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GUIDE TO THE AQUATIC HETEROPTERA OF SINGAPORE ANDPENINSULAR MALAYSIA. I. GERRIDAE AND HERMATOBATIDAE

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ABSTRACT. – This is the first guide to the aquatic Heteroptera of Singapore and Peninsular Malaysia to be published as a series in the Raffles Bulletin of Zoology. The families Gerridae and Hermatobatidae are included. Gerridae, with 22 genera and 54 recorded species, are probably the commonest aquatic bugs in our regions whereas Hermatobatidae, a monotypic family, is represented by only 2 species. We have provided lists of known local species of Gerridae and their habitats, a key to genera as well as keys to species where applicable. We have also included illustrations of representative species of each genus, some of the key characters used, and notes on biology and habitat.

KEY WORDS. – Gerridae, Hermatobatidae, Singapore, Peninsular Malaysia, freshwater, marine, keys to genera, list of species

INTRODUCTION

The Gerridae, commonly known as pond-skaters or water-striders, are the commonest aquatic Heteroptera in Singapore and Peninsular Malaysia (Cheng, 1965a). Cheng & Fernando (1969) listed 18 genera and 41 species in their review of the family. Since then four genera and 16 species have been added to the list. As far as we are aware, only two species, *Pleciobates tuberculatus* and *Amemboa lannae*, are endemic. In this guide we provide a key to the genera of the family and keys to species, where applicable. Keys to species were adapted or modified from those published in the literature. We have tried to provide illustrations of representative species of each genus as well as important key characters to aid in their identifications. Terminologies used were those defined by Andersen (1982). We have included only those species that have been collected or reported from Singapore and Peninsular Malaysia (Table 1). Most of our species are likely to be found also in other parts of Malaysia, Indonesia, or Indochina.

Hermatobates, which was included in the Gerridae by Fernando & Cheng (1969), has now been put into a family of its own, the Hermatobatidae. It is exclusively marine (Cheng, 1966a, 1977) and will be dealt with separately in this paper.

Most of the specimens used for this study have been collected over the years by various members of the University of Singapore, now known as the National University of Singapore (NUS), and have all been deposited in the Zoological Reference Collection, Raffles Museum of Biodiversity Research at the NUS. Additional materials have been kindly provided by Drs. N.M. Andersen, J.T. Polhemus, D. Kovac and others.

FAMILY GERRIDAE

Gerrids are semi-aquatic and are found only at the water surface. They are not known to submerge except when females are laying eggs (Brinkhurst, 1960). In temperate regions some gerrids have been bound to submerge when water temperature is lower than air temperature (Spence et al., 1980). Gerrids can be found in a wide range of freshwater, brackish and even marine habitats (Table 2). In

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Table 1. List of species of Gerridae (subgeneric names not given) recorded from Singapore and Peninsular Malaysia. (Names in brackets are those given in Cheng & Fernando, 1969). (* = not collected by us but expected to occur in our region)

Subfamily: Rhagadotarsinae
Rhagadotarsus kraepelini Breddin, 1905

Subfamily: Trepobatinae
Cryptobates johorensis J. & D. Polhemus, 1995
Cryptobates rufus J. & D. Polhemus, 1995 (*C. raja*)
Gnomobates kuiteri Hungerford & Matsuda, 1958
Naboandelus johorensis J. & D. Polhemus, 1994
Rheumatometroides insularis (Polhemus & Cheng, 1982)
Stenobates biroi (Esaki, 1926)

Subfamily: Cylindrostethinae
Cylindrostethus malayensis D. Polhemus, 1994 (*C. costalis*)
Cylindrostethus scrutator Kirkaldy, 1899

Subfamily: Ptilomerinae
Pleciobates tuberculatus Esaki, 1930
Ptilomera tigrina Uhler, 1860 (P. *lundbladi*)
Rheumatogonus intermedius Hungerford, 1933

Subfamily: Eotrechinae
Amemboa brevifasciata Miyamoto, 1967 (*A. horvathi*)
Amemboa cristata Polhemus & Andersen, 1984
Amemboa incurvata Polhemus & Andersen, 1984
**Amemboa javanica* Lundblad, 1933
Amemboa lannae Polhemus & Andersen, 1984 (*A. javanica*)
Amemboa riparia Polhemus & Andersen, 1984
Amemboa nodosa Polhemus & Andersen, 1984
Onychotrechus esakii Andersen, 1980
Onychotrechus pallidus Andersen, 1980

Subfamily: Gerrinae
Aquarius adelaidis (Dohrn, 1860) (*Gerris adelaides*)
Limnogonus fossarum (Fabricius, 1775)
Limnogonus hungerfordi Andersen, 1975
Limnogonus nitidus (Mayr, 1865)
Limnometra ciliata Mayr, 1865
Limnometra femorata Mayr, 1865
Limnometra insularis Hungerford & Matsuda, 1958
Limnometra matsudai (Miyamoto, 1967) (*L. anadyomene*)
Limnometra octopunctata Hungerford, 1955
Neogerris assimilis Andersen, 1975
Neogerris parvulus (Stål, 1860) (*Limnogonus parvulus*)
Syn. *N. tristan* (Kirkaldy, 1899)
Syn. *N. ysolt* (Breddin, 1905)
Tenagogonus maai Hungerford & Matsuda, 1962 (*T. pravipes*)
Syn. *T. quinquemaculatus* Miyamoto, 1967

Subfamily: Halobatinae
Asclepios annadalei Distant, 1915
Esakia fernandoi Cheng, 1966
Syn. *E. hungerfordi* Miyamoto, 1967
Esakia johorensis Cheng, 1966
Esakia lundbladi Cheng, 1966
Halobates esakii Miyamoto, 1967
Halobates germanus White, 1883
Halobates hayanus White, 1883
Halobates micans Eschscholtz, 1822
Halobates princeps White, 1883
Halobates proavus White, 1883
Halobates sexualis Distant, 1903
Halobates trynae Herring, 1964
Metrocoris malayensis Chen & Nieser, 1993 (*M. strangulator*)
Metrocoris nigrofasciatus Distant, 1903
Metrocoris nigrofasciodes Chen & Nieser, 1993
Metrocoris squamifer Lundblad, 1933
Metrocoris tenuicornis Esaki, 1926
Ventidius harrisoni Cheng, 1965
Ventidius hungerfordi Cheng, 1965
Syn. *V. wallacei* Lansbury, 1988
**Ventidius lundbladi* Miyamoto, 1967
Ventidius malayensis Hungerford & Matsuda, 1960
Ventidius modulatus Lundblad, 1933
Syn. *V. chinai* Hungerford & Matsuda, 1960;
Syn. *V. pubescens* Cheng, 1965
Ventidius pulai Cheng, 1965

our region, they occur most commonly in streams, lakes or ponds. Some are strong skaters and can be found even on the fastest flowing parts of a stream. Others are confined to quieter areas near river banks or to wet rocks splashed by waterfalls. Brackish water species are usually found only in areas under mangroves or associated with other plants. The only truly marine species belong to the genus *Halobates*, represented by six nearshore and two pelagic species (Cheng, 1989; Andersen & Foster, 1992). Studies on the biology, behaviour, life history, ecology and distribution of some species have been published elsewhere (Cheng, 1966b, 1966c, 1985; Cheng & Fernando, 1969; Cheng & Frank, 1993; Kovac & Yang, 1990; Yang & Kovac, 1995; Yang et al., 1997, 1999). Detailed information and general references on the Gerridae can be found in Andersen (1982) and Spence & Andersen (1994).

Pond-skaters are predators, and will feed on any insects or small animals that are trapped or have fallen on the water surface. Adults and older nymphs may be cannibalistic and will feed on younger nymphs or weaker individuals. They are fluid feeders and have powerful digestive enzymes to fluidise muscles and internal organs of the prey before the contents are sucked up (Cheng, 1966b). If the prey is small it is usually held between the front legs, whereas larger prey may be shared by more than one insect. Prey detection is either by sight or by ripples generated by a struggling prey. Gerridae are preyed upon by birds, surface-feeding fish, reptiles, frogs, spiders and other insects (Cheng, 1985; Spence, 1986). Since there are few places to hide at the water surface, many gerrids have rather cryptic coloration which may help them to avoid predation. Several marine *Halobates* species are known to form large aggregations or flotillas which function effectively in predator avoidance (Foster & Treherne, 1982, 1986). Very little is known about diseases of pond-skaters, through the eggs may be parasitised by trichogrammatid wasps (Henriquez & Spence, 1993).

Sexual dimorphism is exhibited by most water-striders, and males are generally smaller than females (Andersen, 1997). Terminal abdominal segments of males are usually modified, and in many species, e.g. *Metrocoris*, the front legs have well-developed teeth and spines for grasping females during mating. Although surface ripples are used for mate attraction in a few pond-dwelling species (Wilcox, 1972; Wilcox & Spence, 1986; J. T. Polhemus, 1990; Gogola, 1996), we do not know whether this is common among all species. It is likely that chemical sex-attractant(s), such as those used in

Table 2. Habitats of Gerridae in Singapore and Peninsular Malaysia

	1	2	3	4	5	6	7	8	9	10	11	12
Amemboa brevifasciata		X		X			X					
Amemboa cristata		X					X					
Amemboa incurvata		X					X					
Amemboa lannae	X					X	X					
Amemboa riparia	X	X		X			X					
Amemboa nodosa	X	X										
Aquarius adelaidis								X				
Asclepios annadalei										X		
Cryptobates johorensis			X									
Cryptobates rufus			X									
Cylindrostethus malayensis		X	X	X								
Cylindrostethus scrutator		X		X								
Esakia fernandoi		X		X								
Esakia johorensis		X		X								
Esakia lundbladi		X										
Gnomobates kuiteri		X						X				
Halobates esakii											X	
Halobates germanus												X
Halobates hayanus											X	
Halobates micans												X
Halobates princeps											X	
Halobates proavus											X	
Halobates sexualis											X	
Halobates trynae											X	
Limnogonus fossarum								X	X			
Limnogonus hungerfordi		X		X		X		X	X			
Limnogonus nitidus			X	X								
Limnometra ciliata		X								X		
Limnometra femorata		X								X		
Limnometra insularis		X	X									
Limnometra matsudai	X	X										
Limnometra octopunctata		X	X									
Metrocoris malayensis	X	X			X							
Metrocoris nigrofasciatus	X				X							
Metrocoris nigrofasciodes	X				X							
Metrocoris squamifer	X				X							
Metrocoris tenuicornis		X		X								
Naboandelus johorensis		X	X									
Neogerris assimilis			X	X				X				
Neogerris parvulus			X	X				X				
Onychotrechus esakii					X							
Onychotrechus pallidus					X							
Pleciobates tuberculatus	X											
Ptilomera tigrina	X	X	X	X								
Rhagadotarsus kraepelini			X	X		X		X		X		
Rheumatogonus intermedius	X		X	X								
Rheumatometroides insularis										X		
Stenobates biroi										X		
Tenagogonus maai		X	X									
Ventidius harrisoni	X	X	X	X			X					
Ventidius hungerfordi	X	X	X	X			X					
Ventidius malayensis	X	X		X			X					
Ventidius modulatus		X		X				X		X		
Ventidius pulai	X											

Key to habitats:-

1. Fast-flowing forest stream
2. Slow-flowing forest stream
3. Peaty stream (blackwater, acidic)
4. Lowland stream (non-acidic, swampy)
5. Waterfalls and seepage rocks
6. Rock pools
7. River banks or margins
8. Lakes, reservoirs or ponds
9. Temporary pools
10. Mangrove swamps
11. Coastal marine habitats
12. Open ocean

the marine veliid *Trochopus* (Cheng & Roussis, 1998), may be used among certain species. Mating occurs at the water surface, usually with the smaller male riding on top and holding the female with its front legs. The pair may remain *in copula* for several hours or even days (Birch et al., 1979). Post-copulatory mate guarding has been observed in a number of the Gerrinae but has not been studied in other subfamilies (Andersen, 1997). Eggs may be laid shortly after mating or after some time interval, depending on the species. They may be laid on submerged vegetation or rocks, or glued to floating vegetation. Incubation can be successfully carried out either in water or in moist air (Andersen, 1982). The incubation period is temperature-dependent.

There are five nymphal instars between the egg and adult stage. Nymphs are similar to adults in external morphology but may be paler, more soft-bodied, or have less elaborate colour patterns. In addition the tarsal segmentation is absent or indistinct, wings are absent or not fully formed, and the genital segments are not developed.

Wingless (apterous) adults of several species can easily be confused with nymphs. Even W. L. Distant (1910) described several gerrid genera based on nymphs. Sexes are not generally distinguishable till the 5th or final nymphal instar. Different nymphal instars may be distinguished by size, but lengths of leg segments should be used instead of body lengths which are less reliable. The abdomen of nymphs may grow to varying degrees between moults, depending on the availability of food

It may be difficult for inexperienced workers to discriminate between apterous adults and nymphs and it is generally difficult to identify any gerrids to species unless adults are found. In most cases, positive identification is not possible unless males are present. The keys provided in this guide are usually applicable only to wingless adults which are the commoner form for each species. Although winged forms are found in about half of the species in our region, they are rare except in those species which inhabit ponds or ephemeral habitats that are likely to dry up. They enable the insects to disperse or colonise new habitats. Only adults are fully winged. The wings may be either long and functional, or too short for flight (brachypterous). Wing-pads are present only in nymphs of stages 3 to 5. Later instar nymphs may be distinguished by the following criteria:

Instar III: Anterior wing-pads just visible as dark, sickle-shaped lateral outgrowths on mesonotum.

Instar IV: Both pairs of wing-pads distinct, semicircular. Anterior pair not covering posterior pair.

Instar V: Both pairs of wing-pads well developed. Anterior pair as long as and covering posterior pair. Abdominal end sexually differentiated (most easily seen in ventral view).

There are 8 subfamilies in the Gerridae: Gerrinae, Ptilomerinae, Halobatinae, Trepobatinae, Rhagadotarsinae, Cylindrostethinae, Eotrechinae and Charmatometrinae. All but the last are represented in our region.

KEY TO GERRIDAE OF SINGAPORE AND PENINSULAR MALAYSIA

(Modified from Cheng & Fernando, 1969; Andersen, 1982, 1995)

1. First abdominal sternite visible (Fig. 7). Tip of abdomen produced to a rod- like point (Rhagadotarsinae) ..... *Rhagadotarsus* (Fig. 6)
– First abdominal sternite not visible (Fig.27). Abdomen not produced 2

2. Mid-femora stout, distinctly shorter than middle tibiae and usually shorter than hind femora (Trepobatinae) 3
– Mid-femora slender, usually distinctly longer than middle tibiae (Fig.24) 7

3. Third antennal segment more than twice as long as second and distinctly longer than the first. Lateral margins of male proctiger (genital segment 10) not modified 4
– Third antennal segment as long as or shorter than second and distinctly shorter than the first. Lateral margin of male proctiger with long, slender process, directed anterolaterally (Fig. 5) 5

4. Third antennal segment three times the length of second segment. Male front femora curved ..... *Gnomobates* (Fig. 3)
– Third antennal segment about twice the length of second segment. Male front femora straight ..... *Cryptobates* (Fig. 1)

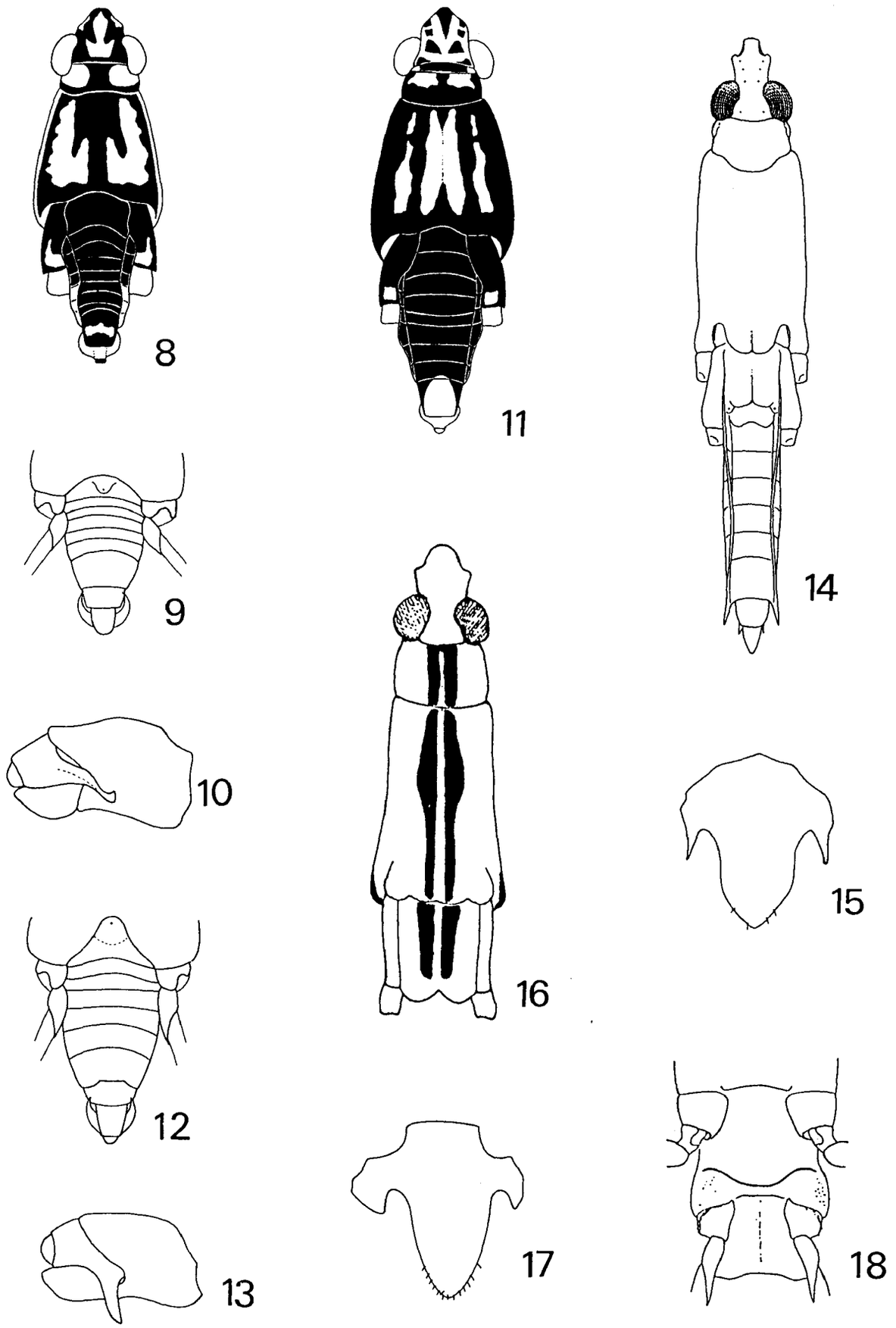
5. Metasternal scent gland orifice distinct, large and prominent in males. Head long, antennal sockets removed from eyes by width of sockets. Front tibiae strongly flattened. Larger species, body more then 3.5 mm long. Marine or brackish water 6
– Metasternal scent gland orifice indistinct. Head short, antennal sockets closer to eyes than width of sockets. Fore tibiae not strongly flattened. Smaller species, body less then 2.0 mm long. Freshwater ..... *Naboandelus* (Fig. 4)

6. Anterior margin of male metasternum distinctly produced (Fig. 12). Male antennae lined with closely packed short to median length hairs of equal length ventrally. Lateral process of male proctiger stout (Fig. 13) ..... *Stenobates* (Fig. 11)
– Anterior margin of male metasternum weakly to moderately produced (Fig. 9). Male antennae without closely packed hairs ventrally. Lateral process of male proctiger more slender (Fig. 10) ..... *Rheumatometroides* (Fig. 8)

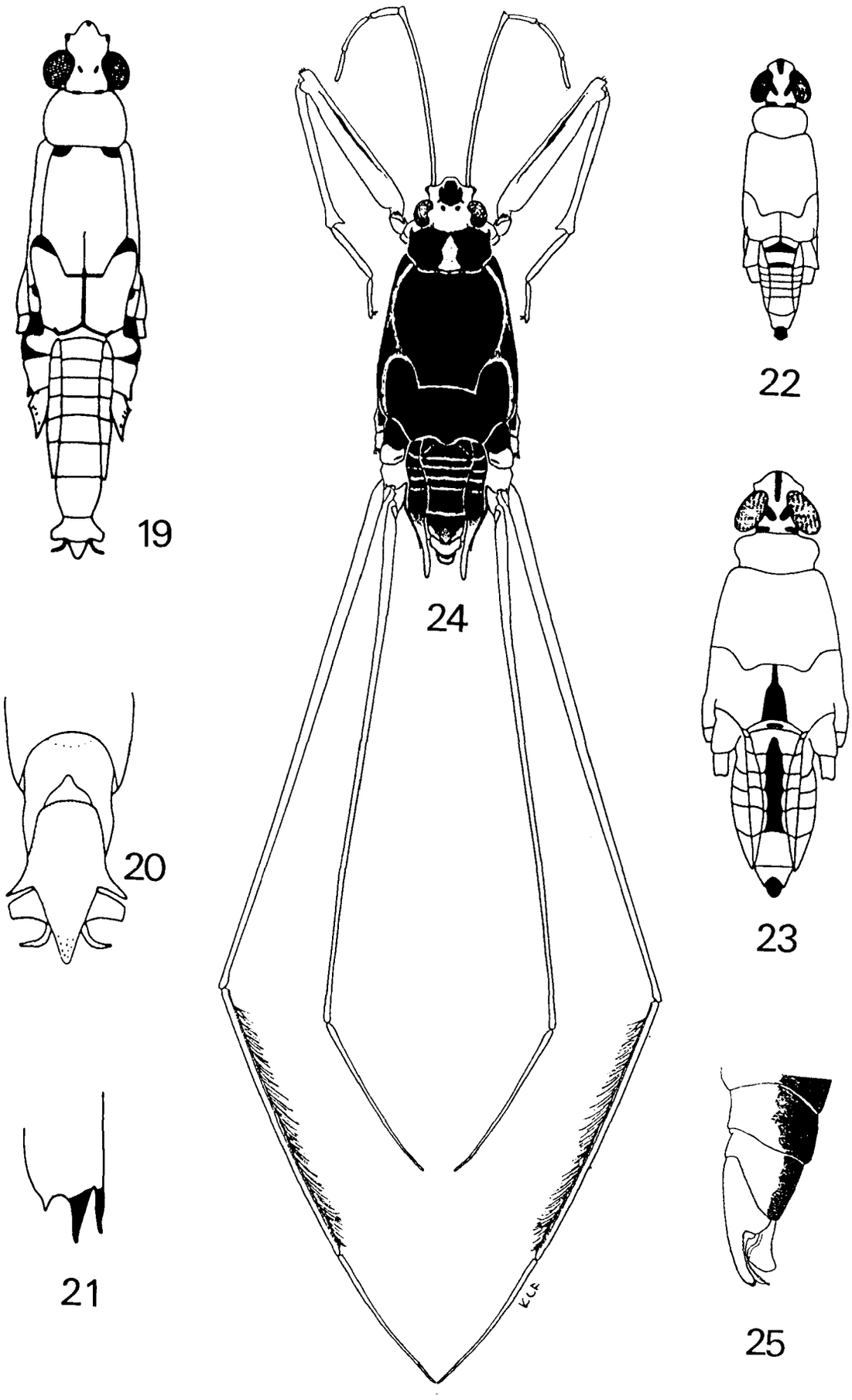
7. Metasternum with lateral evaporative channels leading to metacetabula (Fig. 18). Body at least four times as long as broad (Cylindrostethinae) ..... *Cylindrostethus* (Fig. 14)
– Metasternum not as above. Body greater or less than four times as long as broad 8

8. Front-tarsi very long, at least half the length of tibiae. Mid-femora usually longer than body (Ptilomerinae) 9
– Front-tarsi shorter, mid-femora usually shorter or subequal to body length 11

9. Hind-femora much longer than mid-femora, tarsal segments fused. Posterior half of male mid-femora lined with woolly hairs. Male with symmetrical parameres (Fig. 20). Female with well developed connexival spines on segment 7 (Fig. 21). Over 15 mm in body length ..... *Ptilomera* (Fig. 94)
– Hind-femora subequal or shorter than mid-femora, tarsal segments not fused. Male mid-femora without hair fringe. Female without connexival spines. Less than 10 mm in body length 10



Figs. 8-18. 8-10. *Rheumatometroides insularis,* male: 8, dorsal view; 9, ventral view showing anterior margin of metasternum; 10, lateral view of male genitalia (after Polhemus & Polhemus 1991). 11-13 *Stenobates biroi,* male: 11, dorsal view; 12, ventral view showing anterior margin of metasternum; 13, lateral view of male genitalia (after Polhemus & Polhemus 1991). 14-15. *Cylindrostethus scrutator,* male, dorsal view (after Andersen 1982) and proctiger (after D. Polhemus 1994). 16-17. *Cylindrostethus malayensis,* male, dorsal view and proctiger (after D Polhemus 1994). 18. *Cylindrostethus,* male, ventral view showing metasternal scent channel (after Matsuda, 1960).



Figs. 19-25. 19-21. *Ptilomera tigrina.* 19, male, dorsal view; 20, ventral view, male genital segment; 21, lateral view, female apical abdominal segment, showing connexival spines (after Cheng & Fernando, 1969). 22-23. *Rheumatogonus intermedius,* male and female, dorsal view (after Cheng & Fernando, 1969). 24-25. *Pleciobates tuberculatus*, female dorsal view and male genital segments, lateral view.

& 25), each represented by one species. They are all stream-dwelling species in forests. *Pleciobates tuberculatus*, one of three species in the genus, is so far known only from Peninsular Malaysia. The other two genera are each represented by several species in other parts of S.E. Asia. Winged forms of all three genera are rare.

Subfamily: Eotrechinae

Two genera are found: *Amemboa* and *Onychotrechus*. *Onychotrechus* (Fig. 96) is unique among the Gerridae in inhabiting rocky splash zones of waterfalls (Andersen 1980). The two known species of *Onychotrechus* are rather similar in colour pattern, but *O. pallidus* (Figs. 30 & 31) can be distinguished from *O. esakii* (Fig. 32) by being much paler and having reduced dark markings on the dorsal surface. Six species of *Amemboa* are known. They are found in quiet pools along streams or near stream banks, but are quite inconspicuous and may easily be overlooked. Cheng & Fernando (1969) reported three species of *Amemboa,* one undescribed. *A. javanica.* which they reported, has since been described as a new species, *A. lannae* (Polhemus & Andersen, 1984), which is endemic. However, *A. javanica* is a rather widespread species and may well be found in our region. It has thus been included in the key. *A. riparia*, previously known only from N. Thailand, and *A. brevifasciata* are the commoner species. The six species can be distinguished by the following key:-

KEY TO SPECIES OF *AMEMBOA*

(after Polhemus & Andersen, 1984)
(applicable only to adult males)

1. First segment of mid-tarsi about twice as long as second. Male front-femora modified ventrally with tufts or patches of black hairs 2
– First segment of mid-tarsi distinctly less than twice as long as second. Male front-femora not modified. Female metanotum produced into a lobe posteriorly, bearing a brush of long hair. ..... *nodosa* (Fig. 42)

2. Front-femora with only one patch of short dark hairs on ventral side 3
– Front-femora with at least two separate patches or tufts of dark hair 4

3. Genital segment slong and slender. Phygophore rounded distally, not modified ..... *javanica*
– Genital segments broad and stout. Pygophore modifired distall, with median T-shaped process ..... *lannae* (Fig. 35)

4. Front-femora with two separate hair tufts at distal part ..... *brevifasciata* (Fig.36)
– Front-femora with basal as well as distal patches or tufts of hair 5

5. Posterolateral angles of pygophore only slightly produced, median distal process knob-like ..... *riparia* (Figs. 37 & 38)
– Posterolateral angles of pygophore distinctly produced, median distal process bifid (Fig.40) 6

6. Front-femora with long, narrow patch of short dark hairs in distal half ..... *cristata* (Fig.39)
– Front-femora with small patches of short dark hairs in distal half separated by a notch on ventral side ..... *incurvata* (Fig. 41)

Subfamily: Gerrinae

This is the commonest subfamily, with five genera (numbers of species in brackets): *Limnometra* (5), *Tenagogonus* (1), *Aquarius* (1), *Limnogonus* (3) and *Neogerris* (2). Most of the species are found in still or standing waters. *Limnometra ciliata* and *Limnometra femorata* occur in both fresh and brackish-water habitats whilst *Limnometra insularis* (Fig. 95) and *Tenagogonus maai* occur only on slow flowing streams and are especially common in swampy forests. However, our *Limometra femorata* specimens collected from Pulau Tioman appear to be somewhat different from those found elsewhere in S.E. Asia, and may be a separate species (Zettel, pers. comm.). Winged forms are common in *Limnogonus*, *Aquarius* and *Limnometra*. *Limnometra hungerfordi*, recorded from Sarawak and Sumatra, is a rather rare species in S.E. Asia (Nieser & Chen, 1992). It is not known in Peninsula Malaysia and has not been seen in Singapore since it was last collected in there in 1927 (Andersen, 1975). *Limnogonus anadyomene*, previously reported by Cheng and Fernando (1969), Kovac and Yang (1990) and Yang and Kovac (1995) was misidentified; it is *L. matsudai.*

The two *Neogerris* species, *N. parvulus* and *N. assimilis*, are rather similar in colour pattern but can be distinguished by structures of the genitalia. In *N. parvulus*, the hind margin of the male pygophore is evenly rounded (Fig. 53) and that of the female 7th sternum is slightly convex (Fig. 54). In *N. assimilis* the hind margin of the male pygophore is straight (Fig. 56) and that of the female 7th sternum is bisinuate (Fig. 55).

KEY TO SPECIES OF *LIMNOMETRA*

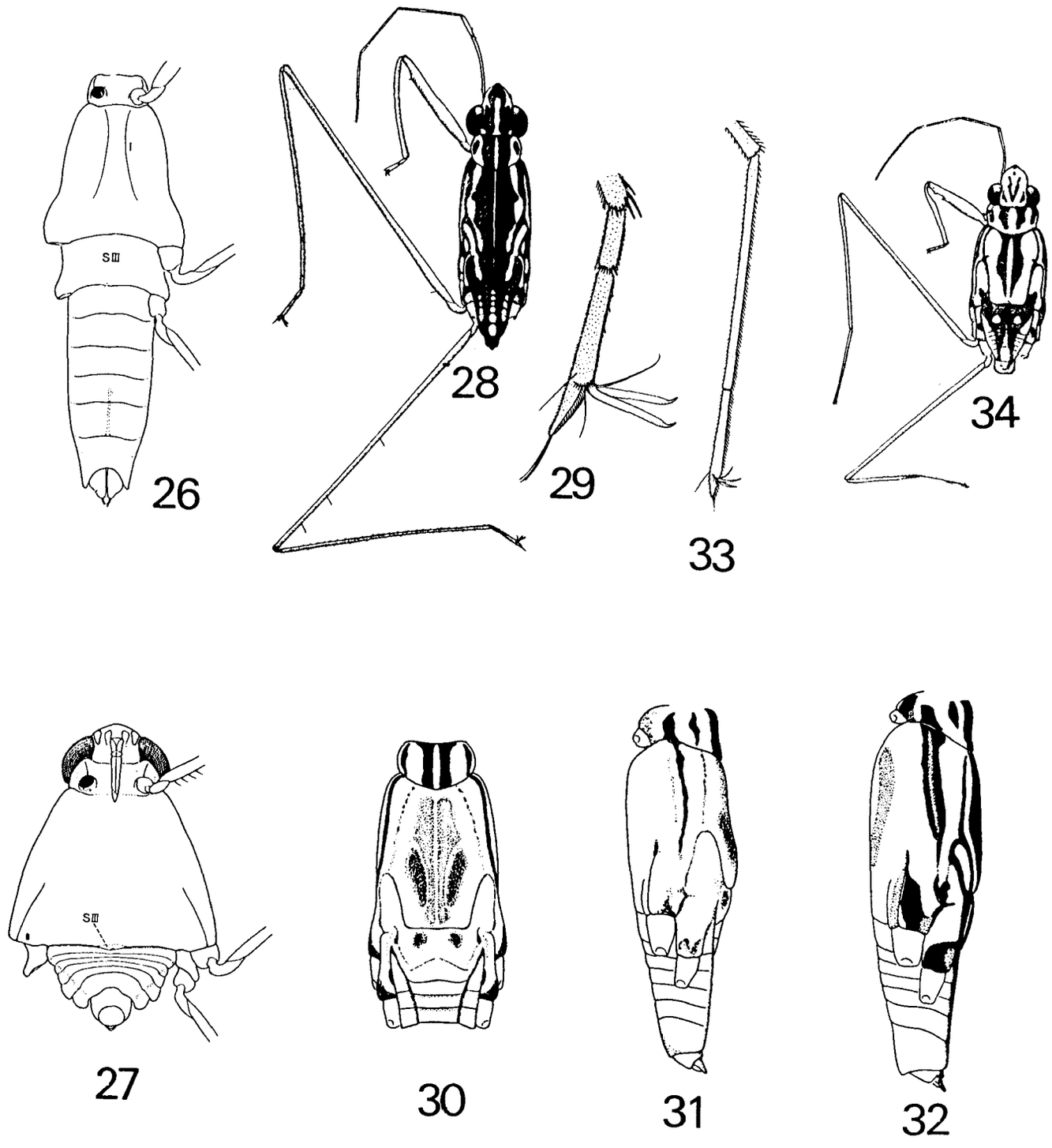
(applicable to adults)

1. Venter with 8 rounded black spots ..... *octopunctata* (Fig. 44)
– Venter without such spots 2

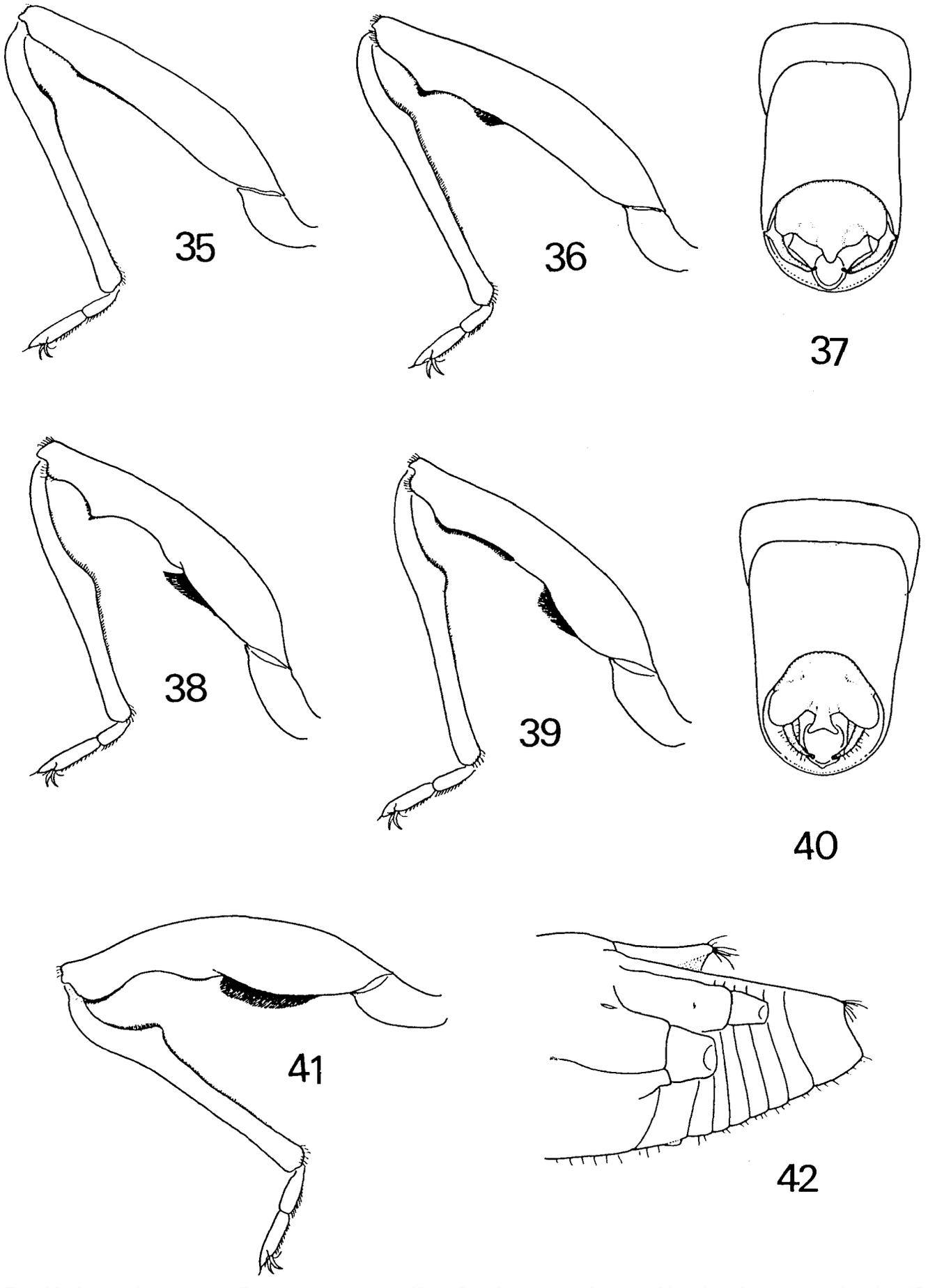
2. Antenna uniformly brown 3
– Antenna not uniform in colour, portion of 3rd and 4th segments white 4

3. Antennal segment 1 subequal in length or longer than 4th. Middle legs fringed with hair ..... *ciliata* (Fig. 43)
– Antennal segment 1 distinctly shorter than 4th. Middle legs not as above ..... *matsudai* (Fig. 45)

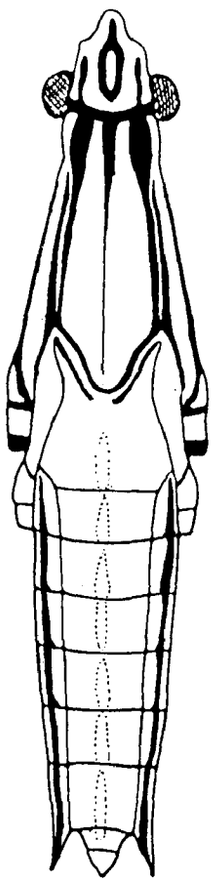
4. Base of 4th antennal segment brown. Body more than 10 mm long ..... *femorata* (Fig. 46)
– 4th antennal segment totally white. Body less than or about 10 mm long ..... *insularis* (Fig. 94)



Figs. 26-34. 26. Gerrinae, ventral view showing well-developed metasternum (SIII) (after Andersen, 1982). 27. Halobatinae, ventral view, showing reduced metasternum (SIII) (after Andersen, 1982). 28-29. *Onychotrechus*, dorsal view and mid-tarsus showing arolia (after Polhemus & Andersen 1984). 30-31. *Onychotrechus pallidus,* dorsal and lateral view (after Andersen, 1980). 32. *Onychotrechus esakii*, lateral view (after Polhemus & Andersen 1984). 33-34. *Amemboa,* mid-tarsus and dorsal view (after Polhemus & Andersen 1984) 35-42. *Amemboa* spp. (after Polhemus & Andersen 1984).



Figs. 35-42. *Amemboa* spp. (after Polhemus & Anderson 1984). 35, *A. lannae*, male front leg; 36, *A. brevifasciata*, male front leg; 37-38, *A. riparia*, male genital segment and front leg; 39-40, *A. cristata*, male front leg and genital segment; 41, *A. incurvata*, male front leg; 42, *A. nodosa*, female lateral view.



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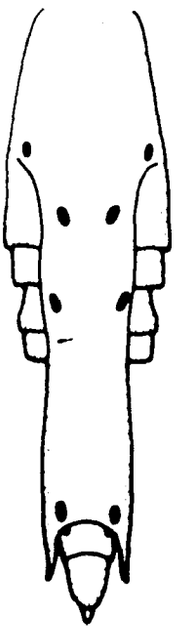

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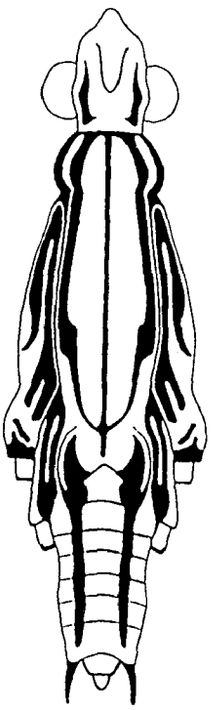

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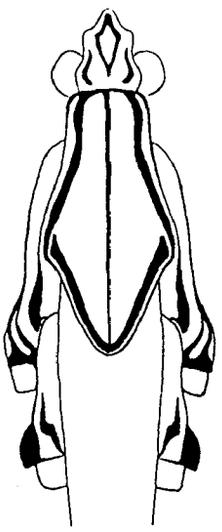

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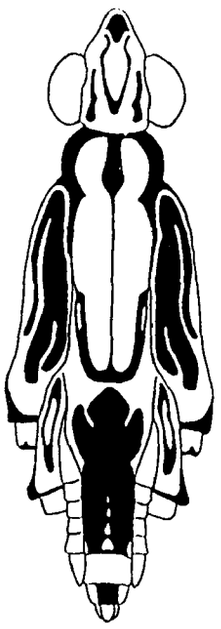

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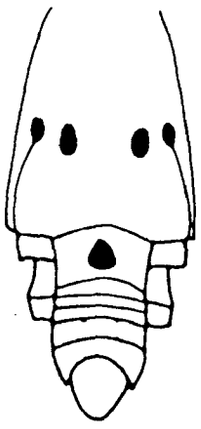

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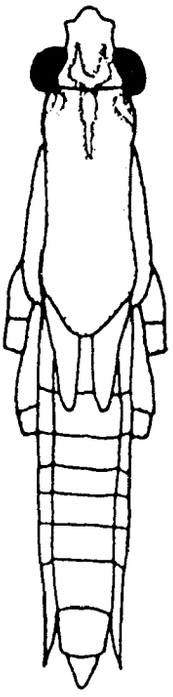

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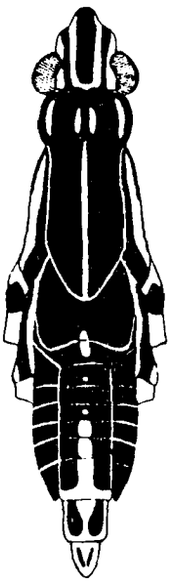

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Figs. 43-50. 43-46. *Limnometra* spp. 43, *L. ciliata*, male dorsal view; 44, *L. octopunctatata*, male ventral view; 45, *L. matsudai*, male dorsal view; 46, *L. femorata*, male dorsal view. 47-48, *Tenagogonus maai*. male dorsal and ventral view (after Cheng & Fernando,1969). 49, *Aquarius adelaidis*, brachypterous male, dorsal view (after Cheng & Fernando, 1969). 50, *Limnogonus fossarum*, male dorsal view (after Cheng & Fernando, 1969).

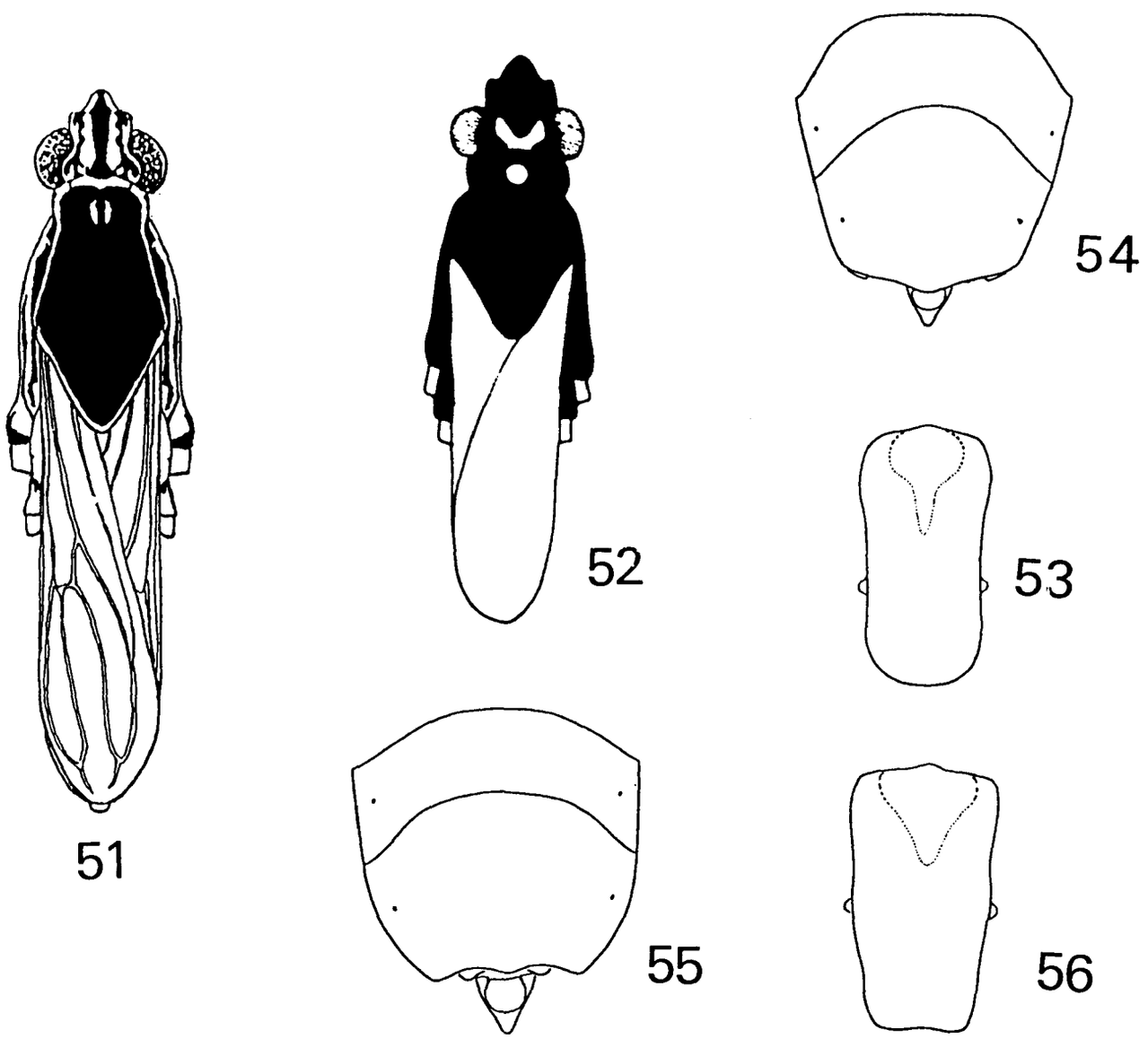
KEY TO SPECIES OF *LIMNOGONUS*
(after Andersen, 1975)
(applicable to adults)

1. Connexivum terminating in a fairly prominent spine. Posterior lobe of pronotum without pale stripe ..... *nitidus* (Fig. 51)
– Connexivum not as above. Posterior lobe of pronotum with longitudinal yellow stripe 2

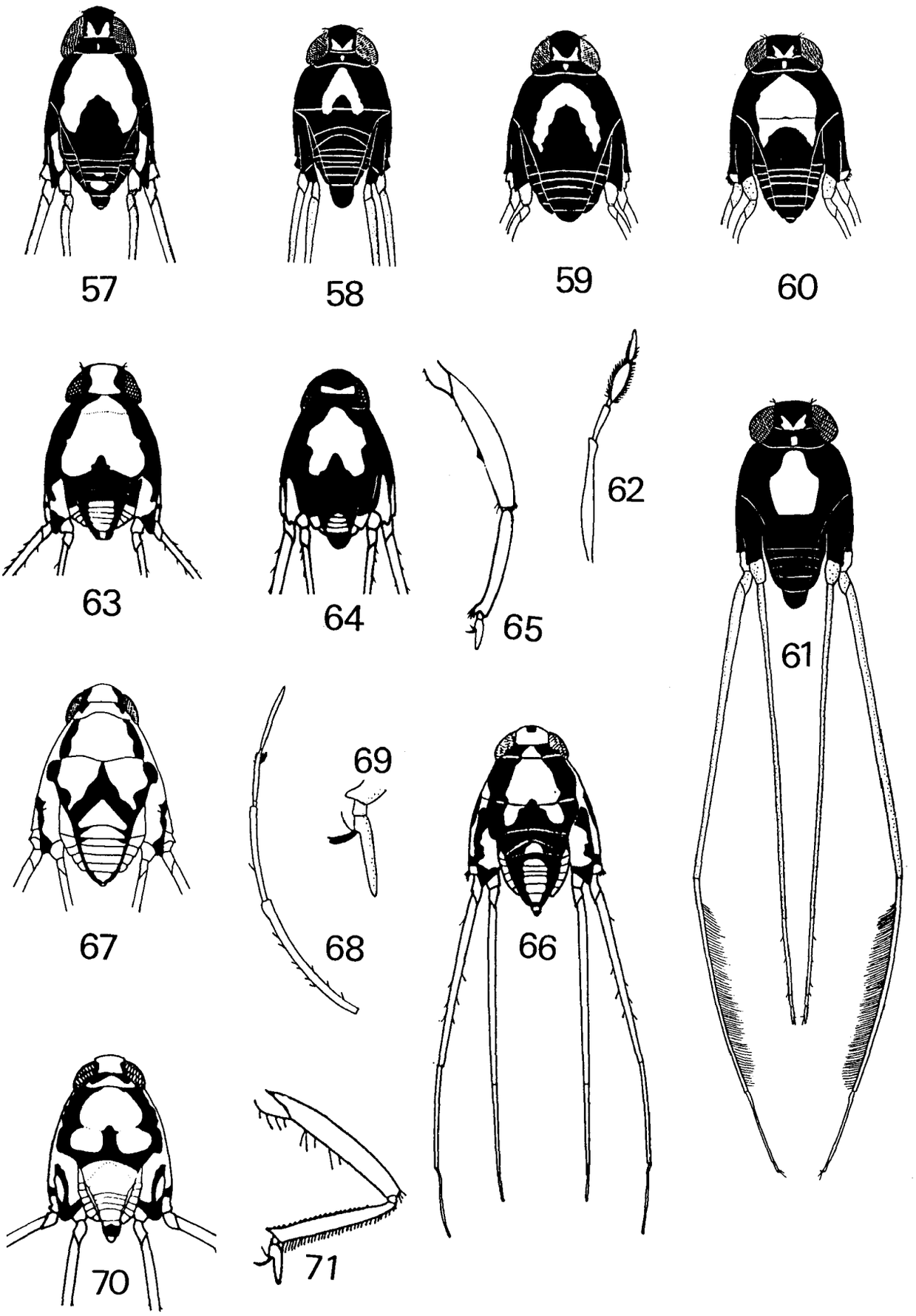
2. Pale stripe on upper part of mesopleuron tapering posteriorly, ending in front of and below second spiracle .... *fossarum* (Fig. 50)
– Pale stripe widened posteriorly, ending above the second spiracle ..... *hungerfordi*

Subfamily: Halobatinae

This is the largest subfamily known in our region, with five genera (numbers of species in brackets): *Esakia* (3), *Ventidius* (6), *Metrocoris* (5), *Asclepios* (1), and *Halobates* (8). *Esakia* and *Metrocoris* occur in forest streams while *Asclepios* and *Halobates* are found in brackish or marine habitats. Among species of *Ventidius* five frequent fresh water while *V. modulatus*, which usually occurs on fresh water, has also been collected from mangrove streams in Pulau Tioman (Yang et al., 1999). Although *V. lundbladi* has so far been reported only from southern Thailand (Chen & Zettel, 1998) we have included it in the key as it is likely to be found in Peninsular Malaysia. A*sclepios annandalei is* found only in mangrove streams and is rather uncommon. Species of *Halobates* are exclusively marine. The six near-shore species may be found along the coast or around offshore islands, usually in areas associated with mangrove or other coastal vegetation (Cheng, 1985; Andersen, 1998). The two pelagic species, *H. micans* and *H. germanus*, are rarely encountered near the coast but may be collected in plankton tows from open waters (Cheng, 1989; Andersen & Foster, 1992). The male genitalia of *Halobates* species are variously modified (Herring, 1961, 1964) and are used for specific identifications (Figs. 84-92).



Figs. 51-56. 51, *Limnogonus nitidus*, winged male, dorsal view 52-56. *Neogerris* spp. (after Andersen, 1975, except 52). 52-54, *N. parvulus*, winged female, dorsal view (after Cheng & Fernando, 1969); 53, male pygophore; 54, female apex of abdomen; 55-56, *N. assimilis*. 55, female apex of abdomen; 56, male pygophore.



Figs. 57-71. 57-62. *Esakia* spp. (after Cheng, 1966d). 57. *E. fernandoi*, male dorsal view; 58-59, *E. johorensis*, male and female dorsal view; 60-62, *E. lundbladi*, female and male dorsal view, male antenna 63-71. *Ventidius* spp. (after Cheng, 1965b); 63, *V. hungerfordi*, male dorsal view; 64-65, *V. pulai*, male dorsal view and front leg; 66, *V. modulatus*, male dorsal view; 67-69, *V. malayensis*, female dorsal view, male antenna and front tarsus; 70-71, *V. harrisoni*, male dorsal view and front leg.

KEY TO SPECIES OF *ESAKIA*
(after Cheng, 1966d)
(applicable to adults)

1. Body black with extensive pale marking covering almost the entire meso- and metanotum. Elongated white spots on meso- and metacetabula ..... *fernandoi* (Fig. 57)
– Body largely black, pale markings on thorax not extensive, Meso and metacetabula totally black 2

2. Metanotum of male almost totally black, pale markings only on mesonotum or extending slightly into metanotum; 3rd antennal segment shortest. Female with pale markings extending to metanotum..... *johorensis* (Figs. 58 & 59)
– White marking extending to metanotum in both sexes. 4th antennal segment shortest in male ..... *lundbladi* (Figs. 60 & 61)

KEY TO SPECIES OF *VENTIDIUS*
(modified from Cheng 1965b, and Chen & Zettel 1998).
(applicable only to adult males)

1. Pronotum yellow with dark lateral stripes and/or triangular mark in middle of hind margin. Parameres symmetrical (subgenus *Ventidius*) 2
– Pronotum usually black. Ventral surface of fore-femur with a small tooth (Fig.65). Parameres asymmetrical. (subgenus *Ventidioides*) 5

2. Antennal segment 1 shorter or subequal to segments 2 and 3 together (Fig. 68). Mid- and hind-femora usually stout 3
– Antennal segment 1 longer than segments to 2 and 3 together. Mid- and hind-femora slender ..... *modulatus* (Fig. 66)

3. More than 3.2 mm in length and 2.3 mm in breadth. Front claws inserted near the base of second tarsal segment (Fig. 69) ..... *malayensis* (Fig. 67)
– Less than 3.0 mm in length and 2.5 mm in breadth. Front claws inserted near the middle of the second tarsal segment (Fig. 71) 4

4. Intersegmental suture between meso- and metanota distinct. Fore-tibiae with rows of stout spines on inner margin .... *harrisoni* (Fig. 70)
– Intersegmental suture obscure. Fore-tibiae without row of stout spines on inner margin ..... *hungerfordi* (Fig. 63)

5. Distal half of left paramere long, slender and straight; right paramere small and rather slender ..... *lundbladi*
– Distal half of left paramere shorter and flattened, twisted at tip; right paramere relatively broad ..... *pulai* (Fig. 64)

KEY TO SPECIES OF *METROCORIS*
(modified from Cheng & Fernando 1969 and Chen & Nieser, 1993a; 1993b)
(applicable only to adult males)

1. Male front-femora not much broader than those of female, without prominent teeth along inner margin at distal end ..... *tenuicornis* (Fig. 74)
– Male front-femora much broader than those of female (L:W ratio about 3) with prominent teeth at distal end along inner margin 2

2. Male front-femora with a single large bicuspid tooth .... *nigrofasciatus* (Fig. 72-75)
– Male front-femora with two teeth, a small proximate tooth and a distal large tooth 3

3. The two teeth well separated by a deep gap or shallow indentation 4
– The small tooth close to the large tooth .... *squamifer* (Fig. 77)

4. Subapical indentation long and shallow. Proximate tooth about 2/5 from distal end of front femora .... *malayensis* (Fig. 78)
– Subapical indentation short and deep. Proximate tooth about 1/5 from distal end of front femora .... *nigrofascioides* (Fig. 76)

KEY TO SPECIES OF *HALOBATES*
(after Andersen & Foster, 1992)
(applicable to adults)

1. Body uniformly black, yellow marking on head restricted to a pair of triangular spots at the base Open-ocean species 2
– Conspicuous yellow or brown markings on venter. Yellow markings on head crescent-shaped and more extensive (Fig. 83). Coastal species 3

2. Body length more than 4.4mm. Male styliform processes asymmetrical, with left process bent upwards almost at a right angle ..... *micans* (Fig. 84)
– Body length less than 4.0mm. Male styliform processes symmetrical ..... *germanus* (Figs. 87 & 88)

3. First segment of front tarsi 1.0 to 1.5 times as long as 2nd segment. Large species, about 6.0mm or more in body length 4
– First segment of front tarsi much shorter than 2nd segment 5

4. Male proctiger with a pointed prominence on each anterolateral angle ..... *princeps* (Fig. 89)
– Male proctiger not as above ..... *esakii* (Fig. 93)

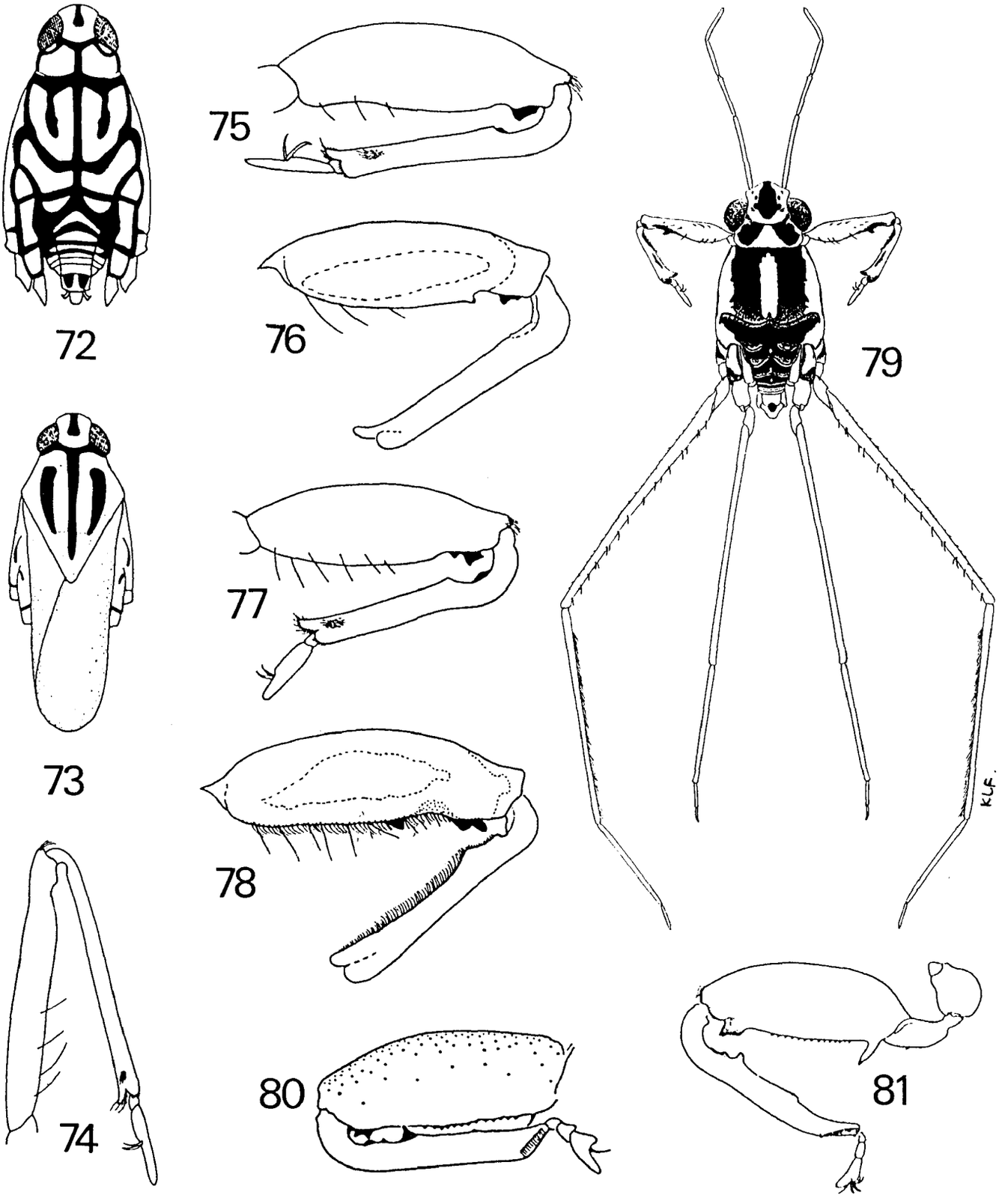
5. Second segment of front tarsi 2.5 to 3 times as long as first ..... *proavus* (Fig. 92)
– Second segment of front tarsi slightly shorter than first 6

6. Male proctiger with patch of stout black hairs on each side . ..... *hayanus* (Figs. 85 & 86)
– Male proctiger without hairs 7

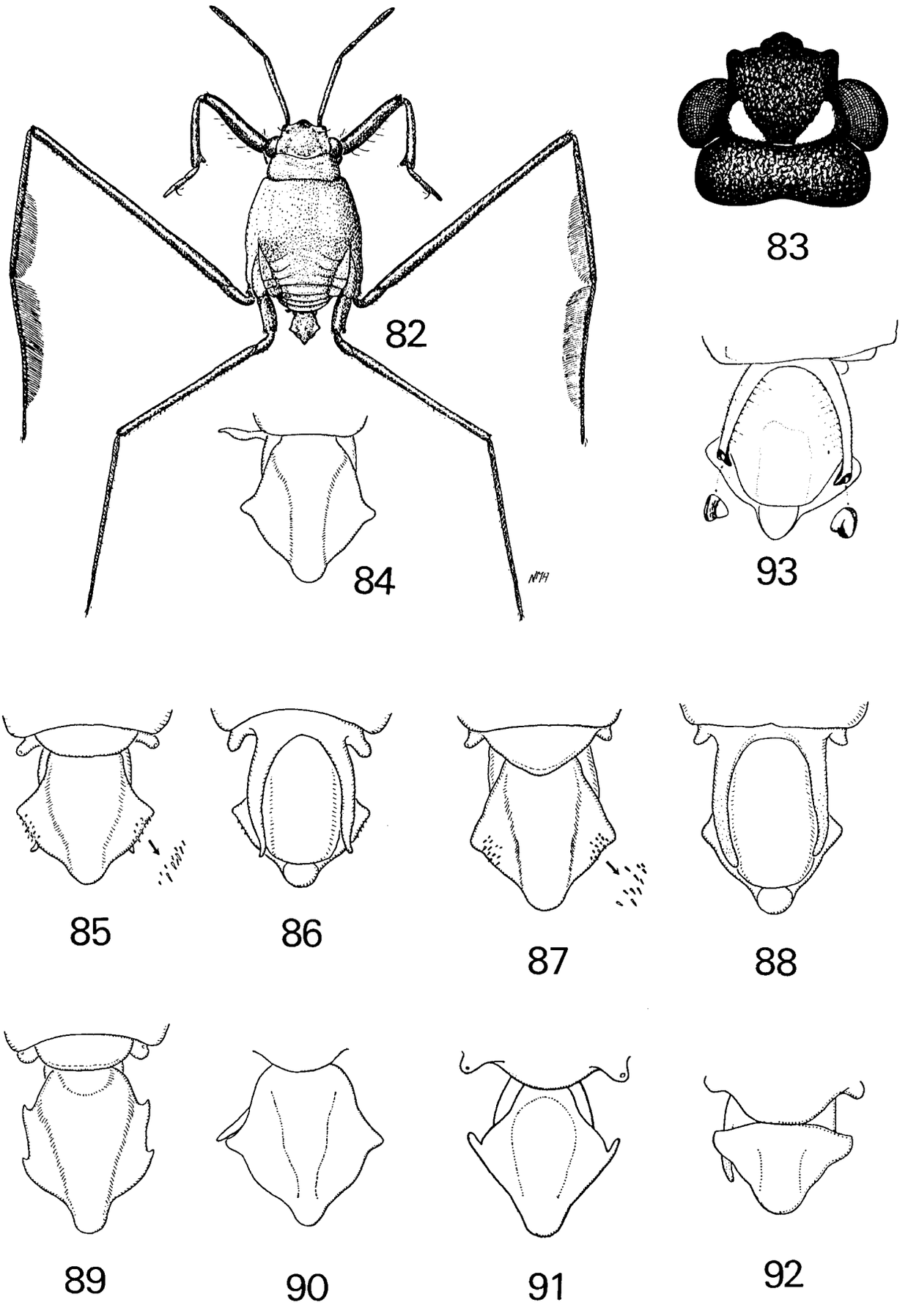
7. Male proctiger with spinous anterolateral processes .... *sexualis* (Fig. 91)
– Male proctiger without spinous processes ... *trynae* (Fig. 90)

FAMILY HERMATOBATIDAE

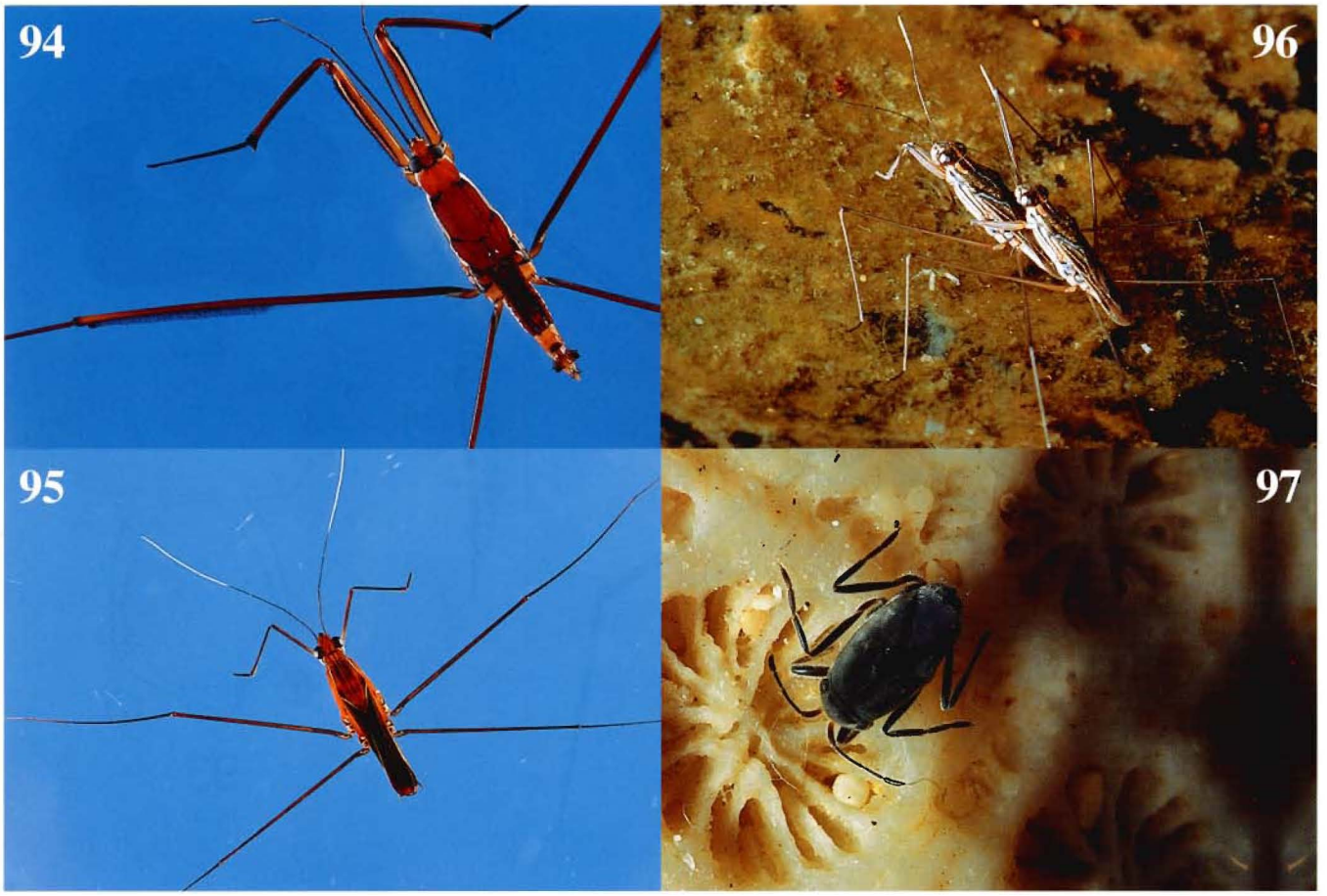
This is a monotypic family, originally considered as a subfamily of the Gerridae but now treated as a separate family (Andersen & Polhemus, 1976; Andersen, 1982). It can be easily distinguished from the Gerridae by the following external morphological characters: all tarsi 3-segmented, only front tarsal claws preapical, extremely short pronotum and completely fused meso- and metanota (Fig. 97). At least eight species of *Hermatobates* are known world-



Figs. 72-81. 72-78. *Metrocoris* spp. 72-73, *M. nigrofasciatus* wingless and winged male, dorsal view; 74-78, Male front legs (after D. Polhemus, 1990 except 76 & 78). 74, *M. tenuicornis*; 75, *M. nigrofasciatus* (after Chen & Nieser, 1993a); 76, *M. nigrofascoides*; 77, *M. squamifer* (after Chen & Nieser, 1993a); 78, *M. malayensis*. 79. *Asclepios annandalei*, male dorsal view. 80. *Hermatobates singaporensis*, male front leg (after Cheng, 1966a). 81. *Hermatobates marchei*, male posterior thorax and abdomen, ventral view (after Andersen & Weir, 2000).



Figs. 82-93. *Halobates* spp. 82, *H. micans*, male dorsal view (after Andersen, 1982); 83, *H. hayanus* head (after Andersen & Weir, 1994); 84-92. Male genitalia (after Andersen & Weir, 1994 except, 90, 91 & 93). 84, *H. micans*, dorsal view; 85-86, *H. hayanus*, dorsal and ventral view; 87-88, *H. germanus* dorsal and ventral view; 89, *H princeps*, dorsal view; 90, *H. trynae*, dorsal view (after Herring, 1964); 91, *H. sexualis*, dorsal view (after Herring, 1961); 92, *H. proavus*, dorsal view; 93. *H. esakii*, ventral view (after Miyamoto, 1967).



Figs. 94-97. Fig. 94. *Ptilomera tigrina*, male (B.H.Tan). Fig. 95. *Limnometra insularis*, male (B.H.Tan). Fig. 96. *Onychotrechus* sp., male and female (D. Kovac). Fig. 97. *Hermatobates* sp., female (L.Cheng).

wide (Cheng, 1977). Since structures of the male front legs previously used for separating the species have been found to be variable, the taxonomy of the family remains to be revised (Andersen, 1998; Andersen & Weir, 2000). Until recently, *H. singaporensis* (Fig. 80) was the only species found in our area, occurring among coral rubble on offshore islands (Cheng, 1966a; 1976). Another species, *H. marchei* (Coutière & Martin) (syn. *H. weddi* China; Andersen &Weir, 2000) was collected off Pulau Tioman (J.T. Polhemus per. comm.). It could be distinguished from *H. singaporensis* by the presence of a median process on the hind margin of the male metasternum (Fig. 81).

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10. First antennal segment longer than the 3 other segments together. Hind-femora more than twice as long as tibiae. Female abdomen with a pair of long and thin spinous processes on segment 6 ..... *Pleciobates* (Fig. 24)
- First antennal segment shorter than the 3 other segments together. Female without abdominal processes .... *Rheumatogonus* (Figs. 22 & 23)

11. Metasternum well developed (Fig. 26: SIII). Body relatively long and slender, length:width ratio usually more than 3.0; if not, then first antennal segment with 4-6 dark spinous hairs 12
- Metasternum reduced, usually represented only by a short triangular plate enclosing the scent gland orifice (Fig. 27: SIII). Body relatively broad and short, length:width ratio less than 3.0 (Halobatinae) ..... .18

12. Pronotum not prolonged posteriorly in apterous specimens. First antennal segment with 4-6 dark spinous hairs. Pretarsal arolia present, arising between the claws (Fig. 29) (Eotrechinae) 13
- Pronotum prolonged posteriorly in apterous specimens; if reduced in length, then dorsal head and thorax generally dark and pretarsal arolia missing. First antennal segment without dark spinous hairs (Gerrinae) 14

13. Hind legs distinctly shorter than middle legs. 1st mid-tarsal segment longer than 2nd. (Fig. 33) ..*Amemboa* (Fig. 34)
- Hind legs subequal in length to middle legs. 1st mid-tarsal segment shorter than 2nd ..... *Onychotrechus* (Fig. 95)

14. Antennae subequal to or longer than body. Pronotal lobe usually pale with longitudinal median dark stripe 15
— Antennae much shorter than body. Pronotal lobe dark with or without longitudinal median pale stripe 16

15. Connexival spines well developed ..... .*Limnometra* (Fig. 43)
- Connexival spines not distinct ..... *Tenagogonus* (Fig. 47)

16. Dorsal surface of head almost uniformly dark. Venter generally dark. First antennal segment subequal to or longer than segments 2+3 ..... *Aquarius* (Fig. 49)
- Dorsal surface of head with orange spots, or with two pale longitudinal stripes or elongate spots. Venter generally pale. First antennal segment shorter than segments 2+3.....17

17. Pronotal lobe dark with a pale median stripe; or, if uniformly dark, anterior part with a pair of elongate pale spots .... *Limnogonus* (Fig. 50)
- Pronotal lobe dark, with a single median pale spot on the anterior part, sometimes shortened in apterous form ....*Neogerris* (Fig. 52)

18. In dorsal view anterior margin of head smoothly rounded. Freshwater 19
- Anterior margin of head not smoothly rounded, with distinct antero-lateral tubercles (Fig. 83). Marine 21

19. Male third antennal segment expanded laterally, with stiff hairs on margin (Fig. 62) ..... *Esakia* (Fig. 57)
- Male third antennal segment not expanded laterally (Fig. 68) 20

20. Eyes overlapping anterolateral angles of mesonotum. Front-femora of male usually slender ..... *Ventidius* (Fig. 63)
— Eyes not overlapping anterolateral angles of mesonotum. Front-femora of male often robust and incrassate (Figs. 74-77) ..... *Metrocoris* (Figs. 72 & 73)

21. Head, pronotum and thoracic pleura with extensive pale markings. Male front-femora with prominent spine ventrally .....*Asclepios* (Figs. 79)
- Head mostly dark, at most with a V-shaped pale marking basally. Pronotum and thoracic pleura uniformly dark. Male front-femora without spine ..... *Halobates* (Fig. 82)

Subfamily: Rhagadotarsinae

The only species found in our region, *Rhagadotarsus kraepelini*, can be easily recognised by the greatly extended long-pointed abdomen (Fig. 6). Adults measure 3-4 mm in body length. Both winged and apterous forms are known. They are common on still waters where the surface is free from scum, and can also be found in mangrove streams (Murphy, 1990, Yang et al., 1999). Ripple communication of this species was first reported by Wilcox (1972) and also observed by Murphy (1990).

Subfamily: Trepobatinae

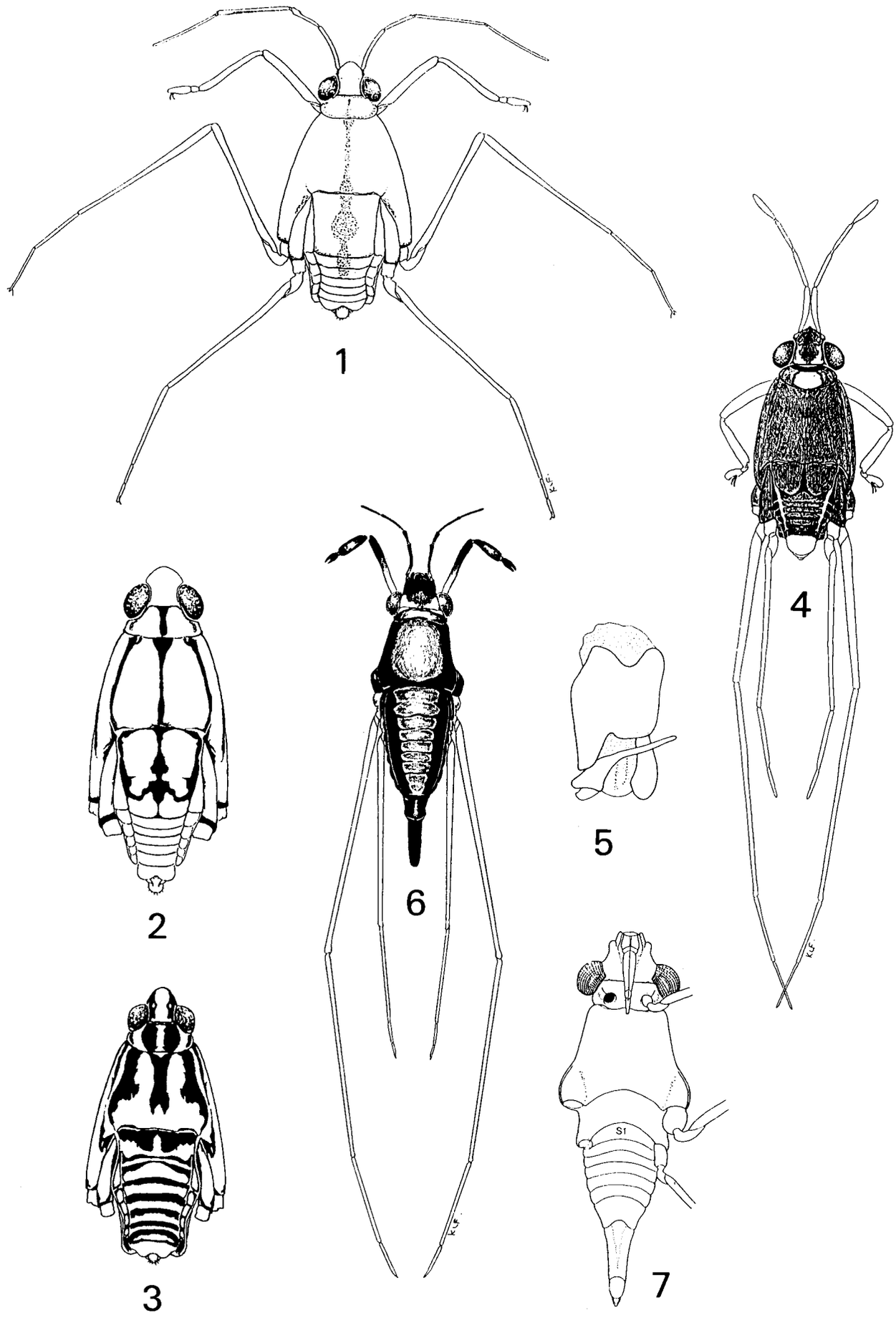
This subfamily has recently been reviewed by Polhemus and Polhemus (1993, 1994, 1995, 1998). Five genera are known: *Gnomobates, Naboandelus, Rheumatometroides*, and *Stenobates* are each represented by one species, and *Cryptobates* by two. *Rheumatometroides* and *Stenobates* are found in brackish habitats (Polhemus & Cheng, 1982) and have been collected together with *Ventidius modulatus* and *Rhagadotarsus kraepelini* in mangrove streams on Pulau Tioman (Yang, et al. 1999). *Cryptobates, Gnomobates* and *Naboandelus* are freshwater in habitat and are all weak skaters. They are not common, being patchily distributed at margins of slow flowing streams in lowland forests. Since they are small (1.5 - 3.5 mm), they can be easily missed in sampling. *Cryptobates johorensis* and *C. rufus* inhabit freshwater swamps. They are both pale brown, but *C. johorensis* has a striking dark brown patterning dorsally (Fig. 2) while *C. rufus* has just a reddish brown stripe down the middle (Fig. 1). Winged forms are known only for *C. rufus*.

Subfamily: Cylindrostethinae

The only genus known, *Cylindrostethus,* was recently reviewed by D. A. Polhemus (1994). It is represented in our area by 2 species, *C. malayensis* and *C. scrutator*. They are some of the largest stream-dwelling gerrids in our region and can be easily distinguished by size, colour and shape of the male proctiger. *C. malayensis* is light brown (Figs. 16 & 17), measures almost 20 mm in length and inhabits lowland swamp forests. *C. scrutator* is almost totally black (Figs. 14 & 15), measures only 10-15 mm, and is found in rocky upland streams. Winged forms are extremely rare. Only one winged female of *C. malayensis* has been collected so far (Cheng & Fernando, 1969).

Subfamily: Ptilomerinae

Three genera are known: *Ptilomera* (Fig. 19), *Rheumatogonus* (Figs. 22 & 23) and *Pleciobates* (Figs. 24



Figs. 1-7. 1. *Cryptobates rufus,* male, dorsal view. 2. *Cryptobates johorensis,* male, dorsal view. 3. *Gnomobates kuiteri,* female. 4-5. *Naboandelus johorensis,* male, dorsal and lateral view of proctiger showing anterolaterally directed process (after Polhemus & Polhemus 1994). 6-7. *Rhagadotarsus kraepelini,* male, dorsal and ventral view showing first abdominal segment (S1) (after Andersen 1982).