section. For this purpose a head, with antennae removed to facilitate orientation, may be left over-night in a drop of Berlese's medium, in which the soft parts become invisible but remain to preserve the shape. The drop is then wetted with fresh medium to prevent shearing, and the head cut in two with a razor blade. This, held with both hands, can be directed to within 0·02 mm or less of the objective. For lateral viewing the eyes are then removed for clarity and to facilitate orientation.

Preparation of the stylets of some species needs special care. For example, the maxillary lacinia of *S. iyengari* and the tip of a hypopharynx or a mandible are almost indistinguishable under a dissecting microscope, and are best mounted in situ on a slide after removal of other structures. Fortunately these time-consuming procedures are seldom necessary in routine work. Much detail of the fascicle can be seen if the labium is removed by drawing it sideways and backwards off the head.

Some antennal ascoids are very delicate, with their tips touching the antenna, and some distal ascoids can be small. In such cases the antennae are best mounted temporarily in water. The small ascoids of *S. malayae* are difficult to expose but can be seen well in occasional specimens. One ascoid was measured for each species, without the spur if present.

The presence or absence of a papilla on antenna 5 is of interest in some species. Its preparation and inspection sometimes take time if a fly is delicate or has been macerated in potash and mounted in balsam. In such a case papillae may be invisible, even under phase contrast, and must be remounted.

Palp segments are unsuitable for measuring if bent or shrunk. In this case a head may be temporarily mounted top-upward in dilute Berlese's medium so that the palps lie flat and expand.

If spermathecae are not visible in whole mounts the tip of the abdomen (sixth and succeeding segments) may be detached and slightly compressed from above (with a backward and forward movement) to release eggs or other loose objects and spread the segments. It is sometimes tempting to clear with potash but one should remember that the spermatheca used by the taxonomist is but a small and often delicate part of the whole spermathecal tissue (Theodor, 1965 : figs 3, 5E) and can easily be distorted by removal of soft parts. If ducts are delicate they can sometimes be exposed by removing virtually all external sclerites except the bifid sternum 8.

Complete descriptions of taxa would be too long. It is often necessary to omit mention of some group characters, absence of features which occur only in a few species, some features shown by figures, and some structures too small for regular inspection or only seen properly with the electron microscope. No description of a single species, therefore, can serve as a model, but the following list of structures includes most of those used in the present work.

♀. *Head*: labrum length and its relation to wing length, labral brush, labral apical, subapical, adoral and cibarial sensilla; cibarial shape and pigmentation, armature, pigment patch and arch, and relative width of the underlying salivary pump; pharyngeal shape and armature of the dorsal, and sometimes ventral, plates; hypopharyngeal teeth; antenna 3 (length and its relation to wing length, 4+5, and labrum; number of ascoids on 3–15, or 16, and shape and relative length of that on 4; presence or absence of papilla on 5); mandible (sharp or blunt tip, width and evenness of teeth); maxilla (shape, number of lateral and ventral teeth, and dental depth, in sample specimen; palpal segment ratio; distribution of Newstead's spatulate sensilla, i.e. in most Old World species scattered or bunched on segment 3). *Thorax*: scutal and pleural pigment; pleural hairs if present; inter-precoxal lobes (Sinton, 1928 : 745) if not narrow as normal; wing (length and relation to width, R_2/R_{2+3}, R_1 overlap/R_2); leg ratios, and femoral spines if present. *Abdomen*: erect-hair sockets if present on tergites 2–6, best seen from above; sperma-

theca (shape and markings, collar if distinct, knob and surrounding pit, ducts and common duct if present; furca and cercus if unusual).

♂. *Head*: labrum length and its relation to wing length; cibarial teeth and pigment patch; pharynx; antenna (as for ♀); palpal ratio. *Thorax*: wing (as for ♀); femoral spines if present. *Abdomen*: standard taxonomic features of aedeagus, filaments and pump, paramere, coxite and its brush, and style.

FEATURES SOMETIMES USED. ♀: eye length, distance between eyes, interocular suture, arrangement of hair sockets on head, markings on pigment patch, shape of cornua, hair sockets on basal costal node of wing, nature of abdominal sternite 2. ♂: long antenna 1 and 2, large abdominal tergite 6, sternite 2, very long hairs on terminalia, shape of surstyle. Early stages: seldom found in nature; various features can be studied in eggs, larvae and pupae obtained by breeding. Patterns have sometimes been discernible on eggs in gravid females, like that of *S. jamesi*.

Taxonomic features

The anatomy of sandflies has been described wholly or partly by Forattini (1973), Lewis (1973*b*; 1975*a*), Perfil'ev (1968), Theodor (1958; 1965) and many others, and here it will suffice to mention particular features.

The length of the labrum is taken as the distance from the tip of the clypeus (omitting membranous connections) to the tip of the distal sensilla in the female, and to the tip of the inconspicuous small hood which covers them in the male. The labral sensilla of females are usually in four groups, namely apical, subapical, adoral (along the shaft) and cibarial (mainly proximal to the tip of the clypeus). Numerous variations include merging of adorals into subapicals or cibarials, and differentiation of adorals into a fore and a submedian hind pair of rows. The pattern of sensilla varies between many individuals and species but cannot practically be included in all descriptions. The labral sensilla appear more or less equivalent to those of mosquitoes (Lewis, 1975*a*), certain of which have some subgeneric significance.

The dorsal wall of the cibarium in the American *Brumptomyia* França & Parrot and *Lutzomyia* França has a hind bulge which, according to Theodor (1965 : 173, 174), is unknown in Old World species. Many of the latter, however, do have a bulge (Figs 117, 118, 181, 182, 186, 228–231, for example) which, in *S. knudseni* at least, is less pronounced than in *Lu. panamensis* (Shannon) (Fig. 232) and in the two species shown in sagittal section by Theodor.

The ventral wall of the cibarium between the chitinous arch and the arc of the hind teeth (here called the inter-arcal area) varies in shape and is sometimes pigmented. The terms concave and convex, applied to the cibarial and pharyngeal armatures, refer to their posterior borders.

The cibarium of most species of *Phlebotomus* either is unarmed, with merely scattered minute spicules, or has scattered large and small spicules. Large ones are occasionally bigger than the teeth of some *Sergentomyia*, which, however, are distinguishable by their linear arrangement. In a few species, such as *S. hassani* and *S. reidi*, some teeth extend onto the cibario-pharyngeal membrane.

The hind teeth in *Sergentomyia*, seen in ventral view, are often more or less foreshortened, and in *S. reidi*, and possibly some others with pear-shaped teeth, the appearance is completely altered by crushing.

In *S. perturbans*, *S. reidi* and some other species with a few strong teeth, the cibarial wall at their bases is thick and refractive and probably acts like the base of a harrow supporting a row of tines. The appearance is complicated in *S. reidi* by the presence of lines on the pigment patch which, in sandflies, is nearly in the same focal plane as the teeth (Theodor, 1965 : fig. 1, AB).

In some females of *S. barraudi* the hind margin of the ventral cibarial wall has a row of lumps which may be fore teeth displaced backwards.

The antennal ascoid formula is often used in males of *Phlebotomus* but varies in forms such as *P. longiductus*, and one ascoid of a pair may be vestigial. The length of an ascoid on antenna 4 is sometimes a useful specific character (Parrot, 1940; Lewis, 1975), but (Schmidt & Schmidt, 1962) *P. papatasi* and *P. argentipes* (discussed later) show great variation. Antenna 5 bears a papilla in most *Phlebotomus* but not in *P. betisi or P. argentipes*.

Occasionally hairs diverge widely from the shaft of the antenna (as in *S. musai*) or enwrap it closely and obscure the joints so that the antenna looks like a thread (as in *S. hamidi* and *S. traubi*).

The basal width of the main teeth of the mandibular armature (excluding extremities) may be measured by dividing a length of about 15 μm by the number of teeth in it. Teeth can be described as small (about 0·9 μm), normal (about 1·5 μm as in *S. antennata* (Newstead)), or large (about 2·5 μm as in *S. fallax* (Parrot)).

The base of the first maxillary palpal segment was taken as its junction with the blade. It and other segments are often rather soft, and their apparent lengths depend somewhat on mounting methods, but approximate measurements of some segments can be useful. Segments 2 and 3 have distal knobs.

Wing length is a useful indication of the size of a fly. The length in female sandflies ranges from 1·37 mm (a small *S. barraudi* from West Malaysia) to 3·8 mm (*P. gigas* Parrot & Schwetz), and species can be grouped around the figures 1·5 mm, small, 2·2 mm, medium size, 2·7 mm, large, and 3·6 mm, very large. The wings of males are shorter, and in one male of *S. tiberiadis* from Saudi Arabia are only 1·17 mm long.

Lengths of the femur, tibia and basitarsus of each leg can be useful (Quate, 1962*b* : 252; Quate & Fairchild, 1961 : 204; Quate & Rosario, 1962 : 788), and are here expressed as the length of the femur followed by a ratio.

The femoral spines present in a few species come off easily and may be difficult to detect or count in some specimens, because their sockets are rather like those of large hairs. If the legs become detached before spines are examined the legs can be recognized as first, second or third by the lengths of their tibiae.

The appearance of the spermatheca can vary according to the mounting medium used. The internal ridges in *S. dhandai* are conspicuous in water but soon disappear in Berlese's or probably any other medium. The spermatheca of *S. barraudi* looks different in Fig. 64 and in Quate's (1962*b*) fig. 4d, and that of *S. zeylanica* in Fig. 204 and in Theodor's (1938) fig. Vf and in Quate's (1962*c*) fig. 1f. In the latter instance a spermatheca of one type simulates another, and in the best conditions it is sometimes difficult to differentiate a swollen tube from a narrow capsule. The true shape may be obscured by disorientation, contraction or pressure from developing eggs, and in many mounts the spermatheca is invisible. The collar is often a useful feature but may be too indefinite. The spermatheca, an essential taxonomic character, must sometimes be carefully studied in several individuals, preferably parous flies with no fat-body or developing eggs, or gravid ones after detachment of terminal segments from the eggs.

The shape of the tip of the aedeagus is important but is sometimes intermediate between blunt and sharp.

Classification

Classification of the Phlebotominae began in 1911 and some aspects are still debatable. The system of Theodor (1948; 1958) is broadly followed here.

The difference between Old and New World sandflies is real but difficult to define precisely (Lewis, 1975*a*; Lewis & Lane, 1976). The significance of the dorsal wall of the cibarium, as shown above, seems to be less clear than was thought. A very general difference between Old and New World groups lies in the pattern of erect hairs on abdominal tergites 2–6. In the New World this varies greatly (Lewis, 1975*b* : 366) but in the Old World there appear to be only two main patterns.

Theodor's subgenera of *Sergentomyia* have not been universally adopted, and even he evidently regarded '*Rondanomyia*' (*Neophlebotomus*) as not very well defined (1958 : 48), treated it with some reservations, and included two exceptional species when dealing with the Palaearctic Region only. The subgenera are used here because they avoid an unduly large assemblage of ungrouped species, and facilitate faunal comparison with other regions. Some Oriental species of *Sergentomyia* are easily placed in the subgenera *Parrotomyia* and *Neophlebotomus*, and others less easily.

Many, however, outside the distinct *Sergentomyia*, *Grassomyia* and *Sintonius*, form a miscellaneous category of species, some of which may be loosely connected with subgenera. Subdivisions of three subgenera are discussed later.

Considerable infraspecific variation is seen in the ascoids of *P. argentipes*, the cibarium of *S. barraudi*, the maxilla of *S. indica* and various features of some other species. Divergent interpretations have led to the existence of many synonyms, and to complex taxonomic citations of species like *S. iyengari*. These become permanent features of catalogues, but may be reduced by the use of informal names for little known taxa.

Key to the species and subspecies of Oriental Phlebotominae

The following key, like all keys, is based on a few of the many characters of each species, therefore for many species it is intended as an aid, and not a means, for identification. For some sandflies, particularly some members of the subgenera *Parrotomyia* and *Neophlebotomus*, it is necessary to examine several females and a male; the females, which are of more biological interest, often have better characters, and a single one may have spermathecae shrunk or obscured by developing eggs. These subgenera are difficult to define, and it is advisable to follow each in the key in the case of problematical species.

The spermathecae provide important taxonomic features but those of genus *Sergentomyia* are little used in the key because they are often difficult to see.

The key will require modification when some of the species are better known.

The following forms are omitted from the key. The female is unknown in *P. nuri* and *newsteadi*, and *S.* A sp., B sp., Besout sp., *brevinervis*, *displicata*, *kachekensis*, *morini*, *pooi*, Rabok sp. and Sepilok sp. The male is unknown in *P. betisi*, *sejunctus*, *teshi* and *tubifer*, and *S. chakravarti*, *cheongi*, *dayapensis* (identity doubtful), *dentacea*, *exastis*, *hamidi*, *jamesi*, *kauli*, *lagunensis*, *mahadevani*, *modii*, *musai*, Okinawa sp., *pachystoma*, *spinifaucis*, *tonkinensis*, *tracheola* and *yoshimotoi*. Forms insufficiently described are *S. angustipennis* (♀ and ♂), *bigtii* (♂), *nankingensis* (♂), and *torrechantei* (♂). These lacunae should not affect identification unduly because some of the species are rare or local, and most gaps represent males of genus *Sergentomyia* in which most determinations are based on the female.

1 Cibarial teeth absent or, if present, usually in the form of spicules and not in a definite row (Fig. 27). Pigment patch nearly always absent. Hind ends of abdominal tergites 2–6 with many erect hairs (Fig. 1), sockets as large as on 1. Style of male with three to five spines (Figs 19, 25) and sometimes (some species of subgenus *Idiophlebotomus*) with two hairs as well (genus ***PHLEBOTOMUS***, p. 233) 2

– Cibarial teeth in a transverse row (Fig. 65), fore teeth sometimes present (Figs 136, 245) and usually pointing upward. Pigment patch (Figs 66, 136) usually present. Hind ends of abdominal tergites 2–6 usually with all or most hairs recumbent, most sockets much smaller than on 1 except in *S. musai*. Style of ♂ with four major spines and an accessory seta (Fig. 80) (genus ***SERGENTOMYIA***, p. 252) 43

2 Cibarium with teeth. Pharynx unarmed. Palp not extending further than antenna 3. Style of ♂ with three to five spines, and a pair of intra-abdominal rods (subgenus ***IDIOPHLEBOTOMUS***, p. 250) 3

– Cibarium with spicules or unarmed. Pharynx usually armed. Palp extending further than antenna 3 15

3 Female 4

– Male 11

4 Cibarial armature with median rod 5

– Cibarial armature without median rod 9

5 Cibarial median rod with large serrations . . . . . ***P. asperulus*** (p. 250)

– Cibarial median rod with minute serrations or none 6

6 Cibarium without teeth except a few granulose spicules . . . . . ***P. erebicolus*** (p. 251)

– Cibarium with teeth 7

7 Cibarial teeth all short . . . . . ***P. pholetor*** (p. 251)

– Some or all cibarial teeth long 8

8 Cibarial teeth in radiating lines . . . . . *P. tubifer* (p. 252)
– Cibarial teeth not in lines, very long, and parallel . . . . . *P. frondifer* (p. 251)
9 Cibarial teeth all small . . . . . *P. stellae* (p. 251)
– Cibarial teeth not all small 10
10 Median tooth the longest . . . . . *P. teshi* (p. 252)
– Anterior teeth the longest . . . . . *P. sejunctus* (p. 251)
11 Apical spine of style with marked basal expansion . . . . . *P. asperulus* (p. 250)
– Apical spine of style without marked basal expansion 12
12 Style with three spines . . . . . *P. erebicolus* (p. 251)
– Style with more than three spines 13
13 Style with four spines . . . . . *P. frondifer* (p. 251)
– Style with five spines 14
14 Aedeagus prominent and capitate; paramere slender and without dorsal appendage *P. pholetor* (p. 251)
– Aedeagus small and triangular; paramere with basal dorsal curved appendage *P. stellae* (p. 251)
15 Coxite of ♂ with sub-basal hairy process. Genital filaments 1·3–2·3 times as long as pump . 16
– Coxite of ♂ without such process. Genital filaments 3–11 times as long as pump . . . 24
16 Coxite 0·37–0·74 mm long, its process very small. Style long and cylindrical with three terminal spatulate spines and two other spines. Paramere with two dorsal processes. Surstyle with terminal spines. Pharyngeal armature comprising either a network of lines or scales. Spermatheca with nearly equal segments and a refractive membrane (Figs 2, 3) near bases of ductules (subgenus ***PHLEBOTOMUS***, p. 233) 17
– Coxite 0·20–0·33 mm long, its process usually large and having a brush of long hairs. Style not long, with four or five spines. Paramere simple, distal upper surface flat and elliptical with short hairs. Surstyle without terminal spines. Pharynx of ♀ with teeth or scales. Spermatheca sometimes with differentiated rounded end-segment 19
17 Female . . . . . *P. papatasi* (p. 233) or *P. salehi* (p. 235)
– Male 18
18 Upper parameral lobe much longer than paramere. Surstyle with two, or sometimes three, similar spines . . . . . *P. papatasi* (p. 233)
– Upper parameral lobe same length as paramere. Surstyle with seven spines, large to very small . . . . . *P. salehi* (p. 235)
19 Style with five long spines, two at the tip and two near the middle. Pharynx of ♀ with irregular scales or punctiform teeth (subgenus ***SYNPHLEBOTOMUS***, p. 236) *P. eleanorae* (p. 237)
– Style with four long spines, two near the tip and two near the base. Pharynx of ♀ with large backwardly directed teeth (subgenus ***PARAPHLEBOTOMUS***, p. 235) . . . 20
20 Female 21
– Male 22
21 Antenna 3 short (0·12–0·16 mm), 0·5–0·6 length of labrum . . . *P. alexandri* (p. 235)
– Antenna 3 long (0·23–0·33 mm), 0·7–1·0 length of labrum . . . *P. sergenti* (p. 236)
22 Basal process of coxite very large and thick with many hairs on its distal third *P. nuri* (p. 236)
– Basal process of coxite small and thin with hairs only at its end 23
23 Antenna 3 short (0·12–0·16 mm), 0·7–0·9 length of labrum. Genital pump short (0·12 mm) with small basal plate or funnel . . . . . *P. alexandri* (p. 235)
– Antenna 3 long (0·25–0·34 mm), 1·0–1·4 length of labrum. Genital pump long (0·17–0·2 mm) with broad basal plate . . . . . *P. sergenti* (p. 236)
24 Style with four long spines of which one is terminal, one subterminal, and two near the middle.
Paramere with two or three lobes, with or without accessory spine. Aedeagus short and conical. Pharynx with a small group of teeth in the middle and behind it some concentric lines. Spermatheca segmented, apical segment not enlarged (subgenus ***ANAPHLEBOTOMUS***, p. 247) 25
– Style with five long spines 30
25 Female 26
– Male 28
26 Spermatheca slightly carrot-shaped with small end-segment, individual duct about four (possibly more) times length of spermatheca.
Sternal tubercle broad . . . . . *P. colabaensis* (p. 247)

– Spermatheca spindle-shaped with very narrow cylindrical apical segment, duct short but common duct very long.
Ascoids long. Palpal segment 3 with peg sensilla grouped around middle . . . 27

27 Pharyngeal armature with antero-median numerous long pointed teeth which blend laterally with ridges. Individual ducts longer than spermathecae . . . ***P. stantoni*** (p. 248)

– Pharyngeal armature with several antero-median rows of small short teeth, and antero-laterally a number of backward-pointing teeth. Individual ducts shorter than spermathecae . . . . . ***P. hoepplii*** (p. 247)

28 Paramere bilobed . . . . . ***P. colabaensis*** (p. 247)

– Paramere trilobed 29

29 Spine near aedeagus not longer than it. Pharynx with a series of oblique ridges radiating from mid-line and ending in loops laterally . . . . . ***P. stantoni*** (p. 248)

– Spine near aedeagus much longer than it. Pharynx with a series of posterior ridges and, antero-laterally, a number of teeth projecting medio-posteriorly . . ***P. hoepplii*** (p. 247)

30 Paramere with three lobes (two in an Iranian species). Pharynx of ♀ as in *Anaphlebotomus*
Spermatheca with differentiated end-segment (subgenus ***EUPHLEBOTOMUS***, p. 240) . 31

– Paramere without ventral process. Pharyngeal armature otherwise 38

31 Female 32

– Male 35

32 Spermatheca with faint transverse striations . . . . . ***P. kiangsuensis*** (p. 244)

– Spermatheca distinctly segmented 33

33 Spermathecal common duct with rather thin walls. Antenna 5 without papilla ***P. argentipes*** (p. 240)

– Spermathecal common duct with thick walls. Antenna 5 with papilla 34

34 Antenna 3/labrum 1·0 . . . . . ***P. philippinensis philippinensis*** (p. 245)

– Antenna 3/labrum 1·4 . . . . . ***P. philippinensis gouldi*** (p. 245)

35 Middle lobe of paramere thicker than main (upper) lobe . . . ***P. kiangsuensis*** (p. 244)

– Middle lobe of paramere thinner than main lobe 36

36 Main lobe of paramere much more than twice length of middle lobe, lower lobe narrow, depth of paramere about 0·29 of its length (measured to junction with coxite) ***P. argentipes*** (p. 240)

– Main lobe of paramere about twice or more length of middle lobe, lower lobe appearing narrow but extending mesally, depth of paramere about 0·35 of its length . . . 37

37 Antenna 3/labrum 1·7. Style 0·54 length of coxite, and 4·1 times as thick as long
P. philippinensis philippinensis (p. 245)

– Antenna 3/labrum 2·0. Style 0·61 length of coxite, and 3·6 times as thick as long
P. philippinensis gouldi (p. 245)

38 Paramere truncated (not in subgenus) . . . . . ***P. newsteadi*** (p. 250)

– Paramere not truncated 39

39 Pharynx of ♀ and ♂ with punctiform teeth. Spermatheca segmented, with long finger-like process. Genital filaments 3–5 times as long as pump (subgenus ***LARROUSSIUS***, p. 237) . 40

– Pharynx of ♀ with triangular or rounded group of medium-size teeth. Spermatheca incompletely segmented. Genital filaments usually very long, 6·6–11·0 times length of pump (subgenus ***ADLERIUS***, p. 239) 46

40 Female 41

– Male 44

41 Pharynx with scarcely visible spicules . . . . . .
Spermatheca with about 22 bead-like segments, a long neck and a very small head. West Malaysia . . . . . ***P. betisi*** (p. 237)

– Pharynx with readily visible spicules 42

42 Spermatheca with 30–35 segments, very long.
Median pharyngeal teeth larger than laterals . . ***P. kandelakii burneyi*** (p. 238)

– Spermatheca with 8–21 segments. 43

43 Spermatheca nearly cylindrical, with 12–16 segments . . . ***P. major major*** (p. 238)

– Spermatheca narrowing at one or both ends, with about 18–21 segments ***P. keshishiani*** (p. 238)

44 Aedeagus with mid-ventral surface finely serrated.
Aedeagus tapering gradually to a point through which genital filaments emerge
P. kandelakii burneyi (p. 238)

– Aedeagus smooth 45

45 Genital filaments 3–5 times length of pump . . . . . ***P. major major*** (p. 238)

– Genital filaments 6–11 times length of pump . . . . . ***P. keshishiani*** (p. 238)

46 Female . . . . . ***P. chinensis chinensis*** (p. 239), ***P. longiductus*** (p. 240)
Male 47

47 Subterminal barb of aedeagus 30–35 μm from tip. Ascoid on antenna 4 about 0·19 length of segment . . . . . ***P. chinensis chinensis*** (p. 239)

– Subterminal barb of aedeagus 12–14 μm from tip. Ascoid on antenna 4 about 0·31 length of segment . . . . . ***P. longiductus*** (p. 240)

48 Abdominal tergites 2–6 with many erect hairs (***musai***-group, p. 253) . ***S. musai*** (p. 253)

– Abdominal tergites 2–6 with few or no erect hairs 49

49 Abdominal tergites 2–6 with a few posterior erect hairs (very few in ♂ *S. clydei*). Spermatheca distinctly segmented (subgenus ***SINTONIUS***, p. 307) 50

– Abdominal tergites 2–6 usually with no erect hairs. Spermatheca not segmented but sometimes striated or wrinkled 63

50 Female 51
Male 57

51 Pharynx very heavily armed. Cibarium with about 27 teeth in pallisade-like convex curve. Two rows of fore teeth present . . . . . ***S. orissa*** (p. 309)

– Pharynx lightly armed or unarmed 52

52 Pharynx with distinct spicules . . . . . ***S. hospitii*** (p. 309)

– Pharynx with minute spicules or none 53

53 Cibarium with about 35 large pointed teeth in a row convex medially . . ***S. eadithae*** (p. 309)

– Cibarium with about 18 teeth or less 54

54 Cibarium with about five widely spaced teeth . . . . . ***S. christophersi*** (p. 308)

– Cibarium with about 10–18 teeth close together 55

55 Cibarium without fore teeth . . . . . ***S. sirohi*** (p. 310)

– Cibarium with fore teeth 56

56 Cibarium with 12–15 long equal pointed teeth.
Pharynx with thick walls and an abrupt constriction behind the bulge. One to four papillae on antenna 3, one or two on 4 . . . . . ***S. clydei*** (p. 308)

– Cibarium with a comb-like row of about 16–18 teeth, their points directed upward and usually hidden, outer teeth sloping towards centre. Pharynx thin-walled, narrowing gradually behind bulge. One papilla on antenna 3 and 4 . . ***S. tiberiadis pakistanica*** (p. 311)

57 Cibarial teeth minute and arranged in groups . . . . . ***S. clydei*** (p. 308)

– Cibarial teeth otherwise 58

58 Cibarium with about 28 teeth . . . . . ***S. hospitii*** (p. 309)

– Cibarium with about 20 teeth or less 59

59 Cibarium with two or three teeth . . . . . ***S. christophersi*** (p. 308)

– Cibarium with ten or more teeth 60

60 Cibarium with 20 teeth . . . . . ***S. eadithae*** (p. 309)

– Cibarium with 14 teeth or less 61

61 Antenna 3 = 0·06 length of wing . . . . . ***S. sirohi*** (p. 310)

– Antenna 3 = 0·11 or 0·12 length of wing 62

62 Cibarial teeth on concave arc . . . . . ***S. tiberiadis pakistanica*** (p. 311)

– Cibarial teeth on arc convex in centre . . . . . ***S. orissa*** (p. 309)

63 Spermatheca a round finely spiculate capsule.
Cibarium of ♀ with convex comb of pointed teeth. Pharynx of ♀ bulging near hind end. Antenna of ♀ with one ascoid on segments 4–15. Abdominal tergites 2–6 with some posterior erect hairs. Genital filaments with rounded expanded tips. Parameres blunt (subgenus ***GRASSOMYIA***, p. 268) . . . . . ***S. indica*** (p. 268)

– Spermatheca elongate and usually without spicules 64

64 Antenna 3 short, 0·08–0·19 mm, shorter than 4+5, usually shorter than labrum. Wing narrow and lanceolate; R_2/R_{2+3} usually less than one (0·3–0·8). Spermatheca tubular with smooth sides and wide duct. Aedeagus thick. Style with four terminal spines, or two terminal and two subterminal (subgenus ***SERGENTOMYIA***, p. 253) 65

– Without this combination. Spermatheca usually not tubular 69

65 Female 66

– Male 68

66 Hind teeth of pharyngeal armature much smaller than fore teeth. Hind width of pharynx about 0·58–0·77 of length . . . . . ***S. punjabensis*** (p. 255)

– Hind teeth of pharyngeal armature not much smaller than fore teeth. Hind width of pharynx about 0·37–0·59 of length 67
67 Length of pharynx 2·25 or less times hind width . . . . . ***S. dentata*** (p. 253)
– Length of pharynx 2·26 or more times hind width. . . . ***S. theodori pashtunica*** (p. 255)
68 Parameres hooked . . . . . ***S. punjabensis*** (p. 255)
– Parameres blunt . . . . . ***S. dentata*** (p. 253), ***S. theodori pashtunica*** (p. 255)
69 Cibarial armature usually a comb-like row of parallel teeth with short points. Pharynx often lamp-glass-shaped. R_2/R_{2+3} often 0·3–1·0 (in some Palaearctic species). Spermatheca a smooth, round or elliptical, capsule. Aedeagus slender, triangular and narrowing gradually, usually to a sharp point. Paramere hooked. Style with all or two of four spines terminal (subgenus ***PARROTOMYIA***, p. 256) 70
– Without this combination 110
70 Female 71
– Male 94
71 Pharynx with many distinct pointed teeth 72
– Pharynx with very fine spicules or none 86
72 Cibarium with notch in hind end of ventral plate, and 10–50 teeth in concave row . . 73
– Cibarium without notch in hind end of ventral plate 75
73 Cibarium with about 10–14 teeth, notch shallow . . . . . ***S. shorttii*** (p. 265)
– Cibarium with about 24–50 teeth, notch deep 74
74 Cibarium with 24–34 teeth . . . . . ***S. babu babu*** (p. 257)
– Cibarium with 45–50 teeth. (Sri Lanka) . . . . . ***S. babu insularis*** (p. 258)
75 Spermatheca nearly spherical.
Cibarium with 20–22 teeth in a straight line. (Pakistan) . . . ***S. palestinensis*** (p. 264)
– Spermatheca not nearly spherical 76
76 Pharynx broad, often with rather straight sides, with many long finely pointed teeth. Cibarium with 40–70 teeth and tip of pigment patch bifid, ragged or fenestrated . ***S. barraudi*** (p. 259)
– Without this combination 77
77 Cibarium with 50–60 short teeth in row concave in centre and straight or convex at sides; fore teeth in two rows . . . . . ***S. spinifaucis*** (p. 265)
– Without this combination 78
78 Cibarium with 64 teeth or more 79
– Cibarium with 60 teeth or less 83
79 Pharyngeal teeth long, numerous and finely pointed. Cibarial teeth more than 65 . . 80
– Pharyngeal teeth not long 82
80 Palpal segment 4 = 1·6 times length of 3. Cibarium with 65–70 hind teeth
Antenna 3 = 0·28–0·31 mm long. Cibarial fore teeth in two rows of about 22. (Philippines) . . . . . ***S. mangana*** (p. 263)
– Palpal segment 4 = 1·1 times length of 3. Cibarium with 90 hind teeth 81
81 Antenna 3 = 0·11–0·14 mm long. Cibarial fore teeth numbering 35, in two ill-defined rows. (Australia and Nusa Tenggara) . . . . . ***S. queenslandi meridionalis*** (p. 264)
– Antenna 3 = 0·26–0·33 mm long. Cibarial fore teeth in two rows of about 22. (West Malaysia) . . . . . ***S. rudnicki*** (p. 264)
82 Hind margin of pigment patch concave . . . . . ***S. himalayensis*** (p. 262)
– Hind margin of pigment patch convex. (South Vietnam) . . ***S. brevicaulis*** (p. 260)
83 Cibarium with 10–12 teeth. (Philippines) . . . . . ***S. bigtii*** (p. 259)
– Cibarium with 26 or more teeth 84
84 Cibarium with 42–50 teeth . . . . . ***S. africana magna*** (p. 256)
– Cibarium with 26–32 teeth 85
85 Cibarial teeth on a distinct arc. (India) . . . . . ***S. kauli*** (p. 263)
– Cibarial teeth on a nearly straight line. (Philippines) . . . ***S. torrechantei*** (p. 267)
86 Cibarium with deep notch in hind end of ventral plate.
Cibarium with 16–20 teeth. Pharynx with transverse ridges and some hind spicules ***S. baghdadis*** (p. 258)
– Cibarium without such notch 87
87 Pharynx with well-defined scales. (Pakistan) . . . . . ***S. grekovi*** (p. 262)
– Pharynx without scales but sometimes with a few transverse wrinkles or minute spicules . 88
88 Cibarium with 60–90 teeth 89
– Cibarium with 34 teeth or less 90

89 Cibarium with about 90 teeth, very narrow and almost invisible. Pharynx lamp-glass-shaped, without spicules. (Borneo) . . . . . *S. denticulata* (p. 262)
– Cibarium with about 60 teeth, easily visible. Pharynx with nearly straight sides and a group of hind spicules. (Nusa Tenggara) . . . . . *S. timorica* (p. 265)
90 Cibarium with 24–32 hind teeth 91
– Cibarium with 14–18 hind teeth 93
91 Cibarial teeth on convex arc . . . . . *S. franciscana* (p. 262)
– Cibarial teeth in nearly straight line 92
92 Cibarium with about 24 teeth . . . . . *S. dayapensis* (p. 260)
– Cibarium with 30–34 teeth . . . . . *S. bukidnonis* (p. 260)
93 Cibarium with 17 hind teeth and a pigment patch . . . . . *S. modii* (p. 263)
– Cibarium with 14–18 hind teeth and no pigment patch
Hind teeth in convex row. Spermatheca ovoid with protuberant knob. (Philippines) *S. yoshimotoi* (p. 267)
94 Tip of aedeagus pointed 95
– Tip of aedeagus rounded 100
95 Style with four apical spines 96
– Style with two of spines subapical 98
96 Cibarium with an irregular row of 13 fore teeth . . . . . *S. brevinervis* (p. 260)
– Cibarium with no fore teeth or with a straight row of a few at bases of hind teeth . . 97
97 Cibarium with about 20–30 hind teeth . . . . . *S. africana magna* (p. 256)
– Cibarium with about 60 hind teeth . . . . . *S. queenslandi meridionalis* (p. 264)
98 Cibarium with 16 or 17 teeth
Fore teeth absent, pigment patch faint. Pharynx with narrow hind end *S. franciscana* (p. 262)
– Cibarium with about 19 or 20 hind teeth 99
99 Cibarium with two rows of fore teeth and a long narrow pigment patch *S. brevicaulis* (p. 260)
– Cibarium with no fore teeth and no visible pigment patch . . *S. denticulata* (p. 262)
100 Style with three large and one small spines . . . . . *S. himalayensis* (p. 262)
– Style with four equal spines 101
101 Style about five or six times as long as thick. 102
– Style about four times as long as thick 106
102 Pharynx unarmed 103
– Pharynx armed 104
103 Cibarium with 12–17 hind teeth and six fore teeth. . . . . *S. bukidnonis* (p. 260)
– Cibarium with about 30 hind teeth, fore teeth faint or absent . . *S. timorica* (p. 265)
104 Cibarial fore teeth well developed . . . . . *S. grekovi* (p. 262)
– Cibarial fore teeth faint 105
105 Antenna 3 = 0·29–0·38 mm long . . . . . *S. rudnicki* (p. 264)
– Antenna 3 = about 0·16–0·18 mm long
S. babu babu (p. 257), *S. babu insularis* (p. 258), *S. baghdadis* (p. 258), *S. shorttii* (p. 265)
106 Two of spines on style subapical . . . . . *S.* sp. (A) (p. 256)
– All spines on style apical 107
107 Cibarium with about 18 teeth . . . . . *S. barraudi* (p. 259)
– Cibarium with about 10–13 teeth 108
108 Pharynx unarmed . . . . . *S.* sp. (B) (p. 257)
– Pharynx armed 109
109 Pharynx with pointed teeth . . . . . *S. mangana* (p. 263)
– Pharynx with scale-like ridges . . . . . *S. palestinensis* (p. 264)
110 Cibarial tooth-row usually comprising parallel teeth, often nearly equal but not very narrow. Pharynx slender, with teeth or scales, or nearly unarmed. Antenna 3 long, longer than 4+5, often 1·25–2·00 times length of labrum. Wing rather broad, R_2 usually longer than R_{2+3}. Spermatheca often a thin-walled capsule, sometimes with cross-striations; duct sometimes narrow and joining common duct. Aedeagus usually slender with blunt tip. Paramere hooked. Style with two terminal spines and two others more or less terminal or near the middle (subgenus *NEOPHLEBOTOMUS*, p. 269) 111
– Without this combination 155
111 Female 112
– Male 134
112 Cibarium with about eight rows of fore teeth 113

– Cibarium without eight rows of fore teeth 114
113 Cibarium with fore process of pigment patch absent or faint. Labrum 0·18–0·21 length of wing . . . . . *S. gombaki* (p. 275)
– Cibarium with fore process of pigment patch prominent. Labrum 0·13–0·15 length of wing . . . . . *S. arboris* (p. 270)
114 Cibarium with three rows of fore teeth 115
– Cibarium with less than three rows of fore teeth or none 117
115 Fore teeth of hind row very large . . . . . *S. gemmea* (p. 273)
– Fore teeth of hind row not very large 116
116 Labrum very long, 0·18–0·20 length of wing. R_2/R_{2+3} = 1·53–2·06 . *S. malayae* (p. 282)
– Labrum not very long, 0·13–0·15 length of wing. R_2/R_{2+3} = 2·10–2·85 . *S. zeylanica* (p. 292)
117 Cibarial central teeth markedly different from the rest 118
– Cibarial central teeth not markedly different from the rest 123
118 Cibarial central teeth much larger than the rest 119
– Cibarial central teeth not much larger than the rest 121
119 Antenna 3 = 1·34–1·42 length of labrum . . . . . *S. silvatica* (p. 290)
– Antenna 3 = 2·19–2·36 length of labrum 120
120 Wing length 2·15–2·23 mm. Spermatheca with simple duct . . . . *S. quatei* (p. 288)
– Wing length 1·79–1·90 mm. Spermatheca with modified duct . . . *S. hamidi* (p. 275)
121 Cibarium with 24 teeth . . . . . *S. dhandai* (p. 271)
– Cibarium with 17 teeth or less 122
122 Cibarium with 14–17 hind teeth, fore teeth absent or varying from one row of four to two rows of up to 20; pigment patch with anterior projection either thick, small or absent (leaving patch hemispherical) . . . . . *S. iyengari* (p. 277)
– Cibarium with about 11 teeth, and one irregular row of fore teeth. Pigment patch with broad anterior projection . . . . . *S. tambori* (p. 291)
123 Cibarial pigment patch very narrow and linear . . . . . *S. linearis* (p. 280)
– Cibarial pigment patch not very narrow 124
124 Cibarium with 18 fold-like teeth longest in the centre
Antenna 3/labrum 2·0. Spermatheca an oval capsule with faint streaks . *S. traubi* (p. 292)
– Cibarial teeth not fold-like 125
125 Cibarium with 14 hind teeth, of which the lateral one on each side is separated from the rest, and about ten fore teeth in one row; pigment patch with marked anterior projection and posterior notch . . . . . *S. nankingensis* (p. 282)
– Cibarial teeth and pigment patch not like this 126
126 Cibarium with nine or ten groups of denticles . . . . . *S. tonkinensis* (p. 291)
– Cibarial teeth not in such groups 127
127 Cibarium with 50–60 teeth . . . . . *S. hodgsoni hodgsoni* (p. 277)
– Cibarium with about 20 teeth or less 128
128 Cibarium with about 20 teeth 129
– Cibarium with less than 20 teeth on average 131
129 Cibarial teeth on a straight line . . . . . *S. balica* (p. 270)
– Cibarial teeth on a curve 130
130 Cibarial teeth contiguous, in row convex in centre . . . . . *S. khawi* (p. 278)
– Cibarial teeth separated, in concave row
Pigment patch narrow and long . . . . . *S. purii* (p. 288)
131 Cibarium with eight or nine main hind teeth arising from refractive brown area with colour different from pigment patch . . . . . *S. perturbans* (p. 283)
– Cibarium otherwise 132
132 Cibarial teeth separated.
Seven to 15 of them in a regular row . . . . . *S. jefferyi* (p. 278)
– Cibarial teeth contiguous 133
133 Cibarium with about 14 hind teeth in a line angular at the centre; seven round teeth present behind hind ones . . . . . *S. chakravarti* (p. 271)
– Cibarium with about eight hind teeth in nearly straight row; no teeth behind hind ones *S. malabarica* (p. 280)
134 Style with two of spines near middle 135
– Style with spines terminal or subterminal 146
135 Brush on coxite with about 183 close hairs. Style not very swollen near middle *S. gombaki* (p. 275)

– Brush on coxite with about 95 hairs or less, or indefinite 136
136 Brush on coxite with about 95 close hairs. Style very wide near middle *S.* sp. (Besout) (p. 271)
– Brush on coxite with 60 hairs or less, or absent 137
137 Cibarial teeth fold-shaped . . . . . ***S. traubi*** (p. 292)
– Cibarial teeth not fold-shaped 138
138 Style with seta at about 0·8 139
– Style with seta at 0·7 or more proximal 140
139 Coxite with long brush of about 60 hairs . . . . . ***S. purii*** (p. 288)
– Coxite with a short brush of about 31 hairs . . . . . ***S. quatei*** (p. 288)
140 Coxite long and narrow and slightly curved . . . . . ***S. perturbans*** (p. 283)
– Coxite not long and narrow and slightly curved 141
141 Aedeagus thick, mid width of shaft about 0·19 of extreme length of aedeagus . . . 142
– Aedeagus slender, mid width of shaft about 0·11 of extreme length of aedeagus . . 144
142 R_2/R_{2+3} about 1·2. Coxite with seta distinctly proximal to middle spines . ***S. khawi*** (p. 278)
– R_2/R_{2+3} about 1·5–2·7. Coxite with seta near middle spines 143
143 Coxite with some of outer hairs concentrated . . . . . ***S. zeylanica*** (p. 292)
– Coxite with outer hairs evenly spaced . . . . . ***S. malayae*** (p. 282)
144 Cibarial fore teeth about four deep in broad band . . . . *S.* sp. (Rabok) (p. 290)
– Cibarial fore teeth not in broad band 145
145 Brush starting at 0·21 of coxite . . . . . ***S. arboris*** (p. 270)
– Brush starting at 0·23 of coxite . . . . . ***S. gemmea*** (p. 273)
146 Style with spines of unequal thickness, three terminal.
Coxite without definite brush . . . . . ***S. tambori*** (p. 291)
– Style with spines of equal thickness, two or four terminal 147
147 All spines of style terminal 148
– Two spines of style at 0·76–0·85 151
148 Paramere with spinose process at base of neck . . . . . ***S. hodgsoni hodgsoni*** (p. 277)
– Paramere without such process 149
149 Cibarium with long narrow pigment patch . . . . . ***S. linearis*** (p. 280)
– Cibarial pigment patch not long and narrow 150
150 Cibarium with conspicuous fore teeth . . . . . ***S. iyengari*** (p. 277)
– Cibarium without fore teeth . . . . . ***S. dhandai*** (p. 271)
151 Cibarial hind teeth comprising four central large ones and a row of about five small ones on each side . . . . . ***S. silvatica*** (p. 290)
– Cibarial teeth not like this 152
152 Cibarium with about eight teeth, some with several points, and a few vestigial fore teeth ***S. balica*** (p. 270)
– Cibarium otherwise 153
153 Cibarium with about six hind and about six fore teeth . . . . *S.* sp. (Sepilok) (p. 290)
– Cibarium otherwise 154
154 Cibarium with ten scattered hind teeth and no fore teeth . . . . ***S. malabarica*** (p. 280)
– Cibarium with about seven ill-defined hind teeth, not widely scattered, and about 15 small fore teeth . . . . . ***S. jefferyi*** (p. 278)
155 Cibarium of ♀ with one or more rows of small, sometimes scarcely visible, hind teetn. Spermatheca smooth, an elliptical or cylindrical capsule. Aedeagus pointed and paramere hooked. Style with all spines terminal or two of them subterminal (***nicnic***-group, p. 294) . 156
– Without this combination (not grouped, p. 295) 161
156 Female 157
– Male 158
157 Hind end of pharynx with a group of small but conspicuous dark spicules . ***S. nicnic*** (p. 295)
– Hind end of pharynx without such spicules.
Cornua divergent . . . . . ***S. bailyi*** (p. 294)
158 Cibarium with multiple row of teeth . . . . . ***S. bailyi*** (p. 294)
– Cibarium with single row of main teeth 159
159 Cibarial hind teeth diamond-shaped . . . . . ***S. kachekensis*** (p. 295)
– Cibarial hind teeth not diamond-shaped 160
160 Pigment patch present. Antenna 3 about as long as 4+5 . . . . . ***S. nicnic*** (p. 295)
– Pigment patch absent. Antenna 3 longer than 4+5 . . . . . ***S. displicata*** (p. 294)
161 Female 162

– Male 185
162 Cibarium without row of teeth . . . . . ***S. jamesi*** (p. 300)
– Cibarium with row of teeth 163
163 Cibarial teeth (in the usual ventral view) broad and often diamond-shaped or pear-shaped . 164
– Cibarial teeth not broad except at bases 169
164 Cibarium with cluster of small teeth behind main teeth . . . . . ***S. reidi*** (p. 305)
– Cibarium without such cluster 165
165 Cibarium with eight wedge-shaped teeth.
Pigment patch absent. Pharynx rather slender with compact group of teeth ***S. tracheola*** (p. 305)
– Cibarium with pear-shaped teeth 166
166 Cibarium with about 25 teeth rather like fish hooks . . . . . ***S. maai*** (p. 301)
– Cibarium with 18 teeth or less 167
167 Cibarium with 12–18 hind teeth . . . . . ***S. heiseri*** (p. 299)
– Cibarium with eight to ten hind teeth 168
168 Cibarial arch about 4·9 tooth lengths from teeth, intervening area dark . ***S. losarcus*** (p. 301)
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169 Cibarium with long median projection . . . . . ***S. anodontis*** (p. 295)
– Cibarium without such projection 170
170 Cibarium with 38 very long teeth in convex row and 65 fore teeth in seven or eight rows
S. dentacea (p. 297)
– Cibarium without this pattern 171
171 Cibarium with 70 teeth. Pharynx with ten short spicules. $R_2/R_{2+3} = 4{\cdot}8$. Spermatheca subovoid . . . . . ***S.*** sp. (Okinawa) (p. 304)
– Without this combination 172
172 Cibarium with several rows of lateral teeth.
Pigment patch with broad process and narrow hind part. Pharynx narrow with many teeth . . . . . ***S. montana*** (p. 303)
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173 Cibarium with 14 inwardly sloping teeth, and no fore teeth or pigment patch. (Philippines)
S. exastis (p. 297)
– Without this combination 174
174 Cibarium with 30 short linear teeth in compact row and about 80 fore teeth in five or six rows. Pharynx with dense patch of teeth. Antenna 3 about twice length of labrum. (Philippines)
S. dapsilidentes (p. 296)
– Without this combination 175
175 Cibarium with 10–14 teeth looking like barbed fish hooks; fore teeth absent; pigment patch rectangular. Pharynx unarmed. (Philippines) . . . . . ***S. delfinadoae*** (p. 296)
– Without this combination 176
176 Cibarium with many small triangular teeth of different sizes tending to form three rows centrally. Pharynx with finely spiculate ridges. (China) . . ***S. fanglianensis*** (p. 297)
– Without this combination 177
177 Pharynx distinctly armed 178
– Pharynx unarmed or with minute spicules 179
178 Cibarium with 26 teeth . . . . . ***S. lagunensis*** (p. 301)
– Cibarium with 50 teeth . . . . . ***S. mahadevani*** (p. 301)
179 Antenna 3 = 0·12 mm long . . . . . ***S. neras*** (p. 303)
– Antenna 3 = 0·19–0·54 mm long 180
180 Cibarium with about eight small blunt teeth in a nearly straight line . ***S. hassani*** (p. 297)
– Cibarium with 9–29 pointed teeth on a distinct arc 181
181 Cibarium with many fore teeth 182
– Cibarium with very few or no fore teeth 183
182 Cibarium with 10–12 teeth . . . . . ***S. imitor*** (p. 299)
– Cibarium with 20–29 teeth . . . . . .
Interarcal area sclerotized and wrinkled. Antenna 3 about 1·3 length of labrum, ascoids with spur. Tergite 8 with patch of hairs on each side . . . . . ***S. pachystoma*** (p. 304)
183 Cibarium with nine teeth . . . . . ***S. kelantani*** (p. 300)
– Cibarium with 12–27 teeth 184
184 Cibarium with 12–15 teeth . . . . . ***S. hitchensi*** (p. 299)
– Cibarium with 24–27 teeth . . . . . ***S. knudseni*** (p. 300)

185 Cibarium with patch of teeth behind main teeth . . . . . *S. reidi* (p. 305)
– Cibarium without such patch 186
186 Style with two of spines subterminal and seta near base, and cibarial teeth small *S. hitchensi* (p. 299)
– Without this combination 187
187 Cibarium with faint median hind process and no definite teeth . . *S. anodontis* (p. 295)
– Cibarium otherwise 188
188 Palpal segment 4 nearly twice length of 3
Cibarium with 12 short linear teeth and ten fore teeth in two rows *S. dapsilidentes* (p. 296)
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189 Cibarium with six to ten barb-like teeth, six fore teeth and a long antenna 3, 0·31 mm
S. delfinadoae (p. 296)
– Without this combination 190
190 Cibarium with many small triangular teeth of different sizes tending to form two rows in the centre . . . . . *S. fanglianensis* (p. 297)
– Cibarial teeth not like this 191
191 Cibarium with eight prominent diamond-shaped hind teeth and eight fore teeth in two rows. Inter-arcal area pigmented . . . . . *S. heiseri* (p. 299)
– Cibarium not like this 192
192 Cibarium with about eight sharp spike-like teeth, and 10–20 fore teeth, usually in one main row . . . . . *S. imitor* (p. 299)
– Cibarium otherwise 193
193 Cibarium with about eight distinct separated teeth on convex arc, a strong bulge, and pigment patch about two-thirds width of cibarium . . . . . *S. knudseni* (p. 300)
– Cibarium otherwise 194
194 Cibarium with seven to nine pear-shaped teeth, no fore teeth and pigmented inter-arcal area . . . . . *S. losarcus* (p. 301)
– Cibarium otherwise 195
195 Cibarium with 12–15 small teeth and eight fore teeth . . . . . *S. maai* (p. 301)
– Cibarium otherwise 196
196 Cibarium with about 18 teeth in one row, about three rows in front of them on each side, and a distinct pigment patch . . . . . *S. montana* (p. 303)
– Cibarium otherwise 197
197 Cibarium with six or seven groups of small fine teeth, and some fore teeth, and no pigment patch . . . . . *S. morini* (p. 303)
– Cibarium otherwise 198
198 Cibarium with six small but distinct teeth, five fore teeth in one row, and no pigment patch. Antenna 3 short, 0·11 mm, style with three apical and one subapical spines, and seta at 0·7
S. neras (p. 303)
– Without this combination 199
199 Cibarium with about six long teeth and about 18 irregular fore teeth . . *S. pachystoma* (p. 304)
– Cibarial hind teeth numbering 23–29; fore teeth numbering 10–15, those at centre less pointed than side ones . . . . . *S. pooi* (p. 305)

Taxonomy and distribution of species

Under each genus and subgenus references to descriptions are cited and brief notes are given on some characters and on distribution. Diagnostic summaries are included in the key.

The species in each genus are arranged in alphabetical order. The taxonomic citations include all references to Oriental species, except some out-of-date ones, and a few to species in other regions. Where holotypes were not studied, paratypes were often examined. Descriptions are given for new species and a number of others.

Specimens headed 'Material examined' were studied in detail. Many others were identified or checked, and some of them are indicated by italicized names of collectors in the distribution lists. Some localities are omitted, either because they cannot be traced, or because they are near other recorded localities, or because they were recorded before 1928 when few species of *Sergentomyia* were reliably identified. Table 2 gives the position of localities not shown on *The Times Atlas* of 1972. Map 1 shows the sources of all the material referred to in this study.

Genus *PHLEBOTOMUS* Rondani & Berté

Flebotomus Rondani & Berté *in* Rondani, 1840 : 12. Type-species: *Bibio papatasi* Scopoli, by monotypy.
Phlebotomus Rondani & Berté [emendation]; spelling fixed under suspension of rules by ICZN, 1954, Opinion 256 : 199; Theodor, 1948 : 96; 1958 : 16; 1965 : 179; Lewis, 1967 : 14.
Phlebotomus subgenus *Phlebotomus* Rondani & Berté; Quate, 1964 : 238.

Normally there is no row of cibarial teeth and no pigment patch. On the antenna there is a papilla on segment 5 and, in the male, two ascoids on segments 3–15. Erect hairs are present on abdominal tergites 2–6, and there are four or five spines on the style of the male. The genus is widespread in the Old World, and most species occur in the north.

Subgenus *PHLEBOTOMUS* Rondani & Berté

Phlebotomus subgenus *Phlebotomus* Rondani & Berté *in* Rondani, 1840 : 12; Theodor, 1948 : 96; 1958 : 16; Perfil'ev, 1968 : 227; Hennig, 1972 : 53.

The pharynx bears ridges or scales and the spermathecal segments are equal. The genital filaments are short, each paramere bears two processes, the long coxite carries a lobe and the style is long. The subgenus is represented in the west of the Region.

Phlebotomus (*Phlebotomus*) *papatasi* (Scopoli)

(Figs 1–5, Map 2)

Bibio papatasi Scopoli, 1786 : 55. No types mentioned: Italy.
Phlebotomus papatasii; Howlett, 1915 : 294 [misspelling]; Sinton, 1924*a* : 814; 1925*a* : 468 [surstyle variation etc.]; 1925*d* : 107; 1927*d* : 27; 1928*c* : 300 [synonymy]; 1932*a* : 59; 1933*d* : 418; Sinton & Barraud, 1928 : 329; Mukerji, 1931 : 442 [larva]; Mitra, 1952 : 550 [palp sensilla]; Mitra & Mitra, 1953*b* : 434.
Phlebotomus papatasi (Scopoli); Schmidt & Schmidt, 1962 : 723.
Phlebotomus (*Phlebotomus*) *papatasi* (Scopoli); Parrot, 1940 : 310; 1946 : 67; Theodor, 1948 : 106; 1958 : 17; Quate, 1964 : 240; Lewis, 1967 : 14; Perfil'ev, 1968 : 228; Abonnenc, 1972 : 99; Bhat & Modi, 1976 : 265, 266.

Recent full or partial descriptions were given by Abonnenc, Perfil'ev, Quate and Theodor.

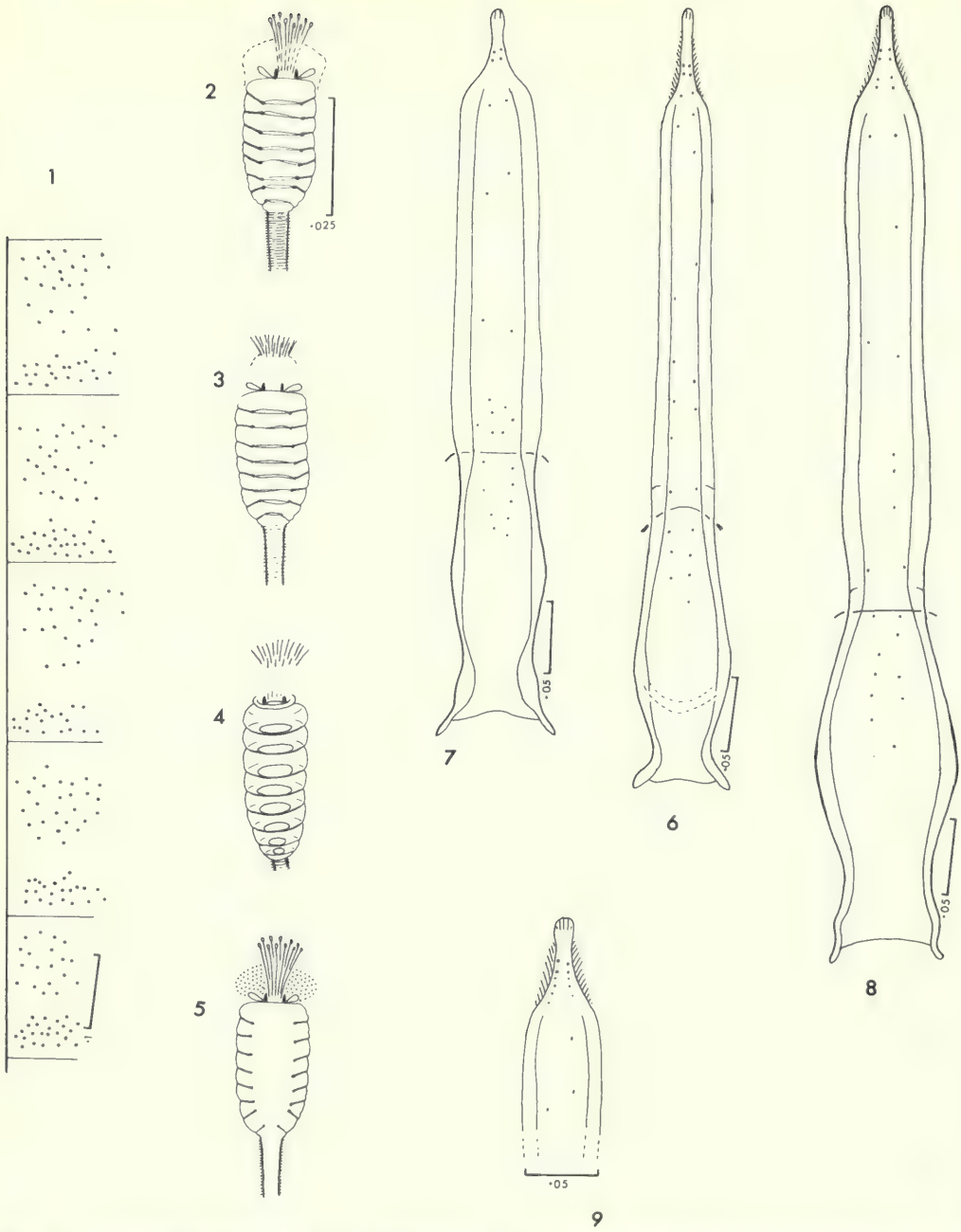
In the male there are two, and sometimes three, spines on the surstyle, the dorsal process of the paramere carries hairs only ventrally and is much longer than the rest of the paramere, and the first two spines of the style are close together. The pharyngeal teeth of the female form a wide-meshed network.

The proximal part of the spermatheca (near the ductules) has been variously described because its structure is difficult to see. Comparison of specimens in Berlese's medium and in water with Theodor's (1965 : 174) figure shows the following features. The chitinous capsule comprises about nine segments or hollow annuli, the most proximal of which is small and collar-like. The head has a thick lateral wall and is connected to the long ductules, the bases of which are obscured by a mushroom-like halo of refractive material which is part of the outer covering of the spermatheca.

♀ (*extra facts*). Labrum with upper brush-hairs blade-like, two median apical sensilla long and narrow and adorals small. Hypopharynx with about 16 teeth on each side. Maxilla with about six lateral and 17 ventral teeth, and a dental depth of 0·10 mm, clavate sensilla concentrated near middle of segment 3 of palp.

Material examined.
Pakistan: Taxla, 1 ♀.

Distribution. **Bangladesh:** Parbatipur, Rajbari (Sinton's notes). **India:** Pusa (Annandale, 1911*c* : 320; Barraud, 1926 : 214; Craighead & Das, 1928 : 862; Howlett, 1915 : 296); Howrah (*S. Das*); Osmanabad (*V. Dhanda*); Aurangabad, Jalna, Patan (Farooq & Qutubuddin, 1945 : 85); Baramula, Ramban, Riasi, Srinagar (Jacob & Kalra, 1951 : 325); Tibi (*N. L. Kalra*); Jalor (Kaul *et al.*, 1973 : 532); Jammu, Uri



Figs 1–9 *Phlebotomus* species. 1–5, *P. papatasi*, ♀: (1) abdominal tergites 2–6; (2) spermatheca in water; (3–5) same in Berlese's medium. 6, *P. betisi*, ♀, labrocibarium. 7, *P. kandelakii burneyi*, ♀, labrocibarium. 8, *P. keshishiani*, ♀, labrocibarium. 9, *P. major major*, ♀, tip of labrum.

(Mitra, 1953*a* : 324); Hoora (Mitra, 1953*b* : 158); Khandwa, Mahad, Mahableshwar, Mundwa, Panchgani, Poladpur, Wai etc. (Mitra, 1954*a* : 111; 1955 : 82); Nowshera in Kashmir (Mitra, 1959 : 59, 62); Hyderabad (commonest species, Qutubuddin, 1944 : 208); Kotelanka, Undi etc. (*R. Reuben*); Bikaner (Sharma *et al.*, 1973*c*); Kirki, Poona (Sinton, 1924f : 1042); Bombay, Maini Majera, Mandapam, Melur, Nagpur, Pamban Island, Roorkee, Saharanpur etc. (Sinton, 1927*b* : 942); Calcutta, Madras (Sinton, 1932*a* : 70); Sagar (Sinton, 1932*c* : 577); Agra, Ajmer, Anandpur area, Coimbatore area, Dehra Dun, Ferozepore, Lucknow, Madhopur, Mahendragarh, Mescara, Naini Tal area (Sinton's notes). **Pakistan:** Abbottabad, Bannu, Chaman, Chilas, Dera Ismail Khan, Digri, Gilgit, Hyderabad, Idak, Jamesabad, Jamrud, Jandola, Jhelum, Kandhkot, Karachi, Kashmore, Khairpur, Khirgi, Kohat, Lahore, Landi Kotal, Larkana, Miramshah, Mir Muhammad, Mirpur Kas, Nowshera, Pano Aqil, Peshawar, Quetta, Rawalpindi, Saidpur, Shikarpur, Tando Bago, Tank, Taxla (Lewis, 1967 : 14); Kotkai, Multan (Sinton's notes).

According to Sinton (1932*a* : 70) this species was scattered all over the plains of India, especially in hot dry areas, and was found as far east as Calcutta and as far south as Madras, but was commonest in the north-west. He (1925*b* : 703) did not find it above 610 m in eastern India, probably because the monsoon makes the hills too wet.

Phlebotomus* (*Phlebotomus*) *salehi Mesghali

(Map 2)

Phlebotomus (*Phlebotomus*) *salehi* Mesghali, 1965 : 264; Mesghali & Rashti, 1968 : 770 [♀]; Kalra & Lewis, 1976 : 522. Holotype ♂, IRAN (depository not stated) [not examined].

In the male the dorsal process of the paramere is shorter than in *P. papatasi*, and the surstyle bears seven spines ranging from large to very small.

♀ (*extra facts*). Labrum and maxillary sensilla as in *P. papatasi*. Hypopharynx with 17 teeth on each side. Maxilla with six lateral and 17 ventral teeth and a dental depth of 0·08 mm.

MATERIAL EXAMINED.
India: Tibi area, 1 ♀.

DISTRIBUTION. **India** (Rajasthan): Bikaner and Tibi areas (Sharma *et al.*, 1973*a*; 1973*b*; Kalra & Lewis, 1976).

Subgenus ***PARAPHLEBOTOMUS*** Theodor

Phlebotomus subgenus *Paraphlebotomus* Theodor, 1948 : 97; 1958 : 19; Perfil'ev, 1968 : 232. Type-species: *Phlebotomus sergenti* Parrot, 1917, by original designation.

The sub-basal process of the coxite is medium-sized to large and bears long hairs, and the style has four spines. This subgenus occurs mainly in the Palaearctic Region where it includes some closely related species. It is represented in the west of the Orient.

Phlebotomus* (*Paraphlebotomus*) *alexandri Sinton

(Map 3)

Phlebotomus sergenti var. *alexandri* Sinton, 1928*c* : 308. Type not indicated, PAKISTAN (depository unknown) [not examined].
Phlebotomus alexandri Sinton; Sinton, 1932*a* : 58; 1933*e* : 418.
Phlebotomus (*Phlebotomus*) *alexandri* Sinton; Parrot, 1940 : 310; 1946 : 67.
Phlebotomus (*Paraphlebotomus*) *alexandri* Sinton; Theodor, 1958 : 19; Theodor & Mesghali, 1964 : 290; Lewis, 1967 : 15; Perfil'ev, 1968 : 241 [variation].

The authorship and date of *P. alexandri* are Sinton, 1932 : 58 (ICZN, 1964 : Article 10(b)). Perfil'ev and Theodor have given recent descriptions.

In the male the basal lobe of the coxite is thickened at the end and antenna 3 is short. The pharynx of the female is conical. This small sandfly with rather narrow wings looks rather like a species of *Sergentomyia*.

♀ (*extra facts*). Labrum and palp sensilla as in *P. papatasi*. Hypopharynx with about 16 teeth on each side. Maxilla with four lateral and nine ventral teeth, and dental depth of 0·06 mm.

MATERIAL EXAMINED.
Pakistan: Qambar.

DISTRIBUTION. **Pakistan:** Dehra Ismail Khan, Hyderabad, Kandhkot, Larkana, Parkuta, Qambar, Shikarpur, Tank (Lewis, 1967 : 15).

Phlebotomus* (*Paraphlebotomus*) *nuri Lewis

(Map 3)

Phlebotomus (*Paraphlebotomus*) *nuri* Lewis, 1967 : 15; Artemiev, 1974*a* : 160, 161. Holotype ♂, PAKISTAN (BMNH) [examined].

P. nuri is the only Oriental species with a large lobe on the coxite.

DISTRIBUTION. **Pakistan:** Rawalpindi, Said Pur (Lewis, 1967).

Phlebotomus* (*Paraphlebotomus*) *sergenti Parrot

(Map 3)

Phlebotomus sergenti Parrot, 1917 : 564; Sinton, 1924*a* : 814; 1928*c* : 307 [synonymy]; 1932*a* : 58; 1933*e* : 418; Sinton & Barraud, 1928 : 329. Syntypes ♂, ALGERIA (depository unknown) [not examined].
Phlebotomus (*Phlebotomus*) *sergenti* Parrot; Parrot, 1940 : 310.
Phlebotomus (*Paraphlebotomus*) *sergenti* Parrot; Theodor, 1948 : 97; 1958 : 21; Lewis, 1967 : 17; Perfil'ev, 1968 : 236; Artemiev, 1974*a* : 159, 160.

Perfil'ev and Theodor have given recent descriptions. The male has a slender basal lobe on the coxite and four spines on a short style. The female has strong pharyngeal teeth and four or five segments in the spermatheca.

♀ (*extra facts*). Labrum and palpal sensilla as in *P. papatasi*. Hypopharynx with 16 teeth on each side. Maxilla with seven lateral and 15 ventral teeth and a dental depth of 0·09 mm.

MATERIAL EXAMINED.
Pakistan: Ahmed Khel, 1 ♀.

DISTRIBUTION. **India:** Delhi, Karnal, Patiala (BMNH); Aurangabad (rare, Farooq & Qutubuddin, 1945 : 85); Banihal, Islamabad area, Srinagar (Jacob & Kalra, 1951 : 324); Abu Mount, Sambhar (Jaswant Singh, 1933); Jaipur (Kaul *et al.*, 1973 : 532); Mandi, Mendhar, Nowshera, Punch, Rajouri, Riasi (Mitra, 1959 : 62); Maini Majera (Sinton, 1927*b* : 942); Agra, Aligarh (Uttar Pradesh), Ferozepore, Karnal, Mohindergarh (Hariana), Narnaul, Rajkot, Roorkee (Sinton's notes). **Pakistan:** Cherat, Chilas, Dehra Ismail Khan, Gilgit, Gol, Gwadi, Jhelum, Keris, Lahore, Landi Kotal, Mir Muhammad, Parkuta, Peshawar, Quetta, Rawalpindi, Said Pur, Shikarpur, Sukkur, Tank, Taxla (Lewis, 1967 : 17).

P. sergenti in Indo-Pakistan seemed to be confined to the plains north and west of the Bombay–Simla line (Sinton, 1932*a*), but extends a little beyond this area.

Subgenus ***SYNPHLEBOTOMUS*** Theodor

Phlebotomus subgenus *Synphlebotomus* Theodor, 1948 : 97; 1958 : 22; Lewis & Ledger, 1976 : 406. Type-species: *Phlebotomus martini* Parrot, 1936, by original designation.

The hairy lobe of the coxite is medium-sized to large and the style has five spines. All but one species of this small subgenus occur in tropical Africa.

Phlebotomus (*Synphlebotomus*) *eleanorae* Sinton

(Map 3)

Phlebotomus eleanorae Sinton, 1931*a* : 817; 1933*e* : 418. Holotype ♂, INDIA (BMNH) [examined].
Phlebotomus (*Phlebotomus*) *eleanorae* Sinton; Parrot, 1940 : 310; 1946 : 67.
Phlebotomus (*Synphlebotomus*) *eleanorae* Sinton; Mesghali, 1965 : 267 [♀]; Lewis & Ledger, 1976 : 406.

This is the only Oriental species in which the coxite is not very long and bears a distinctly visible lobe, and the style is not very long and has five spines. The pharynx of the female has median coarse teeth and the spermatheca 11–12 segments.

♀ (*extra facts*). Labrum 0·25 mm long, 0·13 length of wing (1·94 mm), with wide upper brush-hairs in short row. Hypopharynx with 16 teeth on each side. Antenna 3 = 0·19 mm long, 0·10 length of wing, 1·00 length of 4+5, 0·78 length of labrum.

MATERIAL EXAMINED.
Iran (Minab area): Chelo, 3.x.1964 (*A. Mesghali*), 1 ♀.

DISTRIBUTION. **India:** Karnal (Sinton, 1931*a* : 817).

Subgenus *LARROUSSIUS* Nitzulescu

Phlebotomus subgenus *Larroussius* Nitzulescu, 1931 : 274; Theodor, 1948 : 97; 1958 : 22; Perfil'ev, 1968 : 250. Type-species: *Phlebotomus major* Annandale, 1910*b*, by original designation.

The coxite has no lobe, the style bears five spines, the paramere is not truncated and bears no ventral process, and the spermatheca has an end-process. Two of the three Oriental species occur in the west.

Study of the fascicle has shown that some species have more than four labral adoral sensilla, and some have few maxillary lateral teeth.

Phlebotomus (*Larroussius*) *betisi* Lewis & Wharton

(Fig. 6, Map 3)

Phlebotomus (*Larroussius*) *betisi* Lewis & Wharton, 1963 : 117. Holotype ♀, WEST MALAYSIA (BMNH) [examined].

The pharyngeal spicules are almost invisible, and the spermatheca has about 22 long bead-like segments.

♀ (*extra facts*). Labrum 0·35 mm long, 0·15 length of wing, with four adoral sensilla near the subapicals. Pharynx with ridges and minute, almost invisible, spicules. Hypopharynx with 17 teeth on each side. Antenna 3 = 3 mm long, 0·16 length of wing, 1·32 length of 4+5, 1·01 length of labrum, segment 5 without papilla. Maxilla with seven lateral and 21 ventral teeth and a dental depth of 0·11 mm; palpal segment 3 with most sensilla near middle. Wing (2·23 mm) 3·2 times width, R_2/R_{2+3} 3·60, R_1 overlap/R_2 0·18.

MATERIAL EXAMINED.
West Malaysia: Betis, 1 ♀.

DISTRIBUTION. **West Malaysia:** Betis, Kuala Trengan area (Lewis & Wharton, 1963).

Phlebotomus (*Larroussius*) *kandelakii* Shchurenkova

Phlebotomus kandelakii Shchurenkova, 1929 : 693. Syntypes ♀♂, U.S.S.R. (found in Tbilsi Tropical Institute) [not examined].
Phlebotomus (*Larroussius*) *kandelakii* Shchurenkova; Theodor, 1958 : 23; Perfil'ev, 1968 : 261.

The pointed aedeagus has ventral teeth and the spermatheca is very long with 30–35 segments.

Phlebotomus (*Larroussius*) *kandelakii burneyi* Lewis

(Fig. 7, Map 3)

Phlebotomus (*Larroussius*) *kandelakii burneyi* Lewis, 1967 : 17; Artemiev, 1974*a* : 160. Holotype ♂, PAKISTAN (BMNH) [examined].

P. k. burneyi differs from the nominate form in having two ascoids on antenna 3–7 in the male, and other features.

♀ (*extra facts*). Hypopharynx with 17 teeth on each side. Maxilla with four lateral and 17 ventral teeth and a dental depth of 0·08 mm.

MATERIAL EXAMINED.
Pakistan: Gwadi, 1 ♀.

DISTRIBUTION. **Pakistan:** Gwadi, Kalam, Keris (Lewis, 1967).

Phlebotomus (*Larroussius*) *keshishiani* Shchurenkova

(Fig. 8, Map 4)

Phlebotomus keshishiani Shchurenkova, 1936 : 892. Syntypes ♀ ♂, U.S.S.R. (found in Tropical Institute of Tadzhikistan (SSR), Dushanbe (= Stalingrad)) [not examined].
Phlebotomus (*Larroussius*) *keshishiani* Shchurenkova; Lewis, 1967 : 19; Perfil'ev, 1968 : 274.

P. keshishiani differs from *P. major* in having much longer genital filaments, the aedeagus very narrow distally, and more spermathecal segments.

MATERIAL EXAMINED.
Pakistan: Parkuta, 1 ♀.

DISTRIBUTION. **Pakistan:** Gilgit, Parkuta, Rawalpindi, Said Pur (Lewis, 1967).

Phlebotomus (*Larroussius*) *major* Annandale

Phlebotomus major Annandale, 1910*b* : 46.

The aedeagus is long and narrow with nearly parallel sides, about as long as the paramere. The species extends from the Mediterranean to Central Asia and northern India.

Phlebotomus (*Larroussius*) *major major* Annandale

(Fig. 9, Map 4)

Phlebotomus major Annandale, 1910*b* : 46; 1911*c* : 320; Newstead & Sinton, 1921 : 105; Sinton 1924*a* : 814; 1925*d* : 107; 1927*c* : 948 [variation]; 1927*d* : 27; 1928*c* : 303 [synonymy]; 1932*a* : 59; 1933*e* : 418; Sinton & Barraud, 1928 : 329. Lectotype ♂, INDIA (Zoological Survey of India), designated by Quate, 1962*c* : 157 [not examined].
Phlebotomus major var. *grisea* Annandale, 1911*c* : 320. Syntypes, sex not stated, INDIA (depository unknown) [not examined]. [Synonymized by Quate, 1962*c* : 157.]
Phlebotomus major var. *griseus* Annandale; Sinton, 1932*a* : 59 [name emended; dark variant].
Phlebotomus (*Phlebotomus*) *major* Annandale; Parrot, 1940 : 310; Quate, 1962*c* : 157.
Phlebotomus (*Larroussius*) *major* Annandale; Theodor, 1958 : 250; Theodor & Mesghali, 1964 : 281; Lewis, 1967 : 21; Perfil'ev, 1968 : 253.

The male of the nominate subspecies has a palpal formula of 1, 4, (2, 3), 5, and differs in a few other respects from two Palaearctic subspecies in which the formula is 1, 4, 2, 3, 5. *P. major major* was described in recent years by Perfil'ev and Theodor. It occurs in Pakistan and northern India.

In a male from Kasauli with an abnormal style one of the middle spines is replaced by two narrow ones, and in a male from Sabadu one style has only one terminal spine.

♀ (*extra facts*). Hypopharynx with 21 teeth on each side. Maxilla with four lateral and 26 ventral teeth, dental depth 0·12 mm.

MATERIAL EXAMINED.
India: Dalhousie, 1 ♀.

DISTRIBUTION. **India:** Paresnath Hill (Annandale, 1912 : 41); Bhowali, Dalhousie, vii.1906, Kasauli, 25.vi.1905, Simla (BMNH); Chamoli area (*V. Dhanda*); Banihal, Baramula, Islamabad, Jammu, Ramban (Jacob & Kalra, 1951 : 324, 325); Mandi, Mendhar, Punch, Rajouri, Riasi (Mitra, 1959 : 59, 62); Kurseong, Naini Tal (Quate, 1962*c* : 157); Chamba, Dehra Dun, Mukteswar (U.P.), Ranikhet, Sabathu (Punjab) (Sinton's notes). **Nepal:** Syabrudens (*L. W. Quate*, 28.x, 2.xi.1965, light trap). **Pakistan:** Abbottabad, Rawalpindi, Said Pur (Lewis, 1967 : 21).

Early records have been checked because some (Sinton, 1927*b*) could have referred to *P. longiductus* (='*P. chinensis*') which was often found in the same sites (Sinton, 1928*c* : 306). *P. m. major* seemed to occur all along the Himalayan foothills between 1555 and 2135 m, being, in India, essentially a species of hills with marked summer rains (Sinton, 1932*a*).

Subgenus *ADLERIUS* Nitzulescu

Phlebotomus subgenus *Adlerius* Nitzulescu, 1931 : 275; Theodor, 1948 : 98; 1958 : 27; Perfil'ev, 1968 : 280.
Type-species: *Phlebotomus chinensis* Newstead, 1916, by original designation.

The coxite has no lobe, the style bears five spines, and the paramere is not truncated and carries no ventral process. The spermatheca is incompletely segmented. In the male of most forms the aedeagus has a subterminal minute fin-like barb. The subgenus is closely related to *Larroussius*, and Parrot (1940) suggested possibly uniting them in view of their antennal formulae. The species occur in temperate or in arid parts of the Old World, and two exist in the north of the Orient. M. M. Artemiev (1977, in letter) is revising the *Adlerius* of Afghanistan.

Phlebotomus (*Adlerius*) *chinensis* Newstead

Phlebotomus major var. *chinensis* Newstead, 1916 : 191.

The barb on the aedeagus is 10–35 μm from the tip. The species was divided into several subspecies but is here provisionally treated as comprising only *chinensis*, *arabicus* Theodor and *balcanicus* Theodor, according to Artemiev's tentative suggestions (see under *P. longiductus*). Perfil'ev and Theodor gave recent descriptions. The species is almost entirely Palaearctic.

Phlebotomus (*Adlerius*) *chinensis chinensis* Newstead

(Map 4)

Phlebotomus major var. *chinensis* Newstead, 1916 : 191. LECTOTYPE ♂, CHINA: 'Wo Fu Hsu Temple, 1–6.vii.1914, co-type' (BMNH), here designated [examined].
Phlebotomus chinensis Newstead; Sinton, 1928*c* : 306 [in part, synonymy]; 1932*a* : 59; 1933*d* : 418; Yao & Wu, 1941*b* : 78.
Phlebotomus (*Adlerius*) *chinensis* Newstead; Theodor, 1958 : 28; Perfil'ev, 1968 : 280.

In the nominate form the barb of the aedeagus is 30–35 μm from the tip (not more than 20 in other forms) and the coxite brush has about 20 not very thick-standing hairs. *P. c. chinensis* is one of the three Palaearctic taxa. Perfil'ev and Theodor gave recent descriptions.

♀ (*extra facts*). Hypopharynx with 19 teeth on each side. Maxilla with four lateral and 19 ventral teeth and a dental depth of 0·11 mm.

MATERIAL EXAMINED.
China: 2 ♀, 3 ♂ paralectotypes (BMNH), one labelled as type; same data as lectotype.

DISTRIBUTION. **China:** Hainan (subsp. ?, Leng, 1964 : 127); Kumming (subsp. ?, Yao & Wu, 1941*b* : 79).

Phlebotomus (*Adlerius*) *longiductus* Parrot

(Map 4)

[*Phlebotomus chinensis*; Sinton, 1928*c* : 306 [in part].]
Phlebotomus chinensis var. *longiductus* Parrot, 1928 : 29; 1940 : 310 [♂ ascoid formula variable]; 1946 : 68. Syntypes 2 ♂, U.S.S.R. (depository unknown) [not examined].
Phlebotomus (*Adlerius*) *chinensis hindustanicus* Theodor, 1958 : 29, 30. Syntypes ♂, NORTH-WEST OF INDIAN SUBCONTINENT (TC) [not examined]. [Synonymized by Lewis, 1967 : 21.]
Phlebotomus (*Adlerius*) *chinensis longiductus* Parrot; Theodor, 1958 : 29; Theodor & Mesghali, 1964 : 193 [?]; Lewis, 1967 : 21 [♂ ascoid formula variable]; Perfil'ev, 1968 : 285.
Phlebotomus (*Adlerius*) *longiductus* Parrot; Artemiev, 1974*a* : 163.

In the male the barb of the aedeagus is shallow and about 12–14 μm from the tip, and the coxite brush has 50–60 hairs.

Artemiev treated this form as a species in view of differences from Chinese *P. chinensis* in the number of hairs on the coxite and the shape and position of the aedeagus barb, sympatric relation to form *halepensis* Theodor and *P. simici* Nitzulescu, and sharp differences from the allopatric 'subspecies' of *P. chinensis* except *arabicus* Theodor, *balcanicus* Theodor and *tauriae* Perfil'ev, 1966 : 312, which could be subspecies of *P. longiductus*. He pointed out that *P. longiductus* occurs in southern U.S.S.R., Iran, Afghanistan and northern Pakistan, and that in Afghanistan it is a mountain cold-resistant species occurring from 1000 to 2800 m.

Recent descriptions have been given by Artemiev, Lewis, Perfil'ev and Theodor. In an occasional male from India one of the ascoids on antenna 8 is vestigial.

♀ (*extra facts*). Labrum 0·40 mm long, 0·14 length of wing (2·76 mm). Hypopharynx with 21 teeth on each side. Maxilla with three lateral and 23 ventral teeth and a dental depth of 0·12 mm.

MATERIAL EXAMINED.
Pakistan: Gwadi and Keris, 2 ♀.

DISTRIBUTION. **India:** Bhowali, Kasauli, Simla (BMNH); Banihal (Jacob & Kalra, 1951 : 325); Punch (Lewis, 1967 : 23); Mandi, Mendhar (Mitra, 1959 : 62); Kurseong, Ranikhet (Sinton's notes). **Nepal:** Chobhar (*Jane Wilson*, 1976, in cave); Syabrudens (*L. W. Quate* via BPBM, 1965). **Pakistan:** Gilgit, Gol, Gwadi, Keris, Parkuta, Said Pur (Lewis, 1967 : 23).

In India *P. longiductus* was not usually found below 1555 m and occurred in the same area as *P. major*, according to Sinton (1928*c*; 1932*a*).

Subgenus *EUPHLEBOTOMUS* Theodor

Phlebotomus subgenus *Euphlebotomus* Theodor, 1948 : 98; 1958 : 32; Hennig, 1972 : 53 [related to *Phlebotomus* and *Anaphlebotomus*]. Type-species: *Phlebotomus argentipes* Annandale & Brunetti, 1908, by original designation.

The coxite has no lobe, the style bears five spines, and the paramere has three processes. Hennig's (1972) study of the paramere of a fossil species suggests that this is an ancient subgenus. There are five species in the Old World.

Phlebotomus (*Euphlebotomus*) *argentipes* Annandale & Brunetti

(Figs 10–16, Map 4)

Phlebotomus argentipes Annandale & Brunetti *in* Annandale, 1908 : 101 [authorship according to ICZN Article 51(c)]; Annandale, 1910*b* : 42; 1911*a* : 159; 1911*c* : 309; Howlett, 1915 : 294; França, 1922 : 14; Sinton, 1924*a* : 814; 1925*c* : 789 [colour variation]; 1925*d* : 107; 1927*d* : 27; 1928*c* : 301 [synonymy]; 1932*a* : 59; 1933*d* : 227; 1933*e* : 418; Christophers & Barraud, 1926 : 853 [?]; Christophers, Shortt & Barraud, 1926 : 177; Shortt, Barraud & Craighead, 1926 : 330; Sinton & Barraud, 1928 : 329; Mukerji, 1931 : 441 [larva]; Raynal, 1935*b* : 245; Raynal & Gaschen, 1935*g* : 737 [figs in 1935*h*]; Keilin & Tate, 1937 : 254; Mitra, 1952 : 550 [palp sensilla]; 1956 : 229; Mitra, 1953*b* : 434; Mitra & Roy, 1953*b* : 369

[variation]. Lectotype ♂, INDIA (Zoological Survey of India), designated by Quate, 1962*c* : 157 [not examined].

[*Phlebotomus zeylanicus* Annandale; Annandale, 1910*a* : 61. Misidentification according to Sinton, 1924*a* : 813; 1928*c* : 301.]

Phlebotomus marginatus Annandale, 1910*a* : 62; Sinton, 1932*a* : 59 [colour form]. Holotype ♀, SRI LANKA (depository unknown) [not examined]. [Synonymized by Theodor, 1948 : 108.]

Phlebotomus argentipes var. *marginatus* Annandale; Annandale, 1911*b* : 203; 1911*c* : 319.

Phlebotomus annandalei Sinton, 1923*a* : 744; 1924*a* : 815. Holotype ♂ (ICZN Article 73(a)), INDIA (depository unknown) [not examined]. [Synonymized by Sinton, 1925*c* : 789.]

Phlebotomus (*Phlebotomus*) *argentipes* Annandale & Brunetti; Parrot, 1937 : 116; 1940 : 310; 1946 : 68; 1953 : 114; Lewis, 1957 : 165; Quate & Fairchild, 1961 : 211; Quate, 1962*b* : 254; 1962*c* : 157 [synonymy].

Phlebotomus (*Euphlebotomus*) *argentipes* Annandale & Brunetti; Theodor, 1948 : 99; Lewis, 1967 : 23; 1973*a* : 246; 1973*c* : 147; Lewis & Killick-Kendrick, 1973 : 4.

Phlebotomus argentipes var. *glaucus* Mitra & Roy, 1953 : 372. 10 ♀ syntypes, INDIA (Museum of the Armed Forces Medical College, Poona) [not examined]. [Synonymized by Lewis, 1967 : 24.]

In the female the pharynx has a group of spines, and the spermatheca a large apical segment, and in the male a pair of spines lies parallel to the aedeagus, the paramere has three lobes and the style five spines.

Descriptions include those of Quate & Fairchild, Raynal (1935*b*) and Sinton (1925*c*).

The form *glaucus* is here treated as a synonym in the light of present knowledge of variation.

♀ (East India, Calcutta, Howrah). Eye 0·56 length of head. Labrum 0·25 (0·23–0·27) mm long, 0·12 (0·12–0·13) length of wing, shoulders angular, most sensilla small, the two mid-apical ones prominent. Cibarium with distinct spicules. Pharyngeal armature with median anterior teeth and lateral and posterior spiculate ridges. Hypopharynx with about 16 long teeth on each side. Antenna 3 = 0·22 (0·20–0·23) mm long, 0·11 (0·10–0·11) length of wing, 1·25 (1·25–1·34) length of 4+5, 0·87 (0·80–0·92) length of labrum, no papilla on 5, two ascoids on segments 3–15, that on 4 being 0·41 (0·30–0·53) length of segment. Mandible with very fine teeth about 1·2 μm wide. Maxilla with 8·8 (7–11) lateral teeth, 14·9 (13–17) ventrals, and a dental depth of 0·08 mm; palpal ratio 10 : 22 : 31 : 16 : 34, clavate sensilla close together around middle of segment 3. Scutum dark brown, pleuron pale, inter-precoxal lobes normal, mesanepisternum with about five to eight lower hairs. Wing length 2·06 (1·92–2·22) mm, 3·2 times width, R_2/R_{2+3} 1·91 (1·59–2·06), R_1 overlap/R_2 0·14 (0·09–0·20). Tarsi appearing silvery in some lights. Spermatheca carrot-shaped with about 15 segments, the end one large, outer wall of common duct diverging distally.

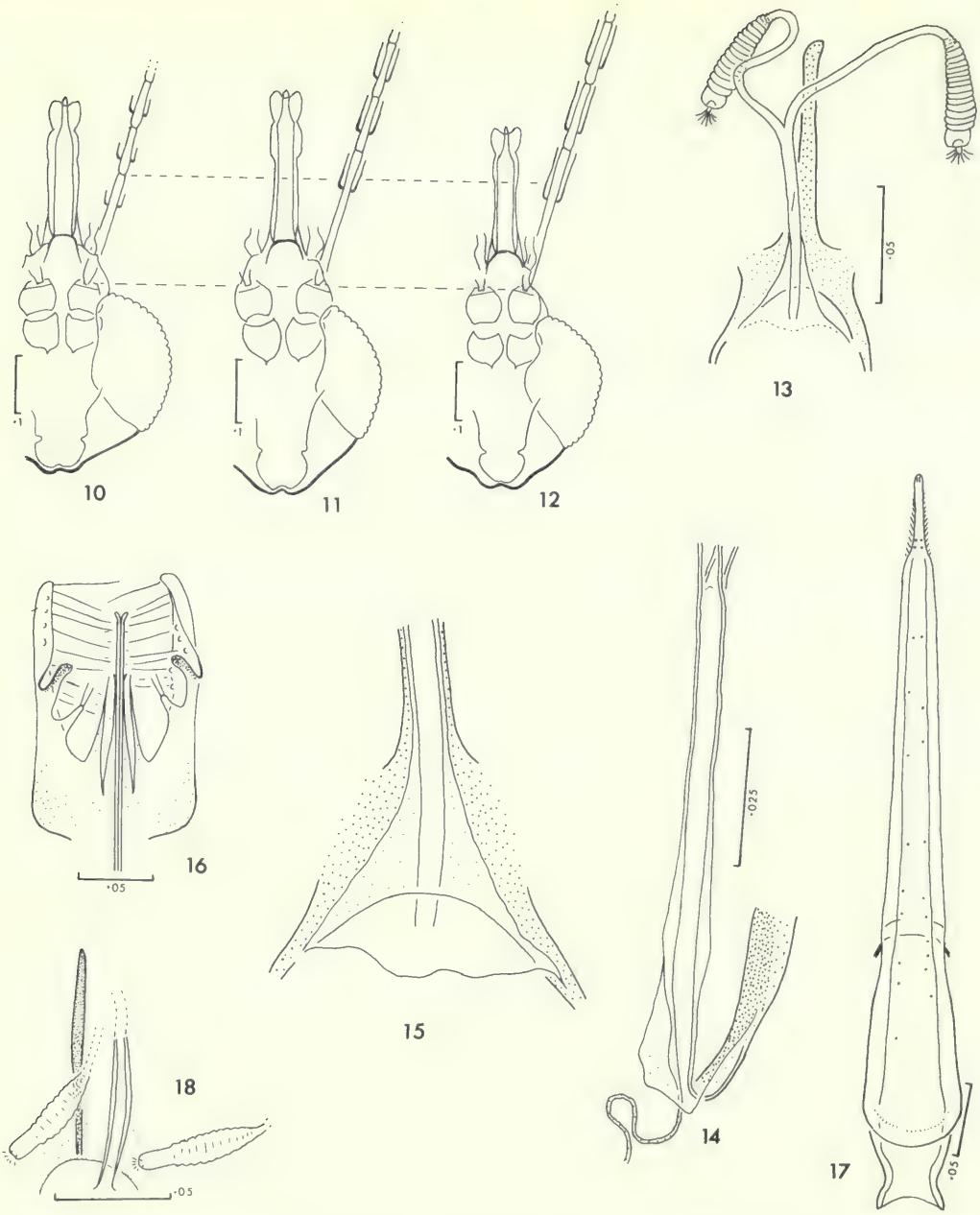
♂ (Calcutta area, *extra facts*). Eye 0·56 length of head. Style 0·62 length of coxite, 5·8 times as long as thickness (basad of middle spines).

VARIATION. This species was known to show some geographical variation (Lewis, 1957), and further observations were made on the limited material available owing to the importance of the species and its biological variation. In parts of India it bites man readily, is peridomestic, and is an important vector of kala-azar, whereas in south-east Asia it seldom if ever attacks man, and in Sri Lanka may be strongly zoophilic (Lewis & Killick-Kendrick, 1973). It has even been suggested, by R. S. Bray in 1974, that *P. argentipes* may be a species complex including a zoophilic and an anthropophilic species in one area.

Available specimens were limited, but those from several areas were examined for comparison with *P. argentipes* from the area around the type-locality of Calcutta, with the following results. In a few flies from some areas one maxillary lateral tooth is vestigial and makes counting difficult.

South India in general. Labrum 0·24 (0·22–0·27) mm long, 0·12 (0·12–0·13) length of wing. Antenna 3 0·22 (0·19–0·23) mm long, 0·11 (0·10–0·12) length of wing, 1·21 (1·18–1·25) length of 4+5, 0·88 (0·84–0·93) length of labrum. Ascoid on 4 = 0·49 (0·39–0·60) length of segment. Maxilla with 7·0 (6–11) lateral and 13·3 (14–19) ventral teeth. Wing length 2·03 (1·82–2·22) mm, R_2/R_{2+3} 1·74 (1·42–1·95), R_1 overlap/R_2 0·15 (0·09–0·21).

North India in general. Labrum 0·25 (0·24–0·27) mm long, 0·12 (0·11–0·12) length of wing. Antenna 3 = 0·22 (0·20–0·26) mm long, 0·10 (0·10–0·12) length of wing, 1·21 (1·14–1·33) length of 4+5, 0·88 (0·80–0·94) length of labrum. Ascoid on antenna 4 = 0·52 (0·33–0·74) length of segment (the highest value is in one of two flies from Bombay, with an antenna 3/labrum value of 0·83; otherwise the mean is



Figs 10–18 *Phlebotomus* species. 10–16, *P. argentipes*: (10–12) ♀, heads from India (Howrah), Sri Lanka (Pannipitiya) and West Malaysia (Lamir) (scales adjusted for wing length); (13) ♀, spermatheca (Venkatapuram); (14, 15) base of its duct (Venkatapuram and Lamir); 16, ♂, aedeagus and parameres (Lamir). 17, *P. kiangsuensis*, ♀, labrocibarium. 18, *P. philippinensis gouldi*, ♀, spermatheca.

0·50 and the maximum 0·64). Maxilla with 8·5 (8–9) lateral and 15·0 (12–18) ventral teeth. Wing length 2·13 (2·01–2·37) mm, R_2/R_{2+3} 1·77 (1·51–2·25), R_1 overlap/R_2 0·12 (0·00–0·18). In a female from Katihar one (short) ascoid on antennal segment 3 has a bifid tip, a feature seen in some ascoids of a few Calcutta flies (S. Das, 1975, in litt.). In two females, outside the series, from Hosur (*H. Trapido*), the ascoid on 4 is 0·39 and 0·70 of the segment length.

India: various. (1) Northern hills. Labrum 0·25 (0·23–0·27) mm, 0·11 (0·10–0·12) length of wing. Antenna 3 = 0·23 (0·21–0·25) mm long, 0·10 (0·10–0·12) length of wing, 1·29 (1·24–1·36) length of 4+5, 0·93 (0·85–1·01) length of labrum, ascoid on 4 = 0·65 (0·64–0·67) length of segment. Maxilla with 10·3 (9–11) and 16·3 (14–18) lateral teeth. Wing length 2·21 (2·08–2·32) mm, R_2/R_{2+3} 1·71 (1·52–1·80), R_1 overlap/R_2 0·10 (0·04–0·11). (2) Near the hills of Kerala. In the single female the labrum is 0·14 as long as the wing, the ascoid on antenna 4 is 0·74 of its length, the maxilla has 12 lateral and 16 ventral teeth, and the wing length is 2·22 mm. The ascoid alone was examined in six flies from Assam (Gologhat) and is 0·62 (0·53–0·67) the length of segment 4. In one female from Mount Abu the figure is 0·46. In these rather peripheral areas the ascoid tends to be long. The ascoid ratio in a fly from Nepal is 0·60.

Sri Lanka. Labrum 0·24 (0·22–0·26) mm long, 0·12 (0·12–0·12) length of wing. Antenna 3 = 0·22 (0·19–0·24) mm long, 0·11 (0·10–0·11) length of wing, 1·24 (1·19–1·31) length of 4+5, 0·90 (0·83–0·94) length of labrum, ascoid on 4 = 0·75 (0·68–0·86) length of segment. Maxilla with 8·9 (8–10) lateral and 13·8 (11–17) ventral teeth. Wing length 2·00 (1·86–2·13) mm, R_2/R_{2+3} 2·00 (1·70–2·31), R_1 overlap/R_2 0·18 (0·14–0·26). The mean ascoid length, R_2/R_{2+3} and R_1 overlap are high. Females are distinguishable from all the east India and south-India-general flies, and all but one of those from the general area of north India.

Thailand. Labrum 0·24 (0·23–0·26) mm long, 0·11 (0·11–0·11) length of wing. Antenna 3 = 0·25 (0·23–0·29) mm long, 0·11 (0·10–0·12) length of wing, 1·12 (1·07–1·20) length of 4+5, 1·04 (0·95–1·08) length of labrum, ascoid on 4 = 0·67 (0·57–0·72) length of segment. Maxilla with 8·7 (8–9) lateral and 12·2 (11–13) ventral teeth. Wing length 2·27 (2·13–2·45) mm, R_2/R_{2+3} 2·12 (1·97–2·65), R_1 overlap/R_2 0·11 (0·07–0·18). The long antenna 3, ascoid and R_2 are close to West Malaysian values, and the wing length is rather high and the number of maxillary ventral teeth low. In South Vietnam the ascoid is rather long (Raynal, 1935*b*).

West Malaysia. Labrum 0·23 (0·22–0·24) mm long, 0·11 (0·10–0·11) length of wing. Antenna 3 = 0·24 (0·22–0·25) mm long, 0·11 (0·10–0·12) length of wing, 1·14 (1·11–1·17) length of 4+5, 1·05 (0·95–1·10) length of labrum, ascoid on 4 = 0·77 (0·69–0·81) length of segment. Maxilla with 8·1 (6–11) lateral and 13·8 (11–17) ventral teeth. Wing length 1·96 (1·74–2·26) mm, R_2/R_{2+3} 1·96 (1·74–2·26), R_1 overlap/R_2 0·16 (0·09–0·24). The labrum is rather short, antenna 3/4+5 low, antenna 3/labrum value high, ascoids long, and R_2/R_{2+3} and R_1 overlap /R_2 values high. All are distinguishable from east India, south-India-general and north-India-general flies; the only one of the latter with a long ascoid has a short antenna 3 and a low antenna 3/labrum value. The West Malaysian form, like the Sri Lanka form, has a long ascoid, but is distinguished from it by a lower labrum/wing length value, a lower antenna 3/4+5 value, and a higher antenna 3/labrum value. In the male of both east India and West Malaysian forms the paired ascoids end at antennal segment 10.

Over-all minima and maxima. The data from all areas give the following result; labrum 0·22–0·27 mm long, 0·10–0·14 length of wing; antenna 3 = 0·19–0·29 mm long, 0·10–0·12 length of wing, 1·11–1·36 length of 4+5, 0·80–1·10 length of labrum; ascoid on 4 = 0·30–0·86 length of segment; maxilla with 6–12 lateral and 11–19 ventral teeth; wing length 1·82–2·45 mm, R_2/R_{2+3} 1·42–2·65. R_1 overlap/R_2 0·00–0·26.

Comments. The specimens examined show similarities between flies from east India and the general areas of south and north India, and they indicate Sri Lanka and West Malaysian forms (with long ascoids and other features) distinct from these. Some specimens from the peripheral areas of India and from north-east Thailand gave intermediate measurements, the differences are small, and little is known of the species in Burma and Thailand. Therefore none of the variants is treated here as a subspecies. There is, however, a striking morphological difference between the short ascoid of the eastern Indian vector of kala-azar and the long ascoid of the non-anthropophilic *P. argentipes* of south-east Asia (Figs 10, 12).

There is nothing to suggest the existence of two species in the *P. argentipes* complex in India, apart from the finding of long and short ascoids at Bombay and at Hosur, but the lack of man-biting *P. argentipes* in the Sagar (Shimoga) area (noted under distribution below) is interesting.

No *P. argentipes* were found in a very large collection from Perak, and there may be some discontinuity of distribution which would suggest a subspecific status for some variants.

Further study of this important species would be instructive, and could well include cytotaxonomy and measurement of more specimens from a wider area, and perhaps the relation of leg measurements to wing length.

MATERIAL EXAMINED.
India. East: Howrah (Calcutta, *S. Das*), 10 ♀; north, general: Aurangabad, Chindwara, Jalna, Karnal, Parel (Bombay, 2), Ranchi, Saharanpur, Sambhar, 10 ♀; south, general: Puligumma, Undi (3), Venkatapuram (2) 6 ♀; various, northern hills: Kathgodam, Simla (3), 4 ♀; various, other: Gologhat, 6 ♀; Kulathupurzha, 1 ♀; Mount Abu, 1 ♀. **Nepal:** Dhunibesi (21.vi.1961, *Y. Shogaki*, 1 ♀). **Sri Lanka:** Pannipitiya (18.iv.1973, *R. Killick-Kendrick*, 10 ♀). **Thailand:** Ban Bon Dan (11.xii.1975, *D. J. Gould*, 6 ♀). **West Malaysia:** Lamir, 10 ♀.

DISTRIBUTION. **Bangladesh:** Dhurmakura (Sinton's notes). **Borneo** (Sabah): Bum Bum Island (Lewis, 1968 : 11); Kalabakan area (Quate & Fairchild, 1961 : 213; Quate & Rosario, 1962 : 791). **Burma:** Rangoon (probably, Sinton, 1928*c* : 311; 1932*a* : 70). **India:** Howrah (as above); Katiher, Kotelanka, Kulathurpuzha, Mount Abu, Nagpur, Nalbari, Ranchi, Simla (BMNH); Calcutta (Basu & Ghosh, 1954*a* : 1955); Aurangabad, Jalna, Patan (Farook & Qutubuddin, 1951 : 85); Kathgodam (14.x.1907, on pony, *J. D. E. Holmes*); Ajmer, Sambhar (Jaswant Singh, 1953); Hoora (Mitra, 1953*b* : 158); Khandwa, Kirki, Mahableshwar, Mahad, Panchgani, Pashan, Poladpur, Wai etc. (Mitra, 1954*b* : 111; 1955 : 82); Hyderabad (near lake, not numerous, Qutubuddin, 1944 : 208); Chamoli area (Rao *et al.*, 1973); Panada Agraharam, Undi, Vellore (6 ♂ on bullock), Vekatapuram (*R. Reuben*); Asansol Kamptee, Palod, Poona, Port Canning (Sinton, 1924 *f* : 1041); Golaghat, Lucknow, Puri, Purneah, Rajmahal (Sinton, 1925*c* : 789); Faizabad, Pamban Island, Patna, Sarahanpur (Sinton, 1927*b* : 942); Sanawar (Sinton, 1932*a* : 70); Gauhati, Karnal, Narnaul, Nedumangad, Parbatipur, Rajbari, Trivandrum (Sinton's notes); Sagar (Shimoga) area (Hosur, Kannur, Konehosur, Kumsi, *H. Trapido*; Work *et al.*, 1957; Trapido *et al.*, 1959; no phlebotomines found biting); Bombay (first record, widespread, Young, 1927 : 679). **Indonesia:** Denpasar area (Lewis & Dyce, 1976 : 208). **Laos:** Luang Prabang (Quate, 1962*b* : 256). **Nepal:** Kathmandu area (as above). **Pakistan:** Lahore, Mir Muhammad, Taxla (Lewis, 1967 : 24). **Sri Lanka:** (not plentiful, Smith, 1959 : 17); Balangoda area (*Jun Akiyama*, 12.viii.1977, 4 ♀, 51 ♂ from cow-baited trap net at Kaltota); Peradeniya (Annandale, 1910*a* : 59; 1911*b* : 203; 1911*c* : 319); Delft Island (Carter & Antonipulle, 1949 : 68); Depanama, Kalagoda, Pannipitiya (Theodor, 1938*a* : 269). **Thailand:** Ban Bon Dan, Khao Yai (as above); Chieng Mai (Quate, 1962*b* : 256). **Vietnam (South):** 22 km south of Nha Trang (Quate, 1962*b* : 256); Duc Pho (Raynal, 1936*a* : 360). **West Malaysia:** Kuantan area (box traps near Lamir), Rantan Panjang, Ulu Gombak (Lewis, 1957 : 106); Gua 'Che Yatim (Lewis & Wharton, 1963 : 118); Batu Caves (Quate, 1962*a* : 226; Quate & Fairchild, 1961 : 212).

Sinton (1932*a*) considered that in India *P. argentipes* occurred in a moist climate mainly east and south of the Bombay–Simla line, but with a focus in the Kathiawar Peninsula. Sanawar, at 1220 m, was unusually high for it (Sinton, 1927*g*), but Mitra (1954*a*) found it at nearly 1555 m in the Bombay area. Smith's (1959 : 17) remarks on patchy distribution in India may explain diverse findings in south-east Asia. In 1975 *P. argentipes* was reported from Iran.

Phlebotomus* (*Euphlebotomus*) *kiangsuensis Yao & Wu

(Fig. 17, Map 4)

Phlebotomus sp. Raynal, 1937 : 83 [China; microfilariae in midgut].
Phlebotomus kiangsuensis Yao & Wu, 1938 : 527; 1941*b* : 78. Holotype ♂, CHINA (depository unknown) [not examined]. Conditional name available under ICZN Article 17(8).
Phlebotomus (*Euphlebotomus*) *kiangsuensis* Yao & Wu; Theodor, 1948 : 108; 1958 : 32.
Phlebotomus (*Phlebotomus*) *kiangsuensis* Yao & Wu; Lewis & Wharton, 1963 : 120 [variation]; Cates & Lien, 1970 : 538.

The male differs from that of *P. argentipes* in having a short aedeagus and the central lobe of the paramere thicker than the upper lobe. *P. kiangsuensis*, first found in the Palaearctic Region, has been redescribed by Theodor (1958).

♀ (China, *extra facts*). Hypopharynx with about 18 teeth on each side. Antenna 5 with papilla. Maxilla with eight lateral and 21 ventral teeth, and a dental depth of 0·11 mm.

♂ (China, *extra facts*). Antenna 4 apparently with one ascoid, antenna 5 bearing one normal ascoid, one very small one, and apparently a papilla.

VARIATION. Males from West Malaysia show reduction of proximal ascoids (Lewis & Wharton, 1963) and apparently no papilla on antenna 5. Further study of these delicate structures is desirable.

MATERIAL EXAMINED.
China: Kiangsu (3 ♀, 1 ♂ bred in laboratory, in BMNH collection, evidently originally treated with strong potash which makes papillae difficult to see). **West Malaysia:** 4 ♀, 3 ♂.

DISTRIBUTION. **China:** Kukong area (Chen & Hsu, 1955 : 302). **Taiwan:** Taitung area (3 ♀, Cates & Lien, 1970 : 539). **West Malaysia:** Batu Cave (5.ix.1959, *N. E. McClure*); Betis (Lewis & Wharton, 1963 : 120).

P. kiangsuensis and two other species of *Euphlebotomus* occur in Palaearctic China.

Phlebotomus (*Euphlebotomus*) *philippinensis* Manalang

Phlebotomus philippinensis Manalang, 1930*b* : 175.

The male differs from that of *P. argentipes* in having longer eyes (as in the female) and a deeper paramere, and in the relative lengths of the main and middle lobes of the paramere.

Quate & Rosario (1962) gave a recent description and indicated that sympatric females of the two species would be difficult to separate and that records should be confirmed by means of males; also that *P. philippinensis* is smaller, and has less developed cibarial spicules, a stronger chitinous arch and slightly longer antenna 3.

Phlebotomus (*Euphlebotomus*) *philippinensis gouldi* Lewis **subsp. n.**

(Figs 18–21, Map 4)

P. p. gouldi has higher antenna 3/wing length and antenna 3/4+5 values in both sexes than does *P. p. philippinensis*, antenna 3 in the female reaches beyond the labrum, the maxillary ventral tooth number and dental depth are greater, wing length is greater in the male, R_1 overlap is longer in both sexes, and the style is rather long and narrow.

♀. Eye 0·43 length of head. Labrum 0·22 (0·22–0·23) mm long, 0·11 (0·11–0·11) length of wing. Antenna 3 extending beyond labrum, 0·34 (0·31–0·36) mm long, 0·17 (0·17–0·18) length of wing, 1·24 (1·23–1·26) length of 4+5, 1·42 (1·39–1·45) length of labrum, two ascoids on segments 3–15, that on 4 = 0·74 length of segment, papilla on 5. Maxilla with seven lateral and 12 ventral teeth and a dental depth of 0·06 mm, palpal ratio 10 : 24 : 34 : 19 : 36. Wing length 1·98 (1·91–2·05) mm, 3·1 times width, R_2/R_{2+3} 1·77 (1·70–1·84), R_1 overlap/R_2 0·13 (0·08–0·17). Spermathecae delicate and indistinctly wrinkled or segmented, with large end-segment, individual ducts delicate and common duct thick-walled.

♂. Eye 0·42 length of head. Labrum 0·20 mm long, 0·10 length of wing. Antenna 3 = 0·40 mm long, 0·20 length of wing, 1·21 length of 4+5, 2·02 length of labrum; two ascoids on segments 3–13, one on 14 and 15, that on 4 = 0·58 length of segment. Wing length 1·95 mm, 3·4 times width, R_2/R_{2+3} 1·58, R_1 overlap/R_2 0·13. Style 0·61 length of coxite, 3·6 times as long as width (basad of middle spines).

MATERIAL EXAMINED.
Holotype ♀, **Thailand:** Ban Bon Dan, 11.xii.1975 (*D. J. Gould*), light trap with CO_2 in evergreen and deciduous tropical forest (BMNH).

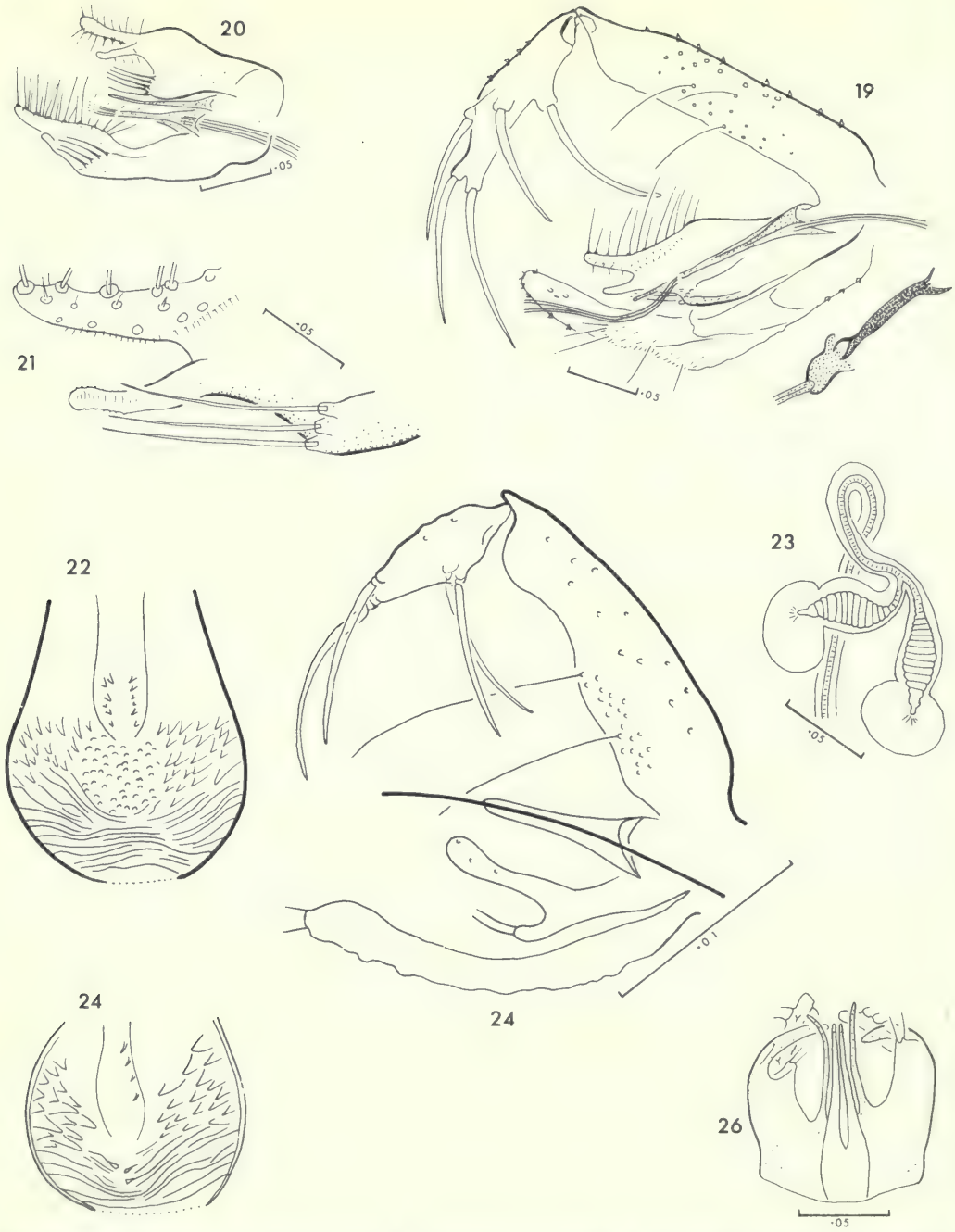
Paratypes. Same data, 10 and 11.xii.1975, 1 ♀, 1 ♂ (BMNH).

DISTRIBUTION. **Thailand:** Ban Bon Dan (as above); Khao Yai (25.iii.1976, *D. J. Gould*, 700 m, rain forest, 1 ♀).

Phlebotomus (*Euphlebotomus*) *philippinensis philippinensis* Manalang

(Map 4)

Phlebotomus philippinensis Manalang, 1930*b* : 175; Sinton, 1931*d* : 104. Syntypes ♀ ♂, PHILIPPINES (destroyed according to Quate & Rosario, 1962 : 789) [not examined].
Phlebotomus (*Euphlebotomus*) *philippinensis* Manalang; Theodor, 1948 : 108.
Phlebotomus (*Phlebotomus*) *philippinensis* Manalang; Quate, 1965 : 20; Quate & Rosario, 1962 : 789.



Figs 19–26 *Phlebotomus* species. 19–21, *P. philippinensis gouldi*, ♂, terminalia, aedeagus and parameres, and tip of paramere. 22–26, *P. hoepplii*, after Tang & Maa: (22) ♀, pharynx; (23) ♀, spermatheca; (24) ♂, pharynx; (25) ♂, terminalia; (26) ♂, aedeagus and parameres.

♀ (*extra facts*). Eye 0·38 length of head. Labrum 0·23 mm long, 0·13 length of wing. Hypopharynx with 16 teeth on each side. Antenna 3 not reaching tip of labrum, 0·24 mm long, 0·13 length of wing, 1·15 length of 4+5, 1·04 length of labrum, ascoid on 4 about 0·8 length of segment, papilla present on 5. Maxilla with seven lateral and 17 ventral teeth and a dental depth of 0·20 mm. Wing length 1·81 mm, R_2/R_{2+3} 1·77, R_1 apex/R_2 0·22. Spermatheca with faint pit and knob; common duct with thick walls.
♂ (*extra facts*). Eye 0·41 length of head. Labrum 0·16 (0·15–0·16) mm long, 0·09 (0·09–0·09) length of wing. Antenna 3 = 0·26 (0·24–0·28) mm long, 0·16 (0·15–0·16) length of wing, 1·16 (1·10–1·22) length of 4+5, 1·67 (1·63–1·71) length of labrum, ascoid on segment 4 = 0·74 length of segment, papilla present on 5. Wing length 1·66 (1·55–1·76) mm, R_2/R_{2+3} 1·62 (1·38–1·86), R_1 overlap/R_2 0·51 (0·08–1·04). Lower lobe of paramere a broad flange extending mesally and bearing four or five spines. Style 0·54 length of coxite, 4·1 as long as width (basad of middle spines).

MATERIAL EXAMINED.
Philippines: Imus, 1 ♂; La Mesa, 1 ♀; Silang, 1 ♂.

DISTRIBUTION. **Philippines:** Novaliches (Manalang, 1930*b* : 175); Cotabato, Eran area, Los Arcos etc. (Quate, 1965 : 20); Imus, La Mesa, Silang (Quate & Rosario, 1962 : 791).

Subgenus *ANAPHLEBOTOMUS* Theodor

Phlebotomus subgenus *Anaphlebotomus* Theodor, 1948 : 99; Hennig, 1972 : 53. Type-species: *Phlebotomus stantoni* Newstead, 1914, by original designation.

The coxite has no lobe and the style bears four spines. It is represented in the Region by three species which, between them, cover a wide area.

Phlebotomus (*Anaphlebotomus*) *colabaensis* Young & Chalam

(Map 5)

Phlebotomus colabaensis Young & Chalam, 1927 : 859; Sinton, 1932*a* : 59; 1933*d* : 226 [♀]; 1933*e* : 418 [♂]. Holotype ♂, INDIA (Central Research Institute, Kasauli) [not examined].
Phlebotomus (*Anaphlebotomus*) *colabaensis* Young & Chalam; Theodor, 1948 : 108; Lewis, 1967 : 24.

The paramere is bilobed and the style has four spines. The following notes are based on Young & Chalam and on Sinton, and study of one fly.

♀. Labrum 0·30 mm long, 0·15 length of wing. Hypopharynx with about 19 teeth on each side. Maxilla with 11 lateral and 23 ventral teeth and a dental depth of 0·11 mm. Antenna 3 = 0·29 mm long, 0·14 length of wing, 1·18 length of 4+5, 0·97 length of labrum, ascoid on segment 3 = 0·61 length of segment, papilla on 5. Palpal segment 3 with sensilla grouped near middle. Thoracic sternal lobe broad. Spermatheca not markedly carrot-shaped, with small end-segment; duct long, about four times length of spermatheca, joining common duct.
♂. Antenna 3 = 0·22 mm long, 1·1 length of 4+5. Palpal formula 1–4–2–(3–5), ratio 10 : 27 : 40 : 20 : 40. Wing length 1·47 mm, width 0·41 mm, R_2/R_{2+3} 1·4, R_1 overlap/R_2 0·1. Hind tibia 1·72 length of femur. Aedeagus pyramidal and sharply pointed. Paramere bilobed, lower lobe bare and mammiform. Style about 3·9 times as long as wide, with four spines of nearly equal thickness, at 0·23, 0·57, 0·73 and tip.

MATERIAL EXAMINED.
India: Kulathurpuzha, 1 ♀.

DISTRIBUTION. **India:** Kulathurpuzha (BMNH); Sambhar (Jaswant Singh, 1933); Hyderabad (near river, Qutubuddin, 1944 : 208); Bombay (Sinton, 1928*c* : 310; Young & Chalam, 1927 : 49); Bissamcuttack (Sinton, 1932*a* : 71). **Pakistan:** Lahore (Lewis, 1967 : 24).

Phlebotomus (*Anaphlebotomus*) *hoepplii* Tang & Maa

(Figs 22–26, Map 5)

Phlebotomus hoepplii Tang & Maa, 1945 : 25, Holotype ♂, CHINA (T. Maa's collection) [not examined].

The male differs from that of *P. stantoni* in having the spine near the aedeagus much longer than it.

The following description is adapted from the original for which five flies of each sex were used for most measurements.

♀. Pharynx about three times as long as wide, armature with faint transverse and slightly oblique lines; anteriorly lines are more developed and there are lateral backward-pointing teeth and medially some small ones. Antenna 3 = 0·25 (0·24–0·27) mm long, 1·2 (1·1–1·3) length of 4 + 5, two ascoids on segments 3–15, that on 4 almost as long as segment and reaching beyond its tip. Palpal formula 1–4–2–3–5, ratio 10 : 31 : 44 : 17 : 34. Wing length 1·86 (1·75–2·07) mm, width 0·55 (0·48–0·61) mm, R_1/R_{2+3} 2·1 (1·8–2·3), R_1 overlap/R_2 about 0·25. Hind tibia 1·84 (1·77–1·91) length of femur. Spermatheca fusiform with small head and short neck; roughly 14 segments figured; duct shorter than spermatheca; common duct long.

♂. Cibarium unarmed. Pharynx about four times as long as wide, armature with a series of oblique ridges radiating from the middle, and antero-lateral sharp teeth pointing postero-medially. Antenna 3 = 0·27 (0·26–0·28) mm long, 1·26 (1·23–1·33) length of 4 + 5; two ascoids on segments 3–15, that on 4 about 0·83 length of segment and reacing its tip. Wing length 1·68 (1·58–1·75) mm, width 0·50 (0·46–0·53) mm. Hind tibia 0·20 length of leg. Aedeagus with rounded tip, and a long spine on each side. Paramere with three lobes, the small ventral one usually bearing three curved spines. Coxite long and slender with a large group of long hairs. Style spindle-shaped with four spines, the two proximal ones being more slender, at 0·48, 0·53, 0·91 and tip. Cerci narrow and club-like distally, not figured.

DISTRIBUTION. **China:** Kuang-chou (Chen & Hsu, 1955 : 302); Masha, Shao-wu (Tang & Maa, 1945 : 25).

Phlebotomus* (*Anaphlebotomus*) *stantoni Newstead

(Figs 27–29, Map 5)

Phlebotomus stantoni Newstead, 1914 : 190; Sinton, 1923*a* : 749; 1928*c* : 311; 1931*d* : 99, 104; 1933*d* : 226; Raynal & Gaschen, 1934*d* : 670 [♂]; Raynal, 1935*b* : 237 [♂]; 1936*a* : 357; Theodor, 1938 : 269; Yao & Wu, 1940 : 773; 1941*b* : 74; Tang & Maa, 1945 : 29. Holotype ♀, WEST MALAYSIA (BMNH) [examined].

Phlebotomus (*Phlebotomus*) *stantoni* Newstead; Parrot, 1946 : 67; Parrot & Clastrier, 1952 : 154; Quate & Fairchild, 1961 : 205; Quate, 1962 : 256.

Phlebotomus (*Anaphlebotomus*) *stantoni* Newstead; Theodor, 1948 : 99.

Phlebotomus maynei Sinton, 1930*b* : 195. Holotype ♂, INDIA (BMNH) [examined]. [Synonymized by Raynal & Gaschen, 1934*d* : 670.]

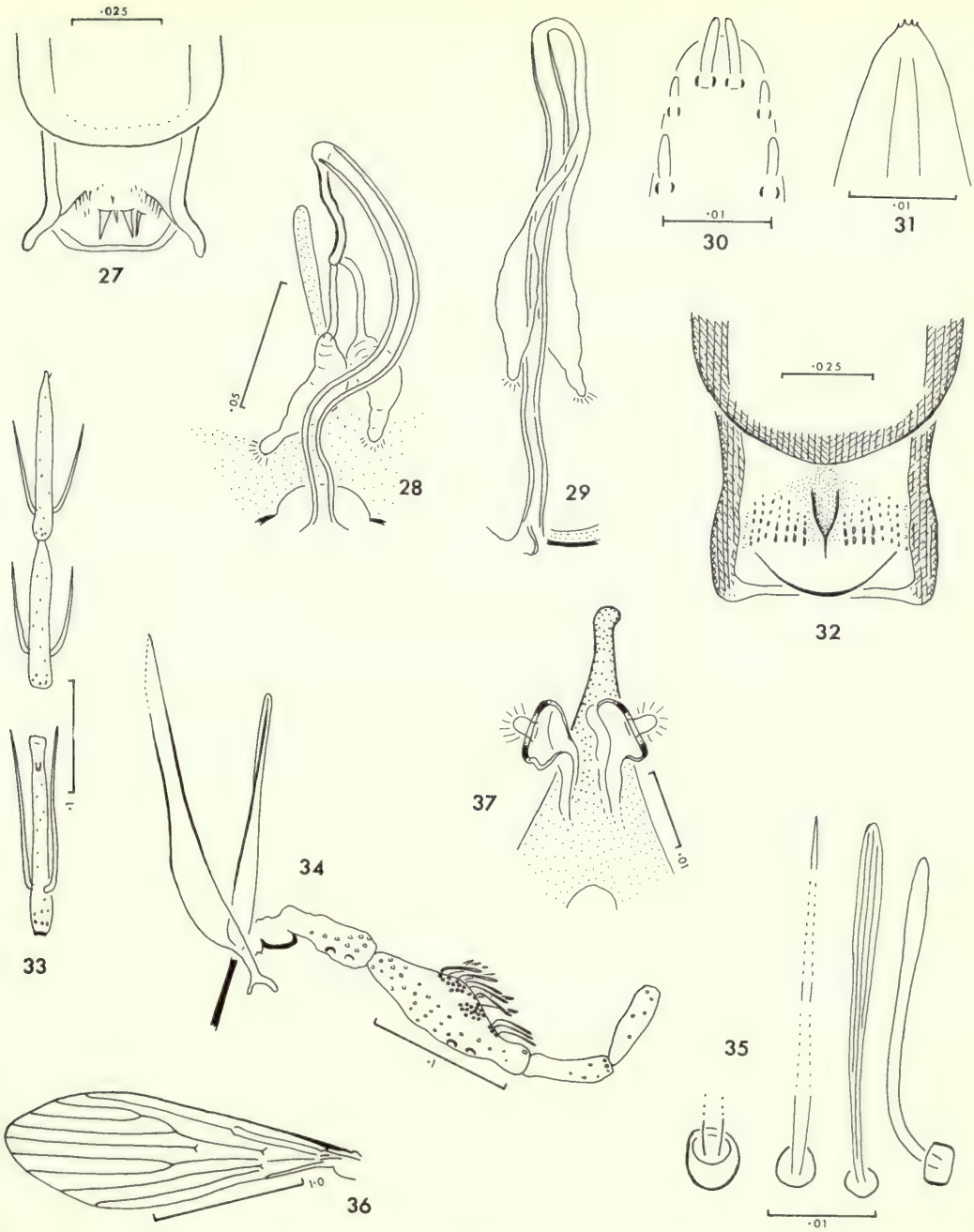
Phlebotomus (*Phlebotomus*) *maynei* Sinton; Parrot, 1940 : 310; Lewis, 1967 : 27; 1974*b* : 190.

The female has individual spermathecal ducts longer than the spermathecae and a very long thick-walled common duct. In the male the rods near the aedeagus are not longer than it. Most of the following description is adapted from those of Newstead, Parrot & Clastrier and Sinton (1923*a*; 1931*d*; 1933*d*), and based partly on the holotype. The species was figured by these authors and by Quate.

Quate & Fairchild (1961) mention a pigment patch, but Raynal (1935*b*), Raynal & Gaschen (1931*d*), Sinton (1931*d*) and Yao & Wu (1940) state that there is none, and I have not found one.

♀. Labrum 0·23–0·26 mm long. Cibarium with about 15 pointed denticles of various lengths, irregularly arranged, the two or three median ones longer and stouter than the others. Pharynx two or less times wider posteriorly than anteriorly, with numerous posterior transverse folds, parallel and concentric, the hinder ones bearing short fine spicules; before the folds are numerous long strong pointed spines in a convex crescent. Hypopharynx with about 16 teeth on each side. Antenna 3 = 0·27–0·30 mm long, longer than 4 + 5, 1·1 length of labrum, two long ascoids on segments 3–15, those on 4 about 0·8 length of segment and reaching to or beyond its tip. Maxilla with nine lateral and 18 ventral teeth and a dental depth of 0·08 mm. Palpal formula 1–4–2–3–5 or 1–4–2–(3–5), ratio 10 : 29 : 46 : 19 : 50. Wing length 1·9 mm, width 0·58–0·61 mm, R_2/R_{2+3} 1·6–1·7, R_1 overlap 0·08–0·12 mm. Hind legs 3·55–3·75 mm long. Spermatheca fusiform, with 15 or 16 rings, neck thick and short, head more or less oblong, duct striated, common duct very long, about 1·5 length of individual ones, with thick wall.

♂. This was described mainly by Raynal & Gaschen (1935*d*) and Raynal (1935*b*).



Figs 27–37 *Phlebotomus* species. 27–29, *P. stantoni*, ♀ (from Java), cibarium and spermathecae. 30–37, *P. teshi*, ♀: (30, 31) tips of labrum and hypopharynx; (32) cibarium; (33) antennal segments 4, 15 and 16; (34) mandible and maxilla; (35) two hairs, a scale and a sensillum from palpal segment 3; (36) wing; (37) spermathecae.

MATERIAL EXAMINED.
Java: Djakarta (see under *S. perturbans*). **West Malaysia:** Gunong Besout Forest Reserve, 1 ♀ (hypopharynx and maxilla blade).

DISTRIBUTION. **China:** Hainan (Leng, 1964 : 127); Mencheong (Yao & Wu, 1940 : 97); Aihsien, Paoting (Yao & Wu, 1941*b* : 76); Mang-shih (Yao & Wu, 1941*c* : 79). **India:** Saharanpur (Sinton, 1930*b* : 195); Golaghat (Sinton, 1932*c* : 225); Sagar area (*H. Trapido*). **Java:** Jakarta (as above). **Laos:** Luang Prabang (Parrot and Clastrier, 1952 : 153); Ventiane (Quate, 1962*b* : 256); Thahkek (Raynal, 1935*b* : 241). **Sri Lanka:** Kalgoda (Theodor, 1938 : 269). **Thailand:** Bangkok (Raynal & Gaschen, 1934*a* : 532). **Vietnam (North):** Bac Muc, Coc Leu, Ha Giang, Lam, Nao Phu, Pho Moi, Phu Doan, Vinh Thuy, Yen Lay (Raynal, 1935*b* : 241); Hai Duong (Raynal, 1936 : 250); Cho Gan (Raynal & Gaschen, 1934*a* : 531). **Vietnam (South):** 22 km south of Nah Trang (Quate, 1962*b* : 256); Kim Son (Raynal, 1935*b* : 241). **West Malaysia:** Kuala Lumpur, Rantau Panjang light trap (Lewis, 1957 : 166); Batu (Quate, 1962*a* : 226).

Raynal (1936*a* : 350, 357) reported that *P. stantoni* seemed rare in India and was common in Indo-China, being abundant between latitudes 20° and 30°.

UNGROUPED

Phlebotomus newsteadi Sinton

(Map 5)

Phlebotomus newsteadi Sinton, 1926 : 559; 1928*a* : 589 [♀]; 1932*a* : 58; 1933*e* : 418; Theodor, 1948 : 418. LECTOTYPE ♂, INDIA: Kasauli; labelled 'Type ♂ . . . Rabbit houses, Pasteur Institute, Kasauli, Punjab, 28/8/25' (BMNH), here designated [examined].

In the female the pharyngeal armature is well developed and the spermatheca is moniliform. In the male there are two spines near the aedeagus, the paramere ends like a crochet-hook, three of the spines on the style are apical or subapical, and the haltere is flattened.

Theodor placed this species provisionally in *Euphlebotomus*, but inspection of the lectotype (below) suggests that it is outside the subgenera.

MATERIAL EXAMINED.
India: Kasauli, 1 ♂, as above.

DISTRIBUTION. **India:** Kasauli, Kurseong (Sinton, 1928*c* : 310).

P. newsteadi, like *P. major*, is a hill species (Sinton, 1932*a*).

Subgenus ***IDIOPHLEBOTOMUS*** Quate & Fairchild

Phlebotomus subgenus *Idiophlebotomus* Quate & Fairchild, 1961 : 208; Theodor, 1965 : 176; Lewis, 1973 : 162; Lewis & Lane, 1976 : 53; Abonnenc & Léger, 1976 : 76. Type-species: *Phlebotomus asperulus* Quate & Fairchild, 1961, by original designation.
Idiophlebotomus Quate & Fairchild; Abonnenc, 1972 : 69, 75.

The cibarium has teeth, the pharynx is unarmed and the palp short. A pair of rods is associated with the genital filaments. All the species are Oriental and most occur in caves. The redefinition by Lewis & Lane should be altered as follows.

Pigment patch absent in all species but one. Antenna 3 with sub-basal swelling and beyond it a slight depression bearing non-spatulate sensilla.

Phlebotomus* (*Idiophlebotomus*) *asperulus Quate & Fairchild

(Map 5)

Phlebotomus (*Idiophlebotomus*) *asperulus* Quate & Fairchild, 1961 : 208; Lewis & Lane, 1976 : 54. Holotype ♂, WEST MALAYSIA (BPBM) [not examined].

The female has a cibarial median rod with large serrations, and the male has an apical spine on the style which is markedly expanded.

DISTRIBUTION. **West Malaysia:** Betis (Lewis & Wharton, 1963); Kuala Lumpur (Quate & Fairchild, 1961; McClure *et al.*, 1967 : 422).

Phlebotomus (*Idiophlebotomus*) *erebicolus* Quate

(Map 5)

Phlebotomus (*Idiophlebotomus*) *erebicolus* Quate, 1965 : 22; Lewis & Lane, 1976 : 57. Holotype ♂, PHILIPPINES (BPBM) [not examined].

The female has a cibarial median rod and a few granulose spicular teeth, and the male has three spines on the style.

DISTRIBUTION. **Philippines:** Mainit Lake (Quate, 1965).

Phlebotomus (*Idiophlebotomus*) *frondifer* Lewis & Lane

(Map 5)

Phlebotomus (*Idiophlebotomus*) *frondifer* Lewis & Lane, 1976 : 57. Holotype ♂, WEST MALAYSIA (BMNH) [examined].

The female has a median rod in the cibarium and very long parallel teeth, and the male has a leaf-like aedeagus and four spines on the style.

DISTRIBUTION. **West Malaysia:** Gunong Besout Forest Reserve (Lewis & Lane, 1976).

Phlebotomus (*Idiophlebotomus*) *pholetor* Quate & Fairchild

(Map 5)

Phlebotomus (*Idiophlebotomus*) *pholetor* Quate & Fairchild, 1961 : 210; Lewis & Lane, 1976 : 57. Holotype ♂, BORNEO: Sabah (BPBM) [not examined].

The female has a cibarial median rod and short teeth, and the male has five spines on the style.

DISTRIBUTION. **Borneo** (Sabah): Gomantong (Quate & Fairchild, 1961). **Philippines:** Eran area (Quate, 1965 : 24).

Phlebotomus (*Idiophlebotomus*) *sejunctus* Quate

(Map 5)

Phlebotomus (*Idiophlebotomus*) *sejunctus* Quate, 1965 : 20. Holotype ♀, PHILIPPINES (BPBM) [not examined].

The female has a cibarium with no median rod and very long anterior teeth.

DISTRIBUTION. **Philippines:** Mainit Lake (Quate, 1965).

Phlebotomus (*Idiophlebotomus*) *stellae* Quate

(Map 5)

Phlebotomus (*Idiophlebotomus*) *stellae* Quate, 1965 : 20; Lewis & Lane, 1976 : 59. Holotype ♂, PHILIPPINES (BPBM) [not examined].

The female has no median cibarial rod and very small teeth, and the male has five spines on the style.

DISTRIBUTION. **Philippines:** Minglanille (Quate, 1965).

Phlebotomus (*Idiophlebotomus*) *teshi* Lewis **sp. n.**

(Map 5)

The female differs from other species of *Idiophlebotomus* in having a cibarial pigment patch and a median large short tooth.

♀. Labrum 0·20 mm long, 0·08 length of wing, with two apical sensilla prominent, and reduced adoral sensilla. Cibarium with chitinous arch far back, a very marked hind bulge, a large pigment patch, a median very thick tooth and, on each side, about seven longitudinal rows of four to six teeth. Pharynx with bulge twice as wide as fore part, and narrow hind opening with minute spicules. Hypopharynx smooth with a few spicules at tip. Antenna 1 and 2 large, segment 3 = 0·58 mm long, 0·24 length of wing, 1·66 length of 4+5, 2·94 length of labrum, two strong ascoids on segments 3–16, that on 4 = 0·87 length of segment and reaching next one, a papilla on 3–5. Mandible pointed, with small teeth and no submedian pit. Maxilla toothless and shorter than mandible; palpal ratio 10 : 14 : 41 : 19 : 20; with a rather diffuse patch of slightly club-shaped sensilla. Thorax pale, without pleural hairs, inter-precoxal lobes broad. Wing length 2·40 mm, 2·9 times width, R_2/R_{2+3} = 2·92, R_1 apex/R_2 = 0·54. Leg ratios: fore (1·04 mm), 10 : 12 : 9; mid (0·96 mm), 10 : 17 : 9; hind (1·00 mm), 10 : 19 : 14. Abdominal tergites 2–6 (as in *P. frondifer* Lewis & Lane) with scattered erect hairs but few in mid line in hind halves of segments. Each spermatheca having a short capsule with a very thick wall near the head, ducts thin-walled and indistinct; furca with broad fore arm.

This species is named in appreciation of Dr R. B. Tesh's studies of sandfly fever viruses and Malaysian sandflies.

MATERIAL EXAMINED.
Holotype ♀, **Nepal:** Pokhara, 18–27.ix.1965 (*L. Quate*), 910 m, Malaise trap, a little red blood in abdomen (BPBM).

Phlebotomus (*Idiophlebotomus*) *tubifer* Lewis & Lane

(Map 5)

Phlebotomus (*Idiophlebotomus*) *tubifer* Lewis & Lane, 1976 : 59. Holotype ♀, INDIA (BMNH) [examined].

The female has a median cibarial rod and teeth on radiating lines. The male has been discovered by Dr G. B. Modi (1972, in letter).

DISTRIBUTION. **India:** Mahableshwar (Lewis & Lane, 1976).

Genus *SERGENTOMYIA* França & Parrot

Phlebotomus subgenus *Newsteadia* França, 1919 : 148. Type-species: *Hebotomus minutus* Rondani, 1843, by subsequent designation of França, 1920 : 234. [Homonym of *Newsteadia* Green, 1902.]
Phlebotomus subgenus *Sergentomyia* França & Parrot, 1920 : 699; Fairchild, 1951 : 12; Quate, 1964 : 249. [Replacement name for *Newsteadia* França.]
[*Neophlebotomus* França & Parrot, 1920 : 699. Incorrectly treated as synonym, now recognized as subgenus.]
Phlebotomus subgenus *Prophlebotomus* França & Parrot, 1921 : 281. Type-species: *Hebotomus minutus* Rondani, 1843 : 265, by monotypy. [Synonymized by Theodor, 1948 : 88.]
Sergentomyia França & Parrot; Theodor, 1948 : 100; 1958 : 33; 1965 : 179; Perfil'ev, 1968 : 295.
Sergentomyia subgenus *Sergentomyia* França & Parrot; Theodor, 1948 : 101; 1958 : 36; Kirk & Lewis, 1951 : 409; Perfil'ev, 1968 : 214, 298; Abonnenc, 1972 : 69.

The cibarium has a definite row of teeth and a pigment patch. The style of the male has four spines and an accessory seta. The genus is widely distributed in the Old World tropics and subtropics.

In early papers on Indian sandflies, mainly before 1928, '*P. minutus*' refers to one or more species of the genus *Sergentomyia*, particularly the common *S. babu*. This was because the taxonomic importance of cibarial teeth and spermathecae was unknown till 1926, and (Sinton, 1928*b* : 185) because *S. babu* was wrongly thought by Annandale (1911*b*) to be the Palaearctic *S. minuta* (Parrot).

The *musai*-group

This group is here proposed for the single species *S. musai*.

Sergentomyia musai Lewis **sp. n.**

(Figs 38–50, Map 6)

The cibarium of the female has 12 long thread-like teeth and no fore teeth or pigment patch.

♀. Labrum 0·22 mm long, 0·14 length of wing, with only two subapical sensilla and small adorals. Cibarium with 12 long thread-like teeth, no pigment patch and a weak arch; salivary pump inapparent. Pharynx damaged but showing lines and denticles. Hypopharynx with short row of nine teeth on each side. Antenna 3 = 0·27 mm long, 0·17 length of wing, 1·01 length of 4 + 5, 1·20 length of labrum, two ascoids on segments 3–15, that on 5 being 0·9 length of segment, papilla present on 5; hairs directed outward and forward. Maxilla with no lateral teeth, 37 small but stout ventrals, and a dental depth of 0·05 mm; palpal ratio 10 : 25 : 35 : 19 : 35; segment 3 with a few scattered spatulate sensilla, hair-like at some angles. Scutum and pleuron pale, mesepisternum without hairs. Wing 1·58 mm long, 3·04 as long as wide, R_2/R_{2+3} 1·95, R_1 overlap/R_2 0·66. Leg ratios: fore (0·62 mm), 10 : 11·5 : –; mid (0·63 mm), 10 : 12·8 : 7·7; hind (0·67 mm), 10 : 14·4 : –. Abdominal tergites 2–6 with many erect hairs and a few recumbent ones near middle line. Spermatheca not fully visible but apparently simple.

Comment. This very unusual species differs from most *Sergentomyia* in its two labral subapical sensilla, shape of cibarial teeth, hypopharynx, papilla on antenna 5, maxillary dentition, short palpal segments 4 and 5 and nature of sensilla, and many abdominal erect hairs. *S. musai* possesses several features of both *Phlebotomus* and *Sergentomyia*, and is placed, for the present, among the ungrouped species of the latter. The hypopharynx and abdominal hairs of *S. musai* may indicate relationship to the subgenus *Parvidens* Theodor & Mesghali. It is named after Musa bin Long of the Arbovirus Unit, Kuala Lumpur, who collected many sandflies in West Malaysia.

Material examined.
Holotype ♀, **Borneo:** Sabah, Kalabakan area, 29.x.1962 (*K. J. Kuncheria*), forest camp 19 km north of Kalabakan, 60 m (BPBM).

Subgenus *SERGENTOMYIA* França & Parrot

Sergentomyia subgenus *Sergentomyia* França & Parrot; Theodor, 1948 : 101; 1958 : 36; Perfil'ev, 1968 : 298.

The spermatheca is tubular with smooth sides and a wide duct, and the aedeagus is thick. The subgenus is represented in the west of the Region.

Sergentomyia (*Sergentomyia*) *dentata* (Sinton)

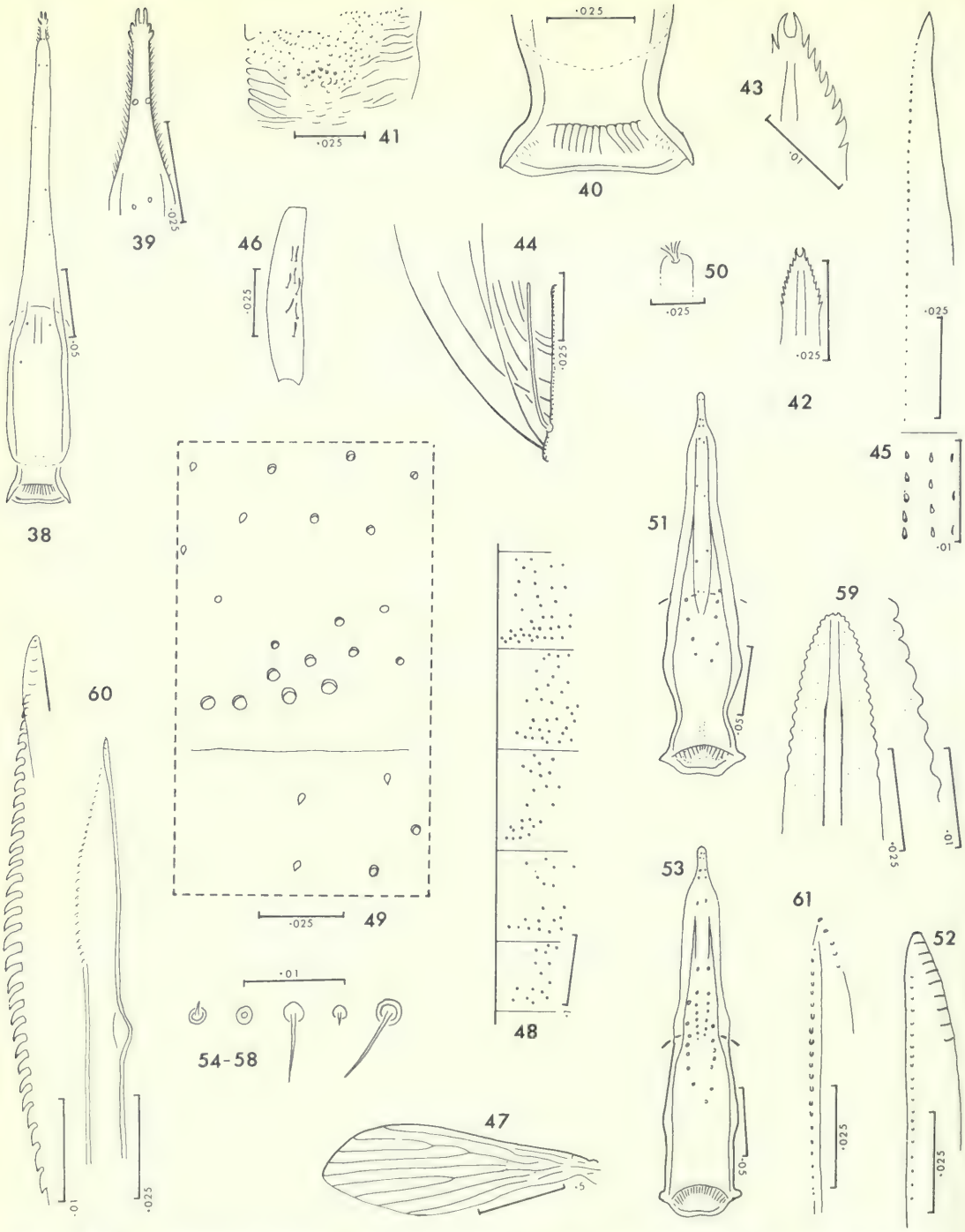
(Figs 51, 52, Map 6)

Phlebotomus dentatus Sinton, 1933*a* : 869; 1933*d* : 228. Lectotype ♀, Pakistan (BMNH), designated by Lewis, 1967 : 25 [examined].
Sergentomyia (*Sergentomyia*) *dentata* (Sinton); Theodor, 1958 : 39 [in part]; Lewis, 1967 : 25; 1974*b* : 190.

In the cibarium of the female about four teeth on each side are much larger than the middle ones.

♀ (*extra facts*). Hypopharynx with distinct low rounded teeth. Mandible (as in *S. punjabensis*) with rather blunt tip, and teeth large except near tip. Maxilla with ten broad lateral teeth, 20 distinct ventrals, and a dental depth of 0·08 mm.

Material examined.
Pakistan: Landi Kotal.



Figs 38–61 *Sergentomyia* species. 38–50, *S. musai*, ♀: (38) labrocibarium; (39) tip of labrum; (40) cibarium; (41) part of pharynx; (42, 43) tip of hypopharynx; (44) one side of antenna 6; (45) maxilla; (46) palp segment 3; (47) wing; (48, 49) sockets of erect hairs on abdominal tergites 2–6 and on parts of 3 and 4; (50) tip of spermatheca. 51, 52, *S. dentata*, ♀ (from Landi Kotal), labrocibarium and maxilla. 53–61, *S. punjabensis*, ♀: (53) labrocibarium; (54–58) subapical sensillum no. 2, adoral sensilla nos 1, 4 and 7, cibarial sensillum no. 5; (59) hypopharynx; (60) mandible; (61) maxilla.

DISTRIBUTION. **Pakistan:** Gwadi, Landi Kotal, Peshawar, Rawalpindi (Lewis, 1967 : 25); Quetta (Sinton, 1933*a* : 869).

Sergentomyia (*Sergentomyia*) *punjabensis* (Sinton)

(Figs 53–61, Map 6)

Phlebotomus antennatus Newstead; Sinton, 1927*e* : 31; 1933*e* : 421.
Phlebotomus minutus var. *antennatus* Newstead; Sinton, 1924*a* : 812; 1932*a* : 61 [♀]; 1933*e* : 421; Qutubuddin, 1952 : 79.
Phlebotomus punjabensis Sinton, 1933*e* : 421. Conditional name available under ICZN Article 17(8). No type-data (INDO-PAKISTAN, specially Punjab) [not examined].
Sergentomyia (*Sergentomyia*) *punjabensis* (Sinton); Theodor, 1948 : 109; Lewis, 1967 : 27; 1974*b* : 190.
Sergentomyia punjabensis (Sinton); Qutubuddin, 1951 : 36.
Phlebotomus antennatus var. *deccanensis* Qutubuddin, 1952 : 79. Syntype ♂, INDIA (depository unknown) [not examined]. [Synonymized by Lewis, 1967 : 27.]

The pharynx of the female is very wide posteriorly, and its armature has a deep acute hind notch and many teeth of which the posterior ones are very small. The cibarial teeth are nearly equal in size.

♀ (*extra facts*). Labrum with adoral sensilla not differentiated into two groups, most of them about as large as cibarials, some of each with long processes. Hypopharynx with distinct rounded main teeth, most nearly twice as long as high. Mandible with large main teeth. Maxilla with strong teeth, five laterals and 22 ventrals, and a dental depth of 0·07 mm.

MATERIAL EXAMINED.
Pakistan: Shahzada (near Lahore).

DISTRIBUTION. **India:** Hardwar, Khandwa, Nagpur, Patiala (BMNH); Aurangabad (*V. Dhanda*); Ajmer area, Jaipur, Jalor, Kota area, Sirohi area (Kaul *et al.*, 1973 : 533); Jammu (Mitra & Roy, 1953*a* : 324); Hyderabad (Qutubuddin, 1944 : 208); Vellore (*R. Reuben*); Bikaner (Sharma *et al.*, 1973*c*); Bhavnagar, Bissamcuttack, Bombay, Calcutta, Chandigarh, Cochin area, Delhi, Itaunia, Junagadh, Kamptee, Karnal, Madras, Parbitapur, Pinjaur, Pipariya, Pipli, Secunderabad, Singarama (Sinton's notes, as *P. antennatus*); Panchgani, Wai area (*H. Trapido*). **Pakistan:** Dehra Ismail Khan, Jhelum, Khanki, Kohat area, Lahore, Peshawar, Rawalpindi, Said Pur (Lewis, 1967 : 28); Bannu, Lyallpur, Sargodha, Tank (Sinton's notes). **Sri Lanka:** Delft Island (Carter & Antonipulle, 1949 : 68).

Sinton (1932*a*) reported that '*P. minutus* var. *antennatus*' (=*S. punjabensis*) had a more general distribution over the Indo-Pakistan plains than did '*P. minutus*' (=*S. theodori*).

Sergentomyia (*Sergentomyia*) *theodori* (Parrot)

[*Phlebotomus minutus* (Rondani, 1840 : 263); Adler & Theodor, 1926 : 403; Sinton, 1932*a* : 73; 1933*e* : 422; Parrot, 1942 : 330, 331. In part.]
Phlebotomus (*Prophlebotomus*) *theodori* Parrot, 1942 : 332. [Replacement name for *minutus* auctorum from Palestine.]
Sergentomyia (*Sergentomyia*) *theodori* (Parrot); Theodor, 1948 : 101; 1958 : 41; Theodor & Mesghali, 1964 : 294.
Sergentomyia (*Sergentomyia*) *dentata* (Sinton) form *theodori*; Lewis, 1974*b* : 191.

This belongs to a complex of closely related species and variants (Lewis, 1974*b*), and its female has a wider pharynx than in typical *S. dentata*.

Sergentomyia (*Sergentomyia*) *theodori pashtunica* Artemiev

(Map 6)

Phlebotomus minutus (Rondani); Sinton, 1932*a* : 61, 73 [in part]; 1933*d* : 421 [in part].
Sergentomyia (*Sergentomyia*) *theodori* (Parrot); Lewis, 1967 : 27.

Sergentomyia (*Sergentomyia*) *theodori pashtunica* Artemiev, 1974*b* : 333. Syntypes 124 ♀, 209 ♂, AFGHANISTAN (depository unknown) [not examined].

In the female, *S. t. pashtunica* has fewer cibarial teeth (22 = 18–24) and a shorter labrum (0·14 = 0·13–0·16 mm) than the nominate form, and in the male differs by having a shorter labrum (0·12–0·14) and shorter antenna 3 (0·10–0·11). Further study of variation and distribution is needed to settle the status of *S. theodori* and its subspecies.

♀ (*extra facts*). Fascicle much as in *S. dentata*, number of maxillary lateral teeth variable.

DISTRIBUTION. **Pakistan:** Dehra Ismail Khan, Kashmore, Landi Kotal, Larkana, Peshawar, Rawalpindi (Lewis, 1967 : 27).

Sinton (1932*a*) stated that '*P. minutus*' (=*S. theodori*) in the Indian subcontinent occurred chiefly in the north-western plains.

Subgenus ***PARROTOMYIA*** Theodor

Sergentomyia africana group Theodor, 1948 : 101.
Sergentomyia subgenus *Parrotomyia* Theodor, 1958 : 42; Perfil'ev, 1968 : 318; Artemiev, 1976*b* : 428 [some abdominal dorsal hairs erect in certain species]. Type-species: *Phlebotomus africanus* Newstead, 1912 : 363 (described as var.), by original designation.

A comb-like cibarial armature, lamp-glass-shaped pharynx, and elliptical capsular spermatheca are characteristic of many species, but it is sometimes necessary to consider all the characters given in couplet 69 of the key, and even they are not easily applicable in every case. The subgenus is large and widely distributed. Some species have a short R_2.

The species are here placed in the *africana*, *denticulata*, *babu* and *grekovi* series. In the *africana* series the ventral plate of the cibarium has no notch and the spermatheca is oblong. A few forms (*brevicaulis*, *himalayensis*, *mangana* and *queenslandi meridionalis*) differ somewhat from the rest in having a very high average, or sometimes maximum, number of cibarial hind teeth which may also be very long with the outer ones directed slightly outward. Members of the *denticulata*-group, which includes the Australasian *S. spinosior* (Quate & Quate), are like those of the *africana*-group but have numerous parallel teeth so narrow (apparently less than a micron wide) as to be invisible at most magnifications. The teeth are about as numerous as some in the *africana*-group which are visible because they occupy a wider space and lean outward near the edges. In the *babu*-group the ventral plate of the cibarium has a hind notch, and the spermatheca is oblong. In the *grekovi*-group the spermatheca is nearly spherical.

Sergentomyia (***Parrotomyia***) sp. (A) Kaul, Dhanda & Modi

(Map 6)

Sergentomyia (*Parrotomyia*) sp. A Kaul, Dhanda & Modi, 1973 : 535 [♂].

This species from the Kota district, India, may be a new one related to *S. grekovi*.

Sergentomyia (***Parrotomyia***) ***africana magna*** (Sinton) form ***asiatica*** Theodor **stat. n.**

(Map 6)

Phlebotomus africanus Newstead; Adler & Theodor, 1927 : 63 [Jericho]; Sinton, 1932*a* : 61; 1933*e* : 42.
Phlebotomus africanus var. *asiaticus* Theodor, 1933 : 541; 1952 : 116 [relation to Israel form unknown]. Syntypes, ISRAEL (TC) [not examined].
Sergentomyia (*Parrotomyia*) *africana* var. *asiatica* (Theodor); Theodor, 1948 : 110.
Sergentomyia (*Parrotomyia*) *africana asiatica* (Theodor); Theodor, 1958 : 45; Lewis, 1967 : 28; Perfil'ev, 1968 : 331.
Phlebotomus africanus asiaticus Theodor; Abonnenc & Yvore, 1969 : 184; Bailly-Choumara, Abonnenc & Pastre, 1971 : 454; Abonnenc, 1972 : 172.
Phlebotomus (*Sergentomyia*) *africanus asiaticus* Theodor; Abonnenc, 1972 : 172.

The cibarium of the female has 45–50 teeth in a concave row and no central patch of fore teeth, and the pigment patch is concave posteriorly and has a simple forward process, and there is no notch in the ventral plate. The pharynx has long teeth and the spermatheca is oblong.

The *S. africana* complex is mainly African and includes a number of forms which have a comb-like cibarial armature and oblong spermatheca, and have been variously treated as several species or as one by Quate (1964). His citation of 36 name-combinations occupies 137 lines and shows the confusion which existed for many years. He, Lewis (1974*b*) and others have emphasized the degree of intergradation between some named forms. There is so much variation that anyone with a large collection at his disposal could, if so minded, create still more names for local variants. For these reasons I regard *S. a. magna* as no more than a subspecies.

No certain specimens of the Pakistan form are available, but it probably belongs to a small northern form found in Morocco, Israel and India, which Abonnenc & Yvore (1969 : 184, 185) and Abonnenc (1972 : 172) treated as a subspecies of *africanus*. Rioux *et al.* (1975) regarded it as infra-subspecific. For the present I am treating the Pakistan form as a form of *S. a. magna*.

MATERIAL EXAMINED.
India: Palod (1934, *M. O. T. Iyengar*), 1 ♀ with about 38 hind teeth and a very concave pigment patch may be related.

DISTRIBUTION. **Pakistan:** Kandhkot, Rhedia, Shikarpur (Lewis, 1967 : 28).

Sergentomyia (*Parrotomyia*) sp. (B) Kaul, Dhanda & Modi

(Map 6)

Sergentomyia (*Parrotomyia*) sp. B Kaul, Dhanda & Modi, 1973 : 536 [♂].

Males from Kota district, India, may be a new species. It is provisionally put in the *africana*-group.

Sergentomyia (*Parrotomyia*) *babu* (Annandale)

Phlebotomus babu Annandale, 1910*b* : 49.

The cibarium of the female has a deep notch in the ventral wall and 24–50 teeth.

Sinton (1932*a* : 60; 1933*e* : 422) pointed out the close affinity between *S. babu*, *S. baghdadis* and *S. shorttii* but retained their specific status in view of their morphology and distribution. *S. babu* and *S. baghdadis* overlap in a considerable area with little intergradation, but many intermediate females, classed here as a *S. babu* variant, have been found in the Sagar (Shimoga) area. Females from Nander and Parbhani, intermediate between *S. baghdadis* and *S. shorttii*, are classed here as a *S. baghdadis* variant; typical *S. baghdadis* may not occur there. *S. babu* and *S. baghdadis*, and now *S. shorttii*, are known to overlap in large enough areas to be regarded as species, but their true status must await further knowledge.

Sergentomyia (*Parrotomyia*) *babu babu* (Annandale)

(Map 6)

Phlebotomus sp., Howlett *in* Maxwell-Lefroy, 1909 : 559 [?].
Phlebotomus babu Annandale, 1910*b* : 49; Sinton, 1927*e* : 31; 1928*b* : 185; 1928*c* : 314; 1932*a* : 60; 1933*d* : 422; Theodor, 1938 : 264 [24–34 cibarial teeth in ♀]. Lectotype ♂, INDIA (Zoological Survey of India, Calcutta), designated by Quate, 1962*c* : 158 [not examined].
Phlebotomus babu var. *niger* Annandale, 1911*c* : 320; Sinton, 1928*c* : 315; 1932*a* : 60. Type, INDIA (believed by Quate to be lost) [not examined]. [Synonymized by Sinton (1932*a*) and Quate (1962*c*).]
Phlebotomus minutus var. *niger* Annandale; Sinton, 1924*a* : 812; 1927*d* : 25; 1927*e* : 31.
Phlebotomus (*Prophlebotomus*) *babu* Annandale; Parrot, 1940 : 311.
Phlebotomus thapari Mitra & Roy, 1952 : 88. Holotype ♀, INDIA (depository unknown) [not examined]. **Syn. n.**

Phlebotomus (*Sergentomyia*) *babu* var. *niger* Annandale; Quate, 1962*c* : 158.
Phlebotomus (*Sergentomyia*) *babu* Annandale; Quate, 1962*c* : 157.
Sergentomyia (*Parrotomyia*) *babu* (Annandale); Lewis, 1967 : 88; Artemiev, 1976*b* : 422.

The cibarium of the female has 24–34 teeth. In an aberrant female from India in the BMNH, marked K1 by Sinton, vein R_2 is absent in one wing and very short in the other.

The form *thapari*, based on a single female, appears to be a synonym, and some of its features due to artefacts and interpretation.

DISTRIBUTION. **India:** Abu Mount, Badam Pahor, Delhi, Krishnagar, Nagpur, Osmanabad, Pinjaur, Saharanpur (BMNH); Aurangabad, Jalna, Patan (Farooq & Qutubuddin, 1945 : 85); Ajmer, Sambhar (Jaswant Singh, 1933); Tibi area (*N. L. Kalra*); Jalor, Kota, Sirohi (Kaul *et al.*, 1973 : 532); Calcutta, Poona, Pusa (Lewis, 1967 : 30); Allahabad, Asansol, Igatpuri, Palod Port Canning, Purnea, Rajmahal, Rambha, Trivandrum (Quate, 1962*c* : 158); Bikaner (Sharma *et al.*, 1973*c*); Bombay, Chindwara, Faizabad, Itarsi, Itaunia, Junaghad, Kamptee, Karnal, Kurseong, Mhow, Nabinagar, Panchmarhi, Patna (Orissa), Pipariya, Rajkot, Singanama, Titilagarh (Sinton's notes); Sagar (Shimoga) area (some typical, many with about 22 cibarial teeth), Wai (H. *Trapido*); Naini Tal (Wattal *et al.*, 1967). **Pakistan:** Cherat, Gilgit, Lahore, Kotal, Rawalpindi, Taxla (Lewis, 1967 : 30); Khanki (Sinton's notes).

According to Sinton (1928*c* : 315; 1932*a*), *S. babu* was the main component of '*P. minutus*' till 1928, and was evidently widely distributed over the Indo-Pakistan plains and foothills. Many localities of this common species are omitted from the above list.

Sergentomyia (*Parrotomyia*) *babu insularis* (Theodor)

(Map 6)

Phlebotomus babu var. *insularis* Theodor, 1938 : 264. Syntypes 6 ♀, 7 ♂, SRI LANKA (TC) [not examined].
Sergentomyia (*Sergentomyia*) *babu* var. *insularis* Theodor; Theodor, 1948 : 110.
Phlebotomus babu Annandale or ally [?]; Carter & Antonipulle, 1949 : 68.
Sergentomyia (*Sergentomyia*) *babu insularis* Theodor; Lewis, 1973*a* : 249.

The cibarial teeth of the female number 45–50. There is much variation in the number of teeth in some species of *Parrotomyia*, and this form is treated as a subspecies partly owing to its geographic isolation.

DISTRIBUTION. **Sri Lanka:** Depanama, Maharamgama, Pannipitiya (Theodor, 1938 : 266).

Sergentomyia (*Parrotomyia*) *baghdadis* (Adler & Theodor)

(Map 7)

Phlebotomus baghdadis Adler & Theodor, 1929 : 281; Sinton, 1932*a* : 60; 1933*e* : 422. ♀♂ syntypes, IRAQ (TC) [not examined].
Sergentomyia (*Parrotomyia*) *baghdadis* (Adler & Theodor); Lewis, 1967 : 30; Artemiev, 1976*b* : 424.

The female has about 16–20 cibarial teeth, a notch near them, and a weak pharyngeal armature.

DISTRIBUTION. **India:** Nander and Parbhani (with 16–18 rather uniform cibarial teeth and a small or very small notch, *V. Dhanda*); Riasi (Jacob & Kalra, 1951 : 325); Ajmer, Sambhar (Jaswant Singh, 1933); Jaipur, Kota (Kaul *et al.*, 1973 : 532); Punch, Rajouri (Mitra, 1959 : 62); Ferozepore, Karnal (Sinton's notes). **Pakistan:** Sukkur (BMNH); Bannu, Dehra Ismail Khan, Gujranwala, Gujrat, Jandola, Jhelum Kandhkot, Kashmore, Lahore, Landi Kotal, Larkana, Lyallpur, Mir Muhammad, Pano Aqil, Peshawar, Rawalpindi, Rohri, Said Pur, Sarghoda, Shikarpur, Tank, Taxla (Lewis, 1967 : 31).

In the Indian subcontinent this species occurs in the west and north-west (Sinton, 1932*a*).

Sergentomyia (*Parrotomyia*) *barraudi* (Sinton)

(Figs 62–69, Map 7)

Phlebotomus barraudi Sinton, 1929*a* : 716; 1932*a* : 61; 1933*e* : 422; Raynal & Gaschen, 1934*b* : 559; 1935*a* : 113; Raynal, 1935*b* : 285; Theodor, 1933 : 542 [variety of *africana* ?]; 1938 : 268 [variation]; Tonnoir, 1935 : 142; Yao & Wu, 1941*b* : 78. Syntypes ♀ ♂, INDIA (depository unknown) [not examined].

Phlebotomus (*Prophlebotomus*) *barraudi* Sinton; Parrot, 1937 : 120; 1940 : 311; 1946 : 70; Parrot & Clastrier, 1952 : 158.

Phlebotomus barraudi var. *siamensis* Causey, 1938 : 488. Syntypes 2 ♀, THAILAND (depository unknown) [not examined]. [Synonymized by Quate, 1962*b* : 261.]

Phlebotomus barraudi var. *kwangsiensis* Yao & Wu, 1941*a* : 67; 1941*b* : 77. Syntypes 2 ♀, 1 ♂, CHINA (depository unknown) [not examined]. [Synonymized by Quate, 1962*b* : 261.]

Phlebotomus barraudi var. *siulamensis* Chen & Hsu, 1955 : 302; Leng, 1964 : 124, 127. Syntypes, CHINA: Samshuihsien (Hua Nan Medical College, Canton) [not examined]. **Syn. n.**

Sergentomyia (*Parrotomyia*) *barraudi* (Sinton); Theodor, 1958 : 44; Lewis & Dyce, 1976 : 208.

Phlebotomus (*Sergentomyia*) *barraudi* Sinton; Quate, 1962*b* : 261; Cates & Lien, 1970 : 535.

The normally bifid shape of the pigment patch of the female is a characteristic feature of this species. The number of cibarial teeth in the female is recorded by Causey, Chen & Hsu, Lewis & Dyce, Quate, Raynal (1935), Sinton (1929) and Theodor, and ranges from about 40 to about 70, being particularly high in some eastern areas. The following note is based on females from West Malaysia.

♀. Tip of labrum small and median apical sensilla prominent. Hypopharyngeal teeth delicate. Mandible pointed. Maxilla with 2·8 (2–4) lateral nodular teeth and 35·4 (35–36) ventrals (n = 5); dental depth 0·10 mm; lateral teeth distinctly smaller in West Malaysia than in India and East Timor.

Professor O. Theodor informed me (1971, in letter) that specimens from Taiwan resemble the type form in general but differ in having a shorter antenna 3 in the female and a short wide pigment patch like that of some Chinese specimens. He remarked that the species seemed to have some local forms and that more material was necessary for assessing their status.

MATERIAL EXAMINED.
Hong Kong: Hong Kong (*G. W. Chau*), 1 ♀ (with 64 hind teeth and faint or no pigment patch, and much indented cibarium and pharynx), 2 ♀ (with about 70 teeth). **Java:** Semarang, ii.1910 (*E. Jacobson*), 1 ♀ (with some 90 cibarial teeth about 6 μm wide, a partly divided process of the pigment patch, and a nodular hind margin of the cibarial ventral plate; it may be related to *S. barraudi*). **West Malaysia:** Gunong Besout area.

DISTRIBUTION. **Bangladesh:** Dhurmakura (Sinton's notes). **Burma:** Mezali (Sinton's notes). **Cambodia:** Phnom Penh (Parrot & Clastrier, 1952 : 153). **China:** Sainan, Suilam (Chen & Hsu, 1955 : 302); Hainan (Leng, 1964 : 127); Se-Tchouen (Gaschen, 1934 : 890; Raynal, 1935*b* : 290); Mang-shih, Nanning, Tienpao (Yao & Wu, 1941*a* : 67; 1941*c* : 79). **Hong Kong:** (as above). **India:** Golaghat (Sinton, 1929*a* : 716); Gauhati (Sinton's notes). **Laos:** Vientiane (Quate, 1962*b* : 261); Xieng Khouang (Raynal, 1935*b* : 290). **Nusa Tenggara:** Dili, Sumbawa (Lewis & Dyce, 1976 : 208). **Japan:** Ryukyu Retto, Iriomote Island (Ohara), 1963 (*G. A. Samuelson*), 1 ♀; R. R., Ishigaki Island (Banna), 1963 and 1964 (*J. L. Gressitt & G. A. Samuelson*, U.S.–Japan Cooperative Scientific Programme), via BPBM, 18 ♀, 1 ♂, the only species found. **Taiwan:** Hengchun (*C. M. Yoshimoto*); Hualien area, Tapei area, Taitung (Cates & Lien, 1970 : 537, *T. C. Maa*); Kuraru (*C. M. Yoshimoto*). **Thailand:** Bangkok (Causey, 1938 : 388); Phra Phuttabat area (Quate, 1962*b* : 261). **Vietnam (North):** Cho Ganh (Raynal, 1935*b* : 290). **Vietnam (South):** Di Linh (Quate, 1962*b* : 261); Duc Pho (Raynal, 1935*b* : 290). **West Malaysia:** Gunong Besout Forest Reserve (*A. B. Knudsen & colleagues*); Klang, Ulu Gombak (*D. J. Lewis*); Kuantan, Tanjong Rabok (*A. Rudnick*).

In Indo-Burma Sinton (1932*a*) knew *S. barraudi* only from Assam and Burma. In Indo-China Raynal (1936*a* : 366) found it between 15° and 25° north, where it was abundant at 1200 and 1600 m in particular, and he regarded it as a hill species.

Sergentomyia (*Parrotomyia*) *bigtii* (Manalang)

(Map 7)

Phlebotomus bigtii Manalang, 1931 : 356; Raynal, 1935*a* : photograph 18; Quate & Rosario, 1962 : 797;

Quate, 1965 : 28. Lectotype ♀, PHILIPPINES (on loan to BPBM), designated by Quate, 1965 : 28 [not examined].

The female of this large species has 10–12 bent pointed teeth, a rather narrow dark pigment patch and a thick mass of pharyngeal teeth.

DISTRIBUTION. **Philippines:** Bigti, Malinao (Quate, 1965 : 28).

Sergentomyia (*Parrotomyia*) *brevicaulis* (Quate)

(Map 7)

Phlebotomus (*Sergentomyia*) *brevicaulis* Quate, 1962*b* : 256. Holotype ♀, VIETNAM (SOUTH) (BPBM) [not examined].

This is a large species with, in the female, about 73 cibarial hind teeth (number taken from figure), about 50 fore teeth in one row, a large pigment patch and long antenna 3 and R_2.

DISTRIBUTION. **Vietnam (South):** Di Linh area (Quate, 1962*b* : 259).

Sergentomyia (*Parrotomyia*) *brevinervis* (Quate & Fairchild)

(Map 7)

Phlebotomus (*Sergentomyia*) *brevinervis* Quate & Fairchild, 1961 : 214 [♂]. Holotype ♂, BORNEO (BPBM) [not examined].

In the male there are 14 cibarial hind teeth and 13 fore teeth, no pigment patch, short antenna 3 and a narrow wing with short R_2. The authors compared the male with *S. babu*. The species is placed provisionally in the *africana*-group.

DISTRIBUTION. **Borneo** (Sabah): Ranau (Quate & Fairchild, 1961 : 214).

Sergentomyia (*Parrotomyia*) *bukidnonis* (Quate)

(Map 7)

Phlebotomus (*Sergentomyia*) *bukidnonis* Quate, 1965 : 33. Holotype ♀, PHILIPPINES (BPBM) [not examined].

In the female of this small species the broad cibarium has 30–34 sharp teeth in a crown-like row and 18–24 fore teeth in one row, the pharynx is unarmed, antenna 3 is short, palpal segment 4 is long, and R_2 is longer than R_{2+3}.

DISTRIBUTION. **Philippines:** Cuernos de Negros, Katanglad Mountain (Quate, 1965 : 33).

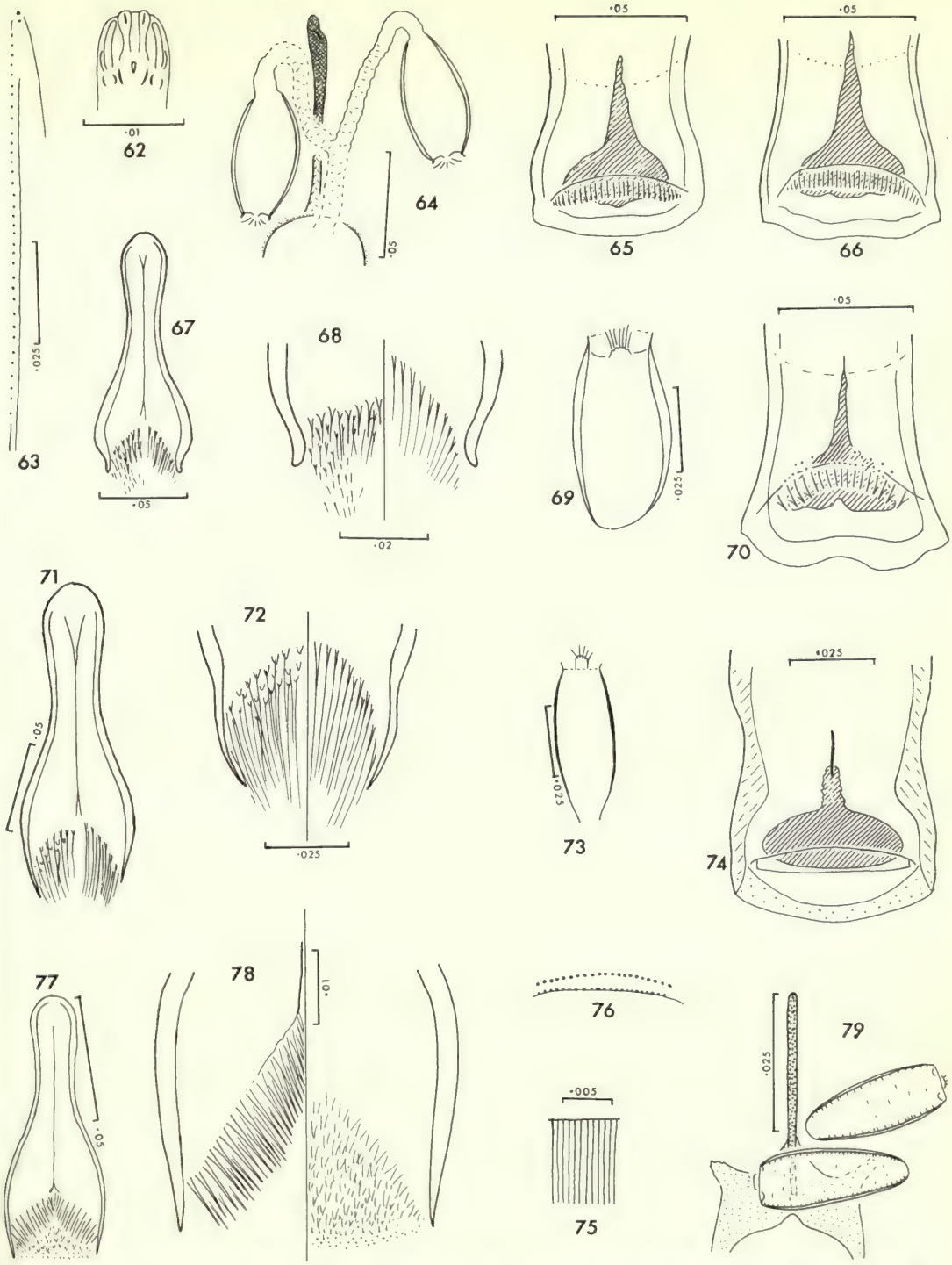
Sergentomyia (*Parrotomyia*) *dayapensis* (Manalang)

(Map 7)

Phlebotomus dayapensis Manalang, 1931 : 358; Raynal, 1935*a* : photograph 17. Holotype ♀, PHILIPPINES (destroyed, according to Quate & Rosario) [not examined].
Phlebotomus (*Sergentomyia*) *dayapensis* Manalang; Quate & Rosario, 1962 : 793 [specificity of ♂ questioned].

In the female the cibarium has some 24 teeth and a broad pigment patch, the pharynx is unarmed, and R_2 equals R_{2+3}.

DISTRIBUTION. **Philippines:** Dayap (Manalang, 1931 : 355).



Figs 62–79 *Sergentomyia* species. 62–64, *S. barraudi*, ♀ (from Gunong Besout area), labral tip, maxilla and spermatheca. 65–69, *S. kauli*, ♀: (65, 66) cibarium; (67, 68) pharynx; (69) spermatheca. 70–73, *S. modii*, ♀: (70) cibarium; (71, 72) pharynx; (73) spermatheca. 74–79, *S. rudnicki*, ♀: (74–76) cibarium, hind teeth, and fore teeth after KOH treatment; (77, 78) pharynx; (79) spermatheca.

Sergentomyia (*Parrotomyia*) *denticulata* (Quate & Fairchild)

(Map 7)

Phlebotomus (*Sergentomyia*) *denticulatus* Quate & Fairchild, 1961 : 216. Holotype ♀, BORNEO (BPBM) [not examined].

The cibarium of the female has about 90 teeth pointing upward, each one being very narrow (apparently less than 1 μm wide) so that at most magnifications the armature looks like a sheet of chitin. The fore teeth number about 20, the pharynx is unarmed, the scutum is brown, and R_2/R_{2+3} is about 1·9. Labrum 0·09 length of wing, in a female paratype.

A female from Sepilok is provisionally placed in this species although its labrum is 1·25 length of wing and the cibarial teeth are scarcely visible, perhaps obscured by food or other structures.

DISTRIBUTION. **Borneo** (Sabah): Sepilok (*D. J. Lewis*, ?1 ♀); Gomantong Caves, Ranau (Quate & Fairchild, 1961 : 217).

Sergentomyia (*Parrotomyia*) *franciscana* (Quate)

(Map 7)

Phlebotomus (*Sergentomyia*) *franciscanus* Quate, 1965 : 33. Holotype ♀, PHILIPPINES (BPBM) [not examined].

In the female the cibarium has 24–26 teeth in a crown-like row and 14–18 fore teeth in one row, the pharynx is unarmed, and R_2 is shorter than R_{2+3}.

DISTRIBUTION. **Philippines:** San Francisco area (Quate, 1965 : 33).

Sergentomyia (*Parrotomyia*) *grekovi* (Khodukin)

(Map 7)

Phlebotomus grekovi Khodukin, 1929 : 101. Syntypes ♀, ♂, U.S.S.R. (depository unknown) [not examined].

Sergentomyia (*Parrotomyia*) *grekovi* (Khodukin); Theodor, 1958 : 44; Lewis, 1967 : 32; Perfil'ev, 1968 : 319; Artemiev, 1976*b* : 425.

In the female the cibarium has 18–35 teeth, possibly indicating more than one form, and the spermatheca is nearly spherical. Artemiev, in Afghanistan, noted much variation in numbers of teeth, and the presence of some erect hairs on certain abdominal tergites.

DISTRIBUTION. **Pakistan:** Gilgit (Lewis, 1967 : 34).

Sergentomyia (*Parrotomyia*) *himalayensis* (Annandale)

(Map 7)

Phlebotomus himalayensis Annandale, 1910*b* : 50; Sinton, 1924*a* : 811; 1924*b* : 321; 1931*b* : 828; 1932*a* : 62 [♀]; 1933*e* : 421. Lectotype ♀, INDIA (Zoological Survey of India), designated by Quate, 1962*c* : 158 [not examined].

Phlebotomus (*Sergentomyia*) *himalayensis* Annandale; Quate, 1962*c* : 158.

The female has about 80–100 cibarial hind teeth in a slightly concave line and a triradiate pigment patch, and many short stout pharyngeal teeth. The male has about 40 cibarial teeth and its style bears at or near the tip three large spines, one small spine and the usual seta.

MATERIAL EXAMINED.

Three females from the Jog-Sagar area of **India** (*H. Trapido*), with 66 hind teeth and a roundly truncated process on the pigment patch, may be this species or a related form.

DISTRIBUTION. **India:** Bhowali, Naini Tal (Brunetti, 1912 : 205; Sinton, 1928*c* : 321); Kurseong (1520 m in eastern Himalayas, Sinton, 1924*b* : 817).

Sergentomyia (*Parrotomyia*) *kauli* Lewis **sp. n.**

(Map 7)

The female slightly resembles *S. africana*, but has a narrow pigment patch, and very short upper pharyngeal teeth and long lower ones.

♀. Labrum 0·23 (0·22–0·25) mm long, 0·11 (0·10–0·12) length of wing. Cibarium with 26–32 teeth, fore teeth if present hidden by pigment patch; patch dark with broad anterior process. Pharynx with long teeth. Antenna 3 = 0·23 (0·22–0·24) mm long, 0·12 (0·11–0·12) length of wing, 1·08 (1·03–1·14) length of 4+5, 1·01 (0·90–1·09) length of labrum, ascoid on 4 about 0·43 length of segment and not reaching next one. Wing length 1·95 (1·84–2·16) mm, 3·5 times width, R_2/R_{2+3} 1·82 (1·66–2·11), R_1 tip/R_2 0·65 (0·58–0·68). Spermatheca thick-walled and oblong with straightening very near tip.

COMMENTS. The specimens from Saharanpur had been provisionally labelled '*P. malabaricus*' and presented to the BMNH by J. A. Sinton. Therefore they were first presumed to be *S. modii* which had been regarded as the female of *S. malabarica* till the true female was found. *S. kauli* is shown to be a separate species, however, by the rounded hind lateral walls of the cibarium, more numerous hind teeth, lack of conspicuous irregular fore teeth, broad forward process of the pigment patch, shorter antenna 3 and ascoid, and relatively short R_2.

MATERIAL EXAMINED.
Holotype ♀, **India:** Ganjam, 21.xi.1972 (*H. N. Kaul*) (BMNH).
Paratypes. **India:** Ramanagar, 28.viii.1970 (*H. R. Bhat*), 400 m, 1 ♀; Saharanpur, ix-x.1927 (*J. A. Sinton*), 4 ♀. (All in BMNH.)
Non-paratypic material. **India:** Munikireti, 6.iii.1973 (*H. R. Bhat*), 1 ♀ (BMNH).

Sergentomyia (*Parrotomyia*) *mangana* (Manalang)

(Map 7)

Phlebotomus mangana Manalang, 1930*c* : 283; Tonnoir, 1935 : 142. Lectotype ♀, PHILIPPINES (BPBM), designated by Quate & Rosario [not examined].
Phlebotomus (*Sergentomyia*) *mangana* Manalang; Quate & Rosario, 1962 : 793.

The cibarium of the female has 65–70 hind teeth, two rows of 20–25 fore teeth, and between them six to eight larger teeth; palpal segment 1 is long.

DISTRIBUTION. **Philippines:** Tunkong Manga (Manalang, 1930*c* : 283); Bigti, La Mesa dam area, Los Baños, San José del Monte, San Mateo, Silang, Tala (Quate & Rosario, 1962 : 794).

Sergentomyia (*Parrotomyia*) *modii* Lewis **sp. n.**

(Figs 70–73, Map 7)

Phlebotomus sp. Sinton, 1927*a* : 933 [measurements].
[*Phlebotomus malabaricus* Annandale; Sinton, 1927*d* : 25 [spermatheca]; 1928*c* : 321; 1932*a* : 61, 74 [cibarium and pharynx]. Misidentification.]

S. modii is distinguished from *S. kauli* by having fewer hind teeth, and from *S. yoshimotoi* by having a pigment patch. Aspects of *S. modii* are noted under *S. malabarica*

♀. Labrum 0·25 (0·24–0·26) mm long, 0·12 (0·11–0·12) length of wing. Cibarium with 17 hind teeth and a few irregular fore teeth; pigment patch with long, rather narrow, forward extension. Pharynx with long teeth. Hypopharynx smooth. Antenna 3 = 0·31 (0·30–0·32) mm long, 0·14 (0·14–0·15) length of 4+5, 1·25 (1·22–1·27) length of labrum; ascoid on 4 = 0·74–0·82 length of segment and extending to 5. Palpal ratio 10 : 22 : 32 : 35 : 72. Wing length 2·16 (2·16–2·16) mm, 3·3 times width, R_2/R_{2+3} 2·97 (2·48–3·45), R_1 apex/R_2 0·79 (0·75–0·82). Spermatheca oblong with well-defined smooth wall.

MATERIAL EXAMINED.
Holotype ♀, **India:** Gologhat, v.1925 (*P. J. Barraud*) (BMNH).
Paratype. 1 ♀, same data as holotype but 22.v.1925 (BMNH).
Non-paratypic material. A female with 28 hind teeth from Banhasa, India, may be related to this species.

Sergentomyia (*Parrotomyia*) *palestinensis* (Adler & Theodor)

(Map 8)

Phlebotomus palestinensis Adler & Theodor, 1927 : 64. Holotype ♀, ISRAEL (TC) [not examined].
Sergentomyia (*Parrotomyia*) *palestinensis* (Adler & Theodor); Theodor, 1958 : 44; Lewis, 1967 : 34; Perfil'ev, 1968 : 326; Artemiev, 1976*b* : 427.

The female has 15–22 cibarial teeth in a straight line and a nearly spherical spermatheca. Artemiev noted the close relationship of this species to *S. sogdiana* (Parrot).

DISTRIBUTION. **Pakistan:** Peshawar (Lewis, 1967 : 34).

Sergentomyia (*Parrotomyia*) *queenslandi* (Hill)

Phlebotomus queenslandi Hill, 1923 : 83. Syntypes 4 ♀, 4 ♂, AUSTRALIA (National Museum, Melbourne) [not examined].

The pharynx of the female has hair-like scales and about 45–80 cibarial teeth.

Sergentomyia (*Parrotomyia*) *queenslandi meridionalis* (Tonnoir)

(Map 8)

Phlebotomus queenslandi meridionalis Tonnoir, 1935 : 140. Syntypes 8 ♀, ♂, AUSTRALIA (Division of Economic Entomology, Melbourne) [not examined].
Sergentomyia (*Sergentomyia*) *queenslandi* var. *meridionalis* (Tonnoir); Theodor, 1948 : 111.
Sergentomyia (*Parrotomyia*) *queenslandi meridionalis* (Tonnoir); Lewis & Dyce, 1976 : 210.

The female has about 80 cibarial hind teeth. This form is treated as a subspecies till more is known of its variation and distribution.

DISTRIBUTION. **Nusa Tenggara:** Tafara Cape (East Timor, Lewis & Dyce, 1976 : 210).

Sergentomyia (*Parrotomyia*) *rudnicki* Lewis **sp. n.**

(Figs 74–89, Map 8)

In the female of this pale species the cibarial teeth are so narrow as to be scarcely visible, the pigment patch is broad and dark, and the pharyngeal teeth are strong.

The female differs from *S. mangana* in having a short labrum, a shorter row of cibarial teeth (0·056 mm in *mangana*), narrower teeth (0·8 μm in *mangana*), two rows of fore teeth, and simple outline to the forward process of the pigment patch.

The female of *S. rudnicki* differs from *S. queenslandi meridionalis* in having a shorter tooth-row (0·072 mm in *S. q. meridionalis*) and narrower teeth.

The female of *S. rudnicki* differs from the Australasian (West Irian) *S. spinosior* (Quate & Quate) in having a wider cibarial armature, shorter pharyngeal ventral teeth, and a long antenna 3 which is distinctly longer than 4 + 5.

♀. Labrum 0·16 (0·15–0·18) mm long, 0·10 (0·09–0·10) length of wing. Cibarium with a row, about 0·43 mm long, of some 90 scarcely visible teeth, each about 0·05 μm wide; two even rows of about 22 fore teeth (seen in macerated specimens) hidden by dark brown posteriorly convex pigment patch; forward process of patch with irregular margin and merging into suture. Pharynx with thick walls, and straight

sides beyond main bulge, and long narrow teeth, the dorsal ones appearing less long because they are seen foreshortened or end-on. Hypopharynx with no teeth or undulations. Antenna 3 = 0·29 (0·26–0·33) mm long, 0·17 (0·16–0·19) length of wing, 0·12 (0·12–0·13) length of 4+5, 1·80 (1·66–1·92) length of labrum, two ascoids on segments 3–15, that on 4 = 0·395 length of segment, no papilla on 5. Maxilla with nine lateral teeth, 19 ventrals and a dental depth of 0·06 mm; palpal ratio 10 : 21 : 38 : 40 : 80; clavate sensilla not very numerous, on basal half of 3. Scutum, pleuron and whole body pale. Wing length 1·69 (1·63–1·74) mm, 3·3 times width, R_2/R_{2+3} 1·61 (1·41–2·00), R_1 overlap/R_2 0·59 (0·47–0·71). Abdominal tergites 4–6 with about one, two and four erect hairs respectively. Spermatheca oblong and sometimes slightly wrinkled, with broad knob and shallow pit, and very thin ducts.

♂. Labrum 0·15 (0·14–0·16) mm long, 0·10 (0·09–0·10) length of wing. Cibarium with about 26 hind teeth and a rather dark, or pale, subtriangular pigment patch having a thin forward process. Pharynx rather as in ♀ but less armed. Antenna 3 = 0·32 (0·29–0·38) mm long, 0·21 (0·20–0·24) length of wing, 1·16 (1·07–1·29) length of 4+5, 2·18 (2·04–2·40) length of labrum, one ascoid on 3–15. Wing length 1·52 (1·45–1·60) mm, 3·7 times width, R_2/R_{2+3} 1·25 (0·89–1·50), R_1 overlap/R_2 0·57 (0·46–0·67). Aedeagus narrow and tapering to a blunt tip. Filament about 3·5 length of pump. Paramere beaked. Style with two spines terminal and two subterminal, and a seta proximal to them.

MATERIAL EXAMINED.
Holotype ♀, **West Malaysia:** Ulu Gombak, 30.x.1968 (*Abu Hassan bin Omar*) (BMNH). Ten of each sex measured.

Paratypes. **West Malaysia:** as for holotype, 26.viii-30.ix.1968, 14 ♀, 3 ♂; 29.ii.1972 (*D. J. Lewis*), 1 ♀, 8 ♂; Ulu Langat Forest Reserve, 25.vii.1968 (*A. Rudnick*), 1 ♀, 1 ♂. (All in BMNH.)

Sergentomyia (*Parrotomyia*) *shorttii* (Adler & Theodor)

(Map 8)

Phlebotomus shorttii Adler & Theodor, 1927 : 65 [palp formula variable]; Sinton, 1928*c* : 317; 1932*a* : 60; 1933*e* : 422. Syntypes 8 ♀, 8 ♂, INDIA (TC) [not examined].
Phlebotomus (*Prophlebotomus*) *shorttii* Adler & Theodor; Parrot, 1937 : 120.
Sergentomyia (*Parrotomyia*) *shorttii* (Adler & Theodor); Lewis, 1967 : 31; Perfil'ev, 1968 : 13.

The female is distinguished by having a notch near the cibarial teeth which number 10–14.

DISTRIBUTION. **Bangladesh:** Dacca (BMNH); Bongong, Kaoraid, Sylhet (Sinton's notes). **Burma:** Rangoon (Sinton, 1927*e* : 31). **India:** Golaghat (Adler & Theodor, 1927 : 66); Gauhati, Sukna (BMNH); Kota (Kaul *et al.*, 1972 : 533); Soraipani (1938, *R. C. Muirhead-Thomson*); Hyderabad (Qutubuddin, 1944 : 208); Naini Tal area (Rao *et al.*, 1973); Calcutta, Jog-Sagar area, Kannur, Konehosur, Kumsi (*H. Trapido*). **Pakistan:** Taxla (Lewis, 1967); Lahore (George, 1970).

Sinton (1928*c*) found that *S. shorttii* represented the *S. babu* complex in Assam, and (1932*a*) knew the former from the north-eastern parts of India and from Burma.

Sergentomyia (*Parrotomyia*) *spinifaucis* (Quate)

(Map 8)

Phlebotomus (*Sergentomyia*) *spinifaucis* Quate, 1965 : 28. Holotype ♀, PHILIPPINES (BPBM) [not examined].

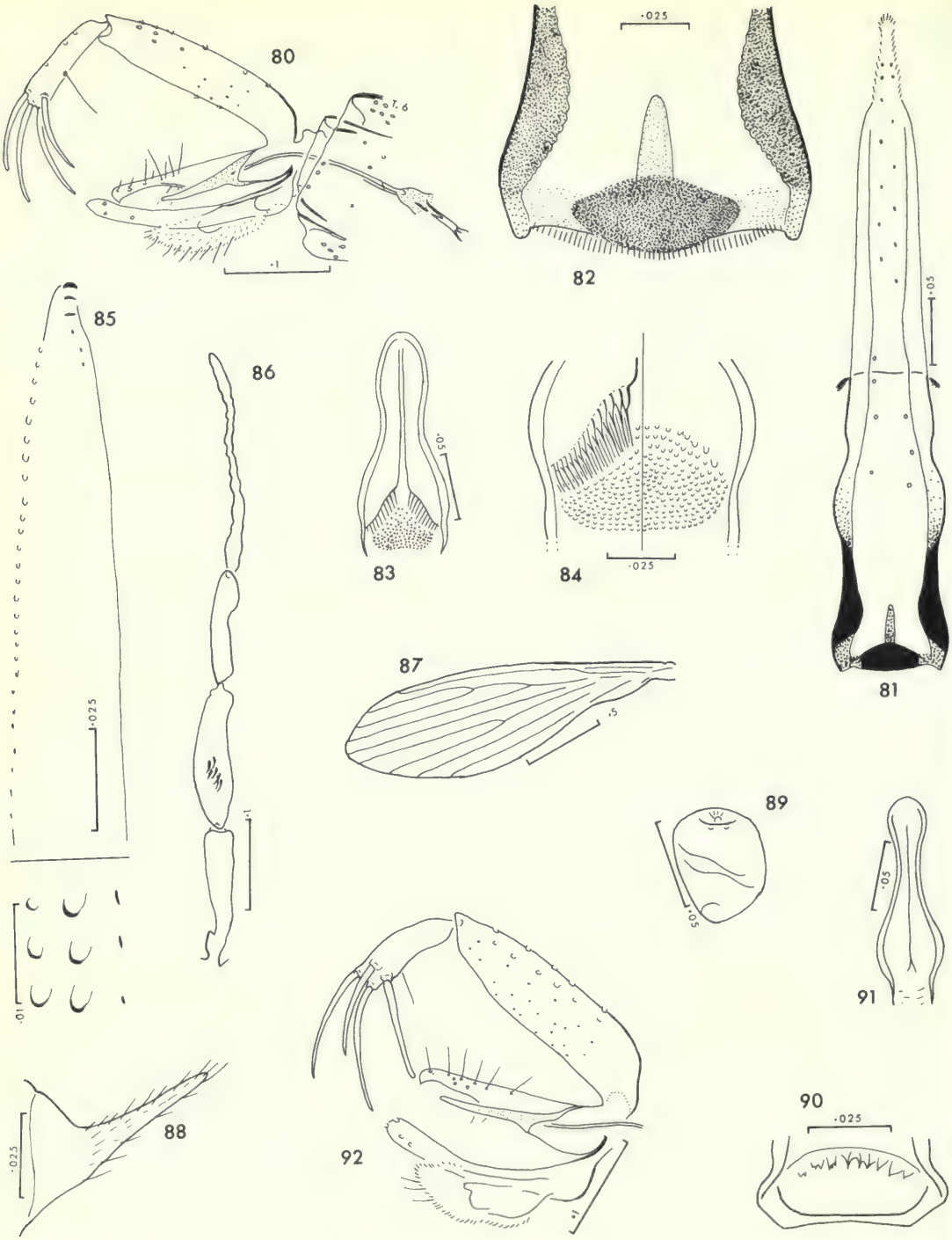
In the female the cibarium has 50–60 teeth in a row concave medially and straight or convex laterally, and 10–12 fore teeth of which the median six are very large; antenna 3 is short and R_2/R_{2+3} is about two. *S. mangana* is somewhat similar but is larger, has a differently shaped tooth-row and a longer antenna 3.

DISTRIBUTION. **Philippines:** Tarumpitao (Quate, 1965 : 28).

Sergentomyia (*Parrotomyia*) *timorica* Lewis & Dyce

(Map 8)

Sergentomyia (*Parrotomyia*) *timorica* Lewis & Dyce, 1976 : 210. Holotype ♀, TIMOR (Australian National Insect Collection) [examined].



Figs 80–92 *Sergentomyia* species. 80, *S. rudnicki*, ♂, terminalia. 81–89, *S. torrechantei*, ♀: (81) labro-cibarium; (82) cibarium; (83, 84) pharynx; (85, 86) maxilla and palp; (87) wing; (88) inter-precoxal lobe; (89) spermatheca. 90–92, *S. balica* (from Carey Island): (90, 91) ♀, cibarium and pharynx; (92) ♂, terminalia.

In the female the cibarium has about 60 (50–65) teeth and a slender pharynx with few spicules, and R_2/R_{2+3} is 0.70 (0·24–0·92).

DISTRIBUTION. **Nusa Tenggara:** Dili, Kupang area, Pedang Bay (?), Tafara Cape (Lewis & Dyce, 1976 : 210).

Sergentomyia (*Parrotomyia*) *torrechantei* (Manalang)

(Map 8)

Phlebotomus torrechantei Manalang, 1931 : 361. Syntypes 2 ♀, 1 ♂, PHILIPPINES (destroyed) [not examined].
Phlebotomus (*Sergentomyia*) *torrechantei* Manalang; Quate & Rosario, 1962 : 797.

The original small figures of the female show about 30 cibarial hind teeth, dark walls, a marked pigment patch and long pharyngeal teeth. Quate & Rosario comment that this species appears close to *S. mangana* which has numerous fine cibarial teeth, an armed pharynx and similar wing venation, but that *S. torrechantei* has a shorter palpal segment 4 and a differently shaped pigment patch. The following description is from females believed to be this species.

♀. Eye 0·58 length of head. Labrum 0·17 (0·17–0·18) mm long, 0·09 (0·09–0·09) length of wing, with well-marked sensilla of which the distal ones are broad. Cibarium with about 48 teeth in a slightly convex row, dark, rather narrow, pigment patch with strong forward process, a brown band on ventral wall partly hiding patch, dark sides and a scarcely visible chitinous arch. Pharynx with strong armature of pointed teeth, those on ventral plates conspicuous. Hypopharynx smooth. Antenna 3 (one specimen) 0·35 mm long, 0·18 length of wing, 1·29 length of 4+5, 2·10 length of labrum; two ascoids on segments 3–8 (rest missing), that on 4 = 0·55 of its length; no papilla on 5, but several on 6 and 8 near middle. Maxilla with six lateral teeth, three of them very small, and 27 ventral teeth, the proximal ones very small; dental depth 0·09 mm; palpal ratio 10 : 28 : 40 : 34 : 62. Scutum brown and pleura pale. Inter-precoxal lobes narrow. Wing length 1·96 (1·89–2·03) mm, about 3·1 times width, R_2/R_{2+3} 2·36 (1·96–2·88), R_1 overlap/R_2 0·73 (0·67–0·79). Leg ratios: fore (0·69), 10 : 11·2 : – : mid (0·69), 10 : 13·9 : 0·75; hind (0·77), 10 : 15·5 : –. Spermatheca thin-walled and oblong.

DISCUSSION. The specimens described here differ from *S. dapsilidentes* in the shape of the pigment patch, weak chitinous arch and shorter palp 4, and from *S. mangana* in the longer antenna 3. They differ from the description of *S. torrechantei* in having more cibarial teeth and a different pigment patch, and palpal segment 3 = 1·44 times as long as 2 (instead of 1·13 times). However, the dark cibarial walls tally, and palpal segments are somewhat flexible. It seems advisable to regard these specimens as *S. torrechantei*, at least till more examples of this species are found, rather than to create a new species on slender evidence.

MATERIAL EXAMINED.
Philippines: Luzon, Nueva Viscaya, 10.iv.1968 (*M. D. Delfinado & D. E. Hardy*), 4 ♀.

DISTRIBUTION. **Philippines:** Apali, Malinao, Sipocot (Quate, 1965 : 28; Quate & Rosario, 1962 : 797); Nueva Viscaya (as above).

Sergentomyia (*Parrotomyia*) *yoshimotoi* (Quate)

(Map 8)

Phlebotomus (*Sergentomyia*) *yoshimotoi* Quate, 1965 : 24. Holotype ♀, PHILIPPINES (BPBM) [not examined].

In this small species with a brown scutum the female has 14–18 short cibarial teeth in a convex row, no pigment patch and pharyngeal teeth.

DISTRIBUTION. **Philippines:** San Francisco area (Quate, 1965 : 26).

Subgenus *GRASSOMYIA* Theodor

Sergentomyia squamipleuris group Theodor, 1948 : 102.

Sergentomyia subgenus *Grassomyia* Theodor, 1958 : 47; Perfil'ev, 1968 : 339. Type-species: *Phlebotomus squamipleuris* Newstead, 1912, by original designation.

The spermatheca and the expanded tips of the genital filaments, alone, distinguish this small subgenus from others. Its distinctive nature led Abonnenc (1972) to equate it with *Phlebotomus* and *Sergentomyia*. *Grassomyia* is very widely distributed in the Region.

Sergentomyia (*Grassomyia*) *indica* (Theodor)

(Map 8)

Phlebotomus squamipleuris Newstead; Sinton, 1923*b* : 65; 1924*a* : 813; 1927*c* : 947; 1927*d* : 27; 1927*e* : 31; 1928*c* : 321; 1932*a* : 60; 1933*e* : 418, 422; Perfil'ev, 1939 : 82 [in part]; Mitra & Roy, 1955*a* : 324 [abdominal hairs].

Phlebotomus squamipleuris var. *indicus* Theodor, 1931 : 470; 1938 : 269; Lewis, 1957 : 168. Type, 'INDIA' (TC) [not examined].

Phlebotomus (*Prophlebotomus*) *squamipleuris* var. *indicus* Theodor; Parrot, 1937 : 119; Parrot & Clastrier, 1952 : 164.

Phlebotomus squamipleuris var. *poonaensis* Mitra & Mitra, 1953 : 434 [hairs]; Mitra & Roy, 1954 : 191 [description]. Syntypes ♀, INDIA (Museum of the Armed Forces Medical College, Poona) [not examined]. [Synonymized by Abonnenc, 1967 : 115; 1969 : 308.]

Phlebotomus (*Sergentomyia*) *squamipleuris indicus* Theodor; Quate, 1962*b* : 259 [variation].

Phlebotomus (*Grassomyia*) *squamipleuris indicus* Theodor; Abonnenc, 1967 : 114.

Sergentomyia (*Grassomyia*) *squamipleuris indica* (Theodor); Lewis, 1967 : 34.

Sergentomyia (*Grassomyia*) *indica* (Theodor); Theodor & Mesghali, 1964 : 296 [India & China]; Perfil'ev, 1968 : 344; Lewis & Dyce, 1976: 210 [Bali form].

The combination of a convex cibarial tooth-row and rounded spermatheca, in the female, and filaments with dilated tips, in the male, distinguishes this from all other Oriental species.

Various forms of *Grassomyia* in different parts of the Old World have undergone nomenclatorial changes, some of which are as follows. *S. squamipleuris* (Newstead) was described from the Sudan in 1912, *S. ghesquierei* (Parrot) from Zaire in 1929, *S. s. indica* in 1931, *S. dreyfussi* (Parrot) from Algeria in 1933, *S. inermis* (Theodor) from Africa in 1938, and several eventual synonyms at various times. Perfil'ev (1939) placed all members of the complex in one species, without individual names. Quate (1962*b* : 260) treated *indica* as a synonym of *squamipleuris* and (1964) regarded *dreyfussi*, *inermis* and *ghesquierei* also as synonyms. Theodor & Mesghali (1964) recognized four species, *S. dreyfussi*, *indica*, *inermis* and *squamipleuris*, and described *S. d. turkestanica* from Turkestan and eastern Iran. Perfil'ev (1966) recognized five species and described *S. s. karakalensis* from Soviet Central Asia, and (1968, in letter) informed me that this was a synonym of *turkestanica* which might be treated as a subspecies of *squamipleuris*. *S. madagascarensis* (Abonnenc) was described in 1969. O. Theodor (1971, in letter) informed me that *squamipleuris* from Taiwan differed distinctly from *indica*, the pharynx being narrower, pigment patch of different form and cibarial teeth only about 25 in number, and he considered it as good a species as the African ones recognized by Abonnenc in 1969. Lewis (1974*b*) regarded the Yemen form as *S. dreyfussi*, and Lewis & Dyce (1976) studied the Bali form of *S. indica* which differed from West Malaysian and Indian specimens.

According to Theodor and Mesghali, the females of *indica* and *turkestanica*, its nearest geographical relative, have respectively: antenna 3/labrum 0·9 and 1·1–1·2; cibarial teeth, 33–36 and 40; antenna 3 length, 0·12–0·17 and 0·2–0·22 mm; spines on femur 1, none and three to four.

Ten females from Peshawar were examined and had antenna 3/labrum of 0·93 (0·91–0·97). Cibarial teeth were difficult to count in uncrushed specimens, but one chosen at random and so treated showed 46 teeth. Antenna 3 was 0·14 (0·14–0·15). Femoral spines are often lost and their sockets look like those of large hairs. None was seen on many flies examined.

The divergence of views, variation in the complex and appearance of new forms from time to time make it difficult to classify some. For the present I am treating the Oriental form as a species,

S. indica, in which the number of teeth may be unimportant but other characters may later indicate the need for subdivision. The mesanepimeron is bare, as in two African forms.

DISTRIBUTION. **Cambodia:** Phnom Penh (Parrot & Clastrier, 1952 : 153). **China:** Hainan (Leng, 1964 : 127); Aihsien, Lingshui, Paoting (Yao & Wu, 1940 : 797; 1941*b* : 77). **Hong Kong:** Saikung (*W. J. Voss & Hui Wai Ming*, via BPBM). **India:** Bhavnagar, Guntur, Itauriga, Tittagash, Undi, Vellore (BMNH); Pusa (about as common as *P. argentipes* according to Craighead & Das, 1928 : 863), Ranaghat (*S. Das*); Bir, Parbhani (*V. Dhanda*); Riasi (Jacob & Kalra, 1951 : 325); Kota (Kaul *et al.*, 1951 : 325); Karnal, Saharanpur (Lewis, 1967 : 35); Mendhar, Punch (Mitra, 1959 : 62); Jammu, Nedumangad, Poona, Singanama, Uri (Mitra & Roy, 1953*a* : 324); Kasauli, Madras, Pipariya (Sinton, 1923*b* : 66); Calcutta, Golaghat, Patna (Sinton, 1927*b* : 942); Bombay, Faizabad, Itaunia, Laharpur, Nabinagar, Narnaul, Roorkee, Trivandrum (Sinton's notes); Naini Tal area (Wattal *et al.*, 1967). **Laos:** Luang Prbang, Ventiane (Quate, 1962*b* : 259). **Nepal:** Pokhara (*L. W. Quate* via BPBM), 21 ♀, 4 ♂. **Nusa Tenggara:** Dili, Kabaru, Los Palos, Same, Suai, Sumbara, Tafara Cape, Waingapu Bay (Lewis & Dyce, 1976 : 210). **Pakistan:** Dehra Ismail Khan, Gujrat, Jhelum, Khanki, Lahore, Peshawar, Rawalpindi, Said Pur, Saidu Sharif, Taxla (Lewis, 1967 : 37); Cherat, Shikarpur, Tank (Sinton's notes). **Taiwan:** Henghun area, Pingtung area, Taitung (lowlands south of 32° north, Cates & Lien, 1970 : 535). **Thailand:** Ayutthaya, Bangkok, Chieng Mai, Meung district, Phra Phutthabat district, Tha Li district (Quate, 1962*b* : 259); in trains (Sinton, 1931*d* : 104). **West Malaysia:** Rantau Panjang (Lewis, 1957 : 168); Carey Island (*A. Rudnick*).

In India *S. indica* is widely distributed all over the plains and up to 1830 m (Sinton, 1932*a*).

Subgenus *NEOPHLEBOTOMUS* França & Parrot

Phlebotomus subgenus *Neophlebotomus* França & Parrot, 1920 : 699. Type-species: *Phlebotomus malabaricus* Annandale, 1910, by original designation.

Sergentomyia zeylanica group Theodor, 1948 : 101.

Sergentomyia subgenus *Rondanomyia* Theodor, 1958 : 48; Perfil'ev, 1968 : 335. Type-species: *Phlebotomus malabaricus* Annandale, 1910, by original designation. **Syn. n.**

S. malabarica is now seen to belong in '*Rondanomyia*', but is the type-species of *Neophlebotomus* (discussed by Theodor, 1948 : 88, 89; Kirk & Lewis, 1951 : 406) which was regarded as a synonym of genus *Sergentomyia*. The original characterization of *Neophlebotomus* was indefinite and tentative, and was based on a non-existent character, but it is technically valid nevertheless (ICZN, 1964 : Articles 17(8) and 18(a)). It is therefore treated here as a subgenus, with *Rondanomyia* as a synonym.

A long antenna 3, a broad wing with long R_2 and a style with two spines near the middle class some species as members of this subgenus, but all the features mentioned in couplet 110 of the key must often be considered, and certain species are difficult to classify subgenerically. The figure for R_2/R_{2+3} in six Palaearctic species studied by Theodor (1958) is 1·30 (0·5–1·98), but if the exceptional *S. pawlowskyi* Perfil'ev is omitted the figure is 1·7 (0·75–1·98).

Species of the subgenus occur mainly in areas of high rainfall in the east of the Region where they are comparable with central African members of the subgenus.

Some species of *Sergentomyia* were placed by Theodor (1948) in the *zeylanica* group which was divided into two series according to the nature of the style. Theodor (1958) converted the group to the subgenus *Rondanomyia* but did not mention the two series.

The spermatheca is of some use as a subgeneric character but, as in some other groups, is often difficult to see and define. Although Theodor refers to the tubular spermatheca, it may sometimes be elliptical (Theodor, 1938 : 264).

The species can be grouped (Table 1) according to cibarial armature of the females and what is known of the spermatheca, sometimes from imperfect specimens.

In the *dhandai* series the spermatheca is long and cylindrical.

In the *arboris* series the spermatheca is more or less oblong, with the knob in a pit, and the female has three or more rows of cibarial fore teeth. *S. arboris* is closely related to *S. gombaki*, and *S. malayae* to *S. zeylanica*, and further knowledge of their distribution and variation is needed, with special reference to the length of the labrum.

In the *balica* series the spermatheca is like that of the *arboris* series and the cibarium of the female has less than three rows of fore teeth. *S. jefferyi* differs from most sandflies in its light maxillary armature.

In the *quatei* series the spermathecal knob protrudes proximally and there is no collar. *S. traubi* has a comparable but short spermatheca.

In *S. hamidi* the spermathecal duct starts as a funnel.

This arrangement, which is based on females partly for their biological interest, cuts across Theodor's (1948) sections a and b (based on the central or distal position of two of the spines on the style of the male).

Sergentomyia (*Neophlebotomus*) *arboris* (Sinton)

(Map 8)

Phlebotomus arboris Sinton, 1931*e* : 107; Theodor, 1938 : 263 [♀, previously mistaken for *S. zeylanica*]; Parrot, 1940 : 311; 1946 : 71. About 20 syntype ♂, INDIA (depository unknown) [not examined].
Sergentomyia arboris (Sinton); Theodor, 1948 : 111.
Sergentomyia (*Rondanomyia*) *arboris* (Sinton); Lewis, 1973*a* : 250.

The presence of about eight rows of cibarial fore teeth and the lack of a definite forward process of the pigment patch differentiate the female from all other species.

♀ (*extra facts*). Labrum 0·32 mm long, 0·14 length of wing (2·26 mm). Hypopharynx with smooth tip and low undulations. Antenna 3 = 0·39 mm long, 0·17 length of wing. Maxilla with eight lateral and 58 ventral teeth, dental depth 0·14 mm.

MATERIAL EXAMINED.
India: Baragi, 24.xii.1957 (*H. Trapido*), 1 ♀.

DISTRIBUTION. **India:** Marianbari (Sinton, 1931*e* : 107); Darjeeling, (Theodor, 1938 : 263); **Baragi,** Hisur, Kannur (*H. Trapido*). **Sri Lanka:** Depanama, Katuwala (Theodor, 1938 : 264).

Sergentomyia (*Neophlebotomus*) *balica* Lewis & Dyce

(Figs 90–92, Map 8)

Sergentomyia (*Rondanomyia*) *balica* Lewis & Dyce, 1976 : 212. Holotype ♀, SUMBAWA (Australian National Insect Collection) [examined].

The female has 18–22 cibarial teeth in a straight line and no pigment patch. *S. bukidnonis*, *S. coronata* (Quate & Quate), *S. crypta* (Quate & Quate), *S. curtata* (Quate) and *S. sansaporensis* Fairchild have a rather similar cibarium but a relatively shorter antenna 3. The male is described below for the first time.

The following measurements of five females from Java (Djakarta, xi.1908; Semarang, i.1910, two; ii.1910, two) agree well with Bali specimens. Labrum 0·20 (0·19–0·20) mm long, 0·10 (0·10–0·10) length of wing. Cibarium with 16–20 hind teeth, accessory fore teeth usually present. Antenna 3 = 0·33 (0·31–0·34) mm long, 0·17 (0·16–0·18) length of wing, 1·36 (1·32–1·44) length of 4+5, 1·67 (1·59–1·74) length of labrum. Palpal ratio about 10 : 23 : 38 : 48 : 67. Wing length 1·97 (1·94–1·98) mm, 3·4 times width, R_2/R_{2+3} 0·83 (0·69–0·93). R_1 overlap/R_2 0·53 (0·49–0·57). Spermathecal ducts not clearly visible.

One incomplete female from Djakarta, xi.1908, apparently of a form near *balica*, has eight cibarial hind tooth and no fore teeth. The labrum is 0·17 mm long and 0·10 length of wing. Antenna 3 is 0·35 mm long, 0·21 length of wing and 2·12 length of labrum. The wing length is 1·68 mm, about 3·5 times width, R_2/R_{2+3} 0·77, and R_1 overlap/R_2 0·47.

♂. Labrum 0·17 (0·17–0·18) mm long, 0·10 (0·10–0·11) length of wing. Cibarium with about eight teeth, some with several points, two or three specks representing fore teeth, and no pigment patch. Pharynx almost unarmed. Antenna 3 = 0·35 (0·35–0·37) mm long, 0·21 (0·20–0·21) length of wing, 1·34 (1·31–1·39) length of 4+5, 2·01 (1·89–2·10) length of labrum, one ascoid on segments 3–14 (15 lacking), that on 4 being about 0·28 length of segment. Wing length 1·70 (1·66–1·74) mm, 3·5 times

width, R_2/R_{2+3} 0·70 (0·66–0·74), R_1 overlap/R_2 0·35 (0·32–0·37). Aedeagus tapering and bluntly pointed. Paramere beaked. Coxite with about 25 scattered brush hairs, mainly in distal half. Style with seta at 0·54, two spines subterminal and two terminal.

DISTRIBUTION. **Borneo:** Sabah, Tawau (*L. W. Quate*, a female with 24 hind teeth and two rows, of four and eight, fore teeth, which may be this species). **Java:** Djakarta, Semarang (*E. Jacobson*). **Nusa Tenggara:** Denpasar area, Pedang Bay, Sumbawa (Lewis & Dyce, 1976 : 212). **West Malaysia:** Kuala Lumpur (5.vii.1923, *H. M. Pendlebury*, 1 ♀); Carey Island (attracted to man or to CO_2-light-trap, 2 ♀, 3 ♂), Port Dixon (1 ♀) (*A. Rudnick*).

Sergentomyia (*Neophlebotomus*) sp. (Besout)

(Figs 93–94, Map 8)

This species differs from many by having some 95 hairs in the coxite brush. It is left without a formal name till females can be associated with the males.

♂. Labrum 0·20 (0·20–0·21) mm long, 0·13 (0·12–0·13) length of wing. Cibarial hind teeth in the form of minute spicules, roughly arranged in about 12 groups on a concave arc; fore teeth comprising a row of about 12. Pharynx unarmed. Antenna 3 = 0·33 (0·30–0·36) mm long, 0·21 (0·20–0·21) length of wing, 1.37 (1·27–1·34) length of 4+5, 1·63 (1·54–1·72) length of labrum; one ascoid on segments 3–15, that on 4 = 0·55 length of segment. Maxilla with about 20 vestigial ventral teeth. Palpal segment 4 = about 1·3 times length of 3. Scutum pale brown and pleura very pale. Wing length 1·60 (1·51–1·70) mm, 3 times width R_2/R_{2+3} 1·20 (1·10–1·30), R_1 overlap/R_2 0·54 (0·53–0·61). Aedeagus very pale except at base. Paramere with beaked and swollen tip. Coxite with discrete dense patch of about 95 stout hairs. Style broad at centre, with a small seta at about 0·37, setae at about 0·44 and 0·6, and two at tip.

MATERIAL EXAMINED.
West Malaysia: Gunong Besout Forest Reserve, 19.x.1973 and 15.vi.1974 (*J. Jeffery*), 3 ♂; Punjong Rabok, 17 and 27.xi.1968 (*A. Rudnick*).

Sergentomyia (*Neophlebotomus*) *chakravarti* (Mitra) **comb. n.**

(Map 8)

Phlebotomus chakravarti Mitra, 1953*b* : 158. Holotype ♀, INDIA (Armed Forces Medical College, Poona, apparently lost, according to V. Dhanda, 1970, in letter) [not examined].

The female has about 14 cibarial teeth on a line angular at the centre, and seven round teeth behind the hind ones.

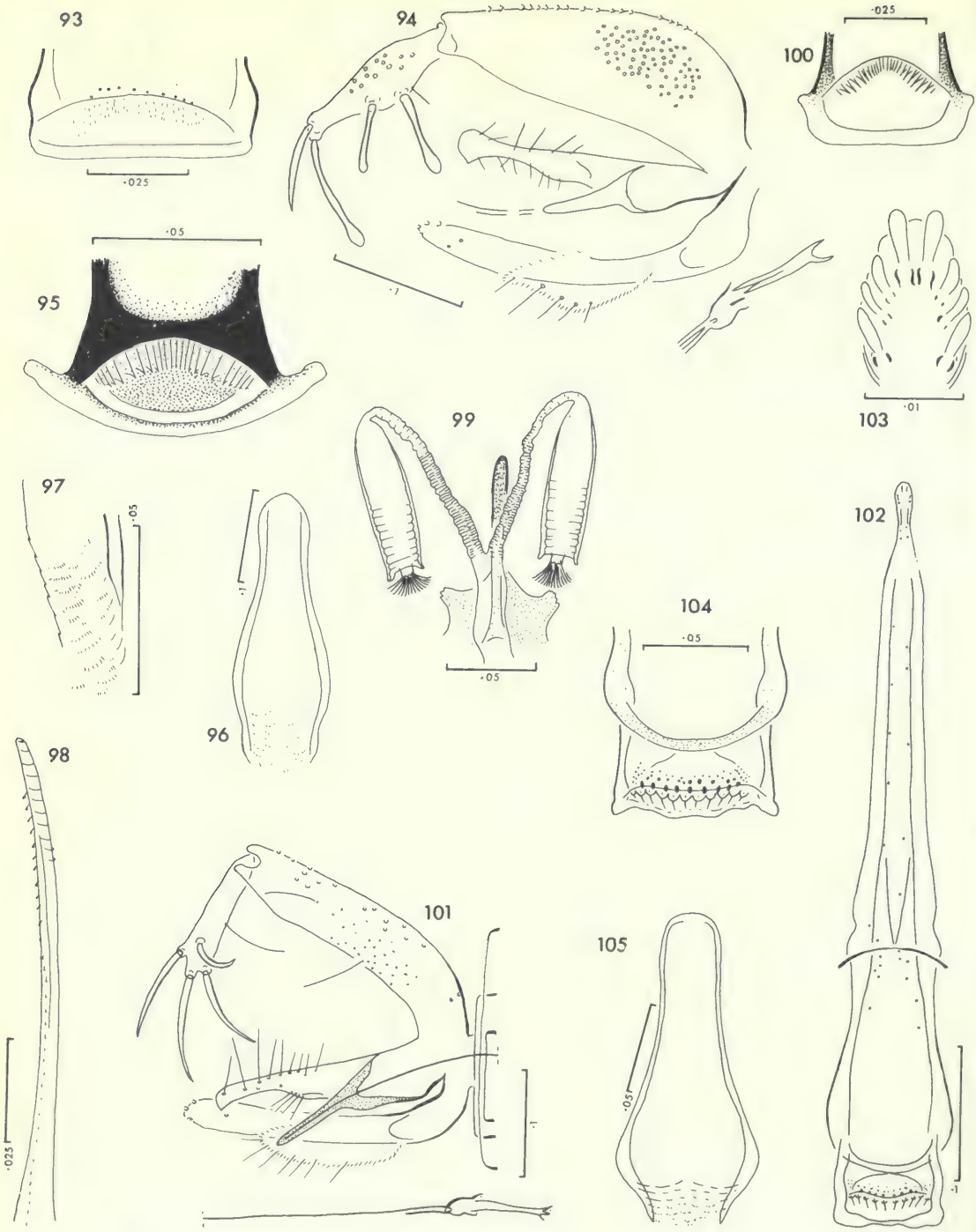
DISTRIBUTION. **India:** Hoora (Mitra, 1953*b* : 158).

Sergentomyia (*Neophlebotomus*) *dhandai* Lewis **sp. n.**

(Figs 95–101, Map 8)

This species differs from *S. hodgsoni* in having more cibarial hind teeth.

♀. Labrum 0·22 (0·21–0·23) mm long, 0·10 (0·10–0·11) length of wing. Cibarium with about 24 contiguous pointed teeth on a deep arc, and a broad pigment patch, cuticle at base of teeth very dark, and chitinous arch inapparent; salivary pump wide. Pharynx with faintly spiculate ridges. Hypopharynx with low undulations. Antenna 3 = 0·27 (0·24–0·29) mm long, 0·13 (0·11–0·14) length of wing, 1·13 (1·03–1·23) length of 4+5, 1·21 (1·15–1·28) length of labrum, two ascoids on segments 3–15, that on 4 = 0·5 of its length. Maxilla with 11 lateral and 36 short broad ventral teeth, dental depth 0·11 mm; palpal ratio 10 : 21 : 35 : 37 : 85, segment 3 with clavate sensilla bunched on basal half. Scutum and much of pleura dark. Wing length 2·13 (2·11–2·15) mm, 3·3 times width, R_2/R_{2+3} 1·40 (1·27–1·53), R_1 overlap/R_2 0·58 (0·58–0·58). Femur 1 with six large sockets and at least three spines, femur 2 with five large sockets. Hind leg in holotype, lengths in mm: femur 0·44; tibia, 0·57; basitarsus, 0·27; whole, 1·68. Spermatheca



Figs 93–105 *Sergentomyia* species. 93, 94, *S.* Besout sp. ♂, cibarium and terminalia. 95–101, *S. dhandai*: (95–99) ♀, cibarium, pharynx, maxilla and spermatheca; (100, 101) ♂, cibarium and terminalia. 102–105, *S. gemmea*, ♀: (102, 103) labrocibarium and tip of labrum; (104) cibarium; (105) pharynx.

subcylindrical with slightly expanded tip, thick walls and faint internal wrinkles which are sometimes invisible; knob short and cylindrical; ducts faintly striated and joining a common duct.

♂. Labrum 0·18 (0·18–0·18) mm long, 0·11 (0·10–0·11) length of wing. Cibarium with about 24 pointed teeth on a deep arc, no pigment patch. Pharynx almost unarmed. Antenna 3 = 0·28 (0·27–0·29) mm long, 0·16 (0·15–0·17) length of wing, 1·11 (1·11–1·11) length of 4+5, 1·54 (1·46–1·63) length of labrum, one ascoid on segments 3–14 (15 lacking), that on 4 about 0·36 of its length. Wing length 1·72 (1·71–1·74) mm, 3·7 times width, $R/_2R_{2+3}$ 1.41 (1·21–1·62), R_1 overlap/R_2 0·55 (0·51–0·59). Femur 1 with four spines, femur 2 with at least one. Aedeagus with rounded bluntly pointed tip. Filament 4·5 times length of pump. Style with two of spines subterminal at different levels, and seta at 0·6.

Comments. *S. dhandai* apparently differs from *S. chakravarti*, from the same general area, in having more cibarial teeth, a different pigment patch, and no teeth behind the main row. Such differences could conceivably be due to different mounting methods, but the shorter leg of *S. dhandai* in a rather larger fly (with longer antenna 3 and wing) indicates that they are different species.

Material examined.
Holotype ♀, **India:** Poona district, Bhor Ghat, 27.ix.1969 (*S. N. Guttikar, G. B. Modi & P. V. M. Mahadev*), tree hole in hilly woodland (BMNH).

Paratypes. **India:** same data, 1 ♀, 2 ♂ (BMNH). Other specimens, examined by Dr V. Dhanda, are in the Virus Research Centre, Poona.

Sergentomyia (*Neophlebotomus*) *gemmea* Lewis & Jeffery **sp. n.**

(Figs 102–113, Map 9)

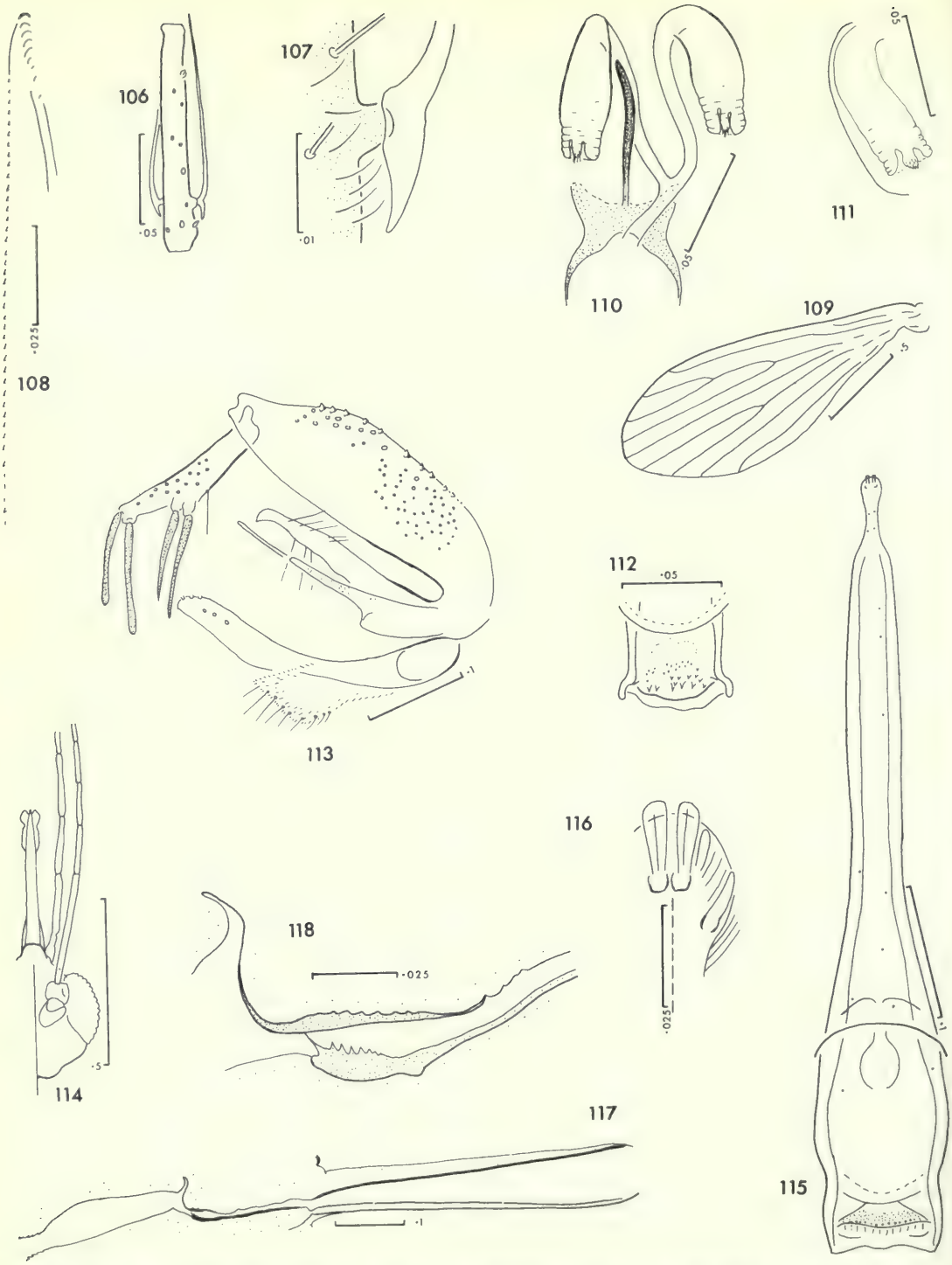
The large size of some of the cibarial fore teeth characterizes this species. The name, meaning jewelled, indicates their ornamental appearance.

♀. Labrum 0·32 (0·29–0·34) mm long, 0·16 (0·15–0·17) length of wing, apical sensilla normal, adorals small. Cibarium with ten hind teeth with broad bases narrowing abruptly to fine points, with one row of eight very large fore teeth, two rows of small teeth in front of them, and a patch of small fore teeth at each side; pigment patch pale; arch strong. Pharynx with linear and with finely spiculate ridges. Hypopharynx with distinct teeth wider than high. Antenna 3 = 0·36 (0·34–0·39) mm long, 0·18 (0·18–0·20) length of wing, 1.26 (1·22–1·31) length of 4+5, 1·13 (1·08–1·19) length of labrum; two ascoids on segments 3–15, that on 4 = 0·87 length of segment and reaching next one, with spur; no papilla on 5. Mandible pointed. Maxilla with about eight lateral teeth and about 41 ventrals, a few of them very small, dental depth 0·12 mm, palpal ratio 10 : 16 : 31 : 34 : 61. Scutum pale brown and pleura mainly pale. Wing length 1·95 (1·98–2·00) mm, 2·7 times width, R_2/R_{2+3} 1·41 (0·99–1·72), R_1 overlap/R_2 rather constant near 0·61 (0·52–0·68). Abdominal tergites 3–6 with a few erect hairs on hind margins. Spermatheca narrow with some wrinkles proximally, with knob in deep narrow pit, delicate ducts uniting into short common one.

♂. Labrum 0·22 mm long, 0·13 length of wing. Cibarium with about six irregular hind teeth and about 20 irregular fore teeth of which a few posterior ones are slightly larger than the others; pigment patch indefinite. Pharynx with faint ridges. Antenna 3 = 0·35 mm long, 0·21 length of wing, 1·21 length of 4+5, 1·59 length of labrum, one ascoid on segments 3–15, that on 4 0·64 length of segment; no papilla on 5. Wing length 1·64 mm, 3 times width, R_2/R_{2+3} 1·01, R_1 overlap/R_2 0·19. Genital filament 3·1 times length of pump. Coxite broad with patch of about 43 narrow hairs merging into large meso-dorsal hairs; style with seta at 0·65 and two of stout spines at about 0·68.

Material examined.
Holotype ♀, **West Malaysia:** Gunong Besout Forest Reserve, 20.iii.1974 (*A. B. Knudsen & colleagues*) (BMNH).

Paratypes. **West Malaysia:** Pulau Meranti, 19.xi.1970, 11.ii.1971 (*S. Mahadevan*), trap baited with monkey *Macaca nemestrina* (beroks) in swamp forest canopy 8·5 m above ground, 19·00–21.00 hours, 2 ♀; as for holotype, 22.ii.1974 (*J. Jeffery & colleagues*), 1 ♀, 1 ♂; Klang, 1.iii.1972 (*D. J. Lewis*), 1 ♀; Tanjong Rabok, 12.xi.1969 (*A. Rudnick*), 1 ♀. (All in BMNH.)



Figs 106–118 *Sergentomyia* species. 106–113, *S. gemmea*: (106, 107) ♀, antenna 4; (108) ♀, maxilla; (109) ♀, wing; (110, 111) ♀, spermathecae; (112, 113) ♂, cibarium and terminalia. 114–118, *S. gombaki*, ♀: (114) head; (115, 116) labrocibarium and tip of labrum; (117, 118) sagittal section of fascicle and cibarium.

Sergentomyia (*Neophlebotomus*) *gombaki* (Lewis & Wharton) **stat. n.**

(Figs 114–126, Map 9)

Phlebotomus sp. Lewis, 1957 : 167.
Phlebotomus (*Sergentomyia*) *zeylanica gombaki* Lewis & Wharton, 1963 : 121. Holotype ♀, West Malaysia (BMNH) [examined].
Sergentomyia (*Rondanomyia*) *zeylanica gombaki* (Lewis & Wharton) Lewis, 1973*a* : 251.

The cibarium of the female has about eight rows of fore teeth and the process of the pigment patch is faint or absent. The labrum is so long that the species looks superficially rather like a *Phlebotomus*. The male is described for the first time.

♀. Labrum 0·40 (0·34–0·42) mm long, 0·20 (0·18–0·21) length of wing, first and last apical sensilla prominent and adorals small. Cibarium with 12 pointed teeth and about seven rows of fore teeth; pigment patch very large and rounded anteriorly. Pharynx with faint ridges. Hypopharynx with low teeth and a smooth tip. Antenna 3 = 0·35 (0·31–0·38) mm long, 0·17 (0·16–0·18) length of wing, 1·26 (1·20–1·34) times length of 4+5, 0·88 (0·83–0·90) length of labrum, two ascoids on 3–15, that on 4 = 0·7 length of segment, with a spur, no papilla on antenna 5. Mandible with about 130 teeth including proximal faint ones, pointed. Maxilla with seven broad lateral teeth and 70 ventrals, dental depth 0·21 mm; palp delicate and difficult to measure, approximate ratio 10 : 20 : 22 : 23 : 57. Scutum brown and pleura mainly pale. Wing length 2·01 (1·97–2·09) mm, 3·1 times width, R_2/R_{2+3} 1·27 (1·07–1·62), R_1 overlap/R_2 0·64 (0·57–0·69). Spermatheca oblong with no collar, and ductules entering deep pit.

♂. Labrum 0·27 (0·25–0·29) mm, 0·14 (0·14–0·15) length of wing. Cibarium with about 16 hind teeth in groups of two or three, and about 16 scattered fore teeth. Pharynx with faint ridges. Antenna 3 = 0·44 (0·41–0·46) mm long, 0·23 (0·21–0·25) length of wing, 1·15 (1·09–1·19) times length of 4+5, 1·62 (1·53–1·70) times length of labrum, one ascoid on segments 3–15, that on 4 = 0·4 of its length. Palpal ratio 10 : 35 : 42 : 42 : 74. Wing length 1·92 (1·83–1·97) mm., 3·6 times width, R_2/R_{2+3} 0·79 (0·48–1·09), R_1 overlap/R_2 0·52 (0·38–0·61). Aedeagus pointed. Paramere beaked. Coxite delicate with sub-basal dense patch of about 183 hairs. Style with two spines terminal and two at 0·6, and a seta at 0·5.

Material examined.
West Malaysia: Gunong Besout Forest Reserve, April 1973 to August 1974 (*A. B. Knudsen & colleagues*), 294 ♀, 218 ♂, 10 of each measured.

Distribution. **West Malaysia:** Bukit Ibam (*L. W. Quate*, via BPBM); Gunong Besout area (as above); Ulu Gombak (Lewis & Wharton, 1963 : 121); Batang Padang, 3.vi.1923, 700 m (*H. M. Pendlebury*).

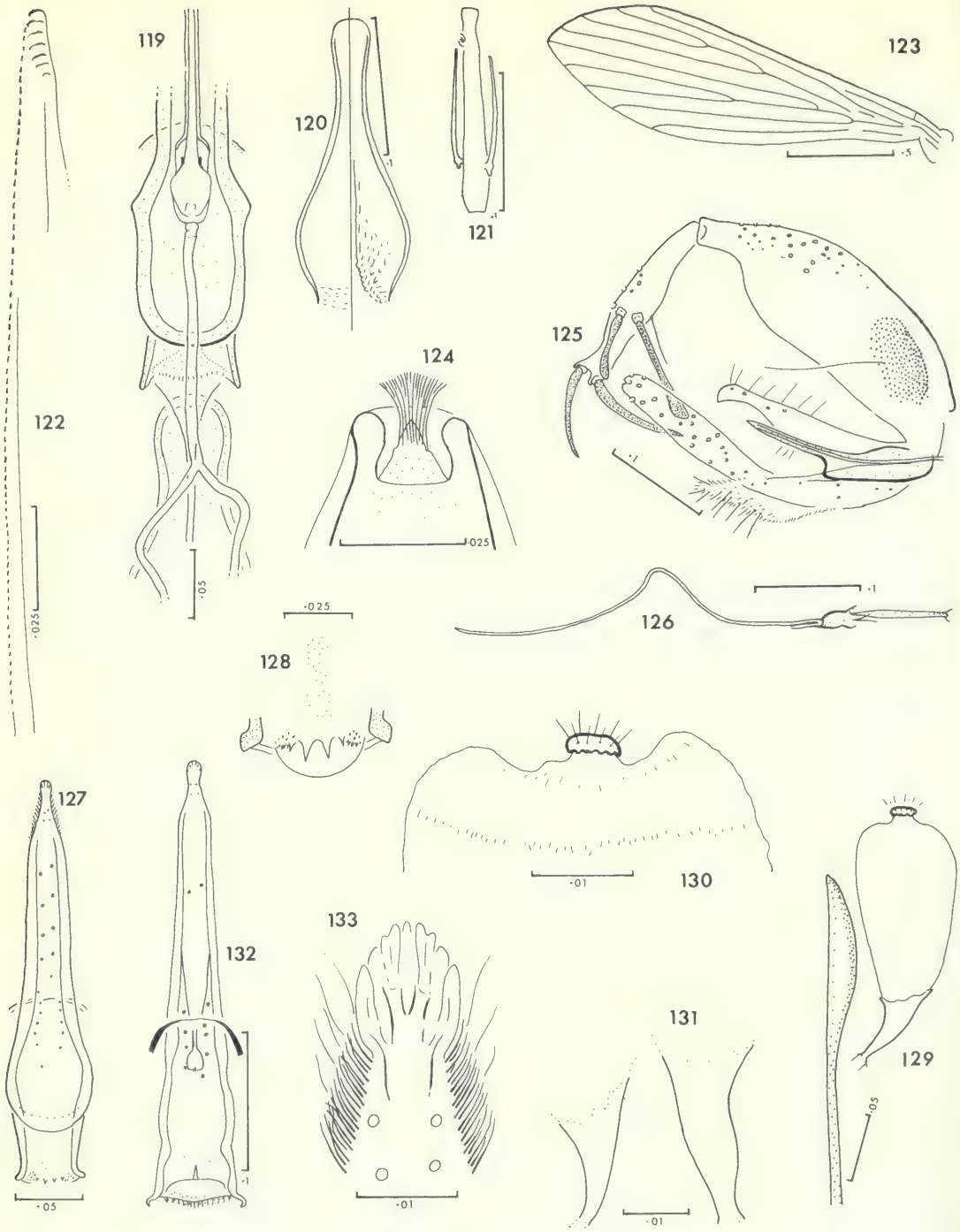
Sergentomyia (*Neophlebotomus*) *hamidi* Lewis & Jeffery **sp. n.**

(Figs 127–131, Map 9)

The female has a cibarium rather like those of *S. quatei* and *S. silvatica*, but different spermathecae.

♀. Eye 0·67 length of head. Labrum 0·16 (0·15–0·17) mm long, 0·09 (0·08–0·09) length of wing, adoral sensilla large. Cibarium with about two to four main spiky teeth, more or less continuous with a group of about ten small teeth at each side, pigment patch elongated and pale. Pharynx with a few lines and spicules. Hypopharynx with low undulations. Antenna 3 = 0·36 (0·35–0·36) mm long, 0·19 (0·19–0·20) length of wing, 0·78 (0·74–0·82) length of 4+5, 2·25 (2·19–2·29) length of labrum, two delicate ascoids, difficult to see, on segments 3–15, that on 4 being 0·28 length of segment, no papilla on 5. Mandible rather blunt, with large main teeth, 1·7 μm wide and very small distal ones. Maxilla with 12 lateral and 24 ventral teeth, dental depth 0·08 mm, palpal ratio 10 : 15 : 30 : 17 : 39. Scutum brown and pleuron brownish. Wing length 1·85 (1·79–1·90) mm, about 3·4 times width, R_2/R_{2+3} 0·85 (0·72–0·97), R_1 overlap/R_2 0·44 (0·33–0·53). Spermatheca with faint ductules, a refractive knob, very thin walls with minute spiculiform specks, narrowing toward the duct which begins as a relatively thick-walled funnel.

Material examined.
Holotype ♀, **West Malaysia:** Gunong Besout Forest Reserve, 29.v.1974 (*Ahmad bin Abd. Hamid*) (BMNH).
Paratypes. Same locality, 18.iii.1974 (*A. B. Knudsen et al.*), 1 ♀; 13.vi.1974 (*J. Jeffery et al.*), 1 ♀; 1974 (*R. B. Tesh*), 2 ♀. (Two in BMNH, two in U.S. National Museum.)
Non-paratypic material. **West Malaysia:** Bukit Ibam (*L. W. Quate*, via BPBM).



Figs 119–133 *Sergentomyia* species. 119–126, *S. gombaki*: (119) ♀, cibarium and base of pharynx; (120) ♀, pharynx; (121) ♀, antenna 4; (122) ♀, maxilla; (123) ♀, wing; (124) ♀, tip of spermatheca; (125, 126) ♂, terminalia and pump. 127–131, *S. hamidi*, ♀: (127, 128) labrocibarium and cibarium; (129–131) spermatheca and ends. 132, 133, *S. iyengari*, ♀, labrocibarium and tip of labrum.

Sergentomyia (*Neophlebotomus*) *hodgsoni* (Sinton)

Phlebotomus hodgsoni Sinton, 1933*a* : 874.

The cibarium of the female has 42–68 teeth, and the paramere of the male bears a spinose process. The species occurs from Central Asia to western India.

Sergentomyia (*Neophlebotomus*) *hodgsoni hodgsoni* (Sinton)

(Map 9)

Phlebotomus hodgsoni Sinton, 1933*a* : 874; 1933*d* : 226; 1933*e* : 419. Lectotype ♀, PAKISTAN (BMNH), designated by Lewis, 1967 : 37 [examined].
Sergentomyia (*Rondanomyia*) *hodgsoni* (Sinton); Theodor & Mesghali, 1964 : 296.
Sergentomyia (*Rondanomyia*) *pawlowskyi hodgsoni* (Sinton); Lewis, 1967 : 37.
Sergentomyia (*Rondanomyia*) *hodgsoni hodgsoni* Artemiev, 1976*a* : 39.

The cibarium of the female has 50–60 teeth, and the paramere of the male bears a ventral spinose process.

DISTRIBUTION. **India:** Mahasu area (Rao *et al.*, 1973). **Pakistan:** Cherat, Gwadi, Jandola, Landi Kotal, Parkuta, Peshawar, Rawalpindi, Said Pur, Taxla (Lewis, 1967 : 38).

Sergentomyia (*Neophlebotomus*) *iyengari* (Sinton) **comb. n.**

(Figs 132, 133, Map 9)

Phlebotomus iyengari Sinton, 1932*c* : 221; Raynal & Gaschen, 1935*c* : 507 [♀]; Raynal, 1935*b* : 249, 294; Theodor, 1938*a* : 268; 1938*b* : 172 [*S. dureni* (Parrot) of Africa as possible variety]. Syntypes 2 ♀, INDIA (depository unknown) [not examined].
Phlebotomus hivernus Raynal & Gaschen, 1935*d* : 582. Syntypes 4 ♀, 4 ♂, VIETNAM (NORTH) (depository unknown) [not examined]. [Synonymized by Quate, 1962*b* : 265.]
Phlebotomus hibernus Anonymous, 1935 : 779 [unjustified emendation under ICZN Article 33a(ii)]; Raynal, 1935*b* : 236, 239; Parrot, 1940 : 311.
Phlebotomus iyengari var. *hivernus* (Raynal & Gaschen) Theodor, 1938 : 267.
Phlebotomus iyengari var. *malayensis* Theodor, 1938 : 266. Syntypes 5 ♀, 17♂, WEST MALAYSIA (depository unknown) [not examined]. [Synonymized by Quate, 1962*b* : 265.]
Phlebotomus (*Prophlebotomus*) *hibernus* Anonymous; Parrot, 1940 : 311.
Phlebotomus iyengari var. *hainanensis* Yao & Wu, 1940 : 786; 1941 : 77; Leng, 1964 : 121, 128. Syntypes 3 ♀, CHINA (depository unknown) [not examined]. [Synonymized by Quate, 1962*b* : 265, 266.]
Phlebotomus (*Prophlebotomus*) *iyengari* Sinton; Parrot, 1946 : 70; Parrot & Clastrier, 1952 : 159.
Phlebotomus (*Sergentomyia*) *iyengari* var. *malayensis* Theodor; Lewis, 1957 : 168.
Phlebotomus (*Sergentomyia*) *iyengari* Sinton; Quate, 1962*b* : 265.
Phlebotomus (*Sergentomyia*) *iyengari taiwanensis* Cates & Lien, 1970 : 530. Holotype ♀, TAIWAN (Taiwan Malaria Research Institute) [not examined]. **Syn. n.**
Sergentomyia (*Rondanomyia*) *iyengari* (Sinton); Lewis, 1973*a* : 250; Yen-Chia, 1977 : 336.

The cibarium of the female has the central teeth smaller than the rest, fore teeth absent or ranging from one row of four to two rows of up to 20, and a pigment patch with forward projection thick, small or absent.

Theodor (1938) pointed out that this species is related to *S. dureni* (Parrot) of Africa. *S. iyengari*, like *S. tambori*, somewhat resembles the African *S. decipiens* (Theodor) and *S. dureni* but has a very pronounced spermathecal collar.

In a female from Gunong Besout, the labral apical sensilla are clearly visible and there are few anterior adorals, the hypopharynx has a few very low serrations, the mandible is normal, and the maxilla has eight broad lateral teeth, 26 well-marked ventrals and a dental depth of 0·10 mm.

The extra ascoids in the male, mentioned by Parrot (1940), are narrow with small bases and resemble colourless spines near the tips of segments 8–16 and on antennae of some other species. They are perhaps best regarded as vestiges to be excluded from the antennal formula.

The form *taiwanensis* is treated here as a synonym in view of Quate's conclusions on variation in the species. Yen-Chia (1977) recognizes *S. hainanensis* as a species with *malayensis* as its synonym.

MATERIAL EXAMINED.
West Malaysia: Gunong Besout Forest Reserve, 1973–74 (*A. B. Knudsen, J. Jeffery & colleagues*), 24 ♀, 18 ♂.

DISTRIBUTION. **China:** Hainan Island (Leng, 1964 : 127); Aihsien (Yao & Wu, 1940 : 797); Lingshui, Paoting (Yao & Wu, 1941*b* : 77). **India:** Trivandrum (Sinton, 1933*e* : 221). **Laos:** Luang-Prabang (Parrot & Clastrier, 1952 : 153); Muong Sing (Quate, 1962*b* : 265). **Taiwan:** many lowland places except west coastal plain, Hua-lien area, Kao-hsiung area, Taipei area (Cates & Lien, 1970 : 531). **Thailand:** Chieng Mai, Doi Sutep, Khon Kaen Province, Nong Khai area, Sara Buri, Tha Li area, Udon Thani area (Quate, 1962*b* : 265). **Vietnam (North):** Bim Son, Cho Ganh (Raynal, 1935*b* : 253, 297). **West Malaysia:** Gunong Besout area (as above); Kuala Lumpur area, Ulu Gombak (Lewis, 1957 : 168); Selangor State (Theodor, 1938 : 267).

In Indo-China Raynal (1936*a* : 361) at first found *S. iyengari* in only one locality (occasionally at the start of the warm season), and in the north (1936*a* : 367) encountered it only on mountain spurs about 20° north in the cold season.

Sergentomyia (*Neophlebotomus*) *jefferyi* Lewis **sp. n.**

(Figs 134–142, Map 9)

The female differs from *S. hitchensi* in having a prominent pigment patch.

♀. Eye 0·55 length of head. Labrum 0·19 (0·17–0·20) long, 0·11 (0·11–0·13) length of wing, apical sensilla very delicate, and subapicals hardly visible, adorals reduced. Cibarium with seven or eight delicate hind teeth and about ten fore teeth in single row; pigment patch about half internal width of cibarium, broader in front than behind, reddish brown, a faint short broad patch in front of it in ventral wall. Pharynx with faint lines. Hypopharynx with very low teeth which approach the tip. Antenna 3 = 0·25 (0·24–0·28) mm long, 0·15 (0·15–0·16) length of wing, 1·18 (1·10–1·20) length of 4+5, 1·36 (1·32–1·45) length of labrum, two ascoids on segments 3–15, that on 4 very thin and about 0·8 length of segment, no papilla on 5. Mandible pointed. Maxillary teeth vestigial; palpal ratio 10 : 20 : 31 : 50 : 74. Scutum pale brown and pleura pale. Wing length 1·69 (1·58–1·75) mm, 3·3 times width, R_2/R_{2+3} 0·96 (0·74–1·15), R_1 overlap/R_2 0·46 (0·29–0·57). Spermatheca usually wrinkled, with a rather low knob in a deep pit.

♂. Labrum 0·16 (0·15–0·17) mm long, 0·11 (0·11–0·12) length of wing. Cibarium with about seven ill-defined hind teeth, and about 15 small fore teeth in irregular row. Pharynx unarmed. Antenna 3 = 0·25 (0·22–0·27) mm long, 0·17 (0·16–0·20) length of wing, 1·16 (1·01–1·23) length of 4+5, 1·55 (1·41–1·71) length of labrum, one ascoid on segments 3–15, that on 4 about 0·33 length of segment, and small transparent hairs on some of distal segments. Wing length 1·44 (1·38–1·50) mm, 3·6 times width, R_2/R_{2+3} 0·72 (0·53–0·85), R_1 overlap/R_2 0·30 (0·18–0·41). Coxite and style with few hairs, seta on style small.

MATERIAL EXAMINED.
Holotype ♀, **West Malaysia:** Perak, Gunong Besout Forest Reserve, 5.v.1974 (*J. Jeffery*) (BMNH).
Paratypes. Same locality, 24.ii.1974 to 10.viii.1974, 12 ♀, 10 ♂, ten of each measured. (All in BMNH.)

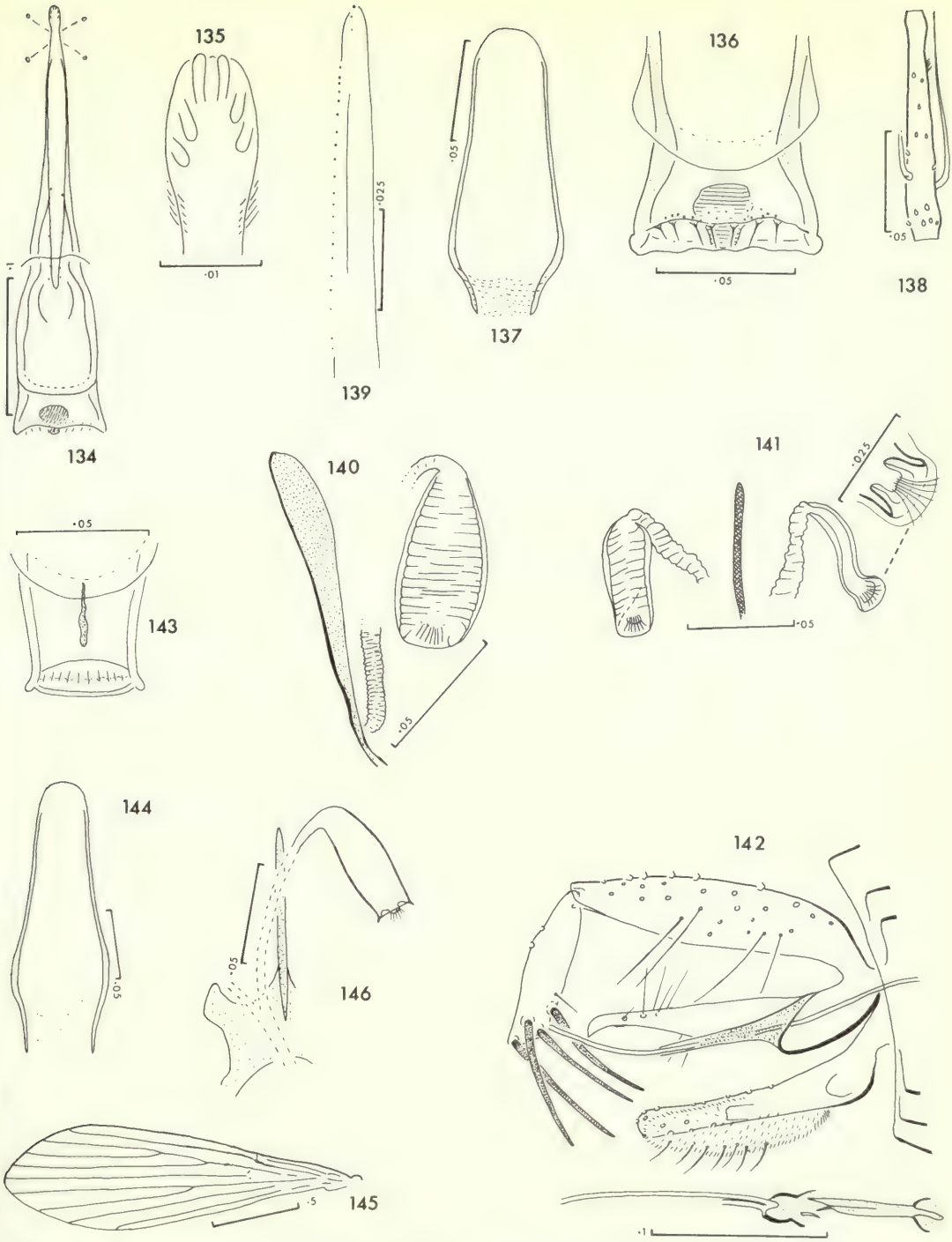
Sergentomyia (*Neophlebotomus*) *khawi* (Raynal)

(Map 9)

Phlebotomus khawi Raynal, 1936*c* : 529; 1937 : 72; Yao & Wu, 1941*b* : 77. Syntypes ♀ ♂, CHINA (depository unknown) [not examined].
Phlebotomus (*Prophlebotomus*) *khawi* Raynal; Parrot & Clastrier, 1952 : 160.
Sergentomyia (*Rondanomyia*) *khawi* (Raynal); Theodor, 1958 : 48; Lewis, 1973*a* : 251.
Phlebotomus (*Sergentomyia*) *khawi* Raynal; Quate, 1962*b* : 265.

The cibarium of the female has no pigment patch and a row of contiguous teeth, convex at the centre.

DISTRIBUTION. **Cambodia:** Phnom Penh (1 ♂, Parrot & Clastrier, 1952 : 133).



Figs 134–146 *Sergentomyia* species. 134–142, *S. jefferyi*: (134–136) ♀, labrocibarium, tip of labrum and cibarium; (137) ♀, pharynx; (138) ♀, antenna 4; (139) ♀, maxilla; (140, 141) ♀, spermatheca; (142) ♂, terminalia. 143–146, *S. linearis*, ♀: (143, 144) cibarium and pharynx; (145) wing; (146) spermatheca.

Sergentomyia (*Neophlebotomus*) *linearis* Lewis **sp. n.**

(Figs 143–148, Map 9)

A long narrow pigment patch in the cibarium distinguishes females and males from those of most other species of *Sergentomyia*.

♀. Labrum 0·25 (0·24–0·26) mm long, 0·12 (0·12–0·12) length of wing. Cibarium with about 10–12 pointed teeth in nearly straight row, and no fore teeth; pigment patch narrow and linear. Pharynx with faint ridges. Hypopharynx smooth. Antenna 3 = 0·34 (0·32–0·36) mm long, 0·16 (0·16–0·17) length of wing, 1·26 (1·21–1·32) length of 4+5, 1·36 (1·31–1·40) length of labrum; two ascoids on segments 3–15, that on 4 = 0·73 length of segment; no papilla on 5. Maxilla with no lateral teeth and vestigial ventrals; palpal ratio 10 : 24 : 32 : 39. Wing length 2·06 (2·00–2·19) mm, about 3·3 times width, R_2 (very long)/R_{2+3} 2·40 (2·16–2·66), R_1 overlap (consistently very long)/R_2 0·75 (0·73–0·76). Spermatheca subcylindrical, with collar and delicate duct.

♂. Labrum 0·18 (0·17–0·21) mm long, 0·11 (0·10–0·13) length of wing. Cibarium with about 12 pointed divergent teeth and no fore teeth, pigment patch linear. Pharynx almost unarmed. Antenna 3 = 0·35 (0·31–0·43) mm long, 0·20 (0·19–0·20) length of wing, 1·21 (1·07–1·30) length of 4+5, 1·89 (1·77–2·07) length of labrum, one ascoid on segments 3–15, that on 4 = 0·55 length of segment. Wing length 1·76 (1·67–2·18), 3·5 times width, R_2/R_{2+3} 2·03 (1·61–2·64), R_1 overlap/R_2 0·73 (0·65–0·96). Genital filament about 2·6 times length of pump. Aedeagus tapering to a blunt point. Coxite with about ten scattered hairs in brush. Style short and narrow, with seta at 0·75 and two of spines subterminal.

The specimens were presented to the BMNH by J. A. Sinton who had labelled them *linearis*, presumably with reference to the pigment patch.

MATERIAL EXAMINED.
Holotype ♀, **India:** Travancore, Kolatupuzha (= Kulathurpuzha ?) Forest Reserve, ix(?). 1934 (*M. O. T. Iyengar*), tree holes (BMNH).

Paratypes. **India:** data as for holotype, 3 ♀, 19 ♂; 6 ♀, 10 ♂ measured; Palod Forest Reserve, ix(?).1934 (*M. O. T. Iyengar*), 2 ♀, 9 ♂. (All in BMNH.)

Non-paratypic material. **India:** Kannur, ix, x.1957 (*H. Trapido*). (In BMNH.)

Sergentomyia (*Neophlebotomus*) *malabarica* (Annandale) **comb. rev.**

(Figs 149–156, Map 9)

Phlebotomus malabaricus Annandale, 1910*b* : 48; Brunetti, 1912 : 214; Sinton, 1924*a* : 833; 1924*c* : 1007 [♂ measurements & figs]; 1928*c* : 321; 1931*e* : 110; 1935*e* : 420, 423; Mitra, 1953 : 162. Lectotype ♂, INDIA (Zoological Survey of India), designated by Quate, 1962*c* : 158 [not examined].
Sergentomyia malabarica (Annandale); Theodor, 1948 : 111 [put in *africana* group].
Phlebotomus (*Sergentomyia*) *malabaricus* Annandale; Quate, 1962*c* : 158.

The cibarium of the female has about eight hind teeth in a nearly straight row.

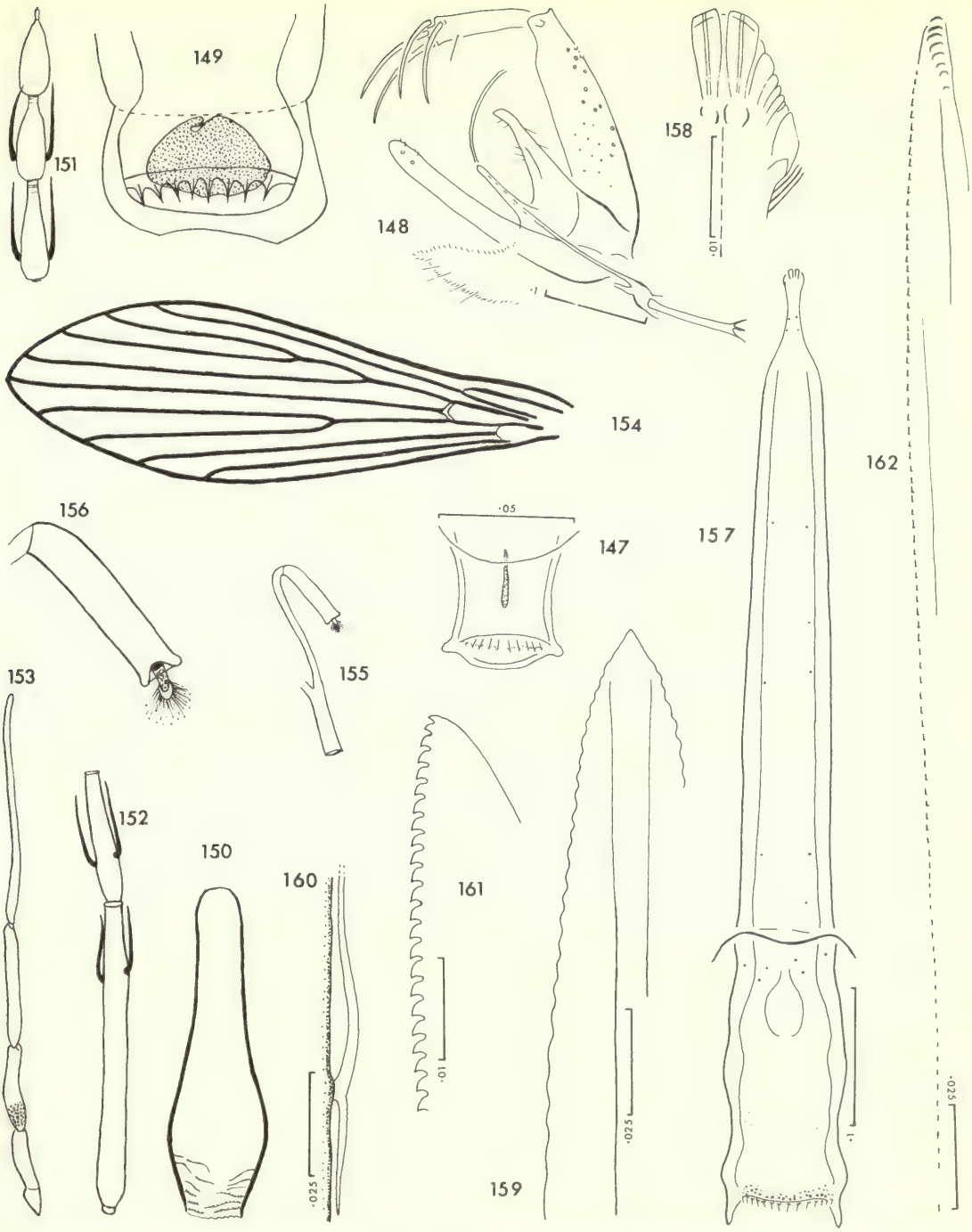
♀. Medium-sized and very dark brown. Labrum 0·20 (0·17–0·23) mm long. Cibarium with eight pointed teeth and a distinct pigment patch. Pharynx almost unarmed. Antenna 3 = 0·28 (0·27–0·29) mm long, 1·16 (1·11–1·20) length of 4+5, 1·42 (1·25–1·64) length of labrum, ascoid on 4 about 0·56 length of segment. Palpal ratio 10 : 21 : 34 : 48 : 90. Wing length 2·06 (1·94–2·23) mm, 3·5 times width, R_2/R_{2+3} 2·51 (2·35–2·61), R_1 overlap/R_2 0·76 (0·74–0·80). Spermatheca tubular.

♂. Described by Sinton (1924*c*).

COMMENTS. *S. malabarica*, described when important characters were still unknown, has for long been a problem species with regard to the structure of the male, the identity of the female, confusion with other species, and suggested use as a type-species (see under *Sergentomyia*).

The male was at first stated to bear spines on the surstyle but these proved to be merely hair-sockets (Sinton, 1924*c*).

Misidentification of the female has occurred (Sinton, 1927*a* : 933; 1927*d* : 25, 1927*e* : 30; 1928*c* : 321; 1932*a* : 61. See under *S. modii*.).



Figs 147–162 *Sergentomyia* species. 147, 148, *S. linearis*, ♂: (147) cibarium; (148) terminalia. 149–156, *S. malabarica*, ♀: (149) cibarium; (150) pharynx; (151, 152) antennal tip and segments 3 and 4; (153) palp; (154) wing; (155, 156) spermatheca. 157–162, *S. malayae*, ♀: (157, 158) labrocibarium and tip of labrum; (159) hypopharynx; (160) base of ascoid on antenna 4; (161) mandible tip; (162) maxilla. (Figs 149–156 J. A. Sinton *del.*)

The female remained unknown till 1934 when Sinton received specimens from Kerala. He left notes in the BMNH from which the above description was prepared.

The species is placed in this subgenus on the basis of the style-spines of the male and the wing and spermatheca of the female.

Slides presented to the BMNH by Sinton and bearing a provisional name *malabarica* included two other species, *S. modii*, which had previously been described as the female of *malabarica*, and *S. kauli*.

DISTRIBUTION. **India:** Travancore (now in Kerala), below western slopes of Western Ghats, Maddathorai and Palod (= Pallode ?) (Annandale, 1910 : 49); Kulathurpuzha Forest Reserve and Palod Forest Reserve, 1934 (*M. O. T. Iyengar*), 4 ♀, 4 ♂.

Sergentomyia (*Neophlebotomus*) *malayae* (Lewis) **stat. n.**

(Figs 157–164, Map 9)

Phlebotomus (*Sergentomyia*) *zeylanica malayae* Lewis, 1957 : 166; Quate & Fairchild, 1961 : 218. Holotype ♀, WEST MALAYSIA (BMNH) [examined].
Sergentomyia (*Rondanomyia*) *zeylanica malayae*; Lewis, 1973*a* : 251.

The female has about three rows of cibarial fore teeth and a very long labrum, 0·18–0·20 of the wing length, and more maxillary ventral teeth than does *S. zeylanica*.

♀. Labrum 0·50 (0·48–0·52) mm long, 0·19 (0·18–0·20) length of wing, with two main apical truncate sensilla, adorals small. Cibarium with 14 teeth and about two or three rows of fore teeth. Pigment patch rounded anteriorly. Pharynx with faint ridges. Hypopharynx (and mandibles) curled like grass, with very low teeth and a smooth tip. Antenna 3 = 0·48 (0·45–0·52) mm long, 0·18 (0·17–0·20) length of wing, 1·23 (1·13–1·28) times length of 4+5, 0·19 (0·88–1·02) length of labrum, two ascoids on segments 3–15, that on 4 delicate with long spur, no papilla on 5. Mandible pointed. Maxilla with eight broad lateral teeth and 88 ventrals, and a dental depth of 0·29 mm, palpal ratios about 10 : 25 : 31 : 25 : 54. Scutum and pleuron mainly pale. Wing length 2·64 (2·53–2·83) mm, 3·0 times width, R_2/R_{2+3} 1·83 (1·53–2·06), R_1 overlap/R_2 0·75 (0·72–0·78), rather constant. Abdominal tergites 5 and 6 with a few hind erect hairs. Spermatheca oblong without collar.

♂. Labrum 0·37 (0·36–0·37) mm long, 0·15 (0·14–0·15) length of wing. Cibarium with about ten irregular hind teeth and about 40 scattered fore teeth. Pharynx with faint ridges. Antenna 3 = 0·61 (0·56–0·63) mm long, 0·25 (0·24–0·26) length of wing, 1·10 (0·98–1·17) length of 4+5, 1·65 (1·59–1·72) length of labrum, one ascoid on segments 3–15, that on 4 with a narrow spur. Wing length 2·47 (2·35–2·55) mm, 3·3 times width, R_2/R_{2+3} 1·81 (1·36–2·11), R_1 overlap/R_2 0·73 (0·70–0·77). Aedeagus bluntly pointed. Genital filaments short. Paramere beaked. Coxite with about 50 hairs in brush which merges gradually into the dorsal thick hairs.

MATERIAL EXAMINED.
West Malaysia: Gunong Besout Forest Reserve, 1973–74 (*A. B. Knudsen, J. Jeffery & colleagues*), 17 ♀, 48 ♂; ten of each measured.

DISTRIBUTION. **West Malaysia:** Gunong Besout Forest Reserve (as above, one with tip of proboscis clogged); Ulu Gombak (Lewis, 1957 : 167).

Sergentomyia (*Neophlebotomus*) *nankingensis* (Ho, Tan & Wu) **comb. n.**

(Map 9)

Phlebotomus nankingensis Ho, Tan & Wu, 1954 : 427. Syntypes 4 ♀, 2 ♂, CHINA: Nanking area, Purple Mountains, 1952 (depository unknown) [not examined].

Of the 14 cibarial hind teeth of the female, one on each side is separated from the rest. The following features are among those given by the author.

♀. Cibarium with 14 hind teeth, the outer two on each side spaced and apart from the rest; a row of 12 fore teeth present; pigment patch pointed in front and notched behind. Pharynx with groups of spicules.

Antenna stated to have one ascoid on 3–15. Palpal formula 1–2–3–4–5. Wing: R_2/R_{2+3} 1·24, R_1 overlap/R_2 0·52. Spermatheca with some distal striations.

♂. Cibarium with eight teeth and a small faint triangular pigment patch. Antenna with one ascoid on segments 3–15. Wing: R_2/R_{2+3} 1·1, R_1 overlap/R_2 0·5. Coxite: persistent hairs not indicated. Style with two of spines at 0·76. Position of seta not shown.

Sergentomyia (*Neophlebotomus*) *perturbans* (de Meijere)

(Figs 165–177, Map 10)

Phlebotomus perturbans de Meijere, 1909 : 201; Sinton, 1924*d* : 1015; 1928*c* : 316, 320; Patton & Hindle, 1926 : 405, 410 [type said to exist in Amsterdam]; 1928 : 533, 542; Edwards, 1928 : 64 [?]. Lectotype ♀, JAVA, designated by Quate, 1967 : 42 (ZMA) [examined].

Phlebotomus sylvestris Sinton, 1924*d* : 1017 [conditional name justified by ICZN Article 17(8)]; 1928*c* : 320; 1931*c* : 1209; 1931*e* : 110; 1932*a* : 62; 1933*e* : 420; Raynal, 1935*b* : 257; 1936*a* : 361 [synonymy]. Syntypes ♀ ♂, INDIA (depository unknown) [not examined]. **Syn. n.**

[*Phlebotomus perturbans* de Meijere; Patton & Hindle, 1926 : 409; 1928 : 542. Misidentification in view of later selection of lectotype.]

Phlebotomus demeijerei Nitzulescu, 1930 : 540. Syntypes 2 ♀, JAVA (depository unknown) [not examined]. [Synonymized (= *sylvestris*) by Theodor, 1948 : 111.]

Phlebotomus (*Prophlebotomus*) *sylvestris* Sinton; Parrot, 1940 : 311; 1946 : 71, 73; Parrot & Clastrier, 1952 : 167.

Phlebotomus (*Sergentomyia*) *whartoni* Lewis, 1957 : 167; Quate & Fairchild, 1961 : 121; Lewis & Wharton, 1963 : 121. Holotype ♀, WEST MALAYSIA (BMNH) [examined]. **Syn. n.**

Phlebotomus (*Sergentomyia*) *sylvestris* Sinton; Quate, 1962*b* : 265 [synonymy].

Phlebotomus (*Sergentomyia*) *perturbans* de Meijere; Quate, 1967 : 42.

Sergentomyia (*Rondanomyia*) *whartoni* (Lewis); Lewis, 1973*a* : 251.

The female differs from all other species in having about nine main cibarial teeth arising from a well-marked refractive area of the ventral wall. The coxite of the male is long, narrow and slightly curved.

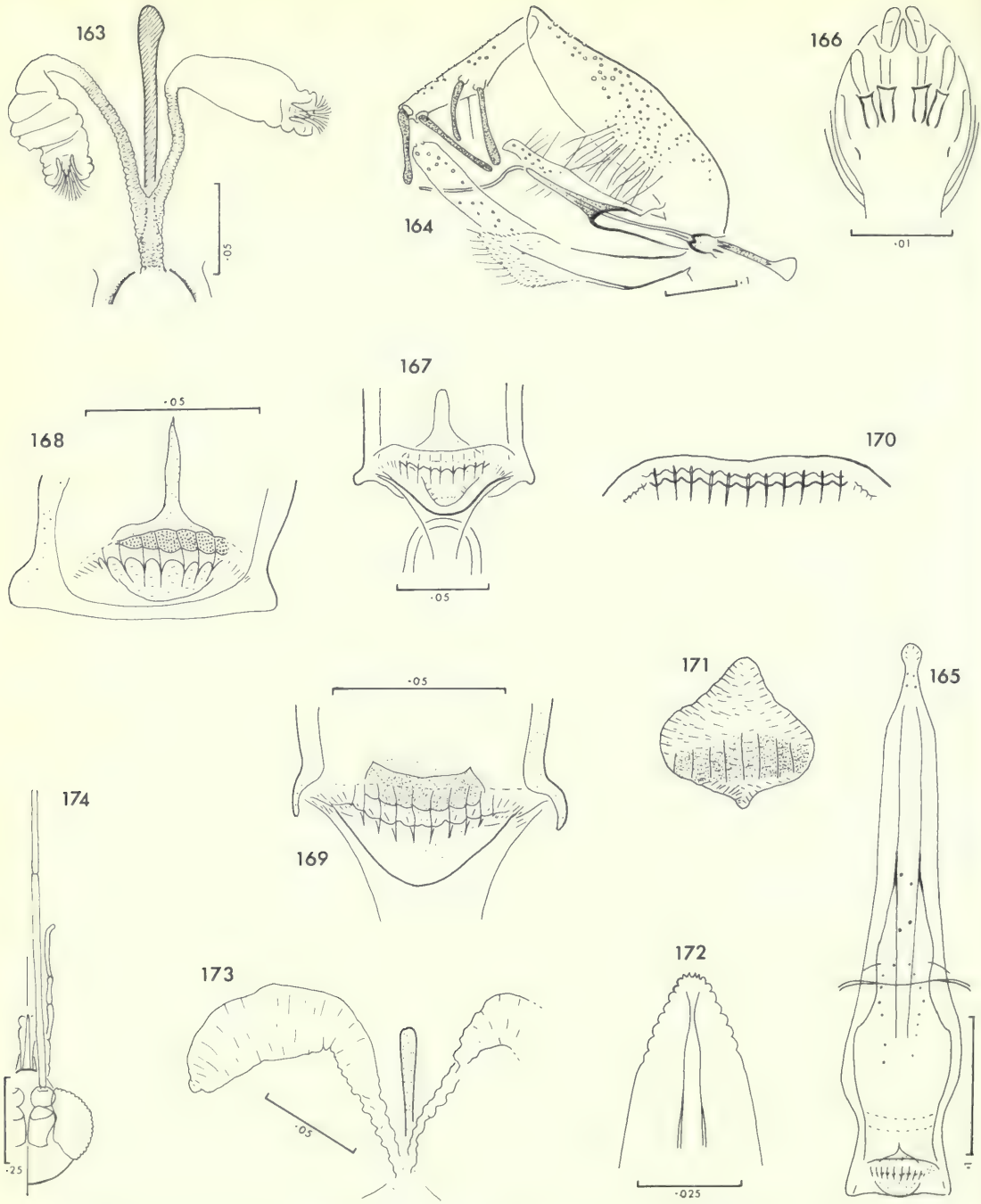
♀. Eye 0·61 length of head. Labrum 0·24 (0·23–0·25) mm long, 0·11 (0·11–0·11) length of wing, first two apical sensilla with conspicuous sockets, adorals well developed. Cibarium with eight or nine distinct pointed teeth merging into about ten spicules on each side, arising from thick refractive band, fore teeth absent, pigment patch dark reddish brown anteriorly and grey posteriorly, with transverse and oblique line, bearing anteriorly about eight longitudinal lines; distinct cibarial bulge present. Pharynx less than twice as wide posteriorly as anteriorly, with faint ridges bearing minute spicules. Hypopharynx with low teeth and a toothed tip. Antenna 3 = 0·36 (0·32–0·39) mm long, 0·16 (0·15–0·17) length of wing, 0·91 (0·85–0·95) length of 4+5, 1·48 (1·38–1·57) length of labrum, two ascoids on segments 3–15, that on 4 with vestigial spur, no papilla on 5. Mandibles nearly pointed. Maxilla with eight broad lateral teeth and 35 well-marked ventrals, and a dental depth of 0·15 mm, palpal ratio 10 : 22 : 30 : 24 : 56. Scutum brown and pleura pale except near coxae. Wing length 2·22 (2·11–2·29) mm, 3·1 times width, R_2/R_{2+3} 0·79 (0·62–0·88), R_1 overlap/R_2 0·47 (0·20–0·67). Abdominal tergites 5 and 6 with a few erect hairs on hind margins. Spermatheca with transverse wrinkles, no collar and a protruding knob.

♂. Labrum 0·18 (0·14–0·20) mm long, 0·91 (0·08–0·10) length of wing. Cibarium with eight irregular denticles of varied shape. Pharynx with faint ridges. Antenna 3 = 0·53 (0·50–0·57) mm long, 0·28 (0·25–0·31) length of wing, 0·78 (0·67–0·85) length of 4+5, 3·14 (2·48–3·78) length of labrum, one ascoid on 3–15. Wing length 1·90 (1·74–2·03) mm, 3·6 times width, R_2/R_{2+3} 0·67 (0·37–0·85), R_1 overlap/R_2 0·36 (0·18–0·44), costal basal node very small. Aedeagus slender and tapering to round point. Paramere beaked. Coxite narrow and curved outward, with diffuse patch of about 40 narrow hairs, and many thick long hairs pointing backward. Style narrow. Genital filaments about four times length of pump.

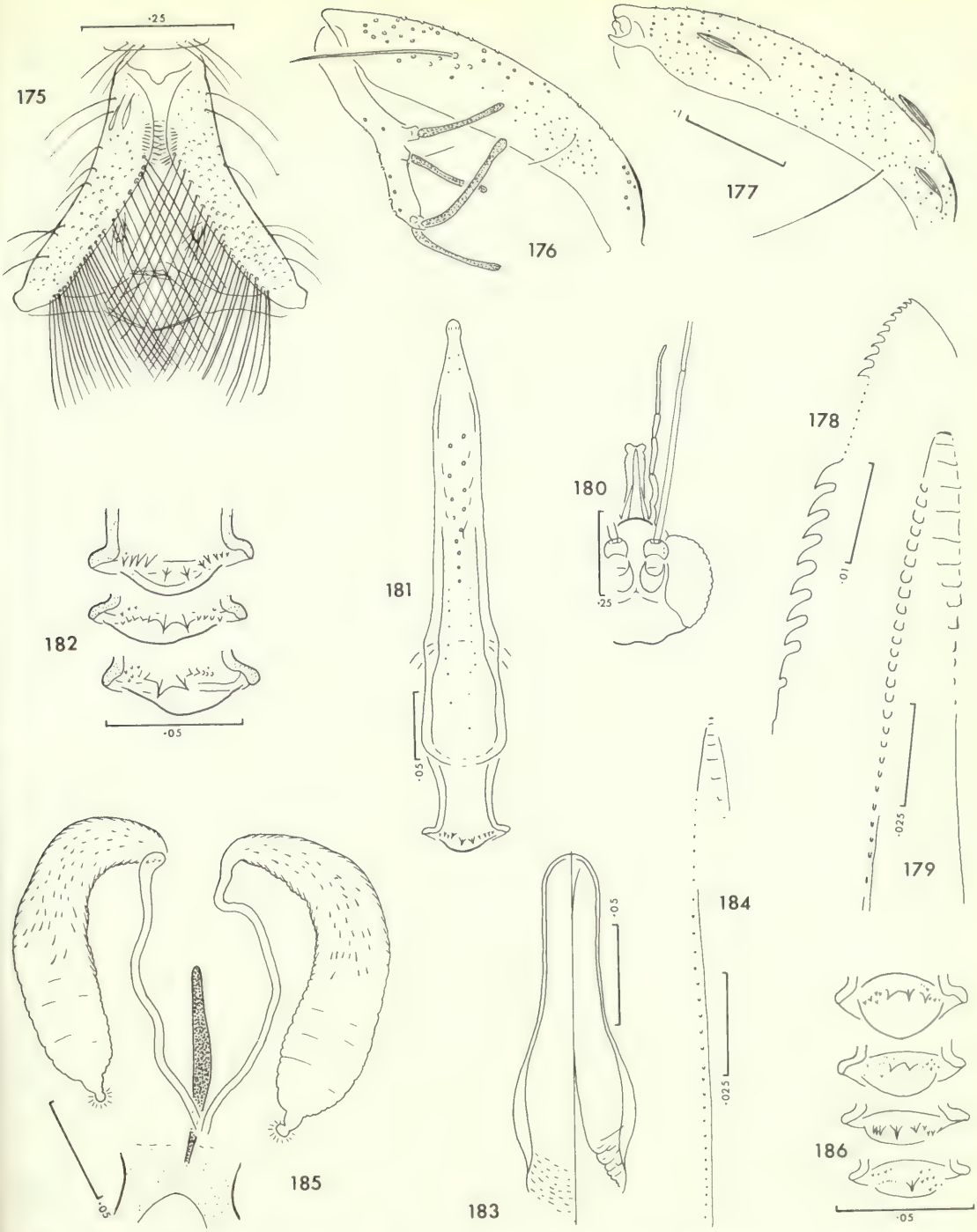
The above description is based on ten of each sex from West Malaysia, Gunong Besout Forest Reserve (1974).

The antenna, very long in this species (Parrot, 1946), and long hairs on the coxite are reminiscent of *P. frondifer* and could indicate life in dark surroundings.

Measurements of four females from Java, namely the lectotype, paralectotype (lacking head) and two from Semarang (ii, iii.1910), are as follows. Labrum 0·26 (0·25–0·27) mm long, 0·12 (0·11–0·12) length of



Figs 163–174 *Sergentomyia* species. 163, 164, *S. malayae*: (163) ♀, spermathecae; (164) ♂, terminalia. 165–174, *S. perturbans*: (165) ♀ (Gunong Besout area), labrocibarium; (166) labrum tip of same; (167) ♀ (Tanjong Rabok), cibarium; (168) ♀, cibarium of lectotype; (169) ♀ (Sukna), cibarium; (170, 171) ♀ (Gunong Besout area), cibarial hind teeth crushed, and isolated pigment patch of same fly; (172) ♀, hypopharynx tip; (173) ♀ (Sukna), spermatheca; (174) ♂ (Gunong Besout area), head.



Figs 175–186 *Sergentomyia* species. 175–177, *S. perturbans*, ♂, terminalia, and coxite in mesad and lateral view. 178, 179, *S. purii*, ♀: (178) mandible; (179) maxilla. 180–186, *S. quatei*: (180) ♀, head; (181) ♀, labrocibarium; (182) ♀, cibarium; (183) ♀, pharynx; (184) ♀, maxilla; (185) ♀, spermathecae; (186) ♂, cibarium.

wing. Antenna 3 = 0·35 (0·33–0·36) mm long, 0·15 (0·15–0·16) length of wing, 0·89 (0·86–0·93) length of 4+5, 1·67 (1·25–1·39) length of labrum. Palpal ratio about 10 : 21 : 28 : 20 : 45. Wing length 2·18 (1·99–2·26) mm long, about 3·3 times width, R_2/R_{2+3} 0·70 (0·59–0·88), R_1 overlap/R_2 0·52 (0·36–0·70). These and other features agree well with flies from West Malaysia.

Measurements of four females from Sukna, India (3.vii.1908), are as follows. Labrum 0·29 (0·27–0·31) mm long, 0·13 (0·12–0·14) length of wing. Antenna 3 = 0·32 (0·29–0·35) mm long, 0·14 (0·13–0·15) length of wing, 0·90 (0·83–0·96) length of 4+5, 1·11 (1·06–1·18) length of labrum. Palpal ratio about 10 : 24 : 32 : 21 : 50. Wing length 2·27 (2·23–2·31) mm, 3·3 times width, R_2/R_{2+3} 0·71 (0·64–0·78), R_1 overlap/R_2 0·45 (0·38–0·48). These figures agree well with data from Java except that antenna 3/labrum is lower, but this could well be due to infraspecific variation.

When *S. perturbans* was named it was probably thought that all sandflies bit man, but there is no evidence that it does so.

Discussion on the cibarium of the female. Nitzulescu (1930) described the cibarial armature of Javanese *S. perturbans* (=*demeijerei*) as a double row of teeth, nine in each, one behind the other. Sinton (1932*a*) studied Indian specimens (=*sylvestris*) and figured about 25 hind teeth on a concave line, and an apparently refractive area (the above-mentioned dark ventral patch) in line with the ten central ones. Raynal (1935*b*) described, in North Vietnam *sylvestris*, 20 strong and very pointed hind teeth and, at the anterior edge of the dark pigment patch, a row of ten or 11 contiguous rectangles, apparently anterior incisor teeth, which were more or less apparent at certain angles during mounting. Raynal & Gaschen (1935*b*) stated that the hind lateral teeth were sometimes difficult to see, and that the rectangles appeared pigmented, apparently owing to the pigment patch on which they were reported to be placed. Parrot & Clastrier (1952), studying specimens (=*sylvestris*) from Cambodia, recognized 13 dimorphic hind teeth, namely nine median long ones, curved slightly inward, and on each side narrow ones which appeared to number two but were hard to see and could be more numerous. They observed the dark rectangles, apparently chitinous thickenings, but could not confirm Raynal's impression of incisor teeth. Quate (1967) described, in Javanese *perturbans*, eight long teeth with bases apparently embedded in a dark nail-shaped pigment patch, with no evident fore teeth, the armature being unlike that of any other Asian species which he knew.

After studying cibaria from the three above-mentioned countries, mounted in Berlese's medium without pressure, and removing the pigment patch from a few specimens, I find that the differences in descriptions are due to several causes. Compression has sometimes increased the number of observed hind teeth. The thick hind part of the inter-arcal area produces a refractive lens-like effect which masks the structure. The lines on the pigment patch (Nitzulescu's first row of 'teeth') have been taken for teeth or bases of teeth; this can easily happen because in a cibarium at rest the arched dorsal and ventral walls are almost in the same optical plane.

The lines on the pigment patch (also seen in *S. reidi*) appear to be imprints of the central cibarial teeth. Among specimens examined in detail were three pinned ones from Sukna, India (3.vii.1908, labelled *P. perturbans*, presented to the BMNH in 1927 by E. Brunetti, and recently slide-mounted). They showed eight cibarial main teeth and, on each side, one vestigial tooth and numerous denticles or spicules such as occur in several species of *Sergentomyia* and could well be disregarded in descriptions. At the bases of the teeth is a dark area which appears to be a thickening of the ventral wall of the cibarium. A hind bulge is conspicuous.

Discussion on synonymy. *S. perturbans* was described at a time when some important taxonomic structures and 98 per cent of the world's sandfly taxa were still unknown. Species in distant lands were wrongly identified as this species, and *S. sylvestris* was treated as a different species, but now proves to be a synonym. For a time workers who examined specimens from de Meijere's collection tended to regard them as one species (they are here shown to comprise at least five), and there was little attempt to distinguish the type-series from other specimens. Two specimens of what proves to be the type-form were described as a new species, *demeijerei*. Confusion has reigned for over 65 years, and has been referred to in part by Patton & Hindle (1928), Sinton (1928*c*), Raynal & Gaschen (1936*c*), Perfil'ev (1968) and Lewis & Dyce (1976).

The situation is clarified, it is hoped, in the following notes on specimens which, except numbers 5, 6, 15 and 16, are in the ZMA. All were collected in Java in 1908, 1909 and 1910 by Edward Jacobson (a private collector who lived in Djakarta, then Batavia, and Semarang) and are females except number 6.

1. *P. stantoni*, Semarang, xi.1909.

2 and 3. *P. stantoni*, Semarang, ii.1910.

4. *S.* (*Parrotomyia*) *mangana* or ally, Semarang, ii.1910. The arc bearing the cibarial teeth is nodular.

5. *S.* sp., probably *balica*, no locality or date recorded. Cibarium figured by Patton & Hindle (1928 : 542) as co-type. This and number 6 were accepted as *perturbans* by Sinton (1928*c* : 320).

6. *S.* sp., possibly near *balica*, ♂, no locality or date recorded. Terminalia figured by Patton & Hindle (1928 : 544) as co-type, name in legend wrong. Aedeagus pointed, paramere hooked, style with all spines terminal.

7. *S.* (*Neophlebotomus*) *balica*, Djakarta, xi.1908, labelled 'Patton, vis.' Wing length 1·97 mm.

8 and 9. *S. balica*, Semarang, i.1910. Wing length 1·97 and 1·98 mm.

10 and 11. *S. balica*, Semarang, ii.1910. Wing lengths 1·94 and 1·98 mm. Average length for numbers 7–11 is 1·97 (1·97–1·98) mm.

12. *S.* (*Neophlebotomus*) Djakarta sp., Djakarta, xi.1908, labelled 'Patton vis. . . . *P perturbans* det. de Meijere', evidently by Patton. Antenna 4–16 and abdomen missing. Wing length 1·68 mm.

13 and 14 (others presumably existed but were not mentioned by describer). *S. perturbans*, Djakarta, November and Semarang, June, described by de Meijere (1909). His mention of colour differences between Djakarta and Semarang specimens foreshadowed what we now know, that he was dealing with at least three species. His measurements for wing length suggested that *perturbans* was a small species and were used by Sinton (1924*d* : 1016) to differentiate provisionally an Indian sandfly, *sylvestris*, from it. He reinforced this view (1928*c* : 320) on the strength of drawings of specimens 5 and 6 by Patton and Hindle. Despite de Meijere's evidently careful drawing of the wing, his lengths prove unreliable, even if adjusted to show the length seen in the figure. This adjusted length is about 0·86 of the wing lengths as measured in the present paper.

No original type-labels now exist, and Quate's remarks (1967, published several years after inspection of the specimens) are not clear. The specimen chosen by him as lectotype, mounted in Euparal, and here numbered 13, retains the label 'Patton vis.' and is presumed to be one of two labelled by de Meijere as 'type'. Apart from this, neither of specimens 13 and 14 retains an original label. Quate's paper merely gives the locality as Java and the month as probably November. His small-scale drawing of the cibarium (perhaps made before the specimen had cleared) differs from the appearance of Fig. 169 which, with other characters, shows that the lectotype is the same taxon as that known for many years as *S. sylvestris*. The wing length is 2·25 mm.

Specimen 14 (wing length 1·99 mm) was labelled as paratype by Quate but not mentioned in his paper, and it is stated to come from Java and has no head. It is here treated as the paralectotype.

15 and 16. *S. perturbans*, Semarang, vii.1909. Depository, if any, unknown. These were treated by Nitzulescu (1930) as being found among co-types and described as *P. demeijerei*.

17 and 18. *S. perturbans*, Semarang, ii, iii.1910. Wing lengths 2·23 and 2·26 mm. Average length for numbers 13, 14, 17 and 18 is 2·18 (1·99–2·26) mm.

The West Malaysian *whartoni* is recognized as a synonym after inspection of *perturbans* from Java and India.

MATERIAL EXAMINED.

India: Sukna, 4 ♀. **Java:** Djakarta and Semarang, 4 ♀. **West Malaysia:** Gunong Besout Forest Reserve, 1974 (*A. B. Knudsen & colleagues*), 14 ♀, 24 ♂; Tanjong Rabok, x, xi.1969, 3 ♀; Ulu Langat Forest Reserve, 25.vii.1968, 1 ♀, 2 ♂ (*A. Rudnick*).

DISTRIBUTION. **Bangladesh:** Sylhet (Sinton, 1932*a* : 71). **Burma:** Rangoon (Sinton, 1928*c* : 320; 1932*a* : 71). **Cambodia:** Phnom Penh (Parrot & Clastrier, 1952 : 153). **India:** Jorhat (Sinton, 1924*d* : 1027); Doloi Valley, Sukna (Sinton, 1928*c* : 200). **Java:** Djakarta, Semarang (de Meijere, 1909 : 201; Nitzulescu, 1930 : 541). **Laos:** Vientiane (Quate, 1962*b* : 265). **Vietnam (North):** Bim Son, Cho Ganh, Dong Giao, Le Mi (Raynal, 1935*b* : 261); Bui Huy Tin, Phu Oc (Raynal, 1936*a* : 362). **West Malaysia:** Gunong Besout area (as above); Lubok Paku (Lewis, 1957 : 167); Gua 'Che Yatim (Quate & Fairchild, 1961 : 211); Tanjong Rabok (x, xi.1969, 3 ♀), Ulu Langat Forest Reserve (25.vii.1968, 1 ♀, 2 ♂) (*A. Rudnick*).

S. perturbans (=*sylvestris*) was taken by Sinton in the Darjeeling district of India, where it seemed to be associated with foothill jungle and Raynal (1936*a* : 361) noted that it occurred at quite a low altitude in India and Indo-China.

Sergentomyia (*Neophlebotomus*) *purii* (Sinton)

(Figs 178, 179, Map 10)

Phlebotomus purii Sinton, 1931*d* : 1203; 1931*e* : 110; 1932*a* : 60; 1933*c* : 421. LECTOTYPE ♀, here designated [examined]. INDIA: Sukna, viii.1928 (*I. M. Puri*), labelled 'type ♀',
Phlebotomus (*Prophlebotomus*) *purii* Sinton; Parrot, 1940 : 311; 1946 : 72.
Sergentomyia purii (Sinton); Theodor, 1948 : 11.
Sergentomyia (*Rondanomyia*) *purii* (Sinton); Theodor, 1958 : 2 [maxilla]; Lewis, 1973*a* : 251.

The long narrow pigment patch of the female is rather like that of *S. linearis* but the curved row of teeth and the spermatheca are quite different.

DISTRIBUTION. **India:** Marianbari, Sukna, Tindharia (Sinton, 1931*d* : 1203).

S. purii was first found in forest tree-holes at the base of the Himalaya in Darjeeling District (Sinton, 1932*a*).

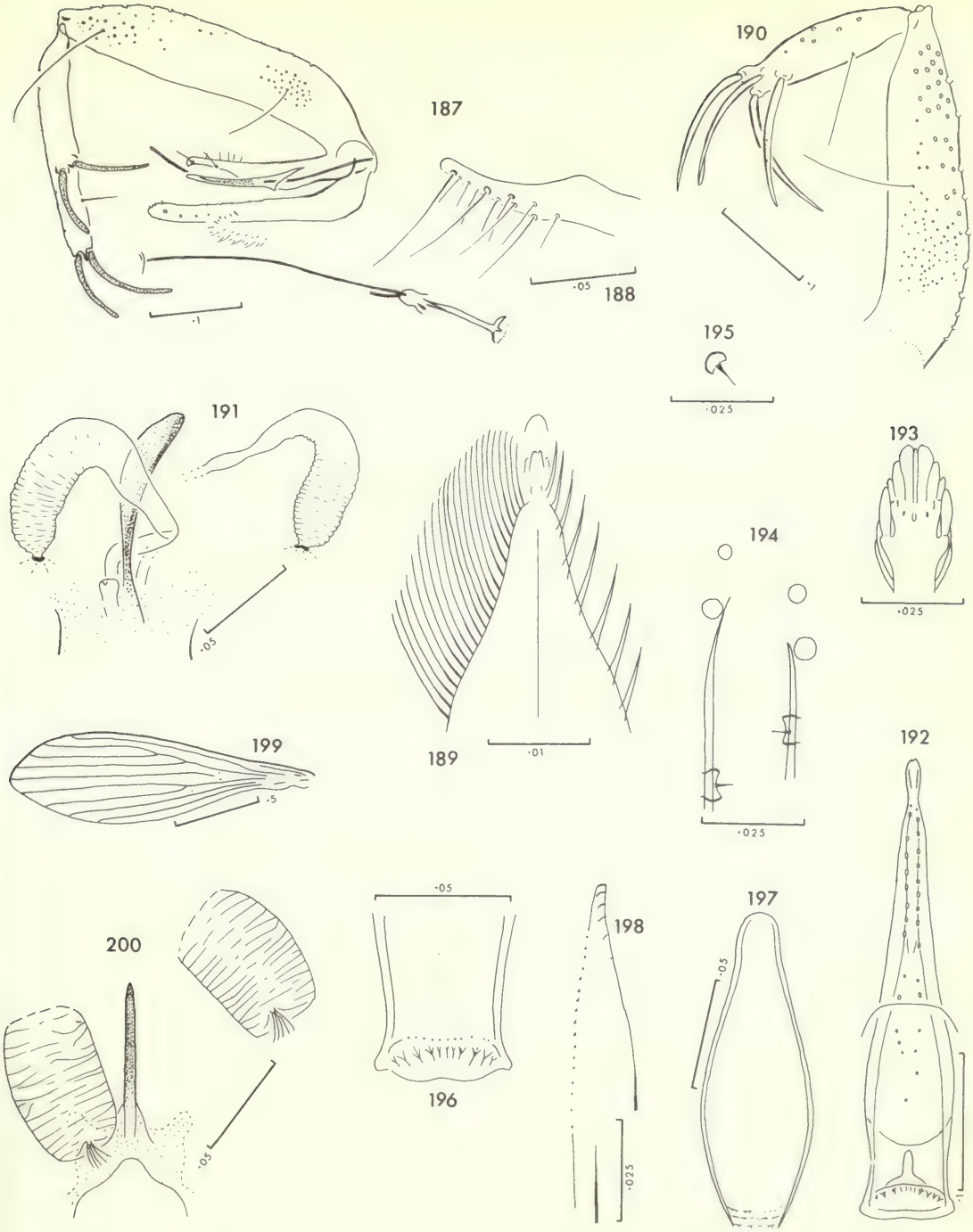
Sergentomyia (*Neophlebotomus*) *quatei* Lewis **sp. n.**

(Figs 180–188, Map 10)

The species is distinguished from all related ones by its cibarial armature, which slightly resembles that of *S. silvatica*, but *S. quatei* differs in having no pigment patch and a greater antenna 3/labrum figure. The armature of *S. quatei* is rather like that of the Australasian *S. brachycornuta* (Fairchild) which has a pigment patch and a shorter antenna 3.

♀. Eye 0·71 length of head. Head and most of labium dark. Labrum 0·21 (0·21–0·23) mm long, 0·10 (0·09–0·10) length of wing, apical sensilla normal, subapicals vestigial, adorals large and some of them accompanied by posteriorly converging lines. Cibarium with two middle teeth set backward, and about five small ones separate from them on each side, pigment patch absent, faint bulge present. Pharynx unarmed. Hypopharynx with vestigial serrations. Antenna 3 = 0·49 (0·46–0·52) mm long, 0·22 (0·22–0·24) length of wing, 0·86 (0·81–0·90) length of 4+5, 2·30 (2·21–2·36) length of labrum, ascoids delicate and difficult to see against brown antenna, two with short blunt spurs seen on segment 3, and one each on 3–10 and 12, many rather similar colourless hairs present, ascoid on 4 about 0·24 length of segment, no papilla on 5. Maxilla with nine low lateral teeth, and 32 small ventrals, dental depth 0·12 mm, palpal ratio about 10 : 14 : 23 : 16 : 41. Scutum, lower part of pleura, and coxae dark. Wing length 2·15 (2·15–2·23) mm long, 3·2 times width, R_2/R_{2+3} 1·30 (1·05–1·50), R_1 overlap/R_2 0·63 (0·40–0·68). Spermatheca with protruding knob and internal spicules which are just visible in freshly mounted specimens.

♂. Labrum 0·18 (0·17–0·19) mm long, 0·10 (0·09–0·11) length of wing. Cibarial teeth very variable, usually one to four large ones in centre and about six to ten small ones on each side, pigment patch absent. Pharynx unarmed. Antenna 3 very long, 0·58 (0·54–0·64) mm, 0·32 (0·28–0·35) length of wing, 0·78 (0·68–0·84) length of 4+5, 3·18 (2·88–3·48) length of labrum, one ascoid on segments 3–10 (others not seen). Wing length 1·82 (1·71–2·01) mm, 4 times width, R_2/R_{2+3} 1·16 (0·91–1·58), R_1 overlap/R_2 0·54 (0·45–0·64). Aedeagus tapering to blunt point. Paramere with very unequal hairs. Coxite with isolated sub-basal patch of about 31 hairs.



Figs 187–200 *Sergentomyia* species. 187, 188, *S. quatei*, ♂: (187) terminalia; (188) paramere from above. 189, 190, *S.* Sepilok sp., ♂: (189) tip of labrum from below, with upper hairs on right; (190) coxite and style. 191, *S. silvatica*, ♀ (Thailand), spermatheca. 192–200, *S. tambori*, ♀: (192) labrocibarium; (193) tip of labrum; (194) subapical and first adoral sensilla; (195) left tenth adoral sensillum; (196) cibarium; (197) pharynx; (198) maxilla; (199) wing; (200) spermathecae.

MATERIAL EXAMINED.
Holotype ♀, **Borneo** (Sabah): Sepilok, 7.ii.1972 (*D. J. Lewis*) (BMNH).
Paratypes. Same data, 7–15.ii.1972, 7 ♀, 27 ♂; 8 ♀ and 10 ♂ measured. (All in BMNH.)

Sergentomyia (*Neophlebotomus*) sp. (Rabok)

(Map 10)

The cibarial fore teeth are about four deep in a broad band, and the aedeagus is slender.

♂. Labrum 0·25 (0·24–0·26) mm long, 0·14 (0·13–0·15) length of wing. Cibarium with three pointed hind teeth and a few denticles on each side, and three rows of fore teeth, each with about ten. Pharynx with faint ridges. Antenna 3 = 0·41 (0·41–0·41) mm long, 0·23 (0·23–0·24) length of wing, 1·18 (1·17–1·19) length of 4+5, 1·66 (1·59–1·72) length of labrum, one ascoid on segments 3–15, that on 4 about 0·63 length of segment, with short blunt spur. Scutum and pleura very pale. Wing length 1·75 (1·71–1·79) mm, about 3·1 times width, R_2/R_{2+3} 1·39 (1·37–1·42), R_1 overlap/R_2 0·63 (0·59–0·66). Aedeagus with tip slightly turned up. Coxite with diffuse patch of about 30 thin hairs; style with seta and two of spines at about 0·6.

In the absence of females this species is left without a formal name.

MATERIAL EXAMINED.
West Malaysia: Tanjong Rabok, 27.xii.1968 (*A. Rudnick*), 2 ♀.

Sergentomyia (*Neophlebotomus*) sp. (Sepilok)

(Figs 189, 190, Map 10)

The coxite brush has over 52 hairs, more than in *S. hitchensi*, and the seta on the style is at 0.4.

♂. Rather dark, antennae with contrasting pale joints. Labrum 0·18 (0·17–0·20) mm long, 0·08 (0·08–0·09) length of wing, with stout upper brush-hairs. Cibarium with about six hind teeth and about six fore teeth, each in a row. Antenna 3 = 0·53 (0·48–0·60) mm long, 0·24 (0·23–0·26) length of wing, 1·22 (1·08–1·29) length of 4+5, 2·93 (2·79–3·10) length of labrum; ascoid on 4 = 0·2 length of segment. Palpal segment 4 subequal to or slightly longer than 3. Wing length 2·21 (2·13–2·27) mm, 3·6 times width, R_2/R_{2+3} 1·77 (1·52–1·89), R_1 overlap/R_2 0·67 (0·54–0·79). Coxite with over 52 hairs in brush; style with seta at 0·4 and the two subterminal spines at about 0·85.

In the absence of a female the species is not formally named.

MATERIAL EXAMINED
Borneo (Sabah): Sepilok, 15, 16.ii.1972 (*D. J. Lewis*), 4 ♂.

Sergentomyia (*Neophlebotomus*) *silvatica* (Raynal & Gaschen)

(Fig. 131, Map 10)

Phlebotomus sylvaticus Raynal & Gaschen, 1935*d* : 592 [♂ in fig. 4 not this sp. according to Quate, 1926*b* : 264]. Syntypes 3 ♀, 2 ♂, VIETNAM (NORTH) (depository unknown) [not examined].
Phlebotomus silvaticus Raynal & Gaschen; Anonymous, 1935 : 779 [justified emendation (ICZN Article 32(B))]; Raynal, 1935*b* : 265.
Phlebotomus (*Prophlebotomus*) *silvaticus* Raynal & Gaschen; Parrot, 1940 : 312; 1946 : 71; Parrot & Clastrier, 1952 : 162 [a ♂].
Sergentomyia silvatica (Raynal & Gaschen); Theodor, 1948 : 112.
Phlebotomus (*Sergentomyia*) *silvaticus* Raynal & Gaschen; Lewis, 1957 : 167 [a ♂].
Phlebotomus (*Sergentomyia*) *sylvaticus* Raynal & Gaschen; Quate, 1962*b* : 262 [description and fig. of antenna 3 different, pigment patch of ♂ variable].
Sergentomyia (*Rondanomyia*) *sylvatica* (Raynal & Gaschen); Lewis, 1973*a* : 251.

The cibarium of the female has about four to six teeth in the centre and a patch of eight to ten smaller ones on each side.

♀ (from Thailand). Labrum 0·22 (0·21–0·22) mm long, 0·09 (0·09–0·09) length of wing, adoral sensilla much as in *S. hamidi* and *S. quatei*. Cibarium with two main teeth and no visible pigment patch. Hypopharynx with low undulations. Antenna 3 = 0·40 (0·39–0·41) mm long, 0·17 (0·16–0·17) length of wing, 0·95 (0·89–1·02) length of 4+5, 1·86 (1·79–1·94) length of labrum. Maxilla with nine lateral and 29 ventral teeth, dental depth 0·10 mm. Wing length 2·38 (2·35–2·41) mm, R_2/R_{2+3} 0·73 (0·53–0·92), R_1 overlap/R_2 0·52 (0·47–0·57).

MATERIAL EXAMINED.
Thailand: Ban Bon Dan, 12.xii.1975 (*D. J. Gould*), 2 ♀.

COMMENTS. The Thailand females appear to be this species despite certain differences from Raynal's and Quate's descriptions. *S. hamidi* and *S. quatei* have a rather similar labrum and cibarial armature but differ in the spermathecal and other features.

Quate disregards the authenticity of Raynal's male because it has a cibarial armature like that of the female. The matter should not be regarded as settled because the sexes of the related *S. quatei* are very similar in this respect.

DISTRIBUTION. **Cambodia:** Phnom Penh (Parrot & Clastrier, 1952 : 155). **Laos:** Vientiane (Quate, 1962*b* : 264). **Thailand:** Ban Bon Dan (as above). **Vietnam (North):** Dong Giao, Nao Phu, Phu Oc (Raynal, 1935*b* : 269). **West Malaysia:** Rantau Panjang (? Lewis, 1957 : 67).

Sergentomyia (*Neophlebotomus*) *tambori* Lewis & Jeffery **sp. n.**

(Figs 192–203, Map 10)

The cibarium of the female has about 11 hind teeth (fewer than in *S. iyengari*), one irregular row of fore teeth, and a broad anterior projection on the pigment patch.

S. tambori, like *S. iyengari*, somewhat resembles the African *S. decipiens* and *S. dureni* but has a broad spermatheca.

♀. Labrum 0·17 (0·17–0·17) mm long, 0·10 (0·09–0·10) length of wing, with normal distal sensilla, subapicals with anterior pair small, adorals large with pegs pointing mesally, and cibarials less large with longer pegs. Cibarium with about 11 large pointed teeth, the two sublaterals on each side very wide, about 11 small fore teeth present in an irregular row, pigment patch pale brown, about 0·7 width of cibarium and having broad anterior projection with rounded tip. Pharynx with a few sparsely spiculate lines. Hypopharynx with about eight scarcely visible undulations on each side. Antenna 3 = 0·42 (0·40–0·44) mm long, 0·24 (0·23–0·25) length of wing, 1·24 (1·21–1·26) length of 4+5, 2·46 (2·42–2·50) length of short labrum, two ascoids on segments 3–15, that on 4 = 0·4 length of segment, no papilla on 5. Mandibles pointed. Maxilla with four low lateral teeth, 16 distinct ventrals, and a dental depth of 0·06 mm, palp with segment 1 small, ratio 10 : 27 : 53 : 56 : 89. Scutum pale brown and pleura pale. Wing length 1·77 mm, 3·2 times width, R_2 (very long)/R_{2+3} 3·31 (3·05–3·55), R_1 overlap/R_2 0·79 (0·76–0·81). Spermatheca broad and oblong, striated, with small knob in shallow pit, and faint ducts.

♂. Head missing. Scutum pale reddish brown and pleura mainly pale. Wing length 1·59 mm, 3·8 times width, R_2/R_{2+3} 1·00, R_1 overlap/R_2 0·71. Genital filament about 4·1 times length of pump which has large barrel. Aedeagus nearly parallel sided, mainly dark, with round tip. Paramere with pointed tip which scarcely turns downward. Coxite with no differentiated brush. Style: dorso-mesad spine thick; dorso-lateral spine thin; ventro-mesad spine (the only non-terminal one) rather thin and somewhat mesad; ventro-lateral spine thick; seta at 0·65.

MATERIAL EXAMINED.
Holotype ♀, **West Malaysia:** Gunong Besout Forest Reserve, 3.v.1974 (*K. A. Tambor*) (BMNH).
Paratypes. Same data as holotype, 3.v.1974, 1 ♂; 5.ii.1974 (*J. Jeffery & colleagues*), 1 ♀. (All in BMNH.)

Sergentomyia (*Neophlebotomus*) *tonkinensis* (Raynal & Gaschen)

(Map 10)

Phlebotomus tonkinensis Raynal & Gaschen, 1935*h* : 742 [figs in 1935*g*]; Raynal, 1935*b* : 273 [figs].
Holotype ♀, VIETNAM (NORTH) (depository unknown) [not examined].
Phlebotomus (*Prophlebotomus*) *tonkinensis* Raynal & Gaschen; Parrot, 1940 : 312; 1946 : 71.

Sergentomyia tonkinensis (Raynal & Gaschen) Theodor, 1948 : 112.
Sergentomyia (*Rondanomyia*) *tonkinensis* (Raynal & Gaschen) Lewis, 1973*a* : 251.

This species has neither fore teeth nor pigment patch.

DISTRIBUTION. **Vietnam (North)** (rare): Phu Doan (Raynal, 1935*b* : 274; 1936*a* : 363).

Sergentomyia (*Neophlebotomus*) *traubi* (Lewis) **comb. n.**

(Map 10)

Phlebotomus traubi Lewis, 1957 : 169; Quate & Fairchild, 1961 : 216. Holotype ♀, WEST MALAYSIA (BMNH) [examined].

The female has fold-like cibarial teeth unlike those of other species. The species is placed in *Neophlebotomus* owing to the structure of the terminalia of the male.

♂. Labrum 0·18 mm long, 0·11 length of wing. Cibarium with 12 fold-like teeth, longer in the centre, and no pigment patch. Pharynx with a few faint ridges. Antenna 3 = 0·53 mm long, 0·33 length of wing, 2·94 length of labrum; ascoid on 4 = 0·15 length of segment; segment 5 and rest missing. Wing length 1·61 mm, R_2/R_{2+3} 0·75, R_1 overlap/R_2 0·35. Genital filament 3·0 length of pump. Aedeagus nearly parallel-sided, and tapering rather abruptly to a broadly rounded tip. Paramere slightly beaked. Coxite long and narrow, with hairs little differentiated except for four big ones in a row near tip. Style narrow with two spines at 0·67, a seta at 0·73 and two spines at tip.

MATERIAL EXAMINED.
West Malaysia: Bukit Ibam, 1.x.1961 (*L. W. Quate*), 1 ♂.

DISTRIBUTION. **West Malaysia:** Bukit Ibam (*L. W. Quate* via BPBM), commonest species, 41 ♀, 1 ♂; Teranggan (Quate & Fairchild, 1961); Ulu Gombak (Lewis, 1957). **Borneo** (Sabah): Kalabakan River (Quate & Fairchild, 1961).

Sergentomyia (*Neophlebotomus*) *zeylanica* (Annandale)

(Fig. 204, Map 10)

Phlebotomus zeylanicus Annandale, 1910*a* : 60; 1911*b* : 203; Brunetti, 1912 : 215; Sinton, 1924*e* : 1029 [sexes misassociated, ♀ valid species, described; ♂ was *P. argentipes*]; 1928*c* : 319; 1931*e* : 110; 1932*a* : 61; 1933*e* : 420; Theodor, 1938*a* : 261 [♀ ♂, ♂ differs from previous descriptions]; Mitra, 1953*b* : 162. Lectotype ♀, SRI LANKA (Zoological Survey of India), designated by Quate, 1962*c* : 158 [not examined].
Phlebotomus chalami Young & Chalam, 1927 : 849 [conditional name]. Syntypes ♀ ♂, INDIA (sent to former Central Research Institute, Kasauli) [not examined]. [Synonymized by Sinton, 1928*c* : 319.]
Phlebotomus (*Prophlebotomus*) *zeylanicus* Annandale; Parrot, 1946 : 70, 71.
Phlebotomus (*Sergentomyia*) *zeylanicus* Annandale; Quate, 1962*c* : 158, 160 [spermatheca].
Sergentomyia (*Rondanomyia*) *zeylanica* (Annandale); Lewis, 1973*a* : 251.

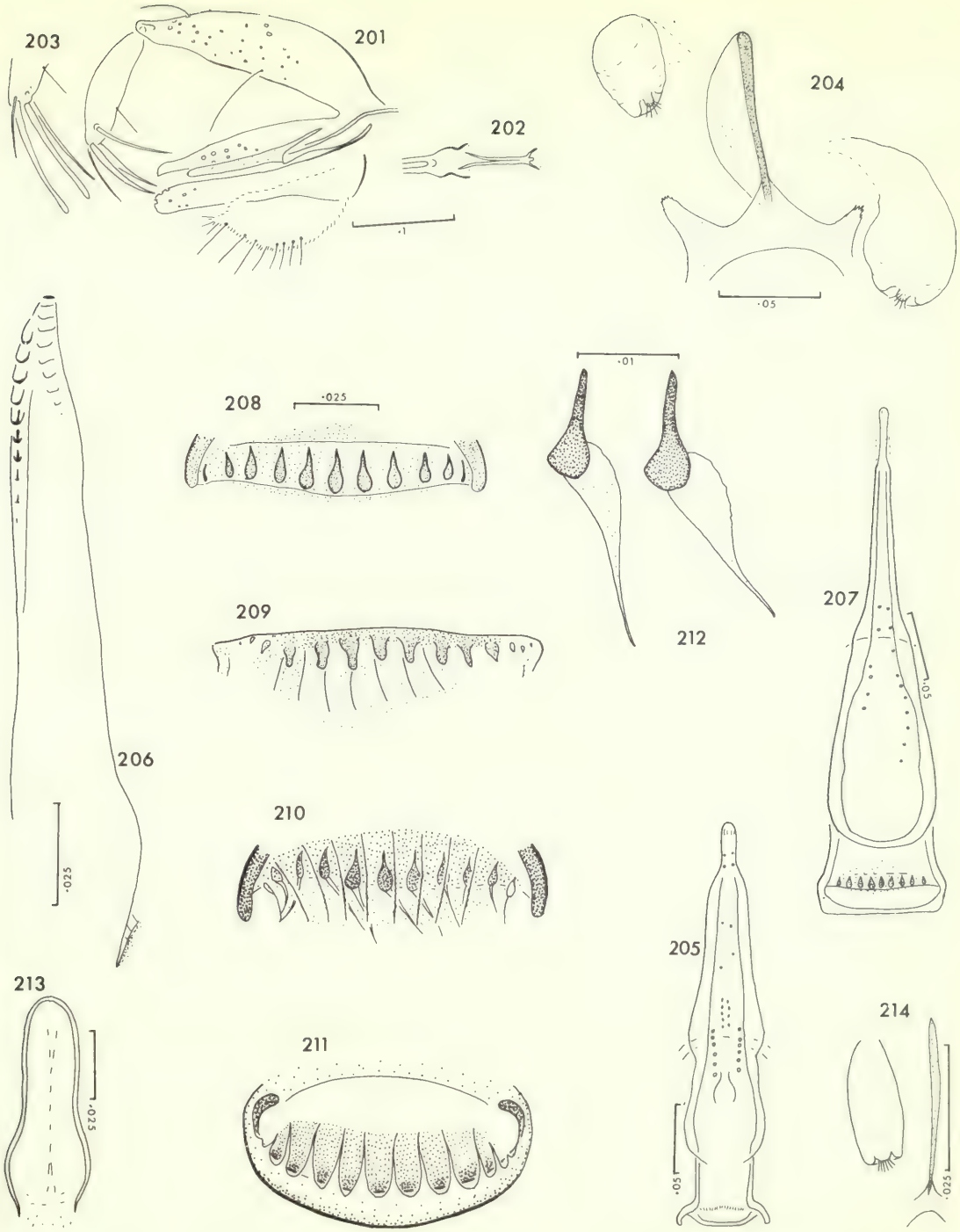
The female of *S. zeylanica* differs from *S. malayae* in having a shorter labrum.

♀ (*extra facts*). Labrum 0·31 mm long, 0·15 length of wing (1·20 mm). Antenna 3 = 0·31 mm long, 0·16 length of wing, 1·14 length of 4+5, 1·01 length of labrum. Maxilla with three lateral and 30 ventral teeth, dental depth 0·11 mm.

MATERIAL EXAMINED.
Sri Lanka: Peradeniya, 30.iv.1914, 1 ♀.

DISTRIBUTION. **India:** Kulathurpuzha (BMNH); Dehra Dun area, Naini Tal area (Rao *et al.*, 1973); Bombay, Gauhati (Sinton, 1928*c* : 319); Marianbari (Sinton, 1931*e* : 107); Darjeeling (Theodor, 1938 : 263). **Sri Lanka:** Peradeniya (Annandale, 1910*a* : 59, fig. 166, 25.viii.1910); Depanama, Kalgoda, Katuwawala, Maharagama (Theodor, 1938 : 262).

S. zeylanica appeared to occur in many widely separated parts of India and to be a wild species associated chiefly with jungle and moist warm conditions (Sinton, 1932*a* : 71).



Figs 201–214 *Sergentomyia* species. 201–203, *S. tambori*, ♂: (201, 202) terminalia; (203) left style in side-view. 204, *S. zeylanica*, ♀ (Sri Lanka), spermatheca. 205, 206, *S. bailyi*, ♀ (Andaman Islands): (205) labrocibarium; (206) maxilla. 207–214, *S. cheongi*, ♀: (207) labrocibarium; (208) teeth; (209) teeth and pigment patch in postero-ventral view; (210) teeth and pigment patch crushed; (211) teeth and pigment patch in thick section, anterior view; (212) crushed teeth; (213) pharynx; (214) spermatheca.

The *nicnic*-group

Sergentomyia nicnic group Theodor, 1948 : 102.

The minute cibarial teeth are a feature of this group in which Theodor placed *S. bailyi*, *S. kachekensis*, *S. nicnic* and one African species which may not belong to it.

Sergentomyia bailyi (Sinton)

(Figs 205, 206, Map 11)

Phlebotomus bailyi Sinton, 1931*b* : 821; 1932*a* : 60; Parrot, 1946 : 72. Syntypes ♀♂, INDIA (depository unknown) [not examined].

Phlebotomus bailyi var. *campester* Sinton, 1931*b* : 822; 1931*d* : 104; Raynal, 1935*a* : 369; 1935*b* : 277; Raynal & Gaschen, 1934*c* : 563; 1934*e* : 858; Theodor, 1938 : 268; Causey, 1938 : 487; Yao & Wu, 1940 : 782; 1941*b* : 77. [Synonymized by Quate, 1962*b* : 262.]

Phlebotomus (*Prophlebotomus*) *bailyi* var. *campester* Sinton; Parrot & Clastrier, 1952 : 155 [including abnormality].

Phlebotomus smithi Mitra & Roy, 1952*a* : 187 [♀]; Mitra, 1953*a* : 473 [♂]. Holotype ♀, INDIA (depository unknown) [not examined]. **Syn. n.**

Sergentomyia (*Sergentomyia*) *bailyi* (Sinton); Theodor, 1948 : 112; Lewis, 1967 : 38.

Phlebotomus (*Sergentomyia*) *bailyi* Sinton; Quate, 1962*b* : 260, 261, 262, 264.

In the female the cibarial cornua are large, the pigment patch is small or absent, and the very small teeth tend to be arranged in rows especially at the sides, the pharynx has spiculate ridges, and the spermatheca (Sinton, 1932*a* : 60) narrows at its apex.

The female, and probably the male, of *S. smithi* appear to be *S. bailyi*, and apparent differences to be caused by mounting methods and variation.

♀ (*extra facts*). Mandibular main teeth 2·0 μm wide. Maxillary ventral teeth large.

DISTRIBUTION. **Andaman Is.:** South Andaman, Chinya Tapu, 12.ii.1970 (*N. L. Kalra*), 2 ♀. **Cambodia:** Phnom Penh (Parrot & Clastrier, 1952 : 153). **China:** Aihsien, Kachek, Kan-en, Lingmen, Lingshui, Linko, Mencheong, Nodoa, Paoting, Wanning (Yao & Wu, 1940 : 797; 1941*b* : 77). **India:** Ajmer (Jaswant Singh, 1933); Badam Pahar, Itaunia, Patna, Vellore (BMNH); Aurangabad, Jalna, Patan (Farooq & Qutubuddin, 1945 : 85); Bundi area, Jaipur, Kota area, Sirohi area (Kaul *et al.*, 1973 : 532); Poona (Mitra & Roy, 1952*a*, *S. smithi*); Hyderabad (Qutubuddin, 1944 : 208); Madras (Rathnaswamy & Rama Krishna, 1954); Barhi, Bissem Cuttack, Chandigarh, Chhindwara, Dehra Dun, Hardwar, Hazaribagh, Itarsi, Kamptee, Karnal, Kasauli, Khandwa, Laharpur, Nagpur, Pachmarhi, Parasia, Pipariya, Roorkee, Saharanpur, Titilagarh (Sinton, 1931*b* : 821); Bhavnagar, Rajkot, Sanawar, Wadhwan (Sinton's notes); Baraga, Hosur, Jog-Sagar area, Kannur, Kumsi, Poona, Wai (*H. Trapido*). **Laos:** Vientiane (Quate, 1962*b* : 262). **Pakistan:** Dehra Ismail Khan, Jandola, Kohat-Hangu valley, Lahore, Larkana, Pano Aqil, Peshawar, Rawalpindi, Shikarpur, Tando Muhammad Khan, Tank, Taxla (Lewis, 1967 : 39). **Thailand:** Bangkok (Sinton, 1931*d* : 104); in train (Causey, 1938 : 487, 488); Pechaburi (Quate, 1962*b* : 262). **Vietnam (North):** Bim Son, Cho Ganh, Cua Rao, Dong Giao, Kep, Phu Qui, Vin Thui (Raynal, 1935*b* : 282). **Vietnam (South):** Duc Pho (Raynal, 1935*b* : 282).

In India Sinton (1931*b*) found that *S. bailyi* was widespread up to 1830 m, but much less numerous than *S. babu*, and that it was relatively more numerous in the hills. In Indo-China Raynal (1936*a* : 351, 357) found *S. bailyi* south of 20° north.

Sergentomyia displicata (Quate & Fairchild)

(Map 11)

Phlebotomus (*Sergentomyia*) *displicatus* Quate & Fairchild, 1961 : 212 [♂]. Holotype ♂, BORNEO (BPBM) [not examined].

The cibarium of the male has about 15 hind teeth and a double row of 20 fore teeth, and the area between them and the arch is dark. The male differs from that of *S. nicnic* in having no pigment patch and a longer antenna 3.

DISTRIBUTION. **Borneo** (Sabah): Kalabakan River (Quate & Fairchild, 1961 : 214).

Sergentomyia kachekensis (Yao & Wu)

(Map 11)

Phlebotomus kachekensis Yao & Wu, 1940 : 790 [♂]; 1941*b* : 78. Holotype ♂, CHINA (depository unknown) [not examined].
Sergentomyia kachekensis (Yao & Wu); Theodor, 1948 : 113.

This species, described from one male, was placed in this group by Theodor. It is left here, in the absence of more material, although the original drawing showing diamond-shaped teeth suggests that it may belong elsewhere.

DISTRIBUTION. **China:** Hainan Island (Yao & Wu, 1941*b* : 77); Kachek (Yao & Wu, 1940 : 790).

Sergentomyia nicnic (Banks)

(Map 11)

Phlebotomus nicnic Banks, 1919*a* : 163; Sinton, 1928*c* : 317; 1930*a* : 165; 1931*b* : 824; Manalang, 1930*a* : 169; Theodor, 1938 : 268. Holotype ♂, PHILIPPINES (destroyed, according to Quate & Rosario) [not examined].
Phlebotomus (*Prophlebotomus*) *nicnic* Banks; Parrot, 1940 : 311; 1946 : 72.
Phlebotomus (*Sergentomyia*) *nicnic* Banks; Quate & Fairchild, 1961 : 214; Quate & Rosario, 1962 : 794.

In this small species the female has a weak armature of many small teeth, big cornua, prominent hypopharyngeal teeth, and spermathecae narrow proximally, and the paramere of the male has an unusually large tip.

DISTRIBUTION. **Nusa Tenggara:** Kabaru, Pedang Bay, Sumbawa (Lewis & Dyce, 1976 : 212). **Philippines:** Los Baños (Banks, 1919*a* : 167; Sinton, 1930*a* : 165); Nueva Viscaya (*M. D. Delfinado & D. E. Hardy*, via BPBM); Novaliches (Manalang, 1930*a* : 169); Pili (Quate, 1965 : 28); Bay, Jose del Monte (Quate & Rosario, 1962 : 796).

UNGROUPED

It is difficult to classify this miscellaneous assemblage, but it is convenient to divide the females, as in the key, into those with thick cibarial teeth, those with certain outstanding features, and those with a rather simple row of equal teeth. A few species could, perhaps, be offshoots of *Parrotomyia* or *Neophlebotomus* which have lost their subgeneric characters.

Sergentomyia angustipennis (de Meijere) **comb. n.**

(Map 11)

Phlebotomus angustipennis de Meijere, 1909 : 202; Annandale, 1910*b* : 52; 1911*a* : 62; Sinton, 1928*c* : 322; Nitzulescu, 1930 : 545. Holotype, sex not given, JAVA (depository unknown [not examined].

The short description of *S. angustipennis*, meaning short-winged, refers to a few external characters and is accompanied by a figure of the wing, the narrowness of which suggests that the species belongs to the genus *Sergentomyia*. An adequate description could be prepared if *S. angustipennis* could be recognized during a survey of the local species.

DISTRIBUTION. **Java:** Semarang.

Sergentomyia anodontis (Quate & Fairchild)

(Map 11)

Phlebotomus (*Sergentomyia*) *anodontis* Quate & Fairchild, 1961 : 220; Lewis & Wharton, 1963 : 120. Holotype ♂, WEST MALAYSIA (BPBM) [not examined].

In this small species with a brown scutum and pale pleuron the cibarium of the female has spine-like projections from a fold in the membrane above the sclerotized part, and a medium projection over which is an inverted V-shaped bar, and tergite 8 has a lateral patch of hairs. The spermatheca is long and tubular with a thick knob and is not differentiated from its duct which joins a common duct. The style of the male is slender with a seta at 0·7, one spine at 0·75, one subterminal and one terminal. *S. anodontis* is closely related to the Chinese *S. koloshanensis* (Yao & Wu).

In a female from Betis the hypopharynx has definite low teeth, and the maxilla has nine lateral teeth of moderate size, 29 strong ventrals, and a dental depth of 0·09 mm.

DISTRIBUTION. **West Malaysia:** Betis (Lewis, 1957 : 121); Batu Caves (Quate & Fairchild, 1961 : 220).

Sergentomyia cheongi Lewis & Jeffery **sp. n.**

(Figs 207–214, Map 11)

The female differs from most species in its pear-shaped cibarial teeth, and from *S. losarcus* in having a very short inter-arcal area, a smaller antenna 3/labrum figure, palpal segment 3 shorter than 4, and Newstead's sensilla concentrated.

♀. Labrum 0·19 (0·18–0·20) mm long, 0·09 (0·10–0·11) length of wing, narrow, with very small subapical sensilla, few adorals and small cibarials. Cibarium with inter-arcal thick posterior area supporting nine large pear-shaped teeth with long dorsal points which are invisible from below; pigment patch brown with about eight longitudinal lines. Pharynx with narrow unarmed hind end. Hypopharynx with low rounded teeth. Antenna 3 = 0·31 (0·30–0·34) mm long, 0·16 (0·16–0·17) length of wing, 1·27 (1·23–1·33) length of 4+5, 1·60 (1·50–1·72) length of labrum, two ascoids on segments 3–15, that on 4 about 0·46 length of segment, no papilla on 5. Mandible with wide-angled tip. Maxilla with 12 broad lateral teeth and 25 ventrals, dental depth 0·07 mm; palpal ratio about 10 : 21 : 33 : 48 : 98; sensilla concentrated on basal quarter of 3. Scutum, pleuron and much of body reddish brown. Wing length 1·90 (1·79–1·99) mm, 3·5 times width, R_2/R_{2+3} 1·34 (0·84–2·09; minimum exceptionally low), R_1 overlap/R_2 0·60 (0·52–0·71). Spermatheca oblong with delicate duct.

The harrow-like cibarial armature is seen in this species, *S. perturbans*, and a few others.

MATERIAL EXAMINED.
Holotype ♀, **West Malaysia:** Gunong Besout Forest Reserve, 4.ii.1974 (*J. Jeffery*) (BMNH).
Paratypes. Same data, 9 ♀ (BMNH). Ten ♀ measured.
Non-paratypic material. **West Malaysia:** Bukit Ibam (*L. W. Quate* via BPBM), 1 ♀.

Sergentomyia dapsilidentes (Quate)

(Map 11)

Phlebotomus (*Sergentomyia*) *dapsilidentes* Quate, 1965 : 26. Holotype ♀, PHILIPPINES (BPBM) [not examined].

In the female of this pale species there are 30 cibarial hind teeth in a compact row and about 80 fore teeth in five or six rows, and an unusually long palpal segment 4.

DISTRIBUTION. **Philippines:** Manucan, Zamboanga del Norte (Quate, 1965 : 28).

Sergentomyia delfinadoae (Quate)

(Map 11)

Phlebotomus (*Sergentomyia*) *delfinadoae* Quate, 1965 : 30. Holotype ♀, PHILIPPINES (BPBM) [not examined].

The female of this large species has a brownish scutum and about 10–14 cibarial teeth like barbed hooks, a rectangular pigment patch and a long antenna 3. The male has six to ten barbed teeth. The species somewhat resembles *S. exastis*.

♀ (*extra facts*). Labrum with the foremost adoral sensilla large, in three diagonal pairs. Hypopharynx smooth. Maxilla with eight moderately broad lateral teeth and 17 distinct ventrals, dental depth 0·10 mm.

DISTRIBUTION. **Philippines:** Cuernos de Negros (Quate, 1965 : 30).

Sergentomyia dentacea (Quate)

(Map 11)

Phlebotomus (*Sergentomyia*) *dentaceus* Quate, 1965 : 26. Holotype ♀, PHILIPPINES (BPBM) [not examined].

In the female of this large species the cibarial teeth are very long and the pharyngeal teeth are markedly posterior.

DISTRIBUTION. **Philippines:** Los Arcos (Quate, 1965 : 26).

Sergentomyia exastis (Quate)

(Map 11)

Phlebotomus (*Sergentomyia*) *exastis* Quate, 1965 : 33. Holotype ♀, PHILIPPINES (BPBM) [not examined].

This is a large species and the female has no pigment patch and 14 inwardly sloping cibarial teeth rather like those of the related *S. delfinadoae* and the African *S. schwetzi*.

DISTRIBUTION. **Philippines:** San Francisco (Quate, 1965 : 33).

Sergentomyia fanglianensis (Leng)

(Map 11)

Phlebotomus fanglianensis Leng, 1964 : 118, 127. Syntypes ♀ ♂, CHINA (Lianming University, Shenyang) [not examined].

In the female the cibarium has no pigment patch and many small triangular teeth tending to form three rows medially, the pharynx has finely spiculate ridges, and the smooth carrot-shaped spermatheca has a deep pit. In the male the cibarial teeth tend to form three rows, R_2/R_{2+3} is over 1·5 (1·63–1·80), and the style has a seta, two subapical spines on a tubercle and two apical spines.

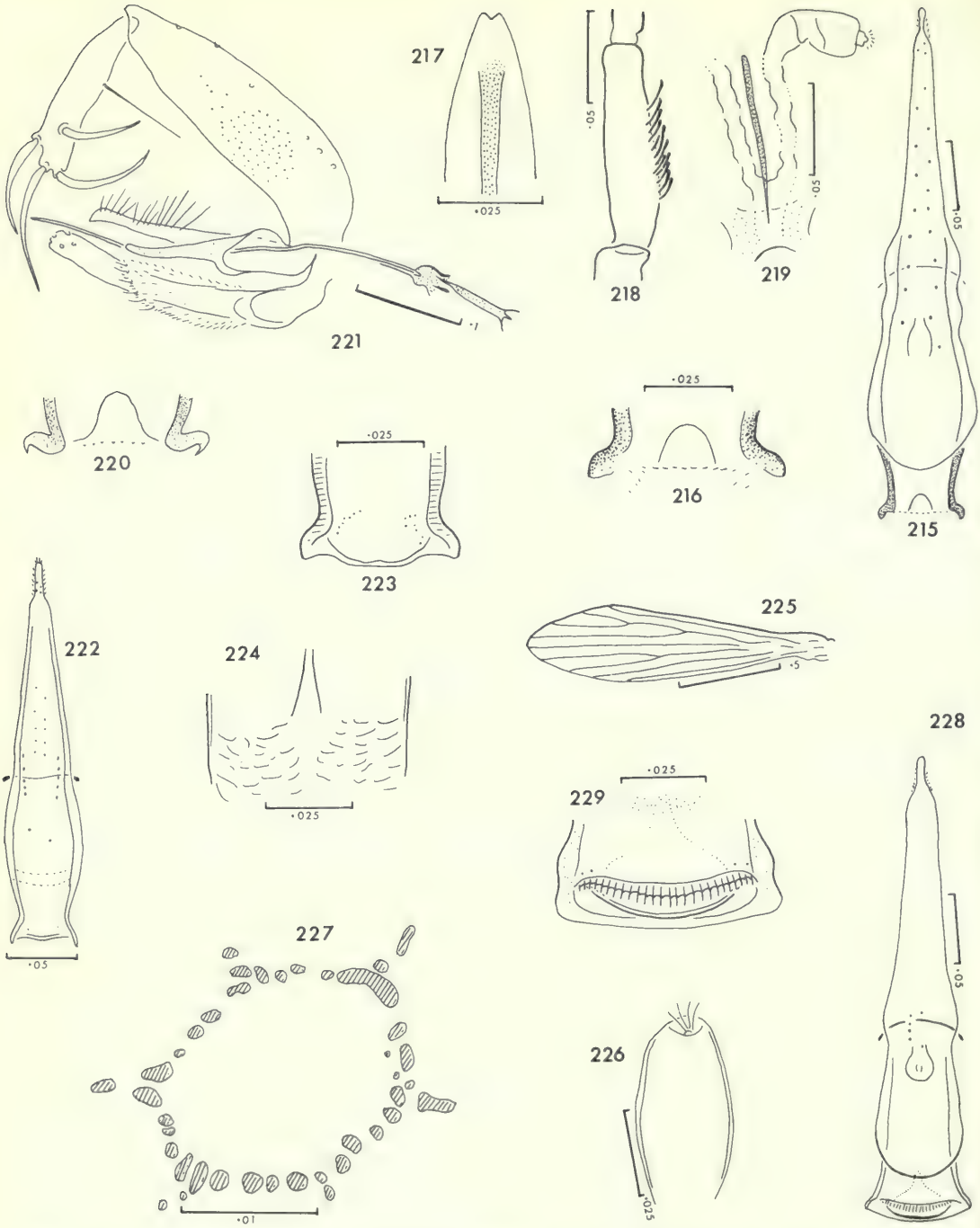
DISTRIBUTION. **China:** Fanglian (Leng, 1964 : 127).

Sergentomyia hassani Lewis **sp. n.**

(Figs 215–221, Map 11)

The female is very like that of *S. hitchensi* but has a long row of palpal sensilla.

♀. Eye 0·62 length of head. Labrum 0·19 (0·18–0·19) mm long, 0·08 (0·07–0·08) length of wing, with adoral sensilla well developed. Cibarium with narrow hind end and deep notch (not seen in macerated flies) in dorsal wall, inter-arcal walls dark, and a nearly straight row of small separate teeth, which are blunt in ventral view and merge into spicules on cibario-pharyngeal membrane, and no pigment patch. Pharynx unarmed and rather soft with variable shape. Hypopharynx completely smooth. Antenna 3 = 0·39 (0·38–0·40) mm long, 0·16 (0·15–0·17) length of wing, 1·35 (1·31–1·36) length of 4+5, 2·13 (2·09–2·16) length of labrum, two ascoids on segments 3–15, that on 4 being slender and about 0·43 length of segment, no papilla on 5. Maxilla with nine narrow lateral teeth, 25 ventrals, and a dental depth of 0·09 mm; palpal ratio 10 : 12 : 26 : 27 : 63; sensilla scattered along most of length of 3. Scutum pale reddish brown, pleuron mainly pale. Wing 2·42 (2·32–2·53) mm long, 3·3 times width, R_2/R_{2+3} 2·38 (2·19–2·56), R_1 overlap/R_2 0·75 (0·74–0·76). Leg ratios: fore (0·96 mm), 50 : 80 : 46 ; hind (0·84 mm), 50 : 99 : 52; hind (0·94 mm), 50 : 104 : 71. Spermatheca subpyriform with delicate duct.



Figs 215–229 *Sergentomyia* species. 215–221, *S. hassani*: (215) ♀, labrocibarium; (216) ♀, cibarium; (217) ♀, tip of hypopharynx; (218) ♀, palpal segment 3; (219) ♀, spermatheca; (220) ♂, cibarium; (221) ♂, terminalia. 222–227, *S. jamesi*, ♀: (222) labrocibarium; (223) cibarium; (224) pharynx; (225) wing; (226) spermatheca; (227) pattern on contained egg. 228, 229, *S. knudseni*, ♀: (228) labrocibarium; (229) cibarium.

♂. Labrum 0·17 (0·15–0·19) mm long, 0·08 (0·07–0·09) length of wing. Cibarium with deep hind notch in soft tissue, about seven minute teeth, and no pigment patch. Pharynx unarmed. Antenna 3 = 0·46 (0·42–0·49) mm long, 0·22 (0·21–0·23) length of wing, 1·33 (1·28–1·38) length of 4+5, 2·78 (2·50–3·01) length of labrum, one ascoid on segment 3–15, that on 4 being 0·27 length of segment. Wing 2·12 (2·01–2·26) mm long, 3·5 times width, R_2/R_{2+3} 1·53 (1·07–1·88), R_1 overlap/R_2 0·69 (0·65–0·77). Aedeagus with narrow rounded tip, filament 3·3 times length of pump. Coxite with about 16 hairs in brush. Style with long stout seta at 0.25, one spine at 0·65, one at 0·75 and two at tip.

COMMENTS. *S. hassani*, like many sandflies, has a mixture of apparently plesiomorphic and apomorphic features. The former comprise a large delicate pale body, well-developed labral adoral sensilla, a cibarium with narrow hind end, small rather irregular teeth, and no pigment patch, extra ascoid-like structures on the antenna of the male, narrow maxillary lateral teeth, scattered Newstead's sensilla, a broad wing with long R_2 and a simple spermatheca.

This species is named after Mr Abu Hassan bin Omar of Kuala Lumpur who collected many sandflies.

MATERIAL EXAMINED.
Holotype ♀, **West Malaysia:** Ulu Langat Forest Reserve, 3.v.1966 (*A. Rudnick*) (BMNH).
Paratypes. Same data, 2 ♀, 8 ♂ (BMNH).
Non-paratypic material. **West Malaysia:** Kuala Tahan (*D. E. Hardy & T. C. Maa*, via BPBM); Bukit Ibam and Kuala Rompin area (*L. W. Quate*, via BPBM).

Sergentomyia heiseri (Manalang)

(Map 11)

Phlebotomus heiseri Manalang, 1930*e* : 299; Tonnoir, 1935 : 142; Raynal, 1935*a* : pls 10, 19; Quate & Rosario, 1962 : 796. Lectotype ♀, PHILIPPINES (on loan to BPBM), designated by Quate & Rosario [not examined].

The cibarium of the female has 12–18 long diamond-shaped hind teeth. It bears some resemblance to species of *Parrotomyia* but has different teeth, and shape and venation of the wing.

DISTRIBUTION. **Philippines:** Bigti, La Mesa, Novaliches, Tungkong Manga (Manalang, 1930*e*); Los Baños (Quate & Rosario, 1962 : 797).

Sergentomyia hitchensi (Manalang)

(Map 12)

Phlebotomus hitchensi Manalang, 1930*d* : 291; Tonnoir, 1935 : 142. Lectotype ♀, PHILIPPINES (on loan to BPBM), designated by Quate & Rosario, 1962 : 791 [not examined].
Phlebotomus (*Sergentomyia*) *hitchensi* Manalang; Quate & Rosario, 1962 : 791; Quate, 1965 : 30.
Sergentomyia (*Rondanomyia*) *hitchensi* (Manalang); Lewis, 1973 : 250.

The female has 12–15 triangular teeth in a regular row and no pigment patch. The species was placed in the *zeylanica* group by Theodor (1948) but is now removed owing to its uncharacteristic cibarial teeth and close affinity to *S. losarcus*.

DISTRIBUTION. **Philippines:** Tungkong Manga (Manalang, 1930*d* : 291); Eran area (Quate, 1965 : 30).

Sergentomyia imitor (Quate)

(Map 12)

Phlebotomus (*Sergentomyia*) imitor Quate, 1965 : 35. Holotype ♀, PHILIPPINES (BPBM) [not examined].

In this small pale species the cibarium of the female has 10–12 sharp spike-like teeth (a convergent resemblance to *S. clydei*) and 24–40 main fore teeth in two or three rows. The small well-defined coxite-brush of the male is at 0·3 and the style has two apical and two postmedial spines and a seta at 0·4–0·6. The terminalia are like those of *S. displicata* but the head is different.

DISTRIBUTION. **Philippines:** Los Arcos (Quate, 1965 : 37).

Sergentomyia jamesi Lewis **sp. n.**

(Figs 222–227, Map 12)

The female differs from all other *Sergentomyia* in having no cibarial teeth except a few lateral denticles.

♀. Labrum 0·16 mm long, 0·11 length of wing, with several posterior adoral sensilla and large lateral labro-cibarial sensilla. Cibarium with no teeth but a small group of denticles at each side; pigment patch absent and arch faint. Pharynx with faint ridges. Hypopharynx smooth. Antenna 3 = 0·12 mm long, 0·08 length of wing, 0·91 length of 4+5, 0·79 length of labrum, two ascoids on segments 3–15, that on 4 = 0·55 length of segment, no papilla on 5. Maxilla with 11 strong lateral teeth, 28 ventrals and a dental depth of 0·07; palp ratio 10 : 21 : 29 : 35 : 68; sensilla in compact bunch around 0·37. Scutum and pleuron brown, inter-precoxal lobes narrow, mesanepisternum without hairs. Wing length 1·48 mm, 4·1 times width, R_2/R_{2+3} 0·89, R_1 overlap/0·39. Leg ratios: fore (0·49 mm), 10 : 8·8 : 4·8; mid (0·54 mm), 10 : 10·5 : 5·5; hind (0·59 mm), 10 : 12 : 6·3. Spermatheca oblong.

Egg sculpture (seen in the single gravid ♀). Polygonal (as in some American species, Ward & Ready, 1975 : 128).

The species is named after Mr Samuel S. James, of the Arbovirus Research Laboratory field staff, West Malaysia.

MATERIAL EXAMINED.
Holotype ♀, **Thailand:** 'Trang Prov., Khaophappha Khaoc Hang, 200–300 m, 3.I.1944' (*G. A. Samuelson*, via BPBM). Mapped in Trang area.

Sergentomyia kelantani (Lewis & Wharton)

(Map 12)

Phlebotomus (*Sergentomyia*) *kelantani* Lewis & Wharton, 1963 : 123. Holotype ♀, WEST MALAYSIA (BMNH) [examined].

The female has nine large delicate cibarial teeth, with blackish pigment near their bases, antenna 3 = 0·19 mm long, and the spermatheca is a rigid thin-walled capsule bent double with a wide duct. The style of the male has two terminal and two subterminal spines.

DISTRIBUTION. **West Malaysia:** Betis (Lewis & Wharton, 1963 : 123).

Sergentomyia knudseni Lewis & Jeffery **sp. n.**

(Figs 228–237, Map 12)

A pale species with, in the female, regular cibarial teeth on a convex row, few or no fore teeth, a large bulge, maxilla without lateral teeth, and a broad wing with (in both sexes) short R_2 and R_1-overlap.

The females of several species have rather similar cibarial hind teeth. *S. bukidnonis* has fore teeth and more hind ones, and *S. franciscana* has fore teeth and a shorter labrum. The three Australian species, *S. cidaria* (Quate & Quate), *S. crypta* (Quate & Quate) and *S. vanella* (Quate & Quate) each have at least one distinct row of fore teeth.

♀. Labrum 0·19 (0·19–0·20) mm long, 0·12 (0·12–0·13) length of wing, with few adoral sensilla. Cibarium with arch far back, pigment patch broad but faint, and a wide hind bulge; 24–27 uniform pointed teeth present on slightly convex arch, and occasionally two fore teeth near each margin. Pharynx with marked brown subterminal bulge, narrow hind end and no teeth. Hypopharynx with low undulations. Antenna 3 = 0·23 (0·21–0·25) mm long, 0·14 (0·13–0·16) length of wing, 1·09 (1·04–1·17) length of 4+5, 1·17 (1·05–1·26) length of labrum, two ascoids on segments 3–15, that on 4 being slender, difficult to see, 0·86 length of segment and reaching the next one, no papilla on 5. Mandible pointed. Maxilla without lateral teeth but five vestigial specks, and 22 small ventrals, dental depth 0·07 mm; palpal ratio 10 : 18 : 31 : 35 : 64; sensilla based on basal third of 3. Scutum brownish, pleuron mainly pale. Wing length 1·59 (1·50–1·66)

mm, three times width, R_2/R_{2+3} 0·71 (0·54–0·90), R_1 overlap/R_2 0·36 (0·27–0·41). Spermatheca oblong and thin-walled with delicate duct joining short common duct.

♂. Labrum 0·16 mm long, 0·11 length of wing. Cibarium with about eight distinct separate pointed teeth on slightly convex arc, a strong bulge, and a pigment patch about two-thirds width of cibarium. Pharynx almost unarmed and very narrow posteriorly. Antenna 3 = 0·31 mm long, 0·21 length of wing, 1·22 length of 4 + 5, 1·89 length of labrum, one ascoid on segments 3–15 (last two missing), that on 4 being 0·75 length of segment and reaching its tip. Wing length 1·45 mm, 3·6 times width, R_2/R_{2+3} 0·52, R_1 overlap/R_2 0·15. Aedeagus with rounded tip. Coxite with nine narrow mesad hairs.

MATERIAL EXAMINED.
Holotype ♀, **West Malaysia:** Gunong Besout Forest Reserve, 24.ii.1974 (*J. Jeffery*) (BMNH).

Paratypes. Same data, 5.v-15.vi.1974, 13 ♀, 1 ♂; same data, 10.viii.1973 (*R. B. Tesh*), 1 ♀; Ulu Gombak, 20.viii.1960 (*Abu Hassan bin Omar*), 1 ♀. (All in BMNH.) Ten ♀ and 1 ♂ measured.

Sergentomyia lagunensis (Quate)

(Map 12)

Phlebotomus (*Sergentomyia*) *lagunensis* Quate, 1965 : 26. Holotype ♀, PHILIPPINES (BPBM) [not examined].

A large species with most of the pleuron brown and, in the female, 26 spike-like cibarial teeth and indistinct fore teeth.

DISTRIBUTION. **Philippines:** Los Baños (Quate, 1965 : 26).

Sergentomyia losarcus (Quate)

(Map 12)

Phlebotomus (*Sergentomyia*) *losarcus* Quate, 1965 : 30. Holotype ♀, PHILIPPINES (BPBM) [not examined].

In the female of this large dark species the slender cibarium has 8–10 stout teeth in a slightly convex row and no fore teeth or pigment patch, and a dark area between the teeth and the strong arch; the pharynx is unarmed and antenna 3 very long, and the spermatheca is sub-pyriform. On the style of the male is a seta at 0·4 or 0·5, two spines at 0·8, and two distal. The name is being treated as a noun.

The species is close to *S. hitchensi*, separable by the smaller number of differently shaped teeth and by distribution, and they may be forms of one species according to Quate.

DISTRIBUTION. **Philippines:** Los Arcos, San Francisco area (Quate, 1965 : 30).

Sergentomyia maai (Quate & Fairchild)

(Map 12)

Phlebotomus (*Sergentomyia*) *maai* Quate & Fairchild, 1961 : 218. Holotype ♀, BORNEO (BPBM) [not examined].

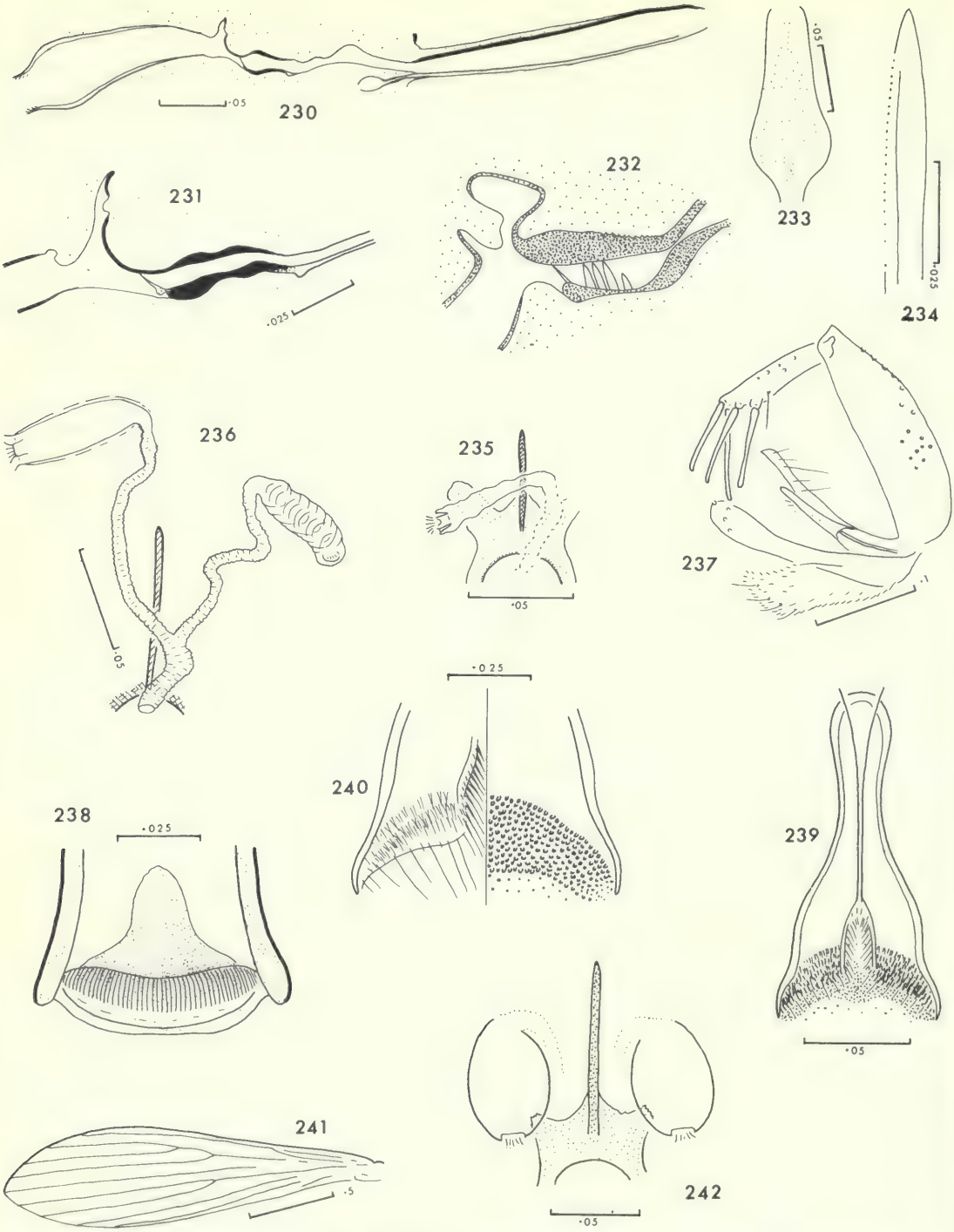
The cibarium of the female has 25 fish-hook-shaped teeth in an even comb and 14 fore teeth of which the centre ones are the larger, the pharynx is unarmed, the ascoids very short, and the spermatheca smooth and ovoid with a small head. On the style of the male two of the setae are subterminal.

DISTRIBUTION. **Borneo:** Tawau (Quate & Fairchild, 1961 : 218).

Sergentomyia mahadevani sp. n.

(Figs 238–242, Map 12)

In the female the cibarium has 50 long parallel teeth and a pigment patch with a broad fore end, the hind end of the pharynx is broad and indented, with numerous small teeth, antenna 3 and



Figs 230–242 *Sergentomyia* species. 230–237, *S. knudseni*: (230) ♀, sagittal section of fascicle and cibarium; (231) ♀, same of cibarium; (232) ♀, same of an American species (*Lutzomyia panamensis*) for comparison; (233) ♀, pharynx; (234) ♀, maxilla; (235, 236) ♀, spermathecae; (237) ♂, terminalia. 238–242, *S. mahadevani*, ♀: (238) cibarium; (239, 240) pharynx; (241) wing; (242) spermathecae.

R_1 are long, and the spermathecae are nearly spherical. The nature of the cibarium and pharynx, alone, suffice to distinguish this species from others.

♀. Labrum 0·20 mm long, 0·09 length of wing. Cibarium with about 50 long parallel teeth and a pigment patch with a broad fore end, hind bulge present. Pharynx with broad indented hind end and numerous closely packed small teeth. Hypopharynx with low rounded teeth. Antenna 3 = 0·44 mm long, 0·20 length of wing, 1·27 length of 4 + 5, 2·16 length of labrum, two ascoids on antenna 3–15, that on 4 being 0·4 length of segment amd having a vestigial spur 7·5 μm long, no papilla on 5. Maxilla with six not very wide lateral and 18 ventral teeth and a dental depth of 0·06 mm, palpal ratio 10 : 23 : 38 : 22 : 113, sensilla grouped near base. Scutum pale brown and pleuron pale. Wing length 2·24 mm, 3·5 times width, R_2/R_{2+3} 3·64, R_1 thick, R_1 overlap/R_2 0·74. Spermathecae nearly spherical with delicate ducts.

Material examined.
Holotype ♀, **Thailand:** Ban Bon Dan, 11.xii.1976 (*D. J. Gould*), light-trap with CO_2 in tropical evergreen and deciduous forest (BMNH).

Sergentomyia montana (Sinton)

(Map 12)

Phlebotomus minutus var. *montanus* Sinton, 1924*a* : 809, 812; 1927*c* : 949; 1927*d* : 26. Syntypes ♀ ♂, India and Pakistan (depository unknown except 1 ♀ in Indian Museum) [not examined].
Phlebotomus montanus (Sinton); Sinton, 1927*d* : 27 [cibarium]; 1927*e* : 31; 1928*c* : 316; 1929*b* : 174; 1932*a* : 61; 1933*e* : 422.
Sergentomyia montana (Sinton); Lewis, 1967 : 39; Artemiev, 1976*b* : 426.

The cibarium of the female has small lateral teeth in several rows, a pigment patch with broad forward process and pointed tail, a narrow pharynx with many teeth, and a spermatheca narrowing distally. The cibarium of the male has several rows of lateral teeth and a distinct narrow pigment patch.

Artemiev proposed to include *S. montana* in *Parrotomyia*, and to modify the diagnosis of the subgenus slightly.

Distribution. **India:** Bhowali (BMNH); Chamba area, Tehri area (Rao *et al.*, 1973); Kasauli, Naini Tal (Sinton, 1924*a* : 812). **Nepal:** Syabrudens (*L. W. Quate*, 2.xi.1965). **Pakistan:** Bahrein, Gilgit, Khaira Gali, Murree, Parkuta, Rawalpindi, Said Pur, Taxla (Lewis, 1967 : 40).

Sinton (1932*a*) found *S. montana* in the western Himalayan foothills at about 1830 m where (1928*c*) it was common and replaced the lowland *S. babu*.

Sergentomyia morini (Raynal & Gaschen)

(Map 12)

Phlebotomus morini Raynal & Gaschen, 1935*f* : 731 [♂]; Raynal, 1935*b* : 301; 1936*a* : 367. Syntypes 2 ♂, Vietnam (South) (depository unknown) [not examined].
Phlebotomus (*Prophlebotomus*) *morini* Raynal & Gaschen; Parrot, 1940 : 312; 1946 : 70.

The cibarium of the male has six or seven groups of small teeth, a few fore teeth, and no pigment patch. R_2/R_{2+3} is 0·73–0·76, and two spines on the style are subapical. The genital filaments are very long, 6·5–6·7 times as long as the pump.

Distribution. **Vietnam (South):** Duc Pho (Raynal, 1935*b* : 303; 1936*a* : 367).

Sergentomyia neras (Quate)

(Map 12)

Phlebotomus (*Sergentomyia*) *neras* Quate, 1965 : 28. Holotype ♀, Philippines (BPBM) [not examined].

This small species has antenna 3 very short and most of the scutum brown. The female has 14

inwardly sloping cibarial teeth in a compact row and two rows of 16 fore teeth, and a subpyriform spermatheca.

DISTRIBUTION. **Philippines:** Eran area (Quate, 1965 : 18).

Sergentomyia sp. (Okinawa)

(Map 12)

Sergentomyia sp. Lien, 1975 : 298.

In the one female known the cibarium has 70 teeth, the pharynx has about ten short spicules, R_2/R_{2+3} is 4·8 and the spermatheca is subovoid.

DISTRIBUTION. **Japan:** Ryukyu Retto, Okinawa.

Sergentomyia pachystoma (Quate & Fairchild)

(Figs 243–250, Map 12)

Phlebotomus (*Sergentomyia*) *pachystoma* Quate & Fairchild, 1961 : 215. Holotype ♀, BORNEO (BPBM) [not examined].

This pale species was named after a thick proboscis. In females from Borneo the cibarium has 22 teeth and 18 fore teeth, the inter-arcal area is sclerotized and wrinkled, the ascoids have a small spur and there appears to be only one ascoid on segments 11–15, and the spermatheca narrows before the tip and has a deep pit. The male is described here for the first time from West Malaysian specimens regarded as this species.

♀. Eye 0·44 length of head. Labrum 0·24 (0·23–0·26) mm long, 0·14 (0·13–0·15) length of wing. Cibarium with 24·2 (20–29) teeth and 19·0 (16–22) fore teeth, and a marked dorsal hind bulge, inter-arcal area with a wide brownish area merging into the brown arch but scarcely a trace of oblique lines, pigment patch rather broad and bearing imprints of fore and hind teeth. Pharynx at widest point about 0.81 width of cibarium. Hypopharynx with rounded teeth less than half as high as wide. Antenna 3 = 0·29 (0·27–0·30) mm long, 0·16 (0·15–0·18) length of wing, 0·13 (0·12–0·14) length of 4+5, 1·19 (1·07–1·25) length of labrum, ascoids with small spur, two ascoids on segments 3–15, distal ones delicate and sometimes difficult to see. Each mandible pointed, with wide teeth. Maxilla slender with small teeth, seven laterals and 36 ventrals, and a dental depth of 0·12 mm. Wing length 1·77 (1·70–1·88) mm, about 3·1 times length, R_2/R_{2+3} 1·52 (1·04–2·01), R_1 overlap/R_2 0·60 (0·52–0·71). Leg ratios, for comparison with original description; fore, 6 : 5·4; mid, 6 : 6·5 : 3·4. Spermatheca narrowing before tip, with deep pit and long knob.

♂. Labrum 0·25 (0·24–0·26) mm long, 0·14 (0·14–0·14) length of wing. Cibarium with about six long teeth and about 18 irregular fore teeth and no pigment patch. Pharynx with ridges and minute spicules. Antenna 3 = 0·42 (0·40–0·46) mm long, 0·24 (0·22–0·25) length of wing, 1·18 (1·16–1·25) length of 4+5, 1·69 (1·62–1·77) length of labrum, one ascoid with short spur on segments 3–15, that on 4 slender and about 0·6 length of segment. Wing length 1·79 (1·73–1·85) mm, 3·2 times width, R_2/R_{2+3} 1·33 (1·11–1·59), R_1 overlap/R_2 0·57 (0·50–0·65). Aedeagus tapering with rounded tip. Paramere beaked. Coxite with about 27 hairs in brush. Style with seta at 0·46, one spine at 0·42, one at 0·53 and two terminal.

COMMENTS. West Malaysian females differ from the Borneo description in several respects. In the former the cibarial teeth are more numerous on average, inter-arcal ridges are inapparent, the pigment patch (dissected out) proves to be a different shape, the pharynx is wider, the proboscis does not appear thick and includes a rather long labrum, and ascoid distribution (probably), wing length and leg ratios are different. Differences, however, could be due to infrasubspecific variation or to differences in mounting, and the two forms are treated as one species till more is known of the Borneo form.

MATERIAL EXAMINED.
West Malaysia: Gunong Besout Forest Reserve, 7.x.1973–15.vi.1974 (*J. Jeffery & K. A. Tambor*), 3 ♀; Tanjong Rabok, 12–28.xi.1969 (*A. Rudnick*), 7 ♀, 10 ♂.

DISTRIBUTION. **Borneo** (Sabah): Kalabakan River, Ranau (Quate & Fairchild, 1961 : 216). **West Malaysia:** Gunong Besout Forest Reserve, Tanjong Rabok (as above); Bukit Ibam (*L. W. Quate*, via BPBM).

Sergentomyia pooi (Yao & Wu)

(Map 12)

Phlebotomus pooi Yao & Wu, 1941*a* : 71; 1941*b* : 78 [♂]. Syntypes 4 ♂, CHINA (depository unknown) [not examined].

The cibarium of the male has no pigment patch, 23–29 hind teeth and 10–15 fore teeth. Its wing is about four times as long as wide, and R_2/R_{2+3} averages 0·76. Satisfactory identification will depend on finding the female.

DISTRIBUTION. **China:** Tienpao (Yao & Wu, 1941*a* : 71).

Sergentomyia reidi (Lewis)

(Figs 251–263, Map 13)

Phlebotomus (*Sergentomyia*) *reidi* Lewis, 1957 : 169 [♀]; Quate & Fairchild, 1961 : 220. Holotype ♀, WEST MALAYSIA (BMNH) [examined].

Behind the main cibarial teeth of the female is a remarkable group of teeth. Occasionally it may be hidden, if a head is tilted, so that the cibarium looks rather like that of *S. cheongi* which, however, has larger main teeth.

♀ (*extra facts*). Labrum about 0·19 mm long and 0·10 length of wing, with well-developed adoral sensilla. Cibarial main teeth arising from tough sclerotized band in front of hind margin of ventral plate; each tooth pear-like in ventral view but supporting long upward-pointing spine which is continuous with dorsal basal ridge of tooth; pigment patch with about 13 longitudinal lines. Hypopharynx with low blunt teeth. Mandible with rounded tip and long low teeth. Maxilla with ten broad lateral teeth, 32 ventrals, and a dental depth of 0·08 mm.

♂ (*first description*). Labrum 0·16 (0·16–0·17) mm, 0·11 (0·11–0·11) length of wing. Cibarium with seven or eight, slightly diverging and narrow, pointed hind teeth merging on each side into spicules of same shape; behind main teeth a patch of 8–16 narrow bent pointed teeth; all teeth under low power appearing spatulate owing to bending; pigment patch faint. Pharynx almost unarmed. Antenna 3 = 0·30 (0·29–0·32) mm long, 0·20 (0·19–0·22) length of wing, 1·20 (1·17–1·26) length of 4 + 5, 1·86 (1·76–1·98) length of labrum, one ascoid on 3–15, that on 4 about 0·39 length of segment, no papilla on 5. Wing length 1·49 (1·42–1·57) mm, 3·7 times width, R_2/R_{2+3} 1·62 (1·33–1·95), R_1 overlap/R_2 0·60 (0·51–0·69). Aedeagus narrow and tapering, filaments about 3·8 length of pump. Paramere hooked. Style with two of spines slightly subterminal, seta at about 0·76.

COMMENTS. The main cibarial teeth look rather like fore teeth because their long shafts point up and therefore do not appear behind the margin of the lower wall of the cibarium. The arrangement of the thick band at the bases of the teeth and of the pigment patch is like that seen in *S. perturbans*.

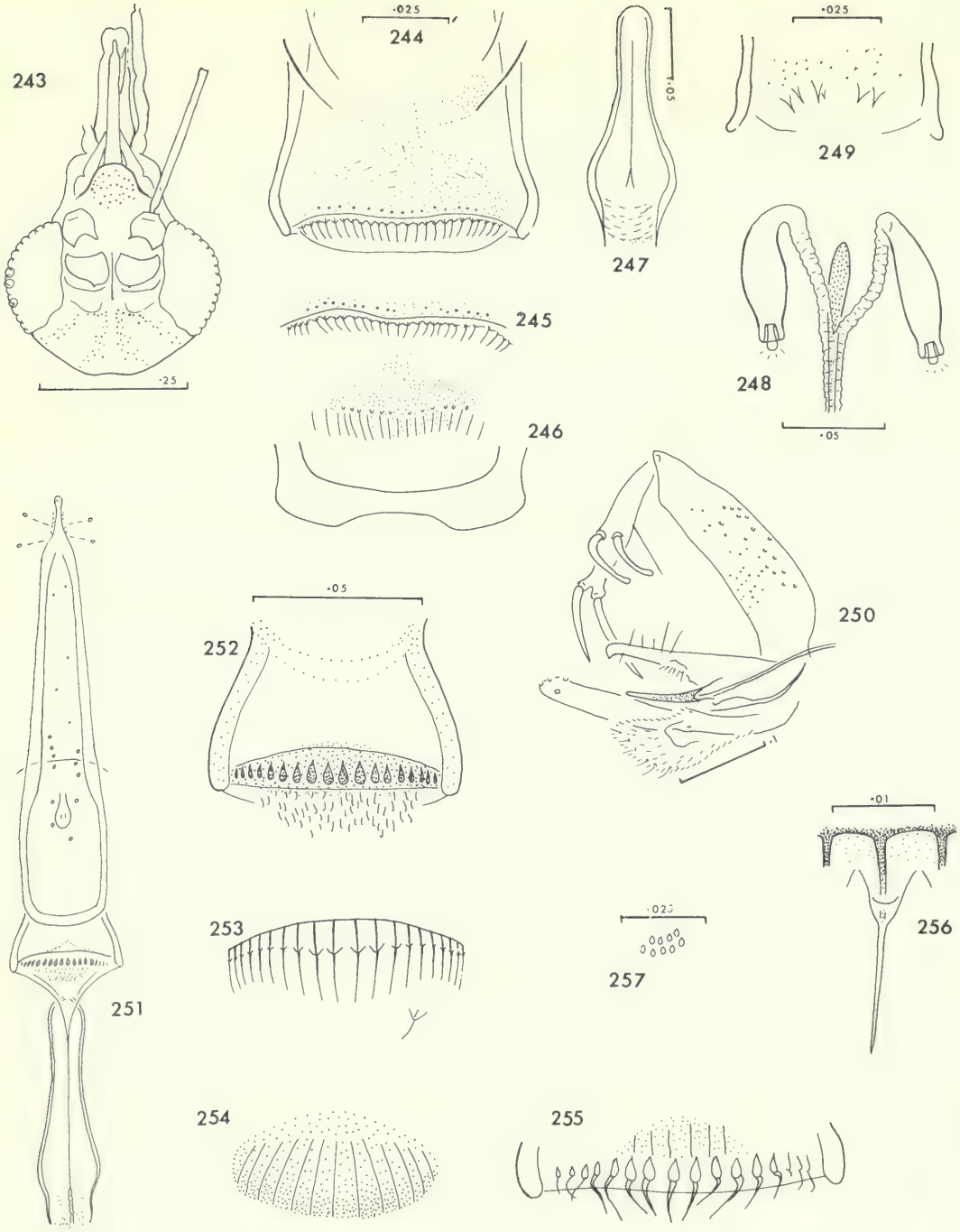
MATERIAL EXAMINED.
West Malaysia: Gunong Besout Forest Reserve, many; for above description, 24.iii.1974–15.vi.1975 (*J. Jeffery and colleagues*). 10 ♂ measured.

DISTRIBUTION. **West Malaysia:** Gunong Besout area (as above); Ulu Gombak (Lewis, 1957); Gua 'Che Yatim (Quate & Fairchild, 1961 : 220); Bukit Ibam, termite hills etc. on Fraser hill at 1360 m (*L. W. Quate*, via BPBM).

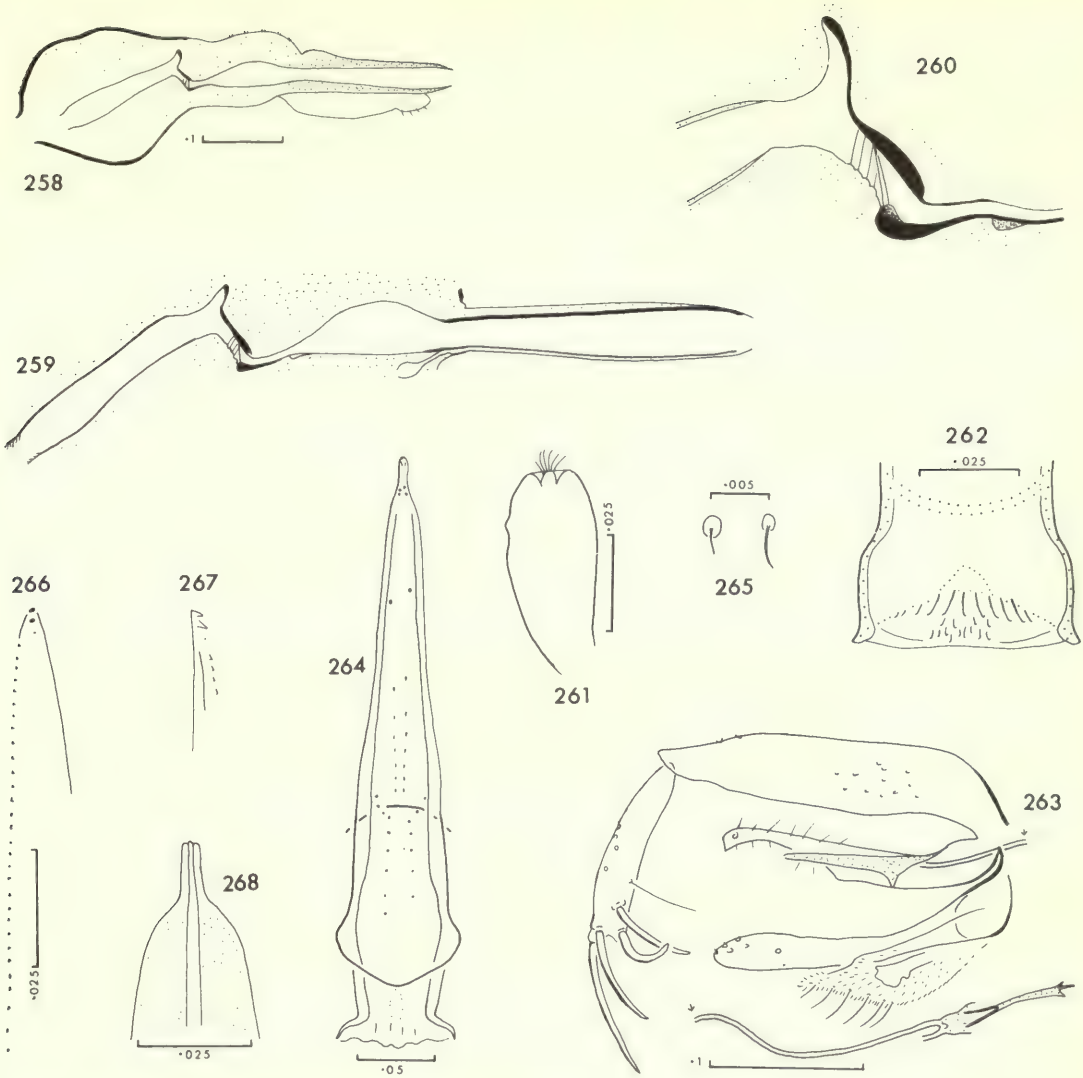
Sergentomyia tracheola (Quate)

(Map 13)

Phlebotomus (*Sergentomyia*) *tracheolus* Quate, 1965 : 24. Holotype ♀, PHILIPPINES (BPBM) [not examined].



Figs 243–257 *Sergentomyia* species. 243–250, *S. pachystoma*: (243) ♀, head; (244) ♀, cibarium; (245, 246) ♀, parts of cibarium crushed; (247) ♀, pharynx; (248) ♀, spermathecae; (249) ♂, cibarium; (250) ♂, terminalia. 251–257, *S. reidi*, ♀: (251) labrocibarium and pharynx; (252) cibarium; (253) main teeth and one small tooth crushed; (254) pigment patch of same fly removed; (255) main teeth and part of pigment patch of holotype partly flattened; (256) one tooth of Fig. 253; (257) small teeth in fresh Berlese's medium.



Figs 258–268 *Sergentomyia* species. 258–263, *S. reidi*: (258–260) ♀, sagittal section of head; (261) ♀, spermatheca; (262) ♂, cibarium; (263) ♂, terminalia. 264, 265, *S. christophersi*, ♀: (264) labrocibarium; (265) first and second adoral sensilla. 266, 267, *S. clydei*, ♀: maxilla, and its tip from another angle. 268, *S. eadithae*, ♀: tip of hypopharynx.

This is a large species with brown scutum. The cibarium of the female, with no pigment patch or fore teeth, has eight wedge-shaped teeth and a strong arch, and the pharynx has a compact group of teeth before the hind end. The spermatheca is pyriform.

DISTRIBUTION. **Philippines:** Katanglad Mount (Quate, 1965: 18).

Subgenus *SINTONIUS* Nitzulescu

Sergentomyia subgenus *Sintonius* Nitzulescu, 1931 : 273; Theodor, 1958 : 51; Perfil'ev, 1968 : 347. Type-species: *Phlebotomus hospitii* Sinton, 1924*g*, by subsequent designation by Lewis, 1973*a* : 232.

The segmented spermatheca, usually small, characterizes this subgenus which occurs largely in

the drier parts of the Old World. The Oriental species exist in the west. They may be divided into the *clydei* series, with 18 or fewer cibarial teeth, and the *hospitii* series, with 35 or more teeth and a narrow tip to the hypopharynx. Erect abdominal hairs are discussed under *S. clydei*.

Sergentomyia (*Sintonius*) *christophersi* (Sinton)

(Figs 264, 265, Map 13)

Phlebotomus christophersi Sinton, 1927*d* : 22, 24; 1927*e* : 31; 1927*f* : 33 [description]; 1932*a* : 60; 1932*b* : 571; 1932*c* : 579; 1933*e* : 420. Syntypes, PAKISTAN (depository unknown) [not examined].
Phlebotomus (*Prophlebotomus*) *christophersi* Sinton; Parrot, 1940 : 312.
Sergentomyia (*Sintonius*) *christophersi* (Sinton); Theodor & Mesghali, 1964 : 297 [cibarium]; Lewis, 1967 : 40; 1974*b* : 195; Artemiev, 1976*a* : 35.
Phlebotomus (*Sergentomyia*) *christophersi* Sinton; Abonnenc, 1972 : 152.

The cibarium of the female has large cornua, four or five separated teeth and a very small pigment patch.

♀ (*extra facts*). Labrum with unusual pattern of adoral and cibarial sensilla. Hypopharynx smooth. Mandible pointed and slender. Maxilla with small teeth, seven lateral, 27 ventral and a dental depth of 0·12 mm.

In view of observations by Theodor & Mesghali on the fore teeth, a few females from several countries were examined. None was found in those from Kenya, India, Morocco, Pakistan, Sudan, Uganda or Yemen. There were distinct teeth in a female from Iran, and minute teeth in one from Ethiopia.

MATERIAL EXAMINED.
Pakistan: Lahore. Others as indicated above.

DISTRIBUTION. **India:** Jaipur (Kaul *et al.*, 1973 : 532); Bikaner (Sharma *et al.*, 1973*c*); Delhi, Karnal, Pinjaur, Pipli, Sahranpur (Sinton's notes). **Pakistan:** Jhelum, Lahore (Lewis, 1967 : 40).

Sergentomyia (*Sintonius*) *clydei* (Sinton)

(Figs 266, 267, Map 13)

Phlebotomus clydei Sinton, 1928*b* : 179; 1928*c* : 312; 1932*a* : 60; 1932*b* : 571; 1932*c* : 579; 1933*e* : 420. Lectotype ♂, PAKISTAN (BMNH), designated by Lewis, 1967 : 42 [examined].
Phlebotomus (*Prophlebotomus*) *clydei* Sinton; Parrot, 1940 : 312; 1946 : 71; 1953 : 112.
Sergentomyia (*Sintonius*) *clydei* (Sinton); Theodor, 1958 : 51; Theodor & Mesghali, 1964 : 297; Lewis, 1967 : 42; Perfil'ev, 1968 : 347; Artemiev, 1976*a* : 37.

The female has 10–15 cibarial teeth and an almost unarmed pharynx, and the male has small cibarial spicules arranged in groups. Among specimens from Tibi, Rajasthan, India, the cibarial fore and hind teeth of females are large, and the length of abdominal tergite 6 of the males is variable.

♀ (*extra facts*). Hypopharynx with long low blunt teeth. Mandible pointed. Maxilla with three lateral teeth, one very small, and a gap between them and the 30 ventrals, dental depth 0·09 mm.

The subgeneric character of a small number of erect hairs on abdominal tergites 2–6 is often inapplicable to males of *S. clydei*. Sinton mentioned four to six erect hairs on segment 3 and fewer behind. In some specimens, examined from the side and from above, there are two erect hairs on tergite 2 and none behind. Tergite 6 normally bears no hairs but small and very small microtrichia.

MATERIAL EXAMINED.
Pakistan: Bazid Khel, drawn.

DISTRIBUTION. **India:** Keliveli, Osmanabad (*V. Dhanda*); Ajmer (Jaswant Singh, 1933); Jaipur, Jalor (Kaul *et al.*, 1973 : 533); Venkatapuram (10.vii.1966, in house on human bait, *R. Reuben*); Tibi (Sharma

et al., 1973*b*); Bikaner (Sharma *et al.*, 1973*c*); Bhavnagar, Delhi, Guntur, Junagadh, Kamptee, Karnal, Madras, Pipli, Sahranpur (Sinton's notes). **Pakistan:** Kandhkot, Karachi, Khairpur, Lahore, Mir Muhammad, Peshawar, Rawalpindi, Tando Muhammad Khan, Taxla (Lewis, 1967 : 42); Jandola, Khirgi (Sinton, 1928*b* : 179); Sargodha (Sinton's notes).

Sinton (1932*c* : 71) found *S. clydei* widely in the plains of India.

Sergentomyia (*Sintonius*) *eadithae* (Sinton)

(Fig. 268, Map 13)

Phlebotomus eadithae Sinton, 1932*c* : 577 [♀]; 1933*c* : 227; 1933*e* : 420 [♂]; Parrot, 1940 : 312. LECTOTYPE ♀, INDIA (Sagar ?), labelled 'P. 4 . . . Type ♀ Saugor . . . 3/8/27' (BMNH), here designated [examined].

The female has about 35 large pointed cibarial teeth, in a row distinctly convex near the middle, a large pigment patch, minute pharyngeal teeth, and a long spermatheca with about 12 segments and a small head.

♀ (*extra facts*). Labrum about 0·19 mm long, 0·10 length of wing. Hypopharynx smooth with narrow forward part. Mandible rather blunt. Maxilla with 11 lateral teeth, not very wide, 24 ventrals and a dental depth of 0·09 mm.

DISTRIBUTION. **India:** Sirohi (Kaul *et al.*, 1973 : 533); Hyderabad (2 ♂, Qutubuddin, 1944 : 208); Sagar (Madyia Pradesh, Sinton, 1932*c* : 577); Velur (Todupuzha, Travancore, Sinton's notes).

Sergentomyia (*Sintonius*) *hospitii* (Sinton)

(Figs 269–273, Map 13)

Phlebotomus simillimus var. *hospitii* Sinton, 1924*g* : 261; 1927*d* : 22, 27 [spermatheca]; 1927*e* : 30 [cibarium]; 1928*c* : 312. Lectotype ♂, PAKISTAN (BMNH), designated by Lewis, 1967 : 44 [examined].
Phlebotomus hospitii Sinton; Sinton, 1929*b* : 174; 1932*a* : 60; 1933*d* : 420; Theodor, 1938*b* : 172 [relationship to *S. thompsoni* Theodor].
Sergentomyia (*Sintonius*) *hospitii* (Sinton); Lewis, 1967 : 43.

The female has 50–60 cibarial teeth, and both sexes have spines on femur 1.

♀ (*extra facts*). Labrum with, on each side, three apical sensilla, each comprising a basal refractive cup, a leaf-like process with narrow shoulders; two very small subapical sensilla, each having, like the apicals, a canal through the labral cuticle; a row of narrow adoral sensilla; a few small adorals near the mid line beneath the tip of the clypeus; and the usual round cibarial sensilla. Hypopharynx narrow anteriorly and without teeth. Maxilla with 12 broad lateral teeth and no ventrals apart from a few vestigial specks.

MATERIAL EXAMINED.
Pakistan: Said Pur, 1 ♀.

DISTRIBUTION. **India:** Almora area, Kasauli (Sinton's notes). **Pakistan:** Abbottabad, Dulai, Rawalpindi, Said Pur (Lewis, 1967 : 44).

This species was known only from the western Himalayan foothills (Sinton, 1932*a*).

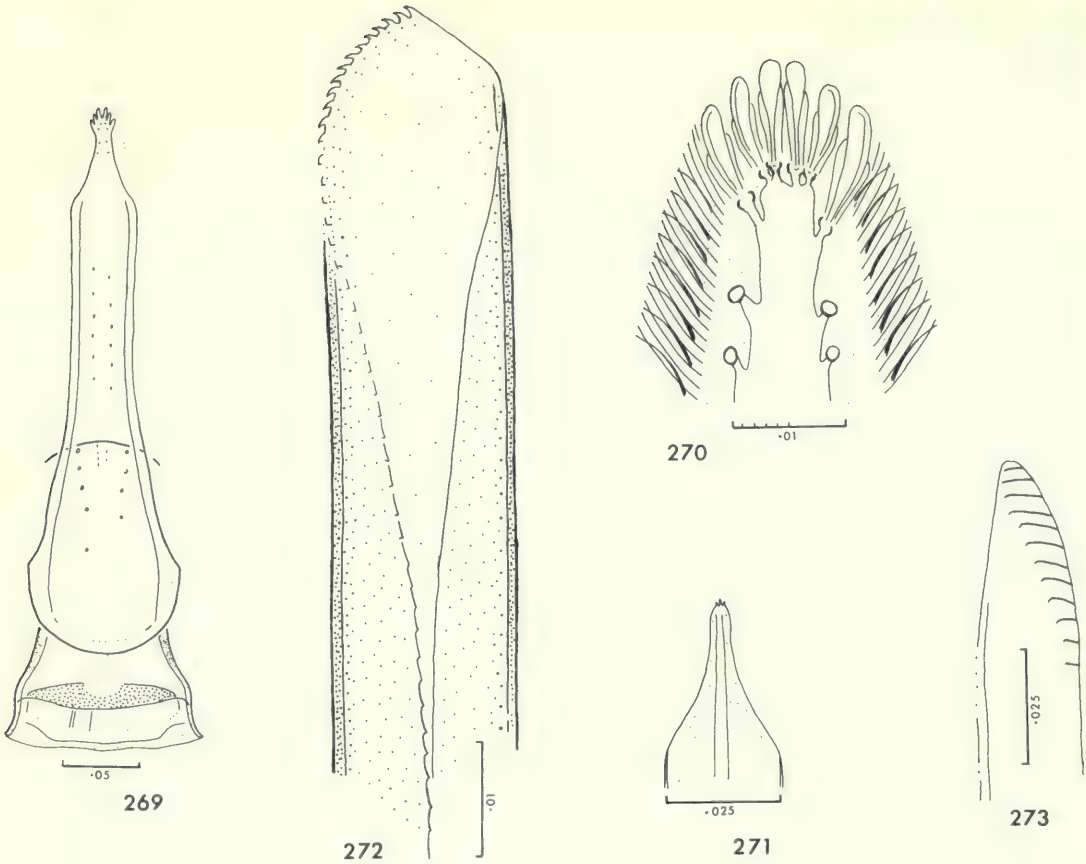
Sergentomyia (*Sintonius*) *orissa* Kaul & Lewis

(Map 13)

Sergentomyia (*Sintonius*) *orissa* Kaul & Lewis, 1977 : 83. Holotype ♀, INDIA (BMNH) [examined].

The female has 24–28 cibarial teeth, more or fewer than those of other Oriental *Sintonius*.

DISTRIBUTION. **India:** Bhubaneswar area.



Figs 269–273 *Sergentomyia hospitii*, ♀: (269) labrocibarium; (270) tip of labrum; (271) tip of hypopharynx; (272) tip of mandible; (273) tip of maxilla.

Sergentomyia (*Sintonius*) *sirohi* Kaul, Dhanda & Modi

(Map 13)

Sergentomyia (*Sintonius*) *sirohi* Kaul, Dhanda & Modi, 1973 : 533. Holotype ♀, India (presumed in Virus Research Centre, Poona) [not examined].

In this small species the female has 10–12 spaced pointed teeth and usually (unlike *tiberiadis*) no fore teeth.

Distribution. **India:** Veerwada (Kaul *et al.*, 1973 : 535).

Sergentomyia (*Sintonius*) *tiberiadis* (Adler, Theodor & Lourie)

Phlebotomus species near *clydei* (Sinton); Adler & Theodor, 1929 : 284.
Phlebotomus tiberiadis Adler, Theodor & Lourie, 1930 : 537; Sinton, 1932*c* : 579. Syntypes, Israel (TC) [not examined].
Sergentomyia (*Sintonius*) *tiberiadis* (Adler, Theodor & Lourie); Theodor, 1958 : 51.

The female has 10–18 cibarial teeth in comb formation, the middle ones being smaller than the laterals.

Sergentomyia* (*Sintonius*) *tiberiadis pakistanica Artemiev & Saf'yanova

(Map 13)

Sergentomyia (*Sintonius*) *tiberiadis* (Adler, Theodor & Lourie); Theodor & Mesghali, 1964 : 297 [Afghanistan]; Lewis, 1967 : 44.

Sergentomyia (*Sintonius*) *tiberiadis pakistanica* Artemiev & Saf'yanova, 1974 : 544; Artemiev, 1976*a* : 38. Syntypes 19 ♀, 33 ♂, AFGHANISTAN AND U.S.S.R. (depository unknown) [not examined].

This subspecies differs from the Ethiopian and Israel nominal subspecies in having a spermatheca narrowing toward the tip with more (9–12) segments, a common spermathecal duct, and 13 (10–17) cibarial teeth instead of 17–18. The authors raised the eastern form to subspecies after considering its morphology and probable allopatricity.

♀ (*extra facts*). Hypopharynx smooth. Maxilla with six, not very broad, lateral teeth, 27 minute ventrals, and a dental depth of 0·10 mm.

MATERIAL EXAMINED.
Pakistan: Ahmed Khel, 1 ♀.

DISTRIBUTION. **Pakistan:** Ahmed Khel, Landi Kotal, Peshawar (Lewis, 1967 : 46).

Nomen nudum

Phlebotomus javanensis Flu, 1920 : 602; Sinton, 1928*c* : 322 (as *javaensis*); Lewis, 1973*a* : 254.

Flu wrote; 'Phlebotomus papatacci komt op Java voor en is er b. v. door Professor de Meyere beschreven onder de naam van phlebotomus javanensis' (Phlebotomus papatacci occurs on the island of Java and has been described as phlebotomus javanensis by Professor de Meyere). *P. papatasi* is unknown in this part of the world and the name *javanensis* is a nomen nudum.

Aspects of biology

Much information on the biology of certain Oriental species is available in the literature, and some of it has been summarized by Forattini (1973). The following paragraphs deal mainly with general distribution, blood-feeding habits and seasonal distribution which is an essential consideration in planning collecting expeditions.

General distribution

The limits of the Oriental Region used here are those of Delfinado & Hardy (see Lewis, 1973*a*) except for the inclusion of Baltistan in Pakistan. The peripheral areas include Pakistan, Nepal, Burma, a southern Chinese belt, Taiwan, Philippines, Mangole Island, Babar Island, Indonesia and Sri Lanka. The subregions were defined by Wallace (1876 : maps 1 and 10) and Bartholomew *et al.* (1911 : pl. I). The north-eastern boundary was discussed by Chang (1965), and all aspects of Indian zoogeography have been reviewed by Mani (1974). Christophers (1921*a*; 1923) discussed mosquito distribution in India and emphasized east–west faunal changes on the lower Indus and in the Sylhet area, a Malabar fauna with affinities in Sri Lanka and east of Calcutta, and a relationship between Himalayan and more eastern forests.

Many species of sandflies occur mainly, not in a particular faunal region, but in parts of three regions, which together make up a vast zone with its axis running from Morocco to India. For ease of discussion this area is here named the Triad Zone, and its approximate boundaries (clockwise from West Africa) are: the Atlantic, 48° N, 90° E and 10° N. Its core is the 'Saharan' district of Christophers (1921*b* : 714, Map III) and the Mediterranean Subregion of the Palaearctic (Christophers, 1923 : 422). The northern limit of this mainly rather dry zone approximates to the cold northern boundary of sandflies, and the eastern and southern limits to the 1000 mm isohyet.

The Oriental Region is here divided into the west (Indian and Ceylonese Subregions), centre (Indo-Chinese and Indo-Malayan Subregions, excluding Borneo and the Philippines) and east (Borneo and the Philippines).

Table 1 and the maps show a relation between distribution and certain taxonomic groupings, and indicate that most species occur largely in either the west, centre or east, but few in both west and centre. Combining west with Triad, centre with Palaearctic (Manchurian) and east with Australasian gives the following figures (percentages in brackets): west, 43 (35·8); centre, 42 (35·0), east, 35 (29·2), and west plus centre, 4 (3.2).

Table 1 The Oriental Phlebotominae showing the *main* area of each in the Old World. The term Triad Zone is explained in the section on general distribution (p. 311), and many of its sandflies are widespread in the west of the Orient. For the subgenera *Parrotomyia* and *Neophlebotomus* code letters are used to indicate groupings mentioned in the text

		Oriental					
	Triad Zone	West	Centre	East	West and Centre	Palaearctic: Manchurian	Australasian
PHLEBOTOMUS							
(*PHLEBOTOMUS*)							
papatasi	+	−	−	−	−	−	−
salehi	+	−	−	−	−	−	−
(*PARAPHLEBOTOMUS*)							
alexandri	+	−	−	−	−	−	−
nuri	−	+	−	−	−	−	−
sergenti	+	−	−	−	−	−	−
(*SYNPHLEBOTOMUS*)							
eleanorae	−	+	−	−	−	−	−
(*LARROUSSIUS*)							
betisi	−	−	+	−	−	−	−
kandelakii burneyi	−	+	−	−	−	−	−
keshishiani	+	−	−	−	−	−	−
major major	−	+	−	−	−	−	−
(*ADLERIUS*)							
chinensis chinensis	−	−	−	−	−	+	−
longiductus	+	−	−	−	−	−	−
(*EUPHLEBOTOMUS*)							
argentipes	−	−	−	−	+	−	−
kiangsuensis	−	−	+	−	−	−	−
philippinensis gouldi	−	−	+	−	−	−	−
philippinensis philippinensis	−	−	−	+	−	−	−
(*ANAPHLEBOTOMUS*)							
colabaensis	−	+	−	−	−	−	−
hoepplii	−	−	−	+	−	−	−
stantoni	−	−	−	−	+	−	−
Ungrouped							
newsteadi	−	+	−	−	−	−	−
(*IDIOPHLEBOTOMUS*)							
asperulus	−	−	+	−	−	−	−
erebicolus	−	−	−	+	−	−	−
frondifer	−	−	+	−	−	−	−
pholetor	−	−	−	+	−	−	−
sejunctus	−	−	−	+	−	−	−
stellae	−	−	−	+	−	−	−
teshi	−	+	−	−	−	−	−
tubifer	−	+	−	−	−	−	−
SERGENTOMYIA							
(*musai*-group)							
musai	−	−	−	+	−	−	−

Table 1 (*cont.*)

		Triad Zone	Oriental West	Oriental Centre	Oriental East	Oriental West and Centre	Palaearctic: Manchurian	Australasian
(*SERGENTOMYIA*)								
dentata		+	−	−	−	−	−	−
punjabensis		−	+	−	−	−	−	−
theodori pashtunica		+	−	−	−	−	−	−
(*PARROTOMYIA*)								
A sp.	a	−	+	−	−	−	−	−
africana magna	a	+	−	−	−	−	−	−
B sp.	a	−	+	−	−	−	−	−
babu babu	b	−	+	−	−	−	−	−
babu insularis	b	−	+	−	−	−	−	−
baghdadis	b	+	−	−	−	−	−	−
barraudi	a	−	−	+	−	−	−	−
bigtii	a	−	−	−	+	−	−	−
brevicaulis	a	−	−	+	−	−	−	−
brevinervis	a	−	−	−	+	−	−	−
bukidnonis	a	−	−	−	+	−	−	−
dayapensis	a	−	−	−	+	−	−	−
denticulata	d	−	−	−	+	−	−	−
franciscana	a	−	−	−	+	−	−	−
grekovi	g	+	−	−	−	−	−	−
himalayensis	a	−	+	−	−	−	−	−
kauli	a	−	+	−	−	−	−	−
mangana	a	−	−	−	+	−	−	−
modii	a	−	−	+	−	−	−	−
palestinensis	g	+	−	−	−	−	−	−
queenslandi meridionalis	a	−	−	−	−	−	−	+
rudnicki	d	−	−	+	−	−	−	−
shorttii	b	−	+	−	−	−	−	−
spinifaucis	a	−	−	−	+	−	−	−
timorica	a	−	−	+	−	−	−	−
torrechantei	a	−	−	−	+	−	−	−
yoshimotoi	a	−	−	−	+	−	−	−
(*GRASSOMYIA*)								
indica		−	−	−	−	+	−	−
(*NEOPHLEBOTOMUS*)								
arboris	ar	−	+	−	−	−	−	−
balica	ba	−	−	+	−	−	−	−
Besout sp.	un	−	−	+	−	−	−	−
chakravarti	dh	−	+	−	−	−	−	−
dhandai	dh	−	+	−	−	−	−	−
gemmea	ar	−	−	+	−	−	−	−
gombaki	ar	−	−	+	−	−	−	−
hamidi	un	−	−	+	−	−	−	−
hodgsoni hodgsoni	ba	−	+	−	−	−	−	−
iyengari	dh	−	−	+	−	−	−	−
jefferyi	ba	−	−	+	−	−	−	−
khawi	ba	−	−	−	−	−	+	−
linearis	dh	−	+	−	−	−	−	−
malabarica	dh	−	+	−	−	−	−	−
malayae	ar	−	−	+	−	−	−	−
nankingensis	ba	−	−	+	−	−	−	−

Table 1 (*cont.*)

		Triad Zone	Oriental West	Oriental Centre	Oriental East	Oriental West and Centre	Palaearctic: Manchurian	Australasian
perturbans	qu	–	–	+	–	–	–	–
purii	qu	–	+	–	–	–	–	–
quatei	qu	–	–	–	+	–	–	–
Rabok sp.	un	–	–	+	–	–	–	–
Sepilok sp.	un	–	–	–	+	–	–	–
silvatica	qu	–	–	+	–	–	–	–
tambori	ba	–	–	+	–	–	–	–
tonkinensis	qu	–	–	+	–	–	–	–
traubi	qu	–	–	+	–	–	–	–
zeylanica	ar	–	–	+	–	–	–	–
(*nicnic*-group)								
bailyi		–	–	–	–	+	–	–
displicata		–	–	–	+	–	–	–
kachekensis		–	–	–	+	–	–	–
nicnic		–	–	–	+	–	–	–
(ungrouped)								
angustipennis		–	–	+	–	–	–	–
anodontis		–	–	+	–	–	–	–
cheongi		–	–	+	–	–	–	–
dapsilidentes		–	–	–	+	–	–	–
delfinadoae		–	–	–	+	–	–	–
dentacea		–	–	–	+	–	–	–
exastis		–	–	–	+	–	–	–
fanglianensis		–	–	+	–	–	–	–
hassani		–	–	+	–	–	–	–
heiseri		–	–	–	+	–	–	–
hitchensi		–	–	–	+	–	–	–
imitor		–	–	–	+	–	–	–
jamesi		–	–	+	–	–	–	–
kelantani		–	–	+	–	–	–	–
knudseni		–	–	+	–	–	–	–
lagunensis		–	–	–	+	–	–	–
losarcus		–	–	–	+	–	–	–
maai		–	–	–	+	–	–	–
mahadevani		–	–	+	–	–	–	–
montana		–	+	–	–	–	–	–
morini		–	–	+	–	–	–	–
neras		–	–	–	+	–	–	–
Okinawa sp.		–	–	+	–	–	–	–
pachystoma		–	–	+	–	–	–	–
pooi		–	–	+	–	–	–	–
reidi		–	–	+	–	–	–	–
tracheola		–	–	–	+	–	–	–
(*SINTONIUS*)								
christophersi		+	–	–	–	–	–	–
clydei		+	–	–	–	–	–	–
eadithae		–	+	–	–	–	–	–
hospitii		–	+	–	–	–	–	–
orissa		–	+	–	–	–	–	–
sirohi		–	+	–	–	–	–	–
tiberiadis pakistanica		–	+	–	–	–	–	–

Table 2 Latitude and longitude (degrees and minutes) of localities not shown in their original spelling in the 1972 *Times Atlas*. All latitudes, except for Java and Nusa Tenggara, are north, and all longitudes east

	Latitude	Longitude
ANDAMAN ISLANDS		
Chinya Tapu	11 41	92 43
BANGLADESH		
Bongong, Tessore area, c.	23 10	89 12
Dhurmakura, Mymensingh area = Nasirabad, c.	24 45	90 23
Doloi Valley = Dhalai ? c.	24 20	91 50
Kaoraid, near Dacca, c.	23 42	90 22
BORNEO: Sabah		
Gomantong	5 32	118 03
Sepilok	5 50	117 22
BURMA		
Mezali, Minbu district, c.	20 09	84 52
CHINA		
Fanglian, Hainan Island, c.	18 30	110 00
Kachek	19 19	110 22
Kukong	24 59	113 10
Lin Ko	19 54	109 43
Masha	27 32	117 53
Nanking = Nan-ching	24 26	117 20
Sainan	23 09	112 52
Samshui county = Ho-k'ou, Kwantung	23 11	112 52
Suilam = Siulam	22 40	113 29
Tche-Souen = Se-Tchouen = Chechuan = Chih-ts'un	23 20	103 30
Tienpao	23 20	106 37
Yungan	25 57	117 18
INDIA		
Aligarh, Uttar Pradesh	27 54	78 04
Baraga, Sagar (Shimoga) area, c.	14 07	75 00
Borghat	18 48	73 28
Hoora, Sagar (Shimoga) area, c.	18 00	73 05
Hosur	14 39	75 07
Jog = Gersoppa	14 12	74 51
Kannur, Sagar (Shimoga) area	14 17	35 10
Keliveli, Akola area, c.	20 40	77 05
Konehosur, Sagar (Shimoga) area, c.	14 07	75 00
Kotelanka	16 43	81 17
Kulathurpuzha	8 54	77 03
Kumsi, Sagar (Shimoga) area, c.	14 07	75 00
Mendhar	33 40	74 08
Mohindergarh = Mahendragarh, Hariana	28 17	76 14
Munikeriti, c.	30 21	78 29
Naushera, Kashmir	33 10	74 12
Nedumangad	8 36	77 01
Paloc	8 42	77 02
Panada-Agraharam	16 32	81 35
Panchgani	17 15	73 15
Patan	19 37	75 26
Pipariya, c.	23 00	73 00
Poladpur	18 00	73 25
Rajouri	33 25	74 18
Ramanagar, Naini Tal area, c.	29 22	79 26
Sagar, Madhya Pradesh	23 50	78 44
Sanawar, Simla area, c.	31 07	77 09
Singanama, c.	21 00	79 00
Soraipani, tea estate near Mariani in Jorhat area, c.	26 38	94 18
Sukna, Darjeeling area, c.	27 02	88 20
Tamilnadu = formerly Madras State	—	—
Tindharia	26 53	88 22
Travancore = former State now in Kerala	—	—
Undi	16 35	81 28
Veerwada, Sirohi area, c.	25 53	72 58
Velur, Todupuzha, Travancore, very approximately	9 00	77 00
Wadhwan = Surendranagar	22 44	71 43
NEPAL		
Chobhar, c.	27 40	85 13
Dhunibesi, near Kathmandu, c.	27 42	85 19
Syabrudens, c.	28 10	85 08
NUSA TENGGARA		
Kabara, c.	10 02	120 44
Los Palos	8 35	126 47
Pedang Bay	8 20	115 25
Same	9 06	125 48
Suai	9 21	125 17
Sumba	8 47	120 24
Tafara Cape	9 21	125 17
PAKISTAN		
Ahmed Khel, Peshawar area, c.	34 01	71 40
Bazid Khel, Peshawar area, c.	34 01	71 40
Bahrein	34 53	72 35
Dulai	34 14	73 30
Gol	35 16	75 20
Gwadi	35 12	76 10
Khaira Gali	33 40	73 20
Khairpur, Khairpur district,	27 30	68 50

Table 2 (*cont*)

	Latitude	Longitude
Kohat area (Kohat-Hangu valley), c.	33 34	71 15
Mir Muhammad	31 40	74 15
Parkuta	35 07	76 00
Said Pur	33 17	72 58
Saidu Sharif	33 40	72 30
PHILIPPINES		
Apali, c.	13 30	123 20
Bay, c.	14 20	121 20
Bigti, Angat and Norzagaray area, c.	14 55	121 01
Cuernos de Negros	9 14	123 10
Dayap, c.	14 10	120 20
Jose del Monte, c.	14 48	121 12
Katanglad Mountain	8 07	124 55
La Mesa dam, c.	14 50	121 10
Los Arcos	8 39	125 59
Los Baños, c.	14 20	121 10
Malinao, c.	13 30	123 20
Minglanilla	10 15	123 47
Nueva Viscaya	16 20	121 20
San Francisco, Agusan area, c.	9 00	125 40
San Mateo	14 42	121 08
Silang, c.	14 10	120 50
Sipocot, c.	13 30	123 20
Tala, c.	14 50	121 07
Tarampitao	9 10	117 40
Tungkong Manga (district)	14 48	121 12
SRI LANKA		
Depanama	6 51	79 57
Kalgoda, prob.	6 52	79 57
Katuwawala	6 49	79 54
Maharagama, c.	7 12	80 04
Pannipitiya	6 51	79 57
TAIWAN		
Tzepeng, c.	23 01	120 14
THAILAND		
Ban Bon Dan	14 32	101 58
Doi Sutep = Ban Bon Doi Sutep	18 48	98 55
Khou Kaen Prov. = Mwang Khou Kaen	16 25	102 50
Meung dist. near Vientiane, c.	17 59	102 38
Meung dist. NE. of Bangkok = Nakhon Rotchasima area, c.	15 08	102 06
Pechaburi	13 06	99 57
Tha Li district = Ban Tha Li	17 37	101 32
VIETNAM (NORTH)		
Bac Muc	22 04	105 01
Bim Son	20 00	105 50
Bui Huy Tin, Bim Son area, c.	20 00	105 50
Cho Ganh	20 12	105 50
Coc Leu	22 28	103 58
Dong Giao	20 03	105 57
Kep	21 23	106 15
Lam	21 20	106 30
Le Mi	21 35	105 15
Nao Phu	21 25	105 20
Pho Doan	21 22	105 12
Pho Moi	22 24	104 02
Pho Oc	20 07	105 53
Vin Thui	22 17	104 53
Yen Ley	20 30	105 38
WEST MALAYSIA		
Batang Padang	4 14	101 21
Betis	4 55	101 45
Bukit Ibam, c.	3 10	103 15
Carey Island	3 01	101 38
Gua 'Che Yatim, c.	4 30	102 10
Gunong Besout Forest Reserve	3 49	101 12
Kuala Rompin, c.	2 40	103 30
Kuala Trengan	4 30	102 25
Lamir, Kampong or village, Kuantan area	3 31	102 43
Lubok Paku, Kuantan area c.	3 50	103 19
Pulau Meranti, Kampong, Bruas area, c.	4 29	100 50
Rantau Panjang, c.	3 10	101 25
Tanjong Rabok	2 09	101 24
Terenggan, Pahang, c.	3 00	103 00
Ulu Gombak	3 19	101 46
Ulu Langat	3 07	101 49

The western Orient

The western area has probably received many species from the Mediterranean subregion of the Palaearctic and from the Triad Zone generally, under the influence of increasing aridity. Many of the species belong to *Phlebotomus* or to the subgenera *Sergentomyia* or *Sintonius* of *Sergentomyia*. *P. papatasi*, perhaps owing to its domestic habit, has penetrated far into the western

Table 3 Showing the percentages of females in five collections

	INDIA	WEST MALAYSIA			THAILAND
	Sagar (Shimoga) area	Gunong Besout area	Bukit Igam area	Lamir village	Ban Bon Dan
PHLEBOTOMUS					
argentipes	3·1	—	—	100·0	60
philippinensis gouldi	—	—	—	—	20
stantoni	0·8	0·78	—	—	—
frondifer	—	0·45	—	—	—
SERGENTOMYIA					
babu and variant	33·4	—	—	—	—
barraudi	—	7·90	1·5	—	—
himalayensis or ally	1·2	—	—	—	—
shorttii	10·7	—	—	—	—
arboris	7·5	—	—	—	—
gemmea	—	0·56	—	—	—
gombaki	—	47·02	4·4	—	—
hamidi	—	0·66	21·0	—	—
iyengari	—	9·45	0·7	—	—
jefferyi	—	3·78	4·4	—	—
linearis	2·7	—	—	—	—
malayae	—	2·78	—	—	—
perturbans	—	5·00	—	—	—
silvatica	—	—	—	—	10
tambori	—	0·33	—	—	—
traubi	—	—	53·7	—	—
bailyi	44·8	—	—	—	—
cheongi	—	5·89	—	—	—
hassani	—	—	5·1	—	—
knudseni	—	2·33	—	—	—
mahadevani	—	—	—	—	10
pachystoma	—	0·18	2·2	—	—
reidi	—	11·34	6·5	—	—
Totals	261	900	138	448	10

Orient, where it occurs in an area with an annual mean relative humidity of less than 70 per cent (Sivaramakrishnaiah & Ramanathan, 1967 : 1166).

The wet area of the Western Ghats lacks some dry-adapted species but harbours some woodland forms known in the central Orient. The *S. arboris* series in India forms a reversed-'C' distribution pattern, with Sri Lanka in the lower arm, and is thus comparable with the *Anopheles leucosphyrus* Dönitz group (Covell, 1927 : 47; Reid, 1970 : 60).

Two species comprised most of the collection (Table 3) made by H. Trapido in 1957 in the Sagar (Shimoga) area which lies between 564 and 609 m above sea level (Work *et al.*, 1957 : 620).

The central Orient

The centre was formerly connected to Africa by forest which persisted in north-west Indo-Pakistan till historical times (Traub & Twisseman, 1966 : 47, 48). Theodor (1938*b* : 172) drew attention to the affinity between the Oriental and Ethiopian sandfly faunas, and many species of the central Oriental area belong to *Neophlebotomus* which is well represented in the Ethiopian forest zone. This is illustrated in Table 3 which shows collections made by A. B. Knudsen, R. B.

Tesh and colleagues in the Gunong Besout area, and by L. W. Quate in the Bukit Ibam area (including Kuala Rompin and Gua 'Che Yatim). There is thus a parallel with the Oriental anopheline mosquitoes which were once linked by forest with the essentially primitive species of the Afrotropical forest (Gillies & de Meillon, 1968 : 321). Similarly, the *Diceromyia* culicines have evidently spread into both Afrotropical and Oriental Regions long ago and developed separate species (Reinert, 1970).

The central area has evidently received a number of species from the Manchurian Subregion of the Palaearctic (Lewis & Wharton, 1963 : 117), which has a rich insect fauna (Gressitt, 1958 : 213) differing from that of the Mediterranean Subregion owing to the intervening inhospitable Siberian Subregion. These two different Palaearctic sources and climatic differences between the western and central Oriental areas give them rather distinctive sandfly faunas.

The central area (Table 3, columns 2 and 3), like the eastern, has a considerable number of ungrouped species of *Sergentomyia*. Australasian influence is small, presumably because even narrow seas can form a strong barrier to weakly flying sandflies, although many of these insects can occupy land barriers between regions.

West and central areas in general

P. argentipes is related to species of the Palaearctic Manchurian Subregion and of the eastern Orient, and it may have extended to the far west by virtue of its peridomestic habit there. Its wide distribution may be somewhat comparable with that of the more domestic *P. papatasi* in the Old World. *P. argentipes* has a patchy distribution in India (Smith, 1959 : 17) and in the Orient generally. Collections by R. H. Wharton at Lamir and by D. J. Gould in Thailand (Table 3) exemplify this and point to the need for further study. The Lamir result could have been due to seasonal or other changes, for no *P. argentipes* was found during a later visit (Lewis & Killick-Kendrick, 1973).

S. indica is closely related to all other members of the small subgenus *Grassomyia* which reaches from Dakar on the Atlantic to Timor, 144° or some 16 000 km. *S. indica* is one of the species which show distinctive features of structure, distribution and biology.

The environment of India (Mani, 1974 : 54) and some other countries has been greatly altered by deforestation and agriculture. Certain areas now have few phlebotomines, and Raynal did not find many in the lowlands of North Vietnam. West-central Taiwan (Cates & Lien, 1970 : 540) is probably an example of the same trend.

The eastern Orient

Wallace (1876 : I, 315) found the Philippines strikingly deficient in many Malayan animals, with an approach to the Sulawesi (Celebes) fauna, and Corbet & Pendlebury (1956 : 26) emphasized differences between Borneo and the Philippines. Their sandfly faunas differ from each other, apart from one species, but the Borneo sandflies are little known.

Most species of the cave-dwelling subgenus *Idiophlebotomus* are known from the eastern Orient, but it is represented in India and West Malaysia and probably constitutes an ancient relict fauna.

No sandfly of the eastern area is known from Australasia.

Breeding habits

Sandfly larvae were discovered in August 1908 (Howlett, 1909 : 239), but are usually difficult or impossible to locate. In the western Orient Napier & Smith (1926), Carter & Antonipulle (1949) and others have collected those of *P. argentipes* around houses. Nowadays biological information is being gained through laboratory colonization, and work on *P. papatasi* and *P. argentipes* has been summarized by Killick-Kendrick *et al.* (1977).

Adult resting sites

Most sandflies are wild and shelter in natural sites such as holes in trees or among stones and rocks, soil cracks and animal burrows. Holes in termite hills have attracted attention in Kenya

where they harbour the vector of 'termite hill kala-azar' (Lewis, 1974*a* : 369). In Pakistan Lewis (1967 : 49) found sandflies in termitaries at Lahore. In India Howlett (1913) found many sandflies in termite mounds and Modi & Dhanda (1972) reported seven species from termitaries in Maharashtra. In the Philippines Quate (1965 : 18) often found sandflies associated with termites.

A few species are largely domestic or peridomestic, resting in dwellings by day after feeding on man, domestic animals or geckos. *P. papatasi* is an important domestic species, and in Poona, Mitra (1956) found it mainly in houses and *P. argentipes* mainly in stables. *P. sergenti* is largely domestic. *P. argentipes*, in most of its range outside India and Sri Lanka, is seldom seen and appears to be a woodland zoophilic and exophilic species. In India *P. argentipes* was not found in the outdoor survey by Kaul *et al.* (1976), and is known to be largely peridomestic and to bite man but to prefer cattle. It may be that in the western Orient relatively dry conditions have driven this species into peridomestic situations.

Raynal (1936*a*) in Indo-China found *P. stantoni* rarely indoors, but *S. barraudi* often around houses. Tang & Maa (1945) encountered *P. hoepplii* in houses.

Food of adults

Plant sugars are probably taken by most sandflies (Lewis, 1966; 1971 : 543), and the subject was long ago brought to prominence in India (Berberian, 1966) by the effect of fruit juice on the transmission of *Leishmania donovani* by *P. argentipes*. An extraneous cap seen on the fascicle of an American species (Lewis, 1975*a* : 511) may have been acquired during plant feeding, and a similar cap was seen on a female of *S. gemmea* from the Gunong Besout area. Sandflies have been reported to feed on caterpillars (Howlett, 1909 : 240), and two females to bite a large moth in Africa (Kirk & Lewis, 1940 : 632; Quate, 1964 : 233; W. Ruttledge, 1965, verbal communication). *S. bailyi*, as noted below, may bite insects.

Vertebrate blood is usually taken by females but the male of *P. argentipes* can suck blood from a puncture wound (Smith, 1959 : 19) and, as noted above, has been taken with biting females in India.

It is well known that many species of *Phlebotomus* bite mammals, and that at least some species of *Sergentomyia* attack lizards or other cold-blooded animals, some feed from amphibia and some from birds. Some mammal-biters feed from a range of species. Certain mammal-biters occasionally bite lizards, and vice versa, and a few African species of *Sergentomyia* sometimes attack man. One American sandfly which normally feeds on wild mammals occasionally bites man, apparently when its normal host is absent (Lewis, 1974*a* : 377), and this type of behaviour may account for some of the records of Oriental *Sergentomyia* biting man.

P. papatasi and *P. sergenti* feed on man in many parts of the Old World. George (1970) showed that the former is primarily anthropophilic in the Lahore and Peshawar areas but can also feed on birds, bovines, dogs and equines, and that *P. sergenti* can feed on birds, bovines and man. Around Aurangabad, Dhanda & Modi (1971 : 1568) showed that most *P. papatasi* fed on man, and a few on cattle, dogs and birds, and Pandyia *et al.* (1972) reported it biting cattle.

With regard to *P. argentipes* in India, Lloyd *et al.* (1925) reported that around Calcutta it bit cattle mainly, and man occasionally, and Napier & Smith (1926) considered that it fed mainly on man and cattle. Lloyd & Napier (1930) observed that *P. argentipes* fed almost entirely on man and cattle. Controversy then developed (Shortt, 1931*a* : 1047–1049; 1931*b*; Napier, 1931) concerning identification of sandflies and the reliability of blood-identification methods. *P. argentipes* in the laboratory was found to be able to bite mice and rabbits (Kala-azar Commission, 1932) and chickens (Bhattacharya *et al.*, 1951). It has been taken on a pony (noted under Distribution). Dogs are unattractive to *P. argentipes* according to Smith (1959 : 19), and Garnham (1965 : 145) discussed the freedom of Indian dogs from *L. donovani* in this connection. Dhanda & Modi (1971 : 1568) found that *P. argentipes* in the Aurangabad area bit cattle mainly and man to some extent, and Pandiya *et al.* (1972) reported that it bit cattle in Gujarat. Man-biting by this species in rural India, where man and cattle are often closely associated, resembles the habits of *P. longipes* Parrot & Martin in Ethiopia (Foster *et al.*, 1972 : 440).

In Bengal, Das & Mukherjee (1969*b*) considered that *P. argentipes* had become more zoophilic than before. Bray (1974 : 73) suggested that either it had been diverted to cattle by irritability to anti-malarial DDT in houses, or that it was a complex containing an anthropophilic form which had been controlled. Sen Gupta (1975) reported that, although about 1960 laboratory-reared sandflies would very rarely feed on man, females with human blood had recently been found in living rooms. It may be that for some years *P. argentipes* had undergone a change like that which overtook a mosquito of the Solomon Islands (Taylor, 1975 : 287).

In Sri Lanka *P. argentipes* occurs in cow sheds but does not seem to bite man readily (Lewis & Killick-Kendrick, 1973).

In West Malaysia *P. argentipes* has been found on cattle and attacking human bait (Lewis, 1957 : 166). Lewis & Wharton (1963) reported that it fed on cows but had rarely been found biting man.

P. kiangsuensis can bite man out of doors in West Malaysia and may perhaps attack bats (Lewis & Wharton, 1963 : 120, 124).

Tang & Maa (1945) found that *P. hoeppli* was attracted to human bait and probably bit man.

Raynal (1936*a* : 360) found that *P. stantoni* fed on mammals, probably rodents, and Parrot & Clastrier (1952 : 153) suggested that it might bite man.

P. betisi bit man in a West Malaysian cave but might normally feed on bats (Lewis & Wharton, 1963 : 118, 123, 124).

Species of subgenus *Idiophlebotomus* probably feed on bats (Lewis & Lane, 1976).

With regard to *Sergentomyia*, early reports of '*P. minutus*' probably refer to *S. babu* or other species, but are of some limited interest. Howlett (1913) reported that at Pusa *P. minutus* fed on geckos and bit man in summer. Lloyd & Napier (1930) recorded a considerable proportion of *P. minutus* biting man, but Shortt (1931*a*) questioned the methods of identifying flies and blood meals. Napier (1931) insisted that some '*P. minutus*' could bite man in Calcutta, specially *babu* and *shorttii*. Shortt (1931*b*) commented briefly on the precipitin test, and (1932*b*) reproduced his 1931*a* paper. Mitra (1956 : 234) found that two species, probably *S. babu* and *S. bailyi*, bit man readily in the laboratory.

S. punjabensis has been taken on or near animal bait without actually being seen to bite (Lewis, 1967 : 50), and Pandiya *et al.* (1972) reported this and a related species biting cattle.

S. babu attacks geckos in India and was said to bite man in Mauritius (Adler & Theodor, 1957), but Theodor (1965, in letter) informed me that the man-biting in Mauritius was recorded on an old label and needed checking. *S. babu* can bite birds in Pakistan (George, 1970).

S. baghdadis has been found on or near animal bait in Pakistan (Lewis, 1957 : 50), and one female examined by George (1970) had fed on man.

Raynal (1936*a* : 366) found that a female of *S. barraudi* in Tonkin had fed on man.

S. shorttii bit geckos in a cage in India, taking up to 20 minutes or more to feed (Shortt & Swaminath, 1931 : 544), and was said by Napier (1931) to be able to bite man.

The normal host of *S. indica* is unknown but, to judge from an observation on *S. squamipleuris* in Africa (Kirk & Lewis, 1951), it may well be the species seen by Howlett (1909 : 240) to bite frogs.

The above-mentioned capture of *S. gemmea* in a monkey-baited trap may have been due to attraction. *S. gombaki*, in the Gunong Besout area of West Malaysia, fed to repletion on the face, hand and foot of collectors, in camp or near a tree hole, and appeared to be often attracted to people, and in the same area *S. iyengari* was taken in a trap baited with leaf monkeys (Knudsen *et al.*, 1978). *S. malayae* has been found on or near animal bait, recorded by Lewis (1957 : 165) as *S. zeylanica* which has bitten man in an Indian jungle (Sinton, 1928*c* : 320).

S. bailyi was found to have bitten fowls in Indo-China (Raynal, 1936*a*; 1936*b*). A female of this species, posted on 26.vii.1962 by the entomologist of the Department of Agriculture, Dacca, to the Commonwealth Institute of Entomology, was stated to have come from the larva of a grain moth, *Sitotroga cerealella* (Olivier). The ovaries were partly developed and the midgut contained an inner peritrophic membrane and a large mass of cells of unknown origin, each about 2 μm long, with a large nucleus, and visible in Berlese's medium.

Banks (1919*b*) collected *S. nicnic* in one place in the Philippines where it was abundant at

times, was attracted to lights, attacked man persistently and gorged slowly. Quate & Rosario (1962) questioned this account of biting but Quate (1965 : 28) reported it biting man.

S. reidi and *S. traubi* have been taken on or near mammal bait (Lewis, 1957 : 165). *S. clydei*, known to bite mammals in Africa, has, as noted above, once been taken on human bait in India.

Seasonal prevalence

In temperate climates some species of sandflies emerge from winter diapause and pass through one or two annual generations which determine their seasonal incidence. In the tropics seasonal occurrence seems to depend on specific biology and local conditions. Some species occur throughout the year. Some flourish in the dry season when breeding places are not flooded. Others are numerous in the rains, when high humidity may favour the adults and larvae of woodland species.

Existing knowledge of seasonal changes in the Orient is summarized below, and seems to reflect the gradual transition from temperate to tropical conditions.

In Lahore, Pakistan, Nasir (1958) found sandflies from February to November, and George (1970) noted a sharp decline in October and November. Dhanda & Modi (1971 : 1567, 1569) pointed out that in Pakistan sandflies tend to vanish in winter and to appear in March and become numerous in April and in the damp month of August, whereas in peninsular India they persist in the milder winter in Aurangabad (Deccan) and Poona districts; around Aurangabad sandflies were abundant throughout most of the year, were most numerous when the monsoon began in June and diminished in December. At Pusa, in Bihar State, Howlett (1909) noted that sandflies were common in late September and early October. Smith (1959 : 17) reported that in north-east India sandflies might vanish in the winter in December and January, and diminish again in midsummer, being numerous after the monsoon, from August to October; in south India numbers were lowest in hot dry months. In Indo-China sandflies were rare in the colder part of the winter from January to March (Raynal, 1936*a* : 353), and at Phnom Penh in Cambodia various species seemed to disappear in winter (Parrot & Clastrier, 1952).

Around Pusa Howlett (1915) observed that larvae of *P. papatasi* which hatched at the start of the cold weather pupated in late February or early March according to temperature, and Craighead & Das (1928) reported that the species increased somewhat in the rains. In north Bengal it was common in April (Brunetti, 1920). In Poona district *P. papatasi* was common throughout the year (Mitra, 1956), and in Bombay City seemed to diminish in the rains (Young, 1927).

Mitra (1959) reported *P. sergenti* from March to October in Punch and Riasi. Sinton (1924*f*) encountered sandflies in Indo-Pakistan in summer, mainly in the less hot period, and found *P. major* in the hills in summer.

At Gauhati in Assam adults of *P. argentipes* were rare from late December to early February but larvae could be found (Kala-azar Commission, 1932 : 155). Mitra (1955 : 82) saw it throughout the year in parts of Maharashtra State and (1956) noted that it was common all the year in Poona district. Sinton (1924*f*) reported that sandflies might occur all the year round in southern and eastern India, and that *P. argentipes* was common and could be found in most parts of the year all along the coast from Bengal to Sri Lanka. Brunetti (1912) recorded it throughout the year at Calcutta, where Bhasu & Ghosh (1954*a*; 1955) found that it reached a peak in July and was least numerous in January.

In China, Tang & Maa (1945) found *P. hoepplii* from April to July and in September and October.

Around Pusa *S. indica* increased somewhat in the rains (Craighead & Das, 1928).

Raynal (1936*a* : 364, 366) reported that *S. barraudi*, an upland species in Indo-China, disappeared from the northern lowlands in summer, and that in Annam *S. bailyi* occurred throughout the year but diminished in the cool weather.

Natural enemies

A number of parasites and predators have been reported by Bhattacharya & Biswas (1968), the Kala-azar Commission (1932 : 158), Lewis & Killick-Kendrick (1973), Lewis (1967), Mitra

(1956 : 234), Mitra & Mitra (1953), Mohan & Suri (1975), Napier & Smith (1926), Rathnaswamy & Rama Krishna (1954), Shortt & Swaminath (1931) and Subramaniam & Suri (1975). *Culicoides* have been found attached to *P. argentipes* according to Smith & Swaminath (1932 : 183) and Das Gupta (1964 : 6, 7).

Relation to disease

The effect of bites

P. papatasi is a very troublesome biter in parts of Pakistan, and has caused intolerable itching which could lead to secondary infection (Howlett, 1909 : 240; Sinton, 1924 : 1036; 1925*b* : 702).

Viruses

The following general summary is based on the work of Tesh & Chaniotis (1975), Tesh *et al.* (1975) and other authors mentioned below. Sandfly-borne viruses of vertebrates may have evolved from arthropod viruses, and belong to three distinct serogroups, vesicular stomatitis, phlebotomus fever and (American) Changuinola. Unlike most vertebrate arboviruses, they seem unable to produce a significant viraemia in infected animals or man. Most individual infected vertebrates are probably dead-end hosts, and the viruses are likely to be maintained by insect-to-insect transovarial transmission. Vesicular stomatitis virus infects a number of animals, including man. Chandipura virus, a member of this group, was first isolated from sick persons in India and has been recovered from wild sandflies there (Modi & Dhanda, 1972).

The phlebotomus fever group includes at least 25 serotypes with eight in the Old World (Tesh *et al.*, 1977*a*; 1977*b*); most have been recovered from sandflies, and at least five cause sandfly fever. Human involvement shows a parallel with leishmaniasis. In tropical America sporadic cases depend on contact with sylvan sandflies, and in the Middle East and Central Asia (and in North Africa, Perfil'ev, 1968) the vector (*P. papatasi*) is domestic. The view that other vectors exist (Mattingly, 1973 : 166) was probably partly based on incomplete knowledge of the distribution of *P. papatasi.*

With regard to the Oriental Region, Mitra (1954*b*) reported that sandfly fever in India was widespread during the warm months in the Punjab plains, Delhi, Uttar Pradesh, Bihar, Bengal, Madhya Pradesh and Bombay; in Punjab, Delhi and western Uttar Pradesh there were spring and autumn outbreaks related to multiplication of sandflies in hot, relatively damp, weather. Barnett (1962) isolated a number of viruses from several species of sandflies in Pakistan, and Lewis (1967) quoted other records from that country. George (1970 : 674, 676) found plebotomus fever in Pakistan and considered that an epidemic was likely to follow the cessation of malaria control. Rao (1975 : 1226) recorded both Sicilian and Naples strains from India. Goverdhan *et al.* (1976) isolated both of these from the Aurangabad area, mainly in June, and regarded *P. papatasi* as the main vector of both forms. They demonstrated a problem previously encountered in Pakistan, that the success of a virus survey depends largely on fluctuating prevalence of the virus.

The sandflies from Gunong Besout Forest Reserve in West Malaysia recorded in Table 3 were part of a collection made during a search for viruses by A. B. Knudsen and R. B. Tesh (1977, in letter) and their colleagues. Altogether 14 636 flies (5308 of them females) were processed but without result. Nearly all the sandflies identified were species of *Sergentomyia.* The survey contributes to the world picture of phlebotomus fever virus by suggesting that flies of this genus play no significant part in the epidemiology, despite reports of a few isolations from *Sergentomyia* elsewhere. Comparable results were obtained by Tesh (1977, in letter) who processed 2500 female and male sandflies from Taiwan where, as in most of the Old World tropics, species of *Sergentomyia* outnumber those of *Phlebotomus.*

Dermal leishmaniasis

The following summary of dermal, and that of visceral, leishmaniasis is based largely on the work of Adler & Theodor (1957), Garnham (1973) and Napier (1946).

Dermal leishmaniasis, generally known as Oriental sore in the Old World, and sometimes locally as Delhi boil or Lahore sore, is caused by the trypanosomatid protozoan parasite *Leishmania tropica* (Wright, 1903). *Le. t. major* Yakimov (1915) is the parasite of rural zoonotic moist dermal leishmaniasis in the U.S.S.R., and *Le. t. minor* Yakimov (1915) causes the urban anthroponotic dry form. In the Indian subcontinent the dry form is generally prevalent (Sen Gupta, 1968). It occurred over the western and drier parts of the Indo-Gangetic plain and was endemic in Pakistan. It existed down the west coast of India as far as Cambay, and east as far as Delhi, and Sinton (1925*b*) regarded the Bombay–Tashkent line as the eastern limit. In an epidemic in Delhi in 1940 there were some 20 000 cases (Sharma *et al.*, 1973*c*). Farooq & Qutubuddin (1945) and Sen Gupta (1967) gave further details of distribution.

P. papatasi is a well-known vector of *Le. tropica* in the Old World. Sinton (1924*b*) pointed out that it was much more widespread than the disease in Indo-Pakistan, but Sen Gupta (1967) considered that it was the principal vector. Sinton (1922 : 579; 1925*b* : 716, 717) compared the distribution of Oriental sore with that of *P. sergenti*, and Sinton & Shortt (1934) noted their coexistence, with *P. papatasi*, in Karnal. Mitra (1934*b* : 311) considered the question of vectors to be undecided, Sen Gupta (1968) thought *P. sergenti* played some part in transmission, and Sharma *et al.* (1973*c* : 69) believed that *P. sergenti* might be the main vector, with *P. papatasi* playing some part.

Sen Gupta (1968) mentioned that *S. christophersi* had been suspected as a vector, but there seems to be no evidence for this, or even for it biting man. On the basis of this report, however, the species has been quoted as a habitual vector in a recent paper on North Africa.

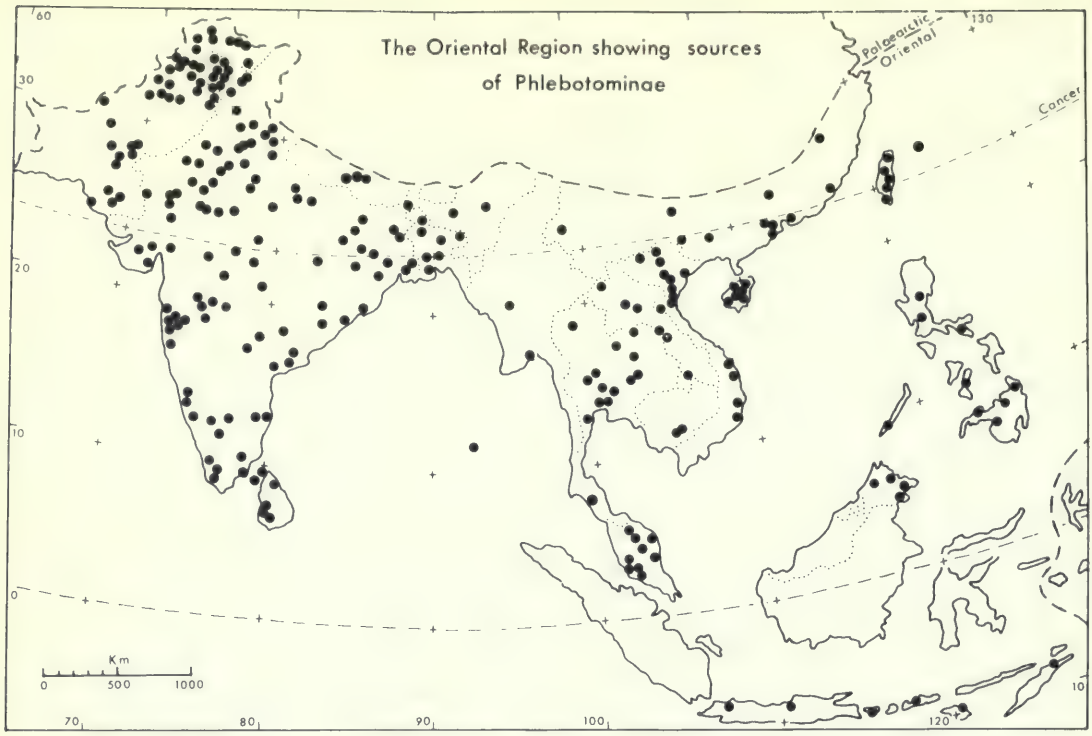
No animal reservoir was known for a long time (Mitra, 1954*b*), and Garnham (1965 : 146) felt that this extremely common disease had practically ceased to be a zoonosis in India, but Sen Gupta (1968) thought one might exist. Now there is strong evidence of a gerbil reservoir (Sharma *et al.*, 1973*b*), and the probable vector among the animals (Kalra & Lewis, 1976) is *P. salehi*. Mohan & Suri (1975) have isolated from it parasites which are probably *Le. tropica* and may be *Le. t. major*.

House spraying for malaria control made Oriental sore rare in Pakistan (Nasir, 1964). In parts of India spraying from 1958 onwards caused a transient disappearance for more than ten years, but an epidemic in Bikaner reached a peak in 1971 (Sharma *et al.*, 1973*a*; 1973*c*), and the disease has reappeared in several areas (Kaul *et al.*, 1976).

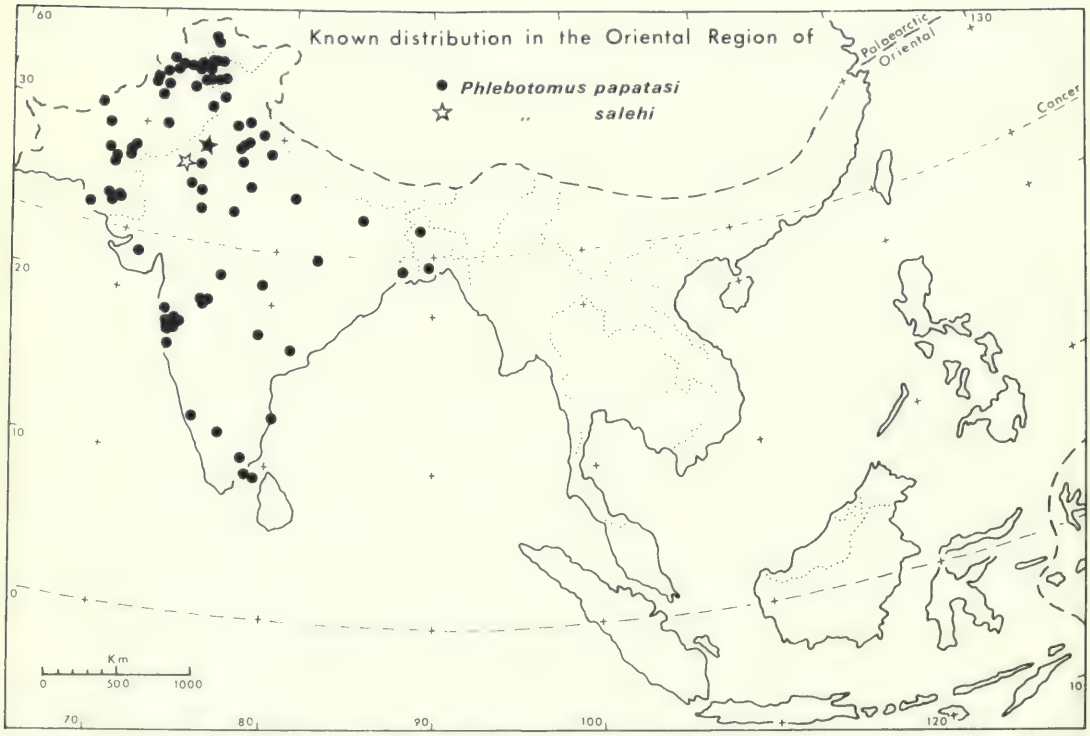
Visceral leishmaniasis

This disease, known as kala-azar, is caused by *Le. donovani* (Laveran & Mesnil, 1903), and India is one of the few countries with no known animal reservoir, though Adler (1964) believed the disease might have developed from a zoonosis and he and Garnham (1965) and Hoare (1955) thought that the infection might still be found in a wild animal. The name kala-azar, meaning black fever, came from the Garo Hills in India, where it referred to the appearance of victims. Before treatment was discovered about 75 per cent of patients died, mostly within two years. Sen Gupta (1968) reported a death rate of 90–95 per cent among infected people and a general mortality of over 25 per cent in some districts. The terror of this once-deadly disease caused many people to desert their villages (Manson-Bahr, 1946), and its severity and tendency to spread led to enormous loss of life, depopulation and failure of agriculture (Sen Gupta, 1967).

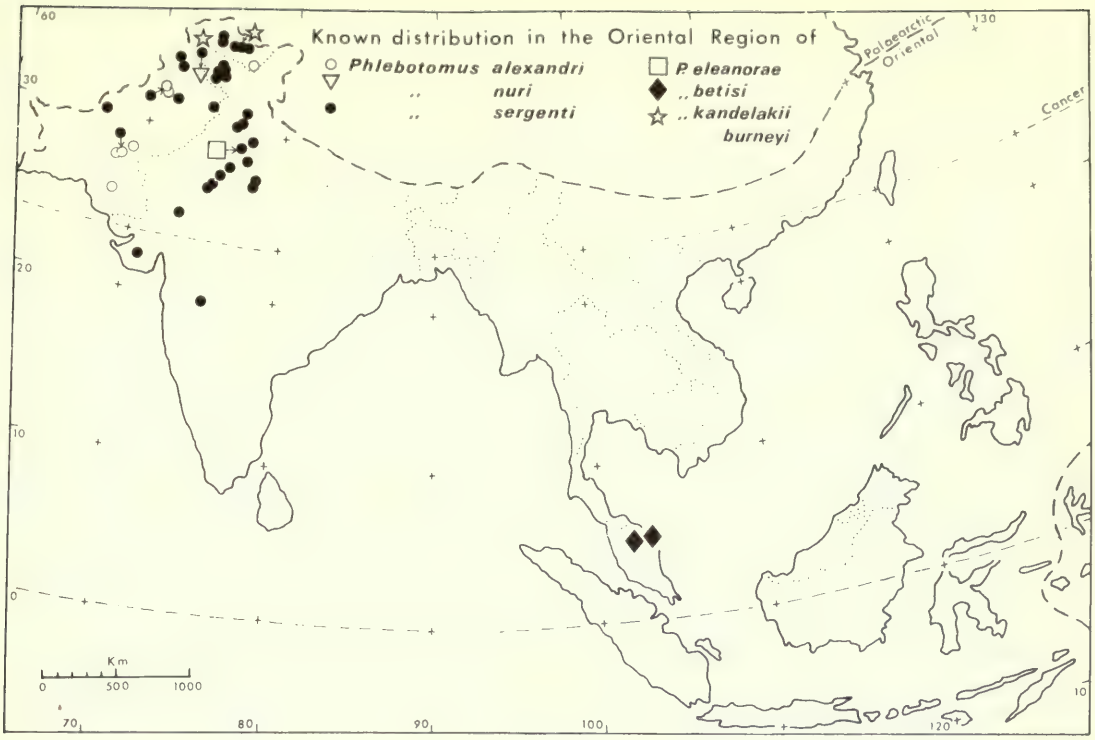
Several epidemics occurred in Bengal and were confused with malaria till treatment failed to prevent many deaths. Kala-azar attracted special attention when it began to invade Assam in 1875 with the development of communications (Sen Gupta, 1967*a*). Between then and 1917 it swept up the Brahmaputra valley in three distinct epidemic waves. There were epidemic periods of about ten years and inter-epidemic periods of 15–20 years (Shortt, 1945). Before 1946 the disease was known to be widely distributed in India but the epidemic areas were well defined (Napier, 1926 : 224). Infections occurred near Cape Cormorin and in Madras, and from there the coast was free till the Ganges delta. The plains of Bengal were heavily infected, and the endemic area extended along the Ganges plain into Bihar and to the eastern side of Uttar Pradesh as far as Lucknow. To the north-east, Assam was heavily infected as far as Sibsagar. Extensions


The Oriental Region showing sources
of Phlebotominae
Palaearctic
Oriental
Cancer
Km
0
500
1000
60
30
20
10
0
70
80
90
100
120
130

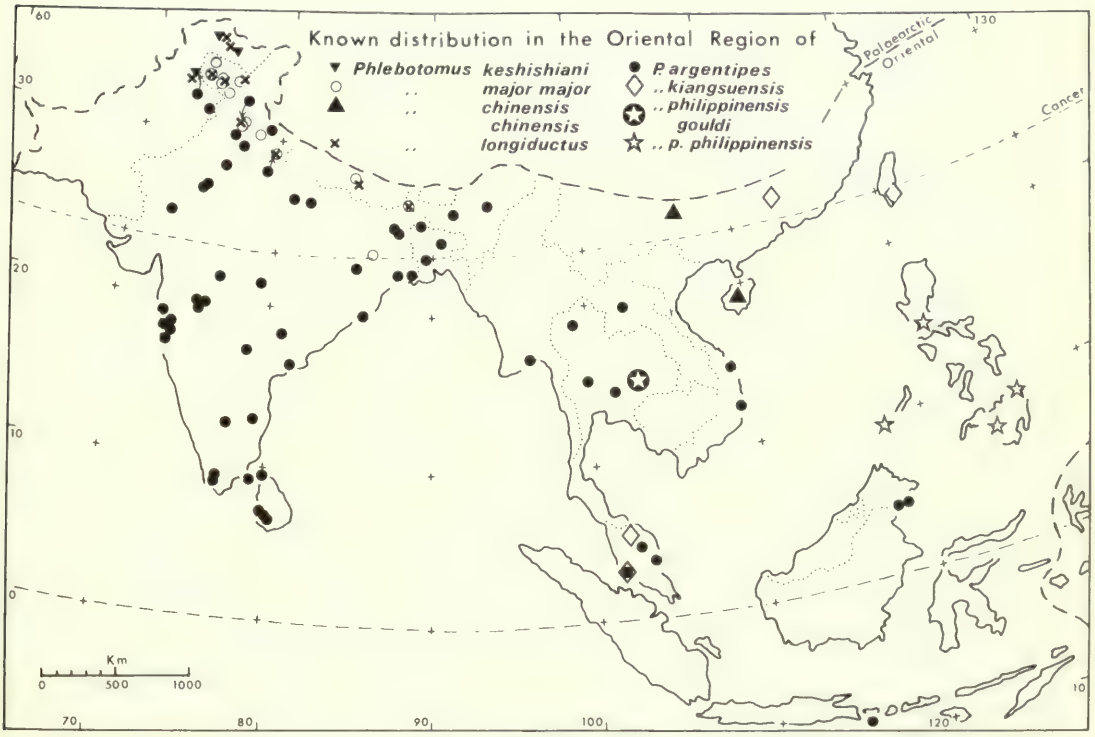
Map 1


Known distribution in the Oriental Region of
Phlebotomus papatasi
" salehi
Palaearctic
Oriental
Cancer
Km
0
500
1000
60
30
20
10
0
70
80
90
100
120
130

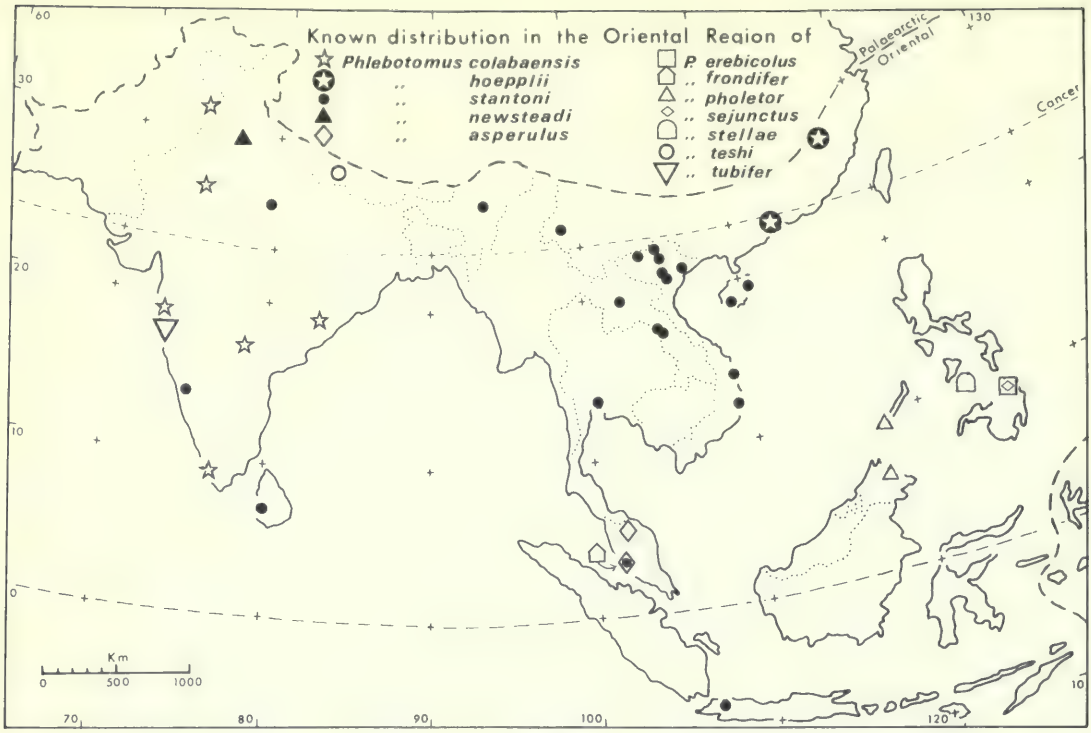
Map 2


Known distribution in the Oriental Region of
Phlebotomus alexandri
" nuri
" sergenti
P. eleanorae
" betisi
" kandelakii burneyi
Palearctic
Oriental
Cancer
Km
0 500 1000

Map 3


Known distribution in the Oriental Region of
Phlebotomus keshishiani
" major major
" chinensis chinensis
" longiductus
P. argentipes
" kiangsuensis
" philippinensis gouldi
" p. philippinensis
Palearctic
Oriental
Cancer
Km
0 500 1000

Map 4


Known distribution in the Oriental Region of
Phlebotomus colabaensis
" hoepplii
" stantoni
" newsteadi
" asperulus
P. erebicolus
" frondifer
" pholetor
" sejunctus
" stellae
" teshi
" tubifer
Palaearctic
Oriental
Cancer
Km
0 500 1000
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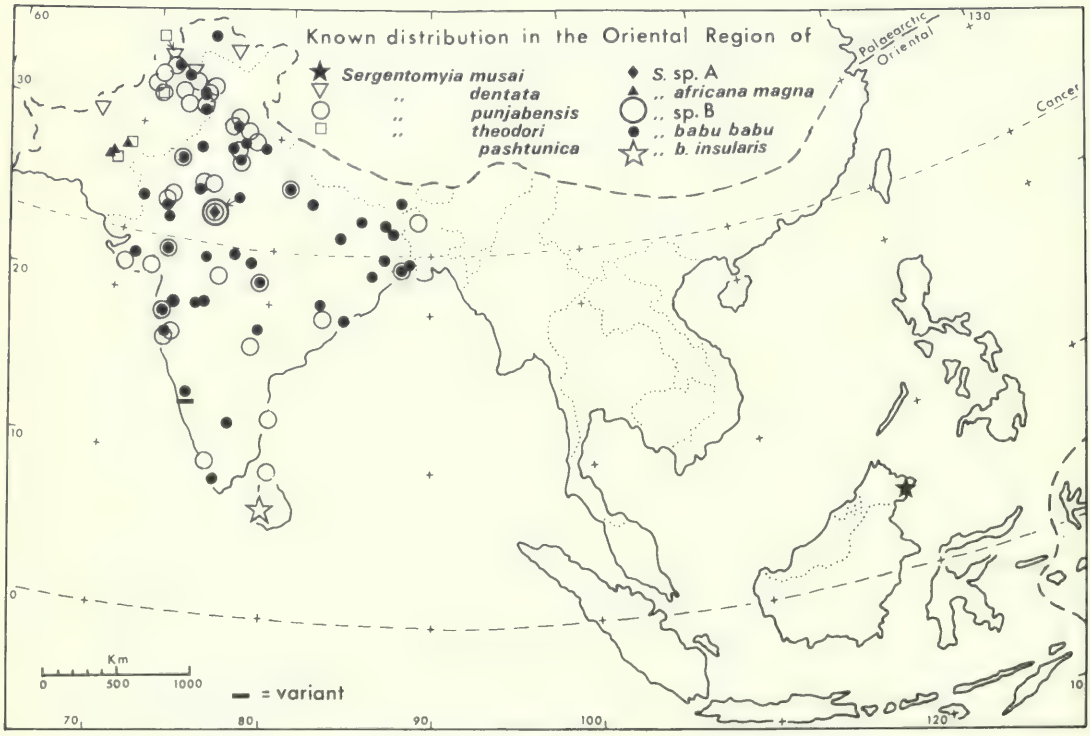
10
0
70
80
90
100
120
130

Map 5


Known distribution in the Oriental Region of
Sergentomyia musai
" dentata
" punjabensis
" theodori pashtunica
S. sp. A
" africana magna
" sp. B
" babu babu
" b. insularis
Palaearctic
Oriental
Cancer
Km
0 500 1000
= variant
60
30
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10
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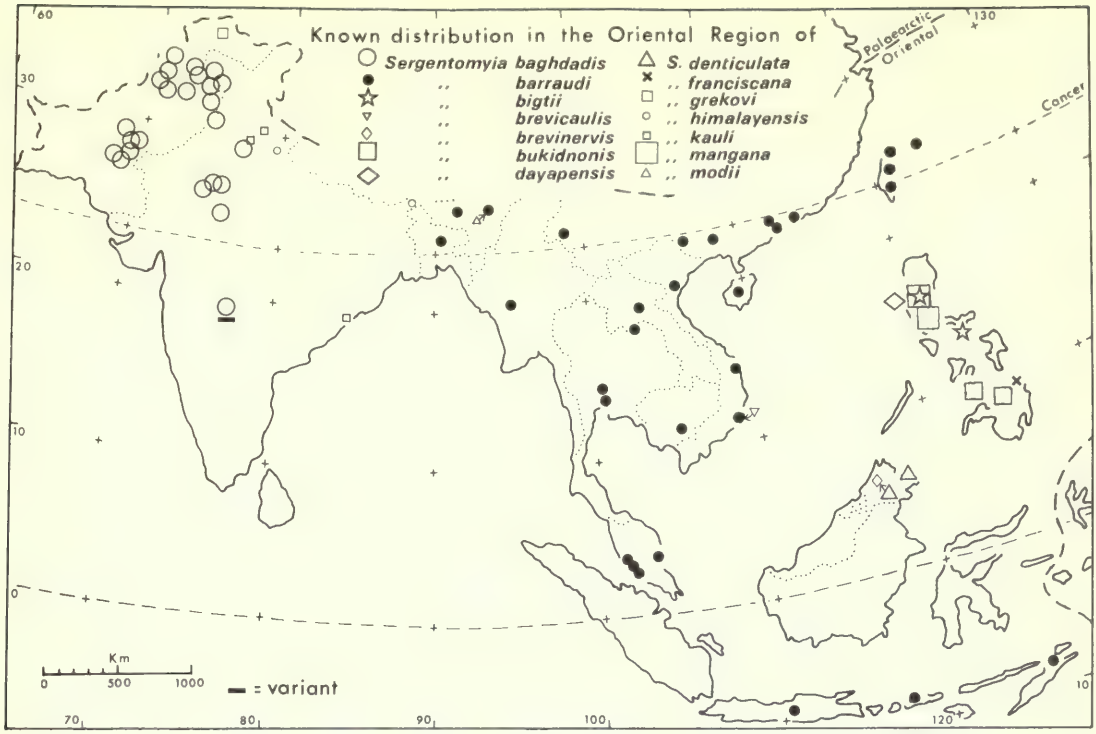
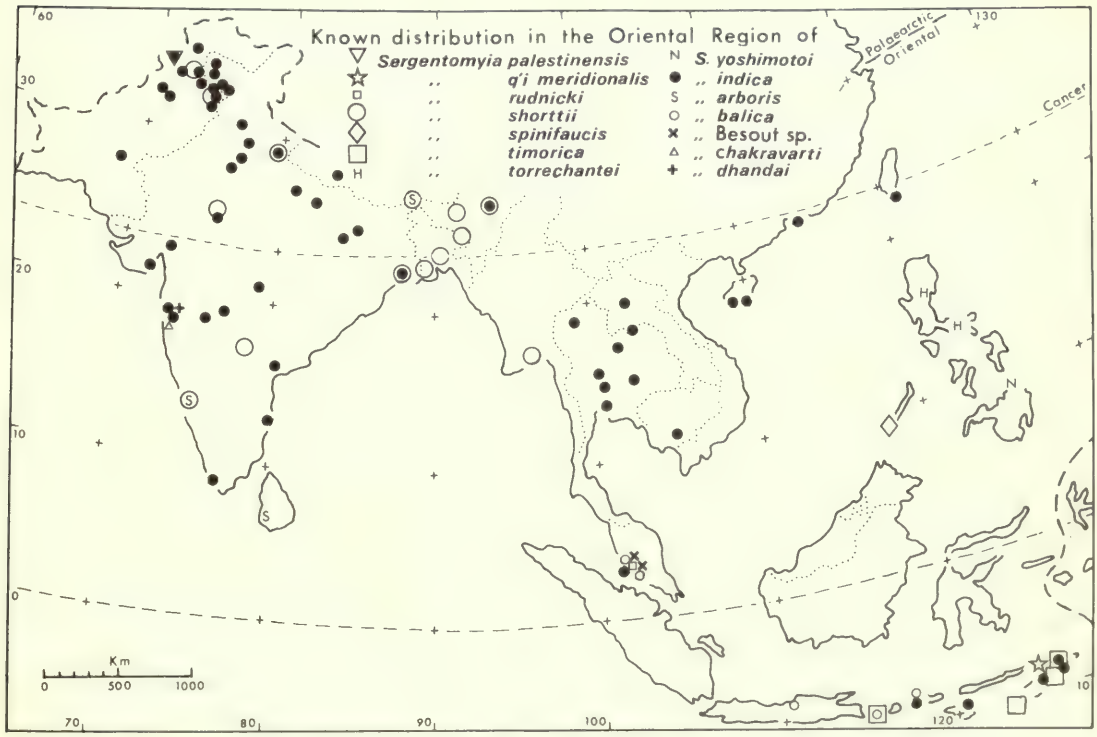
90
100
120
130

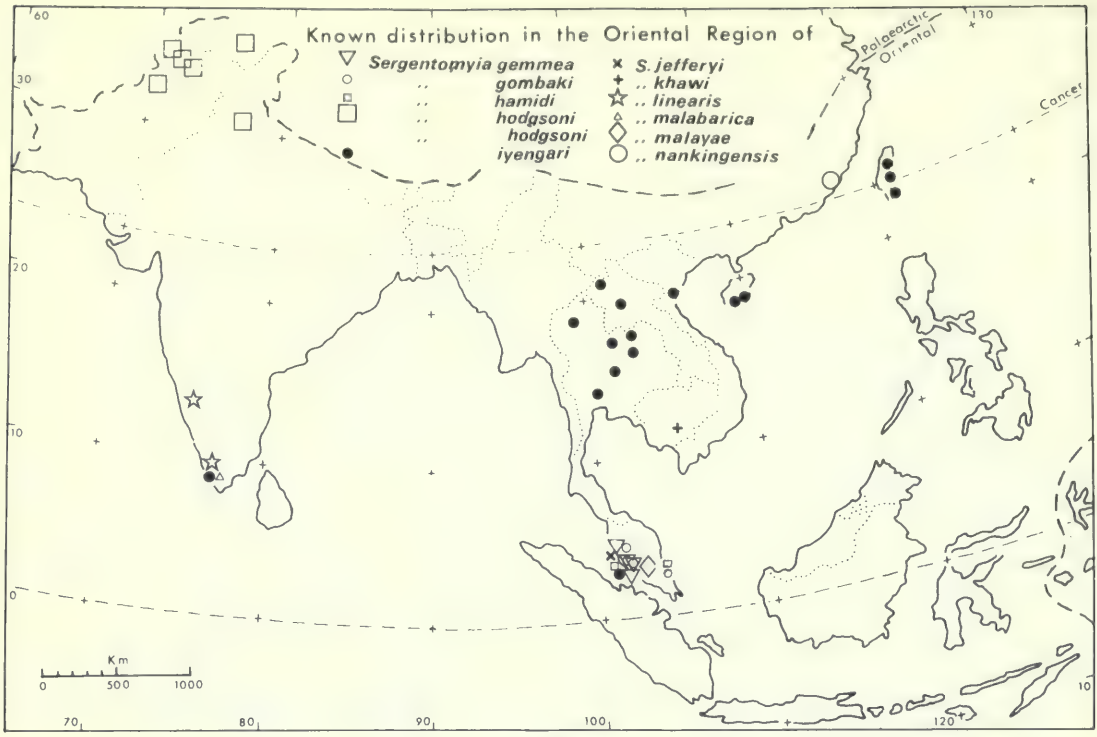
Map 6


Known distribution in the Oriental Region of
Sergentomyia baghdadis
,, barraudi
,, bigtii
,, brevicaulis
,, brevinervis
,, bukidnonis
,, dayapensis
S. denticulata
,, franciscana
,, grekovi
,, himalayensis
,, kauli
,, mangana
,, modii
Palaearctic
Oriental
Cancer
Km
0 500 1000
= variant

Map 7


Known distribution in the Oriental Region of
Sergentomyia palestinensis
,, q'i meridionalis
,, rudnicki
,, shorttii
,, spinifaucis
,, timorica
,, torrechantei
S. yoshimotoi
,, indica
,, arboris
,, balica
,, Besout sp.
,, chakravarti
,, dhandai
Palaearctic
Oriental
Cancer
Km
0 500 1000

Map 8


Known distribution in the Oriental Region of
Sergentomyia gemmea
" gombaki
" hamidi
" hodgsoni
" hodgsoni iyengari
S. jefferyi
" khawi
" linearis
" malabarica
" malayae
" nankingensis
Palaearctic
Oriental
Cancer
Km
0
500
1000
60
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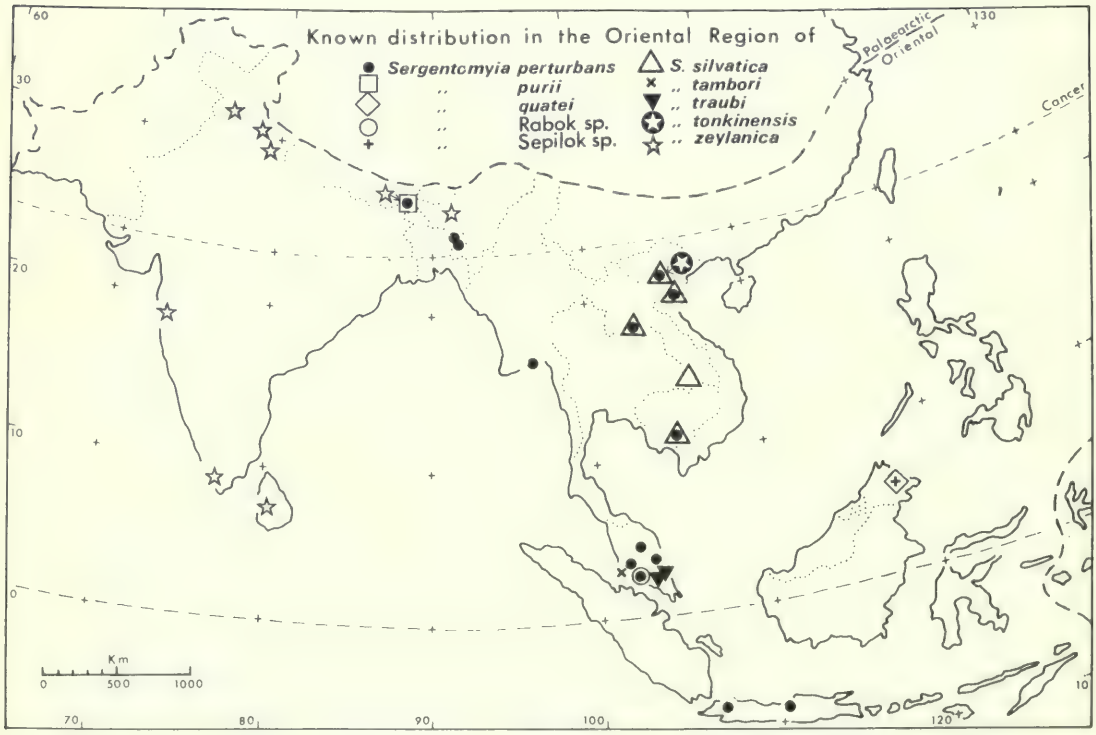
20
10
0
70
80
90
100
120
130
10

Map 9


Known distribution in the Oriental Region of
Sergentomyia perturbans
" purii
" quatei
" Rabok sp.
" Sepilok sp.
S. silvatica
" tambori
" traubi
" tonkinensis
" zeylanica
Palaearctic
Oriental
Cancer
Km
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500
1000
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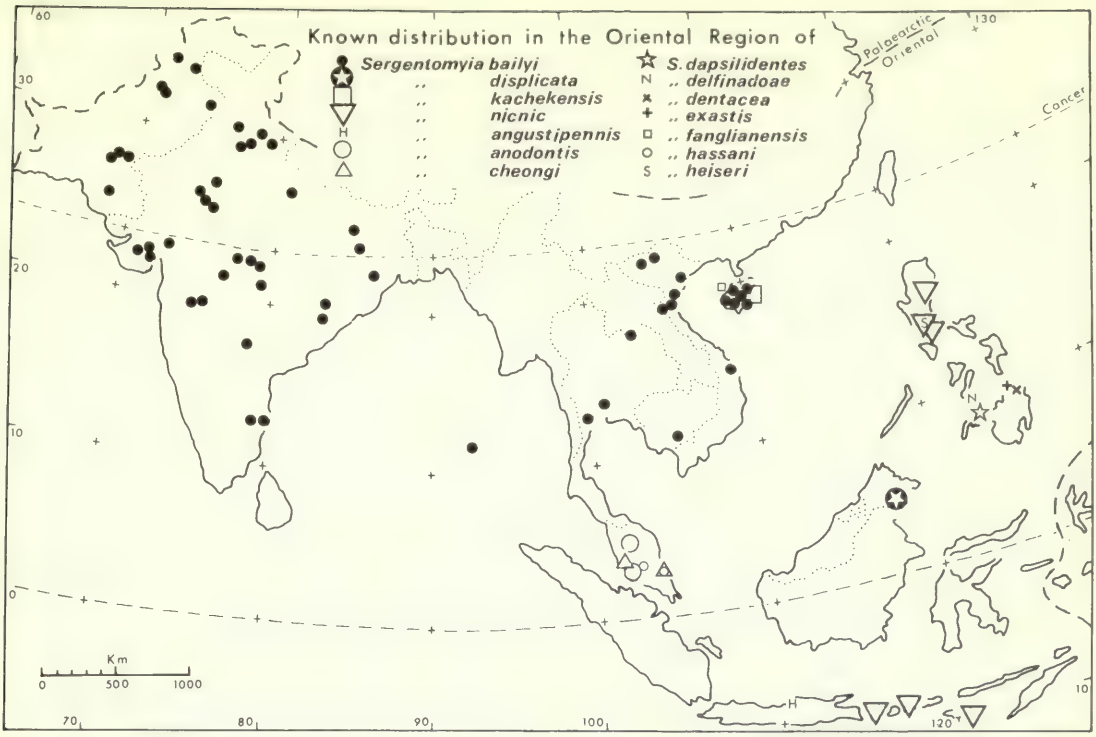
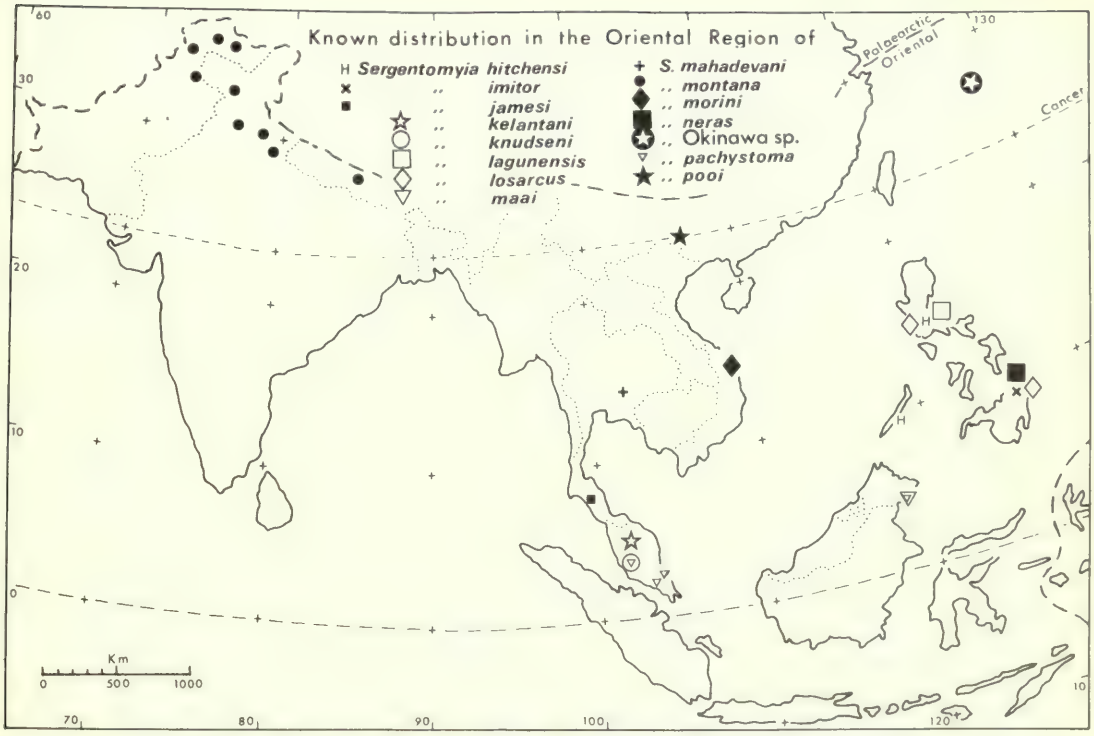
130
10

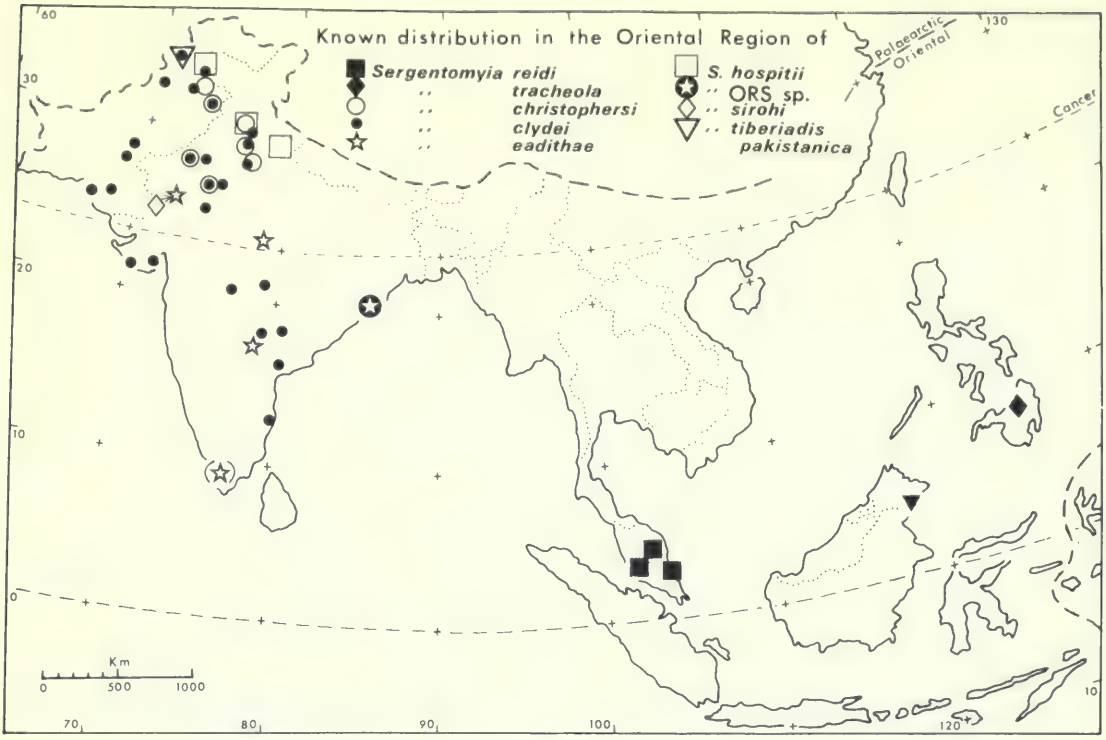
Map 10


Known distribution in the Oriental Region of
Sergentomyia bailyi
" displicata
" kachekensis
" nicnic
" angustipennis
" anodontis
" cheongi
S. dapsilidentes
N " delfinadoae
" dentacea
" exastis
" fanglianensis
" hassani
S " heiseri
Palaearctic
Oriental
Cancer
Km
0 500 1000

Map 11


Known distribution in the Oriental Region of
H Sergentomyia hitchensi
" imitor
" jamesi
" kelantani
" knudseni
" lagunensis
" losarcus
" maai
S. mahadevani
" montana
" morini
" neras
" Okinawa sp.
" pachystoma
" pooi
Palaearctic
Oriental
Cancer
Km
0 500 1000

Map 12



Map 13

from Bengal to the east were limited by mountains. The disease could occur in periodic epidemics or in epidemic invasions. Kala-azar was in general confined to rural areas below 610 m with an annual relative humidity of 70 per cent or more and a mean diurnal temperature range of 11 °C or less. In Bengal there were peaks about January and November. General distribution was described by Omran (1961), Shortt *et al.* (1928) and Sen Gupta (1968) who (1958) recorded an epidemic between 1940 and 1949.

Kala-azar was rare in the west (Gajwani *et al.*, 1967), but has appeared in Gujarat State, where it may have been introduced (Vaishnav *et al.*, 1970; Munshi *et al.*, 1972), and in Maharashtra and Rajasthan (Wattal, 1973).

The disease exists in the absence of *P. argentipes* in Kashmir and south China, probably as extensions of Palaearctic kala-azar. Jacob & Kalra (1951) reported it from Kashmir where *P. chinensis*, the Chinese vector, and *P. kandelakii* occur (Lewis, 1967), and south Chinese kala-azar was found after the war of 1937 (Omran, 1961).

There are records of kala-azar, often isolated or imported cases, from several other Oriental countries, in some of which *P. argentipes* is strongly zoophilic (Lewis, 1974*a* : 372): Bangladesh (WHO, 1968), Borneo, South Vietnam, Sumatra, Thailand, West Malaysia (American Geographical Society, 1954), Burma (Rangoon, Omran, 1961), China (Canton, Theodor, 1964; Che Kiang Province, WHO, 1968), Pakistan lowlands (Lewis, 1967), Sri Lanka (Castellani, 1904; Senadhira, 1967) and Taiwan (leishmaniasis, Drutz *et al.*, 1969).

With regard to transmission, Mackie (1915) urged that sandflies should be studied as possible vectors. Christophers (1926) pointed out that kala-azar was largely associated with alluvium, fairly heavy rainfall and the distribution (Sinton, 1925*b*) of *P. argentipes*. A heavy flagellate infection developed in about 25 per cent of flies fed on a kala-azar patient (Knowles *et al.*, 1924). Shortt *et al.* (1920) and Shortt (1932*a*) showed that the infection passed forward to the cibarium. It was later found that flies could be infected by people with post kala-azar dermal leishmaniasis. After nearly 40 years of investigation Smith *et al.* (1941) showed that many infected flies fed on

plant juices developed forward infections. Finally, Swaminath *et al.* (1942) transmitted the disease to volunteers. *P. argentipes* could be found throughout the year in Bengal and Assam but was most prevalent in and just after the monsoon. Cows seemed to attract the sandfly to dwellings but divert it from man to some extent.

A treatment campaign in 1922 had preventive value, but residual cases made complete success impossible. Mass treatment reduced much transmission (Shortt, 1945) but did not prevent epidemics recurring (Sen Gupta, 1967, 1968), and even in 1937 there were many deaths (Ansari, 1962). After the last of these big epidemics ended in 1924 periodicity became disturbed, probably by insecticide campaigns (Theodor, 1964). In 1953 DDT began to be used in the Indian national malarial control programme (Das *et al.*, 1976), and declining incidence was further reduced (Sen Gupta, 1958), but when control had ceased in Bengal, Das & Mukherjee (1969*a*) and Sen Gupta (1973) realized the risk of some recrudescence, and Boreham (1975 : 89) suggested that houses should be sprayed specifically against sandflies. Tests have indicated that they are normally susceptible to insecticides (Basu & Ghosh, 1954*b*; Sen, 1959; Raghavan *et al.*, 1967). Sen Gupta (1975) reported that kala-azar, once reduced to a rarity, had increased in some areas and spread to new ones. He called for renewed residual spraying against both malaria vectors and sandflies, and indicated the possible value of spraying in the vicinity of infected people. Das *et al.* (1976) warned of the danger of a new outbreak. Seal (1977) considered that treatment, rather than DDT, had previously reduced kala-azar, and he reported an alarming increase and urged the study of direct transmission from man to man. According to available information (A. B. Chowdhury, 1978, in letter) about 70 000 cases of kala-azar, with about 4 000 deaths, were encountered in August 1977 in an area comprising the four districts of Bihar State, Muzzaffapur, Samastipur, Sitamarhi and Vaishali, and it was estimated that 30 000 more cases might exist in other districts. Large-scale spraying and treatment were evidently needed to prevent the cases increasing to 200 000 and to end the outbreak (Anonymous, 1977).

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Invalid names are in *italics*. Principal references are in **bold**.

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