SURFACE TEMPERATURE FIELD IN THE CROZET AND KERGUELEN WHALING GROUNDS

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ABSTRACT

Some oceanographic conditions in the summer season at the surface in the Crozet and Kerguelen Ridge regions, where the good whaling grounds of baleen whales occur, are discussed on the basis of the distribution of the surface temperature observed by the Japanese whaling fleets in the 1965/66 to 1972/73 Antarctic seasons.

The surface isotherms bend northwards over the submarine rising around the Prince Edward, Crozet and Kerguelen Islands. These bends of the isotherms suggest to reflect the bending of the surface current, and that it is presumably influenced by the bottom topography. They may be also suggested that the convergence efficiency of the current is comparatively intense north and east of these submarine risings.

INTRODUCTION

It is well known that the good whaling grounds of baleen whales occur in the Crozet and Kerguelen Ridge regions. In these two regions right whales were taken by the old American whalers mainly in the 19th century and pigmy blue whales were also taken there in the early 1960's. Recently the Japanese whaling fleets have been often searching for the favorite haunts of the sei and fin whales in the regions.

We have little knowledge of the general oceangoraphic conditions in the Crozet and Kerguelen whaling grounds, though the oceanographic conditions are the close living evnvironment to the whales. A knowledge of oceanographic conditions is fundamentally necessary to think systematic study on the environment of the habits of various marine organisms. From this point of view, therefore, the purpose of the present study is to discuss the oceanographic conditions at the surface in the Crozet and Kerguelen Ridge regions on the basis of the surface temperature distribution, which was observed by the Japanese whaling fleets.

MATERIAL AND METHOD

The whaling fleets have been supplying us with the data of the oceanographic conditions in the different whaling grounds. They are temperatures observed by an electric thermometer, of which sensor is fixed to the bottom of a factory ship (ca. 10 m depth) and a scouting boat (ca. 5 m depth). As the surface layer down to a few

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ten meters in the Antarctic Ocean is roughly homogeneous in temperature, it seems to be reasonable to consider that there is no difference in the temperatures between 5 and 10 m depth. Therefore, they are taken as same and defined here as the surface temperature.

The surface temperatures were derived from " The survey report of the whaling grounds by a scouting boat " in the 1965/66 to 1972/73 Antarctic seasons and " The weather and oceanographic conditions at the noon position of a factory ship " in the 1957/58 to 1972/73 Antarctic seasons. A one degree square grid was adopted in making a monthly chart of the mean surface temperature, and isotherms were drawn by interpolation.

The Far Seas Fisheries Research Laboratry, Fisheries Agency of Japan kindly supplied me with the materials for this study.

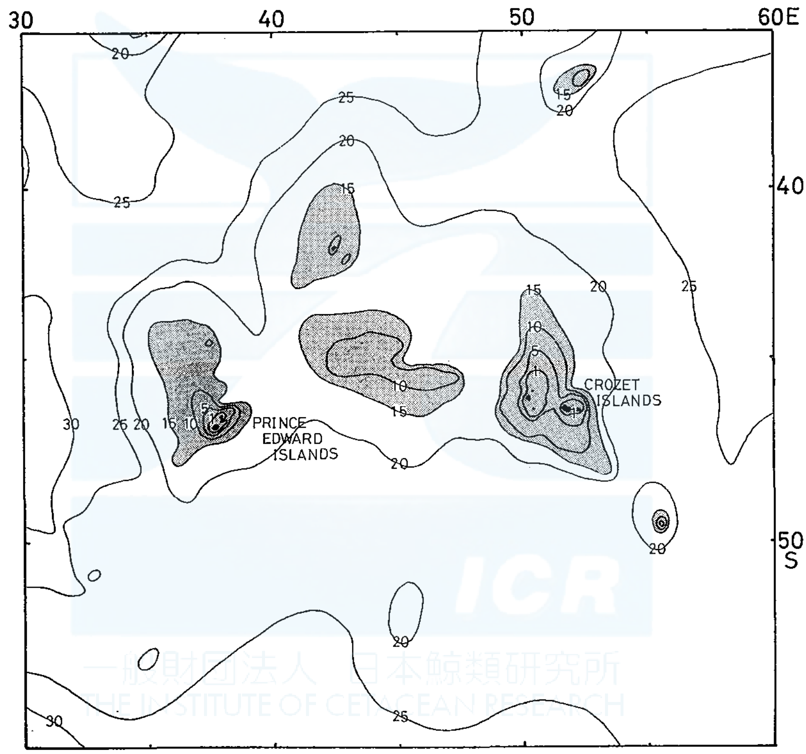

Fig. 1. Chart of the Crozet Ridge region showing general bathymetry. Depths in the 100 fathoms. (After U.S. Chart H.O. Misc. 15, 254–12).

The Crozet and Kerguelen Ridge regions are shown with bathymetric contours in Figs. 1 and 2. Although the submarine rising around the Prince Edward and Crozet Islands is not generally termed the Crozet Ridge (Herdman, Eiseman and Overy, 1965), the Crozet Ridge is named in this study after "Atlas zur Ozeanographie " by Dietrich and Ulrich (1968).

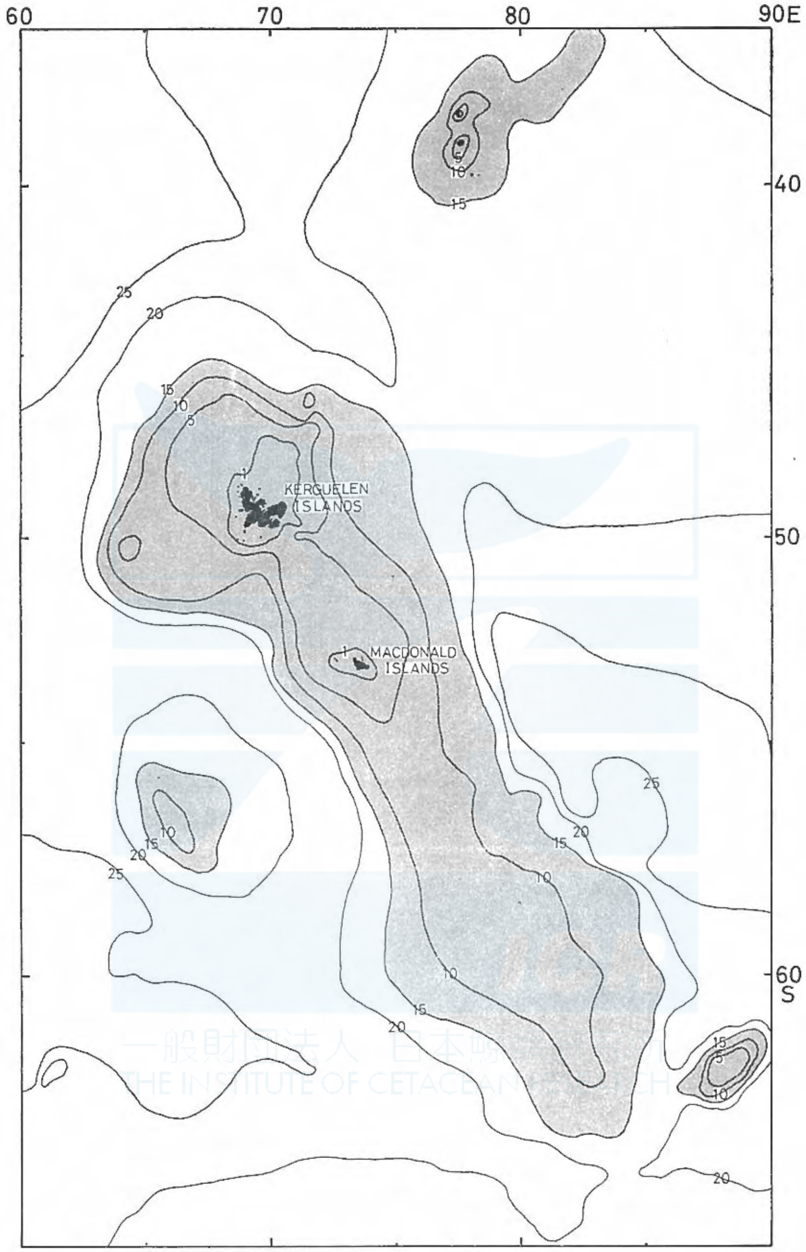

Fig. 2. Chart of the Kerguelen Ridge region showing general bathymetry. Depths in the 100 fathoms. (After U.S. Chart H.O. Misc. 15, 254–12).

LOCATION OF WHALING GROUNDS

Before discussing the features of the temperature distribution at the surface in the Crozet and Kerguelen Ridge regions, the features of the catch distribution of the sei and fin whales, which are the most important baleen whales as well as the minke whale for the recent whaling industry, is summarized.

In these two regions right whales were abundantly caught by the old American whalers mainly in the 19th century, and pigmy blue whales also were bulkly caught there in the early 1960's. The chart of the catch distribution of the right whale by Townsend (1935) and one of the pigmy blue whale by Ichihara (1966) are very usefull. According to them, the good whaling grounds of the right whale were located in the waters adjacent to the Crozet and Kerguelen Islands and ones for the pigmy blue whale were rather distributed over the Kerguelen and Crozet Ridges. Sei whales have been abundantly caught in these regions since the 1964/65 Antarctic season and fin whales have been frequently caught in the north of 60°S since the 1957/58 Antarctic season. The catch distribution of the sei and fin whales are shown in Figs. 3, 4, 5 and 6.

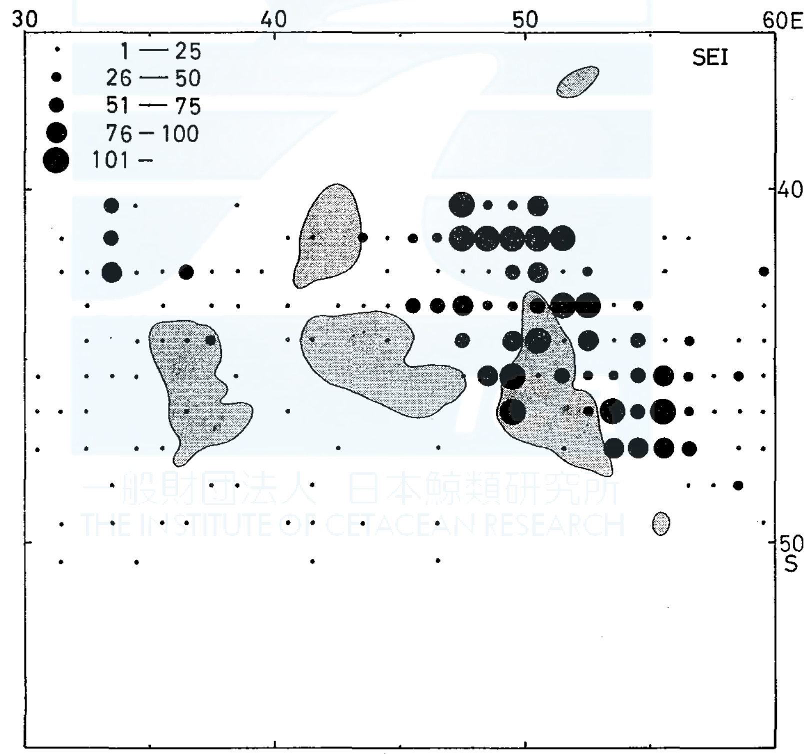

Fig. 3. Distribution of sei whales caught by Japanese Antarctic whaling fleets in the Crozet Ridge region from the 1965/66 to the 1972/73 seasons. Light shading: depths less than 1,500 fathoms (about 3,000 m).

The Crozet Ridge Region

Sei whales were caught abundantly in the submarine rising around the Crozet Islands, though their few catches are distributed widely on the Crozet Ridge. The good whaling grounds of the sei whale are located in the adjacent waters to the Crozet Islands. Although in the shallow waters around the Prince Edward Islands it is somewhat similar in appearance to the Crozet Islands region, catches of sei whales have been a little less than the former. The fin whale, on the other hand, also distributed widely on the ridge, and a great number of their catches is located on the far south-west waters to the Prince Edward Islands.

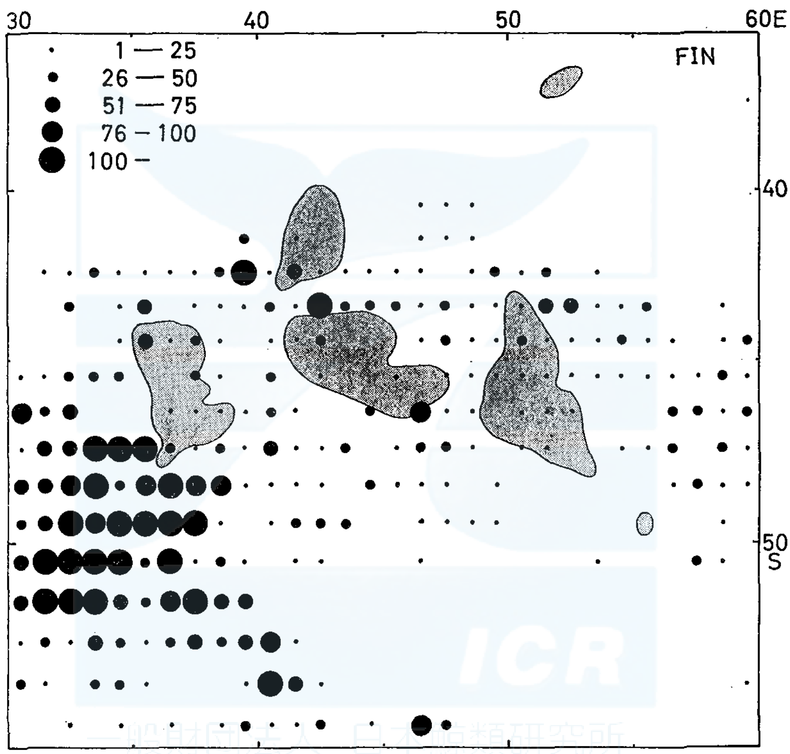

Fig. 4. Distribution of fin whales caught by Japanese Antarctic whaling fleets in the Crozet Ridge region from the 1957/58 to the 1972/73 seasons.

The Kerguelen Ridge Region

The catches of sei and fin whales are widely distributed on the ridge, though the features of their catch distribution is to some extent different from one on the southern part of the ridge. There are two heavy catches areas of sei whales over the ridge. It appears that the whaling grounds of the sei and fin whales between 40° and 45° S are related to the Subtropical Convergence. The fin whales seem to be distributed dominantly south of about 53° S. These two species of whales have a

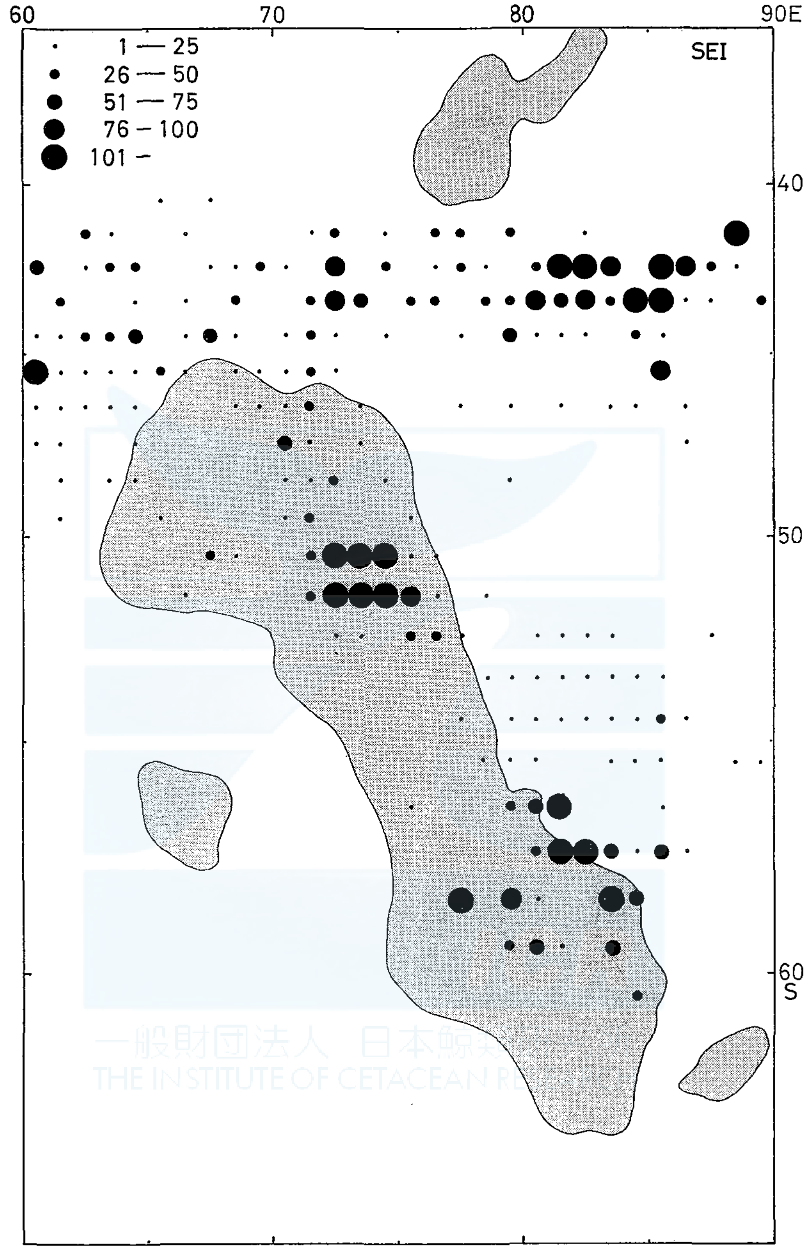

Fig. 5. Distribution of sei whales caught by Japanese Antarctic whaling fleets in the Kerguelen Ridge region from the 1965/66 to the 1972/73 seasons. Light shading: depths less than 1,500 fathoms (about 3,000 m).

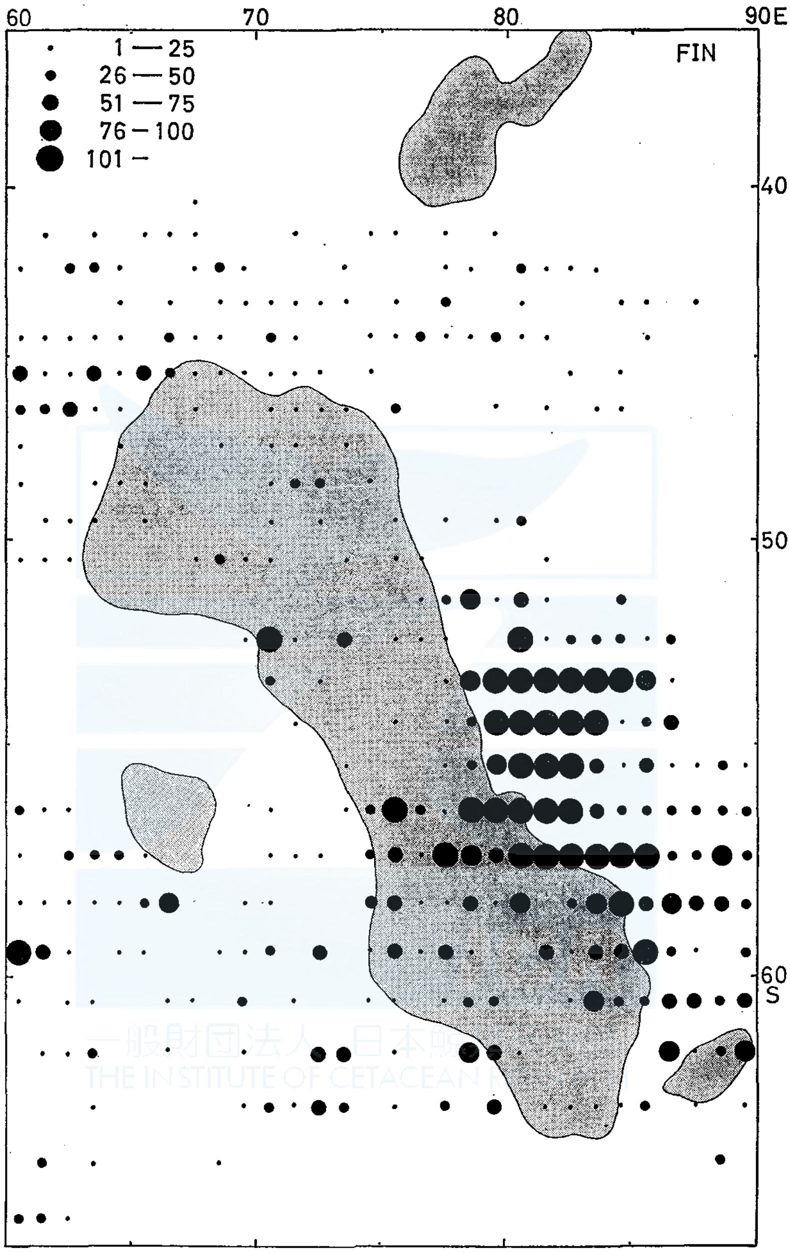

Fig. 6. Distribution of fin whales caught by Japanese Antarctic whaling fleets in the Kerguelen Ridge region from the 1957/58 to the 1972/73 seasons.

strong tendency to be distributed on to the eastern slope of the ridge and a few ones have been caught on to the western slope of it, except in the higher latitudes south of about 56° S, where the fin whales are widely distributed from west to east of the ridge.

The different features of the catch distribution of the sei and fin whales as mentioned above may be partly caused by the difference of their foods and habitat segregation. In the Subantarctic regions of these two whaling grounds, the quantitatively important food organisms of the sei whale is *Parathemisto gandichaudii*, and *Euphausia vallentini* is important as a favorite food of the fin whale (Nemoto, 1959, 1962, 1970; Nasu, 1966; Kawamura, 1970). I do not intend to mention further a pattern of their catch distribution, because it is not the main purpose of the present study.

SURFACE OCEANOGRAPHIC CONDITIONS

Figs. 7–21 show the distribution of the surface temperature in the 1957/58 to 1972/73 Antarctic whaling seasons. Some oceanographic conditions in the Crozet and Kerguelen Ridge regions are discussed on the basis of these distribution of the surface isotherms.

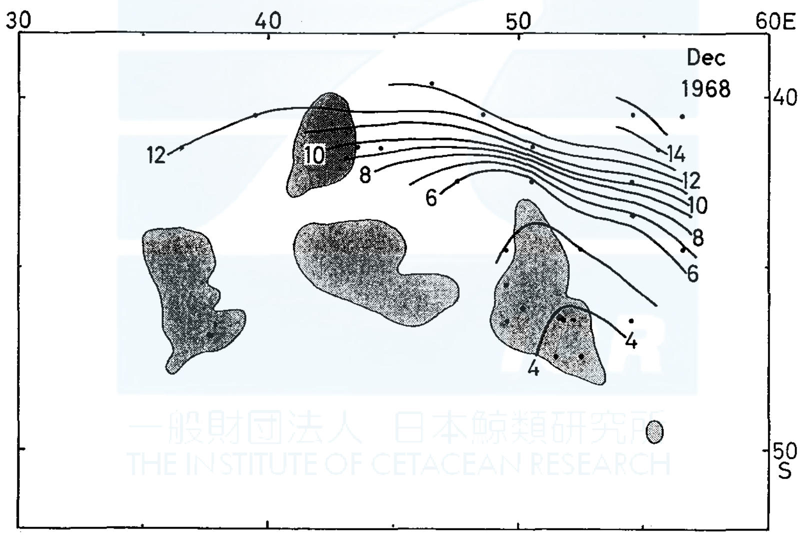

Fig. 7. Surface temperature (°C) in December 1968.

The Crozet Ridge Region

The distibution of th emonthly mean surface temperature in this region are shown in Figs. 7–14. The isotherms are remarkably bending, which is conspicuous in the submarine rising region around the Crozet Islands and less conspicuous in the Prince Edward Islands than the former, namely northward on the rising and

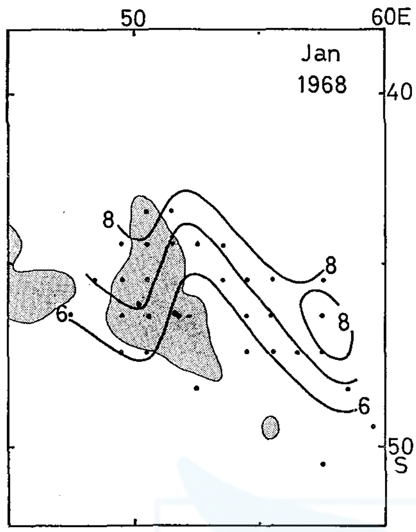

Fig. 8. Surface temperature (°C) in January 1968.

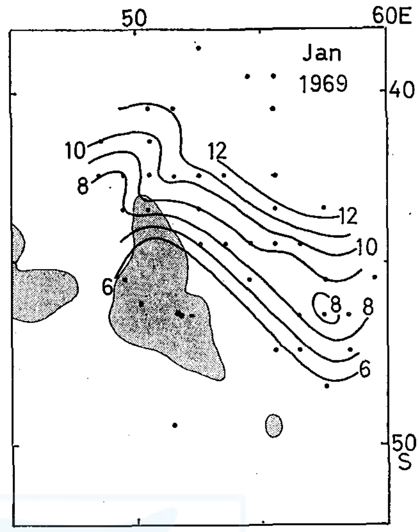

Fig. 9. Surface temperature (°C) in January 1969.

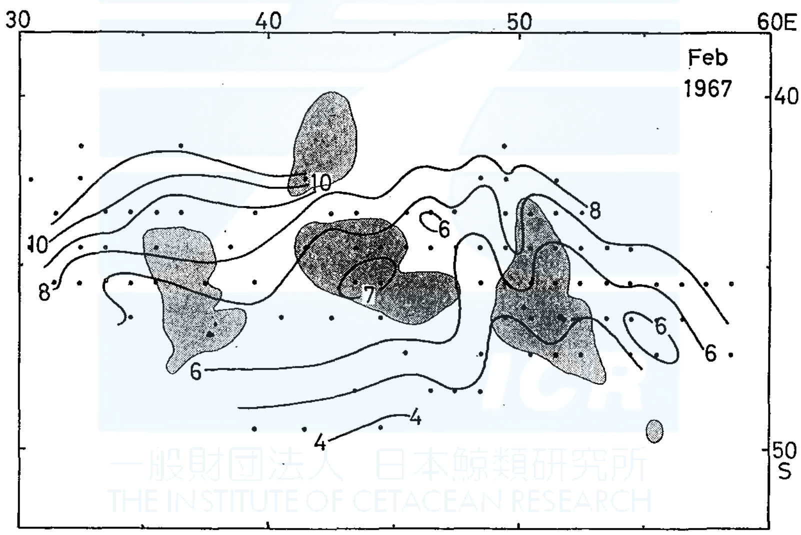

Fig. 10. Surface temperature (°C) in February 1967.

southward on the west and the east sides of it, with some irregularities. Such tendency of the isothermal pattern is especially distinct in the Crozet Islands region, where data are more abundant than in elsewhere. In the Prince Edward Islands region, however, the similar bend are not so clear as in that region in a certain months, perhaps owing to the lack of data.

The bend of isotherms in the adjacent waters to the Crozet Islands in winter

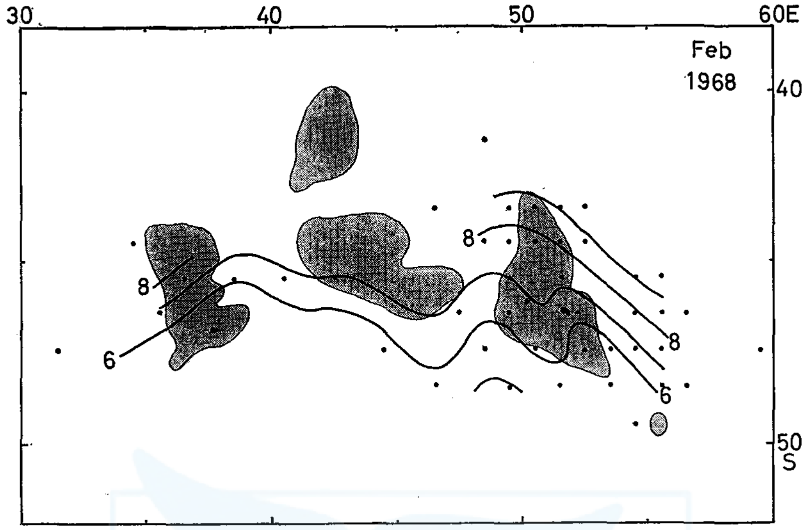

Fig. 11. Surface temperature (°C) in February 1968.

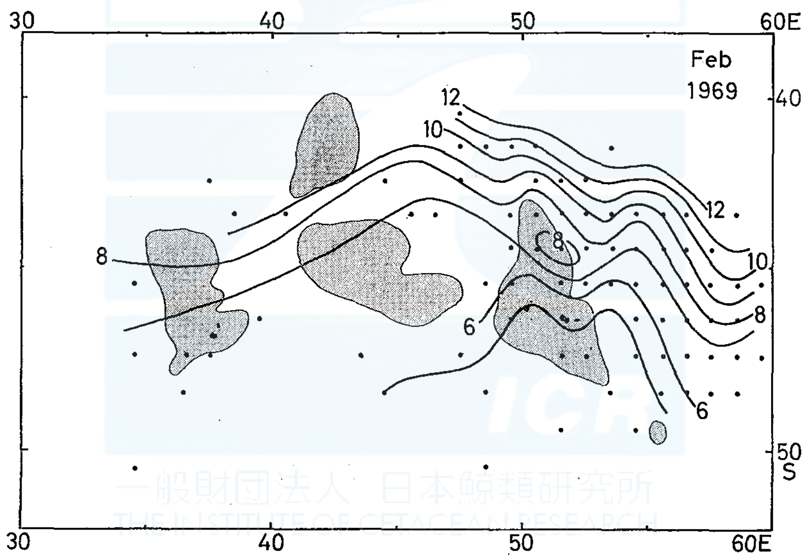

Fig. 12. Surface temperature (°C) in February 1969.

have been already shown by Darbyshire (1964), Visser and Niekerk (1965), Orren (1966) and Nel (1968). By these charts, therefore, it appears that such feature of the surface isotherms to be a permanent one. A steep temperature gradient still occurs in the adjacent waters to south of the Subtropical Convergence. Its oceanographic conditions seem to intencify an effect of the convergent movement in accompany with the Subtropical Convergence, lying about 42° S in the South West

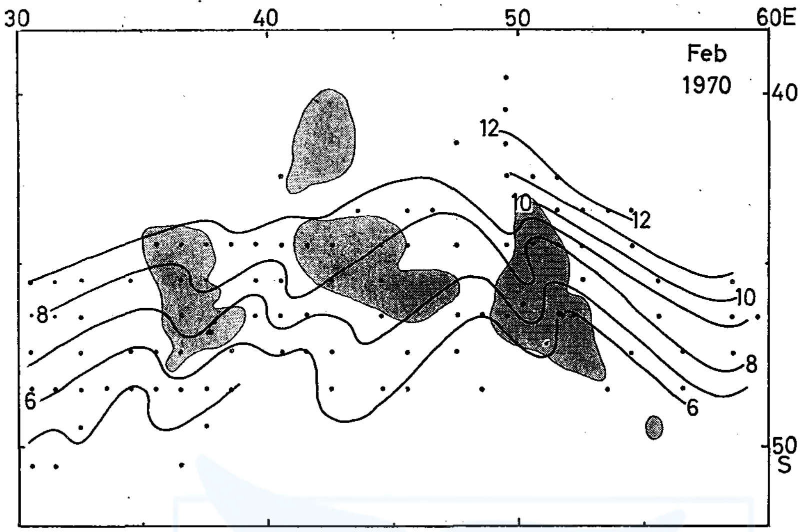

Fig. 13. Surface temperature (°C) in February 1970.

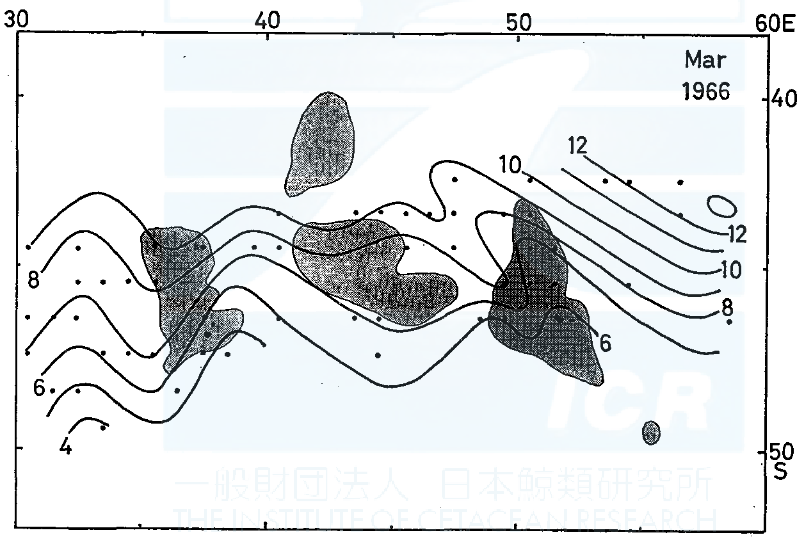

Fig. 14. Surface temperature (°C) in March 1966.

Indian Ocean (Deacon, 1937a; Orren, 1966). It also seems that the Subtropical Convergence bends soutwards on the eastern side of the Crozet Islands, presumably in approximately 60° E. The Subtropical Convergence by Deacon (1937a) also meanders southwards in approximately 60° E.

The Antarctic Convergence, which is one of the major features in the Antarctic Ocean, seems to run across the submarine rising around the Crozet Islands in December 1968, considering the location of the 4°C isotherm at the surface, which is one of the valid indication of the Antarctc Convergence (Deacon, 1937a; Mackintosh, 1946; Houtman, 1968). The 4°C isotherm, however, does not lie on the Crozet Ridge in January, February and March. The greater parts of the Crozet Ridge region, therefore, seems to be usually between the Subtropical and Antarctic Convergences, and so this region is occupied by the major Subantarctic Surface Water.

It is well known that the temperature distribution well reflects the feature of the current. If we accept this general view, the current deflects to the left (north) on approaching a submarine rising around the Prince Edward and the Crozet Islands, and after having passed the rising it deflects to the right (south). Such current deflection over the submarine rising seems to be variable probably under the influence of the bottom topography.

These findings support the view by Darbyshire (1964) and by Visser and Niekerk (1965), who described the current deflection to the left over the submarine rising around the Crozet Islands and the influence of the bottom topography on the ocean current. Orren (1966) also indicated a northward flow of the cold Subantarctic Surface Water in the Crozet Islands region, probably occasioned by a northward movement of the Antarctic Convergence south of that islands.

The Kerguelen Ridge Region

Figs. 15–21 show the distribution of the monthly mean surface temperature in this region. It is clear that the isotherms are bending in a similar way as in the Crozet Ridge region, namely with a northward bend over the ridge and a southward one on the east side of it. The 4°C isotherm lies near the 50° S parallel across the ridge with bending from the west to the east. Furthermore after passing the ridge the Antarctic Convergence bends down to about 55°S in approximately 90°E. Its position roughly coincides with the convergence by Deacon (1937a) or by Mackintosh (1946). In addtion to this convergence, a sharp gradient in the surface temperature occurs on the north slope of the ridge.

The distriburion of the montly mean surface temperature suggests that the current deflects to the left (north) on approaching the Kerguelen Ridge and after having passed the ridge it bends to right (south). These deflection of the surface current in the ridge region seems to be probably influenced by the bottom topography and to be variable as well as in the Crozet Ridge region.

Deacon (1973a, b) and Sverdrup (1942) described the current bends to the north and to the south on passing over the Kerguelen Ridge, and that the current deflection is probably under the influence of the bottom topography.

The deflection for a current on passing over the rising in the bottom topography may be anticipated on the theoritical grounds—in the southern hemisphere a current will deflect to the left as the sounding decreases and to the right as it increase (Deacon, 1937a, b; Sverdrup, 1941; Neuman, 1960), and in the case of eastern flowing is the West Wind Drift a northward movement is expected. These features are actually observed in many ridge regions, besides these two, in the Antarctic

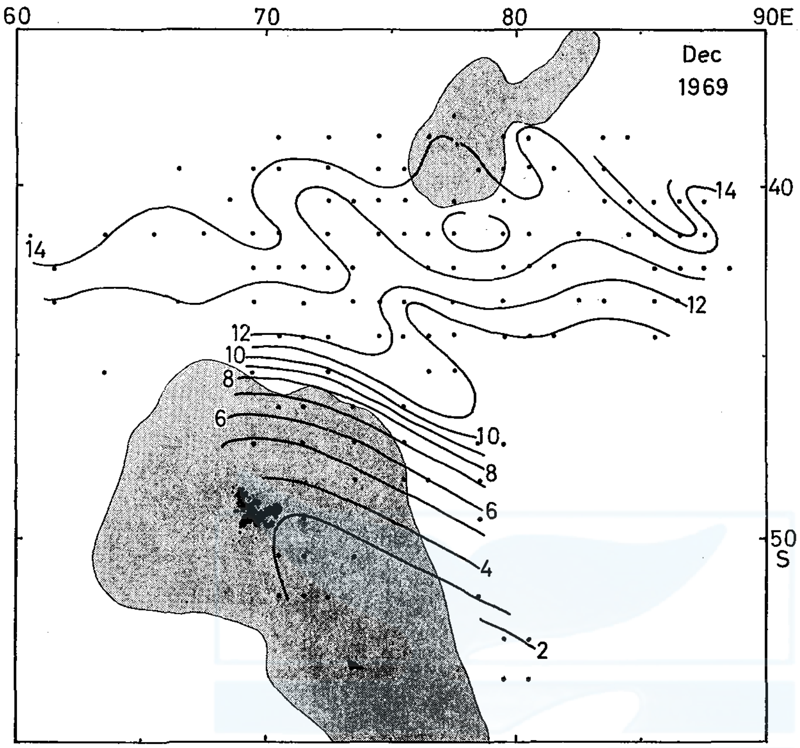

Fig. 15. Surface temperature (°C) in December 1969.

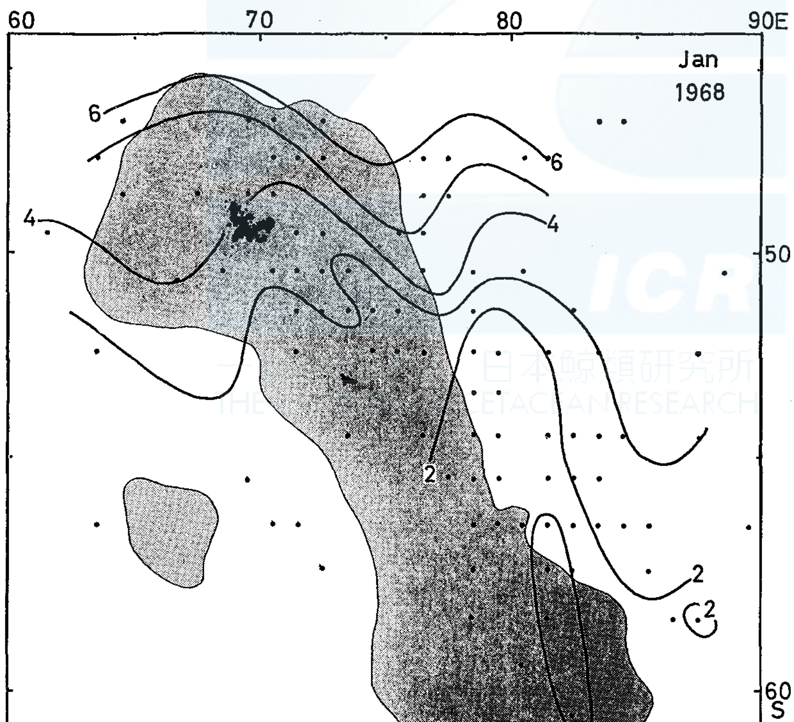

Fig. 16. Surface temperature (°C) in January 1968.

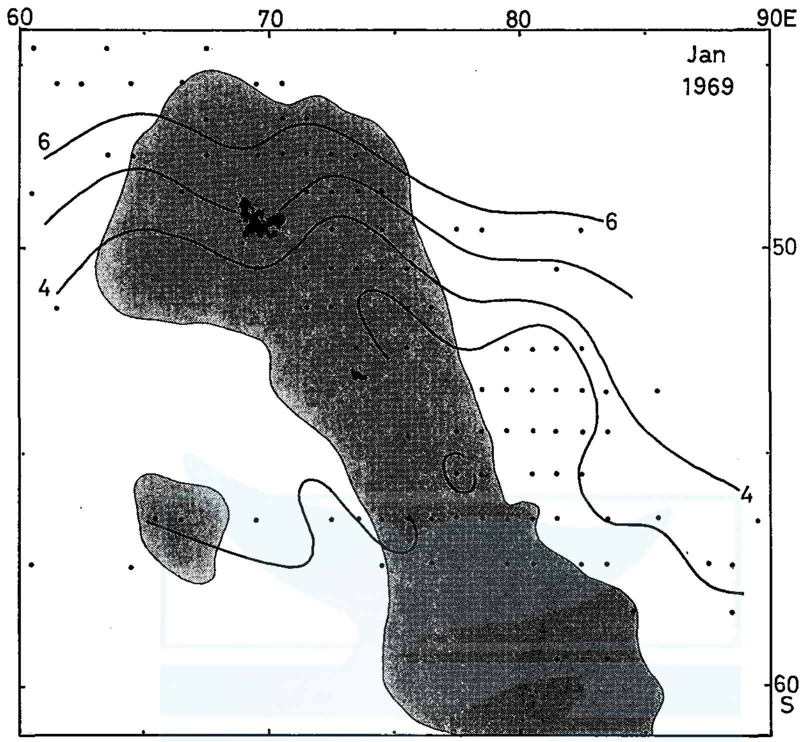

Fig. 17. Surface temperature (°C) in January 1969.

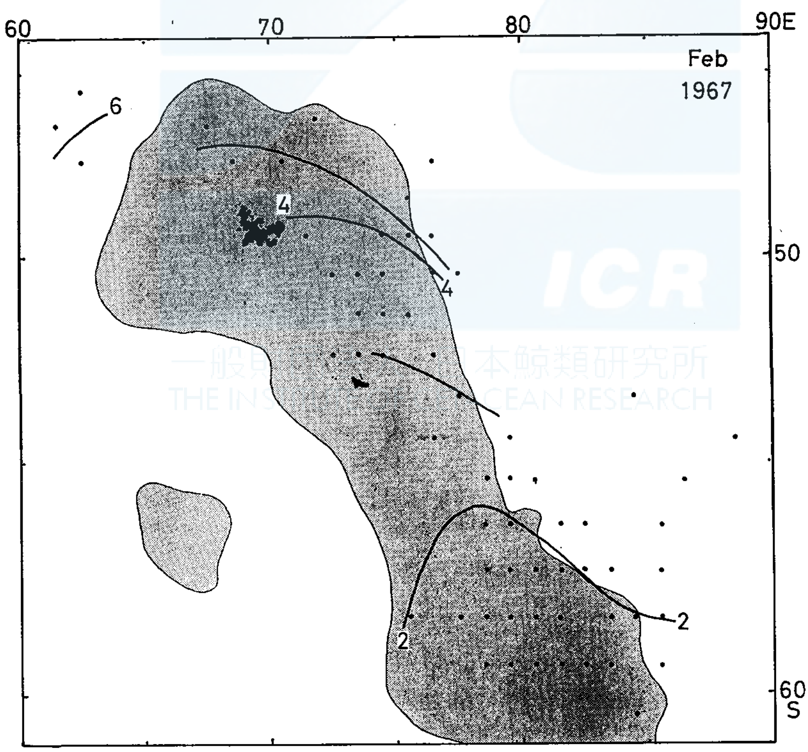

Fig. 18. Surface temperature (°C) in February 1967.

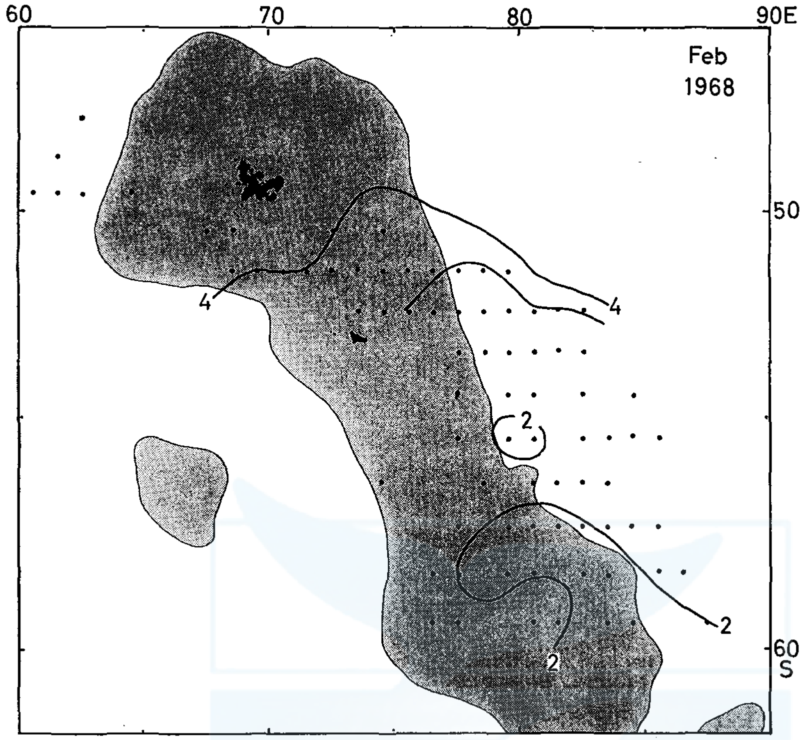

Fig. 19. Surface temperature (°C) in February 1968.

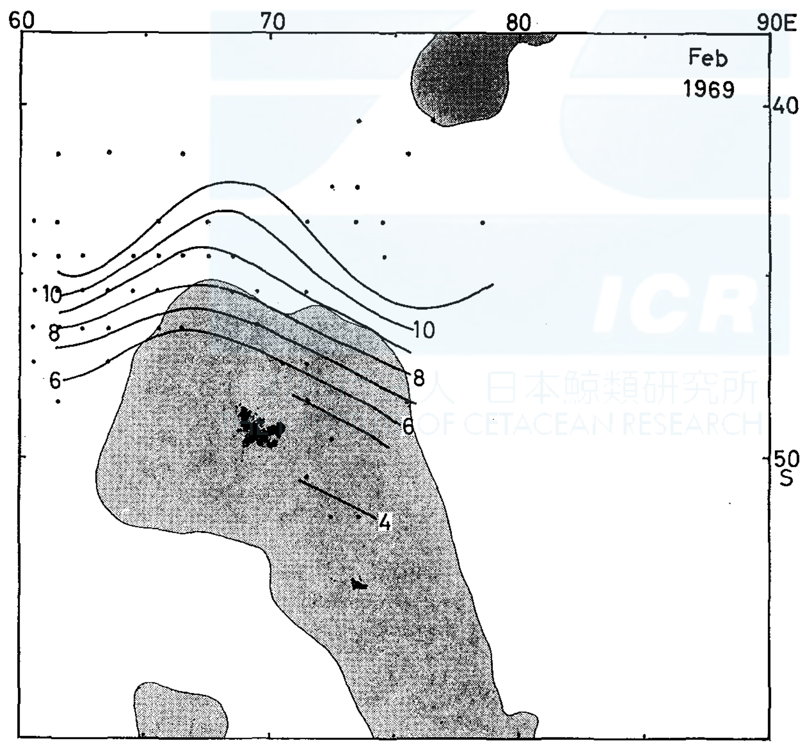

Fig. 20. Surface temperature (°C) in February 1969.

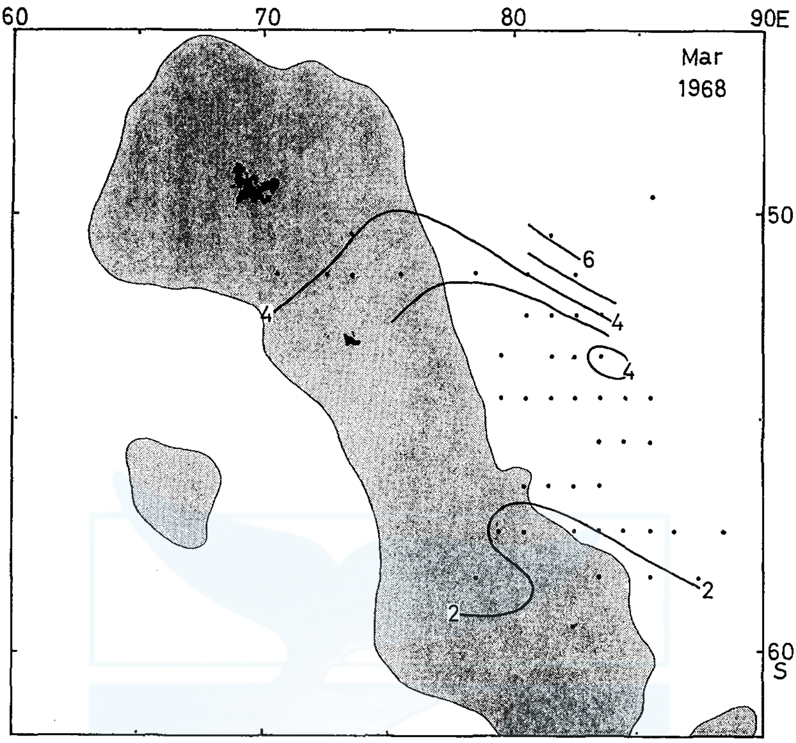

Fig. 21. Surface temperature (°C) in March 1968.

Ocean (Deacon, 1937a, b; Sverdrup *et al.*, 1942; Midttun and Natvig, 1957; Burling, 1961; Harris, 1970) and they support the theory.

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