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Parasites of the Antarctic rattail *Macrourus whitsoni* (Regan, 1913) (Macrouridae, Gadiformes)

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Abstract A total of 386 *Macrourus whitsoni* from Antarctic waters were examined for ecto- and endoparasites. Sixty-five *M. whitsoni* collected near Halley Bay (Weddell Sea) and 321 specimens from the continental slope off King George Island (South Shetland Islands) were studied for sphyriid copepods directly after being caught. A subsample of 25 specimens from the Weddell Sea and of 9 specimens from King George Island were studied for the presence of other metazoan parasites. Twenty-two species were found, including one myxozoan, six digeneans, one monogenean, three cestodes, seven nematodes, one acanthocephalan and three crustacean species/taxa. While *Auerbachia monstrosa* and *Capillaria* sp. are reported for the first time from around the Antarctic, the other parasites have been recorded earlier in the Southern Ocean. Many parasite species found have a wide zoogeographical range and a low host-specificity. The parasite fauna of *M. whitsoni* revealed several similarities with its congeners *M. carinatus* and *M. holotrachys* from Antarctic and sub-Antarctic waters. This can be explained by a wide host range of many macrourid deep-sea parasites, together with an overlap in distribution patterns of their hosts. Other supporting factors are host migration and a close phylogenetic relationship between the hosts, which enable the parasites to infest all three macrourids. Eight new host and 14 new locality records are established.

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Introduction

The knowledge on Antarctic fish parasites is scarce. While most studies in the Southern Ocean deal with taxonomical aspects within fish parasitology, few studies exist on parasite ecology and their life-cycle biology (e.g. Holloway and Spence 1980; Palm 1999; Palm et al. 1998; Wägele 1988). Additionally, most studies have been carried out on notothenioids from shallow coastal waters or the open sea shelf (see Zdzitowiecki 1991, 1997). This is in contrast to the limited knowledge on fish parasites from the continental slope and the deep-sea zone (Zdzitowiecki 1998).

The species of the middle-slope fish genus *Macrourus* occur within water depths between a few hundred meters down to the deep-sea below 3,000 m (Cohen et al. 1990). *Macrourus whitsoni* (Regan, 1913), which is known to feed on pelagic crustaceans, small fish and polychaetes, occurs along the continental slope between 400 and 3,185 m (Cohen et al. 1990; Gon and Heemstra 1990). This benthopelagic species has been recorded from several localities within the Antarctic convergence, as well as around the Falkland Islands (Gon and Heemstra 1990). Johnston and Mawson (1945) studied the parasite fauna of two *M. whitsoni* collected during the B.A.N.Z.A.R.E. and the Australian Antarctic Expedition in the Indian Ocean Antarctic Sector. The authors isolated parts of the nematode *Ascarophis chalinurae* Johnston & Mawson, 1945. Prudhoe (1969) and Prudhoe and Bray (1973) described the cestode *Parabothriocephalus johnstoni* Prudhoe, 1969, as well as the digeneans *Paralepidapedon antarcticum* (Prudhoe & Bray, 1973) and *Paralepidapedon dubium* (Prudhoe & Bray, 1973), respectively, also from B.A.N.Z.A.R.E. Kabata and Gusev (1966) recorded the copepods *Chondracanthodes tuberofurcatus* Kabata & Gusev, 1966 and *Clavella adunca* (Strøm, 1762), both

collected during the Ob Expedition in 1957 near Kemp Land. Zdzitowiecki (1996), Zdzitowiecki and Cielecka (1997), Rocka and Zdzitowiecki (1998), Rocka (1999) and Palm (1999) studied the helminth fauna of 23 *M. whitsoni* from the southeastern Weddell Sea. They described three new digeneans and detected three further digeneans, two cestodes and two acanthocephalans.

The present study was carried out to compare the ecto- and endoparasite faunas of *M. whitsoni* within the Antarctic, obtained from the southeastern Weddell Sea and around the South Shetland Islands. The new locality records allow conclusions concerning the zoogeographical distribution and the host-specificity of Antarctic deep-water parasites.

Materials and methods

A total of 386 specimens of *M. whitsoni* were collected on board the German research vessel "Polarstern" during the cruises ANT XIII/3 (EASIZ I) in the southeastern Weddell Sea and during ANT XIV/2 (CCAMLR) around the South Shetland Islands. The fishes were caught on 14 February 1996 and between 27 November and 6 December 1996, using bottom trawls and benthopelagic nets (Arntz and Gutt 1997; Kattner 1998).

Directly after being caught, 65 specimens collected in the southeastern Weddell Sea near Halley Bay (73°36′S 22°19′W) at a water depth between 620 and 640 m and 321 specimens from different positions along the continental slope at King George Island (61°33′–61°46′S 58°35′–59°24′W) at a depth between 570 and 861 m were examined macroscopically for the presence of ectoparasitic sphyriid copepods. A subsample of 25 specimens from the Weddell Sea (total length 25–39 cm; weight 70–336 g) and of 9 specimens from King George Island (total length 17–43 cm; weight 54–562 g) were deep frozen and studied in the laboratory. Skin, fins, eyes, nasal capsules, gills and the buccal and branchial cavity were studied for metazoan parasites. While the body cavity, internal organs and gastrointestinal tract were examined under a stereomicroscope, the gall bladder was removed and studied using phase-contrast microscopy. Belly flaps and musculature were examined using a candling table. In some specimens, the stomach was extruded into the buccal cavity. In these cases, the stomach contents together with stomach parasites might have been lost.

Isolated parasites were fixed in 4% borax-buffered formalin and preserved in 70% ethanol/5% glycerine. Acanthocephala were transferred to freshwater until the proboscis everted prior to fixation. For identification purposes, Nematoda and Acanthocephala were dehydrated in a gradated ethanol series and transferred to 100% glycerin (Riemann 1988). Digenea, Monogenea and Cestoda were stained with acetic carmin, dehydrated, cleared with eugenol or creosote, and mounted in Canada balsam. Crustacea were dehydrated and transferred into Canada balsam.

Parasite identification literature included original descriptions, as well as Lom et al. (1975) for Myxozoa, Zdzitowiecki (1997) for Digenea, Rubec and Dronen (1994) for Monogenea, Rocka and Zdzitowiecki (1998) for Cestoda, Zdzitowiecki (1991) for Acanthocephala, Mozgovoi (1953) and Moravec (1987) for Nematoda, and Kabata (1979) for Crustacea. Fishes were identified according to Gon and Heemstra (1990); the ecological terminology (e.g. prevalence, mean intensity, etc.) follows Bush et al. (1997).

Results

A total of 22 parasite species were found, and 8 new host and 14 new locality records are established. Two species, *Auerbachia monstrosa* Meglitsch, 1968 and *Capillaria* sp., are reported for the first time from the Antarctic Ocean, while *Gonocerca haedrichi* Campbell & Munroe, 1977, *Paranisakiopsis* cf. *australiensis* Johnston & Mawson, 1945, and *Lophoura szidati* Stadler, 1978 have been previously recorded only from sub-Antarctic waters. They are here reported for the first time from the Weddell Sea and/or the South Shetland Islands.

The predominant species at both localities was the monogenean *Macruricotyle clavipes* Mamaëv & Lyadov, 1975. While most parasites found were similarly abundant at both localities, the myxosporean *Auerbachia monstrosa* and the pseudophyllidean cestode *Parabothriocephalus johnstoni* were common in the Weddell Sea but absent at the South Shetland Islands. The prevalence, intensity and site of infestation for each parasite species are given in Table 1. Further details on the parasites isolated with comments on their zoogeographical distribution and host range are given below.

Myxozoa

Myxozoans were represented by *Auerbachia monstrosa*. While the myxospores could be isolated from the bile of the fish caught in the eastern Weddell Sea, they were absent in specimens from the South Shetland Islands. *Auerbachia monstrosa* was originally described by Meglitsch (1968) from *Caelorinchus australis* (Richardson, 1839) (= *Coelorhynchus australis*) from New Zealand waters. Moser and Noble (1977) detected the species in *Caelorinchus australis* and *C. innotabilis* McCulloch, 1907 (= *Coelorinchus innotabilis*) from the same region. According to Moser and Noble (1977), *Auerbachia* spp. occur in several widely distributed fish species, such as *Caelorhinchus caelorhincus* (Risso, 1810) and *Macrourus berglax* Lacapède, 1810. The present finding of *Auerbachia monstrosa* in *Macrourus whitsoni* represents a new host record and is the first record of *Auerbachia* from the Antarctic Ocean.

Monogenea

Macruricotyle clavipes from the gills of *Macrourus whitsoni* was the only monogenean found, but also the most predominant parasite species in the present study. The prevalence of infestation was high at both localities (Table 1). *Macruricotyle clavipes* was originally described from the Indian Ocean (Mamaëv and Lyadov 1975), occurring on *Macrourus* sp. (cited as *Macrourus* sp. in Campbell et al. 1982), and is common in the Kerguelen subregion (Lyadov 1985). Gaevskaya and Kovaleva (1977) detected the same monogenean on *Macrourus holotrachys* Günther, 1878 from Falkland Patagonia, and Gaevskaya and Rodjuk (1988a) recorded the species from north of the Falkland Islands on *Macrourus carinatus* Günther, 1878. Mamaev and Avdeev (1984) also recorded *Macruricotyle clavipes* from *Coryphaenoides* sp. from the Antarctic. The present

Table 1. Prevalence and intensity of infestation and site of parasites in *Macrourus whitsoni* from the Weddell Sea and the South Shetland Islands ([1] new host record; [2] new locality record)

Parasite	Adult/larva	Weddell Sea ($n=25$; *$n=65$)		South Shetland Islands ($n=9$; *$n=321$)		Site
		Prevalence (%)	Mean intensity (intensity)	Prevalence (%)	Mean intensity (intensity)	
Myxozoa						
Auerbachia monstrosa[1; 2]	a	16	–	–	–	Gall bladder
Monogenea						
Macruricotyle clavipes[1; 2]	a	68	3 (1–13)	100	8 (3–15)	Gills
Digenea						
Glomericirrus macrouri	a	48	18 (1–98)	11	3 (3)	Stomach; mouth cavity
Gonocerca haedrichi[1; 2]	a	–	–	11	1 (1)	Body cavity
G. phycidis	a	4	1 (1)	11	1 (1)	Stomach; mouth cavity
Lepidapedon sp.	a	12	4 (1–6)	22	2 (1–2)	Pyloric caeca; intestine
Paralepidapedon awii[2]	a	72	4 (1–14)	11	3 (3)	Pyloric caeca; intestine
Postlepidapedon opisthobifurcatus	a	36	4 (1–13)	–	–	Intestine
Cestoda						
Parabothriocephalus johnstoni	a	56	5 (1–19)	–	–	Pyloric caeca
Diphyllobothriidae indet.[1]	l	48	45 (2–173)	–	–	Stomach wall; body cavity
Scolex pleuronectis	l	4	1 (1)	–	–	Intestine
Nematoda						
Contracaecum osculatum[1]	l	12	2 (1–2)	–	–	Pyloric caeca; intestine
Capillaria sp.[1; 2]	a	28	4 (1–14)	22	4 (1–6)	Pyloric caeca; intestine
Paranisakiopsis cf. *australiensis*[1; 2]	a/l	56	8 (1–13)	44	12 (1–22)	Pyloric caeca; intestine; stomach
Nematoda sp. I	l	4	1	–	–	Stomach
Nematoda sp. II	l	40	4 (1–24)	44	3 (1–5)	Stomach; liver
Nematoda sp. III	l	4	1	–	–	Stomach
Nematoda sp. IV	l	–	–	33	1	Stomach; pyloric caeca; intestine
Acanthocephala						
Corynosoma bullosum	l	28	1 (1)	44	1 (1–2)	Body cavity
Crustacea						
Chondracanthodes tuberofurcatus[2]	a	4	3 (3)	–	–	Operculum
Clavella adunca[2]	a	32	4 (1–12)	11	1 (1)	Mouth cavity
Lophoura szidati[1; 2]	a	9*	1 (1)	7*	1 (1–2)	Musculature; body cavity

finding represents a new host and two new locality records.

Digenea

With *Glomericirrus macrouri* (Gaevskaya, 1975) (Hemiuridae), *Gonocerca haedrichi*, *Gonocerca phycidis* Manter, 1925 (Derogenidae), *Paralepidapedon awii* Zdzitowiecki & Cielecka, 1997 and *Postlepidapedon opisthobifurcatus* (Zdzitowiecki, 1990) (Lepocreadiidae), five digenean species were identified. A further lepocreadiid species of the genus *Lepidapedon* was also found, but could not be identified to species level. With the exception of *Gonocerca haedrichi* and *Postlepidapedon opisthobifurcatus*, the digeneans were found at both Antarctic localities. *Postlepidapedon opisthobifurcatus* was found only in the Weddell Sea and a single specimen of *Gonocerca haedrichi* was isolated from the body cavity of *Macrourus whitsoni* from the South Shetland Islands.

According to Zdzitowiecki (1997) and Gibson and Bray (1986), *Glomericirrus macrouri* has a wide distribution in the Atlantic Ocean. Its occurrence has been previously recorded from several different shallow-water and deep-sea fish belonging to different fish families, including *Macrourus berglax*, *Macrourus carinatus*, *Macrourus holotrachys* and *Macrourus whitsoni* (Gaevskaya and Rodjuk 1983, 1988a; Zdzitowiecki and Cielecka 1997; Zubchenko 1975). Similarly, the two detected *Gonocerca* species have a wide (*Gonocerca haedrichi*) or cosmopolitan (*Gonocerca phycidis*) distribution pattern. *Gonocerca haedrichi* is known from the Northwest Atlantic (Campbell and Munroe 1977; Campbell et al. 1980), the Southwest Atlantic (Gaevskaya and Rodjuk 1983), and from north of the Falkland Islands (Gaevskaya and Rodjuk 1988a, b). All known hosts belong to the Macrouridae, including *Macrourus carinatus* and *Macrourus holotrachys* (Bray 1995; Gaevskaya and Rodjuk 1983, 1988a, b). The present finding of *Gonocerca haedrichi* is the first finding in the Antarctic Ocean and represents a new host and locality record.

Gonocerca phycidis shows a wide host range, infesting members of different fish families (Prudhoe and Bray 1973; Zdzitowiecki 1997). This species has been recorded from all *Macrourus* species (Bray 1995; Zdzitowiecki and Cielecka 1997, 1998). *Paralepidapedon awii* was originally described by Zdzitowiecki and Cielecka (1997) from *Macrourus whitsoni* collected in the Weddell Sea. No further records have been published, indicating a high host-specificity and an Antarctic distribution for this species. The present record from the South Shetland Islands represents a new locality record. *Postlepidapedon opisthobifurcatus* was originally described by Zdzitowiecki (1990) from *Muraenolepis microps* Lönnberg, 1905 from South Georgia (sub-Antarctic). Zdzitowiecki and Cielecka (1997) recorded it from *Macrourus whitsoni* from the Weddell Sea. All known hosts of *Postlepidapedon opisthobifurcatus* belong to the Muraenolepididae or Macrouridae (Bray 1995). Both *Paralepidapedon awii* and *Postlepidapedon opisthobifurcatus* seem to be restricted to the Southern Ocean.

Some specimens belonging to the genus *Lepidapedon* were isolated, but could not be identified to species level due to their poor condition. About 30 species are known within the genus *Lepidapedon* (Bray and Gibson 1995), with *Lepidapedon brayi* Zdzitowiecki & Cielecka, 1997 and *Lepidapedon ninae* Zdzitowiecki & Cielecka, 1997 occurring in *Macrourus whitsoni* (Zdzitowiecki and Cielecka 1997).

Cestoda

The only adult cestode found was the the pseudophyllidean *Parabothriocephalus johnstoni*. The specimens were isolated from the pyloric caeca. Interestingly, this parasite was absent in fishes from the South Shetland Islands, but common in those from the Weddell Sea (56% prevalence and 1–19 intensity). *Parabothriocephalus johnstoni* was earlier described from east Antarctic waters nearby Enderby Land (Prudhoe 1969) and from the eastern Weddell Sea (Rocka and Zdzitowiecki 1998), occurring only within its type host *Macrourus whitsoni*. *Parabothriocephalus johnstoni* seems to be endemic to the Antarctic Ocean. To date, the species is the only known cestode maturing in Antarctic teleosts.

Pseudophyllidean plerocercoids were found in the fish from the Weddell Sea. Larval Diphyllobothriidae were found encapsulated within the stomach wall and, in a single fish, further capsules were detected in the body cavity, closely attached to the outer wall of the pyloric caeca. An identification of these larvae is not possible due to the lack of genital organs. This is the first record of pseudophyllidean larvae in *Macrourus whitsoni*. However, these cestodes have been found earlier in different Antarctic regions, as well as in different fish (Bartsch 1985; Palm et al. 1998).

A single *Macrourus whitsoni* from the Weddell Sea was infested by a single *Scolex pleuronectis* (larval Tetraphyllidea) within the intestinal lumen. Tetraphyllidean larvae have been previously recorded from *Macrourus whitsoni* by Rocka (1999) from the same locality. In both studies (Rocka 1999; present data), the prevalence of infestation was low (4.3%, 4%, respectively). Tetraphyllidean larvae of the *S. pleuronectis* type are circumpolar and have been found in various fish species (Rocka 1999; Wojciechowska 1993; Wojciechowska et al. 1994). However, further identification of these larvae is not possible without strobila characters and/or knowledge of the species' life-cycles.

Nematoda

Nematoda was the most diverse taxon, and was represented by *Contracaecum osculatum* (Rudolphi, 1802), *Paranisakiopsis* cf. *australiensis*, *Capillaria* sp. and four unidentified larval forms. All species apart from one type of unidentified Nematoda (type IV) were found in the Weddell Sea while *Contracaecum osculatum* and Nematoda types I and III were not detected around the South Shetland Islands. *Capillaria* sp. and *Paranisakiopsis* cf. *australiensis* are herewith described for the first time from Antarctic waters.

Adult *Paranisakiopsis* cf. *australiensis* was the most abundant species, reaching a prevalence of 56% in the Weddell Sea and a mean intensity of 12 along the South Shetland Islands. The only record for this species is the original description of *Paranisakiopsis australiensis* from *Coelorhynchus australis* (= *Caelorinchus australis*) from Commonwealth Bay (Tasmania) by Johnston and Mawson (1945). The genus typically infests deep-water fish including macrourids and morids (Campbell et al. 1980; Johnston and Mawson 1945; Machida 1974). Adult *Capillaria* sp., resembling *Capillaria gracilis* (Bellingham, 1840), reached a maximum intensity of 14. *Capillaria gracilis* is known to occur in the northern hemisphere, infesting different gadiform fish (Moravec 1987).

The anisakid *Contracaecum osculatum* was found in the larval stage at a low prevalence. The species is already known to infest various bottom-dwelling Antarctic fish (Klöser et al. 1992). *Macrourus whitsoni* represents a new host. Four other larval nematodes were found in the stomach and liver of the examined fish. While Nematoda types II and III resembled spirurid and acuariid nematode larvae, Nematoda type IV appeared to be an anisakid. Type I could be clearly distinguished from the other nematode larvae; however, due to the bad condition of the only specimen found, the species was not further identified.

Acanthocephala

Cystacanths of *Corynosoma bullosum* (Linstow, 1892) were found in the body cavity of fish from both localities. This species was previously recorded by Zdzitowiecki (1996) from *Macrourus whitsoni* collected in the Weddell Sea, with a 9% prevalence. During the present study, it occurred with a prevalence of 28 and 44% in the eastern Weddell Sea and around the South Shetland Islands, respectively. *Corynosoma bullosum* is a prominent acanthocephalan in oceanic Antarctic and sub-Antarctic waters, having a wide second intermediate host range and a circumpolar distribution (Zdzitowiecki 1991, 1996).

Crustacea

With *Chondracanthodes tuberofurcatus*, *Clavella adunca* and *Lophoura szidati*, three copepod species were found to infest *Macrourus whitsoni*. Specimens of *Chondracanthodes tuberofurcatus* were attached to the opercular chamber and *Clavella adunca* was isolated from the mouth cavity. The mesoparasite *Lophoura szidati* was located near the base of the dorsal fin, with the enlarged outgrowth of the copepod neck reaching the body cavity throughout the musculature. In several cases, the yellow atrophied liver was damaged by penetration of the prolonged neck. While *Chondracanthodes tuberofurcatus* was present only on fish from the Weddell Sea, the other two species were recorded from both studied localities.

The chondracanthid *Chondracanthodes tuberofurcatus* was originally described by Kabata and Gusev (1966) from *Macrourus whitsoni* collected near Kemp Land, eastern Antarctic. Rohde et al. (1998) found the same species [Chondracanthidae sp. in Rohde et al. 1995 (K. Rohde, personal communication)] on *Macrourus holotrachys* from the sub-Antarctic near Heard Island. This rare parasite has a wide distribution and is also known from *Macrourus berglax* in the North Atlantic (Noble 1973). All species of the genus *Chondracanthodes* infest mainly deep-sea fishes, especially macrourids (Boxshall 1998). However, all currently known hosts of *Chondracanthodes tuberofurcatus* belong to the same genus. The present finding in the Weddell Sea represents a new locality record.

Clavella adunca has been previously recorded from Antarctic waters, occurring on *Macrourus whitsoni* and *Trematomus loennbergi* Regan, 1913 (Kabata and Gusev 1966). Rohde et al. (1995, 1998) found *Clavella adunca* [Lernaeidae sp. in part in Rohde et al. 1995 (K. Rohde, personal communication)] in *Macrourus holotrachys* near Heard Island. Gaevskaya and Rodjuk (1988a) recorded this parasite from the same host from north of the Falkland Islands. According to Kabata (1979) and Boxshall (1998), *Clavella adunca* has a cosmopolitan distribution. It mainly infests gadid fish species in the North Atlantic and North Pacific. In the former, *Clavella adunca* is common on fish species inhabiting the continental shelf, but in deep waters, it appears to be confined to *Macrourus berglax* (Ho 1985). The present finding represents two new locality records.

The present study is the first record of the sphyriid copepod *Lophoura szidati* since its original description from *Macrourus holotrachys*, caught at the South Orkney Islands and the South Sandwich Islands (sub-Antarctic), by Stadler (1978). Other *Lophoura* species are also only known from the original description, due to the lack of parasitological studies of deep-sea fish. In general, *Lophoura* species show a high degree of host-specificity. They are known only from a single or two host species, in the latter case fish belonging to a single family or genus (Boxshall 1998). However, *Lophoura bouvieri* (Quidor, 1912) as a congener of *Lophoura szidati* occurs in the North Atlantic and the Indian Ocean, indicating a wide zoogeographical distribution (Kabata 1979). The present finding represents a new host and two new locality records for *Lophoura szidati*.

Discussion

During the present study, a total of 22 parasite species were recorded from *Macrourus whitsoni*. Fifteen species were earlier known from Antarctic *Macrourus whitsoni*, and 9 of them were detected during the present study. The record of 12 (including Nematoda sp. I–IV) newly recorded parasite species brings the total number to 27 metazoans occurring in Antarctic *Macrourus whitsoni*.

Such a diverse parasite fauna is comparable to that of other predatory Antarctic fish. Palm et al. (1998) recorded a similar high number of metazoan endoparasites (32) and only 5 species of ectoparasites from the Antarctic notothen *Notothenia coriiceps*. The present result also supports Rohde (1999), who stated that the species richness in high latitudes is low for ectoparasites while being rich for endoparasites. Palm et al. (1998) suggested an important role for *N. coriiceps* in the life-cycle of Antarctic parasites. In both fish, most of the parasites detected were in the adult stage, using *Macrourus whitsoni* and *N. coriiceps* as final hosts. However, as several larval forms were also detected, *Macrourus whitsoni* also serves as an important intermediate host. Though *N. coriiceps* mainly occurs in shallower water habitats (0–550 m, Gon and Heemstra 1990) and *Macrourus*

whitsoni is a deep-sea fish, the present study indicates a similar ecological role for both fish species for Antarctic parasites.

However, a comparison of the parasite fauna within *Macrourus whitsoni* and *N. coriiceps* shows some differences. In both species, several parasites demonstrate a wide range of distribution within and also outside Antarctic waters, some of them even having a cosmopolitan distribution. Such a distribution pattern is known for oceanic and deep-sea parasites, living in hosts from a relatively stable and uniform environment (Hureau et al. 1979). However, the species differ, in *Macrourus whitsoni* having cosmopolitan crustaceans and *N. coriiceps* having a great number of endemic acanthocephalans. This can be explained by differences in the habitats depending on water depth. Interestingly, the parasite diversity is also high for *Macrourus whitsoni* (see above). This can be explained by its generalistic feeding behaviour. Crustaceans (especially euphausids), polychaetes and gonostomatid fish have been recorded as prey items of *Macrourus whitsoni* (Cohen et al. 1990), and 6 classes of invertebrates, including copepods, amphipods, mysids, euphausids, fish and cephalopods were recorded for the congener *Macrourus holotrachys* (Dudochkin 1988). An additional large depth range between 400 and 3,185 m (Cohen et al. 1990), and possible vertical migration during the night (as proposed for *Macrourus holotrachys* by Dudochkin 1988), enable *Macrourus whitsoni* to accumulate a wide variety of parasites.

A comparison of the parasite fauna of *Macrourus whitsoni* and other fish species of the Antarctic shelf region reveals distinct differences. It seems that this macrourid has an entirely different parasite fauna, mainly characterised by deep-sea and oceanic species. Similar differences between deep and inshore waters in nearby localities have been previously recorded, especially for digenetic trematodes by Campbell (1983) and Rohde (1984). According to Campbell et al. (1980), macrourids in general show a greater similarity among themselves than with other teleosts. This might be explained by a wide host range of many deep-sea parasites, together with an overlap in distribution and migration patterns of their macrourid hosts. Palm (1999) stated a possible transfer of Antarctic *Pseudoterranova decipiens* (Krabbe, 1878) out of the Antarctic, using fish hosts such as *Dissostichus* spp., as well as seals as their final hosts. A similar situation is also likely for *Macrourus* parasites, which infest host species with a distribution within and without Antarctic waters, as well as overlapping distribution patterns. The close phylogenetic relationship (Oyarzun et al. 1993) between the different macrourids might be another factor that enables their parasites to occur on differently distributed hosts. However, more work is needed to gain more information on Antarctic deep-sea fish parasites.

Campbell et al. (1980) reported a tendency for deep-water fish parasites to be host specific. This might be true for monogeneans, some groups of digeneans, such as the Lepocreadiidae, as well as for adult pseudophyllid cestodes. However, several hemiurid digeneans, larval anisakid nematodes and some crustaceans demonstrate a low host-specificity (see Results). The parasite fauna of *Macrourus* spp. consists of both, taxa with a high host-specificity and a restricted distribution pattern, as well as species with a wide host range and wide or sometimes cosmopolitan distribution. Some taxa seem to be restricted to the Macrouridae or Gadiformes, however, also having a wide range of distribution. In particular, deep-water parasitic copepods of fish have the tendency for an extremely wide distribution (Boxshall 1998; Ho 1975; Ho and Kim 1989). For example, Ho (1975) collected copepods from Macrouridae of the Galapagos Islands, where four of five species had been previously recorded from Japan, the Aleutian Deep, and the Atlantic coast of North America. Furthermore, according to Manter (1934) (cited in Campbell et al. 1980), some groups of deep-sea fish trematodes have a wider geographical distribution than their inshore or pelagic counterparts. The most widely distributed Digenea are the hemiurids, which in all probability are dispersed by a pelagic intermediate host (Campbell 1983).

In the present study, larval nematode species were recorded that are known to mature in fish-eating sea birds and in cetaceans or pinnipeds. This questions the access of deep-water *Macrourus whitsoni* to these parasites, also suggesting a vertical migration (see above). However, this also suggests the possibility of marine-fish nematode larvae occurring not only close to their final host populations but also spreading into deep-water localities. A similar situation has already been demonstrated for Antarctic *Pseudoterranova decipiens*, occurring in water depths between 80 and 820 m around the South Shetland Islands (Palm 1999). This also explains the findings of larval bird nematodes belonging to the Schistophorinae, which were found in deep-water sharks around the Great Meteorbank, Central East Atlantic (Palm and Schröder 2001).

The present study demonstrates that *Macrourus whitsoni* has a highly diverse parasite fauna, which is similar to that of other *Macrourus* species from sub-Antarctic waters. Interestingly, it is also similar to that of *Macrourus berglax* from the northern hemisphere, which appears to have a similar species composition of closely related parasites (see Bray 1995; Campbell et al. 1982; Ho 1985). The diversity of the parasite fauna is a consequence of the large depth range of the host (both deep-water as well as parasites from the upper water column are found), and of many different prey species that can serve as intermediate host. Other factors are host migration and a close phylogenetic relationship among the different macrourid hosts, which enable the parasites to infest all three (sub-)Antarctic *Macrourus* species. However, only a few fish from Antarctic deep-sea waters have been studied, making detailed statements on the zoogeographical distribution, as well as the depth range of the detected parasites, difficult. These aspects should be considered within future parasitological studies of Antarctic fish.

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