

## A new species of the genus *Phoxocephalus* from Pulau Tioman, Malaysia (Crustacea: Amphipoda: Phoxocephalidae)

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**Abstract.** A new species of the phoxocephalid amphipod, *Phoxocephalus tiomanensis*, new species, was discovered from the littoral area of Pulau Tioman, Malaysia, South China Sea. This brings the total members of the genus to 11. These 11 species were examined taxonomically, and variation was noted in some characters. *Phoxocephalus tiomanensis* differs from other congeneric species by the following characters: the subtriangular basis of the pereopod 5, the particular setae at carpus of the pereopod 7, and the absence of facial setae on epimeral plates 2.

**Key words.** *Phoxocephalus tiomanensis*, new species, Phoxocephalidae, Amphipoda, Malaysia, South China Sea

### INTRODUCTION

Family Phoxocephalidae Sars, 1891, one of the most diversified amphipod groups that consists of 10 subfamilies and 72 genera (Lowry, 2015), is known to exhibit fossorial adaptations morphologically. The members of phoxocephalid amphipods have powerful antennae, rostralegs, pleopods, and uropods. These appendages are armed with densely thin spine and setae (Barnard & Karaman, 1991). In 1842, Krøyer established the genus *Phoxus* for a species, *Phoxus holbolli* Krøyer, 1842. However, the genus *Phoxus* was already a homonym of Coleoptera. Therefore, the genus was newly named by Stebbing as *Phoxocephalus* in 1888.

Currently, the genus *Phoxocephalus* Stebbing, 1888 is characterised by presenting the following characters: rostrum well developed and unconstricted; peduncle of antenna 2, article 1 not ensiform; mandible, molar triturative, palpal hump small, apex of palp article 3 oblique; maxilla 1, palp 1-articulate, inner plate without setae; palp of maxilliped, dactylus elongate, apical nail distinct; gnathopods 1 and 2 small, similar, palms oblique, propodus ovato-rectangular; pereopod 5, basis broad form, tapering distally; urosomite 3 without dorsal hook; uropod 3, outer ramus longer than peduncle, bearing article 2 on outer ramus; telson elongate. Member of the genus *Phoxocephalus* consists of 10 species, excluding the new species described here. Of these taxa, seven species, *P. burleus* Barnard & Drummond, 1978;

*P. geniculatus* (Stimpson, 1856); *P. keppeli* Barnard & Drummond, 1978; *P. kukatus* Barnard & Drummond 1978; *P. obtusus* (Stimpson, 1856); *P. rupellus* Barnard & Drummond, 1978; and *P. tunggeus* Barnard & Drummond, 1978, were recorded exclusively from Australian and New Zealand waters. *Phoxocephalus aquos* Karaman, 1985 and *P. holbolli* (Krøyer, 1842) were recorded in the Mediterranean and Atlantic Sea, respectively. *Phoxocephalus proluxus* Hirayama, 1987 was collected from Japan.

Recent work to date on marine amphipods of Pulau Tioman is that by Azman & Othman (2013). The work analysed samples of gammaridean amphipods collected from Monkey Bay to Genting (areas along the west coast of the island), mostly from coral reef area at depths ranging from 5 to 20 m, and recorded 11 taxa of which one species is described as new. This paper represents one more contribution to the knowledge of this important group in these Tioman waters, bringing the total number of species of *Phoxocephalus* to 11. Here we describe and illustrate the new species, *Phoxocephalus tiomanensis*.

### MATERIAL AND METHODS

Recent amphipod collections were made during a research visit in May 2014 by the first author (MHS), hosted by Marine Ecosystem Research Centre (EKOMAR) to Pulau Tioman, Pahang. Specimens were collected by using a light-trap from the shallow water coral reef area of Abect's House Reef, Kg. Tekek, Pulau Tioman (2°49'05.0"N 104°09'15.0"E) on 23 May 2014 (Fig. 1). The specimens were fixed in 80% ethyl alcohol and dissected in glycerol. Dissected appendages were stained with lignin pink. Drawings and measurements were performed with the aid of a Nikon SMZ1500 stereomicroscope and an Olympus BX51 differential interference contrast microscope with drawing tube. Body length was measured from tip of rostrum to the apex of the telson, along the dorsal parabolic line of the body. All illustrations were digitally 'inked' following Coleman (2003). Setae and mouthparts are

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classified following Watling (1989). The type material of the new species is deposited at Universiti Kebangsaan Malaysia Muzium Zoologi (UKMMZ), Marine Arthropod Depository Bank of Korea (MADBK), and Museum für Naturkunde, Berlin (ZMB). The following abbreviations were used on the figures: HD, head; A1–2, antennae 1–2; MD, mandible; MX1–2, maxillae 1–2; UL, upper lip; LL, lower lip; MP, maxilliped; G1–2, gnathopods 1–2; P3–7, pereopods 3–7; U1–3, uropods 1–3; T, telson; r, right; l, left.

## TAXONOMY

### Order Amphipoda Latreille, 1816

### Suborder Gammaridea Latreille, 1802

### Family Phoxocephalidae Sars, 1891

### Genus *Phoxocephalus* Stebbing, 1888

**Species composition.** *Phoxocephalus* contains 11 species of *P. aquosus* Karaman, 1985; *P. burleus* Barnard & Drummond, 1978; *P. geniculatus* (Stimpson, 1856); *P. holbolli* (Krøyer, 1842) (type species); *P. keppeli* Barnard & Drummond, 1978; *P. kukatus* Barnard & Drummond, 1978; *P. obtusus* (Stimpson, 1856); *P. prolixus* Hirayama, 1987; *P. rupullus* Barnard & Drummond, 1978; *P. tiomanensis*, new species; and *P. tunggeus* Barnard & Drummond, 1978.

### *Phoxocephalus tiomanensis*, new species (Figs. 2–4)

**Type material.** Holotype — male (body length 3.03 mm) (UKMMZ – 1532), Abect's House Reef, Kg. Tekek, Pulau Tioman, Pahang, 2°49'05.0"N 104°09'15.0"E, Light-trap, 8 m, coll. Y.K., Tan et al., 23 May 2014. Paratypes — 5 males, 2.7–3.0 mm (UKMMZ – 1534); 3 males, 2.7–2.9 mm (MADBK201906\_001); 5 males, 2.8–3.0 mm (ZMB 28477), all with same data as holotype.

**Type locality.** Abect's House Reef, Kg. Tekek, Pulau Tioman, Pahang, Malaysia.

**Description of holotype (Figs. 2–4).** Head (Fig. 4HD) about 15 percent of total body length, rostrum curved downwards, unconstricted, broad, extending slightly beyond peduncular article 1 of antenna 1, hood-like. Eyes subcircular, large.

Antenna 1 (Fig. 2A1), peduncular article 1 stout, about 1.2 times as long as wide, about 2.3 times as wide as article 2, pubescent on distal half of ventral margin; article 2 about 0.4 times article 1 length, with 4 posterodistal setae; main flagellum 5-articulate, about 2 times as long as peduncular article 1, bearing aesthetascs; accessory flagellum 3-articulate.

Antenna 2 (Fig. 2A2) about 0.6 times body length; peduncular article 3 with long setae on anterior margin; peduncular article 4 obliquely truncated, with long setae along anterior margin and 4 distal robust setae; posterior margin short,

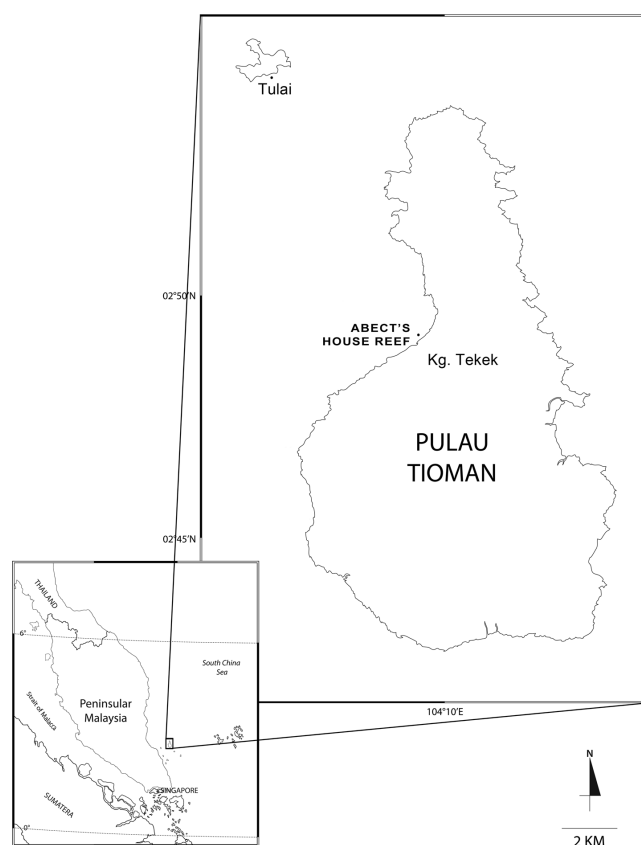


Fig. 1. Map showing the sampling area.

with long robust setae; peduncular article 5 slightly shorter than article 4, provided with facial robust setae; flagellum with 17 articles, about 4 times as long as articles 1–5 of peduncle combined.

Mandible (Fig. 4MD1) rather slender with medium palpal hump; incisor and lacinia mobilis broad, serrate; 3 accessory spines finely pectinate; molar process triturative, distinctly protruded; molar rasp tuberosus; palp 3-articulate, almost uniform in width; palp article 1 small; palp article 2 slightly longer than article 3, with 2 inner distal setae; palp article 3 obliquely truncate, with 11 apical long setae.

Upper lip (Fig. 4UL) broad. Lower lip (Fig. 4LL) mandibular process reduced; shoulders triangular.

Maxilla 1 (Fig. 4MX1) inner plate medium; outer plate provided with one trifold, 2 bifid, and 4 simple tooth-like spines (all simple spines serrate unilaterally); palp uniarticulate, slightly extending beyond outer plate, with 3 apical robust setae.

Maxilla 2 (Fig. 4MX2) inner plate shorter than outer, with facial oblique row of 4 robust setae; outer plate with 4 apical robust setae.

Maxilliped (Fig. 4MP) rather slender; inner plate small, with 3 apical setae; outer plate not reaching middle of palp article 2, provided with 2 short and 2 mid-length robust setae on margin; palp articles 2–3 with short and long robust setae

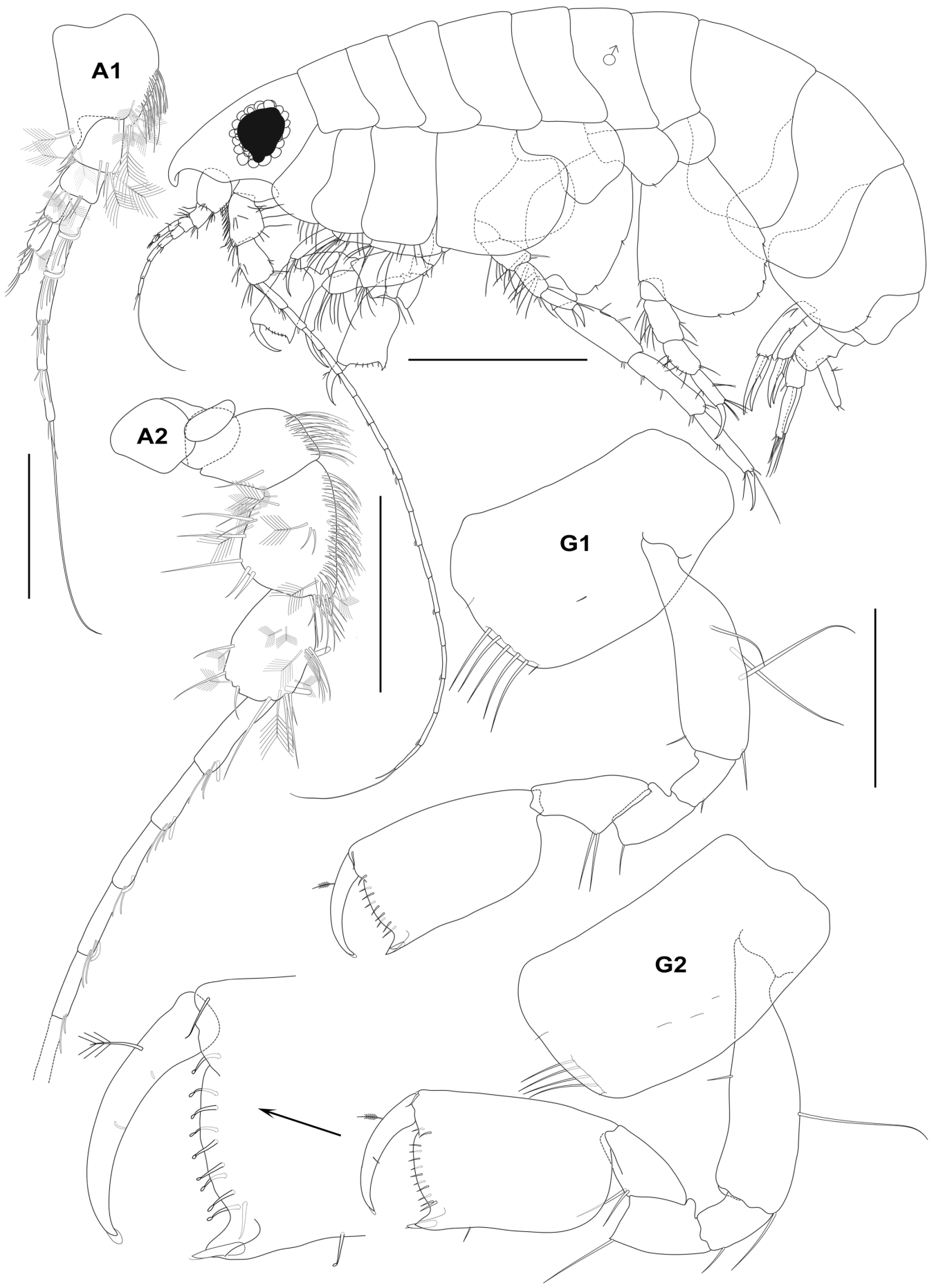


Fig. 2. *Phoxocephalus tiomanensis*, new species, holotype, male, (UKMMZ – 1532) 3.03 mm. Scale bars: A1 = 0.05 mm; A2, G1, G2 = 0.2 mm.

along inner margin, article 3 with one facial seta, no setae in outer margin; nail of article 4 long and falcate, with two accessory setules.

Gnathopod 1 (Fig. 2G1) similar to gnathopod 2 in shape. Coxae 1–2 subrectangular, with 5 and 4 subdistal simple setae on posterior half of ventral margin. Gnathopod 1, basis longest, slightly expanded posteriorly, posterior margin with 2 long setae, one medium seta and one distal short seta, anterior margin with one distal short seta. Ischium short with one short posterodistal seta. Merus about 0.6 times carpus length, meeting middle expansion of carpus with one posterodistal short seta; carpus growing at proximal part of merus, furnished with 2 medium length setae, concave in distal half of its posterior margin, concavity of which receiving propodus. Propodus subrectangular, provided with one robust seta and one tooth posterodistally; palm slightly transverse with stout and small robust setae. Dactylus falcate, reaching inner side of posterodistal tooth, with one short plumose seta at 1/3 length along anterior margin.

Gnathopod 2 (Fig. 2G2) slightly larger than gnathopod 1. Basis posterior margin with one long marginal seta and one medium length distal seta. Ischium short with one short posterodistal seta. Merus slightly longer than ischium with one short posterodistal seta. Carpus about same length as merus, with 2 posteroproximal setae. Propodus longer than broad, with nearly parallel lateral margin, and with transverse palm defined by strong corner tooth bearing one robust seta at outer margin. Dactylus with one short plumose seta at outer margin.

Pereopods 3–4 (Fig. 3P3–P4) similar to each other. Coxa 3 subrectangular, ventral margin with 4 posterior submarginal medium length setae. Coxa 4 posterior margin deeply excavated. Pereopod 4 ischium with one short posterodistal seta; merus 2.2 times carpus length; carpus short, slightly longer than broad, bearing 3 long setae middle part on margin, provided with 2 long robust setae and 1 long seta apically; propodus narrow, posterior margin with one medial seta and with 4 distal unequal slender robust setae; dactylus slender, recurved, slightly shorter than propodus, with one short plumose seta at outer margin.

Pereopod 5 (Fig. 3P5) relatively short, coxa bilobed, posterior lobe expanded; basis subtriangular, anterior margin slightly concave with several distal long setae, bearing developed posterodistal lobe with only 2 setules along posterior margin; ischium-merus-carpus-propodus progressively longer, bearing long marginal setae; dactylus slender, exceeding half of propodus.

Pereopod 6 (Fig. 3P6) nearly twice as long as pereopod 5. Coxa bilobed, anterior lobe shallow; basis subovoid, anterior margin strongly convex, with numerous bunches of long simple and plumose setae, posterior margin with 1 setules, posterodistal lobe well developed, reaching distal tip of ischium; merus and carpus subequal in length, with several short robust setae along both margins; propodus slender,

anterior margin with 2 medial short robust setae; dactylus slender, about half of propodus length.

Pereopod 7 (Fig. 3P7) shorter than pereopod 6. Coxa entire; basis prominently expanded backward, extending beyond middle of merus, slightly truncated ventrally, anterior margin with one distal short robust seta, posterior margin weakly serrate with setules; carpus shorter than merus bearing 3 blunt robust setae on margin; propodus subequal to merus in length; dactylus 0.75 times propodus length, with one short plumose seta at outer margin.

Epimeral plates 1–3 slightly produced posterolaterally; epimeral plates 1–2 bearing slightly concave ventral margin, no facial setae; epimeral plate 3 provided with two short setae on notched posteroventral corner.

Uropod 1 (Fig. 4U1r) extending beyond uropod 2; peduncle slightly longer than rami, with 2 lateral facial setae, 2 dorsomedial and 2 dorsodistal robust setae; rami subequal in length, acuminate; outer ramus provided with one medial robust seta, with one short marginal seta, inner ramus smooth.

Uropod 2 (Fig. 4U2l) peduncle with one dorsomedial and 2 dorsodistal robust setae; outer ramus slightly longer than inner one, bearing one mediodorsal robust seta, inner ramus smooth.

Uropod 3 (Fig. 4U3r) exceeding tip of uropods 1–2; peduncle short, almost 0.5 times outer ramus length, with 2 laterodistal robust setae and one medial subdistal robust seta. Outer ramus biarticulate, proximal article nearly 3 times distal one length, bearing 2 and one short robust setae at both lateral and medial corner, and with one laterodistal and 4 medial pinnate setae; distal article truncate, with 2 apical setae; inner ramus 0.8 times proximal article of outer ramus in length, with 5 lateral and 2 apical pinnate setae, no setae on lateral margin.

Telson (Fig. 4T) completely cleft; each lobe rather slender, truncate, provided with 2 apical robust setae and one apical plumose seta, and a dorsal pair of plumose setae at third proximal part.

Female. Unknown.

**Other specimens.** Based on 13 paratype males, body length 2.7–3.0 mm, smaller than holotype. Other specimens exhibit slight variations on antennae. In specimens with 2.7–2.9 mm long bodies, peduncular articles of antennae bear less aesthetascs compared to the holotype. In case of 2.7 mm male, the number of flagellum is 14 articles, while that of the holotype with 17 articles.

**Etymology.** Named after the type locality, Pulau Tioman.

**Remarks.** The present *Phoxocephalus tiomanensis*, new species, is the first species of genus *Phoxocephalus* known from South East Asian waters. Although *P. tiomanensis*,



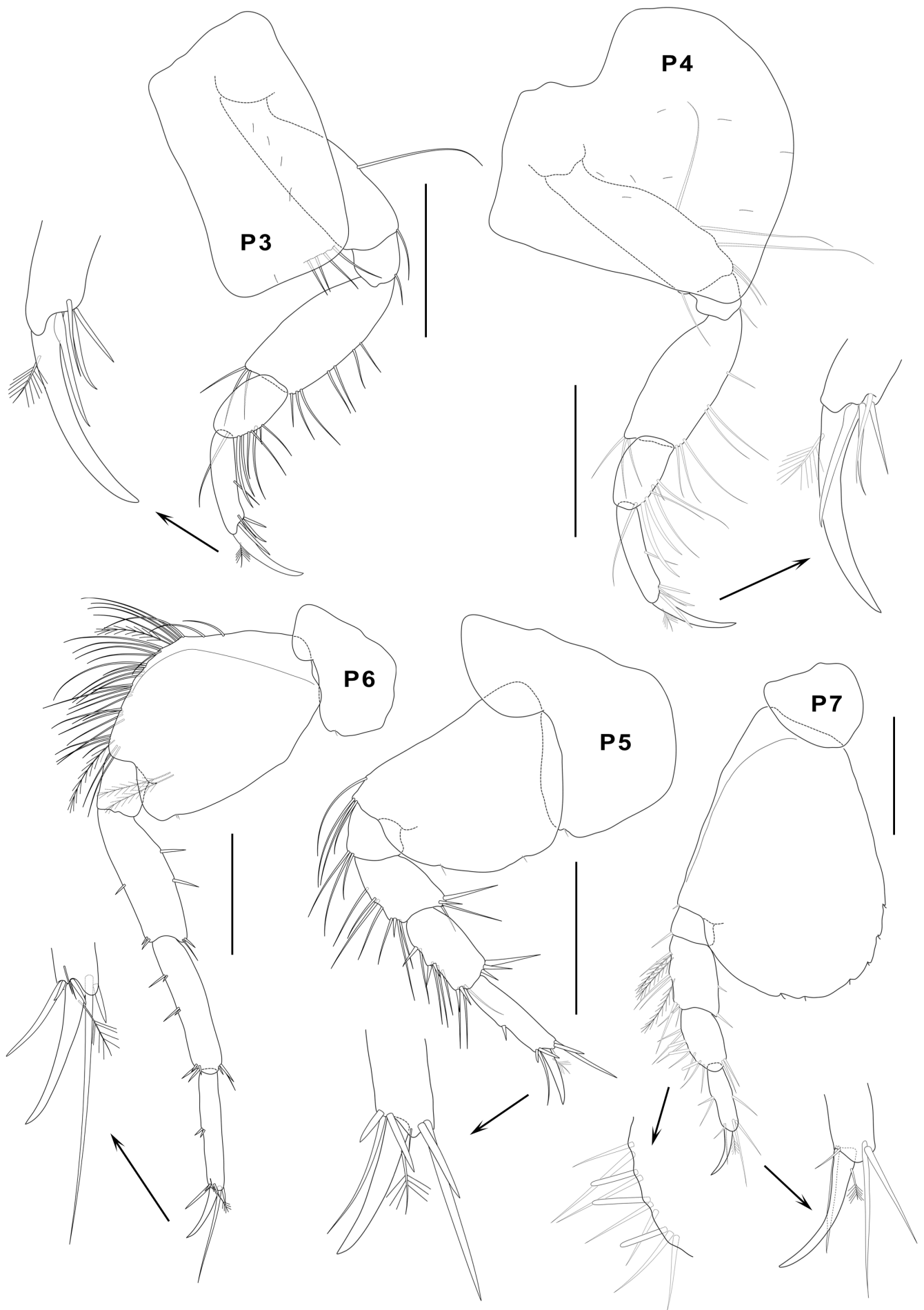


Fig. 3. *Phoxocephalus tiomanensis*, new species, holotype, male, (UKMMZ – 1532) 3.03 mm. Scale bars = 0.2 mm.

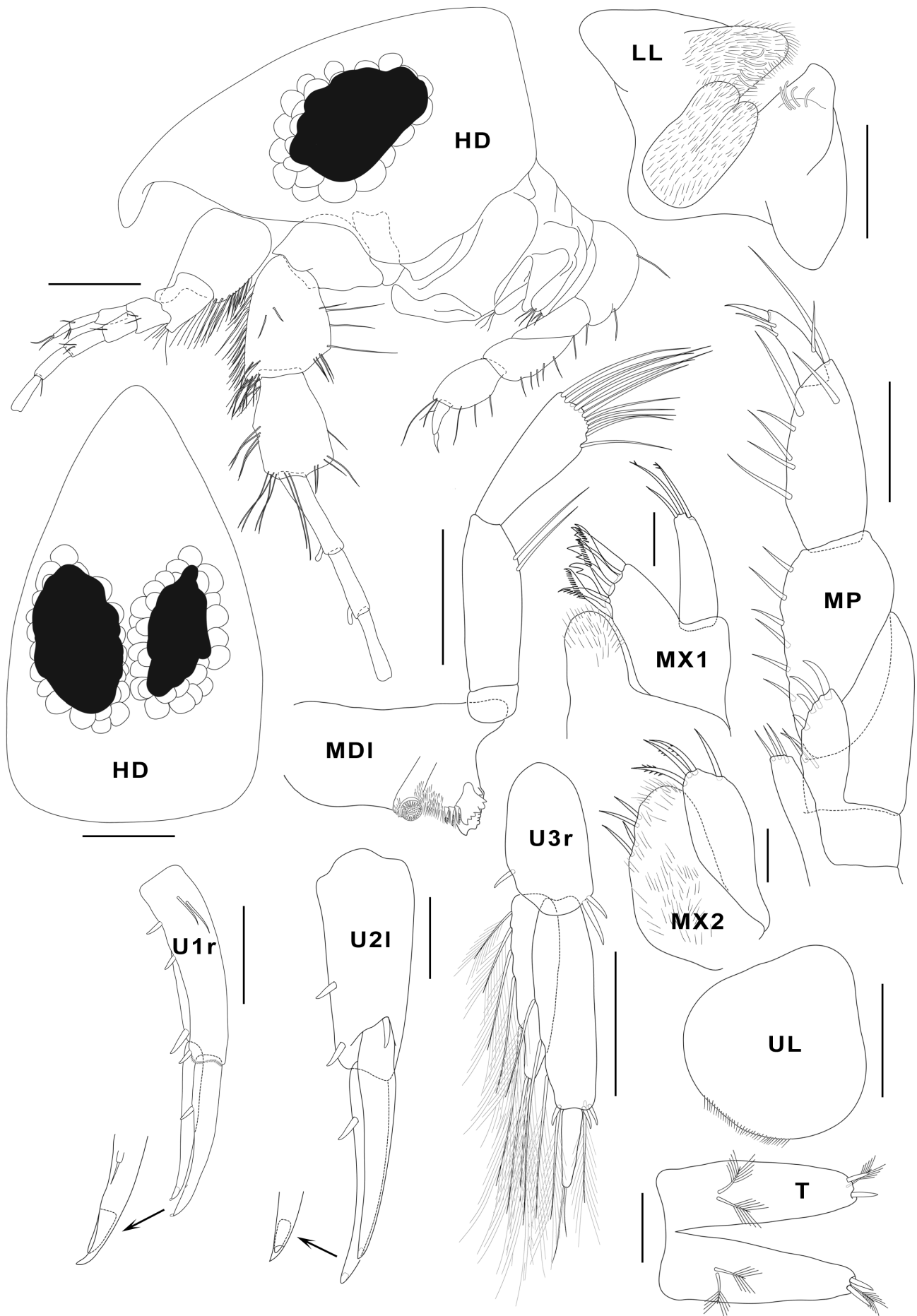


Fig. 4. *Phoxocephalus tiomanensis*, new species, holotype, male, (UKMMZ – 1532) 3.03 mm. Scale bars: HD, MDI, U1r, U3r = 0.1 mm; UL, LL, MP, U2I, T = 0.05 mm; MX1, MX2 = 0.025 mm.

new species, is described from male specimens, it bears many distinct features by which it is easy to distinguish from other males of known species of *Phoxocephalus*. The general appearance of the new species is closely related to *P. proluxus* Hirayama, 1987 from West Kyushu, Japan, by presenting antenna 2 not ensiform; uropod 3 distal article of outer ramus elongate; telson both lobes slender, truncate, with two apical robust setae and a small seta, and a dorsal pair of penicillate setae at the third proximal part.

However, *P. tiomanensis* is differentiated from *P. proluxus* by the morphological features of the male gnathopod 2, epimeron 2, and urosomite 3. In *P. tiomanensis*, the merus of male gnathopod 2 is not extended, whereas that of *P. proluxus* protrudes postero-distally far beyond the backward expansion of carpus and forms a prominent slender extension. The epimeron 2 lacks ventral setae in *P. tiomanensis*, whereas there is a long plumose ventrolateral seta on epimeron 2 in *P. proluxus*. The urosomite 3 of *P. tiomanensis*, moreover, has the smooth margin dorsally, while that of *P. proluxus* is produced a distinct upheaval.

In New Zealand and Australian waters, where the genus *Phoxocephalus* has been well studied, seven species of *Phoxocephalus* (*P. burleus*, *P. geniculatus*, *P. keppeli*, *P. kukatus*, *P. obtusus*, *P. rupullus*, and *P. tunggeus*) have been reported (Barnard & Drummond, 1978). Comparing these taxa with *P. tiomanensis*, only one species *P. kukatus* shows considerable resemblance by having elongated second article of outer ramus in male uropod 3. *Phoxocephalus kukatus*, however, appears to have posteroventral long setae of epimeron 1, while these are absent in *P. tiomanensis*.

Although some characters have not been recorded in all of *Phoxocephalus* species and it is impossible to complete a worthy comparison with male specimens of all species, several differences with respect to *P. tiomanensis*, new species, are noted. Combinations of characters such as: (1) pereopod 5 with subtriangular basis; (2) lack of posteroventral and facial setae of epimera 1–3; and (3) the particular setae at carpus of the pereopod 7, can be easily distinguished from all other known species of the genus. These characters do not exhibit sexual dimorphism.

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