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GUIDE TO THE AQUATIC HETEROPTERA OF SINGAPORE AND PENINSULAR MALAYSIA. X. INFRAORDER NEPOMORPHA—FAMLIES BELOSTOMATIDAE AND NEPIDAE

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ABSTRACT. — This is the tenth part in a series of papers constituting a Guide to the Aquatic Heteroptera of Singapore and Peninsular Malaysia, and treats the families Belostomatidae and Nepidae in the infraorder Nepomorpha. Species treatments are provided for all species in these groups occurring in the region under study, with keys provided for the multiple genera of Belostomatidae and Nepidae occurring in the region, and for the regional species in the nepid genera *Ranatra*, *Cercotmetus*, and *Laccotrephes*. New distributional records for Singapore and Peninsular Malaysia are also provided for many of the species treated.

KEY WORDS. — Belostomatidae, Nepidae, *Lethocerus*, *Diplonychus*, *Cercotmetus*, *Ranatra*, *Laccotrephes*, Singapore, Peninsular Malaysia, keys

INTRODUCTION

This contribution is the tenth in a series of papers constituting a Guide to the Aquatic Heteroptera of Singapore and Peninsular Malaysia (Cheng et al., 2001a, 2001b; Andersen et al., 2002; Nieser, 2002, 2004; Yang & Zettel, 2005; Yang & Murphy, 2011; Zettel et al., 2011; D. Polhemus & J. Polhemus, 2012; J. Polhemus & D. Polhemus, 2012), and treats the families Belostomatidae and Nepidae. As with previous papers in this series, keys are provided to the multiple genera of Belostomatidae and Nepidae occurring in the region, and to the multiple regional species in the genera *Ranatra*, *Cercotmetus*, and *Laccotrephes*. Because the Nepomorpha fauna of Peninsular Malaysia is insufficiently sampled, extralimital species with geographically proximal ranges are also included in order to allow recognition of these taxa should they be encountered in future collections from the region.

MATERIAL AND METHODS

New and clarified distributional records are provided under the individual treatments for each species, including in some cases new extralimital records included to establish broader distributional context; the latter are listed under "Extralimital material examined." Most of the specimens listed are housed in the collections of the National University of Singapore, Kent Ridge, Singapore (ZRC), with additional records from the J. T. Polhemus Collection in Englewood, Colorado, USA (JTPC), the Bishop Museum, Honolulu, Hawaii, USA (BPBM), the United States National Museum, Smithsonian Institution, Washington, DC, USA (USNM), and the National Museum of Natural History, Paris, France (Muséum National d'Histoire Naturelle, MNHN). The material listed from the ZRC collection does not constitute a comprehensive accounting of all specimens held there, but has instead been selected in order to establish exemplar geographic coverage, or because the collection data includes particularly useful habitat notes.

In the Material Examined sections local conventions have been used in regard to geographic names without translation to English, so that the Malay "Sungai Gombak" is retained, rather than being translated to "Gombak River". The most common of these retained Malay terms are: *sungai* = river, *gunung* = mountain, *bukit* = hill, and *kampong* = village. In certain cases additional notations have been added in brackets to provide clarity in cases where label data was insufficiently detailed. For material in JTPC, the CL numbers following

localities refer to a collection locality numbering scheme allowing cross-referencing of photographs and other metadata to specific collecting localities.

All measurements are given in millimeters. Synonymies provided under species are nomenclatural only.

Family BELOSTOMATIDAE Leach, 1815

The family Belostomatidae, or giant water bugs, is worldwide in distribution, attaining its highest species richness in the interior wetlands of South America (Polhemus & Polhemus, 2008). Species are generally ovate in body shape, with fully developed wings and stout raptorial forelegs. Two species representing two genera occur in Singapore and Peninsular Malaysia. Belostomatids include the largest of all aquatic Heteroptera in terms of body size, and should be handled carefully, since all species are capable of inflicting painful bites with their beaks, or lacerations with their stout claws.

KEY TO GENERA AND SPECIES OF BELOSTOMATIDAE OCCURRING IN SINGAPORE AND MALAYSIA

1. Very large species, body length exceeding 60 mm; body shape elongate-ovate and parallel-sided (Fig. 1), lateral margins of hemelytra straight; inner margins of eyes parallel ..... *Lethocerus indicus* (Lepeletier & Serville)
– Smaller species, body length less than 20 mm; body shape more rounded, lateral margins of hemelytra outwardly arcuate (Fig. 2); inner margins of eyes convergent anteriorly ..... *Diplonychus rusticus* (Fabricius)

Genus *LETHOCERUS* Mayr, 1853

Diagnosis. — Very large belostomatids, body length exceeding 60 mm. Head width more than twice the maximum interocular width (Fig. 1); clypeal suture only slightly indicated, nearly absent. Pronotum with lateral expansions, anterior margin relatively straight. Fore trochanter bearing a pit; fore femur bearing three pads, the outer pair symmetrical and wider than the single inner; tarsomere II of foreleg shorter than tarsomere III; anterior tarsi bearing single claw. Abdomen with parasternites II and III narrower than IV, their external margins nearly straight.

Lethocerus indicus (Lepeletier & Serville, 1825)
(Fig. 1)

Belostoma indica Lepeletier & Serville, 1825: 272
Amorgius indicus: Green, 1901: 113
Lethocerus indicum: Hale, 1924: 521

Material examined. — SINGAPORE: 1 male, Changi Airport hanger (origin possibly PNG),14 Nov.1987, coll. Razali (ZRC). MALAYSIA: **Kedah**: 1 male, no further data (ZRC). **Selangor**: 1 male, no further data (ZRC).

Diagnosis. — Body elongate elliptical (Fig. 1), length 64.0–80.0 mm; maximum width 23.5–29.7 mm. Colouration light chestnut brown with darker markings at muscle attachment scars; pronotum bearing two wide, pale, anteriorly diverging stripes (Fig. 1). Head with eyes parallel, interoculus carinate. Legs with fore femur 20% wider than hind femur, outer margin of hind tibia arcuate.

Distribution. — Originally described from "indes orientales", with subsequent records from China, Korea, Hong Kong, the Ryukyu Islands, Burma, Thailand, Vietnam, the Philippines, Java, Sumatra, Borneo, Sulawesi, Singapore, and Peninsular Malaysia (Fernando & Cheng, 1974; Nieser & Chen,1999).

Discussion. — With a body length exceeding 60 mm, *L. indicus* is by far the largest species of aquatic Heteroptera known to occur in Singapore and adjacent Peninsular Malaysia. In addition to the Singapore specimen listed above, which may have been introduced by air transport, we have seen two Peninsular Malaysian specimens of *L. indicus* with minimal data from the states of Kedah and Selangor. Fernando & Cheng (1974) also reported light trap captures from Selangor, Perak and Kedah, although we have not examined these specimens. Overall, collections of this species in Singapore and Peninsular Malaysia are strikingly limited

Fig. 1. *Lethocerus indicus* (Lepeletier & Serville), male, specimen from Laos, Vientiane Prov.

in comparison to Thailand and Laos, where the species is still very abundant, being commonly sold as a food item in local market stalls.

The biology and life history of this species was described by Hoffman (1933a, 1933b). Although lentic habitats potentially suitable for *L. indicus* exist in the Selatar Reservoir and Nee Soon Swamp Forest areas of Singapore, there is no indication that *L. indicus* currently occurs on the island, with no captures of this species in over two decades. The absence of recent specimens in the ZRC collections of an insect this large and conspicuous is notable, and given that *Lethocerus* species are strongly attracted to lights suggests ecological changes, possibly including urban light pollution, may have had a deleterious effect on this species, as has been documented for other *Lethocerus* species elsewhere in Asia (Yoon et al., 2010).

Genus *DIPLONYCHUS* Laporte, 1833

Diagnosis. — Relatively small belostomatids, body length less than 20 mm. Body ovate, dorsoventrally flattened (Fig. 2). Head produced ahead of eyes, apex sub-triangular; eyes with inner margins convergent; head width less than twice the maximum interocular width. Fore tarsi bearing two claws; middle and hind tibiae not flattened.

Discussion. — This genus contains relatively small, ovate, brown belostomatids that are often extremely common along the margins of ponds and other standing water habitats. A confusingly large number of generic and specific names have been applied to the species currently held in *Diplonychus*. For the one species occurring in the region under study, *Diplonychus rusticus*, the relevant nomenclatural synonymy is provided below.

Diplonychus rusticus (Fabricius, 1781)
(Fig. 2)

Nepa rustica Fabricius, 1781: 333
Diplonychus rusticus: Laporte, 1833: 18
Appasus marginicollis Dufour, 1863: 393; syn. by Distant, 1906: 36
Sphaerodema molestum: Fernando & Cheng, 1974: 41, misidentification
Diplonychus indicus Ventaktesan & Rao, 1980: 299; syn. by J. Polhemus, 1995: 651

Material examined. — We have examined several hundred specimens of this species from Singapore and throughout Peninsular Malaysia, including the states of Johor, Malacca, Negeri Sembilan, Selangor, Pahang, Terengganu, Perak, Perlis, and Panang. Many long series have been taken at light, and others from standing water habitats ranging from reservoirs to duck ponds.

Diagnosis. — Body ovate (Fig. 2), length 15.0–16.0 mm; maximum width 9.0–9.5 mm. Colouration medium brown, with lateral margins of pronotum and hemelytra contrasting paler brown. Head with eyes convergent anteriorly, head length shorter than width of vertex. Pronotum, scutellum and hemelytral corium finely punctate.

Distribution. — Originally described from India, and subsequently reported from Sri Lanka, India, Burma, China, Japan, Taiwan, Thailand, Vietnam, Malaysia, Singapore, the Philippines (Mindanao), Sumatra, Java, Borneo and Sulawesi (Chen et al., 2005). Fernando & Cheng (1974) reported this species from Singapore and the Peninsular Malaysian states of Johor, Negeri Sembilan, Perak, Penang and Selangor, with some of the Peninsular Malaysian records erroneously listed under the name *Sphaerodema molestum* (see below).

Discussion. — This relatively small, brown, ovate belostomatid is widespread in the Indo-Australian region, and shows a notable degree of intraspecific variation in size and colouration. It may be found along the margins of ponds and other lentic ecosystems, but does not generally inhabit lotic ecosystems unless current speed is very slow. The life history of this species was investigated in the laboratory by Su & Yang (1992), who found that the species could produce 3–4 generations a year. As with many belostomatids (although not *Lethocerus*) males of *Diplonychus* exhibit parental care for egg masses which are carried on their backs. Such egg guarding may be essential for successful reproduction, given the results of Su & Yang (1992) who found that under laboratory conditions egg masses deprived of such care dessicated and failed to hatch.

Diplonychus rusticus is a beneficial insect whose positive effects are well documented. It is a demonstrated predator of immature mosquitoes, with individuals capable of consuming

Fig. 2. *Diplonychus rusticus* (Fabricius), male, specimen from Philippines, Luzon.

up to 87 larvae a day (Saha et al., 2007). Yano et al. (1981) also noted that this species occurs in rice paddies, and considered it to represent a potential natural biological control agent for certain rice pests. In addition, it is a predator of the molluscan intermediate hosts of the parasitic trematode *Fasciola gigantica* which causes tropical fascioliasis, a disease of the liver that commonly affects livestock, and occasionally humans (Reyes et al., 1970).

J. Polhemus (1994) discussed the history of nomenclatorial confusion surrounding this taxon name. A proposal to conserve the name for the sake of nomenclatural stability was submitted to the ICZN by Polhemus & Kerzhner (1995), and later approved by the ICZN (1996). We also consider previous Peninsular Malaysian records of the Indian species *Diplonychus molestus* (Dufour), listed by Fernando & Cheng (1974) under the name *Sphaerodema molestum*, to be referable to *D. rusticus*.

Family NEPIDAE Latrielle, 1802

Discussion. — The family Nepidae has a worldwide distribution, attaining its highest species richness in the tropics of the Southern Hemisphere (Polhemus & Polhemus, 2008). Members of this family, also known as "water scorpions", have elongate bodies, highly modified raptorial forelegs, and possess an elongate breathing siphon at the posterior tip of the abdomen. Ten species representing three genera occur in Singapore and Peninsular Malaysia.

The work of Keffer (2004) provides a very useful and well illustrated analysis of male genitalic characters in this family. For many nepid species the shape of the male parameres is diagnostic, but these structures are not visible externally. Instead, the male operculum at the posteroventral tip of the abdomen must be raised up, and the genitalic capsule gently pulled out in a posterior direction. This is usually best done by inserting a pair of sharp forceps, capturing the genital capsule between their apices, and then carefully working the entire capsule out of the abdomen. Care should be taken not to pull only on the extreme posterior portion of the capsule, since this will often separate from the remainder, in the process damaging other potentially informative internal sclerites, and making the remainder of the capsule harder to remove.

As with members of the related family Belostomatidae, live nepids should be handled with care, since all species can inflict a painful bite.

KEY TO GENERA OF NEPIDAE OCCURRING IN SINGAPORE, PENINSULAR MALAYSIA AND THE GREATER SUNDA ISLANDS

Note. — The genus *Telmatotrephes* is not currently known from Singapore or Peninsular Malaysia, but the species are rare and very cryptic, with leaf-like bodies, therefore it is possible that diligent collecting may eventually uncover the genus in the region under study. As such, it is included in the present key as a contingency, given its occurrence on Borneo and in Thailand (Sites & J. Polhemus, 2000), but is marked with an asterisk (*) to indicate that it is currently extralimital.

1. Body dorsoventrally flattened; abdominal parasternites visible, not concealed by ventral laterotergites; head distinctly narrower than pronotum and partly enclosed in the anterolateral pronotal angles (Fig. 30; subfamily Nepinae).....2
– Body not dorsoventrally flattened, subcylindrical in cross section; abdominal parasternites concealed by ventral laterotergites; head and pronotum subequal in width, head not cradled between the anterolateral pronotal angles (Figs. 3, 7, 8; subfamily Ranatrinae).....3
2. Respiratory siphon longer than the inner hemelytral commissure (measured as the distance between the apex of the scutellum and the base of the wing membrane along the inner margin of the hemelytra; Fig. 30).....*Laccotrephes* Stål
– Respiratory siphon shorter, not more than half as long as the length of the hemelytral commissure.....**Telmatotrephes* Stål
3. Eyes in lateral view globose, not reflexed downward or obscuring ventral margin of head; respiratory siphon usually long and slender (except in *R. gracilis* species group; Fig. 8)..... .....*Ranatra* Fabricius
– Eyes in lateral view reflexed downwards, obscuring ventral margin of head; respiratory siphon short and stout, length about one quarter the length of the body (Figs. 3, 7)..... .....*Cercotmetus* Amyot & Serville

Subfamily RANATRINAE Douglas & Scott, 1865

Genus *CERCOTMETUS* Amyot & Serville, 1843
(Figs. 3–7)

Discussion. — The genus *Cercotmetus* contains 10 species (exclusive of subspecies) occurring in Asia and Australia. The taxonomy was competently revised by Lansbury (1973), with only *C. minutus* Keffer & J. Polhemus from Laos having been subsequently described. Unlike other nepids, *Cercotmetus* species occur along the margins of flowing streams, where they may sometimes be observed swimming near shore. The individual species are solitary in their habits, and not generally collected in large numbers. As such, the geographic ranges of the constituent taxa are still incompletely understood, and the records provided below serve to fill in a number of distributional gaps.

Key morphological apomorphies defining *Cercotmetus* as provided by Lansbury (1973) include the outer margin of the eyes sloping downward and obscuring the ventral margin of the head, the length of the fore femur shorter than the prothorax, the middle and hind tibiae with fringes of long swimming hairs, and the phallotheca housed in a membranous anterior diverticulum rather than within the sclerotized genital capsule. The eggs of *Cercotmetus* bear slender, elongate respiratory horns that are much longer than the egg itself, being in some cases up to 10 mm in length (see Fig. 1 in Lansbury, 1973). Similar respiratory horns are also found in *Ranatra*, but are shorter that those of *Cercotmetus*, at least in all tropical Asian *Ranatra* species for which this character state is known.

KEY TO THE SPECIES OF *CERCOTMETUS* OCCURRING IN SINGAPORE AND PENINSULAR MALAYSIA

(after Lansbury, 1973)

1. Small species for genus, body length (excluding siphon) 32–41 mm; vertex raised between the eyes, but lacking a prominent tubercle; middle femur shorter than prothorax; male paramere shape as in Fig. 4..... *C. brevipes brevipes* Montandon
– Larger species, body length (excluding siphon) exceeding 46 mm; vertex bearing a prominent tubercle; middle femur longer than prothorax; male paramere not as above (see Figs. 5, 6) 2
2. Very large species, body length (excluding siphon) 48–60 mm; mesosternum lacking a longitudinal keel; middle and hind femora with prominent tufts of long hairs ventrally at distal tips; posterior third of abdominal tergite VI raised and often very hairy; colouration usually dark blackish brown; female operculum of normal length, not projecting posteriorly beyond posterior apices of flanking ventral laterotergites; male paramere shape as in Fig. 5..... *C. compositus* Montandon
– Moderately large species, body length (excluding siphon) 46–53 mm; mesosternum bearing a longitudinal keel; middle and hind femora lacking prominent tufts of long hairs ventrally at distal tips, at most with a few shorter hairs; posterior third of abdominal tergite VI weakly raised at most and lacking hairs; colouration usually light brown; female operculum very long, projecting posteriorly well beyond posterior apices of flanking ventral laterotergites; male paramere shape as in Fig. 6..... .....*C. asiaticus* Amyot & Serville

Discussion. — In addition to the species keyed above, Fernando & Cheng (1974) listed Peninsular Malaysian records for *Cercotmetus pilipes* Dallas, a species known only from a single male holotype taken in Bhutan. Although we have not located the specimen in question, this species is not represented in the extensive *Cercotmetus* material from Peninsular Malaysia present in the ZRC collection. Based on the above, we consider these Malaysian records of *C. pilipes* implausible, and feel it likely that they represent misidentifications of *C. compositus* Montandon (see below).

Cercotmetus asiaticus Amyot et Serville, 1843

(Figs. 3, 6)

Cercotmetus asiaticus Amyot & Serville, 1843: 441

Material examined. — SINGAPORE: 2 males, Selatar Reservoir, Park Stream, 10 May 1991, coll. C. M. Yang et al. (ZRC); 3 males, stream at end of Rifle Range Road, 27 May 1993, coll. C. M. Yang et al. (ZRC); 2 males, Nee Soon swamp forest, 14 Apr.1990, coll. P. K. L. Ng (ZRC). MALAYSIA, **Johor**: 6 males, 3 females, Muar–Labis road, Sungai Tui, 26 Jul.1992, coll. K. Lim et al. (ZRC); 10 males, 2 females, 4 immatures, Sungai Temantang, 24 Feb.1995, coll. H. K. Lua et al. (ZRC); 1 male, 1 female, Layang Layang, stream 2, clear water, sandy bottom, 6 Feb.1991, coll. ZRC staff (ZRC); 1 male, Layang Layang, stream 3, muddy pond with vegetation, 6 Feb.1991, coll. ZRC staff (ZRC); 2 males, stream nr. Pulai Reservoir, 23 May 1991, coll. C. M. Yang & K. L. Yeo (ZRC); 1 male, Kota Tinggi, eastern foothills of Gunung Pantai (Track 266), 22 Oct.1991, coll. P. K. L. Ng et al. (ZRC); 1 male, stream in rubber estate at foot of Mt. Ophir, close to Muar Reservoir, Tankak, 4 Nov. 1959, coll. unk. (ZRC); 1 male, swamp forest stream 61 km. N. of Johor Bharu on Mersing Road, 16 Oct.1986, CL 2220, coll. D. A. & J. T. Polhemus (JTPC). **Pahang**: 2 males, Ulu Rompin, Sungai Kinchin, second stream, 13 Jun.1989, coll. C. M. Yang (ZRC); 3 males, Ulu Rompin, Sungai Kinchin, first tributary (Sungai Jebong), south of base camp, 13 Jun.1989, coll. C. M. Yang & Y. H. Koo (ZRC); 1 male, Lata Iskander waterfall, Cameron Highlands road, 18 Aug.1985, CL 2074, coll. D. A. & J. T. Polhemus (JTPC); 2 females, Cheroh River 6 km. E. of Tapah, 18 Aug.1985, CL 2072, coll. D. A. & J. T. Polhemus (JTPC). **Selangor**: 1 male, Sungai Pelumut, Subang, 14 Mar.1964, coll. unk. (ZRC); 1 female, Sungai Belat, 26 km. from Kuantan, 15 May 1995, coll. B. Tan and G. Sumita, TG03 (ZRC). **Negeri Sembilan**: 1 male, Ulu Bahau, stream in rubber estate, 17 Mar.1964, coll. unk. (ZRC). **Terengganu**: 2 males, 3 females, stream at about Km 6 on road from Kuala Brang to Terengganu, 19 Mar.1992, coll. P. Ng, LHK180 (ZRC). **Perak**: 1 male, 1 female, Sungai Korbu at Jalong, 16 Feb.1997, coll. H. K. Lua, LHK0321 (ZRC); 2 males, 1 female, stream 58 km. S. of Grik, 19 Aug.1985, CL 2077, coll. D. A. & J. T. Polhemus (JTPC).

Fig. 3. *Cercotmetus asiaticus* Amyot & Serville, female, specimen from Thailand, Chiang Mai Prov.

Perlis: 2 males, Sintok–Padang, Senai Rd., 19 Feb.1997, coll. H. K. Lua, LHK0330 (ZRC).

Extralimital material examined. — MALAYSIA, **Sarawak**: 1 male, 1 female, Borneo, Sungai Stok Muda, 6 Sep.1995, coll. H. H, Tan (ZRC); 2 males, 1 female, Borneo, outside Gua Kapo, 7 Sep.1995, coll. H. H. Tan, THH9567 (ZRC); 2 males, 2 immatures, Borneo, Kapit Dist., Sungai Ulu Selirik, 20 mi. upsteam of Rejang, 2°00'01"N, 112°57'24"E, 2 Mar.1998, THH9808, coll. H. H. Tan & R. Kerle (ZRC); 1 male, 1 female, Borneo, stream draining from Gunung Gading, 3 km. before turnoff to Cape Pelandok, nr. Lundu, 1°44'18"N, 112°52'01"E, 2 Sep.1996, THH9692, coll. H. H. Tan (ZRC). **Sabah**: 1 male, 1 female, Borneo, Danum Valley, Sungai Bole Kecil trib., 4°57'33"N, 117°51'34"E, 2 Oct.1996, THH96122, coll. H. H. Tan (ZRC); 1 female, stream 5 km. S. of Poring Hot Springs, 2 Aug.1985, CL 2024, coll. D. A. & J. T. Polhemus (JTPC). INDONESIA, **Jambi Prov.**: 2 females, Sumatra, Sungai Sentang, 12 km. SE of Jambi, nr. Desa Sukajaya, 27 Jul.1997, THH9744, coll. H. H,. Tan (ZRC). **Palembang Prov.**: 1 male, 1 female, Sumatra, Sungai Simpang, small trib. entering Sungai Niru from E. immediately upriver from Muaranira, 22 Feb.1995, coll. M. Kottelat (ZRC). **Riau Islands Prov.**: 3 males, Batam Is., 29 Jan.1991, coll. P. K. L. Ng (ZRC); 5 males, 1 female, Bintan Is., 47 km. to Tanjung Pinang, 1°06'38.1"N, 104°29'18.0"E, 27 Apr.1994, HH008, coll. unk. (ZRC). **Bangka-Belitung Prov.**:1 male, 2 females, Bangka Is., 5.5 km. N. of Payung, secondary forest, blackwater, pH 4.9, 5 Mar.1993, coll. M. Kottelat (ZRC). **Kalimantan Barat Prov**.: 1 male, Gunung Palung Nat. Park, Cabang Panti Research Station, 100–400 m., primary rain forest, 1°15'S, 110°05'E, 15 Jun.–1 Jul.1991, coll. Darling, Rosichon & Sutrisno (JTPC). BRUNEI, **Belait Dist**.: 1 male, 1 female, Borneo, Labi, Rampayoh, Sungai Mendaram and Mendaram Falls, 11 Oct.2001, coll. H. H. Tan and K. K. P. Lim (ZRC). **Temburong Dist.**: 1 male, Borneo, Belalong Basin, Sungai Enkabang, 5 Oct.2001, coll. H. H. Tan & K. K. P. Lim (ZRC). CHINA, **Yunnan**: 2 males, Xishuangbanna, 67 km. from Mengla, rocky stream, 1 Jun.2002, coll. C. M. Yang & P. Chew, YCM0311 (ZRC); 1 male, Xishuangbanna, Manchang stream, 63 km. from Jinghong to Menglun, rocky stream, 30 May 2002, coll. C. M. Yang & P. Chew, YCM0300 (ZRC). CAMBODIA: 1 female, between Phnom Penh and Kampong Som, Trueck Chai River, 24 May 1999, coll. H. H. Tan & H. N. Ng, THH9924 (ZRC). BURMA, **Mandalay Division**: Gelaung River at Pwe Kauk Falls, 8 km. E. of Maymyo, 1005 m., 22°03.52'N, 96°31.96'E, 19 Oct.1998, CL 4012, coll. D. A. & J. T. Polhemus (JTPC).

Diagnosis. — Male body length 46–50 mm, length of respiratory siphon 10–12 mm; female body length 49–53 mm, length of respiratory siphon 11–16 mm. Head with interocular space greater than the width of an eye, tuberculate between eyes. Mesosternum bearing a prominent keel. Fore femur with single relatively small tooth at mid-distance along the margin adjacent to the infolded tibia; middle femur much longer than prothorax. Male paramere deeply and narrowly bifid apically, this incision separating a pair (1+1) of sharply angulate processes (Fig. 6). Female with operculum very long, extending posteriorly well beyond posterior apices of flanking ventral laterotergites.

Distribution. — Originally described from Java, and subsequently recorded from Sumatra, Borneo, Peninsular Malaysia (Johor, Perak, Pahang, Malacca), Vietnam, Thailand, and China (Lansbury, 1973; Fernando & Cheng 1974; Chen et al., 2004). The material listed below includes the first published records for Singapore and the Peninsular Malaysian states of Selangor, Negeri Sembilan, Terengganu and Perlis.

Discussion. — The most commonly encountered *Cercotmetus* in Singapore and Peninsular Malaysia, *C. asiaticus* may be easily recognised by its tuberculate vertex, longitudinally carinate mesosternum, distinctive male paramere (Fig. 6), and very elongate female operculum that extends posteriorly well beyond the flanking ventral laterotergites. It is occasionally encountered syntopically with the smaller and stouter *C. brevipes* (compare body shapes in Figs. 3, 7).

Montandon (1909) described the variety *C. asiaticus* var. *longicollis*, based on specimens with a more elongate and parallel-sided prothorax in comparison to the typical form. We suspect that this morphological variation may be linked to degree of wing development, and have not treated this form as a separate subspecies herein. Lansbury (1973) could not locate the specimens upon which Montandon based this name, but did list two others, one from Borneo, and another from Malacca in Peninsular Malaysia. Therefore this form is known to occur in the region under study.

Cercotmetus brevipes brevipes Montandon, 1909

(Figs. 4, 7)

Cercotmetus brevipes Montandon, 1909: 65
Cercotmetus formosanus Sonan, 1928: 377; syn. by Lansbury, 1973: 92

Material examined. — SINGAPORE: 1 male, 1 immature, Nee Soon, pond, 19 Sep.1991, coll. K. L. Yeo (ZRC); 2 males, 1 immature, Kampong Java Park, 6 Apr.1990, coll. C. M. Yang & H. K. Lua (ZRC); 1 male, Singapore Botanic Gardens, 29 Dec.1989, coll. C. M. Yang (ZRC); 1 female, Nee Soon, 30 Mar.1990, coll. K. Lim (ZRC); 1 female, Tengeh Reservoir, small streams, 21 May 2008, coll. A. D. Tran, TAD0825 (ZRC); 1 female, Upper Selatar Reservoir, 10 Jul.2008, coll. A. D. Tran & A. Lok, TAD0842 (ZRC); 1 male, Poyan Reservoir, 11 Sep.2007, coll. A. D. Tran, TAD0708 (ZRC); 1 female, Lower Peirce Reservoir, 15 May 2008, coll. A. D. Tran, TAD0819 (ZRC). MALAYSIA, **Selangor**: 2 females, big pond with *Hydrilla* at foot of Batu Cave, 14 Dec. 1957 (ZRC). **Malacca**: 1 female, Rembia Stream, 8 Apr.1960, coll. unk. (ZRC); 1 male, Jasin–Kesang Tua road, Station 1, 5 Nov.1966 (JTPC). **Perak**: 1 female, pond nr. Stevens Rd., Taiping, 8 Feb.1960, coll. unk. (ZRC).

Extralimital material examined. — BRUNEI, **Belait Dist**.: 1 male, 1 female, Borneo, Sungai Melilas, 12 May 1996, coll. H. H. Tan (ZRC).

Diagnosis. — Male body length 32–35 mm, length of respiratory siphon 7–8 mm; female body length 38–41 mm, length of respiratory siphon 8–9 mm. Head with interocular space 1.5× the width of an eye, broadly raised but not tuberculate between eyes. Mesosternum rounded longitudinally, lacking a prominent keel. Fore femur with moderate sized tooth centrally along the margin adjacent to the infolded tibia; middle femur shorter than prothorax. Male paramere broadly incised apically, this incision separating a broad, truncate distal process from a more basal angulate

process (Fig. 4). Female with operculum extending posteriorly only to posterior apices of flanking ventral laterotergites.

***Distribution*.** — The nominate subspecies was originally described from Sumatra (Montandon, 1909), and subsequently recorded from Java, Borneo, the Philippines, Vietnam, Thailand, China, India and Langkawi Island in the Peninsular Malaysian state of Kedah (Lansbury, 1973; Zettel & Tran, 2009). The material reported below represents the first published records for Singapore and the Peninsular Malaysian states of Selangor, Perak and Malacca. A second subspecies, *C. brevipes australis*, occurs along the tropical margins of extreme northern Australia (Lansbury, 1975).

***Discussion*.** — Easily distinguished from both *C. asiaticus* and *C. compositus* by its shorter and stouter form (Fig. 7), the absence of a tubercle on the head vertex, and the differently shaped male paramere (Fig. 3). This species is relatively uncommon in collections, especially in comparison to the widespread *C. asiaticus*, but is present at a number of localities throughout Singapore in areas of remnant original forest.

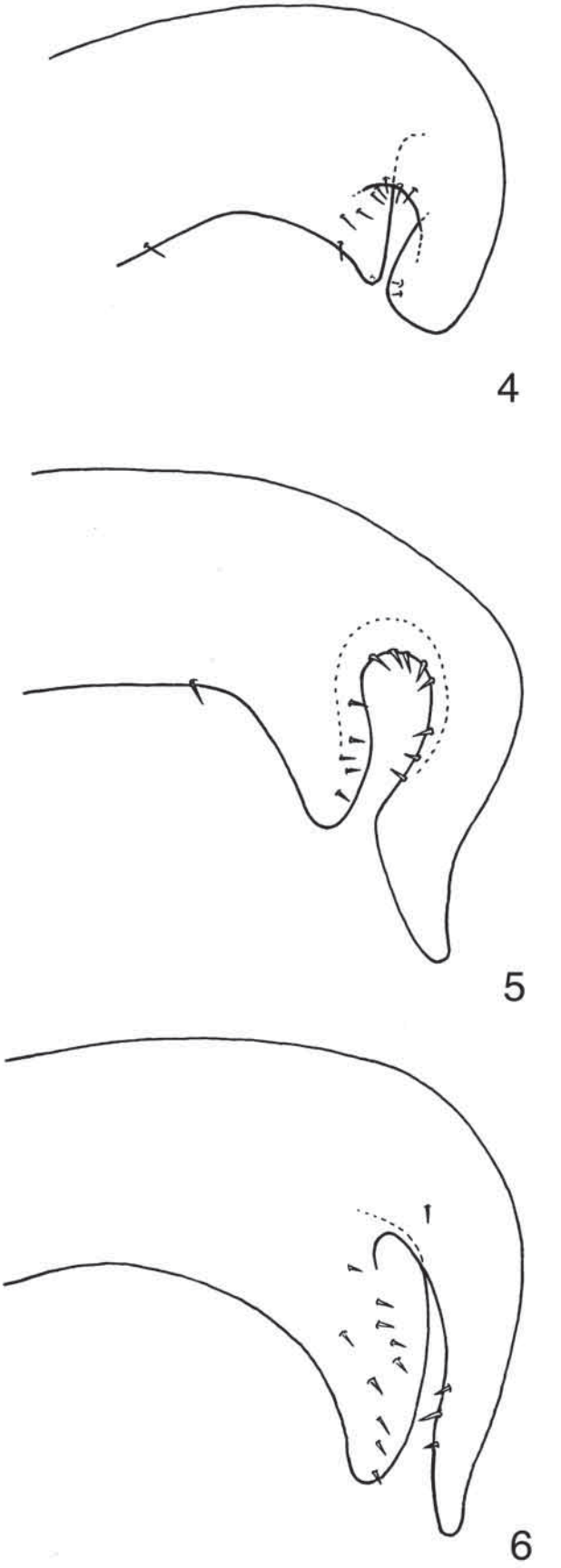
Cercotmetus compositus Montandon, 1903
(Fig. 5)

Cercotmetus compositus Montandon, 1903: 109

***Material examined*.** — MALAYSIA, **Terengganu**: 1 male, 1 female, N. of Rantau Abang, swamp at Km. 56 on road from Kuala Terengganu to Kuantan, 18 Mar.1992, coll. P. Ng, LHK 177 (ZRC); 4 females, N. of Ayer Puteh, about 121 km. on road from Kuantan to Kuala Terengganu, 19 Mar.1992, coll. H. K. Lua, LHK121 (ZRC); 4 males, 3 females, Rantau Abang, 15 May 1995, coll. H. H. Tan, THH9518 (ZRC). **Johor**: 2 males, 2 females, murky water tributary of Sungai Kahang, 10 Mar.1998, coll. H. H. Tan et al., THH9814 (ZRC); 1 male, 1 female, swamp forest stream 61 km. N. of Johor Bharu on Mersing Road, 16 Oct.1986, CL 2220. coll. D. A. & J. T. Polhemus (JTPC); 1 female, swamp forest stream 12 km. N. of Labis, nr. Ayer Panas, 22 Aug.1985, CL 2087, coll. D. A. & J. T. Polhemus (JTPC).

***Extralimital material examined*.** — INDONESIA, **Palembang Prov.**: 1 male, 1 female, Sumatra, Sungai Simpang, small trib. entering Sungai Niru from E. immediately upriver from Muaranira, 22 Feb.1995, coll. M. Kottelat (ZRC). **Jambi Prov.**: 1 female, Sumatra, Sungai Bakong, trib. to Danau Arang Arang, swamp forest, 1°37'31"S, 103°47'21"E, 25 Jul.1997, THH9743, coll. H. H. Tan (ZRC); 2 females, Sungai Sentang, 12 km. SE of Jambi, nr. Desa Sukajaya, 27 Jul.1997, THH9744, coll. H. H. Tan (ZRC); 2 males, 5 females, Sumatra, Sungai Alai, 21 Jun.1995, JMB9511, coll. unk. (ZRC). VIETNAM, **Quang Tri Prov**.: 1 male, 1 female, 1 mi. N. of Quang Tri, from stream, vigorous sweeping in vegetation, 15 Jun.1970, coll. A. R. Gillogly (JTPC).

***Diagnosis*.** — Male body length 48–53 mm, length of respiratory siphon 13–16 mm; female body length 50–60 mm, length of respiratory siphon 14–16 mm. Head with interocular space usually less than the width of an eye, tuberculate between eyes. Mesosternum not carinate, depressed anterior of the middle coxae. Fore femur with single large tooth at mid-distance along the margin adjacent to the infolded tibia;



Figs. 4–6. *Cercotmetus* species, male parameres. 4, *C. brevipes*, specimen from Vietnam, Quang Tri Prov. 5, *C. compositus*, specimen from Malaysia, Johor (CL 2220). 6, *C. asiaticus*, specimen from Vietnam, Gia Lai Prov. (CL 4286).

middle femur about one-third longer than prothorax. Male paramere deeply bifid apically, this incision separating a slender, sinuate distal process from a more basal angulate process (Fig. 5). Female with operculum narrow and sharply carinate, not extending beyond posterior apices of flanking ventral laterotergites.

Distribution. — Originally described from Indochina (composite series from Laos and Thailand) (Montandon, 1903) and subsequently reported from Vietnam and Sumatra (Lansbury, 1973). The Peninsular Malaysian material reported below fills a gap in the previously documented distribution, and represents the first definitive set of published records for this area, although it is possible that the Peninsular Malaysian records of *Cercotmetus pilipes* Dallas provided in Fernando & Cheng (1974) are also referable to this species. Despite occurring on both Sumatra and in Peninsular Malaysia, this species has not been recorded from intervening Singapore, although suitable habitats are present here.

Fig. 7. *Cercotmetus brevipes* Montandon, female, specimen from Thailand, Chiang Mai Prov.

Discussion. — This is the largest species of *Cercotmetus* occurring in Peninsular Malaysia, with male body lengths reaching up to 53 mm, and females up to 60 mm. It is similar to *C. asiaticus* in having a tuberculate vertex and a middle femur longer than the prothorax, but differs in lacking a metasternal keel, having a differently shaped male paramere (compare Figs. 5, 6), and possessing a short female operculum that does not extend posteriorly beyond the flanking abdominal ventral laterotergites. Additional characters separating this species from *C. asiaticus* include the generally dark colouration (versus yellowish brown in *C. asiaticus*), and the prominent brushes of long hairs ventrally at the apices of both the middle and hind femora. Like *C. brevipes*, this is an uncommonly collected species that seems to be patchy in its distribution.

Genus *RANATRA* Fabricius, 1790

(Figs. 8–29)

Discussion. — Members of this genus are elongate, yellowish-brown colored insects that are usually found along the margins of lentic ecosystems amid tangles of submerged sticks and weeds, which they closely resemble. The genus is pantropical in distribution, with 123 species currently recognised (exclusive of subspecies), of which 69 occur in the New World, and 54 in the Old World, with no species shared between the two hemispheres (J. Polhemus & D. Polhemus 2008). This genus was revised for Southeast Asia by Lansbury (1972), with subsequent descriptions of new species from the region by Nieser & Chen (1991), Nieser (1996, 1997), Zettel (1999), Chen et al. (2004), Tran & Polhemus (2012) and D. Polhemus & J. Polhemus (2013), and additional records from China provided by Nieser et al. (2005).

KEY TO THE SPECIES OF *RANATRA* OCCURRING IN SINGAPORE AND PENINSULAR MALAYSIA

(modified from Lansbury, 1972)

1. Head with prominent, keel-like tubercle on vertex between the eyes (Fig. 9).....2
– Head lacking prominent, keel-like tubercle on vertex between the eyes (Fig. 10); if a tubercle present, then small and nodular, prominent and not keel-like 4
2. Respiratory siphon short, approximately one-third the length of the abdomen; male paramere with distal hook and subapical tumescence separated by a narrow incision (Figs. 11–14) (*R. gracilis* species group) 3
– Respiratory siphon longer than the length of the abdomen; male paramere with distal hook and subapical tumescence separated by a broad incision (Figs. 15, 16).....*R. spinifrons* Montandon

3. Ventral prothoracic keel present between fore coxae but then becoming obsolescent posteriorly; body length (excluding siphon) 30–37 mm; middle femur shorter than hind femur; apex of male paramere with distal hook and subapical tubercle separated by a narrow incision, touching at their apices or nearly so (Figs. 13, 14).....*R. parmata* Mayr

Fig. 8. *Ranatra longipes* Stål, female, specimen from Indonesia, Java, Bogor.

– Ventral prothoracic keel running posteriorly from between fore coxae almost entire length of prothorax; body length (excluding siphon) 28–29 mm; middle and hind femora subequal in length; apex of male paramere with distal hook and subapical tubercle separated by a broader incision, apices not touching (Figs. 11, 12)..... *R. gracilis* Dallas

4. Largest tooth on fore femur lying more or less equidistant between base and tip of femur (Fig. 29; *R. varipes* species group).....*R. varipes* Stål
– Largest tooth on fore femur lying clearly nearer to the distal end of the femora than to the base (Figs. 27, 28; *R. biroi* species group).....4

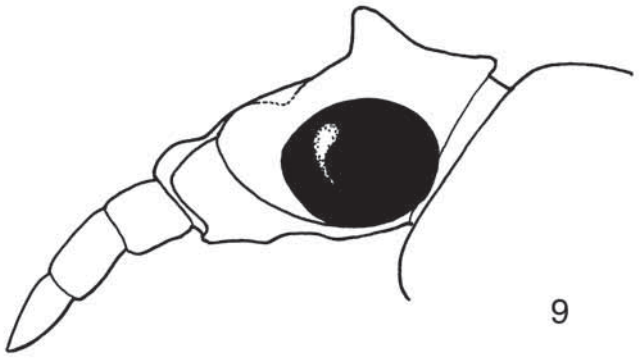
5. Posterior apex of mesosternum pointed or rounded; width of fore femur measured from dorsal margin to apex of largest tooth less than the widest part of the femur basally (Fig. 27)..... 5
– Posterior apex of mesosternum truncate; width of fore femur measured from dorsal margin to apex of largest tooth subequal to or greater than the widest part of the femur basally (Fig. 28).....*R. rafflesi* Tran & D. Polhemus

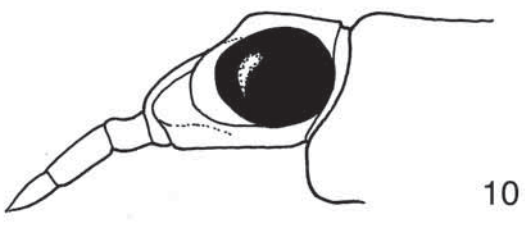
6. Hind tibia distinctly longer than middle tibia; male paramere with a small tooth at apex of distal hook (Figs. 19, 20) ....*R. longipes* Stål
– Middle and hind tibiae subequal in length; male paramere without a small tooth at apex of distal hook (Figs. 21, 22) ....*R. thai* Lansbury

***Ranatra parmata* Mayr, 1865**
(Figs. 13, 14)

Ranatra parmata Mayr, 1865: 446

Material examined. — SINGAPORE: 1 female, Sime Road, 20 Jan.1995, coll. D. H. Murphy & P. K. L. Ng (ZRC); 1 female, Lorong Banir, 24 May 1994, NS141B, coll. unk. (ZRC); 1 male, Bukit





Figs. 9–10. *Ranatra* species, left lateral view of head. 9, *R. parmata*, specimen from Indonesia, Sumbawa (CL 2172). 10, *R. thai*, specimen from Thailand, Chiang Mai Prov. (CL 2201).

Kallang, 6 May 1994, NS129B, coll. unk. (ZRC). MALAYSIA, **Johor**: 1 female, swamp forest stream 15 km. W. of Sedili Besar, 20 m., 16 Oct.1986, CL 2218, coll. D. A. & J. T. Polhemus (JTPC). **Selangor**: 1 male, North Selangor peat swamp forest, stream at 34 km. marker on road to Tanjung Malim, 17 Jun.1991, ZRC 6-15706, LHK 154, H. K. Lua (ZRC) **Perak**: 1 female, Sungai Chebu, 6 Mar.1963, coll. unk. (ZRC); 1 male, 2 females, small shaded stream in disturbed primary forest, 34 km. E. of Grik, 20 Aug.1985, CL 2079, coll. D. A. & J. T. Polhemus (JTPC).

Extralimital material examined. — INDONESIA, **Sumatera Utara Prov**.: 2 males, Kab. Tapanuli Utara, Kec. Parlilitan, small rushing stream in rock bed, 3 km. E. of Parlilitan, 900 m., 10 Nov.1985, CL 2191, coll. D. A. & J. T. Polhemus (JTPC). **Kalimantan Timur Prov.**: 3 males, 2 females, Borneo, small waterfall 4 km. NE of Kota Bangun, 27Aug.1985, CL 2095, D. A. & J. T. Polhemus (JTPC). **Nusa Tenggara Barat Prov**.: 1 male, 2 females, Lombok, Aik Jut River, 1 km. N. of Sesaot, 30 km. NE of Mataram, 350 m., 23 Oct.1985, CL 2178, coll. D. A. & J. T. Polhemus (JTPC); 8 males, 6 females, Sumbawa, Kab. Bima, Bela River, 12 km. N. of Kuta, 28 km. SW of Bima, 100 m., 19 Oct.1985, CL 2172, coll. D. A. & J. T. Polhemus (JTPC). **Nusa Tenggara Timur Prov**.: 3 males, 1 female, Sumba, Kambahapang River, 59 km. SW of Waingapu, 530 m., water temp. 25°C., 14 Sep.1991, CL 2599, coll. D. A. & J. T. Polhemus (JTPC). LAOS, **Bokeo Prov**.: 1 male, Tonpheng [Ton Pheung Dist.], 31 Mar.1966, coll. native collector (BPBM); 1 female, same data as preceding but 15 Apr.1966 (BPBM). ANDAMAN ISLANDS: 1 male, Doligung, S/AND 11, 8 Dec.1976, F. Starmuhlner (JTPC).

Diagnosis. — Male body length 30–33 mm, length of respiratory siphon 10–12 mm; female body length 34–37 mm, length of respiratory siphon 10–13 mm. Colouration brown, with legs often bearing alternating annulations of light and dark brown. Head with frons strongly tuberculate between the eyes. Ventral prothorax with a broad, shallow longitudinal sulcus, closed distally, anterior third of this sulcus bearing weak longitudinal carina. Fore femur with single large tooth near midpoint of margin contacting infolded tibia; middle femur slightly shorter than hind femur; hind femur reaching halfway along abdominal sternite VI in both sexes. Male paramere with a deep, narrow incision subapically, separating a distal hook from a large, rounded subapical lobe with small tubercle, apex of distal hook curving back so as to contact subapical lobe or nearly so (Figs. 13, 14).

Distribution. — Originally described from Java (Mayr, 1865), and subsequently recorded from Sumbawa, Sumba, Nias, Thailand, Laos, the Andaman Islands and Langkawi Island in the Peninsular Malaysian state of Kedah (Lansbury, 1972; J. Polhemus & Starmühlner, 1990; Zettel & Tran, 2009). The material reported below includes the first published records for Sumatra, Lombok, Singapore, and the Peninsular Malaysian states of Johor, Selangor, and Perak.

Discussion. — A moderate-sized *Ranatra* species, immediately recognisable by the tuberculate frons, relatively short respiratory siphon in relation to the body length, and the distinctive shape of the male paramere (Figs. 13, 14). The Singapore and Peninsular Malaysian specimens show variation in size but uniformity in male paramere structure, with the subapical lobe of the male paramere more acute than shown in Lansbury (1972). These specimens will, however, run to *R. parmata* in Lansbury's (1972) key based on the posteriorly obscure longitudinal carina on the prosternum. Given this mix of character states, the Singaporean and Malaysian populations may represent a distinct taxon, but a full review of species concepts in the *R. gracilis* group (to which *N. parmata* belongs) is beyond the scope of the current paper, so all specimens from the region under study that run to *R. parmata* in the current key are retained under that name for the present.

Ranatra gracilis Dallas, 1850
(Figs. 11, 12)

Ranatra gracilis Dallas, 1850: 10

Material examined. — MALAYSIA, **Selangor**: 1 male, Kuala Lumpur, 1950, coll. Army Scrub Typhus Unit (USNM).

Extralimital material examined. — THAILAND, **Chiang Mai Prov**.: 4 males, 3 females, Fang Dist., Huay Hia Creek, Fang Horticultural Station, 500 m., 15 Nov.1985, CL 2198, coll. D. A. & J. T. Polhemus (JTPC); 1 male, Chiangdao, 450 m., 5–11 Apr.1958, coll. unk. (BPBM). VIETNAM, **Lai Chau Prov**.: 2 males, small tributary streams to Lai River at Lai Châu, 230 m., 22°02'35"N, 103°10'03"E, water temp. 23°C., 10 Apr.2000, 1600–1800 hours., J. T. Polhemus & P. Nguyen (JTPC). LAOS, **Khammouane Prov**.: 1 male, Phon Tiou, 11 Jun.1965, coll. N. Wilson (BPBM). **Vientiane Prov.**: 1 male, Van Heue [Ban Van Heue], 16 Mar.1966 (BPBM).

Diagnosis. — Male body length 28–29 mm, length of respiratory siphon 10–11 mm; female body length 29–30 mm, length of respiratory siphon 8–9 mm. Colouration, including legs, uniformly brown. Head with frons strongly tuberculate between the eyes. Ventral prothorax with a very shallow longitudinal sulcus, lateral margins of this sulcus weakly raised posteriorly, a prominent medial longitudinal carina present along entire length. Fore femur with single moderately small tooth near midpoint of the margin adjacent to the infolded tibia; middle and hind femora subequal in length; hind femur reaching to near tip of wing membrane in both sexes. Male paramere with a broad, curving incision subapically, separating a distal hook from a large, rounded subapical lobe with small tubercle, apex of distal hook well separated from subapical lobe and not contacting it (Figs. 11, 12).

Distribution. — Originally described from Bhutan (Dallas, 1850), with subsequent records from India (Assam), Thailand, and Peninsular Malaysia (Lansbury, 1972). We provide the first records herein for Laos and Vietnam.

Discussion. — *Ranatra gracilis* is superficially similar in size and general external appearance to *R. parmata*, but may be separated by its slightly smaller size, better developed ventral prothoracic keel, and the shape of the male paramere apex (Figs. 11, 12), which is armed with blade-like setae. This species is rare in collections, and is recorded from Peninsular Malaysia on the basis of only a single specimen, which was listed by Lansbury (1972) and also re-examined in the course of the current study.

Ranatra spinifrons Montandon, 1905
(Figs. 15, 16)

Ranatra stali Montandon, 1905: 390 (in part)
Ranatra stali var. *spinifrons* Montandon, 1910: 166
Ranatra spinifrons Montandon, 1914: 124

Material examined. — MALAYSIA, **Selangor**: 1 male, North Selangor swamp forest, stream at 34 km. marker on road to Tanjung Malim, 6 Jun.1991, ZRC.6.15525, coll. ZRC 1991–1992 Zool. Honours Class (ZRC).

Diagnosis. — Male body length 34 mm; length of abdomen 22 mm, length of respiratory siphon 28 mm. Colouration, including legs, uniformly brown. Head with frons strongly tuberculate between the eyes. Anterior lobe of prothorax with a pair (1+1) of small, elevated nodules to either side of midline immediately behind head vertex; posterior lobe of prothorax with a pair (1+1) of roughly triangular tumescences widely separated on either side of midline; ventral prothorax with raised longitudinal carina on anterior half. Fore femur with single moderately small tooth near the midpoint of the margin adjacent to the infolded tibia; middle femur slightly shorter than hind femur, respective lengths 16.70/17.50; hind femur when folded back reaching to base of operculum. Male paramere with a broad, moderately deep incision subapically, separating a long, thick, apically truncate distal hook from an angulate subapical lobe (Figs. 15, 16).

Distribution. — Originally described from two specimens, one taken in the Moluccas (Ternate) and the other from Borneo (Montandon, 1910), and not recorded since. The specimen listed below is the first record for Peninsular Malaysia.

Discussion. — This is a rare and unusual species that is easily recognized by the unique character state combination of a prominent tubercle on the head vertex coupled with a long respiratory siphon, and by the distinctively shaped male paramere (Figs. 15, 16), which is most similar to that of *R. stali* Montandon from the Philippines.

Lansbury (1972), in his revision of Oriental *Ranatra*, did not figure *R. spinifrons*, nor did he examine either of the two specimens recorded in the literature. In his brief discussion, he indicates that he considered the Ternate specimen lost, whereas the Borneo specimen was still present in the Genoa Museum. We have not had the opportunity to examine either of these, and given the absence of comparative material have provisionally assigned the distinctive specimen from Selangor listed above to *R. spinipes* based on its salient features, but with the realization that it may eventually prove to represent yet another new species putatively allied to *R. stali*. In particular, the original description by Montandon (1910) states that the respiratory siphon in *R. spinifrons* is two-thirds as long as the abdomen, whereas in the Selangor specimen at hand the length of the siphon (28 mm) is longer than the length of the abdomen (22 mm), thereby raising some question as to whether this Peninsular Malaysian specimen is truly conspecific with those taken further to the east.

Ranatra varipes Stål, 1861
(Figs. 17, 18, 29)

Ranatra varipes Stål, 1861: 203

Material examined. — SINGAPORE: 1 female, Upper Selatar Reservoir, 13 Oct.1986, CL 2213, coll. D. A. & J. T. Polhemus (JTPC); 1 male, Kranji Reservoir, 19 Jun.2008, coll. A. D. Tran, TAD0839 (ZRC); 1 male, 1 immature, Lower Peirce Reservoir, 15 May 2008, coll. A. D. Tran, TAD0819 (ZRC); 1 female, Bukit Timah Nature Reserve, 13 Dec.1995, coll. T. Wong & H. K. Lua, NS214 (ZRC); 1 male, 1 female, Selatar Reservoir, Mandai Lake Road, 16 May 1994, NS134A, coll unk. (ZRC). MALAYSIA, **Johor**: 2 males, 2 females, Muar, Bukit Pasir, 24 Jun.1998, coll. Y. Y. Goh (ZRC); 1 male, 1 female, Pontian, Pekan Nanas, 14 Mar.1999, DW99-04, coll. Y. Cai & D. Wowor (ZRC). **Selangor**: 1 female, North Selangor peat swamp forest, stream at 50 km mark to Tanjung Malim (United Palm Bhd.), 18 Jun.1991, coll. unk. (ZRC). **Penang**: 3 males, 2 females, Penang, 9 Jun.1993, coll. H. H. Tan & S. H. Tan (ZRC). **Perlis**: 1 male, 1 female, Sintok–Pahang, 19 Feb.1997, coll. H. K. Lua, LHK329 (ZRC). **Perak**: 1 male, Sungai Kenderong at Gerik, 17 Feb.1997, coll. H. K. Lua, LHK0324 (ZRC).

Extralimital material examined. — THAILAND, **Chiang Mai Prov.**: 1 female, Fang Dist., ponds at Fang Horticultural Station, 500 m., 15 Nov.1985, CL 2201, coll. J. T. and D. A. Polhemus (JTPC). **Nakhon Ratchasima Prov**.: 1 male, 1 female, Sakaerat Exp. Sta., 60 km. S. of Nakhon Ratchasima, 300–600 m., 14°30'N, 101°55'E, 2–4 Mar.1971, coll. P. & P. Spangler (USNM). VIETNAM, **Dong Ngai Prov**.: 3 males, 1 female, Nam Cat Tien National Park, Crocodile Lake, 100 m., water temp. 31°C., 5 May 1998, CL 3071, coll. J. T. Polhemus (JTPC). LAOS, **Khammouane Prov**.: 1 male, Phon Tiou, 11 Jun.1965, coll. N. Wilson (BPBM).

Diagnosis. — Male body length 20–25 mm, length of respiratory siphon 16–19 mm; female body length 20–27 mm, length of respiratory siphon 15–19 mm. Colouration medium brown, femora mottled with light and dark brown. Head with vertex rounded, not tuberculate or raised above eyes. Ventral prothorax with a prominent medial longitudinal carina present along entire length. Fore femur short and thick, with a large broad, angular tooth near midpoint of the margin adjacent to the infolded tibia and a much smaller angular tooth slightly distal to the midpoint on this same margin (Fig. 29), with the tibia resting between them when closed; hind femora in both sexes reaching beyond posterior margin of abdominal sternite VI. Male paramere with a narrow and shallow incision subapically, isolating a large, highly expanded, blade-like distal process from a very small, obtusely angulate subapical lobe (Figs. 17, 18).

Distribution. — Originally described from Java, and subsequently recorded from Singapore and Peninsular Malaysia (Malacca, Perak, Selangor, Penang), Sumatra, Vietnam, Burma, India, and Ceylon (Lansbury, 1972; Fernando & Cheng, 1974). The material listed below includes the first published records for the peninsular Malaysian states of Johor and Perlis, and the country of Laos.

Discussion. — This species may be easily recognised by its relatively short and stout fore femur, with a broadly angulate tooth located near the center of the posterior face plus a

much smaller angulate tooth proximal to the larger tooth (Fig. 29); and by the very large, blade-like distal process on the male paramere (Figs. 17, 18). It is less common in collections from Singapore and Peninsular Malaysia than *R. thai*, but has been taken syntopically with the latter species at a number of localities.

The life history of *R. varipes* was studied by Chowanadisai et al. (1983), who noted that the species was an efficient predator of mosquito larvae.

Ranatra longipes longipes Stål, 1861

(Figs. 8, 19, 20, 25, 27)

Ranatra longipes Stål, 1861: 203
Ranatra longipes longipes: Lansbury, 1972: 332

Material examined. — The following additional records are in addition to those listed in Tran & Polhemus (2012): MALAYSIA, **Johor**: 1 male, Sungai Kayu, 12 Mar.1998, H. H. Tan & O. S. K. Chia, THH9823 (ZRC); 1 male, 1 female, Mawai, 27 Mar.1992, ZRC 6.22212, coll. unk. (ZRC).

Extralimital material examined. — The following extralimital records are in addition to those listed in Tran & Polhemus (2012): MALAYSIA, **Sabah**: 2 males, Borneo, Sungai Kinabatangan, puddle nr. Danau Biandum Besar, 11 Apr.1994, coll. H. K. Lua & C. Y. Chang (ZRC). **Sarawak**: 3 females, Borneo, Sibu, Sungai Teku, 15 May 1994, MK94-23, coll. unk. (ZRC). INDONESIA, **Sumatera Barat Prov**.: 10 males, 10 females, Sumatra, Bukittingi, Lawang, 5 Jul.1992, W. G. Ullrich (USNM).

Diagnosis. — Male body length 21–26 mm, length of respiratory siphon 16–22 mm; female body length 24–27 mm, length of respiratory siphon 16–22 mm. Colouration medium brown, legs in some specimens weakly annulate with lighter brown. Head with vertex slightly raised above the eyes, sometimes with small incipient tubercle. Ventral prothorax with a prominent medial longitudinal carina present along entire length. Fore femur long and slender with two teeth distal to midpoint on the margin adjacent to the infolded tibia, consisting of a moderate sized tooth on outer face and a smaller tooth on inner face (Fig. 27); middle tibia longer than both middle and hind femora; hind tibia distinctly longer than middle tibia; hind femora in both sexes slightly exceeding operculum. Male paramere with a moderately narrow and deep incision subapically, isolating an apically expanded and weakly toothed distal hook; subapical lobe absent or at best barely suggested (Figs. 19, 20).

Distribution. — The nominate subspecies of *R. longipes* was described from Java (Stål, 1861), with subsequent records from Sumatra (Lundblad, 1933), Borneo (Lansbury, 1972), Peninsular Malaysia (Fernando & Cheng, 1974), and Sulawesi (Nieser & Chen, 1991); the latter authors also made passing reference to specimens from Bali, but provided no specific data. Lansbury (1972) also described the subspecies *R. longipes thai* from Thailand (later elevated to full species status by Tran & D. Polhemus, 2012) and *R. longipes celebensis* from the southwestern peninsula of Celebes. As discussed by Tran & D. Polhemus (2012) most if not all of the Malaysian records of *R. longipes longipes* north of Johor represent *R. thai* Lansbury. Based on currently understood distributional patterns, it now appears that *R. longipes* is a predominantly insular species occurring on the Greater Sunda Islands and immediately adjacent smaller islands eastward to Sulawesi, with the westward limits of its range being reached in the extreme southern Peninsular Malaysia and Singapore. Detailed distribution data for the nominate subspecies were provided by Tran & D. Polhemus (2012), who listed further records from Singapore, Malaysia (Johor and Sabah), and Indonesia (Java, Sumatra, and Borneo).

Discussion. — *Ranatra longipes* is a relatively slender, delicate species, with males noticeably smaller in size than females. It may be separated from the very similar *R. thai* by the structure of the distal hook on the male paramere (compare Figs. 19, 20 to 21, 22), and by the longer hind tibia in relation to the middle tibia. The male genitalic figures attributed to this species in Chen et al. (2005, pg. 53, figs. 34, 35) in fact represent *R. thai* (see below).

Ranatra thai Lansbury, 1972

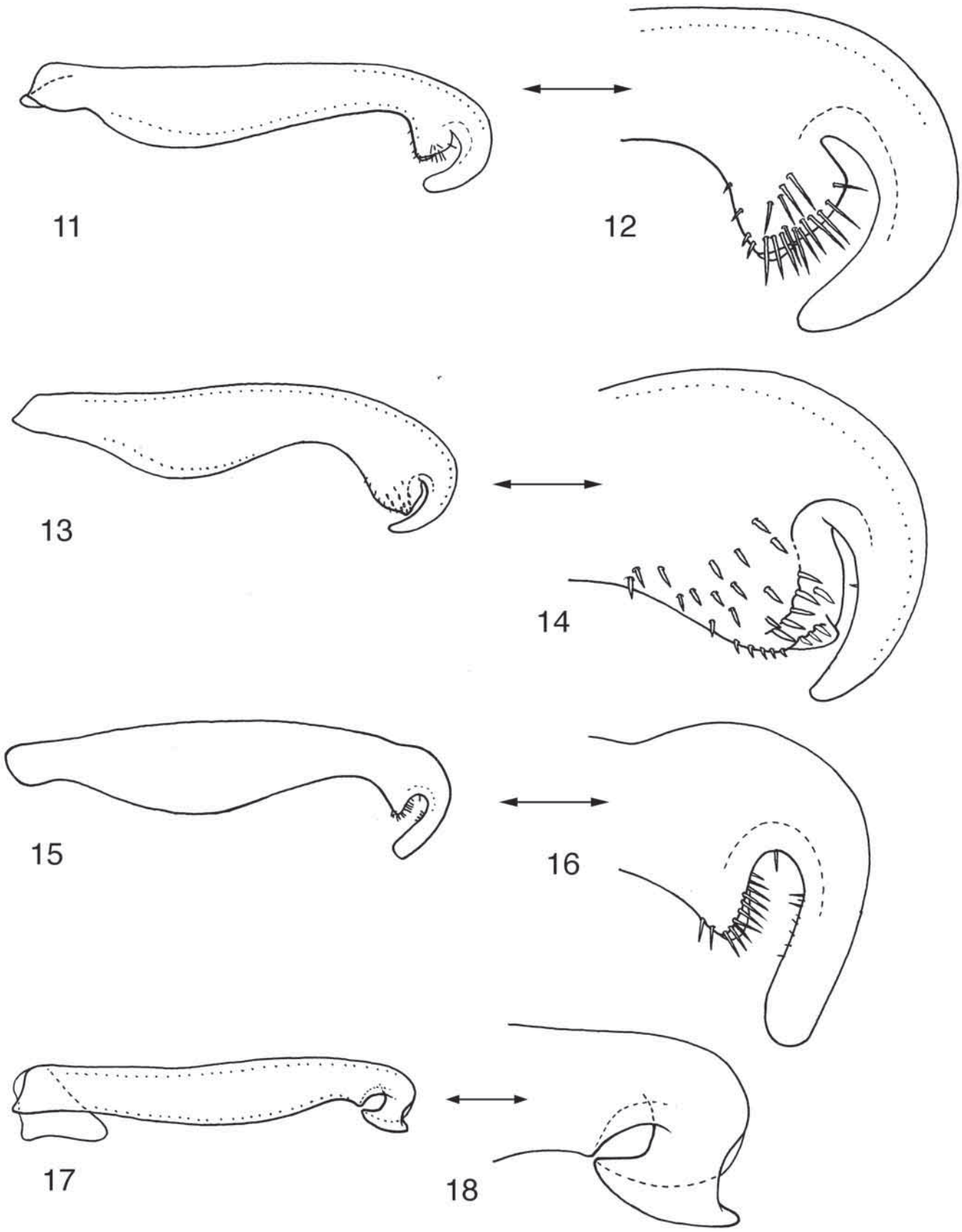
(Figs. 10, 21, 22)

Ranatra longipes thai Lansbury, 1972: 334
Ranatra thai: Tran & D. Polhemus, 2012: 102

Material examined. — The following additional records are in addition to those listed in Tran & Polhemus (2012): MALAYSIA, **Johor**: 2 males, 3 males, Pontian, stream along road to Pekan Nanas, 15 Aug.1995, coll. H. K. Lua (ZRC); 2 males, 1 female, Layang Layang stream 1, muddy water with vegetation on side, 6 Feb.1991, coll. NUS staff (ZRC). **Perak**: 1 male, near Sungai Bernam headwater works, 16 Jun.19919, coll. H. K. Lua, LHK160 (ZRC).

Diagnosis. — Male body length 21–24 mm, length of respiratory siphon 18–24 mm; female body length 22–27 mm, length of respiratory siphon 18–24 mm. Colouration including legs medium brown. Head with vertex raised centrally (Fig. 10), sometimes with a small nodular tubercle in males. Ventral prothorax with a prominent medial longitudinal setiferous carina present along entire length. Fore femur long and slender, with two teeth distal of midpoint on the margin adjacent to the infolded tibia, consisting of a moderate sized tooth on outer face and a smaller tooth on inner face (similar to Fig. 27); middle and hind tibiae subequal in length, both longer than both middle and hind femora; hind femora in both sexes when folded back along body slightly exceeding apex of operculum. Male paramere with a moderately broad and deep incision subapically, isolating a distal hook that is only weakly expanded distally and not weakly toothed; subapical lobe absent (Figs. 21, 22).

Distribution. — Originally described from Thailand (Lansbury, 1972) and subsequently recorded from Langkawi Island in the Peninsular Malaysian state of Kedah (Zettel & Tran, 2009). Additional records for the Peninsular Malaysian states of Terengganu, Selangor, Pahang, Malacca, and Johor, as well as from further localities in Vietnam, and Thailand,



Figs. 11–18. *Ranatra* species, male left parameres, outer view with detail of distal hook. 11, 12, *R. gracilis*, specimen from Laos, Vientiane Prov. 13, 14, *R. parmata*, specimen from Indonesia, Sumbawa (CL 2172). 15, 16, *R. spinifrons*, specimen from Malaysia, Selangor. 17, 18, *R. varipes*, specimen from Laos, Khammouane Prov.

were provided by Tran & D. Polhemus (2012), and we provide new records from the Malaysian states of of Johor and Perak herein.

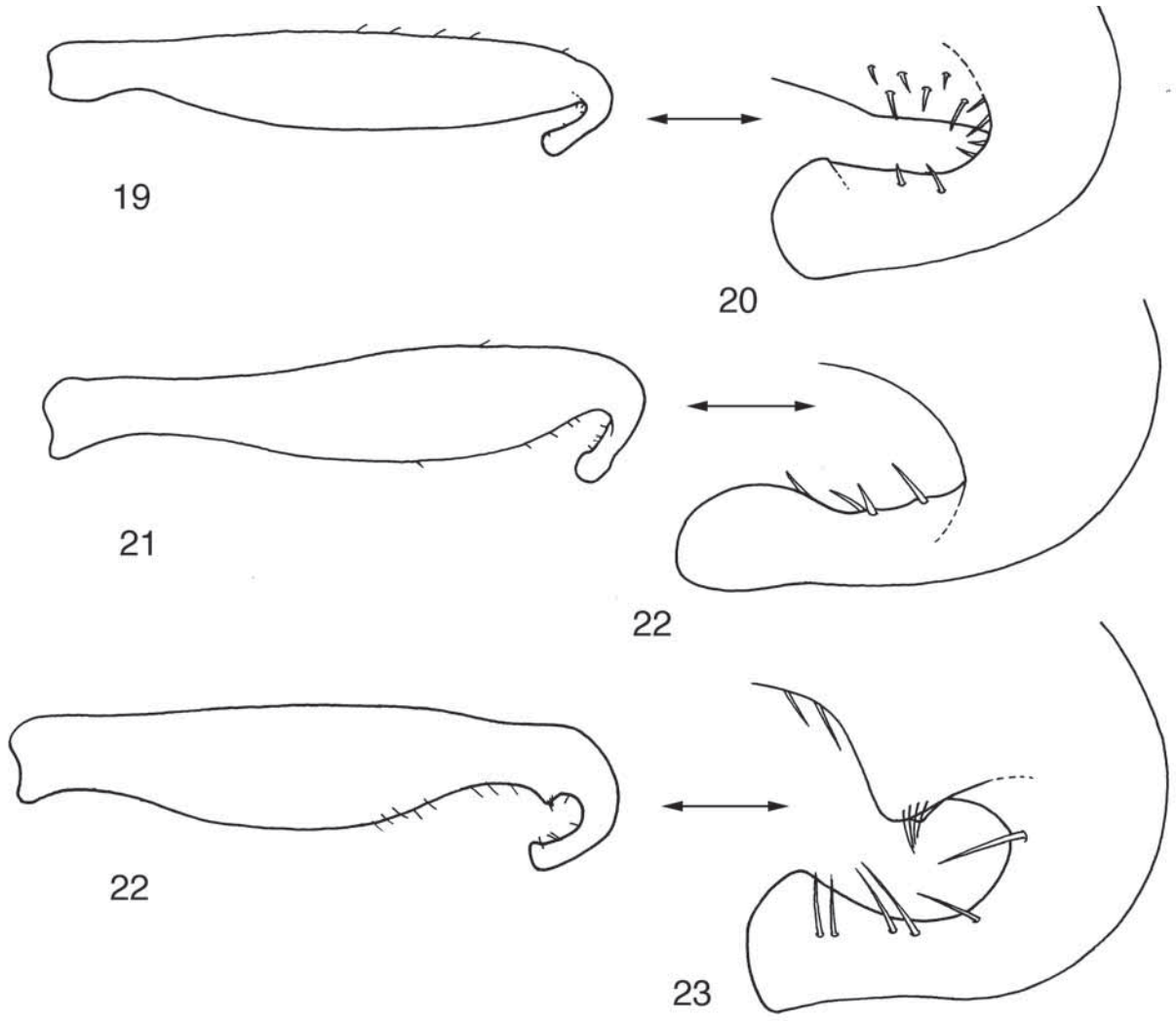
***Discussion*.** — Lansbury (1972) described the subspecies *Ranatra longipes thai* based on specimens from various localities in Thailand. Tran & D. Polhemus (2012), following a fine-scale analysis of male paramere structure, elevated Lansbury's subspecies to full species status. This is the most widespread and commonly encountered *Ranatra* species in Peninsular Malaysia north of Johor, but definitive separation from *R. longipes* requires measurement of leg segment ratios, or a genitalic dissection. In *R. thai* the distal hook of the male paramere lacks a small subapical tooth (compare Figs. 19, 20 to 21, 22), and the middle and hind femora are subequal in length, rather than the hind femur being distinctly longer than the middle femur as in *R. longipes*.

Ranatra rafflesi Tran & D. Polhemus, 2012
(Figs. 22, 23, 26, 28)

Ranatra rafflesi Tran & D. Polhemus, 2012: 104

***Material examined*.** — SINGAPORE: 3 males, 2 females, Upper Selatar Reservoir, 27–28 May 2008, A. D. Tran and A. Lok, TAD0830 (holotype and paratypes, ZRC and BPBM). INDONESIA, **Riau Islands Prov**.: 5 males, Batam [Riau Archipelago, Batam Is.], coll. C. M. Yang et al., 29 Jan.1992, NUS.6.15699–15703 (paratypes, ZRC); 1 male, 2 females, Riau Archipelago, Pulau Bintan North, coll. H. K. Lua, 26 Jun.1995, LHK259 (paratypes, ZRC).

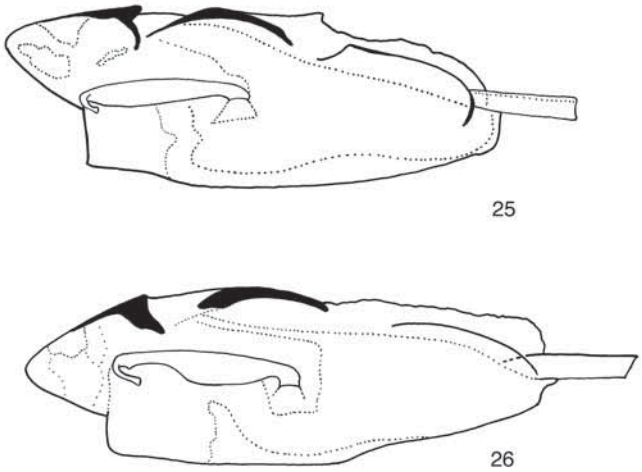
***Diagnosis*.** — Male body length 21–24 mm, length of respiratory siphon 19–23 mm; female body length 25–29 mm, length of respiratory siphon 20–24 mm. Colouration dark brown, legs paler, with yellowish patches on fore femora. Head with vertex slightly raised above the eyes into a low, conical tumescence. Ventral prothorax with a prominent medial longitudinal carina present along entire length. Fore femur long and slender with two sharply angulate teeth distal of the midpoint on the margin adjacent to the infolded tibia, consisting of a relatively large tooth on outer face and a smaller tooth on inner face (Fig. 28); middle and hind femora equal in length; hind tibia very slightly longer than middle tibia; hind femora in both sexes exceeding posterior apex of operculum. Male paramere with a broad, rounded incision subapically, isolating an apically expanded distal hook from a small, angulate subapical lobe (Figs. 22, 23).



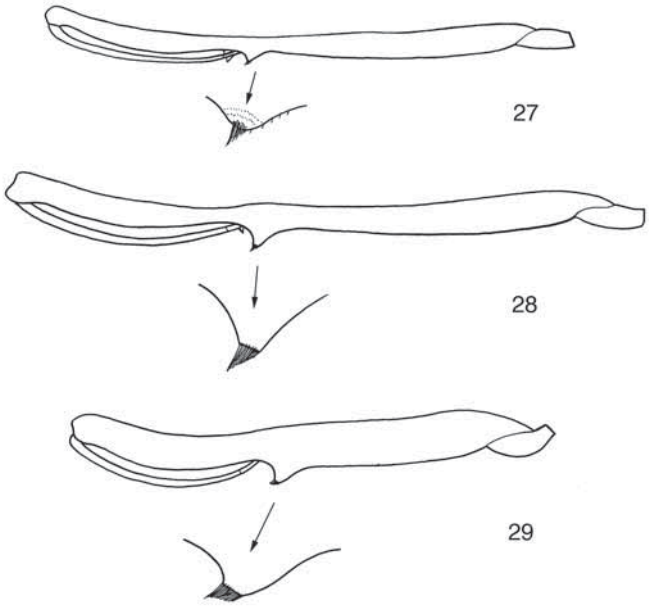
Figs. 19–24. *Ranatra* species, male left parameres, outer view with detail of distal hook. 19, 20, *R. longipes*, specimen from Singapore, Nee Soon. 21, 22, *R. thai*, specimen from Thailand, Chiang Mai Prov. (CL 2201). 23, 24, *R. rafflesi*, specimen from Singapore, Selatar Reservoir.

***Distribution*.** — Known from Singapore and the adjacent Indonesian islands of Bintan and Batam.

***Discussion*.** — *Ranatra rafflesi* may be separated from the superficially similar *R. longipes* and *R. thai* by the more open curve and flared apex of the distal hook on the male paramere (compare Figs. 23, 24 to Figs. 19–22), the more acute dorsal margin of the sclerotized distal section of the male phallotheca when viewed laterally (compare Figs. 25, 26), and the larger, more truncate tooth on the fore femur (compare Figs. 27, 28). *Ranatra rafflesi* may also be separated from the superficially similar *R. malayana* from Sulawesi and *R. natunaensis* from Natuna Island (west of Borneo) by its longer hind femora, which exceed the tip of the abdomen (excluding the respiratory siphon) in males and reach its posterior apex in females.



Figs. 25, 26. *Ranatra* species, male phallotheca, right lateral view. 25, *R. longipes*, specimen from Singapore, Nee Soon. 26, *R. rafflesi*, specimen from Singapore, Selatar Reservoir.



Figs. 27–29. *Ranatra* species, forelegs. 27, *R. longipes longipes*, specimen from Singapore, Nee Soon. 28, *R. rafflesi*, specimen from Singapore, Selatar Reservoir. 29, *R. varipes*, specimen from Laos, Khammouane Prov.

Subfamily NEPINAE Latreille, 1802

Genus *LACCOTREPHES* Stål, 1865
(Figs. 30–38)

***Discussion*.** — Members of the genus *Laccotrephes* are broad-bodied, dorso-ventrally flattened water scorpions, generally brown or grey in colouration, which resemble dead leaves (Fig. 30). The genus contains 66 currently recognised species (exclusive of subspecies) occurring throughout the Paleotropical and southern Palearctic regions, with the vast majority of species endemic to Africa (Polhemus & Polhemus, 2008). The four species of *Laccotrephes* occurring in Singapore and Peninsular Malaysia vary widely in size, from the large *L. pfeiferiae* (over 35 mm in body length) to the small *L. simulatus* (less than 20 mm in body length), and

Fig. 30. *Laccotrephes simulatus* Montandon, male, specimen from Malaysia, Johor.

generally inhabit standing pools amid submerged leaf litter. In certain cases multiple species may occur together in the same pool, such as at Mawai in Johor where *L. archipelagi*, *L. simulatus* and *L. longicaudatus* were found intermixed in the same sample. The most recent works on this group are those of Polhemus & Keffer (1999), Keffer (2004), Zettel (2008), and Nieser et al. (2009), but no current revision of this genus is available for Southeast Asia, making species determinations problematic within the genus as a whole.

KEY TO SPECIES OF *LACCOTREPHES* OCCURRING IN SINGAPORE AND MALAYSIA

1. Very large species, body length (excluding siphon) exceeding 35 mm, usually 40 mm or greater; prosternal keel with an angular projection set back slightly from anterior margin when viewed laterally (Fig. 31); male paramere with apex massive, hooked, acute (Fig. 38) ..... *L. pfeiferiae* (Ferrari)
– Moderate to small sized species with body lengths (excluding siphon) 32 mm or less.....2
2. Moderate sized species, body length (excluding siphon) 30–32 mm; prosternal keel with a broad, rounded projection anteriorly when viewed laterally (Fig. 32); male paramere with apex massive, hooked, apex blunt (Fig. 37)..... ..... *L. archipelagi* (Ferrari)
– Smaller species, body length (excluding siphon) less than 20 mm.....3
3. Prosternal keel flat when viewed laterally, lacking an angular anterior projection (Fig. 33); length of respiratory siphon less than or equal to that of the body; male paramere with a broad, blunt process distally (Fig. 36) ..... *L. simulatus* Montandon
– Prosternal keel with an angular projection anteriorly when viewed laterally (Fig. 34); length of respiratory siphon 1.5X that of the body; male paramere with a slender, acute process distally (Fig. 35).....*L. longicaudatus* Nieser, Zettel & Chen

Laccotrephes pfeiferiae (Ferrari, 1888)
(Figs. 31, 38)

Nepa robusta var. *pfeiferiae* Ferrari, 1888: 187
Laccotrephes robustus: Lundblad, 1933 (in part)
Laccotrephes pfeifferae: Nieser & J. Polhemus, 1998: 22, unjustified emendation
Laccotrephes pfieferae: J. Polhemus & Keffer, 1999: 2, unjustified emendation

Material examined. — SINGAPORE: 2 females, Nee Soon Swamp Forest, 16 Apr.1994, coll. P. K. L. Ng (ZRC); 1 male, 1 female, Bukit Timah Nature Reserve, 6 Dec.1995, coll. H. K. Lua et al. (ZRC); 1 male, 1 female, Nee Soon Swamp Forest, track from firing range to pumphouse, in mud paddies, 29 Jul.1993, coll. H. H. Tan & S. H. Tan (ZRC). MALAYSIA, **Johor**: 2 males, Kota Tinggi, eastern foothill of Gunung Panti (track 266), 22 Oct.1991, coll. P. K. Ng et al. (ZRC); 1 female, Johor, Kota Tinggi, Sungai Mupor, along Johor Bahru–Mersing road, 10 Mar. 1991, coll. P. K. L. Ng (ZRC). **Selangor**: 1 male, 1 female, 7 immatures, Genting Highlands, 14 Jan.2002, coll. T. M. Leong, THH0203 (ZRC); 3 males, 3 females, Kepong, Templer Park, 16 Jan.2002, coll. B. L. Lim, THH0206 (ZRC). **Perak**: 1 male, Sungai Kenderong at Gerik, 17 Feb.1997, LHK0324, coll. H. K. Lua (ZRC); 1 male, near Perlis State Park, 18 Dec.2000, LHK0438, coll. H. K. Lua (ZRC). **Pahang**: 1 male, Kuala Lipis, pool by mud track, 12 Apr.1997, YKL901M, coll. K. L. Yeo (ZRC); 1 male, Kuala Tahan, stream on Bukit Sumpur, 7 Jul.1957, coll. D. S. Johnson (ZRC); 1 female, Cameron Highlands, Tapah, 4 Jan. 1995, W. G. Ullrich coll. (USNM). **Terengganu**: 1 female, Sekuyu waterfall, 18 Mar.1992, LHK 178, coll. P. K. Ng et al. (ZRC). **Malacca**: 1 female, freshwater stream at Tanjung Bidara, in Camp Terendak, 6 Feb.1985, coll. P. K. L. Ng (ZRC).

Extralimital material examined. — BURMA, **Shan Division**: 1 male, Ywangan, tea plantation at foot of mountain, Sep. 1995, T. Subefelt (USNM). THAILAND, **Nakhon Ratchasima Prov**.: 1 female, Sakaerat Exp. Sta., 60 km. S. of Nakhon Ratchasima, 300–600 m., 14°30'N, 101°55'E, 2–4 Mar.1971, P. & P. Spangler coll. (USNM). LAOS, **Vientiane Prov**.: 4 males, 2 females, Ban Van Eue, 15 May 1966, native collector (BPBM); 1 male, Phou Kou Khouei, 31 Oct.1966, native collector (BPBM). **Sayaboury Prov**.: 1 male, Sayaboury, 5 May 1966, native collector (BPBM). **Khammouane Prov.**: 1 male, Phon Tiou, 7 Jun.1965, native collector (BPBM). VIETNAM, **Dak Nong Prov.**: 1 male, Dak Song, 76 km. SW of Ban Me Thuot, 870 m., 19–21 May 1960, light trap, S. & L. Quate (BPBM).

Diagnosis. — Male body length 35–47 mm, maximum width (across abdomen) 11–14 mm, length of respiratory siphon 34–39 mm. Female body length 36–45 mm, maximum width (across abdomen) 11–14 mm, length of respiratory siphon 32–40 mm. Colouration dark brown to black; all femora bearing a single irregular dark yellow annulation distally, a similar annulation present near base of fore femur; venter of abdomen rusty brown, spiracles dark yellow. Antennal segment III slightly shorter than segment II, outer margin bearing numerous long setae, the lengths of these setae approximately twice as long as the width of the segment, inner margin bearing a dense and regularly spaced row of shorter setae, these setae about one-half the width of the segment. Prosternal keel raised to form a somewhat acute tumescence set back slightly from anterior margin when viewed laterally (Fig. 31). Length of respiratory siphon less than the length of the body. Male paramere with apex bearing a massive, blunt, recurved distal hook with an acute apex (Fig. 38).

Distribution. — Originally described from India (Ferrari, 1888), and subsequently recorded from Thailand, Peninsular Malaysia, Sumatra, Java, Borneo, Sulawesi, the Lesser Sunda Islands, and China (Nieser & J. Polhemus ,1998; Chen et al., 2005). We provide new records from Laos, Burma, and Singapore, as well as the first specific records from the Malaysian states of Johor, Selangor, Perak, Pahang, Terengganu, and Malacca.

Remarks. — This is a very large, dark-colored *Laccotrephes* species that can be easily recognised within the regional fauna on the basis of size alone, as well as the characters provided in the diagnosis above. Based on comparison of holotypes, Nieser & Polhemus (1998) determined that *Laccotrephes* specimens formerly treated as *L. robustus* Stål from the Australasian region exclusive of the Philippines should be properly referred to *L. pfeiferiae* (Ferrari), and this was reflected in the distributional table provided in their paper. The status of *L. pfeiferiae* was further discussed by Polhemus & Keffer (1999), who provided a useful table of morphological comparisons within the *Laccotrephes grossus* group. As such, the *Laccotrephes* specimens from Singapore and peninsular Malaysia formerly treated as *L. robustus* (see Fernando &

Cheng, 1974) are treated herein under *L. pfeiferiae* (see also Zettel, 2008, Nieser et al., 2009).

Laccotrephes archipelagi (Ferrari, 1888)
(Figs. 32, 37)

Nepa archipelagi Ferrari, 1888: 183
Laccotrephes archipelagi: Chen et al., 2005: 411

Material examined. — MALAYSIA, **Johor**: 1 male, Mawai Sedili, 21 Aug.1960, coll. G. M. (ZRC); 2 males, 1 female, Mawai, Gunung Panti foothills, 2 Dec.1998, coll. H. K. Lua, LHK420 (ZRC); 1 female, Mawai Stream, 7 Jun.1989, P. Ng (ZRC); 1 male, 1 female, 6 mi. Sedili Road, new pond, 2 Mar.1960, coll. unk. (ZRC).

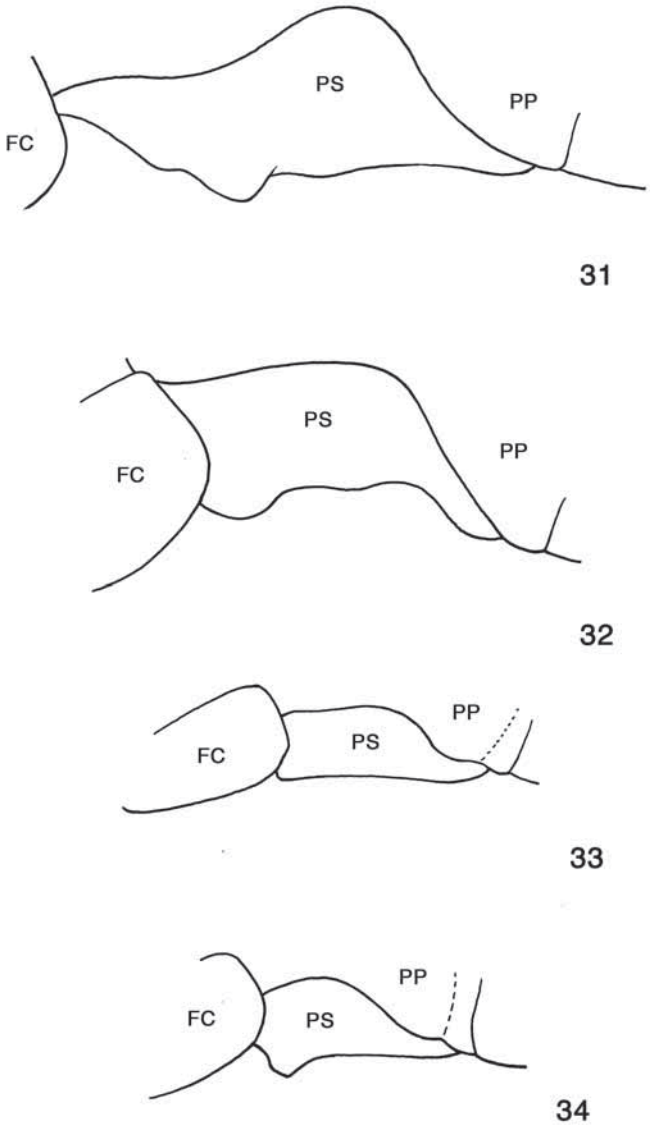
Extralimital material examined. — MALAYSIA, **Sarawak**: 1 female, Borneo, Serian, Sungai Kubas, 10 Jun.1999, THH9938, coll. H. H. Tan, (ZRC); 1 female, Borneo, Long Nawang, O. Borneo, coll. Mjoberg (JTPC); 1 female, Semangoh Forest Reserve, 15 mi. S. of Kuching, 20 Sep.1966, J. F. G. & T. M. Clarke coll. (USNM). INDONESIA, **Sumatera Utara Prov.**: 1 male, Sumatra, Tanjung Morawa, 19 Oct.1951, coll. unk. (JTPC). **Province uncertain**: 1 male, Java, 9167, coll. unk. (JTPC).

Diagnosis. — Male body length 30–32 mm, maximum body width (across hemelytra) 8–9 mm, length of respiratory siphon 26–29 mm. Female body length 35 mm, maximum body width (across hemelytra) 10 mm, length of respiratory siphon 32 mm. Colouration medium brown on head and prothorax, reddish brown on hemelytra with membrane dark brown, legs light brown to yellowish brown with faintly indicated, irregular transverse annulation centrally on fore femur. Antennal segment III about 0.8× the length of segment II, outer margin bearing ~20 long setae, the lengths of these setae 2.0–1.5× the width of the segment, becoming shorter distally; inner margin bearing numerous shorter setae, lengths of these setae about 0.80× as long as the width of the segment. Prosternal keel forming a broadly rounded tumescence when viewed laterally, posterior section level (Fig. 32). Length of respiratory siphon distinctly less than that of the body. Male paramere with apex forming a stout hook with a blunt apex (Fig. 37).

Distribution. — Originally described from Java (Ferrari, 1888), with additional specimens noted from Sumatra, Borneo, and "East India" (the latter possibly not conspecific), and subsequently recorded from Peninsular Malaysia (Fernando & Cheng, 1974, as *L. grossus*).

Discussion. — This species seems to have been consistently overlooked since its original description by Ferrari (1888), with no reference to it in the works of Montandon or Distant. Lundblad (1933), in the chapter on Nepidae in his treatment of the aquatic Heteroptera of Sumatra, Java and Bali provides a list of all the nepid species occurring in the Malay Archipelago region, but this list does not include *L. archipelagi*, which he apparently missed. In this same work Lundblad described *Laccotrephes occultus* from Sumatra, a species of similar form and dimensions to *L. archipelagi*, and provided a table comparing various morphological characters of his new species to those exhibited by *L. grossus* (Fabricius) and *L. tristis* Stål, but not to *L. archipelagi*. The holotype of *Nepa archipelagi* came from Java, and based on comparison of specimens from Java, Sumatra, Borneo and Peninsular Malaysia (listed below), we conclude that all of our material at hand in this body size class from the Greater Sunda Islands and Peninsular Malaysia is referable to *L. archipelagi*. In addition, we strongly suspect that Lundblad's *L. occultus* will prove to be a junior synonym of Ferrari's *L. archipelagi*, but defer final decision on this matter until we can examine the holotype of Lundblad's species.

This is the only Peninuslar Malaysian *Laccotrephes* species with a medium sized body length range of 32–35 mm, a parallel-sided body form, and flattened eyes (see pl. 14, fig. 1 in Lundblad [1933] of *L. occultus* from Sumatra, which shares these same character states). *Laccotrephes archipelagi* falls in the same general body size class as *L. grossus*, a species which occurs further to the north in subtropical regions of



Figs. 31–34. *Laccotrephes* species, prosterna, left lateral views (FC = fore coxa, PS = prosternum, PP = propleuron). 31, *L. pfeiferiae*. 32, *L. archipelagi*, specimen from Malaysia, Johor. 33, *L. simulatus*, specimen from Malaysia, Johor. 34, *L. longicaudatus*, specimen from Malaysia, Johor.

Asia. As a result, we consider the previous records of *L. grossus* from Sumatra and Peninsular Malaysia (Fernando & Cheng, 1974) to in fact represent *L. archipelagi*.

Laccotrephes simulatus Montandon, 1913
(Figs. 30, 33, 36)

Laccotrephes simulatus Montandon, 1913: 122

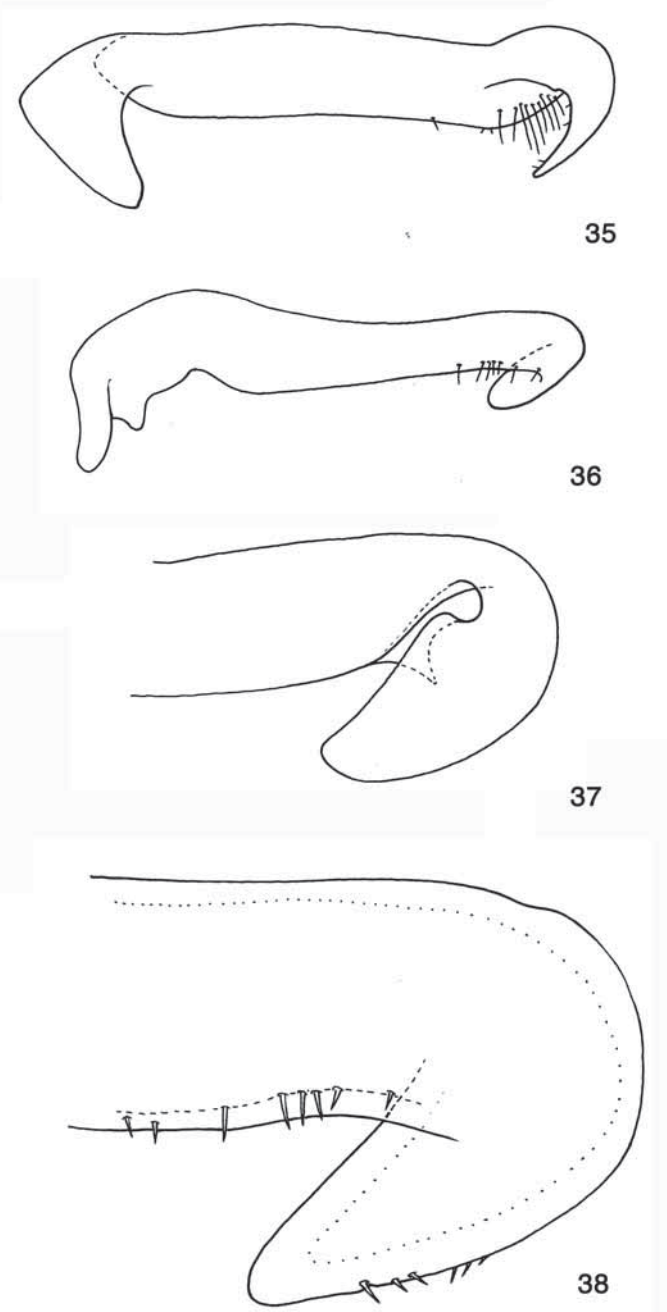
Material examined. — SINGAPORE: 1 female, Sembawang, 12 Mar.1992, K1, coll. L. Yeo (ZRC); 1 male, Selatar Reservoir, amongst debris in shallow water, 25 Oct.1990, coll. unk. (ZRC); 1 female, Lower Peirce Reservoir, north arm, in stream, 11 Aug.1990, coll. P. K. L. Ng (ZRC); 1 male, Ulu Sembawang Road, pond, 17 May 1994, coll. H. K. Lua et al. (ZRC); 1 male, Kranji Reservoir, turut track off New Tiew Road, 10 Oct.1990, coll. C. M. Yang et al., YCM0031 (ZRC). MALAYSIA, **Johor**: 1 male, 1 female, Mawai, Gunung Panti foothills, 2 Dec.1998, coll. H. K. Lua, LHK420 (ZRC); 1 male, between Pekan Nanas and Pentian, no vegetation, 4 Mar.1992, coll. K. L. Yeo (ZRC). **Malacca**: 1 male, 1 female, Batu Berendam, freshwater fishpond, 5 Oct.1960, coll. unk. (ZRC). **Pahang**: 1 male, 68 km. to Kuantan, 15 May 1995, B. Tan & G. Sumita, TG02 (ZRC); 1 male, Gambang site, Kuantan–Kuala Lumpur road, 20 km. after junction with Kuantan–Pekan road, 23 Jul.1992, coll. M. Kottelat & P. K. L. Ng (ZRC); 2 males, 1 female, Lake Chini, shore, 15 Apr.1997, YKL901Q, coll. K. L. Yeo (ZRC). **Selangor**: 3 males, 1 female, North Selangor Peat Swamp, 26 Apr.1993, coll. P. K. L. Ng (ZRC); 1 female, 0.2 km. from Km. 45 on Tanjung Malim–Sungai Besar road, 18 Sep.1992, coll. P. K. L. Ng (ZRC). **Perak**: 1 male, 1500 m after Km 23 on road to Segama from Tai Ping, 6 km. after Bukit Merah, 5°5'5.1"N, 100°40'20.8"E, 18 Nov.1995, THH9587, coll. unk. (ZRC). **Penang**: 1 male, Glugor, paddy field, 24 Oct.1961, coll. unk. (ZRC).

Extralimital material examined. — INDONESIA, **Jawa Barat Prov.**: 1 male, Java, Soekaboemie [Sukabumi], Croisiere du "Nirvana", 30 Dec.1908, coll. E. Cordier (MNHN). **Sumatera Barat Prov**.: 2 males, Sumatra, Solok, Jul.1992, coll. unk. (USNM).

Diagnosis. — Male body length 11–16 mm, maximum width (across hemelytra) 5–6 mm, length of respiratory siphon 10–15 mm. Female body length 13–18 mm, maximum width (across hemelytra) 5–6 mm, length of respiratory siphon 14–18 mm. Colouration medium brown to reddish brown, fore femur with a single irregular dark yellow annulation near mid-length, middle and hind femora each with similar marking on distal half, fore tibia with irregular dark yellow annulation on basal half; meso- and metasternum and abdominal venter orange-brown. Antennal segment III very slightly shorter than segment II, outer margin bearing a double row of long setae, the lengths of these setae approximately equal to the width of the segment, inner margin bearing scattered shorter setae, lengths of these setae about one-half as long as the width of the segment. Prosternal keel flat when viewed laterally, lacking an angular anterior projection (Fig. 33). Length of respiratory siphon less than or equal to the length of the body. Male paramere forming a stout hook with a broad, blunt apex (Fig. 36).

Distribution. — Originally described from "Pingschiang" (Pingxiang , Jiangxi Province), in south-central China (Montandon, 1913), with another specimen noted from Java. Subsequently reported from Peninsular Malaysia (Johor, Malacca), Sri Lanka, China, Vietnam, Sumatra, Borneo, and the Philippines (Lundblad, 1933; Fernando & Cheng, 1974). New records are provided herein for Singapore, and the Peninsular Malaysian states of Pehang, Selangor, Perak and Penang, as well as a better constrained record for Java.

Discussion. — This is the smallest *Laccotrephes* species in the region under study, with a body length of 11–18 mm, and may be separated from the similar sized *L. longicaudatus* by the shorter respiratory siphon, the structure of the prosternal keel (compare Figs. 33, 34) and the structure of the male



Figs. 35–38. *Laccotrephes* species, male parameres, left lateral views (all to same scale). 35, *L. longicaudatus*, specimen from Malaysia, Johor. 36, *L. simulatus*, specimen from Malaysia, Johor. 37, *L. archipelagi*, specimen from Malaysia, Johor (paramere apex only). 38, *L. pfeiferiae*, specimen from Laos, Vientiane Prov. (paramere apex only).

paramere (compare Figs. 35, 36). A useful redescription of this taxon was provided by Nieser et al. (2009), accompanied by comparative figures of the prosternal carinae for *L. robustus*, *L. pfeiferiae*, *L. griseus*, *L. longicaudatus* and *L. simulatus*, and male parameres for *L. griseus*, *L. maculatus*, *L. longicaudatus* and *L. simulatus*.

***Laccotrephes longicaudatus* Nieser, Zettel & Chen, 2009**
(Figs. 34, 35)

Laccotrephes longicaudatus Nieser, Zettel & Chen, 2009: 17

Material examined. — MALAYSIA, **Selangor**: 1 female, rice field ditch, 15 May 1991, coll. Jeffrey and Karprill (ZRC). **Malacca**: 1 male, Bukit Selankor, 25 Jul.1962, coll. L. Cheng (JTPC); 1 male, Rd. 1 mile near Jasin, 4 Nov.1959 (ZRC); 1 female, Bukit Sabukor Road, 6 Apr.1960, coll. unk. (ZRC). **Terengganu**: 1 male, pool at Km. 94 on road from Kuala Terengganu to Kota Bahru, south of Jerteh, 5°32'38.5"N, 102°43'43.9"E, water temp. 26°C., pH 6.7, 19 Mar.1992, coll. H. K. Lua (ZRC); 1 male, 1 female, Marang, 30 Dec.1994, W. G. Ullrich coll. (USNM). **Johor**: 1 female, at about 300 m. S. of 174 Km, marker on Johor Bahru–Kuantan road (Sungai Triang Besar), N. of Mersing, 19 Oct.1991, coll. P. K. L. Ng et al. (ZRC); 1 male, 1 female, 2 immatures, Mawai, Gunung Panti foothills, 2 Dec.1998, coll. H. K. Lua, LHK420 (ZRC). **Kedah**: 1 female, Alor Star, 5 Dec.1955, coll. D. S. Johnson (ZRC).

Extralimital material examined. — VIETNAM, **Hoa Binh Prov.**: 2 males, Hoa Binh, J. De Cooman coll. (MNHN).

Diagnosis. — Male body length 16.0–17.0 mm; maximum width (across hemelytra) 4.0–4.5 mm, length of respiratory siphon 22.0–22.5 mm. Female body length 19.0 mm; maximum width (across hemelytra) 5.0 mm, length of respiratory siphon 26.0 mm. Colouration dark brown dorsally, forelegs uniformly dark brown with femur and tibia lacking annulations, middle and hind femora and tibiae yellowish brown mottled with darker brown, venter medium brown. Antennal segment III very slightly shorter than segment II, outer margin bearing numerous long setae, the lengths of these setae 1.5× the width of the segment, inner margin bearing scattered shorter setae, lengths of these setae about two-thirds as long as the width of the segment. Prosternal keel with an angular projection anteriorly (Fig. 34). Length of respiratory siphon 1.5× longer than the length of the body. Male paramere with a slender, downward-curving apical process (Fig. 35).

Distribution. — Originally described from Vietnam, and not previously recorded outside of that country. The records provided below are the first for Peninsular Malaysia, and include specimens from Johor, Malacca, Terengganu, Selangor, and Kedah.

Discussion. — A small species, similar in body size to *L. simulatus* but easily separated by the long respiratory siphon which is 1.5× the length of the body, by the presence of an angulate projection at the anterior margin of the prosternal keel when viewed laterally (compare Figs. 33, 34), and by the very distinctive shape of the male paramere (compare Figs. 35, 36). Previous records of *Laccotrephes maculatus* from Singapore and Peninsular Malaysia (Fernando & Cheng, 1974) are in fact referable to this species, or to *L. simulatus*.

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