Ser. Cient. INACH 35: 101-117, 1986

The Trophic Niche of *Pleuragramma antarcticum* in the Bransfield Strait, Antarctica: Quantitative Comparison with other Areas of the Southern Ocean[1]

CARLOS MORENO,[2] TERESA RUEDA[2] y GLADYS ASENCIO[2]

ABSTRACT

The stomach contents of Pleuragramma antarcticum *Boulenger was studied in specimens collected in 14 of 27 IKMT stations, during the SIBEX-II expedition to the Bransfield Strait, Antarctica. The aims of the research was to know the trophic niche developed for this species during the ecological radiation of the Nototheniids. With the same objective we reviewed the previously published data of gut contents, and were compared using a quantitative approach in order to find the common elements in the diet of the silver-side in a wide variety of ecological conditions at the Antarctic pelagic ecosystem. We found in our study, that in the Bransfield area the predominant food item in the class 1 + was eggs of crustraceans and in the classes 2 + and 5 + was the copepod* Metridia gerlachei. *This species of copepod has been present in all the previously reported papers. In some opportunities together with krill, heteropods or other copepods, but undoubtedly it is the food item more constant in the diet of* Pleuragramma antarcticum. *With this information at hand we propose that the Antarctic silver-side has exploited an holopelagic niche using the more abundant and predictable resource namely copepods rather than krill as it has been proposed by other authors.*

RESUMEN

Se estudió el contenido gástrico de Pleuragramma antarcticum *Boulenger, recolectados en 14 de 27 estaciones de muestreo realizadas con red IKMT durante la Expedición SIBEX-II en el estrecho Bransfield, Antártica, con el objetivo de detectar cuál es el nicho trófico desarrollado por esta especie en la radiación ecológica de los nototénidos. Con el mismo propósito, se compararon cuantitativamente los datos de alimentación previamente publicados para diferentes cuadrantes del continente antártico incluyendo nuestros datos del Bransfield; así se buscaron elementos comunes que permitieran detectar cuál o cuáles son los alimentos básicos para subsistir en el ambiente pelágico antártico. Se encontró que en el sector del Bransfield el alimento predominante en los ejemplares de la clase 1 + fueron huevos de crustáceos y el copépodo* Calanoides acutus; *en cambio en los ejemplares de las clases 2 + y superiores fue el copépodo* Metridia gerlachei. *Esta última especie está presente además en todos los datos analizados de localidades alrededor de la Antártica, la que algunas veces aparece acompañada de "krill", de heterópodos o de otros copépodos, pero sin lugar a dudas es el alimento más constante en la dieta de* P. antarcticum. *De allí que nuestra conclusión sea que esta especie de nototénido desarrolle un ciclo de vida holopelágico, explotando un nicho trófico basado en el consumo de copépodos y especialmente* Metridia gerlachei *más que utilizando "krill", como han supuesto algunos autores.*

INTRODUCTION

Studies of the stomach contents of the pelagic fish *Pleuragramma antarcticum* Boulenger have been carried out in different areas of Antarctica. The capture areas have generally been close to the edge of the pack-ice; the Ross Sea (DeWitt and Hopkins, 1977), the Weddell Sea (Hubold, 1985a) and Pridz Bay (Williams, 1985).

In relation to the trophic niche the studies have faced one or several of the methodological problems listed: 1) variability introduced by regional differences in prey availability, 2) a cycling feeding pattern and 3) feeding in the net, after capture. Each one of these aspects have cast doubts on the eventual ecological role of the species within the Antarctic midwater community and on the characteristics and variability of its real diet under natural conditions.

1 Results of the second phase of the Chilean SIBEX Expedition.

2 Instituto de Ecología y Evolución, Universidad Austral de Chile. Casilla 567, Valdivia, Chile.

The second phase of the Chilean SIBEX expedition to Bransfield Strait gave us the opportunity of collecting *P. antarcticum* to contribute with information about the fish in the area. Results of this study will be given here. Furthermore, a quantitave comparison among our data and those of the other studies was done to determine the fish's diet in two space scales: regional and circum-antarctic (global). The object was to find an answer to the question: what is it that characterizes the diet of this unique holopelagic nototheniidae independent of place and time of capture.

The question is necessary, first because we want to find out the characteristics of the resources available for the fish, as well as how it uses them with the aim of determining why, coming from a primary benthic family, it has developed an holopelagic niche. In other words, it means asking about what elements in the diet of a species with typically benthonic ancestors can be related with the evolution towards a pelagic life (see Eastman, 1984), Secondly, the question is important since the results of the studies carried out at FIBEX and SIBEX expeditions (1981-1984) showed that the Antarctic marine ecosystem has suffered strong perturbations (see Mujica and Asencio, 1985). This suggests that the Antarctic pelagic populations were, periodically, exposed to changes. In an evolutive scale, this could mean another restrictive element for nothoteniids in their expansion to holopelagic niches if the occupation of these niches meant the exploitation of the krill as feeding resource. In ecological time, on the other hand, it means finding out how this species with a five year lifespan can withstand the alterations of its ecological community.

MATERIAL AND METHODS

The analized *Pleuragramma antarcticum* Boulenger specimens were collected in 14 of 27 stations of the Chilean SIBEX expedition aboard R/V Capitan Luis Alcazar (Fig. 1). Catches were done from January 24th to February 12th, 1985 in the Bransfield Strait, north of Tierra de O'Higgins. Each haul was made with a midwater net (IKMT), in a place determined by maximum acustic signals from a Simrad EKA 120 KHz ecosounder. The net fitted with a Furuno FNR 200 Mark II sounder, made hauls at depths where the fishes were located and determined length and cruise track.

In order to compare gastric contents with the environmental availability, fishes and zooplankton were simultaneously collected at station 22. The availability in this case, is represented by the zooplankton caught with a bongo net, with vertical hauls, between 220 m depth and the surface. The value of this comparison is limited, but it shows what type of food can be found in the fauna. The information about this sample is given by A. Mujica (this volume), together with an aliquot of copepods (1/8 of the sample) which we identified.

The identification of stomach contents and copepods of the zooplankton subsample was made according the procedures and references quoted by Asencio and Moreno (1984). The numeric quantification and frequency of occurrence of the diets was done according to Hureau (1970). For each fish, standard length (mm) and wet weight (g) were considered and they were classified in size categories following the nomenclature proposed by Hubold (1985b) for this species. Prey weight and size were also determined, being this latest variable represented by the most relevant length of each organism, generally the total length.

Similarity among diets in 14 stations, was calculated using the C index by Morisita (1959). With these results a dendrogram was made according to Sokal and Sneath (1963) aided by a computer program developed by Navarro (1985). In this analysis the value of abundance of each prey item per station is considered. They were transformed to Log X + 1 value according to Bartlett (1947), because there were some 0 values that pushed the data from a normal distribution. A nonparametric correlation was also used (Kendall t) as an index of similarity, since the stomach contents data are not normal when tested in relation to that statistic hyphothesis (Moreno and Osorio, 1977).

Using the same statistical procedures mentioned, diet in adult specimens of *P. antarcticum*, collected in Bransfield Strait (station 22 and 21), were compared with the information published from the Ross Sea (DeWitt and Hopkins, 1977), the Weddell Sea (Hubold, 1985a) and from Pridz Bay (Williams, 1985) (fig. 2).

RESULTS

Bransfield Strait

The most abundant catches are from the south end of the strait. Class 2 + and adult specimens were only collected in the coastal area of the Orleans Channel and Primavera Bay (stations 21 and 22).

Most of the material collected corresponded, according to Hubold (1985b), to class 1 specimens. That is, late post-larvae and juveniles up to one year old. The collection of samples was most effective close to the surface and during the night as it happened in stations 25 and 27. On the other hand, the four stations that registered the most abundant captures were sampled at different hours, both diurnal and nocturnal. Also, stations without *P. antarcticum* or with low capture of specimens were distributed along a daily cycle.

Large specimens (classes 2 + to 5 +) captured in stations 21 and 22 were collected by the net at nearly 100 m, as recorded by the ecograph.

All the captured specimens were used to study the stomach contents. All the demographic information and some basic statistic data are summarized in Table 2.

254 fishes were measured and weighed, being their standard length (S.L.) between 38.5 mm and 149 mm and 0.16 g to 25.8 g, respectively. Size distribution in these specimens is clearly bimodal (Fig. 3).

In general, most of the specimens presented stomach contents (Table 2). Table 3 shows the specific composition of the diets separated by size groups. In class 1, consumption is basically of copepods, euphausia larvae and crustaceous eggs. The incorporation of adult krill was observed in class 2 specimens, but copepods and euphausia larvae continue being the dominant items. The extraordinary importance that *Metridia gerlachei* and *Calanoides acutus* have in the diet of class 2 + and 5 + and that *C. acutus* and *Oithona frigida* have on class 1, is outstanding. Other prey groups (Ostracoda, Polychaeta, Chaetognata, Amphipoda and Pisces) are poorly represented.

The mean and range of prey sizes for each one of the ages of *P. antarcticum* is shown in Table 3. It shows that from age 2 +, the diet is greater in diversity and items are larger.

Classifying fish in size classes, the frequency of ocurrence and weight of prey species in the stomach contents was analyzed. Small specimens from station 16, 24 and 25 show a great similarity in their diets (Fig. 4) with the exception of the copepod *C. acutus* which is poorly represented in station 24, located near Livingston isle. In the other stations, it is very important. The frequency of occurrence of egg items, probably belonging to copepods is very important, having a numeric and ponderal importance. However, no embrionary development is observed and they are practically undistinguishable from other crustaceous eggs; their sizes fluctuating from 0.4 to 0.5 mm.

The same variables are presented in Fig. 5 for population of individuals of larger size, collected in stations 21 and 22, located near Trinity Island, extreme south of Bransfield Strait. It shows that the main prey item, *M. gerlachei*, has the same frequency of occurrence but different ponderal importance within the diet recorded in each station. On the other hand, *Calanoides acutus* and *Euchaeta antarctica* have a high frequency but represent a lower fraction of weight. The same happens to euphausiacea, polychaeta, chaetognata and ostracoda larvae.

In station 22, it was possible to compare the diet of fish with the sampling of bongo net, using the criterium by Moreno and Zamorano (1979): If between both samples there is a positive correlation, one can conclude that both present the same way to catch the prey and that the relative abundance of the captured species will be the same. In case that the net or the fish preferently catch one or more items, the resulting correlation must be negative. If no significant correlation is observed, the consumption is made by simple abundance, within the limitations given by the morphological design of the predator. This happens, for example, with Appendicularia which are abundant in the net but not in the stomach contents; they cannot be swallowed by the fish due to their large size.

Data in Table 4 suggest that copepod consumption is due to abundance and to the morphological limitations in the case of Appendicularia. Thus one can ask: Is there a selection mechanism for any particular copepod species? Trying to correlate abundance of copepod species collected by the bongo net versus copepod species in stomach contents, no significant correlation between both data was obtained, being *Metridia gerlachei* the most abundant, both in the media and in the stomach contents (Table 5). Subsequently, copepod consumption is related to abundance. Other morphological characteristics of copepod such as size, do not seem to differ in groups captured by the net and in stomach contents. In relation to this, Figure 6 shows that, generally, the sizes consumed by the fish are similar to those collected by the bongo net, except for *Rhincalanus gigas* and *Euchaeta antarctica* which are larger in the stomach contents than in the media. The contrary occurs with *Calanoides acutus*. All the above differences could be due to the capture at random by the net or to the capture of the prey by individuals of different sizes, whose variability is not studied in this case due to the lack of repeated sampling in the same station.

The analysis of similarity between the diets of 14 stations of the SIBEX II cruise in Bransfield Strait, was carried out using the Morisita index and the nonparametric correlations by Kendall; it suggests the presence of four groups of stations, each one them characterized by the predominance of one species of copepod in particular (Fig. 7). *Oithona frigida* is the dominant item in three specimens collected in hauls four and eight, *Metridia gerlachei* dominates alone in stations 22 and 2. Associated with *Scaphocalanus brevicornis* it dominates in station 27 and in the other eight stations it dominates with eggs and *Calanoides acutus*.

On the other hand, the associations established through correlation (Table 6) show a similar result, supporting thus the use of the Morisita index for these purposes. For example, stations 4 and 8 are significantly correlated ($P < 0.001$). Stations 2 and 22 which form another group, are also significantly correlated. Station 27 which is separated in the dendrogram is correlated with none of the stations.

Many of the differences being found can be attributed exclusively to insufficient samples, very much affected by the aleatory phenomena. Only 4 stations remain with over 17 *P. antarcticum* individuals with stomach contents (stations 16, 22, 24 and 25), if stations with low number of specimens are eliminated. Of the 4 stations, the first group is formed by station 22 with individuals aged 2 + and adults, being *M. gerlachei* dominant. The others are characterized by *M. gerlachei* and *C. acutus* and eggs, including stations 16, 24 and 25 characterized by the presence of individuals aged 1 exclusively (Fig. 8).

Circum-antarctic comparison

The areas where the stomach contents of *P. antarcticum* has been studied are indicated on the map of the Antarctic continent (Fig. 2). The data obtained is similar to ours and consequently possible of being incorporated for a more complete analysis. Characteristics of those areas, type of sampling, collected specimens and their preys are shown in Table 7.

As it has been already established above, the size of a fish has a tremendous influence on its diet. So, the first element to be considered in any comparison is their size. Standard length mean and ranges of *P. antarcticum* in the stations to be compared are shown in Figure 9. The comparison is based on specimens of class 2 + and adults. The samples from Bransfield Strait are well represented by class 1, which is scarce in the rest of the samples, except the sample in the station 1917 of the Ross Sea. Consequently, the comparison will be based on specimens of class 2 + and adults.

Using the same method to analize the samples from Bransfield Strait, it is possible to compare the stations studied by De Witt (1977), Hubold (1985a), Williams (1985) and our stations 21 and 22. The dendrogram made with these data (Fig. 10) shows that far distant stations such as Bransfield Strait, Prydz Bay, 1917 of the Ross Sea and area 2 of Weddell, are in the same group, characterized by *M. gerlachei* and *C. acutus*. Conversely, the other 2 stations of the Ross Sea are different between them, in spite of their proximity. If the criterium to consider as different those stations that differ among them in more than 50% (Fig. 10) is used, it is possible to observe a group characterized by *M. gerlachei* including stations of the 4 areas indistinctly (lower section of dendrogram). This is followed by three groups all with *M. gerlachei* plus some other group such as larvaceous, krill or heteropods. On the other hand, the Kendall t nonparametric correlation shows significant relations among all the areas, except for the sample taken from section one of the Weddell Sea, which is correlated with no other station, since the heteropods appear as the most important item in the diet. This item is scarce in the rest of the areas. Consequently, both analysis coincide in separating similar groups again.

DISCUSSION

Stomach contents of *Pleuragramma antarcticum* in the area of Bransfield Strait

The diet of *Pleuragramma antarcticum* in different stations of the SIBEX-Phase II expedition to Bransfield Strait, presents differences, showing a local diversity of possible diets for the species. This diversity of diets can be related to two main factors: 1) the size structure of the predator population since our results indicate a progressive change in the diet towards those of larger size. Class 1 + individuals have as the dominant item some non identified crustaceous eggs (copepods + euphausids), together with the copepods *Calanoides acutus* and *Oithona frigida*. In the group of larger individuals (2 + to 5 +), *Metridia gerlachei* is by far the main item in number, frequency and weight, even more important than euphauside larvae that follow it in frequency. Also, *M. gerlachei* seems to be the most important copepod in the zooplankton of the Antarctic water. Consequently, it is probable that its capture by *Pleuragramma* is due to its abundance as the relations of selectivity carried out in station 7 show. Other aspects of the prey, such as size, are not to be considered since they do not differ greatly from the rest of the copepods. 2) the differences found in the diet of specimens from different stations have to do with hydrographic conditions that affect fish distribution and the organisms conforming their diet. The area where the larger specimens were captured, is located in the confluence of Gerlache water with a type of continental platform water of the Antarctic Peninsula and the water from the center of Bransfield Strait (Silva, 1985), making the surroundings of Trinidad Island a peculiar area. Unfortunately, at present, there are no correlations among the different types of water in Bransfield Strait and the copepod fauna so as to establish relations between stomach contents and water mass.

The *Pleuragramma* hauls were done at different hours of the day. A pattern of feeding at certain hours of the day, as it occurs with most benthofagous nothotenids, was not observed (Hureau, 1975).

However, juvenile *Chianodracus*, collected in the same haul, present a clear feeding pattern around midday (Rueda and Moreno, unpublished); a known pattern for midwater fish (Baird *et al.*, 1975; DeWitt and Cailliet, 1972).

Thus, according to our results, much of the regional variability found in the feeding of *P. antarcticum* is related to the size of the individuals analyzed. On the other hand, according to our data, it does not seem to be a daily feeding cycle; thus, agreeing with De Witt and Hopkins (1977). However, it is always possible that these cycles may appear in a different chronological scale, such as days for example. Furthermore, we did not find scale residues or other evidences that specimens had been feeding in the IKMT net during the hauls, as ocurred in the case studied by De Witt and Hopkins (1977). Furthermore, copepod items were found both in the stomach contents and gut thus leading us to discard the in the-net-feeding in the interpretation of the trophic niche of *Pleuragramma* in Bransfield water.

Progress in the study of the relation between *Pleuragramma* and krill *(Euphausia superba)*, was not possible since Euphausid specimens were always dominant, specially *Thyssanoesa macrura*. On the other hand, the eggs and larvae in the stomach contents cannot be identified as *E. superba* unless new techniques such as electrophoresis, to classify eggs, were introduced. The predator-prey relation between *Pleuragramma* and krill is very difficult to quantify.

Finally, our data supports the findings by Hubold (1985b) in that *Pleuragramma* larvae are preferently found near the surface. On the other hand, larger specimens were captured at depths of about 100 m.

Considering that larger specimens are able to consume larvae of their own species, the bathymetric segregation of the larvae and adult population would impide cannibalism, thus reducing the probabilities of the larvae-adult encounter. At the same time, there is a geographic segregation since adult populations were only detected ecographically during the southern cruise to the Elephant Islands around Trinidad Island. But, in many of the intermedial hauls we found age 1 post-larvae, suggesting that there is no morphologic or conductual adaptation to avoid eating their own larvae as it has been suggested by Hubold (1985a). Perhaps, the lack of massive consumption of fish larvae could be due to life cycles which keep the different age groups separated, as it has been shown by Hubold (1985b) in the Weddell Sea.

From the SIBEX-Phase II expedition to Bransfield Strait, one can conclude that *Pleuragramma antarcticum* is basically a copepodephagus fish in its adult stage, being *Metridia gerlachei* the constant food-prey in specimens aged 2 + and higher. This is why a positive correlation among *Pleuragramma* abundance, a low copepod representation and a high fitoplanktonic biomass is not strange.

Global characteristics of the diet

Our results agree with William's interpretation (1985) of the diet of *Pleuragramma antarcticum* in Prydz Bay, in that the Euphausids consumed are eaten as "alternative copepods". However, this fact disagrees with the proposals of DeWitt and Hopkins (1977), who suggest that the holopelagic life of this species is a predictable event to make use of the abundant resource. One could easily fall into the temptation of contrasting the two trophic niche hypothesis. However, without a complete historical account of krill abundance, *Pleuragramma* cannot be said to have a feeding cycle related with a greater krill abundance or with a greater copepod abundance; at different times, any of the two hypothesis could prove to be true. Because the two studies cited were carried out at different times, abundance of krill could have been different. This has been the situation observed during the last few years in Bransfield Strait. A methodological alternative to solve this problem is to make a quantitative study of the amplitude and characteristics of the niche, using published data from different places around Antarctica, which represented different stages of the pelagic community.

The results of such a comparison, given in this paper, suggest two interesting patterns: First, the copepod *M. gerlachei* is found at the base of the dendrogram. In the study by Hubold (1985a) of the Weddell Sea, it was even found in stations dominated by heteropods, being krill one of the dominant elements only in station 1880 of the Ross Sea, referred by De Witt and Hopkins (1977). The second aspect is that stations which are close to each other can, at times, be more different from each other than far distant ones. This means that there is a regional heterogeneity of pelagic communities, whose variability could include temporal changes in the same point in space. Supposing that such changes are similar to the changes occurred in an evolutive scale, then *Pleuragramma's* trophic niche which sustains holopelagic habits while it maintains its juvenile characteristics of notothenids, even its small size, as it has been suggested by Eastman (1985), would be basically feeding on copepods instead of krill; *M. gerlachei* is the basic food, common to all the studies carried out, independent of the predominant stage of the pelagic community. An alternative analysis based on correlations of the diet of each station compared with the others, supports the level of similarity found in the index and techniques of the dendrograms. This then suggests that *P. antarcticum* has invaded the pelagic environment looking for copepods.

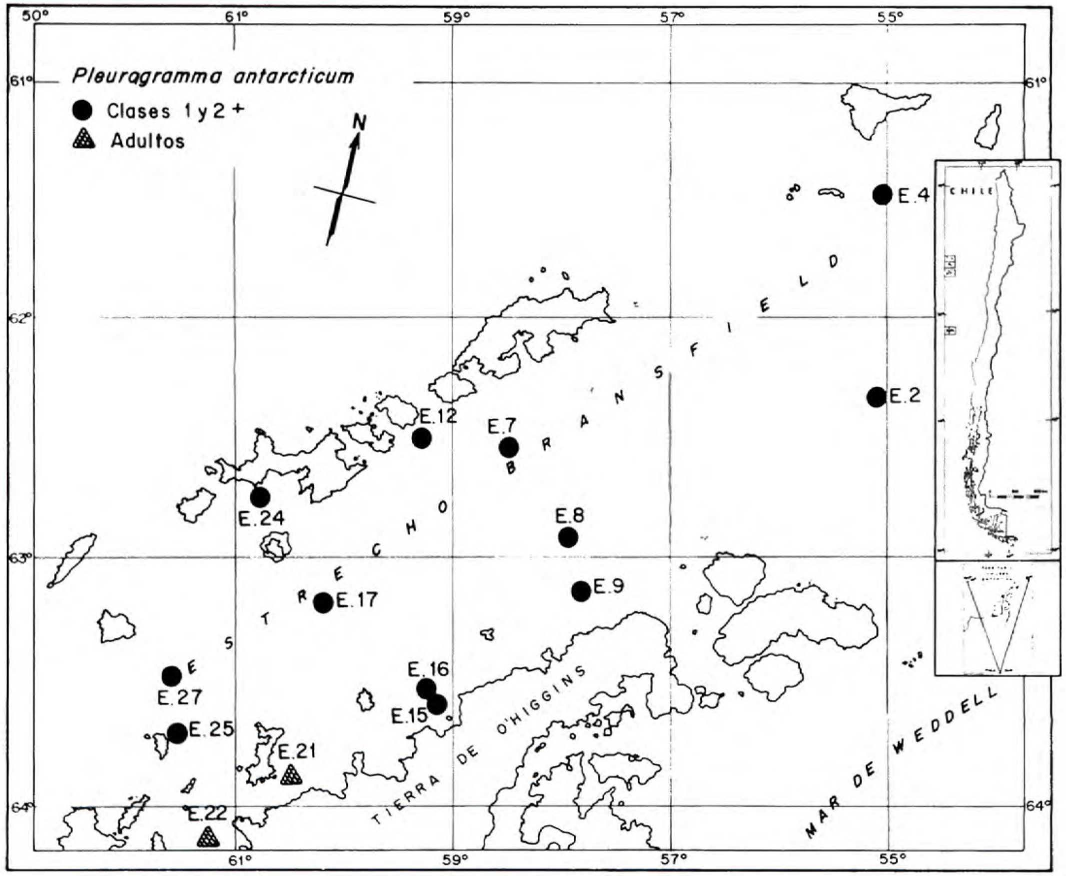

Figure 1.—Sampling Area of *P. antarcticum* in Bransfield Strait, Antarctica. Black Dots = stations where juvenile specimens were captured. Triangles = stations where adult specimens were captured.

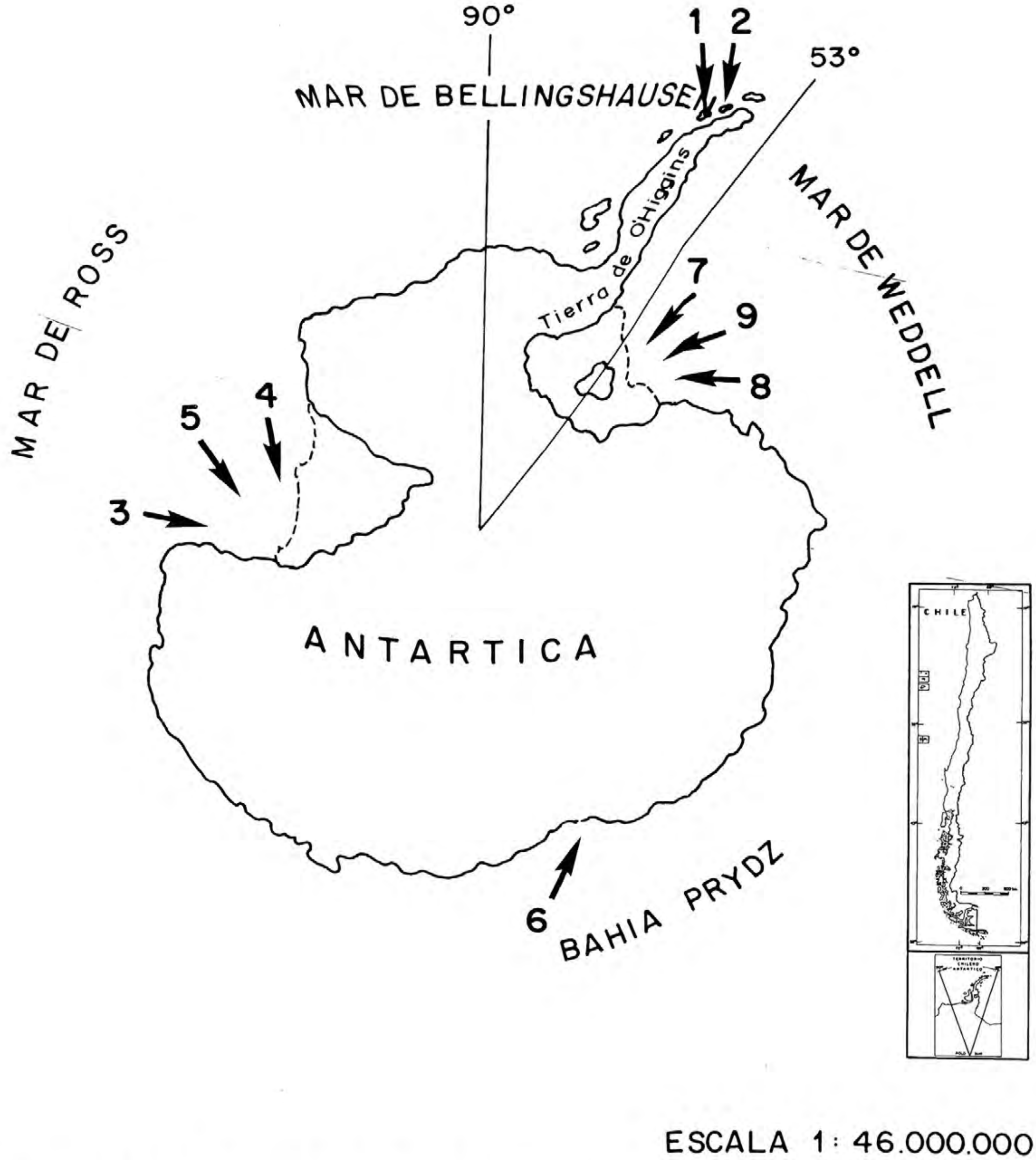

Figure 2.—Location of stations with diet data of *P. antarcticum*. Stations 1 & 2 — this study; stations 3, 4 & 5 - DeWitt and Hopkins (1977); station 6 - Williams (1985); stations 7, 8 & 9 - Hubold (1985a).

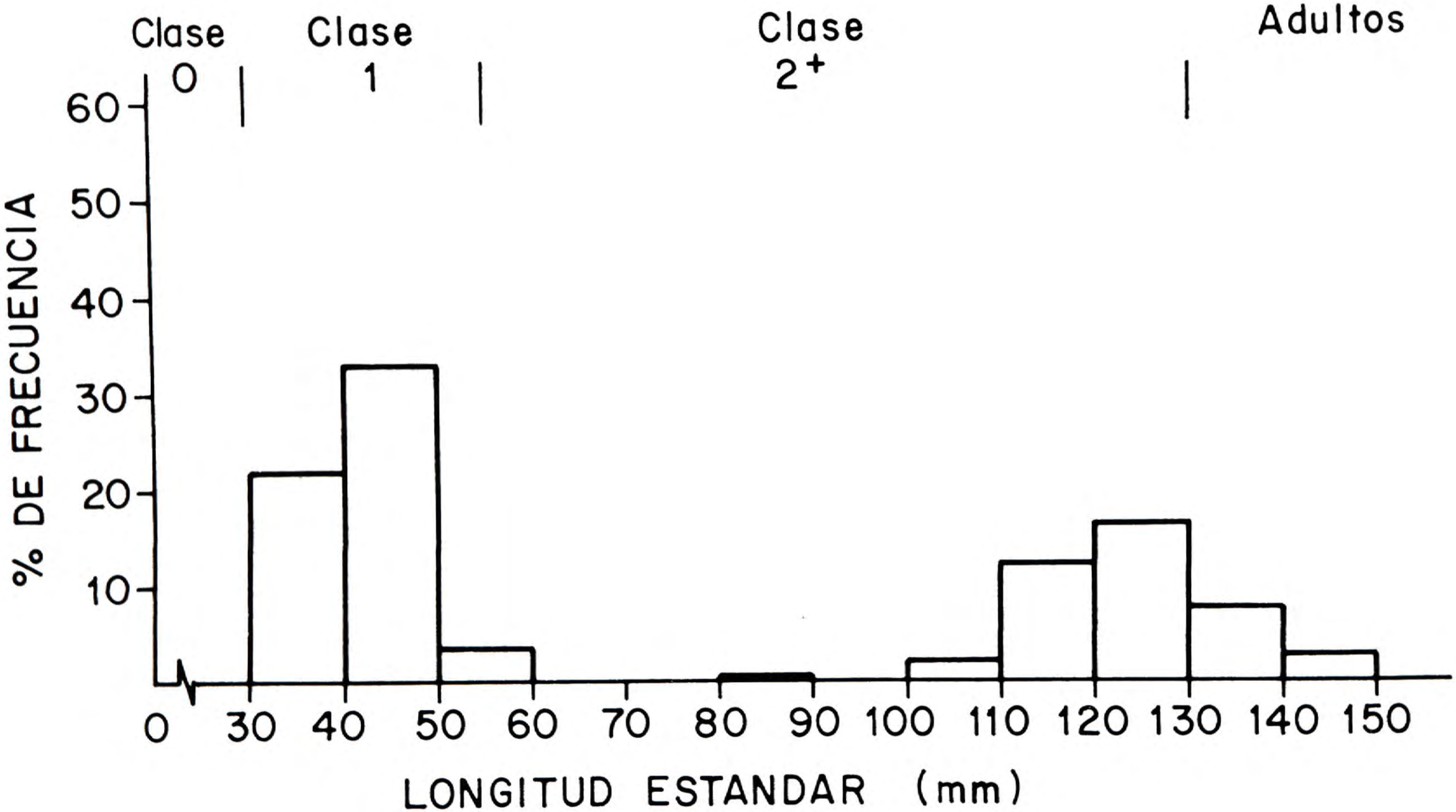

Figure 3.–Demogram of *P. antarcticum* specimens analized in this paper. Age classes according to Hubold (1985a) at the top.

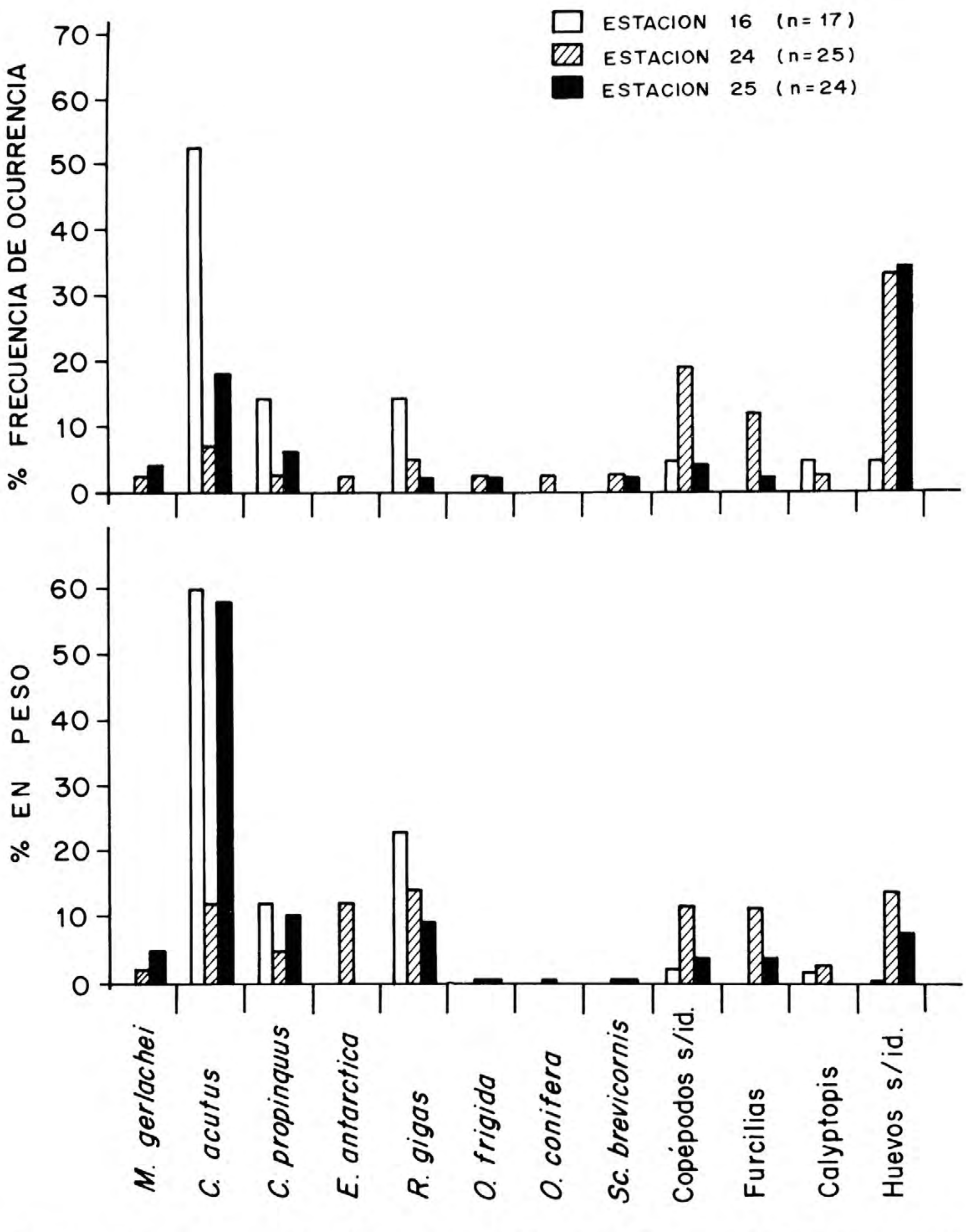

Figure 4.—Diet composition of juvenile *P. antarcticum* (class 1 and 2), measured both in frequency of ocurrence and weight percentage. They are separated by stations of catch to observe the regional variability in the catch of prey.

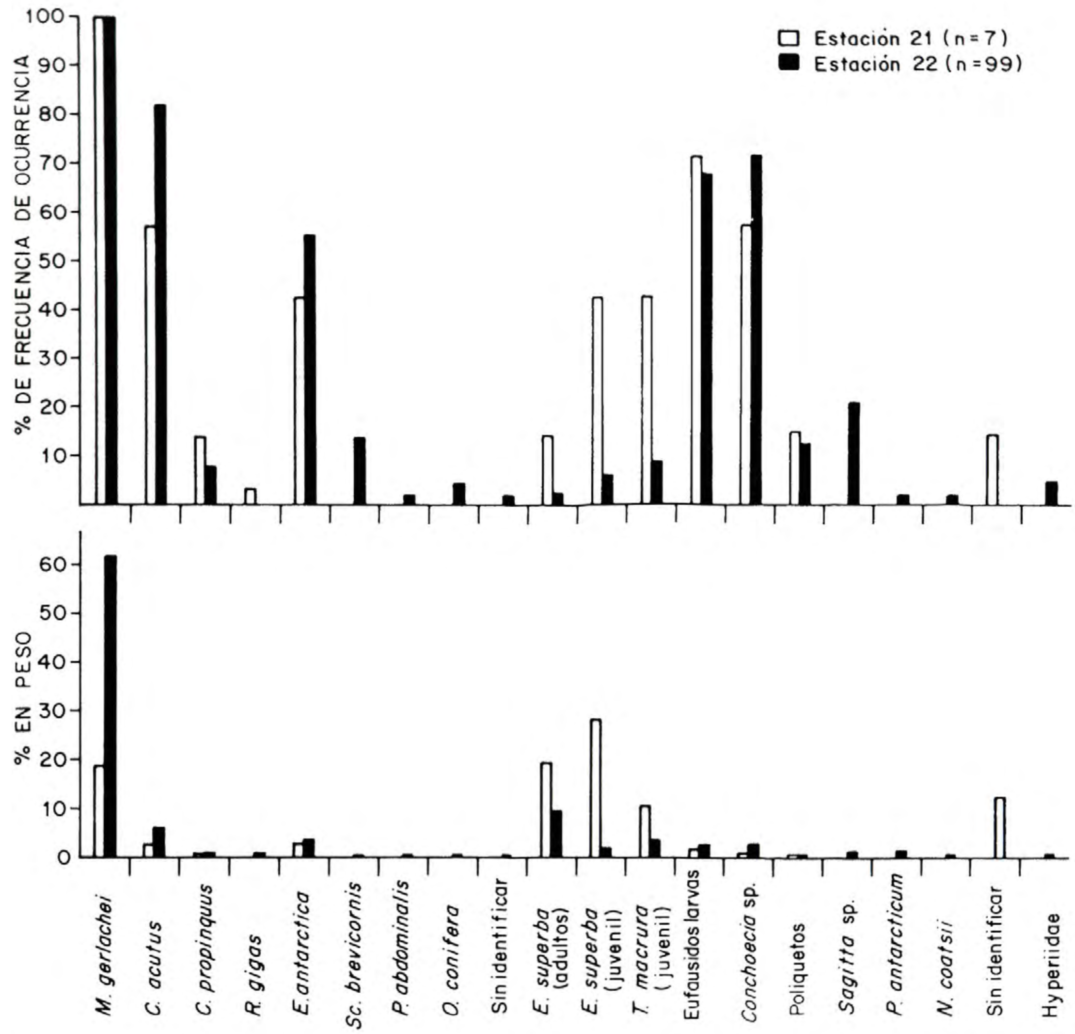

Figure 5.—Diet composition of adult *P. antarcticum* collected in the southern part of Bransfield Strait. Other explanations see Fig. 4.

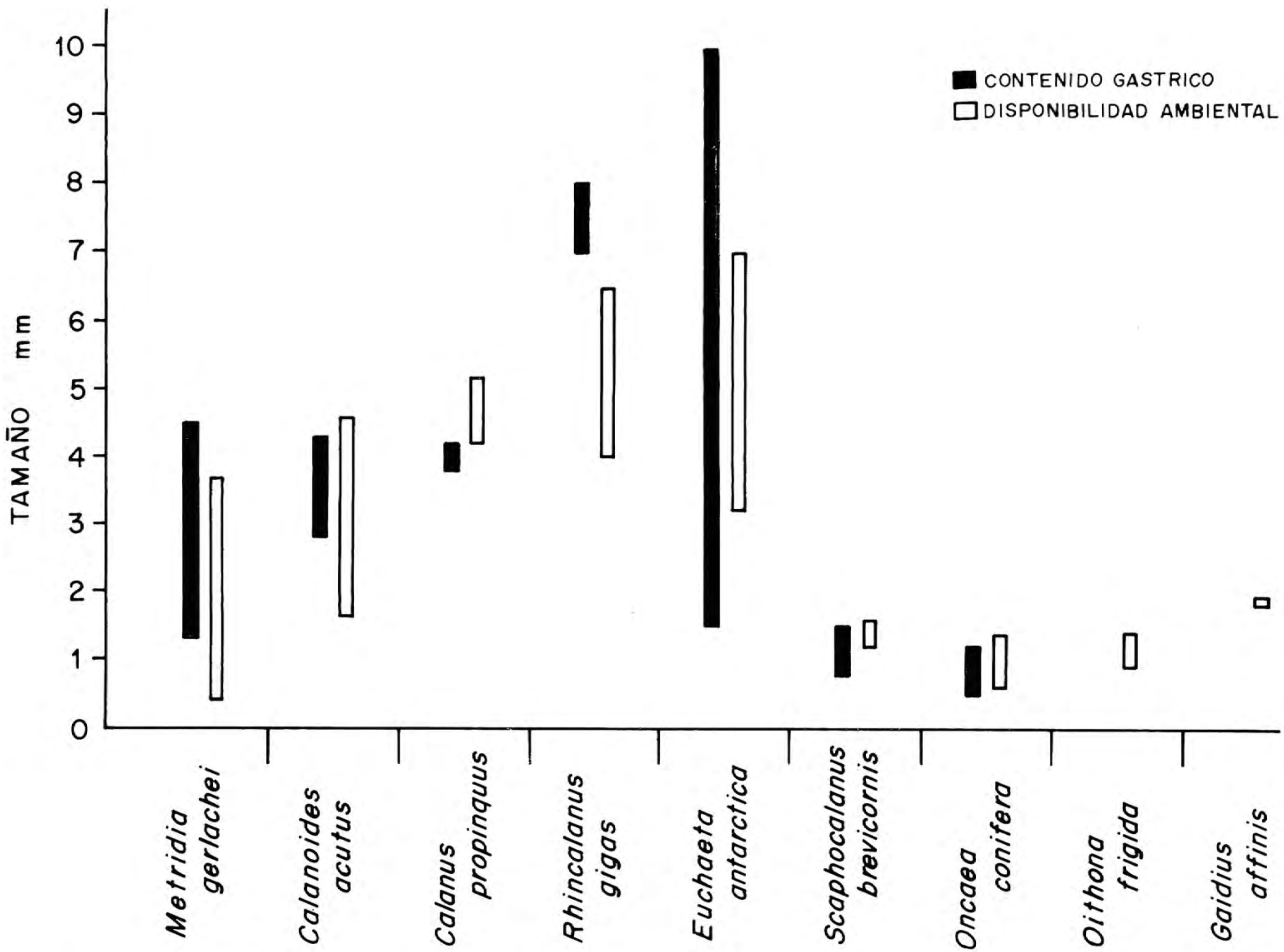

Figure 6.—Size of copepods found in the stomach contents of adult *P. antarcticum* and of those caught with bongo net in station 22 IKMT of SIBEX II.

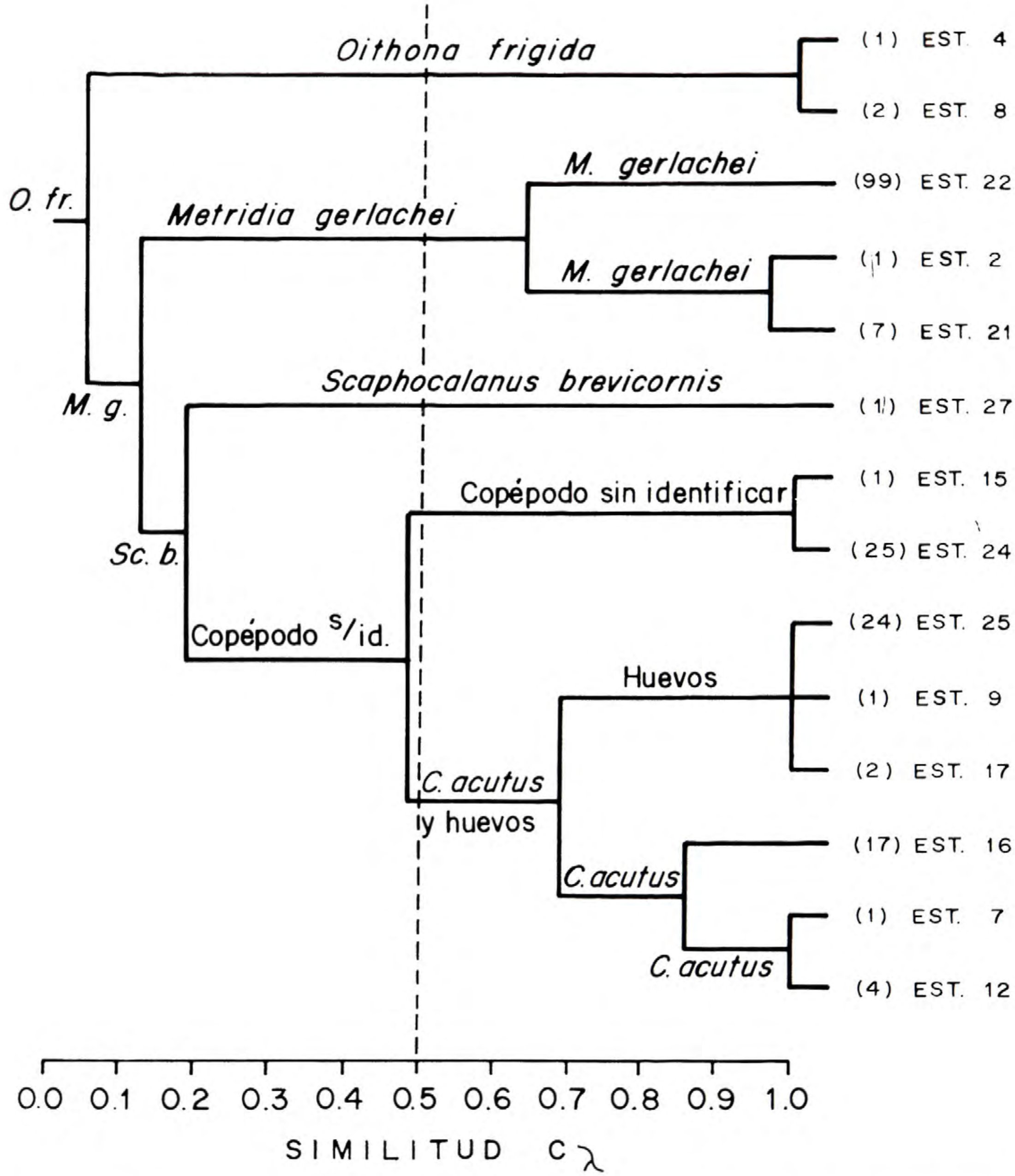

Figure 7.—Dendrogram of diet similarity for 14 stations with positive capture of *P. antarcticum* during SIBEX-Phase II expedition to Bransfield Strait. The dotted line indicates 50% similarity as measured by Morisita's C lambda index. For a better interpretation, a species that shares groups is indicated at the base of the separation: for example, *O. fr. (Oithona frigida)* is present in all samples and *M. g. (Metridia gerlachei)* in all the stations except 4 and 8. *Sc. b. (Scaphocalanus brevicornis)* in the rest except station 4, 8, 22, 2 and 21.

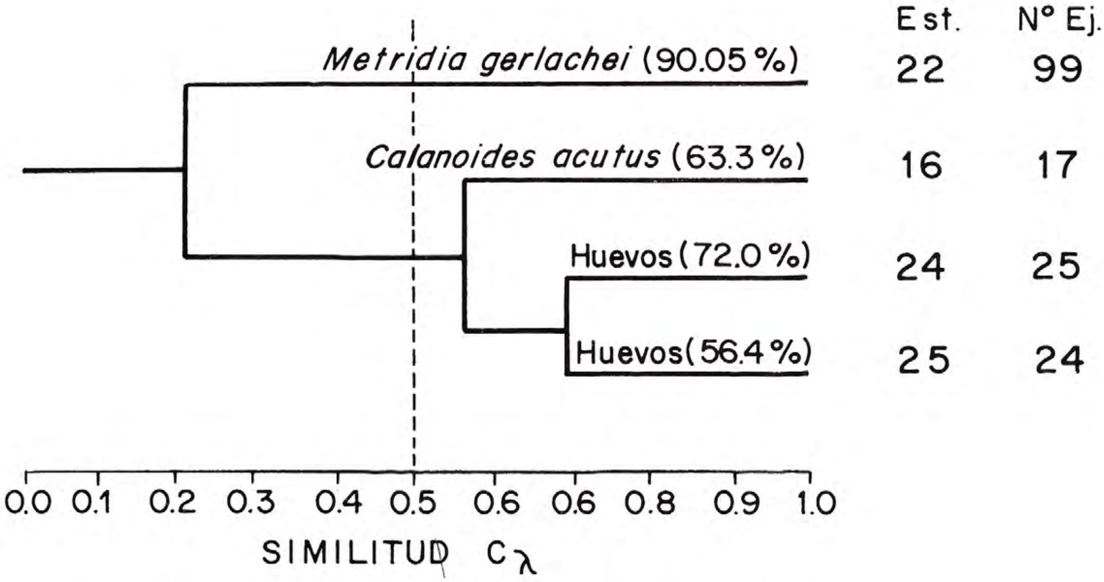

Figure 8.—Dendrogram of stations with N > 17. It can be considered as a summary of dendrogram in Fig. 7.

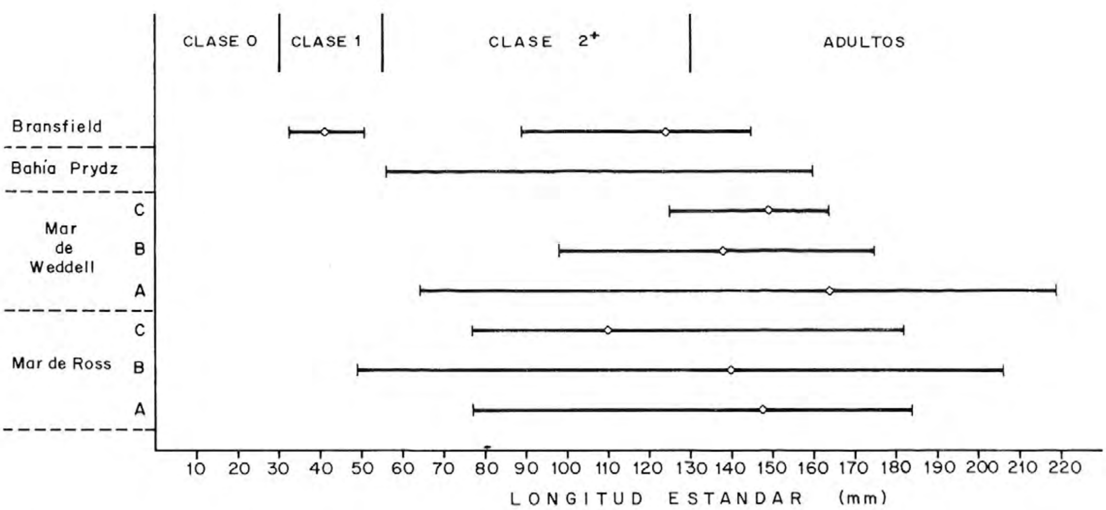

Figure 9.—Size range of *P. antarcticum* specimens analized by several authors from different areas around Antarctica.

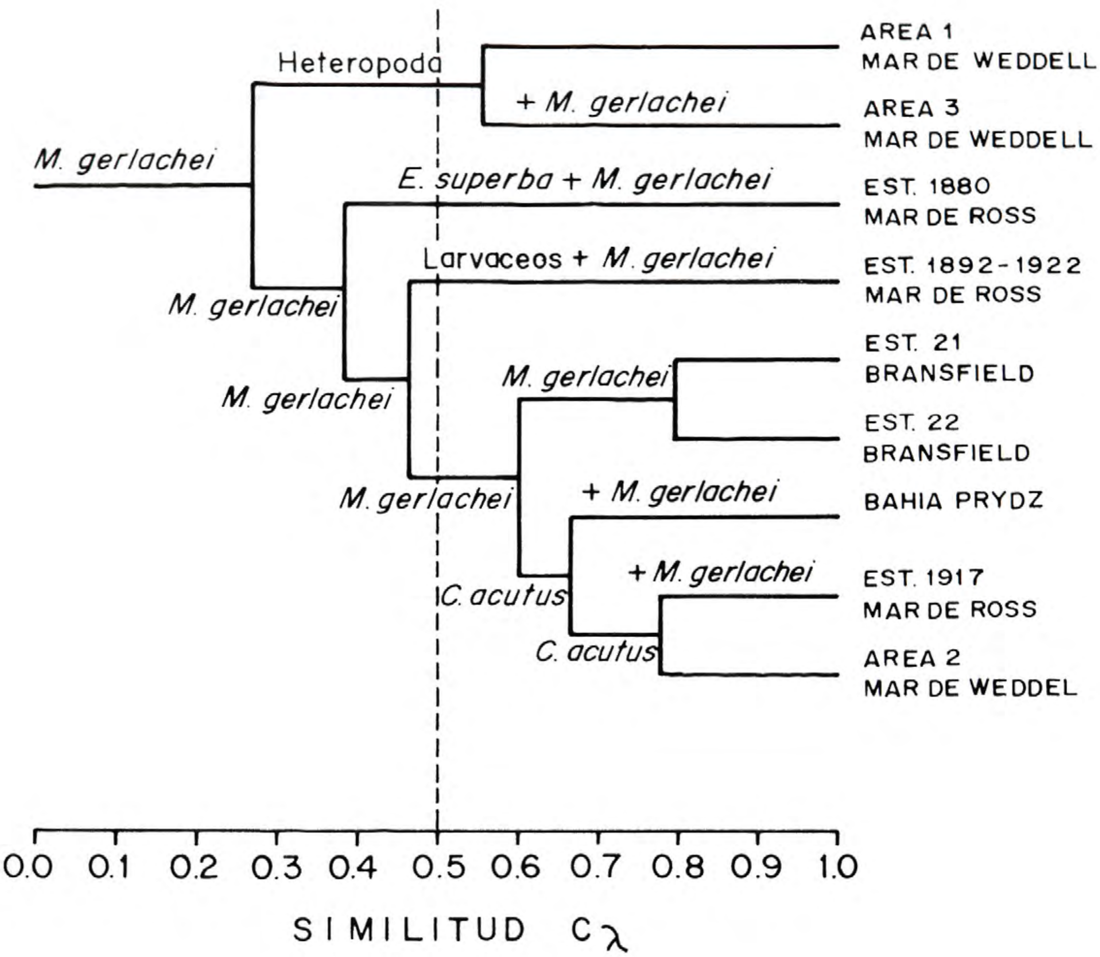

Figure 10.—Dendrogram with feeding habit data of *P. antarcticum* adults from the 9 localities in which stomach contents has been studied. The procedure is explained in Fig. 7.

Table 1

LIST OF IKMT STATIONS FULFILLED DURING SIBEX-PHASE II IN THE BRANSFIELD STRAIT, ANTARCTICA, WITH GEOGRAPHIC POSITION, DATE, HOUR, DEPTH AND NUMBER OF *Pleuragramma antarcticum* COLLECTED, SEPARATED BY SIZE CLASS

Stn.	Latitud (S)	Longitud (W)	Date	Hour	Depth (m)	Speed (knots)	Class 1	Class 2 + and Adults		Total
								male	female	
1	62°29'07"	54°15'00"	25-1-85	14:10-17:06	0 - 70	–	–	–	–	–
2	62°19'07"	54°57'05"	26-1-85	09:30-10:00	25 - 60	–	1	–	–	1
3	61°54'55"	55°00'02"	26-1-85	14:20-15:00	25 - 50	–	–	–	–	–
4	61°29'00"	55°01'06"	26-1-85	17:40-18:00	80	–	2	–	–	2
5	62°51'08"	57°07'03"	30-1-85	18:17-18:42	40 - 80	–	–	–	–	–
6	62°19'00"	58°30'00"	01-2-85	10:31-12:00	110 - 130	–	–	–	–	–
7	62°34'06"	58°16'06"	03-2-85	14:51-15:30	20 - 60	–	1	–	–	1
8	62°56'00"	57°56'00"	03-2-85	18:17-19:11	0 - 120	–	2	–	–	2
9	63°07'09"	57°45'05"	04-2-85	21:45-22:08	5 - 20	–	1	–	–	1
10	63°01'02"	58°52'06"	04-2-85	07:04-07:18	140 - 160	–	–	–	–	–
11	62°44'03"	59°06'05"	04-2-85	15:05-16:05	50 - 60	–	–	–	–	–
12	62°29'05"	59°19'00"	05-2-85	12:00-12:50	100 - 50	–	4	–	–	4
13	63°06'00"	59°30'04"	05-2-85	08:43-09:06	30 - 40	2.5	–	–	–	–
14	63°13'07"	59°23'05"	05-2-85	11:45-12:00	140 - 160	2.8-3.0	–	–	–	–
15	63°34'08"	59°10'08"	05-2-85	15:58-16:07	50	3.0-3.2	2	–	–	2
16	63°33'04"	59°12'00"	05-2-85	16:40-17:20	200	3.0	21	–	–	21
17	63°09'06"	60°06'08"	06-2-85	09:32-10:10	55 - 70	3.0	2	–	–	2
18	63°18'04"	60°32'08"	07-2-85	08:35-08:48	130 - 150	2.8-3.0	–	–	–	–
19	63°26'07"	60°30'03"	07-2-85	10:13-10:24	130 - 150	3.0	–	–	–	–
20	63°43'04"	60°27'05"	07-2-85	13:13-13:28	110 - 160	2.4-2.8	–	–	–	–
21	63°53'01"	60°27'00"	07-2-85	16:04-16:37	80 - 120	3.0	–	6	1	7
22	64°09'00"	61°14'00"	08-2-85	23:09-23:57	120 - 50	2.8-3.0	–	34	65	99
23	63°43'03"	61°13'03"	09-2-85	09:43-	50 - 80	3.0	–	–	–	–
24	62°46'05"	60°54'00"	09-2-85	22:00-24:00	110	3.0	42	–	–	42
25	63°43'07"	61°34'00"	10-2-85	08:01-08:13	0 - 10	2.8-3:5	50	–	–	50
26	63°07'00"	61°44'03"	11-2-85	15:34-15:38	0 - 70	3.0	–	–	–	–
27	63°21'01"	61°37'06"	11-2-85	18:45-18:58	0 - 15	2.0-3.0	20	–	–	20

Table 2

WEIGHT AND MEASURES SUMMARY DATA OF PREYS AS WELL AS SPECIMENS OF *P. antarcticum* COLLECTED BY STATIONS AT THE BRANSFIELD STRAIT

Station	Examd. fishes	Est. Length (mm)		Wet weight (gr)		Prey/ stomach		Wet weight preys (mg)		Num. Taxa prey	Num. Empty stomachs	Stomachs with contents	
		X̄	Rate	X̄	Rate	X̄	Rate	X̄	Rate			Núm.	%
2	1	36.9	39.6	0.16	0.16	1.0	1.0	1.0	1.0	1.0	0.0	1	100
4	2	42.7	42.4- 43.0	0.21	0.19- 0.22	0.50	0.0-1.0	0.1	0.0- 0.1	1.0	1.0	1	50
7	1	39.2	39.2	0.18	0.18	1.0	1.0	2.0	2.0	1.0	0.0	1	100
8	2	36.9	35.0- 38.8	0.13	0.11- 0.16	2.00	1.0-3.0	1.4	1.3- 1.6	3.0	0.0	2	100
9	1	38.5	38.5	0.16	0.16	1.0	1.0	0.9	0.9	1.0	0.0	1	100
12	4	42.5	39.0- 44.8	0.26	0.17- 0.40	1.25	1.0-2.0	8.3	5.4- 10.2	2.0	0.0	4	100
15	2	43.1	41.5- 44.6	0.21	0.19- 0.23	1.00	0.0-1.0	0.5	0.0- 1.0	1.0	1.0	1	50
16	21	43.3	37.4- 52.6	0.26	0.17- 0.45	0.95	0.0-2.0	2.7	0.0- 11.8	6.0	4.0	17	81
17	2	37.7	37.4- 37.9	0.19	0.19- 0.19	1.0	1.0	0.1	0.1- 1.8	2.0	0.0	2	100
21	7	119.0	89.0-149.0	11.38	4.40-20.00	4.71	3.0-6.0	244.6	92.5-523.7	11.0	0.0	7	100
22	99	125.0	105.0-145.0	14.55	8.60-25.80	4.55	1.0-8.0	162.9	21.1-697.0	19.0	0.0	99	100
24	42	44.7	33.5- 55.5	0.29	0.17- 0.59	0.95	0.0-3.0	1.3	0.0- 12.9	13.0	17.0	25	60
25	50	36.7	32.3- 46.9	0.22	0.09- 0.43	0.78	0.0-3.0	1.3	0.0- 12.4	10.0	26.0	24	48
27	20	40.6	37.4- 45.5	0.19	0.15- 0.26	0.05	0.0-1.0	0.1	0.0- 0.1	1.0	19.0	1	5

Table 3

PREYS: NUMBER RATE AND AVERAGE OF *Pleuragramma antarcticum* COLLECTED DURING SIBEX-PHASE II PROJECT, BRANSFIELD STRAIT.

Item	SIZE CLASSES											
	One				Two (+)				Adults			
	Num.	Min.	Max.	$\overline{X}$	Num.	Min.	Max.	$\overline{X}$	Num.	Min.	Max.	$\overline{X}$
COPEPODA												
Metridia gerlachei	6	3.6	5.2	4.5	8598	1.3	3.8	3.0	2922	1.8	4.5	3.1
Calanoides acutus	62	2.3	7.5	5.8	461	2.8	4.0	3.7	162	3.2	4.3	3.8
Calanus propinquus	8	4.2	4.8	4.5	6	3.8	4.1	3.9	3	4.0	4.2	4.1
Rhincalanus gigas	7	9.5	12.3	10.5	3	7.0	8.0	7.6	–	–	–	–
Euchaeta antarctica	2	4.2	6.3	5.3	82	1.5	10.0	6.5	35	3.6	9.8	7.2
Scaphocalanus brevicornis	3	2.2	2.7	2.5	10	0.8	1.5	1.3	5	0.8	1.5	1.3
Pleuromamma abdominalis	–	–	–	–	1	3.5	3.5	3.5	–	–	–	–
Oncaea conifera	1	1.0	1.0	1.0	2	0.6	1.2	0.9	3	0.6	1.0	0.8
Oithona frigida	50	0.9	1.2	1.0	–	–	–	–	–	–	–	–
Unidentified	13	2.8	3.2	3.0	1	2.5	2.5	2.5	–	–	–	–
Total	152	0.9	12.3	4.0	9164	0.6	10.0	3.1	3130	0.6	9.8	3.2
EUPHAUSIDA												
Euphausia superba (adult)	–	–	–	–	3	48.0	62.0	54.0	–	–	–	–
Euphausia superba (juven)	–	–	–	–	6	15.0	25.0	19.5	4	20.0	25.0	23.0
Thysanoessa macrura (juv)	–	–	–	–	10	13.0	28.0	23.0	2	26.0	30.0	28.0
Euphausiids larvae	11	4.2	6.5	5.4	180	1.2	9.3	5.6	58	1.5	9.6	6.2
Total	11	4.2	6.5	5.4	199	1.2	62.0	7.6	64	1.5	30.0	7.9
OSTRACODA												
Conchoecia sp.	–	–	–	–	138	1.3	3.0	2.6	47	1.5	3.2	2.8
POLYCHAETA	–	–	–	–	11	1.2	3.0	2.5	2	2.0	2.8	2.4
CHAETOGNATHA												
Sagitta sp.	–	–	–	–	20	5.0	18.0	15.5	3	16.0	22.0	18.7
AMPHIPODA												
Hyperiidae	–	–	–	–	35	1.3	2.6	2.3	–	–	–	–
PISCES												
Pleuragramma antarcticum	–	–	–	–	–	–	–	–	1	23.0	23.0	23.0
Notolepis coatsi	–	–	–	–	–	–	–	–	1	22.0	22.0	22.0
Unidentified	–	–	–	–	1	31.0	31.0	31.0	–	–	–	–
Total	–	–	–	–	1	31.0	31.0	31.0	2	22.0	23.0	22.5
EGGS	118	0.4	0.5	0.5	–	–	–	–	–	–	–	

Table 4

FREQUENCY OF THE ZOOPLANKTONIC GROUPS COLLECTED BY BONGO NET AT THE STATION 22, AND THOSE FINDINGS IN THE GASTRIC CONTENTS OF *P. antarcticum* COLLECTED BY IKMT NET AT THE SAME STATION

Groups	Bongo net Number	%*	Gastric contents Number	%*
Copepoda	95.227	47.13	12.019	96.08
Euphausida	5.256	2.60	243	1.94
Ostracoda	1.839	0.91	176	1.41
Polychaeta	2.154	1.07	12	0.10
Amphipoda	76	0.04	35	0.28
Chaetognatha	402	0.20	23	0.18
Apendicularia	95.923	47.48	–	–
Mollusca	140	0.07	–	–
Siphonophora	52	0.03	–	–
Medusas	35	0.02	–	–
LARVAE OF:				
Osteichthyes	12	0.01	2	0.02
Echinoderma	47	0.02	–	–
Cirripedia	12	0.01	–	–
Decapoda	6	0.00(3)	–	–
EGGS OF:				
Crustacea	868	0.43	–	–
Totals	202.048	100.00	12.510	99.90

* Spearman's ratio correlation between % $r_s = 0.40$ (no significant value).

Table 5

COPEPODS ABUNDANCE IN SAMPLES OBTAINED BY BONGO NET AT THE STATION 22 AND THOSE FOUND IN THE GASTRIC CONTENTS OF *P. antarcticum* COLLECTED BY IKMT NET AT THE SAME STATION

Species	Bongo net Number*	%**	Gastric contents Number	%
Metridia gerlachei	79.907	83.91	11.264	93.71
Calanoides acutus	4.983	5.23	615	5.11
Calanus propinquus	279	0.29	8	0.06
Rhincalanus gigas	233	0.24	3	0.02
Euchaeta antarctica	512	0.53	107	0.89
Scaphocalanus brevicornis	3.260	3.42	15	0.12
Pleuromamma abdominalis	–	–	1	0.01
Oncaea conifera	931	0.98	5	0.04
Oithona frigida	3.818	4.01	–	–
Gaidius affinis	140	0.15	–	–
indeterminatae	233	0.24	1	0.01
Nauplios	931	0.98	–	–

* Number X 1.000 m^3 of filtered water.
** Sperman ratio correlations. $r_s = 0.514$ n.s.v.

Table 6

RESULT MATRIX OF THE KENDALL'S NON PARAMETRIC CORRELATION (TAU) APPLIED TO THE GASTRIC CONTENTS OF FISHES COLLECTED IN EACH OF THE 14 SIBEX-PHASE II STATIONS. THE DATA OF EACH ONE OF THE 19 ITEMS REPRESENTATION WERE TRANSFORMED (LOG. N + 1). THE PAIR SAMPLES WERE CONSIDERED SIMILAR TO 5% OF SIGNIFICANCY*

	Est. 2	Est. 4	Est. 7	Est. 8	Est. 9	Est. 12	Est. 15	Est. 16	Est.17	Est. 24	Est. 25	Est. 27	Est. 21
Est. 4	−0.0476 (0.417)												
Est. 7	−0.0476 (0.417)	−0.476 (0.417)											
Est. 8	−0.0865 (0.351)	0.6055* (0.001)	−0.0865 (0.351)										
Est. 9	−0.0471 (0.417)	−0.0417 (0.417)	−0.0476 (0.417)	0.5190* (0.007)									
Est. 12	0.6548* (0.001)	−0.0689 (0.380)	0.7237* (0.001)	−0.1252 (0.289)	−0.0689 (0.380)								
Est. 15	−0.0476 (0.417)	−0.0476 (0.417)	−0.0476 (0.417)	−0.0865 (0.351)	−0.0476 (0.417)	−0.0689 (0.380)							
Est. 16	−0.1318 (0.279)	−0.1318 (0.279)	0.4612* (0.015)	0.2430 (0.138)	0.2855 (0.099)	0.2579 (0.123)	0.2855 (0.099)						
Est. 17	−0.0690 (0.380)	−0.0690 (0.380)	0.6901* (0.001)	0.3134 (0.078)	0.6901* (0.001)	0.4745* (0.013)	−0.0690 (0.380)	0.5410* (0.005)					
Est. 24	0.0361 (0.437)	0.0361 (0.437)	0.2704 (0.112)	0.2635 (0.118)	0.3786* (0.041)	0.2295 (0.152)	0.3425 (0.059)	0.5725* (0.003)	0.4702* (0.014)				
Est. 25	0.3014 (0.086)	0.0942 (0.338)	0.3579* (0.051)	0.1820 (0.209)	0.3956* (0.034)	0.4791* (0.012)	0.2072 (0.177)	0.5667* (0.003)	0.5460* (0.004)	0.7786* (0.001)			
Est. 27	−0.0476 (0.417)	−0.0476 (0.417)	−0.0476 (0.417)	−0.0865 (0.351)	−0.0476 (0.417)	−0.0689 (0.380)	−0.0476 (0.417)	−0.1318 (0.279)	−0.0690 (0.380)	0.0361 (0.437)	0.0942 (0.338)		
Est. 21	0.3949* (0.034)	−0.1881 (0.2301)	0.2445 (0.136)	−0.0264 (0.454)	−0.1881 (0.201)	0.4578* (0.016)	−0.1881 (0.201)	0.0836 (0.356)	0.0409 (0.428)	0.0411 (0.428)	0.0210 (0.463)	−0.1881 (0.201)	
Est. 22	0.3632* (0.048)	−0.3113 (0.079)	0.3286 (0.068)	−0.2157 (0.168)	−0.3113 (0.079)	0.4996* (0.009)	−0.1730 (0.221)	0.0754 (0.369)	0.0125 (0.478)	−0.0521 (0.409)	−0.0622 (0.392)	0.1211 (0.296)	0.6716* (0.001)

Table 7

STATION SAMPLES CHARACTERISTICS AND PREVIOUS PUBLISHED DATA OF *P. antarcticum* CONSIDERED IN THIS COMPARISON

After De Witt, H.H. and T.L. Hopkins. 1977	STATIONS Ross Sea		
Observations	1917	1880	1892-1922
Latitud (S)	77°34' - 77°36'	73°32' - 73°32'	75°27' - 75°32'
Longitud	174°50'E-175°18'E	171°26'E-171°29'E	168°50'E-178°50'W
Hour	03:20-05:47	06:22-07:12	00:05-17:09
Date	25-01-1967	16-01-1967	18-01-1967
Net	IKMT	BT	BT
Depth (mt)	730 - 728	527 - 538	364 - 496
Num. indiv.	17	23	13
Est. Long.			
Min. (mm)	49	77	77
Max. (mm)	206	184	182
Average (mm)	140	148	110
Empty			
Stomachs	1	13	7
With scales	14	0	0
Prey taxa	19	6	7
Principal prey	*Metridia gerlachei* (Copepoda)	*Euphausia superba* (Euphausida)	*Metridia gerlachei* (Copepoda) Larvaceos (Tunicata)

After Hubold, G. 1984	STATIONS Weddell Sea		
Observations	Area 1	Area 2	Area 3
Latitud (S)	77°00' - 77°15'	72°30' - 73°00'	77°00' - 77°15'
Longitud	42°00'-W-43°00'W	21°00'W-22°00'W	31°30'W-32°30'W
Hour	11:00-17:00	09:00-19:00	09:00-10:00
Date	18-02-83	26-02-83	22-02-1983
Net	Arrastre de fondo	RMT y RMT1+8	3m-Agassiz Trawl
Depth (mt)	670 - 720	150 - 550	300 - 200
Ejemp. Numbr	63	54	10
Est. Long			
Min. (mm)	64	98	125
Max. (mm)	219	175	164
Average (mm)	164	138	149
Empty			
Stomachs	28	2	0
With scales	0	0	40
Prey taxa	12	19	11
Principal prey	Heteropoda (Mollusca)	Copepoda sp. indet. *Calanoides acutus* (Copepoda)	Heteropoda (Mollusca)

	STATIONS Bransfield Strait		Prydz Bay
Observations	21	22	After Williams, R. 1985
Latitud (S)	63°53' - 63°53'	64°09' - 64°09'	60°45' - 62°00'
Longitud	60°27'W-60°27'W	61°14'W-61°14'W	60°00'E-88°00'E
Hour	16:04-16:37	23:09-23:57	—
Date	07-02-1985	08-02-1985	Ener-Febrero 1981
Net	IKMT	IKMT	RMT-8
Depth (mt)	80 - 120	50 - 120	75 - 0
Ejemp. Numbr.	7	99	45
Est. Long.			
Min (mm)	89	105	56
Max (mm)	141	145	160
Average (mm)	119	125	—
Empty			
Stomach	0	0	0
With scale	3	79	—
Prey taxa	11	19	18
Principal prey	*Metridia gerlachei* (Copepoda)	*Metridia gerlachei* (Copepoda)	*Calanoides acutus* (Copepoda)

Table 8

MATRIX RESULTS OF THE KENDALL'S - T CORRELATION APPLIED TO 9 DIFFERENT STATIONS FULFILLED FOR FEEDING STUDIES OF THE *Pleuragramma antarcticum*. THE ANALYSIS WAS DONE IN THE SAME WAY AS IN TABLE 6

	Ross Est. 1880	Ross Est. 1917	Ross Est. 1892	Weddell Area 1	Weddell Area 2	Weddell Area 3	Bransfield Est. 21	Bransfield Est. 22
Ross Est. 1917	0.4844* (0.001)							
Ross Est. 1892	0.5941* (0.001)	0.4726* (0.002)						
Weddell Area 1	0.0601 (0.362)	0.0349 (0.419)	0.0234 (0.445)					
Weddell Area 2	0.4150* (0.005)	0.5871* (0.001)	0.4391* (0.003)	0.2908* (0.040)				
Weddell Area 3	0.4169* (0.005)	05202* (0.001)	0.5148* (0.001)	0.2218 (0.094)	0.7872* (0.001)			
Bransfield Est. 21	0.5490* (0.001)	0.2862* (0.043)	0.3390* (0.020)	−0.1791 (0.144)	0.3713* (0.012)	0.2897* (0.041)		
Bransfield Est. 22	0.3442* (0.018)	0.2111 (0.105)	0.1646 (0.165)	−0.3029* (0.034)	0.2303 (0.085)	0.1615 (0.170)	0.6843* (0.001)	
Bahía Prydz	0.1594 (0.173)	0.1154 (0.248)	0.1935 (0.126)	0.1171 (0.245)	0.4314* (0.004)	0.2833* (0.045)	0.4994* (0.001)	0.2079 (0.108)

*Shows significant correlations to 5% level.

REFERENCES

ASENCIO, G. y C.A. MORENO, 1984. Dieta y selectividad alimentaria de *Protomyctophum bolini* Fraser-Brunner (Pisces; Mycophidae) en el paso Drake (Antártica). Ser. Cient. INACH *31*: 85-96.

BAIRD, R.C., T.L. HOPKINS y D.F. WILSON, 1975. Diet and feeding chronology of *Diaphus taaningi* (Myctophidae) in the Cariaco Trench. COPEIA, 1975: 356-365.

BARTLETT, M.S., 1947. The use of transformations. Biometrics, *3* (1): 39-52.

DEWITT, F.A. y G.M. CAILLET, 1972. Feeding habits of two bristlemouth fishes, *Cyclothone acclinidens* and *C. signata* (Gonostomatidae). COPEIA, 1972: 868-871.

DEWITT, H.H. y T.L. HOPKINS, 1977. Aspects of the Antarctic Silverfish, *Pleuragramma antarcticum*. In: Llano, B. A. (ed). Adaptations within Antarctic Ecosystems. Gulf Publishing Co., HOUSTON, 557-567.

EASTMAN, J.T., 1985. The evolution of neutrally buoyant notothenioid fishes: Their specializations and potencial interactions in the antarctic marine food web. In: Antarctic Nutrient and Food Webs. Ed. by W.R. Siegfried, P.R. Condy and R.M. Laws. Springer-Verlag. Berlin. pp: 430-436.

HUBOLD, G., 1985a. Stomach contents of the antarctic silverfish *Pleuragramma antarcticum* from the southern and eastern Weddell Sea (Antarctica). Polar Biology 5: 43-48.

HUBOLD, G., 1985b. The early life-history of the high-antarctic silverfish, *Pleuragramma antarcticum*. In: Siegfried, W.R., P.R. Condy and R.M. Laws (ed). Antarctic Nutrient Cycles and Food Webs. Springer-Verlag Berlin Heidelberg. pp: 445-451.

HUREAU, J.C., 1970. Biologie compare de quelques poissons antarctiques (Nototheniidae). Bull. Inst. Oceanogr. Monaco *68* (1391): 1-244.

MORENO, C.A. y H.H. OSORIO, 1977. Bathymetric food habit changes in the antarctic fish, *Notothenia gibberifrons* Lönnberg. (Pisces: Nototheniidae). Hidrobiologia *55* (2): 139-144.

MORENO, C.A. y J.H. ZAMORANO, 1979. Selección de los alimentos en *Notothenia coriiceps neglecta* del cinturón de macroalgas de Bahía South. Ser. Cient. INACH 25-26: 33-44.

MORISITA, M., 1959. Measuring of interspecific association and similarity between communities. Mem. Fac. Sci. Kyushu Univ. Ser. E. (Biology) *3* 65-80.

MUJICA, A. y V. ASENCIO, 1985. Larvas de peces, eufáusidos y estructura comunitaria del zooplancton del estrecho Bransfield (Crucero SIBEX-INACH, 1984). Ser. Cient. INACH. 33: 159-186.

MUJICA, A. y V. ASENCIO, 1986. Composición y abundancia relativa del zooplancton antártico en el estrecho Bransfield (SIBEX-Fase II). Ser. Cient. INACH 35: 95-104.

NAVARRO, R.N., 1984. Programa computacional para el análisis numérico de comunidades: Diversidad y Sobreposición. Medio Ambiente. (Valdivia) 7 (1): 82-87.

SILVA, N., 1985. Oceanografía química de las aguas del estrecho Bransfield: Compuestos micronutrientes (Crucero SIBEX-1984). Ser. Cient. INACH 33: 49-88.

SOKAL, R.R. y P.H.A. SNEATH, 1963. Principles of numerical taxonomy. W.H. Freeman, San Francisco.

WILLIAMS, R., 1985. Trophic relationship between pelagic fish and euphausiids in Antarctic Waters. In: Antarctic Nutrient Cycles and Food Webs. Ed. W.R. Siegfried, P.R. Condy and R.M. Laws. Springer-Verlag, Berlin. pp: 452-459.