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New Host and Locality of the Fish Ectoparasite *Argulus japonicus* (Crustacea, Branchiura, Argulidae) in Japan, with a Note on Its Heavy Infection

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Abstract. As many as 1,079 specimens of the branchiuran parasite *Argulus japonicus* Thiele, 1900 were found on the body surface of an Amur catfish *Silurus asotus* in Ehime Prefecture, Shikoku, central Japan. This finding constitutes the first documented record of *A. japonicus* from Shikoku. *Silurus asotus* is a new host. The sex ratio in the sample of *A. japonicus* was male-biased. Among various skin regions of the fish, both the lateral area of the anterior trunk and the dorsal area of the head were most abundantly infected, and the dermal tissues in these areas were exposed externally.

Key words: *Argulus japonicus*, fish parasite, *Silurus asotus*, Amur catfish, new host, new locality

Introduction

Argulus japonicus Thiele, 1900 is a branchiuran parasite that infects cyprinids and other freshwater fishes (Yamaguti, 1963). The species was originally described from Japan (Thiele, 1900) but has spread to various regions of the world (Poly, 2008). Although it is generally believed to occur throughout Japan, knowledge of its geographical distribution is limited in the country. It has so far been reported from Honshu and Hokkaido, except Shikoku, Kyushu, and the Ryukyu Islands (Nagasawa, 2009, 2010; Nagasawa *et al*., 2009). During a survey of metazoan parasites of freshwater fishes in Shikoku, we found the species infecting the Amur catfish *Silurus asotus* Linnaeus from Ehime Prefecture. The present note deals with this infection as the first documented record of *A. japonicus* in Shikoku.

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Materials and Methods

An Amur catfish *Silurus asotus* was sampled in late July 2009 from an outdoor, small concrete tank (2.6 × 1.4 × 0.7 m, water depth=0.3 m) at the Ehime Prefectural Uwajima Fishery High School (33°22′N, 132°56′E) in Uwajima, Ehime Prefecture, Shikoku, Japan. As this fish was found infected by many argulids, it was frozen and sent to the laboratory of Hiroshima University, where it was thawed, measured (total length [TL]), and examined. When argulids were removed from the fish, they were counted by body region (Table 1). Argulids were fixed in 70% ethanol and identified based on Tokioka (1936*a*, 1936*b*) and Yamaguti (1937). Their sex and TL (from the anterior tip of the shield to the posterior end of the abdomen) were recorded. Voucher specimens are deposited in the crustacean (Cr) collection at the National Museum of Nature and Science, Tokyo (NSMT-Cr 21190). The scientific and English names of fishes follow Froese & Pauly (2010).

Results

A total of 1,079 specimens of *Argulus japonicus* (Fig. 1A) were found on the body surface of *Silurus asotus* (366 mm TL). When collected, the fish was moribund. Many argulids were assembled in several regions of the fish, especially in the lateral area of the anterior trunk and the dorsal area of the head (Table 1), where the epidermis disappeared and the dermal tissues were exposed externally (Fig. 1B). The argulids collected measured 0.8–5.9 (mean 3.2, *N*=1,051) mm TL, and the majority ranged from 2.4–3.8 mm TL for the both males (*N*=592, 89.7%) and females (320, 81.8%) (Fig. 2). The males were more abundant than the females (sex ratio=62.8%).

Table 1. Attachment sites of *Argulus japonicus* (*N*=1,079) on *Silurus japonicus*.

			No. of individuals (%)
Head	dorsal		258 (23.9)
	lateral		97 (9.0)
	ventral		143 (13.3)
Trunk	anterior -	dorsal	25 (2.3)
		lateral	271 (25.1)
		ventral	38 (3.5)
	middle -	dorsal	0 (0)
		lateral	218 (20.2)
		ventral	0 (0)
	posterior -	dorsal	0 (0)
		lateral	16 (1.5)
		ventral	0 (0)
Fins			13 (1.2)

Discussion

As far as we are aware, this finding constitutes a new host record for *Argulus japonicus*. The Amur catfish *Silurus asotus* is widely found in China, Japan, Taiwan, Korea, Mongolia, and Far Eastern Russia (Froese & Pauly, 2010), where there is no previous record of *A. japonicus* from this fish species (see Chen, 1973; Gusev, 1987; Kuang & Qian, 1991; Nagasawa 2009). Only the related species, *A. coregoni* Thorell, is known to infect *S. asotus* (Smirnova, 1971; Kuang & Qian, 1991). The rarity of records of *Argulus* spp. from *S. asotus* in the literature is partly because this fish has a very smooth skin and lacks scales, to which argulids may not be able to attach firmly. Interestingly, *A. japonicus* has not been recorded from the Japanese eel *Anguilla japonica* Temminck & Schlegel and the pond loach *Misgurnus anguillicaudatus* (Cantor) (see Nagasawa *et al*., 2007; Nagasawa, 2009), which also occur in freshwater in East Asia (Froese & Pauly, 2010). Like *S. asotus*, both *A. japonica* and *M. anguillicaudatus* have a smooth skin (with tiny scales embedded in the tissues).

Only a few records are available regarding heavy

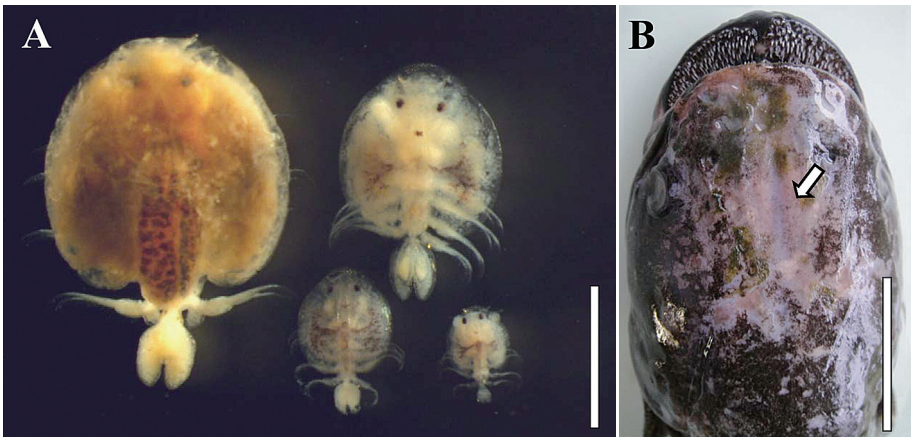

Fig. 1. *Argulus japonicus* of various sizes (A) and the dorsal view of the head of *Silurus asotus* (B). All argulids were removed from the host's head skin to show the injury (arrow). Scale bars: 2 mm in A; 20 mm in B.

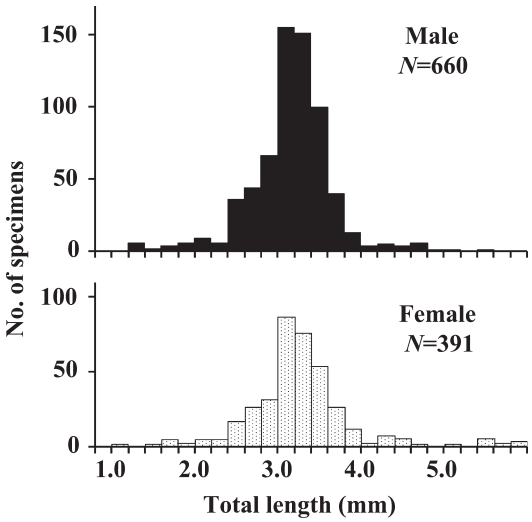

Fig. 2. Size-frequency distribution of male (top) and female (bottom) specimens of *Argulus japonicus* from *Silurus asotus*. Data of damaged specimens (*N*=28) are excluded.

infection of freshwater fishes with *A. japonicus*. More than 250 and 180 individuals of *A. japonicus* were recorded from the largemouth yellowfish *Labeobarbus kimberleyensis* (Gilchrist & Thompson) (as "*Barbus kimberleyensis*") and the common carp *Cyprinus carpio carpio* L. (as "*C. carpio*") from Bloeomhof Dam in South Africa (Kruger *et al*., 1983).

We collected the infected Amur catfish in a concrete tank at the Ehime Prefectural Uwajima Fishery High School in July 2009. Initially, three Amur catfish and 15 'gin-buna' *Carassius auratus langsdorfii* Temminck & Schlegel (Cyprinidae) were stocked into the tank from an irrigation canal at Yoshida in Uwajima in May 2007, but only the infected fish was present when sampled. As no other fish was released into the tank between May 2007 and July 2009, it is most likely that *A. japonicus* was introduced together with the fishes stocked in May 2007 and since had maintained its population in the tank.

Shimura (1983) stated that the sex ratio of three freshwater argulids, including *A. japonicus*, is approximately 1:1. In the present study, however, the males were more abundant than the females. Similar male predominance has been reported for the species by Hsiao (1950) and Stammer (1959, table 12). Unlike Shimura's (1983) suggestion, *A. japonicus* may have a male-biased sex ratio. In addition, the species is known to be abundant during a high water temperature period in fish ponds in Japan (Kimura, 1970). The *A. japonicus* specimens in this study were mostly small individuals (2.4–3.8 mm TL), which are considered to have hatched in the early and mid-summer months (June and July).

The host's skin infected with *A. japonicus* was damaged and the dermal tissues were exposed externally. Branchiuran parasites, including *A. japonicus*, are known to feed on the host's blood and external tissues and also to inject a secretion with the poison stylet into the host (Walker *et al*., 2004; Boxshall, 2005). When collected, the fish was found moribund and appears to have been seriously affected by feeding and injections by numerous individuals of *A. japonicus*.

Shikoku consists of four prefectures, including Ehime Prefecture, in which we collected the Amur catfish infected with *A. japonicus*. No other record of *A. japonicus* is available from Shikoku. More study is necessary on the geographical distribution and hosts of the species there.

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