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Lanternfishes (Family Myctophidae) Collected During SIBEX-Phase II Cruise in the Bransfield Strait, Antarctica

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ABSTRACT

Four species of lanternfishes (myctophids) were captured in the southern area of the Bransfield Strait, Antarctica, during INACH SIBEX-Phase II cruise (summer 1985): Electrona antarctica, Gymnoscopelus (Gymnoscopelus) braueri, Gymnoscopelus (Gymnoscopelus) nicholsi *and* Protomyctophum (Protomyctophum) bolini.

The diet, morphology and morphometry of the otoliths and the length - wet weight relationship of these fishes are analyzed.

Copepods, euphausiids, Euphausia superba *larvae and ostracods are the most frequent and/or numerous components of the stomach contents of these four Antarctic myctophids. An external morphological similarity between the otoliths of* E. antarctica, G. braueri *and* P. bolini *was observed. However, they can still be recognized as being from different species.*

RESUMEN

Durante el crucero SIBEX-Fase II del Instituto Antártico Chileno (INACH), realizado el verano de 1985, se capturaron en el sector sur del estrecho Bransfield, Antártica, cuatro especies de peces linterna o mictófidos: Electrona antarctica, Gymnoscopelus (Gymnoscopelus) braueri, Gymnoscopelus (Gymnoscopelus) nicholsi *y* Protomyctophum (Protomyctophum) bolini.

Se analiza la dieta, morfología y morfometría de los otolitos y la relación largo-peso húmedo de los peces.

Los copépodos, eufáusidos, larvas de Euphausia superba *y ostrácodos son los componentes más frecuentes y/o más numerosos de los contenidos estomacales de estos cuatro mictófidos antárticos.*

Se observó una similitud morfológica externa entre los otolitos de E. antarctica, G. braueri *y* P. bolini, *aunque pueden ser diferenciados entre sí.*

INTRODUCTION

Due to their wide distribution and abundance, myctophids are an important component of the pelagic ecosystem of all the oceans. According to Rowedder (1979a) they are the most abundant pelagic fishes in Antarctic waters. Members of the Family Myctophidae were abundant in catches in the Drake Passage, northwest off the South Shetland Islands (Iwami and Abe, 1982), the Croker Passage adjacent to Brabant Island (Hopkins and Robinson, 1982) and were the principal component of a deep scattering layer in the Pacific sector of the Antarctic Ocean (Linkowski, 1983).

Andriashev (1962) identified thirteen to fourteen species of myctophids belonging to six genera, considering six or seven of them as endemic or predominantly Antarctic species. He also stated that the genera *Electrona* and *Gymnoscopelus* and a subgenera, *Protomyctophum* s. str., were principally restricted to Antarctica and not to all waters of the southern hemisphere. Only one species of these genera, *Electrona risso*, has been found in the northern hemisphere, confirming Andriashev's information (Hulley, 1981; Mc Ginnis, 1982).

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Recognizing the importance of Antarctic myctophids, the Working Group in Fish Ecology of BIOMASS, in its meeting in Hamburg in September 1982, included within its most important objectives the need to evaluate the role of these fishes and their trophodynamic relationships with *Euphausia superba*, in particular their predation upon the larvae of this important Antarctic crustacean.

Several authors have given information about the feeding habits of some species of Antarctic myctophids (Rowedder, 1979b, Linkowski, 1983: Permitin, 1970: Rembiszewski *et al.*, 1978: Hopkins and Robison, 1982; Asencio and Moreno, 1984) and of other biological aspects, like distribution and age composition, using the length frequency method (Rowedder, 1979a).

Myctophids have been recognized as important components of the diet of several dolphins (Perrin *et al.*, 1973; Miyazaki *et al.*, 1973; Torres and Aguayo, 1979), marine mammals like *Arctocephalus gazella* (North *et al.*, 1983), and fishes like the Argentinian hake, *Merluccius merluccius hubbsi* (Angelescu and Cousseau, 1969). North *et al.* (1984) recognizing that the otoliths were very often the only remains in faeces and stomach contents of birds, seals and fishes, stated that it was important to be able to identify species and sizes of organisms consumed using the otoliths, to establish predator-prey relationships in the Antarctic ecosystem. Fitch and Brownwell (1968) had already emphasized the same thing for dolphins captured at several latitudes. To attain this objective, a catalog and/or descriptions of otoliths of the most complete size range of fish is extremely important, considering that there might be morphological differences in them in fishes of different ages.

This paper considers the study of the diets, morphology and morphometry of the otoliths and other biological aspects of the myctophids captured in the southern Bransfield Strait, during INACH SIBEX-Phase II cruise, summer 1985.

MATERIAL AND METHODS

The material was collected during INACH-SIBEX-Phase II cruise of the R/V Capitan Luis Alcazar in the Bransfield Strait, Antarctica, with an IKMT (Isaacs Kidd Midwater Trawl). Eight oblique and horizontal tows were especially directed to capture fishes, previously detected with an ecosounder (Simrad EKA 120 kHz) being five of them positive. In other twenty tows for *E. Superba* no myctophids were caught. The sampling stations are shown in Fig. 1 and the data about them in Table 1. The net was equipped with a net sounder (Furuno FNR 200 Mark II), which allowed to locate exactly the depth where the fishes were detected and center the net in the region of maximum acoustic response.

The specimens were preserved in 70% alcohol; in order not to damage the otoliths with formalin, alcohol was also injected intraperitoneally to stop digestion. The standard length (SL) and the wet weight of the fishes were measured, to the nearest mm and the nearest 0.01 g, respectively. The otoliths were removed and their length and maximum diameter (width) measured to the nearest 0.05 mm under a compound microscope.

The fishes were eviscerated, cutting the esophagus behind the gills and separating the intestine. The stomachs were opened and its degree of filling was classified according to the scale described by Gjosaeter (1973), modified by Rowedder (1979b): 0-empty, 1-stomach with only few contents, 2-half full, 3-full, 4-overfilled. The stomach contents were placed into the following groups: Euphausida, Copepoda, Amphipoda, Ostracoda, *E. superba* larvae, unidentifiable remains. These groups were identified under compound microscope using keys and/or descriptions by Antezana *et al.* (1976), Dilwyn John (1937), Fraser (1937), Giesbrecht (1902), Kane (1966) and Tanaka (1960).

RESULTS

During the SIBEX-Phase II cruise (summer 1985), 41 specimens of four myctophid species: *Electrona antarctica* (Gunther, 1878), *Gymnoscopelus (Gymnoscopelus) braueri* (Lonnberg, 1905) *Gymnoscopelus (Gymnoscopelus) nicholsi* (Gilbert, 1911) and *Protomyctophum (Protomyctophum) bolini* (Fraser-Brunner, 1949), were captured in the southern sector of the Bransfield Strait, Antarctica. The stations and number of specimens captured in each are shown in Table 2.

The major part of the samples were taken in areas with medium depths, near by or associated with shelves of islands or of the Antarctic Peninsula, were water column had around 200 m.

DIETS

Only one of the stomachs analyzed was empty. The degree of filling of the stomachs of the specimens captured is shown in Table 3.

Electrona antarctica

The 96.1% (N = 25) of the stomachs of this species had identifiable contents, corresponding 61.5% (N = 16) of them to the degree of filling 2, 3 and 4, that is stomachs half full to overfilled (Table 3).

A summary of the identifiable stomach contents of *E. antarctica* with their occurrence of presence and minimum and maximum sizes is shown in Table 4. The euphausiids, even though present in 50% of the stomachs, due to their advanced decomposition, were found as remains and only identified as species in two stomachs where two *Euphausia superba* and two *Thyssanoessa macrura* were found. However, the *E. superba* larvae were generally identifiable although not all of them could be measured in their length. The copepods are the better preserved components and the measure taken corresponds to the cephalothorax length, instead of the abdominal length, considering that the first has less error of measurement.

The copepods are the most numerous item consumed by *E. antarctica*, being present in all the stomachs with contents. Among the copepods, *Metridia gerlachei* is the predominant species (96.1%), and it is found in numbers between 1 and 80 specimens per stomach. Four other species were occasionally present: *Calanus propinquus*, *Heterorhabdus farrani*, *Rhincalanus gigas* and *Oithona frigida*.

The *E. superba* larvae were found in nearly 65% of the stomachs. Separating them according with their developmental stage, Calyptopis are present in 50% and Furcilia in 42.2% of the stomachs. The most numerous larvae correspond to Calyptopis II and III and Furcilia I and II. The ostracods were present in 50% of the stomachs, although in low numbers. The amphipods were only occasionally found in the stomachs of *E. antarctica* and are not important, but in one case when a large *Parathemisto gaudichaudi* represented almost all the contents of a stomach.

Gymnoscopelus braueri

Four specimens of this species were captured. However, all their stomachs were full (Table 3).

The copepods were the numerically most important components with 24, 2, 27 and 46 specimens per stomach. They were represented by only one species, *Metridia gerlachei* (N = 106), and one specimen of *Calanus propinquus*.

Euphausiids remains were found in all the stomachs, as well as *E. superba* larvae. These were represented by Calyptopis III (N = 3), Furcilia I (N = 3), one Calyptopis II and one Furcilia I. The ostracods (N = 10) were found in three out of four stomachs. No amphipods were found in the stomach contents of *G. braueri*.

Gymnoscopelus nicholsi

Seven specimens of this species were captured, having most of them their stomachs with only a few remains (Table 3).

The copepods are again the most important components, represented by *M. gerlachei* with 7, 18 and 40 specimens per stomach, and one specimen of *R. gigas*.

Euphausiids remains were found in five out of six stomachs, being four *E. superba* and four *Thyssanoessa macrura* identifiable from the two full stomachs. No euphausiid larvae nor amphipods and only two ostracods were found in the stomach contents of this species.

Protomyctophum bolini

Five specimens of this species were captured. However, all their stomachs were full (Table 3).

The copepod *M. gerlachei* is the almost exclusive component of the stomach contents with 9, 12, 74, 8 and 16 specimens per stomach. Other preys are one *R. gigas*, one ostracod and one Furcilia I of *E. superba*. No euphausiid or amphipod remains were found in the stomachs of *P. bolini*.

Morphology and morphometry of the otoliths.

Although morphologically very similar, the otoliths of *Electrona antarctica*, *Gymnoscopelus braueri* and *Protomyctophum bolini*. can still be recognized and differentiated by some external characteristics.

In general, the otoliths of these three species have an elliptical shape, being those of *P. bolini* and *G. braueri* rounder and thicker latero-laterally as can be seen in Fig. 2. The otoliths of *E. antarctica* show a small depression in their anterodorsal edge and one larger in the anteroventral edge where the sulcus present in its ventral side originates.

Few otoliths of *P. bolini* and *G. braueri* are available and they correspond to a narrow size range, and within it no changes in shape are detected in these bony structures. More otoliths were available from *E. antarctica* and from a wider size range (44-98 mm S.L.), being the external morphology fairly constant through all of it.

The otoliths of *Gymnoscopelus nicholsi* are morphologically very different. They are oval, with two anterior projections with a sulcus between them and several "spiny" projections of irregular shape in the dorsal edge (Fig. 2).

A morphometric analysis of the otoliths (length-width relationship), confirmed the observed similarity in *P. bolini*, *G. braueri* and *E. antarctica* otoliths. Two regressions considering the otoliths of the three species and only the ones from *E. antarctica*. gave almost the same results. However, this similarity disappears when the fish S.L. and the otolith length relationship is analyzed (Fig. 3). The plot shows that at a same length of fish, the otoliths of *P. bolini* are larger than those of *E. antarctica*, and these are larger than the ones of *G. braueri*. The regression equations are not given because they do not add more information and are based in few specimens.

The standard length (S.L.) of fish, and the length and width of the otoliths are shown in Table 5. The otoliths of three out of four species analyzed, show bands and lines which could represent growth and therefore could be useful to determine age in these fishes. In the otoliths of *G. braueri*, these bands and lines are more difficult to see because of its thickness and shape, needing therefore some kind of treatment before being used for ageing.

Standard length - wet weight relationship

The wet weight, despite its intrinsic variability, allows to detect tendencies. Analyzing the S.L. - wet weight relationship, the weights of *P. bolini* and *E. antarctica* of similar size are almost the same, confirming the morphological similarity and the tight taxonomic relationship of these two genera. On the other hand, the weights of *G. braueri* are much lower than those of *E. antarctica* of similar size, fact explained by the characteristics of the two bodies, while *G. braueri* is thinner and has a less deep body, *E. antarctica* has a more stout and deep body (Fig. 4).

The specimens of *G. nicholsi*, caught during SIBEX-Phase II, are in a different size range with respect to the other three species, but they seem to fall under the same exponential curve (Fig. 4).

DISCUSSION

The specimens caught belong to species with Antarctic circumglobal distributions (Andriashev, 1962; Hulley, 1981; McGinnis, 1982; Rembiszewski *et al.*, 1978), although three of them, *G. braueri*, *G. nicholsi* and *P. bolini* have also been found in subantarctic waters. Moreover, Angelescu and Cousseau (1969) identified *G. nicholsi* in stomach contents of the Argentinian hake *(Merluccius merluccius hubsi)* around 35° S and Zama and Cardenas (1984) report the capture of one specimen at 45°31' S off southern Chile. Two other species, *P. bolini* and *G. braueri*, have been reported by Mc Ginnis (1982) as present between 40° and 50° S and by Parin *et al.* (1973) north of 53° S off Chile, respectively. This last species was also captured at 34° S in the South Atlantic (Hulley, 1981).

Electrona antarctica, *Gymnoscopelus braueri* and *Gymnoscopelus nicholsi* are considered the most common myctophid species of the Southern Ocean.

As it was observed by DeWitt (1970) in the Ross Sea, the positive stations for myctophids were generally near continental or island shelves edges. The area where most of the specimens analyzed in this paper were caught, southwest in the Bransfield Strait and near the coast of the Antarctic Peninsula, corresponds to the same area where Mujica and Torres (1982) found the highest values of zooplankton biomass during FIBEX cruise. Of particular interest is their information about *E. superba* larvae, one of the important items in the stomach contents of the myctophids, which were found in the area at stations where the water column had around 200 m and very close to steep slopes to greater depths, where the myctophids were also found.

Most of the *E. antarctica* analyzed correspond to Rowedder's (1979 a,b) group 2, between 52.5 and 77.5 mm S.L. According to Rowedder (1979b), this group consumes mainly copepods and euphausiid larvae, which are the same items found in this study. Between 4 and 80 copepods and 1-9 *E. superba* larvae per stomach were found in this myctophid. Although the number of specimens of larger sizes (82.5 - 102.5 mm, Rowedder's group 3) are low to conclude anything, the occurrence of euphausiids is more common although the copepods still prevail.

No information could be found in the literature about *G. braueri* feeding habits, even though it is widely distributed in Antarctic waters. The few specimens analyzed had *E. superba* larvae, copepods and ostracods in their stomach contents. being the copepods the numerically most important item consumed.

Permitin (1970) found that krill was the principal component of the diet of *G. nicholsi*. being present in the 83% of the stomachs analyzed, while Rembiszewski *et al.*(1978) found it in 93% of the stomachs of 39 specimens of *G. nicholsi*. These percentages correspond to what observed in the specimens available for this study, around 83.3%. It is important to notice the occurrence of *Thyssanoessa macrura* in the stomach contents in the same numbers as *E. superba*. which coincides with large abundances of the first one in the area of the Bransfield Strait during the summer of 1985.

Analyzing the stomach contents of a few *P. bolini*. the copepods were the most important prey item for this species, confirming the findings of Asencio and Moreno (1984) in larger samples captured during the FIBEX cruise in the Drake Passage. The predominance of *Metridia gerlachei* among the copepods is also confirmed, a fact that is also common to the other three species of myctophids.

The results tend to confirm Permitin's (1970) idea, that the limiting factor for Antarctic myctophids to utilize krill is their size, because the percentage of occurence of krill in the stomachs of these fishes increases in larger species and specimens. However. the predation of myctophids over *E. superba* larvae is important in all species and smaller size specimens analyzed, and a change in preys is observed as the sizes of the fishes and therefore of their mouths increase. This seems to reinforce the krill-fish (including myctophids) "trophic team" idea of Rembiszewski *et al.* (1978), in the sense that a predator-prey relationship between the two species there exists. They stated that this "trophic team" persists by way of a constant change of partner and/or fish position in the water column.

The fact that the morphometric similarity between the otoliths of *E. antarctica*, *G. braueri* and *P. bolini* disappears when the standard length/length of the otolith relationship is considered (Fig. 3), it could be due to the different life history period of each species even though they have the same size. This is confirmed when the maximum size, indirectly a measure of age, of the three species is considered, 69 mm for *P. bolini* (North *et al.*. 1984), 110 for females and 82 mm for males of *E. antarctica* (Wisner, 1976) and of 132 mm for *G. braueri* (Hulley, 1981).

The information about the feeding habits of the four species of myctophids analyzed, has to be confirmed or modified with the analysis of more specimens, since the data here presented is for only a few specimens. Also regional differences in the feeding habits should be considered, since Rowedder (1979b) reported that these exist, at least for *E. antarctica*. Another study should consider more intensive sampling in areas chosen by their high abundances of adult or larval krill, to determine the quantitative impact of these fishes upon the different life history stages of *Euphausia superba*.

More samples. and of the widest size range possible, are needed to analyze the possible morphological and morphometric changes in the otoliths of these myctophids, preys of *Arctocephalus gazella* (North *et al.*, 1983) and other birds, seals and fishes. These structures seem also being useful to study growth and ageing, but larger samples are also needed.

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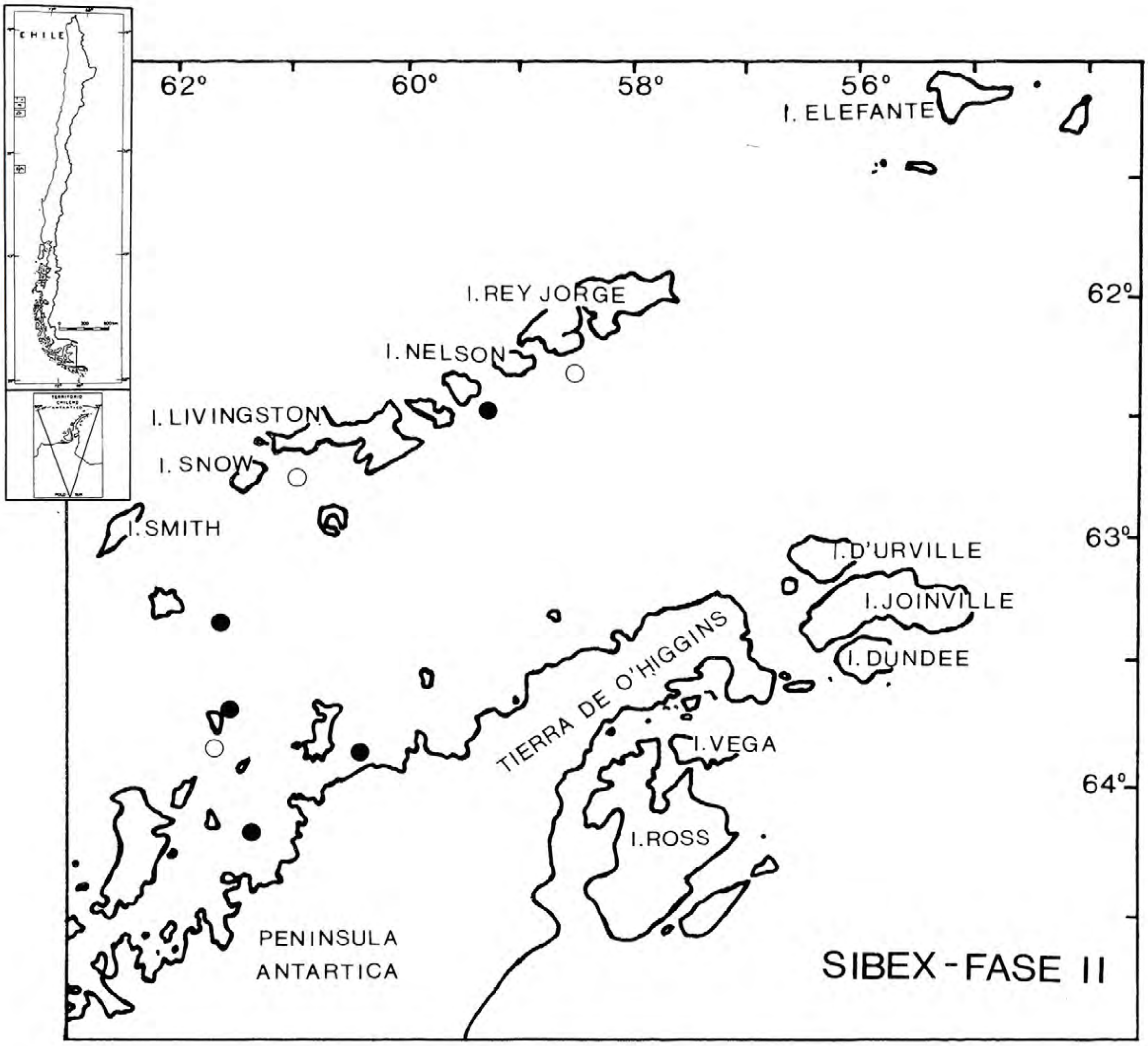

Figure 1.—Fish sampling stations during INACH SIBEX-Phase II Cruise. (o) Positive stations.

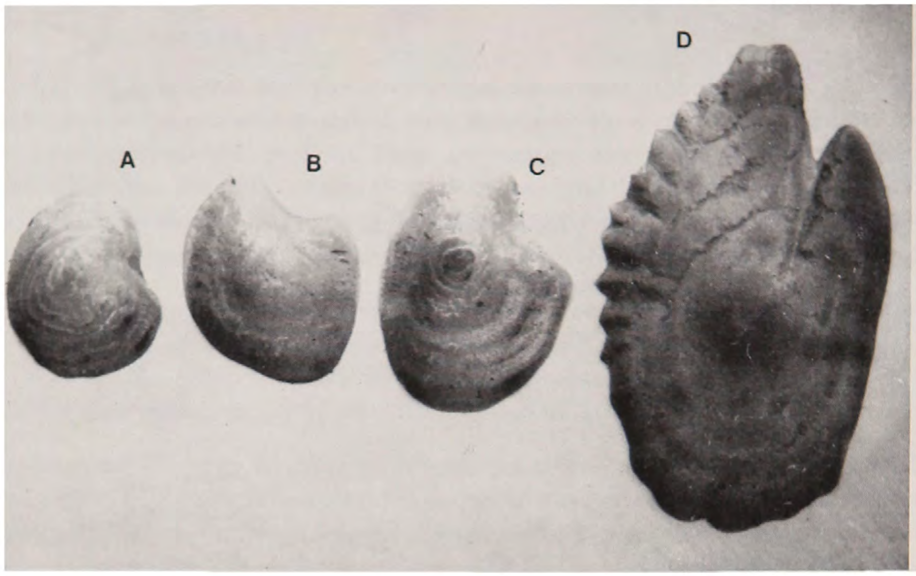

Figure 2.—Otoliths of Antarctic myctophids, treated with graphite to show volume. A. *P. bolini*, B. *G. braueri*, C. *E. antarctica* and D. *G. nicholsi*.

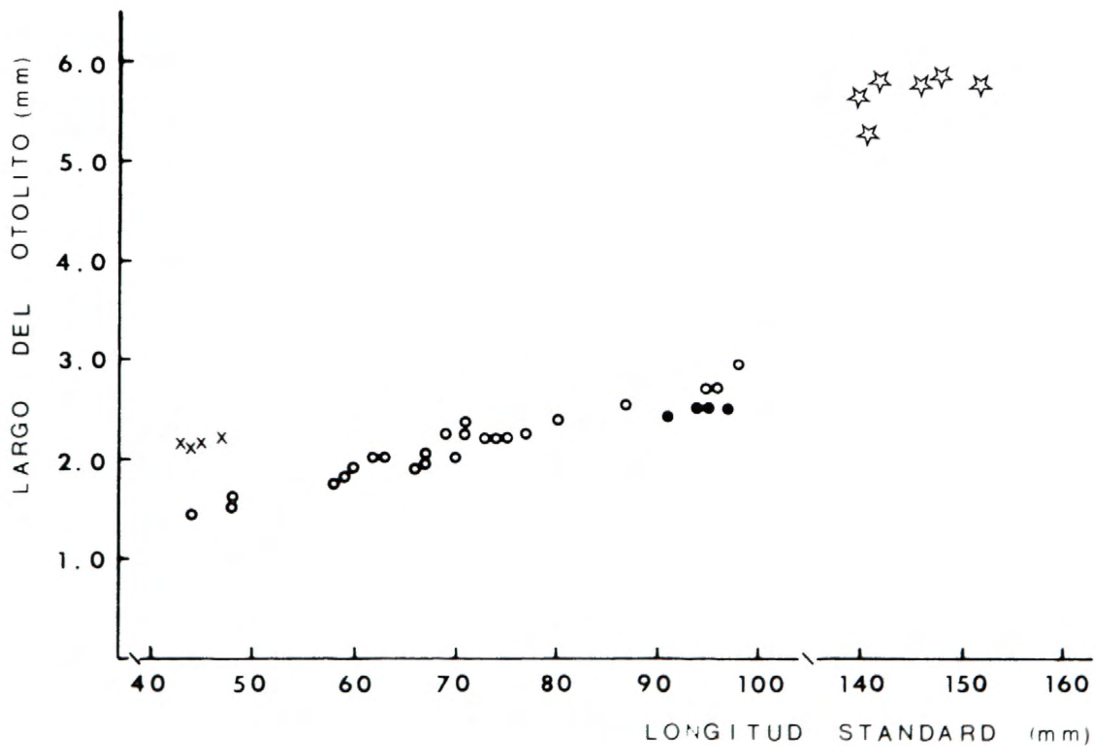

Figure 3.—Standard length of fish - length of the otolith relationship of four species of Antarctic myctophids. (o) *E. antarctica* (o) *G. braueri* (x) *P. bolini* and (*) *G. nicholsi*.

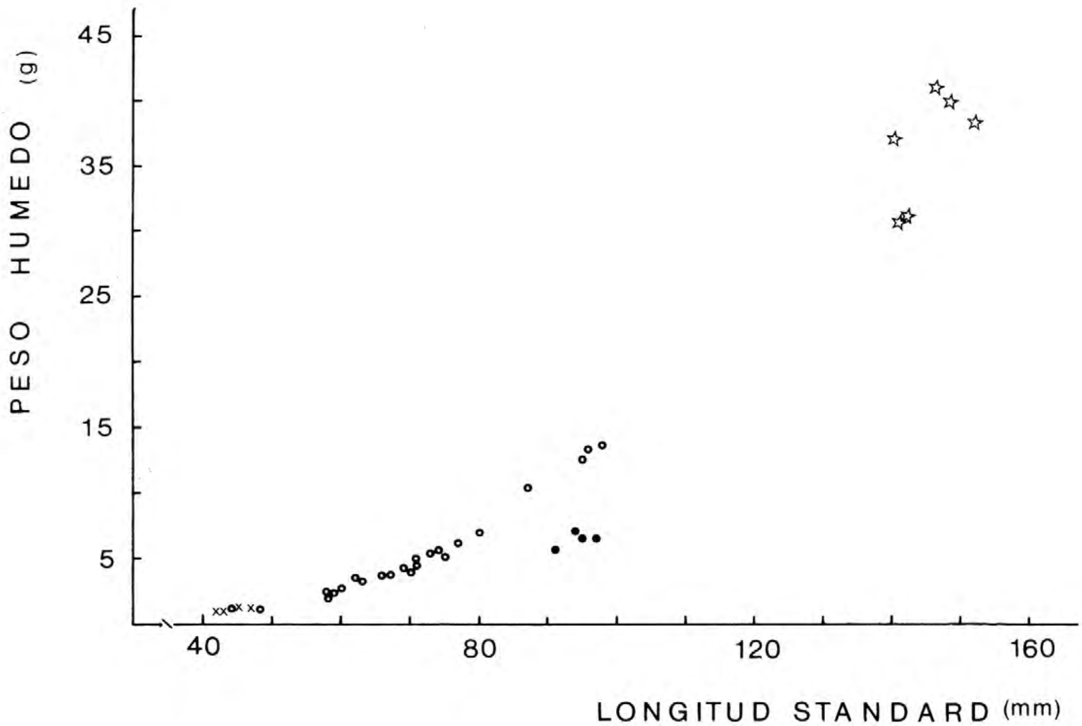

Figure 4.—Standard length - wet weight relationship of four species of Antarctic myctophids captured during INACH-SIBEX-Phase II cruise. Symbols as in Fig. 3.

Table 1

IKMT TOW NUMBER, STATION, POSITION, DATE, TOWING TIME (ST = STARTING TIME, END) AND MAXIMUM DEPTH OF THE MYCTOPHID POSITIVE SAMPLES TAKEN DURING SIBEX-PHASE II

Tow	Station	Latitude	Longitude	Date	Time St.	Time End	Depth (m)
12	4-4	62º29.5'S.	59º19' W.	5.02.85	00:34	00:56	110
21	E-4	63º53' S.	60º26' W.	7.02.85	16:04	16:37	140
22	6-0	64º09.1'S.	61º19.2'W.	8.02.85	23:04	23:57	105
25	F-1	63º43.7'S.	61º34' W.	10.02.85	08:31	08:43	120
27	F-2	63º29.1'S.	61º37.6'W.	11.01.85	19:22	19:50	75

Table 2

MYCTOPHID SPECIES AND TOTAL NUMBER OF SPECIMENS CAUGHT PER SPECIES AND PER STATION, AT THE STATIONS OF SIBEX-II CRUISE IN THE BRANSFIELD STRAIT

Species	Stations 4-4	E-4	6-0	F-1	F-2	Total
Electrona antarctica	—	4	14	8	—	26
Gymnoscopelus braueri	—	—	4	—	—	4
Gymnoscopelus nicholsi	4	—	—	1	1	6
Protomyctophum bolini	—	—	—	1	4	5
Total	4	4	18	10	5	41

Table 3

DEGREE OF FILLING OF THE STOMACHS OF FOUR MYCTOPHIDS CAPTURED DURING SIBEX-II CRUISE

	Degree of filling										
	0		1		2		3		4		
Species	N	%	N	%	N	%	N	%	N	%	Total
Electrona antarctica	1	3.9	9	34.6	5	19.2	9	34.6	2	7.7	26
Gymnoscopelus braueri	—	0.0	—	0.0	—	0.0	4	100.0	—	0.0	4
Gymnoscopelus nicholsi	—	0.0	4	66.6	—	0.0	1	16.7	1	16.7	6
Protomyctophum bolini	—	0.0	—	0.0	—	0.0	4	80.0	1	20.0	5
Total	1		13		5		18		4		41

Table 4

IDENTIFIABLE STOMACH CONTENTS OF *ELECTRONA ANTARCTICA*, NUMBERS, OCCURENCE (%) AND SIZE RANGE

Contents	N	Occurence (%)	Size Range (mm)
COPEDODA			
Metridia gerlachei	321	96.1	1.0– 2.9
Calanus propinquus	4	3.8	2.4– 4.2
Heterorhabdus farrani	3	7.7	3.4
Rhincalanus gigas	4	7.7	3.3– 5.1
Oithona frigida	2	7.7	1.8– 3.2
EUPHAUSIDA			
Euphausia superba			
Adults	2	50.0*(3.8)	50.0
Calyptopis	21	50.0	1.6– 3.9
Furcilla	28	42.3	4.9– 7.0
Thyssanoessa macrura	2	50.0*(3.8)	45.0–54.0
AMPHIPODA			
Parathemisto gaudichaudi	4	11.5	32.0–54.0
sp. A	2	7.7	
sp. B	1	3.8	
DECAPODA			
sp. A	1	3.8	
OSTRACODA			
Conchoecia sp.	19	50.0	1.6– 2.8

* The 50% includes euphausiid remains and 3.8% whole specimens.

Table 5

STANDARD LENGTHS (MM), WET WEIGHTS (G), DEGREE OF STOMACH FILLING, OTOLITH LENGTH AND WIDTH (MM) OF THE MYCTOPHIDS CAPTURED DURING SIBEX-II CRUISE

	Fish			Otolith	
Species	S.L.	Wet Weight	D.F.	Length	Width
E. antarctica	44	1.23	1	1.45	1.05
	48	1.30	1	1.60	1.20
	48	1.34	1	1.55	1.10
	58	2.05	3	1.75	1.35
	58	2.43	1	1.80	1.45
	59	2.50	4	1.80	1.40
	60	2.72	1	1.90	1.40
	62	2.96	3	2.00	1.55
	63	3.32	1	2.00	1.55
	63	3.55	3	1.95	1.60
	66	3.90	2	1.90	1.60
	67	3.65	0	1.95	1.55
	67	4.02	1	2.00	1.60
	69	4.22	4	2.25	1.65
	70	4.05	3	2.00	1.50
	71	4.46	3	2.25	1.80
	71	5.03	3	2.35	1.85
	73	5.37	2	2.20	1.75
	74	5.65	1	2.20	1.75
	75	5.32	2	2.20	1.75
	77	6.21	3	2.25	1.80
	80	7.00	1	2.40	1.95
	87	10.25	2	2.55	2.00
	95	12.48	2	2.70	2.00
	96	13.48	3	2.95	2.15
G. braueri	91	5.70	3	2.40	1.85
	94	7.08	3	2.50	1.95
	95	6.51	3	2.50	1.95
	97	7.00	3	2.40	1.85
G. nicholsi	140	36.41	1	5.65	3.30
	141	30.30	3	5.25	3.15
	142	30.37	1	5.80	3.40
	146	40.05	1	5.75	3.50
	148	39.10	1	5.85	3.50
	152	37.56	4	5.75	3.60
P. bolini	43	1.15	3	2.15	1.60
	44	1.20	4	2.10	1.65
	45	1.35	3	2.15	1.70
	47	1.40	3	2.20	1.85
	47	1.44	3	2.20	1.70

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