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Short communication

Anisakis simplex Rudolphi, 1809, infection in fillets of Barents Sea cod *Gadus morhua* L.

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Abstract

The purpose of this study is to record the infections of the whaleworm (*Anisakis simplex*) in fillets of Norwegian Arctic cod from coastal and oceanic waters of the Barents Sea. The percentage of cod infected was 96%. The mean intensity of *A. simplex* in fillets of oceanic and coastal cod was 4.3 and 6.1 respectively. These values were significantly different. Comparison with previous work indicates that the *A. simplex* infection in Barents Sea cod is little influenced by the large fluctuations in the abundance and distribution of the main fish stocks (i.e. capelin, herring and cod) in this ecosystem. It is not clear which factors are responsible for the maintenance of the high prevalences of *Anisakis* in the Barents Sea.

Keywords: *Gadus morhua*; *Anisakis simplex*; Parasitism

1. Introduction

Two species of nematodes, the sealworm (*Pseudoterranova decipiens*) and the whaleworm (*Anisakis simplex*), are commonly involved in the infection of cod (*Gadus morhua*) fillets (Bowen, 1990), and quantitative investigations have been conducted in the Northwest and Northeast Atlantic. Infected fillets are unappealing to consumers, so heavily infected cod have no commercial value. It is therefore important to study the life cycles of these parasites in order to establish the role of the various hosts in their transmission.

Smith (1983a) noted a higher prevalence of *A. simplex* in teleosts from the

Barents Sea and the Norwegian Sea than in the North Sea. He concluded that the whaleworm has its main distribution in the northern waters. The maturation of *A. simplex* is related to cetaceans (Smith, 1983b).

Platt (1975) investigated the infection of *A. simplex* in fillets of cod from various areas in the North Atlantic including the western part of the Barents Sea. However, since Platt's (1975) investigations there have been large fluctuations in both the abundance and distribution of the main fish and marine mammal stocks in the Barents sea (Hamre, 1991; Ugland et al., 1993). It is therefore interesting to compare the infection level of *A. simplex* in the 1970s with that in the late 1980s. This study also compares the infection in coastal and oceanic cod.

2. Materials and methods

The cod was sampled at four locations in the Barents Sea (Fig. 1) during January and February 1989. The coastal cod were sampled from catches of smaller vessels equipped with gillnets, while the oceanic cod was sampled from commercial oceanic trawlers. A total of 118 and 94 cod were obtained in the coastal localities off Honningsvåg and Vardø. From the oceanic sampling sites, 140 cod were obtained off Honningsvåg and 67 off Vardø. For comparison with the investigation of Platt (1975), only nematodes in the fillets were considered. To avoid migration of *A. simplex* larvae from the liver and intestinal organs, the

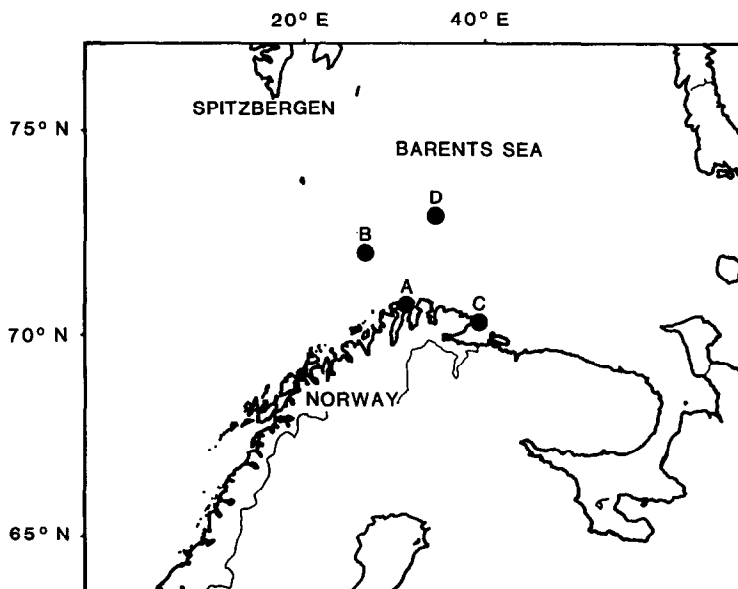


Fig. 1. The positions of the four sampling sites of cod in the Barents Sea. A, Honningsvåg coast; B, Honningsvåg ocean; C, Vardø coast; D, Vardø ocean.

Table 1

Infection (prevalence, abundance, mean intensity) with third stage larvae of *Anisakis simplex* in fillets of Barents Sea cod

	<i>n</i>	Prevalence	Abundance	SD	Mean intensity	SD
<i>Honningsvåg</i>						
Coast	118	94.1	5.84	6.25	6.21	6.26
Ocean	140	98.6	5.21	3.77	5.28	3.74
<i>Vardo</i>						
Coast	94	95.8	5.50	5.14	5.74	5.12
Ocean	67	94.0	3.21	2.18	3.41	2.08

The sample locations are shown in Fig. 1. *n*, sample size; SD, standard deviation.

samples of coastal cod were obtained from fish which were gutted just after capture. All cod from trawlers were iced after capture and only fish fresher than 4 days were examined. The four samples consisted of fish between 4 and 6 years old, fillet weight being in the range of 430–1300 g.

A candling table was used to detect the nematodes in the fillets. The nematodes were removed from the muscle tissue and collected in vials containing fresh water. The worms were identified to species within 24 h, while they were still alive (Berland, 1989). In case of doubt, the parasites were cleared in glacial acetic acid and lactophenol, and examined under a microscope. For each fish the counts of *A. simplex* in the right and left fillets are summed. The definitions of prevalence, mean intensity and abundance used follow Margolis et al. (1982).

3. Results

Prevalence, abundance and mean intensity in the four sampling sites are presented in Table 1. Almost all cod were infected, so the prevalence of *A. simplex* is at the high level of 96% in the Barents Sea. About 10% of the fillets of coastal cod were infected by more than 16 *A. simplex* larvae in the muscle tissue, the highest number recorded in the fillets from one fish being 41. In contrast, the maximum number of *A. simplex* among the oceanic cod was one fish infected with 14 larvae. Nearly 10% of the oceanic cod had a burden in the range of 10–14 larvae in their fillets. The fillets of coastal cod had a mean intensity of 6.1, while the oceanic cod had a mean intensity of 4.3. The mean intensities of *A. simplex* of oceanic and coastal cod were significantly different ($P < 0.01$, *t*-test).

4. Discussion

Platt (1975) investigated *A. simplex* infection in cod fillets from approximately the same areas of the Barents Sea. He found a prevalence of 82% and a mean intensity of 5.0 in the waters off Bear Island. In the Barents Sea he found

98% infection and 9.3 larvae per infected fish. The similarity between Platt's (1975) findings and the present results indicates that (1) a very large percentage of the cod in the Barents Sea are infected with larvae of *A. simplex*, and (2) the average number of larvae in the fillets per fish lies in the range 5–10. The mean intensity of *A. simplex* is of the same order of magnitude in cod from the North Sea, Iceland and the Barents Sea (Young, 1972; Pálsson et al., 1985). However, the prevalences in cod from Iceland and the North Sea are only about one-fourth of the prevalences in the Norwegian Arctic cod (Young, 1972; Pálsson et al., 1985). Since the mean intensity was significantly lower in the oceanic cod we must reject the hypothesis of a uniform geographical distribution of *A. simplex*. The reason for this uneven distribution is likely to be found in both the diet composition of cod and the distribution of cetaceans.

With regard to the influence of the diet composition of the two types of cod, the third stage of *A. simplex* is found in many fish species, including both capelin (*Mallotus villosus*; Polyansky, 1955) and herring (*Clupea harengus*; Kulachkova, 1980). Capelin, deep-sea shrimp (*Pandalus borealis*), redfish (*Sebastes* spp.) and herring contribute to the diet of cod (Mehl, 1989). Since all these prey species are fairly abundant in the oceanic parts of the Barents Sea, it is difficult to understand how the diet composition alone can explain the difference in infection levels between oceanic and coastal cod.

Some major perturbations have occurred in the Barents Sea ecosystem since Platt's (1975) investigation. In 1986 the capelin fishery collapsed. Since the Norwegian spring-spawning herring is overexploited, the cod suffered from lack of food when the capelin disappeared and cannibalism increased drastically (Hamre, 1991). In 1987 and 1988, crowds of harp seals invaded the Norwegian coastal waters (Ugland et al., 1993) and the traditional cod fishery was seriously reduced. This investigation was carried out just after major changes in the stocks of some of the key species in the Barents Sea food web. The comparison of the infections in cod fillets with Platt's (1975) survey indicates that the population dynamics of *A. simplex* maintain the parasite population in spite of large variations in key species of the ecosystems.

The distribution of *A. simplex* may be influenced by the various whale species. Toothed whales such as dolphins (*Lagenorhynchus* sp.) (more oceanic), killer whales (*Orcinus orca*) and porpoises (*Phocoena phocoena*) (more coastal) cover most of the distribution area of the cod in the Barents Sea (Christensen, 1988; Bjørge and Øien, 1990). Unfortunately, the prevalences and mean intensities of *A. simplex* in these whales are not known from the area of interest. Among the baleen whales one should especially consider the potential role of minke whales (*Balaenoptera acutorostrata*) in the population dynamics of *A. simplex* in the Barents Sea. The numbers of sexually mature *A. simplex* in minke whales are of the order of several hundreds (personal observations). Since minke whales occur regularly along the coast, they may make a significant contribution to the abundance of *A. simplex* larvae in the coastal system as well as in the oceanic areas. The present results can be taken as an indication that the *A. simplex* epidemiology follows different dynamics in the coastal and oceanic cod in the Barents Sea.

To establish a real understanding of the roles of the different whales, more knowledge is needed about the infection of first and intermediate hosts of *A. simplex*, as well as about the infection in the various whale species.

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