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The First Record of a Species of Clausiidae (Copepoda: Cyclopoida) from Japanese Waters, with the Proposal of a New Genus

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A new genus and species of clausiid copepod (Cyclopoida), *Oshoroclausia shibazakii* n. g. n. sp., is described based on a single female collected subtidally in Oshoro Bay, on the western coast of Hokkaido, the Sea of Japan. *Oshoroclausia* is characterized by the following feature of female: elongate body lacking distinct segmentation from first pedigerous to the anal somite , 2-segmented antenna with two terminal claws, and legs 1 to 4 bearing 2-segmented rami. This is the first record of a clausiid copepod from Japanese waters.

Key Words: Clausiidae, symbiotic copepod, polychaete, Hokkaido, Sea of Japan, *Oshoroclausia shibazakii* n. g. n. sp.

Introduction

The Clausiidae (Cyclopoida) is one of the copepod families exclusively associated with polychaete hosts (Kim *et al.* 2013). Giesbrecht (1895) established the family to include three genera, *Clausia*, *Rhodinicola*, and *Seridium*. In their revision, Wilson and Illg (1955) included *Clausia*, *Mesnilia*, *Seridium*, and *Teredicola* in the family. Subsequently, *Pontoclausia*, *Pseudoclausia*, *Indoclausia*, *Stockia*, *Megaclausia*, *Synaptiphilus*, *Presynaptiphilus*, and *Likroclausia* were added to the family (Băcescu and Pór 1959; Bocquet and Stock 1960, 1963; Sebastian and Pillai 1974; O'Reilly 1995; Ho and Kim 2003). Bresciani (1964) redescribed *Rhodinicola* and recognized *Seridium* as its junior synonym. Boxshall and Halsey (2004) also reviewed and re-diagnosed the Clausiidae, excluding *Synaptiphilus*, *Presynaptiphilus*, *Stockia*, and *Teredicola* from the family. Since that revision of the family concept, *Spionicola*, *Boreoclausia*, *Sheaderia*, and *Vivgottoia* have been added (Björnberg and Radashevsky 2009; Kim *et al.* 2013). Thus, 12 genera are currently accepted as members of the family.

In this paper, a new species of clausiid is described on the basis of a single female collected on a sandy bottom in Oshoro Bay on the Sea of Japan coast of Hokkaido. A new monotypic genus is established to accommodate the new species.

Materials and Methods

Sediment samples were taken from the sediment surface layer (less than 5 cm thick) in the subtidal zone using a hand-dredge net (mesh 1 mm). After filtering the sediment samples through a fine mesh (100 μm) net, copepods were picked out under a stereomicroscope and then fixed in 70% ethanol. The present clausiid was subsequently soaked in lactophenol for about half a day, dissected, and examined using a modified version of the wooden slide method of Humes and Gooding (1964). Drawings were made with the aid of a drawing tube. The copepod body parts were measured using an ocular micrometer and measurements are given in micrometres (μm). The body length was measured from the rostral area to the anal somite including the caudal rami. The type specimen is deposited in the crustacean collection of the National Museum of Nature and Science, Tsukuba (NSMT), Japan.

Genus ***Oshoroclausia*** n. g

Diagnosis of adult female. Body elongate, cylindrical, comprising cephalothorax and indistinctly segmented postcephalothoracic trunk. Cephalothorax with projecting rostral area bearing pair of sensory elements. Segmentation of second to fifth pedigers, genital complex, and 3-segmented abdomen indistinct. Genital complex with paired lateral lobes. Caudal rami divergent, fused to anal somite at base, bearing six caudal setae.

Antennule 3-segmented, proximal segment with two proximal lobes, all segments bearing simple setae. Antenna 2-segmented; basal segment unarmed; terminal segment peanut-shaped with median crease; proximal part covered with fine spinules; distal part bearing rounded protruding lobe covered with fine spinules, three small elements, and small, knob-like distal projection armed with two serrate spines and two simple setae. Labrum triangular, bearing pointed conical posterior projection and ornamented with paired patches of fine spinules. Mandible rod-like, with distal pointed spine. Paragnath rounded with horizontal concavity, covered with hairs. Maxillule with one medial and two distal setae. Maxilla 2-segmented; proximal segment (syncoxa) unarmed; distal segment (basis) bifurcate, bearing patches of fine spinules on each tip and single blunt element on posterior margin. Maxilliped unsegmented, subdivided into large, conical basal part with row of spinules on anterior margin and small, claw-like distal part.

Legs 1 to 4 biramous with 2-segmented rami; all setae naked. Intercoxal sclerites of legs 3 and 4 absent. Leg 5 2-segmented; proximal segment (protopod) fused to pedigerous somite; terminal segment (exopod) rod-like, bearing conical distal tip with apical seta and three minute setae on posterior margin. Leg 6 represented on each side by two simple setae located at base of lateral lobe of genital complex.

Adult male. Unknown.

Type species. *Oshoroclausia shibazakii* n. sp. by original designation.

Remarks. *Oshoroclausia* shares a biramous leg 4 with *Likroclausia*, *Pontoclausia*, and *Rhodinicola* (see Băcescu and Pór 1959; Ho and Kim 2003; Kim *et al.* 2013). *Likroclausia* clearly differs from *Oshoroclausia* in its cyclopiform body bearing a pair of antler-like lateral processes on the tergites of the second to fourth pedigerous somites (see Kim *et al.* 2013) (*vs* an elongate body without lateral processes on the tergites of the pedigerous somites). *Pontoclausia* can be distinguished from the new genus by the following combination of characters: its distinctly segmented cyclopiform body, 4-segmented antenna, 3-segmented rami on legs 1 to 4, and leg 5 with a free protopod (see Băcescu and Pór 1959) (*vs* elongate body lacking distinct segmentation between first pedigerous and anal somites, 2-segmented antenna, 2-segmented rami on legs 1 to 4, and protopod of leg 5 fused to fifth pedigerous somite). *Rhodinicola* is very similar to the new genus but can be distinguished by the following characters: elongate antenna 3- or 4-segmented with four terminal claws; swimming legs bearing inner coxal setae, and leg 5 bearing setae on anterior margin (see Levinsen 1878; Laubier 1970; Ho and Kim 2003; Björnberg and Radashevsky 2011; Kim *et al.* 2013) (*vs* antenna 2-segmented, its peanut-shaped terminal segment with two terminal claws, legs 1 to 4 lacking inner coxal setae, and leg 5 without setae on anterior margin).

Etymology. The name of the new genus, *Oshoroclausia*, is composed of "Oshoro" (the type locality) and "-clausia" (a common suffix in the Clausiidae).

Oshoroclausia shibazakii n. sp.
(Figs 1–3)

Type material. Holotype female (NSMT–Cr 24117) from sandy bottom off Oshoro Marine Station (43°12′33.30″N, 140°51′31.10″E), Oshoro Bay, Hokkaido, an inlet of the Sea of Japan, 1 m depth, 30 October 2013, leg. K. Kakui.

Description of adult female. Body (Fig. 1A, B) elongate, cylindrical, 5114 long comprising cephalothorax and indistinctly segmented post-cephalothoracic trunk. Cephalothorax longer than wide, 548×387, with projecting rostral area (Fig. 1C) bearing triangular ventral margin and pair of sensory elements (Fig. 1D). Segmentation of second to fifth pedigers, genital complex, and 3-segmented abdomen indistinct. Genital complex 509 at widest point, with paired lateral lobes (Figs 1A, B, 2L). Caudal rami longer than wide 111×54, fused at base to anal somite, bearing one medial, one subterminal, and three small and one long distal setae; all setae naked.

Antennule (Fig. 1F) 3-segmented; proximal segment bearing two lobes; armature formula: 13, 6+1 aesthetasc, 7+1 aesthetasc; all setae naked. Antenna (Fig. 1G) 2-segmented; basal segment unarmed; terminal segment peanut-shaped with median crease (Fig. 1H); proximal part covered with fine spinules and distal part bearing rounded protruding lobe covered with fine spinules, three small elements, and small, knob-like distal projection (Fig. 1I) armed with two serrate spines and two simple setae. Labrum (Fig. 2A) triangular, bearing pointed conical posterocentral projection and ornamented with paired patches of fine spinules in basal region. Mandible (Fig. 2B) rod-like, with distal pointed spine. Paragnath (Fig. 2C) rounded, with horizontal concavity, surface covered with hairs. Maxillule (Fig. 2D) with one medial and two distal setae. Maxilla (Fig. 2E) 2-segmented; proximal segment (syncoxa) robust and unarmed; distal segment (basis) bifurcate, bearing patches of fine spinules on each tip and single blunt element on posterior margin. Maxilliped (Fig. 2F) unsegmented, subdivided into large conical basal part with row of spinules on anterior margin and small, claw-like distal part.

Legs 1 to 4 (Fig. 2G–J) biramous with 2-segmented rami; armature formula of legs shown in Table 1. All setae naked. Both rami of legs 1 and 2 and exopod of legs 3 and 4 bearing row of fine setules on outer margin. Intercoxal sclerites of legs 3 and 4 absent. Leg 5 (Fig. 2K) 2-segmented; proximal segment (protopod) fused to pedigerous somite armed with single distal seta; terminal segment (exopod) rod-like, bearing three minute setae on posterior margin and conical tip with basal membranous crescent and apical seta. Leg 6 (Fig. 2L) represented by two simple setae at base of lateral lobe of genital complex.

Coloration in life. Dull red (Fig. 3A, B).

Adult male. Unknown.

Host and habitat. The copepod was found in sediment on a sandy bottom. The host is unknown.

Etymology. The specific name of the new species, *shibazakii*, was chosen in honor of Mr. Koji Shibazaki, the

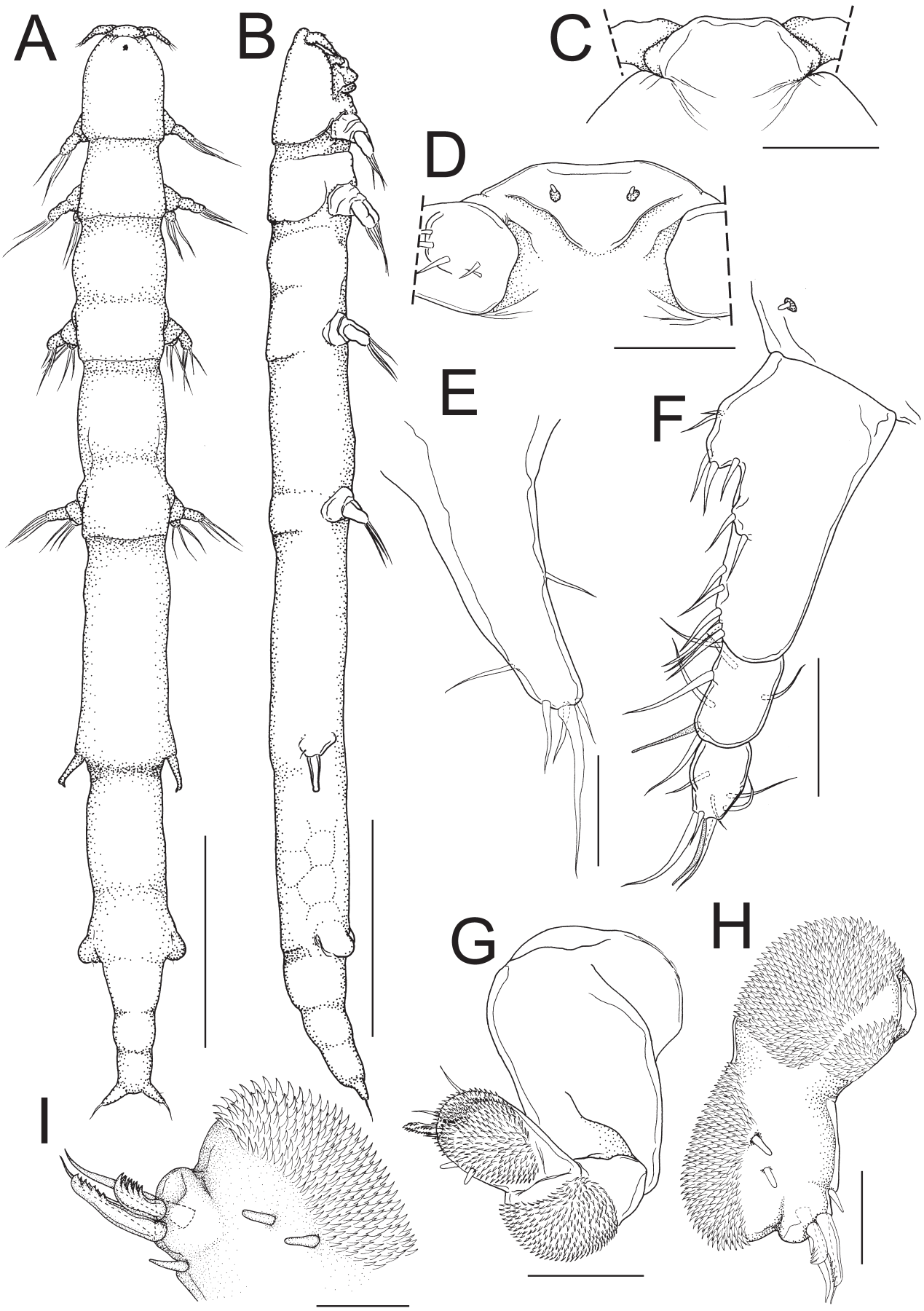

Fig. 1. *Oshoroclausia shibazakii* n. g. n. sp., holotype, adult female, NSMT–Cr 24117. A, habitus, dorsal; B, habitus, lateral; C, anterior part of cephalothorax, dorsal; D, anterior part of cephalothorax, ventral; E, left caudal ramus, ventral; F, left antennule, anterior; G, right antenna, anterior; H, terminal segment of right antenna, posterior; I, distal part of right antenna, posterior. Scale bars: A, B, 1000 μm; C, 100 μm; D–F, 50 μm; G, 30 μm; H, 20 μm; I, 10 μm.

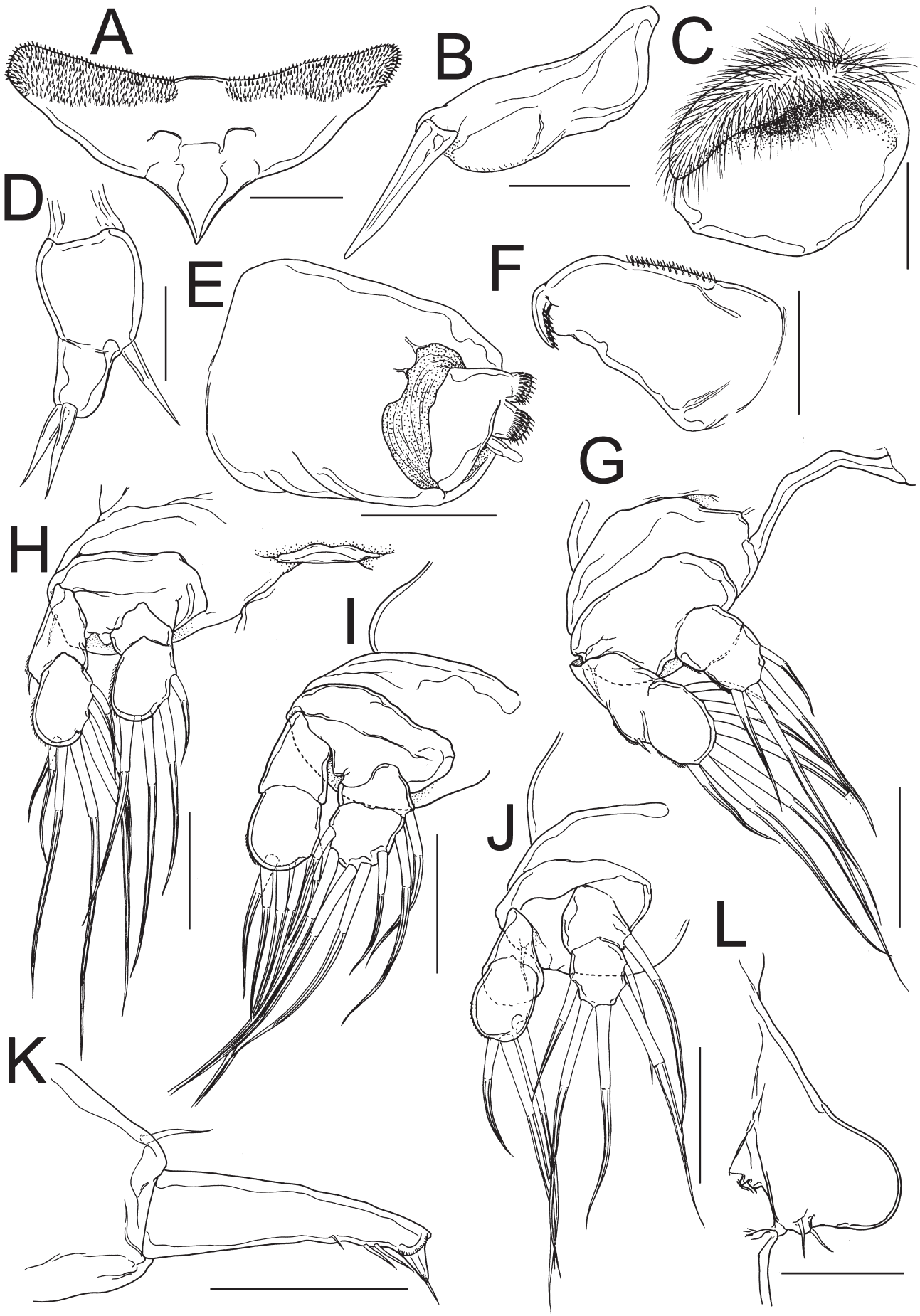
A
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Table 1. Armature formula of legs 1 to 4 of *Oshoroclausia shibazakii* n. g. n. sp., holotype, adult female, NSMT–Cr 24117. Arabic numbers = number of seta, Roman numbers = number of spines.

	Coxa	Basis	Exopod	Endopod
Leg 1	0–0	1–0	I–0; 6	0–0; 4
Leg 2	0–0	1–0	I–0; 7	0–0; 4
Leg 3	0–0	0–0	0–0; 5	0–1; 6
Leg 4	0–0	1–0	0–0; 3	0–1; 5

administrator of the Oshoro Marine Station, Hokkaido University, as a tribute to his constant, devoted support for the many researchers who undertaken fieldwork there.

Newly established Japanese name for the family, the genus and the species. Gokai-mijinko.

Discussion

Clausiids are known to be external associates of various polychaetes (*e.g.*, Boxshall and Halsey 2004; Kim *et al.* 2013). Boxshall and Halsey (2004) suggested that some species recorded in washings of other invertebrates were probably dislodged from their polychaete hosts during collection or were associated with polychaetes inhabiting other organisms such as sponges. In this study, the holotype female of *Oshoroclausia shibazakii* n. g. n. sp. was collected in sandy sediment and was not associated with a host. Since many polychaetes, including maldanids and capitellids, were collected in the same samples with the holotype, the copepod had probably become detached from its host polychaete. Boxshall and Halsey (2004) also suggested that *Pontoclausia tomis* Băcescu and Pór, 1959, a clausiid described as a free-living member of the meiofauna in the Black Sea by Băcescu and Pór (1959), may be the sole free-living clausiid. *Oshoroclausia shibazakii* has an elongate body and flexes as it moves in a vermiform fashion (Fig. 3B). The flexible body and rake-like legs 1 to 4 of the copepod would enable it to move around the host's body and in its burrow. The copepod lacks specific appendages or suckers for firmly attachment to the host. This might indicate that *O. shibazakii* has a relatively loose symbiotic relationship with its host polychaetes (*i.e.*, is frequently dissociated from the host). Kim *et al.* (2013) inferred that parasitic copepods of polychaete hosts may exist at very low prevalence rates and also that they may be easily dislodged from their hosts. Some clausiids are rare: *Boreoclausia recta* Kim, Sikorski, O'Reilly, and Boxshall, 2013, *Rhodinicola elongata* Levinsen, 1878, *R. laticauda* Ho and Kim, 2003, *R. tenuis* Kim, Sikorski, O'Reilly, and Boxshall, 2013, and *Vivgottoia garwoodi* Kim, Sikorski, O'Reilly, and Boxshall, 2013 were each described on the basis of a single female (Levinsen 1878; Ho and Kim 2003; Kim *et al.* 2013). In present study, the second author (K.K.) collected a single specimen of *O. shibazakii* after filtering more than 10 l of sediment. No additional specimens have been collected subsequently. One reason for the low encounter rate might be the above-suggested loose symbiotic behavior of copepods. If it is difficult to collect the copepod together with its host, it may be necessary to use meiofaunal collecting methods for efficient sampling because the copepod, when detached from its host, is functionally the same as meiobenthos.

Fig. 3. Coloration of live specimen of *Oshoroclausia shibazakii* n. g. n. sp., holotype, adult female, NSMT–Cr 24117. A, habitus straight, dorsal; B, habitus curved, ventrolateral. Scale bar: 500 µm.

Various crustaceans are known to synthesize or possess hemoglobin (*e.g.*, Fox 1957; Terwilliger and Ryan 2001), the dull red body color of *Oshoroclausia shibazakii* extends over the whole body, not just in the gut and ovary (Fig. 3A, B), it may possess hemoglobin in its body fluid. In copepods, hemoglobin has been found in species living in habitats with low-oxygen conditions, such as muddy sediments or hydrothermal vents (*e.g.*, Fox 1957; Hourdez *et al.* 2000). Itoh and Nishida (2008) suspected that the red color of the body of *Hemicyclops spinulosus* Itoh and Nishida, 1998 (Cyclopoida: Clausidiidae) was due to the presence of hemoglobin. This copepod is an associate of crab and polychaete burrows in mud-flats. The habitat of *O. shibazakii* is anaerobic fine sandy sediment mixed with mud and is likely to be similar

Fig. 2. *Oshoroclausia shibazakii* n. g. n. sp., holotype, adult female, NSMT–Cr 24117. A, labrum; B, left mandible; C, left paragnath; D, left maxillule, anterior; E, right maxilla, anterior; F, left maxilliped; G, right leg 1, anterior; H, right leg 2, anterior; I, right leg 3, anterior; J, right leg 4, anterior; K, left leg 5, dorsal; L, right leg 6 and lateral lobe, dorsal. Scale bars: A, C, F, 30 µm; B, D, 20 µm; E, 50 µm; G–L, 100 µm.

to that of *H. spinulosus*.

The discovery of *O. shibazakii* n. g. n. sp. is the first record of a clausiid from Japanese waters. During the last two decades, many previously unreported or poorly known benthic invertebrates have been found and described from Oshoro Bay, the type locality of *O. shibazakii* n. g. n. sp. (*e.g.* Shimomura and Mawatari 2001; Kajihara 2002; Shimada *et al.* 2009; Kakui *et al.* 2012; Yamasaki *et al.* 2012; Yoshihara *et al.* 2012). This might indicate that a diversity of habitats in good condition exists in Oshoro Bay, and further field surveys investigating the richness of the marine and coastal fauna are required in this area.

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