Vol. 315: 249–257, 2006 | MARINE ECOLOGY PROGRESS SERIES Mar Ecol Prog Ser | Published June 13

Diet and metazoan parasites of silver scabbard fish *Lepidopus caudatus* from the Great Meteor Seamount (North Atlantic)

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ABSTRACT: Silver scabbard fish *Lepidopus caudatus* (Euphrasen, 1788) (Trichiuridae) from the Great Meteor Seamount (GMS) in the central eastern Atlantic were studied for diet composition and metazoan parasites. A total of 36 specimens with lengths between 39.1 and 52.2 cm were sampled, which had taken 14 different prey items belonging to 4 major taxonomic groups (Chaetognatha, Crustacea, Mollusca and Teleostei). The most abundant prey organisms were Myctophidae and Euphausiacea, followed by Copepoda (Calanoida), Decapoda, Chaetognatha and Cephalopoda. Fishes were also the dominant prey in terms of biomass. Cannibalism was observed in 7 specimens of subadult *L. caudatus*. A total of 11 parasite species were identified in/on *L. caudatus*. We established 9 new host and 8 new locality records. Infestation rates were congruent with diet composition, indicating that parasites were ingested via mesopelagic prey organisms serving as intermediate hosts. The rich parasite fauna in *L. caudatus* reflects a high diversity of mesopelagic species at the GMS, providing niches for parasites and their intermediate hosts. While several species such as *Paradiplectanotrema lepidopi* (Monogenea) and *Nybelinia lingualis* (Cestoda) are typical parasites of *L. caudatus*, other species such as *Sphyriocephalus tergestinus* (Cestoda), *Anisakis simplex* (Nematoda) and *Bolbosoma vasculosum* (Acanthocephala) seem to be transferred by hosts migrating into the area, indicating an important role of the GMS in the transoceanic distribution patterns of such parasites.

KEY WORDS: *Lepidopus caudatus* · Metazoan parasites · Diet composition · Biotic relationships · Diversity · Zoogeography · Seamount

INTRODUCTION

Seamounts are topographic elevations within oceanic deep-water systems. They are commonly defined as formations rising at least 1000 m above the sea floor. Although the 1000 m classification is far from rigid, on this arbitrary basis the Atlantic Ocean is estimated to contain 810 seamounts, while the Pacific Ocean may contain anywhere over 30 000 such structures (Epp & Smoot 1989, Rogers 1994). Seamounts provide a striking contrast to the surrounding flat, sediment-covered abyssal plain and have complex effects on ocean circulation. The physics of water flow, coupled with local biological processes, appear to play a key role in determining productivity of the system (Rogers 1994). Some seamounts may even act as barriers for vertically and/or horizontally migrating zooplankton and micronekton, thus providing an enhanced food resource for deep-water fishes which live at their flanks. They also attract big pelagic fishes, which use seamounts as feeding grounds and breeding areas during their transoceanic migrations (Boehlert & Genin 1987, Wilson & Kaufmann 1987).

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The Great Meteor Seamount (GMS) is one of the largest isolated, flat-topped seamounts in the Atlantic Ocean, located approximately 1500 km west of the Canary Islands. Its plateau area covers an area of 1130 km^2, extending from a depth of almost 4800 m to about 275 m beneath the ocean surface (Ulrich 1971). The unique characteristics of the GMS have recently been documented in numerous studies which report on its hydrography and the faunal assemblages in the area (e.g. Beckmann & Mohn 2002, Fock et al. 2002a,b, Mohn & Beckmann 2002, Diekmann & Piatkowski 2004). Distribution patterns of fishes over the GMS plateau revealed that they were related to habitats at the edge of the plateau (Fock et al. 2002a). In general, the fish fauna appeared to be dominated by benthic suspension feeders over the plateau and highly aggregated pelagic species at the edge and flanks of the GMS (Uiblein et al. 1999, Fock et al. 2002a,b).

The silver scabbard fish *Lepidopus caudatus* (Euphrasen, 1788) (Trichiuridae) is one important inhabitant of the GMS benthopelagic fish community (Fock et al. 2002b). Like most Trichiuridae, *L. caudatus* occurs along the edge and upper slope of the Eastern Atlantic, Indian Ocean and SW Pacific continental shelves over sandy and muddy bottoms, from 100 to 250 m down to 450 m (Nakamura & Parin 1993). More detailed investigations on *L. caudatus* are scarce, and restricted to basic studies on reproduction, diet composition and life history (Mikhailin 1978, Demestre et al. 1993, D'Onghia et al. 2000). *L. caudatus* forms schools and is a mesopelagic predator that primarily feeds on Crustacea (especially Euphausiacea and Decapoda), small Cephalopoda, and Teleostei such as Myctophidae and Clupeidae (e.g. Mikhailin 1978, Demestre et al. 1993). Its major predators are piscivorous Teleostei, Elasmobranchii and large Cephalopoda such as *Merluccius capensis*, *Prionace glauca* and *Todarodes sagittatus* (Roel & Macpherson 1988, Clarke et al. 1996, Quetglas et al. 1999). In contrast to studies on the fish communities at the GMS (e.g. Uiblein et al. 1999, Fock et al. 2002a,b), studies on the parasite fauna and the feeding behaviour of fishes around the GMS are almost completely lacking (Ehrich 1971, Palm & Schröder 2001). Because seamounts are more difficult to study than shallow coastal marine ecosystems, less is known about the biology of their resident species and the overall system ecology.

The purpose of the present study was to make the first detailed analysis of the diet and the metazoan parasites of juvenile and subadult *Lepidopus caudatus* from the GMS to demonstrate its position within the upper trophic food web and its role in the life cycle and distribution of metazoan parasites. Our study will provide useful new information on the ecology of a typical deep-water fish associated with seamounts.

MATERIALS AND METHODS

Fish were sampled during the M42/3 cruise of the RV 'Meteor' in September 1998 at the GMS (Uiblein et al. 1999, Fock et al. 2002b). Sampling was conducted with a GOV bottom trawl with a wing-span of 32 m (detailed description in Fock et al. 2002b). At Stn 469 (30° 04.7' to 30° 02.7' N, 28° 29.2' to 28° 29.9' W; bottom depth ca. 300 m) in the northern plateau region of the GMS (Fig. 1), a total of 36 specimens of *Lepidopus caudatus* were captured in order to study their stomach contents and metazoan parasites.

The fish were frozen at –20°C immediately after capture and subsequently prepared for dissection. In the laboratory, we determined total length (TL, to the

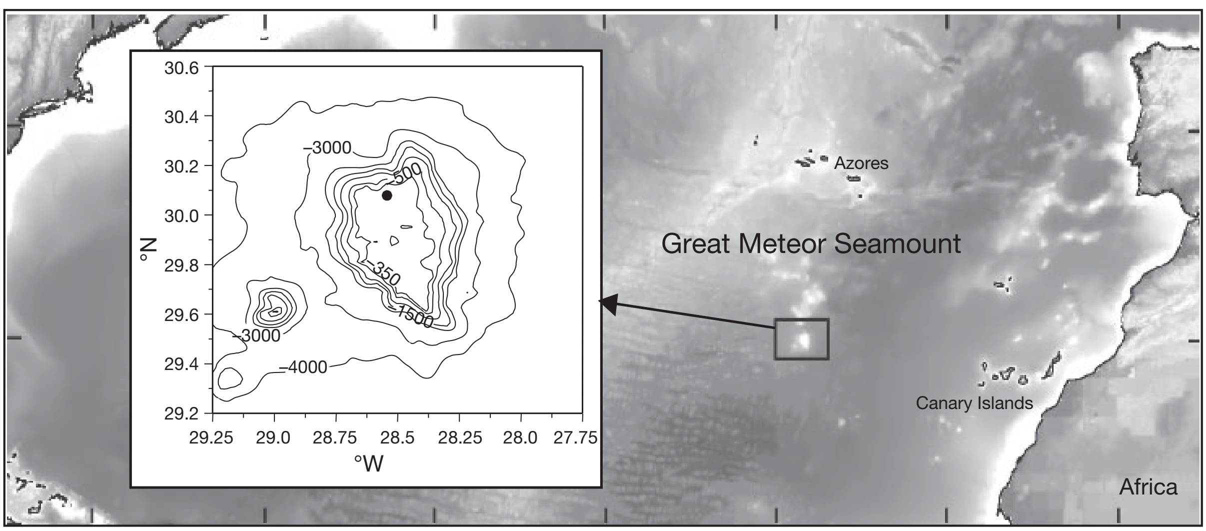

Fig. 1. Investigation area. Stn 469 (•) was located at 30° 04.7' to 30° 02.7' N, 28° 29.2' to 28° 29.9' W

nearest 0.1 cm), total weight (TW, to the nearest 0.1 g), stomach weight (SW, to the nearest 0.001 g) and fish maturity (by macroscopic inspection of the gonads). The stomach contents were sorted and food items were identified to the lowest possible taxon and grouped into taxonomic categories. Where possible, fishes and cephalopods that had been digested beyond visual recognition were identified from their otoliths and beaks, respectively.

In order to determine the relative importance of food items, the frequency of occurrence of each prey item i (% F_i), its percentage by weight (% W), and its percentage by number (% N) was calculated (Hyslop 1980, Amundsen et al. 1996). % F_i was calculated as the number of stomachs with Prey Item i compared to all non-empty stomachs; % W was calculated as the weight of Prey Item i compared to the total weight of all prey items; % N was calculated as the number of Prey Item i compared to the total number of all prey items (Hyslop 1980, Fock et al. 2002a).

Ectoparasite infestation was examined while the fish were still partly frozen. Inspection included skin, fins, eyes, nasal cavities, gills and the buccal and branchial cavities. Thereafter, the body cavity and the gastrointestinal tract were examined. Belly flaps and the musculature were examined for Cestoda and Nematoda on a candling table. Isolated parasites were fixed in 4% borax-buffered formalin and preserved in 70% ethanol:5% glycerine. Prior to fixation, Acanthocephala were transferred to freshwater until the proboscis everted. For identification purposes, Nematoda and Acanthocephala were dehydrated in a graded ethanol series and transferred to 100% glycerine (Riemann 1988). Digenea, Monogenea and Cestoda were stained with acetic carmine, dehydrated, cleared with eugenol or creosote, and mounted in Canada balsam. Crustacea were dehydrated and transferred to Canada balsam. Literature used for parasite identification included original descriptions, as well as descriptions of Golvan (1969), Kabata (1979), Amin (1985), Khalil et al. (1994), Petter & Cabaret (1995), Gibson et al. (2002), Palm (2004). The parasitological terminology (prevalence, intensity, mean intensity) followed the definitions of Bush et al. (1997). Prevalence (P) is the number of infected fish with 1 or more individuals of a particular parasite species (or taxonomic group) divided by the number of hosts examined for that parasite species (commonly expressed as a percentage); intensity of infection (I) is the number of individuals of a particular parasite species in a single infected host (expressed as a numerical range); and mean intensity of infection (mI) is the average intensity, i.e. the total number of parasites of a particular species found in a sample divided by the number of hosts infected with that parasite.

RESULTS

A total of 36 *Lepidopus caudatus* with lengths between 39.1 and 52.2 cm TL (mean 48.0 cm TL) and weights ranging from 30.7 to 81.9 g (mean 56.5 g) were examined; all specimens were immature.

Diet composition

All specimens had non-empty stomachs; 14 different food items belonging to 4 major prey groups were identified (Table 1). Almost all food organisms were of mesopelagic origin. The most frequent (F_i) prey organisms were Myctophidae indet. (F_i = 83.3%), followed by Euphausiacea (crustacean) (F_i = 63.9%); 5 other prey groups were of lower importance (Table 1). With regard to wet weight (W), Myctophidae indet. were again the most important prey (W = 35.69%). Unfortunately, the degree of digestion of most Teleostei did not allow more exact identification, but, juvenile *Lepidopus caudatus* and adult *Chauliodus sloani* constituted a high percentage of prey weight (24.63 and 20.49%, respectively, Table 1). With regard to numerical percentage of prey (N), the most abundant prey items were also Myctophidae indet. (N = 46.93%) followed by Euphausiacea (N = 24.12%), Chaetognatha (*Sagitta* spp.) and Copepoda (Calanoida) (N = 4.39% for both, Table 1).

Table 1. *Lepidopus caudatus*. Frequency of occurrence (F_i) and percentage weight (W) and numerical percentage (N) of Prey i in food items identified in stomach contents at Great Meteor Seamount. n: no. of stomachs with prey

Prey item	n	F_i (%)	W (%)	N (%)
Chaetognatha				
Sagitta spp.	5	13.9	0.12	4.39
Crustacea				
Calanus spp.	4	11.1	0.04	1.75
Copepoda (Calanoida)	7	19.4	0.12	4.39
Euphausiacea	23	63.9	9.25	24.12
Hyperiidae	5	13.9	0.24	2.63
Amphipoda	3	8.3	0.94	3.95
Pasiphaea sp.	7	19.4	5.31	3.07
Decapoda	3	8.3	0.41	1.32
Crustacea indet.	1	2.8	0.08	0.44
Mollusca				
Cephalopoda	5	13.9	1.66	2.19
Teleostei				
Chauliodus sloani	2	5.6	20.49	1.75
Lepidopus caudatus	7	19.4	24.63	3.07
Myctophum spp.	1	2.8	1.04	0.44
Myctophidae indet.	30	83.3	35.69	46.93

Parasites

A total of 11 parasite species were identified, belonging to the parasite groups Digenea (2 species), Monogenea (1), Cestoda (3), Nematoda (2), Acanthocephala (2) and Crustacea (1) (Table 2); 9 new host and 8 new locality records were established. The predominant parasite species were the monogenean *Paradiplectanotrema lepidopi* and *Scolex pleuronectis* (the latter of which is a larval stage of the Cestoda order Tetraphyllidea). We found 2 adult hemiurid digeneans in the stomach lumen of *Lepidopus caudatus*: *Brachyphallus crenatus* had a prevalence of 5.6% and a mean intensity of 1.0 (Intensity Scale 1), while *Lecithocladium excisum* had a prevalence of 13.9% with a mean intensity of 1.0 (Intensity 1). The present findings of *B. crenatus* and *L. excisum* are the first records of these parasites in the waters of the GMS, and represent new host and locality records.

Paradiplectanotrema lepidopi (the only monogenean species found) from the oesophagus of *Lepidopus caudatus* was the most predominant parasite species in the present study, with a prevalence of 100% and a mean intensity of 2.3 (Intensity 1 to 7). The present finding represents a new locality record. Voucher material from the oesophagus of *L. caudatus* from the GMS, (6 Sep 1998) is deposited in the US National Parasite Collection, Maryland (Storage No. 154A-1/4).

Cestoda comprised the most diverse parasite taxon. Only the larval stages (plerocercoids) of 3 different species were found. *Sphyriocephalus tergestinus* (Trypanorhyncha) was isolated from the stomach, with a prevalence of 5.6% and a mean intensity of 1.0 (Intensity 1). The plerocercoids of *Nybelinia lingualis* (Trypanorhyncha), infesting the stomach and intestine wall, had a prevalence of 47.2% and a mean intensity of 1.2 (Intensity 1 to 2). The pyloric and intestinal lumen of *Lepidopus caudatus* was highly infested with *Scolex pleuronectis* (Tetraphyllidea), with a prevalence of 83.3% and a mean intensity of 77.3 (Intensity 1 to 644). *N. lingualis* and *S. pleuronectis* in *L. caudatus* represent new host records.

Nematoda consisted of the anisakids *Anisakis simplex* and *Hysterothylacium aduncum*. The predominant species was *A. simplex*, with a prevalence of 25.0% and a mean intensity of 3.9 (Intensity 1 to 12). The third-stage larvae (L3) were found primarily in the stomach wall, the liver and the mesenteries, and secondarily in or on other organs of the body cavity. Adults and third-/4th-stage larval (L3/L4) *H. aduncum* specimens had a prevalence of 19.4% and a mean intensity of 1.2 (Intensity 1 to 2). The sites of infestation were the lumen of the pyloric caeca and the intestine. The present findings of both anisakid Nematoda represent new host records.

We isolated 2 different acanthocephal species from *Lepidopus caudatus*: Larval stages (cystacanths) of *Bolbosoma vasculosum* were found in the intestine with a prevalence of 16.7% and a mean intensity of 1.0 (Intensity 1). *Rhadinorhynchus pristis* had a prevalence of 8.3% and a mean intensity of 1.0 (Intensity 1). The adult stages of *R. pristis* were isolated from the intestine. Both Acanthocephala in *L. caudatus* represent new host and locality records.

A single *Lepidopus caudatus* was infested by a single crustacean (*Caligus elongatus*) on the operculum. Prevalence was 2.8% with a mean intensity of 1.0 (Intensity 1). The present study is the first record of *C. elongatus* from *L. caudatus* and therefore represents a new host record.

Table 2. *Lepidopus caudatus*. Prevalence (*P*), mean intensity (*mI*), intensity (*I*) and site of infestation for parasites at GMS. 1: new host record; 2: new locality record. a: adult; l: larva. See last paragraph of 'Materials and methods' for details of prevalence and intensity calculations

Parasite	Stage	*P* (%)	*mI* (*I*)	Site
Digenea				
Brachyphallus crenatus (1; 2)	a	5.6	1.0 (1)	Stomach
Lecithocladium excisum (1; 2)	a	13.9	1.0 (1)	Stomach
Monogenea				
Paradiplectanotrema lepidopi (2)	a	100.0	2.3 (1-7)	Oesophagus
Cestoda				
Sphyriocephalus tergestinus (2)	l	5.6	1.0 (1)	Stomach
Nybelinia lingualis (1; 2)	l	47.2	1.2 (1-2)	Stomach wall, intestine wall
Tetraphyllidea indet. (1) (*Scolex pleuronectis*)	l	83.3	77.3 (1-644)	Pyloric caeca, intestine
Nematoda				
Anisakis simplex (1)	l	25.0	3.9 (1-12)	Organs of body cavity
Hysterothylacium aduncum (1)	a/l	19.4	1.2 (1-2)	Pyloric caeca, intestine
Acanthocephala				
Bolbosoma vasculosum (1; 2)	l	16.7	1.0 (1)	Intestine
Rhadinorhynchus pristis (1; 2)	a	8.3	1.0 (1)	Intestine
Crustacea				
Caligus elongatus (1; 2)	a	2.8	1.0 (1)	Operculum

Interaction of prey composition and parasite diversity

The fish specimens investigated were sorted into 4 size classes (39.1 to 42.5, 42.6 to 46.0, 46.1 to 49.5 and 49.6 to 53.0 cm). Fig. 2A shows the frequency of occurrence

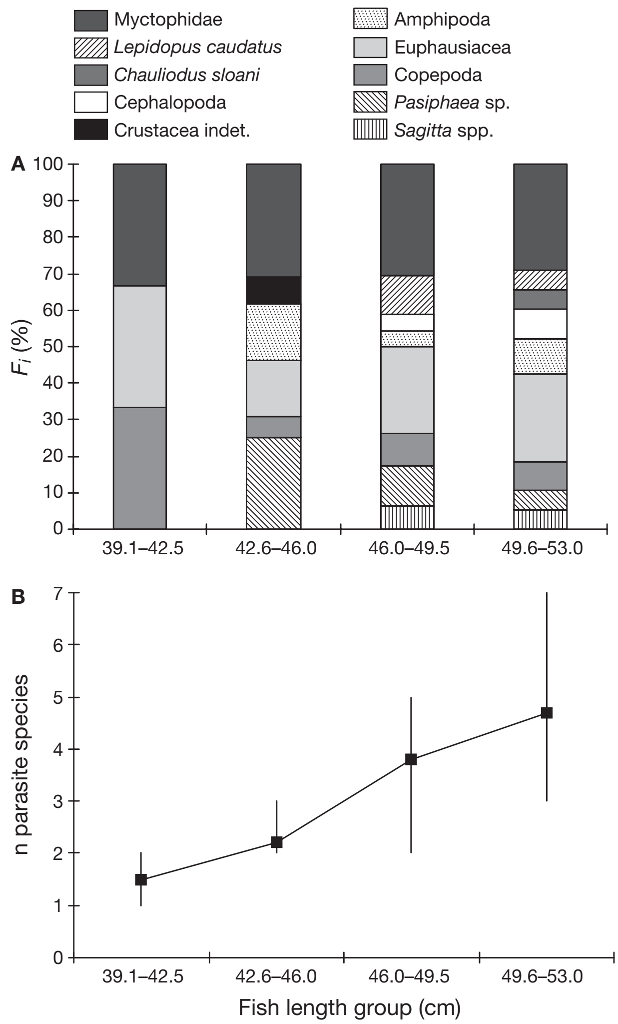

Fig. 2. *Lepidopus caudatus*. (A) Food composition (frequency of occurrence, F_i), and (B) mean (±SE) parasite diversity for 4 size classes

(F_i%) for all food items over the different size classes. The diversity of food items increases with increasing size; smaller fish fed on 3 different food items only, whereas larger fishes fed on 9. Myctophidae indet., Euphausiacea and Copepoda were present in all size classes, with highest numbers in the first length class. Chaetognatha (*Sagitta* spp.), Cephalopoda, and Teleostei (*Chauliodus sloani*, *Lepidopus caudatus*) were found only in the stomachs of fish of the 3rd and 4th length classes. The most important prey items were still Myctophidae indet. and Euphausiacea. Parasite species diversity also increased with increasing fish size (Fig. 2B). *L. caudatus* in the length classes 39.1 to 42.5 cm and 42.6 to 46.0 cm usually harboured 1 to 3 parasite species (mean = 1.5 and 2.2, respectively), whereas specimens in the length classes 46.1 to 49.5 cm and 49.6 to 53.0 cm were mostly infested with 2 to 7 species (mean = 3.8 and 4.7, respectively).

DISCUSSION

Diet composition

Trawl fishing at the GMS yielded only immature specimens of *Lepidopus caudatus*, ranging in size from 39.1 to 52.2 cm total length. Similar to the results of investigations on larger size classes (Demestre et al. 1993), our study revealed clear evidence of size-selection of prey by *L. caudatus*. While juveniles (<42.5 cm TL) feed exclusively on Copepoda, Euphausiacea and Myctophidae, larger individuals show a pronounced diversification of diet, including Decapoda, Amphipoda, Cephalopoda and other fish species. The increase in the proportion of fish prey in the stomach contents of *L. caudatus* with increasing size is mainly due to the onset of cannibalism at a body length of about 46.0 cm. Cannibalism seems to play an important role as a food source for subadult *L. caudatus* at the GMS (values of both F_i and W were around 20.0%), whereas in a previous investigations in the NW Mediterranean (Demestre et al. 1993), cannibalism was of minor importance. Overall, fishes comprised the most important prey group, although their wet weight and frequency may have been underestimated due to advanced state of digestion.

Metazoan parasites

The present study identified 11 different parasite species: a single ectoparasitic monogenean, a single ectoparasitic crustacean, and 9 endohelminth species. The monogenean *Paradiplectanotrema lepidopi* is host specific for *Lepidopus caudatus*, and can therefore be found on that host in other geographical regions. The copepod *Caligus elongatus* was the only crustacean found, indicating that Crustacea were minor parasites of *L. caudatus*. In contrast, the endohelminth fauna was highly diverse. The parasite fauna and infestation rate of larger predatory marine fishes, such as *L. caudatus*, is mainly a result of the increasing amount of food ingested (Klimpel et al. 2004). Infestation rates of marine fishes largely depend on the availability of the parasites' potential intermediate and final hosts, environmental conditions and depth preferences (Klimpel et al. 2003b). Consequently, endohelminth parasites utilising *L. caudatus* and its prey items as intermediate and/or final hosts were also abundant in our study area (Fig. 3).

The absence of benthic food organisms in the diet of *Lepidopus caudatus* is mirrored by its parasite fauna. For example, Digenea are rare, because the numbers of first, obligatory, intermediate gastropod hosts are probably low, due to unfavourable living conditions for

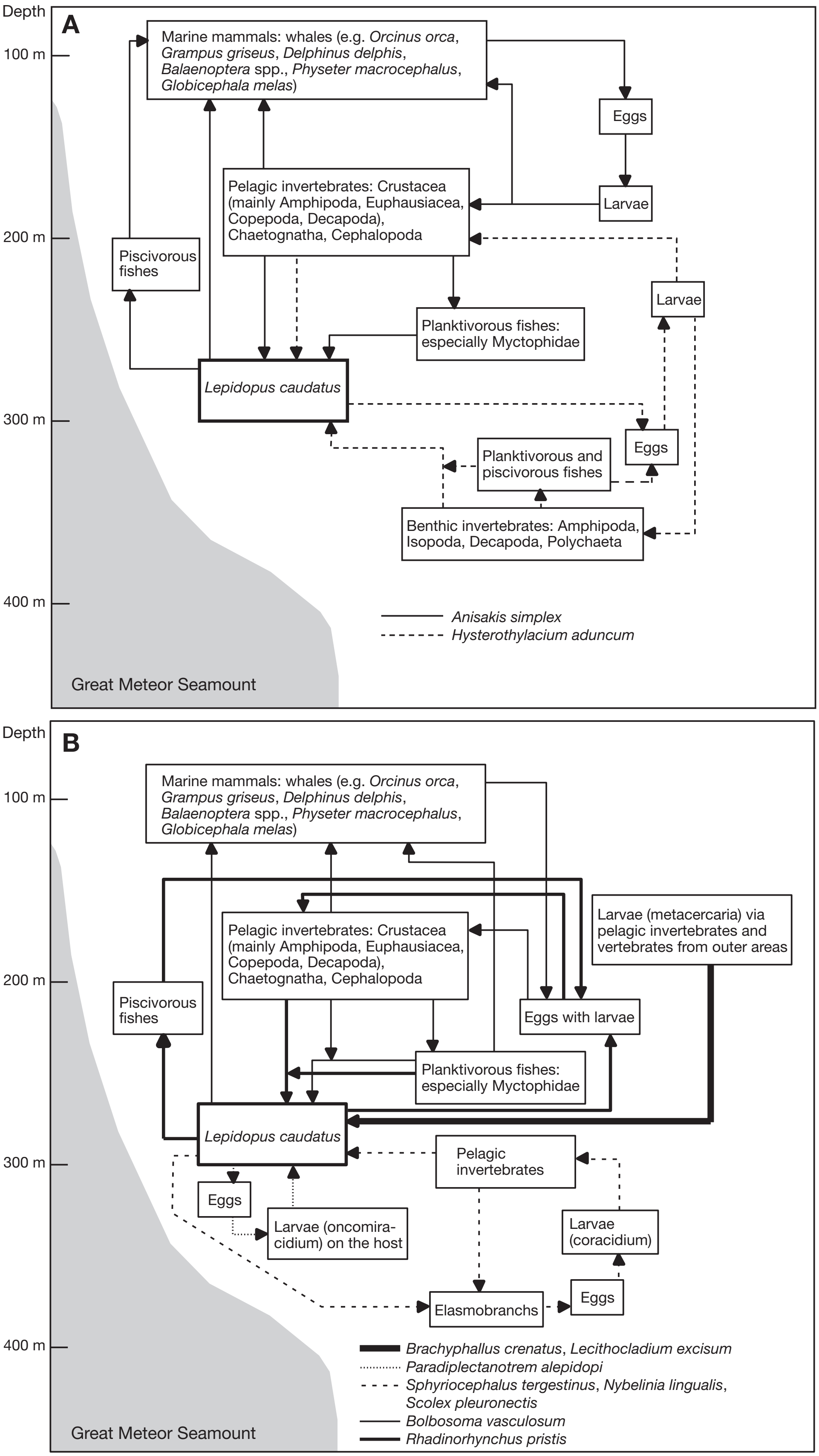

Fig. 3. *Lepidopus caudatus*. Schematic representation of biotic relationships of *L. caudatus* at Great Meteor Seamount, based on stomach and parasitological analyses. Arrows indicate the life cycles (with their different stages and intermediate hosts) for the parasites: (A) *Anisakis simplex* (Nematoda) and *Hysterothylacium aduncum* (Nematoda), and (B) *Brachyphallus crenatus*, *Lecithocladium exisum* (Digenea), *Paradiplectanotrema lepidopi* (Monogenea), *Sphyriocephalus tergestinus*, *Nybelinia lingualis*, *Scolex pleuronectis* (Cestoda), *Bolbosoma vasculosum* (Acanthocephala) and *Rhadinorhynchus pristis* (Acanthocephala)

bottom dwellers at the GMS. As possible second intermediate hosts, Crustacea, Chaetognatha and planktivorous fishes occur in high numbers at the GMS (Pusch et al. 2004, Schnack-Schiel & Henning 2004). Digenea might also be transferred via crustaceans and fishes from outer areas of the seamount bearing infective larval stages of such trematodes. The life cycle of *Lecithocladium excisum* might include a gastropod (Opisthobranchia: e.g. *Philine aperta*) living on the seamount as first intermediate host, Crustacea (various copepod species) and Chaetognatha as second intermediate hosts, and probably *Scomber scombrus* and *Trachurus trachurus* as final hosts (Køie 1991). Together with the latter 2 migratory fishes, *Lepidopus caudatus* might act as alternative final host in the life cycle of this parasite. For *Brachyphallus crenatus*, a similar life cycle is presumed, with gastropods of the genus *Retusa* serving as first intermediate hosts, several planktonic invertebrates and fishes as second intermediate hosts, and a larger variety of fishes as final hosts, indicating low host specificity (Køie 1992, Klimpel et al. 2003b). However, our analyses of its stomach contents showed that *L. caudatus* feeds on suitable intermediate hosts such as mesopelagic Crustacea and Teleostei (Fig. 3B).

The highest diversity of endohelminths was observed for the Cestoda (3 species). The order Trypanorhyncha, represented by the 2 species *Sphyriocephalus tergestinus* and *Nybelinia lingualis* (both of the family Tentaculariidae), represent a typical Cestoda fauna of trichiurid fishes (Palm 2004). Trypanorhyncha are common parasites of marine elasmobranchs, in which they mature in the stomach or spiral valve (Palm 2004). The typical life cycle of oceanic Trypanorhyncha includes a copepod as first, euphausiid or schooling fish as second, and an elasmobranchi as final hosts (Palm 2004). In the present study, the Cephalopoda and Myctophidae are presumed to be the main second intermediate hosts for *N. lingualis*, which was also found in other regions of the NE Atlantic and Indian Ocean (Mordvinova 2000, Palm 2004). Our study documents that Euphausiacea (and probably Myctophidae) are the main second intermediate hosts of *N. lingualis*, with Cephalopoda serving as potential paratenic hosts. By preying upon Euphausiacea and Myctophidae as well as Cephalopoda, *L. caudatus* can function as third intermediate or paratenic host, accumulating the larval stages of *N. lingualis*. An extended 4-host life cycle involving several different fishes as intermediate hosts has already been proposed by Palm (2004). Both *S. tergestinus* and *N. lingualis* infest Elasmobranchii (especially lamniform sharks) as final hosts, obviously following an oceanic or pelagic life cycle at the GMS (Fig. 3B). The presence of Cestoda of the order Tetraphyllidea (*Scolex pleuronectis*) in high numbers is not surprising, since these parasites are common in large predatory oceanic fishes (Klimpel et al. 2001). Their life cycle, however, is still unresolved because of taxonomical difficulties within the Cestoda group. Marine Crustacea (Copepoda) are probably first intermediate hosts, with Elasmobranchii as final hosts. Tetraphyllidean larvae of the *S. pleuronectis* type are cosmopolitan and occur in various fish species (Klimpel et al. 2001). Further identification of these larvae is not possible without knowledge of the strobila characters and life cycles (Fig. 3B).

The 2 nematodes *Anisakis simplex* and *Hysterothylacium aduncum* are abundant parasites of invertebrate and vertebrate hosts and throughout the entire Atlantic Ocean. Both nematodes use various makroinvertebrates (e.g. Hyperiidae, Euphausiacea, Chaetognatha) as first intermediate hosts, fishes as second and/or paratenic hosts (Klimpel et al. 2003a, 2004, Klimpel & Rückert 2005). Whales, and sometimes seals, serve as final hosts for *A. simplex*, whereas the final hosts of *H. aduncum* are bony fishes (Fig. 3A). The prevalence of *A. simplex* in *Lepidopus caudatus* is relatively low, although the potential pelagic intermediate hosts such as pelagic Crustacea (Copepoda, Euphausiacea) and Myctophidae are found in great densities around the GMS (Pusch et al. 2004). The low prevalence of *A. simplex* is probably a result of the availability of final hosts, since whales only pass the GMS during their extensive oceanic migrations. The mature adult stages of *H. aduncum* are commonly found in the digestive tracts of marine fishes (final hosts). Larval stages occur in benthic and planktonic invertebrates (intermediate hosts) (Jackson et al. 1997). Earlier studies have shown that the abundance of various crustacean species responsible for the transfer of infective larval stages of *H. aduncum* varies greatly as a function of geographical area (e.g. Marcogliese 1996, Klimpel & Rückert 2005).

We found 2 species of Acanthocephala, *Bolbosoma vasculosum* and *Rhadinorhynchus pristis*, in *Lepidopus caudatus*. The life cycle of *B. vasculosum* species involves pelagic crustaceans, other zooplankton organisms and fishes as paratenic hosts (Costa et al. 2000). Marine mammals such as whales (e.g. *Delphinus delphis*), which comprise the final hosts of *B. vasculosum*, pass the GMS during their migrations. Myctophidae use the GMS as feeding ground, thus ingesting Crustacea harbouring the infective larval stage (cystacanth) (Fig. 3B). Mordvinova (2000) identified *B. vasculosum* cystacanths in various myctophid species (for which, however, they are not infective), using these fish species as paratenic hosts. Analysis of *L. caudatus* stomach contents revealed Myctophidae to be one of its most important prey items. Thus, they are able to transfer the infective larval stage of *B. vasculosum* to *L. caudatus*, which represents another paratenic host in the life cycle of this parasite (Fig. 3B). As *B. vasculosum* and *A. simplex* are both parasites of Cetacea, it would seem logical to find larval stages of both species in the same paratenic host, *L. caudatus*. The life cycle of *R. pristis* includes pelagic Crustacea as intermediate hosts and fishes as final hosts, and this parasite is highly prevalent in its most important final hosts, the oceanic dolphinfishes *Coryphaena hippurus* and *C. equiselis* (Carbonell et al. 1999) as well as in the chub mackerel *Scomber japonicus* (Costa et al. 2004) in the central E Atlantic (e.g. Canary Islands, Madeira). These fish species probably use the GMS area as feeding grounds during their seasonal migration, when they presumably release eggs of *R. pristis* with their faeces, which are then ingested by the abundant pelagic Crustacea. Bearing the infective larval stages (cystacanth), the crustaceans then transfer the acanthocephalan species to a final host (Mordvinova 2000). *L. caudatus* acquires and accumulates *R. pristis* through preying upon infected pelagic fishes that may act as paratenic hosts of this parasite (Fig. 3B). There is also a clear connection between the prevalence of parasite infection and the availability of infected intermediate hosts in the investigation area, as evidenced by the low prevalence of *R. pristis*, whose intermediate hosts only appear in the area for short periods.

The present study has demonstrated that the diverse parasite load of juvenile and subadult *Lepidopus caudatus* in the GMS region is a result of its predatory feeding behaviour. *L. caudatus* accumulates a variety of larval fish parasites and can act as second intermediate, paratenic or final host. While some of the parasites such as the monogenean *Paradiplectanotrema lepidopi* and the cestode *Nybelinia lingualis* are typical parasites of *L. caudatus*, and are able to fully complete their life cycle around the GMS, other parasites such as the nematode *Anisakis simplex*, the acanthocephalan *Bolbosoma vasculosum* and the cestode *Sphyriocephalus tergestinus* appear to be carried into the area by migrating hosts. They occur in low numbers, and may have been incidentally introduced by their final hosts when these used the GMS as a feeding area during long range migrations. Our study emphasises that the GMS area, and probably other Atlantic seamounts, plays an important role in the transoceanic distribution of several widely distributed marine fish parasites, as demonstrated by the high diversity of fish parasites found in *L. caudatus*, a typical seamount associated fish. Further studies on similar fish species that occur at seamounts are needed to determine if this is a general picture of seamount associated fishes. Moreover, detailed studies of the ecology of the parasites are necessary to determine their complicated life cycles and distributional patterns in host invertebrates, fishes and sea mammals.

Acknowledgements. We are grateful to D.C. Kritsky, Idaho State University USA, for identification and additional information on the monogenean parasite species. Thanks are due to D. Schnack, IFM-GEOMAR Kiel, Germany, for providing the fish material, and the German Research Council (DFG) which financed the field study at the GMS. This study was initiated by the international Census of Marine Life project MAR-ECO coordinated by the Institute of Marine Research in Bergen, Norway. Helpful comments were provided by 4 anonymous reviewers.

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Editorial responsibility: Otto Kinne (Editor-in-Chief), Oldendorf/Luhe, Germany

Submitted: March 1, 2005; Accepted: November 17, 2005
Proofs received from author(s): May 19, 2006