A new species of bomolochid Orbitacolax brevispinus n. sp. and redescription of taeniacanthid Cirracanthus inimici (Yamaguti et Yamasu, 1959) (Crustacea: Copepoda: Cyclopoida) para...

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A new species of bomolochid *Orbitacolax brevispinus* n. sp. and redescription of taeniacanthid *Cirracanthus inimici* (Yamaguti et Yamasu, 1959) (Crustacea: Copepoda: Cyclopoida) parasitic on marine fishes of Korea

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Abstract

Two species of cyclopoid copepods are recorded in this study. (1) A new species of bomolochid, *Orbitacolax brevispinus* n. sp. (Crustacea) is described based on adult females collected from the gill filaments and inner surface of the opercula of red barracuda, *Sphyraena pinguis* Günther (Perciformes: Sphyraenidae), captured in Korean waters. The new species differs from its congeners by the possession of two pairs of spines on the dorsal surface of the cephalothorax located just posterior to the rostrum and a different setal formula on the distal exopodal segments of legs 2–4. (2) A taeniacanthid *Cirracanthus inimici* (Yamaguti et Yamasu, 1959) (Crustacea) is redescribed based on the specimens collected from the gill filaments and inner surface of the opercula of devil stinger, *Inimicus japonicus* (Cuvier) (Scorpaeniformes: Synancellidae). This finding is the first record in Korean waters and the first description of male. A checklist of parasitic copepods of the families Bomolochidae Sumpf, 1871 and Taeniacanthidae Wilson, 1911of Korea is also provided.

Keywords

New species, Copepod, Cyclopoida, Taxonomy, Redescription, Taeniacanthid, Fish, Korea

Introduction

Copepods of the order Cyclopoida Burmeister, 1835 are generally free-living and/or associated with marine invertebrates, but Bomolochidae Sumpf, 1871 and Taeniacanthidae Wilson, 1911, are typically parasitic on marine fishes (Dojiri and Cressey 1987; Boxshall and Halsey 2004; Tang 2006; Kim and Moon 2013; Kim 2014). Bomolochids and taeniacanthids both have an unmodified body with the appendages of the cephalothorax forming a sucker (Dojiri and Cressey 1987; Boxshall and Halsey 2004).

The Bomolochidae comprises 20 genera, including *Orbitacolax* Shen, 1957, which contains 10 valid species (Shen 1957; Dojiri and Cressey 1987; Boxshall and Halsey 2004; Kim and Moon 2013). They usually live on the gills, in the nostrils, mouth, and branchial cavities of their fish hosts. Copepods of the genus *Orbitacolax* are usually parasitic on marine teleosts although one was found on sea weeds (Leigh-Sharpe 1935; Kabata 1979; Dojiri and Cressey 1987; Venmathi Maran *et al*. 2014). They have been reported from various fishes around the world, as recently summarized in detail by Venmathi Maran *et al*. (2014). Two species of cyclopoid copepods are recorded in this study: (1) a new species of bomolochid *Orbitacolax* collected from the red barracuda *Sphyraena pinguis* Günther, 1874 (Perciformes: Sphyraenidae), and (2) a taeniacantid *Cirracanthus inimici* (Yamaguti et Yamasu, 1959), which is redescribed here since previous descriptions were not adequate in distinguishing its taxonomic features. *Cirracanthus inimici* was first reported from the scorpionfish *Inimicus japonicus* (Cuvier, 1829) (Scorpaeniformes: Synancellidae) in the Seto Inland Sea of Japan by Yamaguti and Yamasu (1959) and later by Dojiri and Cressey (1987) from Japan.

Recently, Kim (2014) published a monograph of fish-parasitic copepods including 11 genera and 27 species of cyclopoids . Later, one species of the genus *Anchistrotos* Brian, 1906 was added to the list of taeniacanthid copepods (Moon *et al*. 2015). The recent increase on the known species diver-

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sity of parasitic cyclopoids in Korea is the result of intensive investigations on various marine fishes in Korean waters (Kim and Moon 2013; Kim 2014; Moon *et al.* 2015). We also provide a checklist for both the families collected in Korean waters.

Materials and Methods

Parasitic copepods were collected from marine fishes caught in the Korean coastal waters from 2011 to 2012. The collected copepods were preserved in 70% ethanol and subsequently soaked in a drop of 80% lactic acid prior to examination using an Olympus BX51 differential phase contrast microscope. Examination of copepods was performed using the wooden slide method (Humes and Gooding 1964). Drawings were made with the aid of a drawing tube mounted on a Nikon Eclipse 80i microscope. After microscopical examination, each part of the copepod was dissected using fine tungsten needle under the microscope and the dissected appendages were mounted on a slide in lactophenol mounting medium and were sealed under a coverslip using a transparent nail varnish. In the descriptions, body length was measured using a micrometer from the anterior margin of the cephalothorax to the posterior margin of the caudal rami excluding setae. All measurements are in micrometres unless otherwise indicated. In the formula for the armature of legs 1–4 in the descriptions, Roman and Arabic numerals indicate spines and setae of legs, respectively. Morphological terminology follows Huys and Boxshall (1991) and name of fishe species were confirmed using FishBase (Froese and Pauly 2018). The types were deposited in the National Institute of Biological Resources (NIBR), Incheon, Korea.

Family Bomolochidae Sumpf, 1871
Genus *Orbitacolax* Shen, 1957
***Orbitacolax brevispinus* n. sp.**

Type-host: *Sphyraena pinguis* Günther (Perciformes: Sphyraenidae)
Type-locality: off the Strait, southern Korea (approximately 34°39´N, 127°40´E)
Type material. Holotype ♀ (NIBRIV0000293097) from the gill chambers of *Sphyraena pinguis* Günther caught off the Strait of Korea (approximately 34°39′N, 127°40′E) collected by S. Y. Moon, 1 June 2012.
Site on host: Gill filaments and inner surface of the opercula.
Etymology. The specific name is *brevispinus* is a combination of *brevis* (=small) and *spina* (=spine or thorn). It alludes to the transformation of a pair of spines on dorsal surface of the rostrum.

Description (Figs. 1–3)

Adult female. (holotype)

Body (Fig. 1A) flat and gradually narrowing from anterior to posterior. Body length 1.92 mm (n = 1). Prosome occupying about 74% length of body. Cephalothorax 527 × 860 μm, with distinct protruding rostral area carrying 2 pairs of small spinous processes on dorsal surface of frontal area, pair of small spines on dorsal surface just posterior to rostrum (Fig. 1B) on apex of cephalothorax. Second to fourth pedigerous somites 700, 590, and 397 μm wide, respectively. Urosome (Fig. 1C) 5-segmented, occupying about 26% length of body. Fifth pedigerous somite wider than genital double-somite. Genital double-somite (Fig. 1D) 138 × 229 μm, with convex lateral margins. Three free abdominal somites 98 × 133, 53 × 123, and 61 × 99 μm, respectively, from anterior to posterior, each with spinules on ventral surface. Caudal rami convergent; 1.93 times as long as wide, with spinules on ventral surface and 1 large and 5 small setae.

Rostrum with paired hooks on ventral surface (Fig. 1E). Antennule (Fig. 1F) 5-segmented, with armature formula of 5, 20, 4, 2＋aesthetasc, and 7＋aesthetasc. First 2 proximal segments having plumose setae and next 3 distal segments bearing naked setae. Second proximal segment longer, bearing 2 long, 4 small, and 14 medium setae. Second seta on second proximal segment largest among setae on all 5 segments. Antenna (Fig. 1G) 4-segmented; coxobasis longer than length of endopodal segments combined, bearing distal seta; first endopodal segment with inner seta; second endopodal segment bearing 2 unequal pectinate processes and claw-like spine (large pectinate process with several rows of spinules; small pectinate process with row of minute spinules and small seta); third endopodal segment with 3 claw-like spines and 3 unequal naked setae. Mandible (Fig. 2A) armed with 2 apical blades, both blades spinulate along posterior margin. Paragnath (Fig. 2B) tapering into distal part, with tuft of setules proximally and row of spinules distally. Maxillule (Fig. 2C) lobate, bearing 4 setae consisting of elongate, weakly pinnate seta, 1 pinnate seta, and 2 smaller setae. Maxilla (Fig. 2D) 2-segmented; proximal segment (syncoxa) larger, unarmed; distal segment (basis) with proximal protuberance on posterior side and distally 2 spinulose spines and 1 small seta. Maxilliped (Fig. 2E) indistinctly 4-segmented; first segment (syncoxa) bearing naked seta; second segment (basis) with well developed posterolateral protrusion and 2 pinnate setae medially; third segment indistinct; fourth terminal segment having first endopodal segment small unarmed; second endopodal segment as strongly curved claw bearing 1 seta proximally and small accessory claw on outer margin of curved claw.

Legs 1–4 biramous (Figs. 2F, G, 3A, B) and trimerous, except exopod of leg 1 indistinctly segmented. Armature formula of legs 1–4 as follows (Roman numerals = spines; Arabic numerals = setae):

	Coxa	Basis	Exopod	Endopod
Leg 1	0–1	1–0	1–0; 3, 6	0–1; 0–1; 5
Leg 2	0–0	1–0	1–0; 1–0; 2, I, 2	0–1; 0–2; 3
Leg 3	0–0	1–0	1–0; 1–0; 2, I, 2	0–1; 0–1; I,2
Leg 4	0–0	1–0	1–0; 1–0; 2, I, 2	0–1; 0–1; 2

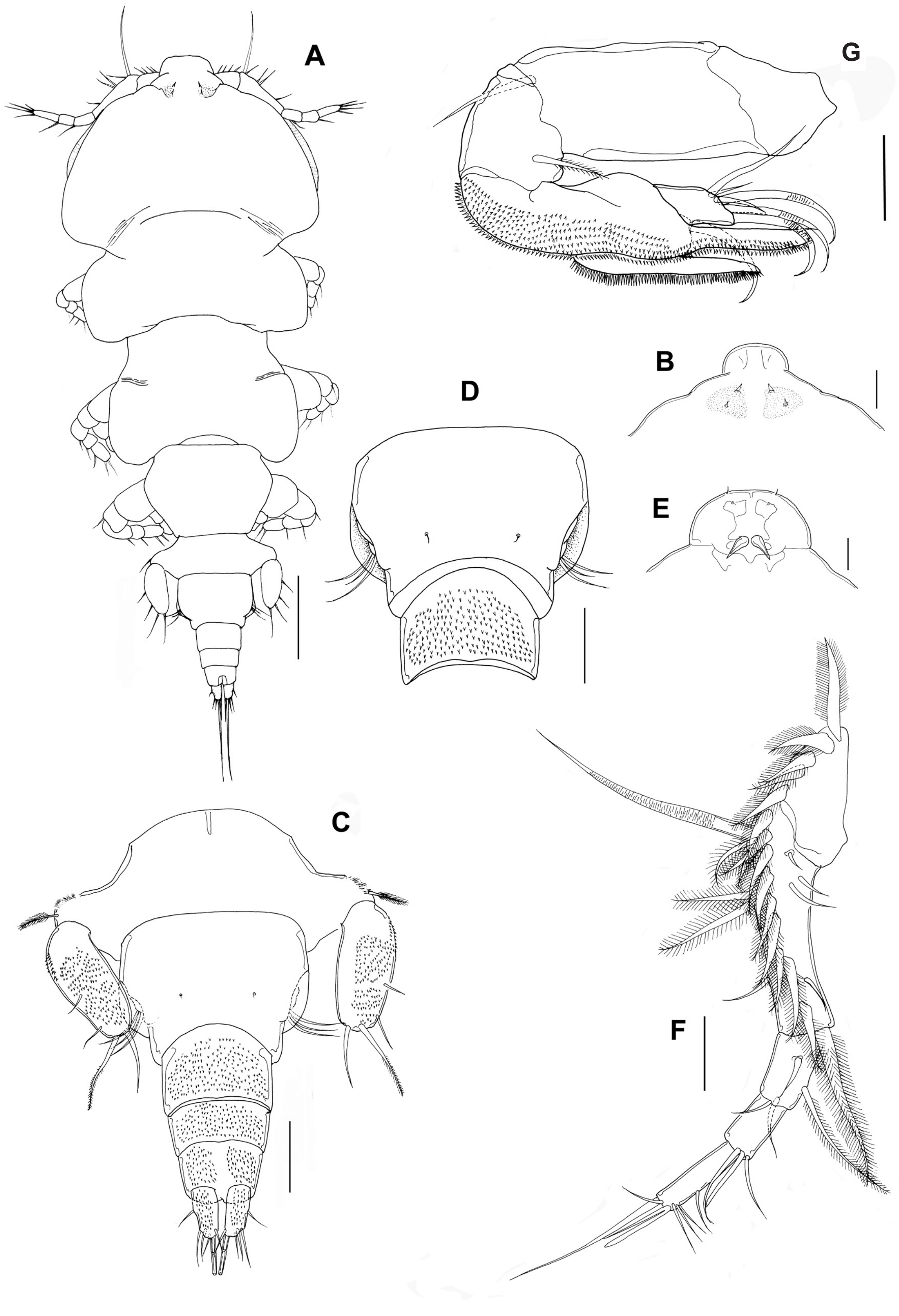

Fig. 1. *Orbitacolax brevispinus* n. sp., female. **A.** – habitus, dorsal; **B.** – rostrum, dorsal; **C.** – urosome, dorsal; **D.** – Genital doublé-somite and first free abdominal somite, dorsal; **E.** – rostrum, ventral; **F.** – Antennule, ventral; **G.** – antenna, dorsal. Scale bars: A, 0.2 mm; B-F, 0.05 mm; G, 0.5 mm

Leg 1 (Fig. 2F) bearing coxa, basis and rami. Posterior margin of intercoxal sclerite with 2 patches of fine spinules on each side of medial region.Coxa with patch of setules on outer border; coxa and basis ornamented with rows of minute spinules. Outer margin of proximal and second endopodal segments with patch of setules.

Leg 2 (Fig. 2G) intercoxal sclerite of leg 2 with rows of spinules on posterior margin. Coxa bears row of minute spin-

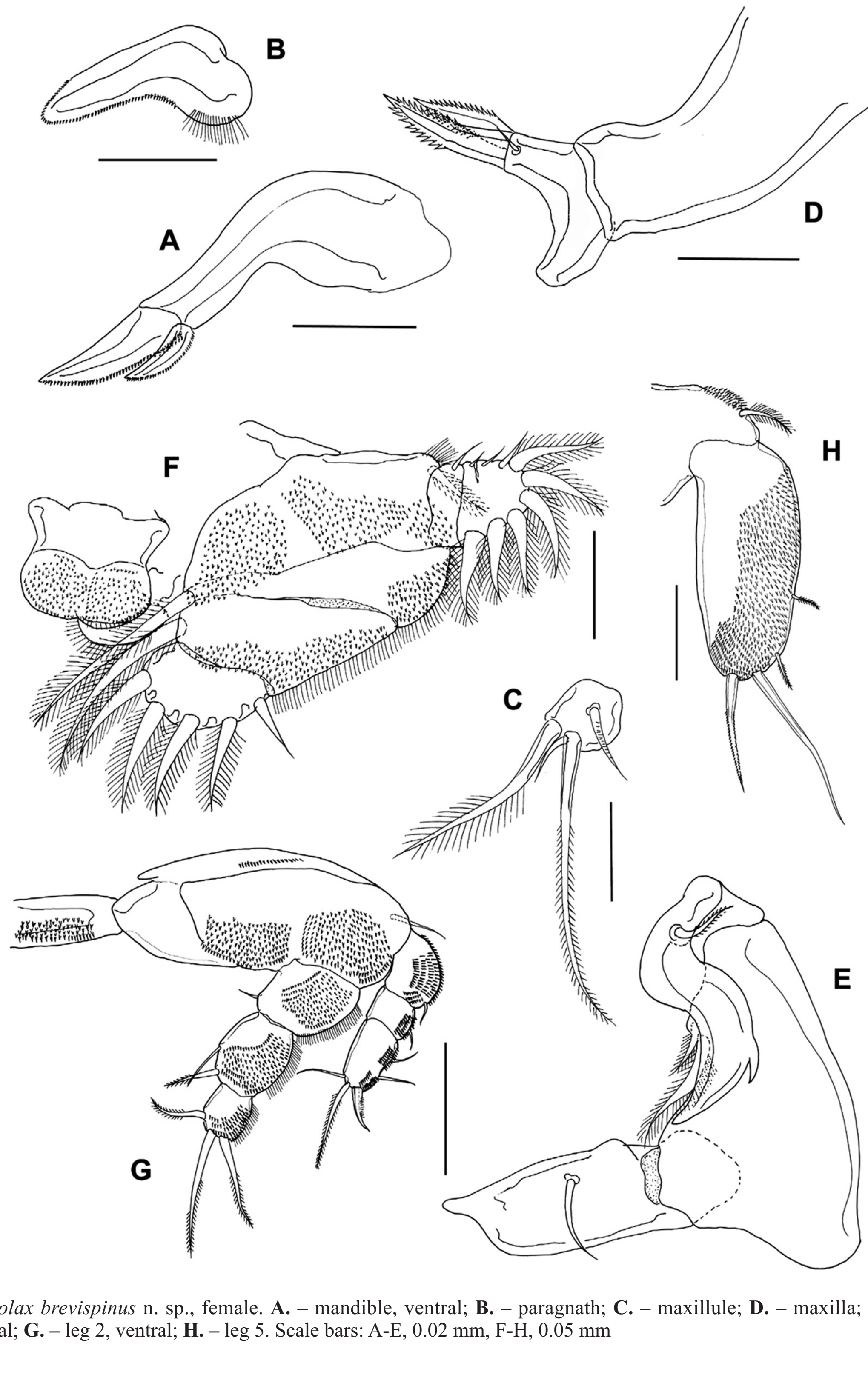

Fig. 2. *Orbitacolax brevispinus* n. sp., female. **A.** – mandible, ventral; **B.** – paragnath; **C.** – maxillule; **D.** – maxilla; **E.** – maxilliped; **F.** – leg 1, ventral; **G.** – leg 2, ventral; **H.** – leg 5. Scale bars: A-E, 0.02 mm, F-H, 0.05 mm

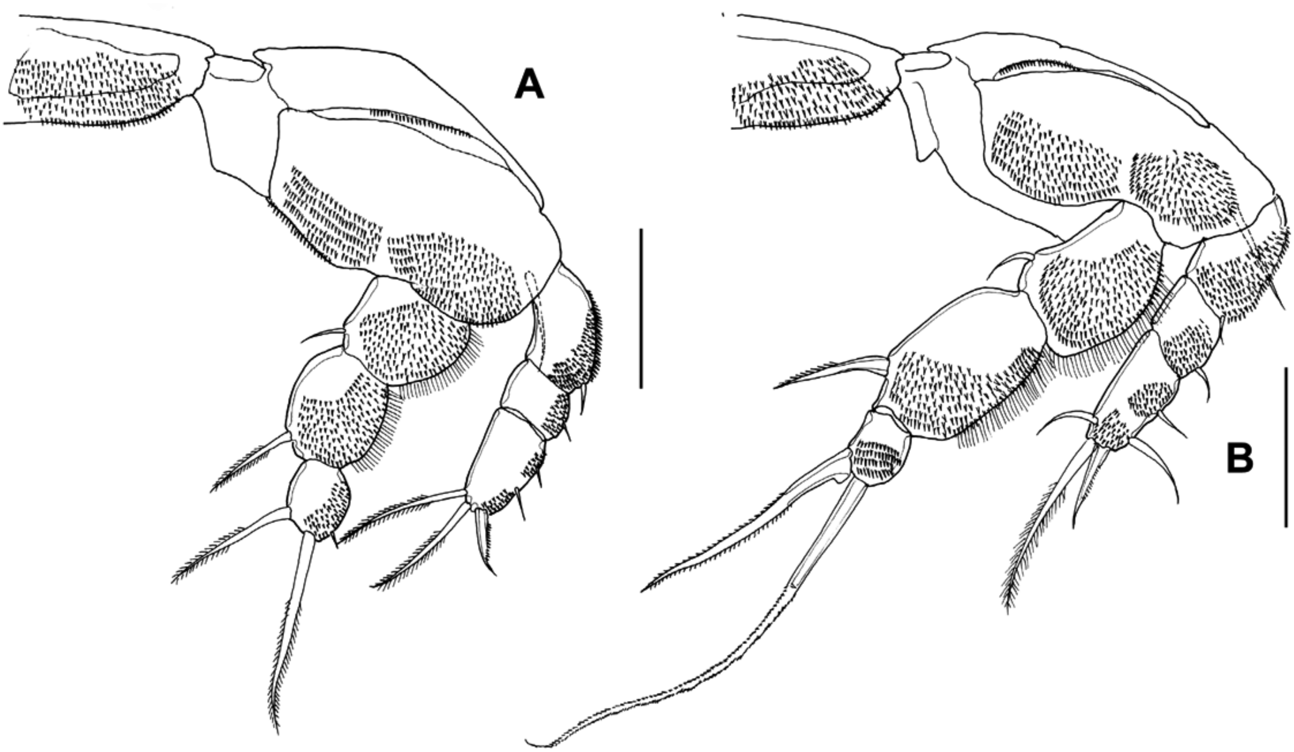

Fig. 3. *Orbitacolax brevispinus* n. sp., female. **A.** – leg 3, ventral; **B.** – leg 4, ventral. Scale bars: 0.05 mm

ules on distolateral margin. Basis ornamented with 2 dense patches of minute spinules on posterior surface. Exopod of leg 2 segments with outer row of minute spinules. Endopod of leg 2 segments with row of spinules and setules along lateral margin; first 2 segments also slightly protruded distolaterally and with row of setules along outer border; spines on terminal spinulate along outer margin.

Leg 3 (Fig. 3A) and Leg 4 (Fig. 3B) ornamented as in leg 2 except for absence of row of setules along outer border.

Leg 5 (Fig. 2H) well developed, 2-segmented; protopod fused to pedigerous somite armed with 1 dorsolateral pinnate seta and outer patch of minute spinules; free segment (exopod) ornamented with patch of spinules on distolateral surface and row of spinules at base of each spine and armed with 3 spinulate spines and naked seta.

Leg 6 (Fig. 1C) vestigial, represented by 3 naked setae at genital openings.

Male: Unknown.

Remarks

The new species *Orbitacolax brevispinus* n. sp. can be recognized by three major diagnostic features: (1) the possession of two pairs of small spinous processes on the dorsal surface just posterior to rostral prominence; (2) the terminal segment of the maxilliped represented by short and strongly curved claw; and (3) the setal formula of the distal exopodal segment of leg 4 consisting of 2 setae, I spine, and 2 setae. Venmathi Maran *et al*. (2014) divided the species of *Orbitacolax* into two groups based on the presence or absence of 2 inner plumose setae on the second endopodal segment of leg 2. *Orbitacolax brevispinus* n. sp. is considered a member of the *hapalogenyos*-group, characterized by the presence of 2 inner plumose setae on the second endopodal segment of leg 2. This group includes five species, namely: *O. hapalogenyos* (Yamaguti and Yamasu, 1959), *O. pteragogi* Kim and Moon, 2013, *O. trichiuri* Kim and Moon, 2013, *O. unguifer* Kim and Moon, 2013, and *O. brevispinus* n. sp.

The new species is morphologically similar to *O. hapalogenyos*, but can easily be differentiated by the following diagnostic features based on the adult female: (1) the terminal segment of the maxilliped consisting of short and strongly curved claw (vs. long and weakly curved claw in *O. hapalogenyos*); (2) the presence of two pairs of spines on the dorsal cephalic area (vs. absence of spines in *O. hapalogenyos*); (3) the endopod of leg 4 has 2 distal setae (vs. 3 setae in *O. hapalogenyos*); and 4) the distal exopodal segment of leg 4 bears 2 inner setae (vs. 3 setae in *O. hapalogenyos*).

Orbitacolax brevispinus n. sp. differs from *O. pteragogi* in the following features: 1) the presence of two pairs of spines on the dorsal cephalic area (vs. absence of spines in *O. pteragogi*); 2) the distal endopodal segment of leg 3 bears 3 setae (vs. 2 setae in *O. pteragogi*); and 3) the distal exopodal segment of leg 4 has 2 setae (vs. 1 seta in *O. pteragogi*). The new species also differs from *O. trichiuri* by the presence of two pairs of small spines, located just posterior to the rostrum (vs. absent in *O. trichiuri*); the distal endopodal segment of leg 2 has 3 setae (vs. 5 setae in *O. trichiuri*), and the distal endopodal segment of leg 3 has 1 spine and 2 setae (vs. only 4 setae in *O. trichiuri*).

The new species can be distinguished from *O. unguifer* by the following features: (1) by the presence of two pairs of spinous processes located just posterior to the rostrum (not spines, but horn-like hooks in *O. unguifer*), the distal exopodal segment of legs 2 and 3 have 2 inner setae (vs. 3 setae in *O. unguifer*), the distal endopodal segment of leg 2 has only 3 setae (vs. II spines and 3 setae in *O. unguifer*), the distal endopodal segment of leg 3 has I spine (vs. II spines in *O. unguifer*), and the distal endopodal segment of leg 4 bears only 2 setae (vs. I spine and 2 setae in *O. unguifer*).

Members of *Orbitacolax* have low host specificity and reported from several fish hosts (see: Yamaguti and Yamasu 1959; Cressey and Cressey 1979; Kim and Moon 2013; Venmathi Maran *et al*. 2014). As an update we could now report that *Orbitacolax* has 11 valid species, including the one described herein: *O. aculeatus* (Pillai, 1962), *O. analogus* Vervoort, 1969, *O. dactylopterusi* (Carvalho, 1958), *O. hapalogenyos*, *O. leptoscari* (Yamaguti, 1953), *O. pteragogi*, *O. brevispinus* n. sp., *O. trichiuri*, *O. unguifer*, *O. uniunquis* Shen, 1957, and *O. williamsi* Cressey and Cressey, 1989. All valid species of *Orbitacolax* can be differentiated from their congeners using the key of Kim and Moon (2013). The structure of dorsal cephalic area and the leg setation of the adult female are of great significance in the identification. However, most of the species of *Orbitacolax* are difficult to identify because of morphological similarities and the lack of detailed descriptions. In relation to that, a more detailed research on morphological and molecular analysis is needed for accurate identification.

Family Taeniacanthidae Wilson, 1911
Genus *Cirracanthus* Dojiri and Cressey, 1987
***Cirracanthus inimici* (Yamaguti andYamasu, 1959)**

Synonyms: *Parataeniacanthus inimici* Yamaguti and Yamasu, 1959 – Yamaguti and Yamasu, 1953; *Taeniacanthus inimici* (Yamaguti and Yamasu, 1959) – Dojiri and Cressey, 1987; *Cirracanthus inimici* (Yamaguti and Yamasu, 1959) – Dojiri and Ho, 1987
Material examined: 14 ♀♀ (NIBRIV0000638812) and 3♂♂ (NIBRIV0000638813) from the gills of *Inimicus japonicus* (Cuvier), caught off Yeosu (approximately 34°39′N, 127°40′E), collected by S. Y. Moon, 1 September 2011.
Site in host: Gill filaments and inner surface of the opercula.

Description (Figs. 4, 5)

Adult female

Body (Fig. 4A) elongate and slender. Body length 3.58 mm (3.04–3.65 mm, *n* = 5). Cephalothorax semicircular, 635 × 824 μm, much wider than succeeding somites. Second through fourth pedigers measuring 384 × 595, 325 × 552, and 243 × 479 μm, respectively. Urosome 6-segmented. Fifth pedigerous somite 203 × 435 μm. Genital somite 231 × 339 μm; genital apertures positioned dorsolaterally near middle of somite. Four abdominal somites from anterior to posterior 266 × 367, 268 × 354, 247 × 232, and 245 × 197 μm, respectively. Anal somite proximally with 5 rows of minute spinules on both sides of ventral surface (Fig. 4B). Caudal ramus (Fig. 4B) weakly tapering 3.09 times longer than wide (198×64 μm), bearing 7 setae (seta 1 minute); setae 2 and 3 each with row of minute spinules at base; setae 4 and 5 ornamented with medial row of bristles and lateral row of spinules; seta 7 about 0.5 times longer than seta 6; seta 5 longest (604 μm), at least twice length of seta 4.

Rostral area (Fig. 4C) with ventromedial, tear-drop shaped, sclerotized plate at posterior end. Antennule (Fig. 4D) 7-segmented, with armature formula of 5, 15, 5, 3, 4, 2 + aesthetasc and 7 + aesthetasc. Antenna (Fig. 4E) composed of coxobasis and 2 endopodal segments; coxobasis with distal seta; first endopodal segment with stout posterior seta; second endopodal segment bearing 2 unequal pectinate processes, 3 claw-like spines and 4 unequal setae; large pectinate process with seta and row of spinules; short pectinate process with row of spinules. Postantennal process (Fig. 4F) elongate, curved distally.

Labrum (Fig. 4G) with row of large spinules along posterior margin. Mandible (Fig. 4H) armed with 2 apical blades and bristled accessory seta; both blades spinulate along inner margin. Paragnath (Fig. 4I), lobe constricted near posterior 2/3 of its length then widening into acuminate distal portion bearing small pit. Maxillule (Fig. 5A) lobate, bearing large pinnate-like seta, anterior knob-like process and 2 long and 2 short naked setae. Maxilla (Fig. 5B) 2-segmented; proximal segment (syncoxa) unarmed; terminal segment (basis) armed with spinulate terminal process, long spinulate spine and naked seta. Maxilliped (Fig. 5C) 3-segmented; proximal segment (syncoxa) large, bearing naked seta; second segment (basis) with 2 proximal naked setae and 2 corrugated areas; terminal segment (endopod) broad claw bearing 2 setae and large corrugated patch on convex margin near tip.

Legs 1–4 biramous (Fig. 5D–G) and trimerous, except leg 1 exopod indistinctly segmented. Armature formula of legs 1–4 as follows (Roman numerals = spines; Arabic numerals = setae, respectively; ss. setiform spine):

	Coxa	Basis	Exopod	Endopod
Leg 1	0–1	1–1	I–0; 9	0–1;0–1; 6
Leg 2	0–0	1–0	I–0; I–1; II, I, 5	0–1, 0–2, II, I, 3
Leg 3	0–0	1–0	I–0; I–1; II, I, 5	0–1; 0–2; II, I, 2
Leg 4	0–0	1–0	I–0; I–1; II, I, 5	0–1; 0–1; II, ss.

Leg 1 (Fig. 5D) bearing coxa, basis and rami. Coxa and basis ornamented with row of minute spinules. Posterior margin of intercoxal sclerite with fine spinules on anterodistal surface. Legs 2 to 4 (Fig. 5E-G): intercoxal sclerites of legs 2 to 4 bearing rows of spinules on posterior margin. Coxa of legs 2 to 4 unarmed. Basis of legs 2 to 4 ornamented with dense patches of minute spinules on posterior surface. Outer margin of second and terminal endopodal segments of legs 2 to 4 bearing

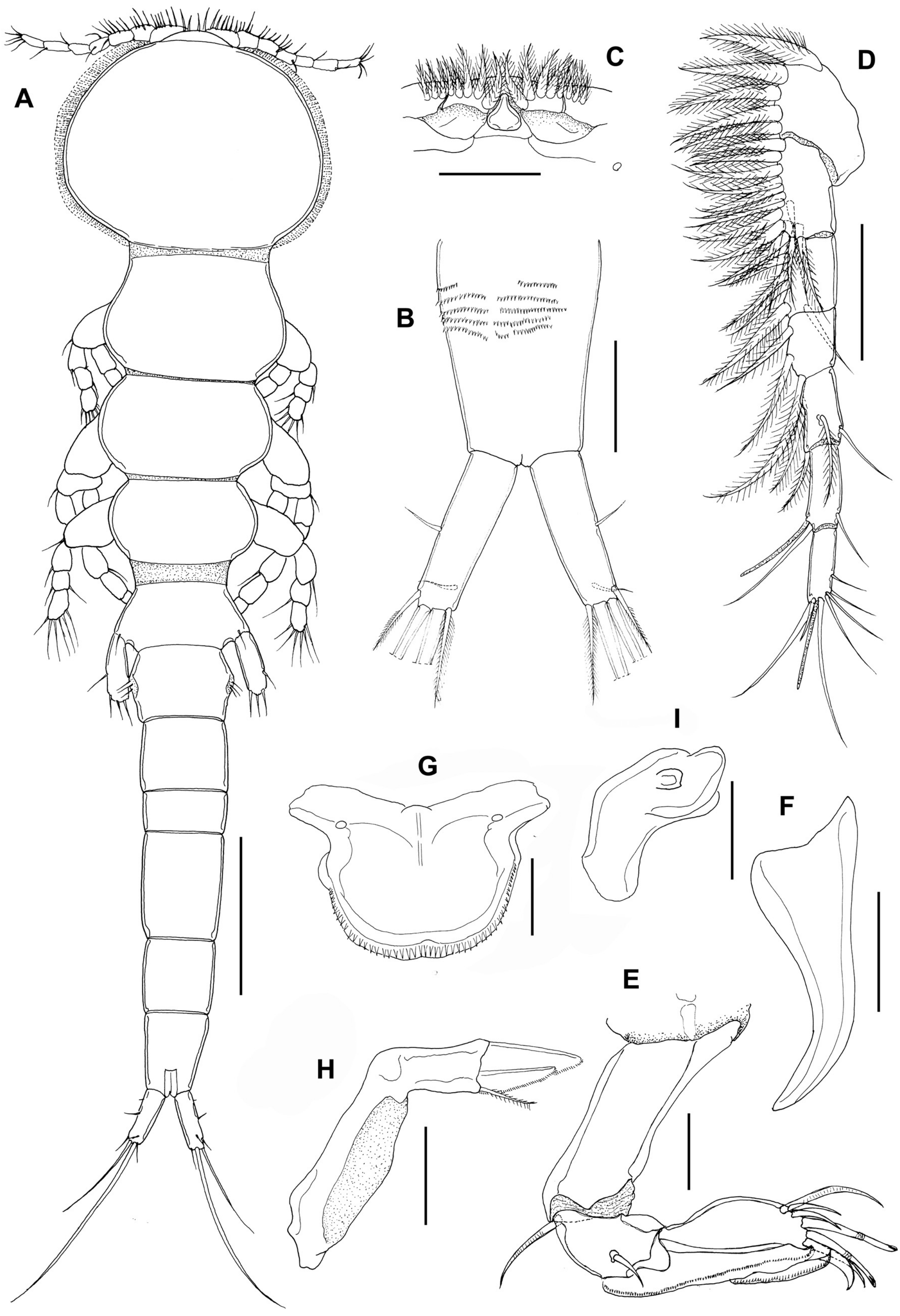

Fig. 4. *Cirracanthus inimici* (Yamaguti and Yamasu, 1959), female. **A.** – habitus, dorsal; **B.** – anal somite and caudal rami, ventral; **C.** – rostral area, ventral; **D.** – antennule; **E.** – antenna; **F.** – postantennal process; **G.** – labrum, ventral; **H.** – mandible; **I.** – paragnath. Scale bars: A, 0.5 mm, B, 0.2 mm, C-I, 0.05 mm

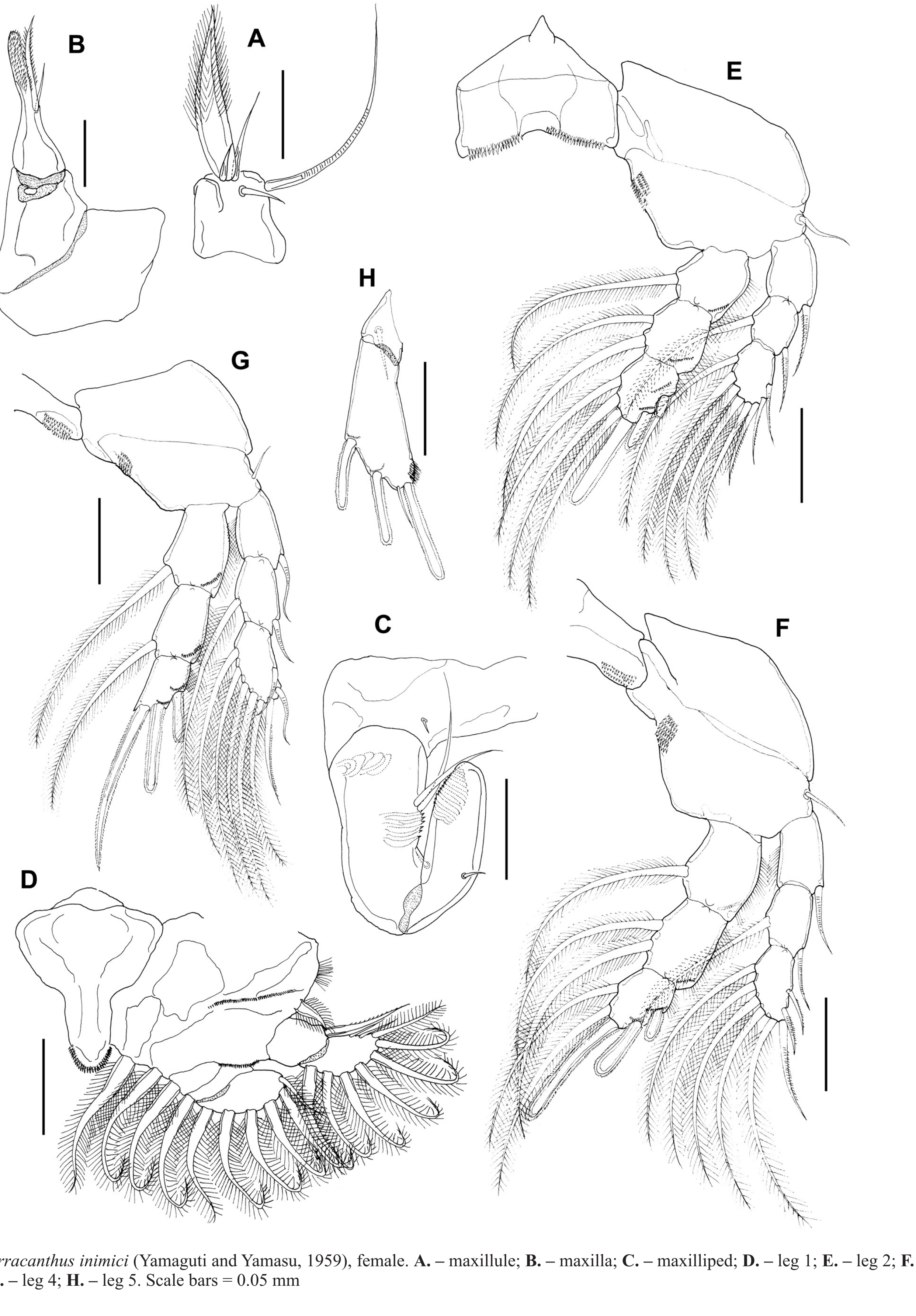

Fig. 5. *Cirracanthus inimici* (Yamaguti and Yamasu, 1959), female. **A.** – maxillule; **B.** – maxilla; **C.** – maxilliped; **D.** – leg 1; **E.** – leg 2; **F.** – leg 3, **G.** – leg 4; **H.** – leg 5. Scale bars = 0.05 mm

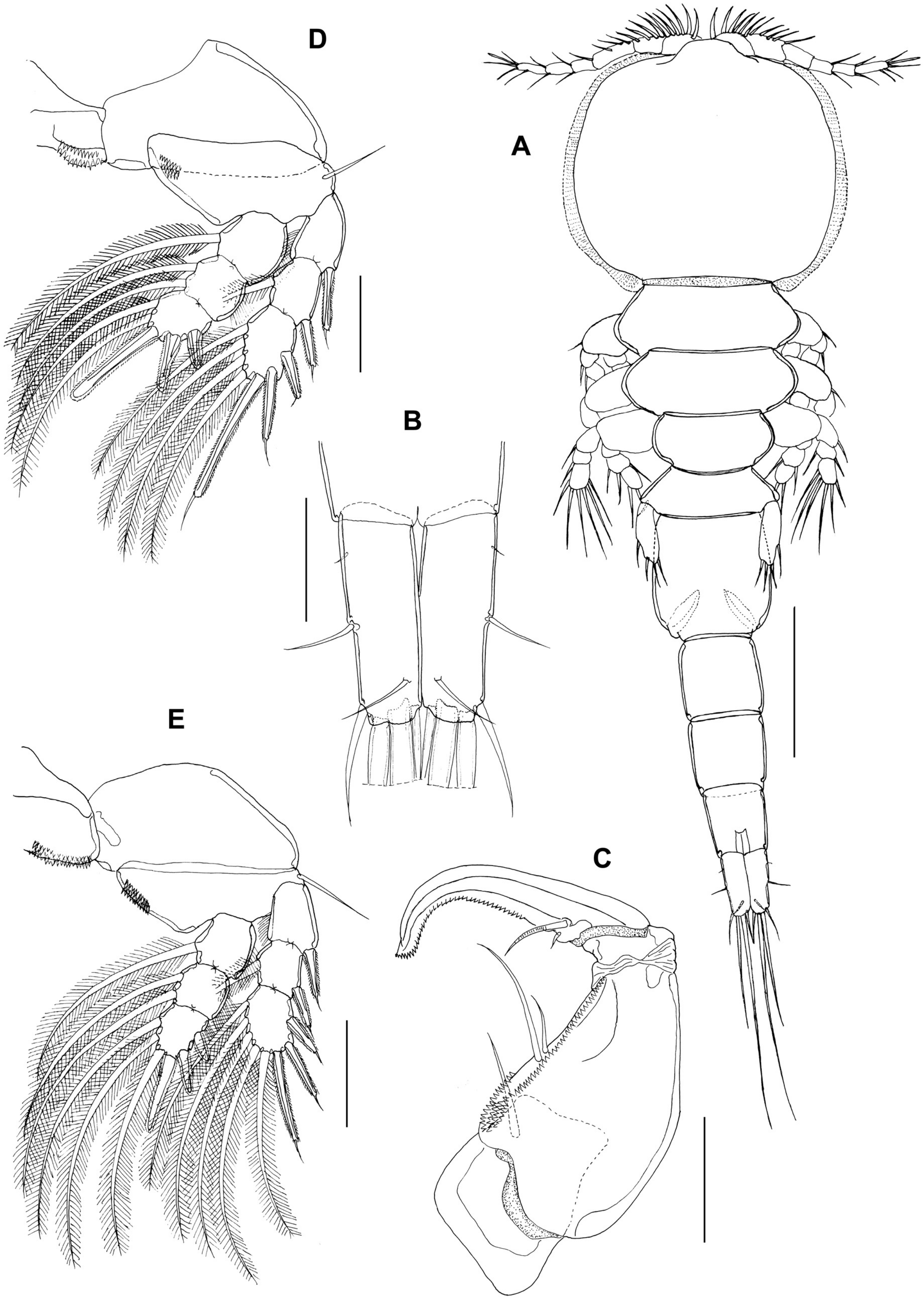

Fig. 6. *Cirracanthus inimici* (Yamaguti and Yamasu, 1959), male. **A.** – habitus, dorsal; **B.** – anal somite and caudal rami, ventral; **C.** – maxilliped; **D.** – leg 2; **E.** – leg 3. Scale bars: A, 0.2 mm; B, 0.1 mm; C, 0.02 mm; D, E, 0.05 mm

Table I. A checklist of parasitic cyclopoids of the families Bomolochidae and Taeniacanthidae (Crustacea: Copepoda) in Korea (after Kim, 2014). Host names follow FishBase (Froese and Pauly 2018)

Species	Host
Family Bomolochidae Sumpf, 1871	
Genus *Bomolochus* Nordmann, 1832	
Bomolochus bellones Burmeister, 1833	*Cololabissaira* (Brevoort) *Strongylura anastomella* (Valenciennes)
Bomolochus decapteri Yamaguti, 1936	*Ditrema temmincki* Bleeker (= *Ditrema temminckii* (Bleeker) *Pennahia argentata* (Houttuyn) (= *Argyrosomus argentatus* (Houttuyn)
Genus *Naricolax* Ho, Do and Kasahara, 1983	
Naricolaxa typicus Ho, Do and Kasahara, 1983	*Hexagrammos agrammus* (Temminck and Schlegel) *Lateolabrax japonicus* (Cuvier)
Naricolax insolitus Ho, Do and Kasahara, 2003	*Pampus argenteus* (Euphrasen)
Genus *Nothobomolochus* Vervoort, 1962	
Nothobomolochus lateolabracis (Yamaguti and Yamasu, 1959)	*Lateolabrax japonicus* (Cuvier) *Sillago sihama* (Forsskål)
Nothobomolochus thambus Ho, Do and Kasahara, 1983	*Konosirus punctatus* (Temminck and Schlegel) *Odontamblyopus lacepedii* (Temminck and Schlegel)
Nothobomolochus triceros (Bassett-Smith, 1898)	*Pampus argenteus* (Euphrasen)
Genus *Orbitacolax* Shen, 1957	
Orbitacolax hapalogenyos (Yamaguti and Yamasu, 1959)	*Hapalogenys mucronatus* (Eydous and Souleyet) (= *Hapalogenys analis* Richardson)
Orbitacolax leptoscari (Yamaguti, 1953)	*Calotomus japonicus* (Valenciennes) (=*Leptoscarus japonicus*)
Orbitacolaxp teragogi Kim and Moon, 2013	*Pteragogus flagellifer* (Valenciennes)
Orbitacolax brevispinus n. sp.	*Sphyraena pinguis* Günther
Orbitacolax trichiuri Kim and Moon, 2013	*Trichiurus lepturus* Linnaeus
Orbitacolax unguifer Kim and Moon, 2013	*Evynnis japonica* Tanaka
Genus *Unicolax* Cressey and Cressey, 1980	
Unicolax ciliatus Cressey and Cressey, 1980	*Scomberomorus niphonius* (Cuvier and Valenciennes
Unicolax quadrispinulus Lin and Ho, 2006	*Sillago sihama* (Forsskål)
Family Taeniacanthidae Wilson, 1911	
Genus *Anchistrotos* Brian, 1906	
Anchistrotos kojimensis Do and Ho, 1983	*Acanthogobius flavimanus* (Temminck and Schlegel) *Synechogobius hasta* (Temminck and Schlegel)
Anchistrotos tongyeongensis Moon, Lee and Kim, 2015	*Myersina filifer* (Valenciennes)
Genus *Biacanthus* Tang and Izawa, 2005	
Biacanthus pleuronichthydis (Yamaguti, 1939)	*Pleuronichthys cornutus* (Temminck and Schlegel)
Genus *Pseudotaeniacanthus*Yamaguti and Yamasu, 1959	
Pseudotaeniacanthus congeri Yamaguti and Yamasu, 1959	*Conger myriaster* (Brevoort) (=*Astroconger myriaster*)
Genus *Taeniacanthus* Sumpf, 1871	
Taeniacanthus balistae (Claus, 1864)	*Aluterus monoceros* (Linnaeus)
Taeniacanthus moa (Lewis, 1967)	*Ostracion immaculatus* Temminck and Schlegel
Taeniacanthus neopercis Yamaguti, 1939	*Parapercis sexfasciata* (Temminck and Schlegel)
Taeniacanthus platycephali (Yamaguti, 1939)	*Lophiomus setigerus* (Vahl)
Taeniacanthus rotundiceps (Shiino, 1957)	*Beroelegans* (Steindachner) *Pseudoblennius cottoides* (Richardson)
Taeniacanthus sebastichthydis Yamaguti, 1939	*Sebastes pachycephalus* Temminck and Schlegel *Sebastes inermis* Cuvier *Sebastes schlegeli* Hilgendorf
Taeniacanthus yamagutii (Shiino, 1957)	*Takifugu poecilonotus* (Temminck and Schlegel)

Species	Host
Taeniacanthus singularis Kim and Moon, 2013	*Halieutaea fumosa* Alcock
Genus *Suncheonacanthus* Venmathi Maran, Moon, Adday and Tang 2016	
Suncheonacanthus luteus (Kim and Moon, 2013)	*Odontamblyopus lacepedii* (Temminck and Schlegel)
Genus *Umazuracola* Ho, Ohtsuka and Nakadachi, 2006	
Umazuracola geminus Kim and Moon, 2013	*Stephanolepis cirrhifer* (Temminck and Schlegel)

row of minute spinules. Each spine with terminal segment of endopod protruding with fringe of minute spinules.

Leg 5 (Fig. 5H) well developed, 2-segmented. Protopodal segment armed with 1 dorsolateral pinnate seta. Free exopodal segment ornamented with rows of spinules at base of each spine and armed with 3 spinulate spines and naked seta. Leg 6 (Fig. 1C) vestigial, represented by 3 naked setae at genital opening.

Adult male

Body length 1.32mm (1.27–1.37 mm, $n = 3$) (Fig. 6A). Second pediger 288 µm wide; remaining prosomites narrower than second prosomite. Genital somite length and width almost equal (185 × 182 µm). Abdomen composed of 3 free somites. Caudal ramus (Fig. 6B) longer (104 µm) than wide (34 µm).

Maxilliped (Fig. 6C) 4-segmented; syncoxa with usual distal seta; basis well developed, with 2 medial setae, longitudinal patch of squarish denticles posteromedially and longitudinal rows of minute spinules anteromedially; first endopodal segment small, naked and unarmed; second endopodal segment represented by curved claw, bearing 2 posterior setae, basal tooth and row of blunt denticles along concave margin.

First and second endopodal segments of legs 2 (Fig. 5D) and 3 (Fig. 5E) with well-developed apical spine; the third endopodal segment of leg 2 considerably shorter than that of leg 3. Leg 6 (not figured) vestigial, represented by unarmed opercular plate on posteroventral surface of genital somite.

Remarks

The prominent features of *C. inimici* are the large pinnate-like seta of the maxillule, the blunt terminal process of the maxilliped, the broad corrugated maxilliped claw, and bluntly rounded-tip of the endopodal spines of legs 2 to 4. All these features match closely with Japanese specimens which allowed the Korean specimens to be identified as *C. inimici*.

Cirracanthus inimici was first reported from the Seto Inland Sea, Japan based on five ovigerous females captured from the same host *I. japonicus* (Yamaguti and Yamasu 1959). After that, 36 females were collected from the same host caught in Tassha Bay, Sado Island by Dojiri and Ho (1987). However, the male has never been reported. Hence, the male is described herein for the first time. The length/ width ratio of the caudal ramus of the Korean specimens was about 3.1:1, in contrast to 3.86 times longer than wide in the Japanese females (Dojiri and Ho 1987). This discrepancy is thought to be due to intraspecific variability.

Taeniacanthidae is the third largest family among the fish-parasite cyclopoids following Chondracanthidae Mine Edwards, 1840 and Ergasilidae Burmeister, 1835 (Ho 2001; Boxshall and Halsey 2004; Tang 2006). It consists of about 100 species in 21 genera (WoRMS 2018). In Korea, 14 species in 6 genera are so far known (see Table 1). The finding of the genus *Cirracnathus* represents the first record in Korean waters. As an update, in total, there are 11 genera including 28 species of Bomolochidae and Taeniacanthidae families have so far been recorded in Korea (Table 1). A checklist of these two families from Korea is provided.

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References

Boxshall G.A., Halsey S.H. 2004. An Introduction to Copepod Diversity. London: The Ray Society, pp. 966

Cressey R.F., Cressey H.B. 1979. The parasitic copepods of Indo-West Pacific lizardfishes (Synodontidae). *Smithsonian Contributions of Zoology*, 296, 1–80

Cressey R.F., Cressey H.B. 1989. A new species of *Orbitacolax* (Copepoda: Bomolochidae) and redescription of two additional species. *Canadian Journal of Zoology*, 67, 2902–2909

Dojiri M., Cressey R.F. 1987. Revision of the Taeniacanthidae (Copepoda: Poecilostomatoida) parasitic on fishes and sea urchins. *Smithsonian Contributions to Zoology*, 447, 1–250

Dojiri M., Ho J.-s. 1987. Copepods of the Taeniacanthidae (Poecilostomatoida) parasitic on fishes of Japan. *Report of the Sado Marine Biological Station Niigata University*, 17, 33–42

Froese R., Pauly D. (Eds.) 2018. FishBase.World Wide Web electronic publication. Available from http://www.fishbase.org/ (accessed 1 March 2018)

Ho J.-s. 2001. Why do symbiotic copepods matter? *Hydrobiologia*, 453/454, 1–7

Humes A.G., Gooding R.U. 1964. A method for studying the external anatomy of copepods. *Crustaceana,* 6, 238–240

Huys R., Boxshall G.A. 1991. *Copepod evolution*. London: The Ray Society, pp. 468

Kabata Z. 1979. *Parasitic Copepoda of British fishes*. London: The Ray Society, pp. 468

Kim I.H. 2014. *Invertebrate Fauna of Korea. Vol. 21, Num. 37, Arthropoda: Maxillopoda: Copepoda: Cyclopoida, Fish-Parasitic Cyclopoid Copepods*. Flora and Fauna of Korea, National Institute of Biological Resources, Ministry of Environment, pp. 226

Kim I.H., Moon S.Y. 2013. Ten new species of parasitic cyclopoid copepods (Crustacea) belonging to the families Bomolochidae, Philichthyidae, and Taeniacanthidae from marine fishes in Korea. *Ocean Science Journal,* 48, 361–398.

Moon S.Y., Lee J.-H., Kim D.N. 2015. A new species of *Anchistrotos* Brian, 1906 (Copepoda: Cyclopoida: Taeniacanthidae) from the filamentous shrimpgoby *Myersina filifer* (Valenciennes) (Perciformes: Gobiidae) in Korea waters. *Systematic Parasitology*, 92, 151–159

Shen C.-J. 1957. Parasitic copepods from fishes of China. Part I. Cyclopoida (1). *Acta Zoologica Sinica*, 9, 297–327

Tang D. 2006. Phylogeny of the copepod family Taeniacanthidae. Proceedings of the 11th International Congress of 395 Parasitology, Glasgow, UK, 6–11 August 2006, Medimond, Bologna, pp. 621–625

Venmathi Maran B.A., Moon S.Y., Adday T.K., Khamees N.R., Myoung J.-G. 2014. A new species of parasitic copepod *Nothobomolochus* and redescription of *Orbitacolax hapalogenyos* (Yamaguti and Yamasu, 1959) (Cyclopoida: Bomolochidae) off Iraq. *Acta Parasitologica*, 59, 139–152

Venmathi Maran B.A., Moon S.Y., Adday T.K., Tang D. 2016. *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. *Zootaxa*, 4174, 249–258

WoRMS Editorial Board. (2018) World Register of Marine Species. www.marinespecies.org

Yamaguti S. 1953. Parasitic copepods from fishes of Japan. Part 7. Cyclopoida, III and Caligoida, IV. *Publications of Seto Marine Biological Laboratory*, 3, 221–231

Yamaguti S., Yamasu T. 1959. Parasitic copepods from fishes of Japan with descriptions of 26 new species and remarks on two known species. *Biological Journal of Okayama University*, 5, 89–165

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