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Short Article

Neoergasilus japonicus (Copepoda: Ergasilidae) parasitic on two alien freshwater fishes (*Lepomis macrochirus* and *Micropterus salmoides*) in central Japan, with its new record from Gunma Prefecture

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Abstract: Adult females of the ergasilid copepod *Neoergaslus japonicus* (Harada, 1930) were collected from the fins of two alien fishes, bluegill (*Lepomis macrochirus* Rafinesque, 1819) and largemouth black bass (*Micropterus salmoides* (Lacepède, 1802)), in a reservoir formed by a small erosion-control dam in the Higashiya River, a tributary of the Kabura River within the Tone River system in Takasaki City, Gunma Prefecture, central Japan. This represents the first record of *N. japonicus* in Gunma Prefecture and its second record from *M. salmoides* in Japan. In *L. macrochirus*, *N. japonicus* was most abundantly attached to the dorsal fin, especially its posterior basal part.

Key Words: *Neoergaslus japonicus, Lepomis marchochirus, Micropterus salmoides,* fish parasite, new prefectural record

Introduction

Our knowledge about the parasite fauna of freshwater fishes of Gunma Prefecture, Japan, is still limited. Only 14 species of parasites are known to occur in this prefecture: *Ichthyobodo* sp. (Kinetoplastida: Ichthyobodonidae), *Ichthyophthirius multifiliis* Fouquet, 1876 (Ciliophora: Ichthyophthiriidae), *Clonorchis sinensis* (Cobbold,1875) Looss, 1907 metacercaria (Trematoda: Opisthorchiidae), *Isoparorchis eurytremum* (Kobayashi, 1915) (as *I. hypselobagri*, see Shimazu *et al*., 2014) metacercaria (Trematoda: Isoparorchiidae), *Metagonimus yokogawai* (Katsurada, 1912) metacercaria (Trematoda: Herterophyidae), *Eudiplozoon nipponicum* (Goto, 1891) (Monogenea: Diplozoidae), *Gyrodactylus* sp. (Monogenea: Gyrodactylidae), *Bothriocephalus acheilognathi* Yamaguti, 1934 (Cestoda: Bothriocephalidae), *Khawia sinensis* Hsü, 1935 (Cestoda: Caryophyllidae), *Ligula interrupta* Rudolphi, 1810 plerocercoid (Cestoda: Ligulidae), *Philometroides* sp. (Nematoda: Philometridae), *Lernaea cyprinacea* Linnaeus, 1758 (Copepoda: Lernaeidae), *Salmincola californiensis* (Dana, 1852) (Copepoda: Lernaeopodidae), and *Argulus japonicus* Thiele, 1900 (Branchiura: Argulidae) (see Nagasawa and Sato, 2014).

This note is the second in a series on the parasites of freshwater fishes of Gunma Prefecture (Nagasawa and Sato, 2014) and reports on *Neoergasilus japonicus* (Harada, 1930) (Copepoda: Ergasilidae), a new prefectural record, as well as the third species of parasitic copepod infecting freshwater fishes from this prefecture.

Materials and Methods

Fishes were collected using hook and line with earthworm bait in an artificial reservoir (36°12′50″N, 138°57′25″E) formed by a small erosion-control dam in the upper reaches of the Higashiya River, a tributary of the Kabura River within the Tone River system in Higashiya, Yoshii Town, Takasaki City, Gunma Prefecture, central Japan, on 21 June 2012, 20 July 2013, and 4 September 2013. The fishes were fixed in 5% formalin immediately after capture and brought to Hiroshima University, where they were identified, measured for standard length in millimeters, and examined for parasitic copepods using a stereoscopic microscope. After the attachment sites of copepods were recorded, they were collected using forceps, and preserved in 70% ethanol. Some copepods were observed using the wooden slide method (Humes and Gooding, 1964) and identified based on Harada (1930), Yin (1956), Urawa *et al*. (1980), and Kim and Choi (2003). Copepod specimens are retained in the senior author's collection, but they will be deposited in the Crustacea collection of the National Science Museum of Nature and Science, Tsukuba City, Ibaraki Prefecture, Japan. Prevalence and mean intensity of infection (Table 1) are as defined by Bush *et al*. (1997). The scientific and English names of fishes used in this paper follow Froese and Pauly (2014).

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Results

The fishes collected (*n*=14) contained two species of the family Centrarchidae (Perciformes) *i.e.*, bluegill (*Lepomis macrochirus* Rafinesque, 1819) and largemouth black bass (*Micropterus salmoides* (Lacepède, 1802). Most of them (*n*=13) were *L. macrochius*, while only one *M. salmonides* was collected. Both species were found infected by adult females of *Neoergasilus japonicus* (Fig. 1). The copepods are 557–686 (mean 626, *n*=10) µm in body length (without caudal setae) and are characterized by the first swimming leg bearing two spines and four setae on the third segment of the endopod and the fourth swimming leg bearing the single-segmented exopod and endopod. No other species of parasitic copepod was found.

The number of adult females per infected fish ranged from 6–202 (mean 64.6) in *L. macrochirus* and was 26 in *M. salmoides* (Table 1). In the specimens of *L. macrochirus* (*n*=13), copepods were most abundantly found on the dorsal fin, followed by the anal, caudal, and pectoral fins (Table 1). In particular, the posterior basal part of the dorsal fin was heavily attached (Fig. 2). A few copepods were found on the pelvic fin. Although one specimen of *M. salmoides* was examined, copepods were abundantly found on the anal and caudal fins (Table 1). Only a few copepods were attached to the dorsal fin.

Fig. 1. Ovigerous female of *Neoergasilus japonicus* from *Lepomis macrochirus* caught in the Higashiya River, Takasaki City, Gunma Prefecture, on 20 July 2013. Alcohol-preserved specimen. A, dorsal view; B, lateral view. Scale bars: 100 µm in A and B.

Discussion

The two species of centrarchids infected by *N. japonicus* are not native to Japan. Since their introduction to Japan from North America, they have become established and spread to most areas in the country (Ministry of the Environment, 2004). By contrast, *N. japonicus* is a native species in Eastern Asia, including Taiwan, China, Japan, Korea, and the Russian Far East (Nagasawa and Uyeno, 2012). The species has been found in Southern Asia (Vietnam, India), Europe (U.K., France, Germany, Italy, Czech Republic, Slovak Republic, Hungary, Ukraine, Finland, Russia), North America (U.S.A., Mexico), and the Caribbean (Cuba) (Nagasawa and Uyeno, 2012). Recently, it was also found in Turkey (Soylu and Soylu, 2012). International translocation of live fishes is one of the reasons for such worldwide distribution of the species (see Nagasawa and Uyeno, 2012). In Japan, it has been reported from five prefectures, *i.e.*, Hokkaido, Hiroshima, Shimane, Nagasaki, and Okinawa (Nagasawa and Uyeno, 2012; Nagasawa and Nitta, 2013; Nagasawa and Obe, 2013; see Nagasawa *et al.*, 2007 for the earlier literature). The present collection of *N. japonicus* in this study represents its first record from Gunma Prefecture, central Japan.

Lepomis macrochirus is known as a common host of *N. japonicus* in Japan (*e.g.*, Muroga *et al.*, 1974; Urawa, 2004; Nagasawa and Obe, 2013). Since this fish is widely distributed throughout the country and samples can be easily caught with a rod and line, Nagasawa and Inoue (2012) have suggested that it has the potential to serve as a host for a suite of ecological studies of *N. japonicus* in Japan. There has been only one record of *N. japonicus* from *M. salmoides* in Japan (Nagasawa and Inoue, 2012). In this study, *N. japonicus* was collected as its second record from *M. salmoides* in Japan. Smallmouth bass *Micropterus dolomieu* Lacepède, 1802, a centrarchid of North American origin, has also been introduced to and become established in Japan (Iguchi *et al.*, 2001), but nothing is known about its parasitic copepod fauna in this country. It is thus desirable to study the occurrence of *N. japonicus* on these *Micropterus* spp. in Japan and also to compare infection levels between three species of centrarchids in order to assess its host utilization in Japan (see Hudson and Bowen, 2002).

While fish sampling was made three times in 2012 and 2013, only two exotic fishes (*L. macrochirus* and *M. salmoides*) were sampled but no native fish was caught. As the sampling site is an artificial reservoir formed by a small erosion-control dam in the river's upper reaches, no native fish might have inhabited it. If this is the case, *N. japonicus* is likely to have been introduced to the reservoir along with *L. macrochirus* and/or *M. salmoides*, because these species have been released into various freshwater bodies in Japan (Ministry of the Environment, 2004).

Neoergasilus japonicus was found most abundantly on the dorsal fin, especially its posterior basal part, of *L. macrochirus*.

Table 1. Occurrence of *Neoergasilus japonicus* on two species of centrarchids in a reservoir, Higashiya, Takasaki City, Gunma Prefecture, central Japan.

Species	Sampling date	Standard length (mean) in mm	Percent prevalence (infected/examined)	Mean intensity (range)	Total number of copepods found	Number of copepods on each fin				
						Pectoral fin	Dorsal fin	Pelvic fin	Anal fin	Caudal fin
Lepomis macrochirus	21 Jun., 2012	99	100 (1/1)	202.0 (202)	202	1	71	4	68	58
Lepomis macrochirus	20 Jul., 2013	77–118 (104.2)	100 (5/5)	69.0 (23–126)	345	41	168	1	64	71
Lepomis macrochirus	4 Sep., 2013	54–125 (82.9)	100 (7/7)	41.9 (6–140)	293	50	137	0	52	54
Total		54–125 (92.3)	100 (13/13)	64.6 (6–202)	840	92	376	5	184	183
Micropterus salmoides	4 Sep., 2013	82	100 (1/1)	26.0 (26)	26	0	2	0	12	12

A similar result was reported by Nagasawa and Obe (2013) who examined the same fish species in Hiroshima Prefecture, western Japan. These authors suggested that infective females of *N. japonicus* can easily attach to the posterior basal part of the dorsal and anal fins due to low turbulent conditions around it.

There was a slight difference in attachment site by *N. japonicus* between *L. macrochirus* and *M. salmoides*. The dorsal fin was most abundantly attached in *L. macrochirus*, while it carried only a few copepods in *M. salmoides*. This difference is probably due to the limited number of *M. salmoides* examined (n=1), because this fish has been reported in the U.S.A. to harbor many copepods on the dorsal fin (Hayden and Rogers, 1998; Hudson and Bowen, 2002). As suggested above, studies are needed on *N. japonicus* infecting *M. salmoides* in Japan.

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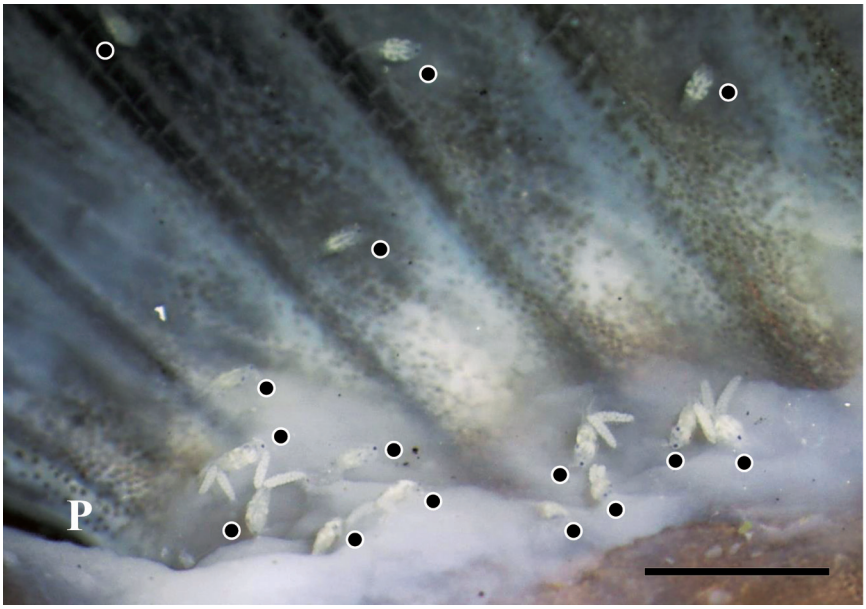

Fig. 2. Adult females of *Neoergasilus japonicus*, indicated by black dots, infecting the posterior basal part of the dorsal fin of *Lepomis macrochirus*. P: Posteriormost ray of the dorsal fin. Scale bar: 2 mm.

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群馬県から新たに見つかったヤマトニセエラジラミと外来淡水魚2種における寄生状況

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要旨：群馬県高崎市を流れる東谷川に設けられた砂防ダムによって形成された溜池で採集した外来淡水魚2種（ブルーギルとオオクチバス）を調べたところ，カイアシ類のヤマトニセエラジラミ*Neoergasilus japonicus*の寄生を認めた．本種は群馬県から初めて採集された．本論文は，わが国のオオクチバスにヤマトニセエラジラミの寄生を認めた第2記録となる．この寄生虫は鰭に寄生し，ブルーギルでは背鰭，特に後方基部に多く寄生していた．

キーワード：ヤマトニセエラジラミ，ブルーギル，オオクチバス，魚類寄生虫，群馬県初記録