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Parasitic copepods of the family Lernanthropidae Kabata, 1979 (Copepoda: Siphonostomatoida) from Australian fishes, with descriptions of seven new species

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Table of contents

Abstract	4
Introduction	4
Systematics	7
Family Lernanthropidae	7
Genus <i>Aethon</i> Krøyer, 1837	7
<i>Aethon bicamera</i> sp. nov.	7
<i>Aethon garricki</i> Hewitt, 1968	12
<i>Aethon morelandi</i> Hewitt, 1968	13
<i>Lernanthropodes trachinoti</i> Pillai, 1962	14
Genus <i>Lernanthropsis</i> Do, in Ho & Do, 1985	15
<i>Lernanthropsis mugilii</i> (Shishido, 1898)	15
Genus <i>Lernanthropus</i> de Blainville, 1822	17
<i>Lernanthropus abitocephalus</i> Tripathi, 1962	17
<i>Lernanthropus alepicolus</i> sp. nov.	17
<i>Lernanthropus atrox</i> Heller, 1865	26
<i>Lernanthropus belones</i> Krøyer, 1863	27
<i>Lernanthropus brevicornutus</i> Kabata, 1979	29
<i>Lernanthropus breviculus</i> Kabata, 1979	30
<i>Lernanthropus cadenati</i> Delamare Deboutteville & Nuñez-Ruivo, 1954	34
<i>Lernanthropus chrysophrys</i> Shishido, 1898	35
<i>Lernanthropus elegans</i> sp. nov.	36
<i>Lernanthropus gisleri</i> van Beneden, 1852	47
<i>Lernanthropus gnathanodontus</i> sp. nov.	48
<i>Lernanthropus latis</i> Yamaguti, 1954	54
<i>Lernanthropus microlamini</i> Hewitt, 1968	54
<i>Lernanthropus mollis</i> Kabata, 1979	57
<i>Lernanthropus paracruciatus</i> sp. nov.	61
<i>Lernanthropus pemphericola</i> sp. nov.	67
<i>Lernanthropus pomadasysis</i> Rangnekar & Murti, 1961	72
<i>Lernanthropus serioli</i> Shishido, 1898	73
<i>Lernanthropus selenotoca</i> sp. nov.	75
<i>Lernanthropus tylosuri</i> Richiardi, in Goggio, 1906	78
Genus <i>Mitrapus</i> Song & Chen, 1976	79
<i>Mitrapus oblongus</i> (Pillai, 1964)	79
Genus <i>Sagum</i> Wilson, 1913	82
<i>Sagum epinepheli</i> (Yamaguti & Yamasu, 1960)	82
<i>Sagum lativentris</i> (Heller, 1865) n. comb.	83
<i>Sagum petersi</i> (van Beneden, 1857)	88
<i>Sagum sanguineus</i> (Song, in Song & Chen, 1976) n. comb.	89
<i>Sagum vespertilio</i> Kabata, 1979	91
Key to adult females of Lernanthropidae found in Australian waters	95
Discussion	96
Acknowledgements	97
Bibliography	97

Abstract

The total number of species of Lernanthropidae previously recorded from Australian waters is 15 (i.e., one species each of *Aethon* Krøyer, 1837, *Lernanthropodes* Bere, 1936, and *Lernanthropsis* Do, in Ho & Do, 1985; 10 species of *Lernanthropus* de Blainville, 1822; and two species of *Sagum* Wilson, 1913), and all of these records are reviewed. We report here the presence of three species of *Aethon*. One species, *A. garricki* Hewitt, 1968, is reported from Australian waters for the first time and a new species, *A. bicamera* **sp. nov.**, is described from the latrid, *Latris lineatus* (Forster, 1801) caught off South Australia. The genus *Lernanthropodes* is represented by a single species, *L. trachinoti* Pillai, 1962. We recognize *Chauvanium* Kazachenko, Kovaleva, Nguyen & Ngo, 2017 as a subjective synonym of *Lernanthropodes* and transfer its type and only species *C. chauvani* Kazachenko, Kovaleva, Nguyen & Ngo, 2017 which becomes *Lernanthropodes chauvani* (Kazachenko, Kovaleva, Nguyen & Ngo, 2017) **n. comb.** *Lernanthropsis mugilii* (Shishido, 1898) is reported here from *Mugil cephalus* Linnaeus, 1758 sampled in Queensland and in New South Wales. The genus *Lernanthropus* is the most species rich and we report the presence of 20 nominal species on Australian marine fishes. This total includes six new species: *L. alepicolus* **sp. nov.** from *Alepes apercna* Grant, 1987, *L. elegans* **sp. nov.** from *Atractoscion aequidens* (Cuvier, 1830), *L. gnathanodontus* **sp. nov.** from *Gnathanodon speciosus* (Forsskål, 1775), *L. paracruciatus* **sp. nov.** from *Protonibea diacanthus* (Lacepède, 1802), *L. pemphericola* **sp. nov.** from *Pempheris compressa* (White, 1790), and *L. selenotoca* **sp. nov.** from *Selenotoca multifasciata* (Richardson, 1846). In addition, we report the presence of another four species in Australian waters for the first time: *L. abitocephalus* Tripathi, 1962, *L. cadenati* Delamare Deboutteville & Nuñez-Ruivo, 1954, *L. microlamini* Hewitt, 1968, and *L. pomadasysis* Rangnekar & Murti, 1961. After reexamination of the types of *L. paenulatus* Wilson, 1922 held in the USNM, we relegate this species to subjective synonymy with *L. serioli* Shishido, 1898. Previous records of *L. paenulatus* from Australian *Seriola* species should be reassigned to *L. serioli*. *Lernanthropus ecclesi* Kensley & Grindley, 1973 is recognized as a junior subjective synonym of *L. micropterygis* Richiardi, 1884, and *L. delamarei* Marques, 1960, which is based on the male only, is tentatively considered to be a junior subjective synonym of *L. micropterygis*. Males are described for the first time for three species; *L. breviculus* Kabata, 1979, *L. microlamini* and *L. mollis* Kabata, 1979. A member of the genus *Mitrapus* Song & Chen, 1976, *M. oblongus* (Pillai, 1964), is reported from Australia for the first time, on *Herklotsichthys castelnaui* (Ogilby, 1897) caught off Queensland and New South Wales. Finally, two species of *Sagum* were previously known from Australia and here we add three more. Two of the newly reported species were originally described as species of *Lernanthropus* but we formally transfer them here to *Sagum* as *S. lativentris* (Heller, 1865) **n. comb.** and *S. sanguineus* (Song, in Song & Chen, 1976) **n. comb.** The males of *S. lativentris* and *S. vespertilio* Kabata, 1979 are described for the first time. A key to the females of the 31 species of lernanthropids found in Australian waters is provided.

Key words: parasites, copepods, Lernanthropidae, taxonomy

Introduction

Copepods of the family Lernanthropidae are relatively large and conspicuous parasites which occur only on the gills of marine teleost fishes and some species have been implicated in causing disease problems in cultured finfish (e.g. Manera & Dezfuli, 2003; Toksen, 2007; Chu *et al.*, 2012). Lernanthropids occur globally but relatively few species have been recorded from the marine fishes of Australia. The earliest record of any lernanthropid from Australian waters was that of Heller (1865) who described *Lernanthropus atrox* Heller, 1865 from *Chrysophrys auratus* (Forster, 1801) (as *Pagrus guttallatus*). More than a century later, Cressey & Collette (1970) in their global review of copepods parasitic on belonid fishes, reported two further species of *Lernanthropus* de Blainville, 1822 from Australia, both parasitic on the needlefish *Strongylura incisa* (Valenciennes, 1846). Kabata (1979a) published the most important work to date on Australian representatives of this family, recording nine species from three different genera, including three new species of *Lernanthropus* and one new species of *Sagum* Wilson, 1913. Since Kabata's (1979a) review a further five species have been reported, bringing the total number of species known from Australian waters to 15. All previous records, together with the new records reported here are summarized in Table 1. The validity of these records is also assessed.

The family currently comprises nine genera: *Aethon* Krøyer, 1837, *Chauvanium* Kazachenko, Kovaleva, Nguyen & Ngo, 2017, *Lernanthropinus* Do, in Ho & Do, 1985, *Lernanthropodes* Bere, 1936, *Lernanthropsis* Do, in Ho & Do, 1985, *Lernanthropus*, *Mitrapus* Song & Chen, 1976, *Norion* von Nordmann, 1832, and *Sagum*. Representatives of five of these genera had previously been reported from Australian waters (Table 1) and here we report the presence of a *Mitrapus* species for the first time. We also discuss the validity of *Chauvanium* as a distinct genus.

In this paper we describe seven new species from Australian marine fishes, one of *Aethon* and six of *Lernan-*

thropus, and we report on an additional nine species recorded for the first time in Australian waters. Male morphology is particularly informative in the Lernanthropidae and in this study we provide data on the males of 14 species, including five species for which the males were previously unknown (i.e., *Lernanthropus breviculus* Kabata, 1979, *L. microlamini* Hewitt, 1968, *L. mollis* Kabata, 1979, *Sagum lativentris* (Heller, 1865) **n. comb.** and *S. vespertilio* Kabata, 1979), and five new species in which both sexes are described. A total of 31 species of the family Lernanthropidae is now known from Australian marine fishes. Either a full description, a supplementary description, or a brief diagnosis is presented for each these lernanthropid species and a key to adult females is provided.

TABLE 1. Species of the family Lernanthropidae and their hosts in Australian waters

Current valid name	Host(s) in Australia:	Source of Australian record
<i>Aethon bicamera</i> sp. nov.	<i>Latris lineata</i> (Forster, 1801)	present account
<i>Aethon garricki</i> Hewitt, 1968	<i>Nemadactylus macropterus</i> (Forster, 1801)	present account
<i>Aethon morelandi</i> Hewitt 1968	<i>Nemadactylus macropterus</i> (Forster, 1801)	Rohde <i>et al.</i> , 1980
	<i>Nemadactylus valenciennesi</i> (Whitley, 1937)	present account
<i>Lernanthropodes trachinoti</i> Pillai, 1962	<i>Trachinotus botla</i> (Shaw, 1803)	Kabata, 1979a
<i>Lernanthropsis mugilii</i> (Shishido, 1898)	<i>Mugil cephalus</i> Linnaeus, 1758	Kabata, 1979a; present account
	<i>Choerodon cyanopodus</i> (Richardson, 1843) (as <i>Choerodon albigena</i> (De Vis))	Kabata, 1979a
<i>Lernanthropus abitocephalus</i> Tripathi, 1962	<i>Pomadasys argenteus</i> (Forsskål, 1775)	present account
<i>Lernanthropus alepicolus</i> sp. nov.	<i>Alepes apercna</i> Grant, 1987	present account
<i>Lernanthropus atrox</i> Heller, 1865	<i>Chrysophrys auratus</i> (Forster, 1801) (as <i>Pagrus gutturalis</i>) <i>Acanthopagrus australis</i> (Günther, 1859)	Heller, 1865; present account Kabata, 1979a; present account
	<i>Rhabdosargus sarba</i> (Forsskål, 1775)	present account
<i>Lernanthropus belones</i> Krøyer, 1863	<i>Strongylura incisa</i> (Valenciennes, 1846)	Cressey & Collette, 1970
<i>Lernanthropus brevicornutus</i> Kabata, 1979	<i>Arrhamphus sclerolepis</i> Günther, 1866	Kabata, 1979a; present account
	<i>Hyporhamphus quoyi</i> (Valenciennes, 1847)	Kabata, 1979a
	<i>Hyporhamphus regularis</i> (Günther, 1866)	present account
<i>Lernanthropus breviculus</i> Kabata, 1979	<i>Cheilinus chlorourus</i> (Bloch, 1791)	Kabata, 1979a
<i>Lernanthropus cadenati</i> Delamare Deboutteville & Nuñez-Ruivo, 1954	<i>Megalops cyprinoides</i> (Broussonet, 1782)	present account
<i>Lernanthropus chrysophrys</i> Shishido, 1898	<i>Acanthopagrus pacificus</i> Iwatsuki, Kume & Yoshino, 2010 (as <i>Acanthopagrus berda</i> (Forsskål, 1775)) <i>Acanthopagrus australis</i> (Günther, 1859)	Byrnes, 1988 present account
<i>Lernanthropus elegans</i> sp. nov.	<i>Atractoscion aequidens</i> (Cuvier, 1830)	present account
	<i>Argyrosomus japonicus</i> (Temminck & Schlegel, 1843) (as <i>A. hololepidotus</i>)	present account
<i>Lernanthropus gisleri</i> van Beneden, 1852	<i>Argyrosomus japonicus</i> (Temminck & Schlegel, 1843) (as <i>Sciaena antarctica</i>) <i>Selenotoca multifasciatus</i> (Richardson, 1846) (as <i>Scatophagus multifasciatus</i>)	Kabata, 1979a; present account Kabata, 1979a
<i>Lernanthropus gnathanodontus</i> sp. nov.	<i>Gnathanodon speciosus</i> (Forsskål, 1775)	present account
<i>Lernanthropus latis</i> Yamaguti, 1954	<i>Lates calcarifer</i> (Bloch, 1790)	Brazenor & Hutson, 2013
<i>Lernanthropus microlamini</i> Hewitt, 1968	<i>Hyperoglyphe antarctica</i> (Carmichael, 1819)	present account
<i>Lernanthropus mollis</i> Kabata, 1979	<i>Sillago analis</i> (Whitley, 1943)	Kabata, 1979a

.....continued on the next page

TABLE 1. (Continued)

Current valid name	Host(s) in Australia:	Source of Australian record
	<i>Sillago bassensis</i> Cuvier, 1829	present account
	<i>Sillago burrus</i> Richardson, 1842	Hayward, 1997
	<i>Sillago ciliata</i> Cuvier, 1829	Kabata, 1979a; present account
	<i>Sillago flindersi</i> McKay, 1985	Hayward, 1997
	<i>Sillago maculata</i> Quoy & Gaimard, 1824	Hayward, 1997
	<i>Sillago schomburgkii</i> Peters, 1864	Hayward, 1997
	<i>Sillago sihama</i> (Forsskål, 1775)	Hayward, 1997
<i>Lernanthropus paracruciatu</i> sp. nov.	<i>Protonibea diacanthus</i> (Lacepède, 1802)	present account
<i>Lernanthropus pemphericola</i> sp. nov.	<i>Pempheris compressa</i> (White, 1790)	present account
<i>Lernanthropus pomadasysis</i> Rangnekar & Murti, 1961	<i>Pomadasys kaakan</i> (Cuvier, 1830)	present account
<i>Lernanthropus seriolii</i> Shishido, 1898 (as <i>L. paenulatus</i> Wilson, 1922)	<i>Seriola hippos</i> Günther, 1876 <i>Seriola lalandi</i> Valenciennes, 1833	present account Rohde <i>et al.</i> , 1995; Hutson <i>et al.</i> , 2007a Hutson <i>et al.</i> , 2007b
(as <i>L. paenulatus</i> Wilson, 1922)	<i>Seriola hippos</i> Günther, 1876	
<i>Lernanthropus selenotoca</i> sp. nov.	<i>Selenotoca multifasciatus</i> (Richardson, 1846)	present account
<i>Lernanthropus tylosuri</i> Richiardi, in Goggio, 1906	<i>Strongylura incisa</i> (Valenciennes, 1846)	Cressey & Collette, 1970
<i>Mitrapus oblongus</i> (Pillai, 1964)	<i>Herklotsichthys castelnaui</i> (Ogilby, 1897)	present account
<i>Sagum epinepheli</i> (Yamaguti & Yamasu, 1960)	<i>Plectropomus leopardus</i> (Lacepède, 1802)	present account
	<i>Epinephelus coioides</i> (Hamilton, 1822)	present account
<i>Sagum lativentris</i> (Heller, 1865) n. comb.	<i>Lutjanus carponotatus</i> (Richardson, 1842)	present account
	<i>Lutjanus johnii</i> (Bloch, 1792)	present account
	<i>Lutjanus russellii</i> (Bleeker, 1849)	present account
<i>Sagum petersi</i> (van Beneden, 1857)	<i>Epinephelus lanceolatus</i> (Bloch, 1790) (as <i>Promicrops lanceolatus</i>)	Kabata, 1979a
<i>Sagum sanguineus</i> (Song, in Song & Chen, 1976) n. comb.	<i>Lutjanus johnii</i> (Bloch, 1792)	present account
<i>Sagum vespertilio</i> Kabata, 1979	<i>Lethrinus laticaudis</i> Alleyne & MacLeay, 1877 (as <i>L. fletus</i>)	Kabata, 1979a; present account
	<i>Lutjanus malabaricus</i> (Bloch & Schneider, 1801)	present account
	<i>Lutjanus erythropterus</i> Bloch, 1790	present account
	<i>Lutjanus sebae</i> (Cuvier, 1816)	present account

Materials and methods

New copepod material was collected during two parasitology workshops organised by Thomas Cribb and Scott Cutmore (University of Queensland) and held at the University of Queensland's Marine Laboratory on North Stradbroke Island in Moreton Bay. The workshops both took place during 2016, one in the austral summer (09 to 22 January) and one in winter (24 June to 07 July). Live fish were sourced each day, either from commercial fishermen using tunnel nets set in Moreton Bay, or by spear-fishing or rod-and-line fishing around the shore of the island. Fish from the commercial fishermen were transported live to the laboratory for examination; those that died during capture were usually placed on ice. Fish that were still alive on arrival at the laboratory were placed in holding tanks in the aquarium room. Fish caught by spear-fishing or rod-and-line were transported in coolboxes containing a mix of seawater and ice. The laboratory protocol for the parasitological examination of the fish is detailed in Cribb & Bray (2010), although it was adapted to make it more suitable for copepods (see Boxshall, 2018, for details). Some additional material from Moreton Bay was collected by Scott Cutmore after the workshops.

Other recent collections of lernanthropids from Australian fishes include material from South Australia collected by K.S. Hutson, material from across northern Australia (from Western Australia to Queensland) collected by D.P. Barton, and material from the Northern Territory and Queensland collected by B.K. Diggles. Fish were collected either by hook and line or from commercial fisheries from a number of locations across northern Australia, from Locker Point in Western Australia to Moreton Bay. Fish were placed on ice or frozen and transported to the laboratory for processing. In the laboratory, each fish was measured (total length; mm), the gills removed and washed in sea water; the gills and the washing water were examined for parasites.

Additional unidentified material from Australian fishes lodged in the collections of the Natural History Museum, London was examined and included in this paper. The majority of this material in London was collected by Klaus Rohde in the early 1980s in the vicinity of Coffs Harbour (New South Wales). Type specimens of the new taxa described by Kabata (1979a) are also housed in the Natural History Museum, London and some were re-examined during this study.

The results presented here are based on the external morphology. After removal from the host, the copepods were typically preserved in 70% ethanol. Fixed specimens were cleaned with brushes and most of the larger species were photographed for habitus illustrations. Prior to morphological examination the specimens were cleared in lactic acid for at least 2 h and mounted on glass slides as temporary preparations in lactic acid. Limbs were dissected where necessary to observe fine details. Measurements were made using an ocular micrometer and drawings were made using a drawing tube on a Leitz Diaplan microscope equipped with differential interference contrast. Morphological terminology follows Huys & Boxshall (1991); host fish names have been updated according to FishBase (Froese & Pauly, 2018).

All holotypes and some paratypes, plus voucher specimens of known species collected from Moreton Bay are deposited in Queensland Museum (QM); the holotype of the new species from South Australia plus voucher specimens of known species collected from South Australia are deposited in the South Australian Museum (SAMA); holotypes of species collected from New South Wales are deposited in the Australian Museum, Sydney (AM). The holotype, allotype and some paratypes of a new species and voucher specimens of other species collected from the Northern Territory are deposited in the Museum and Art Gallery of the Northern Territory (MAGNT), Darwin. Where available additional paratypes and/or vouchers are deposited in the collections of the Natural History Museum, London.

Systematics

Family Lernanthropidae

In the family Lernanthropidae characters relating to the gross body morphology of the adult female have proven valuable in the discrimination of both generic and species level taxa. At the generic level in particular, the general form of legs 1 to 4 provides important characters, as well as the presence and shape of the dorsal trunk plate(s) on the fourth pedigerous somite, and the form of the egg sacs in the adult female. Older descriptions tended to focus on gross morphology, so characters relating to the details of cephalosomic limbs are often not available. Fortunately, gross morphology is unusually informative in this family, even at the species level, so the taxonomy of lernanthropids is relatively robust. Although some species have been transferred to other genera, 148 of the 167 nominal species formally described in the family remain valid, with only 19 species (11 %) recognized as synonyms. Males of ten species are described here for the first time, including five previously unknown males and five from new species.

Genus *Aethon* Krøyer, 1837

Aethon bicamera sp. nov.

(Figs. 1–3)

Type material: Holotype ♀ and allotype ♂ from *Latris lineata* (Forster, 1801), Port MacDonnell, South Australia, January 2008; collected by K.S. Hutson; SAMA Reg. No. C6901. 2♀♀ and 2♂♂ paratypes from *L. lineata*,

Port MacDonnell, South Australia, 06 May 2008; collected by K.S. Hutson; NHMUK Reg. Nos. 2009.276 and 2018.194–195.

Etymology: The name of the new species is derived from the Latin *bi-* meaning two and *camera* meaning chamber, and refers to the two chambers at the posterior end of the trunk.

Description: Female body comprising broad cephalothorax, subquadrate trunk and small urosome completely concealed beneath dorsal trunk plate (Fig. 1A,C). Mean body length 4.71 mm, with a range of 4.65 to 4.76 mm (based on 3 specimens). Cephalothorax comprising cephalosome plus first pedigerous somite; squat, about 2 times wider than long, with weakly convex frontal margin. Lateral margins tapering strongly, widest posteriorly; bearing 2 pairs of lateral lobes, posterior pair more prominent. Both pairs with surface ornamented with cuticular tubercles. Trunk somites completely fused; tergites of second and third pedigerous somites raised, distinct and with surface ornamentation (Fig. 1A–C). Lateral margin of trunk expanding outwards from prominent anterolateral shoulders backwards to tapering posterolateral processes. Entire dorsal surface of trunk ornamented with cuticular tubercles. Dorsal trunk plate covering fourth pedigerous somite and entire urosome; plate short but extending to full width of body, with weakly convex lateral margins and small median indentation in transverse posterior margin. Urosome comprising fifth pedigerous somite, genital complex and anal somite all fused, wider than long. Anal slit terminal, located between paired caudal rami; caudal rami setation not observed.



FIGURE 1. *Aethon bicamera* sp. nov., holotype ♀. A, habitus, dorsal; B, habitus, ventral; C, habitus, lateral. Scale bar 2 mm.

Antennule (Fig. 2A) indistinctly segmented; segmental setation as follows: 1, 4, 2, 2, 1, 3 + ae, 8 + ae; all setae short and naked. Antenna (Fig. 2B) well developed; basal segment massive, bearing spinous process proximally on medial margin; terminal claw strong with spinous accessory process proximally on concave margin. Mandible stylet-like, armed with 8 marginal teeth distally (Fig. 2C). Maxillule bilobate (Fig. 2D); small inner lobe bearing 2 apical spines; laterally-directed outer lobe elongate, armed with 3 apical spines. Maxilla (Fig. 2E) comprising unarmed syncoxa and long basis bearing curved, bilaterally-serrate, terminal claw plus slender spine apically; basis bearing short spine subapically. Maxilliped (Fig. 2F) comprising robust basal segment and curved distal subchela bearing spinous process proximally and small process distally, at level of suture.

Leg 1 biramous (Fig. 2G); unsegmented protopod bearing stout inner spine and slender outer seta; endopod 1-segmented, tapering distally, armed with apical spine about 35% length of segment; exopod indistinctly segmented bearing 5 stout spines around distal margin. Leg 2 (Fig. 2H) unsegmented and modified into large, heavily sclerotized, inwardly-curved process bearing accessory median process proximally; armed with small lateral papilla bearing outer protopodal seta; unarmed distal process representing exopod. Leg 3 (Fig. 2I) with large foliaceous rami; exopod oriented mainly vertically but curving ventrally to form lateral plates enclosing posterior part of trunk both laterally and ventrally (Fig. 1B,C); exopod rigid and strongly sclerotized, ornamented externally with tubercles; endopod unornamented, oriented mainly horizontally, separating upper trunk chamber containing loosely coiled egg

sacs from lower chamber containing adult male. Leg 3 pair meeting in midline at extreme anterior end and posteriorly but with distinct heart-shaped space separating legs in anterior third (Fig. 1B). Leg 4 (Fig. 2J) biramous with outer protopodal seta present proximally on dorsal margin; rami foliaceous, rounded distally, entirely enclosed by modified rami of leg 3. Leg 5 not observed.

Male. Body divided into cephalothorax incorporating first pedigerous somite, and unsegmented trunk representing fused second to fifth somites, genital somite and abdomen (Fig. 3A). Total body length 1.87 and 2.09 mm (2 specimens). Cephalothorax about 1.3 times longer than wide, with weakly convex lateral margins; comprising 57% of body length. Trunk about equal in width to cephalothorax, tapering posteriorly; comprising second to fifth pedigerous somites, genital complex and abdomen, all fused. Anal somite tapering posteriorly, bearing paired caudal rami (Fig. 3B) on posterolateral margins; rami about 2.3 times longer than maximum width; tapering irregularly towards tip; bearing 4 setae, with long dorsal seta located proximally, lateral seta situated about at mid-length, plus apical and subapical spiniform setae.

Antennule 7-segmented and showing traces of geniculation between segments 5 and 6 (Fig. 3C); armed with setae as follows: 1, 4, 2, 5, 1, 2 + ae, 9 + ae. Antenna massive (Fig. 3D) subchelate; comprising unarmed, robust basal segment and strong terminal claw bearing curved spinous process proximally on concave margin. Mandible and maxillule as in female. Maxilla (Fig. 3E) basis with bifid subapical process; terminal claw densely ornamented with fine spinules. Maxilliped (Fig. 3F) comprising muscular basal segment and curved terminal subchela; basal segment ornamented with extensive patches of tiny tubercles proximally on myxal surface, and with patches of spinules distally; subchela with small process near concave margin. Leg 1 biramous (Fig. 3G); unsegmented protopod bearing stout inner spine and slender outer seta: endopod 1-segmented, tapering distally, armed with apical spine about 65% length of segment: exopod 1-segmented armed with 5 spines along distal margin; protopod and both rami ornamented with patches of spinules, as figured. Leg 2 (Fig. 3H) biramous; protopod bearing outer seta on papilla; endopod slender tapering towards tip, bearing apical spine about 47% length of segment; exopod unsegmented, lobate, ornamented with rounded tubercles in zone of wrinkled integument on distal surface. Leg 3 (Fig. 3I) reduced, lamellate, bearing outer seta on elongate papilla; posteriorly directed lamella weakly bilobed and armed with 2 small spines on apex of outer lobe. Leg 4 (Fig. 3J) bi-lobed; bearing outer seta on papilla; larger lamelliform outer lobe ornamented with isolated sensillae and armed with 2 reduced setae distally; smaller inner lobe unarmed. Leg 5 (Fig. 3A) represented by small outer lobe bearing single seta. Unarmed, plate-like operculum closing off each genital aperture probably representing leg 6.

Remarks: The genus *Aethon* currently comprises only four species (Walter & Boxshall, 2018): the type species *Aethon quadratus* Krøyer, 1837, *A. percis* (Thomson, 1890), *A. garricki* Hewitt, 1968 and *A. morelandi* Hewitt, 1968. The type species is known only from the Atlantic, whereas the other three species were all originally described from New Zealand waters (Thomson, 1890; Hewitt, 1968). The new species can be readily distinguished from *A. garricki* by the shape of the posterior part of the trunk, the dorsal trunk plate, which is about 1.6 times longer than wide in *A. garricki*, whereas in the new species the dorsal trunk plate is 1.6 times wider than long. In addition, the lateral margins of the cephalothorax carry distinct lobes at the posterior extremity in the new species but these margins are evenly convex in *A. garricki*.

In both *A. morelandi* and *A. percis* the dorsal trunk plate is about as long as wide, compared to the short, squat plate of the new species. The free posterior margin of the plate forms two evenly rounded lobes separated by a median indentation in *A. percis*, whereas in *A. morelandi* this margin is more sinuous as it has a median indentation plus paired lateral indentations which produce the appearance of angular posterolateral corners. The new species differs from both of these species in having an almost linear, truncated rear margin with just a tiny median indentation. These differences are sufficient to justify the establishment of a new species.

The male was lodged inside a chamber enclosed laterally and ventrally by the sclerotized exopods of the third legs and dorsally by the unsclerotized third leg endopods plus the lamellate fourth legs which together form a horizontal internal wall separating the male from the dorsally-located, upper chamber containing the loosely coiled egg strings. The partitioning of the brood chamber into a dorsal space enclosing the egg strings and a ventral space housing a single adult male has not been reported before for any *Aethon* species. The male was attached directly to the gill filament of the host using its paired antennae which extend out through the anteriorly-located, heart-shaped gap between the third legs (Fig. 1B). It seems likely that the male attaches to the gill of the host and the adult female then moves into position over the male and envelopes it within its ventral chamber by closing the third legs around it. In this position both male and female are still attached to the host.

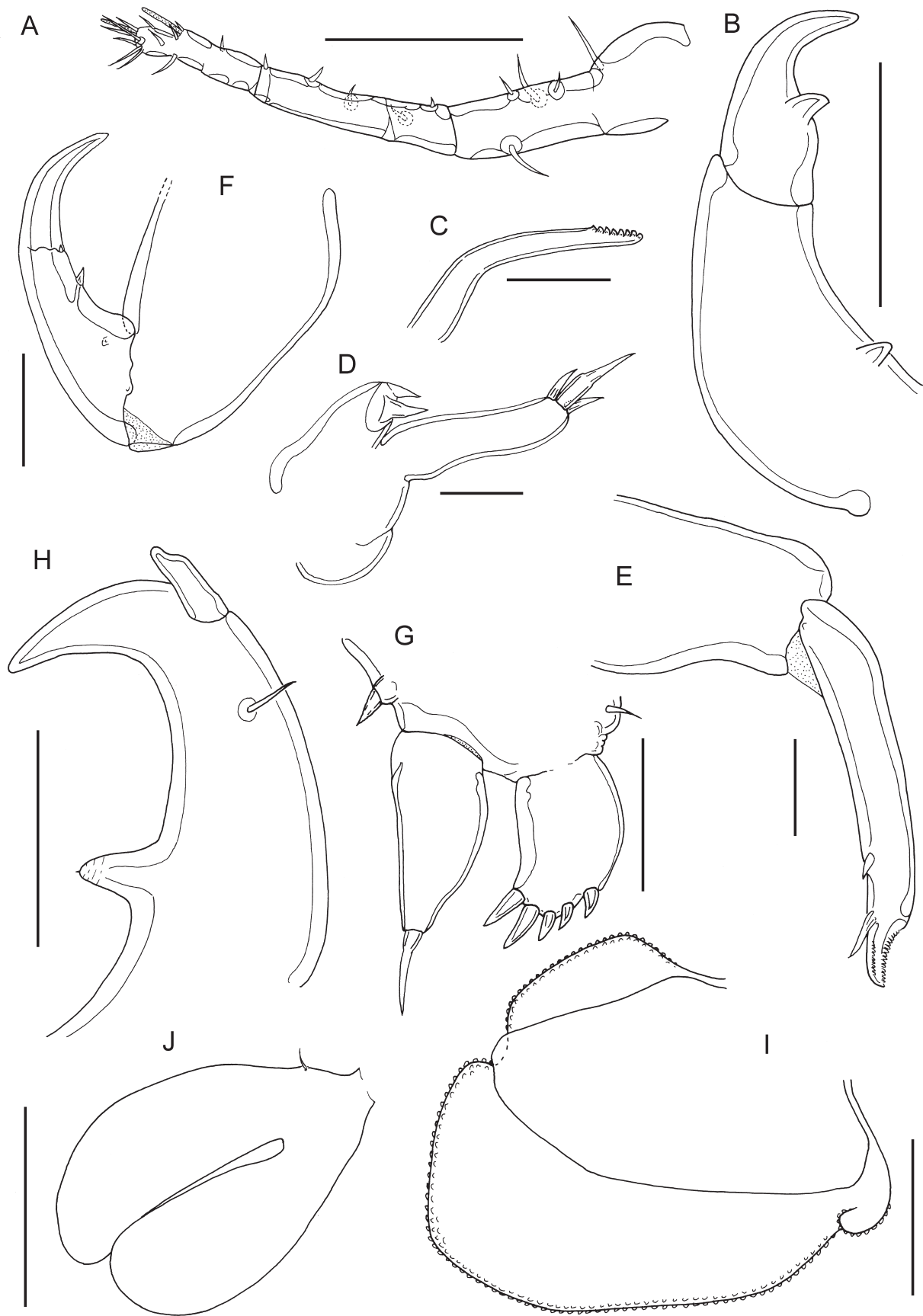


FIGURE 2. *Aethon bicamera* sp. nov., paratype ♀. A, antennule; B, antenna; C, mandible; D, maxillule; E, maxilla; F, maxilliped; G, leg 1; H, leg 2; I, leg 3, internal view; J, leg 4. Scale bars A,F,G 200 µm, B,H, 0.5 mm, C–E, 100 µm, I,J, 1 mm.

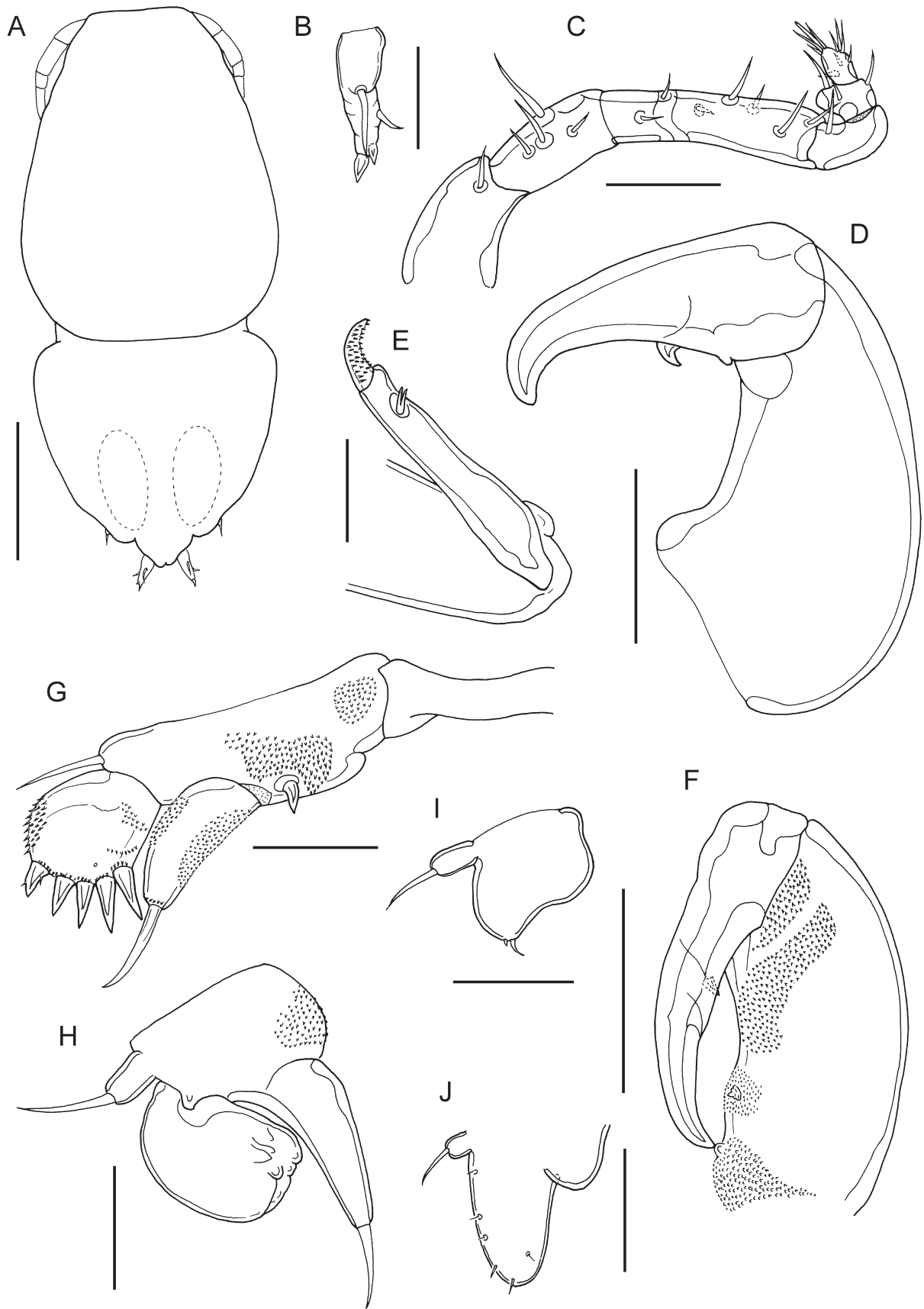


FIGURE 3. *Aethon bicamera* **sp. nov.**, paratype ♂. A, habitus, dorsal; B, caudal ramus, dorsal; C, antennule; D, antenna; E, maxilla; F, maxilliped; G, leg 1 and part of intercoxal sclerite; H, leg 2; I, leg 3; J, leg 4. Scale bars A, 0.5 mm, B–C, E, G–J, 100 μ m, D, F, 200 μ m.

Aethon garricki Hewitt, 1968

(Fig. 4)

Material examined: 1♀ from gills of *Nemadactylus macropterus* (Forster, 1801), Port MacDonnell, South Australia, 09 May 2007; collected by K.S. Hutson; NHMUK 2007.951. 3♀♀ from gills of *N. macropterus* caught 210 km SW of Streaky Bay (33° 51'S, 132° 19'E), South Australia: collected by K.S. Hutson from host material in the Victoria Museum, Melbourne. 1♀ from gills of *N. macropterus*, Port MacDonnell, South Australia, 09 May 2007; collected by K.S. Hutson; SAMA Reg No. C6896.

Differential diagnosis: Cephalothorax longer than wide, with distinct dorsal cephalothoracic shield; lateral margins weakly convex, without processes (Fig. 4A). Trunk distinctly wider than cephalothorax: anterior part with 2 well-defined dorsal tergites derived from second and third pedigerous somites, lateral margins extended into long pointed posterolateral processes (Fig. 4A–C); posterior part of trunk (fourth pedigerous somite) covered by dorsal trunk plate. Plate about 1.6 times longer than wide, with almost linear lateral margins; posterior margin of plate with deep median indentation. Loosely coiled egg strings entirely concealed beneath dorsal trunk plate in dorsal view. Urosome comprising fifth pedigerous somite, genital complex and 1-segmented abdomen, all fused. Anal somite bearing paired caudal rami, each about 2.5 times longer than wide and tapering to acutely pointed apex. Leg 2 with endopod fused to protopod forming curved process bearing reduced exopod as small protuberance on outer side of process. Leg 3 large, comprising 2 fleshy lamellate lobes (Fig. 4B–C); outer lobe (exopod) rigid and sclerotised, orientated vertically and running length of dorsal trunk plate, forming side wall of cavity containing coiled egg strings: inner lobe (endopodal) elongate, orientated horizontally and extending posteriorly about as far as end of dorsal trunk plate; lobes connected by ventrally-directed, curtain-like lamella. Leg 4 bilobate; both lobes lamellate with rounded tips, inner lobe shorter than outer. Mean body length of ♀ 3.86 mm, range 3.47 to 4.37 mm (based on 5 specimens).

Distribution: The original description of *Aethon garricki* was based on a single female collected from the cheilodactylid *Nemadactylus macropterus* (as *Cheilodactylus macropterus*), caught off Somes Island in Wellington Harbour, New Zealand (Hewitt, 1968). This new record from the same host, caught off South Australia, extends the known distribution of this distinctive species.

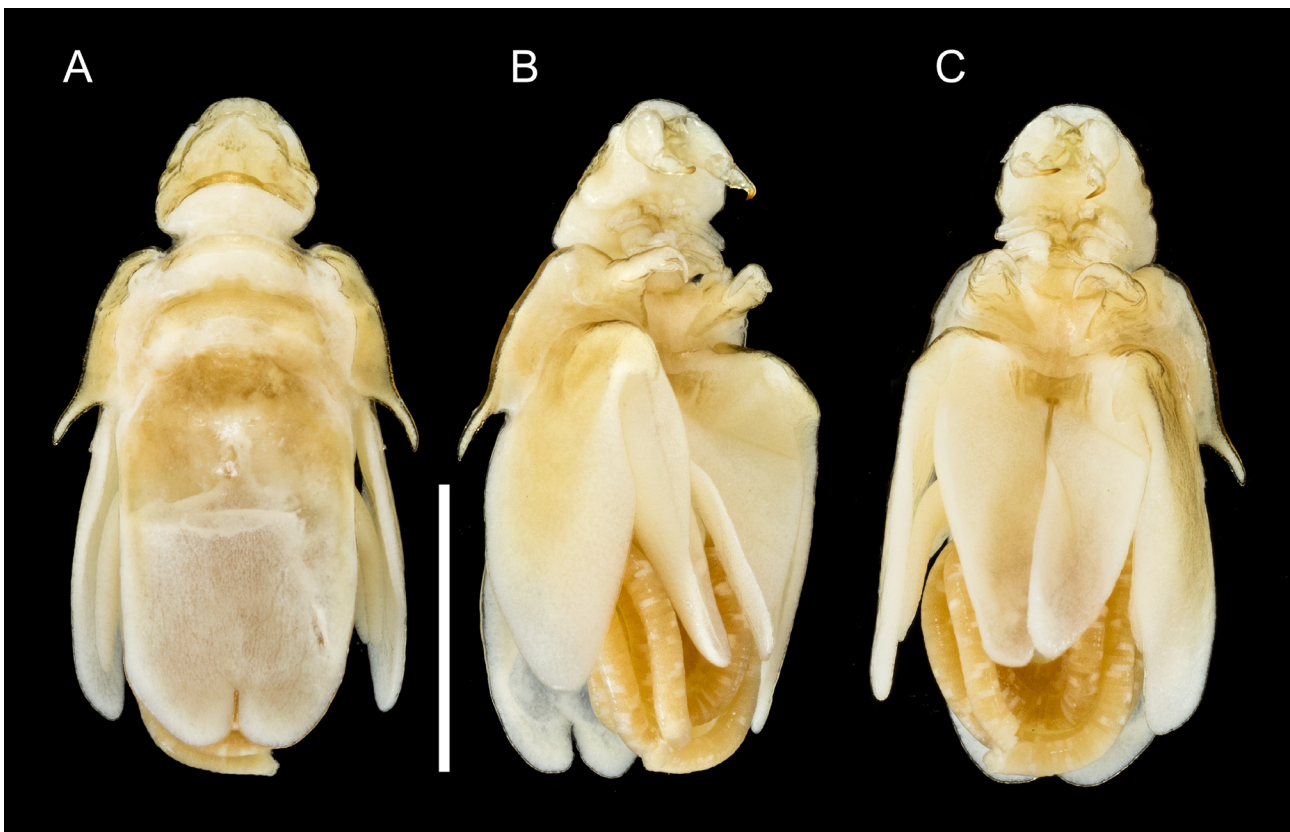


FIGURE 4. *Aethon garricki* Hewitt, 1968, adult ♀. A, habitus, dorsal; B, habitus, lateral; C, habitus, ventral. Scale bar 2 mm.

Remarks: This species is readily distinguished from its congeners by the smoothly convex lateral margins of its cephalothorax: in contrast the lateral margins of all other *Aethon* species have well developed lateral lobes. The holotype female from New Zealand was 3.82 mm long, while the Australian specimens are larger. Vooren & Tracey (1976) studied the metazoan parasites of *N. macropterus* in New Zealand waters and found *A. garricki* to have an overall prevalence ranging from 16.9% off East Cape to 26.9% in Tasman Bay, but it was absent from the Chatham Islands population.

***Aethon morelandi* Hewitt, 1968**

(Fig. 5)

Material examined: 20♀♀, 18♂♂ on *Nemadactylus macropterus* (Forster, 1801), Coffs Harbour, New South Wales, collected by K. Rohde; NHMUK Reg. No. 1982.86. 1♂ from *N. macropterus*, Coffs Harbour, New South Wales, 15 November 1981; collected by K. Rohde; NHMUK Reg. No. 1992.163–172. 1♀ from “Morwong” (Cheilodactylidae), Port Macquarie, New South Wales, 01 September 1980; collected by K. Rohde; NHMUK Reg. No. 1992.153–162. 1♀ from *Nemadactylus valenciennesi* (Whitley, 1937), Port MacDonnell, South Australia, collected by K.S. Hutson, 09 May 2007, SAMA Reg. No. C6891.

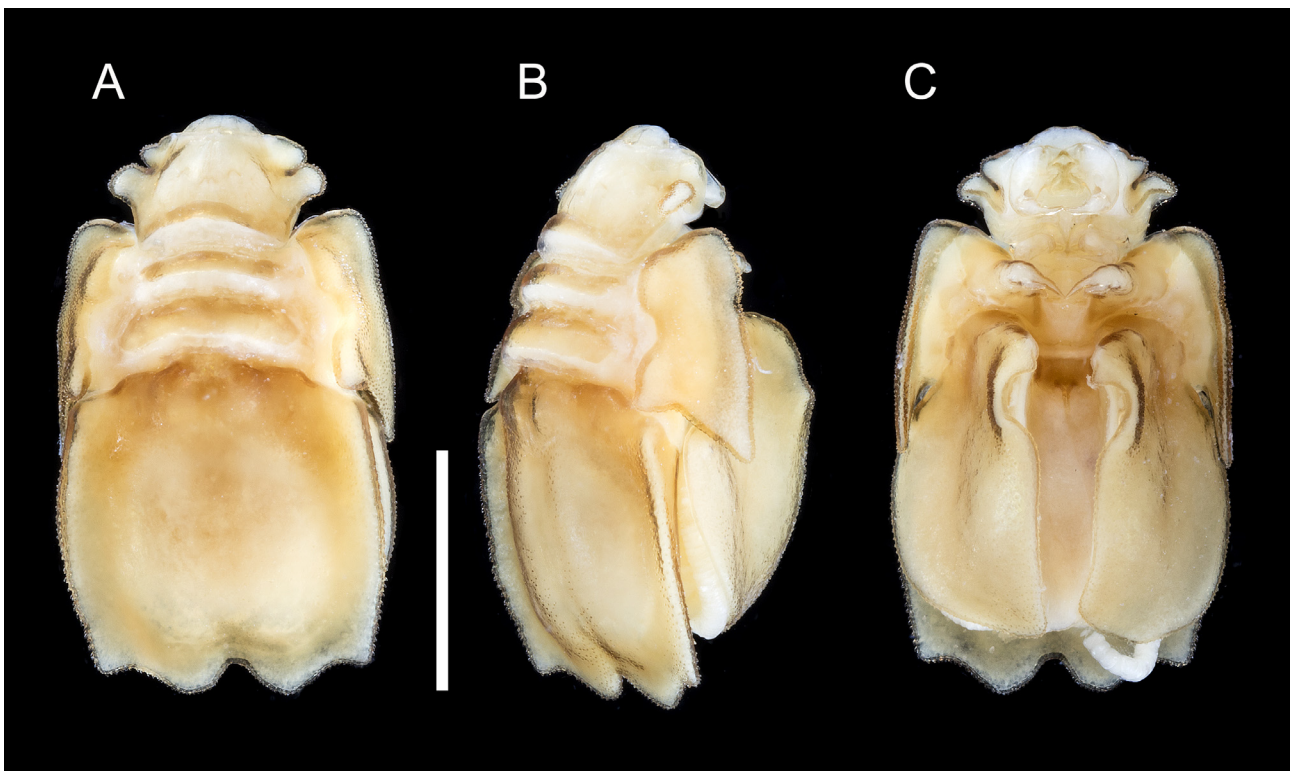


FIGURE 5. *Aethon morelandi* Hewitt 1968, adult ♀. A, habitus, dorsal; B, habitus, lateral; C, habitus, ventral. Scale bar 2 mm.

Differential diagnosis: Cephalothorax markedly wider than long, with distinct dorsal cephalothoracic shield; lateral margins with 2 pairs of lateral processes (Fig. 5A–C), posterior pair much longer than anterior pair; tips of both pairs with papillate surface ornamentation. Trunk distinctly wider than cephalothorax: anterior part with 2 well-defined dorsal tergites derived from second and third pedigerous somites, posterolateral margins extended into pointed posterolateral processes; posterior part of trunk (fourth pedigerous somite) covered by dorsal trunk plate. Plate just longer than wide, with evenly but weakly convex lateral margins; posterior margin with deep median indentation and shallower lateral indentations (Fig. 5A). Looped egg strings entirely concealed beneath dorsal trunk plate in dorsal view. Urosome comprising fifth pedigerous somite, genital complex and 1-segmented abdomen all fused. Anal somite bearing paired caudal rami, each 1.3 times longer than wide, with bluntly rounded apex. Leg 2 with endopod fused to protopod forming curved process bearing reduced exopod as small protuberance on outer side of process. Leg 3 large, comprising 2 lamellate lobes; outer lobe (exopod) rigid and highly sclerotised, orien-

tated vertically and running length of trunk plate, forming side wall of cavity containing loosely coiled egg strings; external surface of outer lobe with papillate surface ornamentation: inner lobe (endopodal) orientated horizontally and extending posteriorly about to end of trunk plate; inner lobe fleshy, lacking surface ornamentation. Leg 4 bilobate; both lobes lamellate with rounded tip, inner lobe shorter than outer. Mean body length of ♀ 4.33 mm and of ♂ 1.66 mm (length data from Boxshall, 1989).

Distribution: This species was originally described from New Zealand waters on the latrid *Latridopsis ciliaris* (Forster, 1801) (Hewitt, 1968). The first record from Australia was from Coffs Harbour (New South Wales) on the cheilodactylid *Nemadactylus macropterus* (Boxshall, 1989). A subsequent record of this species from *N. valenciennesi* caught in South Australia is reported here.

Remarks: *Aethon morelandi* was established on the basis of three females found on the gills of *Latridopsis ciliaris* caught at Ngarauunga near Wellington, New Zealand (Hewitt, 1968). The male was subsequently described from the same host caught at Portobello, east of Dunedin, New Zealand (Rohde *et al.*, 1980). Both sexes were redescribed in detail by Boxshall (1989), based on material from Coffs Harbour.

Genus *Lernanthropodes* Bere, 1936

Lernanthropodes trachinoti Pillai, 1962

Material examined: none.

Differential diagnosis: Cephalothorax longer than wide; lateral margins near linear and tapering anteriorly towards narrow frontal margin; posterior margin concave. Trunk comprising elongate anterior part (second and third pedigerous somites) with more or less parallel sides, lacking dorsal trunk plate, so fourth pedigerous somite and urosome exposed in dorsal view. Urosome comprising fifth pedigerous somite, genital complex and abdomen, all fused; entire urosome sometimes flexed vertically upwards. Egg sacs linear. Caudal rami elongate, about 2.2 times longer than maximum width. Leg 3 lamellate; lamellae fused to form large ventral-ventrolateral tubular extension directed posteriorly but open dorsomedially so urosome visible dorsally: rear margin of tubular extension trilobate. Leg 4 biramous, rami forming slender flattened lobes, almost equal in length. Leg 5 absent. Body length of adult ♀ 4.5 mm (from Pillai, 1962), mean body length of adult ♂ 1.15 mm (from Kabata, 1979a).

Distribution: The original description of *L. trachinoti* was based on material collected from the carangid *Trachinotus blochii* (Lacepède, 1801) caught off Kerala, India (Pillai, 1962). Kabata (1979a) recorded the adult male and an immature female of *L. trachinoti* from *Trachinotus botla* (Shaw, 1803) caught at Tangalooma in Moreton Bay. It has since been reported from *T. blochii* caught off Taiwan (Ho *et al.*, 2011).

Remarks: The female of *L. trachinoti* was redescribed in detail by Ho *et al.* (2011). They noted the close resemblance between their material and the original description of Pillai (1962) but remarked that the females described by Pillai (1985) in his monograph differ and may represent a different species. Kabata (1979a) provided the only available description of the male, based on Australian material.

The genus *Lernanthropodes* is well defined by its lack of a dorsal trunk plate on the fourth pedigerous somite and by configuration of the third legs which are fused to form a large ventral-ventrolateral tubular extension enclosing the posterior end of the body except for a dorsomedial opening through which the urosome is visible in dorsal view (Ho & Do, 1985). These diagnostic characters are shared with the monotypic genus *Chauvanium*, recently established by Kazachenko *et al.* (2017) to accommodate *C. chauvani* Kazachenko, Kovaleva, Nguyen & Ngo, 2017 described from the carangid *Alepes melanoptera* (Swainson, 1839) caught in Bakbo Gulf, Vietnam. The morphological basis for the new genus is the position of the posterior trunk “which is bent dorsally and directed towards the anterior end of the body” in *Chauvanium*, whereas “it is not bent dorsally and is directed towards the posterior end of the body” in *Lernanthropodes* (Kazachenko *et al.*, 2017). Unfortunately, this character does not appear to be robust as a generic discriminant. Indeed, Pillai (1985: Fig. 209A–B) illustrated a female *L. trachinoti* with its entire urosome flexed vertically upwards and out through the dorsomedian opening, whereas the female of the same species illustrated by Ho *et al.* (2011) had its urosome directed posteriorly. The ability to flex the urosome upwards is exhibited by species of *Lernanthropodes* and there is no other support for *Chauvanium* is a distinct genus. The type species of *Chauvanium* is here transferred to *Lernanthropodes* as *L. chauvani* (Kazachenko, Kovaleva, Nguyen & Ngo, 2017), new combination, and *Chauvanium* is here recognized as a junior subjective synonym of *Lernanthropodes*.

Genus *Lernanthropsis* Do, in Ho & Do, 1985

Lernanthropsis mugilii (Shishido, 1898)

(Fig. 6)

Syn: *Lernanthropus mugilii* Shishido, 1898

Lernanthropus mugilis Shishido, 1898 (emended by Yamaguti, 1936)

Lernanthropus shishidoi Shiino, 1955

Lernanthropus nudus Bassett-Smith, 1898

Material examined: 9♀♀, 1♂ from *Mugil cephalus* Linnaeus, 1758 (TC17257), Moreton Bay, Queensland, 18 January 2016; collected by G.A. Boxshall; QM Reg. No. W29475. 3♀♀, 1♂ from *M. cephalus* (TC17120), Moreton Bay, Queensland, 14 January 2016; collected by G.A. Boxshall; QM Reg. No. W29476. 7♀♀, 1♂ from *M. cephalus* (TC17170), Moreton Bay, Queensland, 15 January 2016; collected by G.A. Boxshall. 10♀♀, 1♂ from *M. cephalus* (TC17714, TC17715, TC17718), Moreton Bay, Queensland, 29 June 2016; collected by G.A. Boxshall. 5♀♀, 3♂♂ from *M. cephalus* (TC17692, TC17695), Moreton Bay, Queensland, 28 June 2016; collected by G.A. Boxshall. 5♀♀, 2♂♂ from *M. cephalus* (TC 17763, TC17783, TC17788), Moreton Bay, Queensland, 01 July 2016; collected by G.A. Boxshall. 12♀♀, 4♂♂ from *M. cephalus* (TC17860), Moreton Bay, Queensland, 04 July 2016; collected by G.A. Boxshall; NHMUK Reg. No. 2018.218–227. 3♀♀, 3♂♂ from *M. cephalus*, Clarence River, New South Wales, 28 March 1981; collected by K. Rohde; NHMUK Reg. No. 1984.91. 14♀♀, 5♂♂ from *M. cephalus*, Coffs Harbour, New South Wales, February 1981; collected by K. Rohde; NHMUK Reg. No. 1984.92. 6♀♀, 2♂♂ from *M. cephalus*, Arrawarra Creek, New South Wales, 22 April 1981; collected by K. Rohde; NHMUK Reg. No. 1984.93.

Comparative material examined: Holotype female of *Lernanthropus nudus* Bassett-Smith, 1898 from *Mugil* sp. collected in Aden, BMNH Reg. No. 1898.12.2.12.

Differential diagnosis: Cephalothorax slightly longer than wide with distinct frontal area delimited by distinct constriction (Fig. 6A). Trunk distinctly wider than cephalothorax, divided into anterior and posterior parts by shallow transverse furrow: anterior part (second and third pedigerous somites) with weakly convex lateral margins; posterior part (fourth pedigerous somite) with pair of small flattened lobes located dorsally above bases of fourth legs: dorsal lobes lamellate, clearly separated in midline (Fig. 6A). Urosome comprising fifth pedigerous somite, genital complex and 1-segmented abdomen, all fused. Caudal rami paired, each ramus about 2.1 times longer than wide; with bluntly rounded apex. Parabasal flagellum cylindrical with swollen base. Leg 3 comprising small fleshy lamella located posteriorly on third pedigerous somite; each leg projecting ventrally (Fig. 6B), concave posteriorly and about one quarter width of trunk. Leg 4 bilobate; inner and outer lobes elongate, subequal (Fig. 6A–B). Leg 5 absent. Body length of ♀ ranging from 4.56 to 5.00 mm, with a mean of 4.68 mm (based on 10 specimens).

Male body comprising cephalothorax and trunk (Fig. 6C–D). Cephalothorax comprising 40% of total body length; with distinct frontal area bearing antennules and antennae delimited by constriction. Trunk comprising second to fourth pedigerous somites plus urosome, all somites fused but with grooves delimiting anterior pedigerous somites. Leg 3 uniramous, forming elongate, laterally-directed cylindrical lobe. Leg 4 biramous with subequal endopodal and exopodal lobes, each with rounded tip. Body length of ♂ ranging from 3.35 to 3.60 mm, with a mean of 3.47 mm (based on 5 specimens).

Distribution: This species was originally described from Japan (Shishido, 1898) but it has a wide geographical range across the Indo-West Pacific with reports from Yemen (Bassett-Smith, 1898a), India (Pillai, 1964, 1985; Raja *et al.*, 2018), Sri Lanka (Kirtisinghe, 1964), Taiwan (Ho *et al.*, 2008), and China (Song & Chen, 1976). Kabata (1979a) reported *L. mugilii* from Heron Island (Queensland) based on collections made by P.C. Young in 1963: the hosts in Australian waters were given as *Mugil cephalus* and a labrid, *Choerodon cyanopodus* (Richardson, 1843) (as *Choerodon albigena* (De Vis)). The latter report, from a non-mugilid host, is very unusual and may indicate an error in labelling the original collection. *Lernanthropus mugilii* has been reported from a second mugilid, *Planiliza haematocheila* (Temminck & Schlegel, 1845) (as *Mugil soiuy* Basilewsky) caught in Chinese and Japanese waters (Song & Chen, 1976; Gusev, 1951). Australian material in the collections of the NHM, London was collected from *M. cephalus* caught at three sites in New South Wales by K. Rohde.

Remarks: Kabata (1979a) reviewed the nomenclature of this species concluding that *Lernanthropus shishidoi* Shiino, 1955 was an unnecessary replacement name for *L. mugilii*, and that *Lernanthropus nudus* Bassett-Smith, 1898 was a junior synonym. After examination of the holotype female of *L. nudus* stored in the collections of the

Natural History Museum (BMNH Reg. No. 1898.12.2.12), we can confirm this synonymy. Yamaguti (1936) considered the name *mugilii* of Shishido (1898) to be a “*lapsus calami* or a typographical error” and proposed to correct the name to *L. mugilis*. This is an unnecessary emendation. A detailed redescription of both sexes was provided by Ho & Do (1985). Ho *et al.* (2008) reported this species from *Mugil cephalus* landed in Taiwan and also redescribed both sexes. Izawa (2014) recently provided another re-description based on Japanese material from the same host.

This copepod can be very abundant locally: Raja *et al.* (2018) found a prevalence rate of 98% of *L. mugilii* on *Mugil cephalus* caught off the coast of southeastern India.

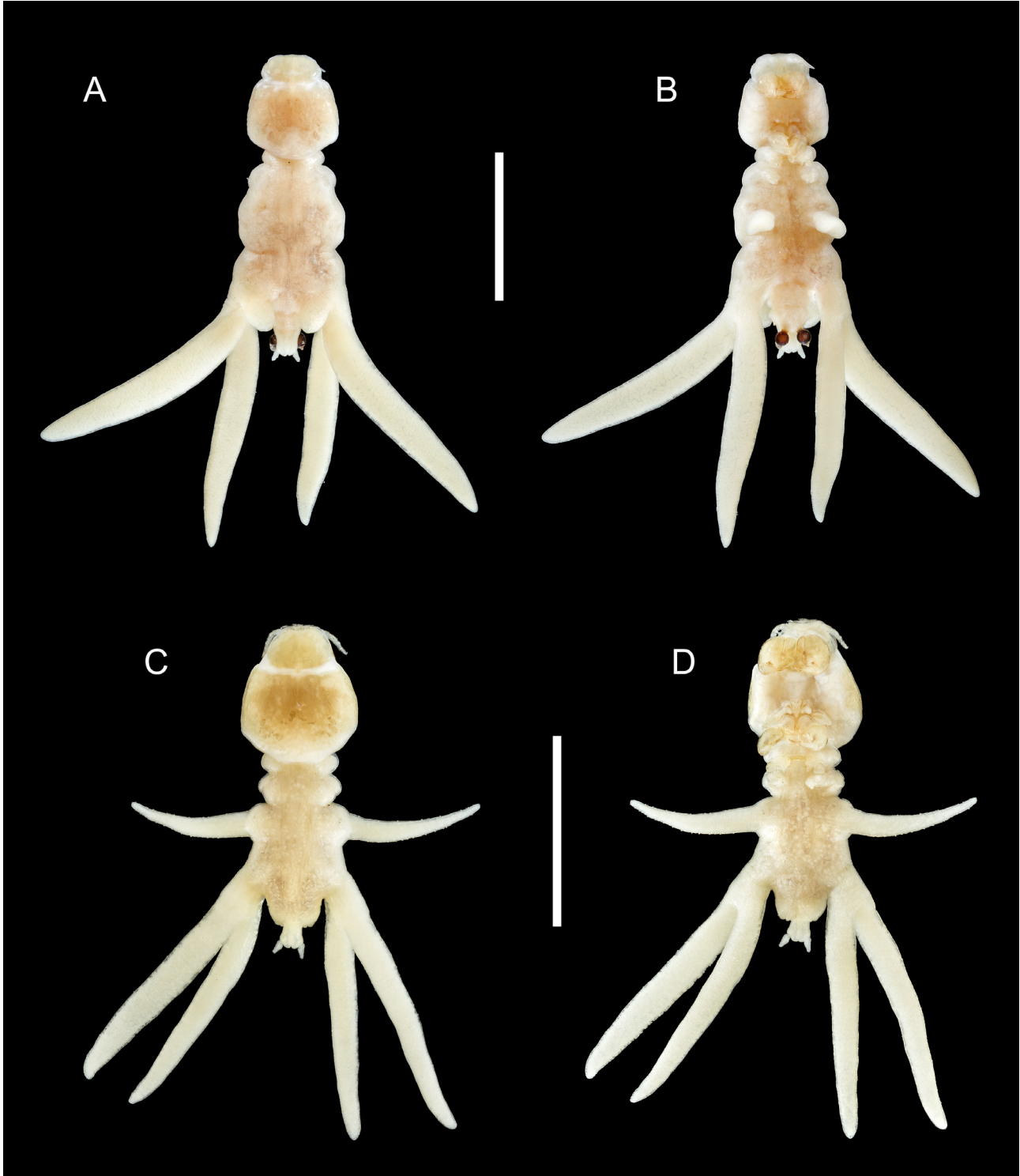


FIGURE 6. *Lernanthropsis mugilii* (Shishido, 1898), adult ♀. A, habitus, dorsal; B, habitus, ventral. Adult ♂. C, habitus, dorsal; D, habitus, ventral. Scale bars 2 mm.

Genus *Lernanthropus* de Blainville, 1822

Lernanthropus abitocephalus Tripathi, 1962

(Fig. 7A–B)

Material examined: 3 ♀♀ from *Pomadasyus argenteus* (Forsskål, 1775), Bynoe Harbour, Darwin, Northern Territory, 24 November 2012, collected by B.K. Diggles; 2 ♀♀ to MAGNT Reg. No. Cr019240; 1 ♀ QM Reg. No. W29477. 2 ♀♀ (1 incomplete) from *P. argenteus*, Adelaide River, Northern Territory, 28 August 2012, collected by B.K. Diggles; NHMUK Reg. No. 2018.230. 2 ♂♂ from *P. argenteus*, Bynoe Harbour, Northern Territory, 16 October 2014, collected by B.K. Diggles; 1 ♂ MAGNT Reg. No. Cr019240; 1 ♂ NHMUK Reg. No. 2018.232. 1 immature ♀ (incomplete) from *P. argenteus*, Inner Harbour, Northern Territory, 25 August 2012, collected by B.K. Diggles; NHMUK 2018.231.

Differential diagnosis: Cephalothorax much longer than wide, narrowing anteriorly towards short transverse frontal margin (Fig. 7A). Anterior part of trunk (second and third pedigerous somites) just longer and wider than cephalothorax, becoming gradually wider towards posterior part (fourth pedigerous somite) covered by dorsal trunk plate. Dorsal trunk plate very wide, with straight transverse free posterior margin. Urosome comprising partly fused fifth pedigerous somite, genital complex and abdomen (Fig. 7B). Paired caudal rami elongate, each ramus about 2.5 times longer than wide; tapering towards blunt apex. Parabasal flagellum tapering linear process, about half length of antennule. Leg 3 forming fleshy lamella, outer lobe splayed outwards at right angle to longitudinal axis of body and extending towards posterior; inner lobe forming vertical lamella close to midline. Leg 4 bilobate; inner lobe shorter than outer; both lobes with distal tips protruding beyond free posterior margin of dorsal trunk plate. Leg 5 represented by unarmed conical process. Mean body length of ♀ 1.88 mm (range 1.82 to 1.92, based on 4 specimens); body length of ♂ specimens 1.31 and 1.34 mm.

Distribution: This species was originally described on the basis of females collected from *Pomadasyus maculatus* (Bloch, 1793) caught in the Bay of Bengal, India (Tripathi, 1962). Song & Chen (1976) subsequently recorded *L. abitocephalus* on *Pomadasyus* sp. in Chinese waters. This is the first record from Australia and *P. argenteus* is a new host record.

Remarks: Pillai (1985) found *L. abitocephalus* on *P. maculatus* caught off Kerala and redescribed it based only on the female. He made comparisons with *L. pomadasysis* described from the same host in Indian waters by Rangnekar & Murti (1961) and concluded, despite some differences which he attributed to mistakes by Rangnekar & Murti, that these two species are synonymous. Inexplicably Pillai (1985) chose to relegate the older of the two names (*L. pomadasysis*) to synonymy with the younger name (*L. abitocephalus*). Ho *et al.* (2008) redescribed female *L. pomadasysis* and described the male for the first time. They noted significant differences from *L. abitocephalus* in the proportions and shape of the cephalothorax, in the form of leg 3 and in the relative lengths of the lobate rami of leg 4. On the basis of these differences (cf. Fig. 7C–D), they resurrected *L. pomadasysis* as a valid species, distinct from *L. abitocephalus*. We follow their treatment here.

Another closely related species is *L. villiersi* Delamare Deboutteville & Nuñez-Ruivo, 1954 which is also parasitic on pomadasysids: it was first reported from *Pomadasyus incisus* (Bowdich, 1825) (as *Pristipoma bennetti* Lowe) and *P. rogeri* (Cuvier, 1830) (as *Pristipoma suillus* (Valenciennes)) caught in the southeastern Atlantic off the coast of Senegal (Delamare Deboutteville & Nuñez-Ruivo, 1954). Its known range was extended south to a latitude of 25° S by Capart (1959) who also reported it from *P. incisus*. An additional host, *P. peroteti* (Cuvier), was later reported from off the coast of Senegal (Diebakate & Raibaut, 1996). The shape of the cephalothorax of *L. villiersi* is somewhat intermediate between *L. abitocephalus* and *L. pomadasysis*, and the posterior margin of the dorsal trunk plate is weakly indented in *L. villiersi* but straight in the other two species. As noted by Pillai (1985), the record of *L. villiersi* on *Sillago sihama* (Forsskål, 1775) caught off Sri Lanka (Kirtisinghe, 1964) may well be a misidentification of the very similar *L. sillaginis* Pillai, 1963.

Lernanthropus alepicolus sp. nov.

(Fig. 8–9)

Type material: Holotype ♀ and 14 paratype ♀♀ from *Alepes apercna* Grant, 1987 (TC17073), Moreton Bay, Queensland, 13 January 2016; collected by G.A. Boxshall, QM Reg. Nos. W29478 (Holotype ♀), W29479 (paratype

♀♀). 8 paratype ♀♀ from *A. apercna* (TC17052), Moreton Bay, Queensland, 12 January 2016; collected by G.A. Boxshall, NHMUK Reg. No. 2018.206–213.

Etymology: the name of the new species combines the generic name of the host with *-icola*, meaning inhabitant.

Description. Female body comprising cephalothorax and trunk (Fig. 8A–C): body length excluding fourth legs ranging from 3.67 to 3.94 mm, with mean of 3.79 mm (based on 10 specimens). Cephalothorax comprising about 30% of total body length, about 1.1 times longer than wide; lateral margins convex, slightly expanded anterolaterally into ventrally-directed folds on either side of cephalothorax (Fig. 8B). Anterior part of trunk (second and third pedigerous somites) well delimited from posterior part by transverse groove; narrowest anteriorly, with prominent anterolateral lobes (shoulders), and widest posteriorly with rounded posterolateral lobes. Posterior part of trunk (Fig. 8A) bearing broad, rounded dorsal trunk plate covering entire abdomen including caudal rami, but with distal half of fourth legs visible in dorsal view; dorsal trunk plate with rounded posterior margin with minor irregularities and slight median indentation. Urosome (Fig. 9A) comprising fifth pedigerous somite fused to broad genital complex, indistinctly separated from unsegmented abdomen. Genital complex wider than long with conspicuous paired genital openings dorsolaterally and paired copulatory pores on ventral surface at extreme posterolateral corners (arrowed in Fig. 9A). Dorsal surface of genital complex ornamented with row of 4 sensillae dorsally. Abdomen about 1.2 times longer than wide, with median anal slit. Paired caudal rami located on ventral surface: each ramus about 2.7 times longer than wide; armed with 2 plumose setae dorsally near base, 1 short lateral seta and 2 short apical setae (Fig. 9A).

Antennule (Fig. 9B) 6-segmented, segments 3 and 4 incompletely separated; some segments with irregular cuticular thickening; setal formula: 1, 3, 2, 1, 1, 11 + 2 ae. Parabasal flagellum lacking. Antenna (Fig. 9C) robust, comprising swollen corpus, bearing papilliform process on medial surface, and distal subchela armed with small process in zone of arthroal membrane in articulation between corpus and subchela; distal claw with flattened area of less sclerotized cuticle on concave margin. Mandible slender, stylet-like, armed with 8 marginal teeth distally (Fig. 9D). Maxillule (Fig. 9E) bilobate, smaller lobe tipped with 1 spiniform element; larger lobe tipped with 3 unequal spiniform elements. Maxilla (Fig. 9F) 2-segmented: comprising proximal syncoxa (lacertus) and distal basis (brachium); basis ornamented with slender process distally; terminal claw armed with rows of sharp denticles along both edges. Maxilliped (Fig. 9G) 2-segmented; comprising massive corpus with papilliform process and rounded knob on myxal surface, and distal subchela; subchela comprising compound endopodal segment, bearing minute seta (arrowhead on Fig. 9G) on concave margin and small knob-like process distally; terminal claw strongly curved.

Leg 1 with protopodal part fused to somite; members of leg pair joined by slender intercoxal sclerite (Fig. 9H). Each leg biramous with outer plumose seta and short, stout inner spine on incorporated protopod; exopod 1-segmented, armed with 5 robust terminal spines with smooth margins; endopod 1-segmented, tapering distally, armed with terminal seta and ornamented with patches of spinules distally. Leg 2 (Fig. 9I) mounted on inflated subspherical prominence derived from incorporated protopod and armed with outer plumose seta: both rami 1-segmented; exopod distinct, armed with 4 small distal spines; endopod incompletely separated basally, armed with small seta. Leg 3 bilobate: both lobes lamellate; outer (exopodal) lobe shoehorn-like in shape and slightly longer than inner (endopodal) lobe: endopodal lamellae of leg pair together forming hollow, shoehorn-like lobe but lobes separate along inner margin, not fused (Fig. 8C); outer basal seta not observed. Leg 4 (Fig. 9J) biramous with both rami forming elongate flattened processes, proximal part broader but tapering in distal half to narrower distal part; outer basal seta present proximally on dorsal surface: lobes of similar length but inner (endopodal) lobe slightly longer than outer (exopodal). Leg 5 (Fig. 9A) represented by cylindrical lobe about 2.5 times longer than width at base; armed with outer basal seta located dorsally near mid-length, plus 1 minute knob on ventral surface and another on dorsal surface of distal part.

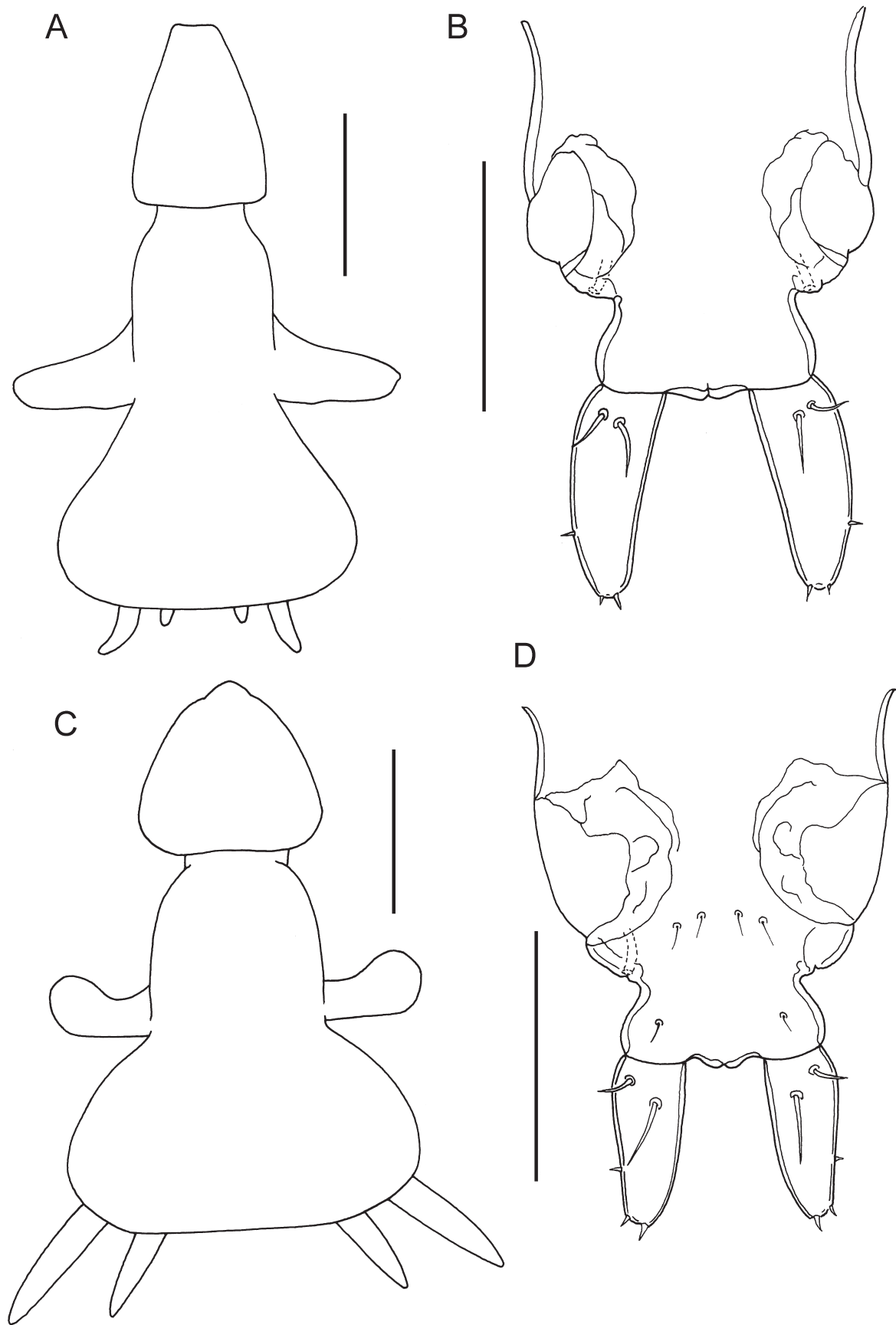


FIGURE 7. *Lernanthropus abitocephalus* Tripathi, 1962, adult ♀. A, habitus, dorsal; B, urosome plus caudal rami, dorsal. *Lernanthropus pomadasysis* Rangnekar & Murti, 1961, adult ♀. C, habitus, dorsal; D, urosome plus caudal rami, dorsal. Scale bars A, C, 0.5 mm; B, D, 200 µm.

TABLE 2. *Lernanthropus* species reported from hosts of the family Carangidae

<i>Lernanthropus</i> species	Host	Locality	Reference
<i>L. alatus</i> Pillai, 1964	<i>Selaroides leptolepis</i> (Cuvier, 1833)	India (Kerala)	Pillai, 1964
<i>L. alepicolus</i> sp. nov.	<i>Alepes melanoptera</i> (Swainson, 1839) <i>Alepes aperna</i> Grant, 1987	Vietnam Queensland, Australia	Kazachenko <i>et al.</i> , 2014 present account
<i>L. corniger</i> Yamaguti, 1954*	<i>Megalaspis corhylla</i> (Linnaeus, 1758)	Indonesia; India; China; Taiwan; Japan; Malaysia; Thailand; Arabian Gulf	Yamaguti, 1954; Pillai, 1985; Song & Chen, 1976; Liu <i>et al.</i> , 2009b; Leong, 1986; Ho & Kim, 2004; Al-Niaem <i>et al.</i> , 2013
	<i>Alepes djedaba</i> (Forsskål, 1775) (as <i>Carangoides malabaricus</i>)	Arabian Gulf	Al-Niaem <i>et al.</i> , 2013
	<i>Alepes djedaba</i> (Forsskål, 1775) (as <i>Caranx djedaba</i>)	South Africa	Kensley & Grindley, 1973
	<i>Decapterus</i> sp.	off Hainan Island, China	Song & Chen, 1976
<i>L. giganteus</i> Krøyer, 1863	<i>Caranx hippos</i> (Linnaeus, 1766) (as <i>Caranx carangus</i>) <i>Caranx crysos</i> (Mitchill, 1815) <i>Caranx hippos</i> (Linnaeus, 1766)	Brazil; Senegal Jamaica; off West Africa Jamaica; Texas (USA); Senegal; Brazil	Krøyer, 1863; Delamare Deboutteville & Nuñez-Ruivo, 1954 Wilson 1913; Capart, 1959 Wilson, 1913; Pearse, 1952; Diebakate & Raibaut, 1996; Luque & Alves, 2001
	<i>Caranx ignobilis</i> (Forsskål, 1775)	Sri Lanka; Taiwan	Kirtisinghe, 1964; Liu <i>et al.</i> , 2009b
	<i>Caranx latus</i> Agassiz, 1831	Brazil	Luque & Alves, 2001
	<i>Caranx melampygus</i> Cuvier, 1833	Yemen; Sri Lanka	Bassett-Smith, 1898a; Kirtisinghe, 1964
	<i>Caranx hippos</i> (Linnaeus, 1766) (as <i>Caranx sansum</i>)	Sri Lanka	Kirtisinghe, 1964
	<i>Caranx senegallus</i> Cuvier, 1833	Senegal	Delamare Debutteville & Nuñez-Ruivo, 1954
	<i>Caranx sexfasciatus</i> Quoy & Gaimard, 1825	Taiwan	Liu <i>et al.</i> , 2009b

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TABLE 1. (Continued)

<i>Lernanthropus</i> species	Host	Locality	Reference
	<i>Carangoides ferdau</i> (Forsskål, 1775) (as <i>Caranx ferdau</i>)	India	Pillai, 1985
	<i>Hemicaranx bicolor</i> (Günther, 1860)	off West Africa	Capart, 1959
	<i>Carangoides praeustus</i> (Anonymous [Bennett], 1830)	China	Song & Chen, 1976
	<i>Setaroides leptolepis</i> (Cuvier, 1833) (as <i>Caranx leptolepis</i>)	Kuwait	Ho & Sey, 1996
<i>L. gnathanodontus</i> sp. nov.	<i>Gnathanodon speciosus</i> (Forsskål, 1775)	Queensland, Australia	present account
<i>L. indicus</i> Pillai, 1967	<i>Caranx hippos</i> (Linnaeus, 1766) (as <i>Caranx sansum</i>)	India	Pillai, 1967
	<i>Megalaspis corbula</i> (Linnaeus, 1758)	Arabian Gulf	Al-Ataby <i>et al.</i> , 2012
	<i>Alepes djedaba</i> (Forsskål, 1775) (as <i>Carangiodes malabaricus</i>)	Arabian Gulf	Al-Ataby <i>et al.</i> , 2012
<i>L. koenigii</i> Steenstrup & Lutken, 1861**	<i>Parastromateus niger</i> (Bloch, 1795)	India	Pillai, 1985
<i>L. micropterygis</i> Richiardi, 1884***	<i>Seriola dumerili</i> (Risso, 1810) (as <i>Micropteryx dumerili</i>)	Mediterranean Sea	Richiardi, 1884; Brian, 1906
	<i>Seriola lalandi</i> Valenciennes, 1833 (as <i>Seriola aureovittata</i>)	Red Sea	Wilson, 1924
[as <i>L. delamarei</i> Marques, 1960]	<i>Seriola lalandi</i> Valenciennes, 1833	São Tomé	Marques, 1960
[as <i>L. ecclesi</i> Kensley & Grindley, 1973]	<i>Seriola lalandi</i> Valenciennes, 1833	South Africa	Kensley & Grindley, 1973
[as <i>L. gisleri</i> van Beneden, 1852]	<i>Lichia amia</i> Linnaeus, 1758	Mediterranean Sea	Brian, 1906
<i>L. mitratus</i> Shiino, 1959	<i>Seriola</i> sp.	06° 30' N, 77° 53' W	Shiino, 1959
<i>L. robustus</i> Pillai, 1964	<i>Caranx</i> sp.	India	Pillai, 1964

.....continued on the next page

TABLE 1. (Continued)

<i>Lernanthropus</i> species	Host	Locality	Reference
<i>L. seriolii</i> Shishido, 1898****	<i>Seriola quinqueradiata</i> Temminck & Schlegel, 1845	Japan	Shishido, 1898
	<i>Seriola lalandi</i> Valenciennes, 1833	Japan	Izawa, 2014
	<i>Seriola hippos</i> Günther, 1876	Queensland, Australia	present account
[as <i>L. paenulatus</i>]	<i>Seriola hippos</i> Günther, 1876	South Australia, Australia	Hutson <i>et al.</i> 2007b
[as <i>L. paenulatus</i>]	<i>Seriola lalandi</i> Valenciennes, 1833	Massachusetts, North Carolina (USA); Australia; New Zealand;	Wilson, 1922; Rohde <i>et al.</i> , 1995; Hutson <i>et al.</i> , 2007a
[as <i>L. paenulatus</i>]	<i>Seriola</i> sp.	China	Song & Chen, 1976
Misidentified species			
<i>L. polynemi</i> Richiardi, 1881†	<i>Alepes djedaba</i> (Forsskål, 1775) (as <i>Caranx kalla</i>)	Sri Lanka	Kirtisinghe, 1956
[as <i>L. trifoliatius</i> Bassett-Smith, 1898]			
<i>L. polynemi</i> Richiardi, 1881†	<i>Carangoides praeustus</i> (Anonymous [Bennett], 1830) (as <i>Caranx Carangoides praeustus</i>)	Sri Lanka	Kirtisinghe, 1956
[as <i>L. trifoliatius</i> Bassett-Smith, 1898]			
<i>L. caranxi</i> Hesse, 1878††	“ <i>Caranx brachurus</i> ”	European waters	Hesse, 1878

**Lernanthropus corniger* has also been reported from a number of non-carangid hosts including: *Mene maculata* (Bloch & Schneider, 1801) (Menidae) and *Myripristis vittata* Valenciennes, 1831 (Holocentridae) by Liu *et al.*, (2009b), and *Rastrilliger brachysoma* (Bleeker, 1851) (Scombridae) by Pillai (1985).

** *Lernanthropus koenigii* has also been reported from the non-carangid host, *Peprilus paru* (Linnaeus, 1758) (Stromateidae) by Pillai (1985)

***Here we propose that *L. ecclesi* Kensley & Grindley, 1973 be recognised as a junior subjective synonym of *L. micropterygis* and that *L. delamarei* Marques, 1960 is tentatively considered to be a synonym of *L. micropterygis*.

**** We consider that the report of *L. seriolii* (as *L. paenulatus*) from *Scienops ocellatus* (Linnaeus, 1766) by Causey (1953) may be a misidentification.

† Piasecki & Hayward (2002) concluded that Kirtisinghe’s material was unlikely to represent *L. trifoliatius*, which they synonymised with *L. polynemi*.

†† *Lernanthropus caranxi* Hesse, 1878 is here transferred to *Lernanthropus caranxi* (Hesse, 1878) **n. comb.** (see text).

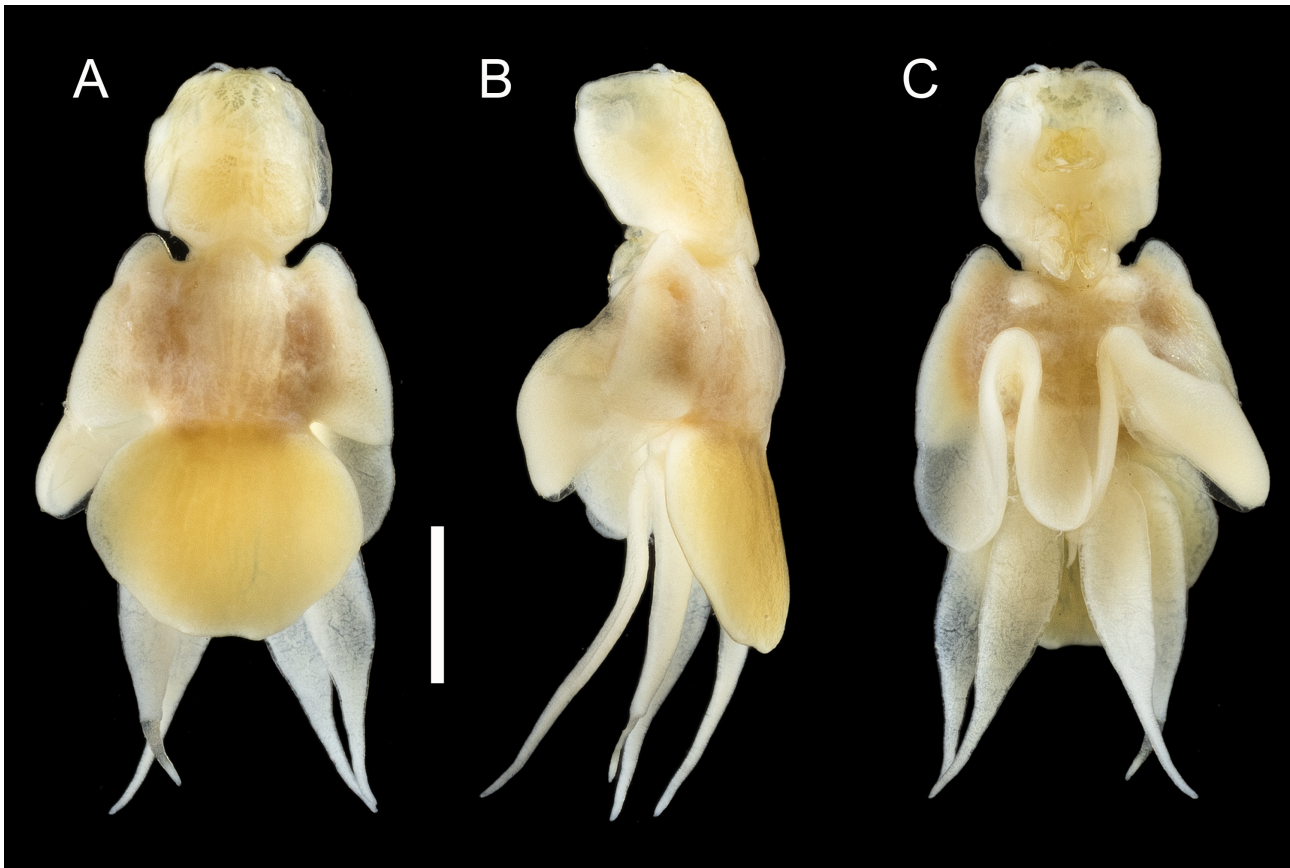


FIGURE 8. *Lernanthropus alepicolus* sp. nov., paratype ♀. A, habitus, dorsal; B, habitus, lateral; C, habitus, ventral. Scale bar 1 mm.

Remarks: Globally, 13 species of *Lernanthropus* are typically found on carangid hosts (Table 2). Six of these species are known only from host fishes belonging to the genus *Seriola* Cuvier, 1816: *L. delamarei* Marques, 1960, *L. ecclesi* Kensley & Grindley, 1973, *L. micropterygis* Richiardi, 1884, *L. mitratus* Shiino, 1959, *L. paenulatus* Wilson, 1922, and *L. seriolii* Shishido, 1898. The adult females of *L. micropterygis* and *L. ecclesi* both have a long slender body form with a lanceolate leg 5 that is about 4 to 5 times longer than wide, and lanceolate caudal rami, the tips of which extend beyond the posterior margin of the dorsal trunk plate. Richiardi's (1884) original description of *L. micropterygis* was based on females collected from *Seriola dumerili* (Risso, 1810) (as *Micropteryx dumerili*). It was very brief and lacked illustrations, however Goggio (1906) subsequently illustrated the habitus of both sexes based on material from the same host also caught in Italian waters. Some further morphological details of *L. micropterygis* were provided by Wilson (1924), based on material from *Seriola lalandi* Valenciennes, 1833 (as *S. aureovittata*) caught in the Red Sea. The South African material from *Seriola lalandi* described by Kensley & Grindley (1973) as a new species, *L. ecclesi*, appears to be identical to *L. micropterygis* in all important respects. We here propose that *L. ecclesi* be treated as a junior subjective synonym of *L. micropterygis*. The female illustrated by Brian (1906: Tav. XVII, fig. 2) under the name *L. gisleri* is misidentified: it is *L. micropterygis* and its host was the carangid *Lichia amia* Linnaeus, 1758.

Lernanthropus mitratus and *L. seriolii* both have long lanceolate fifth legs that extend well beyond the tips of the caudal rami. Both of these species and *L. micropterygis* can be readily differentiated from *L. alepicolus* sp. nov. by the fifth legs, which are reduced to a short, laterally-directed, cylindrical process in the new species, and which are only about the same length as the caudal rami. The fifth legs of *L. paenulatus* were described by Wilson (1922) as “a pair of short fifth leg rudiments just in front of the genital segment”, but re-examination of the type material of *L. paenulatus* has revealed that it has a large lanceolate leg 5. After more detailed consideration (see below) we conclude that *L. paenulatus* Wilson, 1922 is a junior subjective synonym of *L. seriolii* Shishido, 1898.

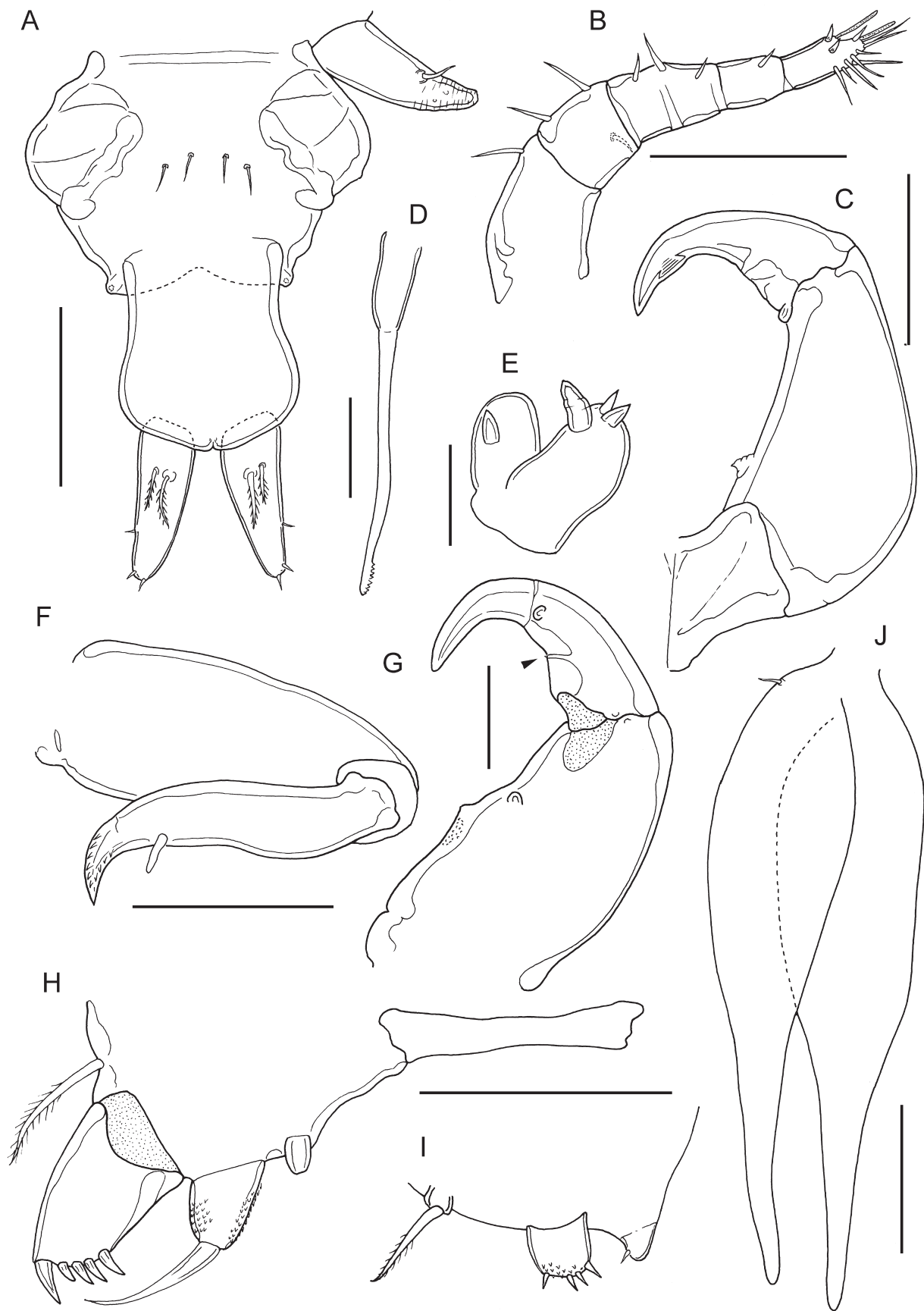


FIGURE 9. *Lernanthropus alepicolus* sp. nov., paratype ♀. A, urosome showing right leg 5 and caudal rami, dorsal; B, antennule; C, antenna; D, mandible; E, maxillule; F, maxilla; G, maxilliped; H, leg 1 and intercoxal sclerite; I, leg 2; J, leg 4. Scale bars A,C, 200 µm, B,F–I, 100 µm, E, 50 µm, J, 0.5 mm.

Unfortunately, *L. delamarei* is known only from the male (Marques, 1960) and the male of the new species is unknown. However, in *Lernanthropus* both sexes usually have very similar antennules: in *L. delamarei* the antennule is 7-segmented compared to indistinctly 6-segmented in the new species. It seems probable that *L. delamarei* is the male of one of the other species known from the Atlantic and Mediterranean, *L. micropterygis* and *L. serioli*. Its body is less elongate than the male of *L. micropterygis* (as *L. ecclesi*) figured by Kensley & Grindley (1973), although this may well be a fixation artefact. The 7-segmented antennules and the presence of a single long seta on the apex of the endopod of legs 1 and 2 are shared characters. The body form of the male of *L. serioli* is more similar to that of *L. delamarei* but the antennules are only 6-segmented and the endopod of leg 2 lacks an apical seta according to Wilson (1922: Pl. 7, Fig. 56). We tentatively place *L. delamarei* into synonymy with *L. micropterygis*, but re-examination of these males is necessary to confirm its true identity.

Among the remaining species listed in Table 2, *L. giganteus* Krøyer, 1863 is the most widely distributed, occurring on at least 11 different species of four different carangid genera, *Caranx* Lacepède, 1801, *Carangoides* Bleeker, 1851, *Hemicaranx* Bleeker 1862 and *Selaroides* Bleeker, 1851 (Table 2). It is characterized by the large processes on the posterolateral corners of the anterior part of the trunk, combined with the elongate fifth legs that extend at least to the tips of the elongate caudal rami (which are themselves about 4.2 times longer than wide, see Liu *et al.*, 2009b). The new species differs in having short posterolateral processes on the anterior part of the trunk, short fifth legs that do not extend back past the genital apertures, and caudal rami that are only about 2.7 times longer than wide.

The other widely distributed species, *L. corniger* Yamaguti, 1954, is similar to the new species in having short fifth legs bearing a single subapical seta and it is also known to occur on a species of *Alepes* Swainson, 1839 (Table 2). However, *L. corniger* is instantly recognizable by the conspicuous paired anterior processes on the dorsal cephalic shield, formed by anterior projections of the ventrally folded lateral margins of the shield. Such frontal processes are lacking in the new species.

Lernanthropus robustus is another distinctive species, distinguishable by the shape of the dorsal trunk plate, which is longer than wide and has a concave posterior margin and angular posterolateral corners. In contrast the new species has a rounded dorsal trunk plate which is wider than long and has a rounded free posterior margin. Another major difference is leg 5, which is long and lanceolate in *L. robustus* but short with a single subapical seta in *L. alepicolus* **sp. nov.**

The new species differs from *L. indicus* Pillai, 1967 in the form of leg 5, which is short with a single subapical seta in the former, but elongate in the latter, extending well beyond the tips of the caudal rami. The dorsal trunk plate of *L. indicus* is just longer than wide and tapers posteriorly whereas in the new species the plate is about 1.3 times wider than long and is widest at mid-length. *Lernanthropus koenigii* Steenstrup & Lutken, 1861, which occurs on both a carangid and a stromateid host (Pillai, 1985), is similar to *L. indicus* in habitus but has enormous fifth legs, which are only just shorter than the inner (endopodal) lobe of the fourth legs. This feature serves to distinguish *L. koenigii* from both *L. indicus* and the new species.

The adult female of *L. alatus* Pillai, 1964 is similar in general habitus to *L. alepicolus* **sp. nov.** and both species have relatively short fifth legs that project laterally and do not extend past the genital openings. These species differ in the shape of the cephalothorax, which is about 1.3 times longer than wide with linear margins in the former but about as wide as long, with convex margins in the new species. In addition, the anterior trunk has pronounced anterior projections (“shoulders”) in *L. alepicolus* **sp. nov.** whereas in *L. alatus* these corners are rounded.

Lernanthropus caranxi Hesse, 1878 is still listed in WoRMS as a valid species under the name *L. carangis* Hesse, 1878 (Walter & Boxshall, 2019) but, as already indicated by Wilson (1922), it almost certainly doesn't belong in *Lernanthropus*. Given the poor quality of the original description, the generic placement of this species appears problematic as it shows some similarities with both *Lernanthropinus* and *Lernanthropodes*, depending on the interpretation of Hesse's description. Wilson (1922) simply rejected it from *Lernanthropus* but was “unable to locate it anywhere else”. Hesse's (1878) description is stylized but shows the female with a deeply-incised dorsal trunk plate combined with paired third legs, as typical for a member of the genus *Lernanthropinus*. Its type host was given as “*Caranx brachurus*” by Hesse (1878), but the name of the host cannot be traced: *brachurus* has never been used as a specific epithet for any member of the family Carangidae (Eschmeyer, 1998). We believe that *brachurus* is a typographical error for *trachurus*, because *Caranx trachurus* Linnaeus, 1758 (now known as *Trachurus trachurus* (Linnaeus, 1758)) is a common carangid in European waters. This is also the type host for *Lernanthropinus trachuri* (Brian, 1903). Comparison between the figures of *Lernanthropus caranxi* published by Hesse (1878) and

the descriptions of *Lernanthropinus trachuri* published by Brian (1903, 1906) shows no major differences that cannot be attributed to the descriptive standards of the late nineteenth Century. We, therefore, recognise *L. trachuri* as a junior subjective synonym of *L. caranxi*, and this species is transferred to *Lernanthropinus* as *Lernanthropinus caranxi* (Hesse, 1878) **n. comb.** Its original spelling is retained and the amended spelling, *L. carangis*, used by Bassett-Smith (1899), Goggio (1906) and Wilson (1922) can be considered an unnecessary emendation.

Among species that do not occur on carangid hosts, the new species most closely resembles *L. opisthopteri* Pil-lai, 1964, a parasite of *Opisthopterus tardoore* (Cuvier, 1829) in Indian coastal waters, a member of the family Pristigasteridae. The basic body shape is similar and both species have a short leg 5 armed with a single seta. However, in *L. opisthopteri* the lobes of leg 4 differ in length, with a longer outer (exopodal) lobe that is longer than the entire body, whereas in the new species the outer and inner lobes are subequal and both are shorter than the entire body.

These comparisons with congeners from carangid hosts and with other congeners with similar body form, reveal multiple differences that justify the establishment of the new species to accommodate the Australian material collected from *Alepes apercna*.

Lernanthropus atrox Heller, 1865

Material examined: 19♀♀, 10♂♂ from *Rhabdosargus sarba* (Forsskål, 1775), Coffs Harbour, New South Wales, 26 November 1981; collected by K. Rohde. 2♀♀, 1♂ from *R. sarba*, Coffs Harbour, New South Wales, 1980; collected by K. Rohde. 21♀♀, 13♂♂ from *R. sarba*, Coffs Harbour, New South Wales, October 1980; collected by K. Rohde. 6♀♀, 12♂♂ from *R. sarba*, Coffs Harbour, New South Wales, 1980; collected by K. Rohde. 12♀♀, 7♂♂ from *R. sarba*, Coffs Harbour, New South Wales, 19 April 1982; collected by K. Rohde; NHMUK Reg. No. 1984.106–111. 5♀ from *R. sarba* (TC17083), Moreton Bay, Queensland, 13 January 2016; collected by G.A. Boxshall; QM Reg. No. W29480. 2♀♀ from *R. sarba* (TC17094), Moreton Bay, Queensland, 13 January 2016; collected by G.A. Boxshall.

2♀♀ from *Acanthopagrus australis* (Günther, 1859) (TC17133), Moreton Bay, Queensland, 14 January 2016; collected by G.A. Boxshall; QM Reg. No. W29481. 2♀♀, 1♂ from *A. australis* (TC17316), Moreton Bay, Queensland, 20 January 2016; collected by G.A. Boxshall; NHMUK Reg. No. 2018.244–246. 1♀ from *A. australis* (TC17135), Moreton Bay, Queensland, 14 January 2016; collected by G.A. Boxshall.

3♀♀ from *Chrysophrys auratus* (Forster, 1801) (TC17145), Moreton Bay, Queensland, 14 January 2016; collected by G.A. Boxshall; NHMUK Reg. No. 2018.247–249. 1♀ from *C. auratus* (TC 16941), Moreton Bay, Queensland, 08 December 2015; collected by S.C. Cutmore; NHMUK Reg. No. 2018.250. 2♂♂ from *C. auratus* (TC17575), Moreton Bay, Queensland, 25 June 2016; collected by G.A. Boxshall. 13♀♀, 9♂♂ from *C. auratus*, Coffs Harbour, New South Wales, collected by K. Rohde; NHMUK Reg. No. 1982.85.

Differential diagnosis: Cephalothorax subrectangular, wider than long. Trunk about as long as cephalothorax; anterior part (second and third pedigerous somites) slightly wider than cephalothorax, bearing third legs ventrally (lateral margins of which visible in dorsal view). Posterior part of trunk (fourth pedigerous somite) covered by ovoid and longer than wide dorsal trunk plate, lateral margins of plate convex, entire free posterior margin weakly convex. Urosome comprising fused genital complex and abdomen bearing paired caudal rami. Caudal rami about twice as long as wide; tapering towards blunt apex; rami entirely concealed beneath dorsal trunk plate in dorsal view. Parbasal flagellum absent. Leg 3 located laterally on ventral surface of third pedigerous somite within trunk region, forming horizontally-orientated fleshy lamella, directed posteriorly, with weakly bilobed tip; outer lobe shorter than inner. Leg 4 bilobate; both inner and outer lobes elongate, subequal, protruding well beyond free posterior margin of dorsal trunk plate. Leg 5 as small unarmed lobe. Body length of ♀ ranging from 2.58 to 3.01 mm, with a mean of 2.80 mm (based on 6 specimens); body length of 2 ♂♂ specimens 1.68 and 1.78 mm.

Distribution: *Lernanthropus atrox* was originally described from Australian waters as parasitic on *Chrysophrys auratus* (as *Pagrus guttatalus*) by Heller (1865). Kabata (1979a) subsequently reported a single male specimen of *L. atrox* from *Acanthopagrus australis* (as *Mylio australis*) collected at Tangalooma in Moreton Bay by P.C. Young in February 1964. Kabata (1979a) considered *L. atrox* to be rather rare but we found it to be common on *A. australis* in Moreton Bay. Roubal (1981) reported *L. atrox* from the same host caught off northern New South Wales, and Roubal *et al.* (1983) reported it from *Chrysophrys auratus* taken off Coffs Harbour. In a more detailed study, Roubal *et al.* (1996) found a significant difference in the prevalence of *L. atrox* on *C. auratus* between the estuarine

(prevalence = 18.8%) and the offshore populations (70.1%) at Port Hacking, Sydney. Byrnes (1988) recorded it on *A. australis*, *A. butcheri* (Munro, 1949) and *A. latus* (Houttuyn, 1782) collected at numerous localities around the coast of Australia including: Carnarvon and Broome (WA), Brisbane (QLD), and Coffs Harbour, Newcastle and Eden (NSW).

This species has also been repeatedly recorded in Japanese waters (Shishido, 1898; Yamaguti, 1936; Shiino, 1955, 1959; Ho & Do, 1985) where it occurs on several sparid fishes including *Chrysophrys auratus* (as *Pagrosomus unicolor*), *P. major* (Temminck & Schlegel) and *Acanthopagrus schlegelii* (Bleeker, 1854) (as *Sparus macrocephalus* and as *A. schlegelii*). *Lernanthropus atrox* has also been reported from China on *A. schlegelii* (as *Sparus macrocephalus*) (Chin, 1947; Song & Chen, 1976). In Brazilian Atlantic waters, *L. atrox* was recorded on *Pagrus pagrus* (Linnaeus, 1758) by Luque (1996), although the geographically disjunct nature of this record invites closer comparison with *L. sarbae* Kensley & Grindley, 1973, described from South African waters.

Remarks: Bassett-Smith (1898b) reported *L. atrox* from *Rhabdosargus sarba* (as *Chrysophrys sarba*) caught at Bunder Abbas in the Persian Gulf but Ho & Do (1985) agreed with Shiino (1955) in suspecting that this *Lernanthropus* should be attributed to *L. sarbae* described from the same host caught off South Africa (Kensley & Grindley, 1973). When describing *L. wilsonis* Capart, 1941 from *Sparus aurata* Linnaeus, 1758 caught off the west coast of Africa, Capart (1941) appeared to distinguish between *L. atrox* as described by Heller (1865) and *L. atrox* as described by Yamaguti (1936). We follow Ho & Do (1985) in considering Yamaguti's Japanese material of *L. atrox* as conspecific with Heller's.

***Lernanthropus belones* Krøyer, 1863**

(Fig. 10A)

Syn: *Lernanthropus chlamydotus* Wilson, 1922

Material examined: none.

Differential diagnosis: Cephalothorax longer than wide with linear lateral margins (Fig. 10A), widest posteriorly and tapering towards straight anterior margin. Trunk just over twice as long as cephalothorax; anterior part (second and third pedigerous somites) as wide as cephalothorax, with weakly convex margins; posterior part (fourth pedigerous somite) covered by long, cloak-like dorsal trunk plate, flared out laterally and widest towards posterior (Fig. 10A). Urosome comprising fused genital complex and abdomen bearing paired caudal rami. Caudal rami short and broad, with bluntly pointed apex; all caudal setae located in distal half of ramus. Leg 3 located ventrolaterally at rear of third pedigerous somite, forming shoehorn-shaped fleshy lamella, directed ventrally; third legs separate along midline. Leg 4 biramous; rami forming elongate, flattened lobes, entirely concealed beneath dorsal trunk plate in adult. Leg 5 absent. Mean body length of ♀ 2.85 mm, of ♂ 1.53 mm (from Cressey & Collette, 1970).

Distribution: In their monographic survey of copepods parasitic on needlefishes (Belonidae), Cressey & Collette (1970) reported *L. belones* from nine different host species collected at numerous localities in tropical, subtropical and warm temperate waters around the world. Their survey included a record of *L. belones* from *Strongylura incisa* caught off Arnhem Land (New Territory).

Remarks: Cressey & Collette (1970) recognized only two species of *Lernanthropus* on belonid hosts, *L. belones* and *L. tylosuri* Richiardi, in Goggio, 1906 (as *L. tylosuri* Richiardi, 1880). They distinguished between them solely on the basis of the shape of the cephalothorax: in *L. tylosuri* there are prominent posterolateral processes on the margin of the cephalothorax while *L. belones* lacks such processes. The males of both species were figured in detail by Cressey & Collette (1970), who noted fine scale differences in the shape of the lamellate leg 4, which they considered to be more deeply bifid at its apex in *L. tylosuri* than in *L. belones*.

Without discussion, Cressey & Collette (1970) placed *L. chlamydotus* Wilson, 1922 (as *L. chlamydotus*) in the synonymy of *L. belones* and this synonymy was accepted by Ho & Do (1985). However, as recognized by Shiino (1955), the Japanese material reported by Yamaguti (1939) under the name *L. chlamydotus* is referable to *L. tylosuri*, as previously noted by Ho & Do (1985).

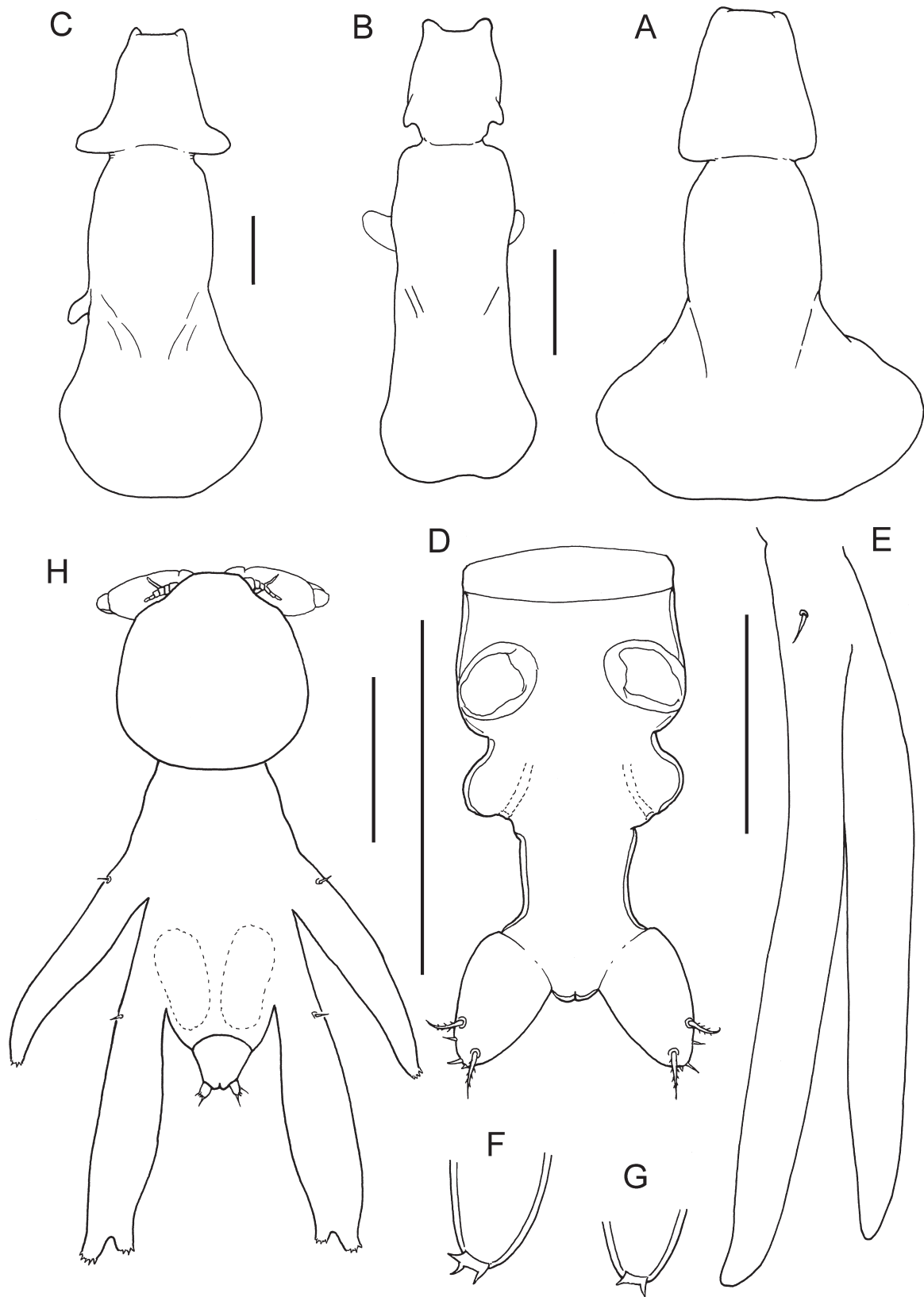


FIGURE 10. *Lernanthropus belones* Krøyer, 1863, adult ♀. A, habitus, dorsal. *Lernanthropus brevicornutus* Kabata, 1979 adult ♀. B, habitus, dorsal. *Lernanthropus tylosuri* Richiardi, in Goggio, 1906, adult ♀. C, habitus, dorsal. [Figures modified from Cressey & Collette, 1970, Kabata, 1979a, and Ho & Do, 1985, respectively]. *Lernanthropus brevicornutus* Kabata, 1979, adult ♀. D, urosome and caudal rami, dorsal; E, leg 4; F, tip of exopod of leg 4; G, tip of endopod of leg 4. Adult ♂. H, habitus, dorsal. All scale bars 0.5 mm.

***Lernanthropus brevicornutus* Kabata, 1979**

(Figs. 10B, D–H, Fig. 11)

Material examined: Holotype 1♀ from *Arrhamphus sclerolepis* Günther, 1846, Moreton Bay, Queensland, 01 October 1963; collected by P.C. Young; NHMUK Reg. No. 1977.114.

Paratype 4♀♀, 1♂ from *A. sclerolepis*, Moreton Bay, Queensland, 01 October 1963; collected by P.C. Young; NHMUK Reg. No. 1977.115–118. 3♀♀, 1♂ from *Arrhamphus sclerolepis* (TC17221), Moreton Bay, Queensland; 18 January 2016; collected by G.A. Boxshall; 3♀♀ and 1♂ QM Reg. No. W29483.

1♀ from *Hyporhamphus regularis* (Günther, 1866) (TC17638), Moreton Bay, Queensland, 27 June 2016; collected by G.A. Boxshall; NHMUK Reg. No. 2018.251.

Differential diagnosis: Cephalothorax longer than wide, with linear lateral margins narrowing anteriorly, and bearing small posterolateral processes (Fig. 10B, 11A–C). Trunk about 3 times longer than cephalothorax with more-or-less parallel lateral margins; anterior part (second and third pedigerous somites) slightly wider than cephalothorax, bearing third legs ventrally; posterior part of trunk (fourth pedigerous somite) covered by long, cloak-like dorsal trunk plate, with convex lateral margins and weak median indentation on posterior margin (Fig. 10B, 11A–C). Urosome comprising fused genital complex and abdomen bearing paired caudal rami (Fig. 10D). Caudal rami short and broad, with bluntly pointed apex; all 5 caudal setae located in distal half of ramus. Parabasal flagellum long and slightly curved, reaching to middle of subapical segment of antennule. Leg 3 forming shoehorn-shaped lamella, projecting ventrolaterally (Fig. 11B); third legs separate along midline and slightly diverging from opposite member of leg pair. Leg 4 biramous (Fig. 10E); rami forming subequal elongate lobes, completely concealed beneath dorsal trunk plate in dorsal view (Fig. 11A); both lobes with complex apical ornamentation (Fig. 10F,G). Leg 5 absent. Body length of ♀ ranging from 3.98 to 4.21 mm, with a mean of 4.12 mm (based on 3 specimens). Male with cephalothorax about as long as wide; comprising 37% of total body length (Fig. 10H). Leg 3 uniramous. Leg 4 forming elongate lobe with bifid tip (Fig. 10H). Body length of single ♂ 1.49 mm.

Distribution: Originally described from Moreton Bay by Kabata (1979a), this species was based on material of both sexes collected from *Arrhamphus sclerolepis* (the type host) and from *Hyporhamphus quoyi* (Valenciennes, 1847) (as *Hemirhamphus quoyi*). This is only the second report of this copepod and *Hyporhamphus regularis* is a new host record.

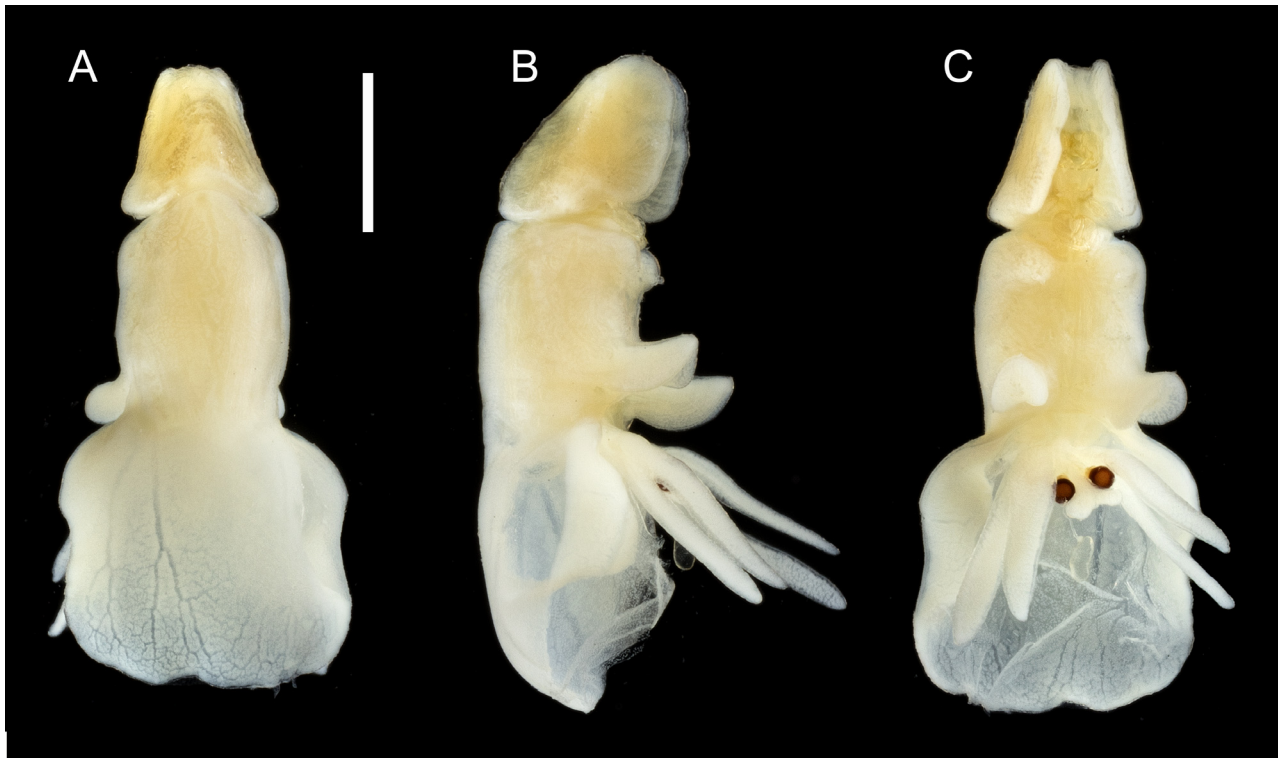


FIGURE 11. *Lernanthropus brevicornutus* Kabata, 1979 adult ♀. A, habitus, dorsal; B, habitus, lateral; C, habitus, ventral. Scale bar 1 mm.

Remarks: Cressey & Collette (1970) recognized only two species of *Lernanthropus* on belonid hosts, *L. belones* and *L. tylosuri*, both of which are globally distributed on needlefish hosts (Belonidae). They noted variation in size of the posterolateral processes on the margins of the cephalothorax but treated the state of development of the processes almost as a continuous variable, although they identified all specimens bearing processes as *L. tylosuri*. When establishing *L. brevicornutus*, Kabata (1979a) highlighted the close similarity between it and both *L. belones* and *L. tylosuri*, but he chose to recognize three species which he distinguished primarily on the basis of the presence and size of the paired posterolateral processes on the cephalothorax: these are absent in *L. belones* (Fig. 10A), short in *L. brevicornutus* (Fig. 10B) and long in *L. tylosuri* (Fig. 10C). The validity of these three very similar species should be tested using molecular data. The female photographed in Figure 11A–C has a distorted dorsal trunk plate (a post-fixation artefact) but a slight median indentation in the posterior margin of the plate is visible and was present in the holotype (Kabata, 1979a: Fig. 3). In both *L. belones* and *L. tylosuri* the posterior margin of the dorsal trunk plate is evenly convex. This is an additional feature which might help to distinguish *L. brevicornutus*.

***Lernanthropus breviculus* Kabata, 1979**

(Figs. 12–14)

Material examined: Holotype 1♀ on *Cheilinus chlorourus* (Bloch, 1791), Heron Island, Queensland, 24 August 1963; collected by P.C. Young; NHMUK Reg. No.1977.121.

Comparative material examined: 1♀ from *C. chlorourus*, Baie de Koutio, New Caledonia; collected by J.–L. Justine, NHMUK Reg. No. 2010.657.

7♀♀, 2♂♂ from *Choerodon graphicus* De Vis, 1885, New Caledonia, collected by J.–L. Justine, NHMUK Reg. No. 2012.249–257. 1♀ from *C. graphicus*, New Caledonia, collected by J.–L. Justine, NHMUK Reg. No. 2012.248.

1♀ from *Cheilinus trilobatus* Lacepède, 1801, New Caledonia, collected by J.–L. Justine, NHMUK Reg. No. 2012.261.

3♀♀ from *Oxycheilinus unifasciatus* (Streets, 1877), New Caledonia, collected by J.–L. Justine, NHMUK 2012.258–260.

Supplementary description of female: Cephalothorax about as long as wide, with slightly angular convex lateral margins (Fig. 12A). Anterior part of trunk (second and third pedigerous somites) broader than cephalothorax and broader than posterior part (fourth pedigerous somite), covered by narrow dorsal trunk plate. Dorsal trunk plate longer than wide, with slightly angular lateral margins and free posterior margin. Urosome comprising fifth pedigerous somite, genital complex and 1-segmented abdomen, all fused (Fig. 13A); genital complex about twice as wide as long, with large paired genital apertures located dorsally and paired copulatory pores at posterolateral corners; surface ornamented with pair of sensillae. Paired caudal rami elongate, about 4.1 times longer than wide; tapering towards blunt apex; bearing 2 plumose setae dorsally, one short naked seta on mid-lateral margin, and 2 short naked setae apically.

Antennule (Fig. 13B) indistinctly 6-segmented; armed with 1, 3, 2, 1, 1, 10 + 2ae. Antenna comprising long corpus with shallow papilla on medial surface, plus strongly recurved distal subchela (Fig. 13C). Parabasal flagellum absent. Maxilla with terminal claw ornamented with spinules (Fig. 13D). Maxilliped (Fig. 13E) 2-segmented; comprising massive corpus with papilliform process and proximal swelling on myxal surface, and strong distal subchela. Leg 1 biramous (Fig. 13F), joined by intercoxal sclerite; protopod with outer seta on papilla plus inner margin spine: exopod 1-segmented with 5 spines on distal margin; endopod 1-segmented, unarmed but with internal glandular structure at apex. Leg 2 forming large ventrally directed lobe (Fig. 13G) derived from protopod armed with outer seta, and carrying small, 1-segmented rami distally; exopod armed with 4 vestigial spines; endopod lobate, unarmed. Leg 3 forming fleshy lamella, orientated horizontally and directed-posteriorly; members of leg pair fully fused along midline (Fig. 12B). Leg 4 bilobate; inner and outer lobes subequal, protruding well beyond posterior margin of dorsal trunk plate (Fig. 12B). Leg 5 absent. Body length of holotype ♀ 1.90 mm (Kabata, 1979a).

Description of male: Body smaller than female (Fig. 14A), total length about 1.70 mm (based on 2 specimens). Cephalothorax large, comprising about 46% of total body length, with convex lateral margins. Frontal area of cephalothorax carrying antennule and antennae, defined by indentation. Trunk comprising all fused post-cephalothoracic somites (Fig. 14A), including urosome. Anal somite defined, bearing paired caudal rami; each ramus

elongate, about 3.0 times longer than wide, armed with 2 plumose setae proximally on dorsal surface, 1 short lateral seta located about at mid-length, plus 2 apical setae.



FIGURE 12. *Lernanthropus breviculus* Kabata, 1979, adult ♀. A, habitus, ventral; B, habitus, dorsal. Scale bar 1 mm.

Antennule 6-segmented as in female; setal formula: 1, 3, 2, 0, 1, 3 + ae, 7 + ae. Parabasal flagellum absent. Antenna comprising long, slender corpus and distal subchela terminating in strongly recurved claw: corpus armed with broad process proximally on medial surface plus inner distal process; subchela armed with strong accessory claw proximally and another accessory claw near middle. Mandible stylet-like, with 8 marginal teeth near apex. Maxillule bilobate, larger lobe armed with 3 unequal elements distally; smaller lobe with strong apical element. Maxilla with 2 rows of denticles on distal claw. Maxilliped comprising robust corpus bearing small pointed myxal process and ornamented with patches of blunt spinules proximally on medial surface, and distal subchela armed with inner seta about at mid-length plus blunt process at base of terminal claw.

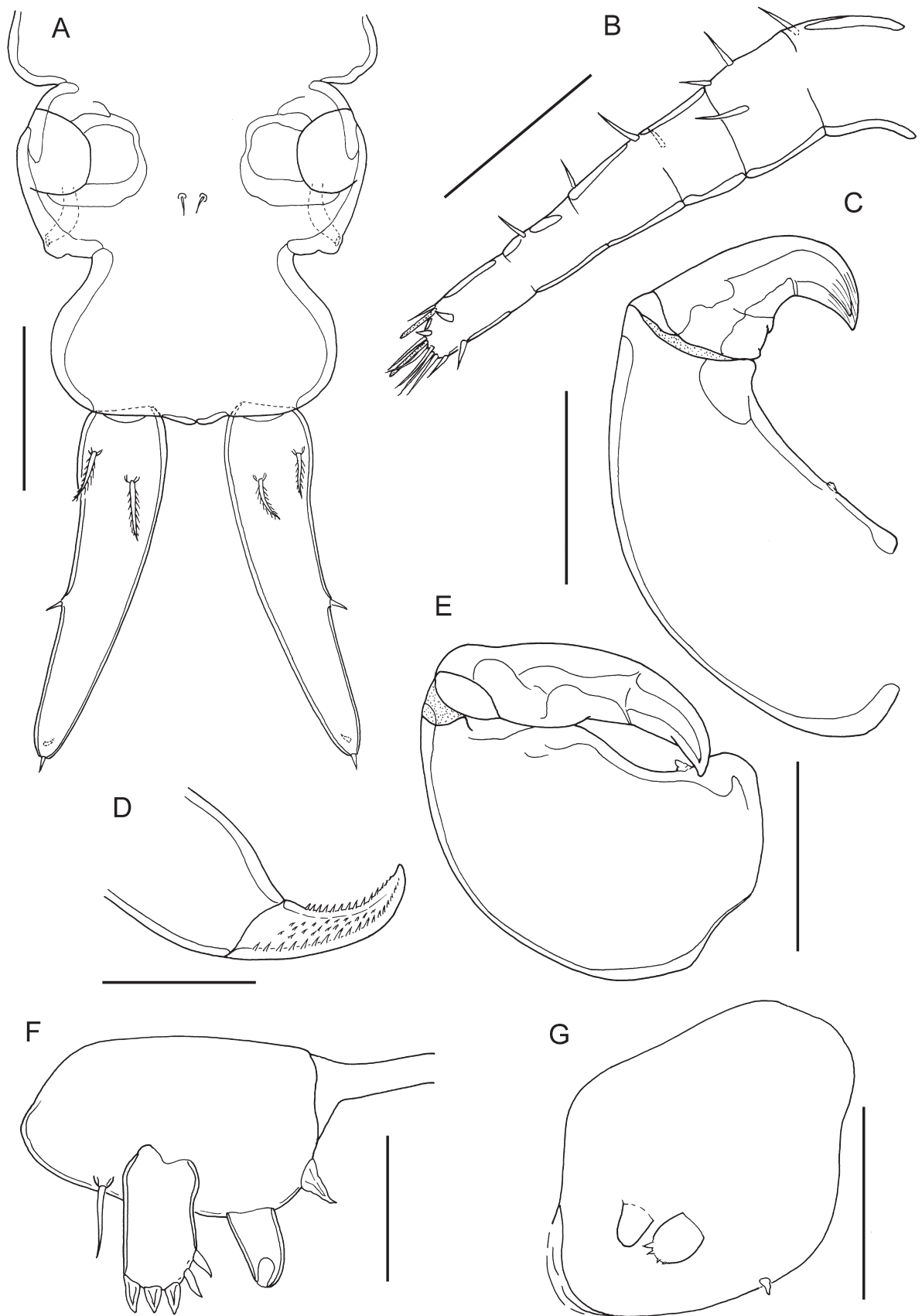


FIGURE 13. *Lernanthropus breviculus* Kabata, 1979, adult ♀. A, urosome and caudal rami, dorsal; B, antennule; C, antenna; D, tip of maxilla; E, maxilliped; F, leg 1 and part of intercoxal sclerite; G, leg 2. Scale bars A,C,E,G, 200 µm, B 100 µm, D,F, 50 µm.

Leg 1 robust, members of leg pair joined by intercoxal sclerite as in female: basis armed with outer seta on papilla and stout inner spine; exopod 1-segmented, broadening distally, armed with 5 distal spines, as in female; endopod 1-segmented (Fig. 14B), tapering distally, armed with spinulose apical seta about 2.5 times longer than segment; segment ornamented with spinules distally. Leg 2 (Fig. 14C) lacking intercoxal sclerite; basis with outer seta; both rami 1-segmented; exopod lobate, modified with spinous structures and rows of spinules on distal surface; endopod just longer than wide and armed with long unilaterally spinulose seta apically; seta about 2.0 times longer than segment; surface of segment ornamented with spinule row proximally. Leg 3 (Fig. 14A) uniramous, forming long cylindrical process directed posterolaterally from ventrolateral origin on trunk, armed with basal seta dorsally at base of limb; surface of leg 3 densely ornamented with rounded tubercles. Leg 4 (Fig. 14A) uniramous, forming long cylindrical process, outer basal seta present dorsally at base of limb. Leg 5 represented by minute papilla with apical seta (arrowed in Fig. 14A).

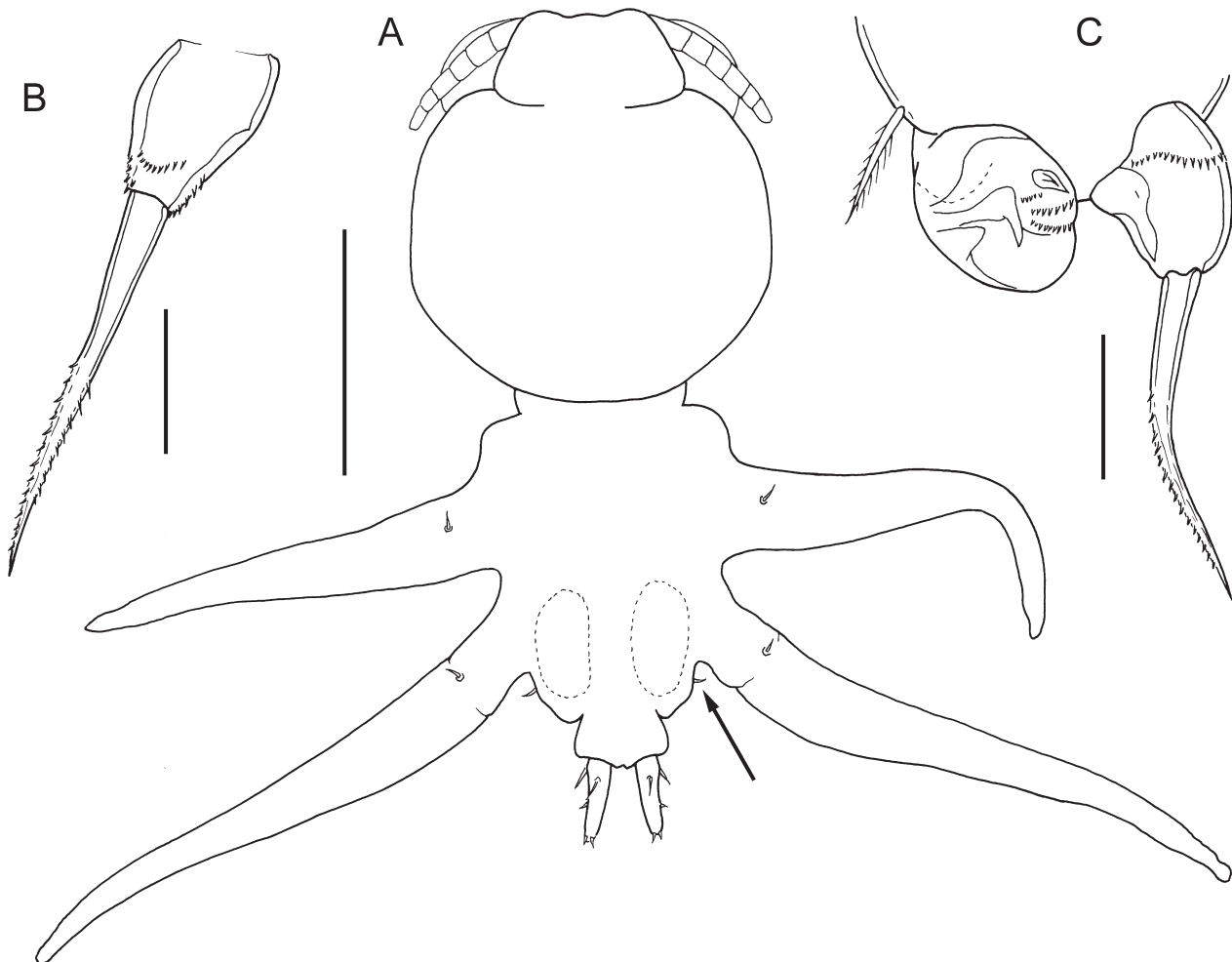


FIGURE 14. *Lernanthropus breviculus* Kabata, 1979, adult ♂. A, habitus, dorsal view with seta representing fifth leg arrowed; B, endopod of leg 1; C, leg 2. Scale bars A, 0.5 mm, B,C, 50 µm.

Distribution: Kabata (1979a) established *L. breviculus* based on a single female collected from the gills of the labrid *Cheilinus chlorourus* (as *C. chlorurus*) caught off Heron Island. It has been collected subsequently by J.-L. Justine from the same host, *C. chlorourus*, caught in the Baie de Koutio, New Caledonia, and from three other labrid species, *Choerodon graphicus* (NHMUK 2012.248 and 2012.249–257), *Oxycheilinus unifasciatus* (NHMUK 2012.258–260) and *Cheilinus trilobatus* (NHMUK 2012.261).

Remarks: Kabata (1979a) had only a single specimen, the holotype, which he did not dissect, so this species has never been fully described. On the basis of material in the collections of the Natural History Museum, we here provide a supplementary description of the female including details of appendage structure, plus the first description

of the male. The material described here was collected by J.-L. Justine from *Choerodon graphicus* caught off New Caledonia.

Considering only the habitus of the female, *L. breviculus* appears to be closely related to *L. callionymicola* El-Rashidy & Boxshall, 2012 described from *Callionymus filamentosus* Valenciennes, 1837 caught in the Mediterranean Sea (El-Rashidy & Boxshall, 2012), but the dorsal trunk plate of *L. callionymicola* is very short and the tips of the caudal rami are visible in dorsal view, whereas in *L. breviculus* the dorsal trunk plate is relatively longer and the caudal rami are completely concealed (Fig. 11A–B).

***Lernanthropus cadenati* Delamare Deboutteville & Nuñez-Ruivo, 1954**

(Fig. 15)

Material examined: 2 ♀♀ and 1 ♂ from *Megalops cyprinoides* (Broussonet, 1782) purchased at West End Market, Brisbane, Queensland, 25 February 2017; collected by R.Q.-Y. Yong; QM Reg. No. W29484. 2 ♀♀ from *M. cyprinoides* Darwin, Northern Territory, 18 October 2012; collected by B.K. Diggles; NHMUK Reg. No. 2018.214–215.

Differential Diagnosis: Cephalothorax just wider than long (Fig. 15A); lateral margins produced anteroventrally into vertical flanges; frontal margin broad, slightly convex. Trunk subrectangular, comprising anterior part (second and third pedigerous somites) wider than cephalothorax and bearing third legs posterolaterally, and posterior part (fourth pedigerous somite) covered by dorsal trunk plate about as wide as anterior part. Dorsal trunk plate with weakly convex lateral margins but extremely short, so urosome entirely exposed and visible in dorsal view (Fig. 15A–C). Egg sacs linear. Caudal rami about 3.2 times longer than width at base. Parabasal flagellum with swollen base and tapering distal part. Leg 3 lamellate, with large fleshy outer lobe directed posteriorly and almost reaching to end of dorsal trunk plate, plus lamellate inner lobe (endopod): endopodal lobes fused in midline to form triangular ventral plate (Fig. 15C). Leg 4 bilobate, both lobes lamellate (Fig. 15C), outer lobe longer than inner with only very bases of lobes concealed beneath dorsal trunk plate. Leg 5 reduced to short conical process, unarmed. Mean body length of ♀ 5.05 mm, range 4.95 to 5.11 mm (based on 3 specimens).



FIGURE 15. *Lernanthropus cadenati* Delamare Deboutteville & Nuñez-Ruivo, 1954, adult ♀. A, habitus, dorsal; B, habitus, lateral; C, habitus, ventral. Scale bar 2 mm.

Distribution. Delamare Deboutteville & Nuñez-Ruivo (1954) first described this species based on females collected from *Elops senegalensis* Regan, 1909 caught off the coast of Senegal (West Africa). It was subsequently reported from India on a megalopid, *Megalops cyprinoides* by Pillai (1966). Liu *et al.* (2009a) recorded it from the same host landed in Taiwan and they also found it on a second elopid host, *Elops machnata* (Forsskål, 1775). In the collections of the NHM there is material of *L. cadenati* collected by J.-L. Justine from the gills of *Elops hawaiiensis* Regan, 1909 caught off New Caledonia (NHMUK 2010.897). Ho & Sey (1996) reported *L. cadenati* from two sparid hosts, *Acanthopagrus berda* (Forsskål, 1775) and *Sparidentex hasta* (Valenciennes, 1830) (as *Acanthopagrus hasta*). This report from sparid hosts, rather than elopid and megalopid hosts, is most unusual and needs confirmation. The present report is the first from Australian waters, and the known distribution now extends from Brisbane in Queensland to Darwin in the Northern Territory.

Remarks. Both sexes of this distinctive species were redescribed in detail by Liu *et al.* (2009a). The form of the third legs with their fused endopodal lobes, in combination with the short dorsal trunk plate which leaves the entire genitoabdomen and bases of the fourth legs exposed in dorsal view, are important diagnostic characters of the female. The male exhibits marked size disparity between its uniramous third and fourth legs: leg 3 is about as long as the male's trunk while leg 4 is about 4 times longer than leg 3 and 1.5 times longer than the entire body of the male.

Lernanthropus delamari Capart, 1959 is also known from elopid hosts, *E. senegalensis* and *E. lacerta* Valenciennes, 1847, from off the coast of Zaire and Senegal (Capart, 1959; Diebakate & Raibaut, 1996). *Lernanthropus cadenati* can be differentiated from *L. delamari* by the extent of the dorsal trunk plate, which is short in the former, revealing the abdomen and caudal rami in dorsal view, but long in the latter, completely concealing the entire urosome in dorsal view. The single record of *L. rathbuni* Wilson, 1922 on *Elops saurus* Linnaeus, 1766 (Causey, 1953) is questionable since, as already remarked by Diebakate & Raibaut (1996): *L. delamari* is very similar to *L. rathbuni* and the former was not recognized as a distinct species until 1959.

***Lernanthropus chrysophrys* Shishido, 1898**

(Fig. 16)

Material examined: 3♀♀ from *Acanthopagrus australis* (Günther, 1859) (TC17145), Moreton Bay, Queensland, 14 January 2016; collected by G.A. Boxshall; QM Reg. No. W29485. 2♀♀ from *A. australis* (TC17250), Moreton Bay, Queensland, 18 January 2016; collected by G.A. Boxshall; QM Reg. No. W29486. 3♀♀ from *A. australis* (TC17563), Moreton Bay, Queensland, 24 June 2016; collected by G.A. Boxshall; QM reg. No. W29487. 2♀♀ from *A. australis* (TC17132), Moreton Bay, Queensland, 14 January 2016; collected by G.A. Boxshall. 1♀ from *A. australis* (TC17310), Moreton Bay, Queensland, 20 January 2016; collected by G.A. Boxshall. 2♀♀ from *A. australis* (TC17316), Moreton Bay, Queensland, 20 January 2016; collected by G.A. Boxshall. 4♀♀, 1♂ from *A. australis* (TC17580), Moreton Bay, Queensland, 25 June 2016; collected by G.A. Boxshall; NHMUK Reg. No. 2018.234–243.

3♀♀ from *Acanthopagrus pacificus* Iwatsuki, Kume & Yoshino, 2010, Darwin Harbour, Northern Territory, 15 October 2014: collected by B.K. Diggles; 2♀♀ MAGNT Reg. No. Cr019241; 1♀ NHMUK Reg. No. 2018.233.

Differential diagnosis: Cephalothorax about as long as wide, with almost straight frontal margin and paired posterolateral processes on lateral margins (Fig. 16A–C); processes slightly curved posteriorly. Anterior part of trunk (second and third pedigerous somites) narrower than cephalothorax, longer than wide with slight indentation marking boundary between fused second and third pedigerous somites. Posterior part of trunk (fourth pedigerous somite) covered by almost circular dorsal trunk plate, with entire and almost linear free posterior margin. Urosome comprising fifth pedigerous somite, genital complex and abdomen, all fused. Paired caudal rami elongate, each ramus about 4 times longer than wide; tapering towards apex. Parabasal flagellum tapering from wide base to cylindrical distal part. Leg 3 forming fleshy lamella, projecting ventrally with distal part curving anteriorly (Fig. 16B); lamella curved (so convex anteriorly and concave posteriorly). Leg 4 bilobate; lobes lanceolate (Fig. 16C), inner lobe slightly shorter than outer, distal halves of both lobes protruding well beyond free posterior margin of dorsal trunk plate. Body length of ♀ ranging from 3.32 to 4.21 mm, with a mean of 3.78 mm (based on 9 specimens); body length of single ♂ 1.73 mm.

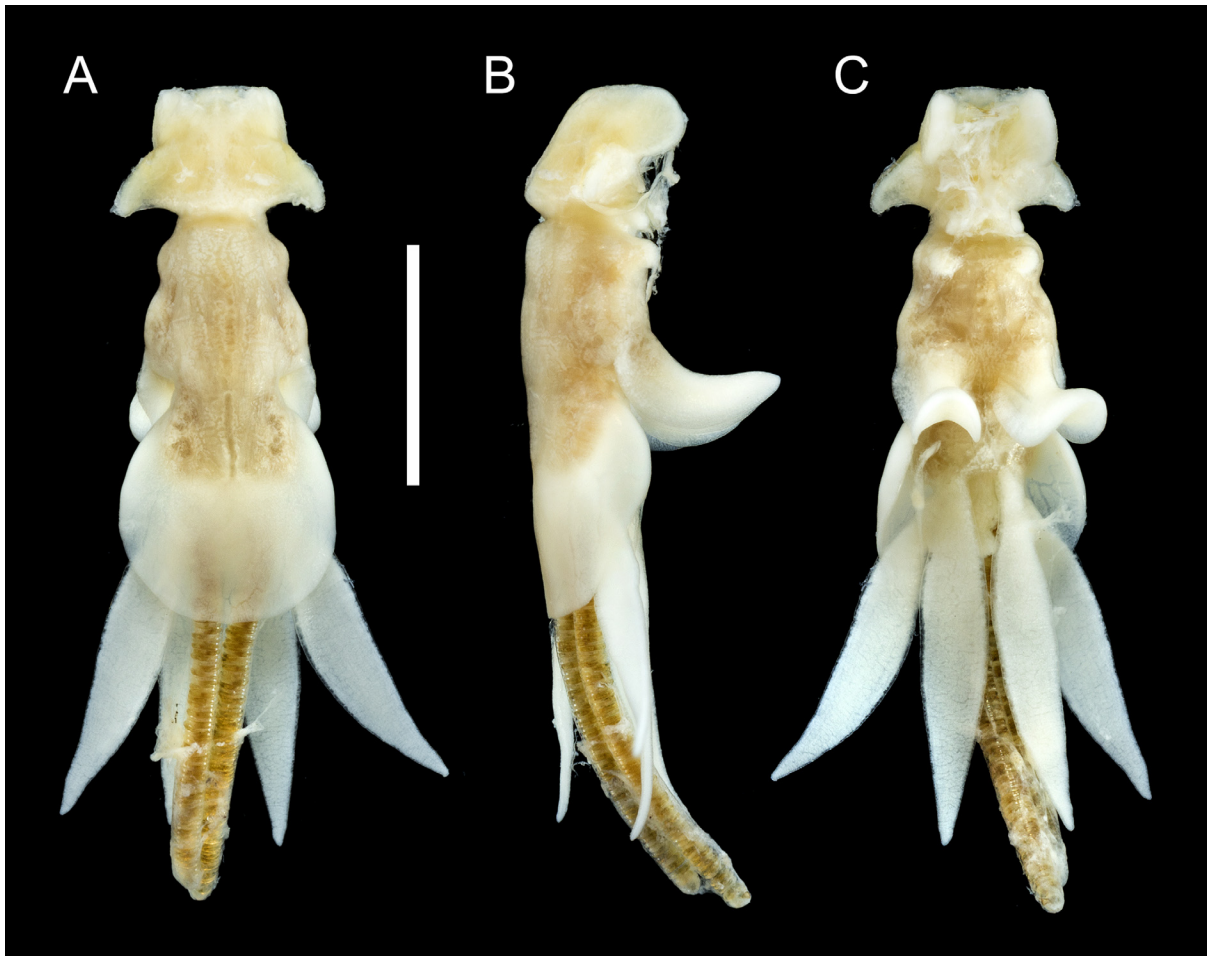


FIGURE 16. *Lernanthropus chrysophrys* Shishido, 1898, adult ♀. A, habitus, dorsal; B, habitus, lateral; C, habitus, ventral. Scale bar 2 mm.

Distribution: This species was originally described from Japan (Shishido, 1898) and has been recorded subsequently on numerous occasions, on *Acanthopagrus schlegelii* in Japanese waters (Yamaguti, 1936 (as *Sparus longispinis*); Shiino, 1955; Ho & Do, 1985). This species has also been reported on *A. latus*, *A. schlegelii* and *A. berda* (Forsskål, 1775) in Taiwan (Liu *et al.*, 2009a); on *A. schlegelii* (as *Sparus macrocephalus*) in China (Song & Chen, 1976), and on *A. berda* in India (Tripathi, 1962; Pillai, 1985). This species has previously been reported in Australian waters, where it is widespread: Byrnes (1988) recorded it on *A. australis*, *A. pacificus* (historically misidentified as *A. berda*, see Iwatsuki *et al.*, 2010) and *A. latus* collected at numerous localities around the coast of Australia including: Point Samson, Broome (WA), Darwin, Bing Bong (NT), Townsville, Gladstone, Brisbane (QLD) and Eden (NSW). It is reported here from Moreton Bay for the first time.

Remarks: This species has been redescribed numerous times, most recently by Liu *et al.* (2009a). The description by Ho & Do (1985) is ideal for comparisons as it is supported by illustrations of the highest quality. The rounded knob-like post-antennal process of the female was figured by Yamaguti (1936).

***Lernanthropus elegans* sp. nov.**

(Figs. 17–19, Fig. 20A–B)

Syn: *Lernanthropus gisleri*: Yamaguti, 1936

Type material: Holotype ♀ and allotype ♂ from *Atractoscion aequidens* (Cuvier, 1830), Coffs Harbour, New South Wales; 10 December 1981; collected by K. Rohde, AM Reg. Nos. P.103901 (Holotype ♀), P.103902 (allotype ♂).

Paratype ♀ from same host; QM Reg. No. W29488. 2 paratype ♀♀, from *A. aequidens*, Coffs Harbour, New South Wales; December 1980–January 1981; collected by K. Rohde, NHMUK Reg. No. 2018.252–253.

Description of female: Female body comprising cephalothorax, trunk and urosome entirely concealed beneath dorsal trunk plate (Fig. 17A–C). Cephalothorax about 1.2 times longer than wide; frontal margin with weakly trilobate appearance; lateral margins more or less parallel, expanded into short, anteroventrally directed folds on either side. Trunk elongate; anterior part (second and third pedigerous somites) about 1.6 times longer than cephalothorax, becoming slightly wider posteriorly towards origin of third legs; posterior part (fourth pedigerous somite) increasing in width towards posterior margin, with dorsal trunk plate covering abdomen but with tips of caudal rami visible in dorsal view (Figs. 17C, 18A). Dorsal trunk plate with linear lateral margins increasing in width posteriorly, posterior margin evenly convex, without median indentation (Fig. 18A). Urosome comprising fifth pedigerous somite, genital complex and abdomen (Fig. 18A–B), all fused; dorsal surface of urosome ornamented with 6 sensillae. Each caudal ramus about 5.0 times longer than wide, tapering towards apex armed with 2 plumose setae proximally on dorsal surface, minute lateral seta located at about 87% of ramus length, and 2 small apical setae (Fig. 18B). Body length of ♀ ranging from 4.64 to 4.95 mm, with a mean of 4.80 mm (based on 3 specimens).

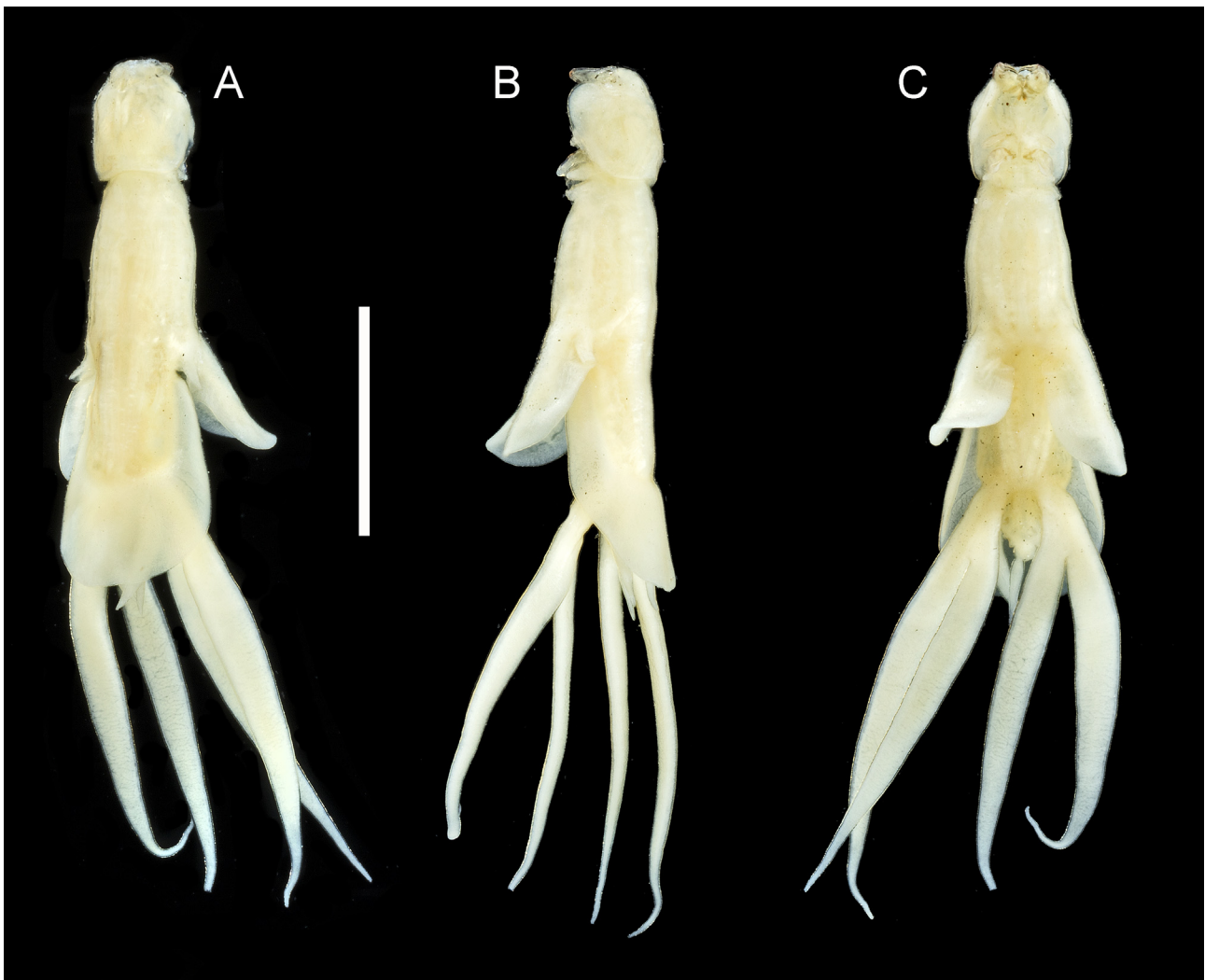


FIGURE 17. *Lernanthropus elegans* sp. nov., holotype ♀. A, habitus, dorsal; B, habitus, lateral; C, habitus, ventral. Scale bar 2 mm.

Antennule (Fig. 18C) 7-segmented, segments 3 and 4 incompletely separated; setal formula: 1, 3, 2, 1, 1, 3 + ae, 7 + ae; swollen first segment and adjacent cephalothoracic surface densely ornamented with long setules. Parabasal flagellum with broad base and curved, slender distal part (Fig. 18D) more than half length of antennule; swollen base lacking ornamentation. Antenna (Fig. 18E) robust, comprising massive corpus, bearing papilliform element proximally on medial surface, and distal subchela unarmed but with pitted surface. Post-

antennal process forming anteriorly-directed rounded lobe, densely ornamented with long setules (Fig. 18F). Mandible stylet-like, armed with 8 marginal teeth distally (Fig. 18G). Maxillule (Fig. 18H) comprising small inner lobe tipped with 1 spiniform element and larger outer lobe with posteriorly-directed swelling at base; lobe armed with 3 unequal spiniform elements; basal swelling densely ornamented with setules. Maxilla 2-segmented: comprising proximal syncoxa (lacertus) and distal basis (brachium); basis ornamented with claw-like process distally; terminal claw (Fig. 18I) armed with sharp denticles on inner surface plus 2 larger denticles proximally. Maxilliped (Fig. 18J) 2-segmented; massive corpus with papilliform element on myxal surface opposing tip of subchela; distal subchela comprising fully fused endopodal segment and strongly curved terminal claw, bearing 2 small spines.

Leg 1 biramous (Fig. 18K) with inflated protopod densely ornamented with long setules on anterior and lateral surfaces, armed with pinnate inner spine and slender outer seta originating close to exopod and not on a papilla: exopod 1-segmented, armed with 5 robust terminal spines (inner and outer with minute serrations on margins, middle 3 spines smooth); endopod 1-segmented, tapering distally, armed with terminal seta about as long as segment, and ornamented with spinules in distal half. Leg 2 (Fig. 19A) mounted on irregularly hemispherical prominence derived from incorporated protopod; armed with outer seta on papilla: both rami 1-segmented; exopod armed with 4 distal margin spines; endopod armed with small apical seta less than half length of segment; both rami ornamented with patches of spinules. Leg 3 located ventrolaterally at rear of third pedigerous somite, endopod forming long fleshy, shoehorn-shaped, lamella, directed laterally: third legs separate along midline; slightly outer protrusion of margin at base of lamella possibly representing reduced exopod; leg 3 armed with dorsal outer basal seta (Fig. 17A–C). Leg 4 bilobate; inner and outer lobes elongate, protruding well beyond free posterior margin of dorsal trunk plate (Fig. 17A–C); outer protopodal seta located dorsally at base of limb. Leg 5 (Fig. 18A–B) forming lanceolate process extending well beyond tips of caudal rami and beyond rear margin of dorsal trunk plate; outer protopodal seta present dorsally near base of process; ornamented with surface sensillae proximally.

Description of male: Body smaller than female (Fig. 19B), total length about 2.43 mm. Cephalothorax comprising about 34% of total body length, with convex lateral margins becoming wider posteriorly; dorsal cephalic shield about 1.4 times longer than maximum width. Frontal area of cephalothorax carrying antennule and antennae, defined by weak indentation. Trunk slender, comprising all fused post-cephalothoracic somites (Fig. 19B), including urosome. Ventral surface of genital area ornamented with setules (Fig. 19C). Anal somite unornamented; bearing paired caudal rami; each ramus elongate, about 5.0 times longer than maximum width, armed with 2 plumose setae proximally on dorsal surface, 1 short lateral seta located at 84% of ramus length, plus 2 apical setae.

Antennule 7-segmented as in female. Parabasal flagellum as in female. Antenna (Fig. 19D) comprising long, slender corpus and distal subchela terminating in strongly recurved claw: corpus armed with papilliform element proximally on medial surface; subchela with small process in area of proximal articulation plus larger claw like process near middle. Postantennal process and mandible as in female. Oral cone ornamented with scattered spinules (Fig. 19E). Maxillule bilobate; smaller lobe with blunt apical element, larger lobe armed with 3 unequal distal elements and ornamented with spinules (Fig. 19E). Maxilla as in female. Maxilliped (Fig. 19F) comprising robust corpus with small myxal process and ornamented with patches of spinules proximally on medial surface, and distal subchela armed with 2 spines.

Leg 1 robust (Fig. 20A), basis armed with slender outer seta and stout inner spine; exopod 1-segmented, broader distally, ornamented with spinules as figured and armed with 5 distal spines, all spinulate; endopod 1-segmented, tapering distally, distally and armed with spinulose apical seta just shorter than segment; segment ornamented with long spinules distally. Leg 2 (Fig. 20B) lacking intercoxal sclerite; basis with slender outer seta; both rami 1-segmented; exopod swollen distally, armed with 3 spines plus a hemispherical swelling and other spinous structures distally, plus rows of spinules on distal surface; endopod tapering distally and armed with long unilaterally spinulose seta apically; seta about as long as segment; surface of segment ornamented with spinules along medial surface. Leg 3 (Fig. 19G) biramous, armed with basal seta dorsally at base of limb; exopodal lobe long and cylindrical, directed posterolaterally from ventrolateral origin on trunk; endopodal lobe about one third length of exopodal lobe. Leg 4 (Fig. 19B) biramous with both rami forming elongate lobes, outer basal seta present dorsally at base of limb. Leg 5 represented by single pinnate seta located laterally on urosome (Fig. 19C).

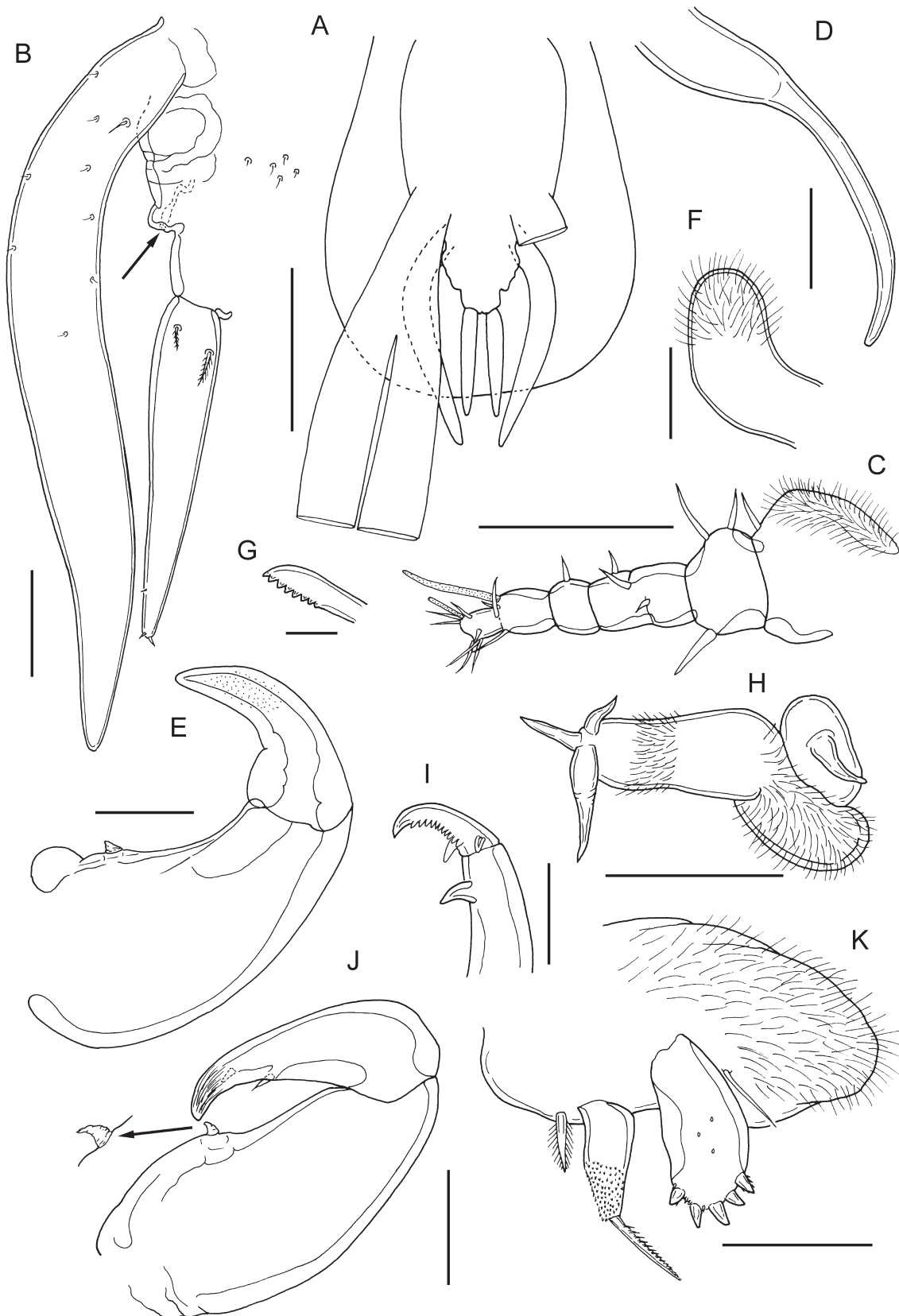


FIGURE 18. *Lernanthropus elegans* sp. nov., paratype ♀. A, dorsal trunk plate, fourth pedigerous somite and urosome, ventral view; B, Left side of urosome showing fifth leg, genital opening, copulatory pore (arrowed) and caudal ramus, dorsal; C, antennule; D, parabasal flagellum; E, antenna; F, postantennal process; G, tip of mandible; H, maxillule; I, tip of maxilla; J, maxilliped, with inset showing detail of papilliform process on myxal surface; K, leg 1. Scale bars A, 1 mm, B, 200 μ m, C,E,H-K 100 μ m, D,F, 50 μ m, G, 10 μ m.

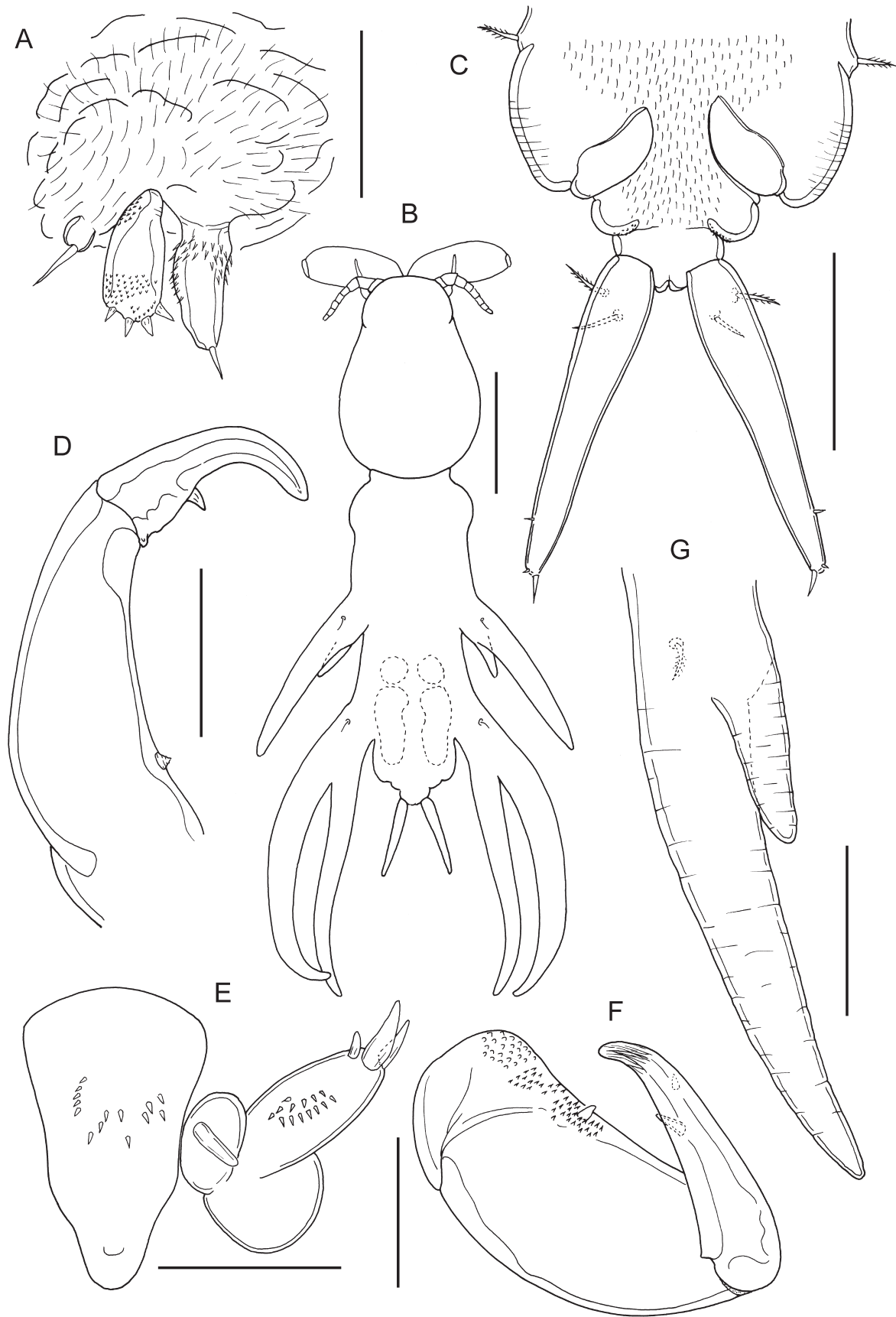


FIGURE 19. *Lernanthropus elegans* sp. nov., paratype ♀. A, leg 2. *L. elegans* sp. nov., paratype ♂, B, habitus, dorsal; C, urosome and caudal rami, ventral; D, antenna; E, oral cone and maxillule, *in situ*; F, maxilliped; G, leg 3. Scale bars A,E,F 100 µm, B, 0.5 mm, C,D,G, 200 µm.

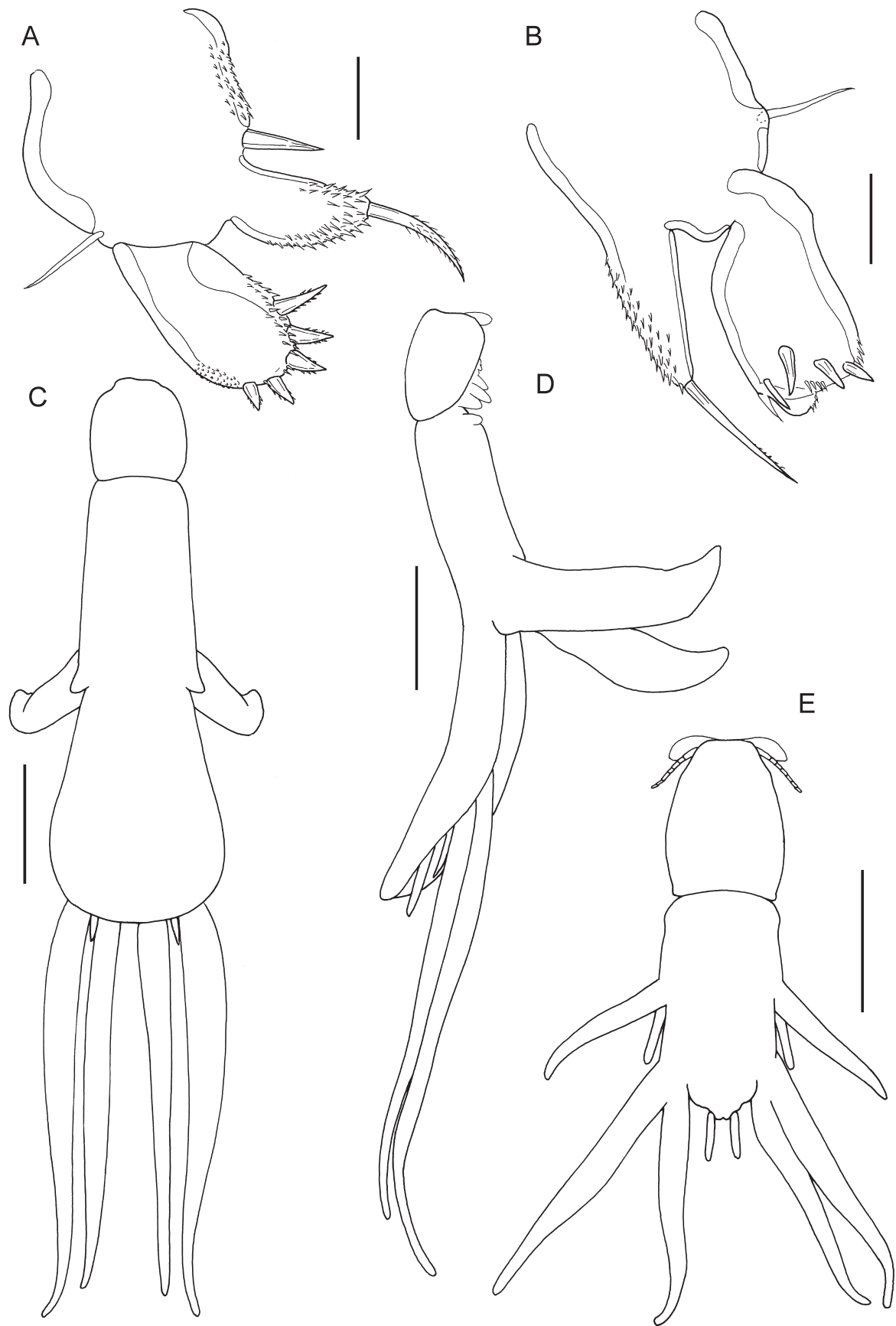


FIGURE 20. *Lernanthropus elegans* sp. nov., paratype ♂, A, leg 1; B, leg 2. *Lernanthropus gisleri* van Beneden, 1852, adult ♀, C, habitus, dorsal; D, habitus lateral. Adult ♂, E, habitus, dorsal. Scale bars A,B, 50 µm, C,D, 2 mm, E, 1 mm.

Remarks: The new species was found on *Atractoscion aequidens*, a member of the family Sciaenidae, and this family serves as host to about 20 species of *Lernanthropus* in total (Table 3). Most of the species listed in Table 3 are exclusively parasitic on sciaenid hosts, but a few, such as *L. gisleri* and *L. leidy* have occasionally been reported from non-sciaenids. In addition, *L. pomatomi*, *L. pupa* and *L. paenulatus* were all originally described from non-sciaenid hosts but each has been reported on a single occasion from a sciaenid host. Detailed comparison of the new species with all of these other species found on sciaenid hosts reveals some significant differences as well as shared character states.

The new species, *L. elegans* **sp. nov.**, can be readily distinguished from *L. huamani* Luque & Farfán, 1990, *L. longipes* Wilson, 1932, *L. pacificus* Oliva & Durán, 1982, and *L. paralonchuri* Luque, Bruno & Covarrubias, 1989, by the length of the lobes of leg 4, which are shorter than the body in the new species but markedly longer than the entire body in these four species. Another very distinctive species is *L. grassei*. This is an elongate, slender species which has very unequal lobes on leg 4: the exopodal lobe is almost twice the length of the endopodal lobe. This contrasts with the more-or-less equal lobes of the new species. The South American species *L. cynoscicola* has an unusually short dorsal trunk plate so that the tip of the abdomen and the entire length of the caudal rami are visible in dorsal view, whereas in *L. elegans* **sp. nov.** the dorsal trunk plate is more extensive, concealing the entire urosome and all but the tips of the caudal rami.

Lernanthropus barnardi Capart, 1959 and *L. nunesi* Capart, 1959 are both known only from their inadequate original descriptions in Capart (1959). However, the former can be distinguished by the relatively short lanceolate lobes of leg 4 which extend beyond the posterior margin of the dorsal trunk plate only by about 30% of their total length, whereas in the new species about 70% of the length of these lobes is visible in dorsal view. The latter species, *L. nunesi*, has elongate fourth leg lobes but differs from the new species in having a very reduced leg 5 compared to the large lobate leg 5 of the new species. The original description of *L. leidy* was also inadequate, but both sexes of this species were redescribed by Luque & Paraguassú (2003). Comparing the new species with this redescription of *L. leidy* allows us to distinguish between them by the length of dorsal trunk plate, which is longer than the anterior part of the trunk in the new species but distinctly shorter in *L. leidy*, and by the fifth leg which is elongate in the new species but short and subcylindrical in *L. leidy*, according to Luque & Paraguassú (2003). The fifth legs of *L. pagodus* Krøyer, 1863 appear to be reduced or absent, since Krøyer (1863: Tab VIII, Fig. 2c) does not figure them in his ventral habitus drawing. This species also differs in having a broad dorsal trunk plate (about 2.0 times wider than the cephalothorax) with a median indentation in its posterior margin, whereas *L. elegans* **sp. nov.** has a more slender dorsal trunk plate (only about 1.5 times wider than the cephalothorax) with an evenly convex posterior margin.

The new species shares a distinctive set of character states with the remaining eight species from Table 2, including the widely distributed *L. gisleri*. This character set includes: 7-segmented antennule with the segment bearing the subapical aesthetasc separate from the apical segment (these segments are fused in many *Lernanthropus* species); the proximal segment of the antennule is fused to a swelling on the surface of the cephalothorax and both the segment and swelling are densely ornamented with long setules; the maxilla bears a curved process on the basis just proximal to the base of the apical claw; the protopod of leg 1 is densely ornamented with long setules; leg 3 forms a large, (postero-) laterally directed lamella; the rami of leg 4 are both elongate; leg 5 forms an elongate process; and the caudal rami are elongate. Detailed comparisons are required to separate *L. elegans* **sp. nov.** from these eight species: *L. gisleri*, *L. capistroides* Olivier & van Niekerk, 1995, *L. cruciatus* Pillai, 1962, *L. francai* Nuñez-Ruivo, 1962, *L. indefinitus* Koyuncu, Castro-Romero & Karaytug, 2012, *L. otolithi* Pillai, 1963, *L. pami* Tripathi, 1962, and *L. sciaenae* Gnanamuthu, 1947.

Lernanthropus pami is included in this group but, unfortunately, only limited comparisons are possible because this species is very poorly known and its original description contains major mistakes (cf. Pillai, 1985). The information available from Tripathi (1962) indicates that the fifth legs (erroneously interpreted as a third lobe of a “trifoliate” leg 4) are elongate but extend only to about the mid-level of the caudal rami. In contrast, *L. elegans* **sp. nov.** has lanceolate fifth legs that extend well beyond the distal tips of the caudal rami. Additionally, the tips of the caudal rami only just reach the posterior margin of the dorsal trunk plate in *L. pami* but extend well beyond this margin in the new species. Tripathi (1962) remarked that *L. pami* was similar to *L. sciaenae* described by Gnanamuthu (1947), probably because Gnanamuthu had also misinterpreted leg 4 as trifoliate. His figure of the antennule of *L. sciaenae* shows the setular ornamentation on the proximal segment, even though the description is lacking in other details. *Lernanthropus sciaenae* resembles *L. pami* in the proportional lengths of the fifth legs and caudal rami, and in the extent of the caudal rami relative to the margin of the dorsal trunk plate, and differs from *L. elegans* **sp. nov.**

in these features. We propose to treat *L. pami* as a *species inquirendum*, but it is also possible that *L. pami* is a junior synonym of *L. sciaenae*.

The original description of *L. capistroides* was supported only by scanning electron micrographs (Olivier & van Niekerk, 1995). These images provide considerable detail of the appendages: for example, the maxilla of the female carries a curved claw (canna in Olivier & van Niekerk, 1995) on the inner margin of the basis plus a thin-walled process (clavus in Olivier & van Niekerk, 1995) on the base of the terminal claw (calamus in Olivier & van Niekerk, 1995). This armature is shared with *L. elegans* **sp. nov.** However, Olivier & van Niekerk (1995) did not provide an illustration of the habitus, which renders comparisons with older descriptions problematic. The most readily observable difference between *L. capistroides* and the new species is the caudal rami, which do not reach the posterior margin of the dorsal trunk plate in the former but extend well beyond this margin in the latter. The mean body length of *L. capistroides* is given as 7.2 mm by Olivier & van Niekerk (1995), of which the dorsal cephalic shield comprised 1.3 mm and the dorsal trunk plate 3.2 mm. We can calculate that the mean length of the anterior trunk was therefore 2.7 mm. This is about 2.1 times longer than the cephalothorax which differs from the new species, in which the anterior trunk is only 1.6 times longer than the cephalothorax.

Lernanthropus francai was first described from off the coast of Angola (Nuñez-Ruivo, 1962) and has only been reported once since, in a list of copepods found on Vietnamese fishes (Kazachenko *et al.*, 2014). It is known only from the female which exhibits many detailed similarities to *L. elegans* **sp. nov.** For example, both species have a densely setulose outer expansion of the protopodal part of leg 1 and the endopod of this leg bears a single apical seta that is about as long as the ramus. Both also have the setulose, posteriorly-directed proximal lobe on the maxillule. The key difference between these species is the extent of the caudal rami, the tips of which do not reach the posterior margin of the dorsal trunk plate in *L. francai*, but extend beyond it in *L. elegans* **sp. nov.** They can also be distinguished by the relative lengths of the lanceolate rami of leg 4 relative to the dorsal trunk plate: in *L. francai* these rami extend beyond the posterior margin of the plate by slightly more than half of their entire length whereas in the new species about 75% of their length is visible in dorsal view, extending beyond the margin.

The Indian species *L. cruciatus* has a body length of over 16 mm (Pillai, 1985) and is instantly recognizable by its enormous third legs, which are laterally directed and about equal in length to the cephalothorax and anterior trunk combined. The dorsal trunk plate of *L. cruciatus* is also very well developed, comprising just over half (53%) of the entire body length. In contrast, *L. elegans* **sp. nov.** has third legs that are slightly shorter than the anterior trunk region alone, and its dorsal trunk plate comprises only 42% of body length.

The slender body shape of the female of *L. elegans* **sp. nov.** contrasts with the rather robust body form of *L. otolithi*. The latter has an almost circular dorsal trunk plate which is slightly wider than long whereas in the former the plate is about 1.3 times longer than wide and has tapering linear lateral margins that expand posteriorly. The ventrally-produced lateral margins of the dorsal cephalic shield of *L. otolithi* project anteriorly generating a trilobate frontal margin whereas the frontal margin is straight with rounded corners in *L. elegans* **sp. nov.**

The original description of *L. indefinitus* (Koyuncu *et al.*, 2012) combines some excellent illustrations of particular limbs (such as the antennule and legs 1 and 2) with inadequate illustrations which fail to show important features (such as the caudal rami, from which most of the caudal setae are missing). In female *L. indefinitus* the fifth leg lobes do not reach the tips of the caudal rami whereas in *L. elegans* **sp. nov.** they extend well beyond the tips of the rami. The caudal rami themselves are about 3 times longer than wide in *L. indefinitus* compared to about 5 times longer than wide in the new species.

Finally, the new species can be differentiated from *L. gisleri* by the length of the caudal rami and fifth legs relative to the free posterior margin of the dorsal trunk plate: in *L. gisleri* the caudal rami are completely concealed in dorsal view, hidden beneath the dorsal trunk plate while the fifth legs reach to the posterior margin of the dorsal trunk plate and the tips may be visible dorsally in some specimens. In contrast, in *L. elegans* **sp. nov.** the tips of the caudal rami and the distal 25% of the fifth legs extend beyond the margin of the plate and are visible in dorsal view. The structure and armature of the limbs are very similar in these two species. The antennules are 7-segmented in both and the setation is almost identical. The absence of setular ornamentation on segment 1 in Kabata's figure (1979b: fig. 1058) is significant since it is very conspicuous in *L. elegans* **sp. nov.** and would not be easy to overlook. Both species possess a hirsute posterior swelling at the base of the maxillule. Legs 1 and 2 are also very similar in the two species. The only difference in leg 1 is the extent of the setular ornamentation, which is much more extensive in *L. elegans* **sp. nov.** In leg 2 both rami are ornamented with surface spinules in the new species but, according to Kabata (1979b), only the endopod carries any spinules in *L. gisleri*.

TABLE 3. Lernanthropus species reported from hosts of the family Sciaenidae.

<i>Lernanthropus</i> species	Host	Locality	Reference
<i>L. barnardi</i> Capart, 1959	<i>Umbrina canariensis</i> Valenciennes, 1843 (as <i>Umbrina valida</i>)	South Atlantic off coast of Angola (12°54'S 11°52'E)	Capart, 1959
<i>L. capistroides</i> Olivier & van Niekerk, 1995	<i>Otolithes ruber</i> (Bloch & Schneider, 1801)	St Lucia estuary, South Africa	Olivier & van Niekerk, 1995
<i>L. cruciatus</i> Pillai, 1962	"sciaenid"	Kerala, India	Pillai, 1962
<i>L. cynoscicola</i> Timi & Etchegoin, 1996	<i>Cynoscion striatus</i> (Cuvier, 1829)	Argentina	Timi & Etchegoin, 1996
<i>L. elegans</i> sp. nov.	<i>Cynoscion guatucupa</i> (Cuvier, 1830) <i>Atractoscion acqidens</i> (Cuvier, 1830)	Argentina & Uruguay; Brazil Coffs Harbour, New South Wales; Australia	Timi, 2003; Sabas & Luque, 2003 present account
<i>L. francai</i> Nuñez-Ruivo, 1962	<i>Umbrina ronchus</i> Valenciennes, 1843	Angola	Nuñez-Ruivo, 1962
<i>L. gisleri</i> van Beneden, 1852*	<i>Larimichthys crocea</i> (Richardson, 1846) <i>Argyrosomus regius</i> (Asso, 1801) as <i>Sciaena aquila</i>	Vietnam Belgium; French coast of North Sea; Senegal	Kazachenko <i>et al.</i> , 2014 van Beneden, 1852; Hesse, 1877; Delamare Deboutteville & Nuñez-Ruivo, 1954
	<i>Argyrosomus regius</i> (Asso, 1801)	Scotland	Deboutteville & Nuñez-Ruivo, 1954
	<i>Umbrina cirrosa</i> (Linnaeus, 1758)	Adriatic Sea; Ligurian Sea	Kabata, 1979b
	<i>Sciaena umbra</i> Linnaeus, 1758 (as <i>Corvina nigra</i>)	Adriatic Sea; Ligurian Sea	Heider, 1879; Brian, 1906
	<i>Argyrosomus japonicus</i> (Temminck & Schlegel, 1843) (as <i>Sciaena antarctica</i>)	Port Willunga, Australia,	Heider, 1879; Brian, 1906
	<i>Argyrosomus japonicus</i> (Temminck & Schlegel, 1843)	Port river, South Australia	Kabata, 1979a
	<i>Sciaena umbra</i> Linnaeus, 1758 (as <i>Corvina nigra</i>)	Senegal	present account
<i>Umbrina steindachneri</i> Cadenat, 1951		Senegal	Delamare Deboutteville & Nuñez-Ruivo, 1954
<i>Umbrina canariensis</i> Valenciennes, 1843		Senegal	Delamare Deboutteville & Nuñez-Ruivo, 1954
<i>Umbrina canariensis</i> Valenciennes, 1843 (as <i>Umbrina valida</i>)		Senegal off West Africa	Diebakate & Raibaut, 1996 Capart, 1959
<i>Cynoscion nebulosus</i> (Cuvier, 1830)		Gulf of Mexico; Texas (USA)	Bere, 1936; Pearse, 1952
<i>Argyrosomus hololepidotus</i> (Lacepède, 1801) (as <i>Johnius hololepidotus</i>)		off West Africa	Kabata & Gusev, 1966
<i>Pseudotolithus moorii</i> (Günther, 1865) (as <i>Corvina cameronesis</i>)		off West Africa	Capart, 1959
<i>Sciaena</i> sp.		Japan	Yamaguti, 1936, 1963

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TABLE 3. (Continued)

<i>Lernanthropus</i> species	Host	Locality	Reference
	<i>Johnius dussumieri</i> (Cuvier, 1830) (as <i>Sciaena dussumieri</i>)	China	Song & Chen, 1976
<i>L. grassei</i> Delamare Deboutteville & Nuñez-Ruivo, 1954	<i>Pseudotolithus senegallus</i> (Cuvier, 1830) (as <i>Otolithus (Johnius) brachygnathus</i>)	Senegal	Delamare Deboutteville & Nuñez-Ruivo, 1954
<i>L. huamani</i> Luque & Farfán, 1990	<i>Menticirrhus ophicephalus</i> (Jenyns, 1840) <i>Sciaena deliciosa</i> (Tschudi, 1846) <i>Stellifer minor</i> (Tschudi, 1846)	Peru Peru Peru	Luque & Farfán, 1990
<i>L. indefinitus</i> Koyuncu, Castro-Romero & Karayug, 2012	<i>Argyrosomus regius</i> (Asso, 1801)	Mediterranean Sea	Koyuncu <i>et al.</i> , 2012
<i>L. leidy</i> Wilson, 1922**	<i>Bairdiella chrysoura</i> (Lacepède, 1802) <i>Umbrina canosai</i> Berg, 1895	North Carolina, Florida (USA) Brazil	Wilson, 1922; Pearse, 1952, Causey, 1955 Luque & Paraguassú, 2003
<i>L. longipes</i> Wilson, 1932	<i>Pogonias cromis</i> (Linnaeus, 1766) <i>Sciaenops ocellatus</i> (Linnaeus, 1766) <i>Larimus fasciatus</i> Holbrook, 1855	Woods Hole, USA North Carolina, Texas, USA Gulf of Mexico	Wilson, 1932 Pearse, 1947; 1952 Bere, 1936
<i>L. nunesi</i> Capart, 1959	<i>Pentheroscion mbizi</i> (Poll, 1950) (as <i>Sciaena mbizi</i>)	South Atlantic off coast of Zaire (05°56'S, 12°0'E) Trivandrum, India	Capart, 1959 Pillai, 1963, 1985
<i>L. otolithi</i> Pillai, 1963	<i>Otolithes ruber</i> (Bloch & Schneider, 1801) (as <i>Otolithus argenteus</i> Cuvier) <i>Pennahia pawak</i> (Lin, 1940) <i>Pterolithus maculatus</i> (Cuvier, 1830) (as <i>Otolithus maculatus</i>)	Taiwan India Vietnam	Ho <i>et al.</i> , 2008 Pillai, 1985 Kazachenko <i>et al.</i> , 2014
<i>L. pacificus</i> Oliva & Durán, 1982	<i>Johnius carouna</i> (Cuvier, 1830) <i>Daysciaena albida</i> (Cuvier, 1830)	S.E. coast of India Peru	Raja <i>et al.</i> , 2018 Oliva & Durán, 1982
[as <i>L. guacolda</i> Villalba & Fernandez, 1984***]	<i>Sciaena deliciosa</i> (Tschudi, 1846)	Concepción Bay, Chile	Villalba & Fernandez, 1984
<i>L. pagodus</i> Krøyer, 1863	<i>Equetus lanceolatus</i> (Linnaeus, 1758) (as <i>Equetus balteatus</i>)	Brazil	Krøyer, 1863
<i>L. pami</i> Tripathi, 1962	<i>Otolithoides pama</i> (Hamilton, 1822) (as <i>Pama pama</i>)	India	Tripathi, 1962; Pillai, 1985
<i>L. paracruciatius</i> sp. nov.	<i>Protonibea diacanthus</i> (Lacepède, 1802)	Northern Territory, Australia	present account
<i>L. paralonchuri</i> Luque, Bruno & Covarrubias, 1989	<i>Paralonchurus peruanus</i> (Steindachner, 1875)	Peru	Luque <i>et al.</i> , 1989

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TABLE 3. (Continued)

<i>Lernanthropus</i> species	Host	Locality	Reference
<i>L. sciaenae</i> Gnanamuthu, 1947	<i>Cynoscion analis</i> (Jenyns, 1842)	Peru	Iannacone, 2005
	<i>Johnius glaucus</i> (Day, 1876) (as <i>Sciaena glaucus</i>)	Madras, Kerala (India)	Gnanamuthu, 1947; Pillai, 1985
Misidentified species			
<i>L. serioli</i> Shishido, 1898	<i>Sciaenops ocellatus</i> (Linnaeus, 1766)	Louisiana, USA	Causey, 1953
[as <i>L. paenulatus</i> Wilson, 1922]++			
<i>L. polynemi</i> Richiardi, 1881	<i>Otolithes ruber</i> (Bloch & Schneider, 1801)	Gulf of Arabia	Bannai, 2002
[as <i>L. trithfoliatus</i>]++			
<i>L. pomatomi</i> Rathbun, 1887+++	<i>Cynoscion nebulosus</i> (Cuvier, 1830)	Louisiana, USA	Causey, 1953
<i>L. pupa</i> Burmeister, 1833++++	<i>Cynoscion nebulosus</i> (Cuvier, 1830)	Louisiana, USA	Causey, 1953

**L. gisleri* has also been reported from a number of non-sciaenid hosts, including *Selenotoca multifasciata* (Scatophagidae) (as *Scatophagus multifasciatus*) by Kabata (1979a), *Centropomus undecimlatus* (Bloch, 1792) (Centropomidae) by Bere (1936), Pearse (1952), and Tavares & Luque (2004), *Polydactylus quadrifilis* (Cuvier, 1829) (Polydactylidae) by Capart (1959) and *Paralichthys* sp. (Paralichthyidae) by Causey (1953). The *L. gisleri* recorded from *Lichia amia* Linnaeus (Carangidae) by Brian (1906) was misidentified, it is *L. micropterygis* (see text).

***L. leiayi* has also been reported from a non-sciaenid host, *Morone americana* (Gmelin, 1789) (Moronidae), by Wilson (1922).

***Luque & Farfán (1990) considered *L. guacolda* Villalba & Fernandez, 1984 to be a junior synonym of *L. pacificus* Oliva & Durán, 1982.

+*Lernanthropus serioli* is typically a parasite of carangids of the genus *Seriola* Cuvier; we consider that the report (as *L. paenulatus* Wilson, 1922) from *Sciaenops ocellatus* by Causey (1953) is probably a misidentification.

++*Lernanthropus polynemi* Richiardi, 1881 is the senior subjective synonym of *L. trifoliatus* Bassett-Smith, 1898 (see Piasecki & Hayward, 2002). The type host of *L. polynemi* is *Eleutheronema tetradactylum* (Shaw, 1804) and it has been recorded from various other polynemids including, *Polydactylus plebius* (Broussonet, 1782), *P. sextarius* (Bloch & Schneider, 1801) and *Filimanus heptadactyla* (Cuvier, 1829) plus two carangids although these are probably misidentifications (see Table 2). Under the name of its junior synonym (misspelt as *Lernanthropus trithfoliatus*), *L. polynemi* was reported from the sciaenid *Otolithes ruber* by Bannai (2002). It is probable that this is a misidentification.

+++The type host of *L. pomatomi* is *Pomatomus saltatrix* (Linnaeus, 1766) (Pomatomidae) but it was also recorded from a serranid (*Mycteroperca* sp.) by Causey (1955) and from the sciaenid *Cynoscion nebulosus* by Causey (1953).

++++*Lernanthropus pupa* Burmeister, 1833 is typically a parasite of *Chaetodipterus faber* (Broussonet, 1782) (Ephippidae) but was reported from the sciaenid *Cynoscion nebulosus* by Causey (1953). This report is doubtful.

The four *Lernanthropus* females from *Sciaena* sp. identified by Yamaguti (1936) as *L. gisleri* are misidentified, as already noted by Koyuncu *et al.* (2012). Although not described in full by Yamaguti (1936), this material appears to belong to the new species, *L. elegans* **sp. nov.**, and it seems possible that the material of *L. gisleri* listed, but not illustrated by Song and Chen (1976) from *Johnius dussumieri* (Cuvier, 1830) (as *Sciaena dussumieri*) caught in China, might also be attributed to the new species.

Although not parasitic on a sciaenid host, *L. antofagastensis* Castro-Romero & Baeza-Kuroki, 1985 is included in our comparisons. This species is parasitic on a haemulid, *Anisotremus scapularis* (Tschudi, 1846), found in Chilean coastal waters and it shares many character states with *L. elegans* **sp. nov.** including: the swollen proximal segment of the antennule with a dense ornamentation of setules, the swollen and densely setulose base of the parbasal flagellum, the armature on the basis of the maxilla, the long cylindrical fifth legs and the elongate caudal rami. However, these two species can be distinguished by the relative lengths of the fifth legs which extend well beyond the tips of the caudal rami in *L. elegans* **sp. nov.**, but only to the base of the caudal rami in *L. antofagastensis*.

***Lernanthropus gisleri* van Beneden, 1852**

(Fig. 20C–E)

Non: *L. gisleri*: Yamaguti, 1936

Material examined: 6♀♀, 4♂♂ from *Argyrosomus japonicus* (Temminck & Schlegel, 1845), Port River, South Australia; 02 September 2007; collected by K.S. Hutson; 2♀♀, 1♂, NHMUK Reg. No. 2007.994–946, and 4♀♀, 3♂♂, SAMA Reg. No. C6889. 1♀ from *A. japonicus*, Coffs Harbour, New South Wales; February 1982; collected by K. Rohde. 8♀♀, 3♂♂ from *A. japonicus*, Coffs Harbour, New South Wales; February 1982; collected by K. Rohde. 8♀♀, 3♂♂ from *A. japonicus*, Coffs Harbour, New South Wales; February 1982; collected by K. Rohde; NHMUK Reg. No. 1984.94–96.

Differential diagnosis: Cephalothorax longer than wide with almost linear lateral margins (Fig. 20C). Anterior part of trunk just wider than, and about twice as long as, cephalothorax and with more-or-less parallel lateral margins. Posterior part of trunk (fourth pedigerous somite) narrowest anteriorly at level of origin of third legs and with dorsal trunk plate increasing in width posteriorly towards strongly convex posterior margin; dorsal trunk plate about 1.15 times longer than anterior part of trunk. Urosome comprising fifth pedigerous somite, genital complex and abdomen, all fused. Paired caudal rami elongate; fully concealed beneath dorsal trunk plate. Leg 3 (Fig. 20D) forming ventrolaterally directed, elongate lobe, just slightly longer than anterior part of trunk; endopodal lobes entirely separate in mid-line: exopod not defined. Leg 4 bilobate; both lobes elongate, lanceolate; outer lobe slightly longer than inner: lobes almost as long as entire body and both protruding well beyond free posterior margin of dorsal plate. Leg 5 elongate, with tips just visible at posterior margin of dorsal trunk plate. Body lengths of 2 ♀♀ 8.80 and 8.90 mm (based on females from *A. japonicus*): male (Fig. 20E) body length 3.10 mm.

Distribution: *Lernanthropus gisleri* is primarily a parasite of sciaenid fishes and was originally described from European waters (van Beneden, 1852). It has since been widely reported from both sides of the North Atlantic and in the Mediterranean Sea (Table 3). It was first reported from Australian waters by Kabata (1979a) who examined two lots of *Lernanthropus* in the collections of the University of Adelaide, one labelled from “Port Willunga” and the other “probably New South Wales”, and identified them as *L. gisleri*. The hosts were *Argyrosomus japonicus* (as *Sciaena antarctica* Castelnau) and *Selenotoca multifasciatus* (Richardson, 1846) (as *Scatophagus multifasciatus*). Kabata (1979a) did not provide any description based on his Australian material, instead referring to his redescription of *L. gisleri* in Kabata (1979b) which was based on specimens collected from Scotland.

As noted above, *L. gisleri* has also been reported from Japan on *Sciaena* sp. (Yamaguti, 1936) and from China on *Johnius dussumieri* (as *Sciaena dussumieri*) (Song & Chen, 1976). Koyuncu *et al.* (2012) considered that Yamaguti’s (1936) report of *L. gisleri* was based on a misidentification and that his material “does not belong to *L. gisleri*”. They concluded that “his specimen probably represents a new species”. On the basis of the brief description provided by Yamaguti (1936) his Japanese material is here re-identified as *L. elegans* **sp. nov.**, described above.

Remarks. Kabata (1979a) did not record the length of the females he reported from Australian waters but the females reported here from *Argyrosomus japonicus* caught in South Australia, have a mean body length of 8.90 mm. The long slender body form of this material (Fig. 20C, D) corresponds closely to that of the Scottish material figured

by Kabata (1979b). Females of *L. gisleri* collected from *Argyrosomus regius* (Asso, 1801) caught off the South coast of England and stored in the NHMUK collections (Reg. No. 1960.1.19.2) exhibited a mean body length of 9.04 mm (range 8.9 to 9.2 mm, based on 5 specimens). The female body length is very similar despite the geographical separation of these records.

Based on Kabata & Gusev's (1966) study of *L. gisleri* material collected from *Argyrosomus hololepidotus* (Lacepède, 1801) (as *Johnius hololepidotus*) caught off the west coast of Africa, Kabata (1979b) considered that *L. gisleri* varied in size according to geographical area. The body length of females from *Argyrosomus regius* caught off the Scottish coast ranged from 9.6 to 11.0 mm, compared to 6.2 mm for the African females. Kabata & Gusev (1966) also noted differences in the third legs, which were shorter relative to body length in the African material, and in body proportions. We consider that the disparity in body size taken together with these morphological differences indicate that the African material probably belongs to another related species, such as *L. francai*, which has a body length of about 6 mm and occurs off the West African coast. This possibility requires further investigation.

***Lernanthropus gnathanodontus* sp. nov.**

(Figs. 21–23, Fig. 24A–F)

Type material: Holotype ♀, 6 paratype ♀♀, 1 allotype ♂ from *Gnathanodon speciosus* (Forsskål, 1775) (TC17577), Moreton Bay, Queensland, 25 January 2016; collected by G.A. Boxshall, QM Reg Nos. W29489 (Holotype ♀), W29490 (allotype ♂), W29491 (paratype ♀♀). 3 paratype ♀♀ from *G. speciosus* (TC17074), Moreton Bay, Queensland, 13 January 2016; collected by G.A. Boxshall. 1 paratype ♀ from *G. speciosus* (TC17075), Moreton Bay, Queensland, 13 January 2016; collected by G.A. Boxshall. 2 paratype ♂♂ *G. speciosus* (TC17116), Moreton Bay, Queensland, 13 January 2016; collected by G.A. Boxshall. 2 paratype ♂♂ *G. speciosus* (TC17950), Moreton Bay, Queensland, 06 July 2016; collected by G.A. Boxshall, NHMUK Reg. No. 2018.254–262.

Etymology: The name of the new species refers to the generic name of its only known host.

Description: Female body comprising cephalothorax, trunk and small urosome concealed beneath dorsal trunk plate (Fig. 21A–C): body length ranging from 3.98 to 4.45 mm, with a mean of 4.27 mm (based on 9 specimens). Cephalothorax slightly wider than long (length measured along dorsal midline); lateral margins slightly convex in dorsal view and produced ventrally and anteriorly into conspicuous “horns” either side of frontal margin. Trunk with narrow anterior part (second and third pedigerous somites) gradually becoming wider towards base of third legs; posterior part covered by dorsal trunk plate covering entire abdomen, with only tips of leg 4 lamellae visible in dorsal view: dorsal trunk plate with narrow anterior base, expanding posteriorly and with shallow median indentation in posterior margin (Fig. 21C). Urosome comprising fifth pedigerous somite, genital complex and abdomen, all fused (Fig. 22A). Genital complex widest anteriorly at level of conspicuous paired, dorsolateral genital openings and narrower posteriorly, bearing paired copulatory pores on ventral surface (arrowed in Fig. 22A). Abdomen slightly wider than long, with median anal slit; ornamented with paired sensillae dorsally. Caudal rami located on ventral surface: each ramus about 4.0 times longer than wide; armed with 2 plumose setae dorsally near base, 1 short lateral seta located at about 80% of ramus length, and 2 short apical setae (Fig. 22A).

Antennule (Fig. 22B) indistinctly 6-segmented with irregular cuticular thickening; setation comprising total of 8 setae on proximal part and 11 + 2 aesthetascs on compound apical segment; proximal 3 setae on anterior margin plumose, all other setae naked. Parabasal flagellum broader proximally with narrow distal part curved (Fig. 22B), located near of base of antennule. Antenna (Fig. 22C) robust, comprising long corpus bearing papilliform element on medial surface, and distal subchela showing traces of suture line; subchela armed with small process in zone of arthrodistal membrane in articulation between corpus and subchela, minute distal seta on concave margin (arrowhead on Fig. 22C) and blunt proximal process; terminal claw with striated cuticle. Rounded post-antennal process present on ventral cephalothoracic surface immediately posterior to base of antenna (arrowed in Fig. 22D). Mandible stylet-like, armed with 8 marginal teeth distally (Fig. 22E). Maxillule (Fig. 22F) bilobate, smaller lobe tipped with 1 spiniform element; larger lobe tipped with 3 unequal spiniform elements. Maxilla (Fig. 22G) 2-segmented: comprising proximal syncoxa (lacertus) and distal basis (brachium); basis ornamented with patch of spinules distally and bearing bifid element plus long process originating adjacent to terminal claw; claw ornamented with sharp denticles along both edges. Maxilliped (Fig. 22H) 2-segmented comprising massive corpus with papilliform element on medial surface opposing tip of claw, and distal subchela; corpus ornamented with minutes spinules on medial surface;

subchela comprising compound endopodal segment and strongly curved terminal claw; armed with minute seta on inner concave margin and distal knob-like process; surface of claw striated.

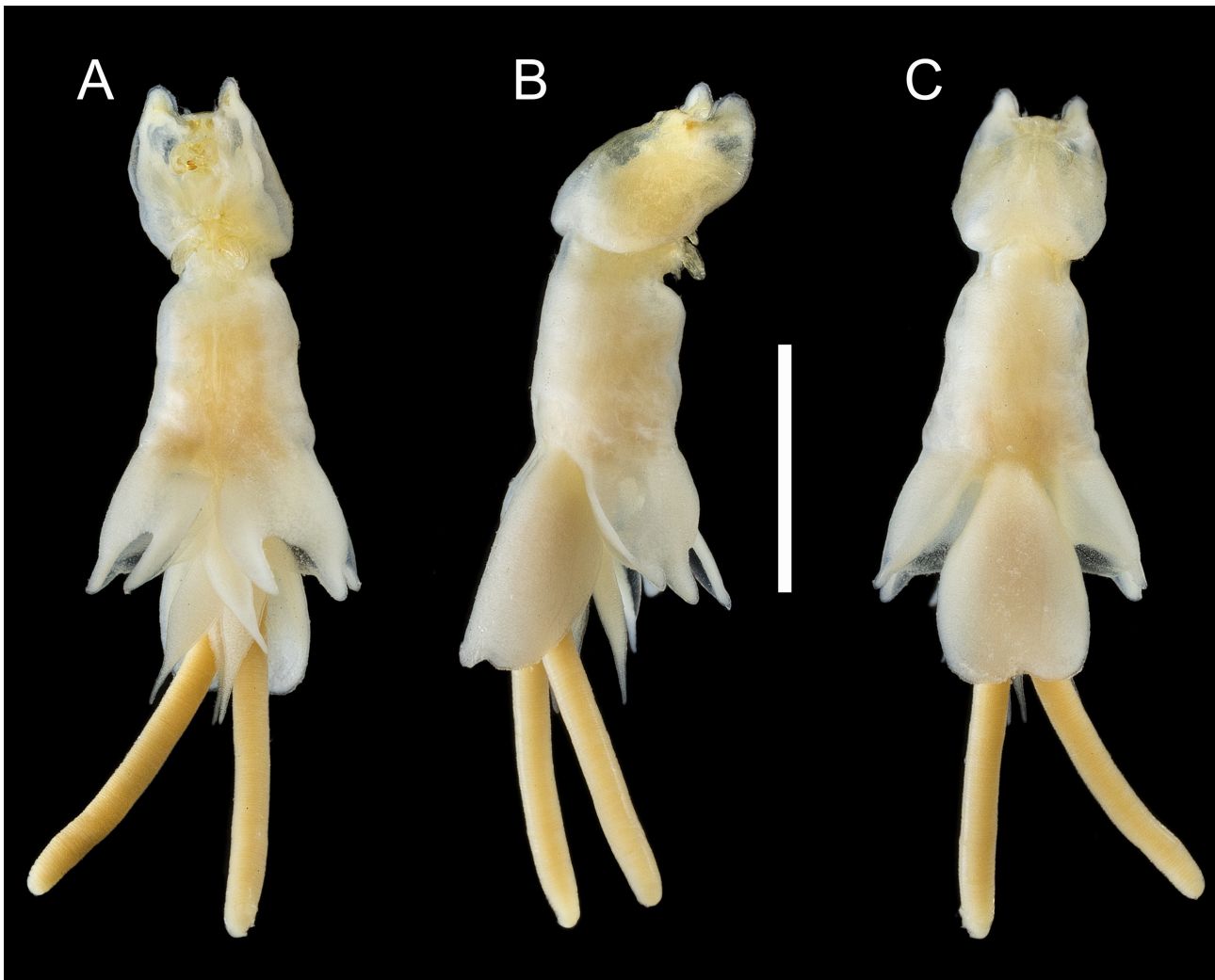


FIGURE 21. *Lernanthropus gnathanodontus* sp. nov., paratype ♀. A, habitus, ventral; B, habitus, lateral; C, habitus, dorsal. Scale bar 2 mm.

Leg 1 with protopodal part fused to somite; intercoxal sclerite absent (Fig. 23A): leg biramous with outer basal seta plus short, stout inner spine on incorporated protopod; exopod 1-segmented, armed with 5 terminal spines with smooth margins, surface of segment ornamented with rows of spinules distally; endopod 1-segmented, armed with terminal seta about twice as long as segment, and ornamented with patches of spinules. Leg 2 (Fig. 23B) mounted on inflated subspherical prominence derived from incorporated protopod and armed with outer seta on papilla: both rami 1-segmented and ornamented with scattered spinules; exopod armed with 4 small distal spines; endopod armed with apical seta about twice as long as segment. Leg 3 lamellate and trilobate (Fig. 23C); 3 digitform lobes connected by membranous web; outer and middle lobes located closer to each other, separated from inner lobe by wider gap; outer lobe ornamented with minute serrated scales on tip (Fig. 23D), ornamentation lacking on middle and inner lobes; members of leg pair separate along ventral mid-line. Leg 4 (Fig. 23E) biramous with both rami forming elongate processes about equal in length; dorsal seta present basally (arrowed in Fig. 23E). Leg 5 well developed; forming cylindrical lobe about 6.6 times longer than wide, reaching beyond tips of caudal rami (Fig. 22A); armed with outer basal seta proximally on dorsal surface.

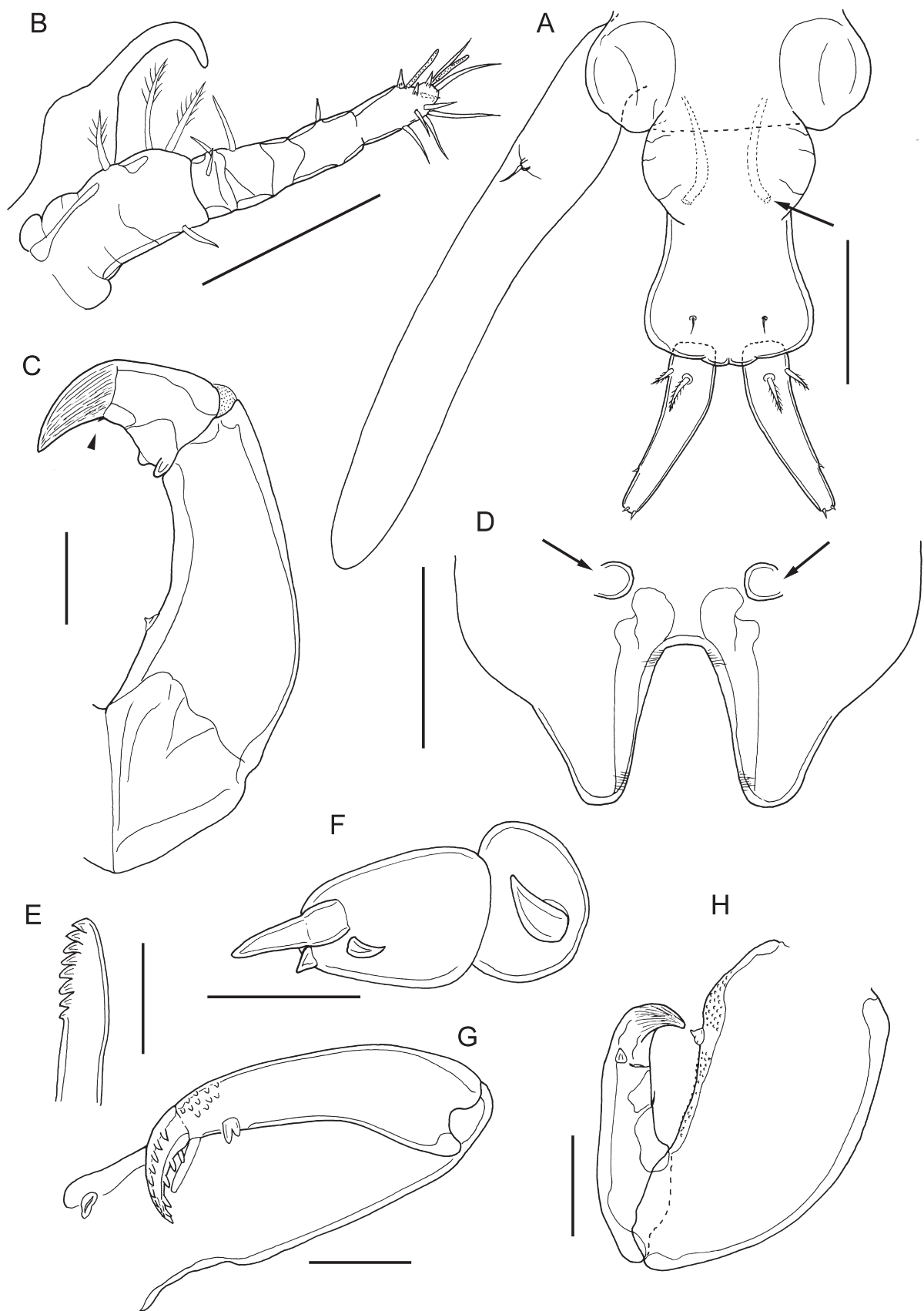


FIGURE 22. *Lernanthropus gnathanodontus* **sp. nov.**, paratype ♀. A, urosome, dorsal view showing fifth leg on left side only, genital openings (arrowed on right side) and caudal rami; B, antennule and parabasal flagellum; C, antenna; D, frontal part of cephalothorax, ventral view showing location of paired postantennal processes (arrowed); E, tip of mandible; F, maxillule; G, maxilla; H, maxilliped. Scale bars A, 200 µm, B,C,H 100 µm, D, 0.5 mm, E, 20 µm, F,G, 50 µm.

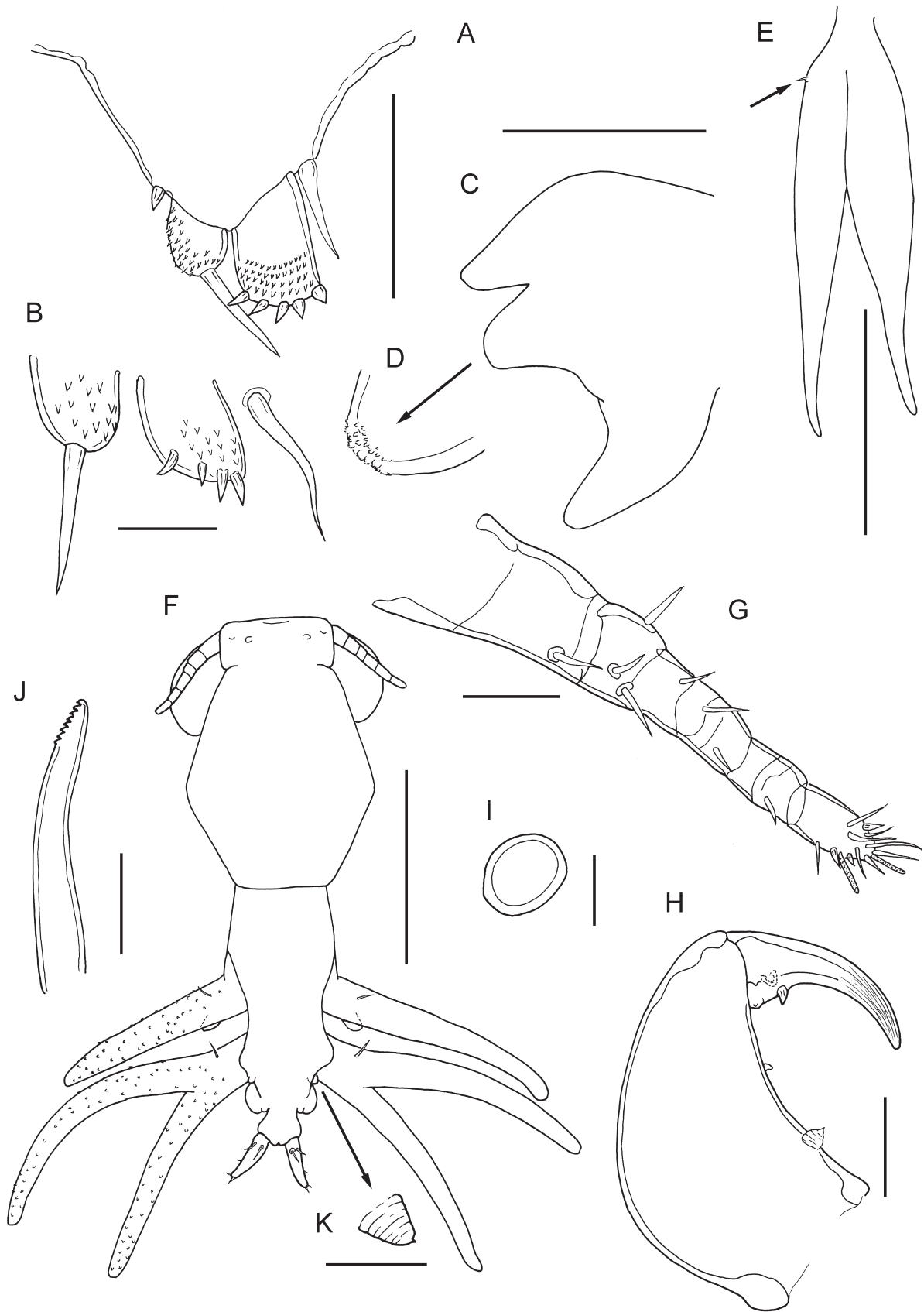


FIGURE 23. *Lernanthropus gnathanodontus* sp. nov., paratype ♀. A, leg 1; B, rami and outer protopodal seta of leg 2; C, leg 3, lateral view; D, tip of outer lobe of leg 3, showing surface ornamentation; E, leg 4. Paratype ♂, F, habitus, dorsal; G, antennule; H, antenna; I, postantennal process; J, mandible; K, leg 5. Scale bars A,H, 100 µm, B,J, 25 µm, C,E, 1 mm, F, 0.5 mm, G,I,K, 50 µm.

Male. Body smaller than female, mean body length 2.00 mm (based on 2 specimens). Cephalothorax comprising about 47% of total body length; slender, broadest at middle, with angular lateral margins; frontal area of cephalothorax carrying antennule and antennae, defined by slight indentation (Fig. 23F). Trunk slender, comprising second to fourth pedigerous somites fused to urosome. Urosome comprising fifth pedigerous somite, genital somite and 1-segmented abdomen, all fused. Genital somite with convex lateral margins, wider than abdomen. Caudal rami as in female.

Antennule indistinctly 6-segmented (Fig. 23G) with irregular cuticular thickenings, setal formula: 1, 3, 2, 1, 1, 11 + 2 ae. Parabasal flagellum absent. Antenna (Fig. 23H) comprising massive corpus and distal subchela; corpus armed with papilliform process and small spinous process medially; subchela armed with 2 blunt elements; small process present in articulation between corpus and subchela. Postantennal process small, hemispherical (Fig. 24I). Mandible (Fig. 23J) and maxillule similar to those of female. Maxilla as for female but with additional spinular ornamentation distally on basis (Fig. 24A). Maxilliped similar to female but with slightly different myxal ornamentation (Fig. 24B); corpus with papilliform element and adjacent spinous elements at mid-level, plus small bifid element distally; subchela as in female.

Leg 1 with protopod distinct from somite; members of leg pair joined by intercoxal sclerite (Fig. 24C). Each leg biramous with outer seta and short, stout inner spine on basis; basis ornamented with patches of spinules; exopod 1-segmented, armed with 5 robust terminal spines and ornamented with spinules distally; endopod 1-segmented, armed with very long terminal seta about 2.5 times longer than segment, and ornamented with spinules. Leg 2 (Fig. 24D) mounted on inflated prominence derived from partly incorporated protopod armed with outer seta; trace of intercoxal sclerite retained; exopod showing traces of subdivision with distal part set at angle to proximal part, exopod (Fig. 24E) armed with 3 small distal spines and larger curved element; endopod well defined basally, armed with long terminal seta about 2.0 times longer than segment, and ornamented with patches of spinules. Leg 3 (Fig. 23F) biramous; comprising long cylindrical exopodal process protruding ventrolaterally from trunk with small ventrally-directed endopodal process near base of exopod; endopod ornamented with surface spinules and conspicuous papillae (Fig. 24F) as present on exopodal lobe; outer protopodal seta present dorsally at base of limb. Leg 4 biramous, comprising 2 long cylindrical processes, with outer protopodal seta on common base (Fig. 23F); leg 4 longer than exopod of leg 3; surfaces of both rami ornamented with conspicuous papillae, as present on leg 3. Leg 5 reduced to small conical process (Fig. 23K) with minute vestige of seta at apex.

Remarks. The species of *Lernanthropus* recorded on hosts belonging to the family Carangidae are listed in Table 2 and their characteristics are discussed above in the remarks section supporting the establishment of *L. alepicolus* **sp. nov.** Comparison of *L. gnathanodontus* **sp. nov.** with congeneric species known from carangids is relatively easy since the new species can be distinguished by the trilobate form of leg 3; no other species of *Lernanthropus* shares this form of third leg. The new species also has prominent anterolateral processes on the cephalothorax which represent frontal projections of the ventrally folded lateral margins of the dorsal cephalic shield. Prominent frontal projections are most notably present in *L. corniger*, but smaller paired processes are also present in *L. alatus*, *L. indicus* and *L. koenigii*, and detailed comparisons are necessary between the new species and these four species known to utilize carangid hosts.

In *L. corniger* the frontal projections are enormous, almost half the length of the dorsal cephalic shield, whereas in the new species they are only about 20% of shield length. The dorsal trunk plate of *L. corniger* is subcircular and about as wide as long whereas that of *L. gnathanodontus* **sp. nov.** is distinctly longer than wide and has a narrow anterior base, expanding posteriorly towards a broader posterior margin which is slightly concave.

Lernanthropus gnathanodontus **sp. nov.** has elongate fifth legs (6.6 times longer than wide) which extend beyond the tips of the caudal rami. This serves to distinguish it from *L. alatus* and *L. alepicolus* **sp. nov.**, both of which have short fifth legs. Both *L. indicus* and *L. koenigii* have elongate fifth legs as in the new species, but the dorsal trunk plate of *L. indicus* and *L. koenigii* is broadest anteriorly and tapers towards the rear margin which is relatively narrow, whereas in the new species the plate has a narrow anterior base and becomes broader posteriorly. The third legs of *L. indicus* and *L. koenigii* are biramous, comprising two flattened lobes (fused in *L. koenigii*, according to Pillai (1985)) and are readily distinguishable from those of the new species which comprise 3 digitiform lobes connected by cuticular membrane. These differences from similar congeneric species fully justify the establishment of the new species.

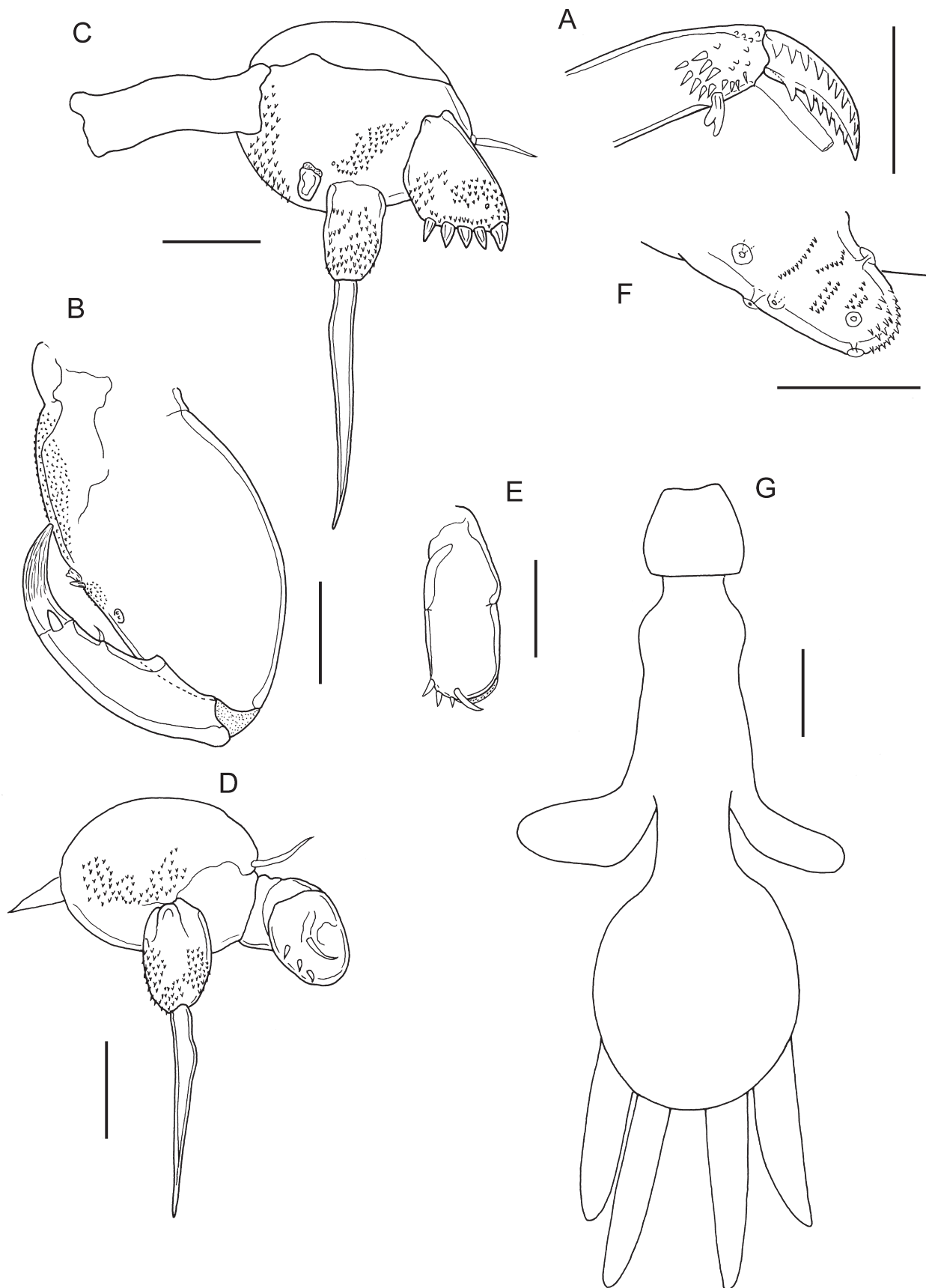


FIGURE 24. *Lernanthropus gnathanodontus* sp. nov., paratype ♂. A, tip of maxilla; B, maxilliped; C, leg 1 and intercoxal sclerite; D, leg 2; E, exopod of leg 2, anterior view; F, endopod of leg 3, showing surface ornamentation. *Lernanthropus latis* Yamaguti, 1954, adult ♀. G, habitus, dorsal. Scale bars A, C–F, 50 µm, B, 100 µm, G 1 mm.

***Lernanthropus latis* Yamaguti, 1954**

(Fig. 24G)

Syn: *Lernanthropus latesi* Tripathi, 1962

Material examined: 7♀♀ from gills of *Lates calcarifer* (Bloch, 1790), Darwin, Northern Territory; collected by B.K. Diggles, MAGNT Reg. No. Cr019242. 10♀♀ from gills of *L. calcarifer*, Darwin, Northern Territory; 11 October 2012, collected by B.K. Diggles, 5♀♀ QM Reg. No. W29492, 5♀♀ NHMUK Reg.No. 2018.263–267.

Differential diagnosis: Cephalothorax small relative to trunk, tapering towards frontal margin: trunk wider than cephalothorax with constriction in anterior part marking boundary between second and third pedigerous somites; posterior part (fourth pedigerous somite) comprising narrow anterior section immediately posterior to origin of laterally-directed third legs and dorsal trunk plate (Fig. 24G). Dorsal trunk plate almost circular, with strongly convex lateral and posterior margins. Urosome comprising fifth pedigerous somite, genital complex and abdomen, all fused. Paired caudal rami elongate, each ramus more than 3 times longer than width as base; tapering towards apex, fully concealed beneath dorsal trunk plate. Parabasal flagellum comprising swollen base and curved distal part; more than half length of antennule. Antenna slender, with strong hook-like process on medial margin of proximal segment. Leg 3 located on lateral surface of somite, forming rounded fleshy lamella, directed posterolaterally: third legs entirely separate. Leg 4 bilobate; inner lobe longer than outer, both protruding well beyond free posterior margin of dorsal plate. Fifth leg forming small laterally-directed process with rounded apex. Mean body length of ♀ 7.26, range 6.9 to 7.6 mm (based on 7 specimens); mean body length of ♂ 1.86 mm (data from Brazenor & Hutson, 2013).

Distribution: This distinctive species was originally described from *Lates calcarifer* caught off Macassar (Sulawesi) by Yamaguti (1954). It has since been reported from the same host taken at Chilka Lake and off Kerala in India (Tripathi, 1962; Pillai, 1985), Sri Lanka (Kirtisinghe, 1964), Thailand (Ho & Kim, 2004) and Malaysia (Chu *et al.*, 2012). It was first reported from Australia on the same host kept in seacages at Port Hurd, Northern Territory (Small *et al.*, 2009).

Remarks: *Lernanthropus latis* is widely distributed and can be abundant locally: Raja *et al.* (2018) found a prevalence of 76.5% on *L. calcarifer* caught off the coast of southeastern India. This species has also been reported from cage cultured *Lates calcarifer* in Malaysia (Abdul Khalid & Shaharoum-Harrison, 2014). Brazenor & Hutson (2013) considered *L. latis* to be a major threat to sustained mariculture of barramundi (*L. calcarifer*). They described the life cycle stages and examined the impact of water temperature and salinity on hatching success of the copepod. The overall prevalence of *L. latis* on wild *L. calcarifer* (n = 121) sampled from Darwin Harbour over 5 half yearly sampling periods between August 2012 and March 2014 ranged between 18.3% and 71.6% (mean intensity 1.0–4.17 copepods per fish), with no apparent seasonality.

***Lernanthropus microlamini* Hewitt, 1968**

(Figs. 25–26)

Material examined: 2♀♀ 3♂♂ from gills of *Hyperoglyphe antarctica* (Carmichael, 1819), Adelaide, South Australia; 10 May 2007; collected by K.S. Hutson; 1♀ and 1♂ NHMUK Reg. No. 2007.948–949 and 1♀ and 2♂♂ SAMA Reg. No. C6900. 1♂ from gills *H. antarctica*, Coffs Harbour, New South Wales; 27 October 1981; collected by K. Rohde; NHMUK Reg. No. 1984.90.

Differential diagnosis: Cephalothorax longer than wide with lateral margins parallel anteriorly; frontal margin weakly concave. Trunk about 2.5 times longer than cephalothorax (Fig. 25A–C); anterior part (second and third pedigerous somites) becoming wider posteriorly, posterior part (fourth pedigerous somite) covered by subrectangular dorsal trunk plate with rounded corners and with weakly convex lateral and posterior margins. Urosome comprising fifth pedigerous somite, genital complex and abdomen, all fused. Paired caudal rami small; each ramus about twice as long as width at base; completely concealed beneath dorsal trunk plate. Parabasal flagellum cylindrical. Leg 3 forming large, ventrally-directed, fleshy lamella, extending posterolaterally from side of body by almost one third of length: third legs separate but overlapping slightly in midline. Leg 4 bilobate (Fig. 25A–C); inner and outer lobes foliaceous, tapering distally, outer lobe longer than inner and protruding posterolaterally from beneath lateral margin of dorsal trunk plate. Leg 5 represented by laterally-directed cylindrical lobe about twice as long as wide, armed with basal seta on dorsal surface. Body length of ♀ 8.45 mm.



FIGURE 25. *Lernanthropus microlamini* Hewitt, 1968, adult ♀. A, habitus, dorsal; B, habitus, lateral; C, habitus, ventral. Scale bar 2.5 mm.

Description of male. Body smaller than female, body length 2.74 mm. Cephalothorax large, comprising about 40% of total body length, broadest at middle, with angular lateral margins; frontal area of cephalothorax carrying antennules and antennae, defined by slight indentation (Fig. 26A). Trunk slender comprising second to fourth pedigerous somites fused to urosome. Urosome comprising fifth pedigerous somite, genital somite and abdomen, all fused. Genital somite with weakly convex lateral margins, wider than abdomen. Caudal rami (Fig. 26B) about 2.1 times longer than wide, as in female.

Antennule indistinctly 6-segmented (Fig. 26C) with irregular cuticular thickenings, setal formula: 1, 3, 1, 2, 1, 12 + 2 ae. Parabasal flagellum (Fig. 26D) comprising broad base and short, curved distal part. Antenna (Fig. 26E) comprising massive corpus and distal subchela; corpus armed with papilliform process medially; subchela armed with rounded knob-like process proximally, curved spine on concave margin, plus distal tooth-like process; small process present in articulation between corpus and subchela; surface integument of claw striated. Postantennal process directed anteriorly, lacking ornamentation (Fig. 26F). Mandible (Fig. 26G) and maxillule (Fig. 26H) similar to those of female. Maxilla with simple subdistal process and additional spinular ornamentation distally on basis (Fig. 26I). Maxilliped (Fig. 26J) comprising robust corpus with small papilliform process on myxal surface, and distal subchela armed with 2 rounded processes; surface of subchela striated.

Leg 1 with protopod distinct from somite; members of leg pair joined by intercoxal sclerite (Fig. 26K). Each leg biramous with outer seta and short, stout inner spine on basis; exopod 1-segmented, armed with 5 robust terminal spines and ornamented with spinules distally; endopod 1-segmented, armed with long terminal seta about 1.2 times longer than segment, and ornamented with patch of spinules distally. Leg 2 (Fig. 26L) lacking trace of intercoxal sclerite: protopod with outer seta; exopod indistinctly articulated at base, armed with 3 small distal spines and larger curved element; endopod well defined basally, armed with single apical seta just shorter than segment, without ornamentation. Leg 3 (Fig. 26A) uniramous, comprising tapering cylindrical exopodal process protruding ventrolaterally from trunk; outer protopodal seta not observed. Leg 4 (Fig. 26A) biramous, comprising 2 long cylindrical processes, with outer protopodal seta on common base; exopodal lobe longer than endopodal lobe. Leg 5 reduced to rounded lobe bearing naked seta subapically (Fig. 26M).

Distribution: This species was established by Hewitt (1968) based on the description of a single female collected from *Seriolella brama* (Günther, 1860) caught “presumably in the region of Wellington”, New Zealand according to Hewitt (1968). The discovery of this species on *Hyperoglyphe antarctica* in Australia extends its known range to include the southeastern sector of the Australian coast from Adelaide in the south to Coffs Harbour on the east coast. Both *H. antarctica* and *S. brama* belong to the Centrolophidae and this parasite appears restricted to hosts belonging to this family. This is the first published report of *L. microlamini* from Australian waters.

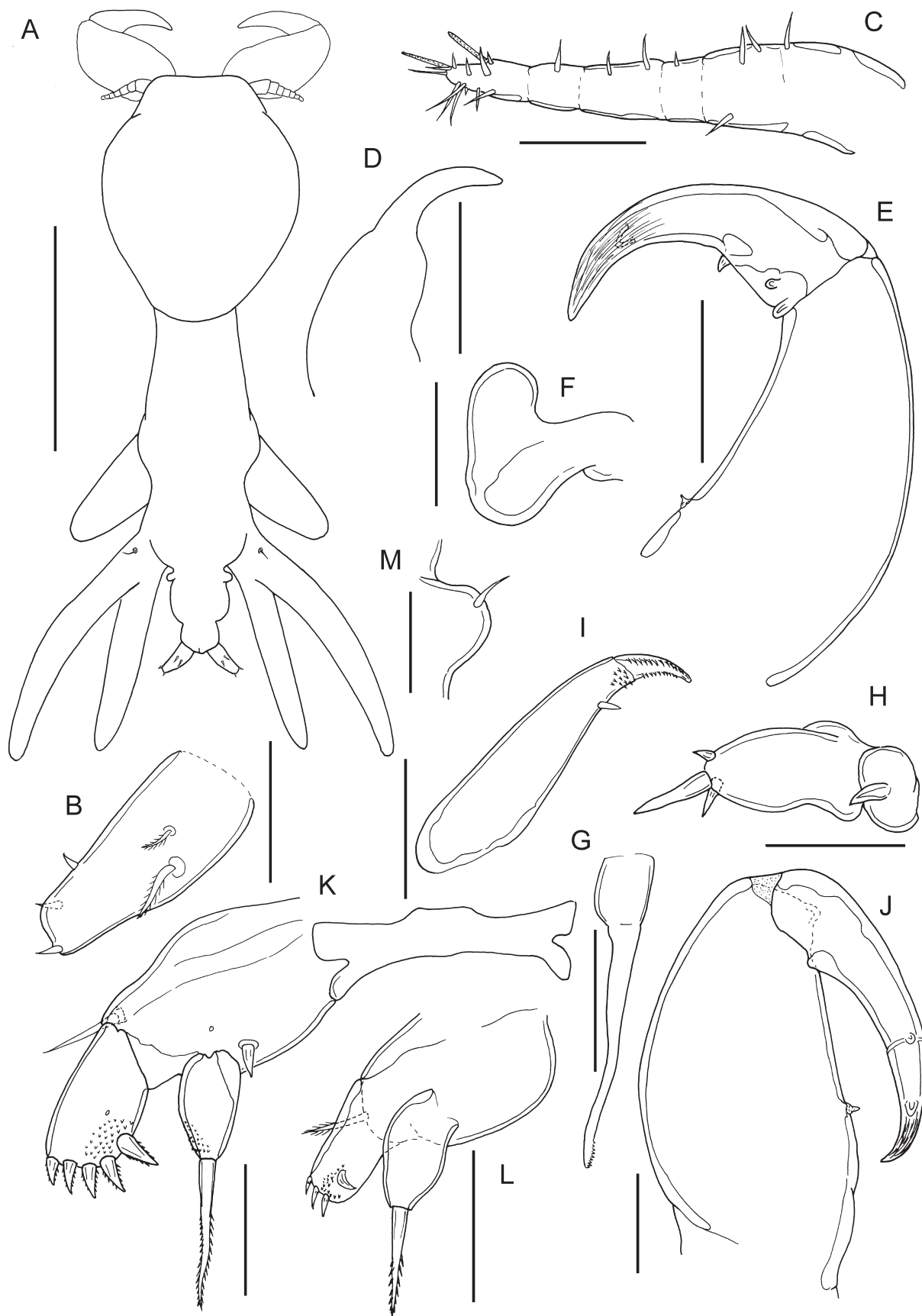


FIGURE 26. *Lernanthropus microlamini* Hewitt, 1968, adult ♂. A, habitus, dorsal; B, caudal ramus, dorsal; C, antennule; D, parabasal flagellum; E, antenna; F, postantennal process; G, mandible; H, maxillule; I, basis of maxilla; J, maxilliped; K, leg 1 and intercoxal sclerite; L, leg 2; M, leg 5. Scale bars A, 1 mm, B,D,F–L 100 μ m, C,M, 50 μ m, E, 200 μ m.

Remarks: This is a large species. The body length of the holotype female was 9.92 mm and the female from South Australia was 8.45 mm. Found here for the first time, the male was 2.74 mm in length. Hewitt (1968) pointed to similarities between his *L. microlamini* and *L. trifoliatum* Bassett-Smith, 1898 (now synonymized with *L. polynemi* Richiardi, 1881 (see Piasecki & Hayward, 2002)), but the shape of the dorsal trunk plate differs: it narrows posteriorly in the former but becomes wider and more rounded posteriorly in the latter.

***Lernanthropus mollis* Kabata, 1979**

(Figs. 27–29)

Material examined: Holotype ♀ from *Sillago analis* (Whitley, 1943) Moreton Bay, Queensland; 08 May 1963; collected by P.C. Young; NHMUK Reg. No. 1977.119. Paratype ♀ from *S. analis*, Moreton Bay, Queensland; 08 May 1963; collected by P.C. Young; NHMUK Reg. No. 1977.120.

49♀♀, 1♂ from *Sillago bassensis* Cuvier, 1829 Coffs Harbour, New South Wales; 15 May 1982; collected by K. Rohde. 44♀♀, 2♂♂ from *S. bassensis*, Coffs Harbour, New South Wales; 15 May 1982; collected by K. Rohde; NHMUK Reg. No. 1984.101–102. 66♀♀ from *S. bassensis*, Coffs Harbour, New South Wales; February 1982; collected by K. Rohde; NHMUK Reg. No. 1984.105. 4♀♀ from *Whiting*, Red Rock, February 1980; collected by K. Rohde; NHMUK Reg. No. 1984.104. 1♂ from *Whiting*, Arrawarra Beach, 21 February 1980; collected by K. Rohde; NHMUK Reg. No. 1984.103.

3♀♀ from *Sillago ciliata* Cuvier, 1829 (TC17210), Moreton Bay, Queensland; 18 January 2016; collected by G.A. Boxshall; QM Reg. No. W29493. 1♀ from *S. ciliata* (TC17590), Moreton Bay, Queensland; 26 June 2016; collected by G.A. Boxshall; NHMUK Reg. No. 2018.265.

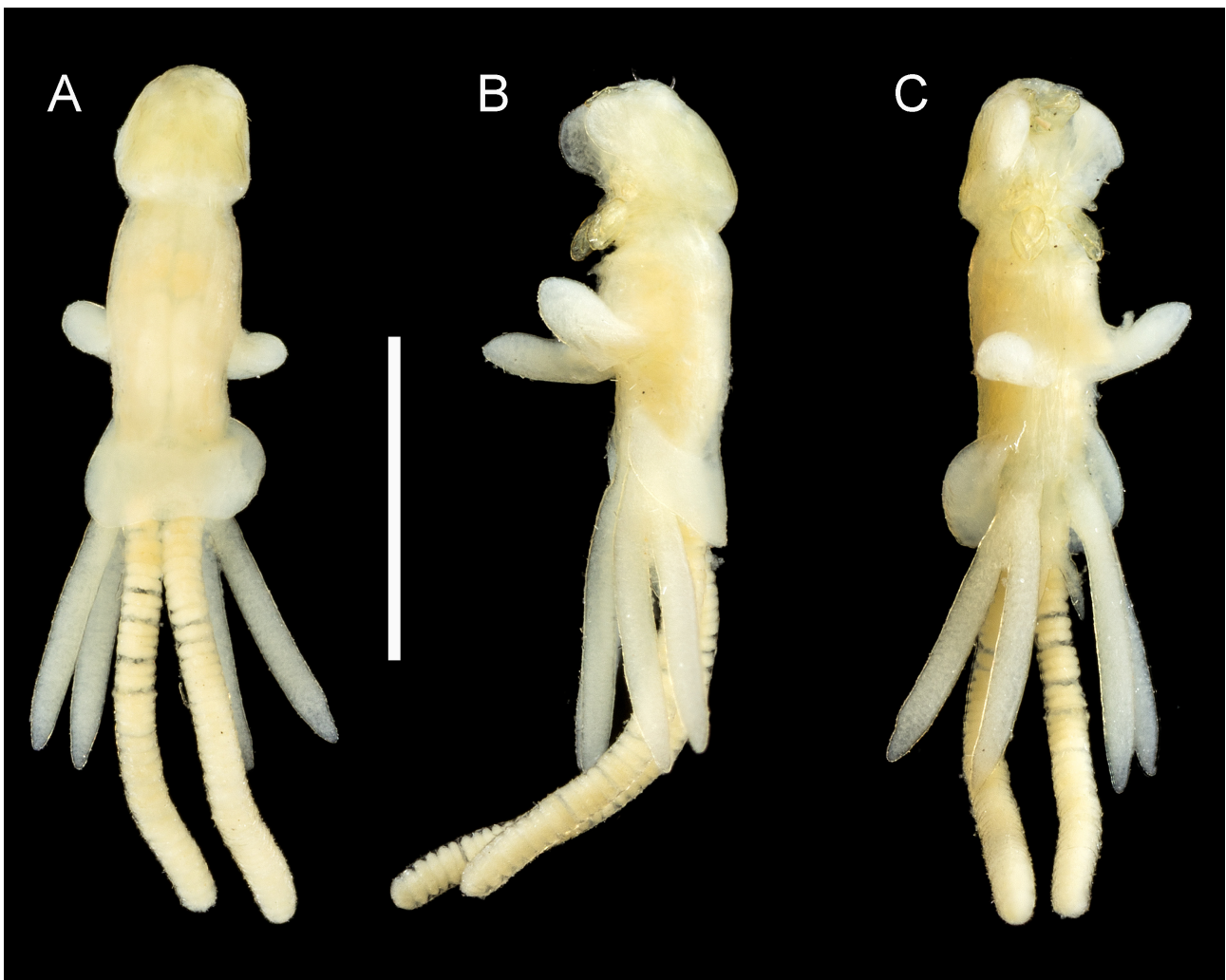


FIGURE 27. *Lernanthropus mollis* Kabata, 1979, adult ♀. A, habitus, dorsal; B, habitus, lateral; C, habitus, ventral. Scale bar 2 mm.

Differential diagnosis: Cephalothorax longer than wide with almost linear lateral margins extended anteroventrally. Trunk about 2.6 times longer than cephalothorax; anterior part (second and third pedigerous somites) as wide as cephalothorax, separated by slight narrowing from posterior part (fourth pedigerous somite) covered by short dorsal trunk plate (Fig. 27A–C). Dorsal trunk plate ovoid, wider than long, with convex lateral margins and linear free posterior margin. Urosome comprising fifth pedigerous somite, genital complex and abdomen, all fused; tip of abdomen visible extending beyond margin of dorsal trunk plate in dorsal view. Genital complex with conspicuous paired gonopores located dorsolaterally (Fig. 28A): surface ornamented with 2 pairs of sensillae located between gonopores; paired copulatory pores located posterolaterally on ventral surface. Paired caudal rami elongate; each ramus about 3.3 times longer than wide; armed with 2 plumose setae on dorsal surface proximally, 1 tiny lateral seta located at about 45% of ramus length and 2 small apical setae. Rami extending well beyond posterior margin of dorsal trunk plate.

Antennule indistinctly segmented: proximal part with total of 7 setae; apical segment with 11 setae plus 2 aesthetascs (Fig. 28B). Parabasal flagellum with swollen base and long distal part, curved at tip; almost as long as entire antennule (Fig. 28C). Antenna, mandible, and maxillule typical for genus. Maxilla (Fig. 28D) with short apical claw. Maxilliped with long and strongly curved subchela (Fig. 28E); ornamented with papilla on corpus opposing tip of subchela, plus minute seta present on concave surface of subchela. Leg 1 biramous with 1-segmented rami: members of leg pair connected by intercoxal sclerite: basis with outer seta and stout inner spine with point on apex; exopod armed with 5 spines; endopod with long apical seta. Leg 2 exopod with 4 spines; endopod with no apical seta but ornamented with spinules. Leg 3 located on ventral surface of third pedigerous somite, forming fleshy lamella, directed laterally and splayed out ventrally: third legs separate along midline. Leg 4 bilobate; inner and outer lobes elongate, almost equal in length, protruding well beyond free posterior margin of dorsal trunk plate. Leg 5 absent. Body length of ♀ ranging from 1.95 to 2.42 mm, with a mean of 2.19 mm (based on 10 specimens).

Description of male. Body smaller than female, mean body length 1.01 mm (based on 4 specimens). Cephalothorax large (Fig. 29A), comprising about 47% of total body length, broadest anterior to middle, with convex lateral margins; frontal area of cephalothorax carrying antennule and antennae produced, defined by slight indentation (Fig. 29A). Trunk slender comprising second to fourth pedigerous somites, and fused to urosome. Urosome comprising fifth pedigerous somite, genital complex and abdomen, all fused. Anterior part of genital complex tapering posteriorly with linear lateral margins contiguous with genital opercula. Abdomen narrow, with strongly convex lateral margins (Fig. 29B). Caudal rami as in female, except dorsal setae apparently naked rather than plumose.

Antennule indistinctly segmented (Fig. 29C) with irregular cuticular thickenings, setal formula: 1, 3, 2, 1, 1, 11 + 2 ae. Parabasal flagellum linear (Fig. 29D), tapering, more than half length of antennule. Antenna (Fig. 29E) comprising massive corpus and distal subchela; corpus with smooth medial surface; subchela armed with rounded process distally; well developed process present in articulation between corpus and subchela. Postantennal process (Fig. 29F) rounded, about 25 µm in diameter. Mandible (Fig. 29G) and maxillule (Fig. 29H) similar to those of female. Maxilla with conspicuous blunt-tipped process and additional spinular ornamentation distally on basis (Fig. 29I). Maxilliped corpus with small conical process on myxal surface and ornamented with patches of minute spinules (Fig. 29J); subchela with rounded process at mid-length.

Leg 1 with protopod distinct from somite; members of leg pair joined by intercoxal sclerite (Fig. 28F). Each leg biramous with outer seta and short, hirsute inner spine on basis; basis ornamented with patches of spinules: exopod 1-segmented, armed with 5 robust terminal spines and ornamented with spinules distally; endopod 1-segmented, armed with terminal seta about 1.4 times longer than segment. Leg 2 (Fig. 28G) biramous, no trace of intercoxal sclerite observed; protopod armed with outer plumose seta: exopod armed with small distal spine and ornamented with spinules over distal surface; endopod 1-segmented, armed with terminal seta just longer than segment. Leg 3 (Fig. 28A) biramous, comprising long cylindrical exopodal process protruding ventrolaterally from trunk with small ventrally-directed endopodal process (Fig. 28I) near base of exopod; endopod ornamented with surface spinules and conspicuous papillae as present on exopodal lobe (Fig. 28H); outer protopodal seta present dorsally at base of limb (arrowed in Fig. 29A): surfaces of both rami ornamented with papillae; tips of rami with irregular spinule rows (Fig. 28G, H). Leg 4 (Fig. 29A) biramous, comprising 2 long cylindrical processes, armed with outer protopodal seta on common base; leg 4 longer than exopod of leg 3; surfaces of both rami ornamented with conspicuous papillae as present on leg 3. Leg 5 absent.

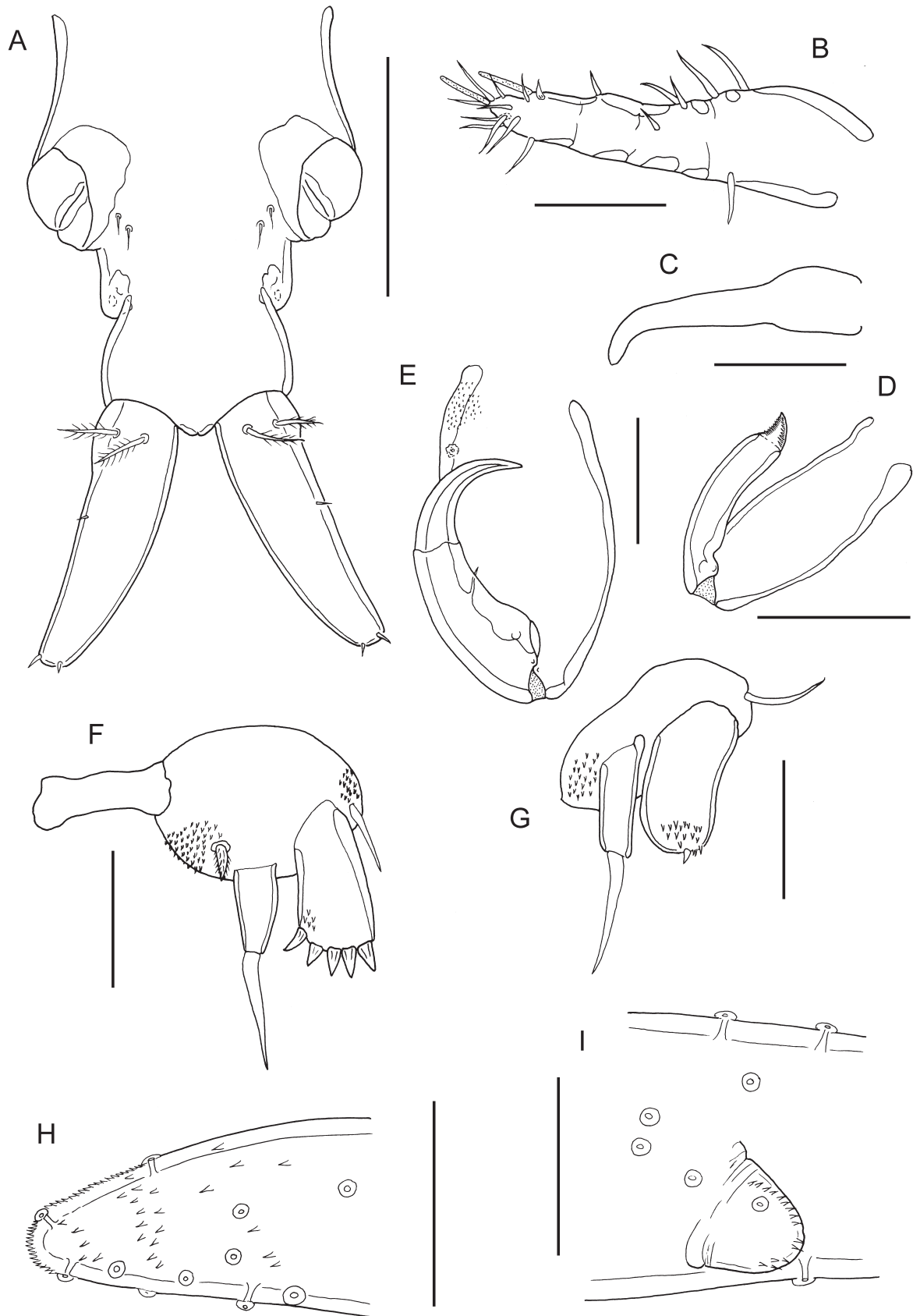


FIGURE 28. *Lernanthropus mollis* Kabata, 1979, adult ♀. A, urosome and caudal rami, dorsal; B, antennule; C, parabasal flagellum; D, maxilla; E, maxilliped. Adult ♂. F, leg 1 and intercoxal sclerite; G, leg 2; H, tip of exopodal lobe of leg 3, showing surface ornamentation; I, endopod of leg 3, showing surface ornamentation. Scale bars A, 200 µm, B,C,F–I, 50 µm, D,E, 100 µm.

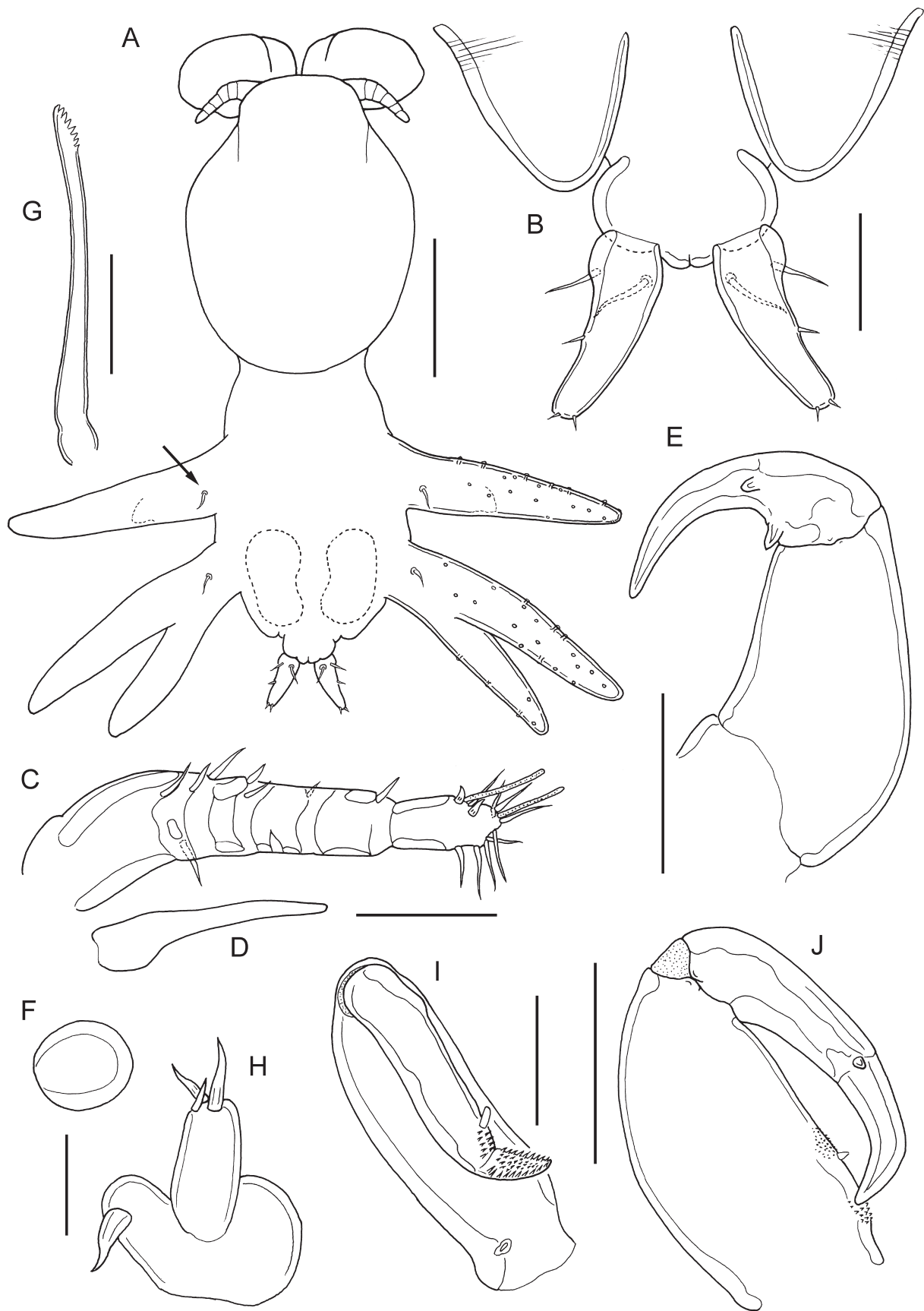


FIGURE 29. *Lernanthropus mollis* Kabata, 1979, adult ♂. A, habitus, dorsal; B, paired genital openings, abdomen and caudal rami, ventral; C, antennule; D, parbasal flagellum; E, antenna; F, postantennal process; G, mandible; H, maxillule; I, maxilla; J, maxilliped. Scale bars A, 200 μm , B–D, H, 50 μm , E, I, J, 100 μm , F, G, 25 μm .

Distribution: *Lernanthropus mollis* was originally described from only two females, both collected in Moreton Bay, Queensland. The type host was *Sillago analis* (Whitley, 1943) and the paratype female was found on *S. ciliata* Cuvier, 1829 (Kabata, 1979a). In his large scale survey of the ectoparasites of sillaginid fishes in the Indo-West Pacific, Hayward (1997) expanded the known distribution of *L. mollis* to include localities in Western Australia, the Northern Territory, and New South Wales, and added five new host species, *Sillago burrus* Richardson, 1842, *S. flindersi* McKay, 1985, *S. maculata* (Quoy & Gaimard, 1824), *S. schomburgkii* Peters, 1864, and *S. sihama*. In addition, Hayward (1997) reported the presence of *L. mollis* in the Gulf of Thailand on *S. aeolus* Jordan & Evermann, 1902. This remains the only record of *L. mollis* outside of Australian waters. *Sillago bassensis* is a new host record.

Remarks: The only other *Lernanthropus* species reported from a sillaginid host is *L. sillaginis* Pillai, 1963 which was described from females collected from the gills of *Sillago sihama* caught off Trivandrum, India (Pillai, 1963). The male of *L. sillaginis* was described subsequently by Song & Chen (1976) based on Chinese material from the same host. There is also material of *L. sillaginis* in the NHM, London collections, from *S. sihama* caught off the Iraq coast in the Arabian Gulf (NHMUK 2013.52–53). *Lernanthropus sillaginis* was reported from *Sillago maculata* caught off Thailand (Sirikanchana, 1982) and by Hayward (1997) from *S. aeolus*, *S. arabica* McKay & McCarthy, 1989, *S. attenuata* McKay, 1985, *S. chondropus* Bleeker, 1849, *S. parvisquamis* Gill, 1861 and *S. sihama* over a range extending from the Arabian Gulf in the west through to China in the east and Bali (Indonesia) in the south. Subsequently, Raja *et al.* (2018) reported it from *S. vincenti* McKay, 1980 in Indian waters. The only record from a non-sillaginid host is that of Ho & Kim (2004), who found *L. sillaginis* on *Priacanthus tayenus* Richardson, 1846 caught off Thailand.

The females of these two species are readily distinguishable: *L. sillaginis* has a large trunk with a broad dorsal trunk plate that flares out posteriorly so that it is twice as wide as the cephalothorax, whereas the trunk of *L. mollis* is slender and the small dorsal trunk plate is only about 1.2 times wider than the cephalothorax. In addition, the bilobed, foliaceous third legs are separated in the midline in *L. sillaginis*, but are unilobate and fused in the midline in *L. mollis*. The male of *L. mollis* is described here for the first time. It is very similar to the male of *L. sillaginis*, but can be distinguished by its better defined abdomen, slightly longer caudal rami, and longer exopodal lobe of leg 3 (relative to leg 4).

***Lernanthropus paracruciatus* sp. nov.**

(Figs. 30–34)

Type material: Holotype ♀, 4 paratype ♀♀, and allotype ♂ from *Protonibea diacanthus* (Lacepède, 1802), Lorna Shoal, Timor Sea, Northern Territory, 22 August 2012; collected by D.P. Barton; MAGNT Reg. Nos. Cr019243 (Holotype ♀), Cr019244 (paratype ♀♀), Cr109245 (allotype ♂). 2 paratype ♀♀, 2 paratype ♂♂ from *P. diacanthus*, Vanderlin Island, Gulf of Carpentaria, Northern Territory, 27 February 2014; collected by D.P. Barton; MAGNT Reg. No. Cr019246. 5 paratype ♀♀ from *P. diacanthus*, Cape Hotham, Northern Territory, 11 May 2014; collected by D.P. Barton; QM Reg. No. W29494. 1 paratype ♂ from *P. diacanthus*, Arafura Sea, Northern Territory, 25 July 2013; collected by D.P. Barton; QM Reg. No. W29495. 3 paratype ♀♀ from *P. diacanthus*, Lorna Shoal, Timor Sea, Northern Territory, 28 March 2014; collected by D.P. Barton; QM Reg. No. W29496. 1 paratype ♀ from *P. diacanthus*, Lorna Shoal, Timor Sea, Northern Territory, 02 October 2012; collected by D.P. Barton. 1 paratype ♀ from *P. diacanthus*, Arafura Sea, Northern Territory, 25 July 2013; collected by D.P. Barton. 1 paratype ♀, 1 paratype ♂ from *P. diacanthus*, Cape Hotham, Northern Territory, 30 August 2013; collected by D.P. Barton. 1 paratype ♂ from *P. diacanthus*, Vanderlin Island, Gulf of Carpentaria, Northern Territory, 26 February 2014; collected by D.P. Barton. 1 paratype ♂ from *P. diacanthus*, Vanderlin Island, Gulf of Carpentaria, Northern Territory, 27 February 2014; collected by D.P. Barton. 1 paratype ♀ and 1 ♂ from *P. diacanthus*, Groote Eylandt, Northern Territory, 15 October 2013; collected by D.P. Barton. 1 paratype ♀, 2 paratype ♂♂ from *P. diacanthus*, Darwin (Outer Harbour), Northern Territory, 07 March 2014; collected by B.K. Diggles. 1 paratype ♀ from *P. diacanthus*, Lorna Shoal, Timor Sea, Northern Territory, 02 December 2012; collected by D.P. Barton; NHMUK Reg. No. 2018.269–280.

Etymology: The species name alludes to the close resemblance between the new species and *Lernanthropus cruciatus* Pillai, 1962.

Description of Female. Body slender, comprising cephalothorax and elongate trunk (Fig. 30A–C): mean body

length excluding fourth legs ranging from 5.27 to 6.54 mm, with a mean of 5.96 mm (based on 8 specimens). Cephalothorax about as long as wide, with small frontal region bearing antennules and antennae defined by marginal indentations; lateral margins more-or-less parallel, expanded into ventrolaterally directed folds on either side of cephalothorax; posterolateral corners of cephalothorax produced into slight lobes (Figs. 30A–C, 34A–F). Anterior part of trunk nearly twice as long as cephalothorax, with linear lateral margins becoming gradually wider posteriorly: posterior part of trunk covered by dorsal trunk plate, typically about 1.3 times longer than wide and concealing entire fifth legs and caudal rami in dorsal view; dorsal trunk plate truncate, typically with nearly straight posterior margin (Fig. 30A). Urosome comprising fifth pedigerous somite, genital complex and abdomen, all fused (Fig. 31A); bearing paired, elongate caudal rami on ventral surface. Each caudal ramus about 7.5 times longer than maximum width; armed with 2 plumose setae on dorsal surface near base, minute lateral seta located subapically, plus 2 tiny apical setae (Fig. 31A).

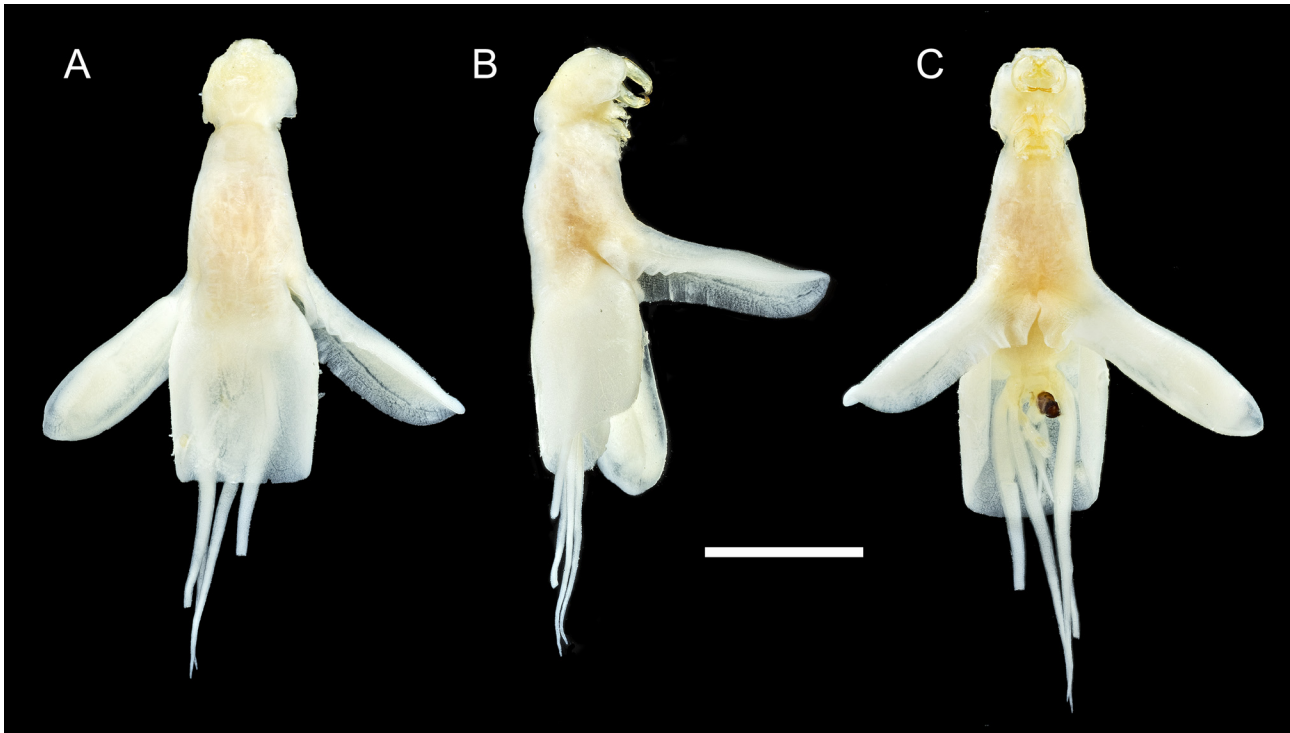


FIGURE 30. *Lernanthropus paracruciatu* sp. nov., paratype ♀. A, habitus, dorsal; B, habitus, lateral; C, habitus, ventral. Scale bar 2 mm.

Antennule (Fig. 31B) distinctly 7-segmented, proximal segment ornamented with long surface setules, some segments with irregular cuticular thickening; setal formula: 1, 3, 2, 1, 1, 2 + ae, 8 + ae. Parabasal flagellum located near of base of antennule, comprising broad base densely ornamented with long setules and curved distal part (Fig. 31C). Antenna (Fig. 31D) slender, comprising elongate corpus, bearing papilliform element proximally on medial surface, and short, strongly-recurved distal subchela; subchela armed with small process in zone of arthrodival membrane in articulation between corpus and subchela, plus small inner seta and blunt proximal process; terminal claw with striated and pitted areas on surface. Mandible stylet-like, armed with 8 marginal teeth distally (Fig. 31E). Maxillule (Fig. 31F) bilobate, smaller lobe tipped with 1 spiniform element; larger lobe tipped with 3 unequal spiniform elements. Maxilla 2-segmented: comprising proximal syncoxa (lacertus) and distal basis (brachium); basis (Fig. 31G) with strong subapical spine and flaccid walled process adjacent to terminal claw; terminal claw ornamented with row of sharp denticles on both margins. Maxilliped (Fig. 31H) 2-segmented comprising massive corpus with papilliform element proximally on medial surface, and distal subchela comprising compound endopodal segment and weakly curved terminal claw; subchela armed with proximal inner seta and distal spiniform process.

Leg 1 members joined by intercoxal sclerite (Fig. 32A); protopodal part armed with outer seta on papilla and inner spine; outer and anterior surfaces of protopod densely ornamented with long setules, inner surface with tiny spinules; exopod 1-segmented, armed with 5 robust terminal spines with serrate margins and ornamented with patch

of spinules on outer surface; endopod 1-segmented, tapering distally, armed with terminal spine about as long as segment and ornamented with spinules. Leg 2 (Fig. 32B) mounted on inflated prominence derived from incorporated protopod and armed with outer seta on papilla; surface ornamented with long setules: both rami 1-segmented; exopod armed with 4 distal spines; endopod armed with robust apical element less than half length of segment, and ornamented with spinules distally. Leg 3 uniramous, with elongate endopodal lobe directed both laterally and posteroventrally, longer than anterior part of trunk; endopodal lobes separate along inner margin (Fig. 30C); armed with dorsal outer basal seta; exopod not defined. Leg 4 (Fig. 30C) biramous with both rami forming elongate processes, inner (endopodal) lobe slightly shorter than outer (exopodal) lobe, but both lobes damaged and incomplete in most specimens (cf. Fig. 34A–F); armed with basal seta dorsally near base of limb. Leg 5 represented by elongate lobe, about 10 times longer than wide; with unarmed tip but bearing single plumose seta dorsally near base (Fig. 31A).

Male. Body smaller than female (Fig. 32C), body length ranging from 2.20 to 2.58 mm, with a mean of 2.39 mm (based on 3 specimens). Cephalothorax comprising about 36% of total body length, broadest at middle, with evenly convex lateral margins: frontal area of cephalothorax carrying antennules and antennae, defined by marginal indentations. Trunk comprising fused pedigerous somites (Fig. 32C) fused to unsegmented urosome incorporating genital complex and abdomen, bearing paired caudal rami. Caudal ramus elongate (Fig. 32D), about 7.5 times longer than wide, armed with 2 plumose setae proximally on dorsal surface, 1 short lateral seta located in distal 17%, plus 2 apical setae; ornamented with single sensilla on dorsal surface.

Antennule 7-segmented (Fig. 32E), setal formula: 1, 3, 2, 0, 1, 3 + ae, 7 + ae. Parabasal flagellum located close to base of antennule, comprising broad base with thickened cuticle plus slender distal part (Fig. 32F). Antenna (Fig. 32G) comprising long, slender corpus and distal subchela terminating in strongly recurved claw: corpus armed with broad process proximally on medial surface plus inner distal process; subchela armed with strong accessory claw proximally and another accessory claw near middle. Postantennal process rounded. Mandible stylet-like with 8 marginal teeth near apex (Fig. 33A). Maxillule bilobate (Fig. 33A); larger lobe armed with 3 unequal elements distally and ornamented with surface spinules; smaller lobe with strong apical element. Maxilla with strong spinous process subapically on basis (Fig. 32H); distal claw with 2 rows of denticles. Maxilliped (Fig. 33B) comprising robust corpus bearing small pointed myxal process and ornamented with patches of blunt spinules proximally on medial surface, and distal subchela armed with inner seta about at mid-length plus blunt process at base of terminal claw.

Leg 1 robust, members of leg pair joined by intercoxal sclerite (Fig. 33C): basis armed with outer seta on papilla and stout inner spine with patch of spinules at base; exopod 1-segmented, broadening distally, armed with 5 distal spines, innermost spine longest with smooth margins, outermost spine short, middle 3 spines all robust, heavily sclerotized and apparently fused to segment: ramus ornamented with inner and outer patches of spinules; endopod elongate, 1-segmented, armed with spinulose apical seta just shorter than segment; segment extensively ornamented with spinules. Leg 2 (Fig. 33D) retaining only slender vestige of intercoxal sclerite; basis with outer seta on papilla; both rami 1-segmented; exopod broad distally, armed with 3 small spines on outer part of distal margin, and ornamented with patches of spinules distally; endopod slender, slightly curved and armed with long spinulose seta apically; shorter than segment; surface ornamented with spinules. Leg 3 (Fig. 32C) uniramous, forming long cylindrical process directed posterolaterally from ventrolateral origin on trunk: armed with dorsal basal seta at base of limb; surface of leg 3 smooth, unornamented. Leg 4 (Fig. 32C) biramous, each ramus forming long cylindrical process, exopodal lobe longer than endopodal lobe: outer basal seta present dorsally at base of limb (Fig. 32I). Leg 5 represented by minute papilla with apical seta (arrowed in Fig. 32I).

Distribution. The type locality of the new species is in the Northern Territory, but this species is also known from Broome and Wyndham in Western Australia (D.P. Barton, unpubl.).

Remarks: The new species is most closely related to *L. cruciatus*. Both species have a very long and well developed leg 3, characterized by an enlarged endopodal lobe projecting both laterally and posteroventrally, which is longer than the anterior part of the trunk (measured from the posterior margin of the dorsal cephalic shield to the shallow groove marking the origin of the dorsal trunk plate at the anterior edge of the fourth pedigerous somite). Both the new species and *L. cruciatus* also share numerous features with several other species found on sciaenid hosts and are similar to *L. gisleri* (see Table 3). These shared features include the following character states: the antennule is 7-segmented with the segment bearing the subapical aesthetasc separate from the apical segment; the proximal segment of the antennule is fused to a swelling on the surface of the cephalothorax and both segment and swelling are densely ornamented with long setules; the maxilla bears a curved process on the basis just proximal to

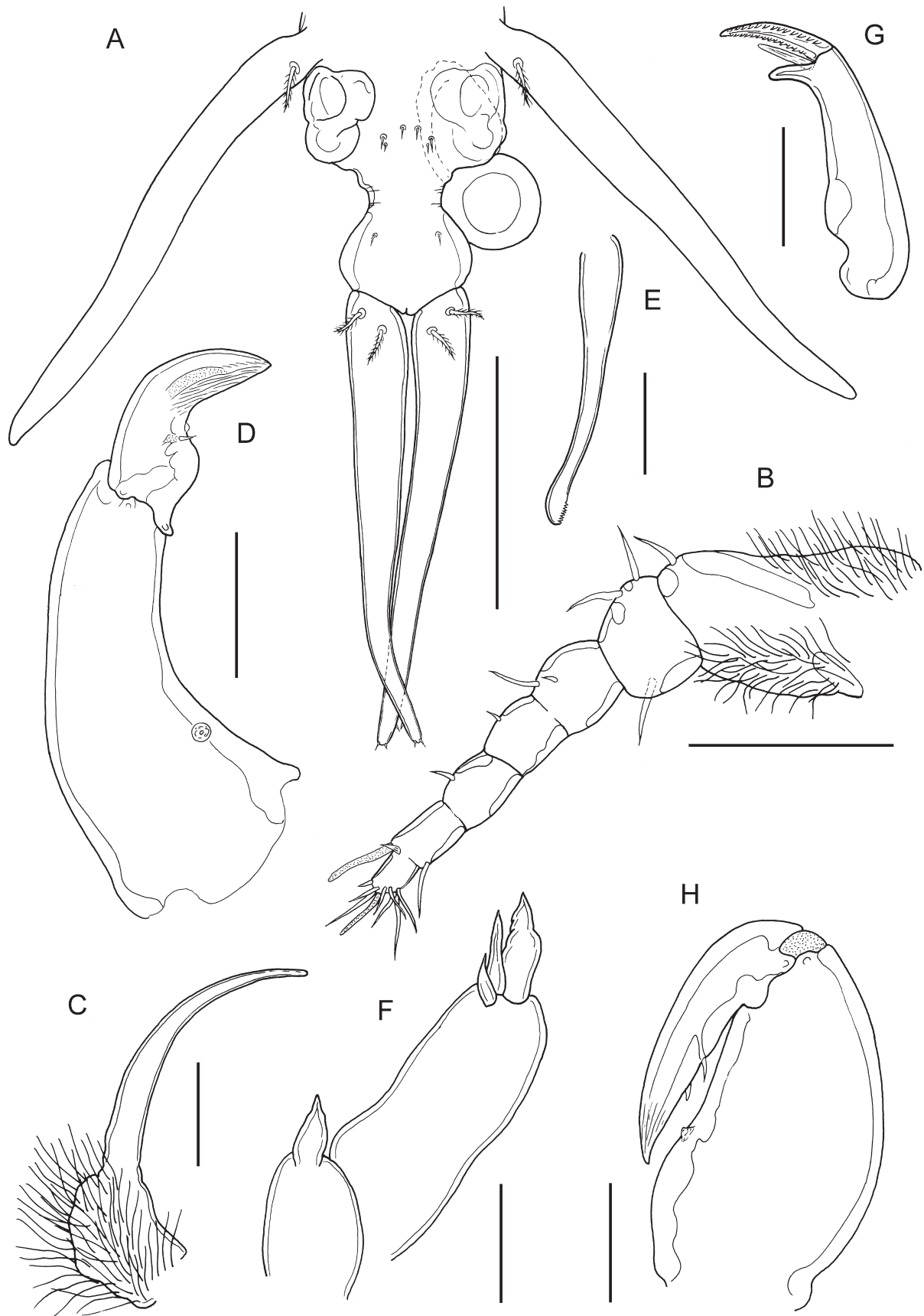


FIGURE 31. *Lernanthropus paracruciatu* sp. nov., paratype ♀. A, urosome, dorsal view showing fifth legs, genital openings and caudal rami; B, antennule; C, parabasal flagellum; D, antenna; E, mandible; F, maxillule; G, basis of maxilla; H, maxilliped. Scale bars A, 0.5 mm, B, G, 100 μm, C, E, F, H, 50 μm, D, 200 μm.

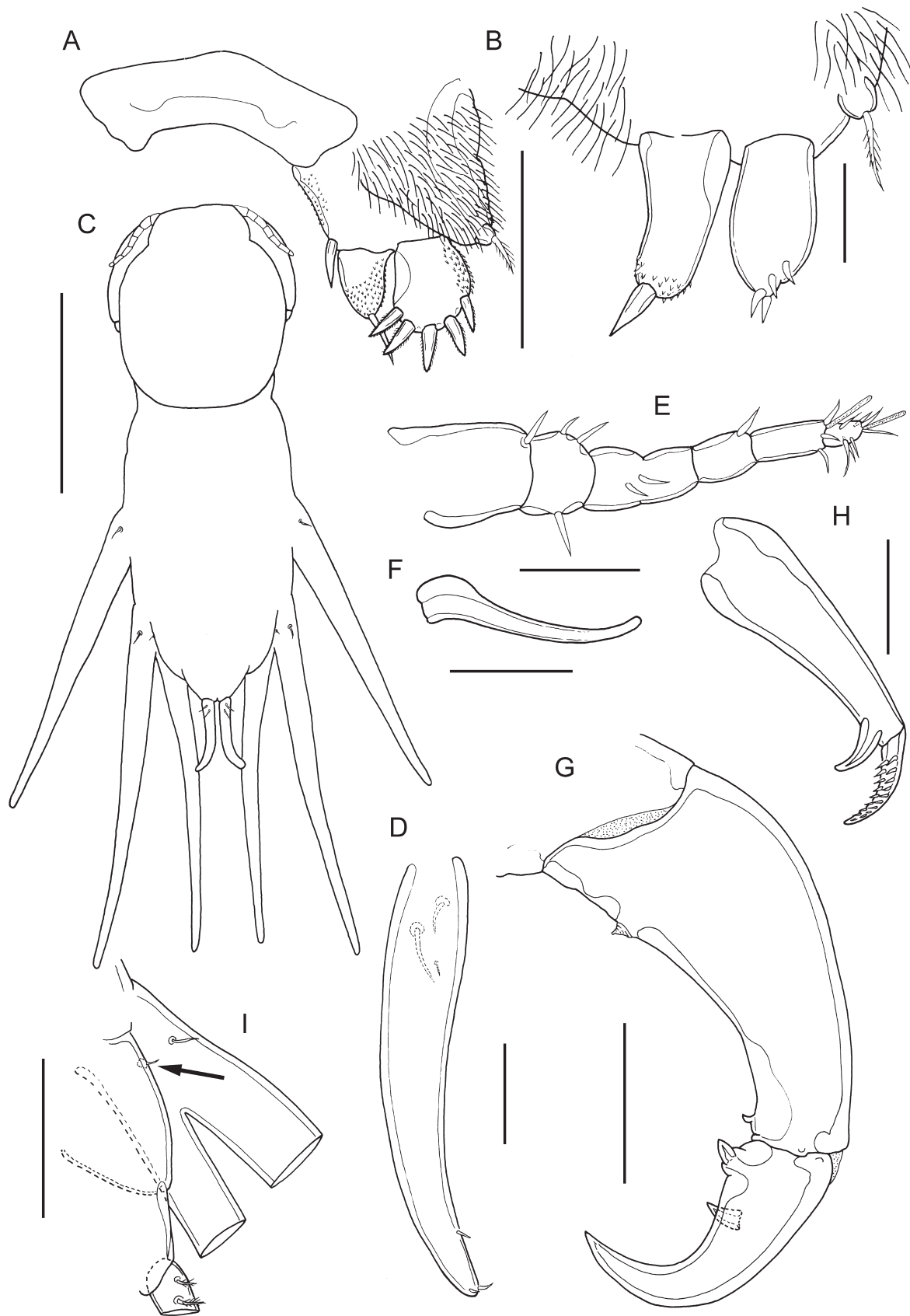


FIGURE 32. *Lernanthropus paracruciatus* sp. nov., paratype ♀. A, leg 1 and intercoxal sclerite; B, leg 2. *L. paracruciatus* sp. nov., paratype ♂. C, habitus, dorsal; D, caudal ramus, ventral; E, antennule; F, parabasal flagellum; G, antenna; H, basis of maxilla; I, right side of genital complex, dorsal view showing vestigial fifth leg (arrowed). Scale bars A,G, 200 µm, B, 50 µm, C, 1 mm, D–F,H, 100 µm, I, 0.5 mm.

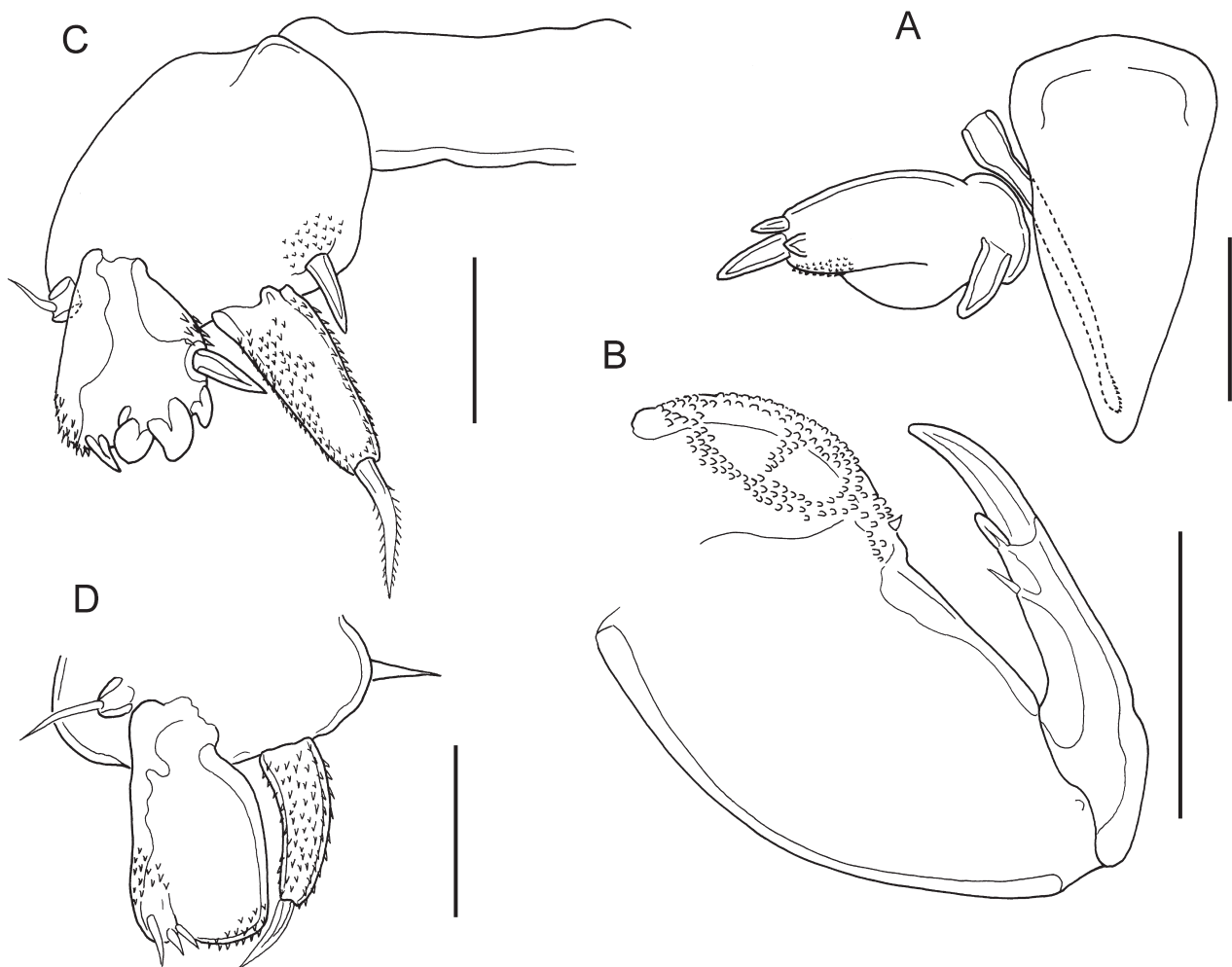


FIGURE 33. *Lernanthropus paracruciatu* **sp. nov.**, paratype ♂. A, maxillule and oral cone, with mandible *in situ*; B, maxilliped; C, leg 1 and intercoxal sclerite; D, leg 2. Scale bars A,C,D, 100 μ m, B, 200 μ m.

the base of the apical claw; the protopod of leg 1 is ornamented with long setules; leg 3 is uniramous with the exopod forming a large, laterally-posteroventrally directed lamella; the rami of leg 4 are both elongate; leg 5 forms an elongate process; and the caudal rami are elongate. However, no other species listed in Table 3 have leg 3 as extremely elongate as in the new species and *L. cruciatu*.

The new species differs from *L. cruciatu* in the proportions of the dorsal trunk plate: in *L. cruciatu* the dorsal trunk plate is about 1.3 times longer than the anterior part of the trunk, whereas in *L. paracruciatu* **sp. nov.** it is only 1.0 to 1.1 times longer. The rami of leg 4 are also much longer relative to the dorsal trunk plate in the new species: in *L. cruciatu* the distal parts of the rami that extend beyond the rear margin of the dorsal trunk plate and are visible in dorsal view, are about one third of the length of the dorsal trunk plate, whereas in the new species the parts of the rami of leg 4 extending beyond the posterior margin of the plate (and visible in dorsal view) are about equal in length to the entire dorsal trunk plate.

The length to width ratio of the dorsal trunk plate is not a reliable character in this species because in fixed specimens it can sometimes be wrapped ventrally around the fourth legs and egg sacs (e.g. Fig. 34C) and thus appear much narrower than in other specimens (e.g. Fig. 30A). Examination of the large sample of material from *P. diacanthu* revealed that the posterior extremities of many specimens were profoundly damaged (Fig. 34A–B, D–F). In many females the dorsal trunk plate was misshapen, to the point of being almost absent in some cases (Fig. 34D), and in virtually every specimen examined one or more of the elongate leg rami was truncated or missing. Here we interpret this damage as due to the feeding activity of cleaner fish. It is important for taxonomists to be aware of the possibility of such damage since the relative lengths of the dorsal trunk plate and the rami of leg 4 have often been used as characters for species discrimination.

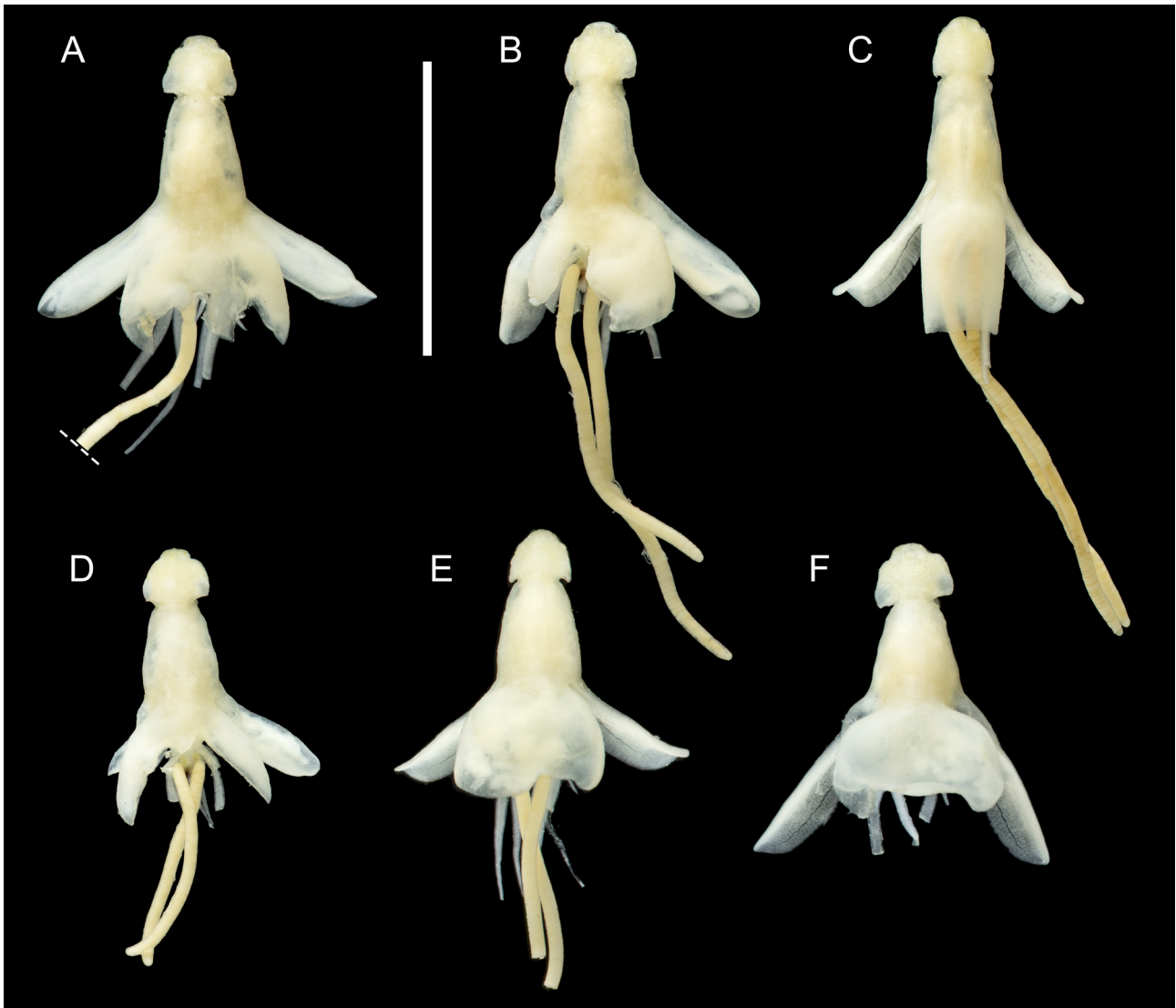


FIGURE 34. *Lernanthropus paracruciatu* sp. nov., paratype ♀♀. A–F, dorsal habitus of different females showing varying degrees of damage to dorsal trunk plate and posterior legs. Scale bar 5 mm.

Sexual dimorphism is very marked in lernanthropids, affecting not only body form but also the structure and armature of almost every limb. However, the sexual dimorphism expressed in the first swimming leg of *L. paracruciatu* sp. nov. is unusual: the spines on the distal margin of the exopod have the normal tapering shape in the female but in the male these spines are thicker, have a more rounded shape and are contiguous (possibly fused).

***Lernanthropus pemphericola* sp. nov.**

(Figs. 35–37)

Type Material: Holotype ♀, allotype ♂, 27 paratype ♀♀, 14 paratype ♂♂ from *Pempheris compressa* (White, 1790), Coffs Harbour, New South Wales; 15 May 1981; collected by M. La Spina: AM Reg. Nos. P.103903 (Holotype ♀), P.103904 (allotype ♂), P.103905 (10 paratype ♀♀ and 5 paratype ♂♂); 10 paratype ♀♀ and 5 paratype ♂♂, QM Reg. No. W29497; 6 paratype ♀♀ and 4 paratype ♂♂ NHMUK 2018.281–290.

Etymology: the name of the new species combines the generic name of the host with *-icola*, meaning inhabitant.

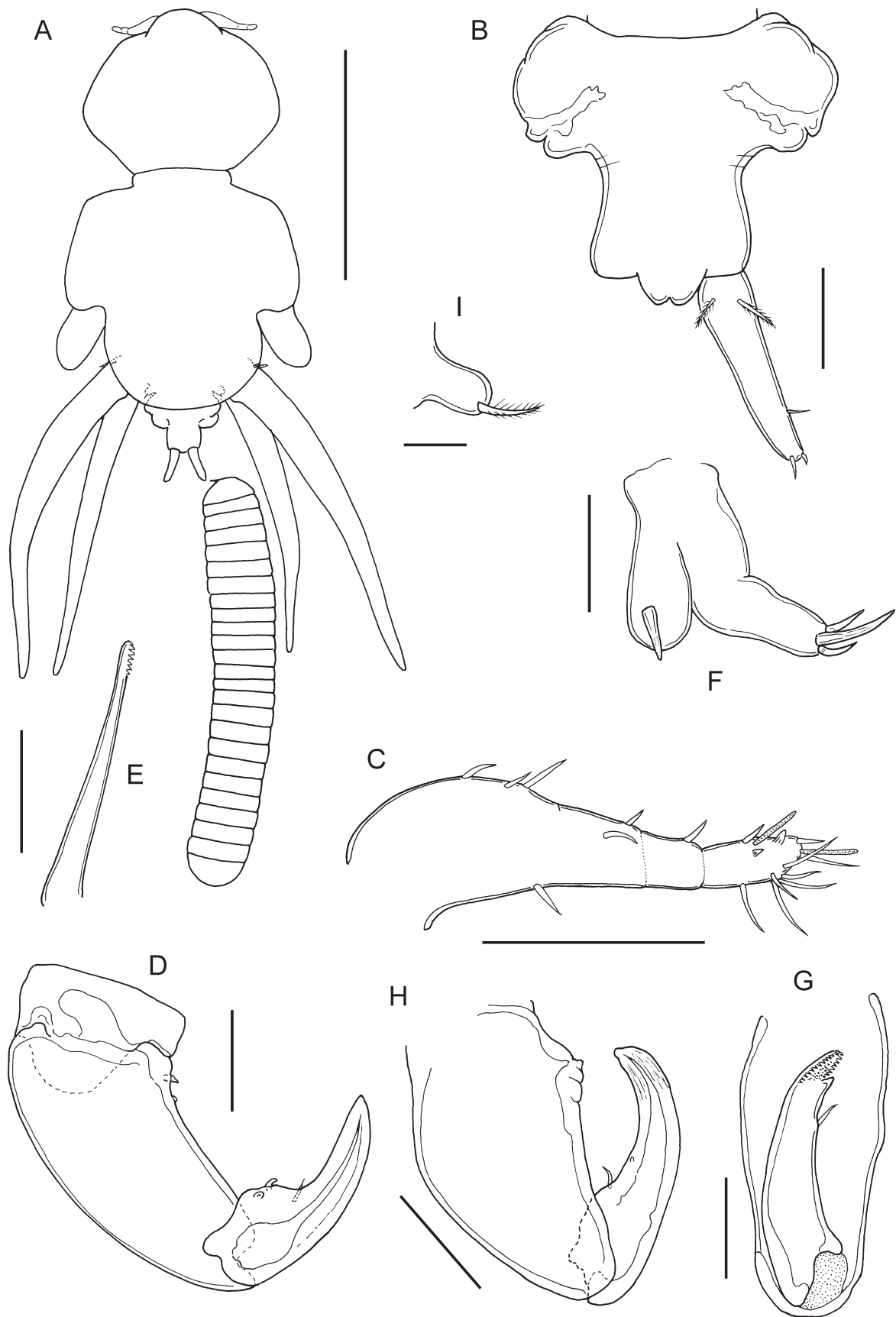


FIGURE 35. *Lernanthropus pemphericola* **sp. nov.**, paratype ♀. A, habitus with detached egg sac, dorsal; B, urosome, dorsal view showing paired genital apertures and right caudal ramus; C, antennule; D, antenna; E, mandible; F, maxillule; G, maxilla; H, maxilliped; I, fifth leg. Scale bars A, 1 mm, B–D, H, 100 µm, E–G, I, 50 µm.

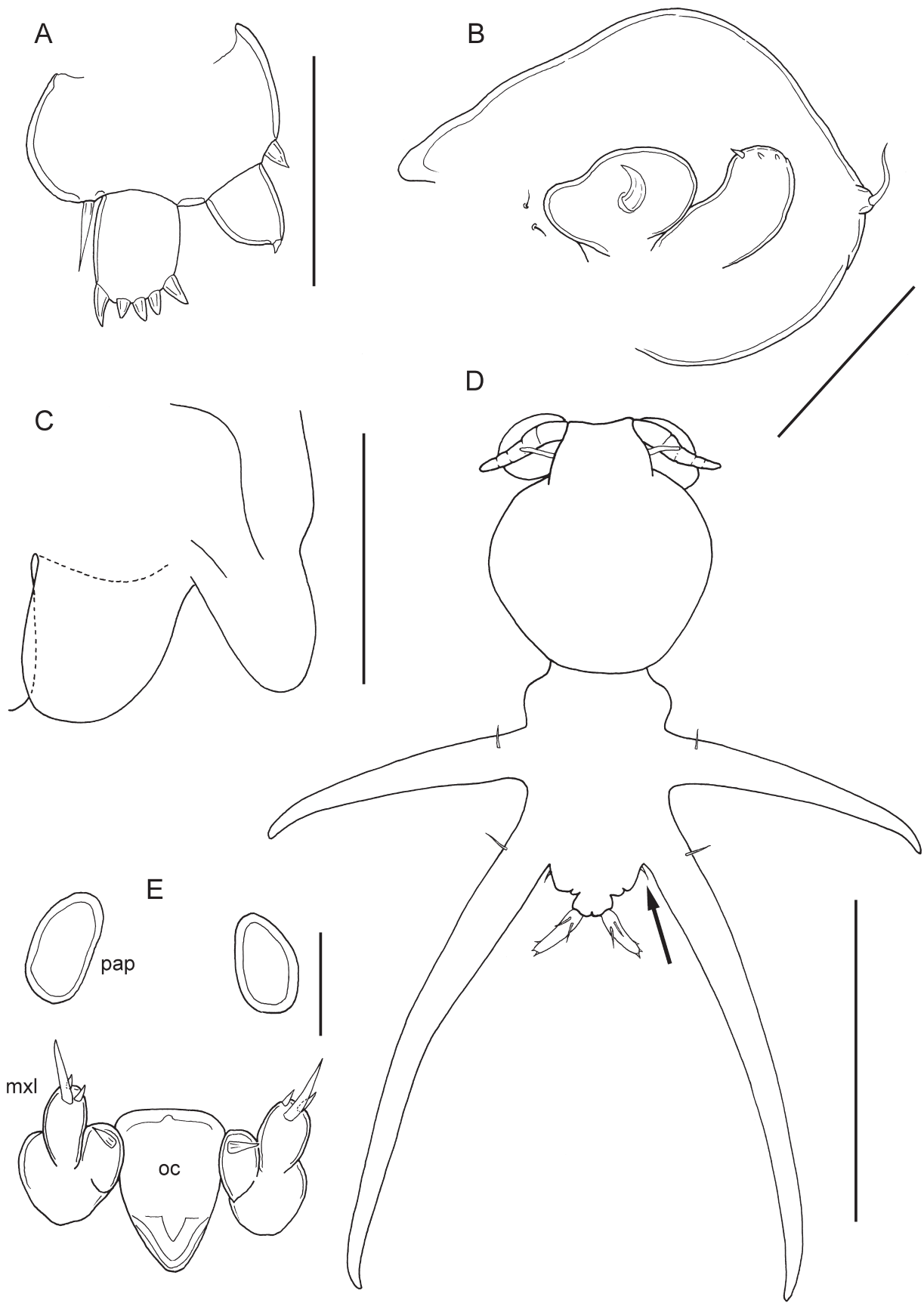


FIGURE 36. *Lernanthropus pemphericola* **sp. nov.**, paratype ♀. A, leg 1; B, leg 2; C, leg 3. *L. pemphericola* **sp. nov.**, paratype ♂. D, habitus, dorsal view with right fifth leg arrowed; E, paired postantennal processes (pap), oral cone (oc) and maxillules (mxl) *in situ*. Scale bars A,B, 100 µm, C, 0.5 mm, D, 1 mm, E, 50 µm.

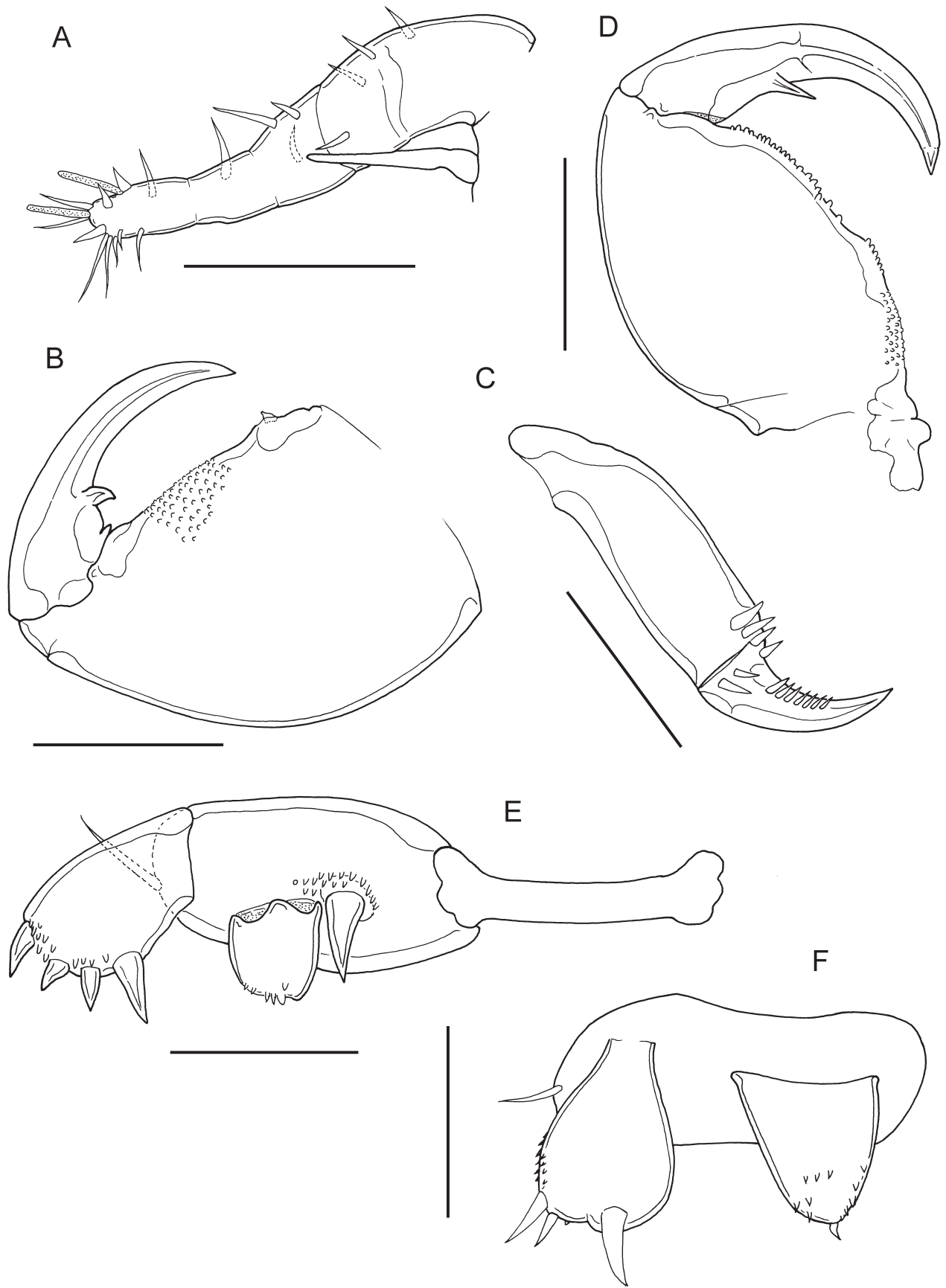


FIGURE 37. *Lernanthropus pemphericola* sp. nov., paratype ♂. A, antennule and parabasal flagellum; B, antenna; C, basis of maxilla; D, maxilliped; E, leg 1 and intercoxal sclerite; F, leg 2. Scale bars A,B,D, 100 µm, C,E,F, 50 µm.

Description: Female body comprising cephalothorax, trunk and urosome (Fig. 35A): body length ranging from 1.47 to 1.69 mm, with a mean of 1.59 mm (based on 10 specimens). Cephalothorax subcircular, about 1.2 times wider than long; frontal margin with convex protruding central part; lateral margins evenly convex, expanded into ventrolaterally directed folds on either side of cephalothorax; posterior margin convex. Trunk broad: anterior part (second and third pedigerous somites) wider than long, expanding posteriorly towards level of origin of third legs; posterior part (fourth pedigerous somite) with short dorsal trunk plate with rounded posterior margin (Fig. 35A). Dorsal trunk plate wider than long, covering anterior part of urosome but with part of genital complex, anal somite and caudal rami all visible in dorsal view. Egg sacs linear (Fig. 35A). Abdomen small, not clearly differentiated from genital complex (Fig. 35B), bearing paired, elongate caudal rami. Each caudal ramus about 3.7 times longer than wide; armed with 2 long plumose setae proximally, 1 short outer seta located at about 75% of ramus length, and 2 spine-like setal elements at apex (Fig. 35B).

Antennule (Fig. 35C) indistinctly segmented, proximal part with irregular cuticular thickening and armed with total of 7 setae; defined apical segment with 11 + 2 aesthetascs. Parabasal flagellum absent in female. Antenna (Fig. 35D) comprising robust corpus, bearing 2 small processes proximally on medial surface, and distal subchela armed with 2 small processes proximally and small seta on concave margin. Mandible stylet-like, armed with 8 marginal teeth distally (Fig. 35E). Maxillule (Fig. 35F) bilobate, smaller inner lobe tipped with 1 spiniform element; larger outer lobe tipped with 3 unequal setal elements. Maxilla (Fig. 35G) 2-segmented: comprising proximal syncoxa (lacertus) and distal basis (brachium); basis with 1 subapical seta plus triangular process distally; terminal claw ornamented with sharp denticles along margins and fine spinules on inner surface. Maxilliped (Fig. 35H) 2-segmented comprising massive corpus with papilliform element on medial surface opposing tip of claw, and distal subchela comprising compound endopodal segment and strongly curved terminal claw, armed with seta and minute process near concave margin.

Leg 1 biramous (Fig. 36A); protopod well defined, intercoxal sclerite absent; basis armed with outer seta and short inner spine; exopod 1-segmented, armed with 5 robust terminal spines; endopod 1-segmented, armed with vestigial seta on apex. Leg 2 (Fig. 36B) mounted on inflated prominence derived from incorporated protopod, armed with outer seta located on small prominence, and ornamented with 2 setules medially: both rami 1-segmented; exopod armed with 4 small terminal spines; endopod armed with curved apical element. Leg 3 biramous: exopod represented by flattened, horizontally-orientated lobe, visible in dorsal view; endopod represented by slightly larger obliquely-orientated lobe, extending back to about level of origin of fourth leg lobes; endopodal lobes of leg pair separate along midline (Fig. 36C); outer basal seta not seen. Leg 4 (Fig. 35A) biramous with rami forming elongate processes, armed with dorsal seta at base: outer (exopodal) lobe elongate, inner (endopodal) lobe slightly shorter than exopodal lobe. Leg 5 represented by small lobe bearing single plumose seta on apex (Fig. 35I).

Male. Body smaller than female; body length ranging from 0.92 to 1.07 mm, with a mean of 0.98 mm (based on 10 specimens). Cephalothorax large, comprising about 46% of total body length: broadest at middle, with strongly convex lateral margins (Fig. 36D); frontal area carrying antennules and antennae, narrow and defined by marked lateral indentations. Trunk comprising second to fourth pedigerous somites fused to urosome. Urosome comprising fifth pedigerous somite, genital somite and abdomen, all fused. Genital somite with linear, tapering lateral margins, more than twice width of abdomen; abdomen wider than long bearing paired caudal rami armed as in female.

Antennule indistinctly segmented (Fig. 37A), proximal part armed with total of 8 setal elements; apical segment with 11 + 2 aesthetascs. Parabasal flagellum straight, with slightly swollen base, located close to base of antennule and reaching 36% along limb (Fig. 37A). Antenna (Fig. 37B) comprising massive corpus and distal subchela consisting of endopod plus terminal claw: corpus armed with papilliform process medially and ornamented with spinules; subchela armed with stout inner process plus; small process in articulation between corpus and subchela. Postantennal processes (Fig. 36, pap) rounded located anterior to short oral cone (Fig. 36E, oc). Mandible similar to that of female. Maxillule with longest seta on apex of outer lobe more than twice length of shorter elements (Fig. 36E). Maxilla as in female but with additional large spinules in distal part of basis and on claw (Fig. 37C). Maxilliped with same segmentation as female; corpus ornamented with spinules along myxal margin, subchela with strong pointed process near concave margin (Fig. 37D).

Leg 1 with well defined protopod and members of leg pair joined by intercoxal sclerite: biramous (Fig. 37E) with outer seta and strong inner spine on basis; basis ornamented with spinules around origin of inner spine: exopod 1-segmented, armed with 4 terminal spines and ornamented with scattered spinules distally; endopod 1-segmented, with small elements and scattered spinules apically. Leg 2 (Fig. 37F) without intercoxal sclerite; protopod defined

from somite proximally and armed with outer seta; both rami 1-segmented; exopod broadening distally, armed with distal spines of varying sizes and with ornamentation of spinules laterally; endopod tapering distally, surface ornamented with scattered spinules, armed with small naked seta apically. Leg 3 (Fig. 36D) uniramous, forming long cylindrical process directed laterally from trunk, armed with outer protopodal seta proximally on dorsal surface. Leg 4 (Fig. 36D) uniramous, forming long cylindrical process directed posterolaterally, with outer protopodal seta proximally on dorsal surface; leg 4 lobe about 1.8 times longer than leg 3.

Distribution: This new species is known only from the type locality, Coffs Harbour, New South Wales.

Remarks: This small species is the first lernanthropid to be recorded from any member of the family Pempheridae. It is similar to *L. atrox* in its broad cephalothorax and narrow dorsal trunk plate allowing the dorsal surface of the posteriorly-directed leg 3 to be visible in dorsal aspect. These species differ, however, in the extent of the dorsal trunk plate which conceals the urosome including the tips of the caudal rami in *L. atrox*, but which reveals the posterior part of the genital complex, the abdomen and the entire caudal rami in the new species. In addition, the lobes of leg 4 are short (less than the length of the trunk) in *L. atrox* but elongate (almost as long as entire body) in *L. pemphericola* **sp. nov.** The males differ markedly in leg structure: legs 3 and 4 are biramous in *L. atrox* (see Shiino, 1955: Fig. 3C) but both are uniramous in the new species.

The other known Australian species with a short and broad anterior trunk and narrow dorsal trunk plate is *L. breviculus*, but in this species the dorsal trunk plate covers the entire urosome and caudal rami, and only the lateral margin of leg 3 is visible dorsally. In contrast, in the new species almost all of the urosome protrudes beyond the posterior margin of the dorsal trunk plate and the entire exopodal lobe of leg 3 is visible in dorsal view. In addition, the members of leg 3 pair are fused along the midline in *L. breviculus*, but separate in *L. pemphericola* **sp. nov.** The new species can also be distinguished from *L. callionymicola* by the same feature, namely that in *L. callionymicola* only the tips of the caudal rami are visible protruding beyond the posterior margin of the dorsal trunk plate (El-Rashidy & Boxshall, 2012) compared to almost the entire urosome in the new species.

The male of the new species has uniramous legs 3 and 4 and this is a relatively unusual condition. Although males are as yet unknown in many species, where males have been described they typically have the fourth legs (and often the third legs) biramous. So the possession of uniramous legs 3 and 4 is not common in males but it is shared with a number of other Indo-Pacific species including *L. breviculus*, *L. callionymicola*, *L. cadenati* and *L. secutoris* Pillai, 1963. The first two of these species have already been distinguished from the new species on the basis of female characteristics. Females of the new species differ from *L. cadenati* in the form of leg 3, which has unfused endopodal lobes in the new species rather than endopodal lobes fused along the midline to form a triangular ventral plate in *L. cadenati*. In male *L. cadenati* leg 4 is about 4 times longer than leg 3 whereas in male *L. pemphericola* **sp. nov.** leg 4 is only about 1.8 times longer than leg 3. The ratio of the lengths of legs 3 and 4 is similar in males of *L. secutoris* and the new species, but the females differ: in *L. secutoris* the dorsal trunk plate is longer than the anterior trunk and conceals the genital complex, whereas in the new species the trunk plate is shorter than the anterior trunk and the genital complex is visible in dorsal view.

***Lernanthropus pomadasysis* Rangnekar & Murti, 1961**

(Fig. 10C–D)

Material examined: 4♀♀, 1♂ from *Pomadasys kaakan* (Cuvier, 1830), Bynoe Harbour, Northern Territory, 16 October 2014, collected by B.K. Diggles. 1♀, 1♂ MAGNT Reg. No. Cr-019247. 1♀ QM Reg. No. W29498, 2♀♀ (1 dissected) NHMUK Reg. No. 2018.228–229.

Differential diagnosis: Cephalothorax wider than long, widest posteriorly and narrowing to medially pointed frontal margin, giving triangular outline in dorsal view (Fig. 7C); lateral margins of cephalothorax produced anteroventrally. Anterior part of trunk (second and third pedigerous somites) narrower than cephalothorax, becoming gradually wider towards posterior part (fourth pedigerous somite) covered by dorsal trunk plate. Dorsal trunk plate short and wide, with entire but irregularly-convex free posterior margin. Urosome comprising fifth pedigerous somite, genital complex and abdomen, all fused (Fig. 7D); genital complex ornamented with 2 pairs of sensillae on dorsal surface, abdomen with 1 pair. Paired caudal rami elongate; ramus about 2.2 times longer than wide; tapering towards blunt apex. Parabasal flagellum simple, cylindrical. Leg 3 forming fleshy outer lamella, splayed outwards at right angle to longitudinal axis of body, plus smaller inner lobe partly fused along midline to other member of

leg pair. Leg 4 bilobate; inner and outer lobes subequal, distal 60% of both lobes protruding beyond free posterior margin of dorsal trunk plate. Leg 5 absent. Body length of ♀ ranging from 1.82 to 1.94 mm, with a mean of 1.87 mm (based on 4 specimens); body length of single ♂ 1.00 mm.

Distribution: This species was originally described from *Pomadasyus maculatus* (Bloch, 1793) caught off Bombay in Indian waters (Rangnekar & Murti, 1961). Subsequently Ho *et al.* (2008) reported it from *P. kaakan* landed in Taiwan. This is the first record of *L. pomadasysis* from Australian waters.

Remarks: Pillai (1985) relegated this species to synonymy with *L. abitocephalus*, which occurs on the same host (*P. maculatus*), but Ho *et al.* (2008) resurrected *L. pomadasysis* as a valid species after examining and re-describing material of both sexes collected from *P. kaakan* landed in Taiwan. They highlighted the differences between *L. abitocephalus* and *L. pomadasysis* in the shape of the cephalothorax and the shape and size of legs 3 and 4 (see Fig. 7). In *L. pomadasysis* the inner and outer lobes of leg 4 are about equal in length whereas in *L. abitocephalus* the inner (endopodal) lobe is markedly shorter than the outer (exopodal). These differences are consistent with the character states exhibited by these two species in Australian waters.

***Lernanthropus serioli* Shishido, 1898**

(Figs. 38, 39A)

Syn: *Lernanthropus seriolae*: Yamaguti, 1963

Lernanthropus paenulatus C.B. Wilson, 1922 new synonym

Lernanthropus paenulatus: Rohde *et al.*, 1995; Hutson *et al.*, 2007

Material examined: 7♀♀, 1♂ on *Seriola hippos* Günther, 1876, Coffs Harbour, New South Wales; December 1980–January 1981; collected by K. Rohde. 10♀♀, 1♂ on *S. hippos*, Coffs Harbour, New South Wales; December 1980–January 1981; collected by K. Rohde; NHMUK Reg. No. 1984.97–98. 17♀♀ on *Seriola lalandi* Valenciennes, 1833, Coffs Harbour, New South Wales; December 1980–January 1981; collected by K. Rohde. 3♂♂ on *S. lalandi*, Coffs Harbour, New South Wales; December 1980–January 1981; collected by K. Rohde; NHMUK Reg. No. 1984.99–100.

Comparative material examined: Holotype ♀ (USNM 54058) and paratype ♀♀ (USNM 54057) of *Lernanthropus paenulatus* C.B. Wilson, 1922 stored in the United States National Museum of Natural History, Washington D.C., USA.

Differential diagnosis: Cephalothorax longer than wide with weakly convex lateral margins and straight frontal margin: trunk elongate, about 5 times longer than cephalothorax; anterior part (second and third pedigerous somites) just wider than cephalothorax and bearing third legs posteriorly; posterior part (fourth pedigerous somite) covered by large dorsal trunk plate; plate becoming wider posteriorly and with evenly convex free posterior margin (Fig. 38A–C). Urosome comprising fifth pedigerous somite, genital complex and abdomen, all fused (Fig. 39A). Genital complex with conspicuous gonopores located dorsolaterally and with paired copulatory pores located posterolaterally on ventral surface. Genital complex ornamented with 2 pairs of sensillae on dorsal surface between gonopore openings. Paired caudal rami slightly curved; about 3.4 times longer than maximum width, tapering from broad base towards apex; not extending beyond posterior margin of dorsal trunk plate; each ramus armed with 2 plumose setae proximally on dorsal surface, 1 small lateral seta located about at 58% of ramus length, and 2 small apical setae (Fig. 39A). Leg 3 bilobate, located ventrally inner lobe forming fleshy lamella, shoehorn-shaped with distal part curved towards head; outer lobe much smaller than inner, but clearly visible in lateral view (Fig. 38A). Leg 4 bilobate; inner lobe longer than outer; tips of both lobes protruding beyond posterior margin of dorsal trunk plate. Leg 5 represented by large lamellate lobe (Fig. 39A) about 4.7 times longer than maximum width, tapering towards tip extending beyond tips of caudal rami: armed with single protopodal seta located in proximal quarter on dorsal surface. Body length of ♀ ranging from 7.85 to 9.00 mm, with a mean of 8.48 mm (based on 10 specimens); mean body length of ♂ 2.43 mm (based on 4 specimens).

Distribution: *Lernanthropus serioli* was originally described by Shishido (1898) based on material collected from the gills of *Seriola lalandi* caught off Japan. Izawa (2014) redescribed this species (as *L. seriolae*) after examination of material from the same host caught in Japanese waters. The change in spelling to *seriolae* is an unjustified emendation, first used by Yamaguti (1963); the original spelling was subsequently used by Izawa (2018) and is maintained here.

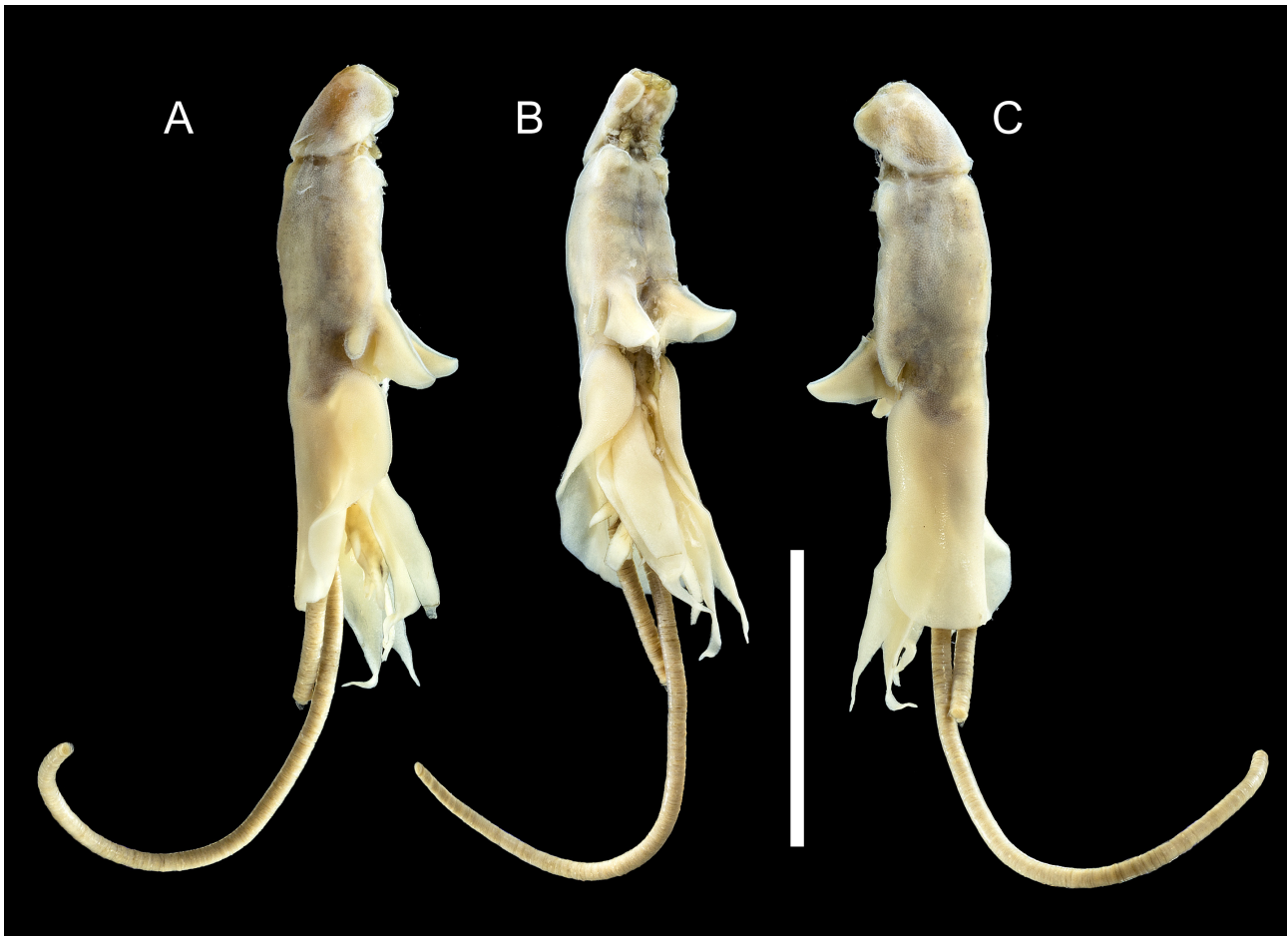


FIGURE 38. *Lernanthropus seriolii* Shishido, 1898, adult ♀. A, habitus, lateral; B, habitus, lateroventral; C, habitus, dorsolateral. Scale bar 5 mm.

Lernanthropus seriolii is very similar in gross morphology to *L. paenulatus* Wilson, 1922 which was described from material collected from the gills of the same host (*S. lalandi*) caught off the Atlantic coast of the USA at Woods Hole, Massachusetts and at Beaufort, North Carolina (Wilson, 1922). According to Izawa (2014), *L. seriolii* can be distinguished from *L. paenulatus* most readily by the form of the female leg 5. In *L. seriolii* the fifth legs form elongate lamellae, which extend well beyond the tips of the caudal rami, whereas in *L. paenulatus* the fifth legs were described by Wilson (1922: 52) as “a pair of short fifth leg rudiments just in front of genital segment”. Re-examination of the type material of *L. paenulatus* stored in the USNM revealed that Wilson’s description was erroneous: *L. paenulatus* possesses elongate lamellate fifth legs, as described for *L. seriolii*. In the absence of other substantive differences, we propose to treat *L. paenulatus* as a junior subjective synonym of *L. seriolii*.

Previous records of *L. paenulatus* from Australia should be attributed to *L. seriolii*: Hutson *et al.* (2007a) re-examined material from *S. lalandi* caught in New Zealand waters, originally reported as *Lernanthropus* sp. by Smith *et al.* (2004) and one of us (GAB) identified it as *L. paenulatus*. Rohde *et al.* (1995) had first reported *L. paenulatus* from Australia, on *S. lalandi* caught at Coffs Harbour (NSW). Re-examination here of Rohde’s material stored in Natural History Museum, London confirms that the Australian material from Coffs Harbour is *L. seriolii*. The material reported by Hutson *et al.* (2007a) as *L. paenulatus* from the same host taken at Sir John Woods Banks (NSW) and off Killarney (Victoria) and material reported by Hutson *et al.* (2007b) from *Seriola hippos* is also now re-assigned to *L. seriolii*, as is the record of *L. paenulatus* from a *Seriola* sp. caught in China (Song & Chen, 1976).

Remarks: This is a distinctive species with a long slender body in the female. A characteristic feature of this species is the small triangular outer (exopodal) lobe located proximally at the base of leg 3.

Lernanthropus micropterygis is similar to *L. seriolii*, both species have a similar elongate body form in the female and both have long, lamellate fifth legs and caudal rami. However, *L. micropterygis* differs from *L. seriolii* in the relative lengths of these structures: the fifth legs are longer than the caudal rami in *L. seriolii* but shorter than the

caudal rami in *L. micropterygis*. In addition, the dorsal trunk plate is much shorter in *L. micropterygis* so that almost the whole of the elongate fourth legs are visible in dorsal view whereas in *L. serioli* only the distal 40% is visible. *Lernanthropus micropterygis* has a more restricted distribution than *L. serioli*, as it is known only from the Mediterranean Sea (Richiardi, 1884; Goggio, 1906), Red Sea (Wilson, 1924) and South Africa (Kensley & Grindley, 1973, as *L. ecclesi*).

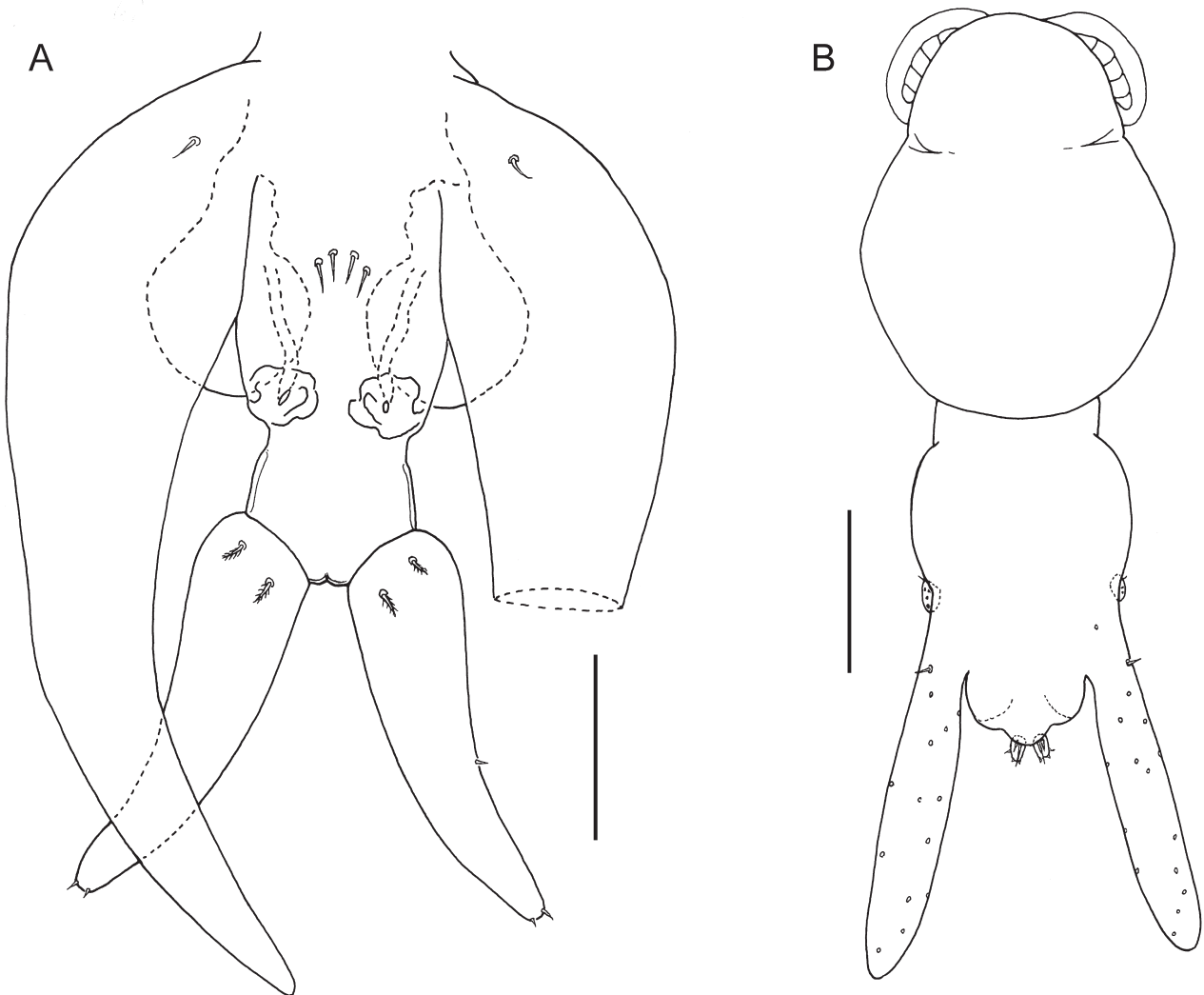


FIGURE 39. *Lernanthropus serioli* Shishido, 1898, adult ♀. A, urosome, dorsal view showing paired fifth legs, genital openings and caudal rami. *Mitrapus oblongus* (Pillai, 1964) ♂, B, habitus, dorsal. Scale bars A, 0.5 mm, B, 200 µm.

***Lernanthropus selenotoca* sp. nov.**

(Figs. 40–41)

Type material: Holotype ♀ and 3 paratype ♀♀ from *Selenotoca multifasciata* (Richardson, 1846) (TC17225), Moreton Bay, Queensland; 18 January 2016; collected G.A. Boxshall; QM Reg. Nos. W29499 (Holotype ♀), W29500 (paratype ♀♀). 2 paratype ♀♀ from *S. multifasciata* (TC17303), Moreton Bay, Queensland; 20 January 2016; collected by G.A.Boxshall; QM Reg. No. W29500. 2 paratype ♀♀ from *S. multifasciata* (TC16942), Moreton Bay, Queensland; 08 December 2015; collected by S.C. Cutmore. 3 paratype ♀♀ from *S. multifasciata* (TC17062), Moreton Bay, Queensland; 13 January 2016; collected G.A. Boxshall; NHMUK Reg. No. 2018.291–295.

Etymology: the name of the new species refers to the genus of the type host.

Description: Female body comprising cephalothorax and trunk (Fig. 40A–C). Body length of ♀ ranging from 3.32 to 3.74 mm, with a mean of 3.56 mm (based on 8 specimens). Cephalothorax about 1.15 times longer than wide, gradually becoming wider posteriorly; lateral margins linear, expanded into ventro-laterally directed folds

on either side and extending anteriorly into slightly produced lobes, giving frontal margin a weakly indented appearance. Trunk about 1.1 times longer than cephalothorax; anterior part (second and third pedigerous somites) just wider than cephalothorax and bearing third legs posteriorly; posterior part (fourth pedigerous somite) covered by dorsal trunk plate; plate with evenly convex lateral margins, posterior margin with distinct median indentation. Urosome (Fig. 41A) comprising fifth pedigerous somite, genital complex and abdomen, all fused. Genital complex with conspicuous gonopores located dorsolaterally and with paired copulatory pores (arrowed in Fig. 41A) located posterolaterally on ventral surface. Genital complex ornamented with 1 pair of sensillae and median pore on dorsal surface between gonopore openings. Paired caudal rami about 2.7 times longer than maximum width; not extending as far as posterior margin of dorsal trunk plate; each ramus armed with 2 plumose setae proximally on dorsal surface, 1 small lateral seta located at about 80% of ramus length, and 2 unequal apical setae (Fig. 41A).

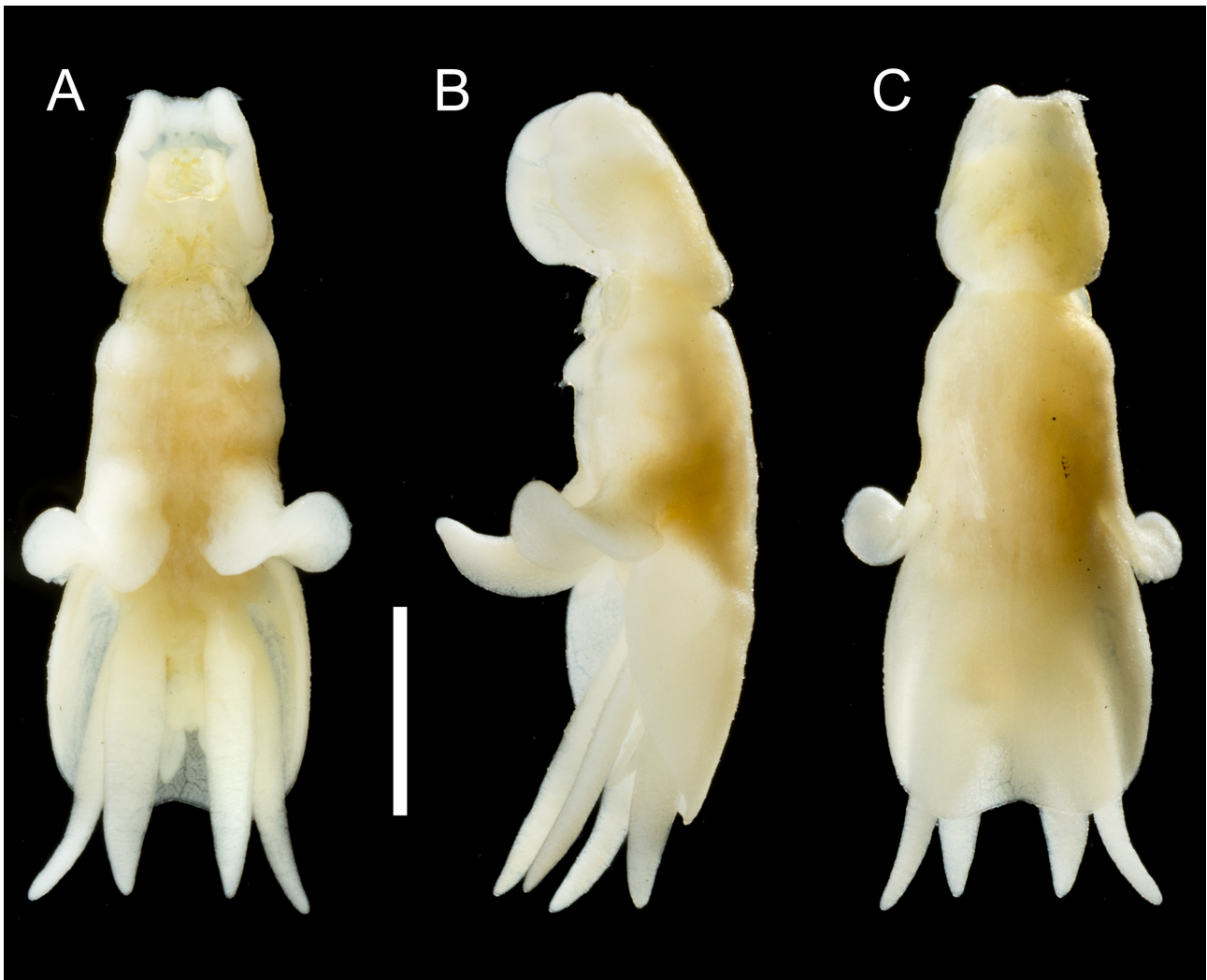


FIGURE 40. *Lernanthropus selenotoca* sp. nov., paratype ♀. A, habitus, ventral; B, habitus, lateral; C, habitus, dorsal. Scale bar 1 mm.

Antennule (Fig. 41B) 6-segmented, some segments with irregular cuticular thickening; setal formula: 1, 3, 2, 0, 1, 10 + 2 ae. Parabasal flagellum (Fig. 41C) with swollen base and slender, slightly curved distal part. Antenna (Fig. 41D) robust, comprising massive corpus bearing papilliform element on medial surface, and distal subchela showing traces of suture line; subchela armed with small process proximally near articulation between corpus and subchela, plus 1 rounded and 1 pointed process; claw ornamented with surface striations and pits towards tip. Mandible stylet-like, armed with 8 marginal teeth distally. Maxillule (Fig. 41E) bilobate, smaller inner lobe tipped with 1 spiniform element; larger outer lobe tipped with 3 unequal spiniform elements. Maxilla 2-segmented, comprising proximal syncoxa (lacertus) and distal basis (brachium); basis (Fig. 41F) ornamented with process distally on inner margin;

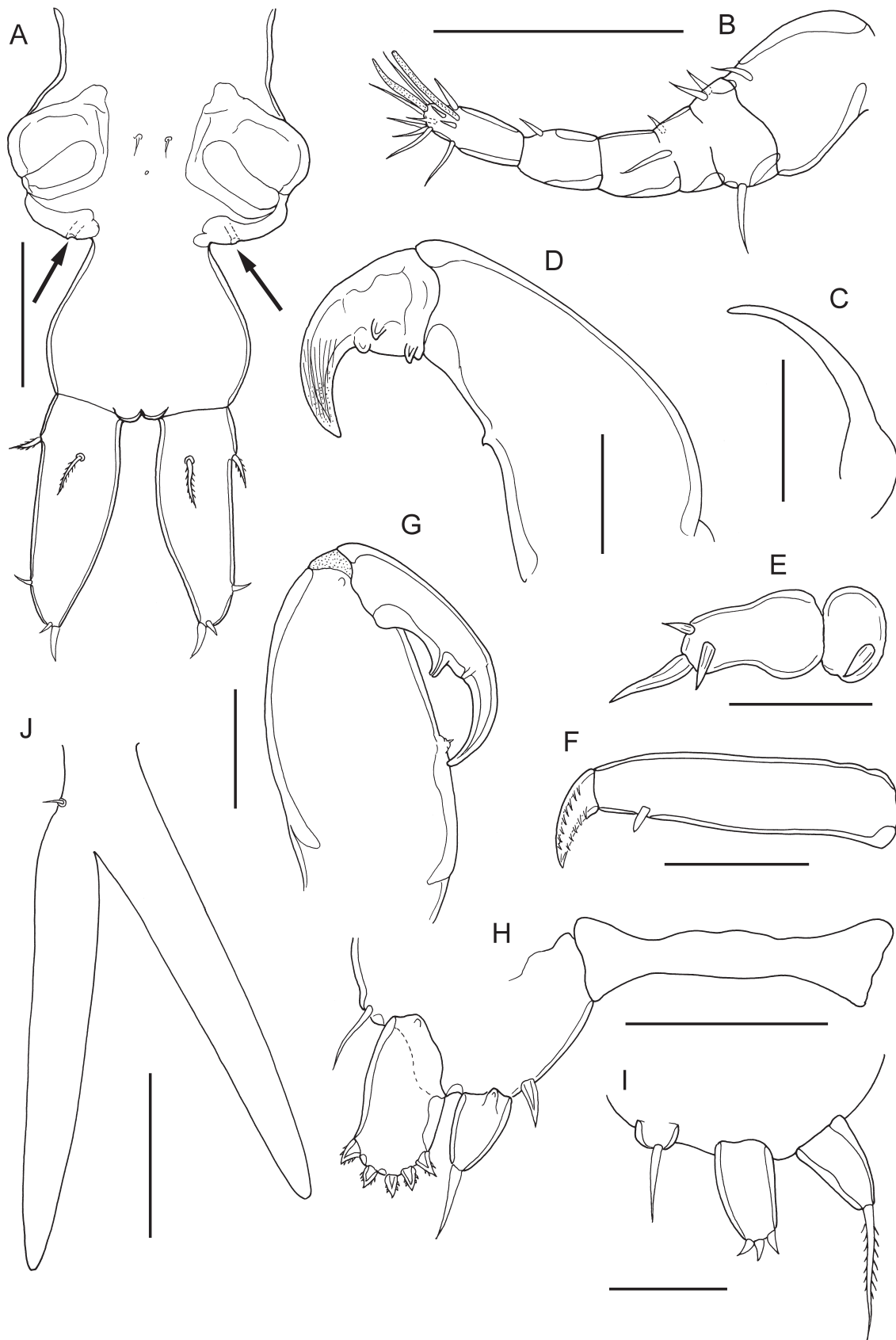


FIGURE 41. *Lernanthropus selenotoca* sp. nov., paratype ♀. A, urosome, dorsal view showing paired genital openings, copulatory pores (arrowed) and caudal rami; B, antennule; C, parabasal flagellum; D, antenna; E, maxillule; F, basis of maxilla; G, maxilliped; H, leg 1 and intercoxal sclerite; I, leg 2; J, leg 4. Scale bars A, 200 μ m, B,D,G,H, 100 μ m, C,E,F, 50 μ m, J, 0.5 mm.

terminal claw armed with sharp denticles along both margins. Maxilliped (Fig. 41G) 2-segmented, comprising massive corpus with papilliform element on myxal surface, and distal subchela; subchela comprising compound endopodal segment and strongly curved terminal claw; armed with distinctive accessory process on mid-concave margin.

Leg 1 biramous, members of leg pair joined by robust intercoxal sclerite (Fig. 41H): protopod inflated, armed with outer seta and inner spine; exopod 1-segmented, armed with 5 robust distal margin spines with minutely serrate margins; endopod 1-segmented, tapering distally, armed with terminal seta about as long as segment. Leg 2 (Fig. 41I) mounted on inflated hemispherical prominence derived from incorporated protopod and armed with outer seta on distinct papilla: both rami 1-segmented; exopod armed with 3 distal spines; endopod armed with pinnate apical seta, about 1.5 times longer than segment. Leg 3 uniramous, lacking exopod; endopodal lobe forming large shoehorn-shaped lamella, directed ventrally (Fig. 40A, B); leg pair separate medially; armed with outer basal seta on dorsal surface. Leg 4 (Fig. 41J) biramous, with rami forming elongate processes: outer (exopodal) lobe slightly longer than inner (endopodal); distal 35% of lobes extending beyond posterior margin of dorsal trunk plate; armed with basal seta proximally on dorsal surface. Leg 5 absent.

Male unknown.

Distribution: The type locality, Moreton Bay, is the only known locality for this species.

Remarks: The only previous record of a lernanthropid from *Selentoca multifasciatus* is that of Kabata (1979a) who reported *L. gisleri* from this host in Australia. No other lernanthropids have been reported from members of the family Scatophagidae.

In body proportions, the female of new species superficially resembles two species reported from carangid hosts in Indian waters, *L. indicus* and *L. koenigii*. In all three of these species the cephalothorax comprises about 25 to 30% of total body length, the anterior trunk is 1.0 to 1.2 times longer than the cephalothorax, and the dorsal trunk plate comprises about 40 to 45% of total body length and has a weak median indentation in its posterior margin. However, both of these Indian species have the fifth leg in the form of an elongate lobe while this leg is absent in *L. selenotoca* **sp. nov.** Most other species have a straight or evenly convex posterior margin on the dorsal trunk plate, unlike the medially indented margin of the new species.

Another unusual feature of the new species is the accessory process on the subchela of the maxilliped in the female. No other Indo-Pacific species (which has been described in sufficient detail) possesses such a process.

***Lernanthropus tylosuri* Richiardi, in Goggio, 1906** (Fig. 10C)

Syn: *Lernanthropus cornutus* Kirtisinghe, 1937

Material examined: none

Differential diagnosis: Cephalothorax longer than wide with linear lateral margins tapering towards straight anterior margin, bearing large process at each posterolateral corners (Fig. 10C). Trunk 2 to 3 times longer than cephalothorax; anterior part (second and third pedigerous somites) as wide as cephalothorax, with weakly convex margins; posterior part (fourth pedigerous somite) covered by long, cloak-like dorsal trunk plate, flared out laterally and widest towards posterior margin. Urosome comprising fifth pedigerous somite, genital complex and abdomen, all fused. Paired caudal rami short and wide; all caudal setae located in distal half of ramus. Parabasal flagellum long and slightly curved, reaching to middle of subapical segment of antennule. Leg 3 located ventrolaterally at rear of third pedigerous somite, forming long fleshy lamella, shoehorn-shaped, directed ventrally: third legs separate along midline. Leg 4 bilobate; inner and outer lobes flattened and entirely concealed beneath dorsal trunk plate; both lobes with complex apical ornamentation. Leg 5 absent. Body length of ♀ 7.8 mm, of ♂ 1.7 mm (length data from Pillai, 1985).

Distribution: The original description of *L. tylosuri* was based on material collected in the Mediterranean Sea by Richiardi (see Goggio, 1906). Cressey & Collette (1970) reported this species from numerous localities across the North and South Atlantic, North and South Pacific, and Indian Oceans. Their global survey included the first Australian record of *L. tylosuri*, from *Strongylura incisa* caught on the Great Barrier Reef (Queensland). Raja *et al.* (2018) reported a prevalence rate of 41.7% on *Tylosurus crocodilus crocodilus* (Peron & Lesueur, 1821) caught off S. E. India.

Remarks. This species has a confused nomenclatural history. The name *Lernanthropus tylosuri* was first used by Richiardi (1880) who simply listed the name in his *Catalogo sistematico dei Crostacei che vivono sul corpo degli animali*, as occurring on the gills of *Tylosurus imperialis* (Rafinesque) (as *Thylosurus imperialis*). Richiardi's name is a *nomen nudum* because citing a host together with a new name but in the absence of any description or illustration is not sufficient to constitute an indication according to the Code. Both Carus (1885) and Brian (1906) noted that *L. tylosuri* of Richiardi (1880) was a *nomen nudum*. However, Goggio (1906: Tav II, Fig. 10) provided an illustration of an adult female labelled as *L. tylosuri* and stated “[of *Lernanthropus tylosuri* I have not found any specimen and therefore I limit myself to reproducing a figure of Prof. S. Richiardi]”. The use of the binomial name and an illustration prior to 1931 is sufficient to constitute an indication under the Code. Wilson (1922) had presumably seen Goggio's work because he was able to use the presence of the conspicuous paired posterolateral processes on the cephalothorax as a distinguishing character of *L. tylosuri* in his key to species.

Kirtisinghe (1937) established *L. cornutus* as a new species, but this is clearly the same species as the *L. tylosuri* of Wilson (1922) and Cressey & Collette (1970). Both names have subsequently been used by numerous researchers (see summary in Ho & Do, 1985). Cressey & Collette (1970) used *L. tylosuri* for this taxon in their major geographic survey and Pillai (1985) used it in his monograph on Indian parasitic copepods, but Ho & Do (1985) used *L. cornutus* in their important analysis of the phylogenetic relationships between the lernanthropid genera and cited numerous other users. Liu *et al.* (2009a) and Ho *et al.* (2011) continued to use *L. cornutus*. Given that Goggio (1906) attributes *L. tylosuri* to Richiardi and uses a figure provided by Richiardi to support the use of the name, we consider that the valid name and authority for this species is *Lernanthropus tylosuri* Richiardi, in Goggio, 1906, and that *Lernanthropus cornutus* Kirtisinghe, 1937 is a subjective junior synonym.

Genus *Mitrapus* Song & Chen, 1976

The validity of *Mitrapus* as a generic level taxon needs testing as it shares multiple character states with *Lernanthropus*. The females are currently distinguished from female *Lernanthropus* only by the marked disparity between the lengths of the endopodal and exopodal lobes of leg 4. Given that the relative lengths of the rami of leg 4 can vary between species within both genera, this character is not robust. The males differ but male characters were not used in the phylogenetic analysis of Ho & Do (1985).

Mitrapus oblongus (Pillai, 1964)

(Fig. 39B, Fig. 42)

Syn: *Lernanthropus oblongus* Pillai, 1964

Material examined: 15 ♀♀ and 5 ♂♂ (attached to ♀) from *Herklotsichthys castelnaui* (Ogilby, 1897) (TC17275), Moreton Bay, Queensland; 19 January 2016; collected by G.A. Boxshall; QM Reg. No. W29502. 1 ♀ and 1 ♂ from *H. castelnaui* (TC17229), Moreton Bay, Queensland; 18 January 2016; collected by G.A. Boxshall; NHMUK Reg. No. 2018.296–297. 6 ♀♀ from *H. castelnaui* (as *Harengula abbreviata*), Coffs Harbour, New South Wales; 15 May 1981; collected by M. La Spina; NHMUK Reg. No. 2018.298–301.

Differential diagnosis: Cephalothorax oval; anterolateral margins of cephalothorax folded downward to encircle base of antenna laterally. Trunk about 1.4 times longer than wide, covered with dorsal trunk plate extending posteriorly to overlap basal part of bilobed leg 4 (Fig. 42A–C); posterior margin of dorsal trunk plate entire and evenly convex. Anterior corners of trunk produced to form conspicuous, paired, knob-like protrusions. Lateral surfaces of trunk ornamented with numerous small papillae. Urosome comprising fifth pedigerous somite, genital complex and anal somite, all fused. Egg sacs linear. Caudal rami carried on ventral surface of abdomen; conical, tapering from broad base; about 1.5 times longer than width at base; armature comprising 2 large caudal setae located dorsally in proximal third, lateral seta located in mid-margin, plus 2 apical setae. Parabasal flagellum absent. Leg 2 biramous, with unimerous rami. Leg 3 bilobate with fleshy outer in inner lamellae; outer lamella orientated vertically, inner lobe shoehorn-like, partly fused along midline to other member of leg pair. Leg 4 bilobate; outer (exopodal) lobe elongate, inner (endopodal) lobe about half (42–52 %) of length of exopod; distal parts of both lobes protruding well

beyond free posterior margin of dorsal trunk plate (Fig. 42A–C). Leg 5 absent. Body length of ♀ ranging from 1.87 to 2.13 mm, with a mean of 2.00 mm (based on 10 specimens). Body length of figured male 0.91 mm (Fig. 39B).

Distribution: This species was originally described (as *Lernanthropus oblongus*) from India on the clupeid *Sardinella fimbriata* (Valenciennes, 1847) (Pillai, 1964). El-Rashidy & Boxshall (2009; 2010) recorded both sexes of *M. oblongus* from two clupeiform fishes caught in Mediterranean coastal waters off Alexandria (Egypt): the dussumieriid *Etrumeus teres* (DeKay, 1842) which is an established immigrant species from the Red Sea, and *Sardinella aurita* Valenciennes, 1847, a native Mediterranean clupeid. Romero & Öktener (2010) subsequently reported *M. oblongus* from the latter host in Turkish coastal waters. This is the first record of the genus from Australian waters and the clupeid host *Herklotsichthys castelnaui* constitutes a new host record for *M. oblongus*.

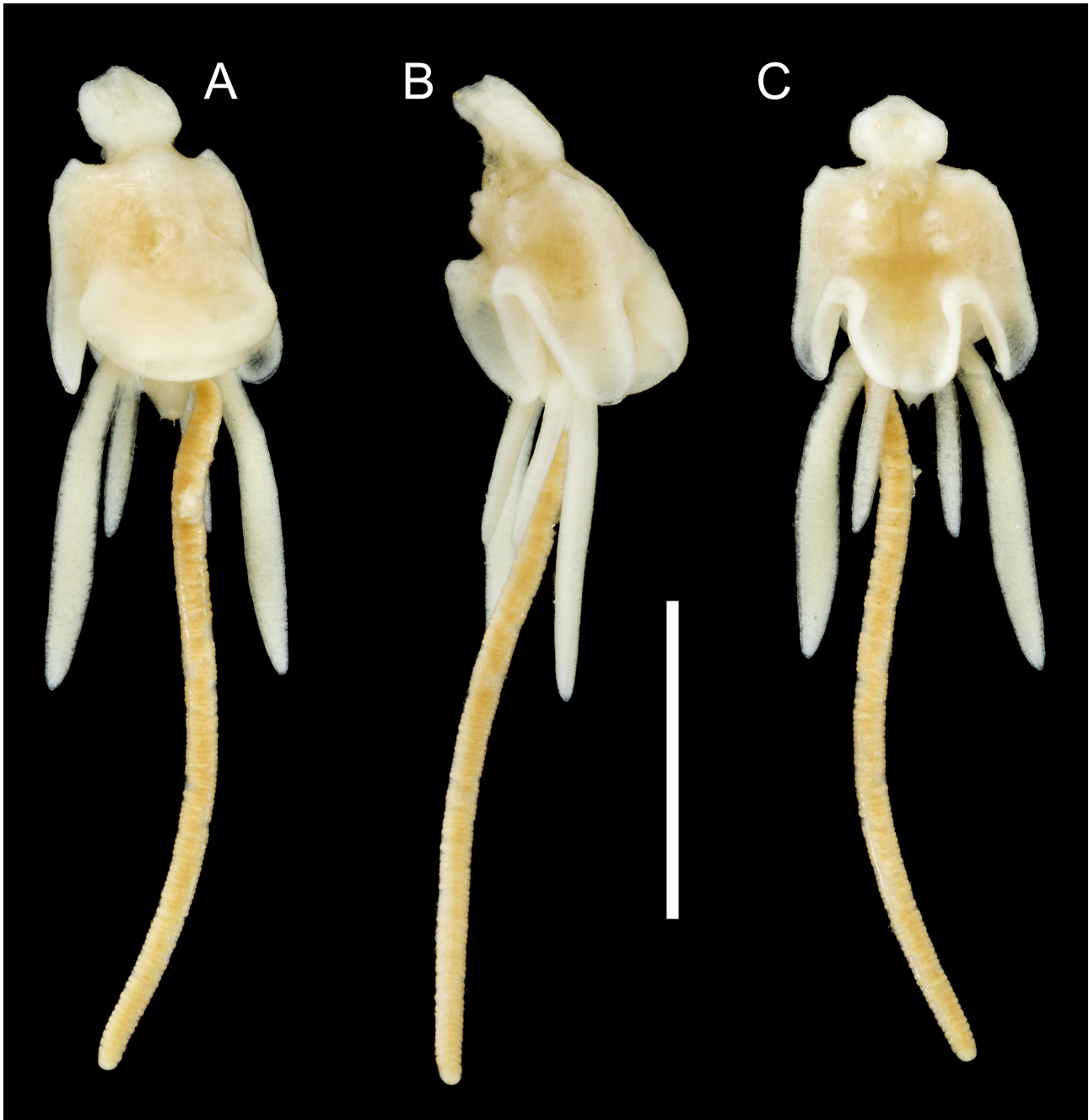


FIGURE 42. *Mitrapus oblongus* (Pillai, 1964) adult ♀. A, habitus, dorsal; B, habitus, lateral; C, habitus, ventral. Scale bar 1 mm.

TABLE 4. Character states of females of *Sagum* species

Species	Lateral head margins	Caudal ramus shape	Caudal ramus L:W ratio	Dorsal caudal setae	Leg 4	Visibility of leg 4	Data source
<i>S. angulatum</i>	paired lobes	short, cylindrical	1.2:1	unknown	tapering	concealed	Krøyer, 1863
<i>S. brotulae</i>	paired lobes	tapering	2.8:1	proximal half	flagellate tips	visible	Izawa, 2018
<i>S. enneacentri</i>	paired lobes	unknown	unknown	unknown	flagellate tips	visible	Pillai, 1985
<i>S. epinepheli</i>	large lobes	tapering	2.8:1	proximal half	flagellate tips	visible	Ho <i>et al.</i> , 2011
<i>S. flagellatum</i>	paired lobes	lobate	“short”	unknown	flagellate tips	tips visible	Wilson, 1913
<i>S. pillaisebastiani</i>	3 angular lobes	tapering	1.8:1	proximal half	flagellate tips	visible	Pillai, 1985
<i>S. posteli</i>	paired lobes	leaf-like	1.0:1	unknown	flagellate tips	visible	Toksen <i>et al.</i> , 2012
<i>S. vespertilio</i>	large lobes	leaf-like	2.5:1	proximal half	flagellate tips	tips visible	Ho <i>et al.</i> , 2008
<i>S. petersi</i>	weakly convex	unknown	unknown	unknown	flagellate tips	visible	Kabata, 1979a
<i>S. bitaro</i>	linear	leaf-like	2.1:1	distal half	tapering	concealed	Uyeno & Naruse, 2018
<i>S. caesionis</i>	linear	leaf-like	1.5:1	unknown	tapering	tips visible	Yamaguti, 1954
<i>S. foliaceum</i>	linear	tapering	2.5:1	unknown	tapering	visible	Hewitt, 1968
<i>S. folium</i>	linear	leaf-like	1.8:1	distal half	tapering	concealed	Ho <i>et al.</i> , 2011
<i>S. gurukun</i>	linear	leaf-like	1.4:1	proximal half	tapering	concealed	Uyeno & Naruse, 2018
<i>S. lativentris</i>	linear	leaf-like	2.8:1	proximal half	tapering	tips visible	present account
<i>S. paracaesionis</i>	linear	leaf-like	2.0:1	distal half	tapering	concealed	Izawa, 2014
<i>S. sanguineus</i>	linear	leaf-like	2.7:1	proximal half	tapering	visible	Song & Chen, 1976; present account
<i>S. vietnamensis</i>	linear	elongate, cylindrical	4.4:1	proximal half	tapering	concealed	Kazachenko <i>et al.</i> , 2017

Remarks: Pillai (1985) commented that *M. oblongus* closely resembled *M. rubiginosus* (Redkar, Rangnekar & Murti, 1949) (as *L. rubiginosus*) collected from the clupeid *Nematalosa nasus* (Bloch, 1795) (as *Chatoessus nasus*), but *M. rubiginosus* was subsequently recognised as a junior subjective synonym of *M. heteropodus* (Yü, 1933) by El-Rashidy & Boxshall (2010). Both sexes of *M. oblongus* were redescribed in detail by El-Rashidy & Boxshall (2010).

Genus *Sagum* Wilson, 1913

Remarks: The genus *Sagum* was established by Wilson (1913) to accommodate a new species, *S. flagellatum* Wilson, 1913, found on the gills of a serranid *Epinephelus adscensionis* (Osbeck, 1765) caught off Jamaica. The new genus was distinguished from *Lernanthropus* by “the rostrum and wings of the cephalothorax, by the long endopods of the third legs, and by the lash-like tips of the fourth legs.” The two female syntypes of *S. flagellatum* lacked egg sacs, so the form of the egg sacs was not included in the original generic diagnosis. In his revision of the North American Dichelesthiidae, Wilson (1922) transferred *Lernanthropus angulatus* Krøyer, 1863 into *Sagum* as *S. angulatum* and gave a revised generic diagnosis which included as a key feature, the possession of coiled egg sacs entirely contained within the space enclosed between the dorsal trunk plate and the third and fourth legs.

In their phylogenetic analysis of the lernanthropid genera, Ho & Do (1985) grouped *Aethon*, *Norion* and *Sagum* together on the basis of the possession of coiled egg sacs. They distinguished *Aethon* by its highly modified second legs and grouped *Sagum* and *Norion* by the shared possession of bilobate fourth legs with lobes that are lamellate proximally and flagellate distally. Although used by Wilson (1922) is his original diagnosis of the genus, this latter character is not robust since at least half of *Sagum* species (see Table 4) have tapering bilobate fourth legs rather than legs with flagellate tips on the exopodal and endopodal lobes. The loss of leg 2 was used to characterize *Norion* species whereas the form of leg 3, described as “divided into 3 branches; lamelliform or cylindrical”, was used to diagnose the *Sagum* branch. This latter character is also not robust, applying only to a minority of species. Given the difficulty in using some of these traditional characters, it is clear that the relationships between the currently recognized lernanthropid genera need to be reassessed using a wider range of characters from both sexes.

Sagum epinepheli (Yamaguti & Yamasu, 1960)

(Fig. 43)

Syn: *Pseudolernanthropus epinepheli* Yamaguti & Yamasu, 1960

Non *Sagum epinepheli*: Pillai & Sebastian, 1967

Material examined: 3♀♀ and 3♂♂ from *Plectropomus leopardus* (Lacepède, 1802), Townsville, Queensland, 01 March 2012, collected by K.S. Hutson; 2♀♀ and 2♂♂ QM Reg. No. W29503, 1♀ and 1♂ NHMUK Reg. No. 2018.216–217. 1♀ from *Epinephelus coioides* Hamilton, 1822, Bynoe Harbour, Northern Territory, 09 March 2014, collected by B.K. Diggles; MAGNT Reg. No. Cr019248.

Differential diagnosis: Cephalothorax wider than long; mid-section of lateral margin produced into process on each side (Fig. 43A–C). Trunk subrectangular, markedly wider than cephalothorax: anterior part of trunk (second and third pedigerous somites) wider than long, produced into tapering posterolateral processes extending almost halfway along lateral margins of dorsal trunk plate. Posterior part of trunk covered by square dorsal trunk plate with weakly convex sides, rounded corners and slight medial indentation in posterior margin. Entire dorsal surface of cephalothorax and trunk densely ornamented with small cuticular papillae. Urosome formed from fifth pedigerous somite, genital complex and abdomen. Egg sacs coiled beneath dorsal trunk plate. Paired caudal rami elongate, tapering towards acute tip. Leg 2 biramous, with unimerous rami. Leg 3 forming fleshy lamella, with large, lamellate outer lobe orientated near-vertically and expanded posteriorly, reaching almost to posterior end of body, connecting via short ventrally directed anterior lobe to elongate, lamellate and horizontally-orientated inner lobe. Leg 4 bilobate; both inner and outer lobes with foliaceous proximal part tapering abruptly to flagellate distal part; flagellate tips sometimes visible, extending beyond posterior margin of dorsal trunk plate (Fig. 43A–C). Leg 5 absent. Mean body length of ♀ from *P. leopardus* 5.02 mm, range 4.89 to 5.14 mm (based on 3 specimens); mean body length of ♂ 1.70 mm, range 1.65 to 1.76 (based on 3 specimens); body length of ♀ from *E. coioides* 4.33 mm.

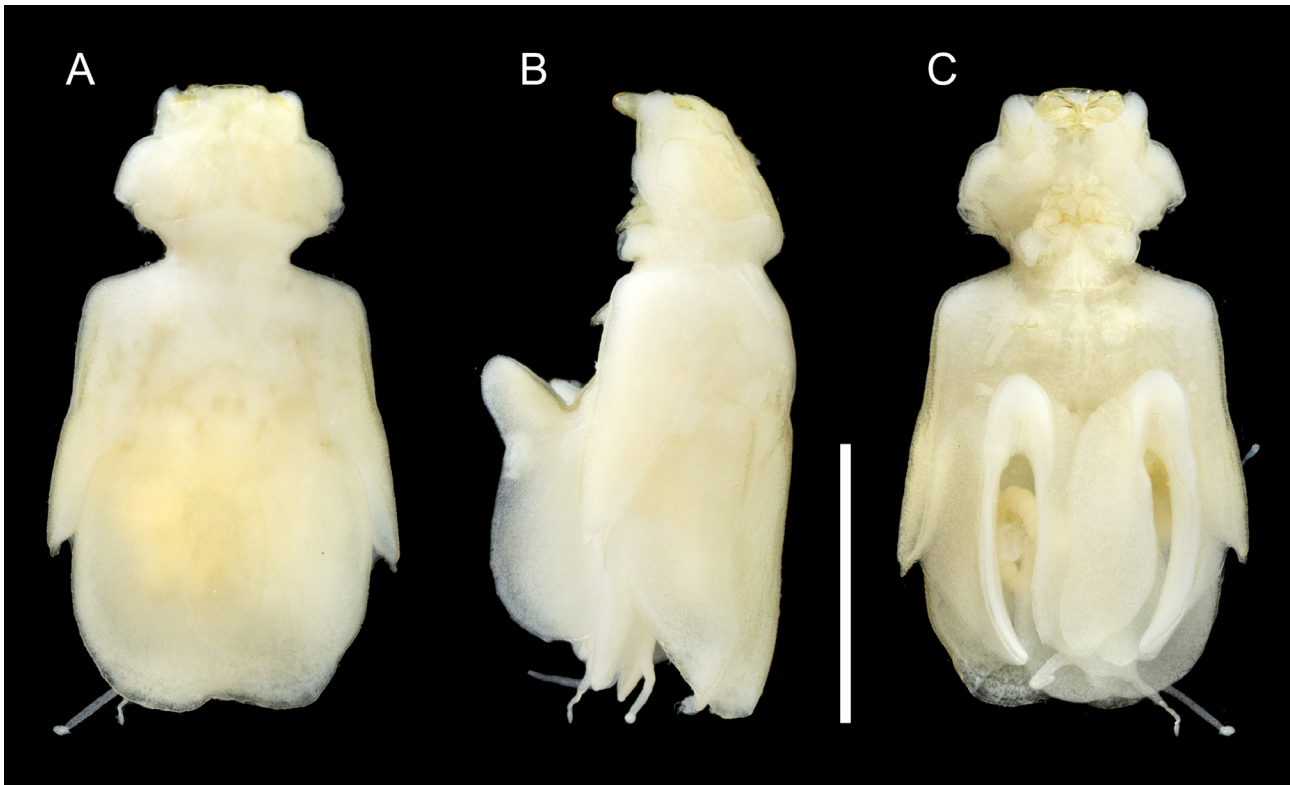


FIGURE 43. *Sagum epinepheli* (Yamaguti & Yamasu, 1960), adult ♀. A, habitus, dorsal; B, habitus, lateral; C, habitus, ventral. Scale bar 2 mm.

Distribution: Originally recorded in Japanese waters from *Epinephelus akaara* (Temminck & Schlegel, 1842) by Yamaguti & Yamasu (1960), this species has been reported subsequently from India on *E. merra* Bloch, 1793 (Pillai, 1985) and from Taiwan on *E. awoara* (Temminck, 1842) (Ho *et al.*, 2011). Justine *et al.* (2010a) reported *S. epinepheli* from five grouper species: *E. chlorostigma* (Valenciennes, 1828), *E. coeruleopunctatus* (Bloch, 1790), *E. cyanopodus* (Richardson), *E. merra*, and *E. morrhua* (Valenciennes, 1833) caught in New Caledonia. Raja *et al.* (2018) have recently reported *S. epinepheli* from *E. fasciatus* (Forsskål, 1775) caught off the coast of southeastern India. In Australian waters this copepod occurs on *Plectropomus leopardus* and *E. coioides*. *Sagum epinepheli* was rare in wild *E. coioides* ($n = 19$) sampled from Bynoe Harbour over 5 half yearly sampling periods between August 2012 and March 2014, with prevalence ranging between 0% and 16.7% (mean intensity = 1), with no apparent seasonality.

Remarks: The original description of this species was based on females from Japan (Yamaguti & Yamasu, 1960). It has been redescribed in detail by Ho *et al.* (2011) and again by Izawa (2018). Pillai & Sebastian (1967) provided a description of females they attributed to *S. epinepheli* collected from an unidentified species of *Epinephelus* caught off Kerala, India but this was clearly a misidentification, as noted by Izawa (2018) who established a new species *Sagum pillaisebastiani* Izawa, 2018, to accommodate Pillai & Sebastian's material. The description of the male attributed to *S. epinepheli* by Pillai (1985) actually refers to *S. pillaisebastiani*.

***Sagum lativentris* (Heller, 1865) n. comb.**

(Figs. 44–46)

Syn: *Lernanthropus lativentris* Heller, 1865

Sagum lativentris: Pattipeiluhu & Gill, 1998

non *Lernanthropus lativentris*: Pillai, 1985

Material examined: 3♀♀ from *Lutjanus johnii* (Bloch, 1792), Darwin (Outer Harbour), 07 October 2012, col-

lected by B.K. Diggles; MAGNT Reg. No. Cr019249. 1♀ from *L. johnii*, Cape Hotham, Northern Territory; 03 January 2014; collected by D.P. Barton; QM Reg. No. W29504. 1♂ from *L. johnii*, Lorna Shoal, Timor Sea, Northern Territory; 15 August 2013; collected by D.P. Barton; MAGNT Reg. No. Cr019250. 1♂ from *L. johnii*, Melville Island, Northern Territory; 12 September 2013; collected by D.P. Barton; QM Reg. No. W29505. 1♀ from *L. johnii*, Cape Hotham, Northern Territory; 03 January 2014; collected by D.P. Barton. 1♂ from *L. johnii*, Melville Island, Northern Territory; 12 September 2013; collected by D.P. Barton; NHMUK Reg. No. 2018.303.

1♀ from *Lutjanus russellii* (Bleeker, 1849), Darwin (Outer Harbour), 07 October 2012, collected by B.K. Diggles; NHMUK Reg. No. 2018.304.

4♀ from *Lutjanus carponotatus* (Richardson, 1842), Bynoe Harbour, Northern Territory, 28 August 2012, collected by B.K. Diggles; NHMUK Reg. No. 2018.305.

Comparative material examined: 3♀, 2♂ from *Lutjanus vitta* (Quoy & Gaimard, 1824) (as *Mesoprion phaeotaeniatum*), Ambon, Indonesia; summer 1993, collected by S. Pattipeiluhu; NHMUK Reg. No. 1994.711–715.



FIGURE 44. *Sagum lativentris* (Heller, 1865) n. comb., adult ♀. A, habitus, dorsal; B, habitus, lateral; C, habitus, ventral. Scale bar 1 mm.

Differential diagnosis: Cephalothorax about 1.1 times longer than wide with almost linear lateral margins narrowing anteriorly towards short frontal margin (Fig. 44A–C); lateral margins of dorsal cephalothoracic shield projecting ventrally, with evenly convex free margin in lateral view (Fig. 44B). Anterior part of trunk (second and third pedigerous somites) about 2.1 times wider than long with distinct anterolateral shoulders; becoming slightly wider posteriorly and with short tapering posterolateral processes; posterior part (fourth pedigerous somite) covered by dorsal trunk plate. Dorsal trunk plate subcircular, with convex lateral and strongly convex posterior margins (Fig. 44A–C); entirely concealing urosome and fourth legs in dorsal view. Urosome comprising fifth pedigerous somite, genital complex and abdomen, all fused (Fig. 45A). Genital complex slender, with conspicuous paired gonopores dorsolaterally and with paired copulatory pores located posterolaterally on ventral surface (arrowed in Fig. 45A); dorsal surface of genital complex ornamented with 2 pairs of sensillae located between gonopores. Egg sacs loosely coiled beneath dorsal trunk plate and partly concealed laterally by third legs. Paired caudal rami elongate, about 2.8 times longer than maximum width; broadest in mid-section. Caudal rami each with 2 plumose dorsal setae; distal dorsal seta located at 44% of length of ramus, small outer seta located at about 60% of ramus length, plus 2 apical setae (Fig. 45A): tips of caudal rami reaching beyond mid-length of lobes of leg 4 (Fig. 45B).

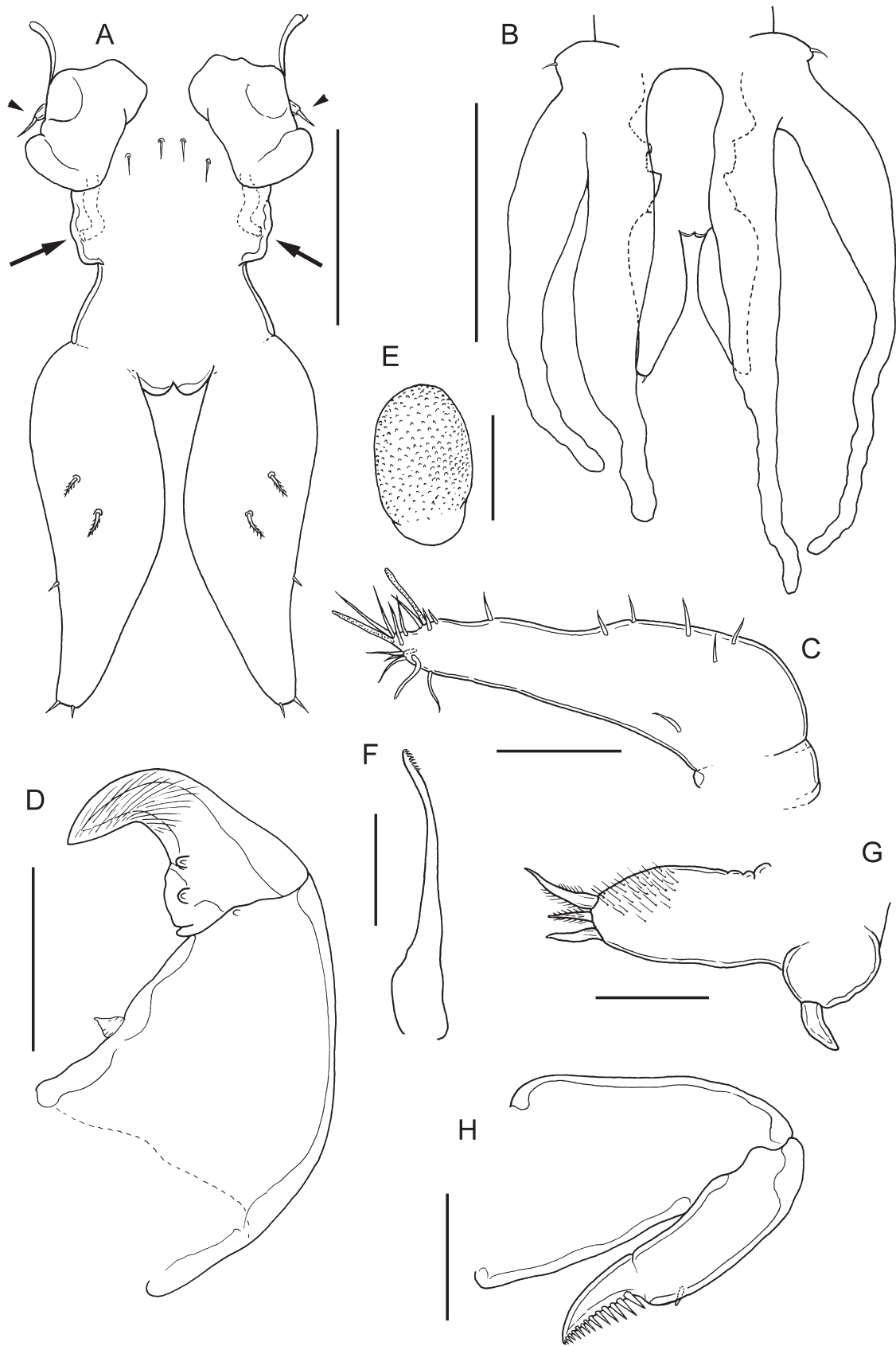


FIGURE 45. *Sagum lativentris* (Heller, 1865) **n. comb.**, adult ♀. A, urosome, dorsal view showing vestigial fifth legs (arrowheads), paired genital openings, copulatory pores (arrowed) and caudal rami; B, posterior end of trunk and urosome, ventral view showing extent of lobes of leg 4 relative to caudal rami; C, antennule; D, antenna; E, postantennal process; F, mandible; G, maxillule; H, maxilla. Scale bars A, 200 µm, B, 0.5 mm, C, E–H, 50 µm, D, 100 µm.

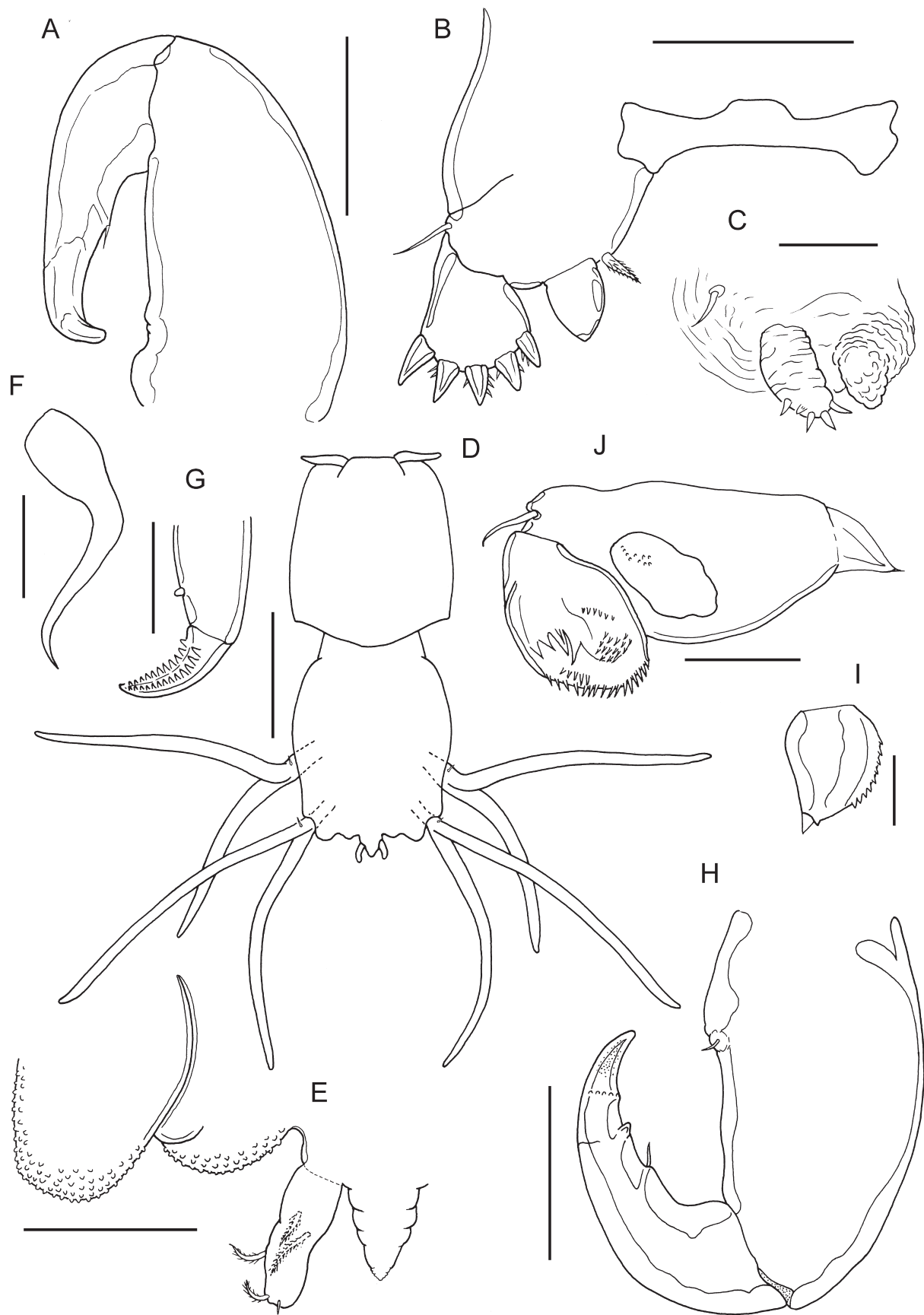


FIGURE 46. *Sagum lativentris* (Heller, 1865) **n. comb.**, adult ♀. A, maxilliped; B, leg 1 and intercoxal sclerite; C, leg 2. Adult ♂. D, habitus, dorsal; E, genital operculum and caudal ramus on right side, ventral view; F, parabasal flagellum; G, tip of maxilla; H, maxilliped; I, endopod of leg 1; J, leg 2. Scale bars A,B,E,H, 100 µm, C,F,G,J, 50 µm, D, 0.5 mm, I, 25 µm.

Antennule unsegmented, armed with 7 setae proximally and 12 setae plus 2 aesthetascs around apex (Fig. 45C). Parabasal flagellum absent. Antenna with robust proximal segment armed with conical process on medial margin; distal subchela armed with 2 rounded processes plus smaller process in articulation with proximal segment (Fig. 45D). Postantennal process rounded (Fig. 45E). Mandible (Fig. 45F) stylet-like with 8 marginal teeth at apex. Maxillule bilobed, smaller lobe tipped with 1 spiniform element; larger lobe tipped with 3 unequal spiniform elements and ornamented with patch of hair-like setules (Fig. 45G). Maxilla (Fig. 45H) with short tapering syncoxa; basis with apical claw ornamented with row of denticles, plus blunt subapical process. Maxilliped corpus with irregular myxal surface but no obvious processes; subchela armed with inner seta on concave margin (Fig. 46A).

Leg 1 with coxa fused to somite and incompletely separated from basis; members of leg pair joined by intercoxal sclerite (Fig. 46B). Each leg biramous with outer plumose seta and short, hirsute inner spine on basis; exopod 1-segmented, armed with 5 robust terminal spines with denticulate margins; endopod 1-segmented, smoothly tapering to unarmed apex; surface unornamented. Leg 2 (Fig. 46C) carried on inflated subspherical prominence derived from incorporated protopod armed with outer plumose seta: biramous, with both rami 1-segmented and both with wrinkled cuticular surface; exopod armed with 5 small distal spines; endopod incompletely separated basally, unarmed. Leg 3 located on ventral surface of third pedigerous somite, forming bilobed fleshy lamella, large outer lobe held vertically and directed posteriorly, reaching about to middle of dorsal trunk plate; smaller inner lobe about one third length of outer lobe; held vertically and extending posteromedially towards midline but legs separate along midline. Leg 4 bilobate (Fig. 45B); inner and outer lobes elongate, flattened and tapering slightly from wider base; distal part irregularly bent and usually concealed beneath dorsal trunk plate, but when fully extended and straight, reaching beyond free posterior margin of trunk dorsal plate. Leg 5 represented by minute papilla carrying short apical seta (arrowheads in Fig. 45A). Body length of ♀ ranging from 2.18 to 3.20 mm, with a mean of 2.72 mm (based on 9 specimens).

Description of male. Body smaller than female, comprising cephalothorax covered with dorsal shield and subrectangular trunk, separated by narrow neck region (Fig. 46D); dorsal surface of shield and trunk both densely ornamented with minute papillae. Cephalothorax about 1.4 times longer than wide with angular posterolateral corners and convex posterior margin. Trunk about 1.3 times longer than wide; lateral margins sinuous; posterior margin with indentations at base of leg 4 and medial to paired genital apertures; anal somite fused to trunk, wider than long, bearing paired caudal rami plus medial tapering process (Fig. 46E). Caudal rami irregularly cylindrical; bearing 2 dorsal setae in proximal half, lateral seta located at two-thirds of ramus length, plus 2 unequal apical setae.

Antennule unsegmented and armed as in female. Parabasal flagellum curved, with broad base tapering towards slender tip (Fig. 46F). Antenna, mandible and maxillule as in female. Maxilla similar to female but subapical process on basis smaller (Fig. 46G). Maxilliped with unisensillate papilla on myxal surface; subchela with small process distal to tiny seta on concave margin; apical claw ornamented with row of tiny spinules at base and with surface striations and pits towards apex (Fig. 46H).

Leg 1 as in female except vestigial setal element on tip of endopod better developed (Fig. 46I). Leg 2 (Fig. 46J) with better defined exopod with complex surface ornamentation; endopod lobate, unarmed. Leg 3 biramous (Fig. 46D), with each ramus forming elongate cylindrical lobe; armed with outer protopodal seta situated on small papilla located dorsally at base. Leg 4 (Fig. 46D) similar to leg 3, also armed with outer protopodal seta situated on small papilla located dorsally at base. Leg 5 absent. Leg 6 represented by paired genital apertures, unarmed. Body lengths of measured ♂♂ 1.59 and 1.66 mm.

Distribution: The original description of *Sagum lativentris* (as *Lernanthropus lativentris*) was based on females found on *Lutjanus vitta* (Quoy & Gaimard, 1824) (as *Mesoprion phaiotaeniatus*) caught off Java, Indonesia (Heller, 1865). Pattipeiluhu & Gill (1998) reported this species from the same host caught off Ambon, Indonesia, but other records of this species from India have been shown to refer to a different species (see Remarks below). The report of *S. lativentris* (as *L. lativentris*) on the gempylid *Thyrsitoides marlayi* Fowler, 1929 from Mozambique (Reimer, 1986) is so unusual as to raise considerable doubt over the identification. [The only *Sagum* species reported from a gempylid host is *S. foliaceum* known from New Zealand waters (Hewitt, 1968).] The present account is the first report of *S. lativentris* **n. comb.** from Australian waters.

Remarks: Pillai (1985) reported a species under the name of “*Lernanthropus lativentris*” from *Lethrinus harak* (Forsskal, 1775) (as *L. rhodopterus*) and *Lutjanus vitta* in Indian waters. Kabata (2005) concluded that the material identified and described by Pillai (1985) as *L. lativentris* in his monograph was misidentified, and he established *L. pillaii* Kabata, 2005 as a new species to accommodate Pillai’s material. We follow Kabata in recognizing that

Heller's *L. lativentris* is valid and distinct, but this species remained poorly known. It is unfortunate that Heller's type material was not ovigerous, since the morphology of the egg sacs indicates that this species belongs in *Sagum*. The discovery of ovigerous material from the type host *Lutjanus vitta* (as *Mesoprion phaiotaeniatus*) collected in Ambon, Indonesia revealed the nature of the loosely coiled egg sacs, so this discovery was reported by Pattipeiluhu & Gill (1998) under the combination *Sagum lativentris*, although the new combination status was not made explicit.

There are another two very similar species currently placed in *Lernanthropus*, *L. caesionis* Yamaguti, 1954 and *L. sanguineus* Song, in Song & Chen, 1976, which also appear to belong in *Sagum*. The former species was described by Yamaguti (1954) based on two females taken from the gills of *Caesio cuning* (Bloch, 1791) (as *C. kuning*) caught off Sulawesi, Indonesia. A complete description of this species is not available but in addition to the habitus of the female, the unarmed endopod of leg 1 and the leaf-like shape of the caudal rami are typical of a cluster of *Sagum* species (see Table 4). We here transfer *L. caesionis* to *Sagum* as *S. caesionis* (Yamaguti, 1954) **n. comb.** We note that *S. caesionis* is very similar to *S. gurukun* Uyeno & Naruse, 2018, but can be distinguished by the length of the rami of leg 4. Finally, *L. sanguineus* was based on study of two females collected from *Lutjanus sanguineus* (Cuvier, 1828) caught at Sanya, Hainan Dao, China (Song & Chen, 1976). The females were not ovigerous but the only subsequent record of this copepod was under the name *Sagum sanguineus* (Song, 1976) and came from Vietnamese waters. This report was based on females from *Lutjanus johnii* (Kazachenko *et al.*, 2014) and the name used was not explicitly identified as constituting a new combination, but the transfer to *Sagum* is confirmed below.

After these generic transfers, *Sagum* now comprises 18 species (Table 4). These three newly transferred species were not included in the comparisons made by Uyeno & Naruse (2018) when they established two new species of *Sagum* from the Ryukyu Islands, Japan, nor were they considered in the brief discussion in Kazachenko *et al.* (2017) who established *S. vietnamensis* Kazachenko, Kovalev, Nguyen & Ngo, 2017. The key to species of the genus provided by Uyeno & Naruse (2018) needs to be updated, but here we provide a Table comparing key character states of all species.

The material of *S. lativentris* collected from *Lutjanus johnii* in Australian waters has smooth linear lateral margins of the cephalothorax and tapering fourth legs, the tips of which may just extend beyond the posterior margin of the dorsal trunk plate when straightened. There are nine species that share these two character states (Table 4). These same species all have a leaf-like caudal ramus, with the exception of *S. vietnamensis* which has cylindrical caudal rami that are about 4.4 times longer than wide according to Kazachenko *et al.* (2017). *Sagum lativentris* has caudal rami that are about 2.8 times longer than wide and can be readily separated from *S. caesionis* and *S. gurukun*, which have short caudal rami (only 1.4 to 1.5 times longer than wide). The setation on the caudal ramus also provides useful characters: in *S. bitaro* Uyeno & Naruse, 2018, *S. folium*, and *S. paracaesionis* Izawa, 2014, the 2 dorsal caudal setae are located in the distal half of the ramus, whereas in *S. lativentris* these 2 setae originate in the proximal half. *Sagum lativentris* differs from *S. foliaceum* in body proportions: so the cephalothorax and anterior trunk combined are longer than the dorsal trunk plate in *S. lativentris* but markedly shorter in *S. foliaceum*. In addition the lobes of leg 4 extend well beyond the posterior margin of the dorsal trunk plate in the latter, but only the tips are visible in dorsal view in the former. Finally, *S. lativentris* and *S. sanguineus* are very similar morphologically and both use lutjanids as hosts. Indeed, both parasites have been recorded from the same host, *L. johnii* (present account; Kazachenko *et al.* 2014). The best characters to differentiate between them relate to the fourth legs and caudal rami. In *S. lativentris* the fourth legs have somewhat flaccid tips and are often bent, but when straightened the tips are visible beyond the posterior margin of the dorsal trunk plate, whereas in *S. sanguineus* the fourth leg lobes are more linear and the distal third of each is visible in dorsal view. The caudal rami in both species are about 2.7 to 2.8 times longer than wide but in *S. lativentris* the distal of the two dorsal setae is located at about 44% of the ramus length while in *S. sanguineus* it is located at about 30% of the ramus length. In addition, the tips of the caudal rami reach beyond the mid-length of the fourth leg lobes in *S. lativentris* (Fig. 45B) but do not reach the mid-length in *S. sanguineus* (Fig. 47C).

***Sagum petersi* (van Beneden, 1857)**

Syn: *Lernanthropus petersi* van Beneden, 1857
Paralernanthropus petersi (van Beneden, 1857)
Pseudolernanthropus petersi (van Beneden, 1857)

Material examined: none.

Differential diagnosis: Cephalothorax about as long as wide, with evenly convex lateral margins. Trunk irregularly subrectangular, wider than cephalothorax: anterior part of trunk (second and third pedigerous somites) wider than long, produced into tapering posterolateral processes extending about 30% of distance along lateral margins of dorsal trunk plate. Posterior part of trunk covered by broad dorsal trunk plate with rounded hexagonal shape. Dorsal surface of cephalothorax and trunk lacking ornamentation. Urosome formed from fifth pedigerous somite, genital complex and abdomen, all fused. Egg sacs loosely coiled beneath dorsal trunk plate. Paired caudal rami short, tapering towards tip. Leg 2 biramous, with unimerous rami. Leg 3 trilobate, with large, lamellate exopodal lobe orientated horizontally across ventral surface, reaching to posterior end of body, connecting via long posteriorly-directed, flagellum-like middle lobe to smaller rounded inner lobe; flagellate middle lobe extending well beyond posterior margin of dorsal trunk plate. Leg 4 bilobate; with inner and outer lobes long and tapering, distal flagellate parts of both lobes extending well beyond posterior margin of dorsal trunk plate. Body length of ♀ about 5.8 mm (from Kabata, 1979a).

Distribution: This species was originally described from *Epinephelus fuscoguttatus* (Forsskål, 1775) (as *Serranus goliath*) caught off Mozambique (van Beneden, 1857). It was also listed as occurring on an unidentified host caught off Zaire by Brian (1939), but in the absence of any voucher specimens or description, this record is in need of confirmation. Kabata (1979a) reported *S. petersi* on *Epinephelus lanceolatus* (as *Promicrops lanceolatus*) from Queensland waters.

Remarks: This species is not well characterized but the trilobate state of the third leg, with the middle flagellum-like lobe extending beyond the posterior margin of the dorsal trunk plate, as described by Kabata (1979a), is unique within the genus.

***Sagum sanguineus* (Song, in Song & Chen, 1976) n. comb.**

(Figs. 47–48)

Syn: *Lernanthropus sanguineus* Song, in Song & Chen, 1976

Material examined: 1 ♀ from *Lutjanus johnii* (Bloch, 1792) (OH-M), Lee Point, Outer Harbour, Darwin, Northern Territory, 10 March 2014, collected by D.P. Barton; MAGNT Reg. No. Cr019251. 1 ♀ from *Lutjanus johnii*, Condor, Melville Island, Northern Territory; 23 August 2012; collected by D.P. Barton; NHMUK Reg. No. 2018.302.

Differential diagnosis: Cephalothorax about 1.25 times longer than wide with almost linear lateral margins narrowing anteriorly towards short frontal margin (Fig. 47A); lateral margins of dorsal cephalothoracic shield projecting ventrally, with strongly convex posterior margin. Anterior part of trunk (second and third pedigerous somites) about 1.7 times wider than long with distinct anterolateral shoulders and with more or less parallel lateral margins; posterior part (fourth pedigerous somite) covered by subcircular dorsal trunk plate. Dorsal trunk plate entirely concealing urosome but with at least distal third of fourth leg lobes extending beyond posterior margin and visible in dorsal view (Fig. 47A). Urosome comprising fifth pedigerous somite, genital complex and abdomen, all fused (Fig. 47B, C). Genital complex slender, with conspicuous paired gonopores dorsolaterally and with paired copulatory pores located posterolaterally on ventral surface (arrowed in Fig. 47B); dorsal surface of genital complex ornamented with 2 pairs of sensillae located between gonopores. Egg sacs loosely coiled (Fig. 47D) beneath dorsal trunk plate and concealed laterally by third legs. Paired caudal rami elongate (Fig. 47B), about 2.7 times longer than maximum width; broadest in proximal-section; tips of caudal rami not reaching middle of elongate fourth leg lobes (Fig. 47C). Caudal rami each with 2 dorsal setae, distal dorsal seta located at 30% of length of ramus, small outer seta located at about 60% of ramus length, plus 2 apical setae.

Antennule unsegmented, armed with 6 setae proximally and 10 setae plus 2 aesthetascs around apex (Fig. 47E). Parabasal flagellum absent. Antenna (Fig. 47F) with robust proximal segment; distal subchela armed with rounded process, small spinous process near medial margin, plus small process in articulation with proximal segment; surface of strongly recurved subchela ornamented with striations and pits. Postantennal process elongate (Fig. 47G). Mandible stylet-like with 8 marginal teeth at apex. Maxillule bilobed, smaller lobe tipped with 1 spiniform element; larger lobe tipped with 3 unequal spiniform elements and ornamented with hair-like setules (Fig. 47H). Maxilla (Fig. 47I) with short tapering syncoxa; basis with apical claw ornamented with marginal rows of denticles, plus blunt subapical process. Maxilliped (Fig. 47J) corpus with irregular myxal surface armed with short spine; subchela armed with minute setal vestige on concave margin.

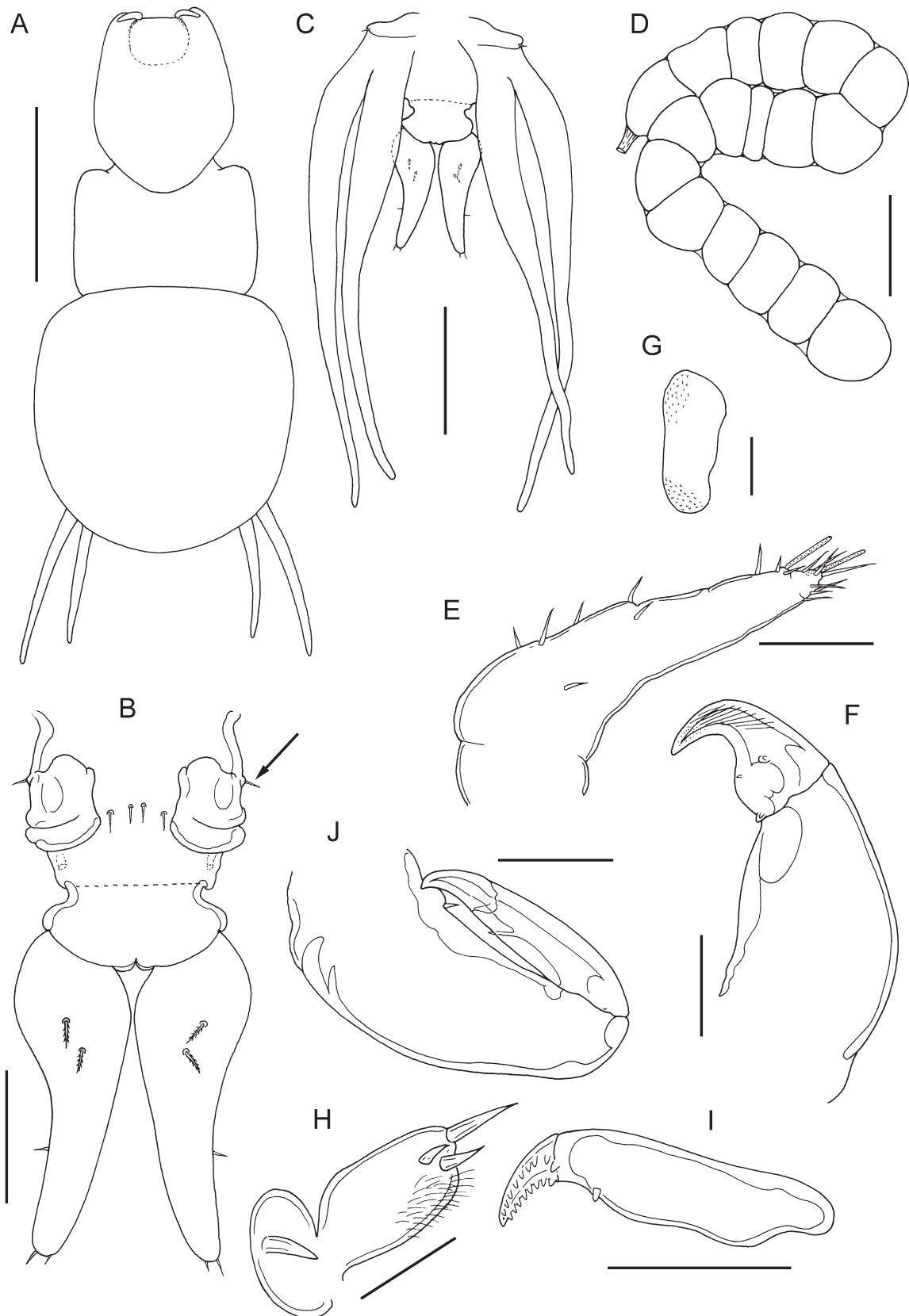


FIGURE 47. *Sagum sanguineus* (Song, in Song & Chen, 1976) **n. comb.**, adult ♀. A, habitus, dorsal; B, urosome, dorsal view showing vestigial fifth legs (arrowed), paired genital openings and caudal rami; C, posterior end of trunk and urosome, ventral view showing extent of lobes of leg 4 relative to tips of caudal rami; D, egg sac; E, antennule; F, antenna; G, postantennal process; H, maxillule; I, basis of maxilla; J, maxilliped. Scale bars A, 1 mm, B,D, 200 µm, C, 0.5 mm, E,G,H, 50 µm, F,I,J, 100 µm.

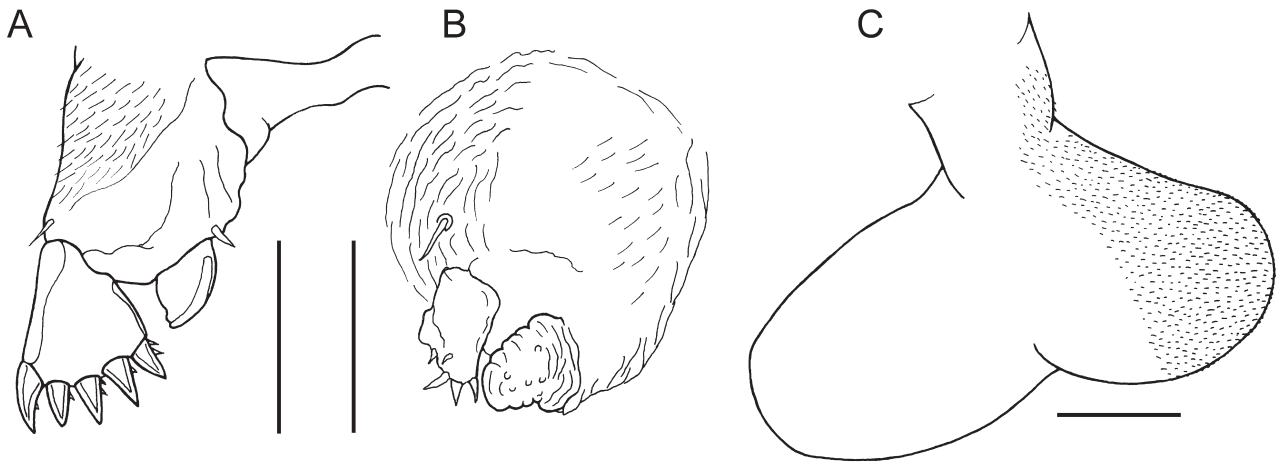


FIGURE 48. *Sagum sanguineus* (Song, in Song & Chen, 1976) **n. comb.**, adult ♀. A, leg 1; B, leg 2; C, leg 3. Scale bars.

Leg 1 with coxa fused to somite and incompletely separated from basis; members of leg pair joined by intercoxal sclerite (Fig. 48A). Each leg biramous with outer seta and short, inner spine on basis; outer surface of coxal part of protopod ornamented with long setules: exopod 1-segmented, armed with 5 robust terminal spines with sparsely denticulate margins; endopod 1-segmented, smoothly tapering to unarmed apex; surface unornamented. Leg 2 (Fig. 48B) carried on inflated subspherical prominence, with wrinkled surface, derived from incorporated protopod and armed with outer seta: biramous, with both rami 1-segmented and both with wrinkled cuticular surface; exopod armed with 5 small distal spines; endopod conical with rounded apex, unarmed but with surface papillae. Leg 3 located on ventral surface of third pedigerous somite, forming bilobed fleshy lamella (Fig. 48C), large outer lobe held vertically and directed posteriorly, reaching about to middle of dorsal trunk plate; smaller inner lobe about one third length of outer lobe; held vertically and extending posteromedially but legs separate along midline. Leg 4 bilobate (Fig. 47C): distinct protopodal part bearing outer basal seta: inner and outer lobes elongate, flattened and tapering slightly from wider base; outer (exopodal) lobe slightly longer than inner (endopodal) lobe: at least distal third of lobes extending beyond posterior margin of dorsal trunk plate. Leg 5 represented by minute papilla carrying short apical seta (arrowed in Fig. 47B). Body lengths of ♀♀ 3.06 mm and 3.14 mm (based on 2 specimens).

Distribution: This species (as *Lernanthropus sanguineus*) was originally established on the basis of two females collected from the gills of *Lutjanus sanguineus* caught off Sanya, China. The only subsequent record of this copepod, as *Sagum sanguineus* (Song, 1976), was from Vietnamese waters on *Lutjanus johnii* (Kazachenko *et al.*, 2014). This is the first report of this copepod from Australian waters.

Remarks: The presence of loosely coiled egg sacs in the female confirms the validity of the transfer of this species to *Sagum* informally carried out by Kazachenko *et al.* (2014). The possession of leaf-like caudal rami, a short and strongly recurved claw on the antenna, and the form of the first leg of the female with its unarmed endopod, are all character states shared by a core group of species within the genus *Sagum* (Table 4). In particular, as mentioned above, this species closely resembles *S. lativentris* and both are reported here from *L. johnii*. These two species share even fine details of limb setation but can be readily distinguished by the length of the fourth legs and the position of the distal dorsal caudal seta on the caudal ramus, as discussed above.

***Sagum vespertilio* Kabata, 1979**

(Figs. 49–50)

Material examined: Holotype ♀ and paratype ♀ from *Lethrinus laticaudis* Alleyne & MacLeay, 1877 (as *Lethrinus fletus*), Moreton Bay, Queensland; 08 April 1964; collected by P.C. Young; NHMUK Reg. No. 1977.122–123. 2♀♀ from *L. laticaudis*, Sunshine Coast, Queensland; date of collection unknown; collected by D.P. Barton; QM Reg. No. W29506.



FIGURE 49. *Sagum vespertilio* Kabata, 1979, adult ♀. A, habitus, lateral; B, habitus, dorsal; C, habitus, ventral. Scale bar 2 mm.

1♀ from *Lutjanus sebae* (Cuvier, 1816) (SSRE2015006), Joseph Bonaparte Gulf, Northern Territory, 03 August 2015; collected by D.P. Barton; MAGNT Reg. No. Cr019252. 2♀♀ from *L. sebae* (SSRE2015008), Joseph Bonaparte Gulf, Northern Territory, 03 August 2015; collected by D.P. Barton; MAGNT Reg. No. CR019253. 1♂ from *L. sebae* (SSRE2015012), Joseph Bonaparte Gulf, Northern Territory, 03 August 2015; collected by D.P. Barton; MAGNT Reg. No. Cr019254. 1♀ from *L. sebae* (SSRE2016010), Arafura Sea East, Northern Territory, 03 February 2016; collected by D.P. Barton. 1♀ from *L. sebae* (SSRE2016013), Arafura Sea East, Northern Territory, 03 February 2016; collected by D.P. Barton. 1♀ from *L. sebae* (SSRE2016031), Arafura Sea West, Northern Territory, 30 March 2016; collected by D.P. Barton; NHMUK 2019.1037–1039.

1♀ from *Lutjanus malabaricus* (Bloch & Schneider, 1801) (SSSTS2015016), Joseph Bonaparte Gulf, Northern Territory, 03 August 2015; collected by D.P. Barton; 1♀ from *L. malabaricus* (SSSTS2015024), Joseph Bonaparte Gulf, Northern Territory, 03 August 2015; collected by D.P. Barton; 1♀ from *L. malabaricus* (SSSTS2015039), Arafura Sea East, Northern Territory, 14 August 2015; collected by D.P. Barton. 1♀ from *L. malabaricus* (SSSTS2015044), Arafura Sea East, Northern Territory, 14 August 2015; collected by D.P. Barton. MAGNT Reg. No. Cr019255. 1♀ from *L. malabaricus* (SSSTS2015058), Arafura Sea East, Northern Territory, 14 August 2015; collected by D.P. Barton. 1♀ from *L. malabaricus* (SSSTS2015063), Gulf of Carpentaria, Northern Territory, 21 August 2015; collected by D.P. Barton. 1♀ from *L. malabaricus* (SSSTS2015075), Gulf of Carpentaria, Northern Territory, 21 August 2015; collected by D.P. Barton. 2♀♀ from *L. malabaricus* (SSSTS2015104), Timor Reef Fishery Zone, Northern Territory, 16 September 2015; collected by D.P. Barton. 1♀ from *L. malabaricus* (SSSTS2015110), Timor Reef Fishery Zone, Northern Territory, 16 September 2015; collected by D.P. Barton. 1♀ from *L. malabaricus* (SSSTS2016003), Arafura Sea West, Northern Territory, 22 April 2016; collected by D.P. Barton. 1♀ from *L. malabaricus* (SSSTS2016009), Arafura Sea West, Northern Territory, 22 April 2016; collected by D.P. Barton; NHMUK Reg. No. 2018.1040–1047.

1♀ from *Lutjanus erythropterus* Bloch, 1790, outer Darwin Harbour, Northern Territory, August 2012; collected by B K Diggles.

Differential diagnosis: Cephalothorax extremely broad (more than twice as wide as long); anterolateral margins of dorsal cephalothoracic shield expanded laterally into large triangular processes (Fig. 49A–C); ventral surface with paired ventrally-directed ridge-like lobes located lateral to base of antennae and postantennal processes. Ceph-

alothorax separated from trunk by short neck bearing paired cylindrical processes laterally. Trunk wide; anterior part (second and third pedigerous somites) forming rounded anterior shoulders and lateral margins extended posteriorly overlapping broad dorsal trunk plate on both sides (Fig. 49A–C); dorsal trunk plate covering fourth pedigerous somite and extending posteriorly to overlap all except flagellate tips of fourth legs; posterior margin of dorsal trunk plate with weak median indentation. Lateral surface of head and dorsal surface of trunk ornamented with numerous small tubercles. Urosome comprising fifth pedigerous somite, genital complex and abdomen, all fused; entirely concealed beneath dorsal trunk plate. Egg sacs loosely coiled beneath dorsal trunk plate and concealed laterally by exopods of third legs. Caudal rami broad proximally, with long distal part tapering to acute tip; armed with 2 dorsal, 1 lateral and 2 apical setae. Leg 1 biramous, lacking intercoxal sclerite; with 1-segmented rami; partly concealed by ventral lobe adjacent to protopod. Leg 2 biramous with 1-segmented rami. Leg 3 with foliaceous rami: exopod flattened and orientated in horizontal plane; endopod orientated vertically and forming looped fold, open posteriorly. Leg 4 biramous; both rami forming foliaceous lobes with broad basal part tapering to distal flagellate part; outer and inner lobes similar in length. Leg 5 as short lobe with single seta. Body length of ♀ ranging from 4.44 to 6.22 mm, with a mean of 5.05 mm (based on 10 specimens from *L. malabaricus*).

Description of male. Body smaller than female, comprising cephalothorax covered with dorsal shield and irregularly tapering trunk, terminating in narrow, angular posterior margin (Fig. 50A). Cephalothorax comprising about 52% of total body length: about as long as wide with rounded corners and slightly concave posterior margin: dorsal shield with narrow antennal part anteriorly and broader posterior part. Trunk about 1.3 times longer than maximum width (at anterior end); lateral margins sinuous; posterior margin with indentations at base of leg 3. Genitoabdomen bearing paired caudal rami, concealed beneath trunk in dorsal view. Caudal rami with broad base and narrow distal part (Fig. 50B); about 4.1 times longer than wide; armed with 2 dorsal setae proximally plus 2 apical setae; lateral seta absent.

Antennule indistinctly 6-segmented (Fig. 50C), armed with 5 setae on proximal segments plus 11 and 2 aesthetascs on compound apical segment; scar on proximal segment probably indicating lost seta in observed specimen. Parabasal flagellum absent. Antenna (Fig. 50D) comprising robust proximal segment, armed with papilliform process on myxal margin, and distal subchela: small process present in articulation at base of subchela; terminal claw tapering gradually, lacking armature. Mandible short, stylet-like; armed with 8 marginal teeth near apex (Fig. 50E). Maxillule with small inner lobe bearing single apical seta; longer outer lobe with 1 apical seta plus 2 setae on mid posterior margin (Fig. 50F). Maxilla with claw fused to basis; spinular ornamentation extending over claw and onto distal part of basis (Fig. 50G). Maxilliped with papilliform process surrounded by minute spinules on myxal surface; subchela with small proximal process on concave margin; apical claw unornamented (Fig. 50H).

Leg 1 biramous, with robust intercoxal sclerite joining members of leg pair (Fig. 50I); protopod with slender outer seta and stout inner spine: exopodal segment short, broader at tip, armed with 5 stout spines distally; endopod 1-segmented, armed with apical spine about as long as segment. Leg 2 (Fig. 50J) with outer seta on basis; exopod 1-segmented with partial transverse suture proximally; armed with 3 stout spines distally: endopod armed with single apical seta, shorter than segment. Leg 3 biramous (Fig. 50A) with each ramus forming elongate cylindrical lobe; anterior (exopodal) lobe apparently with swollen apex; armed with outer protopodal seta situated on small papilla located dorsally at base. Leg 4 biramous (Fig. 50A) with each ramus forming elongate cylindrical lobe; outer lobe slightly longer than inner; armed with outer protopodal seta situated on small papilla located dorsally at base. Leg 5 absent. Leg 6 represented by paired genital apertures, unarmed. Body length of single ♂ 1.81 mm.

Distribution: This distinctive species was originally described from *Lethrinus laticaudis* (as *L. fletus* (Whitley)) caught in Moreton Bay (Kabata, 1979a). It was subsequently reported from *L. nebulosus* (Forsskål, 1775) landed in Taiwan by Ho *et al.* (2008) and from *L. rubrioperculatus* Sato, 1978 caught off New Caledonia (Justine *et al.*, 2010b). The Australian records presented here from *Lutjanus sebae*, *L. malabaricus* and *L. erythropterus* represent new host records. This species is now known from four species of *Lethrinus* and three species of *Lutjanus*. Ho *et al.* (2008) treated *Sagum tuberculatum* Pillai, 1985 described from Indian waters, as a junior synonym of *S. vespertilio*. The host of *S. tuberculatum* was given as *Lutjanus* sp. by Pillai (1985) and its true identity cannot now be established. Pilla *et al.* (2012) reported *S. vespertilio* (as *S. tuberculatum*) from *Lutjanus fulviflamma* (Forsskål, 1775) caught off the coast of India at Visakhapatnam.

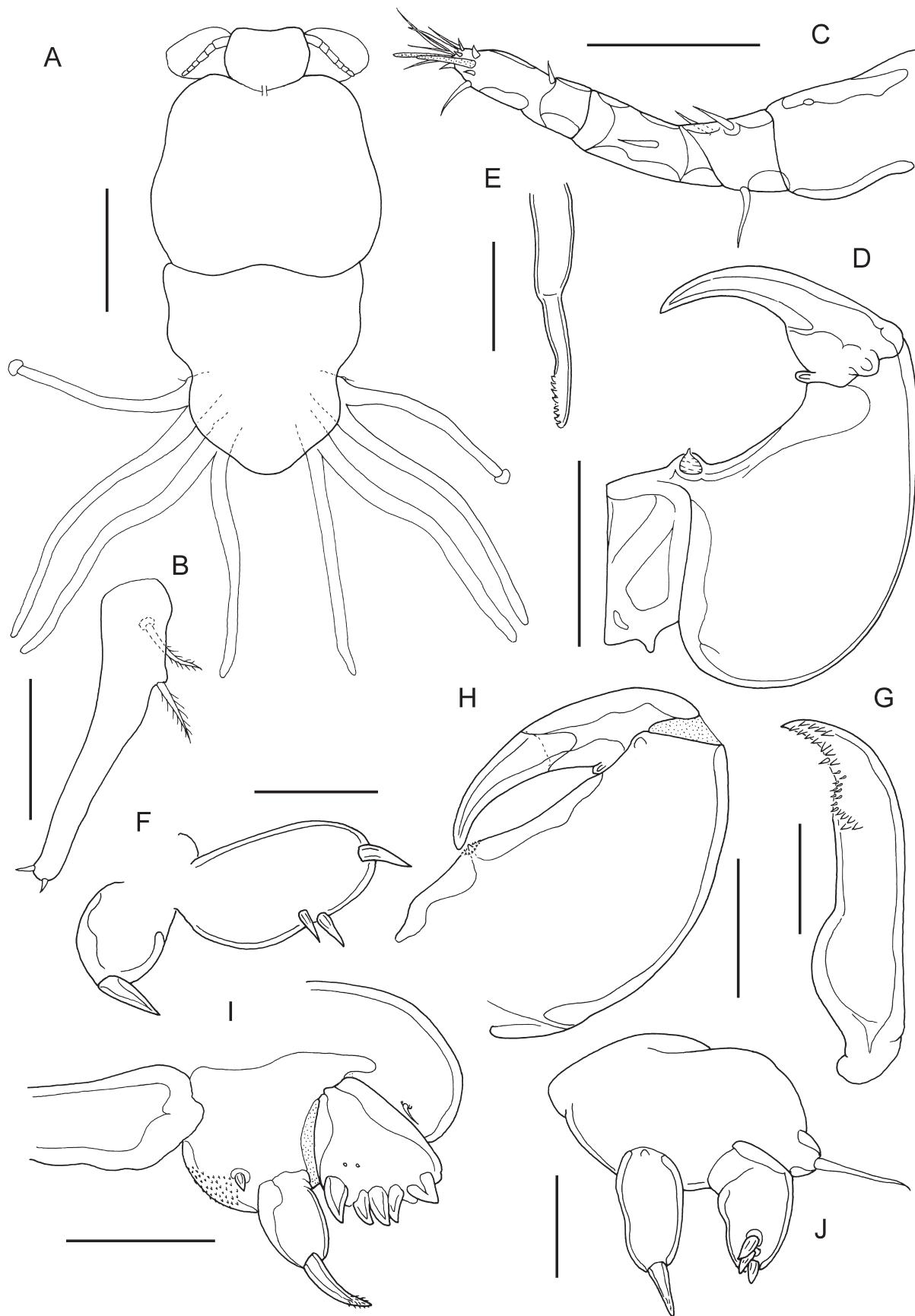


FIGURE 50. *Sagum vespertilio* Kabata, 1979, adult ♂. A, habitus, dorsal; B, caudal ramus, ventral; C, antennule; D, antenna; E, mandible; F, maxillule; G, basis of maxilla; H, maxilliped; I, leg 1 and part of intercoxal sclerite; J, leg 2. Scale bars A, 0.5 mm, B,C,H,I, 100 μ m, D, 200 μ m, E–G, J, 50 μ m.

Remarks: The original description of this species by Kabata (1979a) focused on the female habitus only and provided little detail of limb structure but Ho *et al.* (2008) were able to redescribe the female in detail based on new material from Taiwan. The male is described here for the first time, but only a single specimen was collected and, unfortunately, the urosome was damaged.

The description here of two previously unknown males of *Sagum* species allows us to attempt to formulate a set of diagnostic features for the males in this genus even though it appears that *Sagum* males vary markedly. We exclude the specimen described as the male of *S. enneacentri* Pillai, 1985 because, on the basis of the leaf-like third legs, we consider that it is probably an immature female (a possibility already noted by Pillai (1985)). The male of the New Zealand species, *S. foliaceus*, described by Hewitt (1968) is essentially similar to the males of many *Lernanthropus* species, having a trunk that is longer than the cephalothorax, biramous legs 3 and 4, but with the endopod of leg 3 reduced to a knob-like lobe, and with the genital complex and anal somite projecting posteriorly from the rear margin of the trunk. The males of a cluster of other species including *S. folium*, *S. gurukun*, *S. lativentris*, *S. vespertilio* and *S. pillaisebastiani* (described by Pillai (1985) as the male of *S. epinepheli*) all share a relatively large cephalothorax, a broad trunk incorporating the genital complex, and biramous legs 3 and 4 where both rami are cylindrical and elongate. All of these species utilize hosts belonging to the closely related fish families Lutjanidae, Lethrinidae and Caesionidae.

The male of *Norion tayenus* Ho & Kim, 2004, which occurs on the priacanthid host, *Priacanthus tayenus* (Ho & Kim, 2004), shares numerous character states with this cluster of *Sagum* species, indicating possible close affinity. Interestingly, these characteristics appear to be shared by *Lernanthropus holmbergii* von Nordmann, 1864 which was described on the basis of the male only, collected from an unknown fish caught off Hawaii (von Nordmann, 1864). This species could belong either to *Sagum* or to *Norion*, but at present should be considered as a *species inquirendum* since too few details are available to assess its identity.

Key to adult females of Lernanthropidae found in Australian waters

1. Egg sacs coiled. 2
- Egg sacs linear. 4
2. Second leg absent. *Norion*
- Second leg present. 3
3. Second leg unsegmented, bifid. 7 [*Aethon*]
- Second leg biramous with defined 1-segmented rami. 9 [*Sagum*]
4. Somite bearing leg 4 without dorsal trunk plate or paired dorsal processes: members of leg 3 pair fused to form ventral plate. *Lernanthropodes trachinoti*
- These characters not combined. 5
5. Somite bearing leg 4 with pair of small flattened processes located dorsally near posterior end of fourth pedigerous somite. *Lernanthropsis mugilii*
- Somite bearing leg 4 with dorsal trunk plate deeply incised (right to base) and resulting paired lobes fused to third leg on each side to form lateral plates. [*Lernanthropinus*]
- Somite bearing leg 4 with single dorsal plate (medially indented or weakly incised in some species). 6
6. Exopodal lobe of leg 4 about twice as long as endopodal lobe. *Mitrapus oblongus*
- Exopodal and endopodal lobes of leg 4 of similar lengths. 13 [*Lernanthropus*]
7. Dorsal trunk plate about 1.6 times longer than wide; lateral margins of cephalothorax evenly convex. *Aethon garricki*
- Dorsal trunk plate about as wide as long, or wider than long; lateral margins of cephalothorax with lateral lobes. 8
8. Dorsal trunk plate about 1.6 times wider than long; rear margin of plate truncated, almost linear with slight median indentation. *Aethon bicamera* **sp. nov.**
- Dorsal trunk plate about as wide as long; rear margin of plate sinuous, with median and paired lateral indentations. *Aethon morelandi*
9. Lateral margins of cephalothorax with large lobes. 10
- Lateral margins of cephalothorax linear to weakly convex, without paired lobes. 11
10. Paired lobes on cephalothorax large, triangular, tapering towards pointed apex at posterior margin. *Sagum vespertilio*
- Paired lobes on cephalothorax forming rounded expansion of margin, slightly wider posteriorly. *Sagum epinepheli*
11. Cephalothorax 1.1 to 1.3 times longer than wide; lateral margins of cephalothorax linear; leg 3 bilobate. 12
- Cephalothorax about as long as wide; lateral margins of cephalothorax weakly convex; leg 3 trilobate. *Sagum petersi*
12. Tips of caudal rami reaching beyond mid-length of leg 4. *Sagum lativentris* **n. comb.**
- Tips of caudal rami not reaching mid-length of leg 4. *Sagum sanguineus* **n. comb.**
13. Cephalothorax with large lobes on posterolateral corners of dorsal cephalic shield. 14
- Cephalothorax without posterolateral lobes or with weakly protruding posterolateral corners. 15

14. Leg 4 lobes largely or entirely concealed beneath extensive dorsal trunk plate *Lernanthropus tylosuri*
 - Leg 4 lobes extending well beyond posterior margin of dorsal trunk plate, so that more than 50% of lobe length visible in dorsal view *Lernanthropus chrysophrys*
15. Ventrally expanded lateral margin of dorsal cephalic shield produced anteriorly into paired anterolateral (frontal) projections *Lernanthropus gnathanodontus* **sp. nov.**
 - Cephalic shield without marked frontal projections 16
16. Fifth legs forming elongate process, longer than caudal rami 17
 - Fifth legs forming short processes (about as long as caudal rami), reduced to setiferous lobes, or absent 20
17. Third legs distinctly longer than anterior region of trunk (second and third pedigerous somites) 18
 - Third legs shorter than anterior region of trunk 19
18. Posterolateral corners of dorsal shield on cephalothorax produced into small lobes; posterior margin of dorsal trunk shield truncated, straight *Lernanthropus paracruciatus* **sp. nov.**
 - Posterolateral corners of dorsal shield rounded, not produced; posterior margin of dorsal trunk shield evenly convex *Lernanthropus gisleri*
19. Fifth legs tapering from broad base; about 4.7 times longer than maximum width; caudal rami about 3.4 times longer than wide *Lernanthropus serioli*
 - Fifth legs with parallel lateral margins, tapering near tip; about 8.0 times longer than wide; caudal rami ca. 5.0 times longer than wide *Lernanthropus elegans* **sp. nov.**
20. Trunk more than 4.5 times longer than cephalothorax; antenna slender with large hook-like process on medial surface *Lernanthropus latis*
 - Trunk at most 3.5 times longer than cephalothorax; antenna without large hook-like process on medial surface 21
21. Fifth legs forming laterally-directed lobe about 2.7 times longer than wide 22
 - Fifth legs forming short setiferous lobe, further reduced or absent 23
22. Dorsal trunk plate distinctly wider than long *Lernanthropus alepicolus* **sp. nov.**
 - Dorsal trunk plate longer than wide *Lernanthropus microlamini*
23. Lobes of leg 4 entirely concealed beneath cloak-like dorsal trunk plate in dorsal view 24
 - At least tips of leg 4 lobes visible in dorsal view extending beyond posterior margin of dorsal trunk plate 25
24. Cephalothorax with weakly protruding posterolateral corners *Lernanthropus brevicornutus*
 - Cephalothorax with rounded posterolateral corners *Lernanthropus belones*
25. Dorsal trunk plate concealing entire urosome including full length of caudal rami 28
 - Dorsal trunk plate short, posterior part of urosome including entire length of caudal rami extending beyond posterior margin of plate; only very bases of leg 4 concealed 26
26. Endopodal lobes of leg 3 fused in midline to form triangular ventral plate; parabasal flagellum present *Lernanthropus cadenati*
 - Endopodal lobes of leg 3 separate along midline; parabasal flagellum absent 27
27. Anterior part of trunk about 1.6 times longer than wide and about twice as long as dorsal trunk plate *Lernanthropus mollis*
 - Anterior part of trunk nearly 2 times wider than long, only just longer than dorsal trunk plate *Lernanthropus pemphericola* **sp. nov.**
28. Caudal rami about 4 times longer than wide *Lernanthropus breviculus*
 - Caudal rami less than 3 times longer than wide 29
29. Dorsal trunk plate with median indentation in posterior margin; subchela of maxilliped with distinctive curved process on concave margin *Lernanthropus selenotoca* **sp. nov.**
 - Posterior margin of dorsal trunk plate linear or weakly convex, without any median indentation; maxilliped lacking process on subchela 30
30. Dorsal trunk plate about as wide as anterior trunk and cephalothorax *Lernanthropus atrox*
 - Dorsal trunk plate about twice as wide as anterior trunk and cephalothorax 31
31. Cephalothorax longer than wide with weakly convex lateral margins and straight frontal margin; leg 5 an unarmed conical process *Lernanthropus abitocephalus*
 - Cephalothorax wider than long, with medially pointed frontal margin; leg 5 absent *Lernanthropus pomadasys*

Discussion

Two different formats of uniseriate egg sac are exhibited within the Lernanthropidae. In *Aethon*, *Norion* and *Sagum* the egg sacs are loosely coiled or looped within a chamber located beneath the dorsal trunk plate and enclosed laterally and ventrally by the lamellate third and fourth legs. The external surfaces of the walls of this chamber (the dorsal plate and the exopods of the third legs) are often reinforced by sclerotized ornamentation. The remaining genera, *Lernanthropus*, *Lernanthropodes*, *Lernanthropinus*, *Lernanthropsis*, and *Mitrapus* retain the plesiomorphic linear type of egg sacs, found widely among fish parasitic siphonostomatoid families (Boxshall & Halsey, 2004). In the former group of genera the loosely coiled egg sacs lie within the chamber formed beneath the dorsal trunk plate and are protected as they develop through to hatching in an enclosed space. In genera with linear egg sacs it seems

probable that some measure of protection is afforded by the development of other structures: *Lernanthropus*, *Lernanthropinus* and *Mitrapus* often have the rami of the fourth legs forming elongate lobes which extend posteriorly together with the egg sacs and, in addition, the dorsal trunk plate helps to conceal at least the proximal part of the egg sacs in many species. There is no dorsal trunk plate in *Lernanthropodes* but the fusion of the third legs to form a ventral tube serves to provide some protection to the eggs sacs. In *Lernanthropsis* there is no dorsal trunk plate and the egg sacs are protected by the lobate fourth legs only. These posteriorly-directed structures may help to reduce damage to, and loss of, egg sacs due to the activity of cleaner fish.

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