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Worms within worms: First identification of parasitic nematodes in nemerteans

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Short Communication

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Abstract

We report the first identification of nematode parasitism in a nemertean host (*Arctostemma arcticum*), representing a novel host-parasite interaction in marine ecosystems. Larvae of the anisakid nematode were discovered within the rhynchocoel of *A. arcticum* collected from the White Sea, suggesting transmission via ingestion of infected crustaceans – a previously undocumented pathway. The nematode was identified as *Phocanema bulbosum* through both morphological and molecular analyses.

The presence of nematode in nemertean *A. arcticum* implies trophic transmission through nemertean predation on infected amphipods, supported by hoplonemertean feeding strategy. While some fish occasionally consume nemerteans, their low predation frequency suggests *A. arcticum* could act as a dead-end host.

This study expands the known host range of Anisakidae, though it remains uncertain whether nemerteans serve as competent hosts in the *P. bulbosum* life cycle. Nevertheless, the findings highlight the need to assess nemerteans' potential influence on parasite dynamics in fisheries and aquaculture, particularly where they coexist with intermediate and definitive hosts.

Introduction

Nemerteans (phylum Nemertea) are a group of vermiform animals that comprises over 1,320 recognized species (Norenburg et al., 2025). The most distinctive feature of these animals is their retractable proboscis, which is stored in a specialized cavity known as the rhynchocoel. Most nemerteans are free-living marine bottom-dwellers that feed as predators or scavengers, with only rare exceptions. Far less is known about the parasites that infect nemerteans themselves – including their diversity, life cycles, and ecological roles. Only three haplosporidians, one microsporidian, four gregarines, three ciliates, five mesozoans, one mite, and one copepod have been identified as parasites of nemerteans, alongside rare reports of cestodes and trematodes (McDermott, 2006; Rueckert et al., 2010). Prior to this study, nematode infections were unrecorded, with only a single observation of unidentified larvae in the terrestrial *Geonemertes philippinensis* (Gibson & Moore, 1997).

The family Anisakidae, a group of parasitic nematodes with complex life cycles, is known to exploit a broad range of aquatic hosts – including mollusks, crustaceans, fish, and marine mammals – during their larval stages (Ángeles-Hernández et al., 2020). Here, we present the first confirmed case of an anisakid nematode parasitizing a nemertean host, expanding our understanding of both groups' ecological interactions.

Material and methods

Sample collection and morphological study

Six specimens of *Arctostemma arcticum* were collected in the White Sea (July 2019) during benthic trawling at 30 m depth. Two individuals harbored nematodes visible through their translucent body walls. After collection, the animals were relaxed in an isotonic magnesium chloride ($MgCl_2$) solution and photographed using a Nikon D850 with Venus Optics Laowa 100 mm Macro 2× f/2.8.

One extracted parasite specimen was subjected to morphological examination and photographed using light microscopy, Leica DM2500. Histological sections (5 μm) of the nemertean with the nematode in situ were prepared and stained with Heidenhain's azan for detailed anatomical study. Stained specimens were examined under a light microscope and imaged using an Olympus VS120 SlideScanner.

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Molecular analysis

DNA extraction was performed using the QIAamp DNA Investigator Kit (Qiagen, Hilden, Germany). The *COX2* gene was amplified with primers 210/211 (Valentini et al., 2006) under standard PCR conditions (Gordeev et al., 2023). Phylogenetic analysis was conducted using MUSCLE alignment and RAxML bootstrap (1000 replicates) under the HKY+G model (Elder et al., 2021).

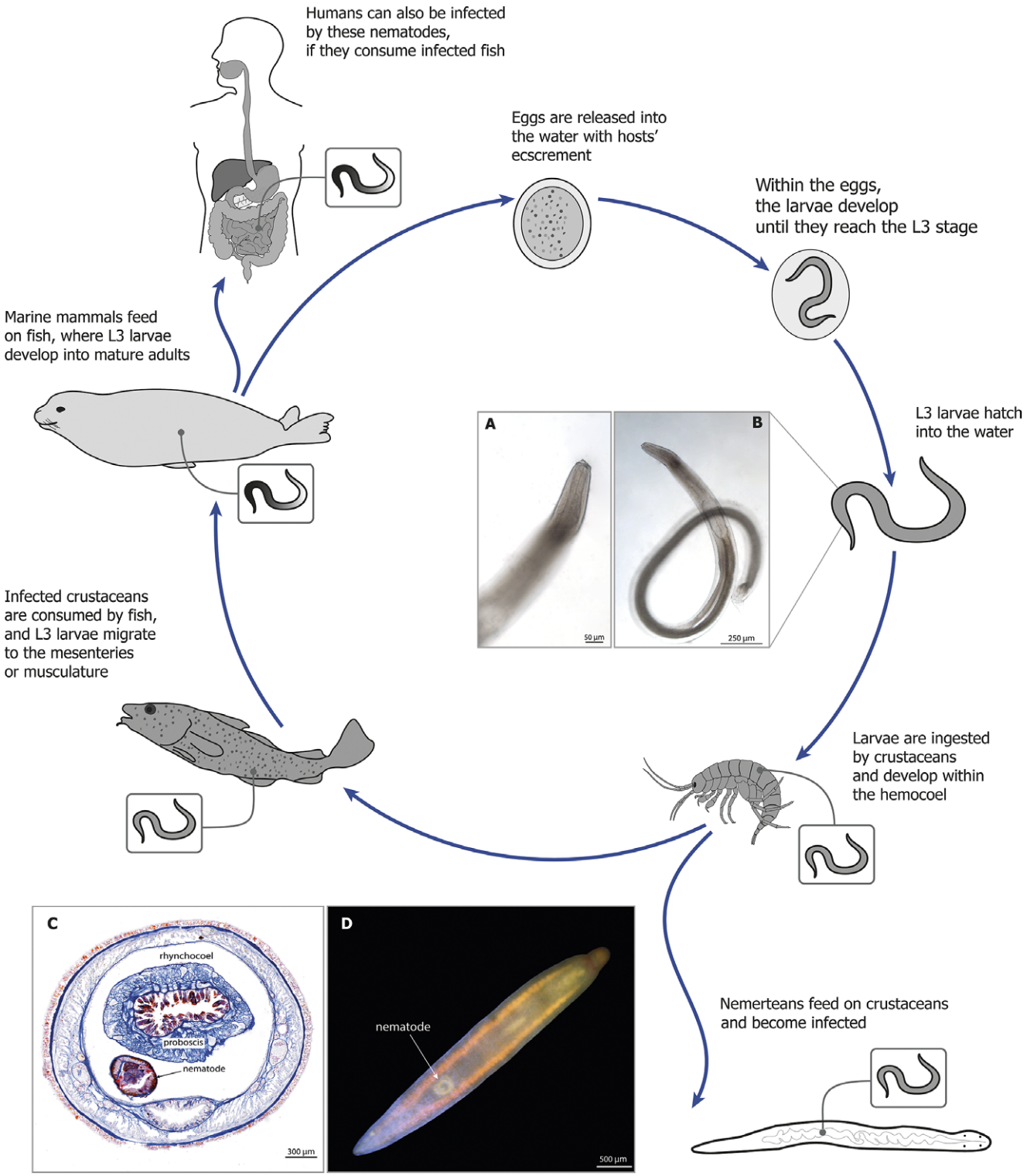


Figure 1. *Phocanema bulbosum* and its estimated life cycle. A, B – the nematode within the nemertean's rhynchocoel. C, D – picture of the extracted nematode. A – anterior end of nematode, B – entire nematode specimen, C – nematode on a cross-section of a nemertean, stained with Azan, D – nematode visible through the translucent body wall of a live nemertean.

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Results and discussion

Morphological characteristics

The examined nematode measured 3.5 mm in length and 0.12 mm in diameter. It lacks a reproductive system because it is a third-stage juvenile (L3).

Morphological examination revealed key diagnostic features: a large ventricular bulb (0.3 mm long), a single caecum directed anteriorly, and an elongated triangular tail (Fig. 1A, B). These morphological traits are characteristic of the *Phocanema* genus (Bao et al., 2023).

Molecular identification

Partial *COX2* gene sequences (468 bp alignment) from our sample (GB number is PX123325) matched almost exactly (>99% sequence similarity) to other *P. bulbosum* (GB numbers OQ731870-3, OQ731876-7, OQ731883, OP418115 [Gordeev et al., 2023]).

Taxonomic confirmation

The combination of morphological and molecular data conclusively identified the parasite as *P. bulbosum*, known to utilize crustaceans as intermediate hosts, fish as paratenic hosts, and seals as definitive hosts (Mattiucci et al., 2017).

Discussion

The discovery raises important ecological questions. The nematode's presence in the nemertean (Fig. 1C, D) suggests transmission occurred during nemertean predation on infected crustaceans (likely amphipods). This is supported by the feeding behavior of hoplonemerteans like *A. arcticum*, which use their stylet to pierce crustacean exoskeletons and inject toxins (McDermott & Roe, 1985). Thus, instead of being eaten by fish, crustaceans infected with third-stage juvenile of *P. bulbosum* are eaten by *A. arcticum*, a hoplonemertean. This is also supported by the fact that *P. bulbosum* is found in the cavity of the proboscis, rhynchocoel, while in fish those nematodes live in the body cavity (mesenteries) (Gordeev et al., 2023).

The alternative hypothesis – direct penetration through the body wall – is unlikely given the potent toxins in nemertean mucus (Kem, 1985). The surface of nemerteans is covered with mucus that often contains toxins (in hoplonemerteans, this may include alkaloids like anabaseine, which is a neurotoxin that induces paralysis in invertebrates) (Kem et al., 2006). This mucus clearly deters predators and, possessing these properties (viscosity and toxicity), may block the penetration of parasites both mechanically and chemically.

The role of nemerteans as competent hosts in the *P. bulbosum* life cycle remains unclear. While some fish (e.g., *Gadus morhua*, Atlantic cod) occasionally consume nemerteans, their low predation rates (0.46% in cod stomachs) and the group's toxicity suggest this transmission pathway may be ecologically insignificant (McDermott, 2001). Understanding these relationships is crucial for reconstructing the full life cycle of parasites like *P. bulbosum* and evaluating their role in food web dynamics. If nemerteans indeed serve as dead-end hosts for fish parasites (Fig. 1), their presence could theoretically reduce parasite transmission to commercially valuable fish species. Future studies should prioritize clarifying whether nemerteans influence parasite transmission in ways that could affect fisheries or aquaculture systems.

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Competing interests. The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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