RAFFLES BULLETIN OF ZOOLOGY 1990 38(1): 65-75

MISCELLANEOUS STUDIES ON THE GENUS *RHAGOVELIA* MAYR (HETEROPTERA: VELIIDAE) IN SOUTHEAST ASIA AND THE SEYCHELLES ISLANDS, WITH KEYS AND DESCRIPTIONS OF NEW SPECIES

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ABSTRACT. - Two new species of *Rhagovelia* are described, *R. andaman* from the Andaman Islands and *R. starmuehlneri* from the granitic Seychelles. A revised diagnosis is also presented for *R. femorata* Dover from Peninsular Malaysia. A key is provided to the species of *Rhagovelia* occurring on the Asian continent, Sri Lanka, Taiwan, and the Andaman Islands, and a separate key to the species of the granitic Seychelles.

INTRODUCTION

This contribution is part of a continuing series of studies of the *Rhagovelia* Mayr of the world. The material upon which the descriptions are based is held in various institutions – Polhemus Collection Englewood , Colorado, U.S.A. (JTPC); the Snow Entomological Museum, Lawrence, Kansas, U.S.A. (SEMC); Smithsonian Institution, Washington, D. C., U.S.A. (USNM); and Rijksmuseum van Natuurlijke Historie, Leiden, The Netherlands (RMNH). All measurements are given in millimetres.

NOTES ON *RHAGOVELIA* FROM SOUTHEAST ASIA

The last revisor of the Old World *Rhagovelia* was Lundblad (1936). Asian species from areas west of the Malay Archipelago have subsequently been described or discussed in short papers by Lundblad (1937) and Polhemus (1979). In addition to the two new species described here, there are numerous undescribed *Rhagovelia* species at hand from other parts of the Old World. This fauna is being revised in parts, a task initiated with a recent monograph on the fauna of Borneo, Sulawesi and Moluccas (Polhemus & Polhemus, 1989). This monograph also covered a number of species occurring on the Asian continent, and delimited the species groups discussed herein.

In the above monograph, it was noted that examination of type material had shown that Lundblad's concept of *Rhagovelia femorata* Dover was incorrect (Lundblad, 1936: 16, and see subsequent discussion), so *Rhagovelia sondaica* J. & D. Polhemus was described

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for one of several species lumped under Lundblad's *"femorata"* (Polhemus & Polhemus, 1989: 188). This and several other changes rendered Lundblad's key unworkable, so a new key is provided below that should allow the identification of all species presently known from continental Asia, here construed to include the mainland from India to China. The key also covers species occurring on Sri Lanka (= Ceylon), Taiwan (= Formosa) and the Andaman Islands, but not the islands lying on the Sunda Shelf (e.g. Java, Sumatra and Borneo) or the Philippines; these will be treated separately in forthcoming publications.

Key to the *Rhagovelia* of continental Asia, Sri Lanka, Taiwan and the Andaman Islands

1. Pronotum shorter than length of an eye (*sarawakensis* group) 2

   Pronotum longer, covering most or all of mesonotum (*papuensis* group) 8

2. Middle coxae entirely dark. Lateral margins of male eighth tergite straight, slightly convergent posteriorly; Male paramere broad distally (Fig. 8). Female tergite eight shining (Peninsular Malaysia) ..... *femorata* Dover

   Middle coxae light colored (occasionally partly brownish, eg. *sumatrensis, karunaratnei*). Lateral margins of male eighth tergite straight or curved. Male paramere narrow distally (Fig. 9). Female tergite eight may or may not be shining 3

3. Mesonotum clearly less than three times as long as pronotum; posterior margin of pronotum straight. Male middle femur with thick thorn-like teeth basally. Female tergite eight not shining (Java, Sumatra, Bali; Southeast Asia; India to Taiwan) ..... *sumatrensis* Lundblad

   Mesonotum equal to or more than three times as long as pronotum; posterior margin of pronotum straight or concave. Male middle femur without thick thorn-like teeth 4

4. Mesonotum clearly more than three times as long as pronotum; posterior margin of pronotum concave. Male without teeth on hind trochanter or basal part of hind femur. Female hind femur with at most one large spine at middle or beyond followed by one or two tiny teeth distally. Female tergite eight not shining 5

   Mesonotum approximately three times as long as pronotum; posterior margin of pronotum straight. Male with teeth on hind trochanter and on basal part of hind femur. Female hind femur with one large spine at middle followed by at least 5 or 6 smaller teeth distally. Female tergite eight may or may not be shining 6

5. Male seventh ventrite with a pronounced median carina; eighth tergite fusiform, lateral margins curved. Female hind femur without spines or with one or two small spines beyond distal two thirds (Peninsular Malaysia, Borneo) .....

   ..... *sondaica* Polhemus & Polhemus

Male seventh ventrite without median carina, smooth; eighth tergite with lateral margins slightly curved, but not fusiform. Female hind femur with one large spine at middle followed one or two tiny teeth distally (Sri Lanka) ..... *karunaratnei* J. Polhemus

6. Narrow species; male posterior femur longer than width of pronotum. Female tergite eight shining medially; tergite nine directed ventrally at a sharp angle (Taiwan, Ryukyu Is.) ..... *esakii* Lundblad

   Broader species; male posterior femur length equal to width of pronotum. Female tergite eight not shining; tergite nine directed caudad 7

7. Legs distally brown. Proepisternum and jugum of head without minute black conical setae (Anadaman Is.) ..... *andaman* new species

   Legs distally black. Proepisternum and jugum of head with minute black conical setae (Burma, Thailand, Java) ..... *hutchinsoni* Lundblad

8. Hind femur with a large proximal tooth; hind tibia with a median tooth larger than any others (India) ..... *tibialis* Lundblad

   Hind femur without a large proximal tooth; hind tibia without a large tooth 9

9. Legs hirsute, thickly set with numerous long hairs of length greater than width of tibia. At most tergite VII shining. Male paramere very broad, truncate apically (Taiwan, Philippines, Borneo) ..... *kawakamii* (Matsumura)

   Legs not hirsute; set with usual rows of long hairs, but not hairy. Abdominal tergites V-VII in male, V-VIII in female shining. Male paramere narrow, pointed apically (Sri Lanka) ..... *ceylanica* Lundblad

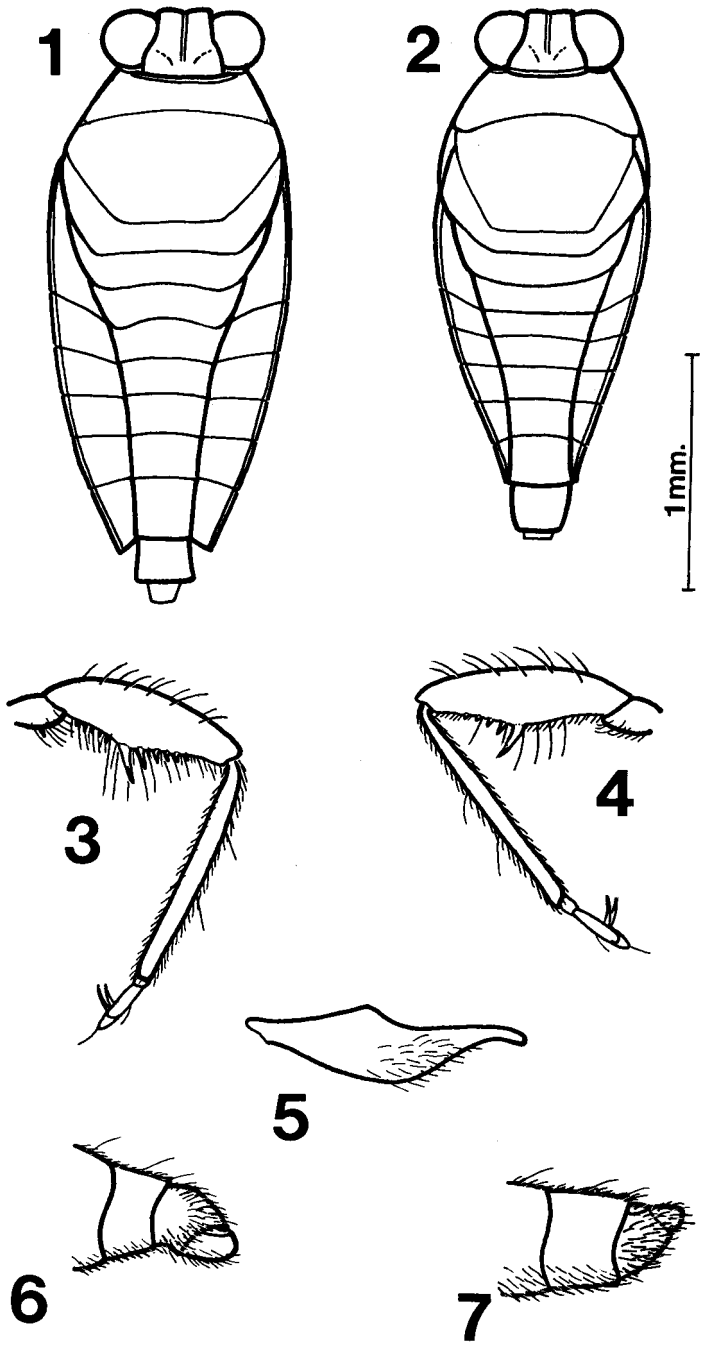
***Rhagovelia andaman*, new species**

(Figs. 1-7)

Material examined. - Holotype, apterous ♂ and allotype apterous ♀ (JTPC), stream near Guptapura, Andaman Is., S-AND 8, coll. F. Starmühlner, 7.xii.1976.

Paratypes as follows: 1 apterous ♂, same data as holotype; 1 macropterous ♂, 1 macropterous ♀ (JTPC), forest stream nr. Bambooflat, North-Bay, South Andamans, S-AND 15, coll. F. Starmühlner, 19.xii.1976.

Description. - Apterous male: Ground color blackish brown; abdominal tergites not shining, connexival margins faintly lighter, anterior transverse band on pronotum orange brown, reaching middle of eye laterally. Venter blackish brown, sternite VII and genital segments brown; coxal cavities broadly testaceous. Legs, antennae brown, lighter basally, all coxae and trochanters luteous. Pronotum shorter than the length of an eye; length: width, 0.15: 0.70. Length of exposed mesonotum, 0.43. Length of metanotum on midline, 0.08. Abdominal tergites I-VI subequal in length (0.10-0.15), tergite VII longer (0.23).



Figs. 1-7 *Rhagovelia andaman*, new species. 1. Female dorsum; 2. Male dorsum; 3. Male hind legs; 4. Female hind leg; 5. Male paramere (not to same scale; x 60); 6. Male abdominal terminalia, lateral view; 7. Female abdominal terminalia, lateral view.

Proepisternum without minute black conical setae. Dorsum clothed with short recumbent golden setae, with scattered longer setae. Venter clothed with short recumbent setae.

Legs, antennae clothed with the usual bristles and a few scattered long hairs, posterior femur beneath with numerous moderate length setae. Posterior trochanters armed with a single stout tooth. Posterior femur armed with six small teeth basally in a row offset from the distal row of teeth, consisting of one stout spine at middle followed by five spines of decreasing length distally. Posterior tibia beneath unarmed.

Downcurving arolia of hind tarsi flattened dorsoventrally.

Antennal formula I:II:III:IV; 0.47:0.30:0.38:0.33.

Proportions of legs as follows:

	Femur	Tibia	Tarsal 1	Tarsal 2	Tarsal 3
Anterior	0.63	0.63	0.03	0.13	–
Middle	1.00	0.75	0.05	0.28	0.53
Posterior	0.75	0.85	0.03	0.05	0.18

Abdominal sternites VII and VIII unmodified, shining. Parameres, symmetrical, shape as shown in Fig.5.

Length, mean = 2.15 mm (N = 2, min. 2.12, max. 2.17)
Width, mean = 0.91 mm (N = 2, min. 0.91, max. 0.91)

Macropterous male: Similar to apterous form except that pronotum is longer, rounded behind. Wings with two closed cells in basal half, extending far beyond tip of abdomen.

Length, mean = 2.78 mm (N = 1)
Width, mean = 1.16 mm (N = 1)

Apterous female: Coloration and hairy vestiture as in male; abdominal tergites not shining. Connexiva only slightly raised, margins brown. Proepisternum without minute black conical setae. Middle femur not flattened. Posterior femur armed beyond middle with a moderate length spine, followed by a row of three or four smaller spines decreasing in length distally. Posterior tibia unarmed.

Abdomen distally unmodified; connexiva distally truncate. Tergite IX directed caudad.

Length, mean = 2.37 mm (N = 1)
Width, mean = 1.01 mm (N = 1)

Macropterous female: Coloration and most other characteristics as in apterous females. Pronotum not prolonged, rounded posteriorly.

Abdomen straight, not upturned. Wings broken off, probably to facilitate mating.

Length, mean = 2.53 mm (N = 1)
Width, mean = 1.16 mm (N = 1)

Etymology. - The species name is derived from its type locality, the Andaman Islands, and is used as a noun in apposition.

Remarks. - Following Lundblad (1936), *Rhagovelia andaman*, new species, keys to *R. hutchinsoni* Lundblad, a member of the *sarawakensis* group which is characterised by the pronotum being shorter in length than an eye. It differs from *R. hutchinsoni* in having fewer basal teeth on the hind trochanter but more on the hind femur, antennae and legs distally brown instead of black, shorter stouter legs, and by the lack of minute conical black setae on the proepisternum and jugum of the head.

Rhagovelia andaman is part of a closely knit species group that occurs from Sri Lanka through Burma, Thailand, the Peninsular Malaysia and Sumatra onto the Lesser Sunda Islands and Borneo. This complex of species is perhaps the most difficult taxonomically of any of the Old World groups.

***Rhagovelia femorata* Dover**
(Fig. 8)

Rhagovelia femorata Dover, 1928: 66.

Material examined. - (All apterous) Peninsular Malaysia - Perak: 10♂♂, 8♀♀, Kerunai River, 9 km N. of Grik at bridge, CL 2078, coll. J. T. & D. A. Polhemus, 19.viii.1985; Selangor: 3 ♂♂, 2 ♀♀, Gombak River, 24 km. E. Kuala Lumpur, CL 2068, coll. J. T. & D. A. Polhemus, 16.viii.1985; 10 ♂♂, 14 ♂♂, small stream, Templer Park, N. of Kuala Lumpur, CL 2070, coll. J. T. & D. A. Polhemus, 17.viii.1985; 1♂, 1♀, Sungai Kanching, Templer Park, N. of Kuala Lumpur, coll. G. F. & C. H. Edmunds, 28.viii.1978. All specimens in JTPC.

Distribution. - Peninsular Malaysia.

Remarks. - Lundblad's species concept of *Rhagovelia femorata* Dover (Lundblad, 1936: 16) was based on a series of specimens from Java, and was shown by Polhemus & Polhemus (1989) to be incorrect, referring instead to a complex of species that does not include *femorata*. In this latter work, one of these species conforming to *Rhagovelia femorata* Lundblad (nec Dover) occurring on Borneo and Peninsular Malaysia was proposed as *R. sondaica* J. & D. Polhemus. Through the kindness of Dr. Amir of the Bogor Museum, the author has also studied the series of specimens from Java upon which Lundblad based his redescription of *"femorata"*. It represents yet another undescribed species in this same complex. All these species belong to the *Rhagovelia sarawakensis* group established by Polhemus & Polhemus (1989: 164), an assemblage of superficially very similar species separable only by characteristics not previously used by Lundblad or other workers.

Lundblad apparently did not study Dover's type material from Peninsular Malaysia, said to be in the Federated Malay States Museum, and since Dover identified mixed series as being *femorata* there was considerable doubt that the Java specimens, identified by Dover as *femorata* and redescribed as such by Lundblad, were conspecific with the species Dover described from Klang Gates (in the city of Kuala Lumpur, Malaysia). Dover's original description states that the species is black except for certain structures that are white, which he carefully lists; among these structures one does not find the middle coxae. In 1985 the author and D. A. Polhemus collected *Rhagovelia* species at several localities in

the vicinity of Kuala Lumpur, and found three closely related species to be present there. One of these matched Lundblad's redescription of *femorata*, with the middle coxae light colored, and was our *R. sondaica;* another was Lundblad's *Rhagovelia sumatrensis;* and the third was the true *Rhagovelia femorata*, which has the middle coxae dark, and matches Dover's brief description (in alcohol some females appear to have the middle coxae partly light, but these may be separated from sympatric *sumatrensis* females by the shining tergite eight). Subsequently the author was fortunate enough to locate Dover's type series in the British Museum (Natural History); it consists of two specimens, both *femorata* males with dark middle coxae, one from Sungai (River) Jahan labelled as "holotype", the other from the type-locality at Klang Gates labelled as "type"; a label has been added to the latter designating it as the holotype.

Lundblad (1933, 1936) gave the distribution of *femorata* as including Java and Sumatra, but those records, as well as that of Hungerford (1933) probably refer to other species in the *sarawakensis* group.

NOTES ON THE *RHAGOVELIA* FAUNA OF THE GRANITIC SEYCHELLES

Key to the *Rhagovelia* of the Seychelles

1. Male abdominal ventrites with a pronounced median carina. Female connexiva reflexed, touching over tergites 5 and 6, hiding dorsal surface of abdomen .... *starmuehlneri*, new species

   Male abdominal ventrites without a pronounced median carina. Female connexiva reflexed, but not touching over tergites 6 and 6, not hiding dorsal surface of abdomen .... *seychellensis* Lundblad

Rhagovelia starmuehlneri, new species
(Figs. 10-17)

Material examined. - Holotype, apterous ♂ and allotype, apterous ♀ (USNM), Du Cap River, W. of Anse aux Pins along Montagne Posee road, 85 m. water temp. 25°C, Mahe, Seychelles Islands, CL 8045, coll. D. A. Polhemus, 1.iv.1989.

Paratypes (all apterous unless otherwise noted): 27 ♂♂, 13 ♀♀, 1 macropterous ♀, 1 nymph (USNM, JTPC), same data as holotype; 1 ♀ (JTPC), Desert River, Mahe, Seychelles, F-SEY 23, coll. F. Starmühlner, 19.ii.1974; 1 ♂, 1 ♀ (JTPC), Desert River, Mahe, Seychelles, F-Sey 24, coll. F. Starmühlner, 19.ii.1974.

Description. - Apterous male: Ground color blackish brown, pronotum, and distal abdominal tergites lighter brown; abdominal tergites 6 medially, most of 7 shining; connexival margins broadly yellowish brown; anterior transverse band on pronotum orange brown, frosted, reaching laterally beyond eyes and contiguous with yellowish propleura and prosternum. Remainder of venter blackish brown, mesothorax yellowish laterally, abdominal sternites variably marked with orange brown; acetabulae yellowish. Legs, antennae brown, lighter basally, all coxae and trochanters luteous. Pronotum long, covering

mesonotum, rounded posteriorly; length: width, 0.36 : 0.44. Length of metanotum on midline, 0.08. Abdominal tergite I short (0.18), II-VI subequal in length (0.25-0.33), tergite VII longer (0.45).

Proepisternum and jugum of head with a few minute black conical setae. Dorsum clothed with short recumbent golden setae, with scattered longer setae. Venter clothed with long fine golden setae, denser and semierect along strongly carinate midline.

Legs, antennae clothed with the usual bristles and a few scattered long hairs; anterior and posterior trochanters and femur beneath with numerous long setae. Posterior trochanters unarmed. Posterior femur armed beyond middle with one stout spine followed by five spines of decreasing length distally. Posterior tibia beneath armed with small black teeth along entire length, and a short distal spur.

Downcurving arolia of hind tarsi flattened dorsoventrally.

Antennal formula I:II:III:IV; 0.95:0.45:0.53:0.48

Proportions of legs as follows:

	Femur	Tibia	Tarsal 1	Tarsal 2	Tarsal 3
Anterior	1.05	1.08	0.03	0.28	-
Middle	1.83	1.50	0.05	0.55	0.73
Posterior	1.53	1.58	0.03	0.13	0.30

Abdominal sternites raised on longitudinal midline, with a blade-like carina on VI-VII; VIII depressed on each side of median carina, shining. Proctiger transversely carinate dorsally, with 2 (1+1) small dorsolateral ear-like protuberences. Parameres symmetrical, shape as shown in Fig. 17.

Length, mean = 3.92 mm (N = 10, min. 4.10, max. 4.24)
Width, mean = 1.17 mm (N = 10, min. 1.11, max. 1.21)

Macropterous male: Unknown

Apterous female: Coloration as in male, hairy vestiture much less pronounced on venter and legs; abdominal tergites not shining, 5 to 7 mostly hidden by reflexed connexivum which meet over tergite 5 and diverge over tergite 7; connexival margins broadly yellowish. Proepisternum with a few minute black conical setae. Middle femur slightly dorsoventrally flattened. Posterior femur armed beyond middle with a moderate length spine, followed by a row of five smaller spines decreasing in length distally. Posterior tibia unarmed.

Abdomen distally unmodified; connexiva distally truncate. Tergite IX directed slightly ventrally.

Length, mean = 3.92 mm (N = 10, min. 3.84, max. 4.09)
Width, mean = 1.15 mm (N = 10, min. 1.11, max. 1.21)

Macropterous female: Coloration and most other characteristics mostly as in apterous females; anterior pronotal band narrower and darker. Pronotum not prolonged, broadly triangular posteriorly. Wings blackish brown, extending beyond tip of abdomen, with 4 closed cells, 2 in distal half. Abdomen straight, not upturned.

Length, mean = 3.99 mm (N = 1)
Width, mean = 1.36 mm (N = 1)

Etymology. - The species name honors Dr. Ferdinand Starmühlner who has contributed greatly to our knowledge of the fauna of tropical running waters, and who collected the first specimens known to the author.

Distribution. - Known only from two rivers on the island of Mahe.

Remarks. - This species does not closely resemble any other from Asia or Africa. The strongly raised blade-like carina on abdominal sternites VI-VII of the male immediately separates this species from all others. The reflexed female connexiva touching over abdominal tergites V-VI are also approximately the same in *R. sulawesiana* J. & D. Polhemus, but the latter is a much broader species with a posteriorly directed projection medially on tergite VII.

Dan Polhemus (pers. comm.) gives the following ecological notes: "This species was found on the Du Cap river just upstream of the Montagne Posee road where the stream flowed through a jumble of large rounded granite boulders. *R. seychellensis*, which occurs in nearly every freshwater stream on Mahe, was also present at this locality in large numbers. Individuals of *R. starmuehlneri* appeared to prefer dark sheltered spots under the overhanging margins of the boulders, and did not seem to form large aggregations. Although collections were made from nine other streams at various altitude ranges from 0 to 555 meters, covering all parts of Mahe and including the Desert River from which Starmühlner's specimens came, no other populations of *R. starmuehlneri* were discovered. This species thus appears to be far more localized in its distribution than *R. seychellensis*, and is apparently not a high altitude endemic, since both of the presently known localities lie under 100 meters elevation."

Acknowledgments. - The author is indebted to the following for the opportunity to study collections under their care, or for the gift of specimens; Dr. M. Amir, Museum Zoologicum Bogoriense, Bogor, Java, Indonesia; Dr. G. F. Edmunds, University of Utah, Salt Lake City, Utah; Dr. Ferdinand Starmühlner, Institut für Zoologie der Universitat Wein, Austria; W. R. Dolling, British Museum (Natural History), London; G. W. Byers and R. W. Brooks (SEMC); R. C. Froeschner and D. A. Polhemus (USNM); and P. H. Van Doesburg (RMNH). Most of the material upon which this paper is based is held in the Polhemus Collection (JTPC). A special debt of gratitute is due to Dan A. Polhemus for assistance in the field, and review of the manuscript. The field work upon which the Asian part of this research was based was supported by a grant from the National Geo-

graphic Society, Washington, D. C. Collections by D. A. Polhemus in the Seychelles were funded by the Smithsonian Institution's Aldabra Program and undertaken in co-operation with the Seychelles Islands Foundation.

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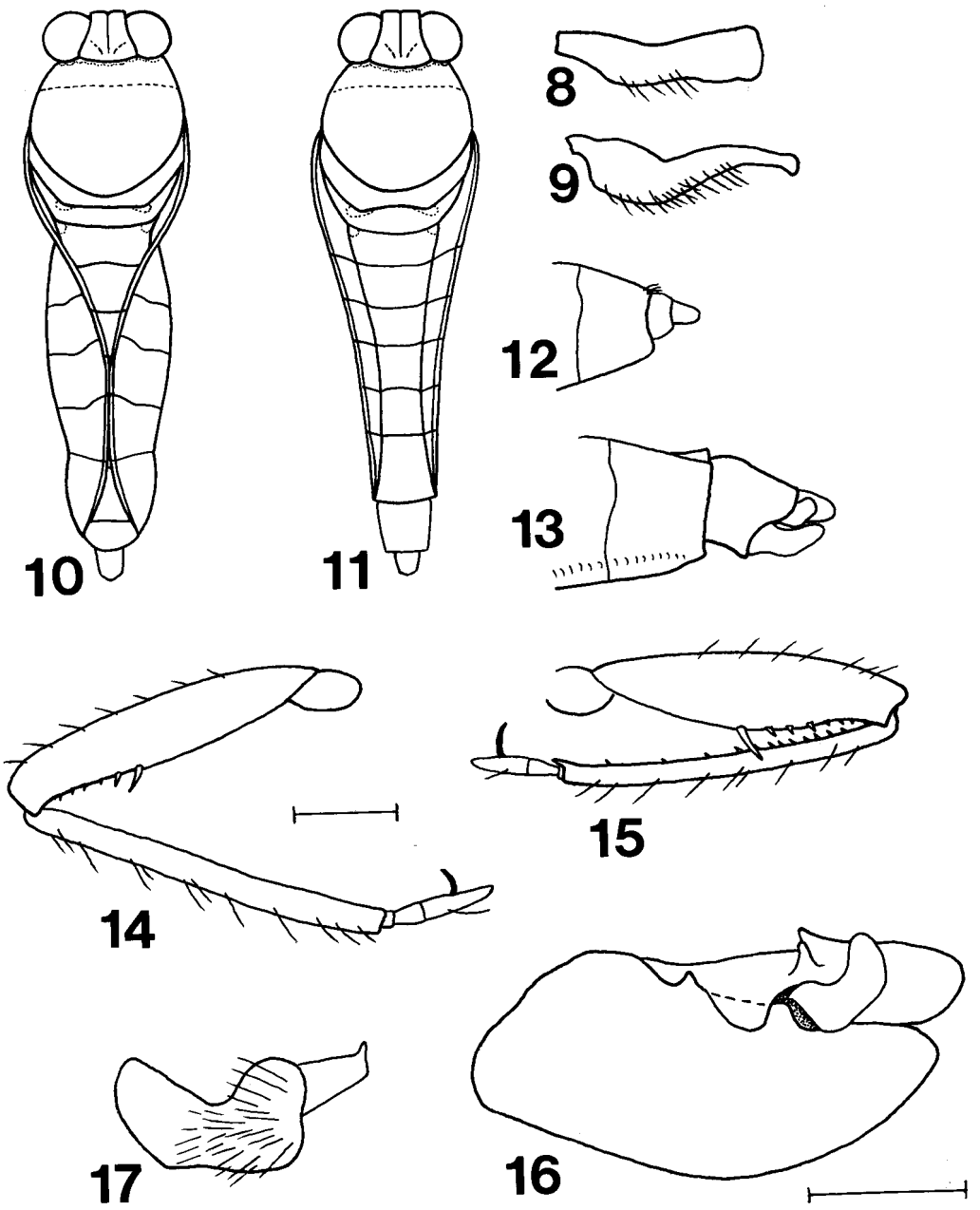

Figs. 8-17. *Rhagovvelia* spp. 8. *Rhagovelia femorata* Dover, male paramere; 9. *Rhagovelia sumatrensis* Lundblad, male paramere; 10-17. *Rhagovelia starmuehlneri*, new species; 10. Female dorsum; 11. Male dorsum; 12. Female abdominal terminalia, lateral view; 13. Male abdominal terminalia, lateral view; 14. Female hind leg; 15. Male hind leg; 16 Male pygophore, proctiger and paramere; 17. Male paramere. Scale = 0.5 mm.