CCAMLR Science, Vol. 4 (1997): 175-193

SHORT NOTE

BY-CATCH OF FISH IN LONGLINE CATCHES OFF THE KERGUELEN ISLANDS (DIVISION 58.5.1) DURING THE 1995/96 SEASON

G. Duhamel, P. Pruvost and D. Capdeville
Museum national d'histoire naturelle
Laboratoire d'ichtyologie générale et appliquée
43 rue Cuvier, 75231 Paris Cedex 05, France

Abstract

By-catches of fish taken during a commercial fishing cruise and an experimental deep-sea longline fishing cruise targeting Patagonian toothfish (*Dissostichus eleginoides*) off the Kerguelen Islands (Division 58.5.1) during the 1995/96 season were analysed. Eleven species were identified, of which the grenadier *Macrourus carinatus*, the skates *Bathyraja eatonii* and *B. irrasa* and the morid *Antimora rostrata* were dominant. The others were mainly shelf-dwelling species found at the limit of their bathymetric range. An abundance index was used to show bathymetric and geographical distributions of the most common by-catch species. The size of some by-catch species shows that they could be of interest commercially if longline fishing operations expand in this part of the Southern Ocean in the future.

Résumé

Les captures accessoires de poisson réalisées lors d'une campagne de pêche commerciale et une campagne expérimentale profonde ciblant la légine *Dissostichus eleginoides* au large des îles Kerguelen (division 58.5.1) pendant la saison 1995/96 ont été analysées. Onze espèces de poissons ont été identifiées parmi lesquelles le grenadier *Macrourus carinatus*, les raies *Bathyraja eatonii* et *B. irrasa* et le moridae *Antimora rostrata* sont dominants. Les autres sont principalement des espèces du plateau qui se retrouvent en limite de leur distribution bathymétrique. Un indice d'abondance a été utilisé pour analyser les distributions bathymétriques et géographiques des captures accessoires les plus communes. Enfin la taille observée de ces dernières prouve leur potentiel commercial si la pêche à la palangre est développée dans le futur dans ce secteur de l'océan Austral.

Резюме

Был проанализирован видовой состав рыб в прилове в ходе одного коммерческого промыслового рейса и одного экспериментального рейса, направленного на глубоководный ярусный промысел патагонского клыкача (*Dissostichus eleginoides*) в районе островов ергелен (Участок 58.5.1) в сезоне 1995/96 г. Из 11 определенных видов рыб в прилове преобладали *Macrourus carinatus*, *Bathyraja eatonii*, *B. irrasa* и *Antimora rostrata*. Другие попавшие в прилов рыбы были в основном представлены видами, обитающими в шельфовых водах, которые вылавливались у предела их глубинного диапазона распространения. Батиметрическое и географическое распространение наиболее массовых видов прилова проиллюстрировано с помощью индекса численности. Судя по их длине, некоторые попавшие в прилов виды рыб могут предствлять интерес для коммерческой эксплуатации если ярусный промысел будет развиваться в данном секторе Южного океана.

Resumen

Se analizaron las capturas secundarias de peces extraídas durante una campaña de pesca comercial y una campaña de pesca experimental de palangre de fondo, cuyo objetivo fue el bacalao de profundidad (*Dissostichus eleginoides*), en los alrededores de las islas Kerguelén (División 58.5.1) durante la temporada 1995/96. Se identificaron 11 especies, de las cuales las predominantes fueron *Macrourus carinatus*, (granaderos), *Bathyraja eatonii* y *B. irrasa* (rayas), y *Antimora rostrata* (moras). Las demás especies se encontraban en su mayoría en la plataforma, en el límite de su distribución batimétrica. Se utilizó un índice de abundancia para demostrar las distribuciones batimétricas y geográficas de las especies más comunes en la captura secundaria. La distribución de tallas de estas especies demuestra su potencial comercial en el posible desarrollo de la pesca con palangres en ésta área del océano Austral.

Keywords: *Antimora rostrata, Bathyraja* spp., by-catch, Kerguelen Islands, longline fishery, *Macrourus carinatus*, CCAMLR

INTRODUCTION

The first experimental longline fishing operation off the Kerguelen Islands took place during the 1990/91 season (Duhamel, 1992). The target species was the Patagonian toothfish (*Dissostichus eleginoides*) which was previously only fished by trawling. Fishing took place in the deep waters of the shelf break where sub-adult and adult fish (mainly 50 to 120 cm in total length) aggregate. Longline fishing for *D. eleginoides* has expanded to other parts of the Southern Ocean (South Georgia and recently Prince Edward and Crozet Islands) and beyond (Patagonian and southern New Zealand shelves). Longlining allows fishing to be carried out at greater depths (currently down to 1 500 m) than trawling, which is in use on only two fishing grounds (Kerguelen and Macquarie Islands).

Statistical and biological data are available for the targeted species but little information exists concerning the by-catch. The main reason for this is that by-catch species are not processed and are often discarded before being hauled on board. Only scientific programs carried out by fishery observers enable the by-catch to be quantified during the fishing operations. The first opportunity to conduct such a program arose during the 1995/96 fishing season off the Kerguelen Islands (Division 58.5.1).

METHODS

The study area consists of the northwestern part of the Kerguelen Plateau. Catches from two fishing cruises in the French Exclusive Economic Zone (EEZ) of Division 58.5.1 were analysed. The first cruise was carried out by the Ukrainian longliner *Nicolay Reshetnyak* conducting commercial fishing operations on the shelf break, west of 69°E over a limited depth range (380 to 540 m). One observer monitored the catches and recorded the by-catch from a number of the longline sets (179 of a total of 721) carried out between 19 October 1995 and 7 March 1996. The fishing method is described in Duhamel (1992) and Cherel et al. (1996). The second cruise was an experimental deep-sea fishing trial carried out by the Japanese longliner *Anyo Maru No. 22*, and covered the whole area from 17 February to 30 April 1996 over the depth range 300 to 1 700 m. Bottom longlines, carrying 3 800 hooks each, baited with squid and set on the bottom for 7 to 12 hours, were used. All 145 sets, including by-catch observations, were monitored by three observers.

The number of fish of each species was recorded for each longline set studied. The by-catch species were identified using recent identification manuals for Antarctic species (Fischer and Hureau, 1985; Gon and Heemstra, 1990). Skates were the only group not identified to the species level, because they are frequently discarded before being taken on board. However the proportions of the two species recorded (*Bathyraja eatonii* and *B. irrasa*) was estimated to be almost equal (52% versus 48% respectively, $n = 129$) from 10 random samples used for length frequency distributions. Photographs were frequently taken in order to enable species identifications to be confirmed after the cruise. An abundance index (fish/hour) is defined as the number of specimens caught per longline unit (= 3 800 hooks) standardised to one hour of fishing. This index was used to investigate the effects of depth and geographical variations during the experimental fishing cruise.

The size of the most common by-catch species was recorded randomly during the experimental

Table 1: Fish species composition in commercial and experimental deep-water longline catches made off the Kerguelen Islands during the 1995/96 season.

	Commercial Fishing Cruise		Experimental Deep-sea Fishing Cruise	
Fishing Period Depth Range (m) No. of Longlines	19 Oct 95 – 07 Mar 96 380 – 540 179		17 Feb 96 – 30 Apr 96 300 – 1 700 145	
Family Genus species	No.	%	No.	%
Lamnidae				
Lamna nasus	1	0	3	0
Squalidae				
Etmopterus granulosus	0	0	38	0.06
Somniosus microcephalus	2	0.01	1	0
Rajidae				
Bathyraja spp.	143	0.64	6 760	11.22
Muraenolepidae				
Muraenolepis marmoratus	1	0	3	0
Moridae				
Antimora rostrata	0	0	746	1.24
Macrouridae				
Macrourus carinatus	1	0	14 028	23.28
Nototheniidae				
Dissostichus eleginoides	22 193	99.33	38 663	64.15
Lepidonotothen squamifrons	0	0	24	0.04
Channichthyidae				
Champsocephalus gunnari	2	0.01	0	0
Total	22 343	100	60 266	100

fishing cruise with sex identification carried out for the two species of skates. The measurement unit used was total length (TL) to the nearest centimetre below.

RESULTS

Species Composition of Longline Catches

Eleven species of fish were identified. Very few by-catch fish were observed (Table 1) in the shallower depth ranges during the Ukrainian longline fishing cruise. Skates were the main species recorded but made up only 0.64% of the total fish catch (22 343 specimens) in the observed sets. Sharks and species of bony fish occurred only in very small numbers. The Japanese experimental deep-sea catches differed in composition, with the target species comprising 64.2% of the total 60 266 specimens (Table 1). The grenadier *Macrourus carinatus* (23.3%) and the skates *Bathyraja* spp. (*B. eatonii* and *B. irrasa*) (11.6%) were also observed to make up significant proportions of the catch. Another species, the morid *Antimora rostrata*, comprised a significant proportion (1.2%) in the total catch. The other species were anecdotal.

Relative Abundance of Species and Variation with Depth

Considering the datasets available for the experimental deep-water fishing trial, the abundance index shows substantial differences between species. Values for *M. carinatus* are the highest, with a significant proportion of stations,

mainly between 800 and 1 500 m, giving mean catch rates of up to 15 fish/hour[1] (Figure 1). The maximum value is 45 fish/hour of fishing for a longline (i.e. 503 fish recorded per longline set). The abundance of *Bathyraja* spp. is normally less than 15 fish/hour and the majority of lines have less than 5 fish/hour, however it should be noted that some upper depth range stations have high catch rates (Figure 2), giving a recorded maximum value of 45 fish/hour (i.e. 464 fish recorded per longline set). Values for *A. rostrata* are comparatively low; i.e. less than 1 fish/hour for the majority of longlines, with the exception of the deepest sets (Figure 3). The maximum index of abundance is 6 fish/hour (i.e. 54 fish recorded per longline set).

M. carinatus was rare at depths of less than 700 m (Figure 1). A clear increase in abundance with depth was noted before a decreasing trend at the greatest depths. High values at the shallower depths (around 600 m) are observed (Figure 2) for the skates *Bathyraja* spp. before a decreasing mean abundance with depth, except in the 1 100 to 1 300 m depth range where values increase again before reaching a negligible level. The abundance of *A. rostrata*, which is insignificant at depths of less than 700 m, shows a steady but gradual increase with depth (Figure 3). The other by-catch species are reported infrequently. The southern lantern shark *Etmopterus granulosus* (previously identified as *E. lucifer* by Meissner and Kratkii, 1978) occurred in eight sets at depths of 725 to 1 348 m. The porbeagle *Lamna nasus* was present in only three sets at depths of 280 to 797 m. Only one record of the Greenland shark *Somniosus microcephalus* was noted on a line deployed between 293 and 407 m. The moray cod *Muraenolepis marmoratus* occurred in two sets carried out between 457 and 710 m, and the grey rockcod *Lepidonotothen squamifrons* in four sets conducted between 286 and 835 m.

Species Distribution in the Study Area

The position of the longline sets allows for geographic coverage of the northern deep-water zone down to about 1 600 m of the Kerguelen Plateau. There were marked differences between distributions of the main by-catch species and their relative abundance. *M. carinatus* had the highest abundance index value from the northwest to the western part of the area (Figure 4) and was abundant in the majority of stations. *Bathyraja* spp. was relatively less abundant in the whole western part of the area but, in contrast, the northeastern sector (Figure 5) and some southeastern stations had the highest values. *A. rostrata* occurred relatively commonly in the stations north of 49°S (Figure 6); down to this latitude it was present in the by-catch at only a few of the eastern stations. At this stage, the distribution of the uncommon species remains as follows: *E. granulosus* was only recorded from the north to the northeastern sector of the area, *L. nasus* and *S. microcephalus* from single longline sets in the west, *L. squamifrons* was observed in a few sets in the west and south and *M. marmoratus* only in the south.

Length-Frequency Distribution by Species

Length-frequency distributions (LFD) of the common by-catch species were investigated. Length of *M. carinatus* was in the range 39 to 87 cm with a mode at 61 cm and a mean length of 64.2 cm (Figure 7). Sexual differences in length were observed in the distributions of the two species of skates. For *B. irrasa*, lengths were between 61 and 126 cm (Figure 8) with a mean length for males of 104.3 cm and for females of 95.3 cm. The same difference was observed in the mean lengths of male (89.2 cm) and female (85.9 cm) *B. eatonii* which is smaller in size (length range: 48 to 105 cm) than the previous species (Figure 9). The other species with enough specimens to establish an LFD was *A. rostrata*, with lengths of 22 to 65 cm, a mode of 52 cm and a mean length of 45.9 cm (Figure 10).

Specimens of *L. squamifrons* measured were in the range 28 to 42 cm (mean = 36.8 cm, n = 16). Only two specimens of *E. granulosus* were measured (TL 38 and 39 cm). A single specimen of *L. nasus* was 187 cm long. The large size (up to 400 cm) of *S. microcephalus* makes them too difficult to haul on board, so measurements of this species are not available. Specimens of *Bathyraja murrayi* from a single longline set in the western sector (614 to 797 m) included a female measuring 38 cm and two males of 45 and 46 cm in length.

DISCUSSION

Differences were observed between catches of by-catch species made during the commercial fishing cruise and those from the experimental

[1] For definition of the abundance index see 'Methods'.

deep-water fishing investigation (Table 1). Statistical comparisons between vessels were however difficult to carry out due to the differences in fishing periods and areas, baiting systems and the types of bait, and set duration. Despite the possibility of an additional selectivity factor (type/size of hook), depth range was considered to be the main factor governing the distribution of the various species. Analysis of abundance indices by depth strata from the experimental fishing survey (Figures 1 to 3) corroborates this assumption. Skates were the only significant component of the by-catch at shallow depths where the commercial longline fishery operates at present. Deeper fishing increases the diversity of the by-catch and yields a smaller proportion of the target species *D. eleginoides*.

It is interesting to note that the same commonly-occurring species (mainly from the families Macrouridae, Rajidae and Moridae) were observed during experimental trawling, and at similar depths, as are taken by the current longline fishery off the Kerguelen Islands (Duhamel, 1987) or further south on the Banzare seamount (Duhamel and Williams, 1990). The fishing method used gives a good representation of the deep-sea ichthyofauna, taking into account the size selectivity of the hooks which eliminates the small species. By-catch species exhibited a depth preference; *M. carinatus* seemed more abundant between 800 and 1500 m (Figure 1) but *A. rostrata* increased in number towards the deep-sea bottom (Figure 3). It is more difficult to explain the *Bathyraja* distribution because the mixture of two species alters the interpretations. The bimodal distribution for the skates (Figure 2) could possibly be due to the two different species (*B. eatonii* and *B. irrasa*) but the data are still too scarce to confirm this. Initial random samples (n = 10) suggest that the first mode relates mainly to *B. eatonii* and the deeper mode to *B. irrasa*. The recognised shelf and slope species such as *L. squamifrons*, *M. marmoratus*, *L. nasus*, *Champsocephalus gunnari* and probably *S. microcephalus* are at the limit of their depth distribution.

The geographical distribution of by-catch species was not homogeneous. Grenadiers dominated in the northwestern and skates in the northeastern sectors. Morids were less abundant south of 49°S. The smallest shark, *E. granulosus*, was recorded in the same sector in which it was previously known to occur in trawl catches (Duhamel, 1997). By-catches of *L. squamifrons* corresponded to the normal adult distribution of the Kerguelen stock (Duhamel, 1987). The by-catch of the large sharks *L. nasus* and *S. microcephalus*, commonly found in the trawl fishery on the shelf-break fishing grounds for other finfish species (*D. eleginoides*, *L. squamifrons*, *C. gunnari* and *Notothenia rossii*) showed that these were attracted to the fish caught on the line and not to the bait as was the case for the other by-catch species.

Data available for by-catch in the longline fishery in other parts of the Southern Ocean are still very limited. Khvichiya (1995) and Kozlov (1995) indicate three main species in catches from lines set off South Georgia (Subarea 48.3) between 460 and 1 500 m: the grenadier *Macrourus whitsoni*, the skate *Raja georgiana* and the Antarctic king crab *Paralomis spinosissima*. It is interesting to note that the two dominant by-catch fish species, taking into account the differences in the taxonomic status, are both found in the Kerguelen and South Georgia areas. The absence of crab by-catches on the Kerguelen shelf break and adjacent deep waters confirms previous reports on the absence of these crustaceans there. However, the red stone crab *Paralomis aculeata* occurred in the eight experimental longlines deployed on the Skif Bank (a nearby but isolated seamount to the southwest), but the by-catch did not reach the proportions given by Khvichiya (1995).

Results of analyses of by-catches off the Kerguelen Islands point out the possibility of some species replacing *D. eleginoides* in deep-water fisheries. The observed level of *Bathyraja* spp. and *M. carinatus* by-catches made up 34.5% of the total catch in numbers during the experimental cruise and the size of specimens proved to be of commercial interest. The species, such the grenadiers and skates, are commonly reported in the catches of the northeastern Atlantic or the South Pacific (FAO, 1994). Rational use of these species would therefore be better discarding them, as is commonly done in the present limited commercial longline fishery. They could prove to be worthwhile as a by-product of a deep-water longline fishery if a future expansion of the use of this fishing method is projected. In addition, these results, associated with information from other sectors of the Southern Ocean, indicate that the statistical reports (CCAMLR Secretariat, 1995) from the longline fishery targeting *D. eleginoides* fail to include the by-catch species, or do so only partially. Thus the real catches from the currently dominant fishing method for finfish in the Southern Ocean are being underestimated.

ACKNOWLEDGEMENTS

The authors thank the crew of *Anyo Maru No. 22* and *Nicolay Reshetnyak* for their cooperative assistance on board. They also acknowledge the other observers, P. Bletterie and S. Takada, on board the first longliner for their constant help during the cruise. Special thanks are given to the two journal referees for their constructive comments and also to Gillian von Bertouch for her editing of the English version of the paper.

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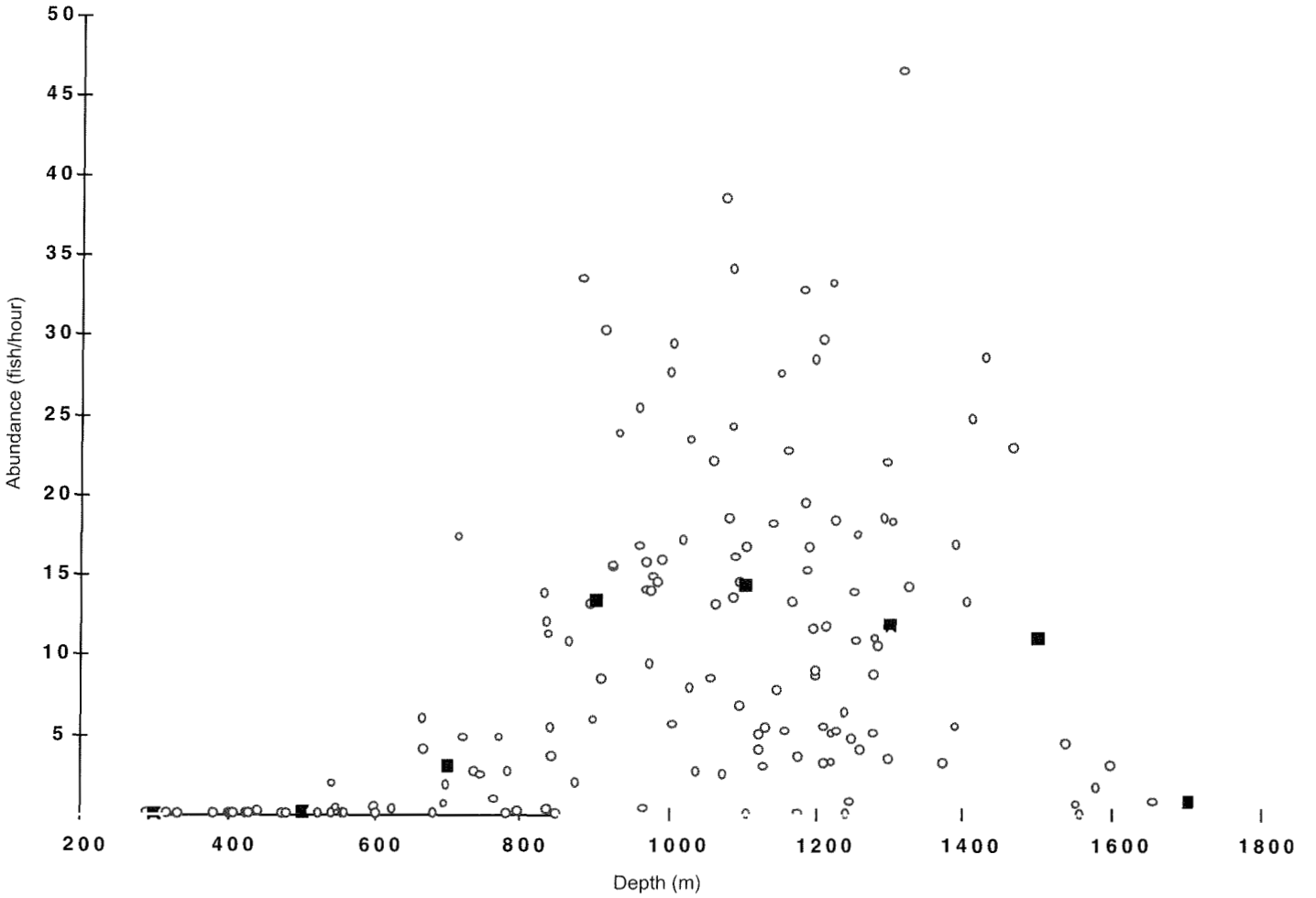


Figure 1: Relative abundance of *Macrourus carinatus* (number of fish per hour of fishing per standard longline set) in relation to depth (in metres) for all longline sets carried out during the experimental fishing cruise in deep waters off the Kerguelen Islands in 1995/96.

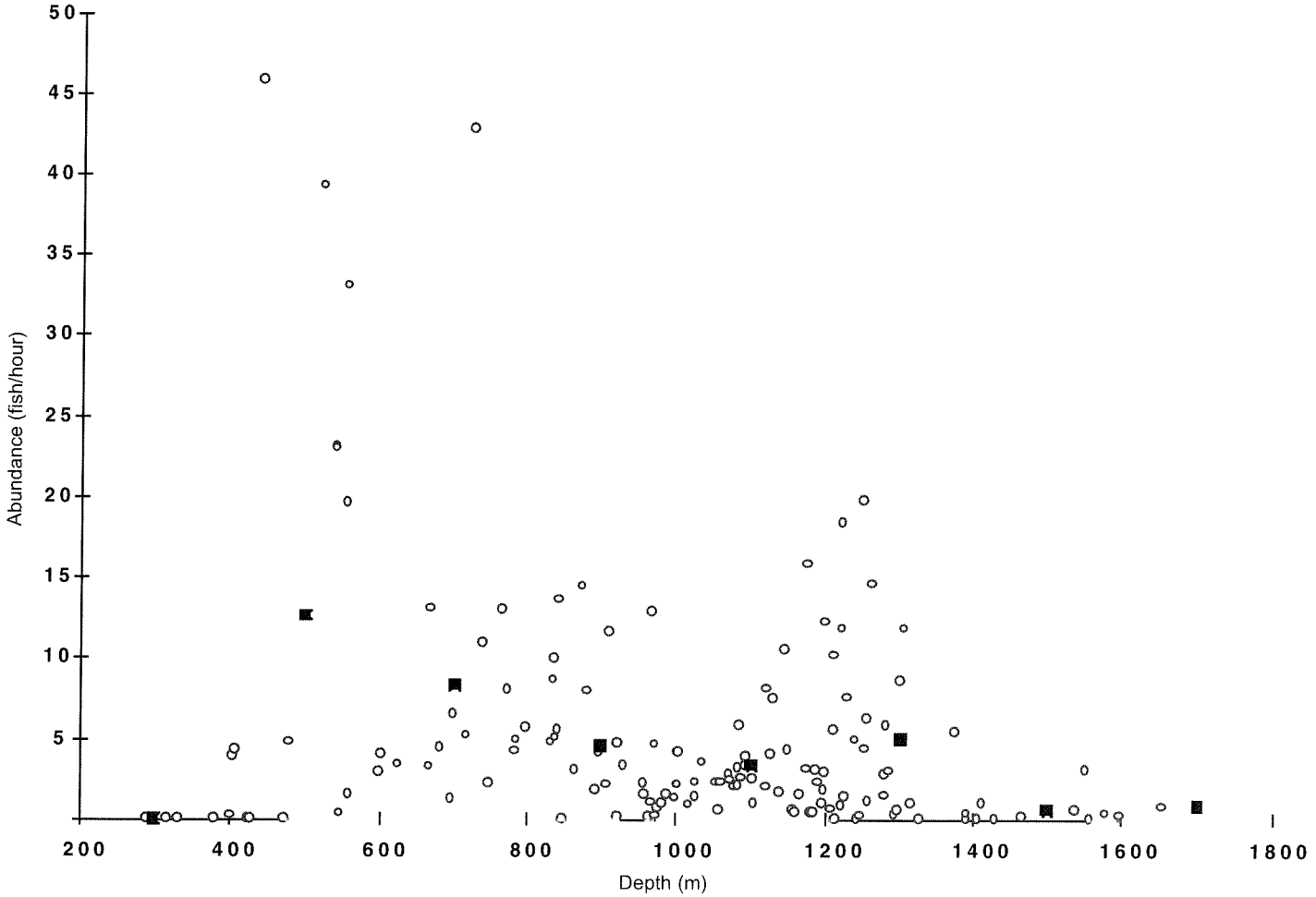


Figure 2: Relative abundance of *Bathyraja* spp. (number of fish per hour of fishing per standard longline set) in relation to depth (in metres) for all longline sets carried out during the experimental fishing cruise in deep waters off the Kerguelen Islands in 1995/96.

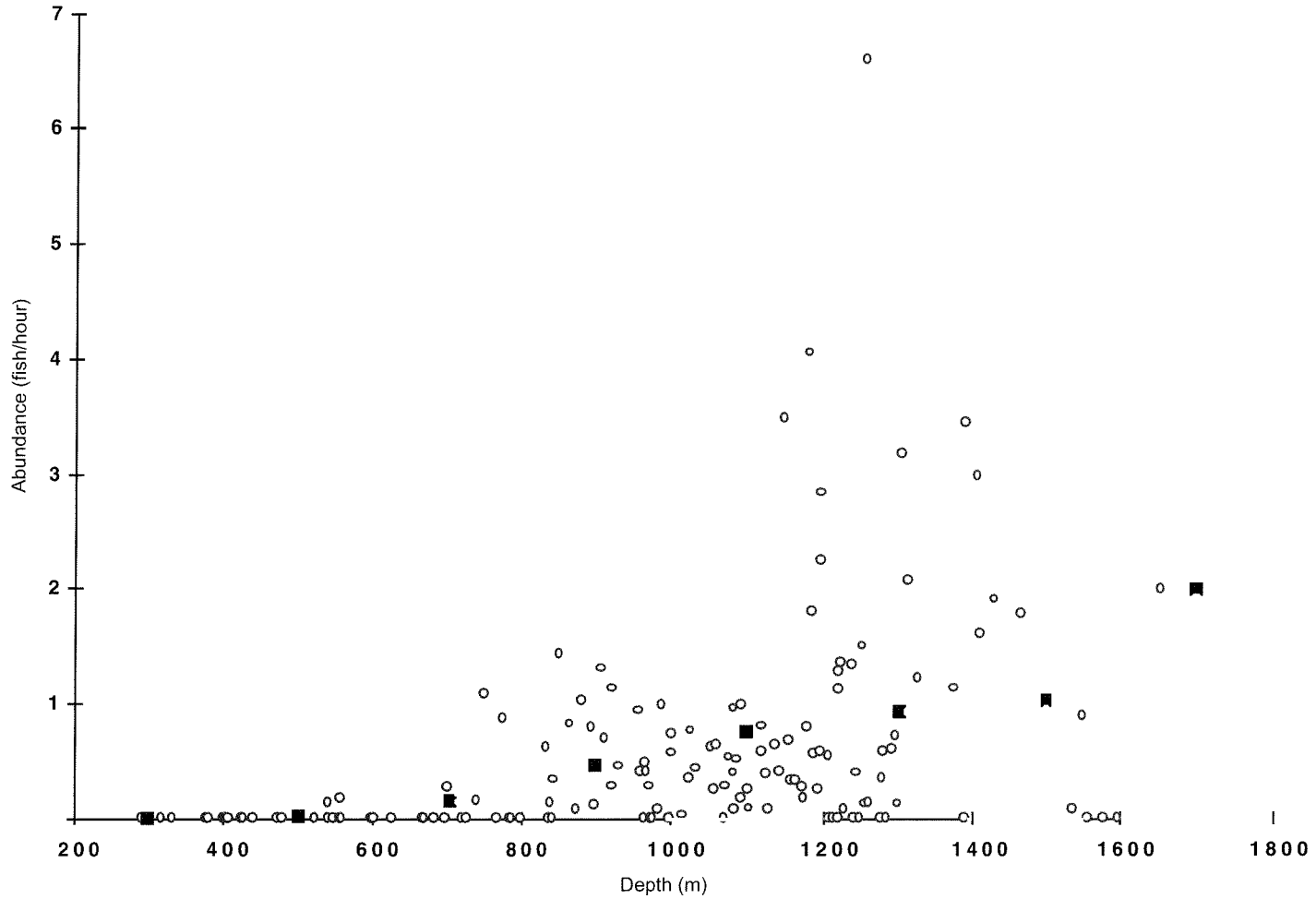


Figure 3: Relative abundance of *Antimora rostrata* (number of fish per hour of fishing per standard longline set) in relation to depth (in metres) for all longline sets carried out during the experimental fishing cruise in deep waters off the Kerguelen Islands in 1995/96.

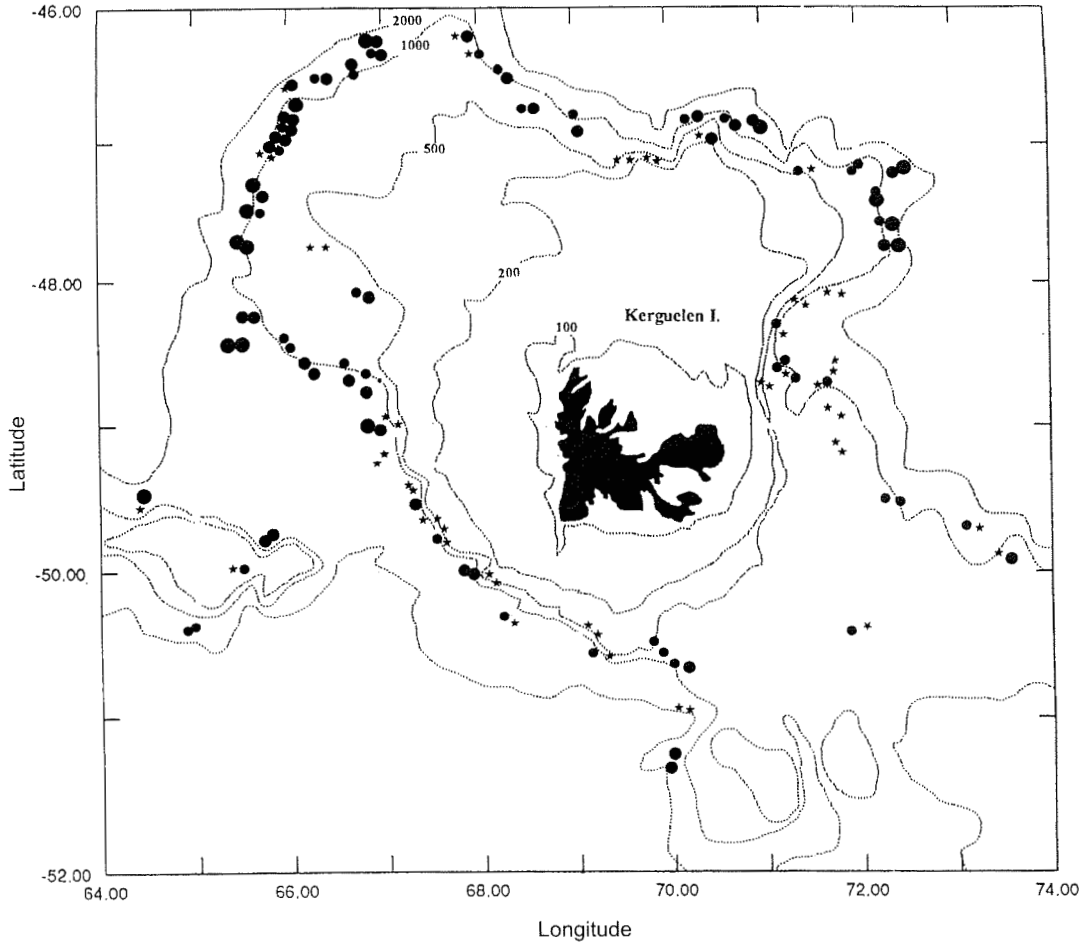


Figure 4: Geographical distribution and abundance (✱no fish caught, • 0.0 < catch < 10.0, ● 10.0 < catch < 20.0, ● > 20.0 fish/longline/hour of fishing) of by-catches of *Macrourus carinatus* during the experimental fishing cruise in deep waters off the Kerguelen Islands in 1995/96.

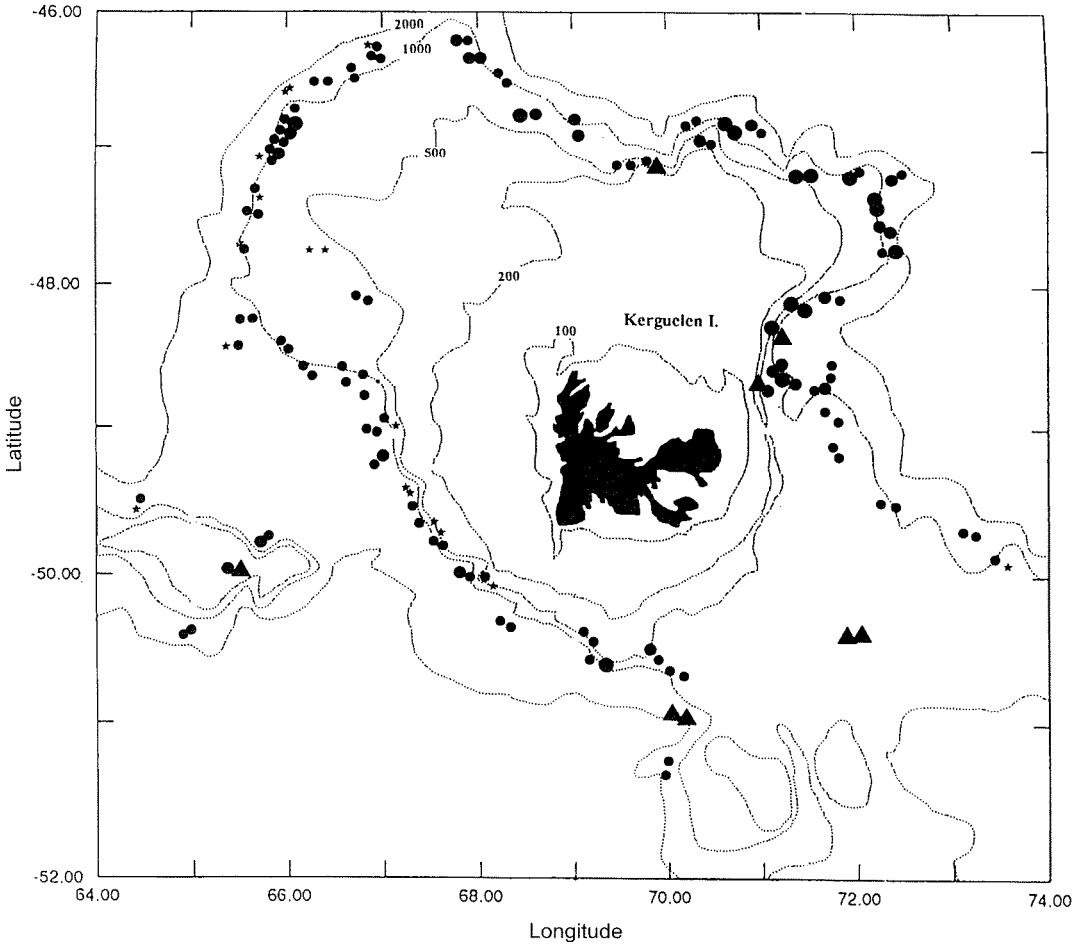


Figure 5: Geographical distribution and abundance (✶ no fish caught, • 0.0 < catch < 5.0, ● 5.0 < catch < 10.0, ● 10.0 < catch < 20.0, ▲ > 20.0 fish/longline/hour of fishing) of by-catches of *Bathyraja* spp. during the experimental fishing cruise in deep waters off the Kerguelen Islands in 1995/96.

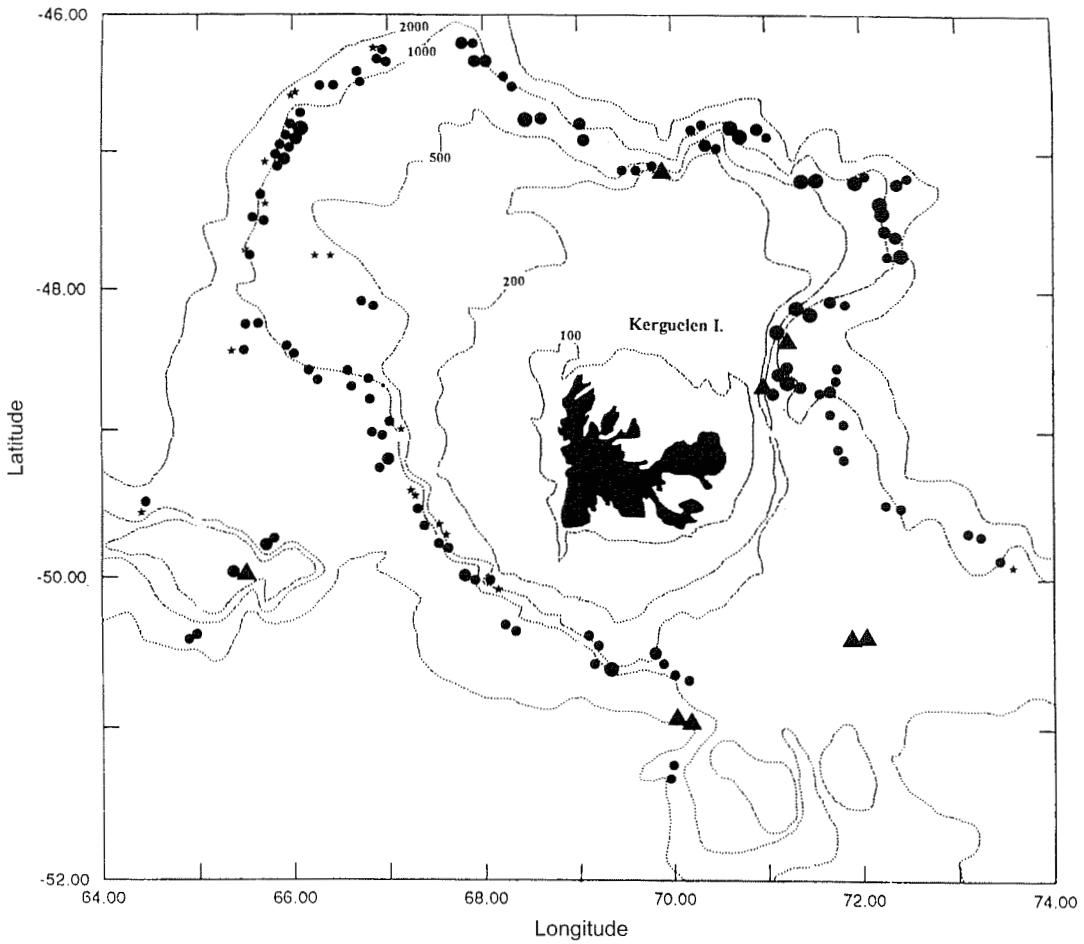


Figure 6: Geographical distribution and abundance (✶ no fish caught, • 0.0 < catch < 1.0, ● 1.0 < catch < 2.0, ● > 2.0 fish/longline/hour of fishing) of by-catches of *Antimora rostrata* during the experimental fishing cruise in deep waters off the Kerguelen Islands in 1995/96.

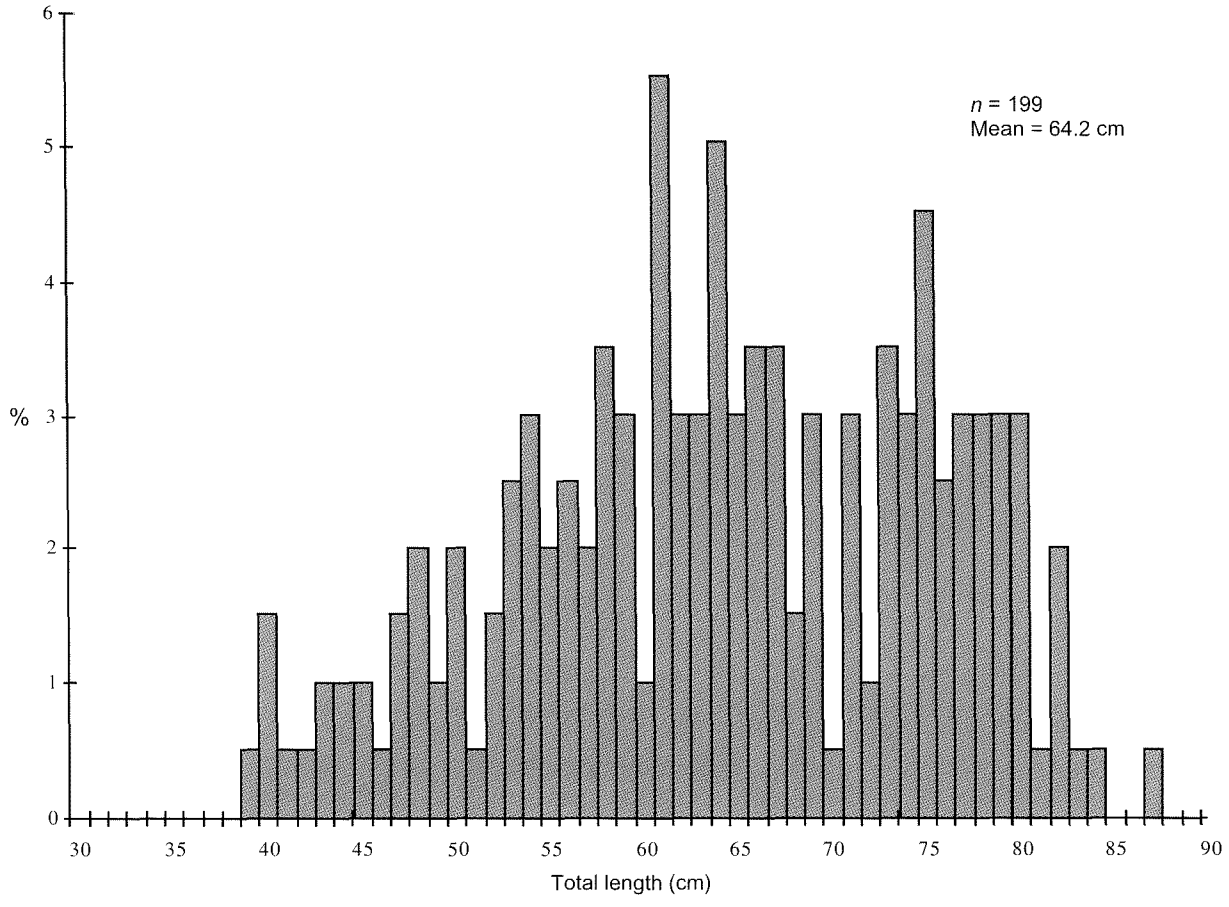


Figure 7: Size distribution of *Macrourus carinatus* caught during experimental longline fishing off the Kerguelen Islands.

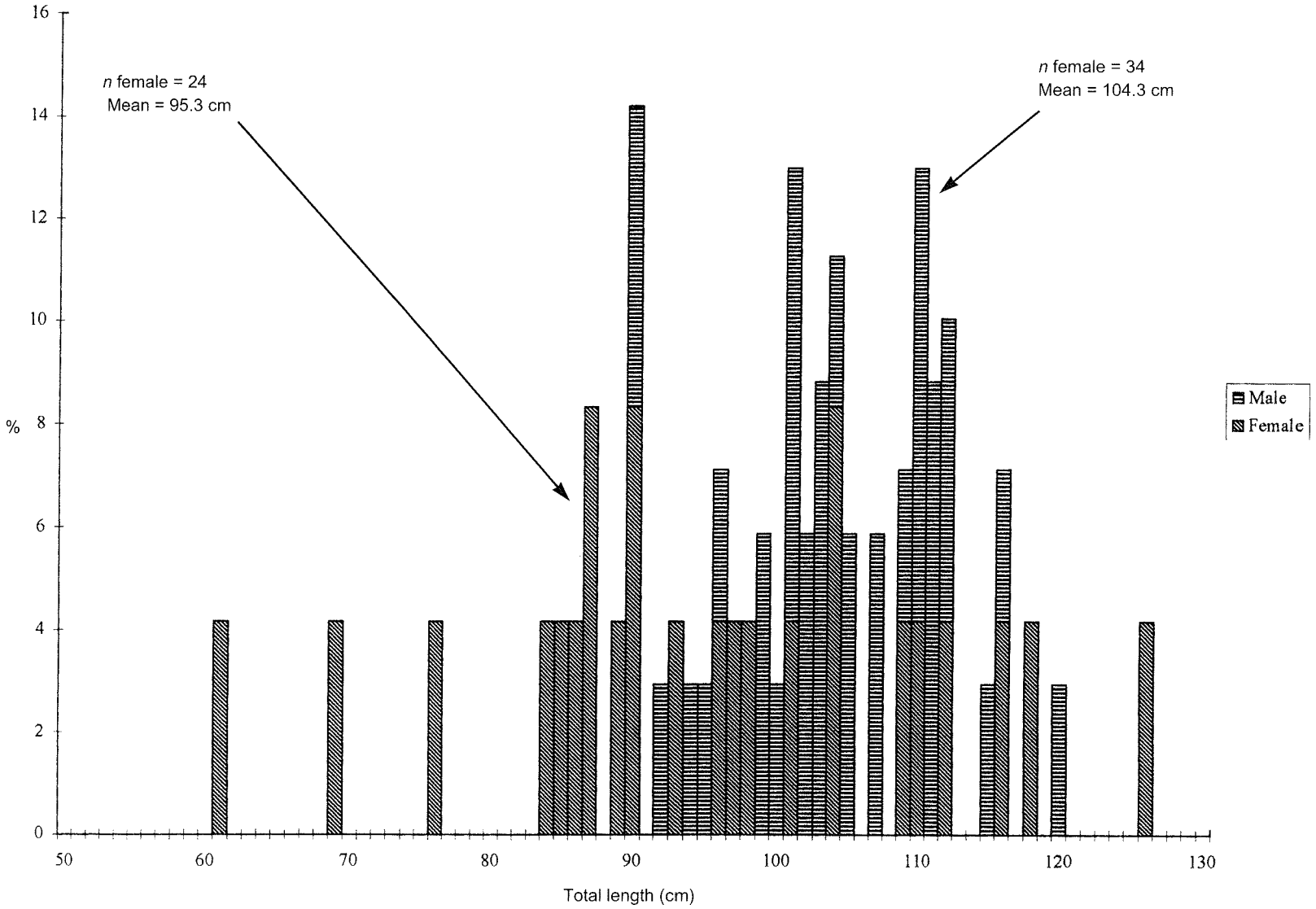


Figure 8: Male and female size distribution of *Bathyraja irrasa* caught during experimental longline fishing off the Kerguelen Islands.

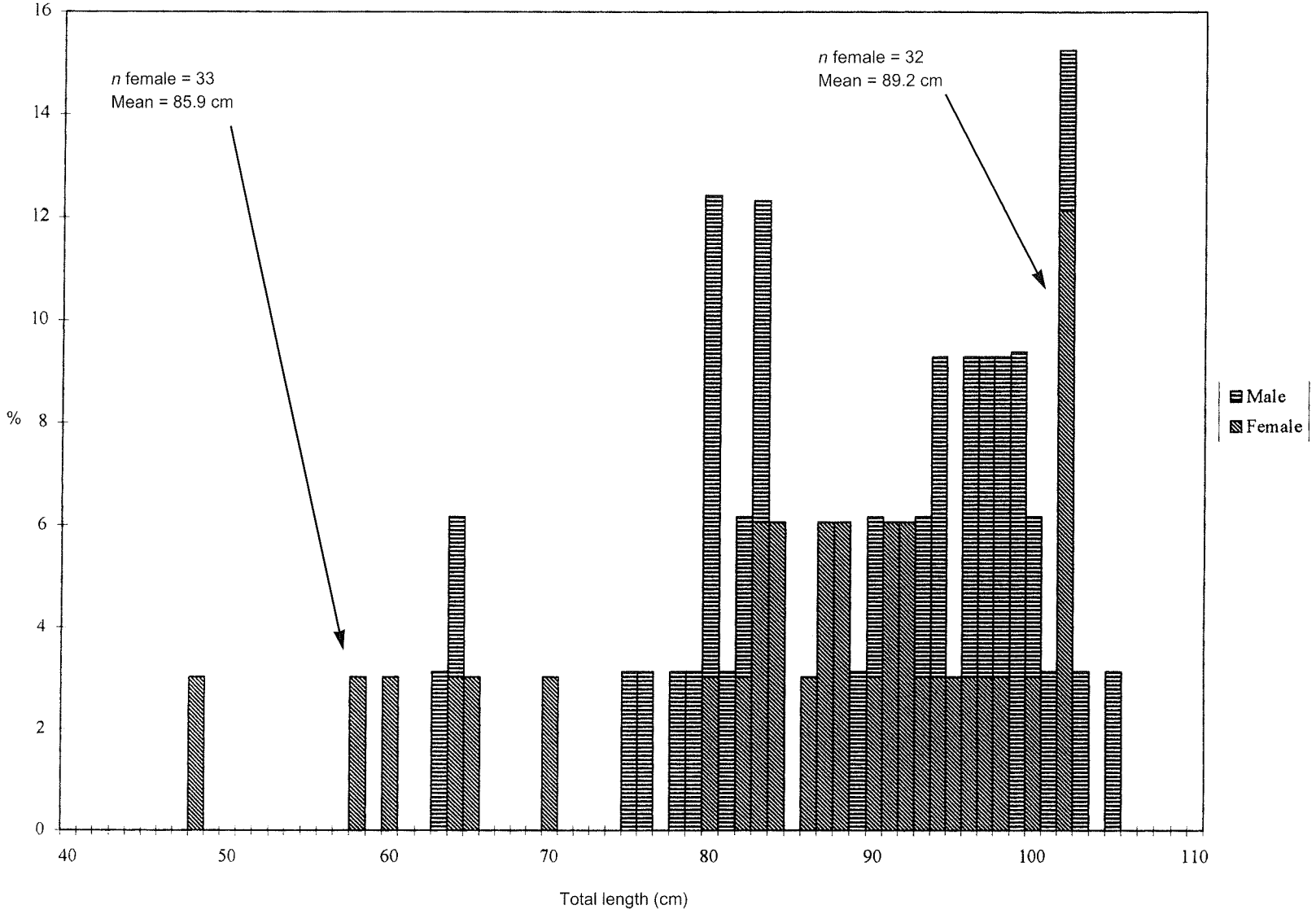
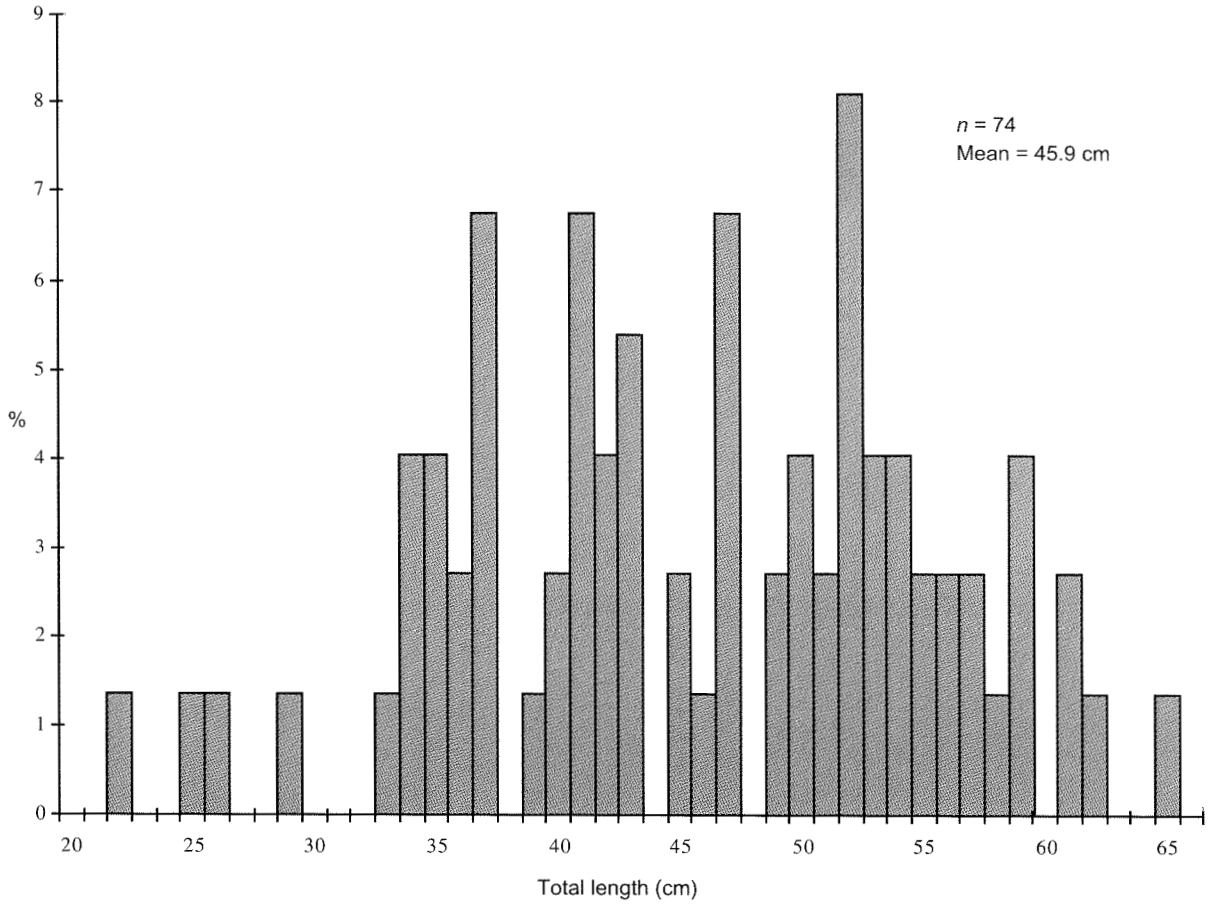


Figure 9: Male and female size distribution of *Bathyraja eatonii* caught during experimental longline fishing off the Kerguelen Islands.



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