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EXPLORATORY FISHING FOR *DISSOSTICHUS* SPP. IN THE ANTARCTIC REGION (SUBAREAS 48.1, 48.2 AND 88.3)

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Abstract

During February and March 1998, a 43-day cruise on FV *Tierra del Fuego* was conducted as part of the New Fisheries Projects developed by Chile, primarily to establish the presence of *Dissostichus* spp. in Subareas 48.1, 48.2 and 88.3. Industrial longlines (Spanish system) were used for the operation, with variable quantities of fish hooks (1 440 to 4 320), No. 9 Mustad Kirby type, set between depths of 600 and 2 550 m. Sardines (*Sardinops sagax*) and squid (*Illex argentinus*) were used as bait. Antarctic toothfish (*Dissostichus mawsoni*) were recorded around Peter I Island (Latitude 68°49'S), and from the Bellingshausen Sea (70°38'S) to Clarence and Elephant Islands (61°14'S), while Patagonian toothfish (*Dissostichus eleginoides*) were caught in waters from King George Island in the South Pacific Ocean (61°24'S) to the Scotia Sea in the South Atlantic (58°03'S). Yields of *Dissostichus* spp. were very low in the three subareas, with values of only 5.7 g/hook (Subarea 88.3), 19.1 g/hook (Subarea 48.1) and 3.0 g/hook (Subarea 48.2), and an average over all areas of 11.1 g/hook.

Résumé

En février et mars 1998 s'est déroulée une campagne d'une durée de 43 jours du palangrier *Tierra del Fuego* dans le cadre du projet des Nouvelles Pêcheries du Chili dont le principal but était d'établir la présence de *Dissostichus* spp. dans les sous-zones statistiques 48.1, 48.2 et 88.3 de la CCAMLR. La pêche s'est réalisée à l'aide de palangres de fond industrielles de conception espagnole composées d'une quantité variable d'hameçons (1 440–4 320), du type Mustad Kirby N°9, et déployées principalement entre 600 et 2 550 m de profondeur. L'appât employé était de la sardine (*Sardinops sagax*) et de l'encornet (*Illex argentinus*). Des résultats de la recherche il ressort que la légine antarctique (*D. mawsoni*) se rencontre des abords de l'île Pierre I^{er} (68°49'S), dans la mer de Bellingshausen (70°38'S) jusqu'aux îles Clarence et de l'Éléphant (61°14'S), alors que la légine australe (*D. eleginoides*) a été capturée de l'île du Roi Georges, dans l'océan Austral pacifique (61°24'S) jusqu'à la mer du Scotia, dans l'océan Austral atlantique (58°03'S). Les rendements de *Dissostichus* spp. ont été très faibles dans les trois sous-zones, d'une valeur de seulement 5,7 g/hameçon (sous-zone 88.3), 19,1 g/hameçon (sous-zone 48.1) et 3,0 g/hameçon (sous-zone 48.2), ce qui donne une moyenne globale de 11,1 g/ hameçon.

Резюме

В феврале-марте 1998 г. в рамках разработанного Чили проекта "Новые промыслы" был проведен 43-дневный рейс на промысловом судне *Tierra del Fuego*, главной целью которого было установление наличия видов *Dissostichus* в подрайонах 48.1, 48.2 и 88.3. В ходе работ использовались промышленные ярусы (испанская система) с различным количеством крючков (от 1440 до 4320) типа Мустад Керби (Mustad Kirby) № 9, выставлявшихся на глубинах от 600 до 2550 м. В качестве наживки использовались сардины (*Sardinops sagax*) и кальмары (*Illex argentinus*). Антарктический клыкач (*Dissostichus mawsoni*) был зарегистрирован вокруг о-ва Петра I (68°49'ю.ш.) и от моря Беллинсгаузена (70°38'ю.ш.) до о-вов Кларенс и Элефант (61°14'ю.ш.), в то время как патагонский клыкач (*Dissostichus eleginoides*) ловился в водах от о-ва Кинг-Джордж в тихоокеанском секторе Антарктики (61°24'ю.ш.) до моря Скотия в атлантическом секторе Антарктики (58°03'ю.ш.). Коэффициенты вылова видов *Dissostichus* в этих трех подрайонах были очень низкими – 5,7 г/крючок (Подрайон 88.3), 19,1 г/крючок (Подрайон 48.1) и 3,0 г/крючок (Подрайон 48.2), со средним значением по всем подрайонам 11,1 г/крючок.

Resumen

En febrero y marzo de 1998 se efectuó un crucero con el PAM *Tierra del Fuego*, de 43 días de duración, como Proyecto de Pesquerías Nuevas autorizadas a Chile, con el fin de establecer principalmente la presencia de *Dissostichus* spp. en las Subáreas estadísticas 48.1, 48.2 y 88.3 de la CCRVMA. Los lances de pesca se realizaron utilizando espineles industriales de profundidad de diseño español, con una cantidad variable de anzuelos (1 440–4 320), tipo Mustad Kirby N°9, principalmente entre 600 y 2 550 m de profundidad. De carnada se utilizó sardina (*Sardinops sagax*) y calamar (*Illex argentinus*). Como resultado de la investigación se determinó que el bacalao antártico (*D. mawsoni*) se registró en la isla Pedro I (68°49´S), Mar de Bellingshausen (Latitud 70°38´S) hasta las islas Clarence y Elefante (61°14´S), mientras que el bacalao de profundidad (*D. eleginoides*) se capturó desde la isla Rey Jorge, en el océano Austral-Pacífico (61°24´S) hasta el Mar de Escocia, en el océano Austral-Atlántico (58°03´S). Los rendimientos de *Dissostichus* spp. fueron notoriamente bajos en las tres subáreas, con valores de sólo 5,7 g/anz. (Subárea 88.3), 19,1 g/anz. (Subárea 48.1) y 3,0 g/anz. (Subárea 48.2), con un promedio global de 11,1 g/anz.

Keywords: exploratory fishery, longline, *Dissostichus*, CPUE, Antarctica, CCAMLR

INTRODUCTION

Attempts at commercial fishing in Antarctic waters date back to the beginning of this century. During World War I, the United Kingdom conducted a detailed study of the fishing possibilities in the Falkland/Malvinas Islands zone; however, nothing ever became of this effort. It was not until the 1960s that the Soviet Union began exploratory, and later commercial, fishing operations in Southern Ocean waters, which heralded the beginning of massive exploitation of Antarctic fish (Hureau and Slosarczyk, 1990). Reports showed that maximum catches of about 335 000 tonnes were taken between 1977 and 1978. The target species for these operations were mainly nototheniids (*Notothenia rossii, Gobionotothen gibberifrons* and *Patagonotothen guntheri*) and icefish (*Champsocephalus gunnari* and *Chaenodraco wilsoni*), generally caught in the South Shetland Islands zone.

In recent years, the Patagonian toothfish (*Dissostichus eleginoides*) has become a highly valued resource, particularly due to the outstanding yields in certain fishing areas and also because of the high value of its meat on the international market. This large, fatty, long-lived fish inhabits the deep waters of the southern hemisphere, mainly near the South American continent, in the sub-Antarctic region, around oceanic islands and submarine ridges of the Atlantic and Indian Oceans (Fischer and Hureau, 1985; Hureau and Slosarczyk, 1990; Prutko, 1997; Yukhov, 1997).

Over the last few years, interest in this resource has increased, resulting in increased exploitation in areas of the South Atlantic and, more recently, the Indian Ocean. This has led to the implementation of a variety of administrative regulations by those countries that possess territory near the areas of extraction in order to regulate the harvest of this species. All of these actions are motivating research on the biology of *D. eleginoides*, as well as establishing new areas where this resource occurs. The search for new fishing areas will have an impact on present and future fisheries for *D. eleginoides*.

The *Dissostichus* group also includes the Antarctic toothfish (*D. mawsoni*), a species of similar characteristics to *D. eleginoides* with a distribution described south of 60°S around the Antarctic continent. Until now, *D. mawsoni* has been subject to only light commercial fishing and, therefore, there is almost no scientific knowledge on this resource.

Consequently, the main objective of this research was to carry out an exploratory fishing cruise in Subareas 48.1, 48.2 and 88.3 under the authority of CCAMLR. This cruise was intended to establish the presence, geographic distribution and relative abundance of *D. eleginoides* and *D. mawsoni* around the Antarctic Peninsula and adjacent areas, as well as determining the existence of any other resource having fishing potential in deep-sea waters.

METHODS

The cruise was carried out by the longliner factory ship FV *Tierra del Fuego* (54 m long and 626 GRT, property of Pesca Chile S.A.). The ship operated a vessel monitoring system (ARGOS),

which is required in the CCAMLR Convention Area. Two research professors from the Universidad Católica de Valparaíso (Chile) and a scientific observer designated in accordance with the CCAMLR Scheme of International Scientific Observation participated in the cruise.

Fishing was conducted using commercial bottom longlines, double-line Spanish design, with No. 9 Mustad Kirby hooks (61 x 30 x 27 mm), unbalanced type, spaced at 1.8 m intervals. To help sink the fishing gear, 6.5 to 7.0 kg rocks were used. Medium-sized (20 cm) (SD = 2.2) sardines (*Sardinops sagax*) and size 3 to 4 squid (*Illex argentinus*), both whole and defrosted, were used as bait. Hooks were baited manually.

At each station, initial and final longline location, number of hooks used, type and size of bait, time of setting and hauling, depth at each end of the longline, type of bottom and catch of target and by-catch species (quantity and weight) were recorded. Additionally, records of air and surface water temperature, atmospheric pressure and sea conditions were kept.

In general, longlines were set at sundown in areas free of ice or icebergs and, whenever possible, on abrupt or irregular bottoms. The longlines were hauled at sunrise. Usually, every night two longlines were set at oblique angles to the coast in order to cover a wide depth range at each station. All baited hooks were set to fish on or near the bottom.

All *Dissostichus* spp. caught were measured for total length (TL). In order to establish the total lengths, a measuring board was used, and the size was rounded down to the nearest centimetre. Once cleaned, the total weight, as well as the weight of the trunks (headed, gutted and tailed – HGT), was registered. The weight of the individuals was determined using a clock-type scale with maximum weight of 100 kg and ±0.5 kg accuracy. The size/weight relationship was established using a power equation, and the conversion factor between the raw material and the HGT product was calculated.

At the same time, sex, maturity stage of the gonads, and stomach fullness was estimated according to a five-point scale: 0 – empty, 1 – quarter full, 2 – half full, 3 – three-quarters full, and 4 – totally full, stomach wall extended (Kock et al., 1991). For those specimens having food in their stomach, contents were identified. The analysis of *D. mawsoni* stomach contents was performed using the frequency-of-occurrence method, where the number of stomachs containing one or more individuals of each prey category is expressed as a percentage of the total number of stomachs containing food (Hynes, 1950; Hyslop, 1980). Maturity stages of *D. mawsoni* specimens were determined according to a five-point scale: 1 – immature, 2 – maturing virgin or resting, 3 – developing, 4 – gravid, and 5 – post-spawning (Kock and Kellermann, 1991).

For by-catch species, total catch weight of each species and the measurements of a certain quantity of randomly selected specimens were recorded. Specimens of by-catch fish were also collected and frozen for subsequent verification of species identification.

Length-frequency distributions were determined by grouping individuals in 5 cm length classes in the case of *D. mawsoni*, and 1 cm length classes for other species. Finally, the catch per unit effort (CPUE) was calculated as the quotient between the catch and the number of hooks used, and expressed in grams per hook (g/hook). This index was calculated for each species, and for all the resources caught in a subarea and for the cruise as a whole.

RESULTS

General Aspects

The port of Punta Arenas was used as the vessel's home base. The exploratory fishing cruise took place between 9 February and 23 March 1998, with fishing operations carried out between 14 February and 18 March. The cruise lasted 43 days, 32 of which were devoted to exploration and fishing activities, and 11 to navigation.

In accordance with the cruise schedule, Subareas 88.3, 48.1 and 48.2 were researched in that order. Approximately 4 500 n miles were navigated, reaching 70°38'S, the southernmost point of this voyage (Bellingshausen Sea). The air temperature ranged between -4.5 and 4.5°C and the surface water temperature between -2.0 and 1.5°C. Many large icebergs were present in Subarea 88.3. In Subarea 48.1, navigation was straightforward due to the total absence of ice and icebergs, while in Subarea 48.2 floating ice ('pack-ice') was encountered several times, forcing changes in the planned navigation route.

Table 1: Effort applied, catch and global yields obtained in each statistical subarea.

	Subarea			Total
	48.1	48.2	88.3	
Total number of hauls	24	7	21	52
Total number of hooks set	49 056	12 192	53 424	114 672
Total soak time (hours)	310.50	40.59	211.94	563.03
Total catch *D. eleginoides* (kg)	43.00	36.00	0.00	79.00
Total catch *D. mawsoni* (kg)	891.70	0.00	301.90	1 193.60
Total catch other species (kg)	835.20	217.20	517.65	1 570.05
Global catch (kg)	1 769.90	253.20	819.55	2 842.65
Global yield (g/hook)	36.08	20.77	15.34	24.79
Standard deviation (SD)	26.46	15.39	16.31	23.72

Table 2: Summary of catch and yield obtained by species and statistical subarea.

Common Name	Scientific Name	Subarea 48.1			Subarea 48.2			Subarea 88.3			Total Catch		
		Catch (kg)	Catch (no.)	CPUE (g/hook)	Catch (kg)	Catch (no.)	CPUE (g/hook)	Catch (kg)	Catch (no.)	CPUE (g/hook)	Catch (kg)	Catch (no.)	CPUE (g/hook)
Pisces													
Patagonian toothfish	*Dissostichus eleginoides*	43.0	3	0.877	36.0	4	2.953				79.0	7	0.689
Antarctic toothfish	*Dissostichus mawsoni*	891.7	55	18.177				301.90	68	5.651	1193.6	123	10.409
Bigeye grenadier	*Macrourus whitsoni*	307.3	239	6.264	96.0	72	7.874	351.25	330	6.575	754.55	641	6.580
Armed grenadier	*Coryphaenoides ferrieri*	36.5	15	0.744							36.5	15	0.318
Smalleye eel cod	*Muraenolepis microps*, *Muraenolepis* spp.	21.0	16	0.430	8.5	8	0.697	17.0	17	0.318	46.6	41	0.406
Blue antimora	*Antimora rostrata*	3.5	1	0.071	3.5	2	0.287	5.4	3	0.101	12.4	6	0.108
Icefish	*Chionobathyscus dewitti*, *Cryodraco antarcticus*	365.7	860	7.455	30.0	54	2.461	33.7	81	0.631	429.4	995	3.745
Striped-eyed rockcod	*Lepidonotothen kempi*	27.7	31	0.565	2.5	4	0.205	86.1	165	1.612	116.3	200	1.014
Humped rockcod	*Gobionotothen gibberifrons*				0.6	1	0.049				0.6	1	0.005
Pearlfish	*Echiodon* spp.							0.5	2	0.009	0.5	2	0.004
Antarctic starry skate	*Raja (Amblyraja) georgiana*	71.5	13	1.458	72.4	19	5.938	17.7	5	0.331	161.6	37	1.409
McCain's skate	*Bathyraja maccaini*				3.7	1	0.303	4.0	1	0.075	7.7	2	0.067
Plunderfish	*Pogonophryne platypogon*	1.9	5	0.039				0.2	1	0.004	2.1	6	0.018
Crustacea													
Antarctic crab	*Paralomis anamerae*							1.8	1	0.034	1.8	1	0.016
Other invertebrates													
	Anasterias antarctica		1									1	
	Anasterias varium		1									1	
	Paralophaster antarcticus		1									1	
Total		1769.9	1241	36.079	253.2	165	20.768	819.55	674	15.340	2842.65	2080	24.789

It is important to point out that in all the areas studied, bottom topography was found to be quite flat, both in the extensive continental shelf in the Bellingshausen Sea and on the eastern coast of the Antarctic Peninsula. An absence of abrupt and irregular bottom topography was also observed on the continental slope. According to fishermen, these conditions are characteristic of the usual habitat of *D. eleginoides*. In most cases fishing was carried out on muddy, gravelly bottoms.

Throughout the cruise, a total of 52 sample stations were made, using the same number of longlines (Figure 1). On most occasions the fishing gear was set at depths ranging between 600 and 2 550 m. The only exceptions were near Adelaide Island, where longlines were set between 290 and 350 m (station no. 20), and in Bransfield Strait, where one end of the longline was hung vertically, from 100 m down to 1 213 m (station no. 35). No *Dissostichus* spp. were caught at these two stations.

During the entire cruise 114 672 fish hooks were used, with 1 440 to 4 320 hooks on each longline (average = 2 205 hooks/haul). Overall soak time was 563 hours with an average of 10.8 hours/haul. Total catch was 2 843 kg (79 kg *D. eleginoides*, 1 194 kg *D. mawsoni* and 1 570 kg by-catch species) (Table 1).

A total of 436 seabirds were observed during longline setting; none were caught or killed during the cruise (Benavides and Arana, 1998).

Catch Composition and Distribution

In general, the catch composition was constant in all hauls and was mainly related to the depth at which the longline was set. In the 600 to 1 600 m range, the main fish caught were: icefish (*Chionobathyscus dewitti* and *Cryodraco antarcticus*) – 47.9% of the total number of fish caught, bigeye grenadier (*Macrourus whitsoni*) – 30.9%, striped-eyed rockcod (*Lepidonotothen kempi*) – 9.6% and smalleye eel cod (*Muraenolepis* spp.) – 2.0%. All other species, such as Georgian ray (*Raja (Amblyraja) georgiana*), plunderfish (*Pogonoprhyne platypogon*) and pearlfish (*Echiodon* spp.), appeared sporadically (9.6%). *M. whitsoni* was caught in fairly large numbers in Subarea 88.3, as were *C. dewitti* and *C. antarcticus* in Subarea 48.1. These species, although less abundant in Subarea 48.2, comprised a large proportion in all catches. The number of *R. georgiana* caught in that subarea was also quite high (19 specimens).

Armed grenadier (*Coryphaenoides ferrieri)* and blue antimora (*Antimora rostrata*) were caught in deeper waters (>1 600 m). It must also be noted, that at station no. 34, carried out near Robert Island (Subarea 48.1), three equinodermata asteroids (*Anasterias varium, Anasterias antarctica* and *Parlophaster antarcticus*) were caught between 694 and 1 114 m.

D. mawsoni were recorded from Peter I Island (68°49'S) and the Bellingshausen Sea (70°14'S) to Clarence and Elephant Islands, while *D. eleginoides* were caught between King George Island, in the South Pacific Ocean (61°24'S), and the Scotia Sea, in the South Atlantic Ocean (58°03'S). *D. mawsoni* were taken at depths ranging between 375 and 1 600 m, and *D. eleginoides* between 530 and 1 602 m.

Catch per Unit Effort

Catch per hook (CPUE) calculated for all species combined was 24.8 g/hook (SD = 23.7). The yields for Subareas 48.1, 48.2 and 88.3 were 36.1 g/hook (SD = 26.5), 20.8 g/hook (SD = 15.4) and 15.3 g/hook (SD = 16.3) respectively. The CPUEs for *Dissostichus* spp. were remarkably low in the three subareas, being only 19.1 g/hook (SD = 18.4), 3.0 g/hook (SD = 6.4) and 5.7 g/hook (SD = 8.0) respectively, with an overall average of 11.1 g/hook (SD = 15.4) for the entire cruise.

M. whitsoni (average CPUE – 6.6 g/hook) and *C. dewitti* and *C. antarcticus* (average CPUE – 3.7 g/hook) were the most significant by-catch species. It is also worth mentioning that *M. whitsoni* was caught in all three subareas, with yields of 7.9 g/hook in Subarea 48.2 (Table 2).

Fishing – Biological Aspects

For *D. mawsoni* it was possible to calculate the sex ratio. The ratio was 1.77 females per one male ($\chi^2 = 7.32$, $p < 0.05$, Df = 1, $n = 123$). By contrast, no significant length differences for this species were observed between males and females (*t*-test, $\alpha = 0.05$; $p = 0.59$). The size of males ranged between 37 and 142 cm, with an average of 78.5 cm (SD = 25.1), while for females it ranged between 41 and 168 cm, with an average of 81.5 cm (SD = 35.1) (Figure 2). The total length range of *D. mawsoni* was similar in Subareas 48.1 and 88.3. However, there were significant average size differences (*t*-test, $\alpha = 0.05$; $p < 0.001$) in each of these subareas, with an average size of 64.0 cm (SD = 20.2) in Subarea 88.3 and 99.5 (SD = 32.2) in

Subarea 48.1. On the other hand, the seven specimens of *D. eleginoides* caught ranged in size between 5 and 122 cm, with an average of 94.9 cm (SD = 23.3).

Of the most abundant by-catch species, *C. dewitti* and *C. antarcticus* were between 27 and 58 cm, with an average of 37 cm; *M. whitsoni* ranged between 39 and 88 cm (average = 57.5 cm) and *L. kempi* averaged 35 cm, ranging between 27 and 47 cm (Table 3 and Figure 3).

The relationship between total length and total weight in *D. mawsoni* was determined by fitting the power function, with $b = 3.1892$ in males, $b = 3.0944$ in females and $b = 3.1288$ in both sexes (Figure 4). The exponents of this function point at slightly positive allometric growth ('*t*' Student, $\alpha = 0.05$). The length–weight relationship for 124 specimens is given by the following equation:

$$W_t = 6.9227 \cdot 10^{-6} L_t^{3.1288}$$
$$R^2 = 0.976$$

where W_t is the total weight (kg) and L_t is the total length (cm).

The average conversion factor for converting the weight of *D. mawsoni* trunks (HGT) to the total nominal weight of the specimen was 1.70 for males, 1.69 for females and 1.70 for both sexes. This gives an average yield of 59% for the HGT product.

With the maturity scale used to analyse *D. mawsoni* gonads, it was determined that most of the specimens caught (males = 91.5%; females = 86.8%) were in the primary development stage of gonads (stage 1, immature fish) (Figure 5). The size range of the specimens in this condition was 37 to 125 cm for males and 41 to 130 cm for females. The rest of the specimens, although a smaller percentage (males = 8.5%; females = 13.2%) showed a state of maturity slightly higher than the above (stage 2, maturing virgin or resting); the total length of males and females exceeded 112 cm and 132 cm respectively.

Feeding intensity, assessed by stomach fullness levels or repletion state, was determined for all *D. mawsoni* specimens. The results showed a higher percentage of empty stomachs in females (67%) than in males (51%). Additionally, varying levels of stomach fullness were observed, particularly in males (Figure 6).

The main prey item found in *D. mawsoni* stomachs was fish of the families Channichthyidae (24.5%) and Macrouridae (12.2%); some cephalopod species (20.4%) were also found. The rest of the food items (18.4%) comprised Caridea, Nototheniidae, *Dissostichus* spp. and Euphausiidae. These were consumed less often, since the occurrence of each one was less than 4% (Figure 7). It is important to point out that of all of the material analysed, 24.5% could not be identified due to the advanced stage of digestion.

DISCUSSION

The main species caught were *D. mawsoni*, *M. whitsoni*, *C. dewitti* and *C. antarcticus*, while *D. eleginoides* was taken in low quantities. In general, all of the areas studied yielded the same fish species. However, the results obtained make it possible to identify two fish groups in the study area. One group can be assigned to the region south of 65°S (Bellingshausen Sea, Subarea 88.3) and mainly comprised species of the families Nototheniidae (*D. mawsoni* and *L. kempi)* and Macrouridae (*M. whitsoni*), and the other to the north of 65°S (Subareas 48.1 and 48.2) and north-northeast of the Antarctic Peninsula, where *C. dewitti* and *C. antarcticus* (Channichthydae) were predominant and, to a lesser degree, *R. georgiana* (Rajidae) and *M. whitsoni* (Macrouridae).

As in other regions, *Dissostichus* spp. were caught together with the families Macrouridae, Nototheniidae, Rajidae and Moridae. Similar results have been obtained in longline operations carried out around the Kerguelen Islands (Duhamel et al., 1997), South Georgia Island (Khvichiya, 1995; Kozlov, 1995) and the South Sandwich Islands (Rubilar et al., 1993), as well as in trawl operations around Elephant Island (Kock, 1988).

As mentioned above, the target species of this research were found in all of the sampled locations, except the Gerlache seamounts in the Bellingshausen Sea. *D. mawsoni* was found to the south of 61°S and all along the west coast of the Antarctic Peninsula to the Antarctic continental shelf and the slope in the Bellingshausen Sea (70°38'S), while *D. eleginoides* was caught to the north of 61°30'S, and also around the South Orkney Islands and the Scotia Sea, around 58°S.

It has also been mentioned that the latitudinal distribution of *D. mawsoni* is described as being the Indian Ocean sector from 63°57'S to 69°30'S

Table 3: Somatometric characteristics of species caught.

Common Name	Scientific Name	Sample						Total Catch	
		Total Length (cm)					Average Weight (kg)	% by Numbers	% by Weight
		Minimum	Maximum	Average	SD	No.			
Pisces									
Patagonian toothfish	*Dissostichus eleginoides*	56	122	94.86	23.26	7	11.29	0.34	2.78
Antarctic toothfish	*Dissostichus mawsoni*	37	168	80.04	31.58	123	9.70	5.92	41.99
Bigeye grenadier	*Macrourus whitsoni*	39	88	57.46	8.49	202	1.18	30.86	26.54
Armed grenadier	*Coryphaenoides ferrieri*	62	80	72.40	5.54	15	2.43	0.72	1.28
Smalleye eel cod	*Muraenolepis microps*, *Muraenolepis* spp.	37	54	48.68	4.56	22	1.14	1.97	1.64
Blue antimora	*Antimora rostrata*	61	65	62.67	2.08	3	2.07	0.29	0.44
Icefish	*Chionobathyscus dewitti*, *Cryodraco antarcticus*	27	58	37.03	4.38	343	0.43	47.91	15.11
Striped-eyed rockcod	*Lepidonotothen kempi*	27	47	35.01	3.98	91	0.58	9.63	4.09
Humped rockcod	*Gobionotothen gibberifrons*			36.00		1	0.60	0.05	0.02
Pearlfish	*Echiodon* spp.	22	22	22.00		2	0.25	0.10	0.02
Antarctic starry skate	*Raja (Amblyraja) georgiana*	48	91	72.68	11.80	28	4.37	1.78	5.68
McCain's skate	*Bathyraja maccaini*	75	78	76.50	2.12	2	3.85	0.10	0.27
Plunderfish	*Pogonophryne platypogon*	20	35	26.67	4.80	6	0.35	0.29	0.07
		Carapace Length (mm)							
		Minimum	Maximum	Average	SD	No.			
Crustacea									
Antarctic crab	*Paralomis anamerae*			104.00		1	1.80	0.05	0.06
Total								100.00	100.00

(Roshchin, 1997). On the other hand, Yukhov (1997) generally locates the northern limit of this species to around 60°S, near the Antarctic Convergence, and in the Pacific Ocean eastern zone, to the south of 62°S. He defines the southern limit as being in the Pacific Ocean area, based on catches taken parallel to 70°S in the southeast sector of Peter I Island (Yukhov, 1997). The catches taken during this cruise indicate a wider distribution for *D. mawsoni*, placing it in the Pacific Ocean eastern sector, between 61°13'S and 70°38'S.

Furthermore, the southern limits of *D. eleginoides* catches were located at 61°24'S, where a specimen weighing 24 kg and measuring 122 cm was caught. This would also extend the southern distribution limit of this species to at least that latitude. According to Prutko (1997), *D. eleginoides* only reached 57°S, while Fischer and Hureau (1985) described the general distribution of this species as being in the sub-Antarctic islands, from Kerguelen to Bouvet Island, in the Indian Ocean and part of the Atlantic east of the Southern Ocean, as well as the Scotia Arc Islands and off the northern Antarctic Peninsula. It was also determined that in the surveyed subareas, both *Dissostichus* species were distributed at similar depths, in general similar to those reported for other regions.

Concerning the biological aspects, an allometric growth pattern in relation to the size/weight ratio was established for *D. mawsoni*; the common value for males and females was $b = 3.1288$. This falls within the range of values for the parameter b reported for *D. eleginoides* (SC-CAMLR, 1992), which vary from $b = 2.407$ in specimens from South Georgia Island (Aguayo and Cid, 1991) to $b = 3.580$ in specimens from the Kerguelen and Crozet Islands (Hureau and Ozouf-Cotaz, 1980). This is also similar to values reported by des Clers et al. (1996) for *D. eleginoides* from the Falkland/Malvinas Islands.

Analysis of the stomach contents of *D. mawsoni* revealed a mixed carnivorous diet (euryphagia), with small identifiable prey comprising 59% fish, 27% cephalopods and 14% crustaceans, which would clearly indicate that this species is a carnivorous opportunist and a consumer of the fifth or sixth level (Prenski and Almeyda, 1997), possibly feeding on the most abundant species of the Antarctic demersal and mesopelagic communities. In general, this result is consistent with various works carried out on the feeding habits of *D. eleginoides* (Movillo and Bahamonde, 1971; Martínez, 1975; Duhamel, 1981; Flores and Rojas, 1987; Pshenichnov, 1996; García de la Rosa et al., 1997; Prenski and Almeyda, 1997). According to available information, *Dissostichus* spp. feeding is greatly dependent on depth. This can clearly be seen in the results obtained by García de la Rosa et al. (1997) from their analysis of *D. eleginoides* samples obtained at different depth ranges around South Georgia Island (Subarea 48.3). In particular, the specimens caught at depths exceeding 1 000 m around this island showed a similar consumption of fish, cephalopods and crustaceans to that established during this cruise for *D. mawsoni* in Antarctic waters ranging in depth from 600 to 1 600 m.

Of the organisms found in *D. mawsoni* stomachs, two specimens of *D. mawsoni* were found, with a frequency of occurrence of 4.1%. A female measuring 154 cm and weighing 48 kg contained a 3 kg specimen of its own species. This indicates a certain amount of cannibalism among *D. mawsoni*, a phenomenon also found in *D. eleginoides* (Duhamel, 1981; Prenski and Almeyda, 1997).

Concerning gonad maturity, all the *D. mawsoni* specimens caught were in maturity stage 1 and 2, which indicated that this species had resting gonads during the research period. These stages coincide with the reproductive period of *D. eleginoides*, when maturing and spawning take place during the austral autumn and winter. According to Young et al. (1995, 1996), spawning of the latter species occurs in July and August in southern Chilean waters; in waters surrounding South Georgia, Kerguelen and Crozet Islands, spawning happens each year between June and September (Duhamel, 1987, 1991; Konforkin and Kozlov, 1992). In the Falkland/Malvinas Islands, spawning takes place during the southern autumn (des Clers et al., 1996). On the other hand, through histological analysis, it has been pointed out that in Patagonian Argentina reproduction takes place between July and November (Collado, 1994).

The most relevant results of this exploratory fishing expedition have been the very low yields from all the sampled bottoms. This indicates a low presence of epibenthic and demersal fish, which indicates poor prospects for fishing operations in this subarea using longlines similar to those used on this occasion. Although this research was carried out during a period of favourable weather conditions (i.e. the southern hemisphere was subject to the El Niño phenomenon), it is unlikely

that the results obtained would be in any way related to these atmospheric–oceanic conditions. This is because of the extreme southern location of the study area and the depths at which fishing operations were carried out.

It should also be mentioned that Aguayo and Cid (1991) have described the results obtained from five longline sets in the Antarctic region (60°53'–61°58'S and 54°47'–60°20'W) at depths ranging between 600 and 1 350 m, using an average of 12 000 hooks per set. During that cruise a total of 61 *D. mawsoni* specimens were caught, with a total weight of 177 kg; this gave an overall average of only 2.95 g/hook.

Other results comparable with the findings of this research are those obtained by Rubilar et al. (1993) during an exploratory fishing expedition carried out around the South Sandwich Islands. On that occasion seven longline sets were made between 950 and 2 000 m, with a total catch of only 43 specimens (395 kg) of *D. eleginoides* and one specimen of *D. mawsoni* (TL 123 cm, weight 7.5 kg), giving an average catch per effort of 5.37 g/hook.

Finally, it should be pointed out that the Antarctic ecosystem is mainly based on phytoplanktonic production which sustains krill and other zooplanktonic species, which in turn constitute the basic food for birds, penguins, seals, whales and pelagic fish such as icefish. The energy transfer to deeper waters is limited, which causes the epibenthic and demersal fauna of the continental shelf and slope to be low in biomass. For this reason, as pointed out by Yukhov (1997), *D. mawsoni* can be found in shallow waters in certain periods, and the link between this species and krill is through feeding on cephalopods and bathypelagic fish, which in turn feed on krill. This characteristic should be taken into account in future investigations; semipelagic nets could be used in order to establish the presence of this species in open waters south of the Polar Front.

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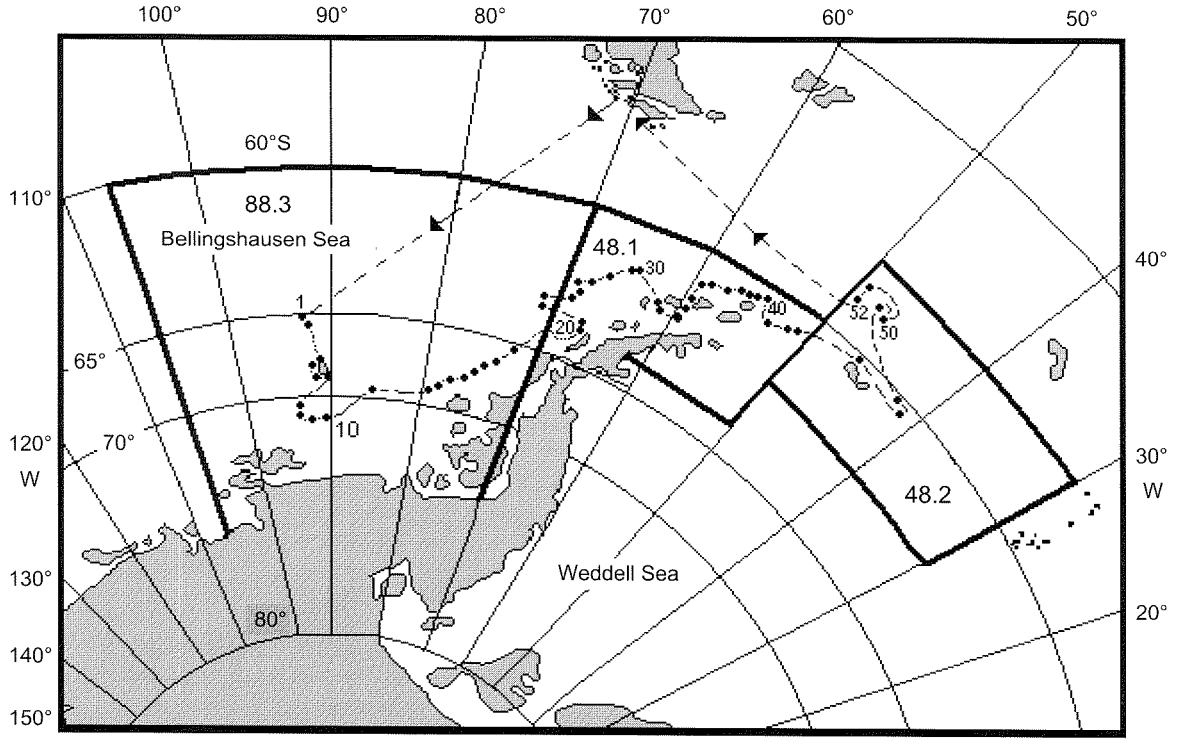


Figure 1: Cruise track (- - -) and stations (•) where longlines were set (Subareas 48.1, 48.2 and 88.3).

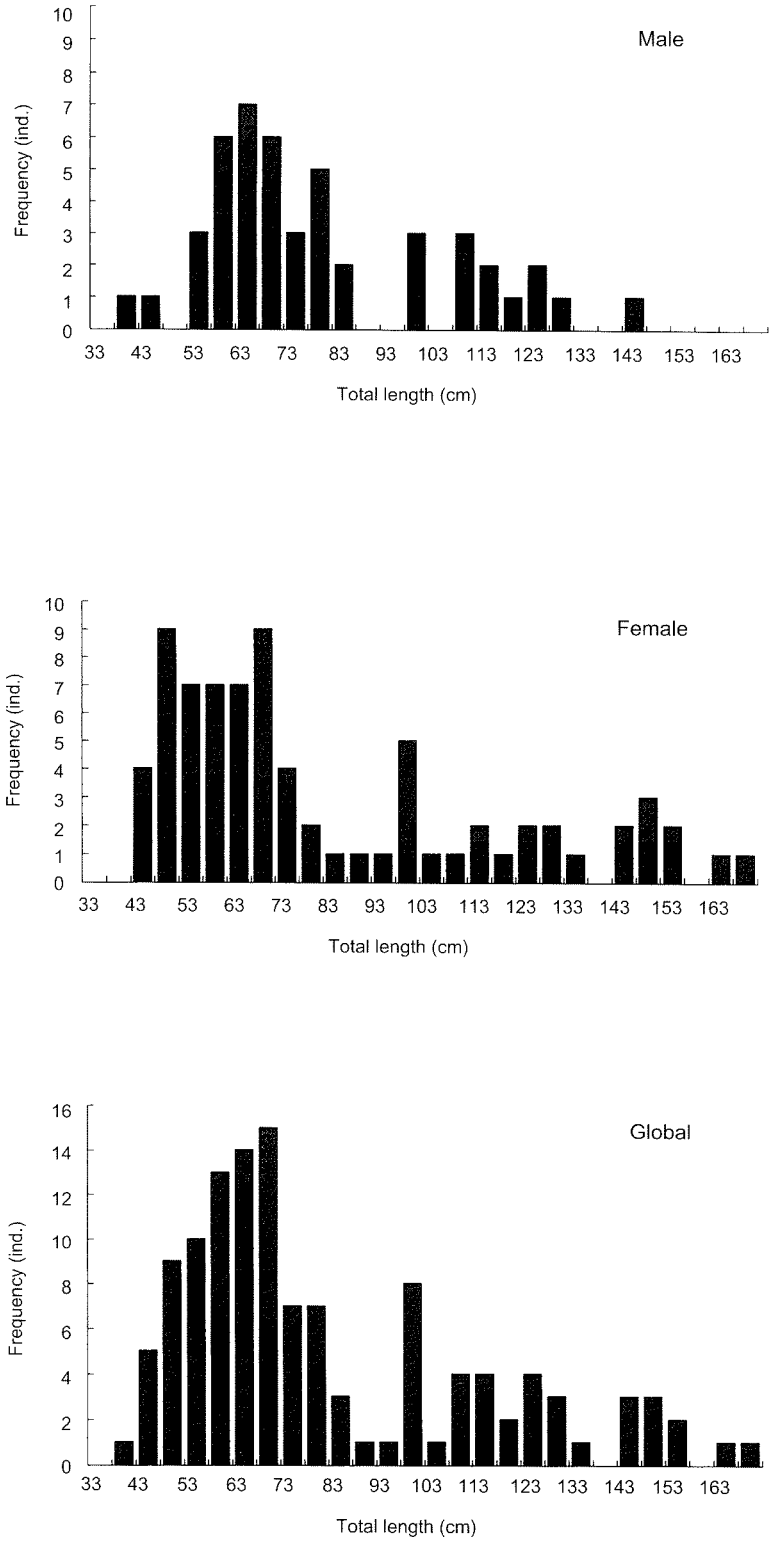


Figure 2: Length-frequency distribution of *Dissostichus mawsoni*.

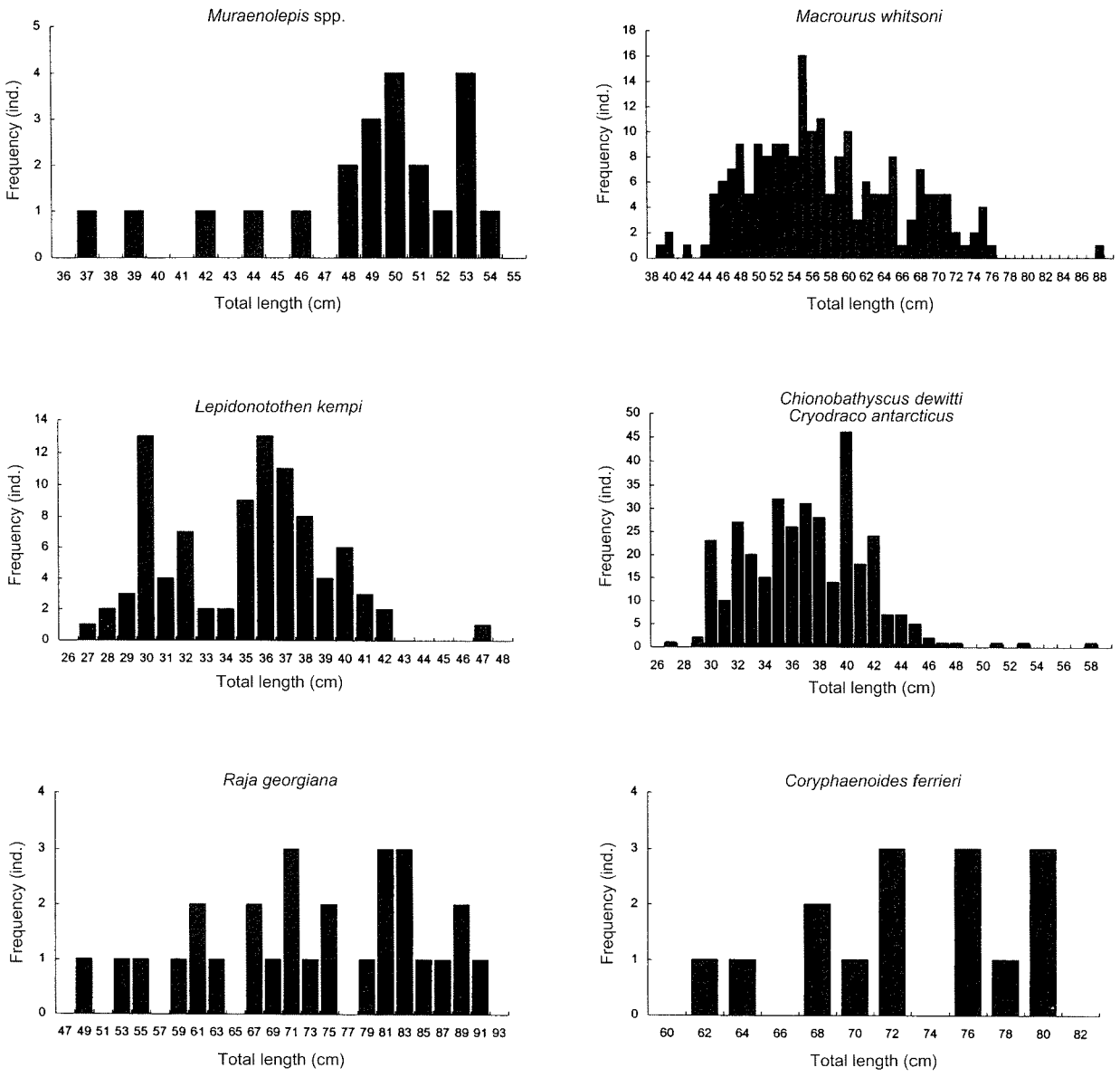
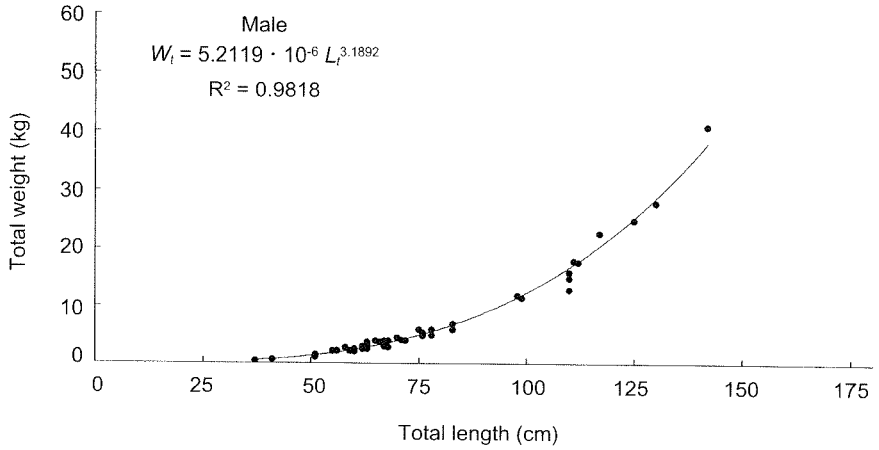
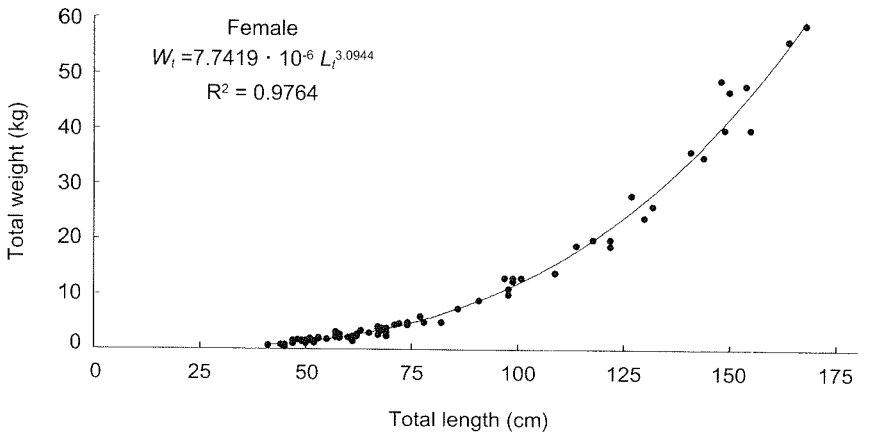


Figure 3: Length-frequency distributions of the most abundant species caught.





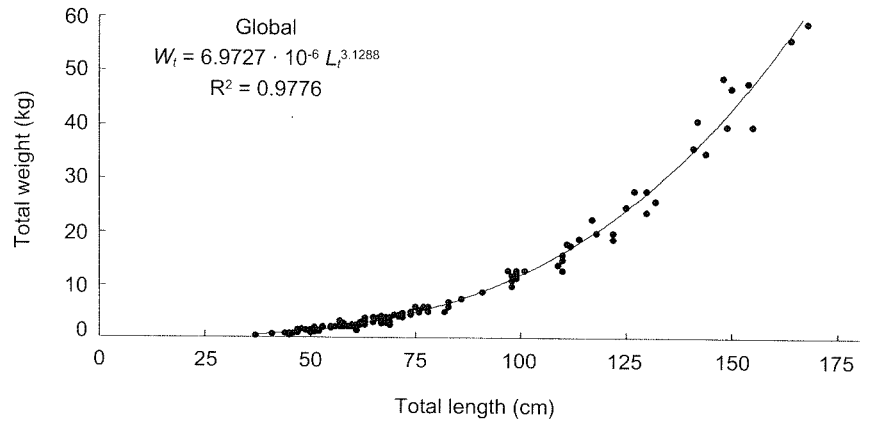


Figure 4: Length–weight relationship for *Dissostichus mawsoni*.

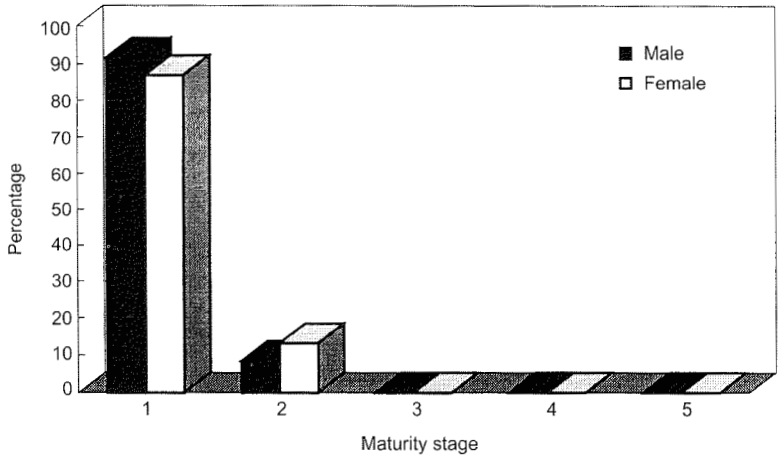


Figure 5: Maturity stages of *Dissostichus mawsoni*: 1 – immature, 2 – maturing virgin or resting, 3 – developing, 4 – gravid, and 5 – post-spawning.

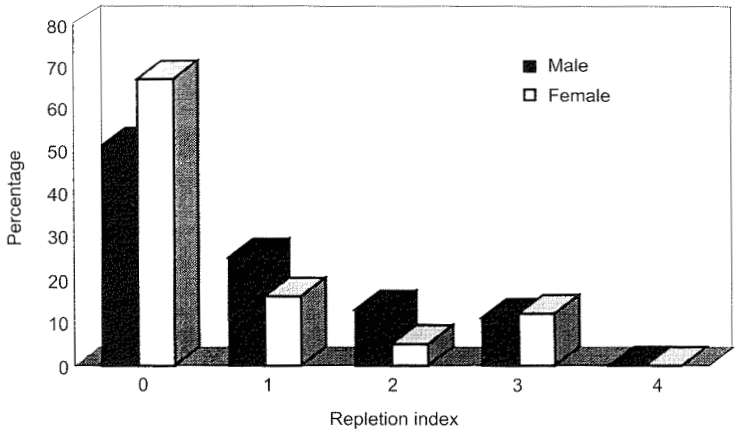


Figure 6: Stomach repletion in *Dissostichus mawsoni*: 0 – empty, 1 – quarter full, 2 – half full, 3 – three-quarters full, and 4 – totally full.

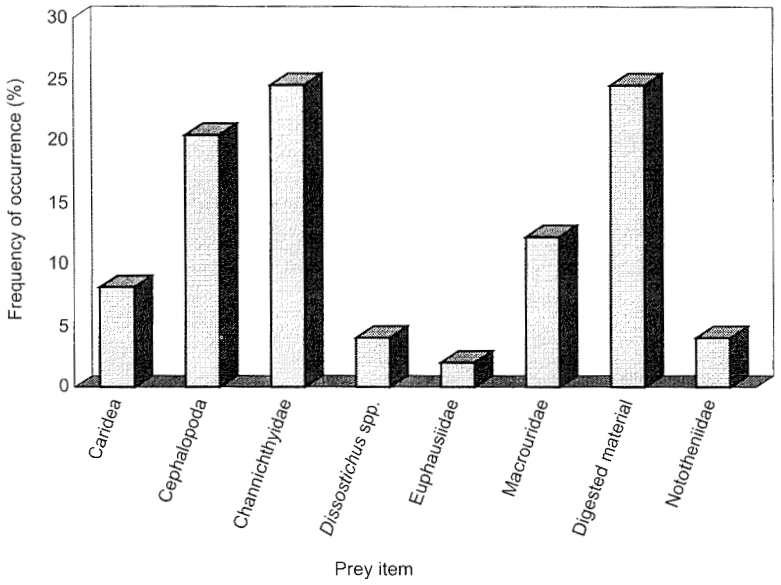


Figure 7: Frequency of occurrence of principal prey items in the diet of *Dissostichus mawsoni*.

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