

VERTICAL MIGRATIONS OF MACKEREL ICEFISH (*CHAMPSOCEPHALUS GUNNARI*) ON THE SOUTH GEORGIA SHELF

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Abstract

High values of coefficient of variation resulting from the calculation of mackerel icefish biomass (*Champsocephalus gunnari*) from trawl survey data on the South Georgia shelf (Parkes *et al.*, 1989) challenge the rationale for round-the-clock trawling and call for clarification of the techniques used. The objective of the present study is to analyse data on daily vertical migrations of mackerel icefish. The study used data from research vessels which had been fishing for commercial concentrations of *C. gunnari* in years of high abundance of the species (1982/83, 1983/84 and 1986/87). Catch-per-hour of fishing was analysed by the time of day. Catches made by both bottom trawls and midwater trawls were taken into account. Information from the round-the-clock hydroacoustic observations on vertical migrations of *C. gunnari* as well as from observations on fish feeding is also considered in the paper. A distinct pattern of daily vertical migrations of *C. gunnari* was observed on the South Georgia shelf. During the day, fish concentrate near the bottom in concentrations 5 to 7 m thick. At night, fish disperse and migrate to the upper layers 50 to 60 m beneath the surface. The main peak of fish feeding activity was also observed at night. Fishing during this period with bottom trawls had yielded almost no catches at all. The information obtained on vertical migrations of *C. gunnari* may be used for clarification of survey techniques used in stock assessment. For a number of years scientists of AtlantNIRO have been conducting trawl surveys for *C. gunnari* during daylight hours only.

Résumé

Les valeurs élevées du coefficient de variation de la biomasse du poisson des glaces (*Champsocephalus gunnari*) calculée à partir des données des campagnes d'évaluation par chalutages sur le plateau de Géorgie du Sud (Parkes *et al.*, 1989) mettent en question le raisonnement selon lequel les chalutages doivent être effectués jour et nuit et demandent une clarification des techniques utilisées. La présente étude, dont l'objectif est l'analyse des données sur les migrations verticales quotidiennes du poisson des glaces, repose sur les données fournies par les navires de recherche ayant effectué des prélèvements dans les concentrations de type commercial de *C. gunnari*, pendant les années d'abondance de l'espèce (1982/83, 1983/84 et 1986/87). La capture par heure de pêche est analysée en fonction de l'heure à laquelle elle a été réalisée. Il est tenu compte à la fois des captures par chalutages de fond et des captures pélagiques. Ce document examine également les informations provenant tant des observations hydroacoustiques continues sur les migrations verticales de *C. gunnari* que des observations sur le comportement alimentaire de ce poisson. Les migrations nyctémérales de *C. gunnari* sur le plateau de Géorgie

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du Sud présentent de nettes tendances. Pendant la journée, les poissons se rassemblent près du fond, dans des concentrations de 5 à 7 m d'épaisseur. La nuit, les poissons se dispersent et fréquentent les couches supérieures, d'une profondeur de 50 à 60 m. Le principal pic d'alimentation des poissons a également été observé de nuit. La pêche au chalut de fond pendant cette période s'est soldée par des captures pratiquement nulles. Les informations obtenues sur les migrations verticales de *C. gunnari* peuvent servir à clarifier les techniques d'évaluation des stocks utilisées. Depuis plusieurs années, les scientifiques d'AtlantNIRO ont pour principe de ne mener d'évaluations par chalutages de *C. gunnari* que de jour.

Резюме

Высокие коэффициенты вариации, полученные при расчетах биомассы щуковидной белокровки (*Champsocephalus gunnari*) по результатам траловых съемок на шельфе острова Южная Георгия (Parkes *et al.*, 1989), ставят под сомнение правомерность круглосуточных учетных работ и требуют совершенствования методики. Целью данной работы является анализ данных по вертикальным миграциям щуковидной белокровки. В работе использованы данные научно-исследовательских судов, облавливавших промысловые скопления *C. gunnari* в годы с высокой численностью этого вида (1982/83, 1983/84 и 1986/87 гг.) Анализировались уловы за час траления, полученные в течение суток как донными, так и разноглубинными тралами. Приводятся также материалы круглосуточных гидроакустических наблюдений за вертикальными миграциями *C. gunnari*, а также данные суточных станций по питанию рыбы. По результатам наблюдений на шельфе острова Южная Георгия установлено наличие вертикальных миграций *C. gunnari* в течение суток. В светлое время рыба находится у грунта. Вертикальное развитие скоплений составляет 5-7 метров. Ночью они рассеиваются и мигрирует в толщу воды, достигая горизонтов 50-60 м. Пик питания приходился на ночные часы. В это время рыба практически не облавливалась донным тралом. Информация о вертикальных миграциях *C. gunnari* может быть полезна для уточнения методики траловых съемок. В течение нескольких лет АтлантНИРО проводит траловые съемки только в светлое время суток.

Resumen

Los altos valores del coeficiente de variación de la estimación de biomasa de draco rayado (*Champsocephalus gunnari*) calculada de los datos de las prospecciones de arrastre realizadas en la plataforma del archipiélago de Georgia del Sur (Parkes *et al.*, 1989), cuestionan el fundamento sobre el cual se basa la realización de arrastres continuados y destacan la necesidad de especificar las técnicas utilizadas. El objetivo de este estudio es el análisis de datos de la migración vertical del draco rayado. El estudio empleó los datos de los buques de investigación que pescaron concentraciones comerciales de *C. gunnari*

en años de gran abundancia de esta especie (1982/83, 1983/84 y 1986/87). La captura por hora de pesca fue analizada de acuerdo a la hora del día en la cual se realizaron los lances, considerándose las capturas con redes de arrastre de fondo y pelágicas. Este documento incluye también la información obtenida de las observaciones hidroacústicas continuas de la migración vertical de *C. gunnari* y de la alimentación de los peces. En la zona de la plataforma de Georgia del Sur se observó un patrón de migración vertical diaria de *C. gunnari*. Durante el día los peces se concentraron cerca del fondo en cardúmenes de 5 a 7 m de espesor. En la noche los peces se dispersaron, desplazándose a las capas más superficiales, hasta una distancia aproximada de 50 a 60 m de la superficie. El máximo de actividad de alimentación se observó durante la noche, y por consiguiente la pesca con redes de arrastre de fondo durante este período fue casi nula. La información obtenida de la migración vertical de *C. gunnari* podría ser utilizada para especificar las técnicas de prospección para evaluar el estado de las poblaciones. Por muchos años los investigadores del AtlantNIRO han adoptado la práctica de efectuar prospecciones de arrastre de *C. gunnari* durante el día solamente.

1. INTRODUCTION

Scientists of several nations have in recent years carried out stock assessment studies of channichthyids and nototheniids in shelf waters of the South Georgia by means of trawl surveys. The assessment methodology suggested by Saville (1977) and widely used by Polish, Spanish, British and American scientists includes round-the-clock trawl surveys. However, availability of mackerel icefish, the main target species on the South Georgia shelf, varied considerably throughout the day. Taking into account this biological characteristic AtlantNIRO conducted trawl surveys only during daylight hours.

High values of coefficient of variation resulted from the calculation of mackerel icefish biomass (*Champscephalus gunnari*) from trawl survey data (Parkes *et al.*, 1989) challenge the rationale for round-the-clock trawling and call for improvement of techniques in order to obtain reliable estimates.

The objective of the present study is to analyse data on daily vertical migrations of mackerel icefish. Results of the study may then be used in improving trawl survey techniques.

2. MATERIALS AND METHODS

The study used data obtained from research vessels which had been fishing for commercial concentrations of *C. gunnari* in years of high abundance (1982/83, 1983/84 and 1986/87). Catch-per-hour of fishing was analysed by time of day. Catches made by both bottom and midwater trawls were taken into account.

Average trawling depth for midwater trawls was measured at the level of the trawl head-rope.

Information from the round-the-clock hydroacoustic observations on vertical migrations of *C. gunnari* as well as observations on fish feeding characteristics is also considered in this paper.

3. RESULTS

Table 1 presents catch data obtained from research vessels fishing for commercial concentrations of *C. gunnari* on the South Georgia shelf. The highest catches were obtained during daylight hours (08:00 to 16:00 hr). With the onset of dusk (17:00 to 19:00 hr) fish begin migrating to the upper layers and the size of catches decreases abruptly from 13-14 to 2-8 tonnes per hour of fishing. At night, catches were usually 2.0 to 2.6 tonnes per hour of fishing. At sunrise, fish migrate to the bottom layers and catches again start to increase. The pattern of catch distribution for bottom trawls at various times of the day was found to be identical for all periods of observation. The combined catch distribution data for all three research cruises are presented in Figure 1. The abrupt decrease in catches during evening hours and the gradual increase of catches in the morning indicates that fish migrate more rapidly to the surface layers than to the bottom layers.

An echo sounder was used to search for fish concentrations when fishing with midwater trawls. Trawls were set at depths where concentration of fish was the highest. Therefore we did not observe any substantial differences in catches according to the time of day, although the highest catches were taken at sunrise and the lowest catches during the first half of the night (Table 1, Figure 2B). From the catch data of midwater trawls it was found that fish concentrations were situated near the bottom or at 10 to 30 m above the bottom during daylight hours (09:00 to 17:00 hr). Fish were found dispersed throughout the water column at night when catches were taken at depths between 60 to 180 m.

Daily vertical distribution of *C. gunnari* was also studied during a census trawl survey by RV *Gizhiga* in May 1984. Catches by bottom trawls demonstrated the same vertical distribution pattern of *C. gunnari* although abundance was low during that season. *C. gunnari* feeding was also examined. Two peaks of feeding activity were observed. Feeding was most intensive (first peak) during the night when fish concentrations moved out of the bottom layers and dispersed. Bottom trawling during this period yielded almost no catches at all. The second peak from 11:00 to 16:00 hr was observed only during cloudy days when fish partially migrated to the upper layers and catches were low.

Hydroacoustic observations on *C. gunnari* vertical distribution were carried out in October 1983. At night (01:00-02:00 hr), concentrations of fish were recorded at 50 to 60 m from the surface in waters from 100 to 200m deep (Figure 3). At sunrise (06:00-07:00 hr), fish were concentrated near the bottom. Concentrations were from 5 to 15 m thick (Figure 4). During the daylight hours (11:10-11:45 hr) fish remained close to the bottom where concentrations were 5 to 7 m thick (Figure 5).

4. CONCLUSION

Trawl surveys and hydroacoustic observations have demonstrated that *C. gunnari* completes vertical migrations on a daily basis. During daylight hours fish remained near the bottom in concentrations of 5 to 7 m thick. At night, fish dispersed and migrated to the upper layers 50 to 60 m beneath the surface. Migration is more rapid in the evening than in the morning.

The results obtained should be used for improving trawl survey techniques for *C. gunnari* stock assessment. For a number of years scientists of AtlantNIRO have been conducting trawl surveys for *C. gunnari* only during daylight hours.

REFERENCES

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Table 1: Catches of *Chamsocephalus gunnari* (tonnes per hour of fishing) from the South Georgia shelf at various times of the day (n = number of hauls).

Cruise date and vessel name	Trawl type	Time of day											
		00-02	02-04	04-06	06-08	08-10	10-12	12-14	14-16	16-18	18-20	20-22	22-24
April 1983 BMRT Pioner Latvii	Bottom	1.2 n = 3	4.6 n = 4	2.6 n = 4	6.0 n = 10	11.8 n = 9	11.1 n = 9	13.7 n = 8	8.9 n = 5	4.1 n = 8	8.8 n = 8	1.9 n = 3	1.7 n = 3
April-May 1983 BMRT E. Krivosheev	Bottom	4.8 n = 11	2.4 n = 10	2.8 n = 8	6.1 n = 11	4.6 n = 11	11.1 n = 13	6.8 n = 11	14.1 n = 13	2.2 n = 4	2.8 n = 6	2.0 n = 4	2.3 n = 10
November 1986 BMRT Atlant	Bottom	1.5 n = 3	0.7 n = 2	7.7 n = 1	3.6 n = 5	7.6 n = 4	4.9 n = 6	6.6 n = 6	4.4 n = 5	2.4 n = 4	4.1 n = 4	1.4 n = 2	0.9 n = 2
January 1983 BMRT Salekhard	Mid-water	5.3 n = 4	3.8 n = 7	9.6 n = 4	5.1 n = 6	5.7 n = 4	5.5 n = 4	3.6 n = 2	7.1 n = 4	-	7.5 n = 4	0.9 n = 2	2.6 n = 2

Table 2: Catches of *Chamsocephalus gunnari* (kg per hour of fishing) from the north-western part of the South Georgia shelf.

Time of the day	07:00-09:00	09:00-10:00	10:00-12:00	12:00-14:00	16:00-19:00	19:00-21:00
Mean catch	2 122	2 054	4 686	2 997	200	300

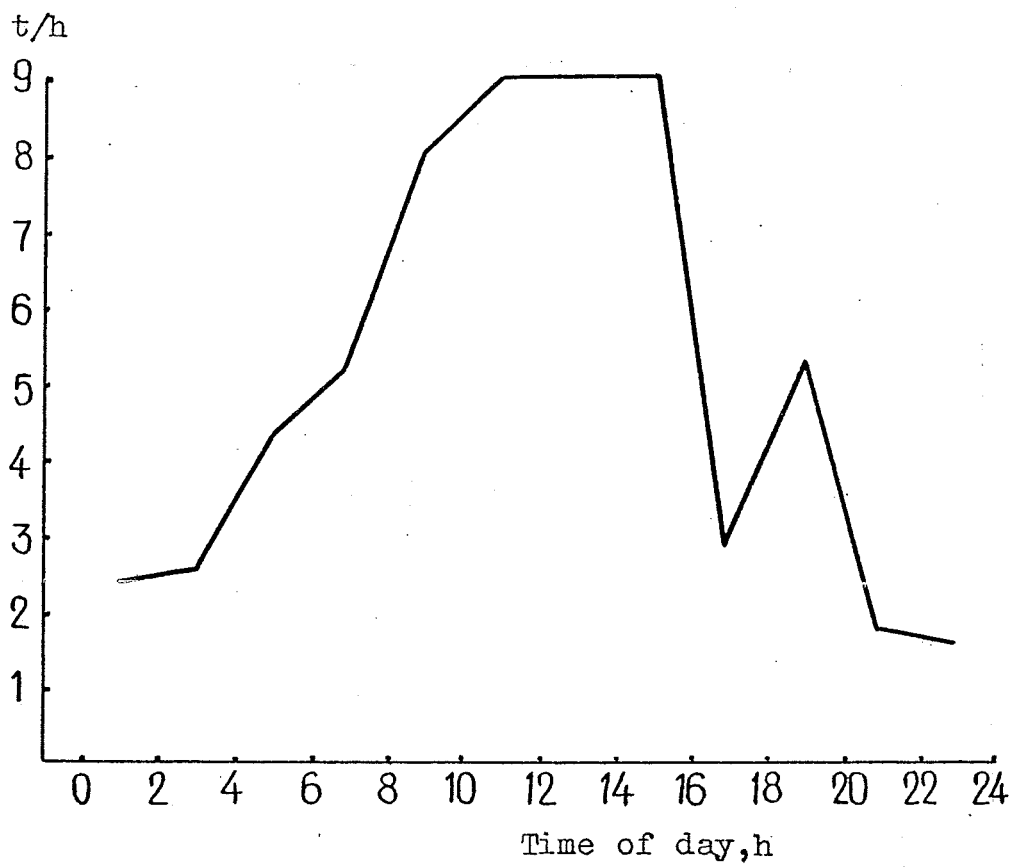


Figure 1: Bottom trawl catches of *C. gunnari* at various times of the day (tonnes per hour of fishing).

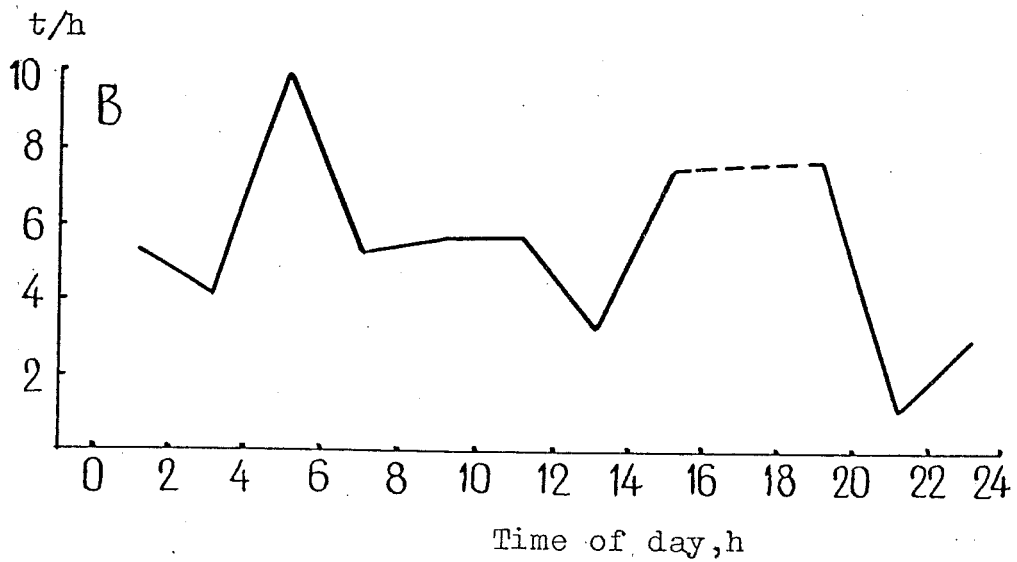
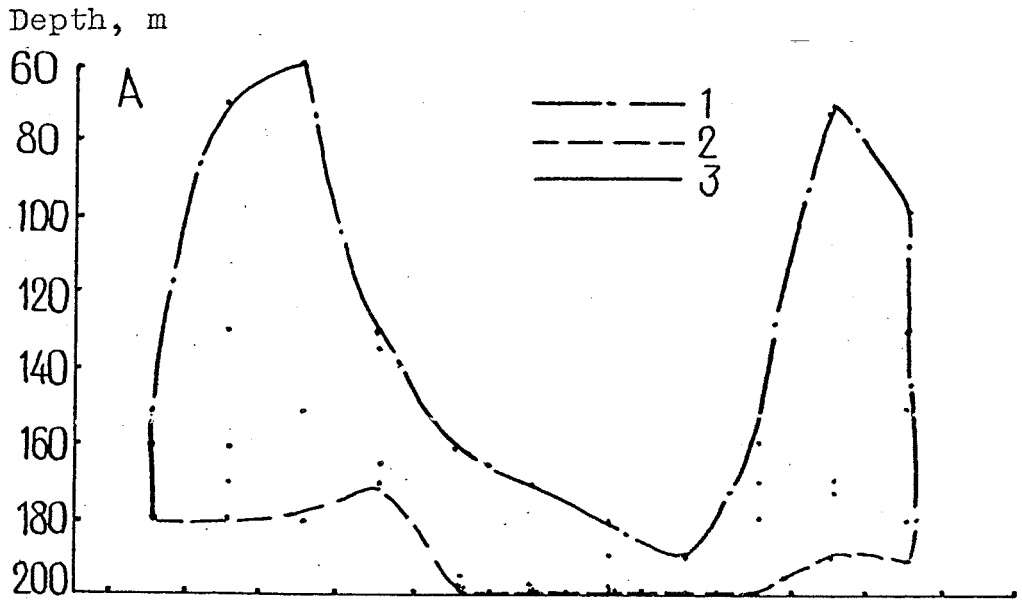


Figure 2: Vertical distribution of fished concentrations of *C. gunnari* (A) and catches per hour of fishing (B) by a midwater trawl in January 1983.
 1 - The upper depth limit of catches;
 2 - The lower depth limit of catches.

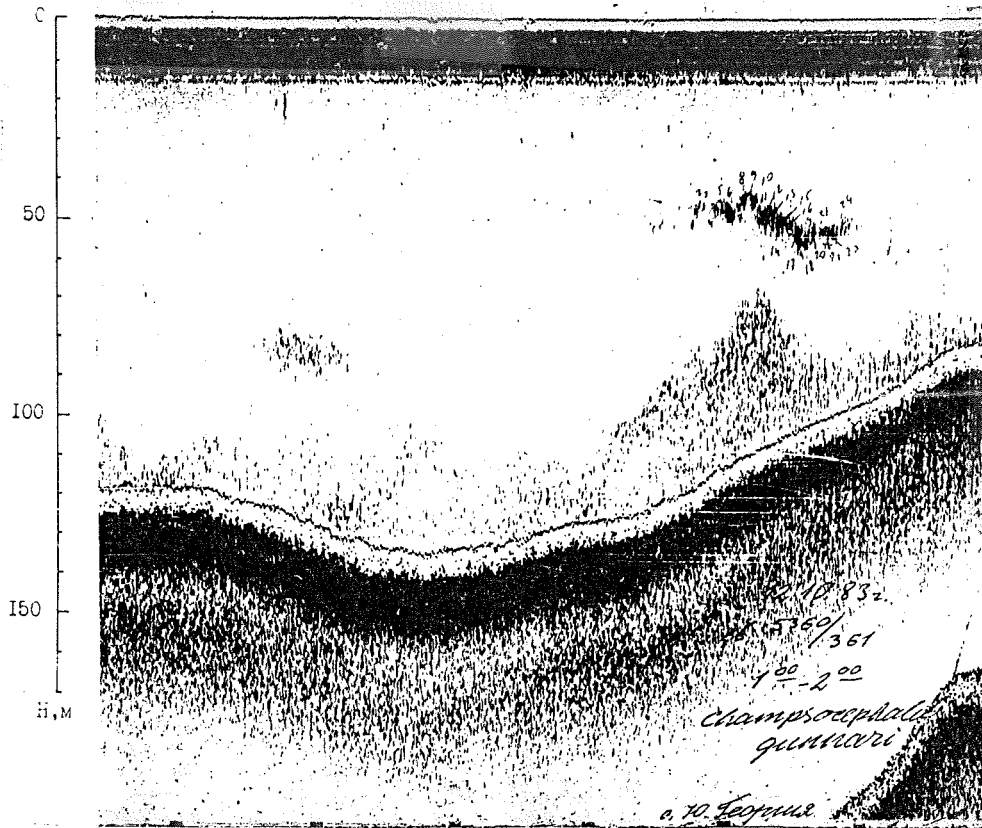


Figure 3: Echo sounder record of *C. gunnari* concentrations over the South Georgia shelf on 12 October 1983, 01:00 to 02:00 hr local time.

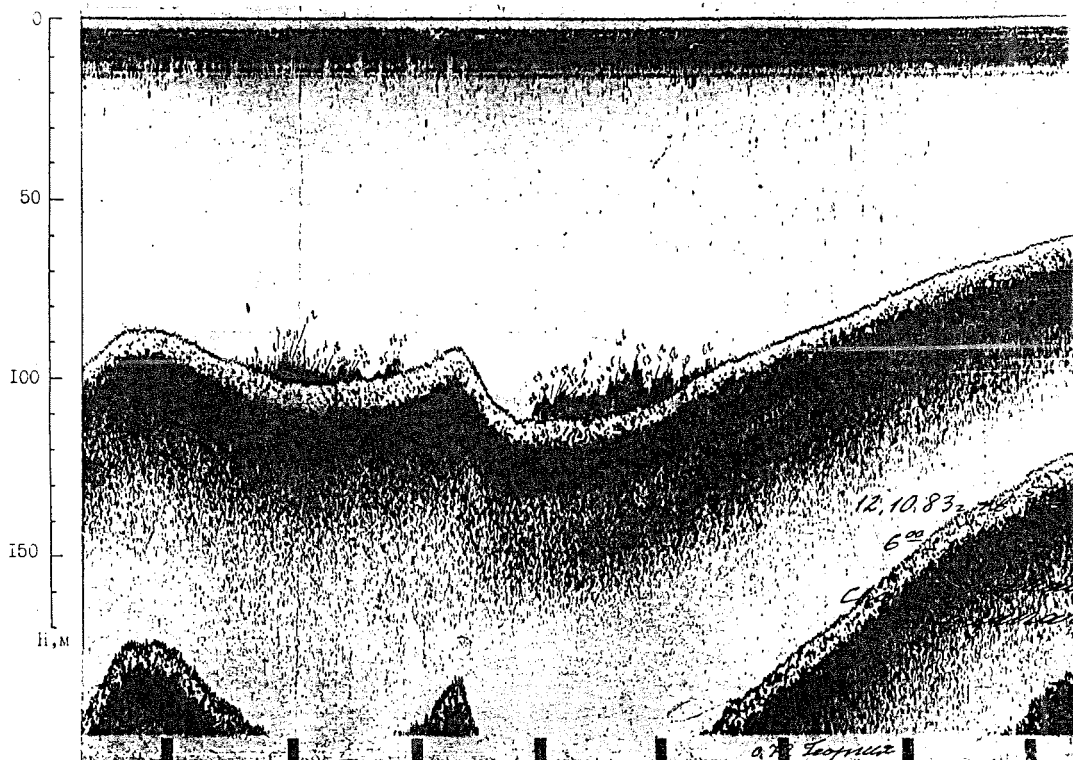


Figure 4: Echo sounder record of *C. gunnari* concentrations over the South Georgia shelf on 12 October 1983, 06:00 to 07:00 hr local time.

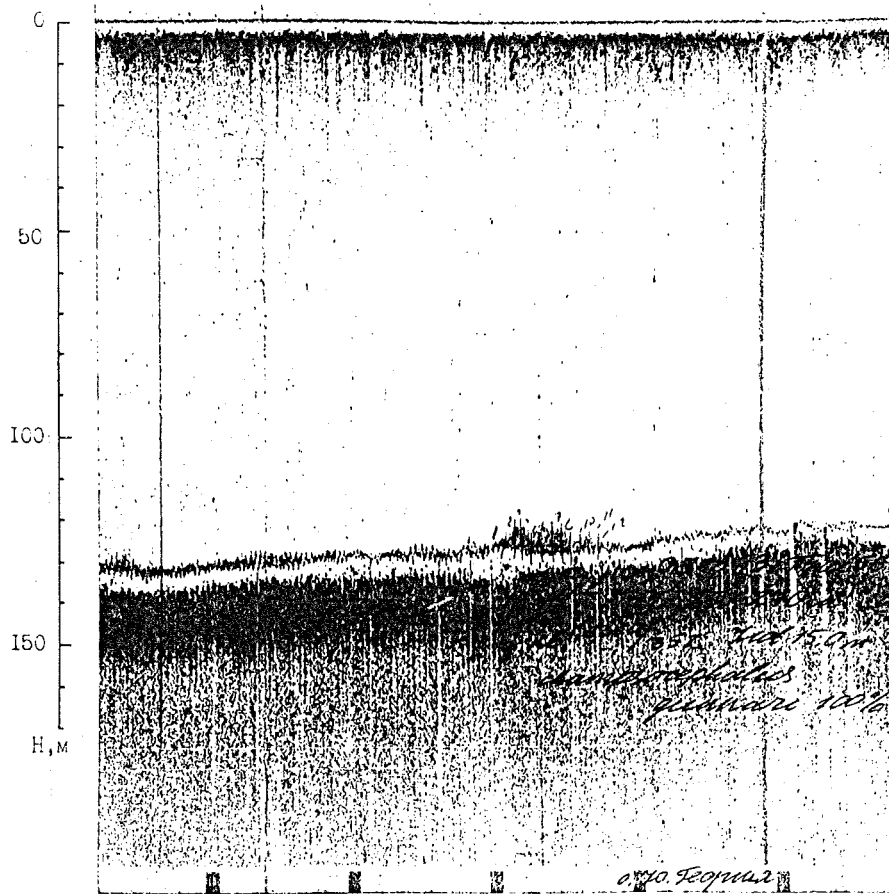


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