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Article *in* Crustacean Research · January 2018

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Ceratothoa verrucosa (Isopoda: Cymothoidae) attached by *Choricotyle elongata* (Platyhelminthes: Monogenea) in the mouth cavity of red seabream *Pagrus major*

Kazuya Nagasawa, Masato Nitta

Abstract.— Over more than one century since 1894, cymothoid isopods attached by the diclidophorid monogenean *Choricotyle elongata* (Goto, 1894) in the mouth cavity of Japanese sparids have not been exactly identified. This note reports that those isopods are identifiable as *Ceratothoa verrucosa* (Schioedte & Meinert, 1883) based on material of the species attached by *Ch. elongata* in the mouth cavity of a red seabream, *Pagrus major* (Temminck & Schlegel, 1843), from the Seto Inland Sea.

Key words*: fish parasite, monogenean, attachment site*

Monogeneans (Platyhelminthes) are mostly ectoparasites of fishes (Yamaguti, 1963). They are usually found on the external surface (mainly the skin and gills) of fishes. The diclidophorid monogenean *Choricotyle elongata* (Goto, 1894), originally described as *Diclidophora elongata*, is a mouth-cavity parasite of crimson seabream, *Evynnis tumifrons* (Temminck & Schlegel, 1843), and red seabream, *Pagrus major* (Temminck & Schlegel, 1843) (Goto, 1894; Yamaguti, 1938, 1963; Maran et al., 2014), both of which belong to the actinopterygian family Sparidae. As early as 1894, a curious association between this monogenean species and an isopod was reported by Goto (1894: 177, 211), in which the species was found to be attached to "the caudal segment of a *Cymothoa*" in the mouth cavity of *E. tumifrons* (reported as *Pagrus tumifrons*) from Mogi, Nagasaki Prefecture, and/or Hakodate, Hokkaido, Japan. *Cymothoa* is a genus of the fish-parasitic isopod family Cymothoidae. Subsequently, a similar observation was made by Yamaguti (1938: 27) for the same monogenean species being attached to the other cymothoid species "*Meinertia oxyrhynchaena*" in the mouth cavity of *P. major* (as *Pagrosomus unicolar*) from the Seto Inland Sea, Japan. In a monograph of Monogenea, Yamaguti (1963) reported that *Ch. elongata* occurs "sometimes on *Cymothoa* or *Meinertia* parasitic in mouth cavity" of the two sparids. Recently, Yamauchi (2009) has suggested that the isopod reported by Yamaguti (1938) was misidentified. Moreover, since no species of *Cymothoa* has been reported from Japanese sparids (Yamauchi, 2016), it is impossible to refer to identification of the isopod reported by Goto (1894). In other words, over more than 120 years since 1894, isopods attached by *Ch. elongata* in the mouth cavity of *E. tumifrons* and *P. major* have not been exactly identified. Moreover, no specimens of the isopods reported by Goto (1894) and Yamaguti (1938) could be located because these authors were not scientists working on cymothoid isopods and probably did not deposit their specimens. During a recent parasitological study of *P. major* in the Seto Inland Sea, we found a mouth-dwelling cymothoid isopod attached by *Ch. elongata* (Fig. 1A).

Three individuals of *P. major* commercially caught in the western Seto Inland Sea on 2 May 2017 were purchased at a fishing port, Imabari, Ehime Prefecture, and transported on ice to the laboratory at Hiroshima University, Higashi-Hiroshima, Hiroshima Prefecture,

Received: 26 Sept 2017. Accepted: 5 Dec 2017. Published online: 13 Jan 2018.

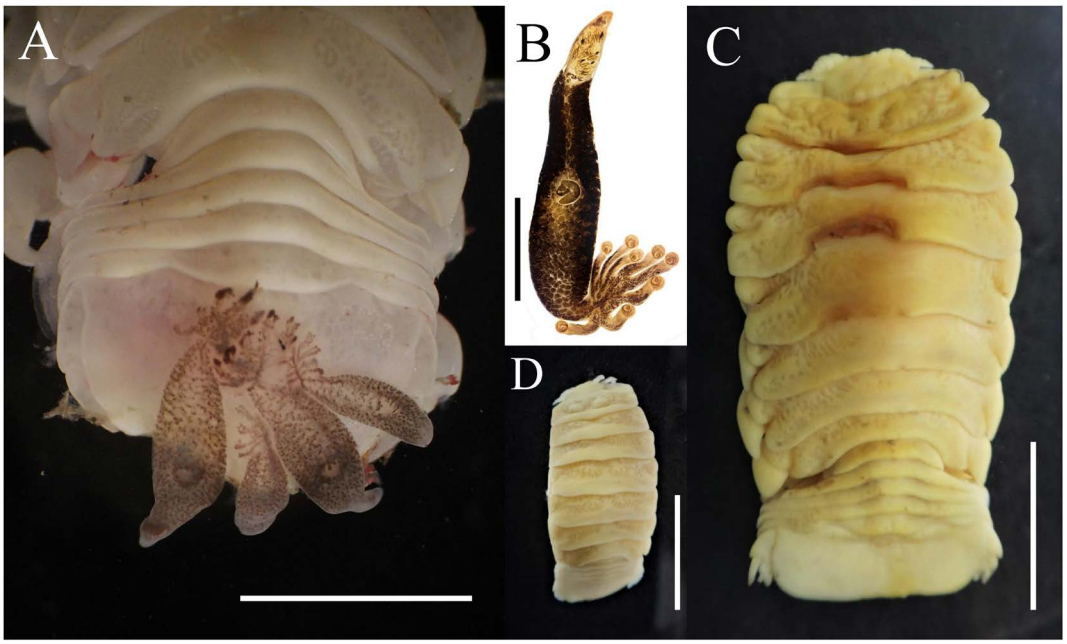

Fig. 1. A, four individuals of *Choricotyle elongata* being attached to the pleotelson of ovigerous female *Ceratothoa verrucosa*, live specimens, dorsal view; B, whole body of one individual of *Ch. elongata* collected from *Ce. verrucosa*, Heidenhain's iron hematoxylin stained specimen, ventral view; C and D, ovigerous female and male of *Ce. verrucosa*, respectively, alcohol-preserved specimens, NSMT-Cr 25615, dorsal view. Scale bars: A, 5 mm; B, 3 mm; C and D, 10 mm.

where they were measured for standard length (SL) and examined for ecto- and endoparasites. Two individuals of cymothoid were found in the mouth cavity of one of these fish (197–257 mm SL) and identified as an ovigerous female and a male of *Ce. verrucosa*.

In total, five individuals of *Ch. elongata* were found in this study: four of them were attached using their opisthohaptor to the dorsal surface of the pleotelson of female *Ce. verrucosa* (Fig. 1A), while the remaining one occurred on the gill rakers of the fish. No individual of *Ch. elongata* was found on the male isopod. Specimens of *Ch. elongata* (Fig. 1B) collected from the isopod were fixed in acetic acid-formalin-alcohol between slide and cover glasses, stained in Heidenhain's iron hematoxylin, dehydrated in a series of ethanol, and mounted in Canada balsam. They measured 7.6–11.5 mm in total length including the opisthohaptor (n = 3).

The ovigerous female of *Ce. verrucosa* (Fig. 1C), 32.7 mm in total length (TL) and 16.5 mm in body width (BW), is morphologically characterized by an oval body, wide anterolateral projections on the first pereonite, uneven dorsal surface of the anterior pereonites, and short uropods not extending to the posterior margin of the pleotelson, which correspond to the description of female given by Shiino (1954) and Hadfield et al. (2016). The male (Fig. 1D) has a smaller (20.2 mm TL, 9.4 mm BW), nearly rectangle body, as figured by Shiino (1954).

No information is available on the morphology of "*Cymothoa*" (Goto, 1894) and "*Meinertia oxyrhynchaena*" (Yamaguti, 1938) for their identification. Nonetheless, the latter species has recently been regarded as *Ceratothoa oxxrrhynchaea* Koelbel, 1878, which uses various fishes as its hosts in the Far East Asian waters, the Mediterranean Sea, and the north-east Atlantic Ocean, but there is no record of the spe-

cies from sparids including *P. major* in Japanese waters (Yamauchi, 2009). In contrast, *Ce. verrucosa* is the only cymothoid species which has been reported from *E. tumifrons* (Nagasawa & Isozaki, 2016; Hata et al., 2017) and *P. major* (*e.g.*, Hiraiwa, 1934; Sanada, 1941; Shiino, 1954; Nunomura, 1985; Yamauchi & Nunomura, 2010; Nagasawa, 2017; Hata et al., 2017) in Japan, and it is thus reasonable to regard the isopods previously reported as "*Cymothoa*" (Goto, 1894) and "*Meinertia oxyrhynchaena*" (Yamaguti, 1938) from Japanese sparids as a single species, *Ce. verrucosa*.

Goto (1894) stated that *Ch. elongata* is a parasite that infects the mouth-cavity wall of sparids and regarded the occurrence of *Ch. elongata* on mouth-dwelling isopods as "accidental." However, since such an unusual occurrence of the species on isopods has been observed by Yamaguti (1938) and in this study as well, we need more information to judge whether *Ch. elongata* only accidentally attaches to the body of *Ce. verrucosa* or not.

The pleotelson of *Ce. verrucosa* was found to be attached by *Ch. elongata* in this study, and Goto (1894) also found an individual of *Ch. elongata* on "the caudal segment of a *Cymothoa*," which may indicate that the pleotelson of *Ce. verrucosa* is a frequent site for attachment by *Ch. elongata*. Recently, Maran et al. (2014) found *Ch. elongata* on the "gills/opercular cavity" of *P. major* in Korea. In the present study, we also found one individual of *Ch. elongata* on the gill rakers of *P. major*. Based on these observations, *Ch. elongata* may use various sites in the mouth cavity and gill region of a host fish.

The specimens of *Ce. verrucosa* are deposited in the Crustacea (Cr) collection of the National Museum of Nature and Science, Tsukuba, Ibaraki Prefecture, Japan (NSMT-Cr 25615). Those of *Ch. elongata* will be redescribed and then deposited at the museum.

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