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AN ISOPOD AS INTERMEDIATE HOST OF COD-WORM

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ABSTRACT

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Ten cod *(Gadus morhua)*, caught at 30–50 m depth in the Froan area (64°N) on the Norwegian coast in October 1977, held an average of 53 cod-worm *(Phocanema decipiens)* larvae in their muscles. Stomach contents included fish, amphipods and isopods. Of 87 isopods, 84 were identified as *Idothea neglecta* and from these one *P. decipiens* larva was recovered. The findings suggest that *I. neglecta* is a significant food resource for coastal cod, and that this isopod also is a first intermidiate host of cod-worm.

INTRODUCTION

Cod-worm larvae (*Phocanema decipiens* Krabbe, synonyms: *Porocaecum, Terranova)* are found in fillets of cod *(Gadus morhua* L) and other commercially exploited benthic fishes from shallow waters around the North Atlantic. The larvae are causing severe economical problems for the fishing industry in several countries, particularly in areas where the grey seal, *Halichoerus grypus* (Fab.), is abundant. Together with other marine mammals, the grey seal is the final host of this parasitic nematode (YOUNG 1972).

Knowledge on the first intermediate host and its biology would give a better understanding of the distribution and incidence of cod-worm. Therefore the life cycle of *P. decipiens* has been extensively studied. SCOTT (1955) and MYERS (1960) have shown experimentally that *P. decipiens* eggs hatch in sea water. The eggs are hatched to larvae which are enveloped by a moulted cuticle (first stage cuticle) from which they cannot free themselves (SCOTT and BLACK 1960). These second stage larvae have a boring tooth (MYERS 1960).

Closely related parasitic nematodes have crustaceans as first intermediate hosts, and SCOTT (1950) suggested that also *P. decipiens* might develop in a crustacean. In 1958 SCOTT and BLACK (1960) collected 8500 Mysidacea in order to look for the first intermediate host of *P. decipiens*. Of the 71 nematodes found, all but 5 belonged to the genus *Contracaecum*. The remaining five were classified as belonging to the genera *Phocanema* or *Anisaksis*. Four of these were discovered in the mysids *Mysis mixta* and *M. stenolepsis*. The last

one came from a mysid which was so poorly preserved that it could not be identified. According to MYERS (1960) the nematode *Monohystera cameroni* Steiner, is a commensal of *Mysis mixta* and *M.stenolepsis*. Myers states that even under magnification this nematode resembles the larvae of *P.decipiens*.

SCOTT (1954) has demonstrated that fish can also become infected by eating other fish containing *P.decipiens*.

LOCALITY, MATERIALS AND METHODS

Froan is an offlying group of small islands, skerries and rocks northwest of the Trondheim fjord at about 64° latitude North, holding Norway's largest concentration of grey seals. It is estimated (personal observation) that at least 1000 grey seals inhabit the area from Halten light-house to Sauøy during the October-November breeding season. ØYNES (1964) roughly estimated that 300 female grey seals were breeding in the Halten-Froan area. FRENGEN and RØV (1976) assessed the number of pups born annually in the same area to be at least 300.

Within the Halten-Froan area at least 10 grey seal pups are born annually on Slettskjæra and Tindskjæra (64°06'N 09°08'E). On 12 October 1977 10 cod were caught by hook and line in shallow waters (30–50 m) near Tindskjæra. The otholits were preserved in a mixture of glycerol and formalin, the stomachs with contents were fixed and stored in 4% formalin, and the fish were salted.

In the laboratory the cod were filleted, and the parasites removed by examination under transmitted light. Stomach contents were sorted and crustaceans present were dissected under a binocular microscope. Some of the crustaceans were too decomposed to be identified and were not included in the analysis.

Isopods from the cod stomachs were identified according to SARS (1899), and nematodes from the isopods were identified by Bjørn Berland, Zoological Laboratory, University of Bergen.

RESULTS

The nematode infestation of the cod fillets was high (Table 1) with an average of 53 larvae per fish. They were all identified as *P.decipiens*.

From the stomach contents listed in Table 1, 114 amphipods and 87 isopods could be identified. Of the isopods, 84 specimens were identified as *Idothea neglecta* Sars, and 3 specimens as *I.baltica* (Pallas). In addition to the contents listed (Table 1), the cod stomachs contained large numbers of the nematode *Contracaecum aduncum* (Rudolphi).

Table 1. The infestation by *Phocanema decipiens* and stomach contents of cod caught at Tindskjæra, Froan, on 12 October 1977.

Cod No.	Age (years)	Number *P. decipiens*	Stomach contents				
			Idothea	Amphipoda	Fish	Other	Empty
1	5	84	+	+	+		
2	4	76	+		+		
3	3	9	+		+		
4	4	19			+		
5	5	73	+	+		+ [1]	
6	3	35					+
7	3	38		+	+		
8	4	14			+		
9	3	3	+	+			
10	5	177	+	+	+		

[1]) One *Munida rugosa* (Fabricius, 1775)

The 84 specimens of *I.neglecta* contained a total of three nematodes: two *C.aduncum* and one *P.decipiens*. No nematodes were found in the three *I.baltica*. A total of five nematodes were found in the amphipods, all being too small or shrunken for proper identification.

DISCUSSION

BENJAMINSEN, BERGFLØDT and HUSE (1976) demonstrated that infestation of *P.decipiens* in cod was greater in shallow waters than at greater depths. SARS (1899) writes that *I.neglecta* is a benthic organism living at depths from upper sublittoral down to 20 fathoms (about 37 m). If *I.neglecta* is an important first intermediate host of *P.decipiens*, as suggested by this study, this may explain the apparent correlation between depth and the infestation of *P.decipiens* in cod.

Our knowledge of the life cycle of *P.decipiens* is still incomplete. However, the probable succession of events may be summarized in the following way: Eggs are excreted with the seal faeces and hatch in sea water to second stage larvae which are enveloped in their first stage cuticle. When eaten by an invertebrate first intermediate host (*e.g.* isopod) they are freed from their cuticle and probably moult to third stage larvae. Both second and third stage larvae have a cuticular boring tooth.

The larvae remain in the first intermediate host until it is eaten by a fish. The larvae, thus freed by digestion, penetrate the intestinal wall and migrate to muscle tissue where they encapsulate in their second intermediate host. If this fish is eaten by another fish, the larvae again migrate from intestine to muscle tissue and become encapsulated once more. In this case the fish acts as a carrying host, the larvae remaining unchanged in development although they may grow in size.

If, alternatively, the second intermediate or the carrying host is eaten by a mammal, the larvae rapidly moult to their fourth stage of development. These fourth stage larvae have well developed labia but lack the boring tooth. They are either attached to the stomach mucosa or lying free in the mucus. They later moult to their fifth stage of development and become sexually mature, thus completing the cycle.

The *C.aduncum* found in the isopods could either have been in the isopods before ingestion by the cod, or they could have penetrated the isopods within the digestive tract of the cod. Because of the quantities of *C.aduncum* in cod stomachs, this finding does not constitute evidence for amphipods as hosts of this nematode.

Working conditions during field work in 1977, particularly the time limits, prevented the use of a more appropriate collecting procedure for nematodes from the amphipods, *e.g.* to dissect out the nematodes while they are alive, and then to kill them in an extended position in hot alcohol or glacial acetic acid (BERLAND 1961).

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REFERENCES

BENJAMINSEN, T., BERGFLØDT, B. og HUSE, I. 1976. Telling av havert på Norskekysten fra Halten–Froan til Bodø og undersøkelser av kveisinfeksjonen i fisk ved Vega. *Rapp. Fiskerinæringens Forsøksfond, 1976* (1): 1–6.

BERLAND, B. 1961. Use of glacial acetic acid for killing parasitic nematodes for collection purposes. *Nature, Lond., 191*: 1320–1321.

FRENGEN,O. og RØV, N. 1976. Faunistiske undersøkelser på Froøyene i Sør-Trøndelag, 1974. *K. norske Vidensk. Selsk. Mus. Rapp. zool.Ser., 1975* (7): 1–42.

MYERS, B. J. 1960. On the morphology and life history of Phocanema decipiens (Krabbe, 1878), Myers, 1959 (Nematoda: Anisakidae). *Can. J. Zool., 38*: 331–344.

SARS, G. O. 1899. *An acount of the Crustacea of Norway 2. Isopoda.* X + 270 p., 100 + IV pl. Bergen Museum, Bergen.

SCOTT, D. M. 1950. A preliminary report on the codworm investigation. *Progr. Rep. Atlant. Coast St. Fish. Res. Bd Can., 48*: 10–12.

– 1954. Experimental infection of Atlantic cod with a larval marine nematode from smelt. *J. Fish. Res. Bd Can., 11*: 894–900.

– 1955. On the early development of *Porrocaecum decipiens. J. Parasit., 41*: 321–322.

SCOTT, D.M. and BLACK, W.F. 1960. Studies on the life-history of the ascarid, *Porrocaecum decipiens,* in the Bras d'Or Lakes, Nova Scotia, Canada. *J. Fish. Res. Bd Can., 17*: 763–774.

YOUNG, P.C. 1972. The relationship between the presence of larval anisakine nematodes in cod and marine mammals in British home waters. *J. appl. Ecol. 9*: 459–485.

ØYNES, P. 1964. Sel på norskekysten fra Finnmark til Møre. *Fiskets Gang, 50*: 694–707.

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