

Infection of *Salmincola carpionis* (Copepoda: Lernaepodidae) on whitespotted charr, *Salvelinus leucomaenis* (Salmonidae), reared in northern Honshu, Japan

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■ Abstract

The lernaepodid copepod *Salmincola carpionis* (Krøyer, 1837) was collected from the buccal cavity of whitespotted charr, *Salvelinus leucomaenis* (Pallas, 1814), reared at a commercial trout farm and a fisheries research institute in Aomori Prefecture, northern Honshu, Japan. These collections of *Salmincola carpionis* at the farm and the institute represent the first and third records of the species in commercial trout farming in northern Honshu and at noncommercial fish-rearing facilities in Aomori Prefecture, respectively.

■ Introduction

Copepods of the lernaepodid genus *Salmincola* are ectoparasites of freshwater fishes, almost exclusively salmonids, in the Northern Hemisphere (Kabata, 1969). Three species of the genus are known from Japan (Nagasawa and Uyeno, 2015): *Salmincola californiensis* (Dana, 1852), *S. carpionis* (Krøyer, 1837), and *S. stellatus* Markevich, 1936. Of these species, *S. carpionis* has been reported from wild and reared salmonids: the wild hosts are kokanee, *Oncorhynchus nerka* (Walbaum, 1792), from Lake Penke (possibly Lake Panke) [Yamaguti, 1939, reported as *Salmincola falcuata* (Wilson, 1908), see Nagasawa et al., 1995] and whitespotted charr, *Salvelinus leucomaenis* (Pallas, 1814), from the Bekanbe-ushi River, Hokkaido (Nagasawa and Urawa, 2002: appendix); whitespotted

charr in tributaries of Lake Chuzenji, Tochigi Prefecture (Nagasawa et al., 1998); whitespotted charr, brook trout, *Salvelinus fontinalis* (Mitchill, 1814), their hybrids, and rainbow trout, *Oncorhynchus mykiss* (Walbaum, 1792), in the Azusa River, Nagano Prefecture (Nagasawa et al., 1995), while the reared hosts are whitespotted charr, Dolly Varden, *Salvelinus malma* (Walbaum, 1792), Miyabe charr, *Salvelinus malma miyabei* Oshima, 1938, and brook trout at the Asamushi Aquarium (Nagasawa et al., 1995) and whitespotted charr at an unspecified fish-rearing site in Aomori Prefecture (Sakaki, 2012); whitespotted charr and rainbow trout at the Iwate Prefectural Inland Fisheries Experimental Station in Iwate Prefecture (Kumagai, 1985; Nagasawa et al., 1995); whitespotted charr and brook trout at the Nikko Laboratory of the National Research Institute of Aquaculture (Nagasawa et al., 1997, 1998) and hybrids of whitespotted charr and brook trout at a trout farm in Tochigi Prefecture (Nagasawa and Ishikawa, 2017); whitespotted charr and amago salmon, *Oncorhynchus masou ishikawae* Jordan and McGregor, 1925, at a trout farm in Yamanashi Prefecture (Yamamoto and Nagasawa, 1999, 2001); and whitespotted charr at trout farms in Toyama Prefecture (Wakabayashi, 1997). In addition to these host and distribution records, Markevich (1956) reported one of the collection localities of *S. carpionis* (reported as *Salmincola smirnovi* Markevich, 1940) as “Japan” (see Nagasawa et al., 1995).

Based on the above information, *S. carpionis* has been found at trout farms in Tochigi, Yamanashi, and Toyama prefectures, all of which are located in central Honshu, the main island of Japan. No information is available on *S. carpionis* infecting salmonids farmed in other regions of Japan.

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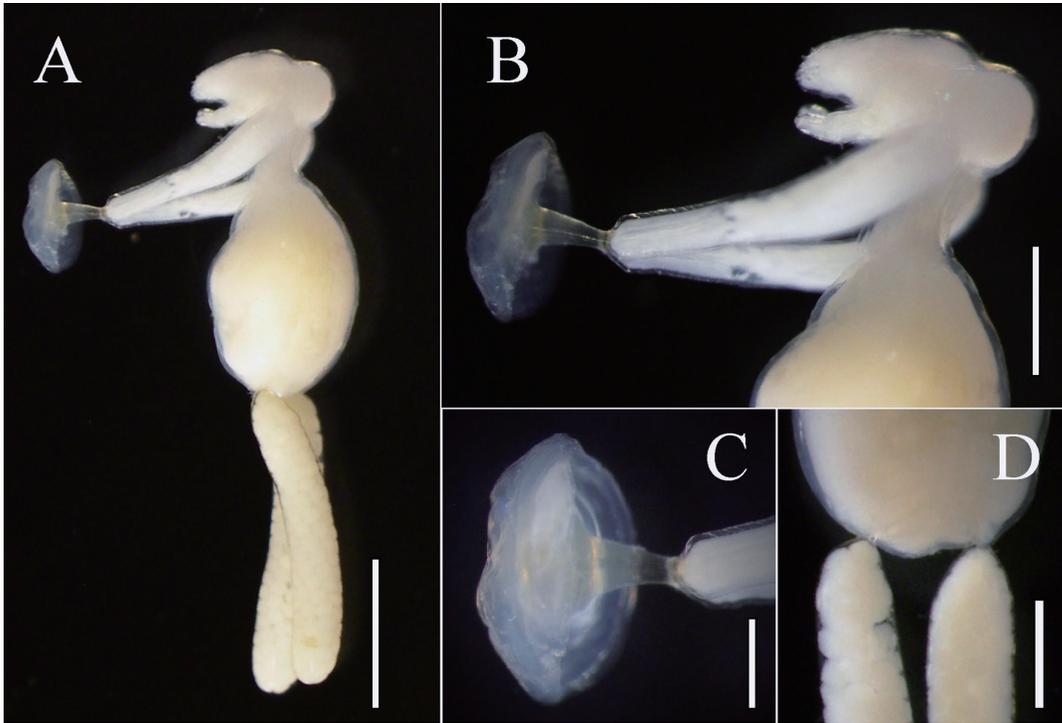


Fig. 1. *Salmincola carpionis*, adult female, from the buccal cavity of whitespotted charr, *Salvelinus leucomaenis*, from a trout farm in Hirosaki, Aomori Prefecture. A, whole body, lateral view; B, anterior part of the body, lateral view; C, bulla and manubrium at the apical joint of the maxillae, lateral view; D, posterior portion of the trunk with a pair of egg sacs, ventral view. Ethanol-preserved specimen. Scale bars: A, 2 mm; B, 1 mm; C, 0.5 mm; D, 1 mm.

Recently, we found specimens of copepod in the parasite collection of the Inland Water Research Institute (IWRI), Aomori Prefectural Industrial Technology Research Center, in Towada, Aomori Prefecture, the northernmost prefecture of Honshu. The specimens were collected from whitespotted charr reared at a trout farm in the prefecture and at the institute. They were identified as *S. carpionis* and are reported herein, especially as the first record of the parasite in commercial trout farming in northern Honshu.

■ Materials and Methods

The specimens of copepod found in the IWRI's parasite collection consist of nine adult females, which were found in the buccal cavity of whitespotted charr at two localities in Aomori Prefecture: five females at a trout farm in Hirosaki on 23 October 1998, and four females at the IWRI on 6 August 2012. The specimens were all fixed in 10% formalin when collected but later preserved in 70% ethanol. The specimens were sent to the Aquaparasitology Laboratory, Shizuoka, where they were examined for their morphology and identified as *S. carpionis*. The specimens are retained by the first author (KN) for a comparative study of *Salmincola*

spp. from Japanese fishes but will be deposited in the Crustacea collection of the National Museum of Nature and Science, Tsukuba, Ibaraki Prefecture.

■ Results and Discussion

The specimens are characterized by an ovoid cephalothorax, a neck-like narrow portion between the cephalothorax and the trunk, an oval trunk with rounded margins, long subcylindrical maxillae, and a mushroom-shaped bulla with long manubrium present at the apical joint of the maxillae (Fig. 1). These morphological features correspond to those of *S. carpionis* collected from Iceland, Greenland, Alaska, Bering Island, Baffin Land, Lake Tamir, South Sakhalin (Kabata, 1969) and Japan (Nagasawa et al., 1995). The specimens measure 3.6–4.7 (mean 4.3) mm long ($n = 5$, from a trout farm in Hirosaki; from anterior extremity of cephalothorax to posterior end of trunk, excluding egg sac).

In Japan, whitespotted charr are widely farmed but their parasites have been poorly studied (Nagasawa et al., 1987). *Salmincola carpionis* is known to parasitize whitespotted charr farmed only in central Honshu (Wakabayashi, 1997; Yamamoto and Nagasawa, 1999,

2001; Nagasawa and Ishikawa, 2017). The present collection of *S. carpionis* from whitespotted charr at the trout farm in Hirosaki, Aomori Prefecture, represents the first record of the parasite in commercial trout farming in northern Honshu. According to the staff of this trout farm, there was no infection of *S. carpionis* before live transportation of some whitespotted charr from a fish farm in the same prefecture, and those fish had been raised using river waters. It is thus most likely that *S. carpionis* was introduced to the trout farm in Hirosaki along with infected host individuals. A similar suggestion was made for a case of infection of *S. carpionis* on whitespotted charr farmed in Toyama Prefecture (Wakabayashi, 1997).

Using two photographs of *S. carpionis* from an unspecified locality, *Salmincola* infection of farmed salmonids was briefly reported in a newsletter from the IWRI (Sakaki, 2012). The specimens of *S. carpionis* found at the IWRI in the present paper are those photographed for the newsletter. In Aomori Prefecture, *S. carpionis* was also reported from the Asamushi Aquarium (Nagasawa et al., 1995). Thus, the species has been found at two noncommercial fish-rearing facilities in this prefecture.

As stated in the Introduction, some species of wild salmonids are known as the hosts of *S. carpionis* in Japan. However, there is little information on the occurrence of the parasite on those wild salmonids: only Nagasawa et al. (1995) reported prevalence and intensity data of the species in salmonids from Azusa River, Nagano Prefecture. Our knowledge of the geographical distribution of *S. carpionis* in Japan is also very limited. We need to study the occurrence of the parasite on wild salmonids in various regions of Japan.

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