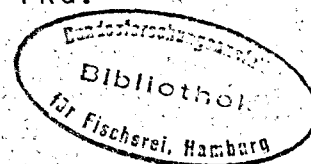


Geographical distribution and trophic ecology  
of the demersal fish fauna in the eastern and  
southern Weddell Sea

by

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ABSTRACT

During two cruises of RV "Polarstern" in austral summer 1983 and 1984 44 fish species belonging to 8 families were collected in the eastern and southern Weddell Sea. On the shelf zones nototheniids dominated the demersal fish fauna. Trematomus scotti, T. centronotus, T. lepidorhinus, and T. eulepidotus were the most common species of the family. T. loennbergii occurred only in deeper zones. Pagetopsis maculatus was the most common channichthyid. Outside the continental shelf, near the Filchner Depression, bathydraconids (A. nudiceps and G. australis) and harpagiferids (D. longedorsalis) dominated the fish fauna.

The species on the shelf were mostly benthos feeders (T. scotti, T. centronotus, A. skottsbergi). Their staple food were gammaridean amphipods and polychaetes. Therefore the proportional prey overlap was relatively high. T. eulepidotus, G. australis and P. maculatus fed mainly on euphausiids. These pelagic feeders had a low prey overlap with other species; the degree of dietary similarity was high within this group.

The results indicated food partitioning among the fish species which was achieved by a division of the food resources within vertical habitat zones; near the Filchner Depression, the four dominant fish species fed in different layers: D. longedorsalis and T. loennbergii fed primarily on benthos, whereas A. nudiceps fed in the benthopelagic-pelagic zone, and G. australis was mainly planktivorous.

Introduction

We have a good understanding of the general nature of the Antarctic coastal fish fauna in terms of species composition and general zoogeography (see reviews by ANDRIASHEV, 1965;

DeWITT, 1971; PERMITIN, 1977). Until now most research was related to fishes of the seasonal pack-ice zone (HEMPEL, 1985), the most productive zone on a yearly basis in the Southern Ocean. There are thorough studies about the trophic structure of the demersal fish fauna of the Antarctic and sub-Antarctic islands of the Scotia Ridge (PERMITIN and TARVERDIYEVA 1972, 1978; TARGETT, 1981) and of the feeding ecology of fishes from the Antarctic Peninsula (DANIELS, 1982). Less knowledge (DeWITT, 1970; IWAMI & ABE, 1981; KOCK et al., 1984; HUBOLD 1984) exists about the fish fauna of the high Antarctic zone, which is covered by ice most of the year and is characterized by a very short primary production season. Information on feeding is limited to some investigations in the Ross-See (EASTMAN, 1985; TAKAHASHI and NEMOTO, 1984), and in the Weddell Sea (KOCK et al., 1984). This paper deals with several aspects of the community ecology of coastal Antarctic fishes of high latitudes presenting information on species composition, distribution and feeding of the most frequently sampled species. The degree of feeding niche overlap between these species is treated and how food resources are partitioned.

### Material and Methods

Demersal fish were collected during two cruises with the RV "Polarstern" between January and March, 1983 and 1984. Bottom trawling was carried out mostly by a 3 m modified Agassiz Trawl; three hauls were made using a commercial 140 feet bottom trawl. Trawling time varied from 7 to 35 minutes at depths of 200 to 1180 m. 29 hauls of a total of 34 AGT hauls were made along the coast of the eastern and southern Weddell

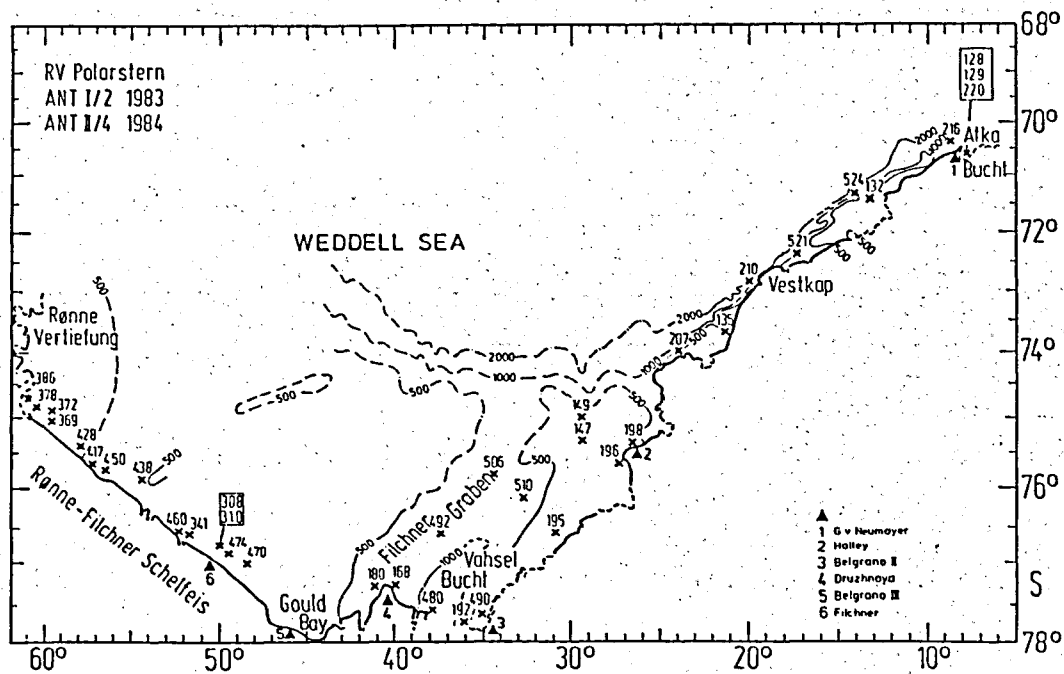


Fig.1: Area of investigation and location of stations

Sea in the area between Atka Bay (8°) and the base of the Antarctic Peninsula (61°19'); most samples were taken on the continental shelf at a depth of 200 to 456 m.

The fish were immediately deep frozen at -36°C. In the laboratory specimens were measured (standard and total length), weighed (nearest 0.01g) and dissected. After preparation the stomachs were removed, opened, and their contents separated into taxonomic groups and counted. Prey organisms were fixed in 70% ethanol. For dry weight determination the contents of the stomachs were dried at 60°C, cooled in a dessicator, and weighed on a microbalance to the nearest 0.1 mg.

The percentage composition of the diet by number and by weight was calculated for each fish. Mean percentage composition of the diet (dominance by number and by weight) and frequency of occurrence of each prey category were then calculated for each fish species.

Proportional overlap in prey consumed between all species pairs was calculated using:

$$C_{ih} = 1 - 1/2 |p_{ij} - p_{hj}|$$

where  $p_{ij}$  and  $p_{hj}$  are the proportions of the diet of fish species  $i$  and  $h$ , respectively, which are composed of prey  $j$  (COLWELL and FUTUYAMAY, 1971).

Diet diversity was examined by number of taxa found in the diet of each species ( $S$ ) and SHANNON & WIENER diversity index  $H' = - \sum p_i \ln(p_i)$  (SHANNON & WEVER, 1949) and evenness  $e = H' / \ln S$  (PIELOU, 1966).

## Results

### Species composition

44 species belonging to 8 families were caught (Tab. 1). More than 98 % of the individuals belong to the Antarctic and Subantarctic suborder Notothenioidei. The others were Lipariidae, Muraenolepidae, Zoarcidae and Rajidae.

Tab.1: Species composition and number of fish collected in 1983 and 1984 in the Weddell Sea

Species	Number	in %	Species	Number	in %
<b>NOTOTHENIIDAE</b>			<b>CHANNICHTHYIDAE</b>		
<i>Trematomus scotti</i>	130	13,1	<i>Pagetopsis maculatus</i>	56	5,7
<i>T. centronotus</i>	36	3,7	<i>P. macropterus</i>	11	1,1
<i>T. eulepidotus</i>	63	6,5	<i>Dacodraco hunteri</i>	7	0,7
<i>T. lepidorhinus</i>	67	6,9	<i>Cryodraco antarcticus</i>	6	0,6
<i>T. loennbergii</i>	65	6,7	<i>Chionodraco spec.</i>	5	0,5
<i>T. hansonii</i>	6	0,6	<i>Ch. hamatus</i>	8	0,8
<i>T. bernacchii</i>	10	1,0	<i>Ch. myersi</i>	6	0,6
			<i>Chaenodraco wilsoni</i>	4	0,4
<b>HARPAGIFERIDAE</b>			<b>LIPARIDAE</b>		
<i>Dolloidraco longedorsalis</i>	148	15,1	<i>Paraliparis spec.</i>		
<i>Histiodraco velifer</i>	4	0,4	<i>Paraliparis antarcticus</i>		
<i>Artedidraco skottsbergii</i>	33	3,4			
<i>A. loennbergii</i>	23	2,4	<b>MURAENOLIPIDAE</b>		
<i>A. shackletoni</i>	16	1,6	<i>Muraenolepis orangiensis</i>	1	
<i>A. orianae</i>	6	0,6			
<i>Pogonophryne spec.</i>	3	0,3	<b>ZOARCIDAE</b>		
<i>P. permittini</i>	19	1,9	<i>Austrolycichthys concolor</i>	1	
<i>P. phyllopogon</i>	6	0,6	<i>A. brachycephalus</i>	5	
<i>P. scottii</i>	3	0,3	<i>A. bothriocephalus</i>	1	
<i>Pogonophryne sp.n.</i>	1	0,1			
<b>BATHYDRACONIDAE</b>			<b>RAJIDAE</b>		
<i>Akarotaxis nudiceps</i>	95	9,7	<i>Bathyraja maccaini</i>	4	
<i>Bathydraco scotiae</i>	1	0,1			
<i>B. antarcticus</i>	2	0,2			
<i>B. macrolepis</i>	7	0,7			
<i>B. marri</i>	1	0,1			
<i>Vomeridens infuscipinnis</i>	8	0,8			
<i>Racovitzia glacialis</i>	8	0,8			
<i>Prionodraco evansii</i>	28	2,9			
<i>Gerlachea australis</i>	63	6,5			
<i>Cygnodraco mawsoni</i>	19	1,9			
<i>Gymnodraco acuticeps</i>	2	0,2			

The most abundant species in the catches were Trematomus scotti, Dolloidraco longedorsalis, Akarotaxis nudiceps and Gerlachea australis. They represented more than half of all individuals. Also important were Trematomus lepidorhinus, T. eulepidotus, Artedidraco loennbergii, Prionodraco evansii, Artedidraco skottsbergii, Trematomus centronotus und T. loennbergii.

Most of the other species were usually represented by only a few specimens (Abb. 2).

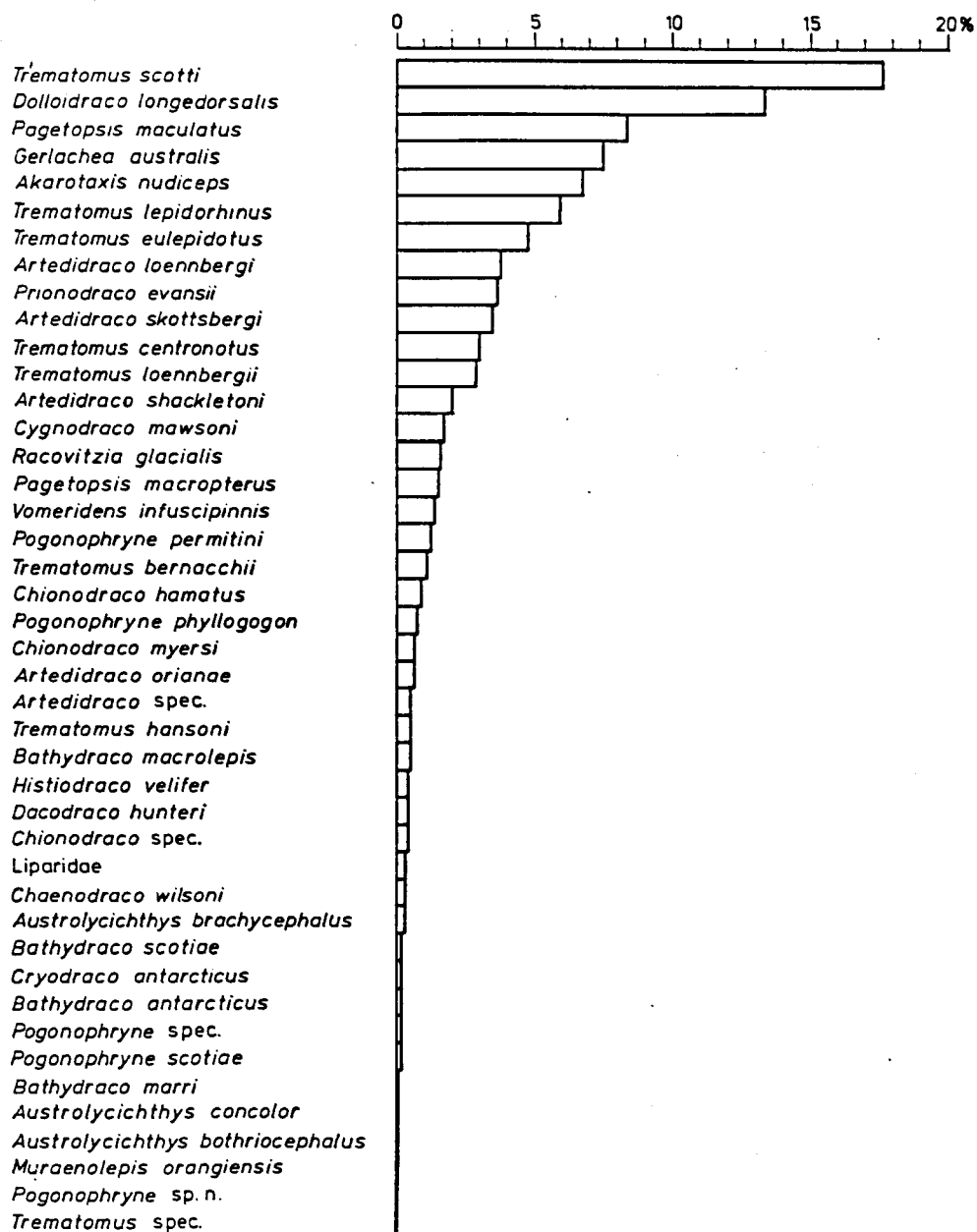


Fig.2: Frequency distribution of all species from the Weddell Sea ( all AGT-samples are included)

## Geographical distribution

### 1. The shelf of the eastern Weddell Sea

The fish fauna of this region is characterized by a high proportion of nototheniids, which were represented by 6 species. 40% of the fish fauna were harpagiferids and channichthyids. Bathydraconids were negligible.

Trematomus scotti was the most abundant species on the shelf. With Pagetopsis maculatus and T. lepidorhinus, they made up 50% of all individuals collected. T. eulepidotus and Artedidraco skottsbergi also occurred frequently.

H' and e indices of fish species diversity were 1.61 and 0.84, respectively.

### 2. Filchner Depression

In this region of a depth of 670 m and more, bathydraconids and harpagiferids had a high occurrence. In terms of species and individuals bathydraconids dominated the fish community. Species diversity was low. The fish fauna was dominated by a few species: Dolloidraco longedorsalis, A. nudiceps and G. australis constituted more than 75% of the individuals. From the nototheniids only Trematomus loennbergii represented 8% of the individuals. The other 13 species were less important. Liparidae and Zoarcidae were a minor component.

### 3. The shelf of the southern Weddell Sea

Nototheniids were the dominant element of the community: their 6 species represented 35% of the individuals. T. scotti was the dominant species. T. eulepidotus, T. lepidorhinus and T. centronotus were represented to a smaller extent than on the eastern shelf. Artedidraco loennbergii was second, Prionodraco evansii third in frequency.

H' and e indices of fish species diversity were 1.59 and 0.82.

### 4. Ronne Depression

The fish community was composed by a relatively high number of species, although the number of individuals was low. H' and e indices of fish species diversity were 1.82 and 0.94, respectively. Individuals showed a relatively equal distribution. This was different to the community near the Filchner Depression, where H' and e indices were lower (1.14 and 0.68).

The most abundant species were D. longedorsalis, T. loennbergii, G. australis and Vomeridens infuscipinnis.

## Food and Feeding

In the following, the diet composition of the 5 most common Trematomus species (Fig.3) and of some species of the Harpagiferidae, Bathydraconidae and Channichthyidae (Fig.4) is presented.

Diets varied among these 10 species and the list ranged from specialized feeders to food generalists.

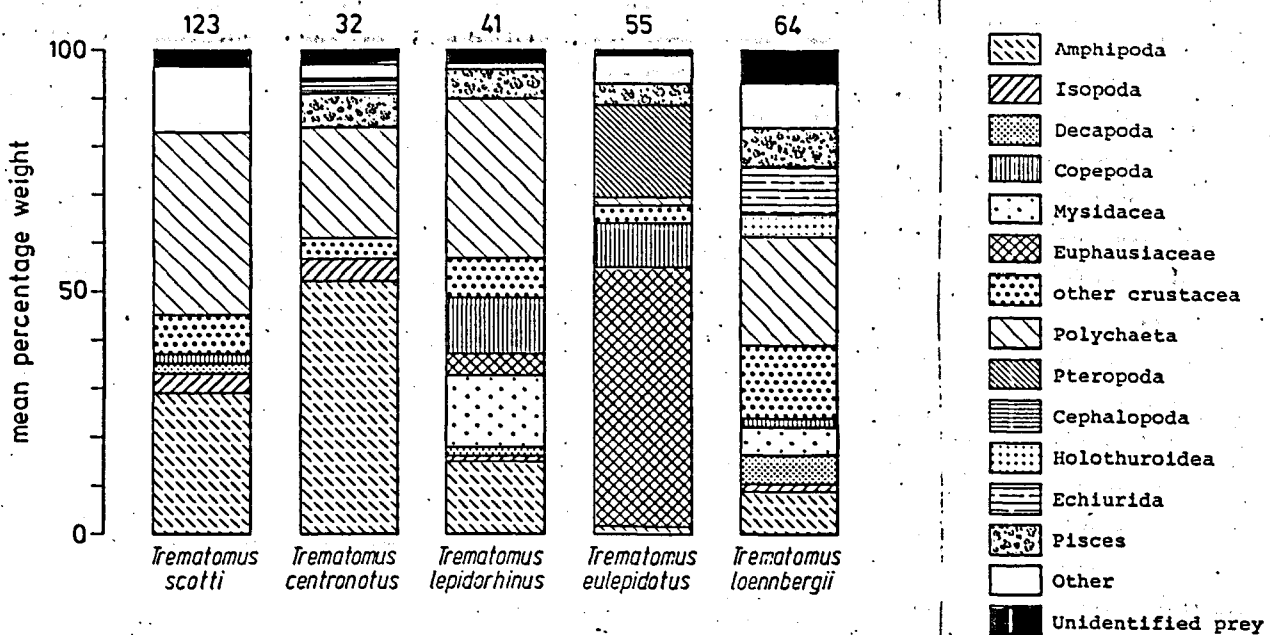


Fig. 3: Food composition by weight of the most abundant nototheniids from the eastern and southern Weddell Sea. Numbers above each histogram are the number of fish with food in stomachs

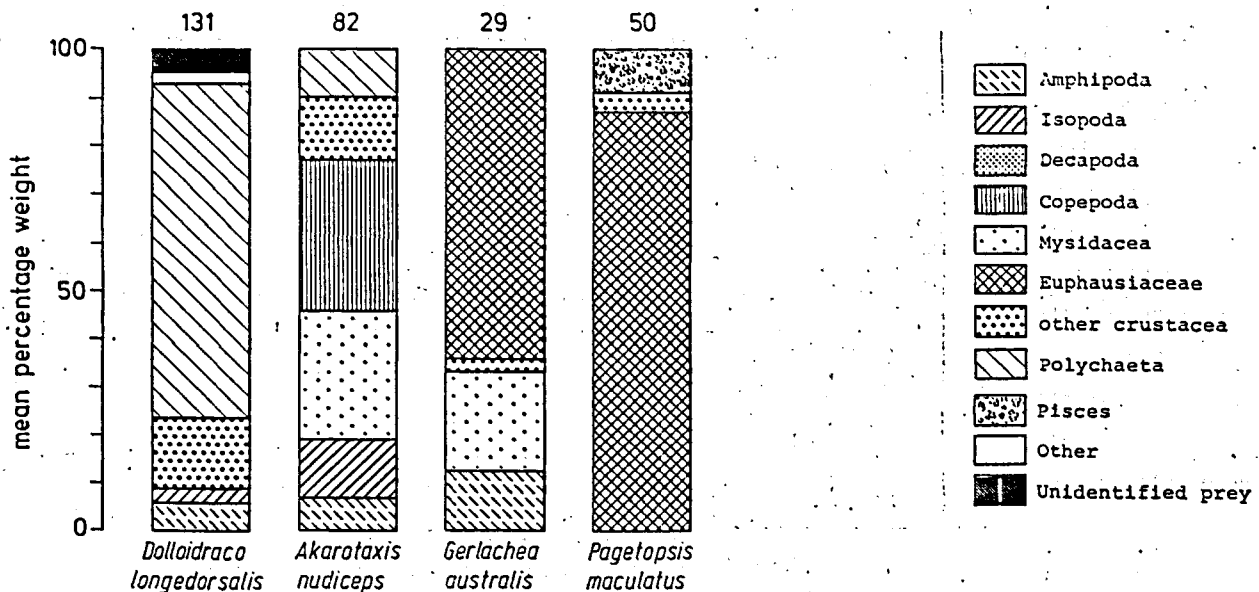


Fig 4: Food composition by weight of the most abundant species of harpagiferids, bathydraconids and channichthyids from the eastern and southern Weddell Sea. Numbers above each histogram are the number of fish with food in stomachs

Trematomus scotti preyed primarily on polychaetes, amphipods and isopods. In larger fish, holothurians, sipunculids, echiurids, crinoids and ophiuroids became more important prey groups. The presence of polychaete tubes in the stomachs indicated that sedentary polychaetes also belong to the food of this species.

Trematomus centronotus also fed primarily upon benthic amphipods and polychaetes with emphasis on amphipods. Both prey categories made up more than two-thirds of the diet by biomass. Larger individuals (19 cm SL) preyed also on fish. 7 % of the diet was composed of fish.

Trematomus lepidorhinus preyed on benthic polychaetes and, to a lesser extent, on benthic gammarideans as well as on mysids and copepods. Other planktonic organisms like euphausiids, siphonophores and chaetognaths were occasionally taken.

Trematomus eulepidotus consumed primarily Euphausia crystallorophias, pteropods and copepods. Euphausiids and pteropods were the most important prey by weight in the northeastern Weddell Sea. Benthic organisms like amphipods were rare in the diet.

Trematomus loennbergii fed on a variety of organisms: polychaetes, amphipods, echiurids, sipunculids and fishes.

Dolloidraco longedorsalis fed upon vagile epifauna, with emphasis on errant polychaetes. Individuals tended to be pronounced specialists: they only consumed prey from one or two taxa.

Arteidraco skottsbergi preyed primarily on polychaetes and various crustacean groups, especially gammaridean amphipods.

The food of Akarotaxis nudiceps was composed mainly of mysids and copepods, but also of benthic organisms (amphipods, isopods, polychaetes).

Gerlachea australis fed mainly on euphausiids and to a lesser degree on mysids and amphipods.

Pagetopsis maculatus consumed primarily euphausiids, but also fish.

#### Proportional prey overlap

Proportional prey overlap values ( $C_{ij}$ ) for the most abundant species are summarized in Table 2.

T.eulepidotus, G.australis, P.maculatus had little overlap with other species. They preyed primarily on pelagic organisms, especially on euphausiids. Among themselves, they had a high level of prey overlap, up to 60 and 66%.

A relatively high degree of overlap was recorded for species that were mainly benthic feeders: T.scotti, T.centronotus, T.loennbergii, T.lepidorhinus and the two harpagiferids D.longedorsalis and A.skottsbergi. A large portion of this overlap was due to polychaetes and gammaridean amphipods, prey constituting 30 - 50% of the prey biomass of these species.

The benthopelagic-pelagic feeding A.nudiceps showed about 30% similarity in diet with other benthic feeders. With T.lepidorhinus there was a higher degree of overlap (50%), due to the more planktonic prey of this species. Both species had a



different distribution in the Weddell Sea. A prey overlap of 30% was obtained to the pelagic feeding G.australis. Diet overlap between pelagic and benthic feeders was usually low.

Table 2: Proportional prey overlap ( $C_{ih}$ ) between fish species from the Weddell-Sea

	T.cen.	T.eul.	T.lep.	T.loe.	D.lon.	A.sko.	A.nud.	G.aus.	P.mac.
<u>Trematomus scotti</u>	0,652	0,191	0,590	0,464	0,586	0,624	0,261	0,168	0,053
<u>Trematomus centronotus</u>	-	0,101	0,449	0,464	0,357	0,419	0,248	0,128	0,109
<u>Trematomus eulepidotus</u>		-	0,252	0,128	0,093	0,072	0,163	0,594	0,595
<u>Trematomus lepidorhinus</u>			-	0,576	0,543	0,570	0,514	0,323	0,159
<u>Trematomus loennbergii</u>				-	0,484	0,501	0,387	0,169	0,119
<u>Dolloidraco longedorsalis</u>					-	0,758	0,311	0,091	0,043
<u>Artedidraco skottsbergi</u>						-	0,310	0,152	0,042
<u>Akarotaxis nudiceps</u>							-	0,304	0,041
<u>Gerlachea australis</u>								-	0,666

## Discussion

The family Nototheniidae constitutes the greatest part of the fish fauna with regard to the number of individuals and biomass of fishes. With the exception of the pelagic Pleura-gramma antarcticum (HUBOLD, 1984) the family is dominated by the genus Trematomus. They are most important on the shelves of the eastern and southern Weddell Sea; only T.loennbergii was encountered to deeper zones. According to the data of the species composition of the Ross Sea (DeWITT, 1971; IWAMI and ABE, 1981) more than 98% of fishes belong to the suborder Notothenioidei. Samples showed the rich diversity of the demersal fish fauna, which is very similar to the inner Ross Sea (IWAMI and ABE, 1981). The demersal fish fauna at South Georgia Island, the South Orkney Islands, and the South Sandwich Islands had a lower diversity. The  $H'$  values ranged from 1.3 to 0.19. They reflect low numbers of species and the pronounced dominance of 3 or fewer species in all communities (TARGETT, 1981). In comparison to the Weddell Sea the species diversity at the South Shetland Islands was in the same order, although that was based on bottom trawl collection (IWAMI and ABE, 1982). Against that bottom trawl from the Weddell Sea showed higher diversity values.

Concerning the food composition, the nototheniids showed the greatest diversity. They preyed on a variety of organisms, mainly on benthic prey. T.scotti, T.centronotus, T.loennbergii are benthic feeders. T.lepidorhinus is a benthopelagic feeder and T.eulepidotus is mainly planktivorous. At the Antarctic Peninsula euphausiids were the most important component in the diet of T.eulepidotus, too. In contrast to these results, krill was also an important component of the diet of T.scotti (DANIELS, 1982). In the Ross Sea errant polychaetes predominated in the diets of most demersal species, for example T.centronotus (EASTMAN, 1985). The diet

of T.loennbergii was composed of amphipods, polychaetes and fish (EASTMAN, 1985).

In comparison to the benthic nototheniids, the harpagiferids tend to be more specialized in both their choice of prey and in the method to get it. Both D.longedorsalis and A.skottsbergi fed on vagile epifauna. D.longedorsalis consumed mainly errant polychaetes; similar results were reported by WYANSKI and TARGETT (1981). Results for A.skottsbergi can be compared to those of WYANSKI and TARGETT (1981) and DANIELS (1982). In all cases A.skottsbergi consumed mainly polychaetes and amphipods. Although harpagiferids are generalists, their diet was not so diverse as that of the nototheniids.

Bathydraconids fed mainly in the benthopelagic or pelagic zone. Diet diversity was comparable to harpagiferids and much lesser than in nototheniids.

Channichthyids showed the greatest specialisation; they are pelagic feeders and fed on euphausiids or fish or had a mixed diet. P.maculatus, the most abundant member of the channichthyids in the Weddell Sea, was mainly planktivorous. Diets of channichthyids examined by PERMITIN and TARVERDIYEVA (1972, 1978) and TARVERDIYEVA & PINSKAYA (1980) showed that they are specialized feeders and, with exception of C.aceratus, planktivorous. In the Weddell Sea Pleuragramma antarcticum was an important component of the diets of channichthyids and nearly all fishes that rise from the bottom to feed in the water column. Similar results reported EASTMAN (1985) from McMurdo Sound, Ross Sea.

The most abundant fish species in the community of the region near the Filchner-Depression in the southern Weddell Sea (D.longedorsalis, A.nudiceps, G.australis and T.loennbergii) clearly partitioned the prey resources. Proportional prey overlap values showed that although most prey items were identified only to taxonomical groups, prey overlap was low, usually less than 50%.

The species partitioned the prey to a large extent by adaptations for feeding in different habitat zones within the community:

D.longedorsalis fed primarily on epifauna, especially on errant polychaetes. T.loennbergii also preyed primarily on benthos, but more on a variety of different prey items of larger sizes (mysids, decapods, echiurids, holothurians and fish). A.nudiceps fed in the benthopelagic-pelagic zone, and G.australis was mainly planktivorous.

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