

FIRST INVENTORY OF THE WATER BUGS (HETEROPTERA: NEPOMORPHA: GERROMORPHA) OF LANGKAWI ISLAND, KEDAH, MALAYSIA

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ABSTRACT. – The first survey of the water bug fauna of Langkawi Island, Malaysia, yielded 55 species (five of which were identified only to the genus level) inhabiting various freshwater habitats, mangroves, and sea shores and belonging to 31 genera and eleven families; 17 species of ten genera from seven families belong to Nepomorpha, 38 species of 21 genera from four families to Gerromorpha. Three species are newly described here: *Hydrotrepes langkawicus*, new species (Helotrephidae), *Strongylovelia narusei*, new species, and *Microvelia (Picaultia) minutissima*, new species (both Veliidae). These new Veliidae have a more wide distribution than only in Langkawi Island: *Strongylovelia narusei*, new species is also known from Terengganu in peninsular Malaysia, and *Microvelia (Picaultia) minutissima*, new species is known from Selangor in peninsular Malaysia and from Singapore. Another nine species are recorded from Malaysia for the first time.

KEY WORDS. – Heteroptera, Nepomorpha, Gerromorpha, check-list, Helotrephidae, Veliidae, *Hydrotrepes*, *Strongylovelia*, *Microvelia*, new species, first records, Langkawi, Malaysia, Singapore.

INTRODUCTION

The island of Langkawi (Pulau Langkawi) is situated off the northwest coast of peninsular Malaysia in the southern Andaman Sea, located approximately at 6°20'N and 99°45'E (The Times Atlas of the World, 1992). In 2003 and 2004 the University of Malaysia organized two scientific expeditions to survey the natural resources of Langkawi Island (Hussin et al., 2005). The results were subsequently published in a special issue of the Malaysian Journal of Sciences (2005, volume 24). As part of this survey, some groups of aquatic insects were studied for their use in a classification of the island's streams, especially Ephemeroptera, Plecoptera, and Trichoptera (Yap, 2005). The check-list presented by Yap (2005) included four genera of Gerromorpha (*Amemboa* sp., *Halobates* sp., *Pseudovelina* sp., and *Rhagovelia* sp.). *Pseudovelina* could not be confirmed here because the material studied by Yap was unavailable for the present study. The record of the marine genus *Halobates* from the island's centre also appears doubtful, thus the Gerromorpha data obtained by Yap (2005) were not included in the present paper.

The water bug fauna of the Malay Peninsula is relatively well known, but only three reliable species records from Langkawi were found in the literature: *Halobates hayanus* White, 1883 (Herring, 1961), *Haloveloides sundaensis* Andersen, 1992 (Andersen, 1992) and *Xenobates murphyi* Andersen, 2000 (Andersen, 2000). These records are based on an old collection by R. Brown in 1934 and on collections by D. Kovac in 1993. More specimens from the latter expedition are housed in the Zoological Reference Collection, Singapore, and in the Senckenberg Museum, Frankfurt am Main, and were included in the present study. In 2006, Dr. Tohru Naruse and the authors visited Langkawi for three days to explore the species diversity of water bugs and crabs. The intensive collections primarily focused on a diverse range of habitats in order to record as many species as possible.

MATERIAL AND METHODS

Collecting. – Field work was carried out from 20–22 November 2006. Samples were taken with hand nets from eleven sites throughout the island (Fig. 1). The following

alphabetical list of sampling localities (including those of other workers) contains the collecting codes used also in the taxonomic section.

Northwestern part of the island (Datai and Telagah Tujuh areas):

Datai, environment: leg. E. Heiss & Perner, 12 Mar.1995 (HP1).

Datai rain forest: leg. E. Heiss, 2–10 Nov.2002 (HE1).

Datai Resort, pool: leg. E. Heiss, 12 Apr.2008 (HE3).

Pantai Datai: 18 Dec.1993, leg. D. Kovac (KV5).

Pantai Kok, near Kuala Teriang, coastal pool: 13 Dec.1993, leg. D. Kovac (KV1).

Pebble beach near Sungei Lengara: leg. A.D. Tran, H. Zettel & T. Naruse, 20 Nov.2006 (TAD0615, HZL3a).

Swamp next to road to Telaga Tujuh: large, open water, near beach, leg. A.D. Tran, H. Zettel & T. Naruse, 22 Nov.2006 (TAD0621, HZL8).

Sungei Lengara: river mouth, leg. H. Zettel, 20 Nov.2006 (HZL3b).

Telaga Tujuh [= Seven Wells] – Air Telaga: streams & waterfalls, leg. A.D. Tran, H. Zettel & T. Naruse, 20 Nov.2006 (TAD0613, HZL1a, HZL1b) & leg. D. Kovac, 19 Dec. 1993 (KV6) & leg. E. Heiss, 4 Nov.2002 (HE2).

Temurun Waterfalls [= Sungei Temurun, Air Temurun]: stream and waterfall with deep pool, leg. A.D. Tran, H. Zettel & T. Naruse, 20 Nov.2006 (HZL2, TAD0614), leg. D. Kovac, 15 Dec.1993 (KV3) & leg. E. Heiss, 15 Apr. 2008 (HE4).

Central part of the island (Gunung Raya and nearby areas):

Air Tejun: small forest stream near Kampung Buku, leg. A.D. Tran, H. Zettel & T. Naruse, 22 Nov.2006 (TAD0623, HZL10).

Durian Perangin: waterfalls with large pools, leg. A.D. Tran, H. Zettel & T. Naruse, 21 Nov.2006 (TAD0618, HZL5) & leg. Kovac, 14 Dec.1993 (KV2).

Gunung Raya: small stream on way to summit, leg. A.D. Tran, H. Zettel & T. Naruse, 21 Nov.2006 (TAD0617, HZL4a).

Stream near road linking Padang Gaong Rd to Makam Mahsuri Rd: leg. A.D. Tran & H. Zettel, 22 Nov.2006 (TAD0622, HZL9).

Northeastern part of the island (Tanjung Rhu areas):

Jalan Tanjung Rhu, fish pond: at road, with dense vegetation, leg. H. Zettel, 21 Nov.2006 (HZL7a).

Jalan Tanjung Rhu, mangroves: tidal channels and pools, leg. A.D. Tran, H. Zettel & T. Naruse, 21 Nov.2006 (TAD0619, HZL6).

Jalan Tanjung Rhu, rocky shore: leg. A.D. Tran, H. Zettel & T. Naruse, 21 Nov.2006 (TAD0620, HZL7b).

Pantai Rhu: 16 Dec.1993, leg. D. Kovac (KV4).

Repositories. – Voucher specimens are deposited in the Natural History Museum Vienna, Austria (NHMW), in the Zoological Reference Collection, National University of Singapore (ZRC) and in the Senckenberg Museum, Frankfurt am Main, Germany (SMFD). Specimens collected by the first author and by Dr. Ernst Heiss were dry-mounted, those collected by the second author were kept in 70 % ethanol. Specimens collected by Dr. Damir Kovac and deposited in ZRC and SMFD, as well as paratype specimens from other parts of Malaysia and from Singapore in ZRC, were partly dry-mounted during this study, but another part of the series was kept in 70 % ethanol.

Identification. – The following literature was used for identification: Lansbury (1972, 1973) for Nepidae;

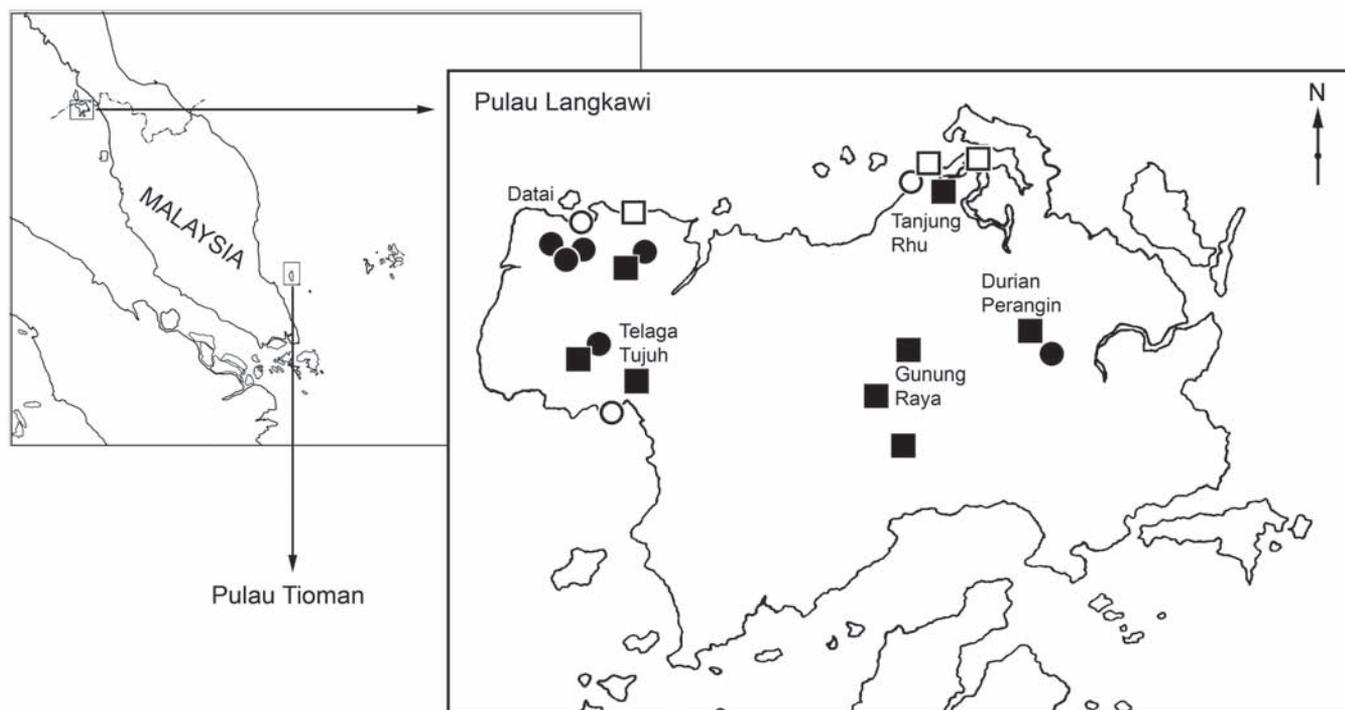


Fig. 1. Map of Langkawi with sampling localities. Filled squares and circles = freshwater habitats; Unfilled squares and circles = marine habitats. Squares = collections by the authors; circles = other collections.

Nieser (2000, 2002) for Micronectidae; Nieser (2004) for Notonectidae and Pleidae; Yang & Zettel (2005) for Hydrometridae; Andersen (1989, 1992, 2000), Yang & Polhemus (1994), and Andersen et al. (2002) for Veliidae; Andersen (1975, 1980), Polhemus & Andersen (1984), Chen & Nieser (2002), Polhemus (1994, 2001), Cheng et al. (2001), and Andersen & Cheng (2004) for Gerridae. Taxa not included in these references were identified by comparison with specimens in ZRC or NHMW; comparison was also used to confirm the results of our identifications.

Description of new taxa. – Type specimens were studied under binocular microscopes. Structures were measured using an ocular micrometer and illustrated (Figs. 7–23) using a camera lucida. Body length, which is strongly depending on preparation of specimens, is measured in tenths of millimetres, other measurements in hundredths of millimetres. Eye Index (in Helotrephidae) is minimum eye distance : maximum eye width, both measured perpendicular to median line of head. Digital photographs (Figs. 2–6) were taken with a Leica DFC camera attached to a Leica MZ16 binocular microscope with the help of Image Manager IM50 and processed with Auto-Montage Pro and Adobe Photoshop 7.0 programs.

TAXONOMY

NEPIDAE

Cercotmetus brevipes Montandon, 1909

Material examined. – Stream near road linking Padang Gaong Rd to Makam Mahsuri Rd: 1 male (macropterous), HZL9.

Distribution. – From northeastern India and southern China to Java, Borneo, and the Philippines (Lansbury, 1973). Lansbury (1973) records this species from “Telaga Pabila” a place which we were unable to locate, but may be in Malaysia. Otherwise, this is the first record from Malaysia.

Ranatra longipes thai Lansbury, 1972

Material examined. – Stream near road linking Padang Gaong Rd to Makam Mahsuri Rd: 1 male, 1 female (macropterous), HZL9.

Remarks. – Because of the different paramere compared with the nominate form (see Lansbury, 1972), this taxon should have the status of a distinct species.

Distribution. – Thailand (Lansbury, 1972). Chen et al. (2005) list the Malay Peninsula with a question mark. First record from Malaysia.

Ranatra parmata Mayr, 1865

Material examined. – (all macropterous): Air Tejun: 1 male, 1 female, HZL10; 2 females, TAD0623.

Distribution. – From northern Thailand to the Lesser Sunda Islands (Lansbury, 1972). Northern records possibly belong to *R. lansburyi* Chen, Nieser & Ho, 2004 described from Yunnan and Chiang Mai (see Chen et al., 2004). First record from Malaysia.

BELOSTOMATIDAE

Diplonychus rusticus (Fabricius, 1871)

Material examined. – Stream near road linking Padang Gaong Rd to Makam Mahsuri Rd: 1 female (macropterous), HZL9.

Distribution. – From India to Japan and Australia (Andersen & Weir, 2004).

MICRONECTIDAE

Micronecta (sensu stricto) *drepani* Nieser, 2000

Material examined. – Temurun Waterfalls: 6 males, 5 females (macropterous), HZL2.

Distribution. – Thailand (Nieser, 2000). First record from Malaysia.

Micronecta (sensu stricto) *haliploides* Horváth, 1904

Material examined. – Telaga Tujuh – Air Telaga: 1 female (macropterous), HE2.

Distribution. – From India and Sri Lanka to Sumatra, Java and Bali (Nieser, 2002).

Micronecta (sensu stricto) *johorensis* Fernando, 1964

Material examined. – (all brachypterous): Telaga Tujuh – Air Telaga: 8 males, 4 females, HZL1a. Temurun Waterfalls: 15 males, 2 females, HZL2.

Distribution. – Johor in Western Malaysia and Singapore (Nieser, 2002). First record from Kedah, which to our knowledge is the northernmost recorded distribution.

Micronecta (*Mesonecta*) *polhemusi* Nieser, 2000

Material examined. – (all macropterous): Telaga Tujuh – Air Telaga: 41 males, 29 females, HZL1a; 1 male, 1 female, HZL1b; 6 males, 7 females, TAD0613.

Distribution. – Thailand, Vietnam, and Singapore (Nieser, 2002). First record from Malaysia.

***Micronecta (Sigmonecta) quadristrigata* Breddin, 1905**

Material examined. – (all macropterous): Telaga Tujuh – Air Telaga: 1 male, 2 females, TAD0613; 11 females, HZL1a. Swamp on way to Telaga Tujuh: 1 male, HZL8.

Distribution. – Widespread from Iran to Australia (Nieser, 2002).

NAUCORIDAE

***Heleocoris* sp.**

Material examined. – Air Tejun: 1 nymph, TAD0623.

Remarks. – The only species of *Heleocoris* thus far recorded from the Malay Peninsula is *H. ovatus* Montandon, 1897 (Chen et al., 2005); however, the genus needs revision, and nymphs cannot be identified to species at present.

NOTONECTIDAE

***Anisops breddini* Kirkaldy, 1901**

Material examined. – Datai Resort, pool: 1 female (macropterous), HE3.

Distribution. – From India and Sri Lanka to Java and Sulawesi (Nieser, 2004).

***Anisops kuroiwaie* Matsumura, 1915**

Material examined. – Telaga Tujuh – Air Telaga: 1 female (macropterous), HE2.

Distribution. – From India to Iriomote (off Japan), Taiwan, the Philippines, and Singapore (Nieser, 2004).

***Anisops tahitiensis* Lundblad, 1934**

Material examined. – Temurun Waterfalls: 1 male (macropterous), KV3. Datai Resort, pool: 1 female (macropterous), HE3.

Distribution. – From the Andaman Islands and Vietnam through Malesian region to Australia, Tahiti, Guadalcanal, and Okinawa (Nieser, 2004); with several records from West Malaysia and Singapore (Kovac & Yang, 1995; Nieser, 2004).

***Enithares metallica* Brooks, 1948**

Material examined. – (all macropterous): Temurun Waterfalls: 10 males, 5 females, HZL2; 2 males, 1 female, TAD0614, 3 males, 1 female, KV3. Air Tejun: 2 males, 2 females, L10HZ; 1 male, TAD0623.

Distribution. – Thailand, Vietnam, and West Malaysia (Nieser, 1998).

PLEIDAE

***Paraplea liturata* (Fieber, 1844)**

Material examined. – Swamp next to road to Telaga Tujuh: 1 female (macropterous), HZL8.

Distribution. – From India to Sulawesi, New Caledonia; several records from West Malaysia (Nieser, 2004).

HELOTREPHIDAE

***Idiotrephes chinai* Lundblad, 1933**

Material examined. – Telaga Tujuh – Air Telaga: 6 males, 1 female (brachypterous), KV6; 2 males (brachypterous), 5 males, 10 females (macropterous), HZL1a; 1 male, 1 female (brachypterous), 5 males, 4 females (macropterous), HZL1b; 1 female (brachypterous), TAD0613.

Distribution. – West Malaysia, Sumatra, and Borneo (Papáček & Zettel, 2000), southern Thailand (Sites & Polhemus 2002).

***Hydrotrephes langkawicus*, new species**

(Figs. 2, 6-12)

Material examined. – Holotype (macropterous male) and paratypes (1 hindwing-micropterous female, 3 macropterous males, 2 macropterous females), HZL9, labeled “MALAYSIA, Kedah\ C-Langkawi, S slopes\ of Gn. Raya, lowland\ stream, 22.11.2006\ leg. H. Zettel (HZL9)”, holotypes and paratypes in NHMW, 1 paratype male in ZRC.

Description of macropterous male. – Habitus: see Figure 2. Body size: length 1.9–2.0 mm, width 1.35–1.40 mm.

Colour: Yellow with extended dark brown markings on dorsum, especially on head (Figs. 2, 6). Venter mostly brownish. Legs and antennae yellow; rostrum light brown.

Cephalonotum with lateral margins behind eyes slightly concave in dorsal view; sharp margin of pronotal part ending in short distance from posterolateral corner and there forming a small, rather blunt angulation; head with densely set small punctures, with very narrow interspaces, almost dull; disk of pronotum set with numerous very fine micropunctures, and with scattered, unequally distributed and

somewhat larger punctures becoming denser towards sides. Mesoscutellum 0.9 times as long as wide, with puncturation of similar size, but slightly denser than on disk of pronotum, micropunctures medially obliterated. Hemelytron with slightly stronger puncturation, interspaces shagreened and dull. Genal plate stout; pronotal plate (Fig. 7) with shallow incision, anteriorly relatively wide. Inner corner of propleural plate broadly convex. Eye index: 2.1–2.2. Fourth rostral segment 2.3 times as long as segment 3.

Ventral carinae (Fig. 8): Prosternal carina with posterior corner approximately rectangular, with posterior edge slightly concave; apices of meso- and metasternal carina thin-laminate, that on mesosternum strongly reduced; carina of sternite 3 with few small denticles, the proximal one variably enlarged. Abdominal segments strongly asymmetrical.

Aedeagus (Fig. 9) moderately slender, apically rather stout and slightly bent to right side; with narrow apical



Figs. 2–6. Habitus of (2) *Hydrotrepes langkawicus*, new species (macropterous male, paratype). (3) *Strongylovelia narusei*, new species (apterous female, paratype). (4) *Microvelia (Picaultia) minutissima*, new species (apterous female, paratype). (5) *Microvelia (Picaultia) minutissima*, new species (macropterous male, holotype, right forewing broken off). (6) Frontal view of cephalonotum of *Hydrotrepes langkawicus*, new species (macropterous male, paratype).

plate posteriorly extended into short spine. Right paramere (Fig. 10) shorter than left paramere, slender-lanceolate, curved, apex minutely pointed. Left paramere (Fig. 11) moderately slender, distally evenly narrowed and slightly curved, apex narrowly rounded.

Description of macropterous female. – Body size: length 2.1–2.2 mm, width 1.46–1.49 mm. Eye index: 2.1. Most characteristics similar to that of male, except the following. Abdomen symmetrical. Sternite 6 with concave hind margin. Subgenital plate (Fig. 12) with broad mediiodistal lobe with broadly convex hind margin; inner ridge strongly concave, almost semicircular. Ventral laterotergites 8 slender.

Hindwing-micropterous female: body size: length 2.1 mm, width 1.42 mm; eye index: 2.6; pronotum with posterolateral corners less elevated and with angulation of lateral margin more blunt; hemelytron without embolar and claval sutures; other characteristics as in brachypterous female.

Hindwing-micropterous male: unknown.

Etymology. – Named after the island of type locality. The species epithet is a Latinized adjective.

Remarks. – This species belongs to the *Hydrotrepes martini* group as defined by Zettel (2000a). Hitherto, this species group contained eight described species, distributed

on the islands of Borneo (five species), Sumatra, Siberut, and Nias (one species each) (Zettel, 2004a; Papáček & Zettel, 2005). *Hydrotrepes langkawicus*, new species is one of the smallest species of the genus; in the *H. martini* group only *H. nitidus* Zettel, 2004, a strongly shiny species with deeply emarginate prosternal carina, is of similar size. The genital structures of the male of *H. langkawicus* are characteristic. Further, the combination of the weakly emarginate prosternal carina, the reduced lamina on the mesosternal carina, and the lobate subgenital plate of the female is unique.

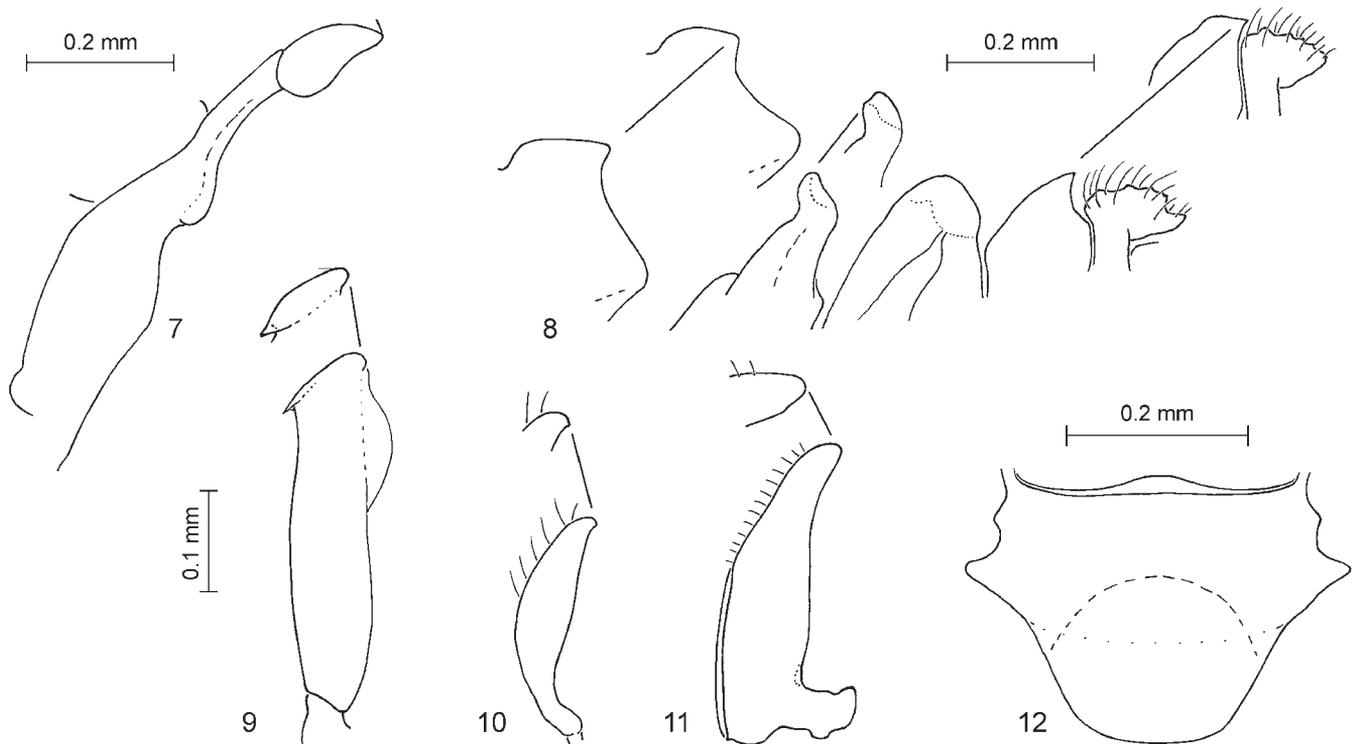
Distribution. – Only known from the type locality on Langkawi Island.

MESOVELIIDAE

Mesovelia horvathi Lundblad, 1933

Material examined. – Swamp next to road to Telaga Tujuh: 1 female (apterous), HZL8. Stream near road linking Padang Gaong Rd to Makam Mahsuri Rd: 2 females (apterous), HZL9.

Distribution. – Widespread in Australasia from southern China to Australia, and in the southeastern Palaearctic (Japan) (Polhemus & Polhemus, 2001); recorded from several localities in West Malaysia (Yang et al., 1999; Polhemus & Polhemus, 2001).



Figs. 7–12. *Hydrotrepes langkawicus*, new species: 7, genal and pronotal plate; 8, ventromedian carina of thorax and abdomen, with variations of prosternal carina, mesosternal carina, and carinae of sternites 2 and 3; 9, aedeagus, right view; 10, right paramere, right view; 11, left paramere, right view; 12, sternite 7 of female, ventral view, pilosity omitted.

Mesovelia vittigera Horváth, 1895

Material examined. – Swamp next to road to Telaga Tujuh: 4 males, 1 female (apterous), 3 males (macropterous), HZL8; 1 male (apterous), 1 female (brachypterous), 1 male (macropterous), TAD6021.

Distribution. – Except for some remote oceanic islands in all warm regions of the Old World (Polhemus & Polhemus, 2001); recorded earlier from West Malaysia by Yang et al. (1999).

Mesovelia sp.

Material examined. – Swamp next to road to Telaga Tujuh: 1 male, 1 female (apterous), HZL8.

Remarks. – This probably undescribed species is similar and closely related to *M. horvathi*, but differs in orange brown ground colour of body with weakly marked dark pattern, relatively long pronotum of apterous morph, short tarsomeres 2, and short apex of parameres of males. Polhemus & Polhemus (2001) regarded *M. horvathi* as a variable and widespread species (see above) and synonymized it with *M. japonica* Miyamoto, 1964, from Japan. The species complex certainly needs careful revision.

HYDROMETRIDAE

Hydrometra annamana Hungerford & Evans, 1934

Material examined. – Swamp next to road to Telaga Tujuh: 1 male (brachypterous), 2 females (macropterous), HZL8.

Distribution. – Thailand and Vietnam (Yang & Zettel, 2005). Vitthepradit et al. (2005) recorded *H. annamana* already from the most-southern part of Thailand (Satun, Songkhla) close to the Malaysian border. First record from Malaysia.

Hydrometra jaczewskii Lundblad, 1933

Material examined. – (all brachypterous): Air Tejun: 1 male, 1 female, HZL10. 1 male, 1 female, TAD0623.

Distribution. – Southern China, West Malaysia, Sumatra, Java, and Borneo (Yang & Zettel, 2005).

Hydrometra kelantan Polhemus & Polhemus, 1995

Material examined. – Temurun Waterfalls: 1 male (macropterous), HZL2.

Distribution. – Thailand and West Malaysia (Vitthepradit et al., 2005; Yang & Zettel, 2005).

Hydrometra orientalis Lundblad, 1933

Material examined. – Swamp on way to Telaga Tujuh: 2 males, (macropterous), HZL8; 2 males (macropterous), 1 female (brachypterous), TAD0621. Telaga Tujuh – Air Telaga: 1 female (macropterous), TAD0613. Stream near road linking Padang Gaong Rd to Makam Mahsuri Rd: 1 male, 1 female (macropterous), TAD0622.

Distribution. – Widespread from southern China to Australia (Yang & Zettel, 2005).

VELIIDAE

Strongylovelia narusei, new species

(Figs. 3, 13–16)

Material examined. – Holotype (apterous female) and paratypes (4 apterous females, 3 apterous males, 1 macropterous-dealate male), HZL10, labeled “MALAYSIA, Kedah\ C-Langkawi, Air Tejun,\ nr Kampung Buku, small\ stream, 22.11.2006\ leg. H. Zettel (HZL10)”, holotypes and paratypes in NHMW, 1 paratype female and 1 paratype male in ZRC. – Further paratypes from Malaysia: 1 apterous female, 1 apterous male “MAL, Terengganu, Sekaya,\ Sg. Brang. HK Lua,\ 21-OCT-1998,\ LHK040” (ZRC).

Description of apterous female. – Measurements: Body length 1.31–1.42 mm (holotype 1.42 mm). Body width 0.74–0.80 mm (holotype 0.79 mm). Relative lengths of antennomeres 1–4 (holotype): 0.9 : 1.0 : 1.8 : 1.4. Relative lengths of leg segments (relative to mesofemur length = 100; holotype): profemur 45, protibia 44, protarsus 4+14, mesofemur 100, mesotibia 81, mesotarsus 36+23, metafemur 71, metatibia 56, metatarsus 9+14.

Body tear-shaped, sides of abdomen not strongly convergent (Fig. 3). Dorsal aspect black except some indistinct dark orange marks along dorsal eye margin and mesonotum yellowish white except narrow lateral margins. In lateral aspect pro-, meso-, and metapleura yellowish white except narrow or broad stripe along dorsal margin of meso- and metapleura black, mesacetabula with or without dark mark, and metacetabula with narrow or broad dark stripe distally. Ventral aspect black, except prosternum and mesosternum yellowish white with or without infuscated acetabula. Antenna and legs black, except metatrochanter, profemur except apex, and basal half of metafemur whitish; coxae variably infuscated.

Median pronotal length 0.35 times eye length. Dorsum of thorax with very short, decumbent pilosity. In lateral aspect, head and mesonotum with scattered black erect setae, those on mesonotum much shorter than those on head. Posterior corners of meso-metanotum slightly acute, apex without conspicuous long setae. Structures of abdomen (Figs. 3, 13, 14) relatively simple: in dorsal view (Fig. 13), connexiva nearly evenly converging, slightly more on segments 5 and 6. Laterotergites directed

more or less dorsad, slightly laterodorsad anteriorly and weakly mediadorsad posteriorly, so that all tergites completely, and all sternites partly visible in dorsal view. Each sternite laterally with 1–2 long, black setae beneath dorsal margin; sternite 7 additionally with relatively long pilosity at connexival corners. Laterotergites 2–4 and 7 and tergites 1–7 with short pilosity; laterotergites 5–6 with conspicuous, mesad directed setae; tergite 7 with some long black setae on its lateral portions. Suture between tergites 1, 2, and 3 weakly impressed, medially hardly curved cephalad; all other sutures well developed and nearly straight. Tergites without median elevations, and dull. Hind margin of tergite 7 slightly convex; tergite 8 medially with shallow impression, with hind margin bearing few long, black setae. In lateral view (Fig. 14), few long setae surpassing connexival margin; connexival corners acute, with black pilosity. Gonocoxa plate-like; proctiger small, directed ventrocaudad.

Description of apterous male. – Measurements: Body length 1.06–1.11 mm. Body width 0.62–0.66 mm.

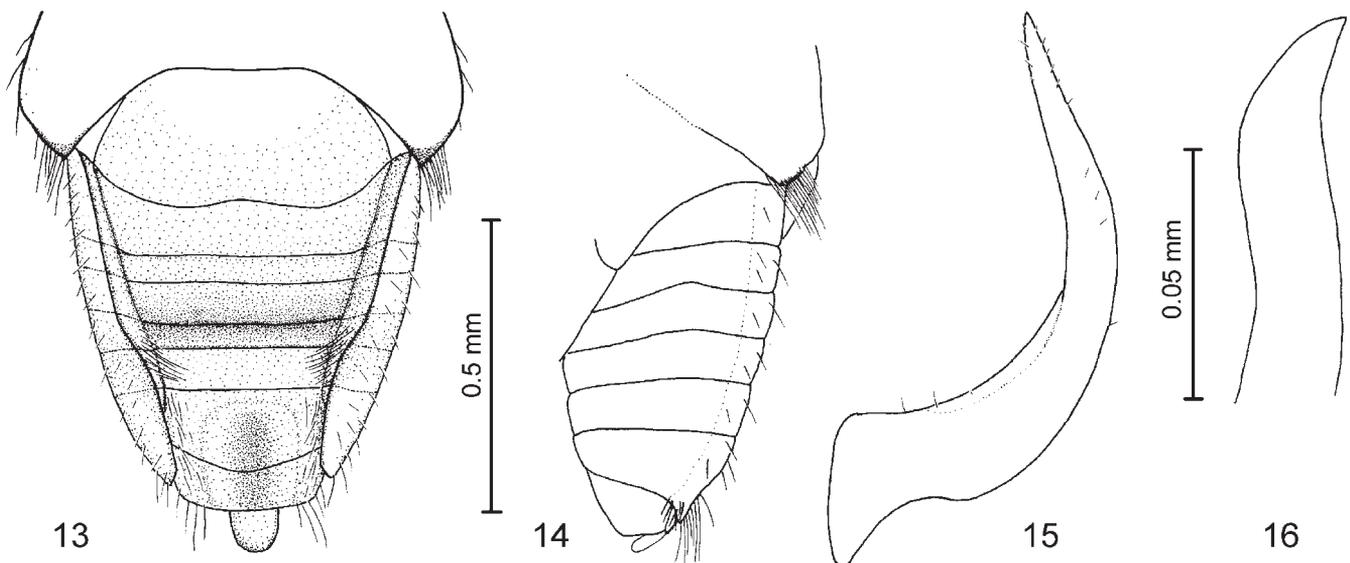
Colour similar to that of female, except yellowish marks on meso- and metanotum separated by narrow black line and pronotum medially with small orange mark in one specimen. Dorsum of thorax and abdomen shinier than in female. Median pronotal length 0.4 times eye length. Black setae laterally on mesothorax and sternites similar with those of female, longest setae on sternites ca. 0.10 mm long. Dorsum of body with very short pubescence, but head and tergite 7 with some longer setae in addition. Suture between tergites 1 and 2 weak, other sutures between tergites well developed. Tergite 5 circa 8 times as wide as long at midline. Paramere (Fig. 15, 16) moderately curved at basal third, strongly twisted, relatively broad, subapically weakly widened (in caudal view), apex very acute.

Description of macropterous male. – Body length 1.18 mm, body width 0.67 mm. Colour similar as in apterous morph, but posterior half of pronotum with half-ovate yellowish mark, and metafemora yellowish white in proximal three-fifths. Pronotum very large, at midline about 2.0 times as long as eye, covering meso- and metanotum, with distinct humeri. Wings of dealate specimen broken off at base, approximately at level of posterior apex of pronotum. All tergites almost flat, tergite 1 not longer than tergite 2.

Macropterous female: unknown.

Etymology. – This species is dedicated to Tohru Naruse, who accompanied the authors for field work in Langkawi.

Remarks. – This species belongs to the *S. esakii* group as defined by Lansbury & Zettel (1997). Within this group, two species complexes are recognized. The *S. esakii* complex includes *S. esakii* Lansbury & Zettel, 1997 from Borneo, *S. palawanensis* Lansbury & Zettel, 1997 from Palawan (Philippines), and some other undescribed Bornean species. It can be distinguished by wide tergites of the apterous female that are completely visible in dorsal view as the laterotergites are directed laterad or laterodorsad, by tufts of hairs on sternite 2 of the female, and by a slender distal section of the parameres of the males (see Lansbury & Zettel, 1997). The second complex, the *S. aberrans* complex, contains *S. aberrans* Lansbury & Zettel, 1997 from Borneo, *S. setosa* Zettel & Tran, 2005 from Vietnam, *S. narusei*, and several other undescribed species from Borneo and southeast Asia. Species of this complex can be recognized by the laterotergites of the apterous female which are flapped over the tergites to a varying degree (at least slightly on segments 6 or 7), by a row of long setae on the sternites of the female (situated



Figs. 13–16. *Strongylovelia narusei*, new species. (13) Abdomen of apterous female (with corners of meso-metanotum), dorsal view. (14) Abdomen of apterous female, lateral view. (15) Paramere of male, lateral view. (16) Paramere of male, perpendicular view on apical part.

parallel with and beneath the connexival margin), by the absence of hair tufts on the female's sternite 2, and by the subapically slightly widened paramere of the male (male of *S. aberrans* unknown). Additionally, the species have a similar colour pattern (but some variation in the extent of the yellow base of the metafemur) and agree in the general structures of meso-metanotum and abdomen. For comparison, the authors used the type series of *S. setosa* and the holotype (female) of *S. aberrans*. Beside the specimens from Langkawi, only two specimens from Terengganu match the diagnostic characters of *S. narusei* and were included in the type series. Numerous specimens were studied from other parts of peninsular Malaysia (Johore), from Singapore, from the Indonesian islands of Batam and Bintan, and from Sarawak on Borneo (all in ZRC), but it was concluded that they either belong to additional undescribed species or that at least the differences are too big to include them in the type series of *S. narusei* without a more detailed revision of the whole complex. *Strongylovelia narusei* differs from *S. aberrans* and *S. setosa* (and from most other material studied, except one population from Johore which is eventually conspecific with *S. narusei*) in a rather conspicuous long pilosity on laterotergites 5 and 6 of the apterous female, and from *S. setosa* in the more slender apex of the paramere of the male. The ratio of antennomeres 2 and 3 of females is 1.9–2.0 in *S. aberrans*, 1.7–1.8 in *S. setosa* and *S. narusei*. The posterior corners of the meso-metanotum of apterous females bear a dense group of long black setae in *S. narusei*, which is absent or inconspicuous in other species. An important characteristic to separate species of the *S. aberrans* complex might be the presence or absence of long setae on tergite 7 of apterous females, which either occur in small numbers on its lateral areas or in a more or less transverse row close to the tergite's hind margin. Unfortunately, these setae tend to break off, so that in some cases either only their base is visible or they cannot be seen at all. Such setae could be observed on the lateral parts of tergite 7 of *S. narusei* and *S. aberrans*, but not in *S. setosa*. The apterous female of *S. setosa* differs also from both species in a deeper, more elongate depression of the tergite 8.

Distribution. – Malaysia: Langkawi, Terengganu.

Halovelia malaya Esaki, 1930

Material examined. – (all apterous): Pantai Dawai: 1 male, 2 females, KV5. Pebble beach near Sungei Lengara: 2 males, 2 females, HZL3a; 3 males, 2 females, TAD0615. Jalan Tanjung Rhu, rocky shore: 9 males, 5 females, HZL7b; 3 males, 5 females, TAD0620.

Distribution. – West coast of the Malay Peninsula, with records from southern Thailand (Phang Nga, Phuket) and West Malaysia (Negeri Sembilan, Pulau Anson) (Andersen, 1989). One male from Vietnam was preliminarily identified as this species (Zettel & Tran, 2006).

Haloveloidea (s. str.) *sundaensis* Andersen, 1992

Material examined. – (all apterous): Pantai Rhu: 16 males, 29 females, KV4. Jalan Tanjung Rhu, rocky shore: 1 female, HZL7b; 1 male, 1 female, TAD0620.

Former record from Langkawi: 1 male (paratype) Langkawi Is., 6.IV.1934, leg. R. Brown, in Coll. J.T. Polhemus (ANDERSEN 1992).

Distribution. – Widely distributed along the coasts of the Sunda Shelf area; recorded from southern Thailand, Malaysia (peninsular, P. Tioman, Sarawak), Indonesia (Pulau Batam, Java), and Vietnam (Andersen, 1992; Yang et al., 1999; Zettel & Tran, 2006).

Xenobates argentatus Andersen, 2000

Material examined. – Jalan Tanjung Rhu, mangroves: 1 female (apterous), HZL6.

Distribution. – Described from southern Thailand, Borneo (Sarawak), and southern Philippines (Andersen, 2000), but records from Borneo and Philippines belong to undescribed, closely-related species (unpublished data). Confirmed record from Malaysia.

Xenobates mandai Andersen, 2000

Material examined. – Jalan Tanjung Rhu, mangroves: 12 males, 21 females (apterous), HZL6.

Distribution. – Described from Singapore (Andersen, 2000) and recorded from Vietnam (Zettel & Tran, 2006). First record from Malaysia.

Xenobates murphyi Andersen, 2000

Material examined. – Pantai Rhu: 2 females (apterous), KV4.

Former record for Langkawi: 1 male, 3 females (paratypes), same locality data (Andersen, 2000).

Distribution. – West Malaysia, Singapore, Borneo, and Philippines (Andersen, 2000).

Microvelia (*Picaultia*) *douglasi* Scott, 1874

Material examined. – Telaga Tujuh – Air Telaga: 1 male (apterous), 2 females (macropterous), HZ1a; 1 male, 1 female (macropterous), TAD0613. Jalan Tanjung Rhu, fish pond: 1 male, 1 female (apterous), 2 females (macropterous), HZL7a. Swamp on way to Telaga Tujuh: 4 males, 2 females (apterous), 2 males, 6 females (macropterous), HZL8.

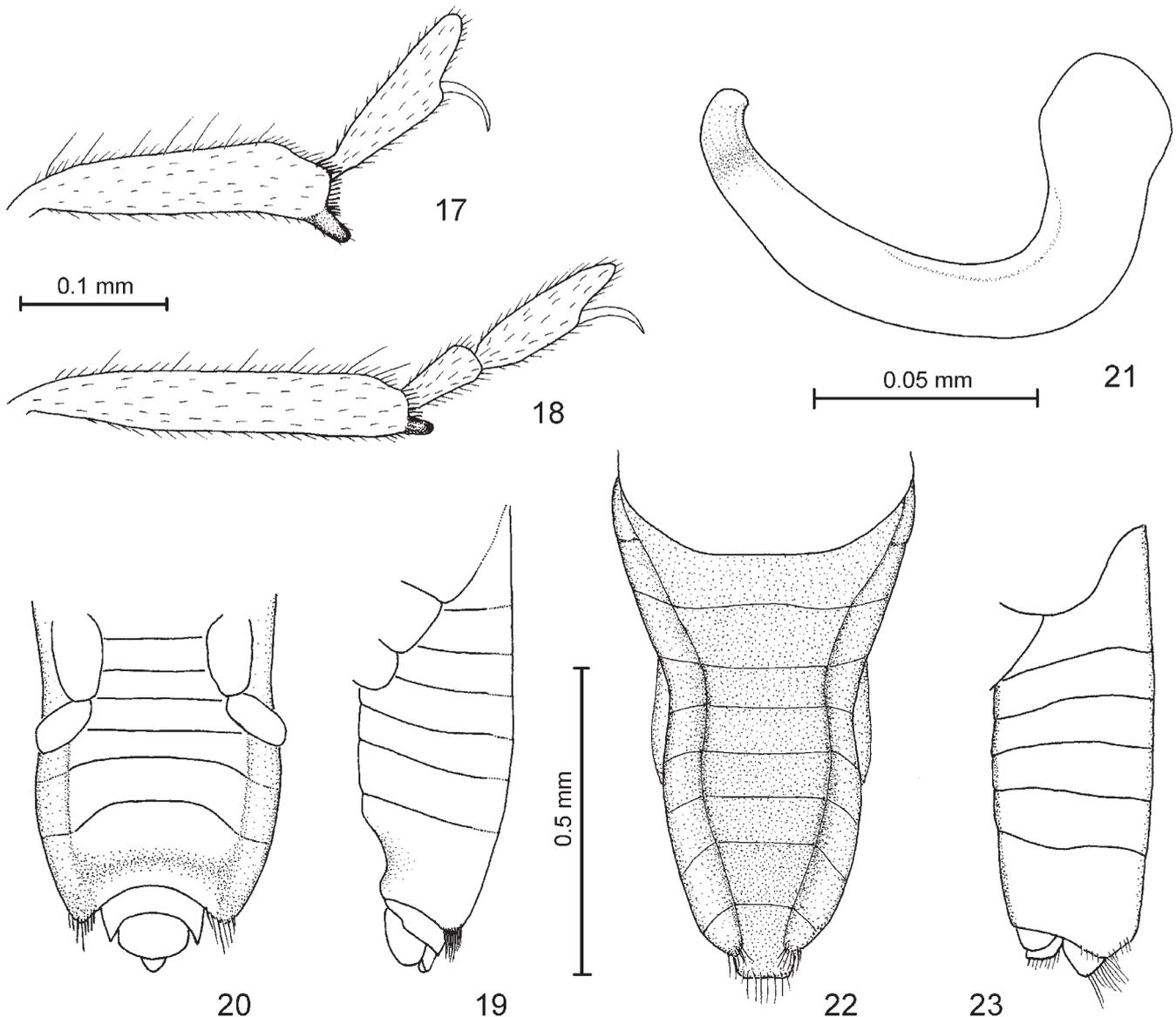
Distribution. – From India to Japan and Australia (Andersen & Weir, 2004).

***Microvelia (Picaultia) minutissima*, new species**
(Figs. 3, 4, 17–23)

Material examined. – Holotype (macropterous male) and paratypes (2 apterous females, 1 macropterous male, 5 macropterous females), HZL1b, labeled “MALAYSIA, Kedah\ W-Langkawi, Telaga Tujuh\ stream, 20.11.2006\ leg. H. Zettel (HZL1b)”, holotype and paratypes in NHMW, 1 paratype macropterous female in ZRC. – Further paratypes from Malaysia: 1 male (macropterous), 1 female (macropterous) “MAL- Selangor, Ulu\ Gombak;\ 06-MAY-1996\ HK Lua et al.\ LHK0305” (ZRCS). – Further paratypes from Singapore: 7 males, 5 females (apterous) “SIN- Bt. Timah NR\ HK Lua et al.\ 08-DEC-1995\ NS0209” (ZRCS, NHMW); 2 females (apterous) “ZRC Chestnut Drive\ NS 128A\ 5th May 1994” (ZRCS); 3 males (apterous) “SIN- Chestnut Dr.,\ Seletar Reservoir,\ 26-MAY-1994\ HK Lua et al.\ NS0142C” (ZRCS, NHMW); 3 females (apterous) “SIN, Chestnut Dr.,\ Seletar Reservoir,\ “Ua2” side stream; HK Lua et al.\ 26-V-1994, NS142G” (ZRCS); 2 females (apterous) “Nature Reserves Survey\ Chestnut Dr., NS 142C\ 26 May 1994” (ZRCS);

1 male (apterous), 1 female (apterous) “Nature Reserves Survey\ Chestnut Dr., NS 138B\ Singapore\ 19 May 1994” (ZRCS); 1 male, 1 female (apterous) “stm #H, Mac Ritchie\ Forest, 2.2.1994\ NS124F” (ZRCS); 1 female (apterous) “Nature Reserves Survey\ MacRitchie, NS 161D\ Singapore\ 13 June 1994” (ZRCS); 2 females (apterous) “Nature Reserves Survey\ MacRitchie, NS 161B\ Singapore, 17 June 1994” (ZRCS); 1 male (apterous), 1 female (apterous) “Nature Reserves Survey\ Nee Soon Swamp Forest\ NS 158B, Singapore\ 13 June 1994” (ZRCS); 1 female (apterous) “SIN- Nee Soon\ swamp forest;\ 12-JUN-1995\ HK Lua et al.\ NS0187A” (ZRCS); 1 female (apterous) “SIN- Nee Soon\ KL Yeo\ 06-MAY-1992\ YKL0794A” (ZRCS); 1 male, 2 females (apterous) “ZRC Nee Soon Swamp Forest\ NS126A upstream #23\ 28 April 1994” (ZRCS).

Description of macropterous male. – Body length 1.28–1.32 mm (holotype: 1.31). Pronotal width 0.56–0.58 mm (holotype: 0.58). Length of second antennomere of holotype 0.11 mm. Length of metatibia of holotype 0.42 mm.



Figs. 17–23. *Microvelia (Picaultia) minutissima*, new species: 17, fore tibia and tarsus of male; 18, middle tibia and tarsus of male; 19, abdomen of macropterous male, lateral view; 20, abdomen of macropterous male, ventral view; 21, right paramere of male, lateral view; 22, abdomen of apterous female, dorsal view; 23, abdomen of apterous female, lateral view.

Colour (Fig. 3): Head and pronotum brownish, humeri, anterior and posterior margin of pronotum yellowish orange to different extend. Sides and venter mainly dark brown, connexival margins, segments 7 and 8, and genitalia yellow or light orange. Antennae brown, except base yellow. Legs yellow, but apices of femora and tibiae, and all tarsi brownish. Fore wings pale brown, base and two weakly delimited spots whitish.

Pilosity: Generally short, except lateral hind margin of sternite 7 set with long setae.

Dorsum without large black impressions. Head width ca. 1.2 times head length. Relative lengths of antennomeres 1–4 (holotype): 1.0 : 1.0 : 1.2 : 2.5. Relative lengths of leg segments (relative to metatibia length = 100; holotype): profemur 66, protibia 54, protarsus 32, mesofemur 74, mesotibia 66, mesotarsus 11+28, metafemur 85, metatibia 100, metatarsus 12+30. Profemur slender. Protibia straight, distally widened, apically with long slender process set in blunt angle with tibia axis and bearing apically a minute grasping comb (Fig. 17). Mesotibia with short process bearing minute grasping comb (Fig. 18). Abdomen slender (Fig. 20). Sternite 6 without modifications. Sternite 7 anteromedially slightly swollen, posteriorly with strong, transverse impression, distinctly concave in lateral view (Fig. 19); hind margin medially slightly emarginated. Segment 8 and genital capsule small. Pygophore and proctiger slightly asymmetrical. Left paramere reduced. Right paramere (Fig. 21) elongate, curved, distally slender.

Description of macropterous female. – Body length 1.37–1.49 mm. Pronotal width 0.60–0.67 mm.

Colour as in male, except sternite 7 ventrally brown; in some specimens, dorsum more infuscated.

Pilosity: generally short, but laterotergites 2 with few longer setae, sternite 7 at connexival corner with tuft of long setae and laterotergites 8 and complete posterior edge of tergite 8 with dense brush of long setae.

Legs simple. Abdomen slender, anteriorly without modifications. Tergite 8 forming a sharp edge, dorsal and posterior face forming a right angle; posterior face ca. 2.5 times as wide as long. Proctiger forming a prominent, ventrocaudad directed knob. Most of gonocoxa 1 concealed by sternite 7.

Description of apterous male. – Body length 1.16–1.23 mm. Pronotal width 0.45–0.48 mm.

Colour: Similar to macropterous morph. Head usually orange. Pronotum brown with broad orange margin anteriorly, posterior margin rarely with narrow yellow margin. Tergites and laterotergites variably brownly infuscated. Most commonly, laterotergites, tergite 7, segment 8, and medial areas of tergites 1–3 orange, tergites 4–5 brown, in other specimens tergites 3–6 to 1–6 brown

and laterotergites 4–5 also brownly infuscated. Tergites 1–3 (–4) more or less frosted.

Pilosity as in macropterous morph.

Legs, abdomen, and genitalia as in macropterous morph. Pronotum much smaller, but long compared with some other species of the genus, medianly ca. 0.8 times as long as head and almost completely covering metanotum, hind margin convex. Sides of abdomen anteriorly subparallel, laterotergites moderately raised throughout. Tergite 7 much larger than preceding tergites, ca. 0.8 times as long as wide and slightly longer than tergites 5 and 6 combined.

Description of apterous female. – Body length 1.17–1.31 mm. Pronotal width 0.48–0.57 mm.

Colour dorsally similar to that of apterous male, but in some specimens dark parts more pronounced and giving a more distinct pattern. Tergites (1–) 2–3 frosted, 4–8 not frosted. Venter and sides as in macropterous female.

Pronotum as in apterous male. Abdomen (Figs. 22, 23) usually very narrow, with sides anteriorly constricted, narrowest at segment 3, slightly convex at segments 5–6 and then again narrowed at segment 7. In such specimens laterotergites almost vertical throughout. In specimens with more swollen abdomen (probably filled with eggs), laterotergites directed more laterad or even totally flat, giving the abdomen a broader appearance. Tergite 7 ca. 0.7 times as long as broad at anterior margin and ca. 1.5 times as long as tergite 6; its sides strongly convergent posteriad. Tergite 8 almost as long as tergite 7, slightly longer than wide, and shallowly concave. Terminalia as in macropterous morph.

Etymology. – From Latin *minutissimus*; referring to the species' extremely small size.

Remarks. – The presence of a mesotibial comb of the male (Fig. 18) and the asymmetrical genitalia of the male with a long right (Fig. 21) and a reduced left paramere place *M. minutissima* in the subgenus *Picaultia* Distant, 1913. The new species is one of the smallest in the genus and has a slender body (Figs. 4, 5). Apterous specimens have the dorsum usually orange to light brownish with variably infuscated pronotum and abdomen. The male can be recognized by the concave outline of sternite 7 in lateral view (Fig. 19), by the small genital capsule (Fig. 20), and by the shape of the slender and curved right paramere (Fig. 21). The female can be easily distinguished from other *Picaultia* species by characteristics of the abdomen: The tergite 8 possesses a dense brush of equally long setae all along its posterior edge which are more than half as long as the tergite length (Fig. 22); in the apterous female, tergite 1 is usually completely frosted, tergites 2–3 discretely, but completely frosted and tergites 4–8 usually not frosted at all.

Distribution. – Malaysia (Langkawi, Selangor) and Singapore.

***Microvelia* sp.**

Material examined. – Telaga Tujuh – Air Telaga: 2 females (macropterous), TAD0613.

Remarks. – The two females possibly belong to an undescribed species. Males are required for subgeneric classification and identification.

***Perittopus asiaticus* Zettel, 2001**

Material examined. – Dati rain forest: 4 males, 1 female (macropterous), HE1; Temurun Waterfalls: 2 males, 1 female (apterous), KV3; 5 males, 7 females (macropterous), TAD0614; 10 males, 10 females, HZL2. Gunung Raja: 36 males, 25 females (macropterous), HZL4a; 1 male (apterous), 2 males, 4 females (macropterous), TAD0617. Durian Perangin: 2 females (macropterous), TAD0618.

Distribution. – Southwestern China, Thailand, and West Malaysia (Zettel, 2001).

***Rhagovelia sumatrensis* Lundblad, 1933**

Material examined. – Telaga Tujuh – Air Telaga: 2 females (macropterous), HZL1a; 1 male, 1 female (macropterous), HZL1b. Temurun Waterfalls: 1 female (apterous), KV3. Durian Perangin: 6 males, 3 females (macropterous), HZL5. Stream near road linking Padang Gaong Rd to Makam Mahsuri Rd: 1 female (apterous), HZL9.

Distribution. – From India to southeastern China and Lombok in Indonesia (Zettel, 2000b).

***Rhagovelia singaporensis* Yang & Polhemus, 1994**

Material examined. – Gunung Raya: 1 male (macropterous), HZL4a. Telaga Tujuh – Air Telaga: 1 female (macropterous), HZL1a; 1 female (apterous), HZL1b. Durian Perangin: 1 female (macropterous), KV2; 1 female (macropterous), HZL5. Air Tejun: 8 males, 12 females (apterous), 2 males, 1 female (macropterous), HZL6; 5 males, 10 females (apterous), 1 male (macropterous), TAD0623.

Distribution. – Described from Singapore (Yang & Polhemus, 1994) and later recorded from the Malay Peninsula and some Indonesian islands (Anambas, Natuna, Bintan, Java) by Tran & Yang (2004).

GERRIDAE

***Tenagonus matsudai* Miyamoto, 1967**

Material examined. – Telaga Tujuh – Air Telaga: 2 females (macropterous), KV6; 1 female (apterous), 2 females (macropterous), HZL1b; 1 male, 1 female (apterous), 1 male, 1 female (macropterous), TAD0613. Temurun Waterfalls: 3 males, 1

female (macropterous), HZL2. Air Tejun: 1 male (macropterous), 1 female (apterous), HZL10; 1 male, 2 females (apterous), TAD0623.

Distribution. – Southwestern China, Thailand, Vietnam, and West Malaysia (Andersen, 1995, Zettel & Chen, 1996; both sub *Limnometra matsudai*).

***Neogerris assimilis* Andersen, 1975**

Material examined. – Temurun Waterfalls: 1 male (macropterous), HZL2.

Distribution. – Thailand, Singapore, Sumatra, Borneo (Andersen, 1995, Chen & Zettel, 1998). First record from West Malaysia.

***Neogerris parvulus* (Stål, 1859)**

Material examined. – Swamp on way to Telaga Tujuh: 1 male, 1 female (macropterous), 1 female (apterous), HZL8.

Distribution. – Widespread in the southeastern Palaearctic and Oriental Region, eastwards to New Guinea and the Solomon Islands (Andersen, 1995); records from the Philippines partly refer to *N. philippinensis* Zettel, 2004 and all material east of the Wallace Line should be re-examined for conspecificity (Zettel, 2004b).

***Limnogonus* (s. str.) *fossarum fossarum*
(Fabricius, 1775)**

Material examined. – Sungei Lengara: 1 male (macropterous), HZL3b. Swamp on way to Telaga Tujuh: 1 male, 1 female (macropterous), HZL8; 2 males (macropterous), 1 female (apterous), TAD0621.

Distribution. – The typical subspecies from India to Japan, Philippines, Borneo, and Sumatra; other subspecies eastwards to Australia and Vanuatu (Andersen, 1975).

***Limnogonus* (s. str.) *nitidus* (Mayr, 1865)**

Material examined. – (all macropterous): Sungei Lengara: 2 males, 1 female, HZL3b. Telaga Tujuh – Air Telaga: 1 male (macropterous), KV6; 2 males, HZL1a; 1 female, TAD0613. Temurun Waterfalls: 1 female, HZL2. Stream near road linking Padang Gaong Rd to Makam Mahsuri Rd: 1 male, 2 females, HZL9; 1 male, TAD0622. Jalan Tanjung Rhu, mangroves: 1 male, TAD0619. Swamp on way to Telaga Tujuh: 1 male, 2 females, TAD0621.

Distribution. – From India to southern China, Philippines, Sulawesi, and the Lesser Sunda Islands (Chen et al., 2005).

***Limnogonus (Limnogonoides) pectoralis* (Mayr, 1865)**

Material examined. – Jalan Tanjung Rhu, mangroves: 1 male, 1 female (macropterous), HZL6; 2 males, 1 female (apterous), TAD0619.

Distribution. – Sri Lanka, eastern India, Myanmar, and southern Thailand (Andersen, 1975; Hecher & Zettel, 1996; Buzzetti et al., 2006). First record from Malaysia.

***Amemboa incurvata* Polhemus & Andersen, 1984**

Material examined. – Air Tejun: 1 male, 1 female (apterous), HZL10; 3 males, 2 females (apterous), TAD0623.

Distribution. – West Malaysia and Sumatra (Polhemus & Andersen, 1984).

***Onychotrechus esakii* Andersen, 1980**

Material examined. – Datai environment: 1 female (macropterous), HP1; Telaga Tujuh – Air Telaga: 1 male, 1 female (apterous), HZL1a; 1 male (apterous), HZL1b; 4 males, 3 females (apterous), TAD0613. Temurun Waterfalls: 1 female (apterous), HZL2; 3 males, 5 females (apterous), 3 males, 5 females (apterous) 2 males (macropterous), TAD0614. Durian Perangin: 1 male (macropterous), TAD0618.

Distribution. – Thailand, Vietnam, and West Malaysia (Andersen, 1980; Polhemus & Andersen, 1984).

***Cylindrostethus malayensis* Polhemus, 1994**

Material examined. – Stream near road linking Padang Gaong Rd to Makam Mahsuri Rd: 3 males, 4 females (apterous), HZL9; 2 males, 2 females (apterous), TAD0622.

Distribution. – West Malaysia, Singapore, and Sumatra (Polhemus, 1994), populations from southern Thailand need revision.

***Ptilomera (sensu stricto) tigrina* Uhler, 1860**

Material examined. – Temurun Waterfalls: 2 males (apterous), HZL2, 2 males, 1 female (apterous), HE4. Durian Perangin: 1 male, 1 female (apterous), 1 male, 1 female (macropterous), HZL5. Stream near road linking Padang Gaong Rd to Makam Mahsuri Rd: 2 females (apterous), HZL9. Telaga Tujuh – Air Telaga: 1 male (apterous), 1 male (macropterous), HZL1a; 1 male (apterous), TAD0613. Gunung Raya: 2 males (apterous), TAD0617. Air Tejun: 1 female (apterous), 1 female (macropterous), HZL10.

Material examined. – From Myanmar and southern China to the Malay Peninsula; in West Malaysia a common species (Polhemus, 2001).

***Rheumatogonus intermedius* Hungerford, 1933**

Material examined. – (all apterous): Datei environment: 1 female, HP1; Air Tejun: 3 males, 2 females, HZL10; 5 males, 4 females, TAD0623.

Distribution. – Southern Thailand, West Malaysia, and Sumatra (Chen & Nieser, 2002).

***Asclepios annadalei* Distant, 1915**

Material examined. – (all apterous): Pantai Rhu: 7 males, 5 females, KV4. Jalan Tanjung Rhu, mangroves: 5 males, 3 females, HZL6.

Distribution. – From India to the Malay Peninsula (Chen et al., 2005).

***Halobates (sensu stricto) esakii* Miyamoto, 1967**

Material examined. – (all apterous): Pantai Rhu: 1 male, 2 females, KV4. Pantai Datai: 1 female, KV5.

Distribution. – From the Malay Peninsula (west coast) to the Philippines and Halmahera in Indonesia (Andersen & Cheng, 2004, Zettel, 2005).

***Halobates (sensu stricto) hayanus* White, 1883**

Material examined. – (all apterous): Jalan Tanjung Rhu, rocky shore: 5 males, 3 females, HZL7b, 3 males, 3 females, TAD0620.

Former record from Langkawi: 1 male, “Langkawi Is., 4.IV.1934, leg. R. Birch”, in the Natural History Museum, London (HERRING 1961).

Distribution. – Indo-West Pacific, from the Red Sea to Australia (Andersen & Cheng, 2004).

***Halobates (sensu stricto) proavus* White, 1883**

Material examined. – (all apterous): Pantai Kok: 1 female, KV1. Pantai Datai: 40 males, 34 females, KV5.

Distribution. – From the Nicobar Islands and southern Thailand until Vanuatu (Andersen & Cheng, 2004).

***Halobates (sensu stricto) sexualis* Distant, 1903**

Material examined. – Pantai Rhu: 3 males, 4 females (apterous), KV4.

Distribution. – Malay Peninsula and Sri Lanka (Andersen & Cheng, 2004).

***Metrocoris nigrofascioides* Chen & Nieser, 1993**

Material examined. – Datai rain forest: 1 male, 2 females (apterous), HE1; Telaga Tujuh – Air Telaga: 1 male, 4 females (apterous), 2 females (macropterous), HZ1b; 2 males, 2 females (apterous), TAD0613. Sungei Lengara: 1 male (apterous), HZL3b. Air Tejun: 1 male, 3 females (apterous), HZL10; 3 males, 2 females (macropterous), KV6; 1 female (apterous), TAD0623. Durian Perangis: 1 male (apterous), 2 males, 5 females (macropterous), KV2. Gunung Raya: 2 males, 3 females (macropterous), TAD0617.

Remarks. – See *M. squamifer*.

Distribution. – Originally described from Myanmar and Thailand (Chen & Nieser, 1993), later recorded from Vietnam (Zettel & Chen, 1996) and West Malaysia (Yang & Kovac, 1995; Yang et al., 1999; Cheng et al., 2001).

***Metrocoris squamifer* Lundblad, 1933**

Material examined. – Datai environment: 1 male (apterous), HP1; Datai rain forest: 1 male, 1 female (apterous), 1 male (macropterous), HE1; Telaga Tujuh – Air Telaga: 1 male, 2 females (apterous), HZ1a. Temurun Waterfalls: 3 males (macropterous), 3 female (apterous), HZL2. Gunung Raya: 1 male (macropterous), HZL4a. Durian Perangin: 1 male, 1 female (apterous), L5HZ. Air Tejun: 1 male (apterous), HZL10.

Remarks. – Identification of the species of the *Metrocoris nigrofasciatus* group is difficult. Identity of *M. squamifer* specimens from Langkawi has been confirmed by comparison with Malaysian specimens in NHMW identified by Dr. Ping-

ping Chen. Using the key characters in Chen & Nieser (1993), male specimens might be identified as *M. nigrofasciatus* Distant, 1903 due to the fact that the subapical tooth on the fore femur is of variable shape and often reduced in small apterous and in all macropterous specimens. Distinction of these two species should be based on genitalia, especially on the shape of the paramere. The paramere of *M. squamifer* has a distinct ventral angle – although rarely so strongly pronounced as in the figure by Chen & Nieser (1993) – but the parameres of *M. nigrofasciatus* and *M. nigrofascioides* are evenly rounded. Although sorting males of *M. squamifer* and *M. nigrofascioides* is easy by the absence or presence of a notch on the fore femur, females can be distinguished only by colour, *M. squamifer* being on average lighter than *M. nigrofascioides*. The key character for females of *M. squamifer* given in Chen & Nieser (1993) is the colour pattern of tergite 8, but it could not conclusively separate the Langkawi specimens because apterous females from Langkawi have a black base of tergite 8. However, if tergite 8 is partly retracted into tergite 7, in some *M. squamifer* females a colour pattern appears which corresponds with the key character. Usually the yellow colour on tergite 8 is reduced to a small circular spot in *M. nigrofascioides*, but more extended in *M. squamifer*. For separation of females, authors used the extension of the mesopleural stripe (reaching further posteriad in *M. nigrofascioides* than in *M. squamifer*), and the result agreed well with the identification of males from the same samples. Macropterous females are generally lighter than apterous females of the same species, and this morph of *M. nigrofascioides* was assigned to the males from the same sample.

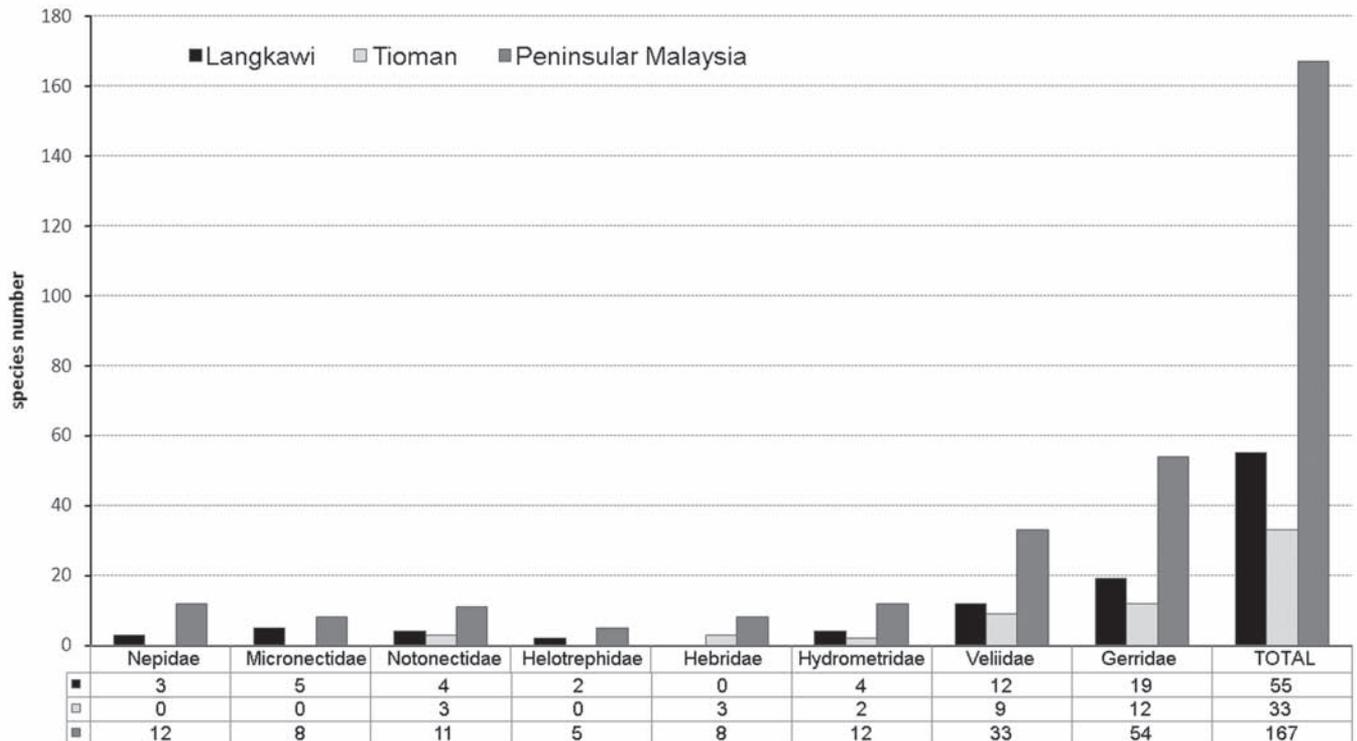


Fig. 24. Comparison of species richness of selected families of Nepomorpha and Gerromorpha of Malaysian islands with those of mainland Malaysia.

Distribution. – Southern Thailand, West Malaysia, Sumatra, and Java (Chen & Nieser, 1993).

Ventidius sp.

Material examined. – Stream near road linking Padang Gaong Rd to Makam Mahsuri Rd: 1 nymph, TAD0622.

Remarks. – Chen & Zettel (1999) record five species of *Ventidius* from West Malaysia and Singapore. Nymphs cannot be identified at present.

DISCUSSION

Species diversity. – Here we recorded species from eleven families on the island of Langkawi. Most of the species belong to two families, the Gerridae (19 species; 35 %) and the Veliidae (12 species; 22 %), while the remaining nine families together contain only 24 species. This agrees proportionally with the species numbers known from the Malay Peninsula (Fig. 24). Species of some families, not yet collected, are expected to occur on Langkawi, particularly representatives of the Ochteridae and the Hebridae.

A total of 55 species (50 identified) belonging to 31 genera was recorded from Langkawi. A similar study based on similar collection efforts was published by Yang et al. (1999) on the island of Tioman; it contains somewhat smaller numbers of taxa: 33 species (25 identified) in 25 genera. Both studies show that the island faunas are composed of only a fraction of the diversity of the mainland fauna, although it can be expected that a more detailed survey would yield some additional species.

For Veliidae, Chen et al. (2005) listed 25 species of Veliidae for the Malaysian faunal region (south of the Isthmus of Kra), and the total number of described species known from that region is presently 31 (including species newly described in this paper). Eleven identified species (35 %) are recorded from Langkawi, and six (19 %) from Tioman (Yang et al., 1999; Andersen, 2000). For Gerridae, Chen et al. (2005) list 53 species for the Malaysian fauna, and 55 described species are presently known. The Langkawi fauna contains 19 species (36 %), the Tioman fauna 12 species (23 %) (Yang et al., 1999).

Endemism. – Our survey of Pulau Langkawi includes descriptions of three new species. One of them, *Hydrotrepes langkawicus*, is unknown from anywhere else. However, it is doubtful that this species is an island endemic, and we expect that it will be recorded from the mainland in the future, when more collections of Helotrephidae become available.

No new species were described by Yang et al. (1999), but several new species were later described from the same Tioman material by other authors (e.g., Andersen, 2000; Zettel, 2001, 2004c; Zettel et al., 2009). Most species

described from Tioman were also recorded from the Malaysian mainland, in some cases more recently. The only endemic water bug described from Pulau Tioman is *Limnometra tiomanensis* Zettel, Yang & Tran, 2009.

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