

## The marine fish parasite *Nerocila japonica* (Isopoda: Cymothoidae) from a euryhaline cyprinid fish (*Pseudaspius hakonensis*) in brackish waters of a river in central Japan

Kazuya Nagasawa<sup>1,2</sup> and Nobuo Inoue<sup>3</sup>

<sup>1</sup>Graduate School of Integrated Sciences for Life, Hiroshima University, 1-4-4 Kagamiyama, Higashi-Hiroshima, Hiroshima 739-8528, Japan

<sup>2</sup>Aquaparasitology Laboratory, 365-61 Kusanagi, Shizuoka 424-0886, Japan

<sup>3</sup>Biodiversity Network Niigata, 1-8-25 Terayama, Higashi, Niigata 950-0892, Japan

### ■ Abstract

A juvenile of *Nerocila japonica* Schioedte and Meinert, 1881 was found parasitizing the ventral fin of a big-scaled redbfin, *Pseudaspius hakonensis* (Günther, 1877) (Cypriniformes: Cyprinidae), in brackish waters of the Ten-no River on Sado Island, Niigata Prefecture, central Japan. The river flows into brackish Lake Kamo, which is connected to the southern Sea of Japan. The big-scaled redbfin is an unusual cyprinid that can inhabit marine and brackish waters as well as fresh waters, and the fish caught most probably became infected by *N. japonica* at sea or in the lake and moved upstream in the river. The cymothoid is also considered euryhaline.

### ■ Introduction

*Nerocila japonica* Schioedte and Meinert, 1881 is a parasite of coastal marine fishes in Japan (Schioedte and Meinert, 1881; Yamauchi and Nagasawa, 2012). The species has been well studied for its morphology, host range, and geographical distribution in Japan (Momoyama and Tensha, 2006; Hashimoto, 2007; Yamauchi and Nagasawa, 2012; Hata et al., 2017; Nagasawa and Kawai, 2019; Nagasawa and Tawa, 2019; Nagasawa et al., 2019; Nagasawa, 2020). It is also known to parasitize a marine fish in captivity (Nagasawa et al., 2018). The species has been reported from Malaysia (Nierstrasz, 1918) and China (Yu and Li, 2003) as well.

Recently, we collected a specimen of *N. japonica* from a big-scaled redbfin, *Pseudaspius hakonensis* (Günther, 1877), in brackish waters of a river on Sado

Island, Niigata Prefecture, central Japan. This is interesting because *N. japonica* is a marine fish parasite but was collected in the river. The present paper reports on this collection and discusses the occurrence of *N. japonica* on euryhaline fishes in brackish waters.

### ■ Materials and Methods

The big-scaled redbfin was caught using a small setnet on 8 November 2012 in the lower reaches of the Ten-no River at Niibo-katagami, Sado City, Niigata Prefecture, central Japan. The river, originating from the nearby the hill area, is small (1–5 m wide, 5 km in total length) and empties into brackish Lake Kamo (known also as Lake Kamo-ko, 4.86 km<sup>2</sup> in area, 8.7 m in a maximum depth). This lake is connected to the southern Sea of Japan via a short channel (200 m in length). The collection site was located about 450 m upstream from the lake (38°02'32"N, 138°26'32"E, Fig. 1A), and marine and brackish-water fishes and jelly fishes were found near the collection site at high tide. When the fish was taken from the setnet and measured for its standard length (SL, mm), a crustacean parasite was found on the left ventral fin of the fish (Fig. 1B–C). The parasite was carefully removed by fingers and fixed in 70% ethanol, and the fish was then released into the river. Later, at the Aquaparasitology Laboratory, Shizuoka Prefecture, the specimen was examined for its morphology using an Olympus stereo microscope (SZX10). It is retained by the first author (KN) for a taxonomic study of cymothoid isopods from Japanese fishes but will be deposited in the Crustacea collection of the National Museum of Nature and Science, Tsukuba, Ibaraki Prefecture. In this paper, *Pseudaspius hakonensis* is used as the scientific name of the big-scaled redbfin because Sakai et al. (2020) recently relegated *Tribolodon*, a generic name used for a long period for the species in Japan, to a junior synonym of *Pseudaspius*.

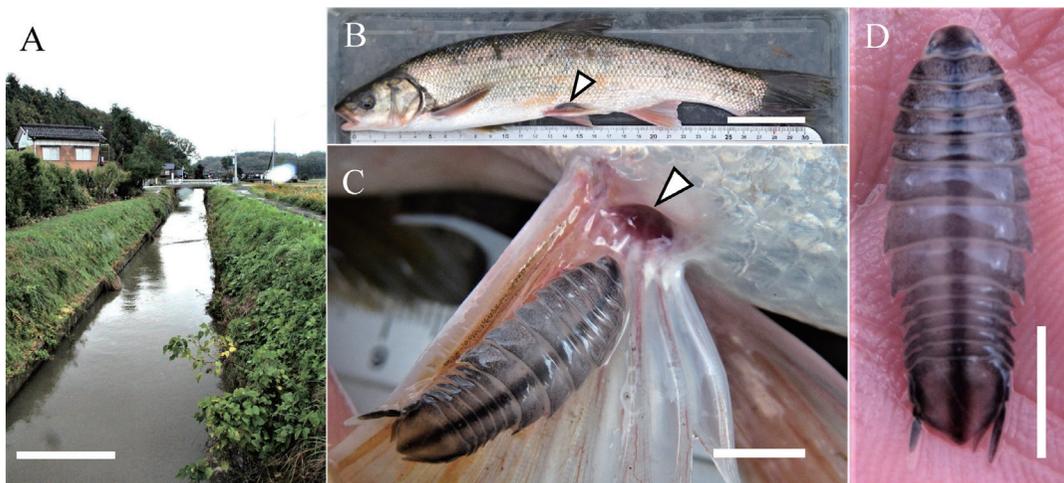


Fig. 1. *Nerocila japonica*, juvenile, parasitic on a big-scaled redfin, *Pseudaspius hakonensis*, from the Ten-no River on Sado Island, Niigata Prefecture, central Japan. A, collection site; B, fish infected by *N. japonica* (arrowhead), lateral view; C, *N. japonica* on the left ventral fin, and a hemorrhage (arrowhead) probably caused by the parasite; D, *N. japonica* sampled from the fish, dorsal view. Scale bars: A, 2 m; B, 5 cm; C, D, 4 mm.

## Results and Discussion

The crustacean parasite collected from the big-scaled redfin (279 mm SL) was a juvenile of *N. japonica* (Fig. 1D). It measures 12.6 mm in body length (BL, from the anterior end of the cephalon to the posterior end of the pleotelson) and 3.8 mm in maximum body width. When fresh, it was dark grey, with a black stripe continued on the central dorsal surface of the pereon, pleon, and pleotelson (Fig. 1C–D). The specimen was similar to an “aegathoid” of *N. japonica* reported by Yamauchi and Nagasawa (2012: fig. 2E) and will be described in detail elsewhere.

To date, only three juveniles of *N. japonica* have been collected in Japan: the first one (9.5 mm BL) from a big-scaled redfin (reported as *T. hakonensis*) from brackish Lake Nakaumi, Shimane Prefecture (Yamauchi and Nagasawa, 2012); the second one (11.2 mm BL) from the same fish species (as *T. hakonensis*) from Hiroshima Bay, Hiroshima Prefecture (Nagasawa and Kawai, 2019); and the third one (10.5 mm BL) from a yellowfin goby, *Acanthogobius flavimanus* (Temminck and Schlegel, 1845) (Perciformes: Gobiidae), from the Seto Inland Sea off Kawajiri, Hiroshima Prefecture (Yamauchi and Nagasawa, 2012). These three juveniles and the specimen reported herein were collected, respectively, on 10 March 2003, 5 January 2018, 1 January 2004, and 8 November 2012, which indicates that *N. japonica* can occur as a juvenile on its hosts at least during the late-autumn to early spring (November to March).

*Nerocila acuminata* Schioedte and Meinert, 1881

was previously reported from Lake Kamo and its nearby coastal marine waters of Sado Island (Honma et al., 1974; Honma and Kitami, 1978; Nunomura, 1981), but currently, the species reported has been regarded as *N. japonica* (Yamauchi and Nagasawa, 2012). The big-scaled redfin (as *Leuciscus (Tribolodon) hakonensis*) was reported as the host of *N. japonica* from Sado Island (Nunomura, 1981), and this paper represents the second record of *N. japonica* from the same host species from the island.

Cyprinid fishes usually stay in fresh waters, but the big-scaled redfin is exceptionally a euryhaline species that can inhabit marine and brackish waters as well as fresh waters (Sakai, 1989; Ishizaki et al., 2009). Thus, the fish caught in this study most probably became infected by *N. japonica* at sea or in brackish Lake Kamo and moved upstream to a brackish area of the Ten-no River. When the fish was caught, the isopod was found alive, indicating that *N. japonica* is also euryhaline. Recently, Nagasawa (2020) found a similar occurrence of the species on a euryhaline gobiid (*A. flavimanus*) in brackish waters of a river in western Japan.

A hemorrhage was found near the base of the ventral fin of the infected fish (Fig. 1C). A similar skin erosion has been found at the attachment site of *N. japonica* on several fish species in Japan (Yamauchi and Nagasawa, 2012; Nagasawa et al., 2018; Nagasawa and Tawa, 2019; Nagasawa and Kawai, 2019). The feeding of *N. japonica* on the host skin is most likely to have caused the observed hemorrhage.

Much remains unknown about the hosts of *N. japon-*

*ica* in Lake Kamo and its adjacent waters. Fifty species of fishes are found in the lake, and most of them migrate from coastal marine waters to the lake (Honma et al., 1974). As *N. japonica* is not host-specific (Yamauchi and Nagasawa, 2012), it is desirable to examine fishes from the brackish lake and coastal marine waters to understand the host utilization of *N. japonica* there.

#### ■ Acknowledgements

We thank Sho-ichi Ito, Sawane, Sado, Niigata, for his cooperation and assistance during the study.

#### ■ References

- Hashimoto, K.-I. 2007. Record of *Nerocila japonica* (Isopoda, Cymothoidae), parasitic on Japanese snook from Kochi Prefecture, Japan. Nanki Seibutu, 49: 183–185. (In Japanese with English title).
- Hata, H., Sogabe, A., Tada, S., Nishimoto, R., Nakano, R., Kohya, N., Takeshima, H. and Kawanishi, R., 2017. Molecular phylogeny of obligate fish parasites of the family Cymothoidae (Isopoda, Crustacea): evolution of the attachment mode to host fish and the habitat shift from saline water to freshwater. Marine Biology, 164: 105. DOI 10.1007/s00227-017-3138-5
- Honma, Y. and Kitami, T. 1978. Fauna and flora in the waters adjacent to the Sado Marine Biological Station, Niigata University. Annual Report of the Sado Marine Biological Station, Niigata University, 8: 7–81.
- Honma, Y., Kitami, T. and Ito, S.-I. 1974. Fauna of Lake Kamo-ko, Sado Island in the Japan Sea (a preliminary report). Proceedings of the Japanese Society of Systematic Zoology, 10: 63–73. (In Japanese with English abstract).
- Ishizaki, D., Otake, T., Sato, T., Yodo, T., Yoshioka, M. and Kashiwagi, M. 2009. Use of otolith microchemistry to estimate the migratory history of Japanese dace *Tribolodon hakonensis* in the Kamo River, Mie Prefecture. Nippon Suisan Gakkaishi, 75: 419–424. (In Japanese with English abstract).
- Momoyama, K. and Tensha, K. 2006. Ugly-looking parasitic infection and other abnormalities of wild fish and shellfish caught in the coastal or inland waters around or in Yamaguchi Prefecture. Bulletin of the Yamaguchi Prefectural Fisheries Research Centre, 4: 143–161. (In Japanese with English abstract).
- Nagasawa, K. 2020. The cymothoid isopod *Nerocila japonica* parasitic on a yellowfin goby, *Acanthogobius flavimanus*, at Okino-shima, Shimane Prefecture, western Japan, with a note on the occurrence of the isopod in brackish waters. Nature of Kagoshima, 46: 279–281. (In Japanese with English abstract).
- Nagasawa, K. and Kawai, K. 2019. *Nerocila japonica* (Isopoda: Cymothoidae) parasitic on big-scaled redbfin *Tribolodon hakonensis* (Cyprinidae) in coastal waters of Hiroshima Bay, western Japan. Cancer, 28: e134–e137. (In Japanese with English title).
- Nagasawa, K. and Tawa, A. 2019. *Nerocila japonica* (Isopoda: Cymothoidae) parasitic on a Japanese seabass, *Lateolabrax japonicus* (Lateolabracidae), from the Pacific coast of central Japan, with a review of the geographical distribution of the isopod in Japan and East Asia. Nature of Kagoshima, 46: 77–80.
- Nagasawa, K., Shirakashi, S. and Yamamoto, S. 2018. *Nerocila japonica* Schioedte & Meinert, 1881 (Isopoda, Cymothoidae) found in a Japanese culture of *Girella leonina* (Richardson, 1846) (Actinopterygii, Kyphosidae). Crustaceana, 91: 375–377.
- Nagasawa, K., Shirakashi, S. and Yamamoto, S. 2019. *Nerocila phaiopleura* and *N. japonica* (Isopoda: Cymothoidae) parasitic on coastal marine fishes off Wakayama Prefecture, central Japan. Nature of Kagoshima, 46: 177–180. (In Japanese with English abstract).
- Nierstrasz, H. F. 1918. Alte und neue Isopoden. Zoologische Mededelingen, 4: 103–142, 2 pls.
- Numomura, N. 1981. Isopod crustaceans in [sic] Sado Island, the Sea of Japan. Annual Report of the Sado Marine Biological Station, Niigata University, 11: 43–62.
- Sakai, H. 1989. *Leuciscus (Tribolodon) hakonensis*. Pp. 259–264 in Kawanabe, H. and Mizuno, N. (eds.) Freshwater fishes of Japan. Yama-kei Publishers, Tokyo. (In Japanese).
- Sakai, H., Watanabe, K. and Goto, A. 2020. A revised generic taxonomy for Far East Asian minnow *Rhynchocypris* and dace *Pseudaspius*. Ichthyological Research, <https://doi.org/10.1007/s10228-019-00726-5>
- Schioedte, J. C. and Meinert, F. W. 1881. Symbolae ad monographiam cymothoarum crustaceorum isopodum familiae 2. Anilocridae. Naturhistorisk Tidsskrift, Series III, 12: 1–166, 10 pls.
- Yamauchi, T. and Nagasawa, K. 2012. Redescription of the fish parasite *Nerocila japonica* Schioedte & Meinert, 1881 (Crustacea: Isopoda: Cymothoidae), with comments on previous records of *N. acuminata* in Japanese waters. Systematic Parasitology, 81: 147–157.
- Yu, H. and Li, X. 2003. Study on the Cymothoidae from Chinese waters. Studia Marina Sinica, 45: 223–238. (In Chinese with English abstract).