



Plerocercoids of *Nybelinia surmenicola* (Cestoda: Tentacularidae) in Squids, *Todarodes pacificus*, from East Sea, the Republic of Korea

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Abstract: A visceral helminth of the squid, *Todarodes pacificus*, is reported from the East Sea, the Republic of Korea. Total 39 squid samples were purchased from a fish market in Jumunjin-eup, Gangneung-si (City) from August 2014 to July 2015 and were examined for helminth parasites with naked eyes and under a stereomicroscope after opening the abdominal cavity with a pair of scissors. Whitish larval worms were mainly found in the stomach and abdominal cavity of the squid. They were detected in 25 (64.1%) out of 39 squids examined, and the infection density was 7 larvae per infected squid. Spatula-shaped larvae were 8.2 × 2.0 mm in average size, round to slightly flattened anteriorly, with round hatching posteriorly, and had characteristic 4 tentacles with numerous hooklets in the scolex. The larvae were identified as the plerocercoid stage of *Nybelinia surmenicola* by their morphological features. This finding represents a new host record and the first report of *N. surmenicola* infection in *T. pacificus* squids from the east coast of Korea.

Key words: *Nybelinia surmenicola*, *Todarodes pacificus*, new record, plerocercoid, squid

The trypanorhynchid cestodes (Order Trypanorhyncha) are one of the main groups of parasites that infect fish and cephalopods. They go through 3-4 host life cycles before reaching their final host [1]. Adult trypanorhynchids are typically found in the stomach and intestine of sharks and rays, while their larval forms infect a wide variety of marine invertebrates and teleosts [2,3]. They are characterized by a scolex bearing 2 or 4 bothria [4] and a tentacular apparatus consisting of 4 retractile tentacles capped with hooks as extensions of the tentacle sheaths [5]. A total of 254 species are currently recognized in the trypanorhynchid cestode group [6]. The important morphological characteristics, i.e., the shape of scolex, number of bothria, tentacular armature, genital organs, and bothrial pits, are considered as major differential points in the taxonomic study of this group [7]. In the present study, we record the plerocercoid larvae of *Nybelinia surmenicola* (Cestoda: Tentacularidae) detected in the squid, *Todarodes pacificus*, from East Sea, the Republic of Korea.

A total of 39 squids were purchased from a fish market in Jumunjin-eup, Gangneung-si (City), Korea from August 2014 to July 2015. The squids were transported to the laboratory, and plerocercoid larvae were obtained from the stomach mucosa, external stomach wall, and body cavities of the squids using a stereoscopic dissecting microscope. They were first observed alive in saline solution (0.9% NaCl), then fixed in formalin saline (4% buffered formalin in 1% saline) for 24 hr. They were subsequently transferred to 70% ethanol. Additional glutaraldehyde-fixed specimens were prepared for SEM via an ethanol dehydration series. The length and width of the parasites were measured. The parasites were identified by the shape and number of hooks on their probosces using light microscopy and scanning electron microscopy (Field Emission Scanning Electron Microscope, FEI, Inspect F, Brno, Czech Republic). Also, tissue specimens were fixed in 10% neutral formalin for routine histological examinations. The fixed samples were washed in tap water overnight and exposed to increasing concentrations of ethanol (70%, 80%, 90%, and 100%), rinsed with xylene, and embedded in paraffin. Worm sections in 5 µm thickness were mounted on slides and stained with hematoxylin and eosin (H-E). Classification of trypanorhynchids in the present study was done according to Palm and Walter [5], Bray [8], and WoRMS [9]. A specimen has been de-

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Fig. 1. Plerocercoids attached to a squid, *Todarodes pacificus*.

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Of the 39 squid samples examined, 25 (64.1%) were infected with the plerocercoid larvae of *N. surmenicola* of the family Tentaculariidae, order Trypanorhyncha. On average, we found 2 larval parasites attached to the stomach mucosa, 3 attached to the external stomach wall, and 2 free in the body cavity (Fig. 1). Seasonal population dynamics showed the highest abundance from May through August. The plerocercoid larvae are pyriform, rounded to slightly flattened anteriorly, with round hatching posteriorly. The larvae have 4 tentacles at the apical end of the scolex (Fig. 2A, B). Each larva is 8.2 ± 0.3 mm long and 2.0 ± 0.2 mm wide, white, and spatula-shaped. The tentacle is armed with hooks that are uniform in size and spirally arranged at regular intervals; the hooks act as anchors (Fig. 2C). The scolices are subcylindrical, 3.13-3.45 (av. 3.3) mm long. The bothridia are broad, shaped like right triangles, and 2.03-2.45 (av. 2.2) mm long. The appendices are 0.70-0.75 (av. 0.72) mm long. The tentacles are 0.75-1.08 (av. 0.87) mm long and 0.12-0.14 (av. 0.12) mm wide, and the microtriches are 0.04 mm long and bent (Fig. 2D). Histological examinations of the specimens revealed the characteristic shape of cestodal larvae (Fig. 3). The tentacular armatures of the scolex are connected to 4 bulbs.

Parasites belonging to the trypanorhynchid genus *Nybelinia* are widely spread among 22 species of ommastrephid squids in the worlds [10]. In the original description of *N. surmenicola*,

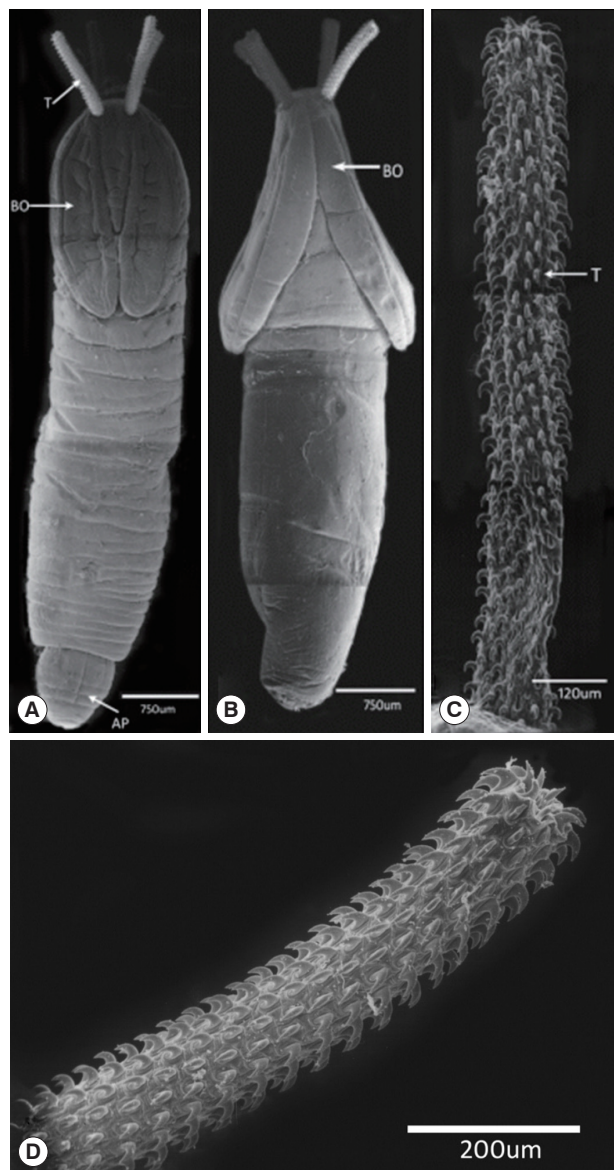


Fig. 2. Scanning electron micrographs of a plerocercoid of *Nybelinia surmenicola* found in *Todarodes pacificus*. (A) A whole body with 2 bothridia (BO), 4 tentacles (T), and an appendix (AP). (B) Lateral view of the whole body. (C) Tentacles and hook profiles (T). (D) Enlargement of tentacles with hooks.

la, Okada (in Dollfus [11]) illustrated a strongly contracted post larva found in the squid *T. pacificus* (Steenstrup, 1880), but drew only the basal part of the tentacles. In this study, a different type of trypanorhynchid larvae was found. The present finding in *T. pacificus* represents a new host record in Korea. This parasite is not infectious to humans and is harmless in food. However, in rare cases, the larvae stick in the throat of humans who eat uncooked squids; they can be readily removed with forceps [12]. Saito et al. [13] reported that a do-

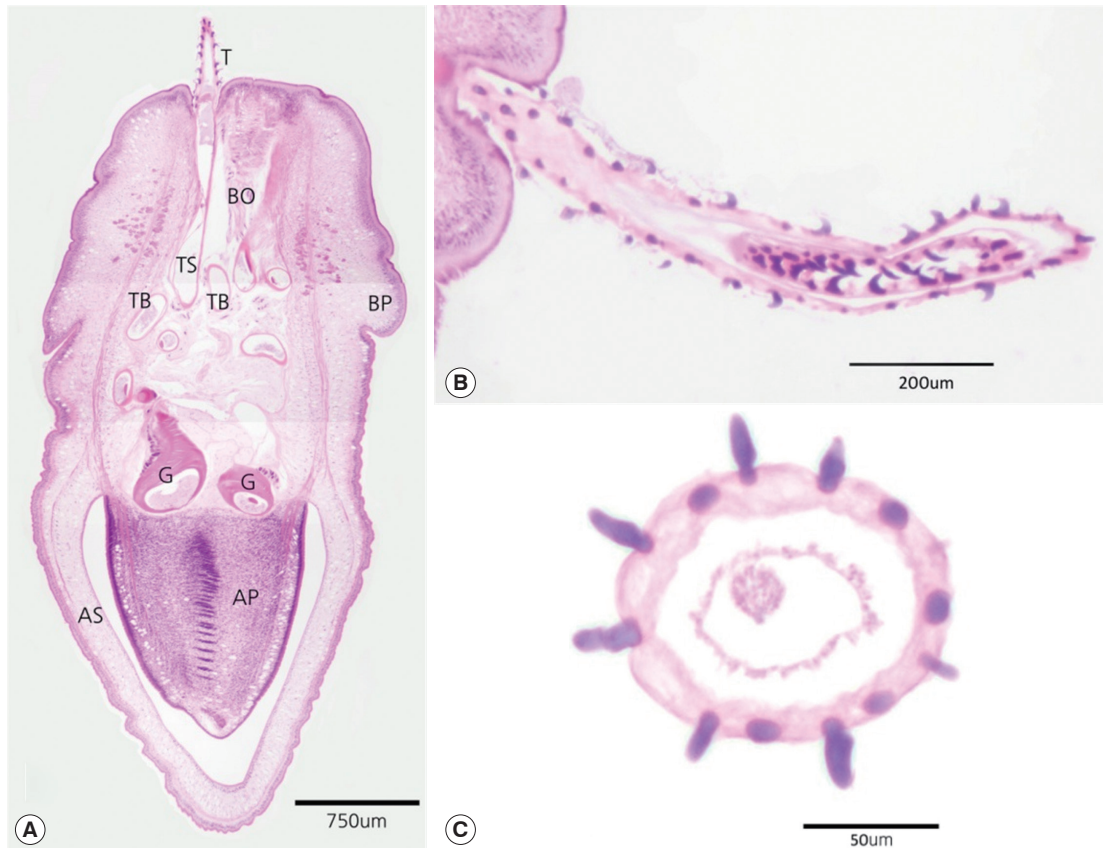


Fig. 3. A photomicrograph of a plerocercoid of *Nybelinia surmenicola*. (A) Cross section. (B) Longitudinal section. (C) Cross section of the tentacle. AP, appendix; AS, appendix sheath; BO, bothria; BP, bothridial pit; G, gut; TB, tentacle bulb; T, tentacle; TS, tentacle sheath.

mestic cat in Japan vomited 2 infective larval forms of tetracyclic cestode.

N. surmenicola has been found in various intermediate teleost and cephalopod hosts [14-16]. *N. surmenicola* utilizes krills (*Euphausia pacifica*) as the first intermediate host, fish as a paratenic host, and salmon shark (*Lamna ditropis*) as the definitive host [17,18]. Rasero et al. [19] surmised that squids are probably infected by larval cestodes via ingestion of small bony fish of the species *Conger conger*, *Trachurus trachurus*, and *Lophius piscatorius*. Chu [20] reported *Nybelinia lingualis* in *Theragra chalcogramma* from Korea. Our finding represents the first report of plerocercoids of *N. surmenicola* in squids from the East Sea of Korea.

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CONFLICT OF INTEREST

We have no conflict of interest related to this work.

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