生物圏科学
Biosphere Sci.
53：27−31 (2014)

The parasitic copepod *Lernaea cyprinacea* from freshwater fishes, including alien species (*Gambusia affinis* and *Rhodeus ocellatus ocellatus*), in central Japan

Kazuya Nagasawa[1)] and Ryo-ichi Torii[2)]

[1)] *Graduate School of Biosphere Science, Hiroshima University, 1-4-4 Kagamiyama, Higashi-Hiroshima, Hiroshima 739-8528, Japan*
[2)] *Mikawa Freshwater Life Network, B101 Plaza Verde, 1-3-1 Fudaki, Hekinan, Aichi 447-0088, Japan*

Abstract Specimens of *Lernaea cyprinacea* Linnaeus, 1758 were collected from four species of freshwater fishes (i.e., mosquitofish *Gambusia affinis,* rosy bitterling *Rhodeus ocellatus ocellatus,* stone moroko *Pseudorasbora parva*, and crucian carp *Carassius* sp.) in ponds and rivers of Aichi Prefecture, central Japan. The collections of the copepod from *G. affinis* and *R. o. ocellatus* represent its first records each from these alien fishes in Japan.

Key words: Copepoda, fish parasite, *Gambusia affinis*, *Lernaea cyprinacea*, *Rhodeus ocellatus ocellatus*

INTRODUCTION

In Japan, *Lernaea cyprinacea* Linnaeus, 1758 is one of the common parasites of freshwater fishes, and it has been reported from more than 30 species of fishes and also from two species of amphibians (newts and frog tadpoles) (Nagasawa *et al*., 2007). Because of its importance in wild and farmed fish populations, various investigations of the species have been conducted, and our knowledge of its geographical distribution and hosts in Japan has been increasing (e.g., Uyeno *et al*., 2011; Nagasawa, 2013; Nagasawa and Nitta, 2014; Nagasawa and Sato, 2014). Recently, we collected specimens of *L. cyprinacea* from freshwater fishes, including two species of alien fishes, the mosquitofish *Gambusia affinis* (Baird and Girard, 1853) (Cyprinodontiformes: Poeciliidae) and the rosy bitterling *Rhodeus ocellatus ocellatus* (Kner, 1866) (Cypriniformes: Cyprinidae), in Aichi Prefecture, central Japan. While many species of alien freshwater fishes have become established in Japan (Ecological Society of Japan, 2002), their parasite fauna is poorly known. The present collections of *L. cyprinacea* represent its first records each from *G. affinis* and *R. o. cellatus ocellatus* in Japan.

MATERIALS AND METHODS

Freshwater fishes were collected using hand nets in four ponds (Ama Pond [35º12′39″N, 137º0′1″E], Kamisawa Pond [35º5′56″N, 136º59′52″E]; Chayagasaka Pond [35º10′53″N, 136º57′52″E]) and two rivers (Toda River [35º8′45″N, 136º48′38″E]; Ueda River [35º8′16″N, 136º59′1″E]), Nagoya, and in one river (Yahagi River [34º53′3″N, 137º1′46″E]), Hekinan, Aichi Prefecture, from August 2011 to October 2013. They were fixed in 70% ethanol at the sampling sites, and only the fishes infected by copepods were sent to the laboratory of Hiroshima University, where they were identified, measured for standard length (SL, mm), and examined for ectoparasites. Copepods were carefully removed from the

* E-mail: ornatus@hiroshima-u.ac.jp

hosts, fixed in 70% ethanol, and identified based on Yamaguti (1939), Kasahara (1962), and Uyeno *et al.* (2011). Copepod specimens are retained in the senior author's collection for morphological study, but they will be deposited at the Crustacea collection of the National Museum of Science and Nature, Tsukuba, Ibaraki Prefecture. Fish specimens are deposited at the Nagoya Biodiversity Center, Nagoya, Aichi Prefecture [as tentative specimen number, NBC-5201401 (n=1), 5201403 (n=1) for *G. affinis*; NBC-5201405 (n=1) for the stone moroko *Pseudorasbora parva* (Temminck and Schlegel, 1846) (Cypriniformes: Cyprinidae); and NBC-5201402 (n=4), 5201404 (n=1), 5201407 (n=1) for the crucian carp *Carassius* sp. (Cypriniformes: Cyprinidae)] and the Hekinan Maritime Science Museum, Hekinan, Aichi Prefecture [HMD2011-19 (n=1) for *R. o. ocellatus*]. The scientific names of fishes used in this paper follow those recommended in Nakabo (2013).

RESULTS

Adult females of *L. cyprinacea* were found infecting two specimens of *G. affinis* (23.2 mm SL, Ama Pond, August 18, 2013; 19.5 mm SL, Chayagasaka Pond, October 14, 2013); one specimen of *R. o. ocellatus* (15.1 mm SL, Yahagi River, August 18, 2011); one specimen of *P. parva* (57.0 mm SL, Toda River, June 1, 2013); and five specimens of *Carassius* sp. (36.0 mm SL, Ueda River, November 13, 2011; 61.0 mm SL, Toda River, May 18, 2012; 25.5, 19.0, and 20.5 mm SL, Kamisawa Pond, June 3, 2012). The copepods inserted their anterior part of the body into the musculature of the host (Fig. 1D). All fish specimens were individually infected by one copepod, except the specimen of *Carassius* sp. from the Toda River which was infected by four copepods. Attachment sites were the skin near the base of the left pectoral fin (n=1) in *G. affinis* (Fig. 1A); the left lateral side of the body (n=1) in *R. o. ocellatus* (Fig. 1B); near the base of the anal fin (n=1) in *P. parva* (Fig. 1C); and near the base of the dorsal (n=3), ventral (n=1), anal (n=1), and right pectoral (n=1) fins in *Carassius* sp. (Fig. 1D). The copepods were 4.2–10.1 (mean: 6.8 mm, n=13) mm long: most (n=10) of them had egg sacs.

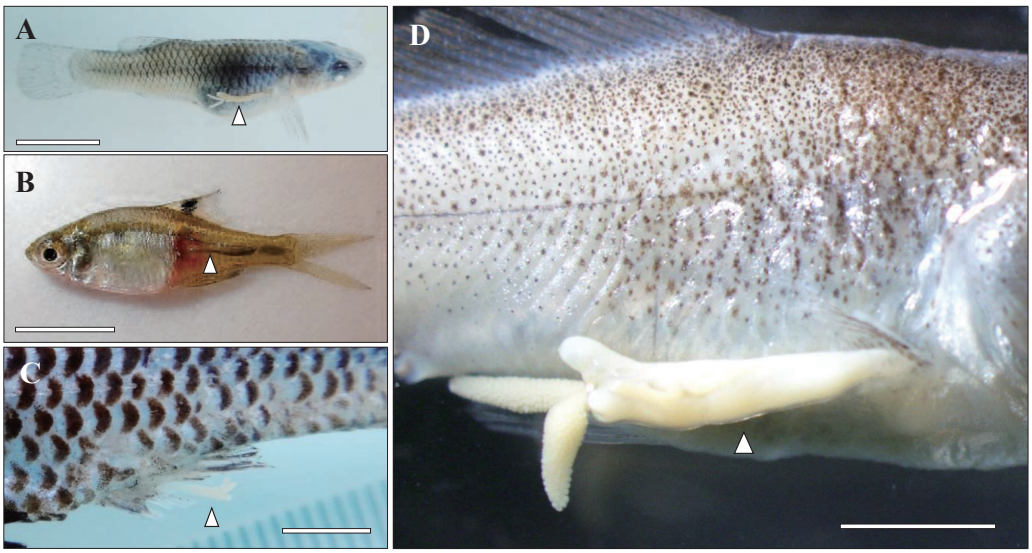

Fig. 1. Adult females of *Lernaea cyprinacea* (arrowheads) infecting *Gambusia affinis* (A), *Rhodes ocellatus ocellatus* (B), *Pseudorasbora parva* (C), and *Carassius* sp. (D) in Aichi Prefecture, central Japan. Scale bars: 5 mm in A, B, C; 2 mm in D.

DISCUSSION

The present findings of *L. cyprinacea* from *G. affinis* and *R. o. ocellatus* represent the first records of the copepod from these fishes in Japan (see Nagasawa *et al*., 2007). *Gambusia affinis* and *R. o. ocellatus* are not native to Japan: both species were introduced into Japan from Taiwan and China in 1916 and 1942, respectively (Sawara, 2002; Kano, 2002). Very little information is available about the parasite fauna of these fishes in Japan. Only three species of parasites, *Salsugius seculus* (Mizelle and Arcadi, 1945) (Monogenea: Ancyrocephalidae), *Genarchopsis goppo* Ozaki, 1925 (Trematoda: Derogenidae), and *Neoergasilus japonicus* (Harada, 1930) (Copepoda: Ergasilidae), are known to infect *G. affinis* in Japan (Shimazu *et al*., 2011; Nagasawa and Uyeno, 2012; Nitta and Nagasawa, 2014). Also, only one species of parasite, *Acanthosentis* (*Acanthosentis*) *alternatspinus* Amin, 2005 (Acanthocephala: Quadrigyridae), has been reported from *R. o. ocellatus* in Japan (Amin, 2005). We need more work on the parasite fauna of *G. affinis* and *R. o. ocellatus* in Japan.

Our sampling was conducted in Aichi Prefecture, where there are several records of *L. cyprinacea* (Leigh-Sharpe, 1925; Matsui and Kumada, 1928; Kasahara, 1962). Leigh-Sharpe (1925) originally described *Lernaea* (*Lernaeocera*) *elegans* from the buccal cavity of the Japanese eel *Anguilla japonica* Temminck and Schlegel, 1846 reared at a fisheries experimental station in Kitajima, Toyohashi, Aichi Prefecture. Subsequently, this species of copepod was synonymized with *L. cyprinacea* by Harding (1950), and the latter scientific name has been commonly used in Japan (see Nagasawa *et al*., 2007). However, based on the experiments made in Russia (see Kabata, 1979: 142-155), there is a suggestion that *L. elegans* is a valid species. Therefore, the present specimens of *L. cyprinacea* collected near the type locality of *L. elegans* are important and will be used to clarify validity of the latter species.

ACKNOWLEDGMENTS

We thank the staff of the Nagoya Biodiversity Center, Yoshizumi Chimura of the Hekinan Seaside Aquarium, and Eikichi Uchihara for their assistance during the study.

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愛知県産淡水魚に寄生していたイカリムシ

長澤和也[1)]・鳥居亮一[2)]

[1)] 広島大学大学院生物圏科学研究科，〒739-8528 広島県東広島市鏡山1-4-4
[2)] 三河淡水生物ネットワーク，〒447-0088 愛知県碧南市札木町1-3-1
プラザ・ヴェルデB101

要　旨　愛知県名古屋市と西尾市にある池沼と河川で採集した淡水魚を調べたところ，カイアシ類の1種，イカリムシ *Lernaea cyprinacea* Linnaeus, 1758の寄生を認めた。寄生を受けていたのはカダヤシ *Gambusia affinis*，タイリクバラタナゴ *Rhodeus ocellatus ocellatus*，モツゴ *Pseudorasbora parva* およびフナ属の1種 *Carassius* sp. である。わが国で，国外外来魚のカダヤシとタイリクバラタナゴにイカリムシの寄生を認めたのは本論文が最初である。

キーワード：イカリムシ，カイアシ類，カダヤシ，魚類寄生虫，タイリクバラタナゴ