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A TAXONOMIC STUDY OF THE MALAYAN* GERRIDAE (HEMIPTERA : HETEROPTERA) WITH NOTES ON THEIR BIOLOGY AND DISTRIBUTION

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ABSTRACT. The Malayan Gerridae are monographed based mainly on the collections made by the authors. Of the total of 41 species recorded from Malaya, 4 species are being described elsewhere and are designated here without specific names. All the species are described and figured except *Stenobates biroi* which we have not collected. Keys to the genera and species are included. Notes on biology and distribution are also given. The Malayan gerrid fauna is both rich and varied and includes 18 genera, representing all six subfamilies of the Gerridae.

INTRODUCTION

The Gerridae are perhaps the best known of all aquatic Hemiptera in the world. Although they are extremely common in Malayan waters, very little is known about their taxonomy and biology. A preliminary survey, carried out in 1963, revealed a very rich and varied fauna, including several new species and a number of undescribed forms (Cheng, 1965a).

The literature on the Gerridae is quite voluminous and widely scattered. The most important taxonomic work for the Malayan region is that of Lundblad (1933). Esaki (1925 ; 1928 ; 1929 ; 1930) and Distant (1903) described several new and inadequately known species from Malaya. More recently contributions to the knowledge of Malayan Gerridae have been made by Hungerford and Matsuda (1958a ; 1958b ; 1958c ; 1960b ; 1962 ; 1965), Andersen (1964), Herring (1961) ; den Boer (1965) and Cheng (1965b ; 1965c ; 1966a). Fernando and Cheng (1963) briefly reviewed the family and gave a provisional key to the known genera. Detailed distributional records of the known species were given by Fernando and Cheng (in press). Records at light, on colonization. and dispersal of a few species were given by Fernando (1960 ; 1961 ; 1963a ; 1963b ; 1963c). Studies on the biology were given by Cheng (1966b ; 1966c).

MATERIAL AND METHODS

The material used in this study was collected mainly during the period 1960-1965. Some of the material was collected prior to this period by various members of the Department of Zoology, University of Singapore. Representative samples of the collection have been presented to the British Museum (Natural History), London, U. K. ; Muzium Negara, Kuala Lumpur, Malaysia ; Zoology

*The word Malayan in this paper refers to Malaya and Singapore.

Department, University of Malaya ; and the National Museum, Singapore. The rest of the material examined is in the Department of Zoology, University of Singapore.

The various collecting localities in Malaya and Singapore are shown in maps I and II. It will be noticed that the more northern states, the east coast, and the central region of Malaya are quite unexplored. This is due to the fact that these parts are less developed than the other parts of Malaya and are difficult of access. The gerrid and other insect fauna of these parts will certainly be of much interest.

The gerrids were collected by using an ordinary pond-net. They were killed immediately on collection in 70% alcohol, which was found to be a very good preservative.

All the drawings were made with a camera lucida. The colour patterns were drawn from entire specimens. The various parts of the insect were drawn after they were dissected out and mounted. All the measurements were made by using a micrometer eyepiece. Lengths of the insects were measured from the tip of the head to the tip of the abdomen and widths were measured at the widest part of the thorax ; the leg segments were measured from end to end ; so were the antennal segments. The small joints between the segments of the antenna were not included in the antennal segment measurements.

Taxonomy of Malayan Gerridae

The family Gerridae consists of six subfamilies, all of which are represented in Malaya. 18 genera and 41 species have been recorded so far from Malaya. It is quite certain that many species and even genera remain to be added to the present list and this study does not by any means include the complete gerrid fauna. The known genera and species of Malayan Gerridae are listed below :

Subfamily Gerrinae : *Limnogonus fossarum* (Fabr.), *L. nitidus* (Mayr), *L. parvulus* (Stål), **Limnogonus* sp.[1] (nr. *luctuosus* Montr.) ; *Tenagogonus pravipes* (Bergroth); *Limnometra anadyomene* (Kirk.), *L. insularis* Hung. & Mat., *L. femorata* Mayr, *L. octopunctata* Hung., *L. ciliata* Mayr ; *Amemboa* sp., *A. javanica* Lundblad, *A. horvathi* Esaki ; *Cylindrostethus costalis* Schmidt, *C. scrutator* (Kirk) ; *Gerris adelaides* Dohrn.

Subfamily Ptilomerinae : *Ptilomera lundbladi* Hung. & Mat. ; *Rheumatogonus intermedius* Hung. ; *Pleciobates tuberculatus* Esaki ; **Rhyacobates* sp.[2]

Subfamily Halobatinae : *Metrocoris nigrofaciatus* Distant, *M. tenuicornis* Esaki, *M. strangulator* Bredd. ; *Ventidius malayensis*, *V. chinai* Hung. & Mat.,

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[1] *Per com.* N.M. Andersen.

[2] *Species believed to be new but not yet described.

[3] *Per com.* S. Miyamoto.

V. pulai Cheng, *V. harrisoni* Cheng, *V. hungerfordi* Cheng, *V. pubescens* Cheng, *V. modulatus* Lundblad ; *Esakia fernandoi* Cheng, *E. johorensis* Cheng, *E. lundbladi* Cheng, *Esakia* sp.[3] ; *Halobates hayanus* White, *H. proavus* White, *H. germanus* White.

Subfamily Trepobatinae : *Cryptobates raja* (Dist.) ; †*Stenobates biroi* Esaki.

Subfamily Rhagadotarsinae : *Rhagadotarsus kraepelini* Bredd.

Subfamily Hermatobatinae : **Hermatobates* sp.[4]

Key to Genera of Malayan Gerridae

1. Front tarsus 3-segmented ; pronotum extremely short, meso- and metanota completely fused ... ... **Hermatobates**
   Front tarsus 2-segmented ; pronotum normal, meso- and metanota not fused ... **2**
2. Body comparatively long and thin ; inner margin of eyes concave **3**
   Body comparatively short and oval ; inner margin of eyes convex **12**
3. Middle and hind femora longer than the whole length of the body **4**
   Middle and hind femora shorter than the whole length of the body **7**
4. Hind tarsus fused ; over 1.5 cm in body length ... ... **Ptilomera**
   Hind tarsus not fused ; less than 1.5 cm in body length **5**
5. First antennal segment shorter than the three others together ; anterior margin of head rounded ... ... **Rheumatogonus**
   First antennal segment longer than the three others together ; anterior margin of head not rounded **6**
6. Second antennal segment equal to or slightly shorter than the third ; middle and hind tibiae lined with short hairs ; female 7th abdominal segment without spinous process ... ... **Rhyacobates**
   Second antennal segment distinctly shorter than the third ; middle tibia lined with long hairs, hind tibia not haired ; female 7th abdominal segment with long, thin spinous process ... ... **Pleciobates**
7. Metacetabula suture reaching intersegmental suture between meso- and metanota ... ... **Cylindrostethus**
   Metacetabula suture not reaching intersegmental suture **8**
8. Hind coxae distinctly longer than wide ; pronotum not prolonged posteriorly **Amemboa**
   Hind coxae shorter than wide ; pronotum prolonged **9**
9. Pronotum with black median longitudinal stripe **10**
   Pronotum with yellow median longitudinal stripe **11**
10. Connexival spines well developed ... ... **Limnometra**
    Connexival spines not distinct ... ... **Tenagogonus**
11. Hind tibia at least 4 times as long as the first tarsal segment ; first antennal segment shorter than segments 2+3 ... ... **Gerris**
    Hind tibia not so proportioned ; first antennal segment equal or longer than segments 2+3 ... ... **Limnogonus**

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[3]L. Cheng.

[4]*Per com.* J.L. Herring. A short account on the biology was given by Cheng (1967).

†Species recorded in literature but not available for study.

12. First abdominal ventrite present ; posterior end of abdomen produced to a spine-like point ... ... Rhagadotarsus
First abdominal ventrite absent ; posterior end of abdomen not produced to a spine-like point 13
13. Third antennal segment more than twice as long as the second ; distinctly longer than the first ; first and second abdominal tergites completely absent ... Cryptobates
Third antennal segment not so proportioned ; first and second abdominal tergites present 14
14. Front tibia strongly flattened apically ; omphalium conspicuous ... ... Stenobates
Front tibia not flattened ; omphalium if present not conspicuous 15
15. Anterior margin of head not smoothly rounded ; marine forms ... ... Halobates
Anterior margin of head broadly rounded ; freshwater forms 16
16. Lateral suture of metanotum reaching intersegmental suture between meso- and metanota ; male third antennal segment expanded with stiff hairs on margin ... ... Esakia
Lateral suture not reaching intersegmental suture ; male third antennal segment not modified 17
17. Eyes extending beyond antero-lateral angles of mesonotum ... ... Ventidius
Eyes not extending beyond antero-lateral angles of mesonotum ; thorax with beautiful yellow and black markings ... ... Metrocoris

Genus Limnogonus Stål

This genus first described by Stål (1868) is represented in Malaya by three species which can be separated using the following key :—

1. A large round or quadrangular yellow spot on pronotum ... ... parvulus
Two short longitudinal lines on anterior lobe of pronotum 2
2. Posterior lobe of pronotum with a longitudinal yellow line ... ... fossarum
Posterior lobe of pronotum without such a line ... ... nitidus

L. parvulus was treated as a species of the subgenus *Limnogonellus* (Hungerford and Matsuda, 1959), but in this paper the older name is used.

1. Limnogonus fossarum (Fabr.) (Figs. 1-12)

Series studied : 9 ♂♂ (3 winged), 15 ♀♀ (5 winged) from fish pond at Batu Berendam, Malacca, 1.xi.1964.

Other material examined (Number of collections in brackets) : Singapore (17), Johore (35), Malacca (10), Pahang (6), Selangor (5), Perak (5), Negri Sembilan (4), Penang (2), Province Wellesley (1).

Apterous male : *Length 8.40-9.20, width 2.67-2.93. Dark brown in ground colour with black markings ; head protruding well beyond eyes, with a broad central and two narrow lateral black stripes ; anterior lobe of pronotum with 2 yellow spots, one on each side of the median longitudinal line (Fig. 1) ; venter largely white with central brown patch at mesosternum. Antenna brown, segments 1-4 of the specimen examined measure 2.07,1.30,1.30 and 1.27 ;

*All measurements in mm unless otherwise mentioned.

rostrum surpassing posterior margin of prosternum ; front leg (Fig. 2) light brown, femur with dark brown longitudinal stripe and small apical spine at distal end, tibia shorter and narrower than femur, tarsal claws arising at apical 1/3 of 2nd tarsal segment (Fig. 3) ; middle leg with femur and tibia light brown and armed with spines, tarsus dark brown to black ; hind leg light brown, femur and tibia armed with spines, tarsus dark brown. Measurements of leg segments (femur, tibia, tarsus 1, tarsus 2) : front leg 2.93, 2.47, 0.33, 0.60 ; middle leg 7.60, 6.53, 2.93, 0.60 ; hind leg 8.13, 4.80, 1.13, 0.47.

Apterous female : Length 9.07-9.73, breadth 3.07-3.33. Colour pattern and general body structure similar to the male but broader (Figs. 11 & 12). Antennal segments 1-4 measure 1.97, 1.20, 1.20, 1.50. Measurements of leg segments : front leg 2.80, 2.47, 0.37, 0.53 ; middle leg 7.60, 6.93, 3.27, 0.63 ; hind leg 7.73, 4.93, 1.10, 0.43.

Winged male : Length 9.33-10.0, width 2.93-3.33. Colour pattern and body structures similar to the apterous male. Wings dark brown, extending beyond tip of abdomen (Fig. 6 and 7).

Winged female : Length 10.0-11.3, width 2.93-3.33. Colour pattern similar to winged male (Fig. 5).

Biology : Eggs average 1.10-1.20 x 0.33-0.37 ; white, opaque, with bluntly rounded ends (Fig. 4). Nymphs are similar to adults in colour pattern except pronotum lacking pale spots.

This is the commonest and most widespread of Malayan gerrids frequenting fish-ponds, freshwater reservoirs, lakes, roadside pools, slow-flowing streams, all sorts of temporary habitats, and even brackish waters. It is, however, absent in the fast-flowing streams.

Winged forms are as common as wingless in this species, which explains its success in colonising temporary habitats. Its habitat range also includes sulphur pools and hot springs (Lundblad, 1933), and brackish waters (Dover, 1929). Records at light were given by Fernando (1961) and Distant (1903). Life history studies of this species were made by Hoffmann (1936a). Studies on feeding were made by Cheng (1966b).

2. Limnogonus nitidus (Mayr) (Figs. 13-25)

Series studied : 4♂♂ (all winged), 4♀♀ (all winged) from pool in Rambutan Estate, Padang Maidin, Kuala Trengganu, Trengganu, 30.x.1964.

Other material examined : Singapore (1), Negri Sembilan (1), Trengganu (1).

Winged male : Length 6.13-6.40 ; width, 1.53-1.60. Base of head greatly expanded, anterior tip pointed and projecting well beyond eyes ; anterior lobe of pronotum with 2 white dots, posterior lobe black with slightly pointed posterior margin (Fig. 13) ; body largely pale with dark brown to black margins (Fig. 20) ; venter white with lateral black dots and brown patches on sides of the abdominal segments 2 to 7 (Fig. 21). Antenna with first 2 segments brown, the other 2 dark brown ; segments 1-4 measure 1.20, 0.77, 0.87, 1.20. Rostrum reaching anterior 1/5

of mesosternum; front leg pale brown, femur stouter than tibia with few black spines at base, tarsus with claws at apical 1/3 of second segment (Fig. 14); middle leg brown with femur and tibia armed with spines, 1st tarsal segment more than 3 times as long as 2nd; hind leg light brown, tarsus dark brown. Measurements of leg segment: front leg 1.77, 1.63, 0.17, 0.27; middle leg 4.20, 3.87, 1.40, 0.43; hind leg 4.40, 2.50, 0.43, 0.27. Wings extending slightly beyond tip of abdomen; fore wings dark brown with narrow embolium, haired (Fig. 17); hind wings extremely thin and transparent with large anal lobe.

Winged female: Length 8.40-9.47. width 2.00-2.24. Similar to male in colour pattern and general structure but much larger; connexival spines black and almost reaching tip of abdomen (Figs. 22 and 23); antennal segments 1-4 measure 1.47, 0.97, 1.03, 1.47. Measurements of leg segments: front leg 2.20, 1.93, 0.23, 0.37; middle leg 5.53, 5.00, 2.00, 0.52; hind leg 5.73, 3.67, 0.67, 0.37.

Apterous male: length 6.27, width 1.60. Similar to winged male in general body structure; abdomen dark brown with lateral margins of connexiva white; connexival spines shorter and only reaching middle of 8th abdominal segment (Figs. 18 and 19).

Biology: Eggs (Fig. 16) average 0.90-1.00 × 0.30-0.40. Similar to those of *L. fossarum*.

This is the least common of *Limnogonus* spp. in Malaya, occurring only in rice fields and temporary pools. It has been collected from similar habitats in Ceylon (Fernando, 1959), and Indonesia (Lundblad, 1933). Fernando (1960) reported *L. nitidus* at light in Ceylon.

3. Limnogonus parvulus (Stål) (Figs. 24-33)

Series studied: 10 ♂♂ (4 winged), 10 ♀♀ (4 winged) from Tasek Berah, Pahang, 13.v.1963.

Other material examined: Singapore (1), Johore (10), Malacca (3), Negri Sembilan (2), Pahang (6), Selangor (2), Penang (1).

Apterous male: Length 4.47-4.93, width 1.67-1.80. Dark brown with white markings on head and pronotum (Fig. 28). Connexiva broad with very short connexival spines (Fig. 29); venter brownish with 7th ventrite much longer than the preceding ones (Fig. 30). Antenna dark brown, first segment the longest; segments 1-4 measure 1.20, 0.60, 0.60, 0.67. Rostrum dark brown to black, slightly surpassing posterior margin of prosternum. Front leg with femur stout, anterior half light brown, posterior half dark brown; tibia much thinner and slightly curved inwards; 1st tarsal segment about 1/2 the length of 2nd, claws at basal 1/3 of 2nd. Middle leg with femur as long as tibia, both armed with bristles; 1st tarsus much longer than 2nd. Hind leg with femur and tibia armed with spines, tarsus black. Mesurements of leg segments: front leg 1.73, 1.50, 0.17, 0.33; middle leg 4.13, 3.80, 1.43, 0.43; hind leg 3.80, 1.80, 0.43, 0.30,

Apterous female : Length 4.67-5.73, width 1.67-2.00. Similar to male in colour pattern and general structure. Genital segments usually telescoped within the 7th abdominal segment leaving only the tip outside (Figs. 31 & 32). Antenna and front leg shown in Figs. 25 and 26. Antennal segments measure 1.33, 0.70, 0.67, 0.77. Lengths of segments : front leg 1.80, 1.60, 0.18, 0.37 ; middle leg 4.27, 4.07, 1.57, 0.43 ; hind leg 3.93, 1.93, 0.47, 0.30.

Winged male : Length 5.33-5.73, width 1.67-1.80. Colour pattern on head and pronotum similar to apterous male (Fig. 24). Hemelytra dark brown, slightly surpassing tip of abdomen ; venation of fore wing shown in Fig. 27.

Winged female : Length 5.67-6.00, width 1.87-2.00. Colour pattern similar to winged male, other body structures similar to wingless female.

Biology : Eggs oval with bluntly rounded ends (Fig. 33). This is a very common gerrid in Malaya and often occurs together with *L. fossarum* in slow-flowing streams, water reservoirs, ponds and temporary pools. The winged forms are as common as the wingless forms, hence their frequent occurrences in temporary habitats.

Genus Tenagogonus Stål

This genus is closely related to *Limnometra* Mayr and was treated as a subgenus of it by Hungerford and Matsuda (1958c).

Only one species of this genus is recorded from Malaya. It is found to agree quite closely to *T. pravipes* Bergroth. The venter of our species has 5 distinct rounded black dots, which are not mentioned in the original description of Bergroth (1915, cited by Hungerford and Matsuda, 1958c). Since the type specimens are not available for study, the species in Malaya is tentatively identified as *T. pravipes* until a comparison with the type could be made.

4. Tenagogonus pravipes Bergroth (Figs. 34-48)

Series studied : 7 ♂♂, 2 ♀♀ from small fish pond at Tasek Berah, Pahang, 8.v.1963; 2 winged ♂♂ from stream in Dunlop Rubber Estate near gate to Tasek Berah, Pahang, 14.v.1963.

Other material examined : Johore (2), Pahang (1).

Apterous male : Length 4.33-5.00, width 1.47-1.53. Light brown in ground colour with dark brown markings (Fig. 34) ; head protruding well beyond eyes ; anterior lobe of pronotum not distinctly separated from posterior lobe ; venter white with 5 black dots 2 on each side of the mesosternum and one centrally placed on the metasternum (Fig. 41) ; connexivum broad, spines not formed (Fig. 48) ; 1st genital segment with strong depression on the ventral surface along the mid-line, brown and hairy ; 2nd genital segment much narrower than 1st, with pointed tip (Fig. 46). Rostrum short, only reaching anterior 1/5 of metasternum, pale with 4th segment black ; antennae long and slender, 1st segment slightly stouter than the others, 4th the longest ; antennal segments 1-4 measure

1.20, 1.07, 1.50, 1.83 ; front leg with femur slightly enlarged at the anterior 1/3, armed with few spines and curved slightly inwards, apical spine found at the distal end of femur, tibia thin, first tarsus much shorter than 2nd, claws arising near apex of 2nd (Fig. 35) ; middle leg with femur armed with spines (Fig. 38), tarsal segments often missing in this species but both segments found on right leg of specimen examined (Fig. 40) ; hind leg with femur slightly stouter than tibia ; 1st tarsus longer than 2nd, claws at apex of 2nd (Fig. 39). Measurements of leg segments : front leg 1.67, 1.43, 0.13, 0.22 ; middle leg 3.73, 2.80, 0.32, 0.11 ; hind leg 3.40, 1.20, 0.27, 0.23.

Apterous females : Length 5.27-6.00, width 1.93-2.20. Much larger than apterous male with similar colour pattern except without 5 black dots on venter but with 2 dark dots at anterior margin of 7th ventrite, short spines found at postero-lateral angles of 7th ventrite (Figs. 44 and 45) ; antenna not longer than body unlike in the male, segments 1-4 measure 1.33, 1.13, 1.50, 1.70 ; front femur not enlarged but also armed with spines at anterior 1/3 as in the male ; measurements of leg segment : front leg 2.07, 1.80, 0.22, 0.33 ; middle leg 4.73, 3.67, 1.40, 0.42 : hind leg 4.13, 1.80, 0.33, 0.30.

Winged male : Length 5.67-5.73, width 1.60. Colour pattern similar to apterous male (Fig. 37) ; wings dark brown, extending well beyond tip of abdomen, venation shown in Figs. 42 and 43.

Biology : This species is only known from slow-flowing streams and ponds in Malaya. It is peculiar in that one of the tarsal segments is often missing from the specimens apparently not due to breakage. In one of the females examined, the 1st tarsal segment of the left hind leg is fused with the tibia.

Genus **Limnometra** Mayr

The species in this genus are characterised by the presence of prominent connexival spines in contrast to the closely related *Tenagogonus*. Five species are recorded from Malaya and except for *L. ciliata*, the others are all new records (Hungerford and Matsuda, 1958c).

KEY TO SPECIES OF *LIMNOMETRA*

1.	Body more than 1.5 cm long	**femorata**
	Body much less than 1·5 cm long	**2**
2.	Venter with 8 rounded black dots	**octopunctata**
	Venter without such black dots	**3**
3.	Antennal segments 1 and 4 almost equal in length	**ciliata**
	1st antennal segment distinctly shorter than the 4th	**4**
4.	All antennal segments brown	**anadyomene**
	Antennal segments not evenly brown, portion of 3 and 4 white	**insularis**

5. Limnometra anadyomene (Kirkaldy) (Figs. 49-59)

Series studied : 6 ♂♂, 6 ♀♀ from Sungei Kongsi Lapan, Ampang, Selangor, 13.iii.1964.

Other material examined : Selangor (1), Perlis (1).

Apterous male : Length 8.67-11.1, width 2.53-3.60. Brown with black markings (Fig. 49) ; venter pale with 2 black dots at anterior corner of mesoacetabula ; head protruding well beyond eyes, anterior lobe of pronotum expanded laterally : posterior lobe not expanded, about 4 times the length of anterior lobe. Connexival spines well developed, black, not surpassing tip of abdomen (Figs. 58 & 59). Rostrum long, reaching the anterior 1/3 of mesosternum, 1st 3 segments pale, 4th black. Antenna longer than body, 1st 2 segments short and slightly stouter than the remaining 2 (Fig. 52), segments 1-4 measure 2.40, 2.27, 3.47, 3.87. Front leg with femur slightly stouter than tibia (Fig. 50), tarsal segments lined with hair, claws arising near apex of 2nd segment (Fig. 51) ; middle leg with 1st tarsus more than 4 times as long as 2nd, with claws near apex of 2nd segment (Figs. 54 & 55) ; hind leg also with 1st tarsus longer than 2nd (Fig. 53). Measurements of leg segments : front leg 4.00, 3.60, 0.47, 0.57 ; middle leg 10.3, 7.60, 2.87, 0.60 ; hind leg 10.0, 4.80, 0.87, 0.60.

Apterous female : Length 9.07-10.0, width 2.93-3.20. Similar to male in colour pattern except connexiva paler with connexival spines almost reaching tip of abdomen (Figs. 56 & 57). Antennal segments differently proportioned from that of male, with 2nd segment distinctly the shortest ; segments 1-4 measure 2.10, 1.63, 2.47, 3.13. Measurements of leg segments-front leg 3.67, 3.07, 0.87, 0.53 ; middle leg 9.33, 7.33, 2.80, 0.67 ; hind leg 8.93, 4.53, 0.80, 0.60.

Biology : Eggs oval, measuring 1.27-1.37 × 0.40-0.47. Females containing eggs, with posterior part of dorsal surface of abdomen expanded upwards, giving an arched apearance. Nymphs brown, with dark brown instead of black markings, unlike the adults but with similar colour pattern.

This is the smallest of all *Limnometra* spp. found in Malaya, and has only been collected from fast-flowing mountainous streams so far.

6. Limnometra insularis Hungerford and Matsuda (Figs. 60-71)

Series studied : 6 ♂♂ (all winged), 9 ♀♀ (all winged), from stream in Dunlop Estate near gate to Tasek Berah, Pahang, 14.v.1963

Other material examined : Singapore (3), Johore (1).

Winged male : Length 9.3-11.2, width 2.40-2.93. Brown in ground color, no distinct markings on head, pronotum with median longitudinal dark stripe ; head protruding well beyond eyes, posterior lobe of pronotum about twice the length of anterior and with pointed posterior margin ; connexival spines well developed, long and surpassing tip of abdomen with dark brown and pointed tips (Fig. 70). Rostrum reaching anterior 1/4 of mesosternum, brown with 4th segment black. Antenna long and slender, with 1st segment stouter than the

rest (Fig. 61) ; segments 1 and 2 and anterior 1/3 of 3 brown, rest of 3 and 4 white, tip of 4 may be brown; segments 1-4 measure 2.73, 2.27, 3.47, 3.87. Front leg largely brown, femur thin with apical spine, tibia slightly broadened at distal end (Fig. 66), 1st tarsus almost equal to 2nd with claws arising at apical 1/3 of 2nd segment (Fig. 67) ; middle leg, femur armed with spines and apical spine present (Fig· 68), tibia with few spines at distal end, 1st tarsus much longer than 2nd ; hind leg, femur armed with small spines with tuft of hair at outer distal corner (Fig. 69), tibia tapering towards distal end, 1st tarsus much longer than 2nd. Measurements of leg segments : front leg 3.80, 3.27, 0.53, 0.53 ; middle leg 10.7, 8.13, 2.67, 0,46 ; hind leg 11.2, 7.87, 1.27, 0.53.

Winged female : Length 8.93-9.60, width 2.40-2.67. Smaller than male with similar colour pattern (Fig. 60). Connexival spines well developed, surpassing tip of abdomen (Fig. 71). Antenna shorter than body, brown except posterior 2/3 of 4th ; segments 1-4 measure 1.87, 1.33, 1.87, 2.73. Middle femur with apical spine as in the male but hind femur lacking tuft of hairs at outer distal corner. Measurements of leg segments : front leg 2.73, 2.47, 0.40, 0.37 ; middle leg 7.33, 6.27, 2.10, 0.43 ; hind leg 7.47, 4.33, 0.87, 0.37.

Biology : Eggs peculiar in shape with semi-circular lid-like structure at anterior end (Figs. 64 & 65) ; measuring 1.40-1.50 × 0.40 including the lid.

Nymphs paler in colour, with somewhat different colour pattern (Fig. 63) from the adults. Front tarsus of nymphs not segmented (Fig. 62).

This species was described from winged specimens (Hungerford & Matsuda, 1958c). All the specimens collected in Malaya are winged and apterous forms are not known. They occur only in slow-flowing streams.

7. Limnometra femorata Mayr (Figs. 72-83)

Series studied : 1 ♂ (winged), 4 ♀♀ (all winged), from forest pond, Kaki, Bukit, Perlis, (JIF).

Other material examined : Selangor (2).

Winged male : Length 21.6, width 5.47. Reddish-brown, with dark brown to black markings, colour on posterior lobe of pronotum darker than the head and the anterior lobe ; venter pale yellow with distinct omphalium situated at posterior half of metasternum ; head longer than broad ; posterior lobe of pronotum about 6 times the length of the anterior lobe ; distinct tubercles found at each of the postero-lateral corners of pronotum. Rostrum long, reaching anterior 1/3 of mesosternum ; antennae long and thin, 1st black, 2nd with basal half and distal end, black but with central portion brown, 3 and 4 with basal and distal ends dark brown but central portion pale brown or white ; segments 1-4 measure 4.93, 3.47, 5.07, 5.33 ; front leg, base of femur pale brown, remaining parts brown, with golden-brown hairs at distal end of tibia and tarsus forming a groove-like structure ; middle leg, femur brown except distal 1/5 white armed with tubercles and spines with one sub-apical and 2 apical spines,

tibia with anterior half dark brown, posterior half pale yellow, tarsi dark brown 2nd tarsus incomplete ; hind leg, femur dark brown with distal 1/8 pale yellow, tibia dark brown with pale brown distal end. Measurements of leg segments : front leg 8.53, 7.73. 1.20, 1.07 ; middle leg 25.47, 26.27, 5.33 ; hind leg 24.27, 24.80, 3.00, 0.83. (2nd mid tarsus missing). Wings dark brown surpassing tip of abdomen but not surpassing tip of connexival spines (Fig. 78). Venation shown in Figs. 79 & 80.

Winged female : Length 16.1-17.6, width 3.73-4.13. Very much smaller than male, with similar colour pattern (Fig. 72). Antenna similarly proportioned as in male (Fig. 73) ; segments 1-4 measure 3.33, 2.13, 3.40, 3.93. Structures of front and middle legs similar to the male (Figs. 74-76). Connexival spines well developed surpassing tip of abdomen (Fig. 77). Measurements of leg segments : front leg 5.60, 5.001, 0.80, 0.73 ; middle leg 16.13, 16.40, 3.87, 0.67 ; hind leg 16.13, 13.73, 2.00, 0.67.

Biology : Eggs very elongated, with beautiful lid-like structure at anterior end (Figs. 81-83), measuring 2.57-2.60 × 0.53-0.60.

The apterous forms and nymphs of this species have not been collected. This species has only been collected from forest ponds.

8. **Limnometra octopunctata** Hungerford (Figs. 84-93)

Series studied : 3♀♀ (all winged) from stream in Mersing Forest Reserve, Johore, 3.vii.1963 ; 1 winged ♂ from stream in Coronation Park, Taiping, Perak, 2.ii.1960.

Winged male : Length 12.3 ; width 3.07. Brown in ground colour, without distinct dark markings on the head ; pronotum with central longitudinal dark brown stripe extending to the posterior margin, anterior end of stripe much expanded laterally ; anterior lobe of pronotum expanding laterally, posterior lobe tapered to a rounded point. There are two lateral brown oval markings on the posterior lobe of pronotum, which is dark brown at the posterior margin. Rostrum pale in colour, except the last segment which is black ; it is short and reaching only the anterior 1/5 of mesosternum. Venter pale with 8 black dots placed as follows : 2 at bases of middle leg, 2 at postero-lateral corners of mesosternum, 2 at postero-lateral corners of metasternum, and 2 lateral sides of 7th ventrite (Fig. 88). Connexival spines brown and only reaching the anterior half of the first genital segment.

Antennae brown with all the segments almost equal in length (Fig. 85) ; segments 1-4 measure 2.80,2.67,2.60, and 2.70. Front leg with femur modified ; anterior outer margin of femur armed with several spines with a sudden narrowing in width in the middle towards the distal end ; inner margin also armed with spines at the distal half ; tibia thinner than femur and broadened slightly towards the distal end (Fig. 86) ; first tarsus longer than second with claws arising near the apex of the 2nd segment (Fig. 87). Middle leg with femur

brown and armed sparsely with long hairs and spines ; tibia dark brown, almost as long as femur; tarsus dark brown, 1st segment more than 10 times as long as 2nd. Hind leg dark brown except anterior half of femur which is light brown ; femur much longer than tibia ; 1st tarsal segment about twice the length of the 2nd. Measurements of leg segments : front leg 3.73, 3.20, 0.63, 0.60 ; middle leg 10.9, 10.3, 5.80, 0.57 ; hind leg 11.5, 6.13, 0.97, 0.50. Wings dark brown not extending beyond the tip of the abdomen (Fig. 92) ; wing venations as shown in Figs. 93 and 91.

Winged female : Length 10.1-11.3 ; width 2.67-2.93. Similar to the male in colour pattern (Fig. 84) and other body structures. Venter also with 8 black dots but the 2 on the 7th ventrite may be very small and inconspicuous (Fig. 93). Antennae differently proportioned from the male, with 2nd segment distinctly the shortest. Antennal segment measure 2.33, 1.87, 2.07, and 2.53. Front femur similarly modified as in male. Measurements of leg segments : front leg 3.40, 2.80, 0.47, 0.60 ; middle leg 9.47, 8.27, 2.53, 0.60 ; hind leg 9.07, 5.07, 0.80, 0.47.

Biology : Eggs simple and oval in shape without any lid (Fig. 89). A female dissected contained 24 eggs which range in size from 1.00-1.03 × 0.30-0.33. This species is found in slow-flowing streams. It is not common in Malaya, and only the winged forms have been collected. It has, however, only been known from apterous specimens from Sumatra (Hungerford, 1955).

9. Limnometra ciliata Mayr (Figs. 94-98)

Series studied : 1♀ from Muban Estate, Kuala Lumpur, Selangor 18.iii. 1960 ; 1 ♀ from fish pond at Tasek Berah, Pahang, 8.v.1963.

Apterous female : Brown in ground colour, with dark brown markings (Fig. 94) ; antennae pale brown; rostrum short, reaching the anterior ¼ of mesosternum, pale brown with 4th segment black ; venter pale. Connexival spines well developed reaching tip of the abdomen (Figs. 95 and 96). Antennae shorter than body, long and thin with distal end of the 4th segment darker brown. Front leg pale brown with brown tarsi ; femur stouter and longer than tibia. Middle leg also pale brown with small black longish stripe at anterior end of femur, distal end of femur with apical spine ; tibia as long as femur with distal end darker brown; tarsal segments dark brown, 1st much longer than 2nd. Hind leg with femur slightly longer than midfemur and pale brown ; tibia dark brown, much shorter than femur; tarsal segments dark brown, 1st longer than 2nd.

Biology : Eggs oval with groove-like structure on the ventral side (Figs. 97 and 98) ; range in size from 1.00-1.07 × 0.33-0.40. This species inhabits ponds and slow-flowing streams. Only the apterous females have been collected in Malaya. It was recorded from Lenggong, Perak, by Hungerford and Matsuda (1958c).

Genus **Amemboa** Esaki

This genus, first described by Esaki (1925) is characterised by its elongated body, highly modified suranal plate, and the loss of parameres (Matsuda, 1960). Sexual dimorphism is exhibited by members of this genus. The male front leg is variously modified in different species. Three species have been collected from Malaya, namely, *A. javanica*, *A. horvathi*, and *Amemboa* sp. 1. The structure of the male genitalia of the last named species is similar to *Amemboa* sp. from Thailand, figured by Matsuda (1960). The three Malayan species can be separated by the following key :

1. Suranal plate with rounded posterior margin ; male front femur with 2 tufts of hairs on the inner margin of the distal half ... ... **horvathi**
   Suranal plate indented and variously shaped ; male front femur differently modified **2**
2. Suranal plate with central process, which is bifurcated at the distal end ; male front femur with one broad tuft of hairs on inner margin near the proximal end and two small tubercles at distal end ... ... **Amemboa sp. 1**
   Suranal plate without central process ; male front femur with a broad hair-comb at the distal inner margin ... ... **javanica**

10. Amemboa sp. 1. (Figs. 99-102)

Series studied : 3 ♂♂ (1 winged) from stream at Gunong Pulai, Johore, 17.iii.1963.

Apterous male : Length 3.50-3.90 ; width 1.27-1.37. Pale brown, with dark brown markings as in other *Amemboa* spp.; venter whitish with median brown stripe, which is broadened at the distal end, and 2 crescent-shaped brown markings at antero-lateral margins of the mesosternum. Suranal plate of male highly modified with a central process which is bifurcated at the distal end (Figs. 100 and 101). Antennae long and thin with 2nd segment the shortest and last segment the longest. Segments 1-4 measure 0.87, 0.77, 0.87, and 1.30. Front leg highly modified with broad tuft of hairs at the proximal inner margin and 2 tubercles at distal inner margin of femur ; tibia bears a tubercle at the proximal inner margin (Fig. 102). Measurements of leg segments : front leg 1.30, 1.10, 0.17, 0.25 ; middle leg ; 3.33, 2.20, 0.85, 0.38 ; hind leg 3.13, 1.28, 0.48, 0.33.

Winged male : Head with 3 brown spots, anterior lobe of pronotum with 2 brown stripes at anterior margins; posterior lobe with broadly rounded posterior margin and separated from the anterior lobe by its mottled brown pattern (Fig. 99). Hemelytra brown and extend well beyond the tip of the abdomen. Other structures similar to wingless form.

Biology : This species has only been collected from the fast-flowing stream at Gunong Pulai, Johore.

11. Amemboa javanica Lundblad (Figs. 103-105)

Series studied : 1 ♂ from Ayer Terjung, Templar Park Kuala Lumpur, Selangor, 16.iii.1964.

Apterous male : Length 3.77, width 1.30. Very similar in colour pattern to *A. horvathi*, except brown markings more prominent. Head mottled brown with 2 transverse brown stripes at base of the 'neck' region ; there are 4 longitudinal brown stripes on pronotum, 2 medium brown stripes on mesonotum and 2 lateral brown stripes flanging thorax at the mesothoracic region ; metathorax dark brown. Antennae long and slender, 4th segment the longest ; segments 1-4 measure 0.90, 0.77, 0.77, and 1.37. Front femur differently modified from *Amemboa horvathi* with a dense hair-comb at the inner distal margin about 1/3 from the distal end of the femur and a bump at inner margin of tibia about 1/3 from the anterior end of the segment (Fig. 104). Structure of genital segments figured in Figs. 103 & 105.

Biology : Only one collection was made from a fast-flowing stream at the foot of a water-fall in Selangor. This species was described from Java by Lundblad (1933) and recorded from mountain streams, flowing streams and freshwater swamps.

12. Amemboa horvathi Esaki (Figs. 106-119)

Series studied : 7 ♂♂, 4 ♀♀, from stream 121, Mersing-Kluang Road, Johore, 5.x.1064.

Other material examined : Singapore (1), Johore (1), Selangor (2).

Apterous male : Length 3.63-3.83, width 1.33-1.50. Light brown in ground colour, with darker brown but not well defined markings. Head protruding well beyond eyes, with a faint V-shaped brown marking at base ; pronotum expanded laterally and about as long as head ; mesonotum at least twice as long as pronotum : metanotum shorter than pronotum with a W-shaped posterior suture (Fig. 106). 9th abdominal segment modified bearing 2 lateral spinous processes (Fig. 114). Venter white, with dark brown stripe extending from anterior 1/3 of mesosternum to the abdomen ; metasternum much shorter than mesosternum with a prominent omphalium ; 8th ventrite longer than 2 preceding ventrites together with concave posterior margin (Fig. 115). Rostrum surpassing posterior margin of prosternum with first 3 segments pale and 4th segment black. Antennae thin and pale brown with tips slightly darker ; last segment longer than the others (Fig. 109) ; segments 1-4 measure 0.90, 0.77. 0.83, and 1.33.

Front leg largely brown ; femur stout with two tufts of hairs at distal half ; tibia thinner than femur with a bump at the anterior 1/3 ; 1st tarsus shorter than 2nd which has pointed dark brown tip with claws arising at 1/3 from the apex (Fig. 107). Middle leg pale brown with distal tip of tibia

and tarsus dark brown ; femur sparsely armed with black bristles ; tibia armed with a row of spines along its inner margin ; 1st tarsus about 2½ times as long as 2nd with claws arising at tip of 2nd tarsus (Fig. 113). Hind leg also pale brown ; femur sparsely armed with spines and long hairs ; tibia much shorter than femur and armed with spines ; tarsi with a row of spines along their outer margin, 1st segment much longer than 2nd with claws arising near the apex of the 2nd (Fig. 112). Measurements of leg segments : front leg 1.33, 1.17, 0.17, 0.25 ; middle leg 3.53, 2.37, 0.90, 0.40 ; hind leg 3.27, 1.23, 0.53, 0.33.

Apterous female : Length 4.00-4.20 ; width 1.47-1.53. Similar to the male in colour pattern and general body structure, except front leg not modified (Fig. 108) and apical abdominal segments also differ from the male (Figs. 116-118). Antennal segments 1-4 measure 0.93, 0.70, 0.78 and 1.40. Measurements of leg segments : front leg 1.37, 1.20, 0.18, 0.30 ; middle leg 3·67, 2.37, 1.03, 0.43 ; hind leg 3.27, 1.30, 0.57, 0.37.

Biology : Eggs elongate, with one end pointed and the other end truncate (Fig. 119). One female dissected has only 6 eggs which range in size from 1.10-1.20 × 0.23-0.33. The nymphs are much paler in colour than the adults and covered with greyish hairs with more or less oval body and very little brown markings (Fig. 110). Front femur of nymph with 2 bumps but without hairs unlike the adult (Fig. 111). The usual habitat of this species is a flowing stream. This is the commonest of the three *Amemboa* species found in Malaya. It is usually found amongst the vegetation near the edges of streams or at quieter portions of the stream.

Genus **Cylindrostethus** Fieber

The genus *Cylindrostethus* was first described by Fieber in 1860 without naming any type species. Mayr (1865) was the first to assign a species to this genus. The taxonomy of this genus in the Eastern Hemisphere was in quite a confusing state, until a monograph was produced by Hungerford and Matsuda (1962), in which they redescribed all the species known, synonymised a number of species and also provided a key for the separation of the 7 species recorded. In Malaya, 2 species have been collected, namely, *C. scrutator*, and *C. costalis*. They can be separated by size alone. *C. costalis* is well over 15 mm in length whilst *C. scrutator* is only about 12 mm in length.

13. **Cylindrostethus costalis** Schmidt (Figs. 120-133)

Series studied : 10 ♂♂ and 10 ♀♀, from Tasek Berah, Pahang, 29.ii.1963 ; one winged ♀ from stream in rubber estate, Ulu Bahau, Negri Sembilan, 17.iii.1964.

Other material examined : Johore (4), Singapore (1), Negri Sembilan (1), Selangor (1), Pahang (3),

Apterous male : Length 18.5-20.3 ; width 2.80-3.08. Long and cylindrical in shape, reddish-brown in ground colour with 2 pairs of black spots on either side of the pronotum and anterior half of the mesonotum (Fig. 120). Venter light brown with short black spines on posterior half of metasternum as well as the more anterior segments of the abdomen. Head protruding well beyond eyes which are inserted at the posterior half of head. Pronotum shorter than head with narrow central longitudinal white stripe ; mesonotum about 3 times as long as pronotum with narrow longitudinal pale stripe at anterior half and broadened slightly towards the posterior end ; metanotum slightly longer than pronotum. Abdomen long and slender with the 9th segment greatly modified (Figs. 132 & 133). The suranal plate bears two wings which are asymmetrical, the left being larger than the right (Fig. 126). The parameres are small and symmetrical (Fig. 125). The connexiva are narrow and paler than the abdomen, with well developed connexival spines surpassing tip of abdomen.

Antennae dark brown, very much shorter than the body with the 1st segment the longest and the 3rd the shortest (Fig. 123). Segment 1-4 measure 2.77, 1.33, 0,77, and 1.07. Front leg with femur pale brown but inner and outer margins dark brown; femur much stouter than tibia which is curved slightly inwards and dark brown (Fig. 121); 1st tarsal segment shorter than the 2nd which expands slightly towards the distal end and claws are inserted near the apex of the 2nd segment (Fig. 122). Middle leg brown, both femur and tibia armed with spines. Hind leg also brown with femur and tibia armed with spines. Measurements of leg segment: front leg 4.87, 4.27, 0.20, 0.63; middle leg 16.5, 11.1. 5.07, 0.93; hind leg: 18.54, 10.4, 0.57, 0.33.

Apterous female: Length 20.8-21.6, width 3.08-3.20. Colour pattern and body structure similar to the male, except that the connexival spines are much longer and project well beyond the tip of the abodmen and the 9th abdominal segment is not modified (Figs. 130 & 131). Antennal segments 1-4 measure 2.87, 1.27, 0.80, and 1.17. Measurements of leg segments : front leg 4.67, 4.33, 0.27, 0.60; middle leg 16.1, 11.5, 5.00, 0.93; hind leg 17.9, 10.7, 0.53, 0.35.

Winged female : Length 20.9, width 3.33. Colour pattern on head similar to apterous female; there is also a pair of dark brown spots on the anterior lobe of pronotum; posterior lobe of pronotum about 4 times as long as anterior lobe with broadly rounded distal margin ; 2 tubercles are found on the postero-lateral angles of the pronotum (Fig. 129). Wings shorter than body reaching only the 8th abdominal segment. Hemelytra very narrow and dark brown without any distinct embolium (Fig, 127); hind wings brown and narrow with small anal lobe and without distinct anal vein (Fig. 128).

Biology : Eggs more or less ovoid and measure 2.27-2.50 × 0.47-0.60. One female dissected contained 15 eggs. The nymphs are quite different in colour pattern from adults, with dark brown patches on abdomen alternating with light brown stripes (Fig. 124). The usual habitat of this species is flowing stream. It is extremely common in peaty stream in Malaya and occur in

thousands in the peaty stream at Tasek Berah, Pahang. Winged forms are extremely rare in Malaya and only one female has been collected so far.

14. Cylindrostethus scrutator (Kirkaldy) (Fig. 134-147).

Series studied : 14 ♂♂, 12 ♀♀, from Sugei Mupoh, Johore, 16.iv.1963.

Other material examined : Johore (12), Selangor (1), Malacca (1), Perak (1).

Apterous male : Length 11.2-12.4 ; width 2.00-2.12. Dark brown to almost black in ground colour, with central pale yellow spot at basal region of head which projects into a long snout anteriorly with eyes situated at the basal half. Pronotum shorter than head with a very narrow pale yellow stripe in the centre ; mesonotum more than 3 times as long as pronotum with median longitudinal depression ; metanotum as long as pronotum with central logitudinal depression joining that of mesonotum. Venter black with broad central white stripe extending from base of head to posterior margin of 8th abdominal segment ; short black spines found scattering on the venter, denser on the last few ventrites (Fig. 142). Connexival spines well developed with black pointed tips (Fig. 143). 9th sternite elongated with 2 lateral wings which are not symmetrical in shape, the left being larger than the right (Fig. 145). Parameres very small but symmetrical in shape (Fig. 144). Rostrum very short and scarcely reaching base of the head.

Antennae brown with first segment the longest and the 3rd segment the shortest (Fig. 135). Antennal segments 1-4 measure 1.67, 1.03, 0.60, and 1.03. Front leg dark brown ; femur with light brown patch at anterior end and much stouter than tibia ; tibia curved slightly inwards (Fig. 140) ; 1st tarsus short, 2nd tarsus more than twice as long as the first with claws arising near the apex (Fig. 141). Middle leg brown ; both femur and tibia armed with spines ; 1st tarsus more than 5 times as long as the 2nd (Fig. 137) ; Hind leg also brown with femur longer than that of middle leg, tibia short, less than 1/3 the length of femur, 1st tarsus slightly longer than the 2nd (Fig. 136). Measurements of leg segments : front leg 3.10, 3.00, 0.20, 0.47 ; middle leg 12.4, 7.48, 3.72, 0.73 ; hind leg 14.3, 5.60, 0.43, 0.32.

Apterous female : Length 15.1-16.2 ; width 2.56-2.80. Much larger than the male, but with similar colour pattern (Fig. 134). Differs from the male in having 2 small tubercles on the postero-lateral angles of mesonotum and much longer connexival spines almost reaching the tip of the abdomen (Figs. 146 & 147). The venter, unlike the male, is almost white except the sides of thorax and with a median suture along the whole length of abdomen. Antennal segments 1-4 measure 1.87, 1.00, 0.63 and 1.02. Measurements of leg segments : front leg 3.33, 3.17, 0.20, 0.50 ; middle leg 14.4, 8.52, 4.92, 0.11 ; hind leg 15 1, 8.00, 0.60, 0 33.

Biology : Females dissected contained about 20 eggs, which are elongated with one end more pointed than the other (Figs. 139) and range in size from 2.00-2.23 × 0.53-0.57. The nymphs are very different in colour pattern from the adults (Fig. 138). This species inhabits slow-flowing forest streams and also lowland streams. Only wingless forms are known from Malaya, winged forms have never been collected.

Genus **Gerris** Fabricius

This genus is world-wide in distribution and is the commonest genus of the family in Europe. It is, however, quite rare in Malaya and only one species has been recorded so far.

15. Gerris adelaides Dohrn (Figs. 148-161)

Series studied : 3 ♂♂ (1 long-winged, 2 short-winged), 5 ♀♀, (1 long-winged 4 short-winged) from Batu Beremdam Fish Pond, Malacca, 1.xi.1963.

Other material examined : Singapore (1), Johore (1), Malacca (1), Pahang (1).

Long-winged male : Length 10.1, width 2.93. Dark brown in ground colour, with whitish markings on head and pronotum (Fig. 148). Venter light brown, with 2 dark brown patches at anterior half of mesosternum ; connexival spines reaching posterior margin of 8th abdominal sternite with black pointed tips (Fig. 158) Rosturm short, only slightly surpassing base of head. Hemelytra brown, with dark brown embolial region (Fig. 155) ; hind wings extremely thin and membranous with big anal lobe.

Antennae dark brown, 1st segment longest and slightly shorter than the three others together (Fig. 153). Segments 1-4 measure 2.53, 1.13, 0. 77, and 1.33. Front leg with stout femur which is pale yellow at base and with a conspicuous spine at the distal end (Fig. 151) ; tibia brown and thinner than femur (Fig. 149) ; tarsal segments 1 and 2 almost equal with claws arising near apex of the 2nd (Fig. 152). Middle leg with femur brown at anterior half and dark brown at posterior half ; a spine is present at the distal end ; tibia and tarsus dark brown ; 1st tarsal segment about 4 times as long as the 2nd. Hind leg with femur brown at anterior half and dark brown at posterior half ; tibia slightly more than half the length of the femur ; 1st tarsus about twice the length of the 2nd. Measurements of leg segments : front leg 4.00, 3.93, 0.60 9.73 ; middle leg 11.90, 9.20, 2.93, 0.87 ; hind leg 13.6, 7.47, 1.80, 0.73.

Short-winged male : Length 9.13-10.1 ; width 2.80-2.93. Similar to long-winged male in all aspects, except for the shorter wings (Fig. 161). The hemelytra dark brown, reaching only the anterior half of 2nd abdominal segment. Fore wing as in Fig. 156.

Long-winged female : Length 14.9, width 3.33 ; similar to male in colour pattern, except the mesosternum is pale brown with two brownish spots (Fig.

150). Connexival spines extend well beyond the 8th segment but not reaching the tip of abdomen (Figs. 159 and 160). Antennal segments 1-4 measure 2.73, 1.07, 0.73, and 1.33. Measurements of leg segments : front leg 4.13, 3.53, 0.67, 0.73 ; middle leg 12.4, 10.40, 3.20, 0.87 ; hind leg 14.00, 8.40, 1.93, 0.80.

Short-winged female : Length 14.8-15.2 ; width 3.07-3.33. Similar to long-winged female in colour pattern and general body structure, except colour pattern on mesosternum (Fig. 157).

Biology : The nymphs are different in colour pattern from the adults (Fig. 154). This species has been collected from canals, fish-ponds, lakes, temporary pools and flooded rice fields. The apterous forms are not known in Malaya.

Genus Ptilomera Amyot et Serville

This genus is one of the most difficult of the Gerridae taxonomically ; also all the species described are very closely allied to one another. Most of the earlier descriptions are very inadequate and without illustrations. In their recent study of *Ptilomera*, Hungerford and Matsuda (1965) found that the shape of the pygofer, suranal plate and paramere is a very useful character for separating the species. Our collection of *Ptilomera* males from Malaya resembles closely the male of *P. pamphagus* Bredd., figured by Lundblad (1933), but Hungerford and Matsuda (1965) found that these characters figured were quite different from the male of *P. pamphagus* which was described from Celebes and they renamed this species *P. lundbladi*. The female and winged forms of *P. lundbladi* have not been described before.

16. Ptilomera lundbladi Hung. and Mat, (Figs. 162-178)

Series studied : 5 ♂♂, 9 ♀♀, from stream at Gunong Pulai, Johore, 17.iii.1963 ; 1 winged ♂ from Lombong waterfall, Kota Tinggi, Johore, 8.xi.1961 ; 3 winged ♀♀ from ditch at Ampang Reservoir, Kuala Lumpur, Selangor, 13.iii.1964.

Other material examined : Singapore (2), Johore (13), Malacca (1), Negri Sembilan (4), Selangor (13), Perak (4), Penang (13), Kelantan (1).

Apterous male : Length 15.6-10.5 ; width 3.73-4.26. Reddish-brown in ground colour with black markings ; head protruding well beyond eyes which are inserted at the posterior half of it ; pronotum expanded slightly laterally ; mesonotum about twice as long as pronotum ; metanotum longer and broader than pronotum (Fig. 162). Abdomen long and thin, segments 8th and 9th modified to form the genitalia (Fig. 175). Venter pale brown with 7th ventrite slightly longer than preceding ones ; 8th ventrite with concave posterior margin lined with hairs ; 9th much elongated and modified (Fig. 176) ; parameres large and symmetrical with tips curved outwards and lined with long brown hairs (Fig. 170) ; suranal plate with two lateral projections and a very pointed tip ; pygophore characteristically shaped.

Antennae brown with 1st segment longer than three following segments together (Fig. 166). Segments 1-4 measure 8.00, 1.80, 2.20, and 1.37. Front femur with distal end greatly modified having several black tubercles ; tibia slightly shorter than the femur with anterior end toothed and an inner projection at the distal end ; 1st tarsal segment about 2½ times as long as the 2nd with claws arising near the apex of the 2nd segment (Fig. 163). Middle leg with trochanter possessing a number of black tubercles ventrally ; femur very much longer than the body with posterior half lined with closely set woolly hairs which are curled at the ends (about 0.5 mm in length) and dark grey ; tibia sparsely lined with straight brown hairs along its entire length (Fig. 164) ; anterior end of 1st tarsal segment sparsely lined with hairs, 1st tarsus about 3 times as long as the 2nd. Hind leg with trochanter possessing several black turbercles dorsally ; femur armed with short black spines all over in addition to the row of large black spines along its entire length (Fig. 165) ; tibia with few spines at its anterior end ; tarsal segments extremely short and the two segment are completely fused. Measurements of leg segments : front leg 8.40, 77.33, 4.40, 1.72 ; middle leg 25.00, 16.00, 2.10, 0.77 ; hind leg 30.00, 17.70, 0.34.

Apterous female : Length 15.5-16.7 ; width 3.79-4.10. Colour pattern and general structure similar to male, except that middle femur lacks the line of hairs and genital segments differently modified ; 7th abdominal segment produced laterally forming dorsal and ventral spines (Fig. 171) ; connexivum also produced into spine-like projection which is black (Figs. 177 and 178). Antennal segments 1-4 measure 6.53, 1.33, 1.87, and 1.40. Measurements of leg segments : front leg 7.33, 6.52, 3.72, 1 42 ; middle leg 19 0, 17.7, 6.67, 0.60 ; hind leg 22.5, 13.5, 0.27.

Winged female : Length 14.9-15.6 ; width 3.73-4.00. Pronotum with well defined anterior and posterior lobes, the latter with broadly rounded posterior margin (Fig. 174). Hemelytra brown and extend well beyond the tip of the abodmen ; hind wings much shorter than fore wings, with anal lobes folded beneath in their natural position ; venations of fore and hind wings as in Figs. 172 and 173.

Winged male : Length 15.3, width 3.73. Colour pattern on head and pronotum similar to winged female ; other structures similar to wingless male.

Biology : Eggs are elongated, with bluntly round ends ; females dissected contained about 29 eggs which range in size from 2.23-2.37×0.60-0.73. The nymphs are quite similar in colour pattern to the adults but paler (Fig. 167). Sexes can only be separated in the last instar, in which 7th ventrite is entire and armed with small black tubercles in the male (Fig. 168) but divided in the female (Fig. 169). The mid tibial hairs present in the nymphs but their is no trace of hairs on mid femur even in 5th instar male. This species inhabits fast-flowing forest streams and also waterfalls. It is very widely distributed in Malaya.

Genus Pleciobates Esaki

The genus *Pleciobates* was discribed by Esaki (1930) for an apterous female collected from Klang River near Klang Gates, Selangor, Malaya. The male and macropterous forms were all unknown. The genus is characterised by the structure of the connexivum, which is almost perpendicularly erected in the female and ending in a very long and stout spine-like process. Matsuda (1960) doubted the interpretation by Esaki of the metanotum, the position of the metacetabula suture and lengths of the hind tarsal segments but he was not able to obtain any specimens of this genus for study. It has been found by examining the specimens collected by us that the posterior lobe of the metanotum stated by Esaki is actually the first abdominal tergite, the position of the metacetabula suture is as in *Ptilomera*, and the first tarsal segment of the hind leg, contrary to that stated by Esaki, is shorter (not longer) than the second segment.

17. Pleciobates turberculatus Esaki (Figs. 179-194)

Series studied: 10 ♂♂ (2 winged), 13 ♀♀, from Sungei Langut, Ulu Langat, Kuala Lumpur, Selangur, 18.iii.1964.

Other material examined: Negri Sembilan (1), Selangor (1), Kelantan (1).

Apterous male: Length 7.07-7.63 ; width 1.87-2.00. Body black above with a short white median stripe on pronotum but head white with black patch at the anterior end (Fig. 179). Venter largely pale brown, anterior half of thorax with W-shaped black marking. Head protruding well beyond eyes ; pronotum short and somewhat biconcave in shape ; mesonotum about three times as long as pronotum ; metanotum about the same length as pronotum. Abdomen shorter than thorax ; connexivum well developed but with very short connexival spines which only project beyond the 7th ; 9th segment longer than the preceding segment which are more or less equal; 8th segment slightly shorter than the 7th ; 9th segment short with parameres protruding beyond its hind margin (Fig. 191). Parameres large and symmetrical, with pointed tips (Fig. 188).

Antenna long and slender, with the 1st segment the longest and the last segment the shortest ; 1st segment is also longer than three following segments together (Fig. 180). Segments 1-4 measure 3.53, 0.87, 1.00, and 0.73. Front leg with pale yellow femur, which has a longitudinal brown stripe along its long axis ; tibia shorter than femur and brown ; 1st tarsus longer than 2nd, both dark brown ; claws arising near the apex of the 2nd tarsus (Fig. 181). Midddle leg with coxae, trochanter and base of femur pale yellow and the rest of leg dark brown ; inner margin of femur with a single row of stout spines ; tibia lined with long hairs along its entire length ; 1st tarsus much longer than 2nd (Fig. 186). Hind leg with coxae, trochanter and base of femur pale yellow and the rest of leg dark brown ; femur thinner and shorter than middle femur ; tibia very short and less than 1/3 the length of femur ; tarsal segment not easily separable externally, 1st shorter than the 2nd (Fig. 185). Measure-

ments of leg segments : front leg 3.60, 2.60, 0.87, 0.53 ; middle leg 10.0, 4.93, 2.27, 0.40 ; hind leg 9.33. 2.67, 0.12, 0.15.

Apterous female : Length 7.20-7.73; width 2.53-2.67. General colour pattern similar to male; differs from male in that the connexivum is reflexed with well developed and long connexival spines extending well beyond the tip of abdomen (Figs. 192 and 193). The connexiva black but the spines pale yellow and with very pointed tips. The female also possesses a spine-like tubercle, which is lacking in the male, at the posterior margin of the metanotum (Fig. 194). Other structures of female are similar to male. Antennal segments 1-4 measure : 3.53, 0.93, 1.07 and 0 80. Measurements of leg segments : front leg 3.53, 2.87, 1.27, 0.87 ; middle leg 10.3, 6.13, 2.73, 0.47 ; hind leg 9.87, 3.27, 0.10, 0.17.

Winged male : Length 7.20-7.33, width 2.00. Wings extend well beyond the tip of abdomen and the individuals measure more than 8mm in length with the wings. Pronotum with well expanded posterior lobe, which has a broadly rounded posterior margin. As in apterous forms, there is a short white stripe on the anterior lobe of pronotum and the posterior lobe is totally black (Fig. 187). The other structures are similar to the apterous male. Wing venation as in Figs. 189 and 190.

Biology : Eggs oval, with one end slightly more pointed than the other. There is a shallow but broad depression on the ventral surface. Size of egg averaging 1.33-1.47 × 0.43-0.53. The colour pattern of nymphs completely different from that of adult. They are light brown, with dark brown markings (Fig. 182). The 5th instar male can be separated from the female by the structure of the 8th abdominal ventrite, which is entire in the male but divided in female (Figs. 183 & 184). This species has only been collected from broad fast-flowing mountainous streams in Malaya and is not known to occur in any other types of habitats.

Genus Rheumatogonus Kirkaldy

This genus was first described by Kirkadly (1909) as a subgenus of *Ptilomera* but was raised to generic level by Esaki (1927), who gave a redescription of the type species *Rheumatogonus luzonicus*, as the original description of Kirkaldy was very incomplete. Esaki (*loc. cit.*) also synonymized *Jucundus* Distant (1910a) with *Rheumatogonus* Kirkaldy. In the same paper Esaki stated that a specimen of *Rheumatogonus custodiendus* (Distant) collected by Dover from the Malay Peninsula is in the British Museum collection. The original description of *R. custodiendus* by Distant (1910a) was based on a macropterous female and was very incomplete. The species of *Rheumatogonus* collected from Malaya was tentatively identified as *R. custodiendus* but Dr. Jon L. Herring (*per. com.*) informed us that our *Rheumatogonus* descriptions agree in all particulars with *R. intermedius* Hungerford, which was described from Sumatra (Hungerford, 1933), and was distinct from specimens of *R. custodiensis* from Ceylon, in the U.S. National Museum, that have been compared with the type.

18. Rheumatogonus intermedius Hungerford (Figs. 195 & 210)

Series studied : 23♂♂, 16♀♀, from Sungei Pelampus, Subang, Kuala Lampur, Selangor, 14.iii.1964 ; 1 winged ♂ from Sungei Buntu, Pontian, Johore, 20.iii.1963.

Other material examined : Singapore (4), Johore (16), Malacca (1), Negri Sembilan (4); Selangor (3); Penang (1).

Apterous male : Length 4.27-4.80; width 1.00-1.14. Light browh in ground colour with very little dark markings (Fig. 206). Body long and cylindrical; anterior margin of head broadly rounded, posterior margin almost straight; pronotum short, expanding laterally; mesonotum about 3 times as long as pronotum; metanotum slightly longer than pronotum. Intersegmental suture between meso-and metanota distinct. Abdomen long and thin, with 2 tufts of hairs at the postero-lateral corners of the 5th ventrite (Fig. 209). Connexivum narrow, reflexed, and pale. Parameres symmetrical and sickle-shaped with very pointed ends (Fig. 210).

Antennae much shorter than body, with the 1st segment the longest; segments 1-4 measure 1.20, 0.70, 0.61 and 0.57. Front leg with stout femur; tibia armed with several spines and broadened slightly towards the distal end; 1st tarsal segment slightly shorter than 2nd with claws arising near the apex of the latter (Fig. 198). Middle leg with femur much longer than tibia, posterior 2/3 of tibia lined with long hairs (Fig. 199); 1st tarsus about 5 times as long as 2nd (Fig. 201). Hind leg with tibia only about 1/3 the length of femur; 1st tarsus very short, 2nd tarsus about twice the length of the 1st (Fig. 202). Measurements of leg segments : front leg 2.00, 1.37, 0.27, 0.30 ; middle leg 5.40, 3.47, 1.03, 0.22; hind leg 5.40, 1.43, 0.07, 0.13.

Apterous female : Length 6.00-6.47; width 1.80-2.00. Much larger than males; colour pattern differs from the male in having a central dark brown stripe extending from the metanotum to the posterior end of abdomen (Fig. 195), also front femur pale yellow except for the distal end which is dark brown (Fig. 197); middle femur lined with long hairs along almost the entire length. Genital segments as shown in Fig. 208, other structural characteristics as in male. Antennal segments 1-4 measure 1.43, 0.83, 0.67 and 0.67 (Fig. 196). Lengths of leg segments : front leg 2.43, 1.70, 0.48, 0.43; middle leg 6.60, 4.13, 1.33, 0.27; hind leg 6.53, 5.00, 0.17, 0.30.

Winged female : Length 5.60; width 1.67. Colour pattern very similar to apterous female; pronotum expanded posteriorly with broadly rounded posterior margin (Fig. 20.7); hemelytra brown, projecting well beyond abdomen; venations as in Figs. 204 and 205. Antennal segments 1-4 measure 1.47, 0.77, 0.70 and 0.57.

Biology : Eggs range in size from 1.13-1.20×0.23-0.37, elongated, with convex dorsal surface and almost flat but broadly grooved ventral surface which may be an adaptation to its running stream habitat (Fig. 203). The

nymphs are more or less similar to the adults in colour pattern but paler (Fig. 200). This species is most commonly found in slow-flowing forest streams and often occur in quite large numbers. They have been collected from fast-flowing forest streams and lowland streams but never from still waters. The males are very much smaller than females and can easily be mistaken as nymphs. Winged forms are extremely rare, only one female has been collected so far.

Genus Halobates Eschscholtz

This genus is exclusively marine and is one of the rare true marine insects that occur in oceans miles away from land (Usinger, 1956). The fact that *Halobates* is always wingless suggests that it is possibly the ancestor or closely allied to the ancestor of fresh-water forms (White, 1883). Herring (1961) reviewed the genus in detail and described several new species.

Halobates is not at all common in Malayan seas. It is rarely seen close to the shore and then only in pairs or as early instar nymphs. Older nymphs and adults have been collected a few miles from the shore on several occasions.

19. Halobates hayanus White (Figs. 211-219)

Series studied : 4 ♂♂, 3 ♀♀, from a Kelong off Siglap Coast, Singapore, December, 1963.

Other material examined : Johore (1).

Apterous male : Length 4.53-4.67; width 1.60-1.67. Body dark brownish-grey above; head protruding well beyond eyes with 2 white spots at base (Fig. 212); thorax reddish-brown ventrally except prothorax which is white, ventral side of abdomen largely white. Antenna dark brown except base of 1st segment pale yellow; 1st segment longest, 3rd segment shortest (Fig. 217); segments 1-4 measure 1.43, 0.57, 0.40, 0.53. Front leg with femur stout and armed with spines on inner margin; tibia short with apical inner projection; 1st tarsus about half the length of 2nd (Fig. 216). Middle leg with femur and tibia armed with spines, posterior half of tibia and 1st tarsus lined with long hairs. Hind leg with trochanter, femur, tibia and tarsus all armed with spines; tarsal segments not separable externally. Genital segments highly modified as shown in Figs. 213 and 214. Measurements of leg segments: front leg 1.73. 1.27, 0.27, 0.53; middle leg 5.15, 3.40, 2.00, 0.63; hind leg 4.53, 1.97, 0.63.

Apterous female : Length 4.80-5.80; width 2.33-2.53. Longer and much wider than males, with similar colour pattern (Fig. 211). Venter largely white with head region and sides of mesosternum dark brown leaving a central triangular white area. Front femur, unlike the male, is not much broadened (Fig. 215). Genital segments as in Figs. 218 and 219. Antennal segments

1-4 measure 1.40, 0.53, 0.43, 0.53. Measurements of leg segments: front leg 2.03, 1.53, 9.40, 0.70; middle leg 5.33, 3.67, 2.03, 0.67; hind leg 4.13, 2.33, 0.78.

Biology : Numerous 1st instar nymphs were collected from a tidal pool, together with a pair of mating adults. The nymphs pale brown, with dark brown patches all over the body.

20. Halobates proavus White (Figs. 221-226)

Series studied : 32 ♂♂, 24 ♀♀, collected off Tioman Island, Pahang, August, 1964.

Other material examined : Singapore (1), Penang (2).

Apterous male : Length : 3.33-3.80 ; width 1.53-1.60. Body above dark brownish-grey, thorax covered with soft spines laterally ; head with 2 white markings at base, body with a longitudinal white stripe extending from pronotum to anterior half of abdomen (Fig. 24). Genital segments twisted and highly modifid (Figs. 225 & 226). Antenna brown with 1st segment the longest and 3rd segment the shortest (Fig. 220) ; segments 1-4 measure 1.17, 0.48, 0.33 and 0.50. Front leg with femur much stouter at proximal 2/3 and armed with several spines ; tibia with an inner distal projection ; 1st tarsus much shorter than the 2nd (Fig. 223). Middle leg with both femur and tibia armed with spine ; distal 2/3 of tibia and 1st tarsus lined with long hairs. Hind leg with all segments armed with short spines ; tarsal segments not separable externally. Measurements of leg segments : front leg 1.50, 1.10, 0.17, 0.40 ; middle leg 4.13, 2.93, 1.57, 0.53 ; hind leg 4.00, 1.67, 0.47.

Apterous female : Length 4.33-5.47 ; width 2.20-2.40. Much larger than males, with similar colour pattern. Posterior half of body much broadened but genital segments not modified (Figs. 221 & 222). Antennal segment 1-4 measure 1.30, 0.60, 0.43, and 1.50. Measurements of leg segments : front leg 1.80, 0.50, 0.30, 0.70 ; middle leg 5.07, 3.40, 1.83, 0.63 ; hind leg 4.13, 2.17, 0.65.

Biology : Egg white, opaque and elongate, with bluntly rounded ends, averaging in size from 1.07-1.17×0.33-0.40. Females dissected contained about 15 eggs. Nymphs light brown in ground colour, with dark brown markings.

21. Halobates germanus White (Figs. 227-238)

Series studied : 3♂♂, 4♀♀ collected off Siglap Coast, Singapore, 3.x1963.

Apterous male : Length 3.47-3 93 ; width 1.67. Silvery-black with 2 white markings at base of head (Fig. 227). Ventral surface of thorax silvery-black but abdomen has white stripes alternating with dark stripes. Genital segments twisted and greatly modified (Figs. 234 & 235). Antenna silvery-black with 1st segment the longest, 3rd segment the shortest (Fig. 229) ; segments 1-4 measure 1.03,0.40,0.23, and 0.53. Front leg with femur much broadened at the proximal 2/3 and armed with a row of 7-8 spines along the inner margin in addition to the silvery hairs ; tibia also armed with long spines along its inner margin and

short hairs along its outer margin; 1st tarsus much shorter than the 2nd with claws arising at basal 1/3 of the latter (Fig. 228). Middle leg with femur armed with short spines; distal 2/3 of tibia and 1st tarsus lined with long hairs (Fig. 231). Hind leg with femur much shorter than middle femur, tibia armed with spines and tarsal segments fused (Fig. 232). Measurements of leg segments: front leg 1.50, 1.17, 0.30, 0.43; middle leg 3.87, 2.40, 1.50, 0.40; hind leg 3.20, 1.67, 0.50.

Apterous female: Length 3.33-3.73; breadth 1.80-1.93. Shorter but broader than male with similar colour pattern (Fig. 237). Front femur unlike male, is not broadened (Fig. 238) and genital segments not modified (Fig. 237). Antennal segments 1-4 measure 0.97, 0.37, 0.27, and 0.53 (Fig. 233). Measurements of leg segments: front leg 1.53, 1.17, 0.33, 0.50; middle leg 4.13, 2.43, 1.53, 9.43; hind leg 3.13, 1.70, 0.50.

Biology: Nymphs are very different in colour pattern from the adults as shown in Fig. 230. They are light brown, with dark brown markings.

Genus **Ventidius** Distant

The genus *Ventidius*, first described by Distant (1910b), comprised nine species, two of which were recorded from Malaya (Hungerford and Matsuda, 1960b). Cheng (1965c) described four more species and recorded one other species from Malaya, bringing up the record to seven species. A key for the separation of the seven Malayan *Ventidius* was given by Cheng (*loc. cit.*).

22. Ventidius malayensis Hung. and Mat. (Figs. 239 and 245)

Series studied: 2♂♂, 4♀♀, Sg. Sedili Ulu, Johore, 4.x.1964.

Other material examined: Johore (4).

Apterous male: Length 3.73-4.00; width 2.73-2.87. Pale yellow in ground colour, with dark brown to black markings; anterior margin of head broadly rounded and produced slightly beyond the eyes; both anterior and posterior margins of pronotum medially concave; intersegmental suture between meso- and metanota distinct except the middle portion; connexivum broad; hind margin of metacetabula bilobed; paramere small and symmetrical. Antenna longer than body, with a tuft of hairs at the distal end of 3rd segment; segments 1-4 measure 1.97, 1.20, 067, and 0.83. Front leg with femur sparsely armed with black bristles, tibia fringed with dense hairs, 1st tarsus much shorter than 2nd which bears claws near the base; middle leg and hind leg both armed spines and hairs, 1st mid tarsus 5 times as long as 2nd (Fig. 245). 1st hind tarsus only twice as long as 2nd. Measurements of leg segments: front leg 1.63, 1.40, 0.10, 0.47; middle leg 4.47, 2.70, 1.34, 0.26; hind leg 4.80, 2.43, 0.45, 0.22.

Apterous female: Length 3.80-4.26; width 2.67-2.80. Similar to male in colour pattern (fig. 239); antenna shorter than body not surpassing distal end of hind coxae; segments 1-4 measure 1.57, 0.80, 0.57, and 0.77. Measurements

of leg segments: front leg 1.53, 1.27, 0.09, 0.44; middle leg 4.13, 2.37, 1.31, 0.26; hind leg 4.33, 2.37, 0.50, 0.25.

Biology : This is the largest of all Malayan *Ventidius* species and has only been collected from slow-flowing and lowland streams, never, in fast-flowing or standing waters.

23. Ventidius chinai Hung. and Mat. (Fig. 240)

This species has only been collected once from Malaya and an illustration of the female is given in Fig. 240. A very good description of this species was given by Hungerford and Matsuda (1960b).

24. Ventidius pulai Cheng (Fig. 241)

This species was described from Malaya on both winged and apterous specimens (Cheng, 1965c). The type locality is Gunong Pulai, Johore, and collections from Selangor or (1), Kelantan (1), and Pahang (1) have also been examined. It is black in ground colour, with white marking (Fig. 241). The parameres are large and asymmetrical, one being slightly longer and broader than the other.

25. Ventidius harrisoni Cheng (Fig. 242)

The type material of this species was collected from Singapore and other material examined included those from Johore (5) and Selangor (1). It is pale brown in ground colour, with dark brown to black markings (Fig. 242). The parameres are symmetrical and very small.

26. Ventidius hungerfordi Cheng (Fig. 243)

This is a pale yellow species with dark markings (Fig. 243). The type material, including a winged male, was all collected from Malaya (Cheng, 1965c). Other material has been collected from Johore (1) and Singapore (1). The parameres are large, with an indistinct tubercle at the rear end.

27. Ventidius pubescens Cheng (Fig. 244)

This species is characterised by its densely haired body and is the only *Ventidius* species of which both winged male and females besides the apterous forms were described (Cheng, 1965c). It is pale yellow in ground colour and has less dark markings than most *Ventidius* (Fig. 244). Parameres large and symmetrical and twisted characteristically in the middle. The type material was collected from Johore and collections from Malacca (1) and Negri Sembilan (1) were also examined.

28. Ventidius modulatus Lundblad

Lundblad (1933) described this species from four males collected from Java. The female was described by Cheng (1965c) from Pahang, Malaya. The body is largely black ; parameres are large and symmetrical.

Genus **Esakia** Lundblad

This genus was described by Lundblad (1933) for the species *Esakia ventidoides* from Sumatra. Hungerford and Matsuda (1958a) described two other species for this genus and gave a key for separation of these three species. Three *Esakia* species have been collected from Malaya and were described by Cheng (1966a), bringing the total to six.

29. Esakia fernandoi Cheng (Fig. 246 & 249)

This species was described from material collected from Sungai Mupoh, Johore. It is distinct from all other known species of *Esakia* in possessing a horseshoe-shaped white marking on the meso- and metanota (Fig. 246), in the extremely long middle femur and in the absence of long hairs on middle tibia (Cheng, 1966a). The male antenna, like all *Esakia* spp., has the 3rd segment modified (Fig. 249). Besides the type material, specimens from Singapore (1) and Johore (2) have also been examined. The parameres large and symmetrical with very pointed tips, which are curved inwards.

30. Esakia johorensis Cheng (Fig. 247)

This species was described from material collected from Johore State and has only been collected from this state so far. The colour pattern of male (Fig. 247) is quite different from female, with the white marking on the meso- and metanota of male much smaller than that of the female. Parameres symmetrical and more or less leaf-shaped. The type material included a winged specimen, which is of rather rare occurrence in this genus.

31. Esakia lundbladi Cheng (Fig. 248)

This species was described from material collected from several localities in Malaya (Cheng, 1966a). It is black in ground colour, with pale markings on the head and thorax (Fig. 248). Parameres symmetrical and with pointed tips.

Genus **Metrocoris** Mayr

Species of this genus are characteristic of running waters. They are pale yellow in ground colour, with beautiful black markings. Three species occur in Malaya : *Metrocoris nigrofasciatus* Distant described from Malaya by Distant

(1903) from a single male; *M. strangulator* Bredd. and *M. tenuicornis* Esaki. These three species can be separated by the following key :

1. Male front femur not much broader than female ; without prominent teeth along inner margin at distal end ... ... **tenuicornis**
   Male front femur much broader than female ; with prominent teeth at distal end along inner margin **2**
2. Male front femur with one large tooth and several small teeth ... **nigrofasciatus**
   Male front femur with two groups of teeth separated by a gap, each group has one large tooth, with or without smaller teeth ... ... **strangulator**

32. Metrocoris nigrofasciatus Distant (Fig. 250-262)

Series studied : 10♂♂, 21♀♀, from stream at Gunong Pulai, Johore, 17.iii.1963.

Other material examined : Johore (1), Negri Sembilan (3), Selangor (5), Perak (1), Pahang (1).

Apterous male : Length 5.60-6.33 ; width 2.53-2.67. Yellow in ground colour with dark brown to black markings (Fig. 250). Head protruding well beyond eyes ; pronotum as long as head, not expanded laterally ; mesonotum about twice as long as pronotum ; metanotum slightly shorter than pronotum. Venter pale ; metasternum a small triangular piece ; omphalium distinct ; 8th ventrite with 2 tufts of hairs (Fig. 262). Rostrum short, slightly surpassing posterior margin of prosternum. Antennal segments 1-4 measure 2.53, 0.93, 1.00, 0.67. Front leg with femur greatly broadened, 2½ times as stout as tibia ; tibia dark brown with conspicuous inner tooth at distal end ; tarsal segments dark brown with claws arising near apex of 2nd tarsus (Fig. 256). Middle leg largely brown, femur stouter than tibia and armed with black tubercles ; 1st tarsus about 8 times as long as 2nd (Fig. 255). Hind leg also brown, femur with several black tubercles ; tibia shorter and thinner than femur ; tarsal segments short (Fig. 254). Measurements of leg segments : front leg 3.00,2.43,0.13,0.70 ; middle leg 8.00,5.00,2.33,0.30 ; hind leg 7.07,3.80,0.27,0.37.

Apterous female : Length 4.33-4.87 ; width 2.27-2.60. Much smaller than male, but with similar colour pattern. Front femur, unlike in the male, not enlarged (Fig. 251). Genital segment as in Figs. 260 and 261. Antennae with 4th segment shortest ; segments 1-4 measure 1.57,0.67,0.73, and 0.53. Measurements of leg segments : front leg 1.93, 1.67, 0.17, 0.50 ; middle leg 5.07, 3.53, 2.00, 0.30 ; hind leg 4.60, 2.83, 0.23, 0.33.

Winged male : Length 6.26-6.40 ; width 2.00-2.20. Colour pattern differs from apterous forms ; head with central brown speck as in apterous forms but pronotum with central T-shaped brown marking and 2 brown longitudinal stripes one on each side of the 'T' (Fig. 253). Wings dark brown, extending well beyond the tip of the abdomen ; embolium dark brown and haired (Fig. 258) ; hind wing with large anal lobe (Fig. 259). Other structural details similar to apterous male.

Winged female : Length 6.06; width 2.33. Similar to winged male in colour pattern ; structural details as in apterous female.

Biology : Eggs white, opaque and oval ; averaging 1.10-1.23×0.33-0.40. This species inhabits fast-flowing streams in Malaya and is the only stream gerrid in which winged forms are common.

33. Metrocoris tenuicornis Esaki (Figs. 263-269)

Series studied : 2♂♂, 2♀♀ from stream north of Pierce Reservoir, Singapore, 31.v. 1963.

Other material examined : Singapore (3), Johore (1), Negri Sembilan (1), Selangor (1).

Apterous male : Length 4.67-5.33 ; width 2.20-2.40. Colour similar to *M. nigrofasciatus*. Front femur not greatly broadened with an inconspicuous blunt tooth at inner distal angle (Fig. 267). Antennal segments 2 and 4 equal in length ; segments 1-4 measure 1.77, 0.68, 0.73, and 0.60. Genital segments and paramere as in Figs. 266, 268 & 269. Measurements of leg segments : front leg 1 97, 1.70, 0.10, 0.50 ; middle leg 6.47, 5.73, 1.03, 1.17 ; hind leg 6.40, 3.47, 0 30, 0.23.

Apterous female : Length 3.87-4.20 ; width 2.13. Smaller than male, with very similar colour pattern. Antennal segments 1-4 measure 1.37, 0.47, 0.63, and 0.50 (Fig. 265). Genital segments as in Figs. 263 and 264. Measurement of leg segments : front leg 1.60, 1.27, 0.10, 0.38 ; middle leg 4.13, 3.20, 1.50, 0.20 ; hind leg 3.80, 2.27, 0.23, 0.20.

Biology : This species is commonly found in slow-flowing forest streams and there is much size variation in specimens from different parts of Malaya. The life history of this species has been studied by Cheng (1966*c*).

34. Metrocoris strangulator Bredd. (Figs. 270-276)

Series studied : 9♂♂, 16♀♀, from stream in Philip Farm, Tana Rata, Cameron Highlands, Pahang, 31.xii.1964.

Other material examined : Pahang (3).

Apterous male : Length 5 60-6.8) ; width 2.60-3.67. Very similar in colour pattern and general body structures to the other two species of *Metrocoris*, but can be easily separated from them by its differently modified front leg with greatly expanded femur, which has two groups of tubercles separated by a gap, and tibia with several small teeth at the proximal end (Figs. 273 and 274). The genital segments are shown in Figs. 270 and 271 ; paramere leaf-shaped with very pointed tips (Fig. 272).

Biology : This species has so far only been collected from mountainous streams in Malaya. Winged forms are not known.

Genus Cryptobates Esaki

This genus was erected by Esaki (1929) for *Gerris raja* Distant. Only two species are known namely, *Cryptobates raja* (Dist.) from India, and *C. kuiterti* Hung. and Mat. (1958b) from Burma.

35. Cryptobates raja (Dist.) (Figs. 277-291)

Material studied : 1 ♂, 3 ♀♀ from Sungei Seletar, Singapore, 16.iv.1964 ; 2 females (1 winged) from stream at 10½ miles, Mersing-Endau Road, Johore, 31.vii.1963.

Apterous male : Length 3.07 ; width 1.37. Reddish-brown in ground colour, with median dark brown longitudinal stripe extending from anterior margin of pronotum to anterior half of abdomen ; venter brownish-yellow. Head projecting well beyond eyes ; pronotum shorter than head with almost straight anterior but convex posterior margin ; mesonotum about 2½ times as long as pronotum; first 2 abdominal segments not separable from metanotum; abdominal segments 3-7 elevated forming an arch, segment 8 with deeply concave posterior margin whilst 9 has very rounded posterior margin (Fig. 291). Genital segments not modified (Fig. 286) ; parameres symmetrical, with pointed ends and twisted in the middle (Fig. 290). Rostrum very long, reaching anterior ¼ of mesosternum. Antenna brown. 1st segment stouter than the others ; segments 1-4 measure 0.65, 0.40. 0.90 and 0.80. Legs all brown but intensity of colour increases towards the distal end of all segments. Front leg with tibia expanding slightly towards the distal end. 1st tarsus very much shorter than 2nd with claws arising at ⅓ from apex of the 2nd. Middle leg with femur stouter but shorter than tibia ; hind leg with femur very much longer than tibia. Measurements of leg segments : front leg 1.07, 0.09, 0.10, 0.28 ; middle leg 1.87, 2.07, 0.67, 0.70 ; hind leg 1.93, 0.93, 0.20, 0.27.

Apterous female : Length 2.83-3.13 ; width 1.43-1.63. Similar to male in colour pattern (Fig. 277), and structures of the leg (Figs. 279, 282 & 287). Third antennal segment, unlike in male is slightly shorter than the 4th (Fig. 278) ; antennal segments 1-4 measure 0.53. 0.37, 0.83 and 0.90. Abdomen also arched (Fig. 255) ; genital segment shown in Fig. 283. Measurements of leg segments : front leg 0.27, 0.83, 0.10, 0.30 ; middle leg 1.83, 2.03, 0.70 ; hind leg 1.97. 0.93, 0.22, 0.27.

Winged female : Length 3.10, width 1.37. Similar to apterous females in colour pattern and general body structure, except pronotum greatly expanded posteriorly (Fig. 281). Hemelytra brown with distinct embolium, distal membranous portions of both fore and hind wings were broken off in the specimen collected (Figs. 288 & 289).

Biology : Eggs ovoid with bluntly rounded tips (Fig. 284) range in size from 0.83-0.87 × 0.23-0.30. This species has only been found in slow-flowing streams amongst the vegetation near the edges of the stream.

Genus Rhagadotarsus Bredd.

This genus is only represented by one species, which is very widely distributed in the Oriental Region (Hungerford and Matsuda, 1960a). One winged male has been recorded from Malaya before by Esaki (1930).

36. Rhagadotarsus kraepelini Bredd. (Figs. 292-306)

Series studied : 6♂♂, 6♀♀ from Potian Reservoir, Johore, 18.iv.1963 ; 6♂♂ (winged), 2 ♀♀ (winged), from Clementi Road fish-pond, Singapore, 4.iv.1963.

Other material examined : Singapore (5), Johore (1), Malacca (2), Pahang (1), Selangor (2), Trengganau (2).

Apterous male : Length 3.20-3.60 ; width 1.13-1.20. Body above largely black with a white marking at base of head and a silvery-blue patch on thorax and anterior part of the abdomen (Fig 292) ; genital segments black, ending in a rather pointed projection (Figs. 305 and 306). Antenna dark brown with 1st segment the longest and 2nd the shortest (Fig. 296) ; segments 1-4 measure 0.50, 0.23, 0.38 and 0.40. Front leg with base white, anterior half of femur pale yellow and posterior half brown ; tibia dark brown, extremely short and greatly expanded at distal end (Fig. 293) ; tarsi dark brown, 1st segment extremely short ; 2nd cleft at the tip (Fig. 294). Middle leg with coxa, trochanter and base of femur white, remaining parts brown ; femur and tarsus sparsely armed with spines ; 1st tarsus much longer than 2nd, with few spines (Fig. 295). Hind leg with colour pattern similar to middle leg ; femur thin, tibia very short, tarsal segments almost equal (Fig. 301). Measurements of leg segments : front leg 1.17, 0.47, 0.03, 0.23 ; middle leg 3.47, 2.73, 1.10, 0.57 ; hind leg 2.77, 1.30, 0.23, 0.25.

Apterous female : Length 3.73-3.93 ; width 1.20. Colour pattern and general body structure similar to male ; tip of abdomen very much more pointed (Figs. 303 and 304). Antennal segments 1-4 measure 0.47, 0.23, 0.37, and 0.37. Measurements of leg segments : front leg 1.13, 0.47, 0.03, 0.23 ; middle leg 3.47, 2.80, 1.20, 0.60 ; hind leg 2.73, 1.30, 0.23, 0.27.

Winged male : length 3.47-3.93 ; width 1.27-1.33 ; body black except for white marking on head ; general body structures similar to apterous male. Wings dark brown, not extending beyond the tip of the abdomen ; wing venations shown in Figs. 299 and 300.

Winged female : Length 3.73-3.80 ; width 1.22. Colour pattern similar to winged male (Fig. 302) ; other structural details as in apterous female.

Biology : Eggs very elongated with rather pointed ends (Fig. 298) ; females dissected contained about 10 eggs ranging in size from 0.97-1.00 × 0.17-0.20. Nymphs light brown, with dark brown markings and appear very different from adults (Fig. 297) ; wing-buds often found in 5th instar nymphs. This species frequents fish-ponds, water reservoirs, lakes and temporary pools, but

is seldom found in flowing waters and then only in quieter portions near the edges of the streams. The life history of this species has been studied by Hoffmann (1936 b).

Notes on Distribution and Biology

Collection of Malayan Gerridae, made during the period 1960-1965 including a more intensive survey during 1963-1965, has revealed a fauna more numerous in species than in any other area of similar size. This richness of the fauna is evident from a comparison with the fauna of aquatic insects of a number of temperate and tropical countries. We have chosen countries where the fauna has either been studied extensively (Germany, Britain, Sweden), or to an extent comparable to that of Malaya (Indonesia, Australia, Ceylon). Table I gives the number of species of 4 selected families of aquatic Hemiptera known from each of these countries. The data for this compilation have been taken from Lundblad (1933), Macan (1956), Mendis and Fernando (1962), Fernando (1963), Leong (1962), Fernando and Leong (1962, 1963), Fernando and Cheng (1963), and Cheng (1965a).

The reasons for the abundance of gerrid species in Malaya may lie in the geological history. Corner (1960) showed that the Malayan region has been the meeting place for the Australasian and the Indo-Chinese floras and that the flora of Malaya is very rich in certain groups. The abundance of suitable habitats must play a very significant part in the evolution of new species. The lack of a marked dry season in the Malay Peninsula would also enable gerrids to avoid the need for aestivation which of necessity must be terrestrial.

The majority of the Malayan Gerridae are freshwater forms, except for the three marine genera, *Halobates*, *Hermatobates*, and *Stenobates*. *Halobates* and *Hermatobates* are true marine insects and are often found miles away from the shore (Usinger, 1956; Herring, 1961). Specimens of *Halobates*, collected near the shore during the present survey, were almost without exception 1st and 2nd instars nymphs and a few mating pairs; large numbers of adults were however, collected only from localities several miles away from land. *Stenobates*, described from Singapore by Esaki (1926), has never been collected since. It was reported to be a shore or brackish-water species.

The rest of the Malayan Gerridae fall roughly into 2 major categories, the running water and the still water forms. A strict line cannot, however, be drawn between these two types of habitats, because still waters are often found as portions of a stream and gerrids which spend part of their time moving from such still to running portions of the habitat cannot be conveniently classified. For the purposes of this study, the running waters are further divided into fast-flowing forest streams, slow-flowing forest streams, peaty streams which are acidic, lowland streams which are mostly muddy, and canals; the still waters are divided into 5 categories : freshwater reservoirs, fish-ponds, lakes, temporary pools and rice fields. Table 2 gives the occurrence

of each gerrid species known in each of these habitats. Unfortunately very little data are available in the literature on the ecology of aquatic insects as regards to their habitats. Lundblad (1933) gave rather extensive data on the habitats of some species also based on physical features alone. Undoubtedly in addition to the water flow other factors such as degree of shade, type of emergent vegetation, availability of food, and other physical characteristics of the habitat must influence the distribution of these aquatic insects.

If we examine the composition of the freshwater gerrid fauna of Malaya we find that the stream dwelling forms predominate and are usually endemic, and the still water forms are almost without exception widely distributed species (see Table II). It seems reasonable to assume that the tropical forest habitat has provided a very suitable situation for the evolution of a rich stream gerrid fauna which Malaya shares with Indonesia and perhaps to a lesser extent with Thailand, Burma and Eastern India. The known distribution of Malayan gerrid species is summarised in Table III.

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ADDENDUM

Since the completion of the manuscript, the following species have been described from Malaya (Miyamoto, S. 1967. Gerridae of Thailand and North Borneo taken by the Joint Thai-Japanese Biological Expedition 1961-62. *Nature and Life in Southeast Asia* **5** : 217-257) :—

Amemboa brevifasciata Miyamoto—our *Amemboa* sp. 1.

Rhyacobates imadatei Miyamoto—one nymph from Templar Park, Kuala Lumpur was placed in this species by Miyamoto (loc.cit.). We have recorded a very closely related species *Pleciobates tuberculatus* from streams in the same area.

Tenagogonus quinquemaculatus Miyamoto—This species is very similar to our material identified as *T. pravipes*.

REFERENCES

ANDERSEN, N.M. 1964. The genus *Tenagogonus* Stål in the collection of the Zoological Museum of Copenhagen (Hemiptera : Gerridae). *Ent. Medd.* **32** : 321-334.

DEN BOER, M.H. 1965. Revisionary notes on the genus *Metrocoris* Mayr (Heteroptera, Gerridae), with descriptions of four new species. *Zool. Verh.* **74** : 1-38.

CHENG, L. 1965a. Studies on the taxonomy and biology of the Malayan Gerridae (Hemiptera : Heteroptera). M.Sc. thesis, University of Singapore.

CHENG, L. 1965b. The Malayan Pond-skaters. *Malay. Nat. J.* **19**: 115-123.

CHENG, L. 1965c. The genus *Ventidius* Distant (Heteroptera : Gerridae) in Malaya with the description of four new species. *Proc. R. Ent. Soc. London* (B) **34** : 153-163.

CHENG, L. 1966a. Three new species of *Esakia* Lundblad (Heteroptera : Gerridae) from Malaya. *Proc. R. Ent. Soc. London* (B) **35** : 16-22.

CHENG, L. 1966b. Studies on the biology of the Gerridae (Hem., Heteroptera) I. Observations on the feeding of *Limnogonus fossarum* (F.). *Ent. Monthly Mag.* **102** : 121.128.

CHENG, L. 1966c. Studies on the biology of the Gerridae (Hem., Heteroptera) II. The life history of *Metrocoris tenuicornis* Esaki. *Ent. Monthly Mag.* **102** : 273-282.

CHENG, L. 1967. A curious marine insect, *Hermatobates. Malay. Nat.* **19** : 283-285.

CORNER, E.J.H. 1960. The Malayan flora. *Proc. Cent. Bicent. Congr. Biol. Singapore* (1958) : 21-24.

DISTANT, W.L. 1903. Report on the Rhynchota : PT. I. Heteroptera. *Fasciculi Malayensis* **48** : 219-274.

DISTANT, W.L. 1910a. The Fauna of British India, Ceylon and Burma. Vol. V. Rhynchota Heteroptera : Appendix, 141-166.

DISTANT, W.L. 1910b. Some undescribed Gerridae. *Ann. Mag. Nat. Hist.* **8** : 140-153.

DOVER, C. 1929. Notes on a collection of aquatic Rhynchota from the Buitenzorg Museum. *Treubia* **10** : 65-72.

ESAKI, T. 1925. New or little-known water striders from the Oriental Region. *Philipine J. Sci.* **29** : 57-66.

ESAKI, T. 1926. The water striders of the subfamily Halobatinae in the Hungarian National Museum. *Ann. Mus. Nat. Hungarici* **23** : 117-164.

ESAKI, T. 1927. Revision of the *Ptilomera* group of the Gerridae, with the descriptions of three new species. *Eos. Rev. Esp. Ent.* **3** : 251-268.

ESAKI, T. 1928. New or little-known Gerridae. I. Ceylonese species. *Ann Mag. Nat. Hist.* **10** : 505-513.

ESAKI, T. 1929. New or little-known Gerridae. II. Indian species. *Ann. Mag. Nat. Hist.* **10** : 412-419.

ESAKI, T. 1930. New or little known Gerridae from the Malay Peninsula. *J.F.M.S. Mus.* **16** : 13-24.

FERNANDO, C.H. 1959. Some observations on aquatic insects found in temporary and artificial habitats in Ceylon. *Ceylon J. Sci.* **2** : 1-4.

FERNANDO, C.H. 1960. Colonization of freshwater habitats with special reference to aquatic insects. *Proc. Cent. Bicent. Congr. Biol. Singapore* (1958) : 182-186.

FERNANDO, C.H. 1961. Notes on aquatic insects caught at light in Malaya with a discussion of their distribution and dispersal. *Bull. Nat. Mus. Biol. Singapore* **30** : 19-31.

FERNANDO, C.H. 1963*a*. Notes on aquatic insects colonizing an isolated pond in Mawai, Johore. *Bull. Nat. Mus. Singapore* **32** : 82-89.

FERNANDO, C.H. 1963*b*. Records of insects caught at light in Kahang, Johore. *Bull. Nat. Mus. Singapore* **32** : 159-160.

FERNANDO, C.H. 1963*c*. The distribution of aquatic insects in South East Asia with special reference to their dispersal. *Bull. Nat. Mus. Singapore* **32** : 72-79.

FERNANDO, C.H. & L. CHENG 1963. Guide to Malayan water-bugs (Hemiptera-Heteroptera) with keys to the genera. Cyclostyled copy issued by Department of Zoology, University of Singapore. 33 pp.

ERNANDO, C.H & L. CHENG. A preliminary study on the fauna and distribution of aquatic Hemiptera in Malaya and Singapore, *Bull. Nat. Mus. Singapore* (In press).

FERNANDO, C.H. & C. Y. LEONG 1962. The genus *Anisops* (Hemiptera : Notonectidae) in Ceylon. *J. Bombay Nat. Hist. Soc.* **59** : 513-519.

FERNANDO, C.H. & C.Y. LEONG 1963. Further studies on the water bugs of the genus *Anisops* Hemiptera : Notonectidae) in Ceylon. *Bull. Fish. Res. Stn. Ceylon.* **16** : 39-48.

HERRING, J.L. 1961. The genus *Halobates* (Hemiptera : Gerridae). *Pacific Ins.* **3** : 223-305.

HOFFMANN, W.E. 1936*a*. The life history of *Limnogonus fossarum* (Fabr.) in Canton (Hemiptera : Gerridae). *Lingnan Sci. J.* **15** : 285-299.

HOFFMANN, W.E. 1936*b*. Life history notes on *Rhagadotarus kraepelini* Breddin (Hemiptera : Gerridae) in Canton. *Lingnan Sci. J.* **15** : 477-482.

HUNGERFORD, H B. 1933. Some aquatic and semi-aquatic Hemiptera from Sumatra. *Misc. Zool. Sumatrana* **75** : 1-5.

HUNGERFORD, H.B. & MATSUDA, R. 1958*a*. The genus *Esakia* Lundblad with 2 new species (Heteroptera : Gerridae). *J. Kansas Ent. Soc* **31** : 193-197.

HUNGERFORD, H.B. & MATSUDA, R. 1958*b*. A new species of *Cryptobates* Esaki from Burma. (Hemiptera : Gerridae). *J. Kansas Ent. Soc.* **31** : 246.248.

HUNGERFORD, H.B. & MATSUDA, R. 1958*c*. The *Tenagogonus-Limnometra* complex of the Gerridae. *Kansas Univ. Sci. Bull.* **39** : 371-457.

HUNGERFOAD, H.B. & MATSUDA, R 1959. Concerning the genus *Limnogonus* and a new subgenus (Heteropetra : Gerridae). *J. Kansas Ent. Soc.* **32** : 40-41.

HUNGERFORD, H B. & MATSUDA, R. 1960*a*. Key to subfamilies, tribes, genera and subgenera of the Gerridae of the world. *Kansas Univ. Sci. Bull.* **41** : 3-24.

HUNGERFORD, H B. & MATSUDA, R. 1960*b*. Concerning the genus *Ventidius* and 5 new species (Heteroptera : Gerridae). *Kansas Univ. Sci. Bull.* **40** : 323-343.

HUNGERFORD, H.B. & MATSUDA, R. 1962. The genus *Cylindrostethus* Fieber from the Eastern Hemisphere). *Kansas Univ. Sci. Bull.* **43**: 83-111.

HUNGERFORD, H.B. & MATSUDA, R. 1965, The genus *Ptilomera* Amyot and Serville (Gerridae : Hemiptera). *Kansas Univ. Sci. Bull.* **45** : 397-515.

KIRKALDY, G.W. 1909. Hemiptera, old and new. *Canadian Ent.* **41** : 389.

LEONG, C.Y. 1962. Studies on the taxonomy and biology of some aquatic Hemiptera-Heteroptera of Malaya. M.Sc. thesis, University of Singapore.

LUNDBLAD, O. 1933. Zur Kenntnis der aquatilen und semiaquatilen Hemipteren von Sumatra, Java und Bali. *Arch. Hydrobiol. Suppl.* **12** : 11-195 ; 263-488,

MACAN, T.T. 1956. A revised key to the British water bugs (Hemiptera-Heteroptera). *Freshwater Biol. Assn. Sci. Publ.* **16** : 1-73.

MATSUDA, R. 1960. Morphology, evolution and a classification of the Gerridae (Hemiptera-Heteroptera). *Kansas Univ. Sci. Bull.* **41** : 25-631.

MAYR, G. 1865. (Quoted in Hungerford, H.B. & Matsuda, R., 1962).

MENDIS, A.S. & FERNANDO, C.H, 1962. A guide to the freshwater fauna of Ceylon. *Bull. Fish. Res. Stn. Ceylon.* **12** : 160pp.

USINGER, R.L. 1956. Aquatic Insects of California. U. California Press. 508 pp.

WHITE, B. 1883. Report on the pelagic Hemiptera procured during the voyage of HMS Challenger in the year 1873-1876. *Report Voyage Challenger* (*Zool.*) **7** : 1-82.

TABLE I. NUMBER OF AQUATIC HEMIPTERA IN SOME TEMPERATE AND TROPICAL COUNTRIES

	Nepidae	*Notonectidae*	*Veliidae*	*Gerridae*
Australia	5	13	6	7
Sweden	2	4	2	8
Britain	2	5	8	10
Germany	2	4	3	10
Sumatra	5	6	7	7
Java	8	12	7	13
Ceylon	10	17	6	21
Malaya	11	13	8	41

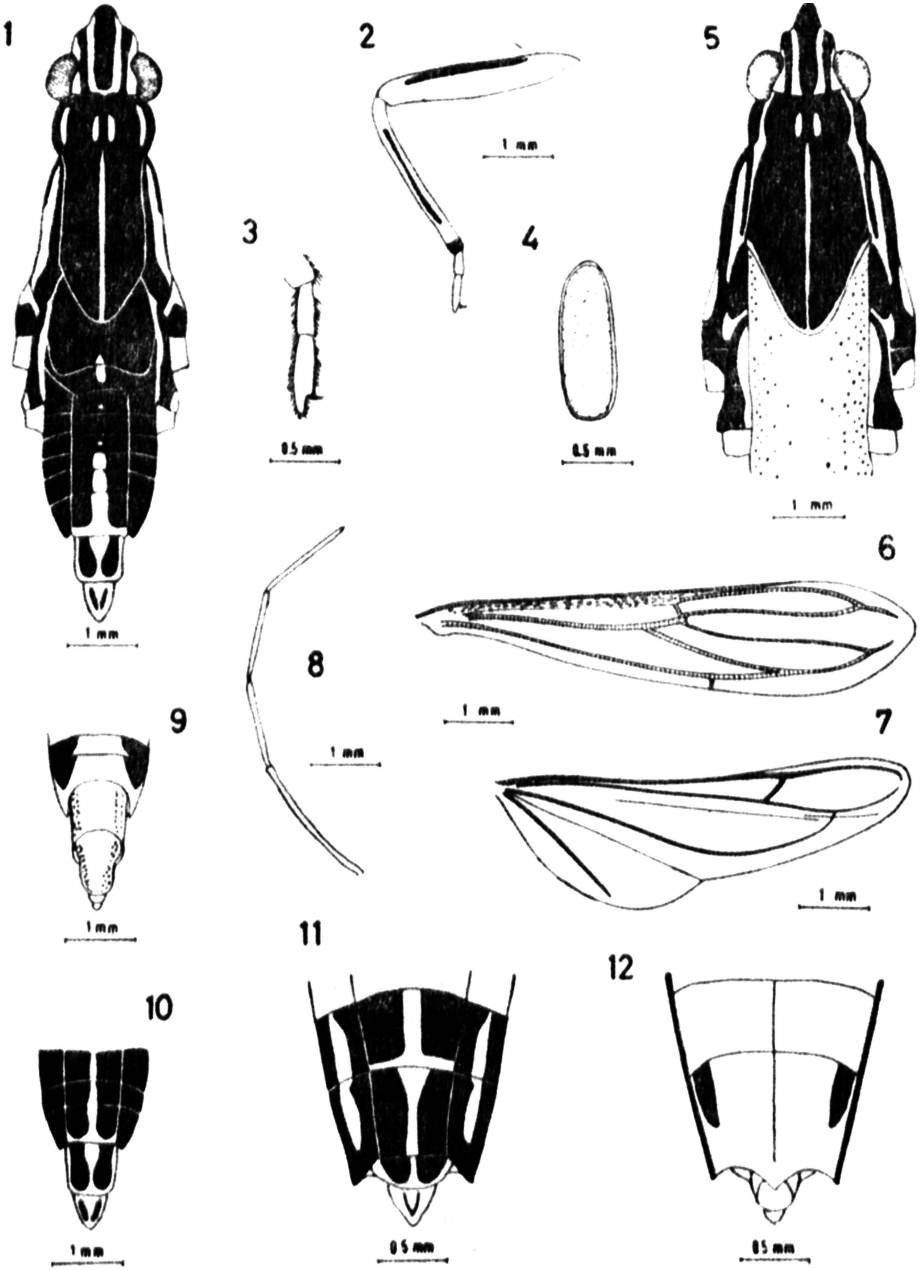
TABLE II. OCCURRENCE OF MALAYAN GERRID SPECIES IN DIFFERENT CATEGORIES OF FRESHWATER HABITATS. (EACH ENTRY SHOWS THE NUMBER OF COLLECTIONS OF THAT SPECIES FROM THE HABITAT)

	Running water				Still Water					
Habitats	Fast flowing forest stream	Slow flowing forest stream	Peaty stream (Blackwater-acidic)	Lowland streams (non-acidic)	Canals	Freshwater reservoirs	Fish ponds	Lakes	Temporary pools	Rice fields
No. studied	45	51	8	19	4	7	9	13	13	5
Limnogonus fossarum		6	10	5	4	2	5	2	23	2
L. parvulus		1	4	2	2	3	1	2	5	1
L. nitidus							2		1	1
Rhagadotarsus kraepelini		1				3	3	2	5	
Gerris adelaides					1		2	1	1	1
Tenagogonus parvipes		2	1	1			1			
Limnometra ciliata		1							1	
L. femorata		2								
L. analyamene	1	1								
L. insularis		5								
L. octopunctata		2								
Amemboa sp. 1	2									
A. horvathi	2	2		1	1					
A. javanica	1									
Cylindrostethus costalis		3	3	1						
C. scrutator		7		6						
Ptilomera lundbladi	30	14		2						
Rheumatogonus intermedius	5	15	1	8						
**Pleciobates tuberculatus*	5									
**Ventidius pulai*	5									
**V. harrisoni*		10								
**V. hungerfordi*	1	3								
**V. pubescens*	2	1		4						
V. modulatus			1							
**V. malayensis*		3		3						
**V. chinai*		1								
**Esakia fernandoi*		2		2						
**E. johorensis*		1		1						
**E. lundbladi*				1						
Metrocoris nigrofasciatus	13	2								
M. tenuicornis		4		1						
M. strangulator	4									
Cryptobates raja		1		1						

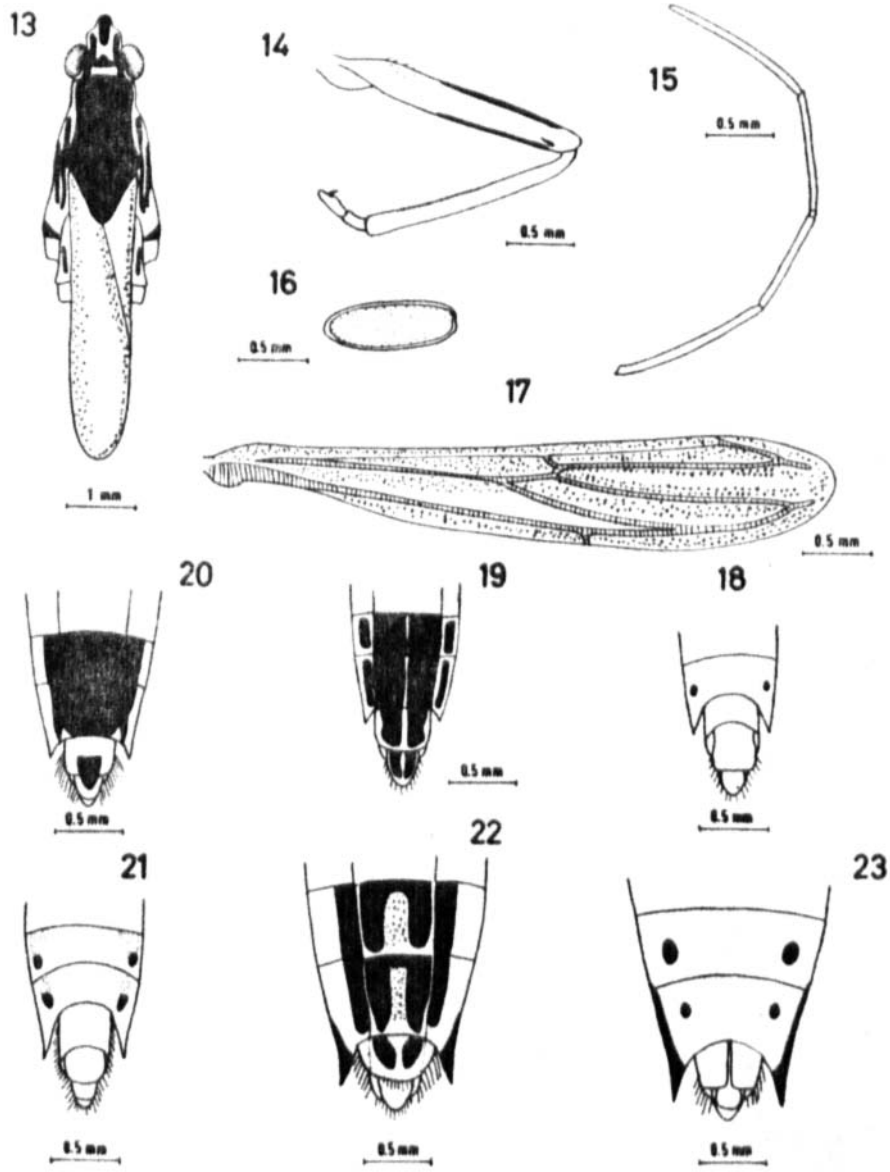
* *species known only from Malaya.*

TABLE III. RANGE OF DISTRIBUTION OF MALAYAN GERRIDAE

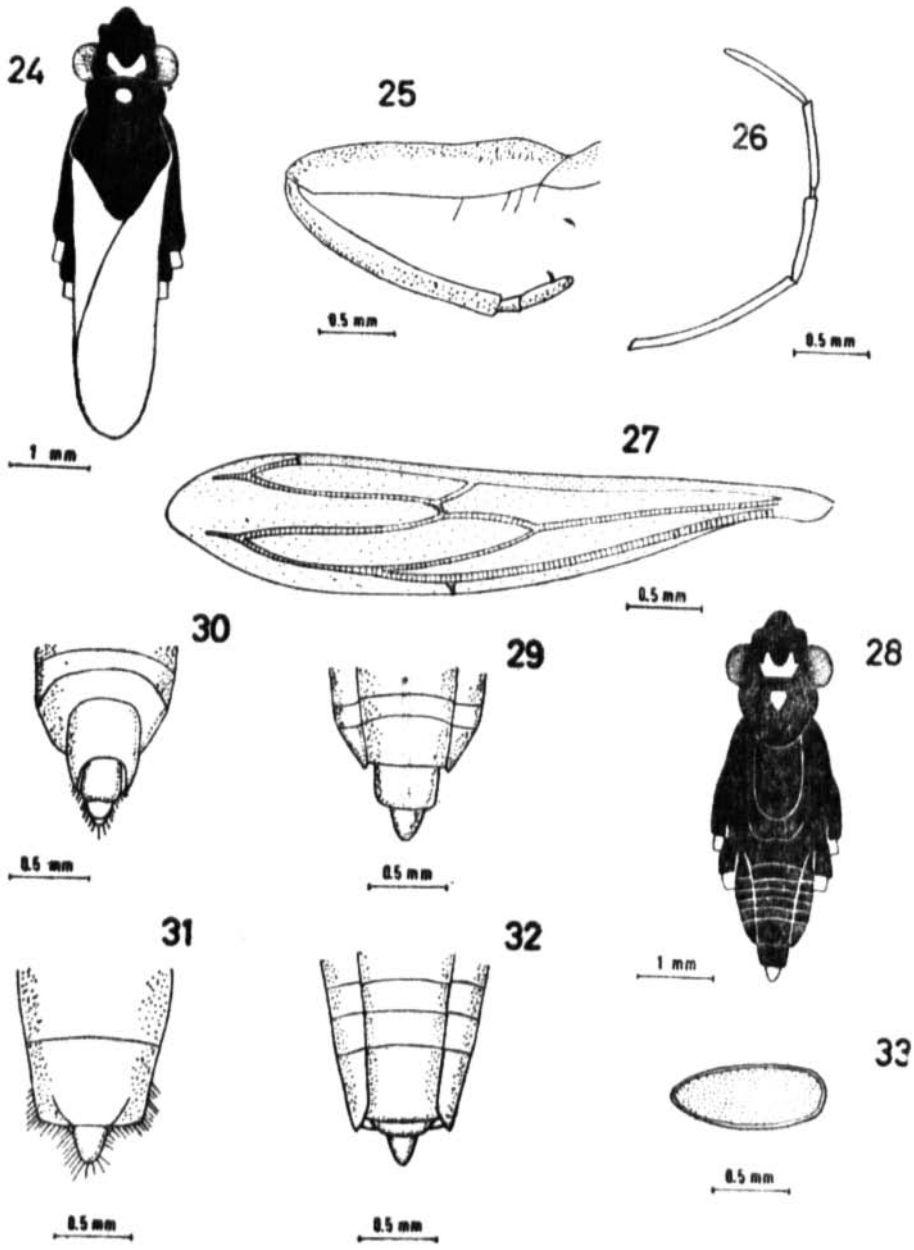
Species	*Range*
Limnogonus fossarum	Ceylon, China, Formosa, India, Java, Malaya, Philippines, Sumatra.
L. nitidus	Ceylon, India, Java, Malaya.
L. parvulus	Arabia, Ceylon, China, India, Java, Malaya.
Tenagogonus pravipes	Java, Malaya.
Limnometra anadymene	Burma, Ceylon, India, Malaya, Philippines
L. insularis	Burma, Java, Malaya, Pulo-Laout near Borneo, Sumatra.
L. femorata	Banguey Islands, Borneo, Malaya, Philippines
L. octopunctata	Malaya, Sumatra.
L. ciliata	Borneo, Celebes, Fiji Islands, Java, Lesser Sunda
Amemboa sp. 1.	Islands, Malaya, Moluccas, New Britain, New
A. javanica	Guinea, Solomon Islands, Sumatra, Thailand.
A. horvathi	Malaya.
Cylindrostethus costalis	Java, Malaya.
C. scrutator	India, Malaya.
Gerris adelaides	Borneo, Burma, Cambodia, Malaya, Thailand
Ptilomera lundbladi	Burma, India, Java, Malaya, Sumatra Ceylon, China, India, Malaya.
Pleciobates tuberculatus	Java, Malaya.
Rheumatogonus intermedius	Malaya.
Rhyocobates sp.	Malaya, Sumatra.
Halobates proavus	Malaya.
H. hayanus	Gilolo, Malaya, New Guinea.
H. germanus	Arabian Sea, New Guinea, Red Sea, Singapore.
Ventidius pulai	China Sea, Pacific Ocean, Singapore.
V. harrisoni	Malaya.
V. hungerfordi	Malaya.
V. pubescens	Malaya.
V. modulatus	Malaya.
V. malayensis	Malaya, Sumatra.
V. chinai	Malaya.
Esakia sp.	Malaya.
E. fernandoi	Malaya.
E. johorensis	Malaya,
E. lundbladi	Malaya.
Metrocoris nigrofasciatus	Malaya.
M. tenuicornis	India, Malaya.
M. strangulator	Annam. Borneo, China, Java, Laos, Malaya Java, Malaya.
Cryptobates raja	Borneo, Ceylon, India, Malaya.
Stenobates birai	Singapore.
Rhagadotarsus kraepelini	Ceylon, China, Formosa, India, Java, Malaya, Philippines.
Hermatobates sp.	Singapore.



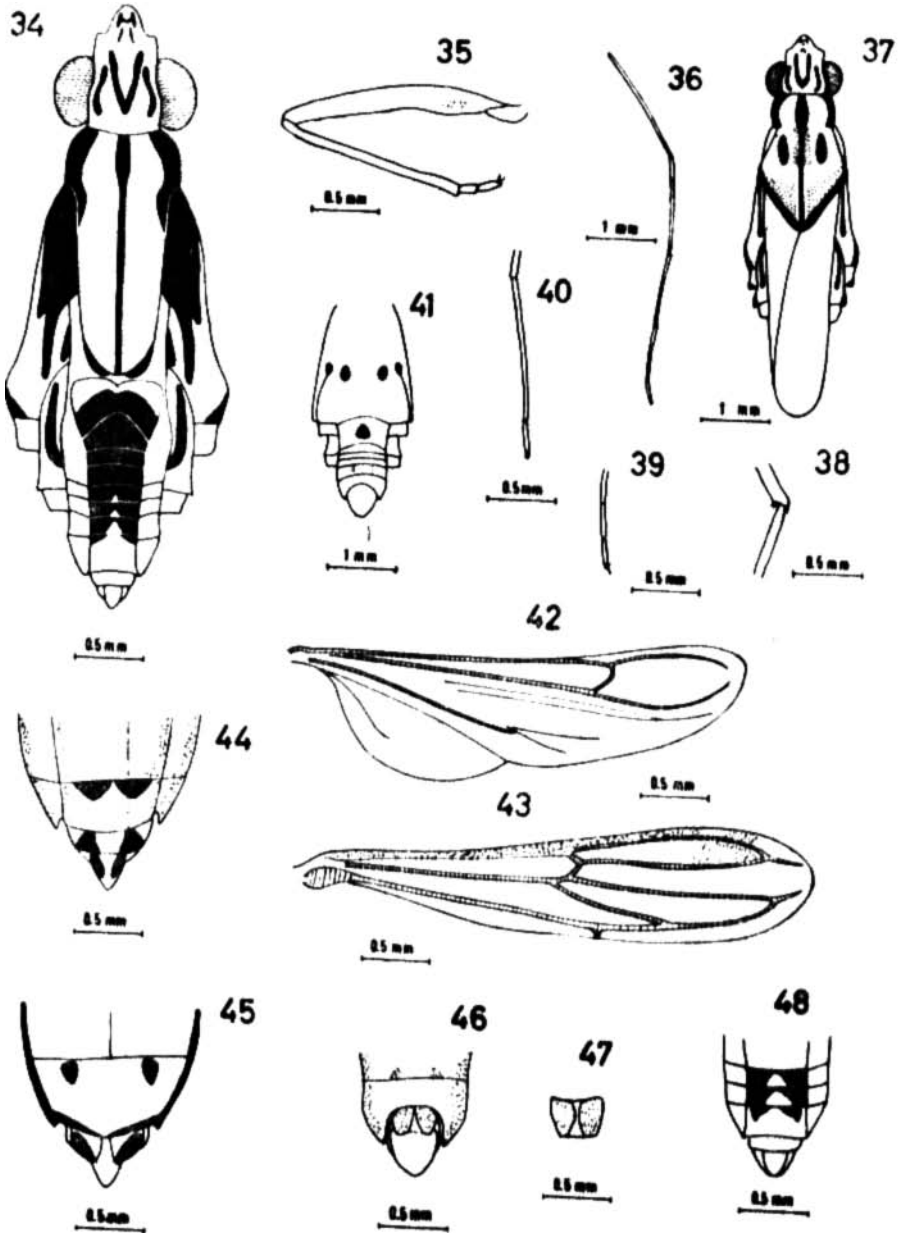
Figs. 1-12. *Limnogonus fossarum*: 1, apterous male dorsal view; 2, male front leg; 3, male front tarsus; 4, egg; 5, winged female dorsal view; 6, fore wing; 7, hind wing; 8, male antenna; 9, male apical abdominal segment ventral view; 10, male apical abdominal segment dorsal view; 11, female apical abdominal segment dorsal view; 12, female apical abdominal segment ventral view.



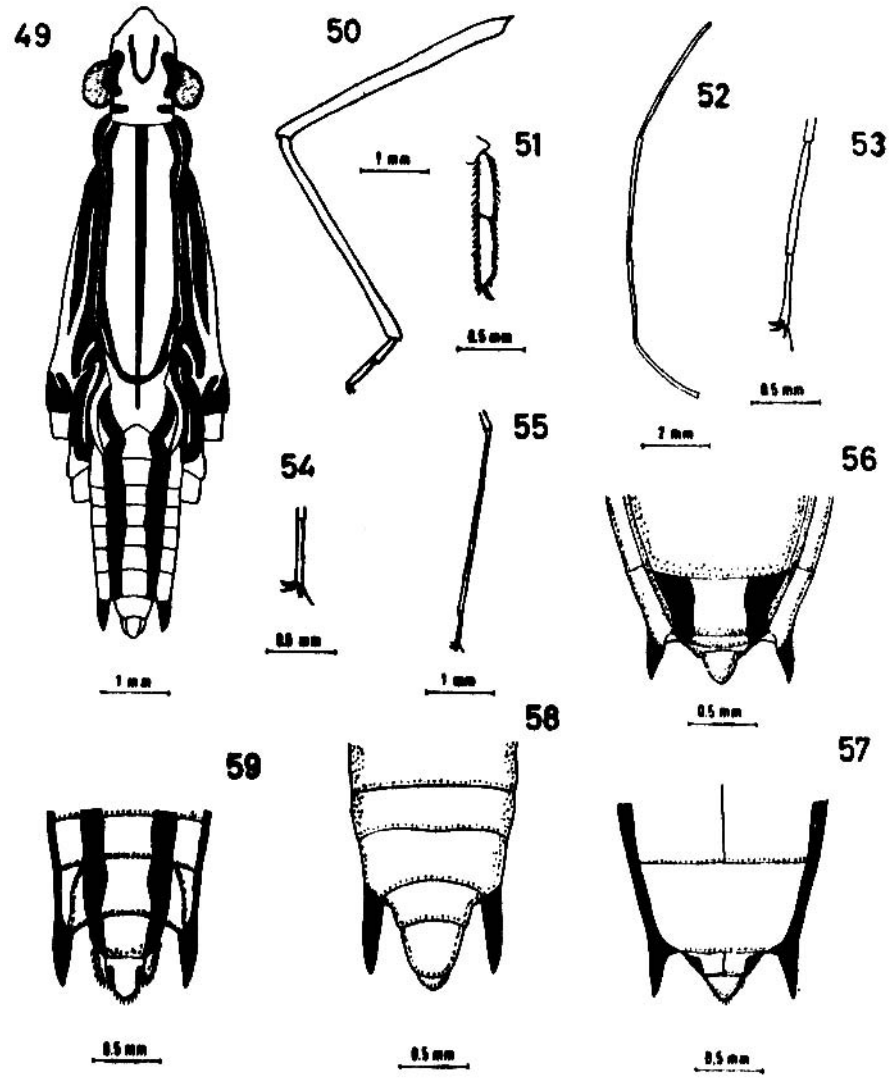
Figs. 13-23. *Limnogonus nitidus* : 13. winged male dorsal view ; 14, male front leg ; 15, male antenna ; 16, egg ; 17, fore wing ; 18, apterous male apical abdominal segment ventral view ; 19, apterous male apical abdominal segment dorsal view ; 20, winged male apical abdominal segment dorsal view ; 21, winged male apical abdominal segment ventral view ; 22, winged female apical abdominal segment dorsal view ; 23, winged female apical abdominal segment ventral view.



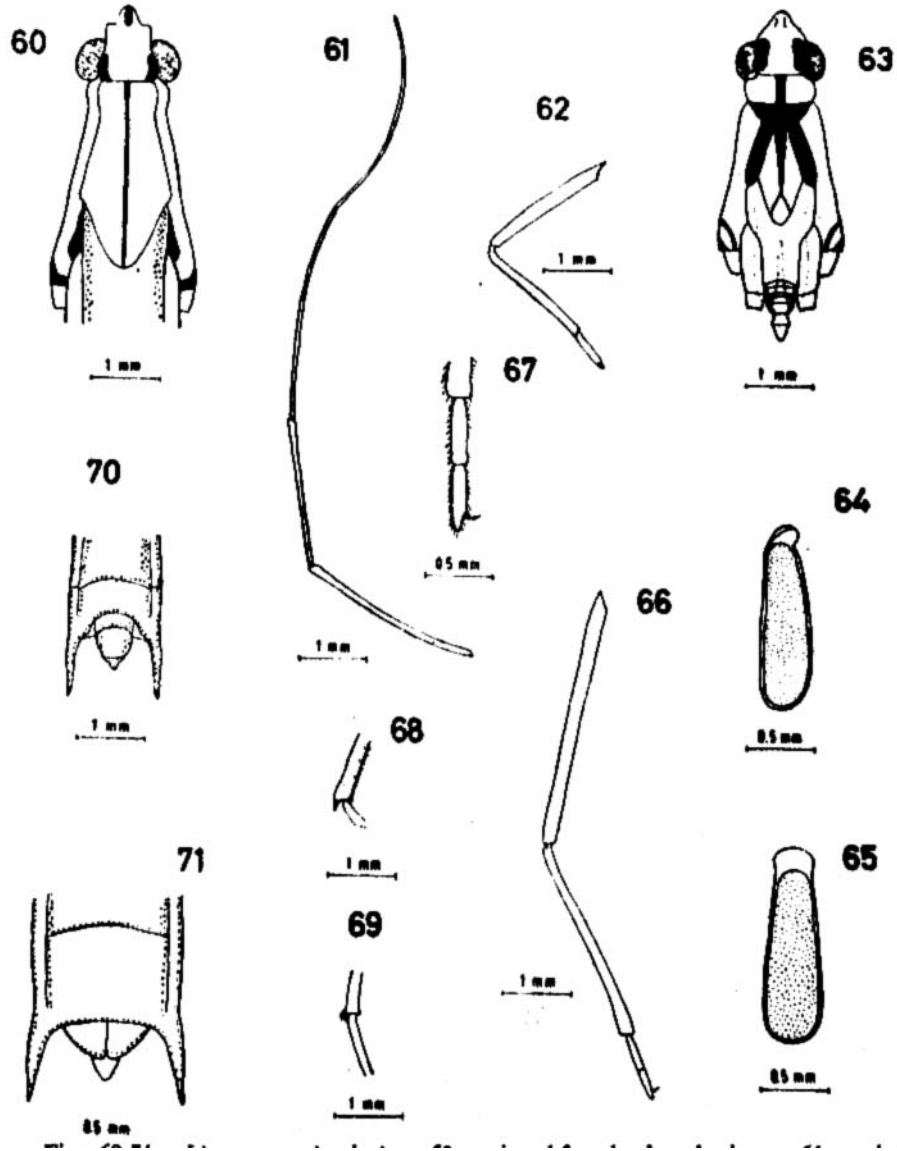
Figs. 24-33. *Limnogonus parvulus*: 24, winged male dorsal view; 25, female front leg; 26, female antenna; 27, fore wing; 28, apterous male dorsal view; 29, male apical abdominal segment dorsal view; 30, male apical abdominal segment ventral view; 31, female apical abdominal segment ventral view; 32, female apical abdominal segment dorsal view; 33, egg.



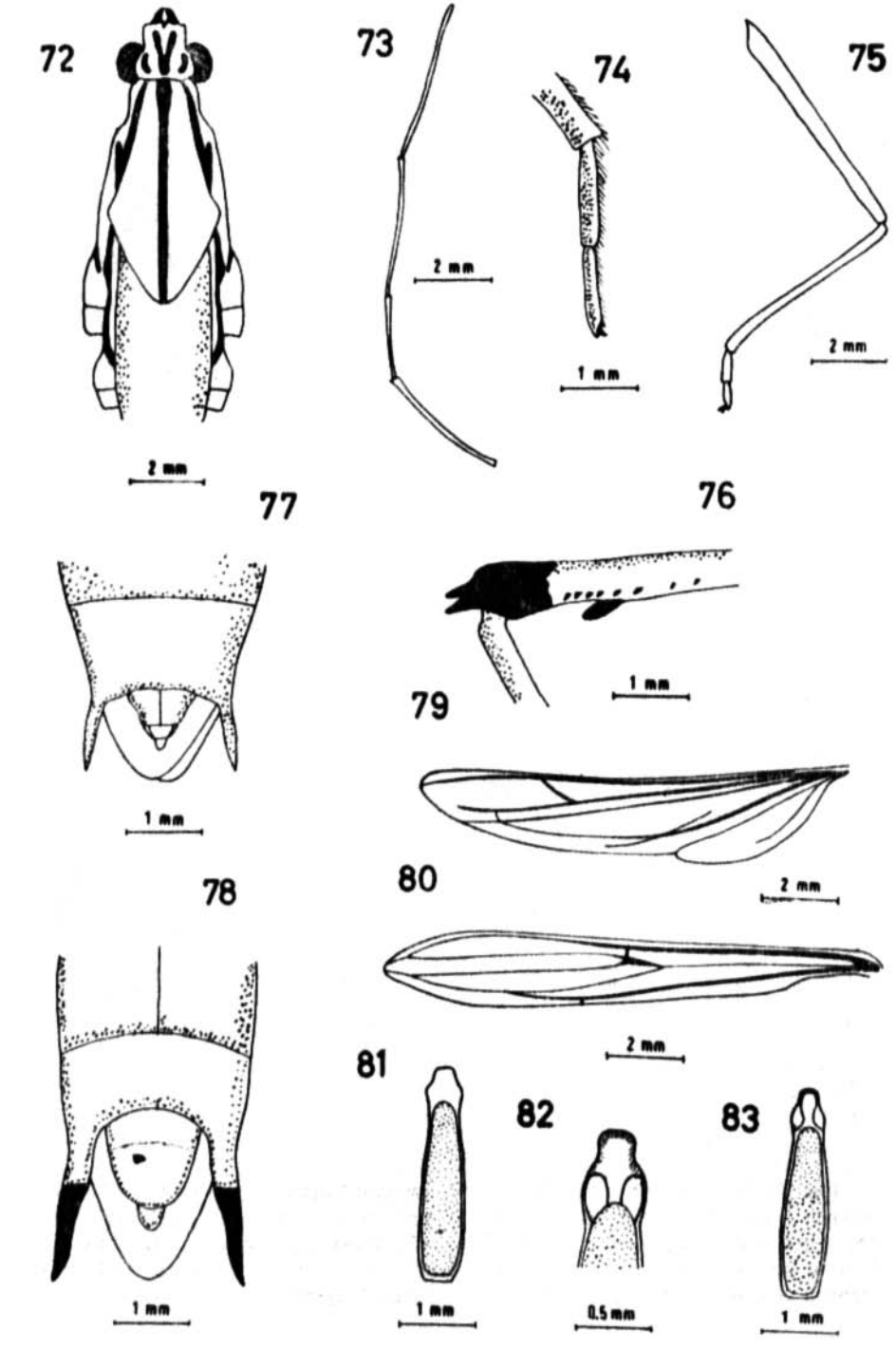
Figs. 34-48. *Tenagogonus pravipes* : 34, apterous male dorsal view ; 35, male front leg ; 36, male antenna ; 37, winged male dorsal view ; 38, tubercle on mid femur ; 39, hind tarsus ; 40, mid tarsus ; 41, apterous male ventral view ; 42, hind wing ; 43, fore wing ; 44, female apical abdominal segment dorsal view ; 45, female apical abdominal segment ventral view ; 46, male apical abdominal segment ventral view ; 47, male 1st genital segment ventral view ; 48, male apical abdominal segment dorsal view.



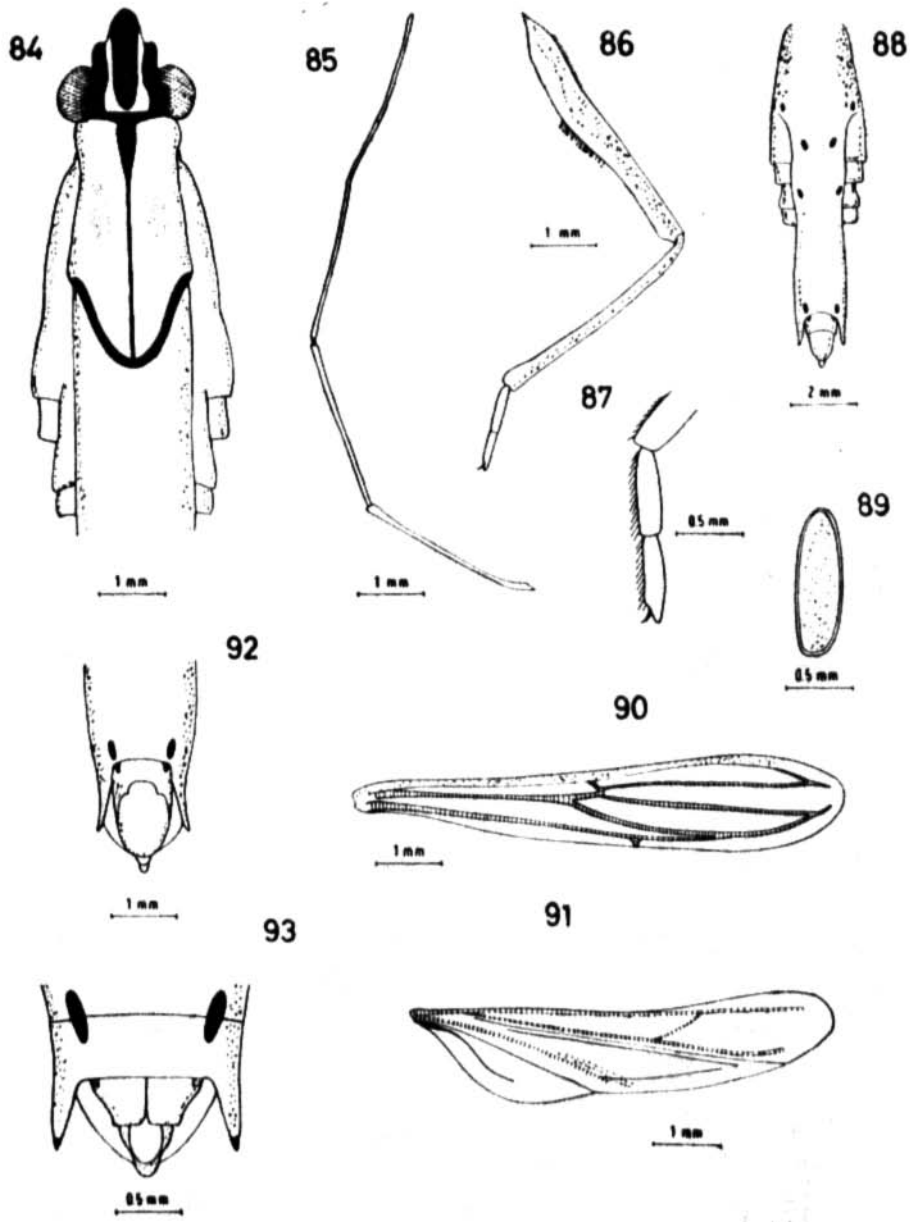
Figs. 49-59. *Limnometra anadyomene* : 49, apterous male dorsal view ; 50, male front leg ; 51, male front tarsus ; 52, male antenna ; 53, male hind tarsus ; 54, male 2nd mid tarsal segment ; 55, male mid tarsus ; 56, female apical abdominal segment dorsal view ; 57, female apical abdominal segment ventral view ; 58, male apical abdominal segment ventral view ; 59, male apical abdominal segment dorsal view.



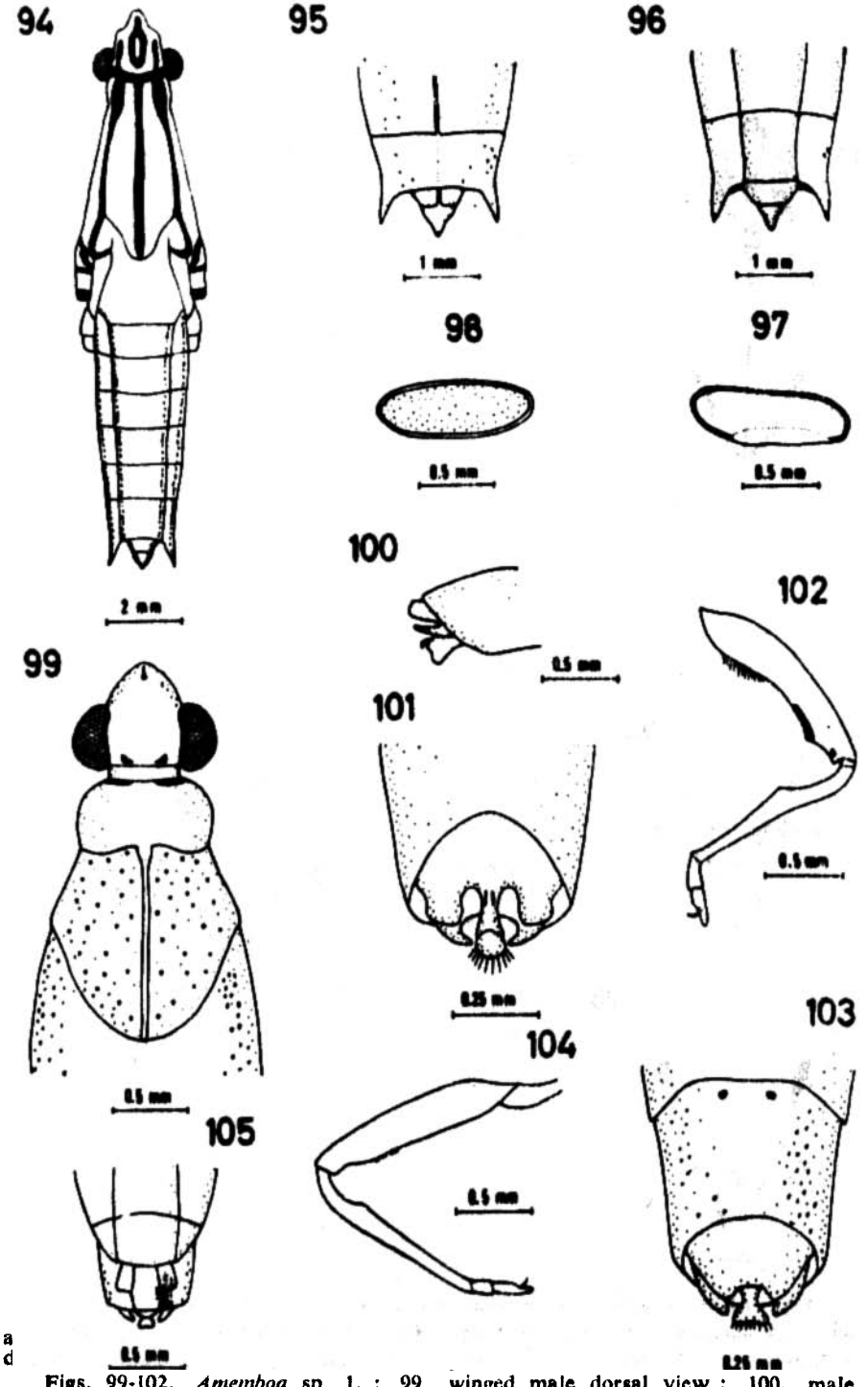
Figs. 60-71. *Limnometra insularis* : 60, winged female dorsal view ; 61 male antenna ; 62, front leg of nymph ; 63, Nymph dorsal view ; 64, egg lateral view ; 65, egg dorsal view ; 66, male front leg ; 67, male front tarsus ; 68, male mid femoral apical spine ; 69, male hind femoral hairs ; 70, male apical abdominal segment ventral view ; 71, female apical abdominal segment ventral view.



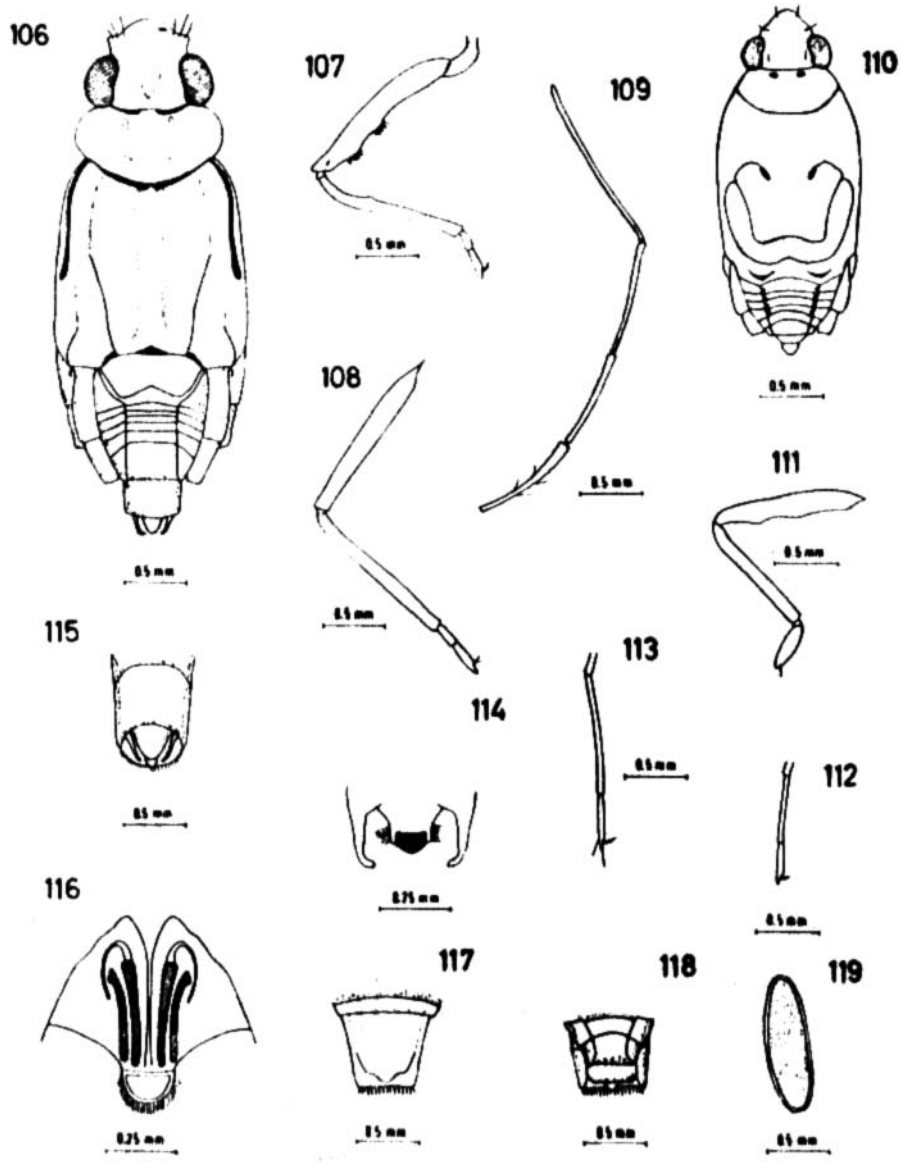
Figs. 72-83. *Limnometra femorata*: 72, winged female dorsal view; 73, female antenna, 74, female front tarsus; 75, female front leg; 76, female portion of middle femur and tibia; 77, female apical abdominal segment ventral view; 79, hind wing; 80, fore wing; 81, egg dorsal view; 82, lid of egg ventral view; 83. egg ventral view.



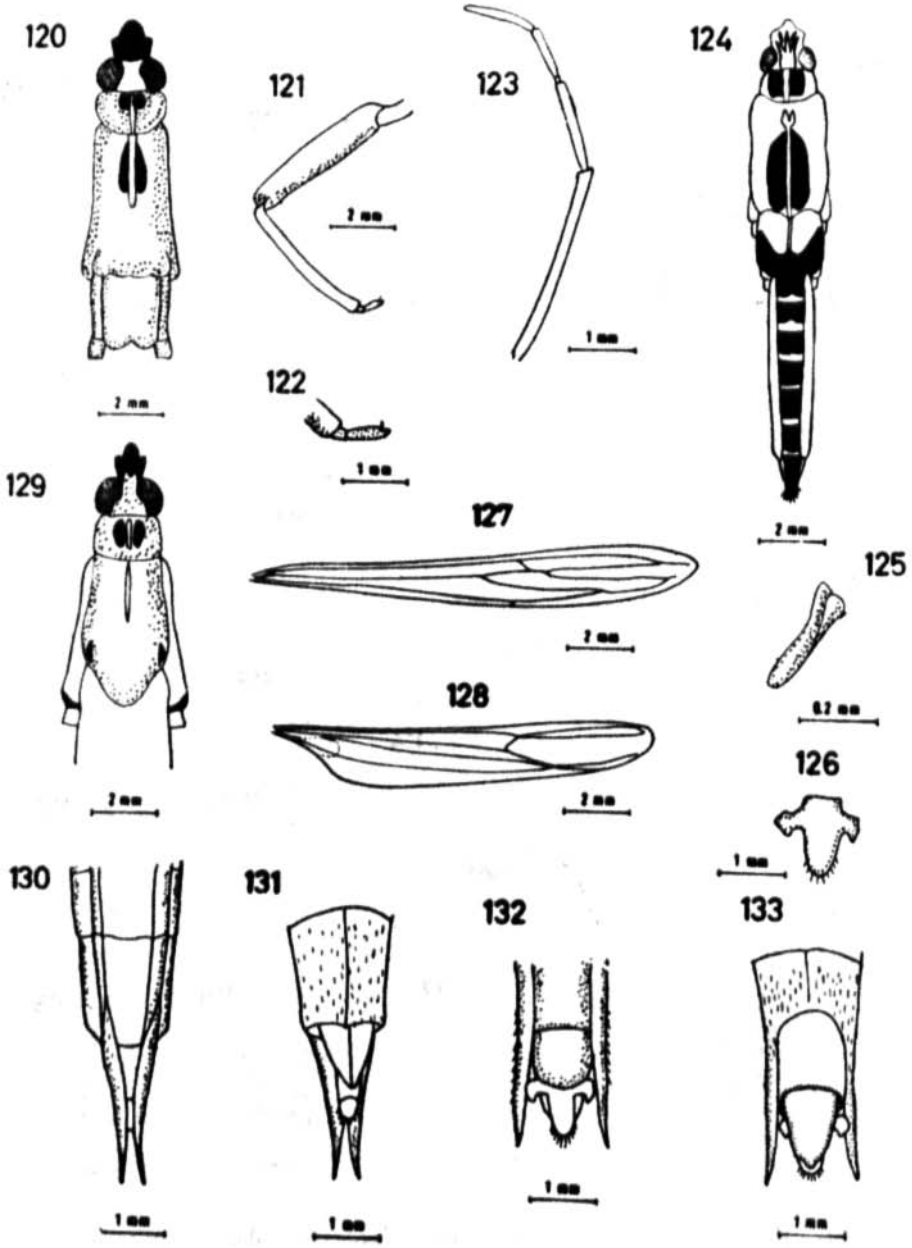
Figs. 84-93. *Limnometra octopunctata* : 84, winged female dorsal view ; 85, male antenna ; 86, male front leg ; 87, male front tarsus ; 88, apterous male ventral view ; 89, egg ; 90, fore wing ; 91, hind wing ; 92, winged male apical abdominal segment ventral view ; 93, winged female apical abdominal segment ventral view.



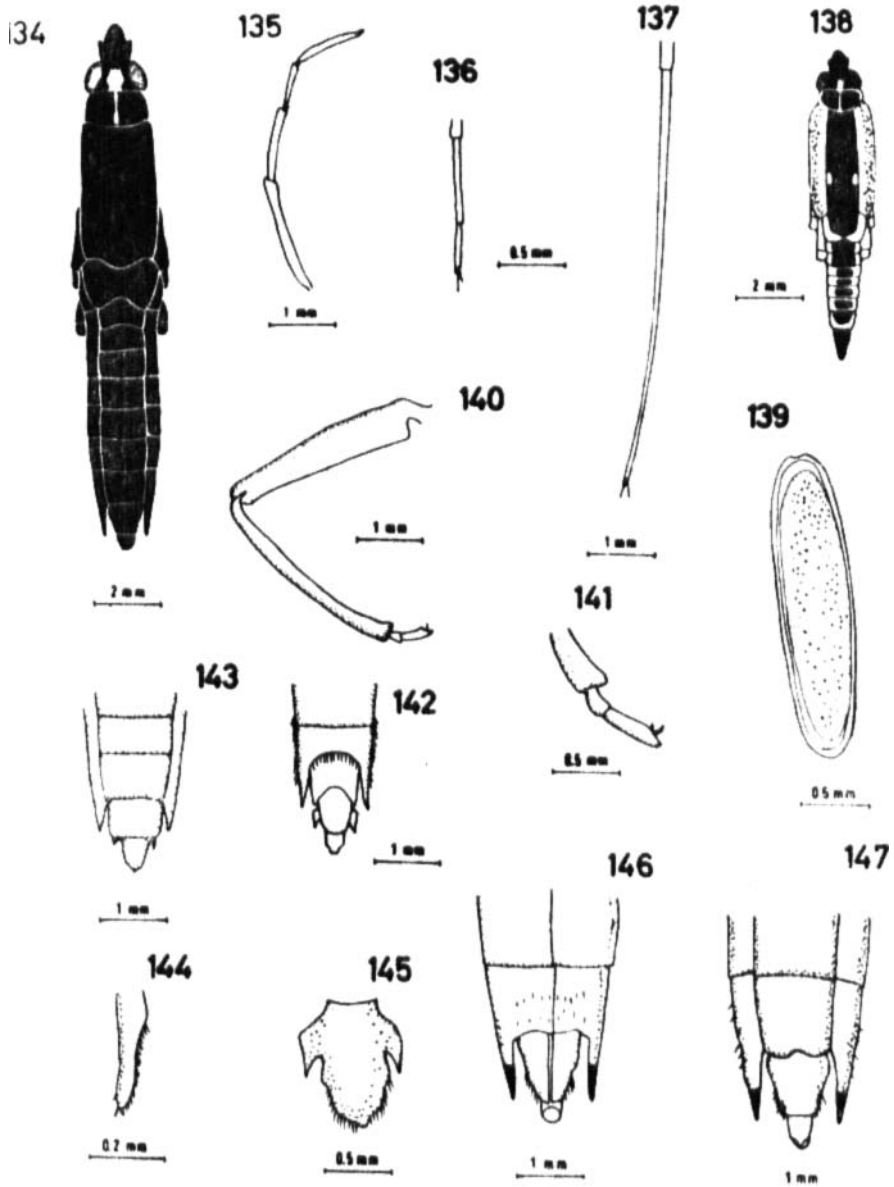
Figs. 99-102. *Amemboa* sp. 1. : 99, winged male dorsal view ; 100, male apical abdominal segment lateral view ; 101, male apical abdominal segment ventral



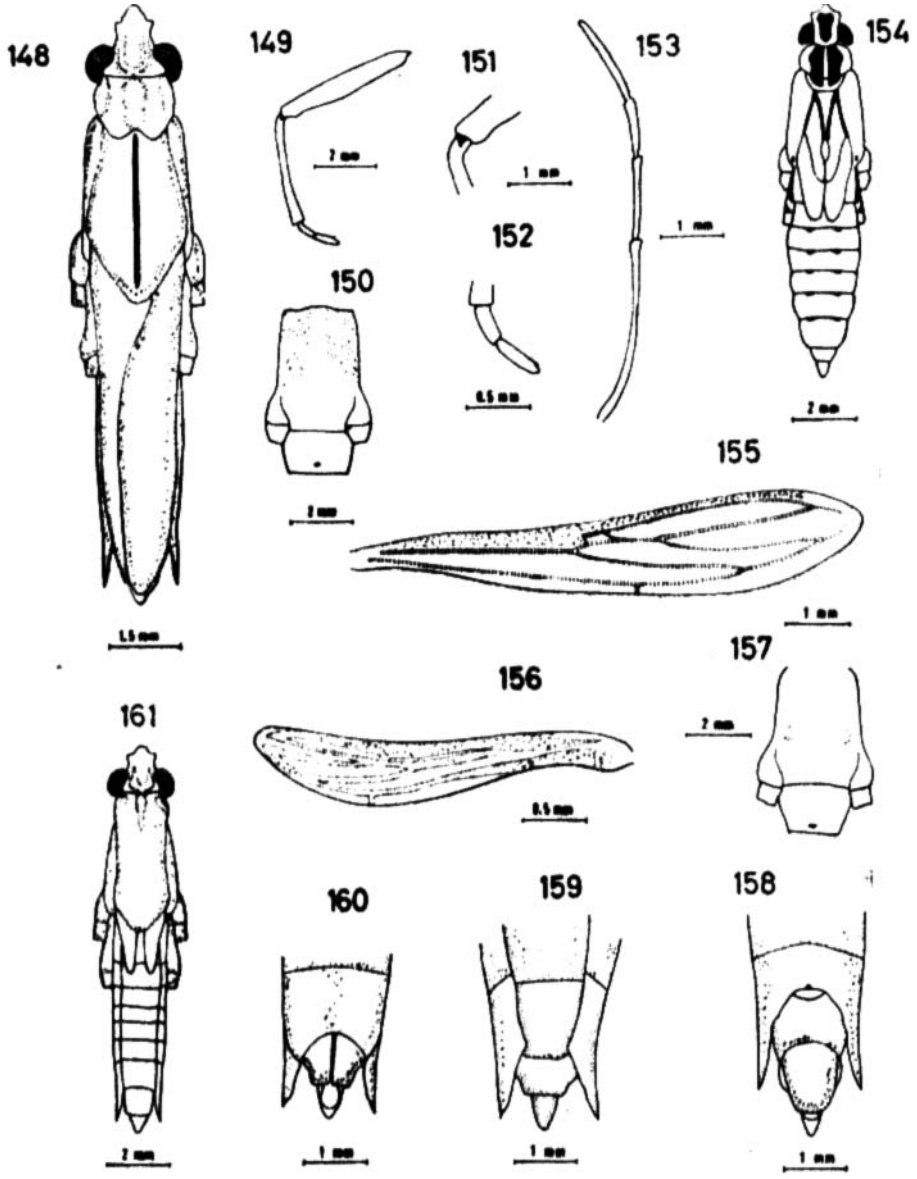
Figs. 106-119. *Amemboa horvathi* : 106, apterous male dorsal view ; 107, male front leg ; 108, female front leg ; 109, male antenna ; 110, nymph dorsal view ; 111, nymph front leg ; 112, male hind tarsus , 113, male mid tarsus ; 114, male 9th abdominal segment ; 115, male apical abdominal segment ventral view ; 116, female genitalia ; 117, female apical abdominal segment ventral view ; 118, female apical abdominal segment dorsal view ; 119, egg.



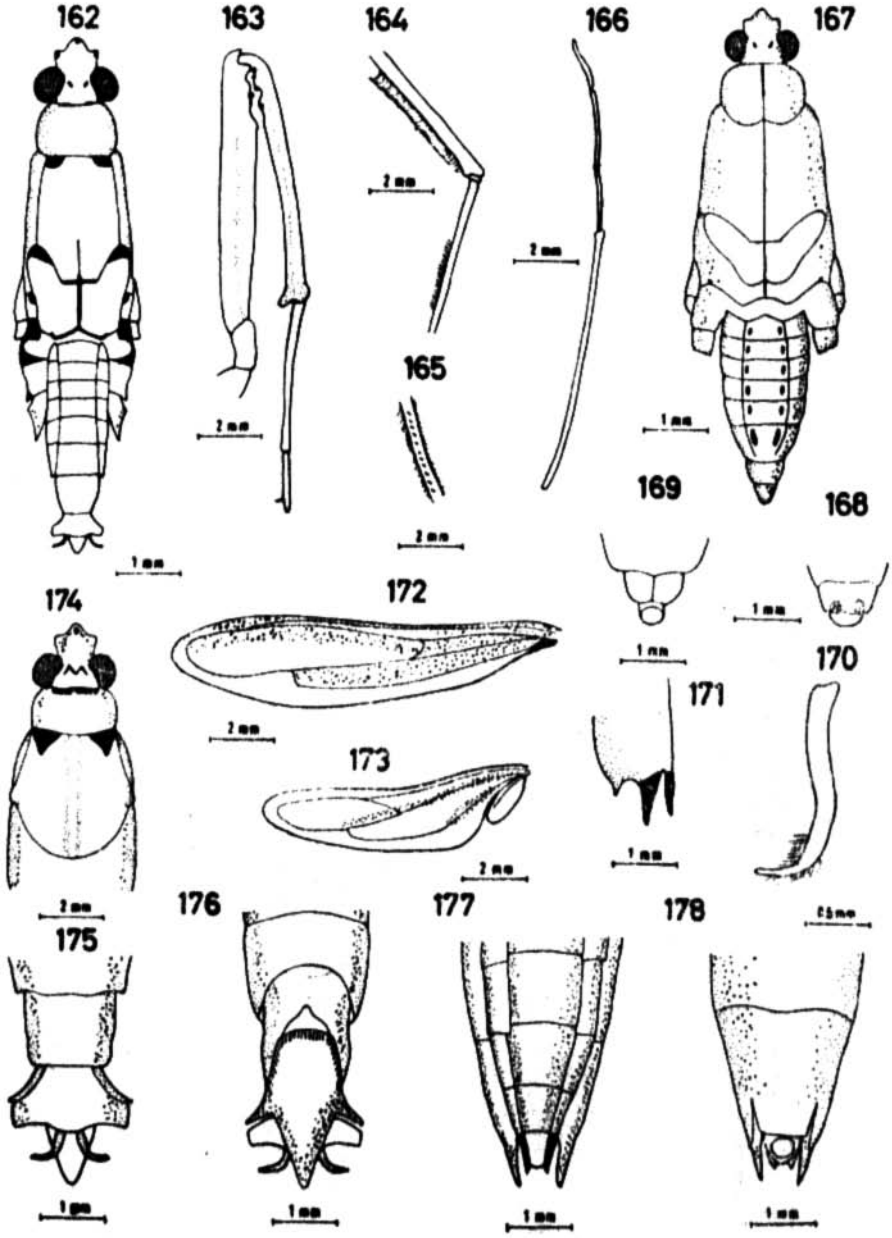
Figs. 120-133. *Cylindrostethus costalis* : 120, apterous male dorsal view ; 121, male front leg ; 122, male front tarsus ; 123, male antenna ; 124, nymph ; 125, male paramere ; 126, male suranal plate ; 127, fore wing ; 128, hind wing ; 129, winged female dorsal view ; 130, female apical abdominal segment dorsal view ; 131, female apical abdominal segment ventral view ; 132, male apical abdominal segment dorsal view ; 133, male apical abdominal segment ventral view.



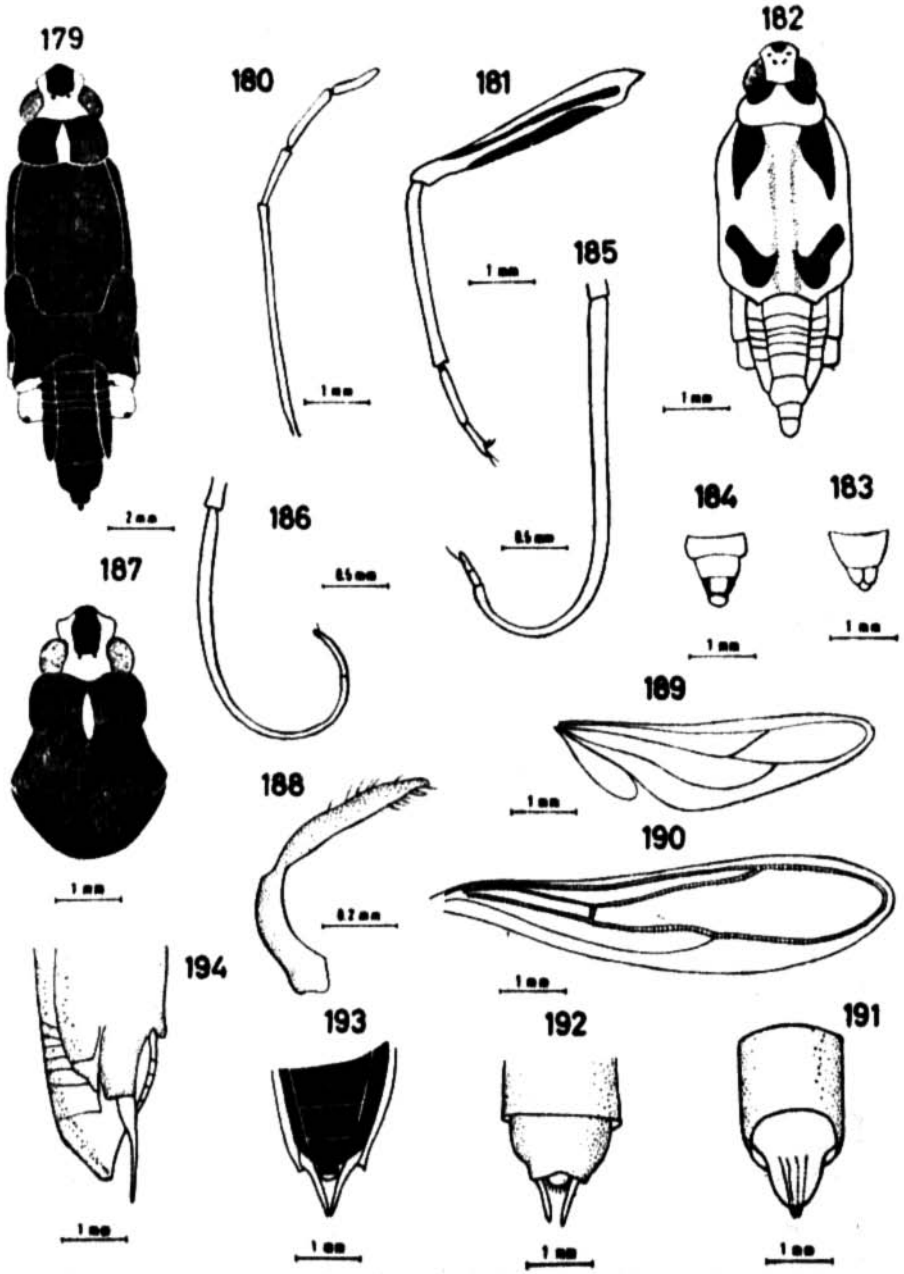
Figs. 134-147. *Cylindrostethus scrutator* ; 134, apterous female dorsal view ; 135, male antenna ; 136, male hind tarsus ; 137, male mid tarsus ; 138, nymph ; 139, egg ; 140, male front leg ; 141, male front tarsus ; 142, male apical abdominal segment ventral view ; 143, male apical abdominal segment dorsal view ; 144, male paramere ; 145, male suranal plate ; 146, female apical abdominal segment ventral view ; 147, female apical abdominal segment dorsal view.



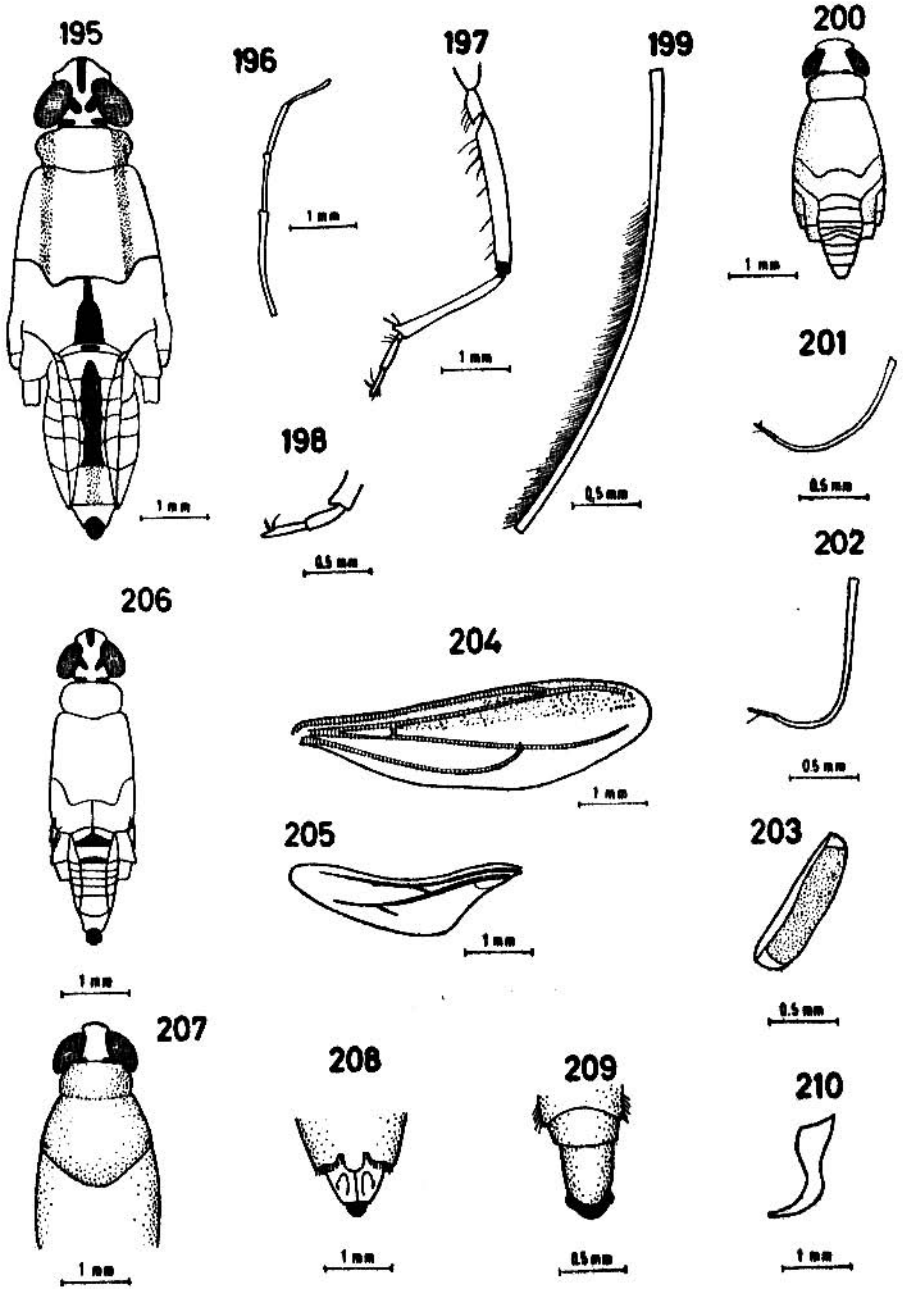
Figs. 148-161. *Gerris adelaides* : 148, macropterous male dorsal view ; 149, male front leg ; 150, macropterous female thoracic region ventral view ; 151, male front femur ; 152, male front tarsus ; 153, male antenna ; 154, nymph 155, macropterous male fore wing ; 156, brachypterous male fore wing ; 157, brachypterous female thoracic region ventral view ; 158, macropterous male apical abdominal segment ventral view ; 159, macropterous female apical abdominal segment dorsal view ; 160, macropterous female apical abdominal segment ventral view; 61, brachypterous male apical abdominal segment dorsal view.



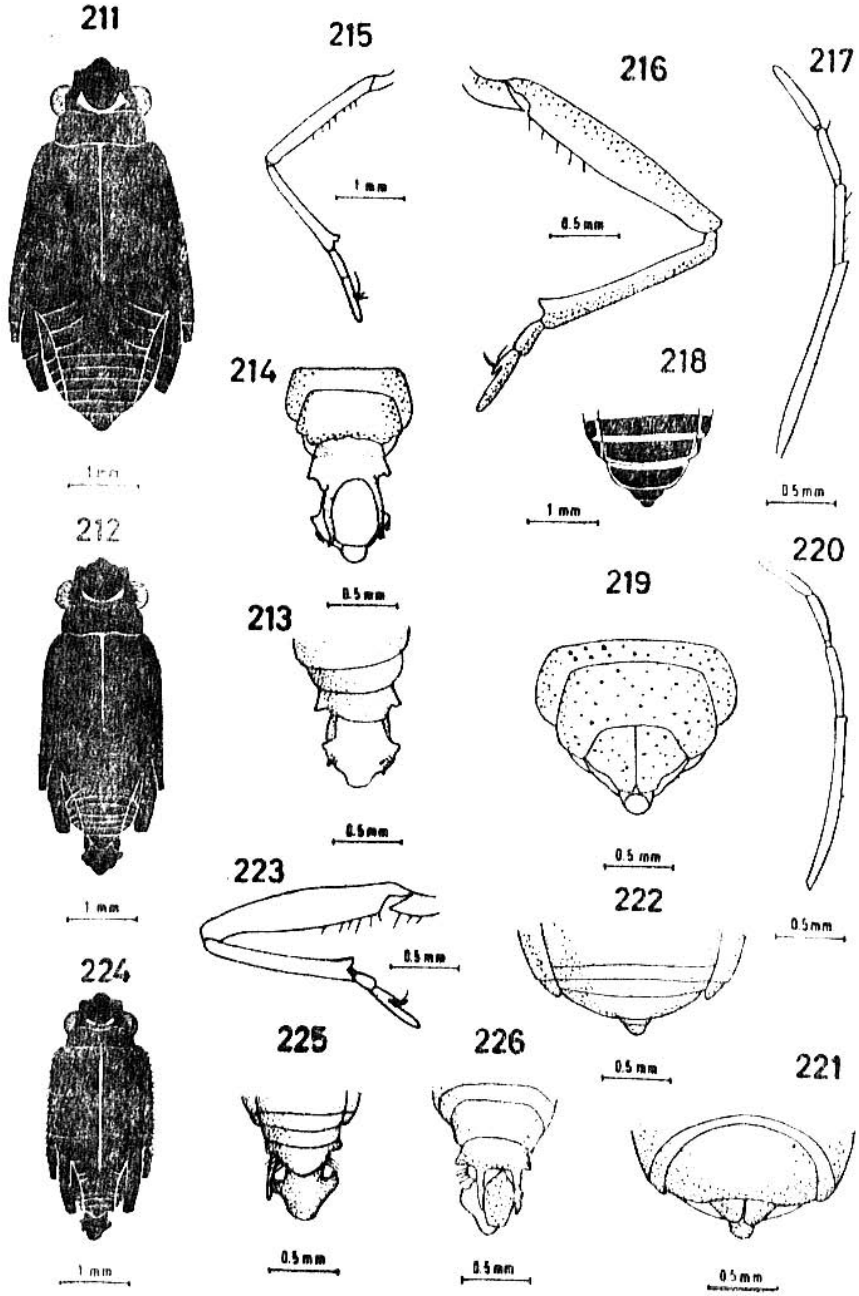
Figs. 162-178. *Ptilomera lundbladi* ; 162, apterous male dorsal view ; 163, male front leg ; 164, male middle femur and tibia ; 165, male hind femur ; 166, male antenna ; 167, nymph ; 168, male 5th instar nymph apical abdominal segment ventral view ; 169, female 5th instar nymph apical abdominal segment ventral view ; 170, male paramere ; 171, female apical abdominal segment lateral view ; 172, fore wing ; 173, hind wing ; 174, winged female dorsal view ; 175, male apical abdominal segment dorsal view ; 176, male apical abdominal segment ventral view ; 177, female apical abdominal segment dorsal view ; 178, female apical abdominal segment ventral view.



Figs. 179-194. *Pleciobates tuberculatus* : 179, apterous male dorsal view ; 180, male antenna ; 181, male front leg ; 182, nymph ; 183, female 5th instar nymph apical abdominal segment ventral view ; 184, male 5th instar nymph apical abdominal segment ventral view ; 185, male hind tibia and tarsus ; 186, male mid tarsus ; 187, winged male dorsal view ; 188, male paramere ; 189, hind wing ; 190, fore wing ; 191, male apical abdominal segment ventral view ; 192, female apical abdominal segment ventral view ; 193, female apical abdominal segment dorsal view ; 194, female abdomen lateral view.

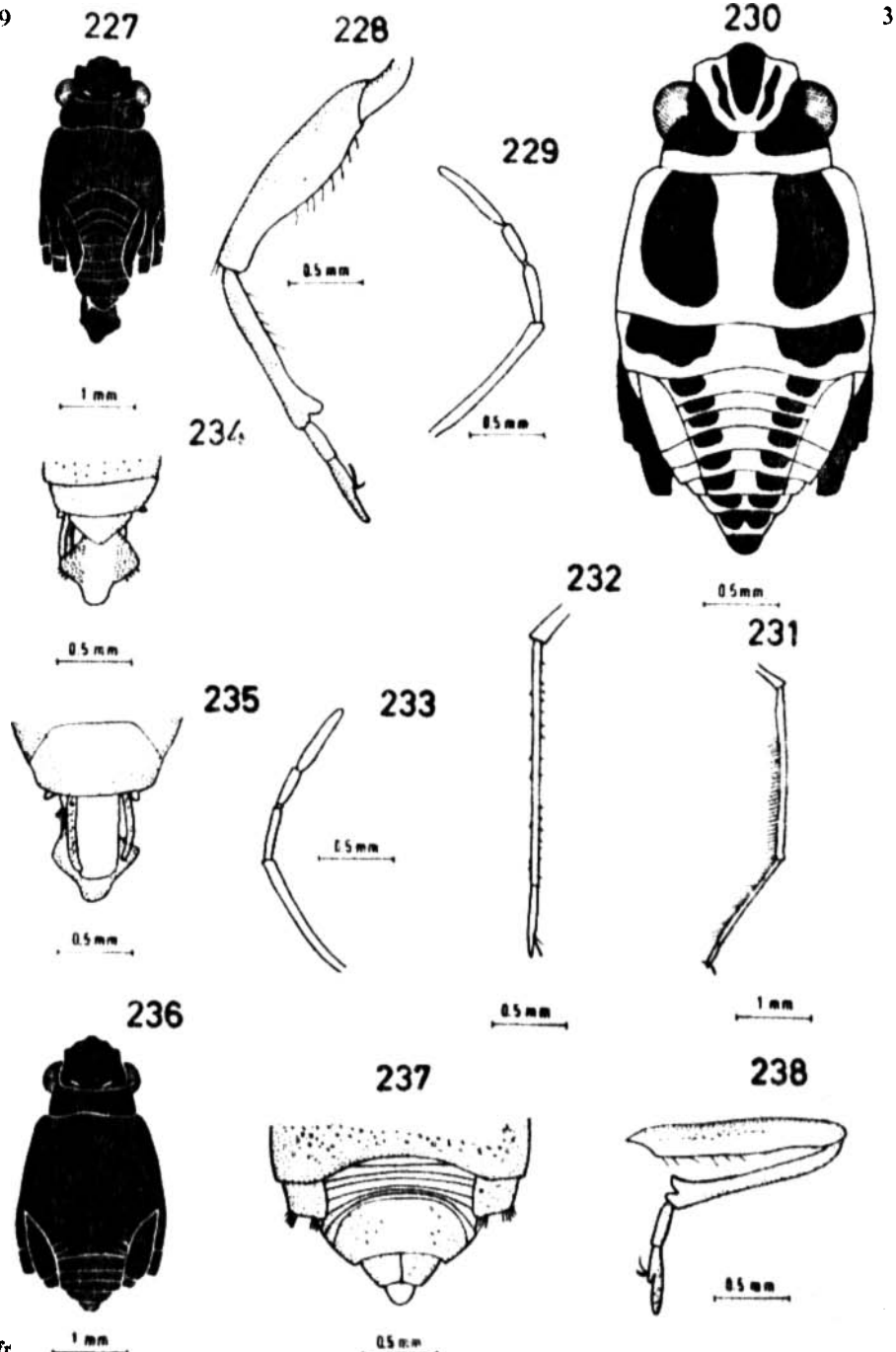


Figs. 195-210. *Rheumatogonus intermedius* : 195, apterous female dorsal view ; 196, female antenna ; 197, female front leg ; 198, male front tarsus ; 199, male mid tibia ; 200, nymph ; 201, male mid tarsus ; 202, male hind tibia and tarsus ; 203, egg lateral view ; 204, fore wing ; 205, hind wing ; 206, apterous male dorsal view ; 207, winged female dorsal view ; 208, female apical abdominal segment ventral view ; 209, male apical abdominal segment ventral view ; 210, male paramere.



Figs. 211-219. *Halobates hayanus* : 211, apterous female dorsal view ; 212, apterous male darsal view , 213, male apical abdominal segment dorsal view ; 214, male apical abdominal segment ventral view ; 215, female front leg ; 216, male front leg ; 217, male antenna ; 218, female apical abdominal segment dorsal view 219, female apical abdominal segment ventral view.

Figs. 220-226. *Halobates proavus* : 220, male antenna ; 221, female apical abdominal segment ventral view ; 222, female apical abdominal segment dorsal view ; 223, male front leg ; 224, apterous male dorsal view ; 225, male apical abdominal segment dorsal view ; 226, male apical abdominal segment ventral view.



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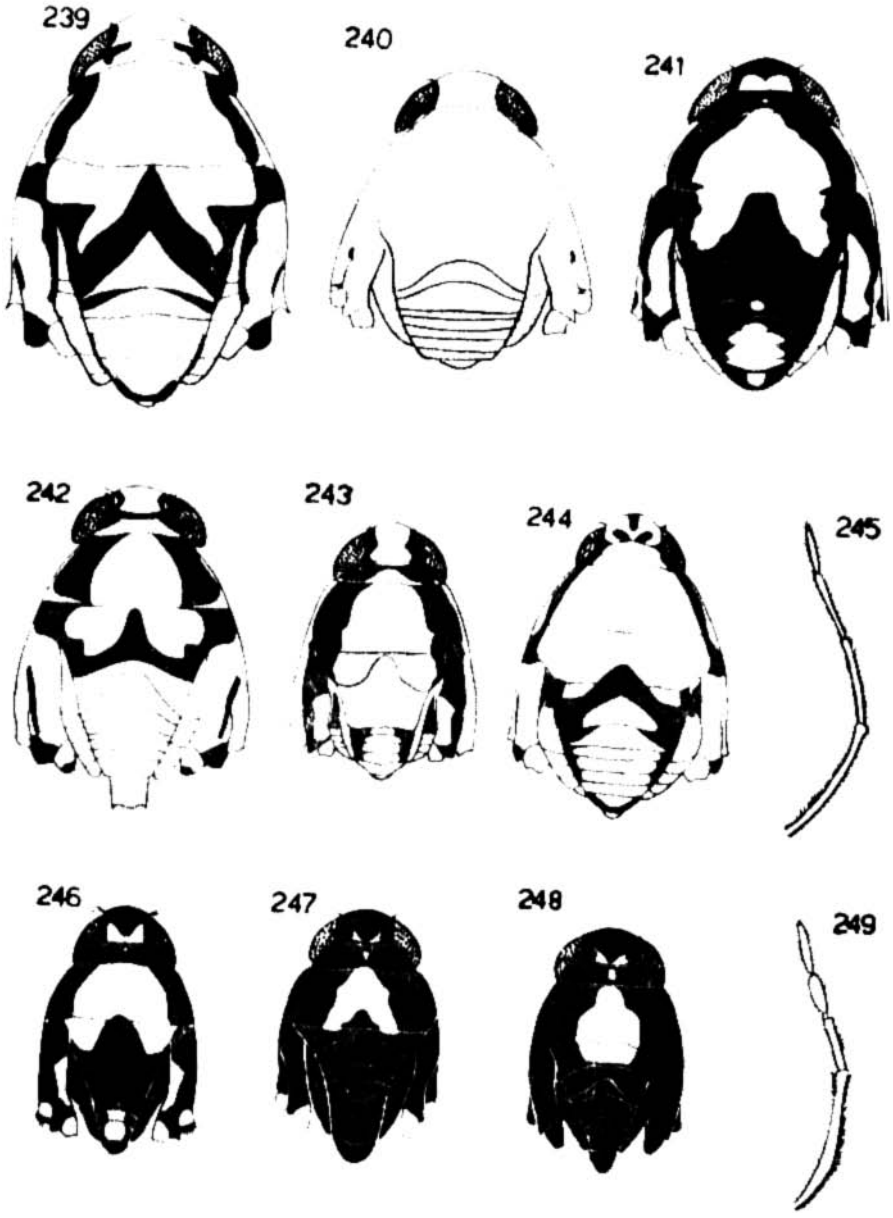
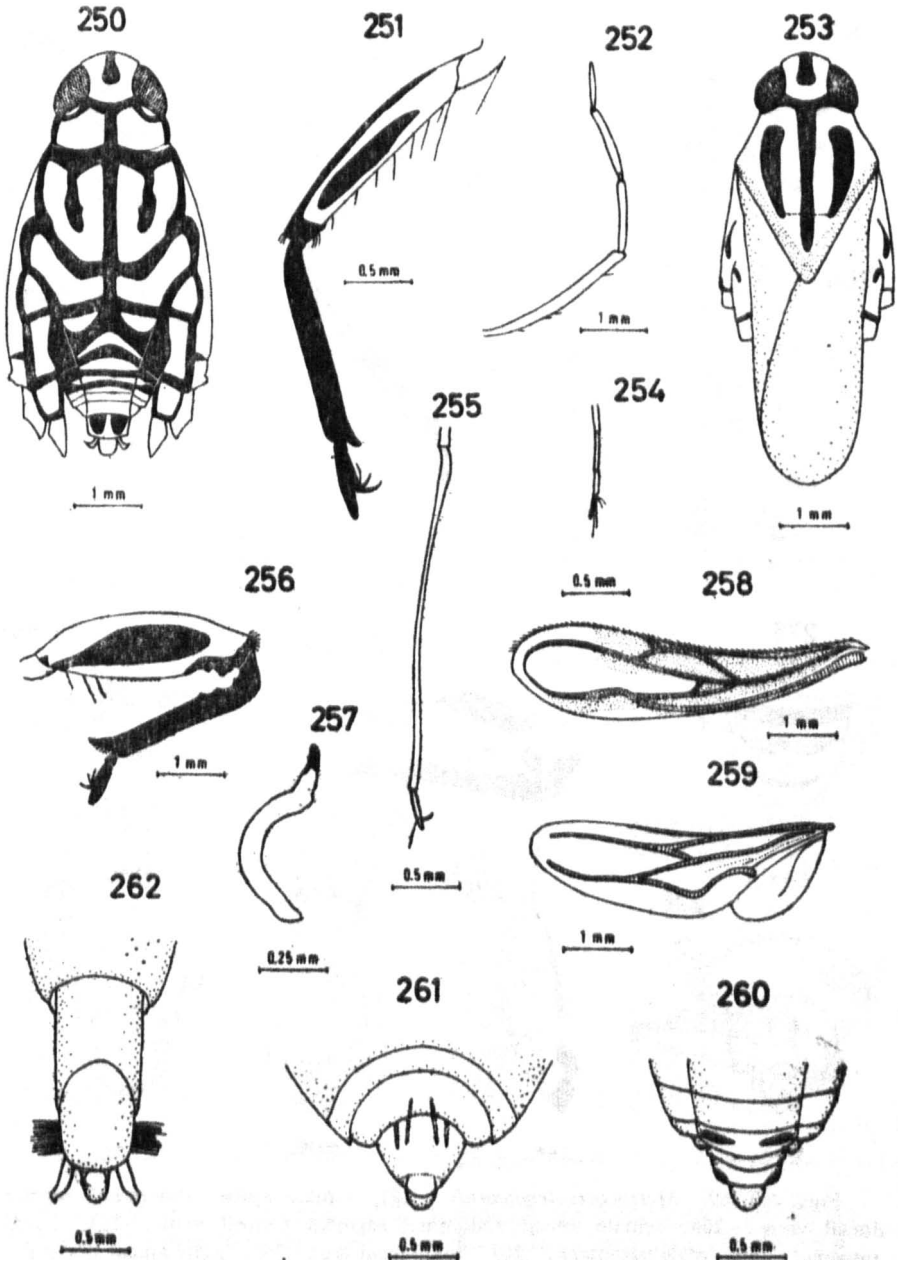
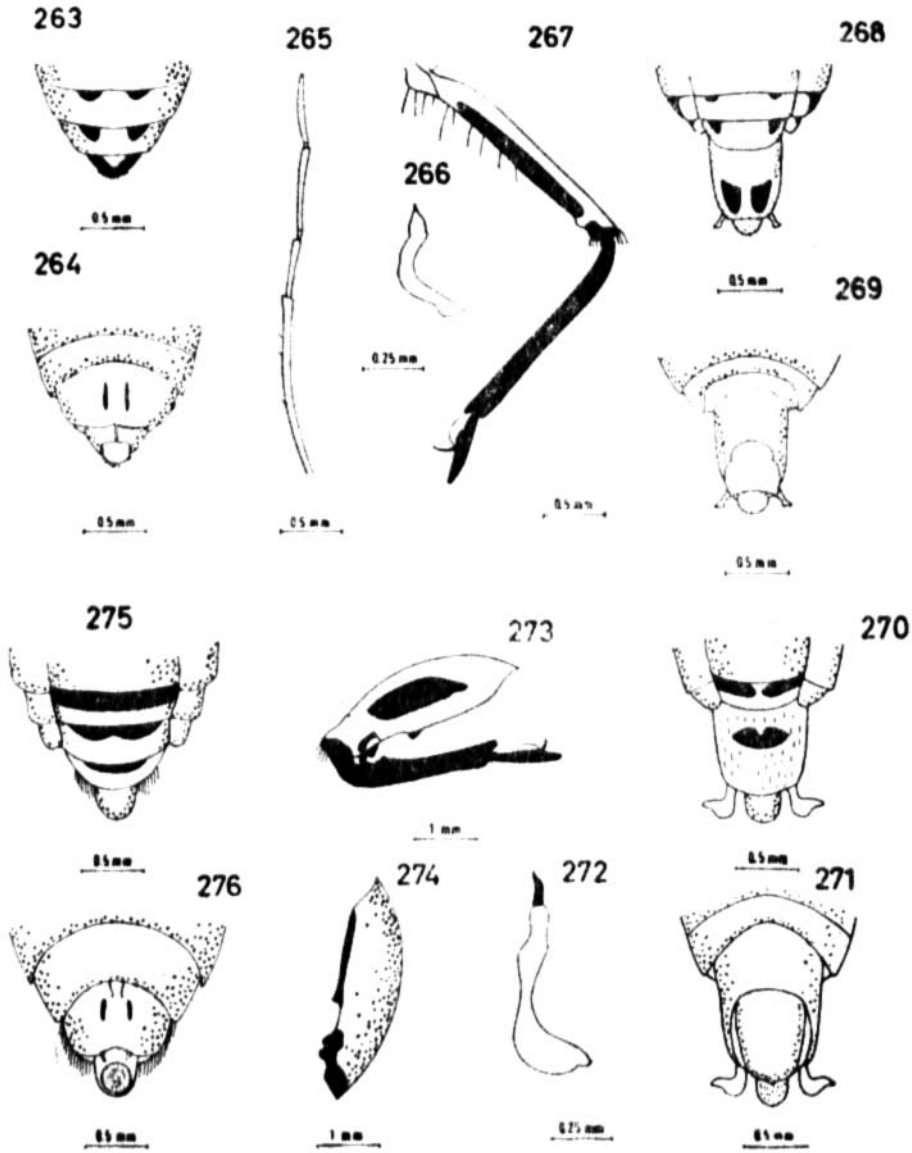
232, male hind tibia and tarsus; 233, female antenna; 234, male apical abdominal segment dorsal view; 235, male apical abdominal segment ventral view; 236, apterous female dorsal view; 237, female apical abdominal segment ventral view 338, female front leg.



Figs. 239-249. 239, *Ventidius malayensis* apterous male dorsal view ; 240, *V. chinai* apterous female dorsal view ; 241, *V. pulai* apterous male dorsal view ; 242, *V. harrisoni* apterous male dorsal view ; 243, *V. hungerfordi* apterous male dorsal view ; 244-245, *V. pubescens* : 244, apterous male dorsal view ; 245, male antenna ; 246, *Esakia fernandoi*, apterous male dorsal view ; 247, *E. johorensis*, apterous male dorsal view ; 248-249, *Esakia lundbladi* ; 248, apterous male dorsal view ; 249, male antenna.

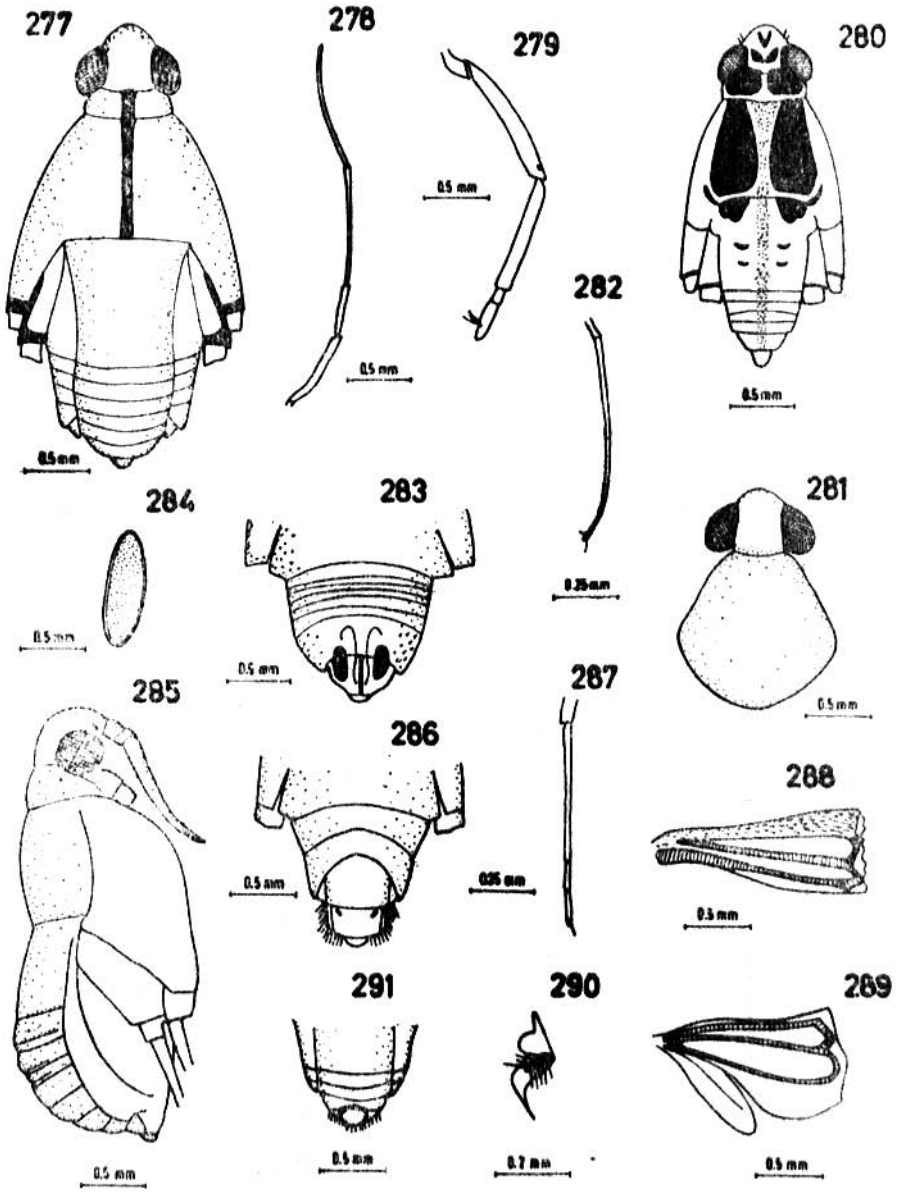


Figs. 252-262. *Metrocoris nigrofasciatus* : 250, apterous male dorsal view ; 251, female front leg ; 252, male antenna ; 253, winged male dorsal view ; 254, male hind tarsus ; 255, male mid tarsus ; 256, male front leg ; 257, male paramere ; 258, fore wing ; 259, hind wing ; 260, female apical abdominal segment dorsal view ; 261, female apical abdominal segment ventral view ; 262, male apical abdominal segment ventral view.

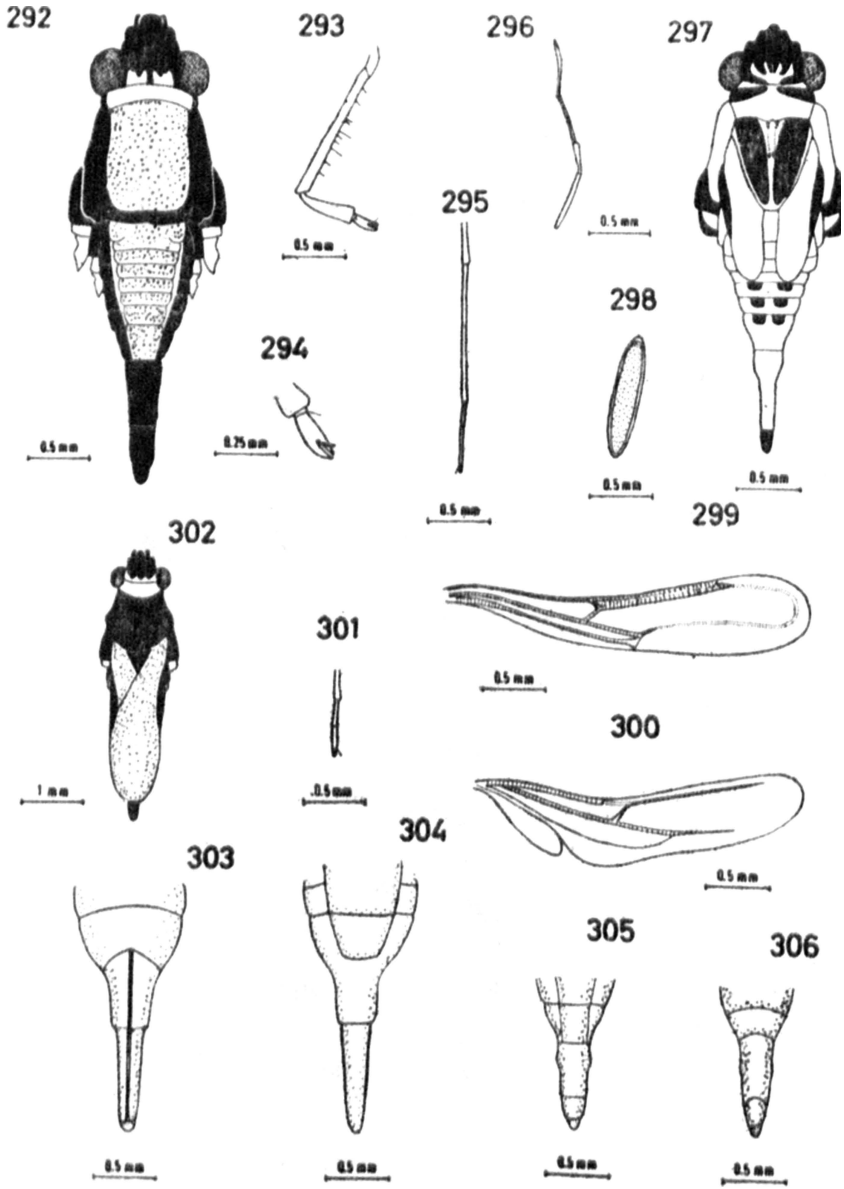


Figs. 263-269. *Metrocoris tenuicornis*: 263, female apical abdominal segment dorsal view; 264, female apical abdominal segment ventral view; 265, female antenna; 266, male paramere; 267, male front leg; 268, male apical abdominal segment dorsal view; 269, male apical abdominal segment ventral view.

Figs. 270-276. *Metrocoris strangulator*: 270, male apical abdominal segment dorsal view; 271, male apical abdominal segment ventral view; 272, male paramere; 273, male front leg; 274, male front femur; 275, female apical abdominal segment dorsal view; 276, female abdominal segment ventral view.



Figs. 277-291. *Cryptobates raja* ; 277, apterous female dorsal view ; 278 female antenna ; 279, female front leg ; 280, nymph ; 281, winged female dorsal view ; 282, female middle tibia and tarsus ; 283, female apical abdominal segment ventral view ; 284, egg ; 285, apterous female lateral view ; 286, male apical abdominal segment ventral view ; 287, female hind tibia and tarsus ; 288, fore wing ; 289, hind wing ; 290, male paramere 291, male apical abdominal segment dorsal view.



Figs. 292-306. *Rhagadotarsus kraepelini* : 292, apterous male dorsal view, 293, male front leg ; 294, male front tarsus ; 295, male mid tarsus ; 296, male antenna ; 297, nymph ; 298, egg ; 299, fore wing ; 300, hind wing ; 301, hind tarsus ; 302, winged female dorsal view ; 303, female apical abdominal segment ventral view ; 304, female apical abdominal segment dorsal view ; 305, male apical abdominal segment dorsal view ; 306, male apical abdominal segment ventral view.

Map I. Collecting localities in Malaya.

Map II. Collecting localities in Singapore.