Acta Parasitologica, 2001, 46(1), 12–17
ISSN 1230-2821

Some helminth and copepod parasites of three rajid species from the continental slope of the north-eastern Norwegian Sea

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Abstract. Nine helminth and two copepod parasite species, totalling 1 323 specimens, were recorded from a total of 69 skates – 47 *Raja radiata*, 11 *R. hyperborea* and 11 *Bathyraja spinicauda* – trawled in deep water on the continental slope between northern Norway and Spitsbergen in May 1996. Monogenea: *Rajonchocotyle batis*, *Pseudoacanthocotyle verrilli*; Digenea: *Otodistomum cestoides*, *Gonocerca phycidis*; Cestoda: *Echeneibothrium affine*, *Pseudanthobothrium hanseni*; Nematoda: *Anisakis simplex* larva, *Pseudanisakis tricopula*, *Contracaecum/Phocascaris* sp. larva; Copepoda: *Schistobrachia ramosa*, *Lernaeopodina longimana*. Endoparasites and food preferences are discussed.

Key words: Helminths, copepod parasites, rajid fishes, Norwegian Sea

Introduction

Elasmobranchs, including rays and skates, caught as bycatches in the north Atlantic, are not economically important. But as carnivores they feed on invertebrates and teleosts, and they harbour parasites whose larval stages may occur in commercially important teleosts. In general, elasmobranchs are hosts to monogeneans, crustaceans and hirudineans on gills and skin, several orders of cestodes in the intestine, but relatively few digeneans and nematodes are known.

Three rajids have previously been reported from the continental slope of the eastern Norwegian Sea (Bergstad *et al.* 1999): *Raja radiata* Donovan, 1808 – thorny or starry skate, *R. hyperborea* Collett, 1879 – Arctic skate and *Bathyraja spinicauda* (Jensen, 1914) – spinytail skate or spinetail ray, but as far we know their parasites have not been studied. In the present paper we report nine helminth and two copepod parasites from these three rajid species caught in deep water on the continental slope between north Norway and Spitsbergen.

Five *Raja* species occur in the cool Barents Sea (Whitehead *et al.* 1989), but in the warmer water on the Norwegian coast and around the British Isles their numbers increase.

Our knowledge on parasites of *Raja* species derives mainly from occasional studies on limited host numbers: von Linstow (1901, 1903, 1905) from Arctic seas, Averincev (1908), Lyaĭman and Borovkova (1926), Bazikalova (1932), Polyanskiĭ (1955), Epshtein (1961) and Zubchenko and Karasev (1986) recorded parasites from the Barents Sea region. Monogeneans and digeneans in British waters were recorded by Dawes (1947), and Williams (1959) recorded fish parasites. From Norway Brinkmann (1940, 1952) reported monogeneans from elasmobranchs, including *R. radiata*. Brinkmann (1956) recorded monogeneans and digeneans from *R. radiata* in Iceland and later (Brinkmann 1975) monogeneans and digeneans from *R. radiata* and *R. hyperborea* in West Greenland. Berland (1961) reported nematodes from *Raja* species. Kabata (1988) and McDonald and Margolis (1995) respectively, listed crustacean and helminth parasites recorded from *R. radiata* in the Canadian Atlantic.

Materials and methods

At the end of May 1996 the commercial trawler "Varegg", hired by the Institute of Marine Research, Bergen fished by bottom-trawl on the continental slope between northern Norway and Spitsbergen. The target species was the Green-

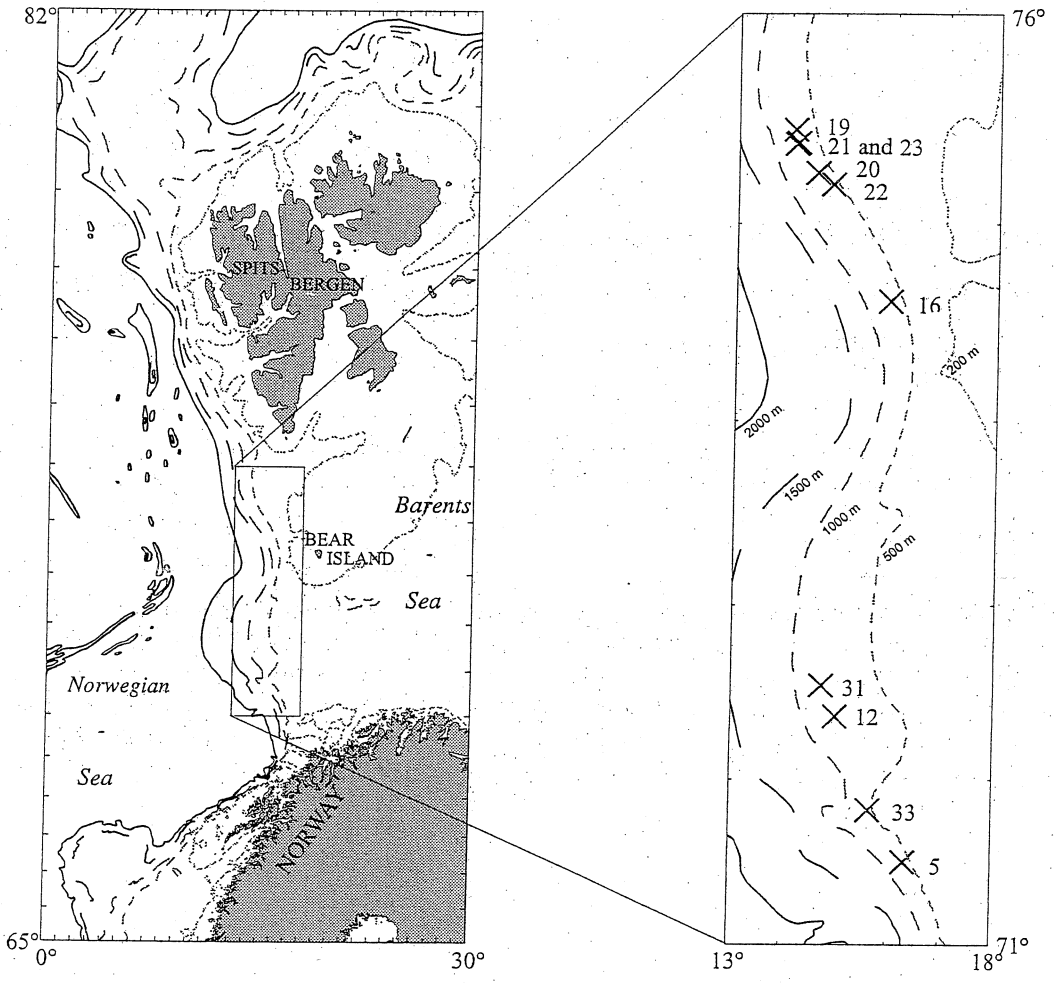

Fig. 1. Map of the fishing area, with details of the stations in inset

land halibut, *Reinhardtius hippoglossoides* (Walbaum, 1792), but several other teleost species were also caught. A total of 69 skates were caught as bycatch: 47 *Raja radiata*, 11 *Raja hyperborea* and 11 *Bathyraja spinicauda*. Figure 1 shows the location of the trawl stations where the skates were collected, and Table I presents depth range of the hauls and number of each skate species collected.

The skates were identified and labelled (by OB) on board before being frozen and they were all brought frozen to Bergen. The frozen fish were transferred to Zoological Institute, University of Bergen and were by OB kindly placed at the disposal of JR and BB. In June – July 1996 the skates were individually thawed, measured and weighed, and skin, gills and viscera were searched for parasites by JR, who refroze any stomach contents for OB.

Although all parasites were dead after having been frozen, the helminths recovered were fixed in Berland's fluid (Gibson 1979) and transferred to 70% ethanol. Monogeneans and digeneans were stained in Mayer's carmalum, dehydrated in glacial acetic acid, cleared in beechwood creosote and mounted in Canada balsam. The nematodes were cleared in beechwood creosote or glycerol for microscopy. Copepods were collected in 70% ethanol and cleared in glycerol.

The specimens studied are kept by JR at Marine Biology Center, Polish Academy of Sciences, Gdynia, Poland.

Table I. Trawl stations with depth range and number of the three skate species collected, May 1996

Station number	Fishing depth (m)		Number of specimens collected		
	min	max	*Bathyraja spinicauda*	*Raja hyperborea*	*Raja radiata*
5	745	785	2	7	7
12	695	715	4	1	–
16	696	740	3	–	9
19	718	738	1	–	7
20	725	754	–	1	3
21	760	808	–	1	9
22	720	760	–	–	6
23	800	820	–	–	2
31	685	760	–	1	4
33	667	714	1	–	–
Total			11	11	47

Table II. Parasites of *Raja radiata* (n = 47) examined

Parasite	No. of infected fish	Total no. of parasites	Prevalence (%)	Intensity, mean (range)
Rajonchocotyle batis	32	282	68.09	8.8 (1–35)
Pseudoacanthocotyle verrilli	2	3	4.26	1.15 (1–2)
Otodistomum cestoides	14	52	29.79	3.71 (1–9)
Gonocerca phycidis	12	33	25.53	2.75 (1–5)
Echeneibothrium affine	2	5	4.26	2.5 (1–4)
Anisakis simplex, 3rd stage larva	41	425	87.23	11.2 (1–37)
Pseudoanisakis tricopula	21	162	44.68	7.71 (1–63)
Contracaecum/Phocascaris sp.	1	1	2.13	1
Schistobrachia ramosa	12	27	25.53	2.25 (1–6)
Lernaeopodina longimana	2	10	4.26	5 (4–6)

Results

Fish data

Raja radiata: 47 specimens, 6♂ and 41♀. Length 30–54 cm, mean 43.66 cm. Body round weight 308–1 960 g, mean 956 g.

Raja hyperborea: 11 specimens, 5♂ and 6♀. Length 39–88 cm, mean 68 cm. Body round weight 714–6 800 g, mean 1 396 g.

Bathyraja spinicauda: 11 specimens, 4♂ and 7♀. Length 31–72 cm, mean 40.8 cm. Body round weight 141–3 500 g, mean 634.3 g.

Parasites

Eleven parasite species, with a total of 1 323 specimens, were recovered from the three skate species. The parasites found on each of the three skate species and their infection data are presented in Tables II–IV.

Ten parasite species were found on and in *R. radiata*, while *B. spinicauda* harboured seven and *R. hyperborea* only four. Three specimens of *R. radiata* and two of *B. spinicauda* were found negative.

Monogenea

The gill parasite *Rajonchocotyle batis* (Olsson, 1876), occurred on all three skate species; its infection is shown in Tables II–IV; its prevalence being highest in *R. radiata*, least in *R. hyperborea*. *Pseudoacanthocotyle verrilli* (Goto, 1899) was found on skin of *R. radiata* and on the gills of *B. spinicauda*, none on *R. hyperborea*; its prevalence in both was low.

Digenea

Otodistomum cestoides (van Beneden, 1871) occurred in the stomach of *R. radiata* only (Table II). *Gonocerca phycidis* Manter, 1925, occurred in the stomach of *R. radiata* and *B. spinicauda* only (Tables III and IV).

Cestoda

Echeneibothrium affine (Olsson, 1867), of the spiral intestine, was present in two *R. radiata* and in three *B. spinicauda*. *Pseudanthobothrium hanseni* (Baer, 1956) was found in intestine of four *B. spinicauda*.

Nematoda

The nematode *Anisakis simplex* (Rudolphi, 1809) occurred as encapsulated 3rd stage larvae in the intestinal and stomach wall of all three skate species, at high prevalence, 100%, in *R. hyperborea*, 87% in *R. radiata* and 27% in *B. spinicauda*. The stomach nematode *Pseudanisakis tricopula* (van Beneden, 1870) was present in the stomach of all three skate species. A single 3rd larva of *Contracaecum/Phocascaris* sp. was recovered from the stomach of *R. radiata* (Table II).

Copepoda

Schistobrachia ramosa (Krøyer, 1863) was found on the gills of *R. radiata* and *R. hyperborea* (Tables II and III). *Lernaeopodina longimana* (Olsson, 1869) was found on the gills of *R. radiata* only (Table II).

Table III. Parasites of *Raja hyperborea* (n = 11) examined

Parasite	No. of infected fish	Total no. of parasites	Prevalence (%)	Intensity, mean (range)
Rajonchocotyle batis	1	12	9.09	12
Anisakis simplex, 3rd stage larva	11	164	100	14.9 (1–42)
Pseudanisakis tricopula	2	5	18.18	2.5 (1–4)
Schistobrachia ramosa	3	4	27.27	1.33 (1–2)

Table IV. Parasites *Bathyraja spinicauda* (n = 11) examined

Parasite	No. of infected fish	Total no. of parasites	Prevalence (%)	Intensity, mean (range)
Rajonchocotyle batis	3	8	27.27	2.67 (1–4)
Pseudoacanthocotyle verrilli	1	4	9.09	4
Gonocerca phycidis	2	3	18.18	1.5 (1–2)
Echeneibothrium affine	3	28	27.27	2.55 (4–20)
Pseudanthobothrium hanseni	4	30	36.36	2.82 (1–14)
Anisakis simplex	3	43	27.27	14.3 (1–33)
Pseudanisakis tricopula	1	1	21.28	1

Discussion

The Latin names of the fish hosts according to Stehmann and Bürkel (1984). It should be noted that those used by Scott and Scott (1988) are slightly different, this also applies to their vernacular names.

Of the eleven parasite species found *R. radiata* harboured ten, *B. spinicauda* seven and *R. hyperborea* only four, as shown in Tables II–IV.

Of the monogeneans, the gill parasite *Rajonchocotyle batis* was recorded on all three skate species. Polyanskiĭ (1955) found *R. batis* (as *R. emarginata)* on the gills of *R. radiata* in the Barents Sea, at 20% prevalence and very low intensity. We found *Pseudoacanthocotyle verrilli* at low prevalence in *R. radiata* and *B. spinicauda*, and not in *R. hyperborea*. *P. verrilli* was found by Polyanskiĭ (1955) on the skin of *R. radiata* caught off Murmansk.

The digenean *Otodistomum cestoides* was present in the stomach of *R. radiata* only (Table II). Zubchenko and Karasev (1986) recorded it only from this host in the Barents Sea. Although *O. cestoides* is regarded as a cosmopolitan parasite in skates (Gibson and Bray 1977), it may be restricted only to *R. radiata* in the cold northern waters. Brinkmann (1975) recorded *O. veliporum* (Creplin, 1837) in *R. hyperborea* and *R. radiata* from West Greenland, and later (Brinkmann 1988) discussed the validity of the two forms or species *O. veliporum* and *O. cestoides*. As this taxonomic question remains unresolved, we here use the latter name. Many teleosts harbour their metacercariae in muscles and viscera. Thus the presence of mature specimens in skates show that these feed on teleosts.

Gonocerca phycidis was found in *R. radiata* and *B. spinicauda*, at low prevalence and intensity (Tables II and IV). Zubchenko and Karasev (1986) did not record it from *R. radiata* in the Barents Sea. According to Campbell and Munroe (1977) this species is known from several species inhabiting medium and great depths of subpolar regions in both hemispheres, and also at great depths in the moderate and subtropical zones. Polyanskiĭ (1955) did not record it from the Barents Sea, and Zdzitowiecki (1978, 1987, 1997) found this parasite in teleosts in Antarctic waters; however, the skates he examined were not infected.

Of the two cestode species recorded, *Echeneibothrium affine* (Olsson, 1867) was found in the spiral intestine in *R. radiata* at low infection and at somewhat higher infection in *B. spinicauda* (Tables II and IV). The genus *Echeneibothrium* is very typical of the Rajidae (Williams and Jones 1994).

Pseudanthobothrium hanseni was present only in *B. spinicauda* at moderate prevalence. Jarecka and Burt (1984) showed experimentally that larval stages of tetraphyllidean cercoids, including *P. hanseni,* have more primitive morphologic features than do proteocephalan cercoids.

Of the nematodes *Pseudanisakis tricopula* occurred in the stomach of all three skate species, which are definitive hosts. This species is known from several skates. Various Crustacea serve as intermediate hosts.

Anisakis simplex, as 3rd stage larvae, occurred encapsulated in the wall of stomach/intestine in all three skate species, at high prevalence. *Anisakis* larvae are very common in most marine teleosts, mainly encapsulated on and in viscera, occasionally free in gut before they have had time to bore into viscera (Smith and Wooten 1978). Primarily whales, are definitive hosts, and krill are by far the most common first intermediate host. The presence of *Anisakis* larvae in elasmobranchs clearly shows that they have fed or krill and/or teleosts. It is well known that marine plankton make diurnal vertical migrations, thus krill may stay close to the sea bottom during daytime, being exposed to predation by bottom-dwelling skates. The digestive tract of sharks and rays does not seem to suit teleost parasites, otherwise such species should be present together with the remains of ingested bony fishes. In order to become established *Anisakis* larvae must move into the wall of the digestive tract. However, in skates they become trapped and eventually die and degenerate *in situ*. From the parasites' point of view these fish are "dead ends" as skates are not likely to be preyed upon by whales.

Of the two copepods from the gills, Kabata (1988) listed *Schistobrachia ramosa* as known from *R. radiata* only in the Canadian Atlantic, thus our record may possibly be the first from *R. hyperborea.* According to Kabata (1988) *Lernaeopodina longimana* has in the Canadian Atlantic been reported from four *Raja* species, one of them being *R. radiata.*

Bjelland *et al.* (2000) recently studied the trophic ecology of deep-water fishes on the continental slope of the eastern

Norwegian Sea. The general impression from their study and some previous reports (Collett 1880, 1905; Koefoed 1956) is that pelagic crustaceans such as euphasiids, hyperid amphipods and carideans occur frequently in the diet of the three rajids, and are particularly important to *Raja radiata*. They suggest that smaller *R. radiata* feed on crustaceans, but shift gradually to demersal fish as they grow. The other two species, *B. spinicauda* and *R. hyperborea* seem to be more piscivorous, and among the identified prey were both demersal and pelagic fishes (zoarcids and blue whiting, *Micromesistius poutassou*). As the blue whiting is heavily infected with *Anisakis* larvae (Højgaard 1980), the high prevalence of this parasite in *R. radiata* and *R. hyperborea* may support the view that the blue whiting is an important food item for these skates.

Acknowledgements. The Norwegian Research Council (NFR: 96/1331/DIA/RNH) is thanked for a grant permitting JR to work in Bergen in 1996. We thank Mrs Olaug Gjervik for helping to search the skates in the laboratory.

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(Accepted December 28, 2000)

May 2–4, 2001
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