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Descriptions of two large water striders of the genus *Limnometra* MAYR, 1865 (Insecta: Heteroptera: Gerridae) from the Philippines and Malaysia

H. Zettel*, C.M. Yang** & A.D. Tran***

Abstract

Two large gerrine water striders, *Limnometra freitagi* sp.n. from Mindanao, the Philippines, and *L. tiomanensis* sp.n. from Pulau Tioman, Malaysia, are described and illustrated. *Limnometra freitagi* sp.n., *L. femorata* MAYR, 1865, and *L. spinosa* ZETTEL, 2002 are closed related and form the newly defined *Limnometra femorata* species group. The relationship of *L. tiomanensis* sp.n. is presently dubious.

Key words: Heteroptera, Gerridae, *Limnometra*, new species, Malaysia, Philippines

Zusammenfassung

Zwei große Wasserläufer aus der Unterfamilie Gerrinae werden neu beschrieben und illustriert: *Limnometra freitagi* sp.n. von Mindanao (Philippinen) und *L. tiomanensis* sp.n. von Pulau Tioman (Malaysien). *Limnometra freitagi* sp.n., *L. femorata* MAYR, 1865 und *L. spinosa* ZETTEL, 2002 sind nahe verwandt und bilden die hier neu definierte *Limnometra femorata*-Artengruppe. Die verwandtschaftlichen Beziehungen der *L. tiomanensis* sp.n. sind derzeit unklar.

Introduction

The gerrine genus *Limnometra* MAYR, 1865, is restricted to the Oriental, Malesian, Australian, and West Pacific Regions. The taxonomy of the ca. 30 described species has been treated, e.g., by HUNGERFORD & MATSUDA (1958), NIESER & CHEN (1992), ANDERSEN (1995), ANDERSEN & WEIR (1997), POLHEMUS & POLHEMUS (1997), ZETTEL & CHEN (2000), and ZETTEL (2001, 2002, 2007). However, because of species identification is difficult – some species can be identified only by the mesofemoral armature and by the vesica sclerites of males – there are still undescribed species to be discovered. The genus contains beautifully coloured species, a few of which are very large striders.

In this paper, we describe two large species, one from a unique male specimen originating from Mount Apo, Mindanao, The Philippines; and another one from a formerly misidentified series from Pulau Tioman, offshore of the Malay Peninsula.

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Material and methods

All type specimens were pinned and deposited in the Natural History Museum Vienna, Austria (NHMW) and in the Zoological Reference Collection, Singapore (ZRCS); they are referred to by citing the original locality labels.

Specimens were studied with binocular microscopes, ink drawings were done with the help of a camera lucida. Specimens were photographed with a Nikon D1X digital camera (lens: PC-Micro 85 mm f/2.8D Micro); several focal layers were stacked and manually assembled in Adobe Photoshop CS programme.

Limnometra freitagi sp.n. (Figs. 1, 3, 5, 6, 8, 9)

Etymology. Named in honour of Dr. Hendrik Freitag (Dresden, Germany), who discovered this extraordinary species.

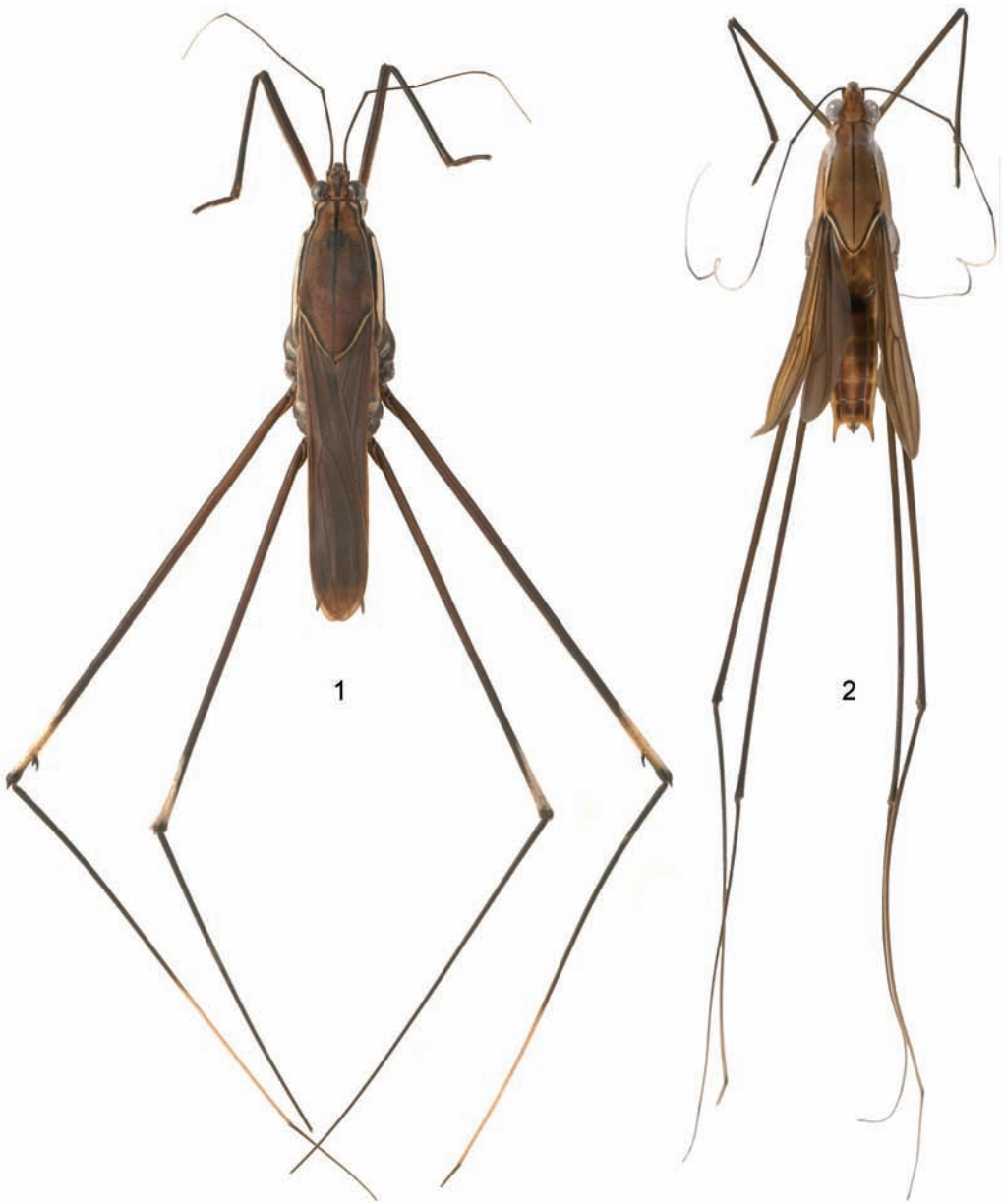
Type material. Holotype (macropterous male): labelled "Philippines: Mindanao, Kidapa-\ wan, Balabag, 1.1 km E Maw-\ reg, calm trib. of Paniqui Riv.\ prim.forest, 950m, 07°02'N\ 125°13'E 14.4.1995\ leg. Hendrik Freitag (36b)M" (NHMW).

Type locality. Philippines, Mindanao Island, Cotabato Province, Mt. Apo area, municipality of Kidapawan, Barangay Balabag, 1.1 km E of Mawreg, ca. 950 m a.s.l., N 07°02', E 125°13'.

Diagnosis. Very peculiar, large (body length of male 23.5 mm) and robust species with brown posterior lobe of pronotum (Fig. 1), wide black mesopleural stripe (Fig. 3), and small yellow dots on meso- and metacetabula. Mesofemur of male (Figs. 5, 6) with distinct anteapical spine, but without long hair fringe. Male vesica sclerites (Figs. 8, 9) diagnostic. Probably monomorphic macropterous.

Description of macropterous male. Dimensions: Body length inclusive wings 23.5 mm, exclusive wings until apex of connexival spines 23.3 mm. Maximum body width at mesoacetabula 6.1 mm. Head width 2.9 mm. Length of second antennomere (measured straight from base to apex) 2.8 mm. Length of mesofemur 25.7 mm.

Colour: Dorsum of head brownish yellow with distinct black markings: narrow rhomboid mark medially and pair of longitudinal stripes near eye margins. Side of head in front of eye with broad black stripe. Antenna blackish brown, antennomere 4 white except base brownish. Pronotum and pronotal lobe medium brown; black lateral stripes of pronotum very broad, black sublateral stripes and black median stripe of pronotum and pronotal lobe narrow; yellowish white margin uninterrupted. Sides of thorax pale brown or yellowish brown, gradually turning to pale yellow towards venter. Mesopleura with two broad black stripes at dorsal margin, both separated until posterior end of mesopleura by a broad silverish shining stripe, but connected near anterior end; black mark at cephalic end of coxal cleft very small. Mesoacetabulum with small, elongate silverish yellow mark, mark on metacetabulum roundish, both pronounced by blackish marks dorsally and ventrally. Fore wing dark brown with black veins. Legs mainly blackish brown, except procoxa, protrochanter, base of profemur, and ventral sides of mesocoxae, metacoxae, meso-, and metatrochanters yellow; apices of meso- and metafemora and distal two-fifths of mesotibia whitish. Sternites light brownish yellow. Tergites and laterotergites reddish.



Figs. 1–2: Dorsal aspects of (1) *Limnometra freitagi* sp.n., ♂, holotype; (2) *Limnometra tiomanensis* sp.n., ♂, paratype.

Structural characteristics of male: Relative lengths of antennomeres: 1.6 : 1 (= 2.8 mm) : 1.3 : 1.3. Lengths of leg segments relative to mesofemur: profemur 30, protibia 26, protarsus 5+4, mesofemur 100 (= 25.7 mm), mesotibia 93, mesotarsus 22+4, metafemur 86, metatibia 93, metatarsus broken on both legs. Profemur slender, 14 times as long as

Figs. 3–4: Lateral aspects of head and thorax of (3) *Limnometra freitagi* sp.n., ♂, holotype; (4) *Limnometra tiomanensis* sp.n., ♂, paratype.

wide, widest at mid-length, ventrally with very dense, relatively long pilosity, hair length ca. one-third of femur width. First protarsomere hardly longer than second (ca. 1.1 times). Mesofemur distinctly longer than metafemur (almost 1.2 times), without obvious pilosity, except subapically, with long anteapical spine (Figs. 5, 6); spine on left mesofemur bifid, spine on right mesofemur with apical indentation; proximal of anteapical spine with row of 8 or 9 short, widely spaced spines, distal of spine with two more or less straight rows of several, densely set short spines. Abdominal sternites with median carina. Connexival spines narrow and relatively slender, slightly divergent and upcurved, surpassing apex of proctiger, not reaching apex of fore wings. Segment 8 and genitalia relatively small; segment 8 without ventral modifications. Pygophore, proctiger, and parameres as characteristic for the genus. Vesica of male (Figs. 8, 9): Lateral sclerite narrow, weakly curved, caudally almost straight in lateral view; dorsal sclerite basodorsally relatively wide, apically hardly split; ventral part of vesica large and slightly sclerotized; ventral sclerite reduced, small.

Comparative notes. The anteapical mesofemoral spine (Figs. 5, 6) of the male sets *L. freitagi* sp.n. in close relationship with *L. femorata* MAYR, 1865 and *L. spinosa* ZETTEL, 2002. These three species form a clade, which is hereby named the ***Limnometra femorata* species group** for the first time. It is defined by the following set of character-

istics: Large, elongate species, body length ca. 15–24 mm, males more variable in size than females and on average larger. Antennomere 4 (or antennomeres 3 and 4) partly whitish. Apices of meso- and metafemora whitish. Mesopleura with two black stripes. Profemur of male slender. Mesofemur of male distally with two rows of spines, with anteapical spine (reduced only in very small individuals of *L. femorata*; see ZETTEL & CHEN 2000), without fringe of long setae.

Limnometra freitagi sp.n. can be easily distinguished from *L. femorata* and *L. spinosa* by its stout body, by the colour pattern, and by the lateral sclerite of the male. Differences between these three species are listed in Table 1. Further, *L. freitagi* sp.n. has slightly shorter antennae (ca. 3/5 of body length vs. 3/4 of body length in *L. femorata* and *L. spinosa*).

The holotype of *L. freitagi* sp.n. has modified mesofemoral spines, the left one being clearly bifid, the right one having a small apical indentation (Figs. 5, 6); in addition, the ventral spine row is very dense. However, these modifications are expected to be inconsistent, especially in small individuals.

Tab. 1: Differences among the species of the *L. femorata* species group.

Characteristics	***L. femorata***	***L. spinosa***	***L. freitagi* sp.n.**
Yellow mark on mesoacetabulum	small, ovate	large, roundish	small, ovate
Yellow mark on metacetabulum	small, roundish	large, roundish	small, roundish
Ventral black mesopleural stripe	narrow or weak, ventral margin sharp	broad, ventral margin faded	broad, ventral margin sharp
Yellow mesopleural stripe posteriorly confluent with ventral yellow area	yes	no	no
Pronotal lobe colour	light brown	reddish brown	medium brown
Median black line on pronotal lobe, (nearly) reaching light margin	yes	usually not	yes
Connexivum colour	orange	infuscated	orange
Forewing colour	dark brown, costal margin reddish	blackish costal margin blackish	dark brown costal margin brown
Ratio maximum body width / head width	1.57–1.85 (n = 12)	1.67–1.91 (n = 6)	2.07 (n = 1)
Lateral sclerite in vesica of male caudally (in lateral view)	with long hook	curved	almost straight

***Limnometra tiomanensis* sp.n.** (Figs. 2, 4, 7, 10–13)

Tenagogonus (*Limnometra*) *femoratus*: YANG et al. 1999 (misidentification).
Limnometra femorata: CHENG et al. 2001 (partim; misidentification).

Notes. As pointed out by ZETTEL (2002) *Limnometra femorata* is distributed in the Philippines and reaches southwards Malaysia on Banggi Island north of Borneo; more northern records from southern Japan and Taiwan are probably correct, but need confirmation. Other records of *L. femorata* from Malaysia (Peninsular

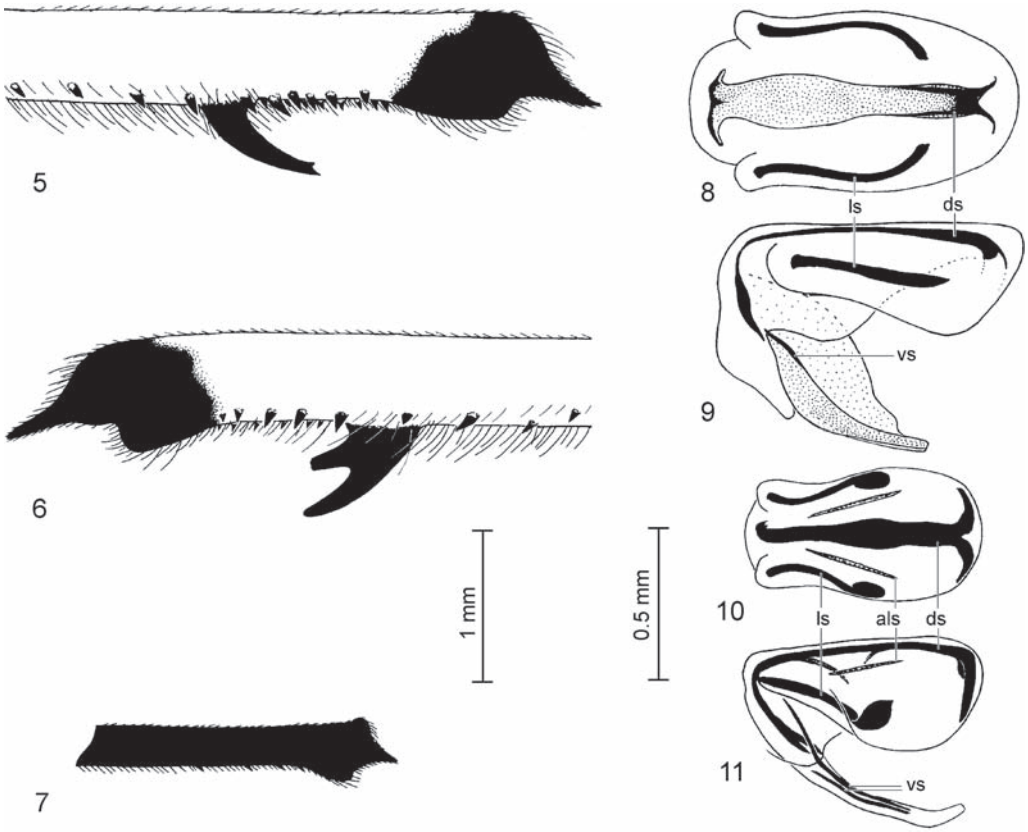


Fig. 5–11: (5–8) Apices of mesofemora of males: (5, 6) *Limnometra freitagi* sp.n., holotype; (7) *L. tiomanensis* sp.n., paratype. (8–11) Vesicae: (8) vesica of *L. freitagi* sp.n., holotype, lateral aspect; (9) same, dorsal aspect; (10) vesica of *L. tiomanensis* sp.n., paratype, lateral aspect; (11) same, dorsal aspect; als = accessory lateral sclerite; ds = dorsal sclerite; ls = lateral sclerite; vs = ventral sclerite.

and Borneo) and Indonesia (Sumatra, Java) refer to *L. spinosa* ZETTEL, 2002. However, the species from Pulau Tioman formerly identified as *L. femorata* belongs to another species; it is here described as new to science.

Etymology. The Latinized adjective refers to the island of Tioman, where this species is possibly endemic.

Type material. Holotype (winged male) labelled "MALAYSIA- Pahang, Pulau\ Tioman, Kg Tekek, saline pool\ CM Yang & HK Lua\ YCM0148 29-JUN-1996" (ZRCS). **Paratypes** (all winged): 1 male, 2 females, same label data as holotype (ZRCS, NHMW); 1 male "MAL, Pulau Tioman, Sg. Keliling,\ downstream towards river mouth;\ HK Lua et al., 27-JUN-1996, YCM133" (ZRCS); 1 female "MAL, Pahang, P. Tioman, Sg. Keliling,\ downstream, HK Lua et al., 26-JUN-1997,\ LHK343A" (ZRCS); 1 female, "MAL, Pahang, P. Tioman, Sg. Baharu;\ T Wong, 27-JUN-1997, LHK344C" (ZRCS); 1 male, 2 females "Mal, Pulau Tioman, YCM101\ Track to Juara, brackish pool\ Kg. Tekek; 24. Jun. 1996\ CS Tang & T Wong" (ZRCS); 1 female "TAD0516\ Malaysia, Tioman\ Paya, 18/7/05" (ZRCS); 1 male " Malaysia, Tioman Island\ Sg. Keliling, 20 July 2005\ coll. Tran, A.D., TAD0518"; 1 male, 2 females, "Malaysia, Tioman

Island\ Sg. Paya, 13 July 2007\ coll. Tran, A.D., TAD0704" (ZRCS); 1 female "MALAYSIA: Tioman, 0-100m\ rd. Kampong Tekek - K. Juara\ 4.-16.III.1998; 2.48°N104,11°E\ leg. L.Dembicky & P.Pacholatko" (NHMW).

Type locality. West Malaysia, Pahang, Tioman Island, Kampong Tekek, saline pool.

Diagnosis. Slender, medium sized to large species, males (14.5–16.5 mm) larger than females (12.2–13.5 mm), head width 1.9–2.4 mm. Only winged morph known, possibly monomorphic macropterous. Colour light, pronotum light rufous brown to medium brown with narrow black stripes; mesopleura with narrow black dorsal margin and one narrow black stripe; meso- and metacetabula with small, elongate yellow spots. Antennomeres 3 and 4 partly white in both sexes, meso- and metafemora distally unicolourous brown, fore wings pale yellowish brown with brown veins. Profemur of male slender. First protarsomere distinctly longer than second. Mesofemur distinctly shorter than metafemur, in both sexes without conspicuous long pilosity and without long subapical spine, in male distally with row of 2–8 short spines. Connexival spines narrow and elongate, slightly surpassing apex of proctiger in both sexes. Vesica of male: lateral sclerite distally strongly enlarged and twisted; dorsal sclerite distally split into two long, widely divergent arms.

Description of macropterous morph. Dimensions (males: n = 6; females: n = 10): Body length of male inclusive wings 14.5–16.5 mm (average 15.6 mm; holotype 15.8 mm), exclusive wings until apex of connexival spines 14.0–15.6 mm (average 15.0 mm; holotype 15.3 mm), of females (wing apex at same level as apex of connexival spines) 12.2–13.5 mm (average 12.8 mm). Maximum body width at mesoacetabula of males 3.5–4.2 mm (average 3.9 mm; holotype 3.9 mm), of females 3.1–3.5 mm (average 3.3 mm). Head width of males 2.1–2.4 mm (average 2.3 mm; holotype 2.2 mm), of females 1.9–2.0 mm (average 1.9 mm). Length of second antennomere of males 3.8–4.6 mm (average 4.2 mm; holotype 4.0 mm), of females 2.2–2.5 mm (average 2.3 mm). Length of mesofemur of males 16.0–19.5 mm (average 17.7 mm; holotype 16.9 mm), of females 10.9–12.2 mm (average 11.5 mm).

Colour: Dorsum of head yellowish brown with more or less distinct dark marking of the shape of an M. Antennal tubercles laterally black until anterior eye margin. Antenna dark brown, antennomere 2 at approximately midlength with indistinct yellowish annulation (absent in some females), antennomere 3 white except base and apex, antennomere 4 white except base. Pronotum and pronotal lobe orange brown to medium brown; black lateral stripes of pronotum, black sublateral stripes and black median stripe of pronotum and pronotal lobe narrow; yellowish white margin uninterrupted, but very narrow apically. Sides of thorax pale orange brown, gradually turning to pale yellow towards venter. Mesopleura with thin brown stripe at dorsal margin and one thin, anteriorly and posteriorly shortened brown stripe slightly dorsal of middle; black mark at cephalic end of coxal cleft distinct. Meso- and metacetabula each with rather small, elongate yellow mark pronounced by two blackish marks dorsally and ventrally. Fore wing pale yellowish brown with brown veins. Legs: coxae and trochanters, and base of profemur yellow; all femora gradually darkened from base to apex; protibia dark brown, or with pale stripe on extensor side; protarsus blackish brown; meso- and metatibiae gradually lighter from brown base to pale apex; meso- and metatarsi pale, whitish. Sternites light orange to yellow except infuscated connexival spines.

Structural characteristics of male: Relative lengths of antennomeres (holotype): 1.1 : 1 (= 4.0 mm) : 1.6 : 1.4. Relative lengths of leg segments (holotype): profemur 34, protibia 32, protarsus 6+5, mesofemur 100 (= 16.9 mm), mesotibia 89, mesotarsus 24+4, metafemur 114, metatibia 69, metatarsus 12+4. Profemur slender, 18 times as long as wide, widest near base, ventrally with very short pilosity. First protarsomere distinctly longer than second (1.2 times). Mesofemur (Fig. 7) distinctly shorter than metafemur (0.9 times), without obvious pilosity, without long anteapical spine, distally with row of 2–8 small spines (in holotype 4 on left femur, 2 on right femur). Abdominal sternites with median carina. Connexival spines narrow and slender, slightly surpassing apex of proctiger, not reaching apex of fore wings. Segment 8 and genitalia relatively small; segment 8 without ventral modifications. Pygophore, proctiger, and parameres as characteristic for the genus. Vesica of male (Figs. 10, 11): Lateral sclerite distally strongly enlarged and twisted; dorsal sclerite distally split into two long, widely divergent arms.

Structural characteristics of female: Body slightly stouter than in male, antennae and legs relatively shorter. Profemur length 16 times maximum width near base; first protasomere longer than second (1.1 times). Mesofemur distinctly shorter than metafemur (0.9 times), without any subapical spine. Abdominal sternites faintly carinate throughout. Connexival spines long and slender, directed straight caudad in ventral and lateral view, surpassing apex of proctiger, reaching approximately level of apex of fore wings.

Comparative notes. Because of its considerably large size and the absence of a mesofemoral hair fringe in males, *Limnometra tiomanensis* sp.n. was earlier confused with *L. femorata*. However, it clearly differs from species of the *L. femorata* group, e.g., by the absence of a large mesofemoral spine in males (although this anteapical spine is very rarely lacking in the smallest specimens of *L. femorata*; see ZETTEL & CHEN 2000), in the apically twisted lateral sclerite in the males' vesica, and in the completely dark meso- and metafemora of both sexes. When using the key by NIESER & CHEN (1992), identification of *L. tiomanensis* sp.n. would key to *L. kallisto* (KIRKALDY, 1899), a species recorded from the eastern parts of Malesia, namely from Misool, New Guinea, New Britain, and the Solomon Islands (NIESER & CHEN 1992, POLHEMUS & POLHEMUS 1997). However, the two species can be readily distinguished by, among other characters, the strongly different lateral sclerites in the vesica and by the colour of the meso- and metafemora, which is dark in *L. tiomanensis* sp.n. and whitish in *L. kallisto*. Small females of *L. tiomanensis* sp.n. (head width of smallest female: 1.87 mm) may also be mistaken for *L. insularis* HUNGERFORD & MATSUDA, 1958 or one of its close relatives, but they can be distinguished from those species by the whitish annulation of antennomere 3.

The phylogenetic position of *L. tiomanensis* sp.n. is presently dubious. Following NIESER & CHEN (1992), the apically twisted lateral sclerite is an important characteristic for a large species group distributed from Sulawesi eastwards. In *L. tiomanensis* sp.n., this character is also present. Although the colour characters of *L. tiomanensis* sp.n. do not fit well in the character assembly of that group, the new species is tentatively placed therein; it is the first species of this group west of Wallace's Line.

Size polymorphism and sexual dimorphism. A sexual dimorphism and strong variation in males is observed in body length and mesofemur length of *L. tiomanensis* sp.n. (Fig. 12). Females are consistentlly smaller than males and have much shorter legs. In contrast, males vary strongly in body length and mesofemur length. The smallest males

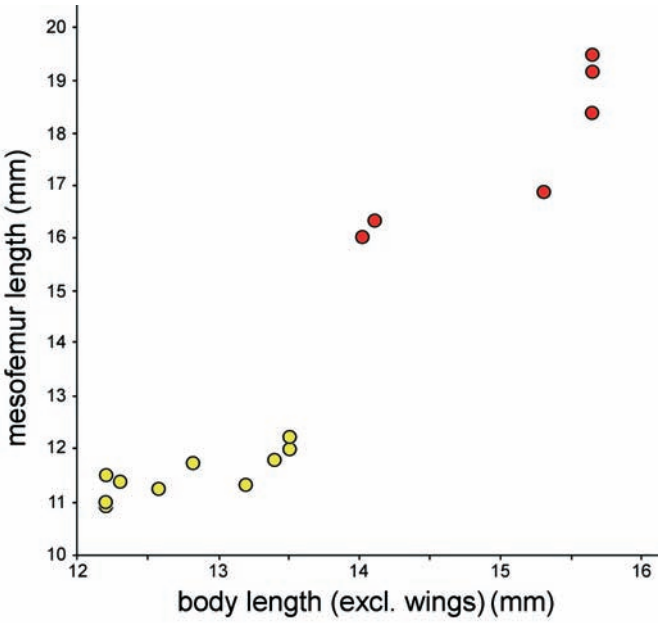


Fig. 12: Diagramme showing relationship between mesofemur length and body length in *Limnometra tiomanensis* sp.n. Females (yellow circles) are smaller than males (red circles), which show high variation in body length.

are of similar size to the largest females, but they have much longer legs. A similar situation can be observed in many species of *Limnometra* and it is related with their mating system (ANDERSEN 1994, 1996, 1997). Observations (e.g., in *Limnometra femorata*; see ZETTEL & CHEN 2000) indicate that males – at least in some species of *Limnometra*– are highly territorial, and the mesofemoral armature might be used as a weapon during fights among males. Females of *Limnometra* can variably retract anterior parts of tergite 8 and gonocoxae 1 into the abdominal segment 7, which is armed by long connexival spines in most species. These morphological features of females indicate that mating process in *Limnometra* is probably determined by female choice.

Ecological notes. *Limnometra tiomanensis* sp.n. was found mostly at lower reaches of small and shallow freshwater streams, where the current is relatively slow and the water level is strongly affected by tide, although it is still fully freshwater (0.02 % salinity during high tide in July 2007; recorded by a YSI 556 multi-probe meter). This section of the stream is mainly shaded under a secondary forest, with dense vegetation at its banks and certain parts partially open to direct sunlight. The bottom is covered with small gravels and sand, and with scattered leaf litter. The bugs were found resting at shaded parts of the water body, usually on small and very shallow pools or other quiet areas of the main stream. These insects, when disturbed, either skate away or even fly up with great agility, and they usually "disappear" from their original resting place and do not come back within a short time. Surprisingly, they were found resting or hiding on large leaves of trees (Fig. 13) at the height of about 0.5–1.5 m above the water surface. So far, this *Limnometra* has not been found at upper sections of the same foothill stream. The holotype and some paratypes were collected from a temporary saline pool (2.0 m wide and 0.5 m deep), shaded under coconut trees near the beach, with about 20 individuals colonizing there.

Fig. 13: *Limnometra tiomanensis* sp.n. alertly resting on a leaf of Sea hibiscus, *Hibiscus* sp., about 1.5 m above the water surface, Tioman, Sungai Paya, July 2007 (photo: ©Tran Anh Duc).

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A total of 496 localities has been investigated thoroughly in 20 of the 33 administrative regions of China in the last decade. Supplementary material from Taiwan and additional Chinese administrative regions became available through numerous private collections. Almost 200 new species (and subspecies), and nine new genera (and subgenera) of aquatic and riparian Coleoptera are described from China and neighbouring areas in the three volumes of WATER BEETLES OF CHINA. On more than 1300 pages numerous taxonomic revisions and keys are published by 50 (!) authors from 18 countries. The three books are richly illustrated with many colour plates showing more than 80 top quality habitus paintings (mostly by the famous artist W. Zelenka), more than 80 habitat photographs, and dozens of distribution maps.

Several rare species, e.g. *Colymbetes minimus* (originally collected by the famous explorer Sven Hedin in 1901), *Mataeopsephus nitidipennis* (not collected since 1849!), or *Metagyrinus sinensis* have been rediscovered. A photograph of *Hygrobia davidi*, regarded as extinct globally, is provided.

Several contributions are dedicated to larval morphology. For the first time, the habitus of a hydraenid larva (i.e. *Ochthebius gonggashanensis*) is depicted in colour.

Two families, Epimetopidae and Torridincolidae, are recorded from China for the first time. The discovery of an entirely new beetle family, Aspidytidae, which was detected in central China in 1995, is reported.

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