



***Ttetaloia hoshinoi*, a new genus and species of chondracanthid copepod (Poecilostomatoida) parasitic on triplefins (Actinopterygii: Tripterygiidae) from Japanese waters**

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Abstract

A new genus and species of copepod, *Ttetaloia hoshinoi*, of the poecilostomatoid family Chondracanthidae is described based on specimens removed from the body surface of three species of triplefins (Perciformes: Tripterygiidae), *Enneapterygius etheostomus* (Jordan & Snyder) (type host), *E. miyakensis* Fricke, and *Springerichthys bapturnus* (Jordan & Snyder), collected in the coastal waters of Izu-Oshima Island and the Izu Peninsula, the North Pacific Ocean, Japan. The new genus resembles *Diocus* by sharing some important characters in the female, such as a squat trunk bearing well-developed posterolateral processes, a pair of minute caudal rami situated on the midventral surface of the genito-abdomen, and unmodified and biramous legs 1 and 2. The male of the new genus also shares distinct body somites, an atrophied tip on the antenna, and three pairs of legs with the males of *Diocus*. However, it is clearly differentiated from *Diocus* by the combination of the following characters: the female has a body comprised of a head and trunk, a head composed of the cephalosome fused with the first and second pedigers and bearing two pairs of cephalothoracic processes on the ventrolateral surface, an unsegmented, asetose antennule, and an accessory process on the terminal uncinat segment of the antenna; and the male has the cephalosome distinctly separated from the first pediger and legs 1 to 3 are all highly vestigial, with the first two pairs consisting of setose knobs and the third pair represented by a minute conical process.

Key words: parasitic copepod, Chondracanthidae, Izu Peninsula, Izu-Oshima Island, North Pacific Ocean

Introduction

The Chondracanthidae Milne Edwards, 1840 is a family of highly transformed parasitic copepods (Østergaard 2003) and its species predominantly occur in the oral or branchial cavities of marine demersal fishes (Boxshall & Halsey 2004). Thirty genera were recognized in Ho's (1970) revision of the Chondracanthidae. Since then, 17 new genera have been added to the family (see Etchegoin *et al.* 2003; Luque & Alves 2003; Østergaard 2003; Østergaard *et al.* 2003; Boxshall & Halsey 2004; Thatcher & Pereira 2004; Ho *et al.* 2011). Østergaard *et al.* (2003) recently transferred *Pharodes* C. B. Wilson, 1935 to the Chondracanthidae, and Tang & Ho (2005) resurrected *Acanthocanthopsis* Heegaard, 1945. Furthermore, Huys *et al.* (2006) relegated the Lernaesoleidae Yamaguti, 1963 to a junior subjective synonym of the Chondracanthidae (thus, the former lernaesoleid genera *Lernaesolea* C. B. Wilson, 1944 and *Bobkabata* Hogan & Benz, 1990 are by default transferred to

the family), and Huys (2009) established *Bereacanthus* Huys, 2009 as a replacement name for *Berea* Yamaguti, 1963. Since two monotypic genera, *Pseudolernentoma* Luque & Alves, 2003 and *Pterochondria* Ho, 1973, were recently regarded as a junior synonym of *Argentinochondria* Etchegoin, Timi & Sardella, 2003 and *Acanthochondria* Oakley, 1930, respectively (see Braicovich & Alarcos 2007; Tang *et al.* 2010), 49 genera are currently valid. All genera exhibit sexual size dimorphism with the females being significantly larger than the dwarf males. In this study, a new genus and species of chondracanthid copepod is described based on material collected from the body surface of three species of tripterygiid fishes (Actinopterygii; Perciformes) captured from the coastal waters of Japan.

Materials and methods

Specimens of three tripterygiid species, *Enneapterygius theostomus* (Jordan & Snyder), *E. miyakensis* Fricke, and *Springerichthys bapturnus* (Jordan & Snyder), were collected while SCUBA diving and snorkeling in the western North Pacific Ocean, off Izu-Oshima Island and the Izu Peninsula, Japan. Copepods were removed from the body surface either near the base of the pectoral fins or the bottom of the operculum of the hosts and preserved in 80% ethanol. Copepod specimens were soaked in lactophenol for 24 h before dissection. The appendages of the copepods were dissected and observed using the method of Humes & Gooding (1964). Drawings were made with the aid of a drawing tube. Morphological terminology follows Huys & Boxshall (1991). Measurements given are in millimeters and are shown as the range followed by the mean and standard deviation in parentheses. Type specimens are deposited in the crustacean collection at the National Museum of Nature and Science, Tsukuba (NSMT).

Results

Ttetaloia n. gen.

Diagnosis.

Adult female. Body consists of head and trunk. Head composed of cephalosome fused to first and second pedigers, with two pairs of digitiform processes on ventrolateral surface. Trunk without lateral outgrowths, but bears pair of large posterolateral processes, each with widely bifurcate tip. Genito-abdomen acorn-shaped, with caudal ramus. Antennule fleshy, unsegmented, asetose, and with basal constriction and tiny, conical process near tip. Antenna 2-segmented, composed of unarmed coxobasis and uncinat endopodal claw bearing accessory process at midlength. Labrum with apically blunt, conical process on each distolateral corner and pair of digitate papillae (each with small process at its base) extending beyond posterior margin. Mandible bearing serrated blade with teeth along both margins. Paragnaths not observed. Maxillule knob-like, bearing 2 tapering setae. Maxilla 2-segmented, composed of unarmed syncoxa and basis tapering into process bearing marginal teeth and 2 basal setae. Maxilliped 2-segmented, composed of syncoxa and basis fused to short claw (endopod). Legs 1 and 2 unmodified, each composed of protopod with 1 distal seta on outer margin, indistinctly 2-segmented exopod with setae, and 1-segmented endopod with setae. Legs 3 and 4 absent. Leg 5 bilobate with apical element on each lobe.

Adult male. Body with distinct somites. Cephalosome separated from first pediger. Antennule apparently 4-segmented, with indistinctly subdivided proximal segment and setae on each segment. Antenna 2-segmented, composed of coxobasis with 1 seta and unciniate endopodal claw bearing atrophied tip armed with 3 unequal setae. Labrum bearing pair of posterolateral protrusions and single median protrusion on posterior margin. Mandible as in female. Paragnaths not observed. Maxillule knob-like, with 3 setae. Maxilla as in female. Maxilliped 3-segmented, composed of syncoxa, basis, and setiform claw (endopod). Legs 1 and 2 highly reduced, each represented by knob armed with setae. Leg 3 vestigial, represented by conical process.

Type species. *Ttetaloia hoshinoi* n. sp. by original designation.

Etymology. The generic name refers to the Greek, *ttetalo*, meaning a petal, alluding to the body shape of the new genus. The gender is feminine.

Ttetaloia hoshinoi n. sp.

(Figs 1–3)

Type material. Holotype female (NSMT–Cr 22200) and allotype male (NSMT–Cr 22201), ex *Enneapterygius theostomus* (Jordan & Snyder), off Akinohama (34°47'N, 139°23'E), Izu-Oshima Island, Tokyo, North Pacific Ocean, Japan, 4 m depth, 27 April 2011, collected by O. Hoshino. Paratypes: 1 female (NSMT–Cr 22202), ex *E. theostomus*, off Akinohama (34°47'N, 139°23'E), Izu-Oshima Island, Tokyo, North Pacific Ocean, Japan, 3 m depth, 16 May 2010, collected by O. Hoshino; 2 females (NSMT–Cr 22203), ex *E. theostomus*, off Nabetahama (34°40'N, 138°56'E), Shimoda, Izu Peninsula, Shizuoka, North Pacific Ocean, Japan, 1 m depth, 23 July 2010, collected by D. Uyeno, K. Tanaka, Y. Ota, and R. Yoshida; 1 female and 1 male (NSMT–Cr 22204), ex *E. theostomus*, off Nabetahama (34°40'N, 138°56'E), Shimoda, Izu Peninsula, Shizuoka, North Pacific Ocean, Japan, 0.2 m depth, 24 July 2010, collected by Y. Ota and R. Yoshida; 1 female (NSMT–Cr 22205), ex *E. theostomus*, off Akinohama (34°47'N, 139°23'E), Izu-Oshima Island, Tokyo, North Pacific Ocean, Japan, 4 m depth, 20 April 2011, collected by O. Hoshino; 1 female and 1 male (NSMT–Cr 22206), collection data same as those of the holotype.

Other material examined. 3 females and 3 males (NSMT–Cr 22207), ex *Springerichthys bapturnus* (Jordan & Snyder), off Akinohama (34°47'N, 139°23'E), Izu-Oshima Island, Tokyo, North Pacific Ocean, Japan, 4 m depth, 16 May 2010, collected by O. Hoshino; 1 female (NSMT–Cr 22208), ex *E. theostomus*, off Akinohama (34°47'N, 139°23'E), Izu-Oshima Island, Tokyo, North Pacific Ocean, Japan, 4 m depth, 20 April 2011, collected by O. Hoshino; 1 female and 1 male (NSMT–Cr 22209), ex *E. miyakensis* Fricke, off Akinohama (34°47'N, 139°23'E), Izu-Oshima Island, Tokyo, North Pacific Ocean, Japan, 4 m depth, 10 May 2011, collected by O. Hoshino; 1 female and 1 male (NSMT–Cr 22210), ex *E. miyakensis* Frick, off Akinohama (34°47'N, 139°23'E), Izu-Oshima Island, Tokyo, North Pacific Ocean, Japan, 4 m depth, 20 May 2011, collected by O. Hoshino.

Description of female holotype. Body (Fig. 1A–C) divided into head and trunk. Body length (anterior margin of head to distal end of posterior processes on trunk) 2.10. Head (Fig. 1D) composed of cephalothorax incorporating first to second pedigers; cephalothorax shorter than wide (0.72×0.96), with pair of midlateral processes, 2 pairs of digitiform processes ventrolaterally, and well-developed dorsal shield. Trunk 2.22 wide, bearing pair of large posterolateral processes, each with widely bifurcate tip. Genito-abdomen (Fig. 1E) 0.25 long, composed of 2 indistinct somites; anterior somite (genital double-somite) large, acorn-shaped, with ventral genital apertures; anal somite (Fig. 1E–F) much smaller than genital double-somite, bearing pair of minute caudal rami distally. Caudal ramus (Fig. 1F) bearing 1 spinulated apical element, 3 setae, and 1 outer knob. Leg 5 (Fig. 1E, G) located on anterior margin of genito-abdomen, bifurcated, with single element on each tip.

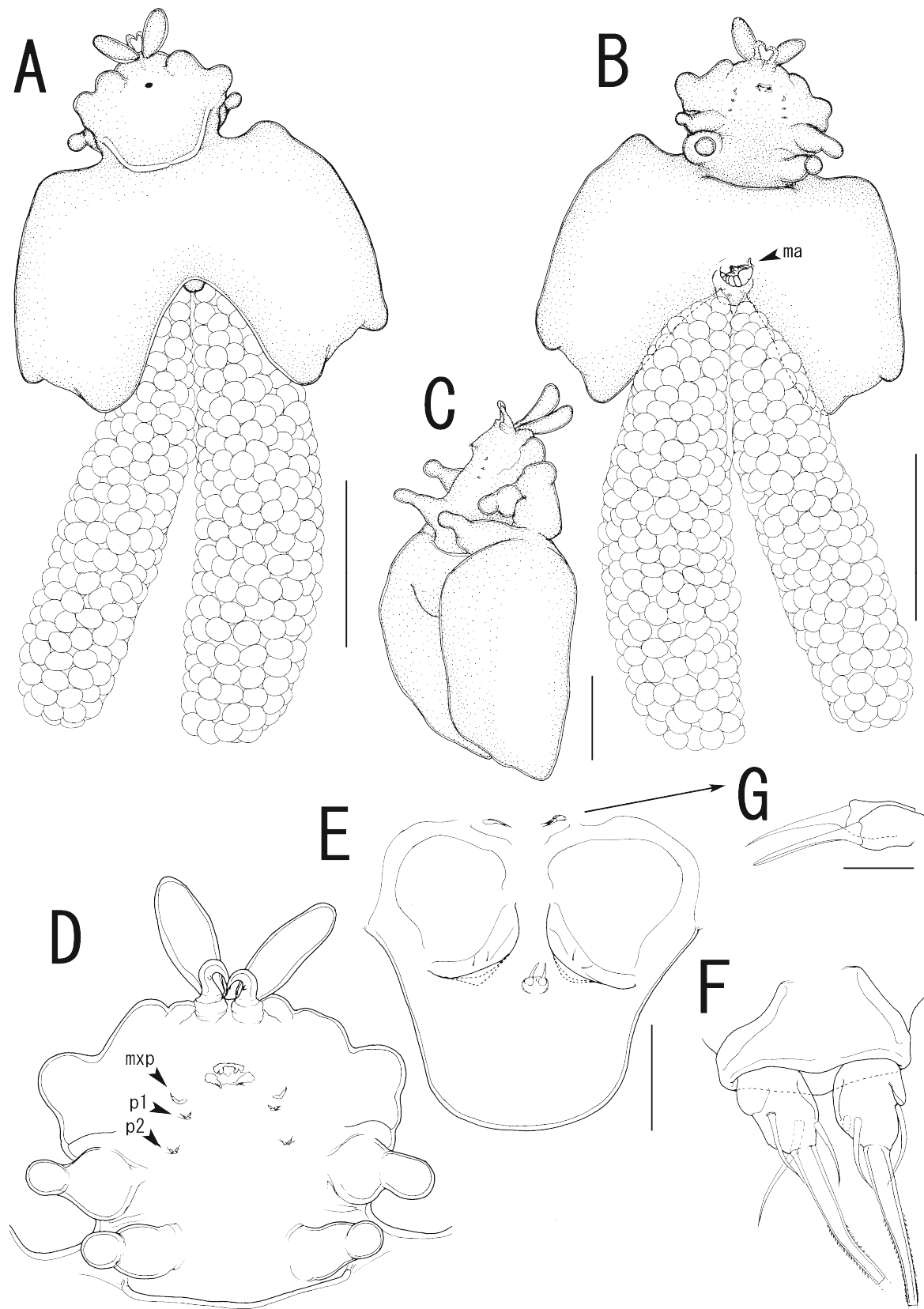


FIGURE 1. *Ttetaloia hoshinoi* n. gen. et n. sp., female holotype (NSMT–Cr 22200). A, habitus, dorsal; B, same (ma = allotype male), ventral; C, same, lateral; D, head (mxp = maxilliped, p1 = leg 1, p2 = leg 2), ventral; E, genito-abdomen, ventral; F, posterior region of genito-abdomen and caudal rami, ventral; G, leg 5. Scale bars: A–B = 1,000 μ m; C = 500 μ m; D = 400 μ m; E = 50 μ m; F–G = 10 μ m.

Antennule (Fig. 2A) unsegmented, but with basal constriction, fleshy, aetose, and with tiny, conical process near rounded tip. Antenna (Fig. 2B) 2-segmented, composed of coxobasis and endopod; coxobasis short, unarmed; endopodal segment forming uncinat e claw with accessory process at midlength. Labrum (Fig. 2C) bilobed, bearing 2 long inner processes, each with small blunt protrusion at its base. Mandible (Fig. 2D) bearing apical blade with 8 teeth on convex margin and 5 teeth on concave margin. Paragnaths not observed. Maxillule (Fig. 2E) unilobate, bearing 2 apical setae. Maxilla (Fig. 2F) 2-segmented, composed of syncoxa and basis; syncoxa unarmed; basis bearing 2 unequal basal setae and claw-like process furnished with 5 marginal teeth. Maxilliped (Fig. 2G) 2-segmented, composed of wrinkled syncoxa and rod-like basis indistinctly fused to knob with apical setiform process (endopod). Leg 1 (Figs 1D, 2H) located posterior to maxilliped on ventral side of head; protopod bearing 1 outer distal seta; exopod indistinctly 2-segmented, with constriction at midlength and 3 apical setae; endopod 1-segmented, bearing 3 apical setae. Leg 2 (Figs 1D, 2I) located posterior to leg 1, near base of anterior pair of processes on ventral side of head; protopod and rami as in leg 1, except exopod bearing 6 setae.

Variability of female. Legs 1 and 2 (Fig. 2J–K) of one paratype (NSMT–Cr 22206) bears 6 and 4 setae on the exopod and endopod, respectively. Right side of the trunk of two female specimens from “other material” (NSMT–Cr 22208, 22209) is undeveloped and lacks posterolateral processes (not figured). Measurements of the body parts of the specimens from the remaining type series and “other material” ($n = 12$) were as follows: body length (anterior margin of head to distal end of posterior processes on trunk) 1.50–3.07 (2.21 ± 0.48), cephalothorax length 0.43–0.99 (0.64 ± 0.15), cephalothorax width 0.71–1.18 (0.95 ± 0.13), trunk width 1.13–2.61 (2.13 ± 0.49), and genito-abdomen length 0.14–0.32 (0.24 ± 0.05).

Description of male allotype. Body (Fig. 3A–B) 0.24 long, with distinct somites and ventrally flexed genito-abdomen; latter with pair of opercula covering genital apertures (Fig. 3C). Cephalosome separated from first pediger. Caudal ramus (Fig. 3C) digitiform, bearing 1 distal seta and 4 subequal setae.

Antennule (Fig. 3D) unmodified, seemingly 4-segmented, with indistinctly separated proximal segment; armature formula: 7, 4, 2, 7 + 1 aesthetasc. Antenna (Fig. 3E) composed of coxobasis, with 1 inner seta, and stout, uncinat e claw (endopodal segment) bearing atrophied tip armed with 3 distal spiniform setae. Labrum (Fig. 3F) with pair of posterolateral knobs and single median knob on posterior margin. Mandible (Fig. 3G) with apical blade bearing 12 teeth on convex margin and 4 teeth on concave margin. Maxillule (Fig. 3H) knob-like, with 3 unequal setae. Maxilla (Fig. 3I) as in female, except basis with 4 teeth. Maxilliped (Fig. 3J) 3-segmented, composed of rod-like syncoxa, spinulated basis, and lanceolate terminal claw (endopod). Legs 1 and 2 (Fig. 3K–L) rudimentary; former bearing 2 setae and 1 process with tapering element; latter bearing 1 medial and 2 distal setae. Leg 3 (Fig. 3M) vestigial, represented by conical process on body surface.

Variability of male. The body length of specimens from the remaining type series and “other material” ($n = 7$) was 0.21–0.25 (0.23 ± 0.014).

Etymology. The specific name of the new species, *hoshinoi*, is dedicated to Osamu Hoshino, who is a professional diver in Izu-Oshima Island, Tokyo, and provided us with almost all of the copepod specimens used in this study.

Newly established Japanese name for *Ttetaloia hoshinoi* n. sp. Hanabira-tsubumushi.

Attachment site. All females were attached using their uncinat e antennae in the axillary region near the base of the pectoral fins (Fig. 4), except for one female which was attached to the isthmus. Males were attached to the trunk of the female immediately anterior to the genito-abdomen (Fig. 1B).

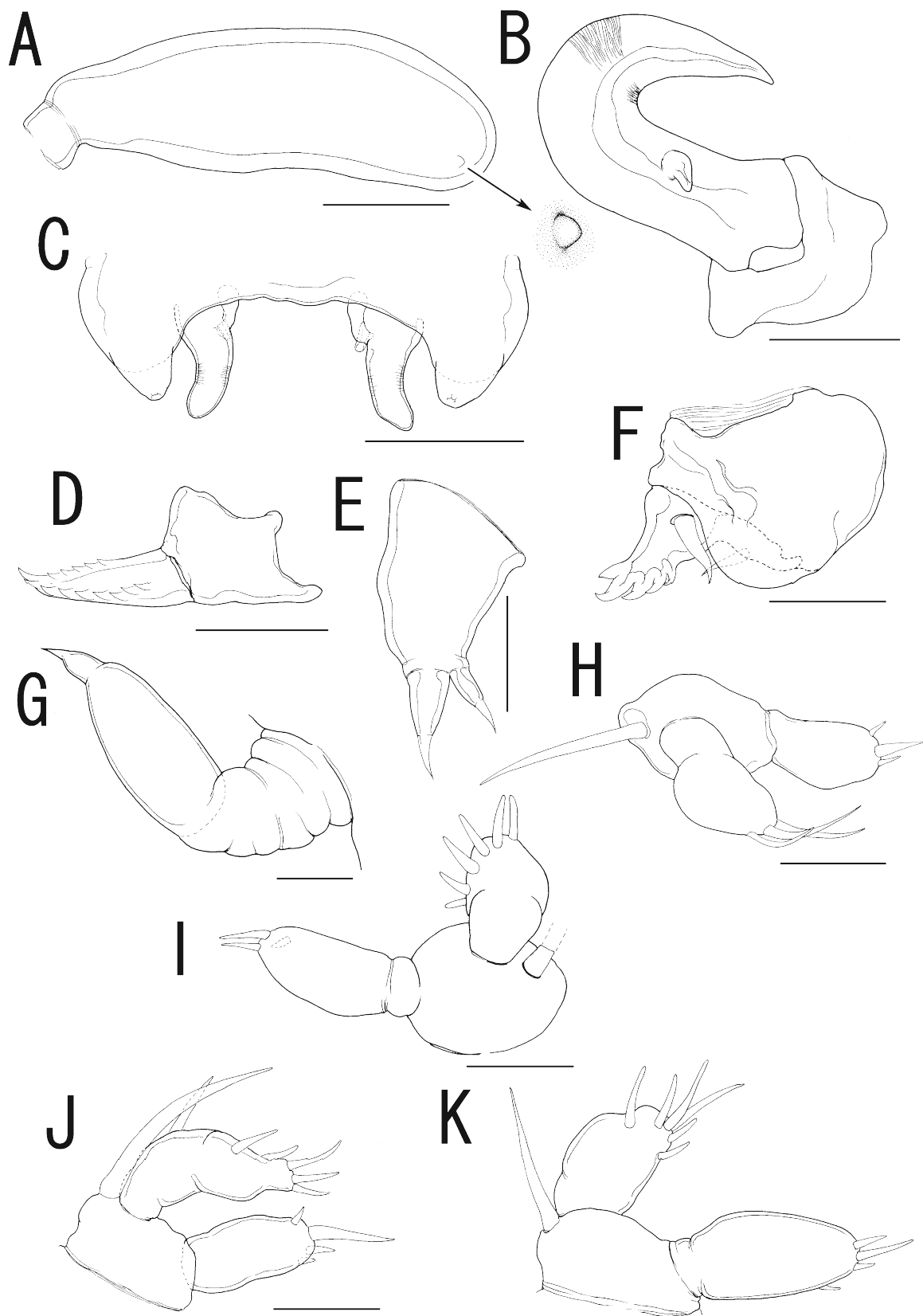


FIGURE 2. *Ttetaloia hoshinoi* n. gen. et n. sp., female holotype (NSMT–Cr 22200) (A–I) and female paratype (NSMT–Cr 22206) (J–K). A, left antennule with enlarged view of conical process near tip, posterior; B, right antenna, posterior; C, labrum, anterior; D, right mandible, posterior; E, right maxillule, posterior; F, right maxilla, posterior; G, left maxilliped; H, right leg 1, posterior; I, left leg 2, posterior; J, right leg 1, posterior; K, right leg 2, posterior. Scale bars: A = 100 μ m; B = 50 μ m; C = 30 μ m; D–F = 20 μ m; G–K = 10 μ m.

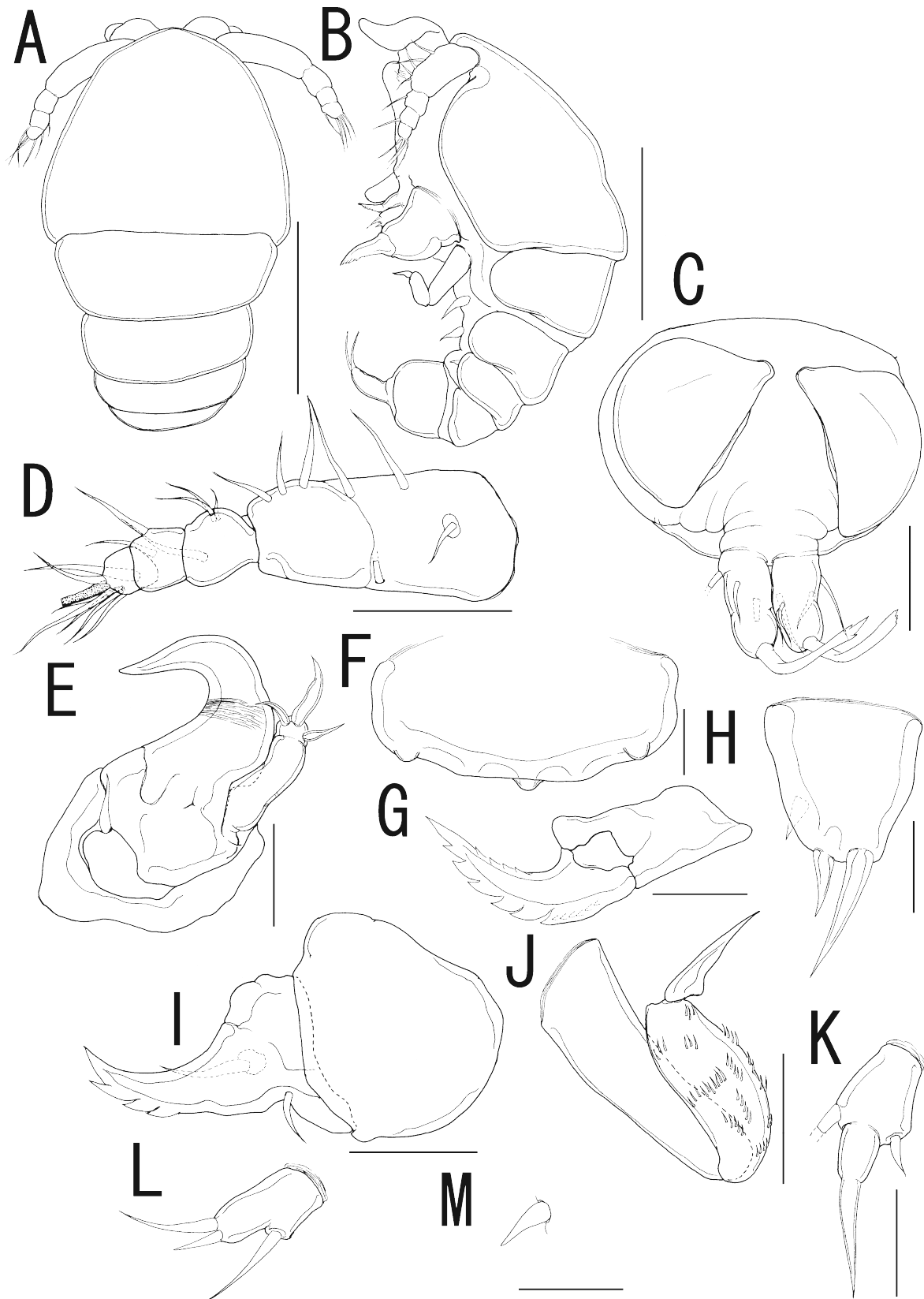


FIGURE 3. *Tietaloia hoshinoi* n. gen. et n. sp., male allotype (NSMT–Cr 22201). A, habitus, dorsal; B, same, lateral; C, genito-abdomen, ventral; D, left antennule; E, right antenna, anterior; F, labrum, anterior; G, left mandible, anterior; H, left maxillule, anterior; I, left maxilla, anterior; J, right maxilliped; K, right leg 1, anterior; L, left leg 2, anterior; M, left leg 3. Scale bars: A–B = 100 μ m; C, E, I–J = 20 μ m; D = 30 μ m; F–H, K–M = 10 μ m.



FIGURE 4. Photographs taken by O. Hoshino on 16 May 2010 showing *Ttetaloia hoshinoi* **n. gen. et n. sp.** attached in situ on *Springerichthys bapturnus* (ca. 60 mm standard length) in the coastal waters off Akinohama, Izu-Oshima Island, Japan. A, fish carrying several copepods in the axillary region near the base of each pectoral fin, dorsal; B, same fish, left-side.

Discussion

The females of *Ttetaloia* **n. gen.** closely resembles those of *Diocus* by having a squat trunk bearing well-developed posterolateral processes, a pair of minute caudal rami situated on the midventral surface of the genito-abdomen, and legs 1 and 2 unmodified and biramous. The males of *Ttetaloia* **n. gen.** also share distinct body somites, an atrophied tip on the antenna, and three pairs of legs with those of *Diocus* (see Walters 1953; Kabata & Gusev 1966; Ho 1970; Hogans & Sulak 1992; Ho & Kim 1995). However, *Ttetaloia* **n. gen.** can be clearly distinguished from *Diocus* spp. by the following characters in the female: the head is composed of the cephalosome fused with the first and second pedigers (this feature is not found in any other member of Chondracanthidae); the neck region is absent; the antennule is unsegmented, aetose, and bears a tiny conical process near the tip (vs. 3- to 6-segmented, filiform, and setose); and the antenna bears an uncinat e claw with 1 additional process on the inner surface (vs. T-shaped claw without additional process). The male of *Ttetaloia* **n. gen.** can be differentiated from that of *Diocus* by the following features: the cephalosome is distinctly separated from the first pediger (vs. completely or incompletely fused to the first pediger); and legs 1 and 2 are vestigial, each consisting of a setose knob (vs. each biramous, except for the male of *Diocus lycenchelus* Hogans & Sulak, 1992 which has a biramous leg 1 and a vestigial leg 2) (see Shiino 1960; Kabata & Gusev, 1966; Ho, 1970; Hogans & Sulak 1992; Ho & Kim 1995). Walters (1953) stated that the first two pairs of legs of the male of *Diocus frigidus* (Hansen, 1923) appeared to be uniramous, but this requires verification.

In this study, specimens of *T. hoshinoi* **n. gen. et n. sp.** were collected from the body surface of three species of tripterygiid fishes (*Enneapterygius theostomus*, *E. miyakensis*, and *Springerichthys bapturnus*). The occurrence of chondracanthids on the body surface of their hosts is rare, as they occur predominantly in the oral or branchial cavities, and occasionally in the nares and cloaca, of marine demersal fishes (Boxshall & Halsey 2004). *Ttetaloia hoshinoi* **n. gen. et n. sp.** along with *Apodoichondria medusae* Ho & Dojiri, 1988, *Diocus semilunaris* (Kabata & Gusev, 1966), and *Acanthocanthopsis quadrata* Heegard, 1945 are the only chondracanthids known thus far to attach to the outer exposed surfaces of their hosts (see Boxshall & Halsey 2004; Tang & Ho 2005).

Although various species of coastal fishes at Akinohama, Izu-Oshima Island were visually inspected for copepods while diving, there was no record of *T. hoshinoi* **n. gen. et n. sp.** on fishes of other families (Osamu Hoshino *pers. comm.*), which implies that this copepod is host specific to tripterygiid fishes.

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