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Short note

Anisakidae nematodes in capelin *Mallotus villosus* (Müller, 1776) (Actinopterygii: Osmeridae) caught for food purposes

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ABSTRACT. Capelin *Mallotus villosus*, a representative of the Osmeridae, is a common species found in the North Atlantic, Pacific and Arctic Ocean. Being one of the main components of the diet of various fish species, it plays an important role in the circulation of different parasite species, including the nematodes of the Anisakidae. Capelin is also extensively caught and used for human food, and has become increasingly available to consumers in Poland. Thirty six capelin specimens, smoked fish bought at a store in Gdynia, were examined for the presence of Anisakidae. Ten specimens of nematode (*Anisakis simplex*, *Contracaecum* sp.) were found in eight fish. The overall prevalence for the fish was 22.2%, with a mean intensity of 1.3 (range 1–3). Despite its widespread acquisition and use, capelin has been the subject of few parasitological analyses. Our findings indicate that it is a typical host of Anisakidae nematodes, a species of great zoonotic importance. While dead nematode specimens found in smoked fish do not pose a direct threat to humans as parasites per se, they can cause food allergies. It seems, therefore, that fish intended for consumption should be the subject of constant parasitological monitoring, linked to food quality control.

Keywords: *Anisakis simplex*, *Contracaecum* sp., fish, Osmeridae, zoonotic risk to humans

Introduction

Capelin (Müller, 1776) (Actinopterygii: Osmeridae) is a small fish, commonly found in the North Atlantic, Pacific and Arctic Ocean [1–3]. It is one of the major fish species upon which the Atlantic cod *Gadus morhua* Linnaeus, 1758, Atlantic herring *Clupea harengus* Linnaeus, 1758, as well as the Atlantic mackerel *Scomber scombrus* Linnaeus, 1758, seals, whales, cephalopods and marine birds feed. Thus, it is of key significance in trophic networks, as it occupies a place between zooplankton and larger fish in the food chain, and thus constitutes an important link in the circulation of parasites in the marine environment. It is also a species that is caught intensively (more than 0.5 million tons/year in 2018) [4–11].

Most capelin is used for the production of fish meal and fish oil [12,13], but it is also extensively used for food purposes: it is consumed fried, braised, cooked, roasted, pickled, but also salted and dried, and it is a common pub snack in Japan [14–17]. Capelin constitutes a valuable source of easily absorbable proteins, B group vitamins, fatty acids and many other valuable substances, and hence is recommended for various diets related to the prevention of atherosclerosis, diabetes, diseases of the nervous system, musculo-skeletal system, heart, thyroid and cancers. It has also been linked to faster metabolism and weight loss, and is hence incorporated in weight reduction diets [17–19].

Its small size means that the fish is typically consumed whole with all of its organs [20] as such it retains its entire parasitofauna. Studies on the capelin parasitofauna are relatively scarce and tende to be of a fragmentary and local nature [21]. Several species of various group, *viz.* Protista, Monogenea, Digenea, Cestoda, Acanthocephala, Copepoda, as well as Nematoda, including epidemiologically-significant Anisakidae species (*Anisakis simplex*

(Rudolphi, 1809), *Contracaecum osculatum* (Rudolphi, 1802) and *Pseudoterranova decipiens* (Krabbe, 1878)) have been identified in this fish species [21–26].

The present study examines the presence of Anisakidae nematodes in capelin intended for consumption.

Materials and Methods

Thirty six capelin specimens (19 females, 17 males; 13.1–17.7 cm, mean 15.6 cm; 7.0–26.4 g, mean 15.6 g) were examined for infection with Anisakidae nematodes. The fish were purchased in June and September 2022 at a store in Gdynia (Poland, Pomeranian Voivodeship). The fish had been smoked, imported to the Polish market from the Netherlands, and collected in the north-east part of the Atlantic (western Scotland).

The internal organs were inspected for the presence of parasites; subsequently, from the parenchymal organs (liver, spleen) crushed slides were prepared, which were studied under a light microscope. The muscles were comminuted using dissecting needles and studied under a stereoscopic microscope.

The collected parasites were fixed and preserved in 70% ethanol solution. They were then cleared and embedded in polyvinyl lactophenol for the purpose of identification [27].

Results and Discussion

Ten specimens of nematodes were detected in eight capelin specimens. This group comprised third stage larvae of *Anisakis simplex* (two nematodes) and *Contracaecum* sp. (eight nematodes). The overall prevalence (including both parasite species) for the fish was 22.2%, with a mean intensity of 1.3 and a range of intensity 1–3 (Tab. 1, Fig. 1).

The previous research demonstrate that Anisakidae nematodes constitute a constant element of the capelin parasitofauna, present in various regions of of its distribution [21,23,28]. This underlines the role of the fish in the circulation of these nematodes in the environment and their transmission to subsequent hosts such as Atlantic cod and Atlantic herring [29,30]. However, due to the scale of economic usage of capelin, there is a need to determine their significance in the context

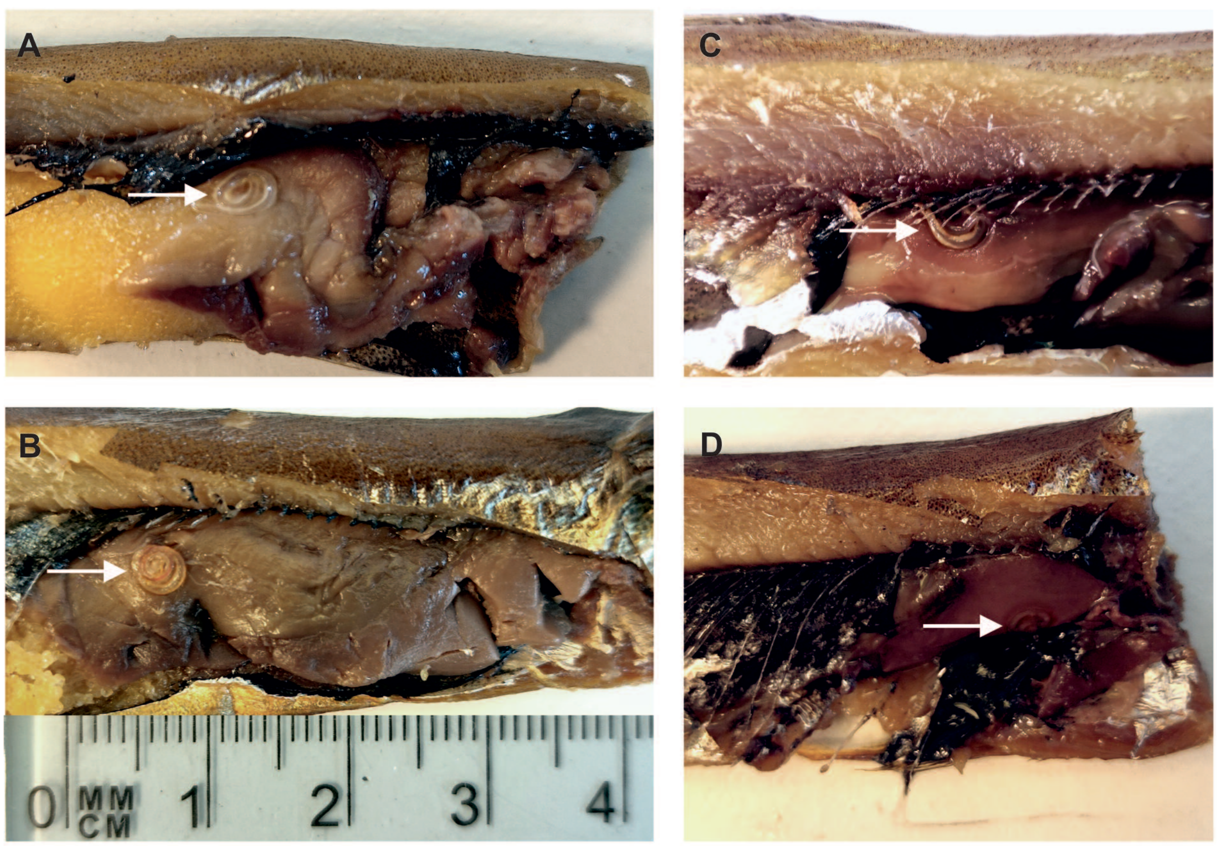

Figure 1. *Anisakis simplex* (A, B) and *Contracaecum* sp. (C, D) in the examined capelin

Table 1. Infected capelin (length/weight/sex) including the nematode species and habitat

Host no.	Host length (cm)/ weight (g)/sex	*Anisakis simplex* (number/habitat)	*Contracaecum* sp. (number/habitat)
1	14.2/11.9/F		1/gonad
2	15.5/13.8/M		1/gonad
3	16.0/13.3/M	1/muscles	
4	16.2/17.3/M	1/liver	
5	16.8/17.0/M	1/liver	
6	16.9/26.4/F		1/on the intestine
7	17.2/24.0/M		1/liver
8	17.7/23.8/M		1/gonad, 2/liver

of human health hazards. These nematodes have zoonotic (being known to cause anisakidosis) and allergenic significance in humans [31–34]. The presence of parasites in the edible parts may have unfavorable effects on product quality and consumer safety [21].

The present study examined a random sample of commercially-available capelin used for food purposes. The confirmation of the presence of Anisakidae larvae in the examined specimens does not only confirm the frequent presence of these parasites, but also the possibility of their contact with humans. Although the examined fish were smoked and only contained dead nematodes, they may nevertheless pose a hazard in terms of food allergies. In addition, while the infection level was not high, this small fish is consumed in high quantities, e.g. as a snack, and is recommended by dietitians for regular consumption due to their extensive nutritional value [15,19]. Thus, they may constitute an important allergenic agent. Moreover, the presence of nematodes may itself lower the commercial value of the fish. It is also important to add that the fish has been increasingly available in Poland and has garnered growing interest among consumers.

Undoubtedly, capelin should be subject of regular examinations, not only to determine the presence of Anisakidae in the environment, but also to better understand the zoonotic risk and health issues associated with consumption.

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