The three-lips, *Opsariichthys uncirostris uncirostris* (Cyprinidae), a new host of *Argulus japonicus* (Branchiura: Argulidae), with its first host record from Lake Biwa, Japan

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Abstract

Lake Biwa is the largest and ancient lake in Japan. The parasite fauna of aquatic animals of the lake has been extensively studied, but little information is available on the biology of fish-parasitic branchiurans. Two adult males of the argulid branchiuran *Argulus japonicus* Thiele, 1900 were collected from the body surface of an individual of the three-lips, *Opsariichthys uncirostris uncirostris* (Temminck and Schlegel, 1846), in Lake Biwa. This represents a new host record for *A. japonicus* and its first host record from the lake.

Introduction

Lake Biwa is the largest (670 km^2) lake in Japan with a 4-million-year-old history, and the best studied inland waters for the parasite fauna of aquatic animals in Japan: 241 nominal species of the parasites have so far been reported from the lake and its basin (Nagasawa, 2020a; Urabe, 2020). Fish-parasitic branchiurans are among such parasites, and two species, *Argulus japonicus* Thiele, 1900 and *Argulus coregoni* Thiele, 1864, are known to occur in this region (Nagasawa, 2020a, b). However, despite the fact that research on these branchiurans has been conducted since the mid-1930s (Tokioka, 1936), much remains to be studied on their biology, especially that of *A. japonicus*, in the region.

Grygier (2004) showed a picture of a specimen of *A. japonicus* from the Lake Biwa basin, stating that the speices is often found on "the common carp, *Cyprinus carpio* Linnaeus, 1758", which, however, was later re-identified as an unidentified crucian carp, *Carrassius* sp. (Nagasawa, 2009). Grygier's and several other specimens of *A. japonicus* were actually examined during a parasite workshop held in May 1998 at the Lake Biwa Museum (Nagasawa, 2011a), and the specimens had been collected from the common carp (Nagasawa, 2009, 2011a, reported as *Cyprinus carpio haematopterus* Marten, 1876 in Nagasawa, 2011a), the bighead carp, *Hypophthalmichthysn nobilis* (Ricahrdson, 1845) (Nagasawa, 2009, as *Aristichthys nobilis*), and two nominal and an unidentified species of crucian carps [*Carassius cuvieri* Temminck and Schlegel, 1846 (Nagasawa, 2011a), *Carassius langsdorfii* Temminck and Schlegel, 1846 (Nagasawa, 2009, 2011a, as *C. auratus langsdorfii*), and *Carassius* sp. (Nagasawa, 2009)]. The bighead carp was sampled from a rearing tank of the Lake Biwa Museum, while the other fishes were collected at unspecified sites in Shiga and Osaka prefectures (Nagasawa, 2009). Detached individuals of *A. japonicus* were also collected in a pond near Lake Biwa (Okano, 1996) and the lake (Goda et al., 2017). Based on these records, no information has yet been published on hosts of *A. japonicus* in Lake Biwa.

In 2019, two adult males of *A. japonicus* from the body surface of an individual of the three-lips, *Opsariichthys uncirostris uncirostris* (Temminck and Schlegel, 1846) (Cypriniformes: Cyprinidae), in Lake Biwa. This represents the first host record from the lake for *A. japonicus* and its new host record.

Materials and Methods

A freshly dead individual of *O. uncirostris unciros-*

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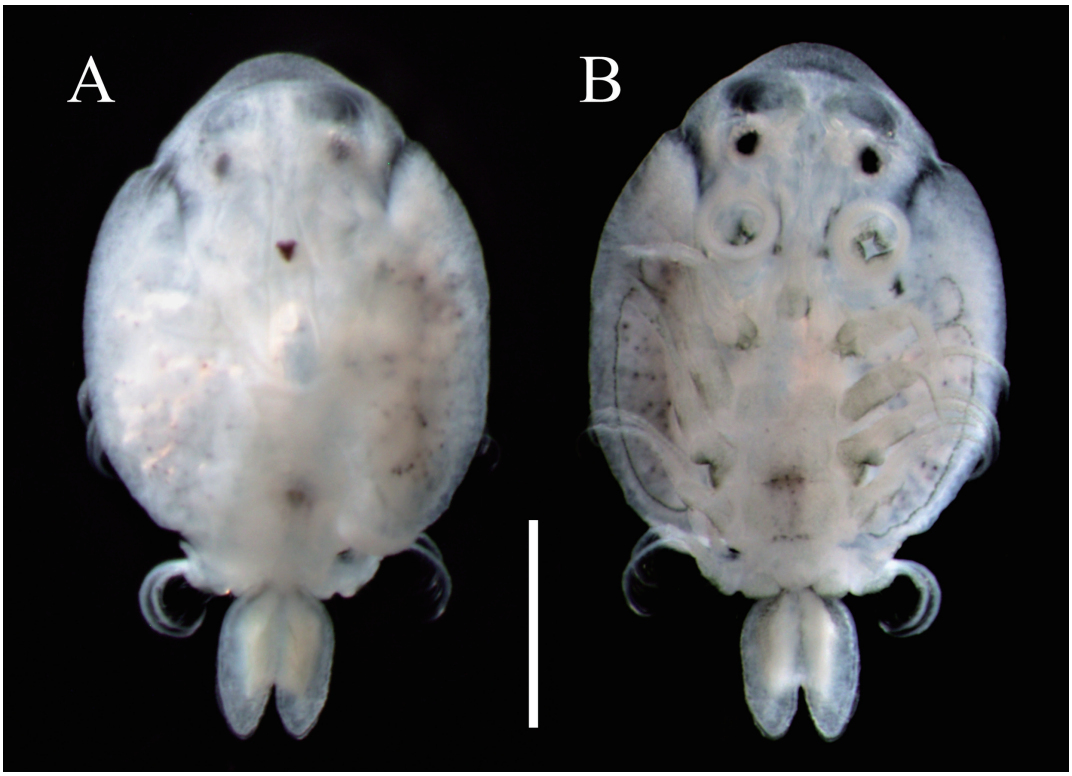

Fig. 1. *Argulus japonicus*, adult male, 3.3 mm long, from a three-lips, *Opsariichthys uncirostris uncirostris*, from Lake Biwa, Japan. A, habitus, dorsal view; B, habitus, ventral view. Scale bar: 1 mm.

tris (about 30 cm in total length) was collected on 10 July 2019 in Lake Biwa at Katayama (35°27′32.3″N, 136°11′55.3″E), Nagahama, Shiga Prefecture, central Japan. As two crustacean parasites were found on the fish's body surface, they were removed by fingers and fixed in 99.5% ethanol. Later, at the Aquaparasitology Lobaoratory, Shizuoka Prefecture, these specimens were examined for identification. They are retained at the laboratory for an ongoing taxonomic study of *Argulus* spp. from Japanese freshwater fishes but will be deposited in the Crustacea collection of the National Museum of Nature and Science, Tsukuba, Ibaraki Prefecture. The scientific and common names of fishes mentioned in this paper follow those in FishBase (Froese and Pauly, 2021).

Results and Discussion

The specimens collected in this study are two adult males, each measuring 3.3 × 2.0 mm and 2.9 × 2.0 mm (total body length × maximum body width). They correspond almost exactly to the descriptions of *A. japonicus* using specimens from Japan (Thiele, 1904; Nakazawa, 1914; Tokioka, 1936; Yamaguti, 1937; Meeheran, 1940) and are thus identified as the species (Fig. 1).

Cyprinids are preferred hosts of *A. japonicus* in Japan (Nagasawa, 2011b), where eight nominal species and one unidentified species of cyprinids have been recorded as its hosts (see Nagasawa et al., 2018b). *Opsariichthys uncirostris uncirostris*, is herein reported as a new host of the parasite. This fish subspecies is endemic to central Japan, occurring in the Lake Biwa-Yodo River basin and the Mikata Five Lakes (Takeuchi, 2018).

The cyprinid genus *Opsariichthys* are composed of two species, *O. uncirostris uncirostris* and *O. platypus* (Temminck and Schlegel, 1846), in Japan (Takeuchi, 2018), and *A. japonicus* has been reported three times from *O. platypus* (Nagasawa and Sato, 2014; Nagasawa, 2017; Nagasawa and Miyajima, 2018).

In addition to *A. japonicus*, another congeneric species, *A. coregoni* is known to parasitize freshwater fishes in the Lake Biwa basin (Tokioka, 1936; Grygier, 2004; Nagasawa, 2009, 2020a, b; Nagasawa et al., 2018a; Nagasawa and Kawai, 2019). A cyprinid, *Acheilognathus* sp. (reported originally as *A. moriokae*, see Goda et al., 2017 for the current scientific

name of the fish) is one of the known hosts of *A. coregoni* in the lake basin (Tokioka, 1936), and both *A. japonicus* and *A. coregoni* are morphologically similar. Thus, it is important to identify correctly these two *Argulus* species in research on their biology in the region. Their males can be differentiated by the presence (in *A. coregoni*) or absence (in *A. japonicus*) of a postrerioly directed finger-like projection on the posterior margin of the coxa of the second leg (Tokioka, 1936, 1965).

More than 70 species and subspecies of fishes are found in Lake Biwa and its tributaries, and more than half of these fishes are cyprinids (Yuma et al., 1998). Since both *A. japonicus* and *A. coregoni* are not strictly host-specific (Nagasawa, 2009, 2011b), it is desirable to examine cyprinids and other fishes from different sites for clarifying the host utilizations of these branchiurans under various habitat conditions of the region.

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