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Markevitchielinus anchoratus Titar, 1975 (Copepoda: Chondracanthidae) parasitic on sea raven *Hemitripterus villosus* (Pallas, 1814) (Actinopterygii: Hemitripteridae), with the range extension of the copepod in the Northwestern Pacific Ocean

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Abstract.— *Markevitchielinus anchoratus* Titar, 1975 is reported based on an adult female from the floor of the buccal cavity of a sea raven *Hemitripterus villosus* (Pallas, 1814) caught in Onagawa Bay, an inlet of the Northwestern Pacific Ocean, Miyagi Prefecture, northern Japan. The female specimen is briefly described. The female inserted its head with a pair of large, lateral processes and the anterior part of an elongate neck into the tissues of the buccal cavity floor. The present collection of *M. anchoratus* represents the third occurrence record of the species and extends its distributional range from Kunashiri and Shikotan islands, east of Hokkaido, to Onagawa Bay off Honshu, the largest main island of Japan. The species is specific to the sea raven and may be a subarctic species.

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Key words: parasitic copepod, marine fish parasite, new distribution record

■ Introduction

Markevitchielinus anchoratus Titar, 1975 is a marine fish parasite in the Northwestern Pacific Ocean and belongs to the copepod family Chondracanthidae Milne Edwards, 1840. Titar (1975) erected the monotypic genus *Markevitchielinus* to accommodate *M. anchoratus*. While the original description of the species was brief (Titar, 1975), Kabata (1979) later redescribed it in detail. The specimens of *M. anchoratus* have been collected only from two nearby islands, Kunashiri and Shikotan islands, east of Hokkaido, northern Japan (Titar, 1975; Kabata, 1979). The sea raven, *Hemitripterus villosus* (Pallas, 1814), is the only known host for this parasite.

In 2009, we found a copepod on the floor of the buccal cavity of a sea raven caught in Onagawa Bay, Miyagi Prefecture, northern Honshu, Japan. The general appearance of the copepod was very unusual with its body carrying large rounded outgrowths and, as reported below, the copepod was identified as *M. anchoratus*. This represents the third occurrence record of the species. Because the biology of *M. anchoratus* remains poorly studied, this paper briefly redescribes the species and discusses its host specificity, geographical distribution, and attachment mode.

■ Materials and Methods

One specimen of *H. villosus* infected by the copepod was caught with a bottom gillnet on 28 February 2009 in Onagawa Bay (38°26′05″ N, 141°27′45″E, locality 3 in Fig. 1) off Konorihama, Onagawa, Miyagi Prefecture, north-

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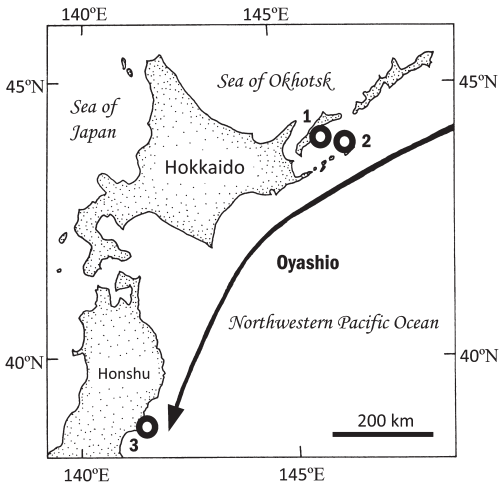

Fig. 1. Map of northern Japan, showing the previous and present collection localities (open circles) of *Markevitchielinus anchoratus*. 1, Kunashiri Island (Titar, 1975); 2, Anama Bay, Shikotan Island (Kabata, 1979); 3, Onagawa Bay, Miyagi Prefecture (this paper). Since no detailed information on the collection site of *M. anchoratus* was given by Titar (1975), it is provisionally plotted near the center of the coast of Kunashiri Island. The route of a cold current, the Oyashio, is shown based on Isoguchi & Kawamura (2006).

ern Honshu, Japan. The fish was transported frozen to the laboratory of Hiroshima University, Higashi-Hiroshima, where it was thawed, measured for its standard length (SL, mm), and examined for the copepod. After the copepod was carefully removed from the fish, it was fixed in 5% formalin and then preserved in 70% ethanol. Later, at the Aquaparasitology Laboratory, Shizuoka, the copepod specimen was observed with an Olympus SZX10 stereo microscope. Since only one copepod specimen was collected, it was not dissected, thus minute appendages were not observed. Drawings were made with the aid of a drawing tube fitted on the stereo microscope. As illustrated in Fig. 3, the specimen bears some processes on the trunk and, following Kabata (1979), those processes are individually differentiated by alphabets (a, b, c, d, d′, e). Voucher copepod speciemen is deposited in the Crustacea (Cr) collection of the National Museum of Science and Nature, Tsukuba, Ibaraki Prefecture (NMST-Cr 31013).

Results

Family **Chondracanthidae**
Milne Edwards, 1840
[Japanese name: Tubumushi-ka]
Genus ***Markevitchielinus*** Titar, 1975
[Japanese name: Ikari-tsubumushi-zoku, based on Nagasawa *et al.* 2013]
Markevitchielinus anchoratus Titar, 1975
[Japanese name: Ikari-tsubumushi, based on Nagasawa *et al.* 2013]
(Figs 2–3)

Markevitchielinus anchoratus Titar, 1975: 59–61, fig. 1; Kabata 1979: 43–45, figs 1–8; Kabata 1981: 19, fig. 4E; Østergaard 2003: 142 [Russian to English translation of Kabata (1979)]; Huys *et al.* 2006: 417; Nagasawa *et al.* 2013: 131.

Adult female. Body (Fig. 3A) comprising head, neck, and trunk, and bending at neck-trunk junction. Length from anterior margin of head to posterior end of neck 9.9 mm and that of trunk including posterolateral processes 8.8 mm. Head with a pair of large, blunt lateral processes (7.0 and 5.9 mm wide). Antenna (Fig. 3B) distinctly two-segmented; first segment stout with two swellings (one larger than another) near anterior margin, second segment a curved claw. Neck elongate and divisible by shallow constriction into cylindrical anterior part (7.1 mm long) and shorter, slightly wider and wrinkled posterior part (3.2 mm long). Trunk longer than wide (8.8 × 6.1 mm, including posterolateral processes), bearing two pairs of large, lateral oviform processes (a and b in Fig. 3B, C), a pair of large, ventral oviform or fava bean-shaped processes (c in Fig. 3B, C), a pair of long, blunt posterolateral processes (6.2 and 6.0 mm long, d in Fig. 3B, C) and a dorsomedial process at posterior end (e in Fig. 3B, C). Posterolateral processes slightly wider around midlength, each carrying a dorsal, oviform process in anterior region (d′ in

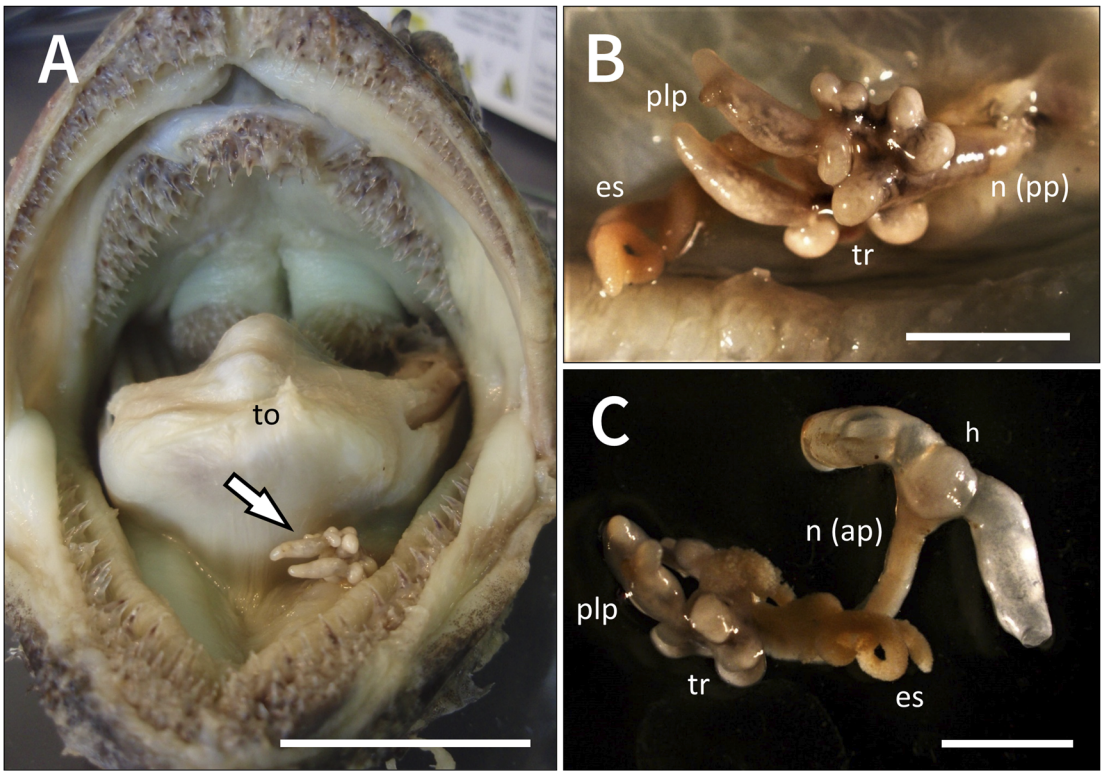

Fig. 2. *Markevitchielinus anchoratus*, adult female, NSMT-Cr 31013, parasitic on *Hemitripterus villosus* in Onagawa Bay, Miyagi Prefecture, northern Japan. A, copepod (arrow) attached to host's buccal cavity floor; B, copepod inserting its head and anterior part of neck into host's tissues; C, copepod removed from host. The posterior part of the neck is not seen because it was behind the egg sac (Fig. 2C). Frozen-thawed specimen. Abbreviations: es, egg sac; h, head; n (ap), anterior part of neck; n (pp), posterior part of neck; plp, posterolateral process; to, tongue; tr, trunk. Scale bars: A, 20 mm; B, C, 5 mm.

Fig. 3B, C). Genito-abdomen wider than long, egg-shaped. Egg sac long, slightly coiled, containing rows of small eggs. No legs on neck and trunk.

Locality. Onagawa Bay, an inlet of the Northwestern Pacific Ocean, off Konorihama, Onagawa, Miyagi Prefecture, northern Honshu, Japan.

Host. *Hemitripterus villosus* (Pallas, 1814) (Actinopterygii: Perciformes: Hemitripteridae).

Site of infection and attachment mode. Floor of the buccal cavity (Fig. 2). The copepod was found on the floor near the anterior base of the tongue. It inserted its head with large, blunt lateral processes and the anterior part of an elongate neck into the host's tissues (see Fig. 3A for the boundary between the anterior and posterior parts of the neck). The posterior part of the neck and the trunk protruded externally.

Remarks. The morphological characters of the adult female specimen collected in this study correspond to the original description and the redescription of *M. anchoratus* made by Titar (1975) and Kabata (1979), respectively, and the specimen is identified as *M. anchoratus*. While Kabata (1979, translated in Østergaard (2003)) called the neck "the posterior part of the cephalothorax", this species is characterized by the head with a pair of large, blunt lateral processes, an elongate neck, and the trunk with large processes and a pair of long, posterolateral processes (Fig. 3). There are no legs in the neck and trunk regions. Two swell-

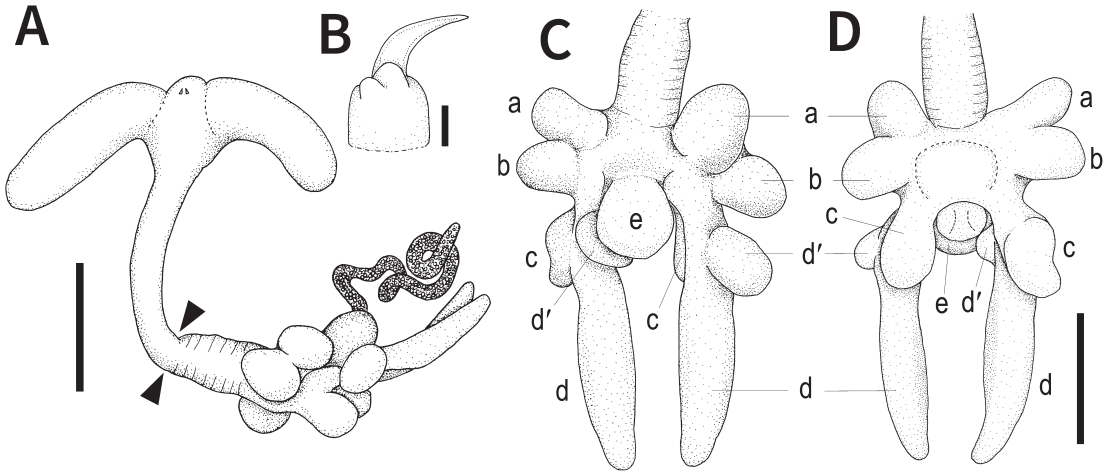

Fig. 3. *Markevitchielinus anchoratus*, adult female, NSMT-Cr 31013. A, habitus, ventrolateral view; B, antenna, ventral view; C and D, posterior part of neck and trunk, dorsal and ventral views, respectively. Two triangles indicate the boundary between the anterior and posterior parts of the neck (Fig. 3A). Following Kabata (1979), alphabets (a, b, c, d, d′, e) are used to distinguish individual processes on the trunk (Fig. 3C, D). Since one egg sac was missing, only the remaining egg sac is shown (Fig. 3A). The latter egg sac is omitted to show the trunk morphology (Fig. 3C, D). Scale bars: A, 5 mm; B, 0.1 mm; C, D, 3 mm.

ings were found near the anterior margin of the first segment of the antenna in the specimen (Fig. 3B), but Kabata (1979) did not state such swellings. In the present study, the nondissected specimen was examined using the stereo microscope, and the presence of the antennule, mouth, labrum, and other minute appendages was not confirmed. However, according to Kabata (1979), the antenulle is short, unsegmented, and apically armed with short setae; the mandible has a terminal blade with teeth of nearly same size on both inner and outer margins; the maxilliped is three-segmented, comprising a strong first segment, a shorter second segment, and third segment with a curved hook; and the paragnath, maxillule, and maxilla are not present. Kabata (1979) mentioned that "the mouth is very small and difficult to find. The mouth parts are very reduced (e.g. no spinules on medial part of maxilliped) and are clearly smaller than those of the majority of chondracanthid species" (Østergaard, 2003). No male has so far been discovered or described.

Only one specimen of *M. anchoratus* was collected from the fish examined (330 mm SL) from Onagawa Bay. Prevalence and intensity of infection have not been reported to date (Titar, 1975; Kabata, 1979).

■ Discussion

Markevitchielinus anchoratus has so far been reported only from sea raven *H. villosus* (Titar, 1975; Kabata, 1979; this paper), which indicates that this parasite is specific to this fish species. The copepod has been collected from the waters around Kunashiri and Shikotan islands east of Hokkaido, northern Japan (Titar, 1975; Kabata, 1979, locations 1 and 2 in Fig. 1), and the present collection extends its distributional range from the two islands to Onagawa Bay off Honshu, the largest main island of Japan (location 3 in Fig. 1). In the original description of the species, Kunashiri Island was reported as its type locality without detailed information on the collection site (Titar, 1975). Furthermore, the collection site at Shikotan Island was erroneously reported as "Anam Bay" (Østergaard, 2003), but the correct name is Anama Bay.

The Oyashio, a cold current, flows south-

westward in the Northwestern Pacific Ocean (Fig. 1) and affects the water temperatures off the Pacific coast of northern Japan (Isoguchi & Kawamura 2006; Kuroda *et al.*, 2015) and *M. anchoratus* may be regarded as a subarctic species. Nonetheless, the sea raven is known to widely occur in the Northern North Pacific Ocean and adjacent seas (Antonenko *et al.*, 2010). Thus, it is desirable to examine specimens of sea raven from various localities in order to clarify the geographical distribution of *M. anchoratus*.

Kabata (1979) found a much reduced lateral process of the head in an immature specimen of *M. anchoratus* and stated that such reduction might have been caused by the host tissue immunity. However, as described above, lateral processes of the head were not reduced in the adult specimen examined in this study (Figs 2C, 3A). The holotype (adult female) of the species also had the head with a pair of lateral processes being of almost the same size (Titar, 1975). It is thus unlikely that the reduced lateral process observed by Kabata (1979) was related with the host tissue immunity.

As shown in Fig. 2A, the specimen of *M. anchoratus* was found on the floor of the buccal cavity of the fish examined. When Titar (1975) originally described the species, he similarly reported "the oral cavity" as attachment site. However, Kabata (1979) stated that the species was found in "the gill cavity", and Østergaard (2003) reported it "the branchial cavity" in the English translation of Kabata's paper.

The head with a pair of large lateral processes of *M. anchoratus* and its anterior part of an elongate neck were found buried in the tissues of the host's buccal cavity floor. Since this floor moves actively especially when a fish feeds, such anchorage of the head and neck in the host's tissues is inferred to prevent the copepod from being detached from the fish host.

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