J. Grad. Sch. Biosp. Sci.,
Hiroshima Univ. (2008), **47** : 23－28

New host record for *Argulus coregoni* (Crustacea: Branchiura: Argulidae), with discussion on its natural distribution in Japan

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Abstract An adult male of *Argulus coregoni* Thorell, 1864 was collected from the skin of a gogi charr *Salvelinus leucomaenis imbrius* Jordan and McGregor (Salmoniformes: Salmonidae) in the uppermost reaches of the Takatsu River in Yoshiga, Shimane Prefecture, Japan. This finding represents the first record of *A. coregoni* from western Japan. *Salvelinus leucomaenis imbrius* is a new host for *A. coregoni*. This salmonid is endemic to rivers in part of the Chugoku Region, western Japan, and small isolated populations of the fish occurred at the sampling sites. No other salmonids had been stocked there. These facts indicate that *A. coregoni* is native to the river, which does not support the view put forward in the 1960's that *A. coregoni* had been probably introduced from Europe into Japan.

Key words: *Argulus coregoni*, Branchiura, Argulidae, fish parasite, new host, *Salvelinus leucomaenis imbrius*

INTRODUCTION

Argulid branchiurans are predominantly extoparasites of fishes (Yamaguti, 1963). In Japan, *Argulus coregoni* Thorell, 1864 is a parasite of freshwater salmonids (e.g., Hoshina, 1950; Nagasawa et al., 1987; Nagasawa and Ohya, 1996a) although this parasite was initially reported from a cyprinid (Tokioka, 1936). Various aspects of the biology and pathogenicity of *A. coregoni* have been currently studied in Japan, especially by S. Shimura and his colleagues (Shimura and Egusa, 1980; Inoue *et al*., 1980; Shimura, 1981, 1983a, 1983b; Shimura *et al*., 1983a, 1983b; Shimura and Inoue, 1984), but most of the studies were conducted by examining salmonids held in a fish hatchery or in a laboratory. Exceptionally, only Takegami (1984) studied the occurrence of *A. coregoni* in wild populations of amago salmon *Oncorhynchus masou ishikawae* Jordan and McGregor (as *Salmo* (*Oncorhynchus*) *masou macrostomus*) in a river, central Japan. Little information is thus available on the ecology of *A. coregoni* in wild fish populations in this country. Currently, we collected a male specimen of *A. coregoni* from a gogi charr *Salvelinus leucomaenis imbrius* Jordan and McGregor in Shimane Prefecture, Japan. We herein report on this finding as a new host record for *A. coregoni* and discuss its natural distribution in Japan because Tokioka (1965) suggested that this parasite had been probably introduced together with fish from Europe into Japan.

MATERIALS AND METHODS

Six and two gogi charr *Salvelinus leucomaenis imbrius* were sampled with rod and line in two

Accepted on September 12, 2008

localities (Tachigochi River and nameless stream) of the uppermost reaches of the Takatsu River on June 21, 2008 at Tachigochi (34°20'08"N, 131°57'48"E) and Tadeno (34°20'16"N, 131°54'50"E) in Yoshiga, Shimane Prefecture, Japan, respectively. Both locations ware close, being only about 5 km away each other. The fish sampled were kept alive together in a small bag and brought to the laboratory, where they were measured for total length (TL, mm) and examined for ectoparasites. One *Argulus* specimen was taken and photographed. This specimen was fixed and preserved in 70% ethanol. It is deposited in the crustacean (Cr) collection at the National Museum of Nature and Science, Tokyo, Japan (NSMT-Cr 18777). The fish names used in this paper follow those adopted in Nakabo (2002).

RESULTS

One adult male of *Argulus coregoni* (Fig. 1) was found on one (135 mm TL) of the eight fish examined (100-190 mm TL). Attachment site was the dorsal skin of the head of the fish. The specimen of *A. coregoni*, 7.5 mm in total length, is characterized by the sharply pointed abdominal lobes, the black speckled surface of the testes, and the sympods of the second to fourth legs bearing various protuberances. Since we kept alive all fish collected in the two locations in the same small bag for transportation to the laboratory, the exact origin of the infested fish is unknown. Thirteen specimens (75-120 mm TL) of the minnow *Phoxinus oxycephalus jouyi* (Jordan and Snyder) (Cypriniformes: Cyprinidae) were also collected in the nameless stream at Tadeno. No fish of this species was infested with *A. coregoni*.

DISCUSSION

In Japan, *Argulus coregoni* is known to occur in central Japan, including Tokyo, Nagano, Aichi,

Shiga, Kyoto, and Wakayama prefectures (Tokioka, 1936; Yamaguti, 1937; Nagasawa *et al*., 1987; Nagasawa and Ohya, 1996a, 1996b). The present finding represents the first record of *A. coregoni* from western Japan. This species occurs in China (Wang, 1958, 1961; Chen, 1973; Kuang and Qian, 1991), Far Eastern Russia (Smirnova, 1971; Gusev, 1987) and Europe (e.g., Romanovský, 1955; Penczak, 1972; Fryer, 1982; Mikheev *et al*., 2007; Bandilla *et al*., 2007) but is not found in North America (Kabata, 1988; Hoffman, 1998).

The gogi charr *Salvelinus leucomaenis imbrius* is endemic to rivers in part of the Chugoku Region, western Japan (Kimura, 1989). This subspecies of *S. leucomaenis* is a new host of *A. coregoni*. In Japan, the following fishes are known as the hosts of *A. coregoni* (e.g., Tokioka, 1936; Yamaguti, 1937; Hoshina, 1950; Nagasawa *et al*., 1987; Nagasawa and Ohya, 1996a, 1996b): masu salmon *Oncorhynchus masou masou* (Brevoort), amago salmon *O. masou ishikawae* Jordan and McGregor, rainbow trout *O. mykiss* (Walbaum), brook trout *Salvelinus fontinalis* (Mitchill), iwana charr *S. leucomaenis pluvius* (Hildendorf) (Salmoniformes: Salmonidae), ayu *Plecoglossus altivelis altivelis* Temminck and Schlegel (Salmoniformes: Plecoglossidae), and *Acheilognathus melanogaster* Bleeker (Cypriniformes: Cyprinidae).

Our sampling sites are located in the uppermost reaches of the Takatsu River, in which small populations of gogi charr are land-locked and isolated between tributaries. No other salmonids had been stocked there before our sampling. These facts suggest that *A. coregoni* is native to the sampling sites, which does not support the view put forward by Tokioka (1965) that *A. coregoni* had been probably introduced together with fish from Europe into Japan. As stated above, this species is found in China and Far Eastern Russia, and it is thus reasonable to conclude that it naturally occurs in the Far Eastern region of Asia including Japan.

Of the two fish species examined, only gogi charr was found to be infested with *A. coregoni*, suggesting that this parasite maintains its populations using this fish as a host. However, since there is a record of *A. coregoni* from a cyprinid in Japan (Tokioka, 1936), it is also probable that minnows *Phoxinus oxycephalus jouyi* harbor the parasite. Nevertheless, even if *A. coregoni* occurs on minnows, its infestation level may be lower than that in gogi charr because salmonids are common hosts for the parasite.

Much remains to be studied on various aspects of the biology of *A. coregoni* in wild fish populations, and we need to conduct intensive research on the species in natural waters.

REFERENCES

Bandilla, M., Hakalathi-Sirén, Valtonen, E. T., 2007. Experimental evidence for a hierarchy of mate-and host-induced cues in a fish ectoparasite, *Argulus coregoni* (Crustacea: Branchiura). *International Journal for Parasitology*, **37**: 1343-1349.

Chen, C.-L. (ed.), 1973. An Illustrated Guide to the Fish Diseases and Causative Pathogenic Fauna and Flora in the Hupei Province. Science Press, Beijing. 456 pp. (In Chinese).

Fryer, G., 1982. The Parasitic Copepoda and Branchiura of British Freshwater Fishes: A Handbook and Key. Freshwater Biological Association, Ambleside. 87 pp.

Gusev, A. V., 1987. Branchiura. In: Identification Key to Parasites of the Freshwater Fishes of the USSR. Vol. 3, Metazoan Parasites, Part 2 (ed. by O. N. Bauer), Nauka, Leningrad: 515-520. (In Russian).

Hoffman, G. L., 1998. Parasites of North American Freshwater Fishes. Comstock Publishing Associates, Ithaca and London. 539 pp.

Hoshina, T., 1950. Über eine *Argulus*-Art im Salmonidenteiche. *Bulletin of the Japanese Society of Scientific Fisheries*, **16**: 239-243.

Inoue, K., Shimura, S., Saito, M., Nishimura, K., 1980. The use of trichlorfon in the control of *Argulus coregoni*. *Fish Pathology*, **15**: 37-42. (In Japanese with English abstract).

Kabata, Z., 1988. Copepoda and Branchiura. In: Guide to the Parasites of Fishes of Canada. Part Ⅱ- Crustacea (ed. by L. Margolis and Z. Kabata), *Canadian Special Publication of Fisheries and Aquatic Sciences*, **101**: 3-127.

Kimura, S., 1989. *Salvelinus leucomaenis* f. *imbrius*. In: Freshwater Fishes of Japan (ed. by H. Kawanabe and N. Mizuno), Yama-kei Publishers, Tokyo: 128-131. (In Japanese).

Kuang, P., Qian, J., 1991. Economic Fauna of China. Parasitic Crustacea of Freshwater Fishes. Science Press, Beijing. 199 pp. (In Chinese).

Mikheev, V. N., Pasternak, A. F., Valtonen, E. T., 2007. Host specificity of *Argulus coregoni* (Crustacea: Branchiura) increases at maturation. *Parasitology*, **134**: 1767-1774.

Nagasawa, K., Ohya, S., 1996a. *Argulus coregoni* (Crustacea: Branchiura) from amago salmon *Oncorhynchus masou ishikawai* reared in central Honshu, Japan. *Bulletin of the Fisheries Laboratory, Kinki University*, (5): 83-88. (In Japanese with English abstract).

Nagasawa, K., Ohya, S., 1996b. Infection of *Argulus coregoni* (Crustacea: Branchiura) on ayu *Plecoglossus altivelis* reared in central Honshu, Japan. *Bulletin of the Fisheries Laboratory, Kinki University*, (5): 89-92.

Nagasawa, K., Urawa, S., Awakura, T., 1987. A checklist and bibliography of parasites of salmonids of Japan. *Scientific Reports of the Hokkaido Salmon Hatchery*, (41) : 1-75.

Nakabo, T. (ed.), 2002. Fishes of Japan with Pictorial Keys to the Species. English Edition. Tokai University Press, Tokyo. 1749 pp.

Pasternak, A., Mikheev, V., Valtonen, E. T., 2004. Growth and development of *Argulus coregoni* (Crustacea: Branchiura) on salmonid and cyprinid hosts. *Diseases of Aquatic Organisms*, **58**: 203-207.

Penczak, T., 1972. *Argulus coregoni* Thorell, 1864 (Crustacea, Branchiura) in Poland *Fragmenta Faunistica*, **18** : 272-282. (In Polish).

Romanovský, A., 1995. The Czechoslovak species of the genus *Argulus* and their distribution. *Acta Societatis Zoologicae Bohemoslovenicae*, **19** : 27-43. (In Czech with English abstract).

Shimura, S., 1981. The larval development of *Argulus coregoni* Thorell (Crustacea: Branchiura). *Journal of Natural History*, **15**: 331-348.

Shimura, S., 1983a. Seasonal occurrence, sex ratio and site preference of *Argulus coregoni* Thorell (Crustacea: Branchiura) parasitic on cultured freshwater salmonids in Japan. *Parasitology*, **86**: 537-552.

Shimura, S., 1983b. SEM observation on the mouth tube and preoral string of *Argulus coregoni* Thorell and *Argulus japonicus* Thiele (Crustacea: Branchiura). *Fish Pathology*, **18**: 151-156.

Shimura, S., Egusa, S., 1980. Some ecological notes on the egg deposition of *Argulus coregoni* Thorell (Crustacea, Branchiura). *Fish Pathology*, **15**: 43-47. (In Japanese with English abstract).

Shimura, S., Inoue, K., 1984. Toxic effects of extract from the mouth-parts of *Argulus coregoni* (Crustacea: Branchiura). *Bulletin of the Japanese Society of Scientific Fisheries*, **50**: 729.

Shimura, S., Inoue, K., Kudo, M., Egusa, S., 1983a. Studies on effects of parasitism of *Argulus coregoni* (Crustacea: Branchiura) on furunculosis of *Oncorhynchus masou* (Salmonidae). *Fish Pathology*, **18**:

37-40. (In Japanese with English abstract).

Shimura, S., Inoue, K., Kasai, K., Saito, M., 1983b. Hematological changes of *Oncorhynchus masou* (Salmonidae) caused by the infection of *Argulus coregoni* (Crustacea: Branchiura). *Fish Pathology*, **18**: 157-162. (In Japanese with English abstract).

Smirnova, T. S., 1971. Parasitic Crustacea from the fishes of the river Amur s̓ basin. In: Parasites of the River Amur. *Parasitological Papers*, **25**: 177-195. (In Russian).

Takegami, T., 1984. On *Argulus coregoni* parasitic on *Salmo* (*Oncorhynchus*) *masou macrostomus* in Hiki River. *Nankiseibutu*, **26**: 45-60. (In Japanese).

Tokioka, T., 1936. Preliminary report on Argulidae found in Japan. *Annotationes Zoologicae Japonenses*, **15**: 334-343.

Tokioka, T., 1965. *Argulus coregoni* Thorell. In: New Illustrated Encyclopedia of the Fauna of Japan, Part I (ed. by Y. Okada, S. Uchida, and T. Uchida), Hokuryukan Publishing, Tokyo: 504. (In Japanese).

Wang, K.-N., 1958. Preliminary studies on four species of *Argulus* parasitic on fresh-water fishes taken from the area between Nanking and Shanghai, with notes on the early larval development of *Argulus chinensis. Acta Zoologica Sinica*, **10**: 322-340. (In Chinese with English abstract).

Wang, K.-N., 1961. Notes on the ecology and life history of *Argulus* (parasitic Copepoda) from the freshwater fishes of China. *Acta Zoologica Sinica*, **13** : 154-170. (In Chinese with English abstract).

Yamaguti, S., 1937. On two species of *Argulus* from Japan. *Papers on Helminthology Published in Commemoration of the 30 Year Jubileum of the Scientific, Educational and Social Activities of the Honoured Worker of Science K. J. Skrjabin, M. Ac. Sci. and of the 15th Anniversary of the All-Union Institute of Helminthology*, Moscow: 781-784.

Yamaguti, S., 1963. Parasitic Copepoda and Branchiura of Fishes. Interscience, NewYork. 1104 pp.

チョウモドキの新宿主と日本における自然分布に関する論議

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要　旨　島根県吉賀町の立河内・蓼野両地区を流れる高津川最上流部の立河内川と無名沢で採集したゴギ*Salvelinus leucomaenis imbrius* 8尾のうち，1尾の頭部背面からエラオ（鰓尾）類チョウ科のチョウモドキ*Argulus coregoni*の成体雄1個体を採集した。これは西日本におけるチョウモドキの初記録である。これまでにゴギからチョウモドキが採集された記録はなく，ゴギは新宿主となる。ゴギは中国地方の一部の河川にのみ生息し，調査河川でゴギ個体群は陸封・分断されており，他のサケ科魚類の放流が過去にないことから，チョウモドキはそこにもともと分布していたと考えられた。これは，チョウモドキは「多分欧州から魚の体表について移入されたものであろう」とする過去の見解を支持しない。

キーワード：チョウモドキ，エラオ類，ゴギ，魚類寄生虫，新宿主