HYDROLOGICAL CONDITIONS AND CHARACTERISTICS OF ICEFISH (*CHANNICHTHYIDAE*) DISTRIBUTION ON THE SOUTH GEORGIA SHELF IN 1986/87

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Abstract

Some characteristics of spatial and temporal variability of the distribution of icefish (*Channichthyidae*) on the South Georgia shelf in relation to environmental conditions, have been revealed from summaries and analyses of hydrographic, commercial fisheries and biological data for 1986/87.

Résumé

Certaines particularités de la variabilité spatiale et temporelle de la distribution du poisson des glaces (*Channichthyidae*) sur le plateau de la Géorgie du Sud, par rapport aux conditions du milieu, ont été révélées par les données récapitulatives et les analyses des données hydrographiques, biologiques et en provenance des pêcheries commerciales de 1986/87.

Резюме

На основании сводок данных и анализа данных по гидрографии, биологии и коммерческому промыслу за 1986/87 г. были выявлены некоторые особенности пространственной и временной изменчивости распределения рыб семейства *Channichthyidae* на шельфе Южной Георгии в зависимости от условий окружающей среды.

Resumen

Ciertas características de variabilidad espacial y temporal de la distribución de los peces de hielo (*Channichthyidae*) en la plataforma de Georgia del Sur, en relación a las condiciones ambientales, han sido descubiertos en resumenes y análisis de datos biológicos, hidrográficos y de pescas comerciales para 1986/87.

1. INTRODUCTION

The task of this work has been to try to identify the main characteristics and patterns of spatial and temporal distributions of icefish (*Channichthyidae*) on the South Georgia shelf relative to environmental conditions.

2. MATERIALS AND METHODS USED

Material collected during the course of two integrated surveys conducted on board the vessel BMRT *Gizhiga* in the area of South Georgia is used in this work (Figure 1). The periods chosen for the surveys (16 September to 21 October 1986 and 10 to 31 August 1987) coincided with hydrological winters of the Southern Hemisphere. In South Georgia, this season lasts from 15 July to 10 November (Polishchuk et al., 1987).

Each so called "integrated study station" consisted of a 30 minute census trawl survey by bottom trawl and a hydrological station to determine water temperature and salinity over standard depths.

In total, 75 integrated stations were made. Unfortunately, due to severe ice conditions on the southwest and eastern shelves of the island, a second survey could not be finished.

Mean monthly water temperature data taken from the bench mark area of 10^2 miles (central point at 54°S and 36°W) were used in the analysis of environmental conditions for 1986/1987 in the South Georgia area. Since commercial concentrations of icefish generally occur near the bottom, mean monthly catch-per-unit-effort data have been compared with the anomalies of mean water temperature in the layer from 150 m depth to the bottom. The standard value for mean weighted temperature in this area has been calculated from monthly observations over the period from 1969 to 1988. The boundaries of the Antarctic water modifications were identified by means of plotting TS-diagrams (Timofeev and Panov, 1962).

3. RESULTS AND DISCUSSION

Analysis of environmental conditions and the fishery in 1986 and 1987 showed significant differences between these two years.

In 1986 positive anomalies of the mean weighted water temperature predominated in the layer from 150 m depth to the bottom (Figure 2, a). Three peaks of maximum catches were observed during the year: one pre-spawning peak in March and two post-spawning (feeding) peaks in July/August and December (Figure 2, b). This was consistent with the average long-term pattern of the fishery.

In 1987 the situation was quite different. A negative anomaly of the mean weighted temperature was observed in the layer from 150 m to the bottom from March until the end of the year (Figure 2, c). Throughout the year only two peaks of maximum catches of icefish were noted. These occurred in February and June and coincided either with the period of positive anomalies (January to February) or with the period of decreased value of negative anomaly of the mean weighted temperature (May to June) (Figure 2, d). Maximum catches in 1987 were taken a month earlier than in 1986.

During both periods there was a close relationship between the mean weighted water temperature in the layer from 150 m to the bottom and the dynamics of fisheries. In general, catches of icefish increased under conditions of positive temperature anomalies and decreased when negative temperature anomalies prevailed.

The hydrological regime in the South Georgia area was determined by the interaction of Deep Circumpolar Waters (DCW) and Shelf Waters (SW). This resulted in the formation of a frontal zone in near bottom layers along the shelf periphery. The isotherm line of 1.0 to 1.1°C and isohaline line of 34.20 to 34.25‰ were set as the conventional boundary dividing DCW and SW (1:1 ratio of both waters by volume).

In 1986 commercial concentrations of icefish were observed along the island shelf slope in the water temperature gradient zone (Figure 3). In the exceptionally cold year of 1987, commercial concentrations were also found in the frontal zone but they were very few in number and fishing was carried out only in limited areas to the northeast and west of the island (Figure 4).

Such a distribution of icefish is obviously associated with the weakening intensity of the DCW upwelling over the island shelf slope in exceptionally cold years which results in a decrease in the volume of warm water on the shelf. The variability of the position of the 1° isotherm clearly illustrates this fact (Figures 5 and 6). In September 1986 it was located at a depth of 150 to 190 m, while in August 1987 at 220 to 250 m. It may therefore be assumed that in cold years such as 1987, concentrations of icefish scatter around the periphery of the island shelf or migrate to depths of 300 m or more, and do not form commercial concentrations.

4. CONCLUSIONS

Analysis of the link between mean weighted water temperature in the layer from 150 m depth to the bottom and daily catches by month demonstrated that, in general, catches of icefish increase under conditions of positive temperature anomalies and decrease when negative anomalies prevail.

In 1986/87 commercial concentrations of icefish were noted at a depth of 200 to 300 m and appeared towards the gradient zone formed by the interaction of warm, deep circumpolar waters (DCW) with the colder shelf waters (SW). The most dense concentrations were observed on the warmer side of the gradient zone where the water temperature was above 1.0°C and salinity more than 34.20‰.

In the exceptionally cold year of 1987 the icefish fishing grounds were significantly smaller than in 1986 which is evidently associated with the small volume of DCW waters on the shelf.

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TIMOFEEV, V.T. and V.V. PANOV. 1962. Indirect Methods for Identifying and Analyzing Water Masses. Gidrometeoizdat, Leningrad. p. 348. (In Russian).

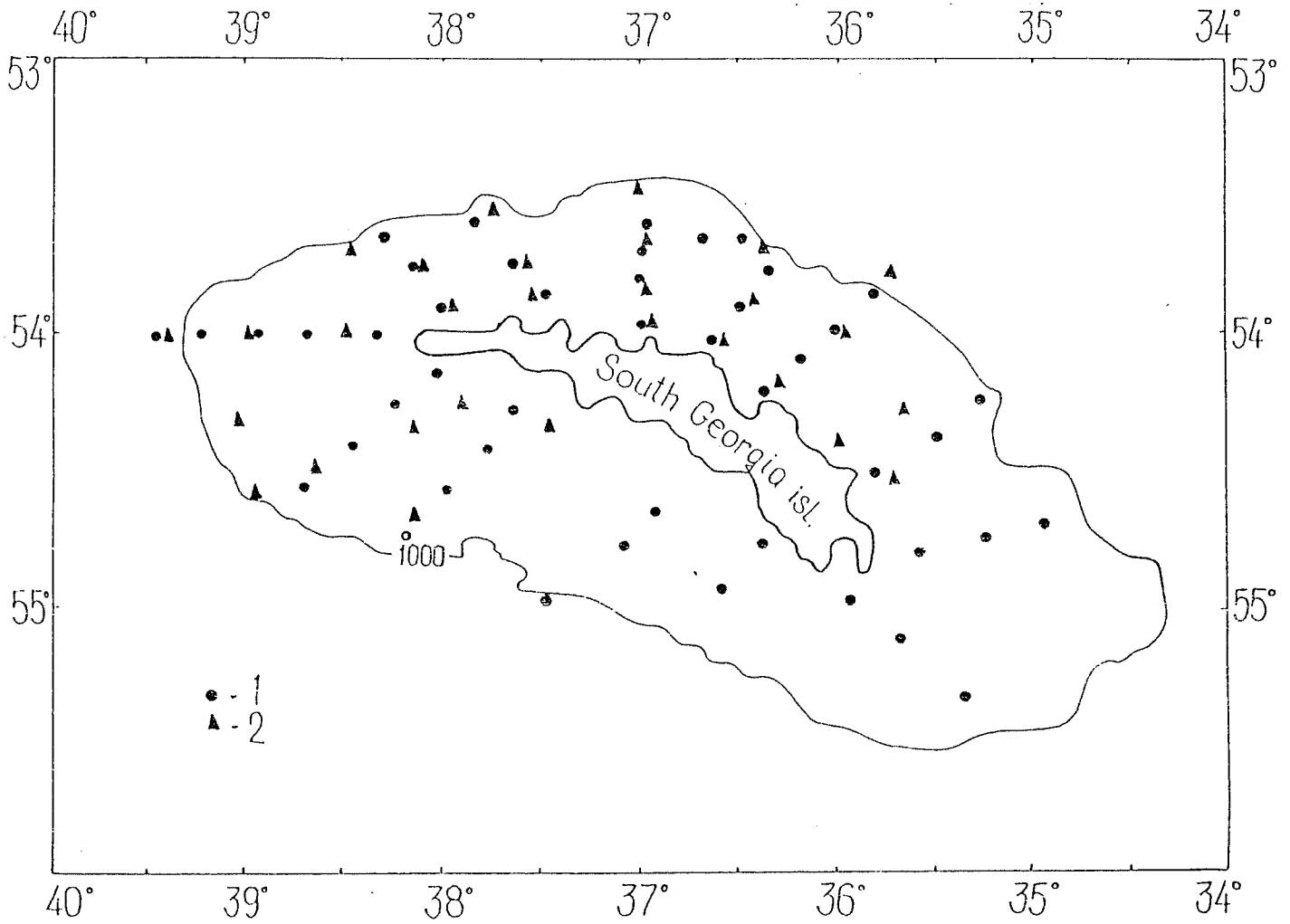


Figure 1: Locations of integrated study stations made from 16 September to 21 October 1986 (1) and from 10 to 31 August 1987 (2) on the South Georgia Island shelf.

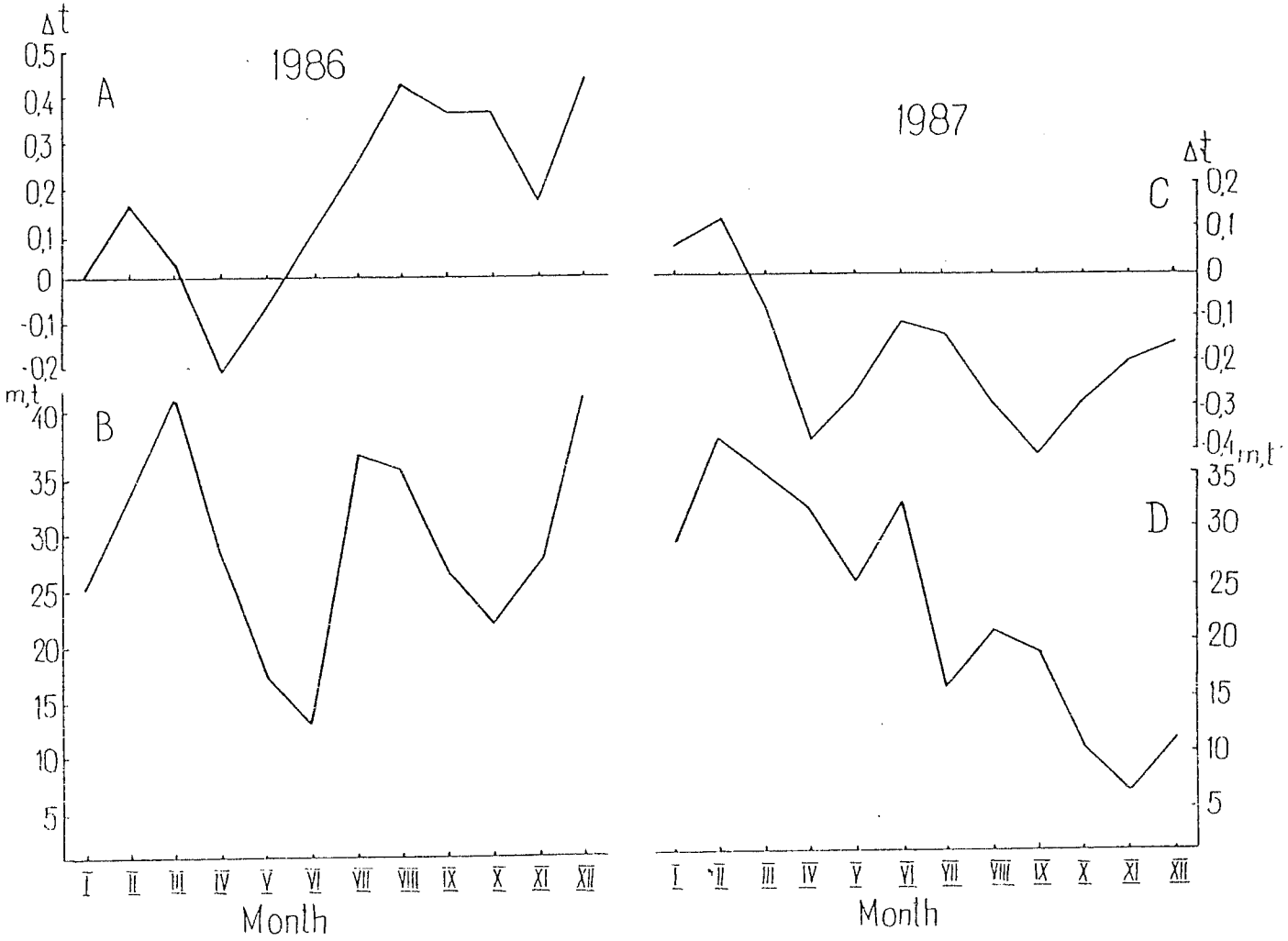


Figure 2: Variation in mean weighted water temperature in the layer from 150 m depth to the bottom (Δt) and daily catches (tonnes) of icefish (*Channichthyidae*) in the South Georgia area in 1986 (a, b) and 1987 (c, d).

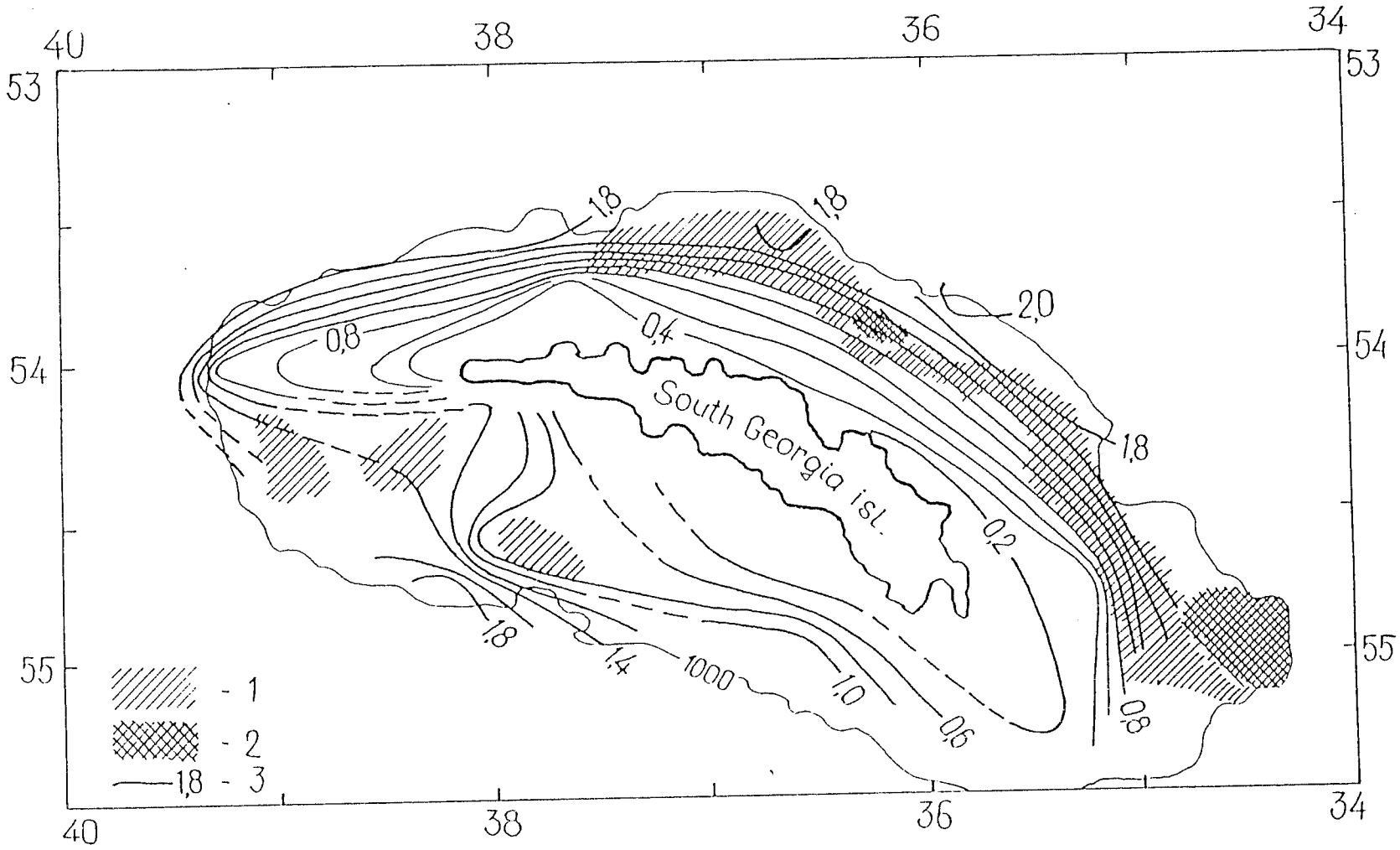


Figure 3: Distribution of near bottom water temperature and catches of icefish (*Channichthyidae*) during the trawl survey from 16 September to 21 October 1986.

1 - catches per hour trawling less than 0.5 tonne
2 - catches per hour trawling more than 1.0 tonne
3 - near bottom temperature

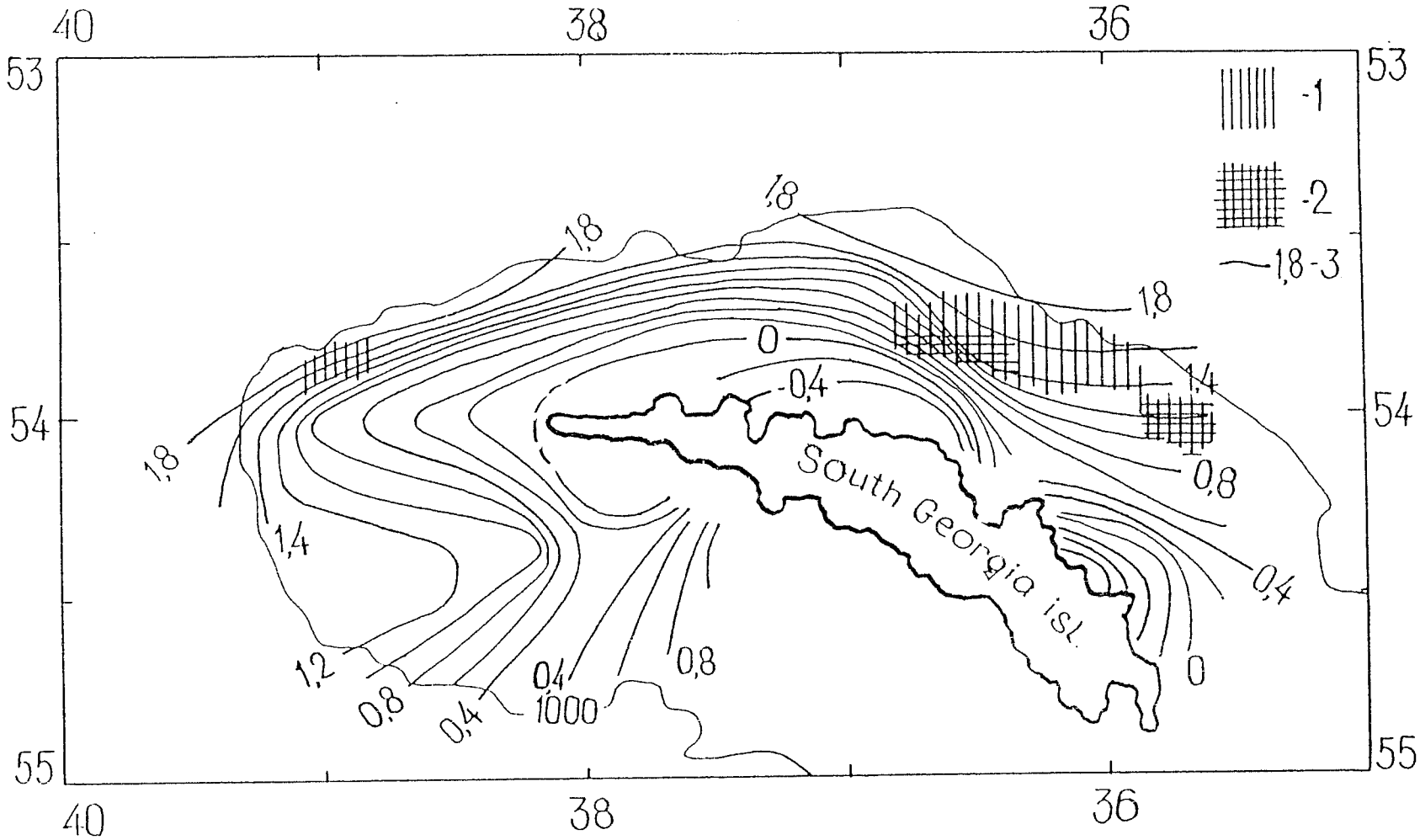


Figure 4: Distribution of near bottom water temperature and catches of icefish (*Channichthyidae*) during the trawl survey from 10 to 31 August 1987.

1 - catches per hour trawling less than 0.5 tonne
2 - catches per hour trawling more than 1.0 tonne
3 - near bottom temperature

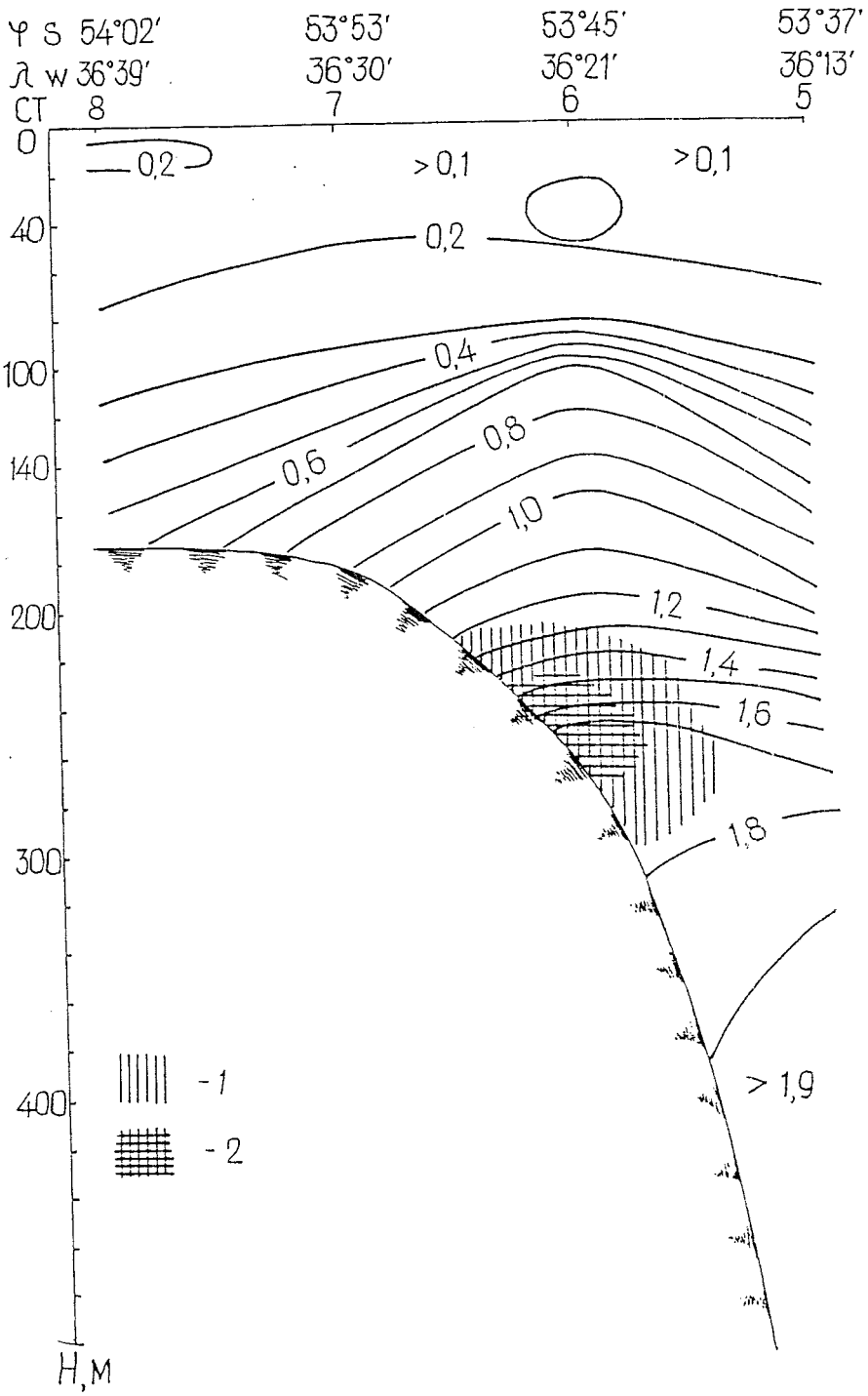
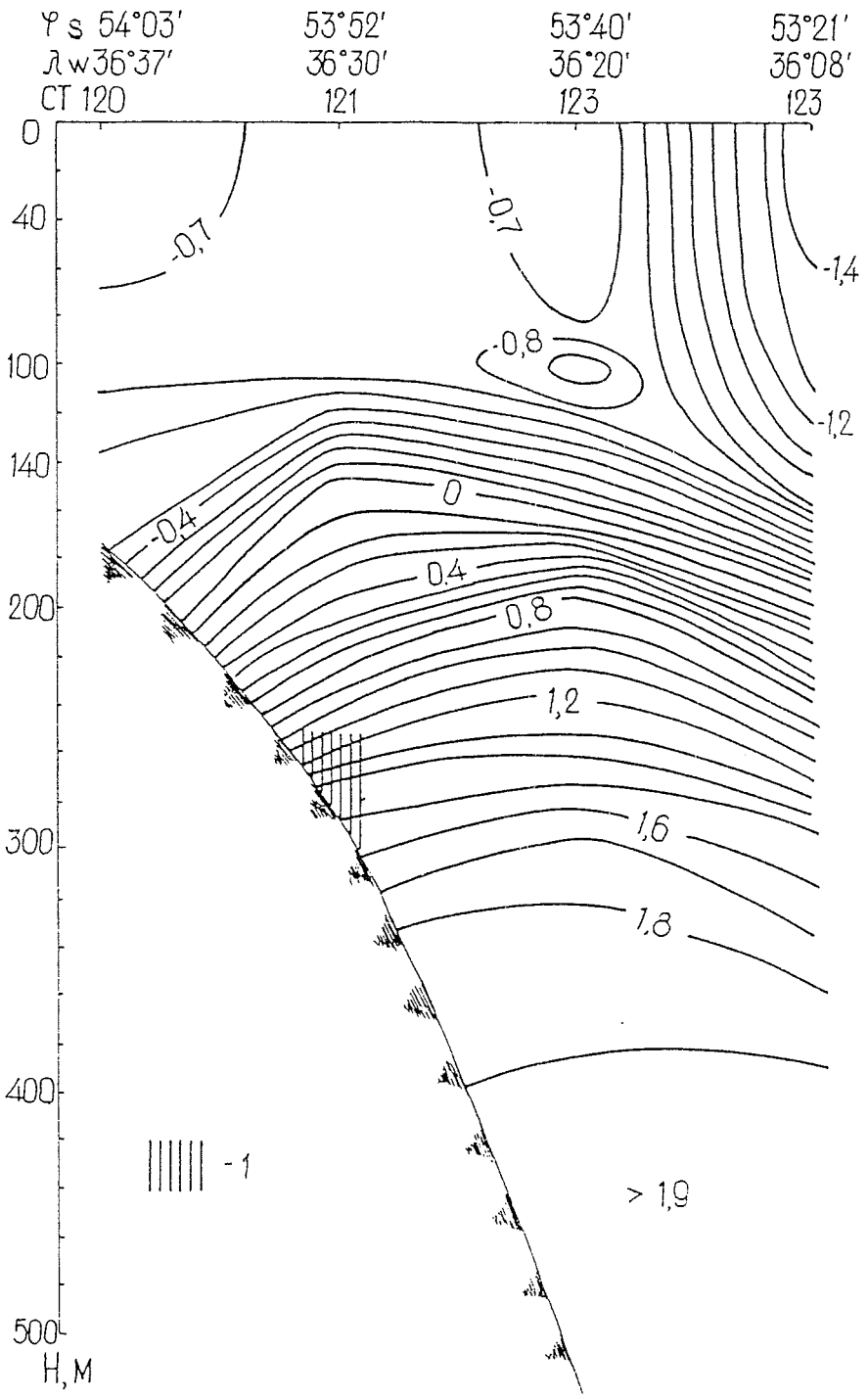


Figure 5: Vertical distribution of water temperature and commercial aggregations of icefish (*Channichthyidae*) in the South Georgia area (17 to 19 September 1986).

1 - catches per hour trawling less than 0.5 tonne
2 - catches per hour trawling more than 1.0 tonne



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1 - catches per hour trawling less than 0.5 tonne

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Figure 3: Distribution de la température des eaux proches du fond et des captures de poissons des glaces (*Channichthyidae*) pendant la campagne d'évaluation par chalutage du 16 septembre au 21 octobre 1986.

1 - captures par heure de chalutage inférieures à 0,5 tonne
2 - captures par heure de chalutage supérieures à 1,0 tonne
3 - température proche du fond

Figure 4: Distribution de la température des eaux proches du fond et des captures de poissons des glaces (*Channichthyidae*) pendant la campagne d'évaluation par chalutage du 10 septembre au 31 août 1987.

1 - captures par heure de chalutage inférieures à 0,5 tonne
2 - captures par heure de chalutage supérieures à 1,0 tonne
3 - température proche du fond

Figure 5: Distribution verticale de la température de l'eau et des concentrations commerciales de poisson des glaces (*Channichthyidae*) dans la zone de la Géorgie du Sud (17 au 19 septembre 1986).

1 - captures par heure de chalutage inférieures à 0,5 tonne
2 - captures par heure de chalutage supérieures à 1,0 tonne

Figure 6: Distribution verticale de la température de l'eau et des concentrations commerciales de poisson des glaces (*Channichthyidae*) dans la zone de la Géorgie du Sud (22 au 23 août 1986).

1 - captures par heure de chalutage inférieures à 0,5 tonne

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1 - уловы за час траления, составляющие менее 0,5 тонны
2 - уловы за час траления, составляющие более 1,0 тонны
3 - температура придонных вод

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1 - уловы за час траления, составляющие менее 0,5 тонны
2 - уловы за час траления, составляющие более 1,0 тонны
3 - температура придонных вод

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1 - уловы за час траления, составляющие менее 0,5 тонны
2 - уловы за час траления, составляющие более 1,0 тонны

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1 - уловы за час траления, составляющие менее 0,5 тонны.

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1 - capturas por hora de arrastre menos de 0.5 tonelada
2 - capturas por hora de arrastre más de 1.0 tonelada
3 - temperatura cerca del fondo

Figura 4: Distribución de temperatura del agua cerca del fondo y capturas de peces de hielo (*Channichthyidae*) durante el arrastre de estudio realizado desde el 10 al 31 de agosto de 1987.

1 - capturas por hora de arrastre menos de 0.5 tonelada
2 - capturas por hora de arrastre más de 1.0 tonelada
3 - temperatura cerca del fondo

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1 - capturas por hora de arrastre menos de 0.5 tonelada
2 - capturas por hora de arrastre más de 1.0 tonelada

Figura 6 : Distribución vertical de la temperatura del agua y agregaciones comerciales de peces de hielo (*Channichthyidae*) en el área de Georgia del Sur (22 al 23 de agosto de 1986).

1 - capturas por hora de arrastre menos de 0.5 tonelada