

Two new species of *Pendanthura* (Isopoda, Cymothoida, Anthuroidea) from the east coast of Peninsular Malaysia with an identification key to the species of *Pendanthura*

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ABSTRACT.—Two new *Pendanthura* species are described and illustrated. *Pendanthura tinggiensis* sp. nov. was collected from coral rubble on the coral reefs of Pulau Tinggi, Johor, Malaysia, and *Pendanthura tiomanensis* sp. nov. from similar habitats at Pulau Tioman, Pahang, Malaysia. The former species is recognizable by a blunt tooth on the propodal palm of pereopod 1, while the latter species is characterized by a pointed tooth with a transparent margin on the propodal palm of pereopod 1 and a significant large brown patch on cephalon dorsally.

A new classification of anthuroids based on a cladistics analysis of family and generic relationship was presented by Poore (2001). Following that, the suborder Anthuridea Monod, 1922 was replaced by the superfamily Anthuroidea Leach, 1814 within the Cymothoida Wägele, 1989 (Brandt and Poore 2003). Both revisions are necessary to address the previous concerns raised by various authors regarding their taxonomic and evolutionary relationships.

The species of *Pendanthura* Menzies and Glynn, 1968 are distinguishable from other species of Anthuridae by the prominent rostrum, uniarticulate article of maxillipedal palp, and uniarticulate mandibular palp (Poore 2001). The genus was established with the type species *Pendanthura tanaiformis* Menzies and Glynn, 1968, a female specimen from Puerto Rico (Menzies and Glynn 1968, Kensley 1984). It was then redescribed with the addition of a male specimen from Carrie Bow Cay, Belize (Kensley 1982). Seven new members were subsequently included in the genus: *Pendanthura anophthalma* Negoescu, 1994, *Pendanthura hendleri* Kensley, 1984, *Pendanthura picardi* Kensley and Schotte, 2000, *Pendanthura rarotonga* Kensley, 1979, *Pendanthura seminigra* Kensley and Schotte, 2000, *Pendanthura siamensis* Kensley and Schotte, 2000 and *Pendanthura waegelei* Müller, 1992 (Poore and Schotte 2015).

In the present study, two new species of *Pendanthura* were collected from the coral reefs of the east coast islands of Peninsular Malaysia. While there are a few recent published works on anthuroids from this region (Müller 1992b,c,d, Müller 1993, Chew et al. 2014), there has been no record of *Pendanthura*. The nearest report is *P. siamensis* from Thailand (Kensley and Schotte 2000). A key to all 10 species of *Pendanthura* is presented.



Figure 1. Pulau Tinggi, Johor and Pulau Tioman, Pahang of Malaysia.

Methods

The specimens in the present study were obtained from coral reef areas off Pulau Tinggi, Johor, and Pulau Tioman, Pahang, Peninsular Malaysia (Fig. 1). The coral rubble was collected by scuba divers into a 5-gal bucket with seawater; after being moderately broken up, about 10 drops of 37% formaldehyde were added and left to stand for about 30–45 min. Next, the samples were rinsed and washed with seawater passing through a 500-μm sieve. In the field, samples were fixed with about 10% formalin in seawater. At the laboratory, the specimens were sorted and conserved separately in 4% formalin. Specimens were then examined and selected for dissection. Whole bodies and dissected appendages were mounted in glycerol and illustrated under a Leica DMLB light microscope equipped with a camera lucida. Materials were deposited in the Muzium Zoologi, Universiti Kebangsaan Malaysia, Malaysia and Lee Kong Chian Natural History Museum, National University of Singapore, Singapore. In the present study, the following abbreviations are used: A, antenna; AM, appendix masculina; MD, mandible; MP, maxilliped; MX, maxilla; P, pereopod; PL, pleopod; PLT, pleotelson U, uropod; UN, uropod endopod; UX, uropod exopod; UKMMZ, Universiti Kebangsaan Malaysia Muzium Zoologi; ZRC, Zoological Reference Collection.

Systematics

Order Isopoda Latreille, 1817 Suborder Cymothoida Wägele, 1989 Superfamily Anthuroidea Leach, 1814 Family Anthuridae Leach, 1814 *Pendanthura* Menzies and Glynn, 1968

Pendanthura Menzies and Glynn, 1968: 31; Kensley and Schotte, 1989: 56; Kensley and Schotte, 2000: 2086; Poore, 2001: 115.

Type Species.—Pendanthura tanaiformis Menzies and Glynn 1968, by original designation.

Diagnosis.—Female: body irregularly darkly pigmented and smooth. Pleonites 1–5 together distinctly shorter than wide, fused. Antenna 2 flagellum of 1–4 articles, short. Mandibular palp of 1 minute article. Maxillipedal endite present as a triangular lobe; palp articles 1–5 fused. Pereopod 1 propodus palm straight or sinuous, with or without tooth. Pereopod 2–3 carpus without robust seta posterodistally. Pereopod 4–7 carpus triangular, without free anterior margin, without robust seta on postero-distal angle. Pleotelson with two statocysts.

Male: antenna 1 flagellum 1 basal with 2-5 aesthetasc-bearing articles, retractile.

Remarks.—This diagnosis is slightly modified from Poore (2001). The propodal palm of pereopod 1 has not previously been reported with a tooth present in this genus. Only a transparent lobe present in *P. tanaiformis* was noted by Kensley (1982). Both *Pendanthura tinggiensis* sp. nov. and *Pendanthura tiomanensis* sp. nov. exhibit a tooth on the palmar margin.

This is the first record of the genus *Pendanthura* recorded from Malaysian waters. The two new species and all existing members can be identified with the key presented below. Prior to this, Negoescu (1994) provided a key to five tropical *Pendanthura* species and subsequently Kensley and Schotte (2000) constructed a key to the Indian Ocean species.

Key to the species of *Pendanthura* (female)

| 1a. Eyes absent | P. anophthalma |
|---|---------------------------|
| 1b. Eyes present | 2 |
| 2a. Pereopod 1 propodal palm without tooth or lobe | |
| 2b. Pereopod 1 propodal palm with tooth or lobe | |
| 3a. Pleotelson length about as long as last pleonite width | |
| 3b. Pleotelson length much greater than last pleonite width | |
| 4a. Anterior half more heavily pigmentend than posterior with o propodus of pereopod 1 dark blackish-brown color | cephalon, pereonite 1 and |
| 4b. Faint scattered pigment | P. rarotonga |

| 5a. Pleotelson posterior margin broadly rounded |
|---|
| 5b. Pleotelson posterior half tapering to a rounded apex7 |
| 6a. Antenna 2 about two times as long as cephalon greatest length; Pleotelson slightly twice more than width, posterior margin finely setose |
| 6b. Antenna 2 about as long as cephalon greatest length; Pleotelson 1.7 times longer than basal width, posterior margin not finely setose <i>P. siamensis</i> |
| 7a. Pereopod 1 propodal palm obviously sinuous; Pleotelson with a pair of shallow tubercles at midlength dorsally <i>P. waegelei</i> |
| 7b. Pereopod 1 propodal palm weakly convex; Pleotelson without a pair of shallow tubercles at midlength dorsally <i>P. hendleri</i> |
| 8a. Pleonites 1–6 fused, not separated by folds dorsally P. tanaiformis |
| 8b. Pleonites not separated by folds dorsally except between pleonites 5 and 6 dorsally $\ldots9$ |
| 9a. Pereopod 1 propodal palm with a weak blunt tooth; Body with several small irregular black pigments mostly on cephalon dorsally <i>P. tinggiensis</i> sp. nov. |
| Ob Dereased 1 proposal palm with a pointed conical tooth with transparent margin: Cophalon |

9b. Pereopod 1 propodal palm with a pointed conical tooth with transparent margin; Cephalon dorsally with a distinct large wide brown patch of pigmentation *P. tiomanensis* sp. nov.

Pendanthura tinggiensis new species

(Figs. 2–8)

urn:lsid:zoobank.org:act:7318A4A8-D4A9-473C-BD29-1478CDA749D5

Type Material.—Holotype: immature female, UKMMZ-1541, 2°16′21.67″N, 104°7′18.61″E, C. Melvin, 19 April, 2013, coral rubble, approximately 3 m.

Paratype: 39 immature females, UKMMZ-1543, same station data as holotype; 10 immature females, ZRC 2016.0013, same station data as holotype; 2 males, UKMMZ-1544, same station data as holotype; 2 males, ZRC 2016.0014, same station data as holotype.

Type Locality.—Mentinggi, Pulau Tinggi, Johor, Malaysia, South China Sea.

Description.—Holotype, immature female (Fig. 2A,B): total body length 2.41 mm (tip of rostrum to base of pleotelson), approximately 5.9 times longer than greatest width with several small irregular black pigments mostly on cephalon dorsally. Cephalon with prominent rostrum; eyes present. Pereonites smooth, with pereonite 1 longest, pereonite 7 very short, about 4 times as wide as long. Pleonites 1–5 short, about 2.2 times as wide as long, pleonite 6 distal margin smooth.

Antenna 1 (Fig. 3 A1) peduncle article 1 longest about 1.8 times as long as wide, articles 2 and 3 progressively narrower, article 2 about as long as article 3; flagellum of 3 articles, very short about one third the length of peduncle article 1, article 1 half exposed, article 2 longest, article 3 minute about 0.3 times as long as penultimate article, with 3 aesthetascs and setae apically.

Antenna 2 (Fig. 3 A2) peduncle longer than of antenna 1, article 1 subtriangular, article 2 widest, article 3 shortest, article 4 almost as long as wide, article 5 almost as long as article 2; flagellum of 3 articles with article 1 largest, article 2 and 3 almost hidden by numerous setae.



Figure 2. *Pendanthura tinggiensis* sp. nov. (A) holotype female lateral (UKMMZ-1541), (B) holotype female dorsal (UKMMZ-1479), (C) allotype male dorsal (UKMMZ-1542). All scales represent 0.5 mm.



Figure 3. *Pendanthura tinggiensis* sp. nov., holotype, female (UKMMZ-1541). All scales represent 0.05 mm.



Figure 4. *Pendanthura tinggiensis* sp. nov., holotype, female (UKMMZ-1541). All scales represent 0.1 mm.



Figure 5. *Pendanthura tinggiensis* sp. nov., holotype, female (UKMMZ-1541). All scales represent 0.1 mm.



Figure 6. *Pendanthura tinggiensis* sp. nov., allotype, male (UKMMZ-1542). All scales represent 0.05 mm.

Mandibular (Fig. 3 MD) incisor 2-cuspidate, lamina dentata with 6 serrations; molar process triangular; palp article subcircular, terminally with 1 long and short setae.

Maxilla (Fig. 3 MX) with a strong distal spine and 6 subterminal spines, medially with many fine setae; endite present with a distal seta.

Maxillipedal palp with 2 mesial setae and 6 distal setae; endite subtriangular with a rounded apex bearing 1 seta.

Pereopod 1 basis about as long as ischium; merus short about one fourth the length of ischium; carpus quadrilaterally elongated, about twice as long as wide, posterodistal margin pointed and slightly serrated; propodus expanded about as long as greatest width, with a continuous row of short setae on mesial surface and submarginally 11 setae, propodal palm weakly serrated with a blunt tooth; unguis about half length of dactylus.

Pereopod 2 (Fig. 4 P2) basis upper margin with 1 plumose sensory seta; ischium as long as propodus; merus with convex upper margin; carpus subtriangular with 4 setae on distal region; propodus about 2 times as long as greatest width, mesial surface smooth, palm straight with 1 distal serrulated robust seta; unguis about one third of dactylus.

Pereopod 3 (Fig. 4 P3) similar to pereopod 2, except propodus mesial surface with several setae (none in pereopod 2).

Pereopods 4–5 (Fig. 4 P4,P5) similar in form to each other; basis with 1 plumose sensory seta on medial upper margin; ischium about 0.8 times the length of basis; merus upper margin with a rounded lobe; carpus subtriangular with 4 setae on the lower margin; propodus distal upper margin with a plumose sensory seta, mesial



Figure 7. *Pendanthura tinggiensis* sp. nov., allotype, male (UKMMZ-1542). All scales represent 0.1 mm.



Figure 8. *Pendanthura tinggiensis* sp. nov., allotype, male (UKMMZ-1542). All scales represent 0.1 mm.

surface with several setae, palm with a few short setae and 1 posterodistal serrulated strong seta; dactylus curved, unguis about a third of dactylus.

Pereopod 6 (Fig. 4 P6) similar to pereopods 4–5 except that propodus about 2.5 times longer than wide (1.8 times as long as wide in pereopods 4–5).

Pereopod 7 (Fig. 4 P7) basis about 2.9 times as long as wide; ischium about 0.7 times the length of basis; merus upper margin convex with 2 distal setae; carpus subtriangular with 4 setae on lower margin; propodus about 3.3 times as long as wide with 3 setae on mesial surface, palm concave with palmar comb setae along margin with 3 strong denticulate setae posterodistally; dactylus curved, unguis about a third of dactylus

Pleopod 1 (Fig. 5 PL1) sympod subquadrate; exopod operculiform, about 1.5 times longer than greatest width, distal margin with 17 plumose setae; endopod almost reaching apex of exopod, about 3.8 times longer than greatest width, distal margin with 7 plumose setae.

Pleopod 2 (Fig. 5 PL2) sympod subquadrate; exopod about 2 times longer than greatest width with 5 plumose setae on apical margin, cleft medially; endopod about 3.5 times as long as greatest width, distal margin with 4 plumose setae.

Uropod (Fig. 5 UN) sympod elongated about 1.9 times as long as wide; endopod ovate with numerous setae and 3 plumose setae on distal margin; exopod (Fig. 5 UX) elongated oval, about 3 times as long as wide with 23 marginal plumose setae and 6 simple setae.

Pleotelson (Fig. 5 PLT) about 1.9 times longer than wide, linguiform, about 7.1 times longer than last pleonite, width with a pair of statocyst proximally, distal margin rounded with weak crenulation and 3 pairs of short marginal setae.

Allotype, male (Fig. 2C): total body length 2.19 mm (tip of rostrum to base of pleotelson), about 5.7 times longer than greatest width; slightly more slender than female.

Similar to female except for the following: antenna 1 (Fig. 6 A1) peduncle article 1 robust longer than wide, article 2 and 3 progressively narrower; flagellum of 4 articles with article 1 shortest, article 2 and 3 bearing numerous aesthetascs, terminal article with 4 aesthetascs apically.

Mandible (Fig. 6 MD) palp with 1 seta apically. Maxillipedal (Fig. 6 MP) palp with 2 mesial setae and 5 distal setae; endite long and slender with a rounded apex bearing 1 seta. Pereopod 1 (Fig. 7 P1) basis with 1 plumose sensory seta; posterodistal margin of carpus not serrated. Pleopod 2 (Fig. 8 PL2) exopod with 5 distal marginal plumose setae; endopod with 4 distal marginal plumose setae; appendix masculina (Fig. 8 AM) long and slender about 17.8 times longer than wide with rounded apex, extend beyond apex of endopod. Uropodal endopod (Fig. 8 UN) oval shape with numerous setae; exopod (Fig. 8 UX) about 2.5 times longer than wide, less slender than in female. Pleotelson (Fig. 8 PLT) about 1.6 times longer than greatest width, widest medially, distal margin slightly truncated and less crenulated.

Etymology.—This species is named after the type locality, Pulau Tinggi, Johor, Malaysia.

Remarks.—Pendanthura tinggiensis sp. nov. has close affinities to *P. rarotonga* due to the dorsal pigmentation on their cephalons. However, on a closer examination, the former has a stronger color of pigments on the body while the latter is reported to have a faintly developed chromatophores (Kensley 1979, Müller 1992a). Apart from

that, the noticeable differences lie in *P. tinggiensis* sp. nov. having a blunt tooth present on the palmar margin of pereopod 1 propodus, a weak crenulation on distal margin of pleotelson and antenna 2 flagellum of 3 articles compared to Kensley's (1979) species flagellum of 1 article only.

Pendanthura tiomanensis new species

(Figs. 9-11)

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Type Material.—Holotype: immature female, UKMMZ-1547, 2°54′15.44″N, 104°6′1.08″E, C. Melvin, 18 April, 2014, coral rubble, approximately 7 m.

Paratype: 3 immature females, UKMMZ-1549, same station data as holotype; 2 immature females, ZRC 2016.0015, same station data as holotype.

Type Locality.—Batu Malang, Pulau Tioman, Pahang, Malaysia, South China Sea.

Description.—Holotype, immature female (Fig. 9A): total body length 1.72 mm (tip of rostrum to base of telson), approximately 4.7 times longer than greatest width. Cephalon very short, about 2 times as wide as long, with a large wide brownish patch dorsally; prominent rostrum present; eyes present. Pereonites smooth with pereonite 1 stoutest, pereonite 7 shortest in length. Pleonites 1–5 very short about 3.3 times as wide as long, pleonite 6 distal margin with a weak medial cleft.

Antenna 1 (Fig. 9 A1) peduncle longer than flagellum, article 1 widest, article 2 and 3 continuously decrease in width; flagellum of 2 articles, article 1 longest with proximal margin having a seta-bearing papilla, article 2 minute almost hidden by 3 aesthetascs and 4 setae on terminal end.

Antenna 2 (Fig. 9 A2) peduncle longer than of peduncle of antenna 1, article 1 subtriangular, article 2 large with a distal lobe bearing 4 marginal setae, grooved to accommodate antenna 1, article 3 and 4 subequal in length and width, article 5 slightly longer than article 3 and 4; flagellum of 4 articles with article 1 being the widest, progressively smaller articles 2–4, article 4 smallest hidden by numerous setae.

Mandibular (Fig. 9 MD) incisor with 2 rounded teeth; lamina dentata about 9 weak serrations; molar process rounded tubercle; palp article larger than molar process, apex rounded with 1 short and 1 long setae.

Maxilla (Fig. 9 MX) with strong distal spine and 6 subterminal spines.

Maxillipedal (Fig. 9 MD) palp with 2 mesial setae and 7 distal setae; endite subtriangular with a rounded apex bearing 1 seta.

Pereopod 1 (Fig. 10 P1) basis about 2 times as long as greatest width; ischium about twice the size of merus; carpus elongated triangular about half as long as propodus, with 2 short setae on lower distal margin; propodal palm convex with a pointed conical tooth with transparent margin, lower margin with 5 setae and 1 serrated seta; unguis about half length of dactylus.

Pereopod 2 (Fig. 10 P2) basis with plumose sensory seta on medial upper margin; ischium slender about 2.8 times as long as wide; merus upper margin with a produced lobe bearing 2 setae; carpus subtriangular with 5 setae on posterodistal angle; propodal palm slightly concave with a posterodistal serrated strong specialized spine; unguis about one third of dactylus.



Figure 9. *Pendanthura tiomanensis* sp. nov., holotype female dorsal (UKMMZ-1547). A scale represents 0.5 mm, A1, A2, MD, MX, MP scales represent 0.05 mm.



Figure 10. *Pendanthura tiomanensis* sp. nov., holotype, female (UKMMZ-1547). All scales represent 0.1 mm.



Figure 11. *Pendanthura tiomanensis* sp. nov., holotype, female (UKMMZ-1547). All scales represent 0.1 mm.

Pereopod 3 (Fig. 10 P3) basis with plumose sensory seta on medial upper margin; basis slender about 2.5 times as long as wide; merus upper margin with a pronounced lobe bearing 1 seta; carpus subtriangular with 4 setae on posterodistal angle; propodus about 1.5 times as long as wide, more robust than propodus of pereopod 2, palm with a distal strong serrated specialized spine, weakly jagged on subdistal margin; unguis one third of dactylus.

Pereopod 4–6 (Fig. 10 P4–P6) similar in form to each other, about as long as pereopod 3; basis without plumose sensory seta; ischium with 1 distal seta on the lower margin; merus upper margin with a produced lobe; carpus subtriangular with 1 plumose sensory seta on free upper margin, posterodistal angle with a few setae; propodal palm slightly concave with a strong specialized distal serrated spine; unguis about one third of dactylus.

Pereopod 7 (Fig. 11 P7) about as long as pereopod 4–6; basis without plumose sensory seta; ischium about 2.1 times as long as wide; merus upper margin with a produced lobe; carpus subtriangular with a free anterior margin bearing 1 plumose sensory seta; propodus slender about 2.1 times as long as wide, palm slightly concave with 4 scale-like structure along the margin, 1 specialized robust serrated spine and 1 strong leaf-like seta on posterodistal angle; unguis about one fourth of dactylus.

Pleopod 1 (Fig. 11 PL1) sympod subquadrate; exopod operculiform about 1.6 times longer than greatest width, distal margin with 15 plumose setae; endopod about 4.4 times longer than greatest width reaching beyond apex of exopod, distal margin with 6 plumose setae.

Pleopod 2 (Fig. 12 PL2) sympod subquadrate; exopod about 1.8 times longer than greatest width, distal margin with 5 plumose setae, weakly cleft medially; endopod

narrower and longer than exopod, about 4 times longer than greatest width, distally surrounded by 4 plumose setae.

Uropod (Fig. 11 UN) sympod elongated about 2.2 times as long as wide; endopod margin somewhat ovate with numerous setae; exopod (Fig. 11 UX) about 3 times longer than wide, elongated oval with 33 plumose setae and 4 setae along the margin.

Pleotelson (Fig. 11 PLT) about 1.8 times longer than greatest width, 8 times longer than the pleonite 6 with a pair of statocyst proximally, proximal margin with a pair of short seta and subdistal margin with 3 pairs of short setae, distal half tapering to a truncate crenulated apex with 4 pairs of short setae.

Etymology.—This species is named after the type locality, Pulau Tioman, Pahang, Malaysia.

Remarks.—Pendanthura tiomanensis sp. nov. is the third species in the genus to be documented as small in size after *P. siamensis* from Thailand and *P. seminigra*. It is unique in having a pointed tooth with transparent margin on the propodal palm of pereopod 1. Besides that, the cephalon is distinctly shorter and it bears a large wide brown patch on the dorsal surface of cephalon.

A possible existence of an inner ramus of a single article on antenna 1 was suggested by Menzies and Glynn (1968) in *P. tanaiformis*. However, Kensley (1982) noted that the apparent article is more likely an enlarged articulated base of a specialized plumose seta. This seta-bearing papilla was found also on the antenna 1 of *P. tiomanensis* sp. n. except it is located on the proximal margin of article 1 flagellum and instead of bearing a plumose seta, it bears a normal seta.

Pendanthura tiomanensis sp. nov. differs from *P. tinggiensis* sp. nov. by its small size, very short cephalon with a large brown patch dorsally, larger mandibular palp, antenna 2 article 2 with a distal lobe bearing 4 setae marginally, pereopod 1 propodal palm bearing a pointed tooth with transparent margin, pereopod 2–7 propodus with a specialized serrated robust setae posterodistally and posseses one leaf-like strong seta on posterodistal angle of pereopod 7.

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