Mothocya parvostis or *Mothocya sajori* ?: cymothoid (Isopoda) parasitic on Japanese halfbeak, *Hyporhamphus sajori*, in Hiroshima Bay, the Seto Inland Sea, Japan

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Abstract

Five ovigerous females and five males of cymothoid isopod were collected from the branchial cavity of five individuals of Japanese halfbeak, *Hyporhamphus sajori* (Temminck and Schlegel, 1846), in Hiroshima Bay, the Seto Inland Sea, Hiroshima Prefecture, Japan. They were found in female-male pairs. The isopod resembled *Mothocya parvostis* Bruce, 1986 and *Mothocya sajori* Bruce, 1986, but the body length (BL) of the five ovigerous females ranged from 17.0 to 19.4 (mean, 18.4) mm, which do not correspond to the BL ranges of the ovigerous females of *M. parvostis* (11.0–15.0 mm) and M. sajori (20.5–27.5 mm) reported in the original descriptions of these species. Thus, the isopod collected cannot be identified as either *M. parvostis* or *M. sajori* and is herein reported as *Mothocya* sp. It is highly probable that *M. parvostis* and *M. sajori* are indistinguishable from each other and regarded as conspecific. A taxonomic work of these two species is needed.

Introduction

Japanese halfbeak, *Hyporhamphus sajori* (Temminck and Schlegel, 1846), has been reported since the mid-1930's to have isopod infection in Japanese waters. The isopod was earlier identified as *Irona melanosticta* (Schioedte and Meinert, 1884) (Hiraiwa, 1934; Inouye, 1941; Shiino, 1951, 1965, 1979; Ogawa, 1952; Hattori and Seki, 1956; Nunomura, 1981: 55) or *Irona* sp. (Nunomura, 1981: 55–56). However, since the mid-1980's, *Mothocya parvostis* Bruce, 1986 and *Mothocya sajori* Bruce, 1986 have been reported to infect Japanese halfbeak (Bruce, 1986; Nunomura, 1987, 1995, 2011; Saito et al., 2000; Yamauchi et al., 2004; Yamauchi and Nunomura, 2010; Yamauchi, 2016; Kawanishi et al., 2016; Hata et al., 2017; Yamauchi and Kashio, 2018; Nagasawa, 2020a; Nagasawa and Tawa, 2020).

Nonetheless, very recently, Nagasawa (2020b) reported isopods from Japanese halfbeak in northern Japan as *Mothocya* sp., which resembled *M. parvostis* and *M. sajori* but differed in body length from these two species. This information is important in identification of *M. parvostis* and *M. sajori* because their body length has been regarded as one of the important characters to differentiate them from each other (Bruce, 1986). Herein, I report on a similar observation of the body length of isopod from Japanese halfbeak captured in Hiroshima Bay, the Seto Inland Sea, Japan.

Materials and Methods

In total, 10 specimens of cymothoid isopod kept in five vials were recently found in the parasite collection at the Aquaparasitology Laboratory, Shizuoka Prefecture, Japan. These specimens were given to me in mid-June 2006 by the students of the Aquaculture Laboratory, Hiroshima University, who took them from five individuals of Japanese halfbeak caught using hook and line on 15 June 2006 in Hiroshima Bay (the Seto Inland Sea) off the southeast coast of Ujina-jima Island, Moto-Ujina, Hiroshima City, Hiroshima Prefecture, Japan. The students found two individuals of isopod on each fish and fixed them in 70% ethanol in the same vial. No data were taken on the body size of the fish examined and infected. At the Aquaparasitology Laboratory, the specimens were examined using an Olympus SZX10 stereo microscope. They were measured for body length (BL, mm, from the anterior margin of the cephalon to the posterior margin of the pleo-

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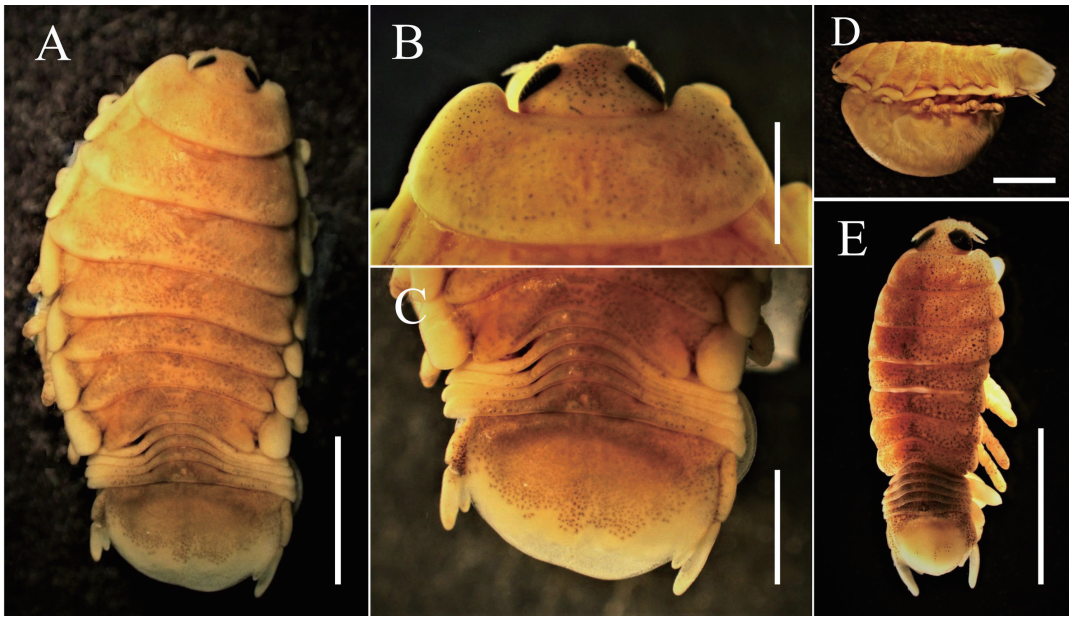

Fig. 1. *Mothocya* sp., ovigerous female (18.5 mm BL) and male (11.0 mm BL), NSMT-Cr 28228, from the branchial cavity of a Japanese halfbeak, *Hyporhamphus sajori*, in Hiroshima Bay, the Seto Inland Sea, Hiroshima Prefecture, Japan. Ethanol-preserved specimens. A, female, habitus, dorsal view; B, female, cephalon and pereonite 1, dorsal view; C, female, pereonite 7, pleon, and pleotelson, dorsal view; D, female, habitus, lateral view; E, male, dorsal view. Scale bars: A, 5 mm; B, C, 2 mm; D, E, 5 mm.

telson) and for body width (BW, mm, across the widest pereonite). Voucher specimens (three females and three males in pairs) of isopod have been deposited in the Crustacea collection of the National Museum of Nature and Science, Tsukuba, Ibaraki Prefecture, Japan (NSMT-Cr), while the remaining specimens are kept at the Aquaparasitology Laboratory for a future taxonomic study of cymothoids parasitic on Japanese fishes. The scientific and common names of Japanese halfbeak mentioned in this paper follow Froese and Pauly (2019).

Results

Mothocya sp.

(Figs. 1–3)

Material examined. Five ovigerous females (18.3, 18.5, 19.4, 18.6, 17.0 mm BL), five males (12.1, 11.0, 11.4, 9.2, 9.9 mm BL), Hiroshima Bay (the Seto Inland Sea) off southeast coast of Ujina-jima Island (34°20′ 38.7″N, 132°27′50.8″E), Moto-Ujina, Hiroshima City, Hiroshima Prefecture, Japan, from branchial cavity of Japanese halfbeak, *Hyporhamphus sajori*, 15 June 2006, coll. students of Hiroshima University (NSMT-Cr 28227–28229).

Ovigerous female. *Body* weakly twisted to one side, 1.91–2.08 times as long as greatest width; dorsal surface slightly convex; widest at pereonite 3 or 4. *Cephalon* with rounded (Fig. 1B, Fig. 2A–C) or weakly flattened (Fig. 2D) frontal margin, 0.47–0.57 times longer than wide. Eyes oval, well visible, moderate (Fig. 2A) to slightly large (Fig. 1B, Fig. 2B–D), 0.29–0.39 times width of cephalon, 0.50–0.75 times length of cephalon. *Pereonite 1* smooth, anterior border indented to surround posterior region of cephalon, anterolateral angle beyond posterior end of eye. Pereonite 7 with shallowly (Fig. 1A, C, Fig. 3B–D) to slightly deeply (Fig. 3A) recessed posterior margin. Coxae lateral margins nearly straight (Fig. 1A, C, Fig. 3A), slightly convex (Fig. 3B), or slightly concave (Fig. 3C–D); 2–3 narrow; 4–7 with posteroventral angles mostly rounded; 7 slightly extending past pereonite margin (Fig. 1A, C, Fig. 3). Pereonites 1–3 long; 4–7 decreasing in length; 1–3 or 4 increasing in width; 5–7 decreasing in width. *Pleon* with pleonite 1 largely concealed by pereonite 7, slightly visible in dorsal view; pleonite 2 partially overlapped by pereonite 7; pleonites posterior margin smooth; pleonite 5 widest, posterior margin straight. *Pleotelson* 0.61–0.71 times as long as anterior width, dorsal surface smooth, lateral margins indented immediately posterior to pleonite 5 and weakly convex, posterior margin broadly rounded. *Uropod* more than half length of pleotelson; peduncle 0.65–0.83 times longer than rami, peduncle lateral

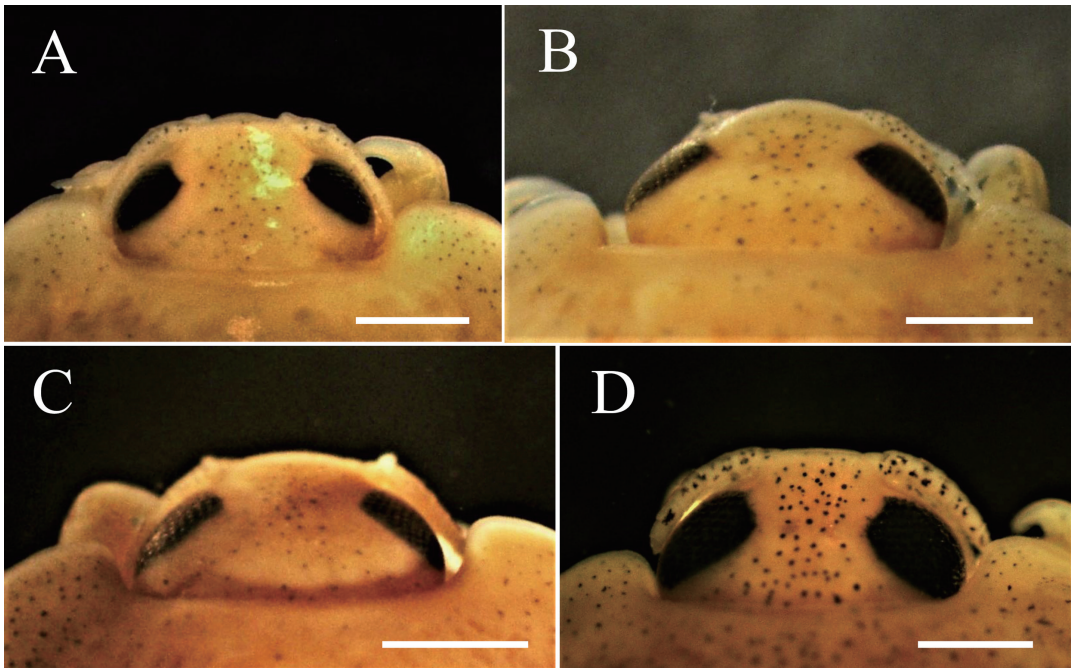

Fig. 2. *Mothocya* sp., ovigerous females, from the branchial cavity of Japanese halfbeak, *Hyporhamphus sajori*, in Hiroshima Bay, the Seto Inland Sea, Hiroshima Prefecture, Japan. Ethanol-preserved specimens. Cephalon, dorsal views. A, 18.3 mm BL, NSMT-Cr 28227; B, 19.4 mm BL, NSMT-Cr 28229; C, 18.6 mm BL; D, 17.0 mm BL. Scale bars: A–D, 1 mm.

margin without setae; rami extending to or slightly beyond posterior margin of pleotelson. Exopod 1.35–1.43 times longer than endopod, both apically rounded, terminating without setae.

Tan in ethanol, many black chromatophores visible on dorsal surface of body.

Male. Males smaller and slender than females. *Body* not twisted, 2.09–2.63 times as long as greatest width, widest at pereonite 3. *Pleotelson* shield-shaped with rounded posterior margin. *Uropod* extending past posterior margin of pleotelson. Exopod 1.31–1.43 times longer than endopod, both apically bluntly rounded.

Tan or dark brown in ethanol, black chromatophores well visible on dorsal surface of body.

Prevalence and intensity. No data were taken on prevalence of isopod. Two (female and male) isopods were collected from each infected fish.

Site of infection. Branchial cavity.

Remarks. Previously, the isopod infecting the branchial cavity of Japanese halfbeak from Hiroshima Bay was identified as *Irona melanosticta* (Hiraiwa, 1934; Inouye, 1941) but recently has been regarded as *Mothocya sajori* (Bruce, 1986; Yamauchi et al., 2004). The latter species was described using specimens from Japanese halfbeak in Japan (Bruce, 1986) and resembles *Mothocya parvostis*, which infects three Japanese marine fish species including Japanese halfbeak (Bruce, 1986). Currently, *M. parvostis* is also known to infect Japanese halfbeak in the Seto Inland Sea (Kawanishi et al., 2016; Nagasawa, 2020a), in which Hiroshima Bay is located. The specimens examined in the present study almost completely correspond to the descriptions of *M. parvostis* and *M. sajori* given by Bruce (1986) in the shape of the body, the coxae, and the posterior margin of pereonite 7.

Mothocya parvostis and *M. sajori* have been reported to be distinguished from each other by the size of the body and the eyes, the degree of twisting of the body, and the shape of the coxae and the posterior margin of pereonite 7 (Bruce, 1986). Of these characters, the BL of ovigerous females is very important for differentiation of these species because their BL ranges do not overlap: 11.0–15.0 mm in *M. parvostis* and 20.5–27.5 mm in *M. sajori* (Bruce, 1986). The five ovigerous females examined in this study measured 17.0 to 19.4 (mean, 18.4, n = 5) mm BL, which do not match the above BL ranges of *M. parvostis* and *M. sajori*. This indicates that the BL is more variable than those reported in their original descriptions and is not reliable to differentiate the two species from each other. Thus, the specimens from Japanese halfbeak in Hi-

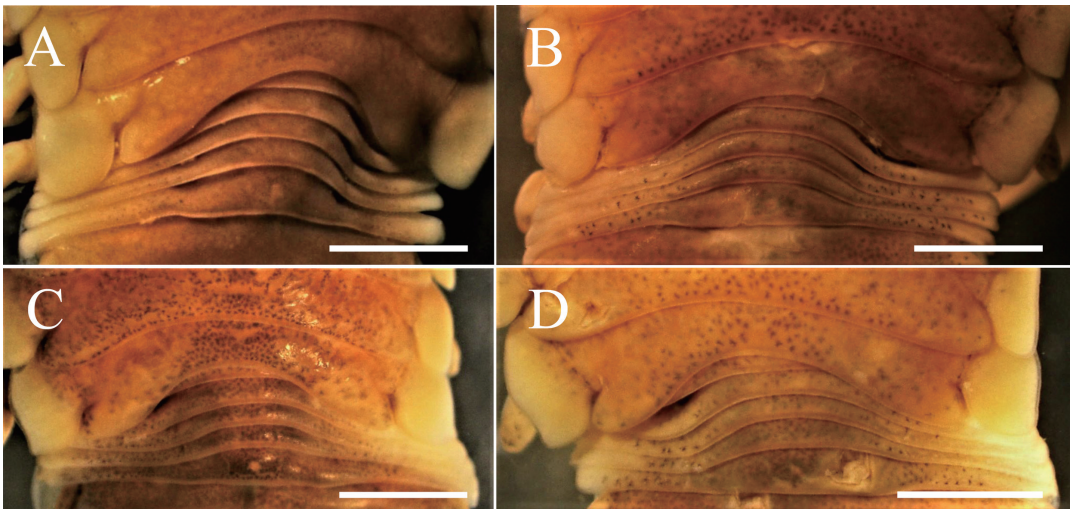

Fig. 3. *Mothocya* sp., ovigerous females, from the branchial cavity of Japanese halfbeak, *Hyporhamphus sajori*, in Hiroshima Bay, the Seto Inland Sea, Hiroshima Prefecture, Japan. Ethanol-preserved specimens. Pereonite 7 and pleon, dorsal views. A, 18.3 mm BL, NSMT-Cr 28227; B, 19.4 mm BL, NSMT-Cr 28229; C, 18.6 mm BL; D, 17.0 mm BL. Scale bars: A–D, 2 mm.

roshima Bay are herein reported as *Mothocya* sp. Recently, two ovigerous females of *Mothocya* sp. (16.4 and 16.9 mm BL) were also reported from Japanese halfbeak in the coastal Sea of Japan off Hokkaido Island, northern Japan (Nagasawa, 2020b).

The body shape of adult females of *M. sajori* is known to be affected by their attachment to the left or right side in the host's branchial cavity (Hiraiwa, 1934; Shiino, 1965, reported as *Irona melanosticta* in both papers). When the female is attached to the left and right branchial cavities, its body becomes twisted to the left and right sides, respectively. In the present study, no exact attachment site was recorded for the five ovigerous females of *Mothocya* sp., but three and two of them are considered to have been attached to the left and right branchial cavities because the body of these individuals twisted to the left and right sides, respectively. In addition, Nagasawa (2020a) reported that two ovigerous females of *M. parvostis* occurred each in the "right" branchial cavity of two Japanese halfbeak from the central Seto Inland Sea, but it was not true. Actually, the females were collected from the left branchial cavity, which is supported by the fact that their body twisted to the left side (see figs. 1A and 2A in Nagasawa, 2020a).

Discussion

Despite the fact that *M. parvostis* and *M. sajori* closely resemble each other, both species have been reported to be easily distinguished from each other using the size of the body and the eyes and several other characters, such as the degree of twisting of the body and the shape of the coxae and the posterior margin of pereonite 7 (Bruce, 1986). However, as mentioned above, the size of the eyes and the shape of the coxae and the posterior margin of pereonite 7 were variable among only the five ovigerous females examined herein. Moreover, based on two figures (fig. 6e and fig. 30e each for *M. parvostis* and *M. sajori*) given by Bruce (1986), the frontal margin of the cephalon is slightly different in shape between two species, being rounded and "weakly produced", respectively. In the present study, the frontal margin of the cephalon was rounded in the four ovigerous females but weakly flattened in the other single ovigerous female.

Hiraiwa (1934) reported that the ovigerous females of *M. sajori* (as *I. melanosticta*) from Japanese halfbeak in Hiroshima Bay were 10–22 mm BL. Inouye (1941) also collected the ovigerous females (10.0–17.5 mm in mean BL) of *M. sajori* (as *I. melanosticta*) from Japanese halfbeak mostly from Hiroshima Bay. Later, Yamauchi et al. (2004) suggested that *M. sajori* from Japanese halfbeak in the Seto Inland Sea showed wide variations in the degree of twisting of the body and the shape of the posterior margin of pereonite 7. Kawanishi et al. (2016), who collected *M. parvostis* from Japanese halfbeak in western Japan including the Seto Inland Sea, noted the presence of adult females which were larger than *M. parvostis* but smaller than *M. sajori*. Based on such publications and this paper, it is highly probable that *M. parvostis* and *M. sajori* are indistinguishable from each other and regarded as con-

specific.

Japanese halfbeak is commercially caught in coastal waters of Japan ranging from Abashiri, Hokkaido Island, in the north to Kagoshima, Kyushu Island, in the south (Sadakata et al., 1998; Tsuji and Sadakata, 2000) and has been reported to be frequently infected by *M. parvostis* (Kawanishi et al., 2016) or *M. sajori* (Hattori and Seki, 1956, as *Irona melanosticta*). The fish species is the most important host for *M. parvostis* (Nagasawa, 2020a) and the only known host for *M. sajori* (Bruce, 1986). As pointed out by Nagasawa (2020a) and Nagasawa and Tawa (2020), it is necessary to conduct a taxonomic study of *M. parvostis* and *M. sajori* using many specimens from Japanese halfbeak.

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