

SHORT NOTE

PATAGONIAN TOOTHFISH IN INTERNATIONAL WATERS OF THE SOUTHWEST INDIAN OCEAN (STATISTICAL AREA 51)

L.J. López Abellán
 Instituto Español de Oceanografía
 Centro Oceanográfico de Canarias
 Ctra. San Andrés nº 45
 Santa Cruz de Tenerife, España
 Email – luis.lopez@ca.ieo.es

Abstract

Experimental fishing for Patagonian toothfish (*Dissostichus eleginoides*) took place from 28 June to 27 July 2003. This experiment was carried out by a Spanish longliner, following commercial fishing procedures, in a restricted area south of Madagascar and north of Prince Edward and Marion Islands and the Crozet Islands, outside EEZs and CCAMLR waters. A total of 57 hauls was made at depths between 360 and 1 950 m. *D. eleginoides* was present in all hauls, with catches varying from 53 to 1 158 kg. The northward distribution of *D. eleginoides* is closely related to the extension of the Sub-Antarctic Front, and especially the intermediate layer of sub-Antarctic water masses, which defines the area of *D. eleginoides* toothfish distribution. The survey area would seem to be located at the edge of the principal area of *D. eleginoides* concentration, in which a residual recruitment effect persists. The total CPUE was 42.21 kg/thousand hooks. Within the study area, depth was the most important factor in the distribution of CPUE of *D. eleginoides*.

Résumé

Une campagne de pêche expérimentale a eu lieu du 28 juin au 27 juillet 2003, avec pour espèce-cible la légine australe (*Dissostichus eleginoides*). L'expérience a été réalisée par un palangrier espagnol, aux procédures de pêche commerciale, dans une zone restreinte au sud de Madagascar et au nord des îles du Prince Edouard, Marion et Crozet, en dehors des ZEE et des eaux de la CCAMLR. Un total de 57 chalutages a été réalisé entre 360 et 1 950 m de profondeur. Des individus de *D. eleginoides* étaient présents dans chacun d'eux, avec des captures entre 53 et 1 158 kg. La distribution de *D. eleginoides* vers le nord est étroitement liée à l'extension du front subantarctique, notamment à la couche intermédiaire des masses d'eaux subantarctiques, qui définit le secteur de distribution de *D. eleginoides*. La zone de prospection semble se situer à la bordure de la concentration principale, dans laquelle persiste un effet de recrutement résiduel. La CPUE totale était de 42.21 kg/millier d'hameçons. La profondeur est le facteur le plus important dans la distribution de la CPUE de la légine australe dans la zone étudiée.

Резюме

Экспериментальный промысел патагонского клыкача (*Dissostichus eleginoides*) проводился с 28 июня по 27 июля 2003 г. Этот эксперимент проводился испанским ярусоловом, который следовал процедурам коммерческого промысла, в ограниченном районе, лежащем к югу от Мадагаскара и к северу от о-вов Принс-Эдуард, Марион и Крозе, за пределами ИЭЗ и вод АНТКОМа. В общей сложности было выполнено 57 выборок на глубинах 360–1950 м. *D. eleginoides* присутствовал во всех выборках и его уловы варьировали от 53 до 1158 кг. Распространение *D. eleginoides* в северном направлении тесно связано с расположением Субантарктического фронта, и особенно промежуточного слоя субантарктических водных масс, которое определяет район распространения *D. eleginoides*. Как представляется, район съемки расположен на краю основного

района концентрации *D. eleginoides*, где сохраняется остаточное влияние пополнения. Общий CPUE составил 42.21 кг/1000 крючков. В районе исследования глубина была наиболее важным фактором, влияющим на распределение CPUE для *D. eleginoides*.

Resumen

Entre el 28 de junio y el 27 de julio de 2003 se realizó una campaña de pesca experimental, teniendo como especie objetivo la austromerluza negra (*Dissostichus eleginoides*). La experiencia fue realizada por un palangrero español, por medio de pescas comerciales, en un área restringida al sur de Madagascar y al norte de las islas Príncipe Eduardo, Marion y Crozet, por fuera de las ZEE y de las aguas de la CCRVMA. Se realizaron un total de 57 pescas, entre 360 y 1950 metros de profundidad. En todos los lances aparecieron ejemplares de *D. eleginoides*, con capturas comprendidas entre 53 y 1158 kg. La distribución de *D. eleginoides* en dirección norte está estrechamente relacionada con la extensión del frente sub-antártico y especialmente con la capa intermedia de masas de agua sub-antártica, que actúa como vehículo de dispersión. El área prospectada parece estar situada en el borde de la concentración principal, en el cual persiste un efecto de reclutamiento residual. La CPUE total fue de 42.21 kg/1000 anzuelos. La profundidad es el factor más importante en la distribución de la CPUE de *D. eleginoides* en la zona estudiada.

Keywords: *Dissostichus eleginoides*, geographical distribution, population structure, Area 51, Indian Ocean, CCAMLR

Introduction

There is little information available on fishing activities for Patagonian toothfish (*Dissostichus eleginoides*) in international waters of the southwest Indian Ocean (Area 51) adjacent to the Convention Area. The information in this paper was presented at the 2003 meeting of the Working Group on Fish Stock Assessment (WG-FSA) and SC-CAMLR-XXII (SC-CAMLR, 2003).

This paper seeks to shed some light on this matter, showing toothfish population size and sex structures and the CPUE in relation to depth and latitude. However, the analysis does not include some adjacent areas to the north of the surveyed area where *D. eleginoides* may hypothetically be found, as these places were not sampled.

The analysis presented here also considers the relationship between physical processes, underwater ridges and the distribution pattern of *D. eleginoides* in the region. Further information on the subject is available from Lutjeharms (1990), Williams et al. (2002) and Burlenko (2003).

Methods

Experimental fishing for *D. eleginoides* took place from 28 June to 27 July 2003. This experiment was carried out on a Spanish longliner, strictly following commercial fishing procedures, in a restricted area south of Madagascar and north of the Prince Edward and Marion Islands and the

Crozet Islands, outside EEZs and CCAMLR waters (Figure 1). Scientific observations were conducted by a national observer.

Using the Spanish bottom longline system, a total of 57 hauls (9 000–12 000 hooks) was made at depths between 360 and 1 950 m within the proposed area. The depth ranges of individual sets were greater than 200 m in 79% of cases and this factor affects the final analysis in which data were related to depth, mainly in terms of whether fish size data could be assigned to a single depth stratum.

Fish length was measured as total length (TL) to the nearest centimetre and fish were weighed to the nearest 100 g. Maturity of individuals was recorded using the five-stage maturity scale.

An attempt to characterise the harvested population is made, comparing the current length structure of catches with others from previously described places.

Results and discussion

Catches

No zero catches were taken during the fishing experiment, *D. eleginoides* being present in all hauls, with catches varying from 53 to 1 158 kg. This circumstance makes it impossible to identify the northern boundary of toothfish distribution in this area. Data from Ukrainian cruise logbooks

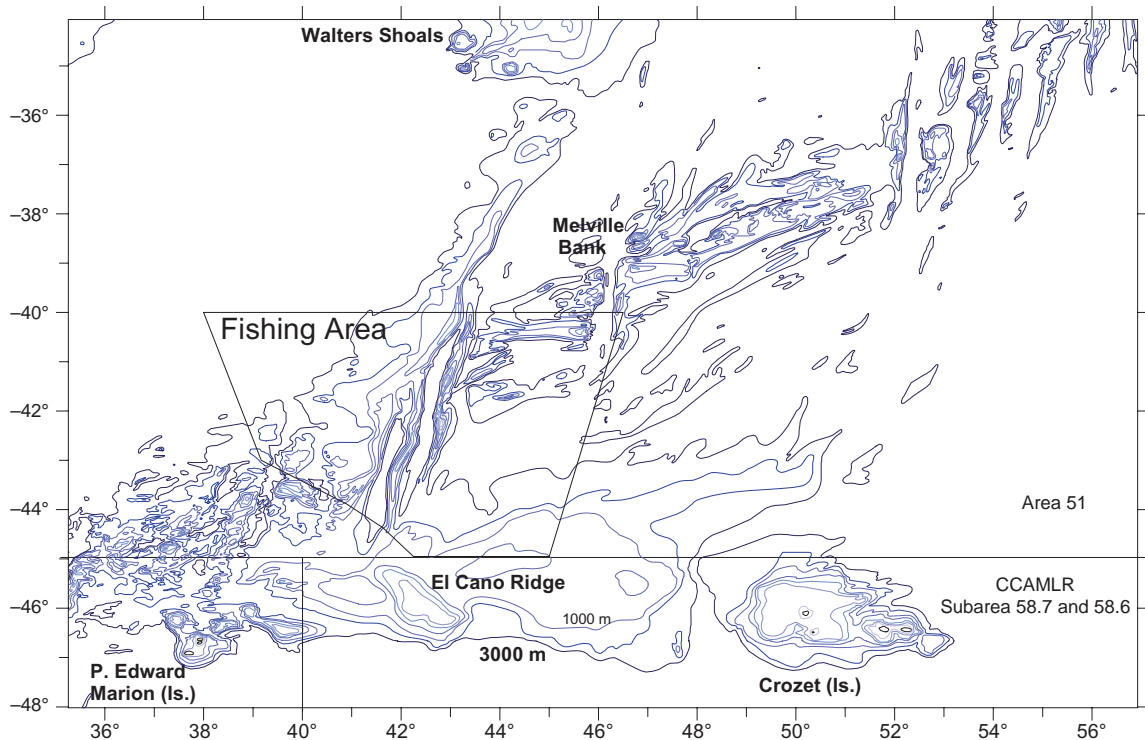


Figure 1: Map showing the limits established for the experimental fishing conducted (fishing area).

place the northern boundary of *D. eleginoides* distribution in Area 51 at 37°S (Pschenichnov, pers. comm.).

According to the Park et al. (1993) description in Williams et al. (2002) of the frontal structure in the region showing the presence of the Sub-Antarctic Front and the intermediary sub-Antarctic water masses (Burlenko, 2003) in the survey area, it seems that the presence of this front as a dynamic process, in combination with the presence of seamounts (Southwest Indian Ridge) at the appropriate depths, could produce the essential habitat for the distribution of this species.

Lutjeharms (1990) indicated that physical properties and processes in the Southern Ocean influence the creation of specific biogeographical boundaries and habitats. One of these boundaries is located in the Southwest Indian Ridge where the Subtropical Front and the Sub-Antarctic Front collide at the Subtropical Convergence. Over the ridge, the surface consists of subtropical water masses, followed by a mixture layer below, and the intermediate sub-Antarctic water masses in the layer deeper than 800 m (Burlenko, 2003). Therefore, this latter downwelling layer would represent the environment suitable for *D. eleginoides* distribution in the region.

The bottom temperatures at some of the fishing positions were between 3.72°C and 4.7°C, with depths ranging from 947 to 1730 m. Thus, any trace of *D. eleginoides* in the area should be able to be found by following these water masses at increasing depths when moving northwards.

However, the stability or any displacement (latitudinal migration) of this front and the associated water masses would affect the distribution area of the species. Thus, any expansion of the front activity to the north would mean an increase in the distribution area, with the opposite effect taking place when the intensity of the front activity decreased. This process is very common in other species, such as hakes, which are associated with thermal fronts and whose geographical distribution varies seasonally according to frontal displacement (López Abellán and Aríz Tellería, 1993; Sætersdal et al., 1999).

The survey area does not represent the most appropriate location for recruitment to take place, particularly considering the absence of depths shallower than 300 m. Thus, the origin of the population inhabiting these seamounts must be adjacent to the south basins associated with the islands and the mechanism would be ontogenetic migration to deeper waters, as described by Duhamel (1987) and López Abellán and González Jiménez (1999), and migration from other areas. As

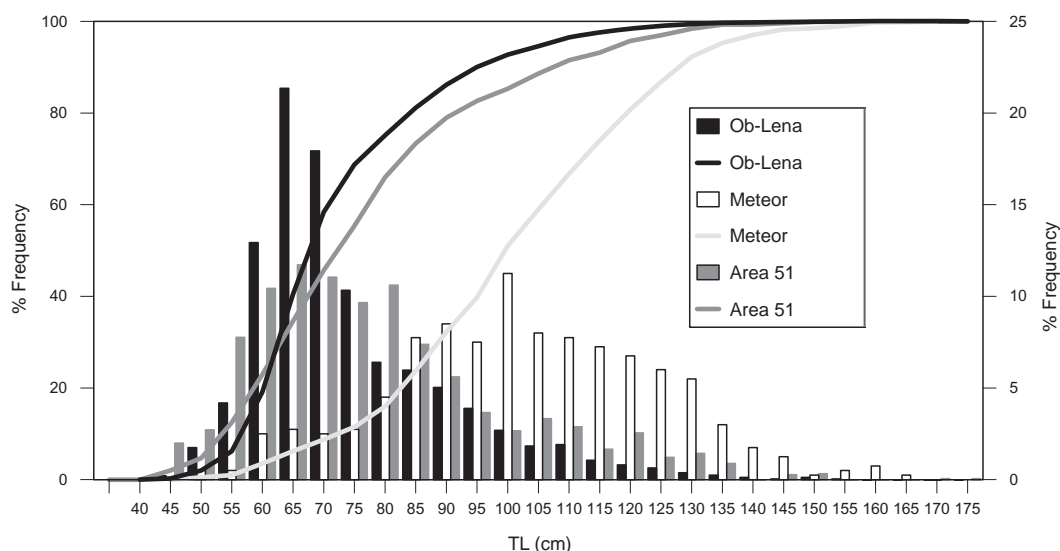


Figure 2: Length-frequency distributions and cumulative length-frequency distributions of *Dissostichus eleginoides* obtained in this study (AR51) and from other banks, such as Meteor, Ob and Lena.

Williams et al. (2002) described, a displacement pattern may have taken place in the region towards the northwest from the Heard fishing grounds, which would demonstrate that *D. eleginoides* may move long distances. This behaviour is reflected in isolated seamounts, such as Meteor Bank, where there is a characteristic size structure dominated by individuals of greater sizes (López Abellán and González Jiménez, 1999).

Length-frequency distribution of catches

Length distributions could not be assigned to depth strata because the ranges in depth for individual sets were greater than 200 m in 79% of cases. Therefore, only the total and cumulative length-frequency distributions are presented and compared with others obtained by López Abellán and González Jiménez (1999) on Meteor Bank (8°30'E 48°S) and Ob (41°15'E 52°19'59"S) and Lena (44°15'E 53°S) Banks (Figure 2).

Figure 2 shows the size structure of a characteristic location dominated by recruitment success (Ob and Lena) (77.04 cm, SD = 16.21) and another where the resident population may consist primarily of adults moving from other areas through migration, with few juveniles (Meteor) (105.24 cm, SD = 21.5). Comparing these structures with those obtained in this study (81.20 cm, SD = 20.91) it can be seen that this last structure is similar to those at Ob and Lena but less influenced by juveniles. Consequently, the survey area seems

to lie towards the outer edge of the principal area of concentration, in which a residual recruitment effect persists.

Sex ratio and maturity

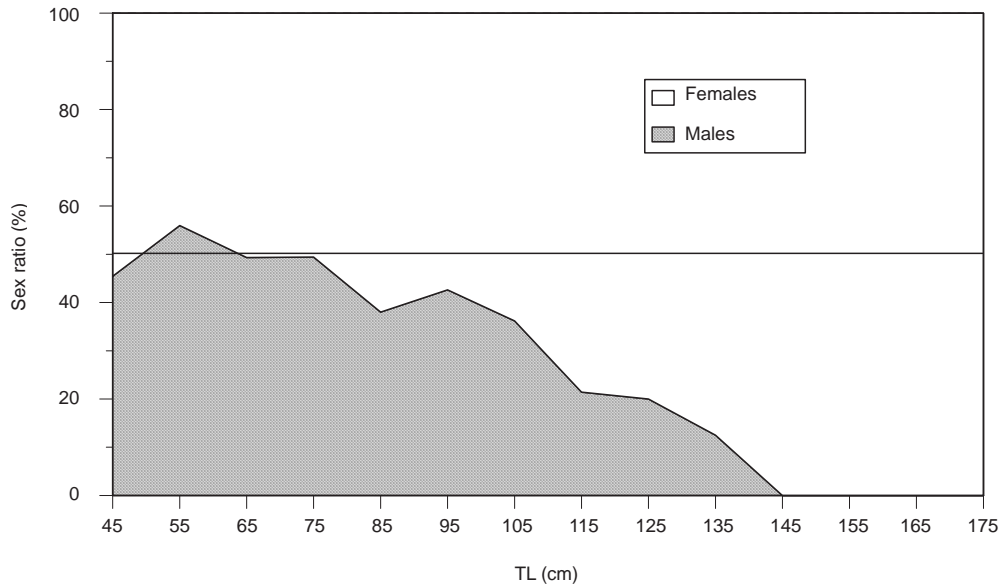
Of the 972 individuals of *D. eleginoides* used in the sex ratio analysis, 437 were males and 535 females. Females reached larger sizes than males (females 177 cm TL, males 137 cm TL). The proportion of males in the catch decreased as body size increased (Figure 3). The goodness-of-fit analysis of the expected ratio 1:1 indicated that, up to 85 cm TL, the ratio of sexes was not significantly different from 1:1. At sizes above 95 cm TL, the sex ratio (male:female) increased with length from 1:1.35 to 1:7 in the 135 cm interval.

These results are similar to those obtained by López Abellán and González Jiménez (1999). In this work, the authors related the size at which the sex ratio undergoes an abrupt shift (male:female) to the size at which males reached sexual maturity (72 to 90 cm, Konforokin and Kozlov, 1992) and a natural process that reduced their presence, probably spawning mortality.

Of the 164 individuals used in the maturity analysis, 83 were males and 81 females. Approximately 50% of individuals of both sexes were at stages 4 (ripe or gravid) and 5 (spent). Lengths for males at these stages ranged from 70 to 140 cm TL and from 80 to 150 cm TL for females.

Table 1: CPUE obtained from experimental fishing.

Depth strata	CPUE (kg/thousand hooks)
<800 m	35.93
800–1 500 m	50.11
>1 500 m	26.41
Total	42.21

Figure 3: Sex ratio of *Dissostichus eleginoides* by size.

CPUE

Although it was not possible in this study to define depth strata in relation to fish size, CPUE data have been calculated taking into account the results of the stratification by López Abellán and González Jiménez (1999). Table 1 includes these data and points out that the 800–1 500 m stratum reaches its maximum value at 50.11 kg/thousand hooks. The total CPUE was 42.21 kg/thousand hooks.

Figure 4 illustrates the CPUE distribution of individual sets in relation to depth and latitude. The relationship between CPUE and depth shows that the higher values (80–100 kg/thousand hooks) are concentrated in the 900–1 400 m depth stratum. In the case of CPUE and latitude, the distribution of the data points indicates a zero latitudinal trend and would point to depth as being the most important factor in the CPUE distribution of *D. eleginoides* within the study area.

Conclusions

The following conclusions were drawn from this analysis:

- (i) The northward distribution of *D. eleginoides* seems to be closely related to the extension of the Sub-Antarctic Front and especially to the intermediate sub-Antarctic water masses, which represents an environment suitable for the distribution of the species.
- (ii) The survey area seems to be located towards the outer edge of the main ground, in which a residual recruitment effect persists.
- (iii) The CPUE–depth and CPUE–latitude relationships indicate a zero latitudinal trend and would point to depth as being the most important factor in *D. eleginoides* CPUE distribution within the study area.

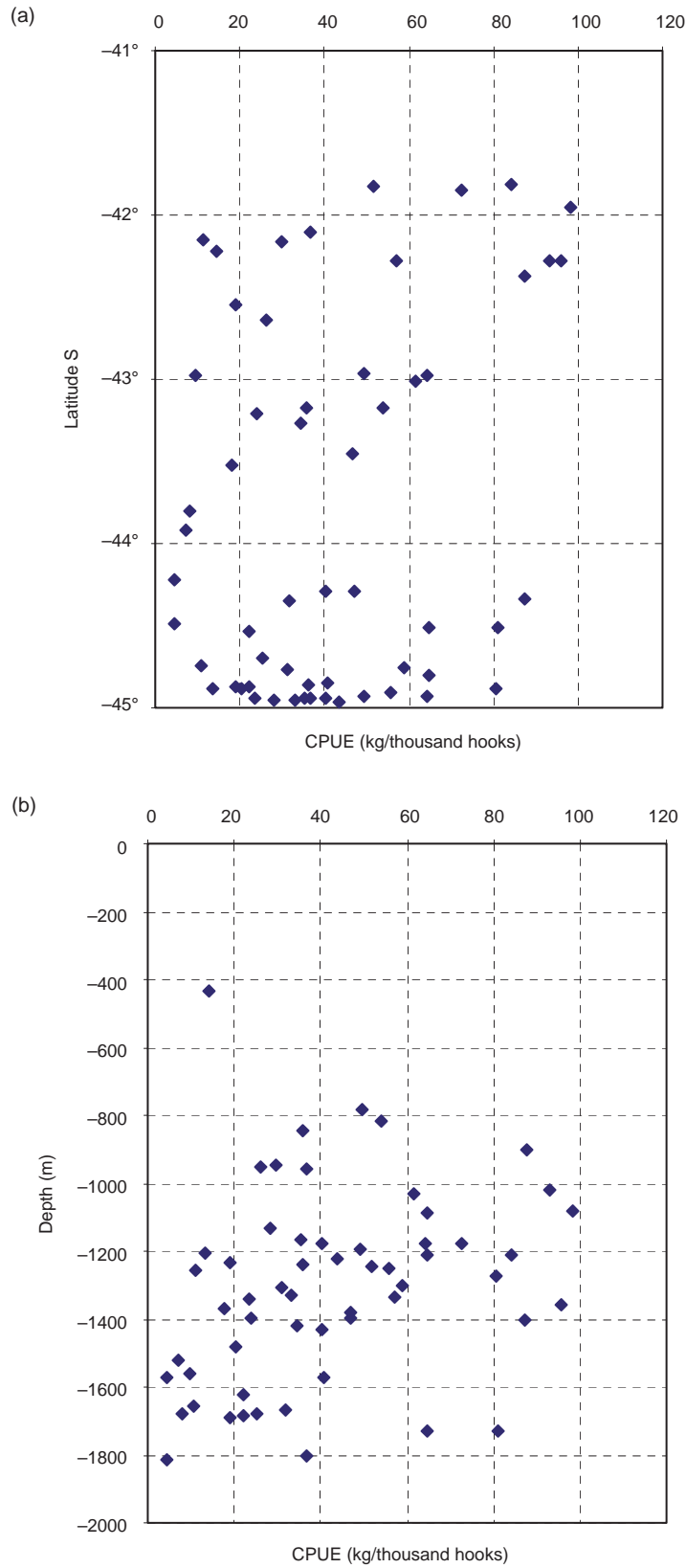


Figure 4: CPUE distribution of single sets in relation to latitude (a) and depth (b).

Acknowledgements

The author wishes to thank the scientific observers for their collection of fishery data, and the officers and crew on the fishing vessel. Thanks also to L. Pshenichnov and an anonymous reviewer for their useful comments on an earlier draft of this paper.

References

- Burlenko, T.I. 2003. General physical and geographical characteristics of the underwater ridges of the Southern Indian Ocean. In: Romanov, E.V. (Ed.). *Summary and Review of Soviet and Ukrainian Scientific and Commercial Fishing Operations on the Deepwater Ridges of the Southern Indian Ocean*. FAO Fisheries Circular, No. 991, Rome, FAO: 84 pp.
- Duhamel, G. 1987. Ichtyofaune des secteurs indien occidental et atlantique oriental de l'océan Austral: biogéographie, cycles biologiques et dynamique des populations. Thèse de doctorat d'État. Université Pierre et Marie Curie, Paris VI: 687 pp.
- Konforokin, I.N. and A.N. Kozlov. 1992. Pre-spawning and spawning biology of the Patagonian toothfish, *Dissostichus eleginoides*, around South Georgia (Subarea 48.3). Document WG-FSA-92/13. CCAMLR, Hobart, Australia: 14 pp.
- López Abellán, L.J. and J. Ariz Tellería. 1993. Aspectos generales de la distribución y biología de las especies del género *Merluccius* Rafinesque, 1810, en aguas de Senegal y Gambia (16°00'N–12°25'N). *Bol. Inst. Esp. Oceanogr.*, 9 (1): 101–121.
- López Abellán, L.J. and J.F. González Jiménez. 1999. Results of a longline survey on seamounts in the southeast Atlantic and in Subarea 48.6 and Division 58.4.4. *CCAMLR Science*, 6: 99–116.
- Lutjeharms, J.R.E. 1990. The oceanography and fish distribution of the Southern Ocean. In: Gon, O. and P.C. Heemstra (Eds). *Fishes of the Southern Ocean*. J.L.B. Smith Institute of Ichthyology, Grahamstown: 462 pp.
- Park, Y.-H., L. Gamberoni and E. Charriaud. 1993. Frontal structure, water masses and circulation in the Crozet Basin. *J. Geophys. Res.*, Series C, 98: 12361–12385.
- SC-CAMLR. 2003. Report of the Working Group on Fish Stock Assessment. In: *Report of the Twenty-second Meeting of the Scientific Committee (SC-CAMLR-XXII)*, Annex 5, paragraph 5.310. CCAMLR, Hobart, Australia: p. 359.
- Sætersdal, G., G. Bianchi, T. Strømme and S.C. Venema. 1999. The Dr Fridtjof Nansen Programme 1975–1993. Investigations of the fishery resources in developing regions. History of the programme and review of results. *FAO Fisheries Technical Paper*, No. 391. Rome, FAO: 434 pp.
- Williams, R., G.N. Tuck, A.J. Constable and T. Lamb. 2002. Movement, growth and available abundance to the fishery of *Dissostichus eleginoides* Smitt, 1898 at Heard Island, derived from tagging experiments. *CCAMLR Science*, 9: 33–48.

Liste des tableaux

Tableau 1: CPUE obtenue à partir d'activités de pêche expérimentale.

Liste des figures

- Figure 1: Carte indiquant les limites établies de la pêche expérimentale menée (secteur de pêche).
- Figure 2: Distributions des fréquences de longueurs et distributions des fréquences de longueurs cumulées de *Dissostichus eleginoides* obtenues dans cette étude (AR51) et d'autres bancs, tels que Meteor, Ob et Lena.
- Figure 3: Sex ratio chez *Dissostichus eleginoides* selon la taille.
- Figure 4: Distribution de la CPUE par trait en fonction de la latitude (a) et de la profondeur (b).

Список таблиц

Табл. 1: Индексы CPUE, полученные при экспериментальном промысле.

Список рисунков

Рис. 1: Карта, показывающая границы проводившегося экспериментального промысла (район промысла).

Рис. 2: Распределение частот длин и кумулятивное распределение частот длин *Dissostichus eleginoides*, пойманных в ходе данного исследования (AR51) и на других банках, таких как Метеор, Обь и Лена.

Рис. 3: Соотношение полов *Dissostichus eleginoides* по размерам.

Рис. 4: Распределение CPUE отдельных постановок в зависимости от широты (a) и глубины (b).

Lista de las tablas

Tabla 1: CPUE de la pesca experimental.

Lista de las figuras

Figura 1: Mapa ilustrativo de los límites geográficos establecidos para la pesca experimental realizada (área de pesca).

Figura 2: Distribución de frecuencias de tallas y distribución de frecuencia de tallas acumulada de *Dissostichus eleginoides* de este estudio (AR51) y de otros bancos, tales como, Meteor, Ob y Lena.

Figura 3: Proporción de sexos por intervalo de tallas de *Dissostichus eleginoides*.

Figura 4: Distribución del CPUE por lance en relación con la latitud (a) y la profundidad (b).