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Cepolacanthus kimi, a new genus and species of copepod (Cyclopoida: Taeniacanthidae) parasitic on Bandfish *Acanthocepola abbreviata* (Valenciennes, 1835) (Actinopterygii: Cepolidae) caught off the Iraqi coast

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Abstract

A new genus and species, *Cepolacanthus kimi*, of the family Taeniacanthidae is established based on adult female specimens collected from the gills of Bandfish *Acanthocepola abbreviata* (Valenciennes, 1835) (Actinopterygii: Perciformes: Cepolidae) caught off the coast of Iraq. The new genus is characterised by the following combination of features: 1) the urosome is composed of five somites, with the last urosomite probably being a compound somite formed from the failure of the third and fourth abdominal somites to separate; 2) the seta on the maxillary basis is displaced proximally from the free spinulated element; 3) the terminal claw (endopod) of the maxilliped is long and attenuate; 4) the endopod of legs 2–4 is 2-segmented; and 5) the terminal exopodal segment of leg 4 bears a prominent distolateral protuberance. *Cepolacanthus kimi* **gen. et sp. nov.** is the first copepod reported from *A. abbreviata* and the second taeniacanthid species recorded from the Iraqi coast. A new replacement name, *Suncheonacanthus* **nom. nov.**, is proposed for the preoccupied generic name, *Triacanthus* Kim & Moon, 2013.

Keywords: Copepoda, gill parasite, taxonomy, wild fish, first record, *Suncheonacanthus* **nom. nov.**, *Suncheonacanthus luteus* (Kim & Moon, 2013) **comb. nov.**

Introduction

The family Taeniacanthidae is comprised of cyclopoid copepods parasitic on both marine invertebrates and vertebrates (Dojiri & Humes 1982; Dojiri & Cressey 1987; Boxshall & Halsey 2004). This family has traditionally been grouped with the Bomolochidae and the monogeneric Tuccidae, Telsidae, and Tegobomolochidae in the bomolochiform complex based on the synapomorphic pectinate processes and claw-like spines on the antenna and two spinulated blades on the mandible (Dojiri & Cressey 1987; Boxshall & Halsey 2004). Huys *et al*. (2012) recently redefined the bomolochiform complex by amalgamating the Tuccidae and Tegobomolochidae with the Taeniacanthidae and Bomolochidae, respectively. They also included *Umazuracola* Ho, Ohtsuka & Nakadachi, 2006 in the Taeniacanthidae and established the new family Makrostrotidae to accommodate two former taeniacanthid species, *Makrostrotos acuminatus* Ho & Lin, 2006 and *M. hamus* Ho & Lin, 2006. Based on these recent changes and including new taxa established after Dojiri & Cressey's (1987) comprehensive revision of the Taeniacanthidae, this family presently contains 20 genera and 116 species, however one genus needs a replacement name, since the generic name is preoccupied (Table 1).

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TABLE 1. List of genera and species counts within each genus of the family Taeniacanthidae (data compiled from Walter & Boxshall 2016).

Genus	Number of species
Anchistrotos Brian, 1906	10
Biacanthus Tang & Izawa, 2005	1
Caudacanthus Tang & Johnston, 2005	1
Cirracanthus Dojiri & Cressey, 1987	4
Clavisodalis Humes, 1970	7
Echinirus Humes & Cressey, 1959	2
Echinosocius Humes & Cressey, 1959	5
Irodes Wilson, 1911	8
Metataeniacanthus Pillai, 1963	10
Nudisodalis Dojiri & Cressey, 1987	1
Phagus Wilson, 1911	1
Pseudotaeniacanthus Yamaguti & Yamasu, 1959	10
Saging Uyeno, Tang & Nagasawa, 2013	1
Scolecicara Ho, 1969	1
Taeniacanthodes Wilson, 1935	3
Taeniacanthus Sumpf, 1871	42
Taeniastrotos Cressey, 1969	4
Triacanthus Kim & Moon, 2013*	1
Tucca Krøyer, 1837	2
Umazuracola Ho, Ohtsuka & Nakadachi, 2006	2
Total	116

* The genus name *Triacanthus* Kim & Moon, 2013 is preoccupied by *Triacanthus* Oken, 1817 (type species by monotypy: *Balistes biaculeatus* Bloch, 1786) (Actinopterygii: Tetraodontiformes: Triacanthidae), making the former an unavailable name. Although Cuvier (1817: 153) was the first to coin the term "Les Triacanthes" and is occasionally credited with the authorship of *Triacanthus*, it was Oken (1817) who subsequently gave Latin equivalents for all French names in Cuvier's first edition of his *Le Règne Animal* (later translated as *The Animal Kingdom*). A new replacement name, *Suncheonacanthus* **nom. nov.** (gender masculine), is proposed to resolve this case of homonymy and hence the type species should be cited as *Suncheonacanthus luteus* (Kim & Moon, 2013) **comb. nov.** The new name is based on a combination of the type locality (Suncheon Bay, Korea) of *S. luteus* and the Latin *acanthus* (= spine), a common suffix used in the formation of generic names in the Taeniacanthidae.

To date only eight copepod species taken from six marine fish species collected off Iraq have been reported in the primary literature: *Hatschekia shari* Uyeno & Ali, 2013 (Hatschekiidae) from the Spangled emperor *Lethrinus nebulosus* (Forsskål, 1775); *Bactrochondria formosana* Ho, Lin & Liu, 2011 (Chondracanthidae) from the Largescale tonguesole *Cynoglossus arel* (Bloch & Schneider, 1801); *Caligus epinepheli* Yamaguti, 1936 (Caligidae) and *Orbitacolax hapalogenyos* (Yamaguti & Yamasu, 1959) (Bomolochidae) from the Japanese threadfin bream *Nemipterus japonicus* (Bloch, 1791); *Hermilius longicornis* Bassett-Smith, 1898 (Caligidae) from the Giant catfish *Netuma thalassina* (Rüppell, 1837); *Lernanthropinus temminckii* (von Nordmann, 1864) (Lernanthropidae) from the Greater lizardfish *Saurida tumbil* (Bloch, 1795); and *Nothobomolochus ilhoikimi* Venmathi Maran, Moon, Adday, Khamees & Myoung, 2014 (Bomolochidae) and *Anchistrotos tangi* Venmathi Maran, Moon & Adday, 2014 (Taeniacanthidae) from the Hilsa shad *Tenualosa ilisha* (Hamilton, 1822) (Uyeno & Ali 2013; Venmathi Maran *et al*. 2014a, b, c). In this study, a new genus and species of taeniacanthid is described based on material collected from the gills of Bandfish *Acanthocepola abbreviata* (Valenciennes, 1835) caught off the Iraqi coast.

Materials and methods

Parasitic copepods were collected from the gills of *A. abbreviata* caught off the fishing port of Al-Faw City, Basrah Province, Iraq (29°46'N; 48°49'E) on 21 July 2011. Copepods were carefully removed from the host using fine forceps under a Nikon SMZ745T dissecting microscope and preserved in 70% ethanol. Selected copepods were cleared in a drop of 85% lactic acid or lactophenol for 24 h prior to examination using an Olympus BX51 compound microscope equipped with phase contrast. Selected specimens were measured intact using an ocular micrometer and/or dissected and examined using the wooden slide procedure (Humes & Gooding 1964). Drawings were made with the aid of a drawing tube. Morphological terminology follows Huys & Boxshall (1991) and fish names conform to FishBase (Froese & Pauly 2016). Type material is deposited at the National Institute of Biological Resources (NIBR), Incheon, Korea.

Results

Family Taeniacanthidae Wilson, 1911

Cepolacanthus gen. nov.

Diagnosis. Adult female. Body elongated. Prosome composed of cephalothorax (cephalosome fused with first pediger) and three free pedigerous somites. Urosome composed of fifth pedigerous somite, genital somite, and three free abdominal somites. Caudal ramus bearing seven setae. Rostrum well developed. Antennule 6-segmented, with armature formula 5, 15, 8, 4, 2 + 1 aesthetasc, 7 + 1 aesthetasc. Postantennal process present. Antenna 3-segmented, composed of coxobasis and two endopodal segments; distal endopodal segment bearing two pectinate processes, three claws and five setae. Labrum broad, ornamented. Mandible 1-segmented, with accessory seta and two terminal blades. Paragnath digitiform, ornamented. Maxillule lobate, armed with five setae. Maxilla 2-segmented, composed of syncoxa and basis; latter tapering into serrated process and bearing two unequal, separated elements. Maxilliped 3-segmented, composed of syncoxa, basis and long terminal claw (endopod). Legs 1–4 biramous. Leg 1 lamelliform, consisting of coxa, basis and 2-segmented rami. Legs 2–4 each with 3-segmented exopod and 2-segmented endopod; third exopodal segment of leg 4 with large distolateral protuberance. Leg 5 uniramous, 2-segmented, composed of protopod and 1-segmented exopod; exopod bearing one seta and three spines. Leg 6 vestigial, bearing three setae in egg sac attachment area.

Adult male. Unknown.

Type and only species. *Cepolacanthus kimi* **sp. nov.**

Etymology. The generic name is an amalgamation of *cepola* (= suffix of the host genus *Acanthocepola*) and the Latin *acanthus* (= spine), a common suffix used in the formation of generic names in the Taeniacanthidae.

Remarks. *Cepolacanthus* **gen. nov.** is assigned to the Taeniacanthidae because it possesses a postantennal process, two pectinate processes plus setae and clawlike spines on the antennal endopod, at least two spinulated blades on the mandible, a spinulated terminal process on the maxilla, and a lamelliform leg 1, with an outwardly-directed endopod bearing setae along the inner margin (Dojiri & Cressey 1987; Huys *et al*. 2012).

The taeniacanthid maxilla is 2-segmented and primitively bears a maximum of four elements on the distal segment. In the great majority of taeniacanthids, the distal segment of the maxilla bears only one seta and two spinulated spines, one of which is invariably fused to the terminal segment, forming what is known as a terminal process (Dojiri & Cressey 1987). More importantly, the seta is usually positioned on the same transverse plane as the free spinulated spine (Dojiri & Cressey 1987: Figs. 59H, 128D, 146G). In *Cepolacanthus* **gen. nov.**, however, the relative positions of the two free maxillary elements are unique in that the seta is displaced more proximally on the terminal process than the spinulated spine.

The vast majority of taeniacanthids possess a 3-segmented endopod on legs 2–4. By contrast, *Cepolacanthus* **gen. nov.**, *Taeniacanthus mcgroutheri* Tang, Uyeno & Nagasawa, 2011a, *Saging cebuana* Uyeno, Tang & Nagasawa, 2013 and members of *Umazuracola* Ho, Ohtsuka & Nakadachi, 2006 all have a 2-segmented endopod on legs 2–4. This derived character state stems from the failure of the middle and terminal segments, rather than the proximal and middle segments, to separate. *Cepolacanthus* **gen. nov.** differs markedly from *T. mcgroutheri*, *S. cebuana* and *Umazuracola* spp. in having: 1) a relatively smaller rostrum which bears sclerotized structures on the

ventral surface; 2) plumose (vs. naked) setae on antennulary segments 1–4; 3) an accessory seta (vs. none) on the mandible; 4) eight (vs. six) elements on the terminal exopodal segment of legs 2–3; 5) seven (vs. six) elements on the terminal exopodal segment of leg 4; 6) spinulated (vs. setiform) spines on the exopod of leg 4; and 7) three spines and one seta (vs. four setae) on the free exopodal segment of leg 5. *Cepolacanthus* **gen. nov.** differs further from *T. mcgroutheri* by having a considerably longer body, a much longer maxillipedal claw and two (vs. one) armature elements on the terminal process of the maxilla, and from *S. cebuana* and *Umazuracola* spp. by having a maxillipedal claw (vs. absent), a well-developed (vs. vestigial) leg 1 and spinulated (vs. coarsely serrated) spines on both rami of legs 2–3 and on the endopod of leg 4.

***Cepolacanthus kimi* sp. nov.**
(Figs. 1–19)

Type material. Holotype female (NIBRIV0000306931) and paratype adult female (dissected and mounted on one glass slide) (NIBRIV0000306932), collected from the gills of a single specimen of *Acanthocepola abbreviata* captured off the fishing port of Al-Faw City, Basrah Province, Iraq, 21 July 2011.

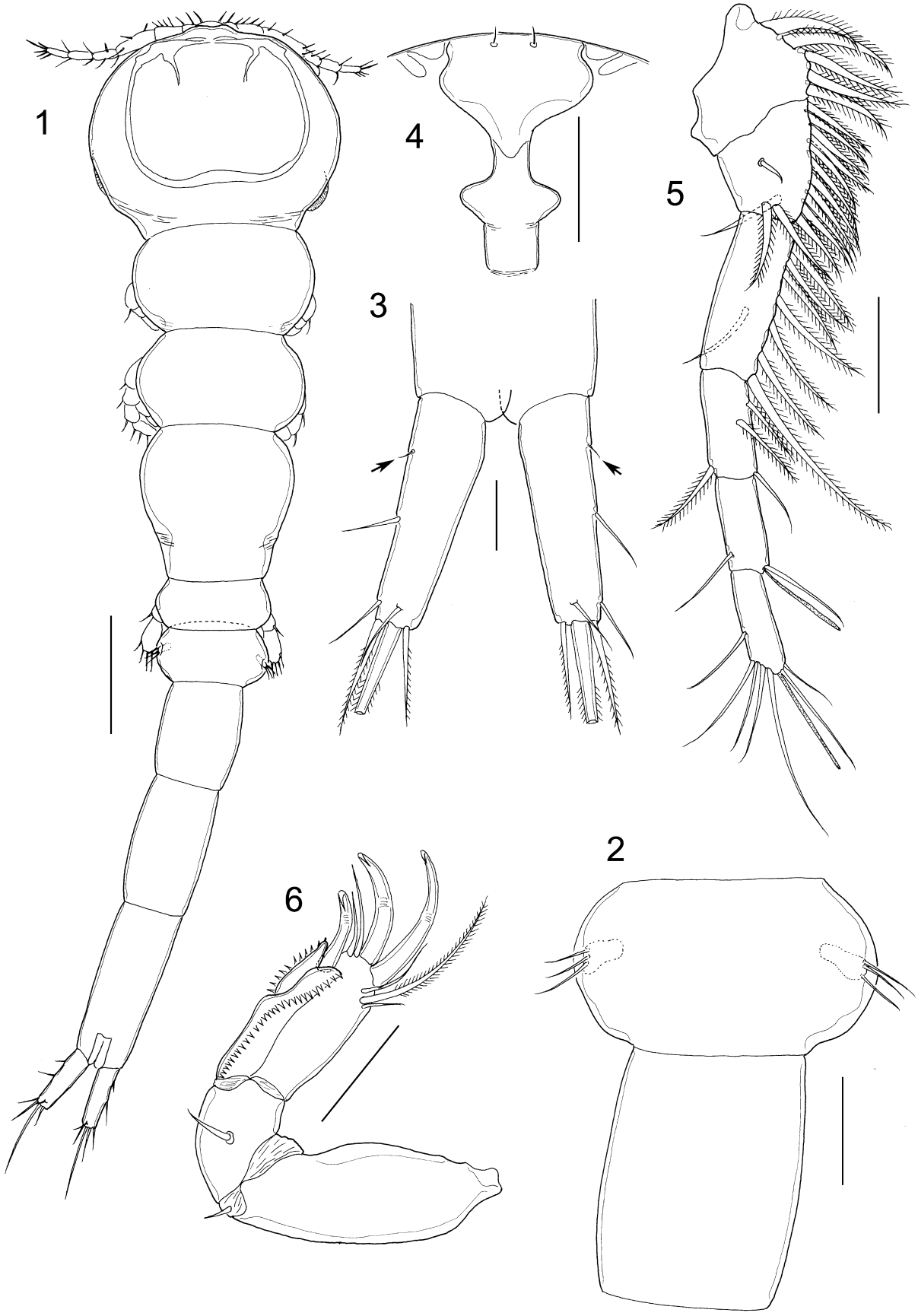
Adult female. Body (Fig. 1) elongated, 1.37–1.51 mm (mean = 1.44, *n* = 2) long (excluding caudal setae) and 0.31–0.36 mm wide (mean = 0.34). Prosome composed of broad subcircular cephalothorax (first pedigerous somite fused with cephalosome) and narrower free second to fourth pedigerous somites; fourth pedigerous somite twice as long as two preceding somites. Urosome nearly as long as prosome and composed of fifth pedigerous somite, genital somite, and three free, successively longer abdominal somites. Genital somite (Fig. 2) 1.77 times wider (169 μm) than long (95 μm). Abdomen long (0.59 mm), with proportional lengths (%) between first to third abdominal somites 26.1: 33.5: 40.4; all abdominal somites naked. Caudal ramus (Fig. 3) 3.16 times longer (98 μm) than wide (31 μm), bearing seven setae; setae I, II, III and VII naked; setae IV and V with bristles along both margins; seta VI with medial row of spinules; seta VI (37 μm) about 1.32 times as long as seta VII (28 μm); seta V (153 μm) longest, about 2.94 times as long as seta IV (52 μm).

Rostrum (Fig. 4) well developed, reflexed ventrally and bearing one frontal pair of sensilla; ventral area of rostrum with longitudinal sclerotized structure bearing mid-lateral bulge. Antennule (Fig. 5) 6-segmented (articulation between ancestral segments XIV–XVII and XVIII–XX not expressed), with armature formula 5, 15, 8, 4, 2 + 1 aesthetasc and 7 + 1 aesthetasc. Antenna (Fig. 6) composed of coxobasis and two endopodal segments; coxobasis with inner distal naked seta; first endopodal segment with naked seta on inner central surface; second endopodal segment bearing two unequal pectinate processes (each with row of spinules), three claw-like spines and five unequal setae (four naked; one pinnate). Postantennary process (Fig. 7) elongated, curved distally.

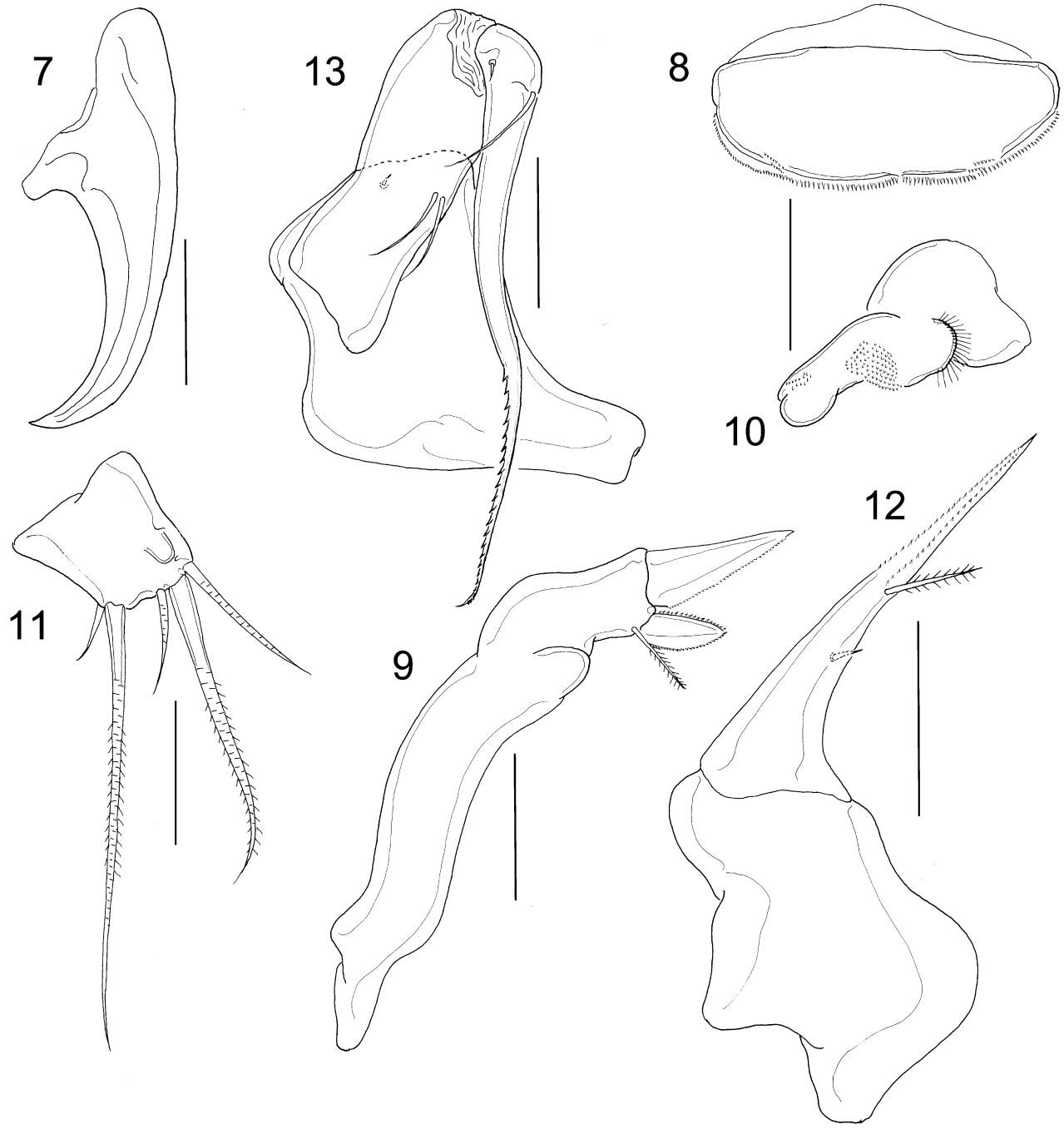
Labrum (Fig. 8) broad, with row of minute spinules along rounded posterior margin. Mandible (Fig. 9) 1-segmented, armed with two apical blades and bristled accessory seta; outer blade twice length of inner blade and spinulate along inner margin; inner blade spinulate along both margins. Paragnath (Fig. 10) digitiform, bearing tuft of minute setules proximally and one midventral and one distal patch of minute spinules. Maxillule (Fig. 11) lobate, with knob-like process anteriorly and two long bristled setae (outer 89 μm, inner 68 μm) and three short naked setae. Maxilla (Fig. 12) 2-segmented; syncoxa robust, naked; basis represented by serrated terminal process armed with long spinulated spine and minute naked seta; latter situated more proximally on terminal process than spinulated spine. Maxilliped (Fig. 13) 3-segmented; syncoxa robust, irregularly-shaped, bearing minute naked seta on anteroventral margin; basis elongate, with two mid-medial naked setae; terminal claw (endopod) long and attenuate, bearing two unequal naked setae proximally and row of teeth along inner distal margin.

Legs 1–4 biramous (Figs. 14–18); leg 1 with 2-segmented rami; legs 2–4 with 3-segmented exopod and 2-segmented endopod. Armature on rami of legs 1–4 as follows (Roman numerals = spines; Arabic numerals = setae; int. = intermediate spine):

	Coxa	Basis	Exopod	Endopod
Leg 1	0-1	1-1	1-0; 9	0-1; 7
Leg 2	0-0	1-0	I-0; I-1; II, I, 5	0-1; II, I, 2
Leg 3	0-0	1-0	I-0; I-1; II, I, 5	0-1; II, I, 1
Leg 4	0-0	1-0	I-0; I-1; II, I, 4	0-1; I, I, int.

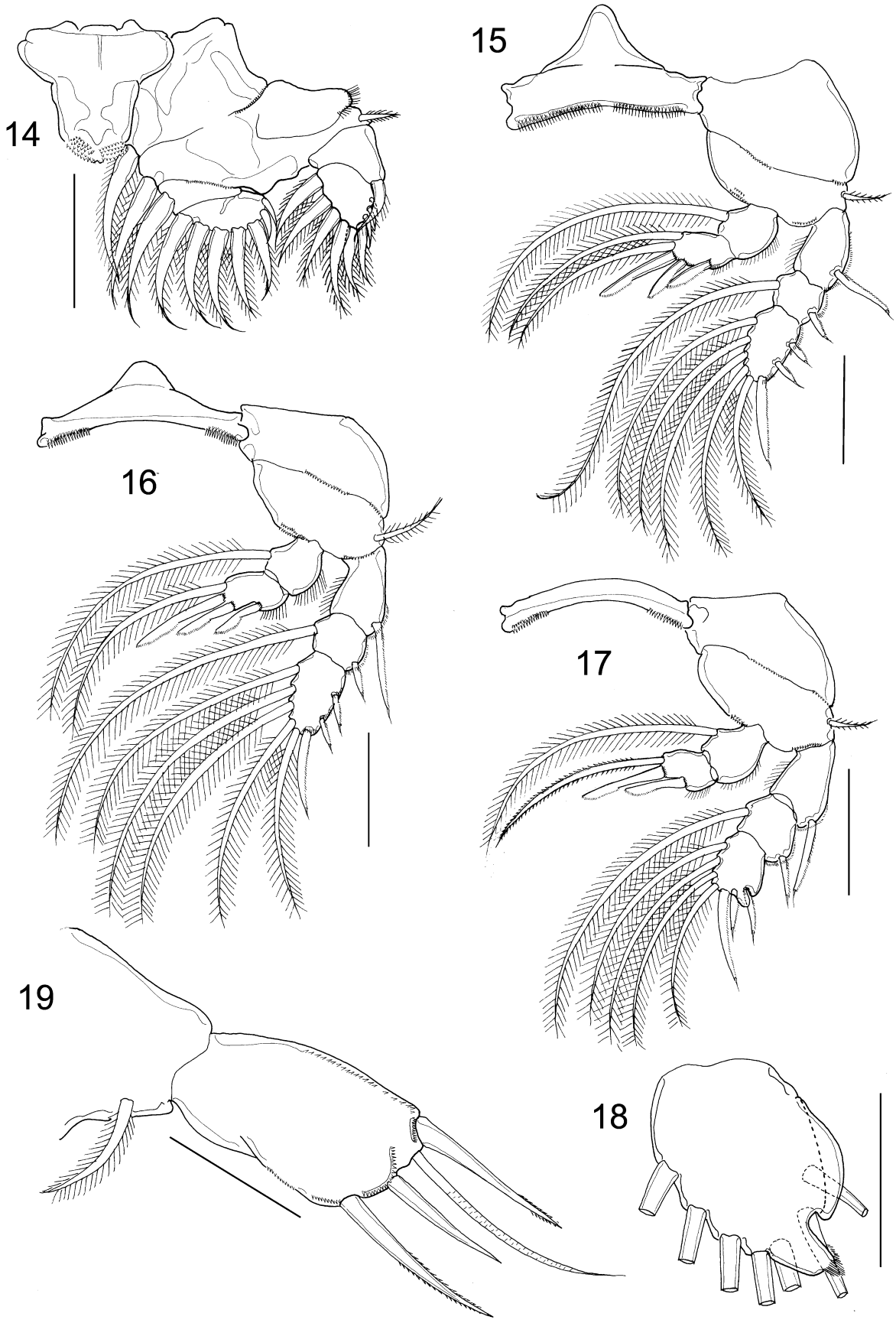


FIGURES 1–6. *Cepolacanthus kimi* **gen. et sp. nov.** (female). 1, habitus, dorsal; 2, genital and first abdominal somites, dorsal; 3, caudal rami (seta I indicated by arrows), dorsal; 4, rostral area, ventral; 5, antennule, ventral; 6, antenna, dorsal. Scale bars: 1 = 200 μm; 2–6 = 50 μm.



FIGURES 7–13. *Cepolacanthus kimi* **gen. et sp. nov.** (female). 7, postantennal process, ventral; 8, labrum, ventral; 9, mandible, ventral; 10, paragnath, ventral; 11, maxillule, ventral; 12, maxilla, ventral; 13, maxilliped, ventral. Scale bars: 50 μm.

Leg 1 (Fig. 14) coxa, basis and rami flattened; intercoxal sclerite subtriangular, ornamented with fine spinules on anterodistal surface; coxa with minute spinules along distolateral margin; basis ornamented with patch of setules on outer border and row of minute spinules at insertion of endopod. Leg 2 (Fig. 15) intercoxal sclerite triangular, ornamented with two patches of spinules along posterior margin; coxa with two short rows of minute spinules along posterior margin; basis with minute spinules near insertion point of each ramus; exopodal spines spinulate along outer margin, each with accessory terminal flagellum; outer margin of exopodal segments ornamented with row of spinules; endopodal segments with row of setules along lateral margin; second endopodal segment also with minute spinules at base of each spinulate spine. Legs 3 (Fig. 16) and 4 (Fig. 17) similar to leg 2, except intercoxal sclerite much wider than long, each furnished with spinulate patch on posterolateral corners, and terminal exopodal segment of leg 4 (Fig. 18) with large, outer subapical protuberance bearing fine apical spinules.



FIGURES 14–19. *Cepolacanthus kimi* **gen. et sp. nov.** (female). 14, leg 1, anterior; 15, leg 2, anterior; 16, leg 3, anterior; 17, leg 4, anterior; 18, distal exopodal segment of leg 4, anterior; 19, leg 5, anterior. Scale bars: 14–17, 19 = 50 µm; 18 = 25 µm.

Leg 5 (Fig. 19) well developed, 2-segmented, 1.81 times longer (58 μm) than wide (32 μm). Protopodal segment unornamented and armed with dorsolateral pinnate seta. Free exopodal segment ornamented with row of spinules on both margins and at base of each spine, and armed with two spinulated spines, one naked spine and one long naked seta. Leg 6 (Fig. 2) vestigial, represented by opercular plate armed with three naked setae at egg sac attachment area on genital somite.

Adult male. Unknown.

Attachment site. Gills.

Etymology. The species is named in honor of Prof. Il-Hoi Kim (Gangneung-Wonju National University, South Korea), a world-renowned parasitic copepod expert.

Discussion

The female urosome of most taeniacanthids consists of six somites: a fifth pedigerous somite, a genital somite and a maximum of four free abdominal somites (Dojiri & Cressey 1987). In some species however (*e.g. Taeniacanthus larsonae* Tang, Uyeno & Nagasawa, 2011b), the urosome is composed of five somites as a result of the fusion of the first abdominal somite to the genital somite. In this condition, the compound genital somite is referred to as the genital double-somite (Huys & Boxshall 1991). *Cepolacanthus* **gen. nov.** and members of *Taeniacanthodes* Wilson, 1935 also possess five urosomites, but in these taxa the last urosomite is probably a compound somite formed from the failure of the third and fourth abdominal somites to separate. Despite this synapomorphy, *C. kimi* **gen. et sp. nov.** can be readily distinguished from *Taeniacanthodes* spp. by the absence of posterolateral flaps on the cephalothorax and a ventromedian spiniform process on the rostral area, as well as the presence of an accessory seta on the mandible, a long and thin endopodal claw (vs. stout claw) on the maxilliped, a 2-segmented (vs. 3-segmented) endopod on leg 2, eight (vs. nine) armature elements on the third exopodal segment of leg 2, an inner seta (vs. none) on the proximal endopodal segment of legs 3–4, and four (vs. three or five) armature elements on the free exopodal segment of leg 5.

The terminal exopodal segment of leg 4 is unmodified in nearly all taeniacanthids (Dojiri & Cressey 1987: Fig. 81D). Nevertheless, this segment is distomedially inflated in *Taeniacanthus acanthocepolae* Yamaguti, 1939, is distolaterally protruded in *Taeniacanthus spiniferus* Ho & Lin, 2007, is slightly elongated in *Saging cebuana* and *Umazuracola* spp., is highly elongated in *Taeniacanthus balistae* (Claus, 1864), *Taeniacanthus occidentalis* (Wilson, 1924) and *Taeniacanthus similis* Dojiri & Cressey, 1987, or bears a large rounded protuberance on the outer distal margin in *Cepolacanthus kimi* **gen. et sp. nov.**

Cepolacanthus kimi **gen. et sp. nov.** is the first copepod reported from *Acanthocepola abbreviata* and the second taeniacanthid species recorded from the Iraqi coast. The related Blackspot bandfish *A. limbata* (Valenciennes, 1835) is known to harbor two other taeniacanthids, *i.e. T. acanthocepolae* from Japan (Yamaguti 1939) and China (Dojiri & Cressey 1987) and *T. spiniferus* from Taiwan (Ho & Lin 2007). *Acanthocepola abbreviata* is distributed along the Indo-West Pacific while *A. limbata* is distributed along the Northwest Pacific and also the Western Central Pacific (Froese & Pauly 2016).

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