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NEAR-BOTTOM TEMPERATURE AROUND ICELAND

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INTRODUCTION

It is well known that directly and indirectly, temperature plays an important role in the ecology of the ocean. Thus faunistic classification of the sea is much better achieved on the basis of temperature rather than depth, and temperature serves as a most useful indicator of prevailing and changing ecological conditions. It is generally recognized that the effect of temperature on fish behaviour is particularly pronounced during spawning, and it has been demonstrated that the survival of larvae of commercially important species of fish and consequently the strength of the year classes may be largely determined by temperature and other environmental factors following the spawning period (e.g. HERMANN 1951, HACHY, HERMANN and BAILEY 1954, CHASE 1955). Furthermore, rates of feeding, metabolism and growth are affected, not only by the availability of food, but also directly by the water temperature. Finally, not only the temperature *per se,* but also its horizontal and vertical gradients have biological implications, e.g. in the migrational pattern of pelagic fish.

In Icelandic waters, with their highly variable hydrographical conditions, the influence of temperature on the distribution of marine species and their growth rate has been clearly established. During this century we have experienced a more conspicuous climatic change in the arctic regions than in any of the previous mild periods during the last 200 years. This change was characterized by an increase of the mean annual air and sea temperature and a retreat of the polar ice. In Icelandic waters the sea surface temperature increase was particularly rapid after 1920 and it appears to have culminated in the thirties. In the forties and fifties there was a downard trend followed by a sharp decrease during the last decade (STEFÁNSSON 1954, 1969). At subsurface depths, at least down to 200 m, similar variations have occurred in the North Icelandic region (STEFÁNSSON 1969). Concurrent with the temperature increase during the first decades of this century, marked biological changes were found. These were reflected not only in the increased occurrence of new, more boreal species, but also in the extension of spawning areas of commercially important fish stocks (SÆMUNDSSON 1934, FRIDRIKSSON 1948). Thus prior to 1920 the spawning of cod appeared to be limited to the grounds off the south and west coasts, whereas in the period after 1930 spawning has taken place practically all around the coast. The relation between bottom temperature and distribution of catchable cod and redfish were studied between 200 and 500 meters on the grounds north and east of Iceland in 1955. It was found that catches per hour trawling decreased markedly when the temperature dropped below 2°C (HALLGRÍMSSON 1955, MAGNÚSSON 1955). Furthermore, investigations on the rate of growth of cod as a function of temperature have revealed a strong positive correlation (JÓNSSON 1965).

From these and other examples it is evident that information on the distribution of near-bottom temperature should be of considerable interest to marine ecologists, fishery scientists as well as fishermen. It was therefore decided to compile and summarize the available temperature data to make them accessible to biologists and others working in the shelf area around Iceland.

MATERIAL AND METHODS

The study area extends from 63° N to 67° 30′ N and 11° W to 27° W. The source material is derived from the Hydrographic Card Index of the Service Hydrographique in Copenhagen up to 1947, data published in *Bulletin Hydrographique* 1948—1961, and Icelandic observations during the years 1962—1967 in addition to observations from selected stations in the years 1968—1973.

The number of observations by months and for different depth ranges is summarized in Table 1. It will be seen that about 74% of the available material was collected during the months May–August, much less frequent observations exist from the months January–April and September (22%), and only

TABLE 1.
Number of Observations for Different Months

Month	Depth Range				
	0–100 m	101–200 m	201–300 m	> 300 m	Total
January	79	138	21	10	248
February	101	117	48	6	272
March	142	64	23	9	238
April	146	110	24	8	288
May	326	281	99	46	752
June	397	387	224	106	1114
July	582	518	236	73	1409
August	509	473	183	67	1232
September	100	115	47	13	275
October	18	17	5	3	43
November	49	48	18	3	118
December	34	18	5	4	61
Total	2483	2286	933	348	6050

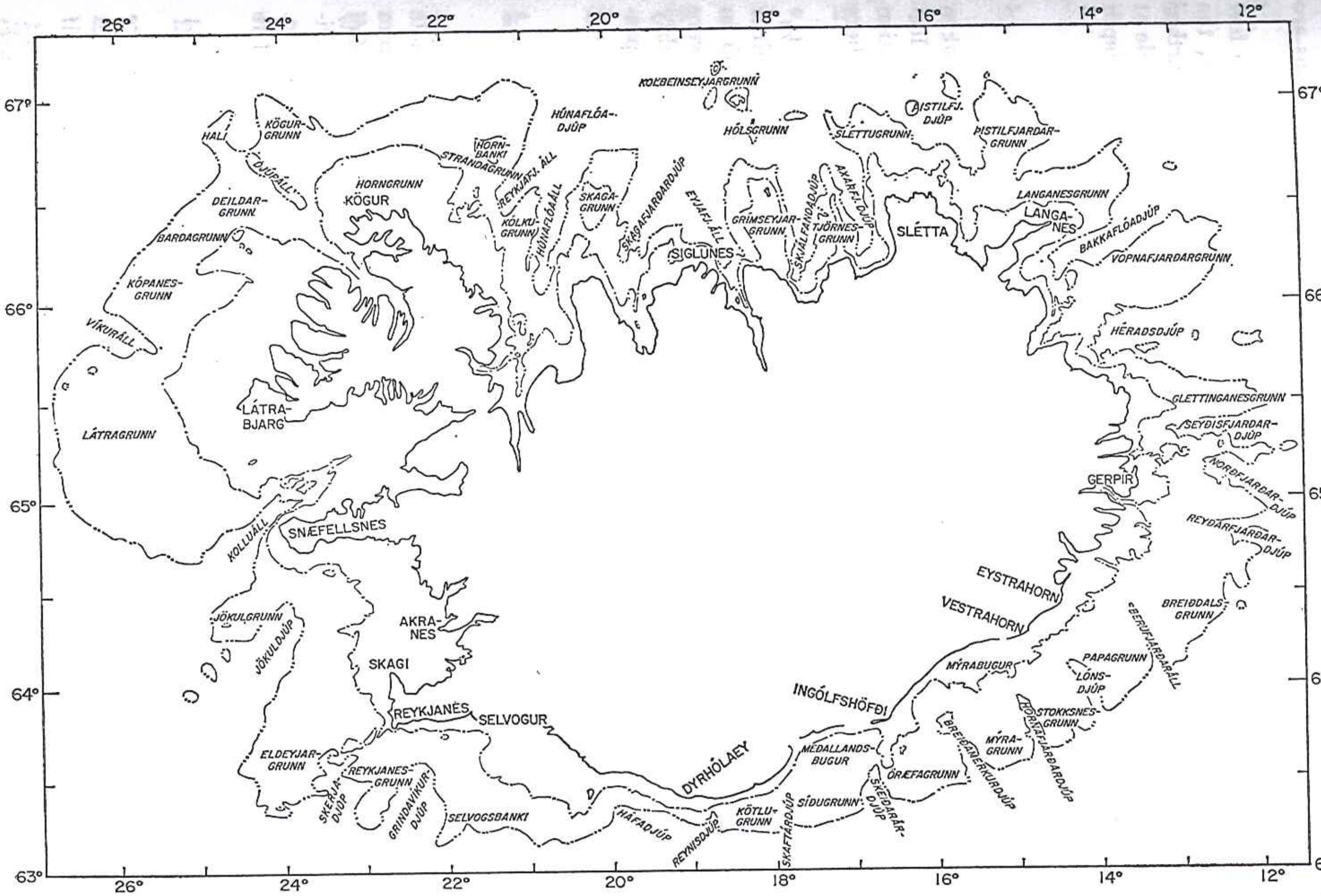

FIG. 1. *Names of the principal bathymetrical features of the Icelandic coastal region. Depth curves for 100 and 200 meters.*

few (<4%) from October–December. More than 94% of the observations are derived from the area inside the 300 m isobath.

Observations have rarely been made right at the bottom, but rather a few meters or more above the bottom, depending upon depth. Consequently, the available data refer to "near-bottom" temperature. This term requires further clarification. Normally, the data used where derived from observations made at a distance from the bottom less than 10% of the total depth. For different depth ranges the mean distances were as follows:

0–100 m	101–200 m	201–300 m	> 300 m
6.6 m	9.1 m	11.2 m	18.9 m

In the shallowest depth range, 0—100 m, 86% of the observations were taken within 10 m and 98% within 15 m above the bottom. In most part of the Icelandic shelf area the temperature changes only slightly in vertical direction within 20 meters from the bottom. Hence, it is assumed that the values here used very nearly represent the true bottom temperature.

Near-bottom temperature normals were computed as follows: For each ½° latitude and 1° longitude (see illustration preceding Appendix I) mean values were calculated for the depth ranges 0—100 m, 101—200 m, 201—300 m and greater than 300 m. The monthly observation values for each year were first averaged and grand means then computed by averaging the mean monthly values for the various years. The results are compiled in Appendix I and presented in the form of mean charts (Figs. 2—8).

MEAN CHARTS

Due to limited data is was only possible to draw mean charts of the whole shelf area for the months May, June, July and August. Observations from February and March were combined to draw a mean chart for the Faxaflói and Selvogsbanki regions and for September the near-bottom temperature distribution is shown for the southwest, southeast and part of the north coast area. Names of localities frequently referred to in the text are shown in Fig. 1. The essential features revealed by these charts will now be summarized.

a, February/March.

During this coldest period of the year the mean near-bottom temperature (Fig. 2) drops below 3° in the nearshore region of the inner part of Faxaflói, but increases to 5° or more at the mouth of the bay. In the outer part of the shelf southwest of Faxaflói the mean temperature ranges from 6°—6.8°.

South of Reykjanes and in the Selvogsbanki region the winter temperatures remain uniform, 6—7°, over almost the whole area. It is only in the shallowest

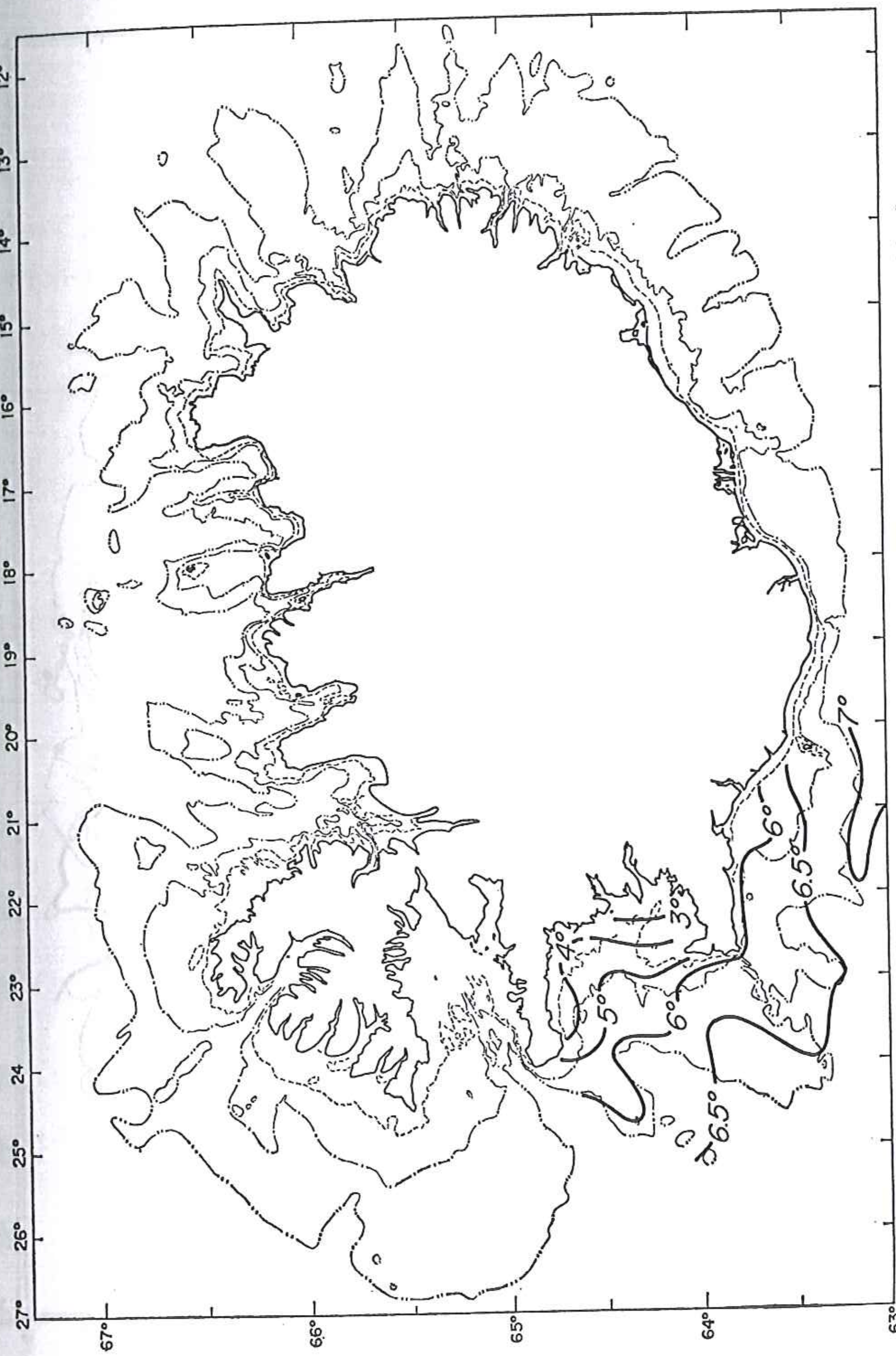

FIG. 2. *Mean near-bottom temperature southwest of Iceland in February–March.*

FIG. 3. *Mean near-bottom temperature southwest of Iceland in April.*

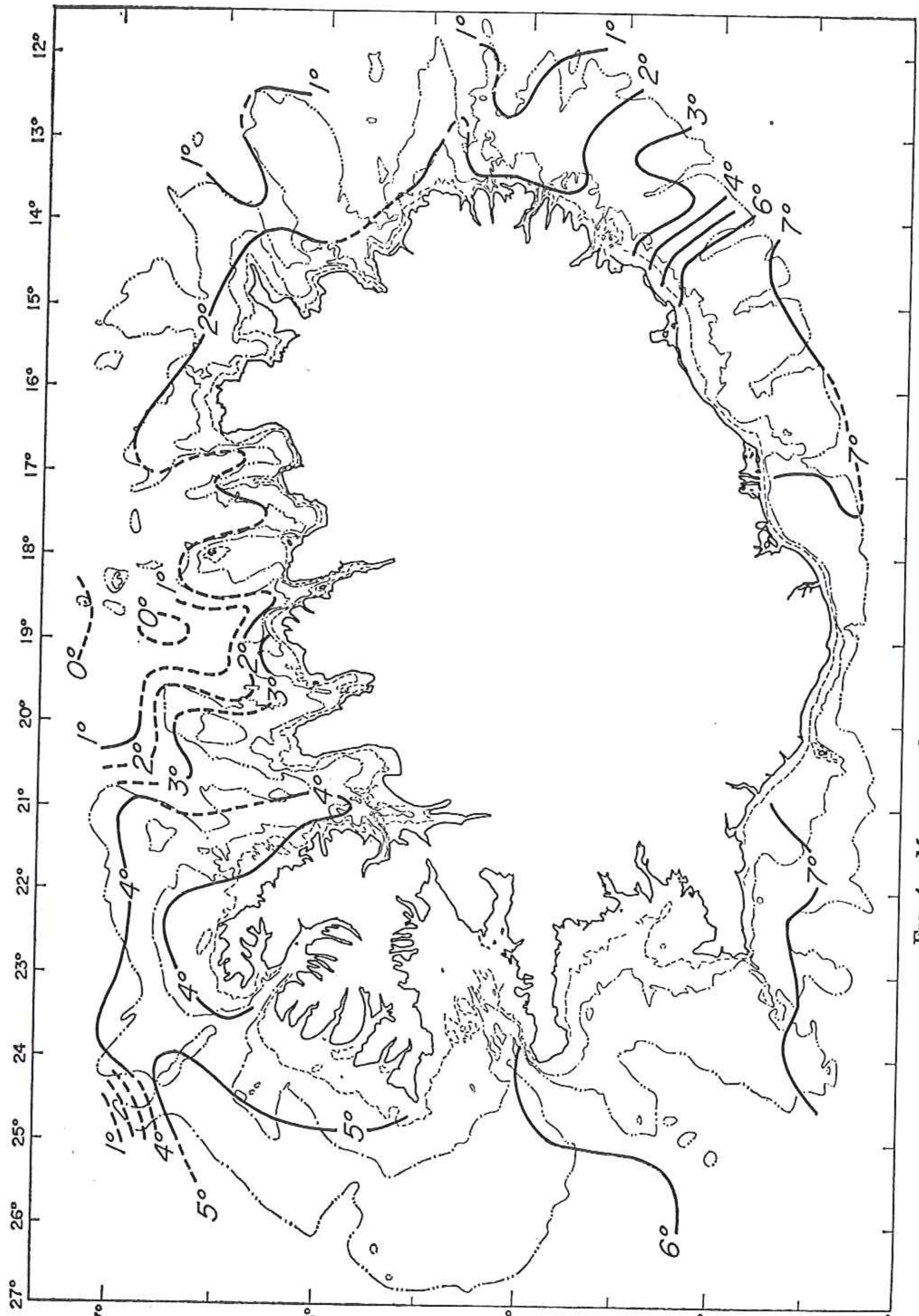

FIG. 4. *Mean near-bottom temperature around Iceland in May.*

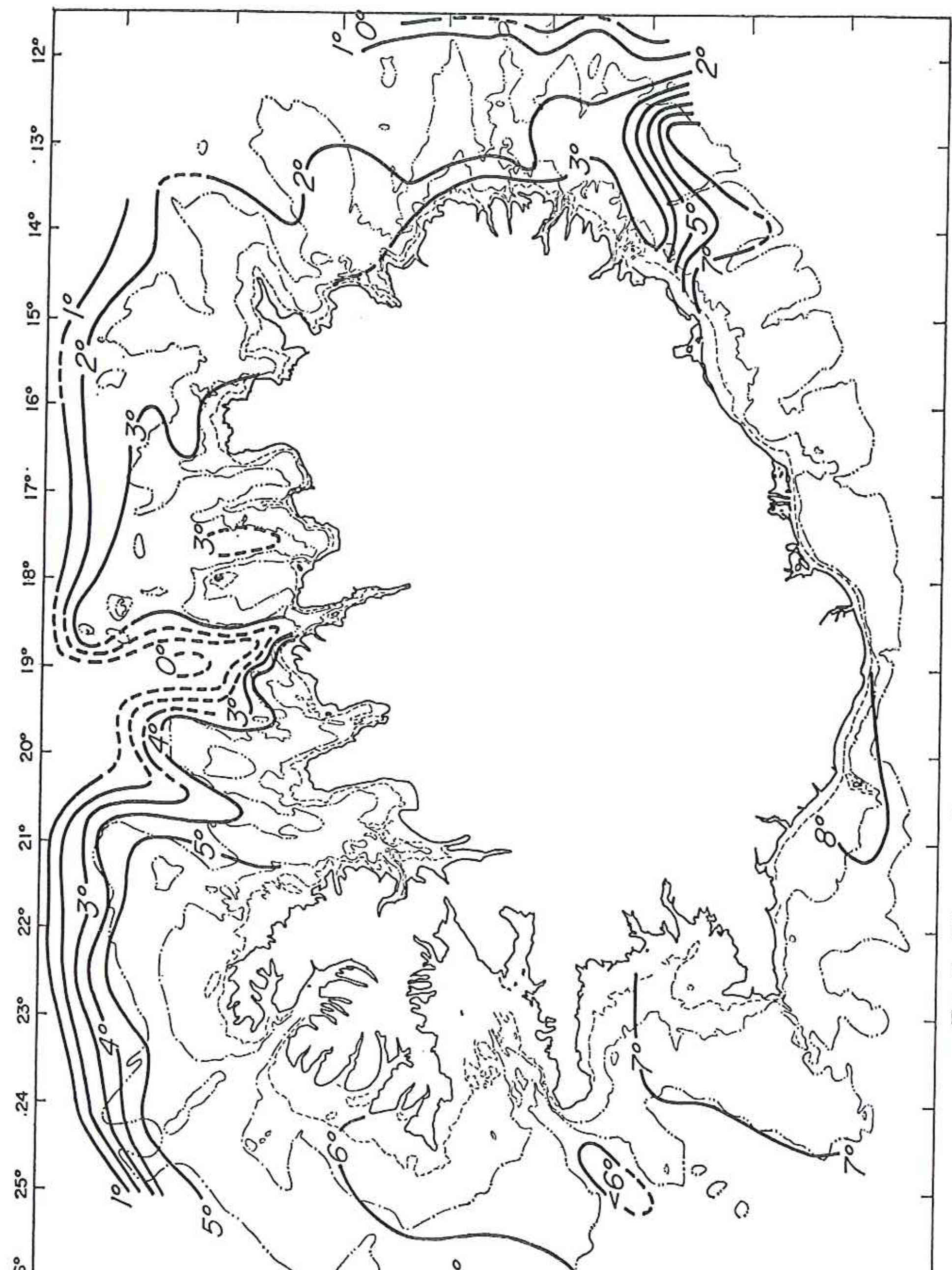

FIG. 5. *Mean near-bottom temperature around Iceland in June.*

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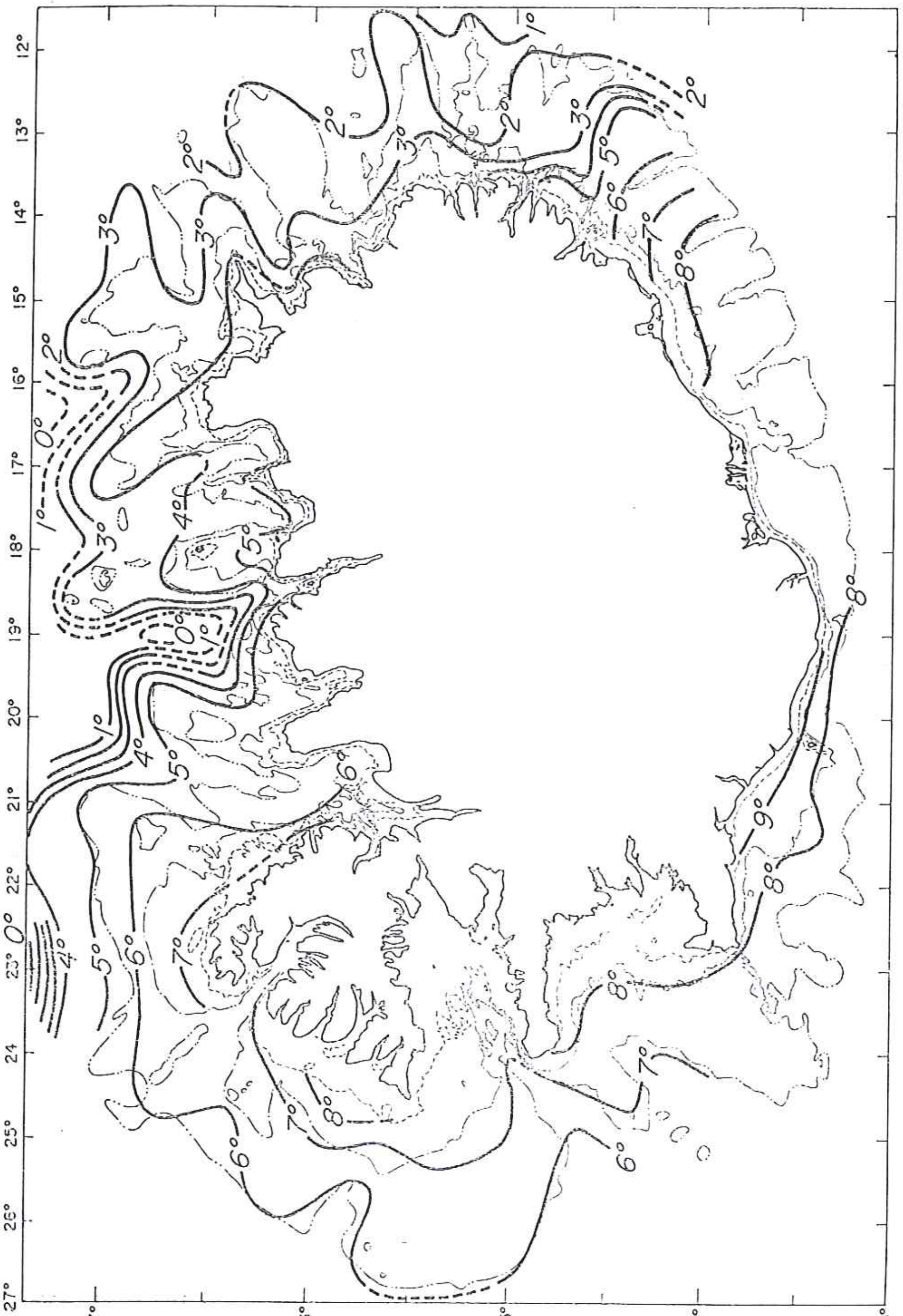

Fig. 6. *Mean near-bottom temperature around Iceland in July.*

FIG. 7. *Mean near-bottom temperature around Iceland in August.*

Fig. 7. *Mean near-bottom temperature around Iceland in August.*

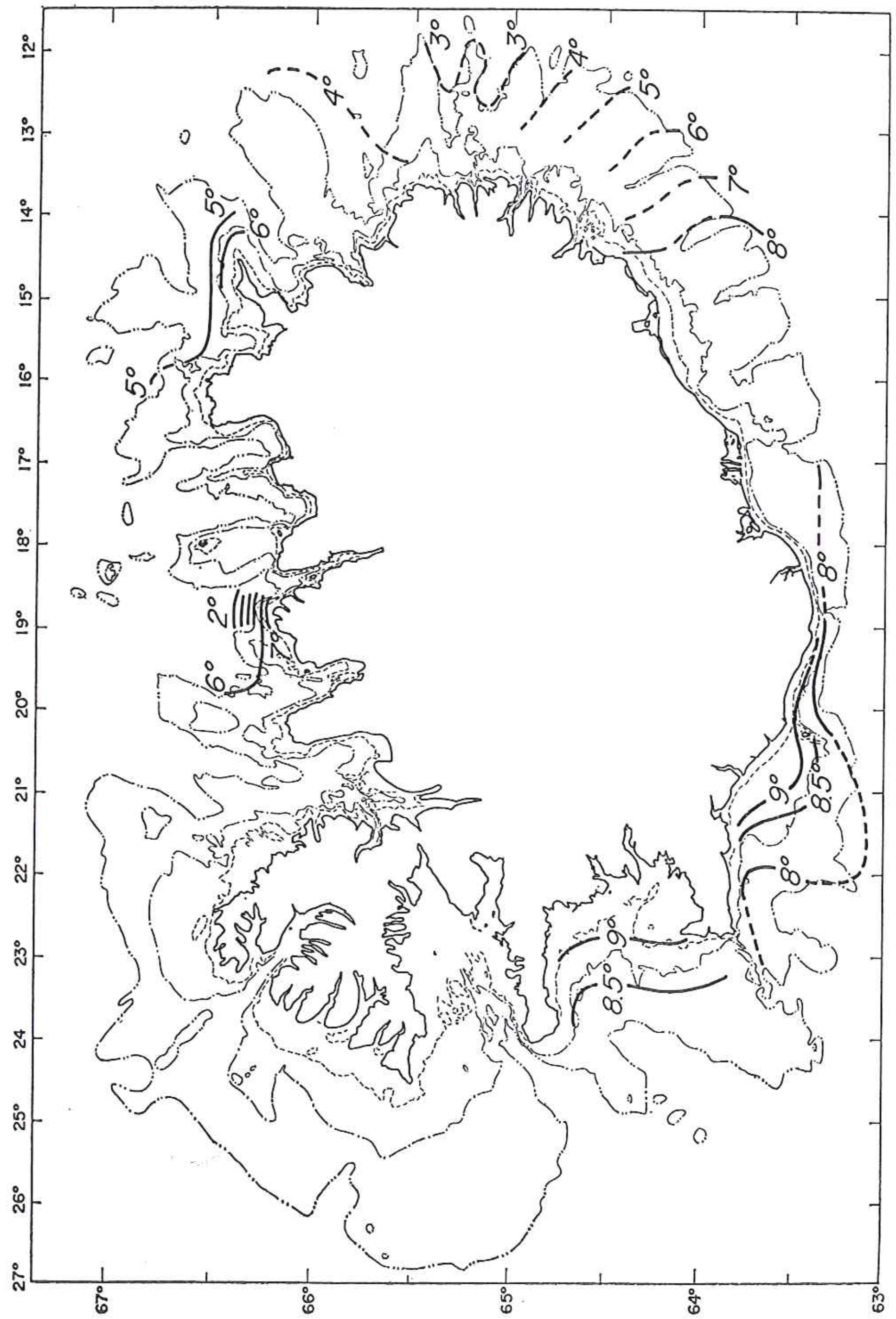

Fig. 8. *Mean near-bottom temperature over the southwest, south, east and part of the north Icelandic coastal area in September.*

nearshore area along the south coast that the temperature drops below 6°. In this respect there is a significant difference between Faxaflói and the coastal area south of Iceland.

b. April.

In the nearshore area the temperature (Fig. 3) has increased from the February/March mean, by about 1° in Faxaflói and about 0.5° south of Iceland. In the outer part of the shelf, however, the April temperature remains practically the same as in February/March, i.e. 6—7°.

c. May.

In Faxaflói and south of Reykjanes the near-bottom temperatures (Fig. 4) range from 6° to 7° and have thus increased by more than 2° from the April mean in the nearshore part of Faxaflói but have increased only slightly south of Reykjanes. In the outer part of the shelf area between Reykjanes and Snæfellsnes the mean temperature remains 6—7°, i.e. almost the same as for February/March and April. The effect of the vernal heating has therefore been to equalize the temperature distribution across the shelf in this region.

Off the northwest coast and as far east as Húnaflói the nearshore bottom temperatures are still somewhat lower than farther out on the shelf where the influence of Atlantic water is greater. Thus a tongue of water warmer than 5° penetrates as far as Djúpáll off the Ísafjarðardjúp, and the 4° isotherm forms another tongue extending into the Húnaflói region. Between Húnaflói and Eyjafjörður the temperature is 3—4° in the shallower part, but drops down below 1° in the deep basin west of Grímsey. In the coastal area from Eyjafjörður eastward along the north coast and within a narrow zone along the east coast temperature lies between 2° and 3°. However, over most part of the shelf area east of Iceland inside the 200 m isobath the temperature is in the range 1—2°. East and south of Berufjörður there is a slight increase in the near-bottom temperature, and farther south, in the region between Eystrahorn and Vestrahorn, there is a sharp boundary between arctic and Atlantic water. As expected, the highest May temperatures are found off the south coast where they exceed 7° between Ingólfshöfði and Selvogur.

d. June.

Over most part of the shelf area around Iceland the June mean (Fig. 5) is about 1° higher than the mean for May. Thus the temperature lies between 7° and 8° in the Selvogsbanki region and in the southern part of Faxaflói, the 6° isotherm has moved north of Látrabjarg, the 5° isotherm has moved to the western part of Húnaflói, and the 4° isotherm practically follows the same course as did the 3° isotherm in May. However, off the northwest peninsula (Vestfirðir) the increased warming nearshore has led to more uniform temperature distribution over the whole shelf area inside the 200 m isobath. Over the banks off the northeast coast the temperature distribution is also more uniform than in May: 3—4° between Eyjafjörður and Slétta, 2—3° between Slétta and Héraðsdjúp. The low temperatures, 1—2°, still persist over most of the banks east of Iceland in the region between Héraðsdjúp and Breiðdalsgrunn, while close inshore the temperature has increased to 3° or more. South of the temperature boundary east of Eystrahorn and in the whole region along the south coast the temperature is 7—8° except for a small area near Vestmannaeyjar where it exceeds 8°.

e. July.

The continued summer heating which affects the shallower part of the shelf to a greater extent than the deeper part leads to a sharper temperature gradient in offshore direction in July (Fig. 6) than in June. In the Selvogsbanki region the temperature has reached more than 9° in the nearshore region decreasing to less than 8° in the outer part of the bank. Off the west coast of Iceland the temperature on the inner banks lies between 8° and 9° decreasing to 6° on the outer part of the shelf, where it has not increased appreciably from the June mean. Off the north coast an appreciable temperature increase has also taken place in nearshore areas, but only slight increase over the deeper part of the shelf. There is, however, one exception to this, i.e. off the northeast coast where in the region near 67°, between 14° and 16° W, the temperature has increased markedly from the June mean. This can no doubt be mainly attributed to the influence of east-flowing Atlantic water rather than vertical diffusion. It has been shown (Stefánsson 1962, p. 170—183) that the influx of Atlantic water to the North Icelandic shelf area increases in spring and reaches a maximum in summer. The effect of this accelerated inflow will be delayed in the easternmost part of the coastal area which may explain the marked increase in temperature from June to July on the outer part of the shelf north of Langanes. East of Iceland bottom temperatures are somewhat higher in July than June, in particular on the Glettinganesgrunn, but a littler farther south, east of Gerpir, the temperature remains between 1° and 2° as it was in May and June. South of Iceland the July temperature inside the 200 m isobath ranges between 8° and 8.5°.

f. August.

Off the southwest and west coasts near-bottom temperatures in August (Fig. 7) range from more than 9° inshore to 7° or less on the outer banks, and have thus increased by 0.5—1° from the July mean. Similar temperature increase has taken place off the north coast, in particular in the eastern part of the area, where the range is now from more than 5° near-shore to about 3° at the shelf break. Off the east coast temperatures have increased appreciably over the whole shelf area between the coast and 12° W. Along the coast it is more than 5°, dropping rapidly to 3° over a distance of 10—20 miles in offshore direction except in the Digranes region where temperatures higher than 3° prevail beyond the edge of the Digranesgrunn. Over the remaining part of the shelf from Digranesgrunn to Reyðarfjarðardjúp the temperature ranges between 2° and 3°. Off the southeast coast the temperature increase from northeast to southwest appears to be more gradual than in the previous summer months and the boundary between Atlantic and arctic water less clearly defined. Off the south coast the temperature distribution is quite similar to the July mean.

g. September.

For this month (Fig. 8) the observation material is too scanty to make it possible to plot the near-bottom temperature distribution around Iceland. In Faxaflói and the Selvogsbanki region the temperatures have increased from the August mean, in particular on the deeper part of the shelf. The same appears to apply to the area north of Iceland judging from the few observations available. Most conspicuous, however, seems to be the temperature increase east of Iceland. This can probably be attributed to the increased influx of Atlantic water, previously mentioned, from the west to the North Icelandic region, this influence reaching the area northeast and east of Iceland in late summer (cf. STEFÁNSSON 1962, p. 111). Thus on the Þistilfjarðargrunn the September mean is 4.4° and in the normally coldest region east of Gerpir, the bottom temperature exceeds 3° inside the 200 m isobath.

General remarks.

Characteristic for the near-bottom temperature distribution is a seasonal change not only in the temperature values, but also in the gradients normal to the coast line. In winter the lowest temperatures occur, as would be expected, close to the shore but increase away from the coast. In spring the distribution tends to become uniform on transects across the shelf, while in summer the trend becomes reverse to that of the winter season, so that the temperatures are higher inshore but decrease with increasing distance from land.

There is, however, one exception to this general rule, viz. in the boundary zone off the southeast coast between Atlantic and arctic water, where the near-bottom isotherms tend to be perpendicular to the coast line throughout the summer. There appears to be a slight displacement towards the north of this near-bottom frontal zone as the season advances from May to August. Further data are needed to establish whether a seasonal displacement exists, which would be opposite to that found for the surface layer in this region (STEFÁNSSON 1972).

SHORT-PERIODICAL VARIATIONS IN BOTTOM TEMPERATURE

In frontal zone regions such as on the Iceland-Greenland and Faroe-Iceland submarine ridges the bottom temperature may change abruptly within a period of few days or even less, due to intermittent overflows of cold arctic water. Thus observations made in August 1960 near bottom on the southern side of the Iceland-Greenland Ridge, between 450 and 700 m, showed a temperature decrease from 2.5° to 4° C in only 20 hours (Harvey 1961). Farther north, at the shelf break off Hali such rapid changes are claimed to be of common occurrence by many trawler captains fishing in that region. During the international survey organized by ICES in June 1960 analogous changes were observed in the distribution of bottom temperature on the Faroe-Iceland Ridge within a period of about one week (Tait et al. 1967).

Only very limited data exist on short-periodical variations in bottom temperature in the coastal region around Iceland. In August 1966 an anchor station was worked for 36 hours in the southeastern part of Faxaflói. The bottom depth was 61 m and the deepest sampling depth 50 m. The results (Fig. 9) showed a

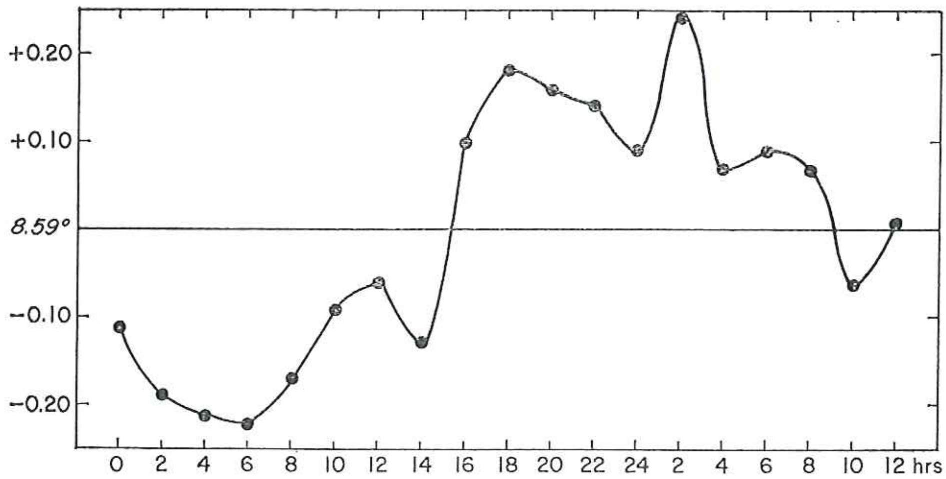

Fig. 9. *Variations in near–bottom temperature during a 36 hour period at 64°14'N, 22°13'W in Faxaflói, 12-13/8 1966.*

maximum variation of 0.46° over the 36 hour period. Simultaneous current measurements (Malmberg 1968) revealed a residual current of 5.8 cm/sec towards NNE, but considerable tidal components (maximum: 9.7 cm/sec). However, no correlation was found between the changing tide and the temperature variations.

In the summer of 1967 three anchor stations were worked off Kögur where the depths were 60, 77 and 155 m respectively. Observations were repeated over a period of 36 hours. The results (Fig. 10) show that the near–bottom temperature variations were exceedingly small at the two deeper stations and at the shallowest station, where tidal effects must be greater, the maximum variation amounted to only 0.45°. However, the results from these measurements made on one occasion in the middle of summer do not necessarily mean that short-time variations may not be appreciable under a different set of conditions.

In late April 1968 two surveys, 4 days apart, were made in the region off the northwest coast, between Látrabjarg and Kögur and inside the 600 m isobath. Observations were carried out at the same stations during the two surveys. Comparison between the bottom temperature distributions revealed only small changes (< 0.5° C) over most part of the shelf, but significantly greater changes (1.0—1.5° C) in the nearshore region and over the edge of the shelf.

Based on these few observations, it appears probable that over most of the Icelandic shelf area short-periodical variations in bottom temperature are relatively small, but may be quite significant near the edge of the shelf and in particular in the frontal zone regions on the Iceland-Greenland and Faroe-Iceland Ridges.

SEASONAL VARIATIONS

Seasonal variations of bottom temperature will depend mainly on three processes: 1) turbulent vertical diffusion, 2) vertical convection in winter, and 3) horizontal advection.

Under the very simple conditions that the temperature variations are caused by vertical turbulence alone, i.e. horizontal or vertical advection is absent, and the eddy diffusion coefficient is constant, the local change in temperature with time can be studied by means of the well-known heat diffusion equation

$$\frac{\partial \theta}{\partial t} = \frac{A}{\varrho}\frac{\partial^2 \theta}{\partial z^2} \tag{1}$$

where θ is temperature, t is time, A the eddy diffusion coefficient (in g x cm^{-1} x sec^{-1}), ϱ is density and z is depth.

If it can be further assumed that the average temperature is a linear function of depth, and if the seasonal variations at the surface can be represented by a simple harmonic term (e.g. NEUMANN and PIERSON 1966), then an approximate solution of the heat conductivity equation (1) can be expressed as

$$\Delta\theta_z = \Delta\theta_o e^{-rz} \cdot \cos(\sigma t - rz) \tag{2}$$

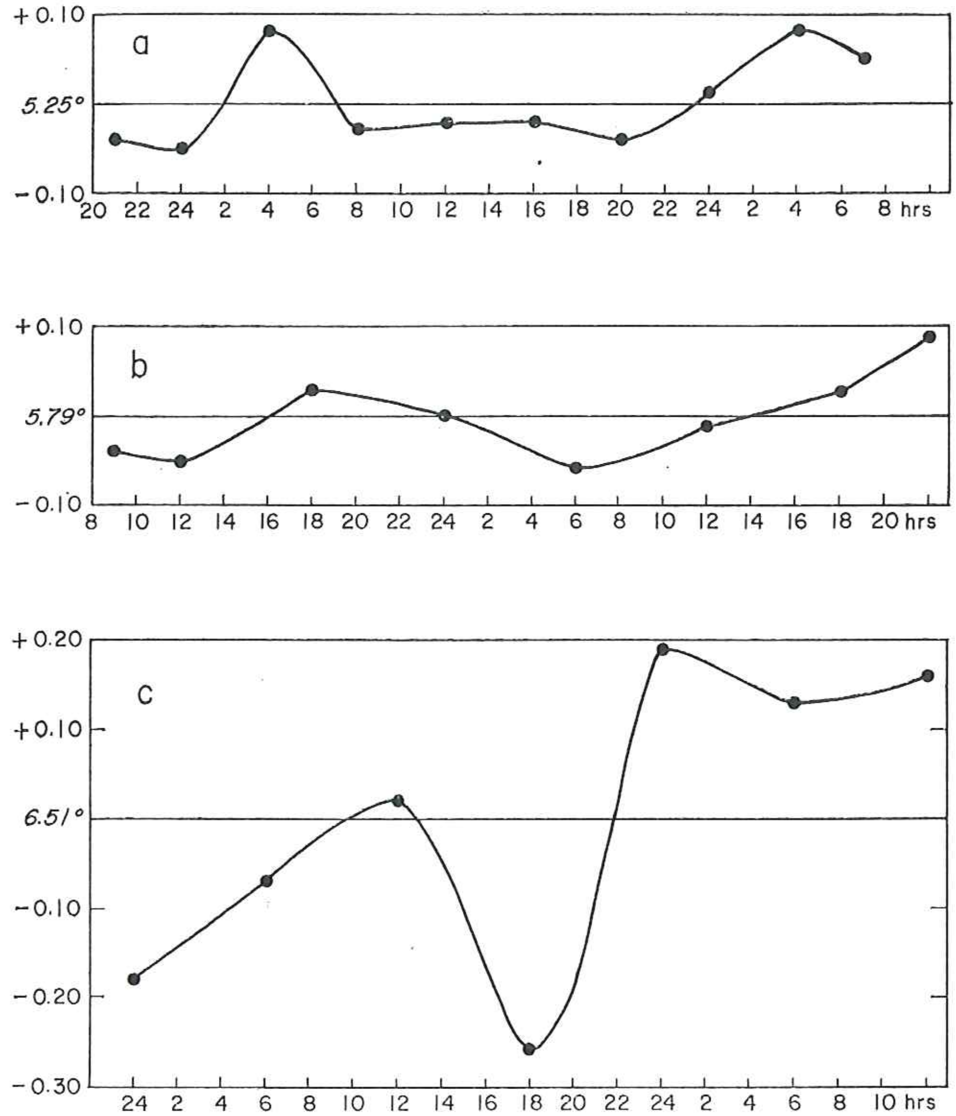

FIG. 10. *Variations in near–bottom temperature during a 34 hour period at three stations off Kögur, a) at 66°47′N, 23°13′W, 29/6-1/7 1968, b) at 66°41′N, 23°09′W, 1-2/7 1968 and c) at 66°30′N, 23°00′W, 3-4/7 1968.*

where $\Delta\theta_z$ is the amplitude of the annual temperature variation at the depth z, $\Delta\theta_o$ the amplitude of the annual temperature variation at the surface, $\sigma = \frac{2\,\pi}{T} =$ 1.99×10^{-7} sec^{-1}, where T ($= 365 \times 24 \times 60^2$sec) is the period length of the harmonic term and $r = \sqrt{\frac{\pi\varrho}{TA}}$. The temperature maxima or minima at the depth z should occur when cos $(\sigma t - rz) = \pm 1$, or $(\sigma t - rz) = \begin{cases} 0 \\ \pi \end{cases}$. Hence the annual temperature range (twice the amplitude) should decrease exponentially with depth, while the phase angle (i.e. the delay in the occurrence of maxima and minima) should increase linearly with depth.

The various assumptions here mentioned certainly do not hold for our study area. However, it is of interest to investigate the importance of vertical eddy diffusion compared to other processes and to which extent the simple equation (2) can be used to describe the actual conditions.

Some information on seasonal variations at different localities off the southwest, west and north coasts appears in Table II (Appendix II). However, at most of the stations observations are scarce from other seasons than spring and summer, and the mean monthly values may therefore not be too meaningful. The most complete continuous seasonal measurements are those from the 23 stations worked in the Faxaflói region 1966—1967 (Figs. 11—13 and 15—18), and they provide the best available material for studying the variations in relation to depth and time.

As would be expected the annual bottom temperature range decreases with increasing depth in the Faxaflói region, from 9.8°*) at the shallowest station at 30 m to 1.6° at the deepest station at 320 m. (Fig. 13 f). Associated with this marked dependence of seasonal variation on depth and distance from land there is, as previously mentioned (p. 16), a characteristic seasonal change in the horizontal temperature gradient along the bottom. During the coldest winter months the temperature may increase from less than 1° at inshore stations to more than 6° in the Jökuldjúp where the depth is 200—300 m. In late summer the gradient is reversed: the temperature decreases from about 10° inshore to about 7.5.° in the deepest part of the region. During certain time intervals between these extremes, i.e. late spring (May-June) and late autumn (October-November) the bottom temperature may remain almost uniform in offshore-inshore directions.

The annual bottom temperature range plotted against station depth (Fig. 14) for all 23 stations, suggests that an exponential relationship in conformity with equation (2) applies as a first approximation, indicating that vertical diffusion may be an important process in creating seasonal temperature variations in this region. For many of the stations, however, there are large deviations from this relationship, which suggests that the bottom temperature variations are due to other processes besides vertical diffusion alone.

Even greater discrepancies are found in the relationship between depth and time of bottom temperature maxima and minima, which in conformity with the simple equation (2) should be linear. For many of the stations the lowest bot-

*) It should be noted, however, that nearshore winter temperatures in 1966 were considerably lower than average (cf. Table II, 4—5), thus giving rise to relatively large annual range.

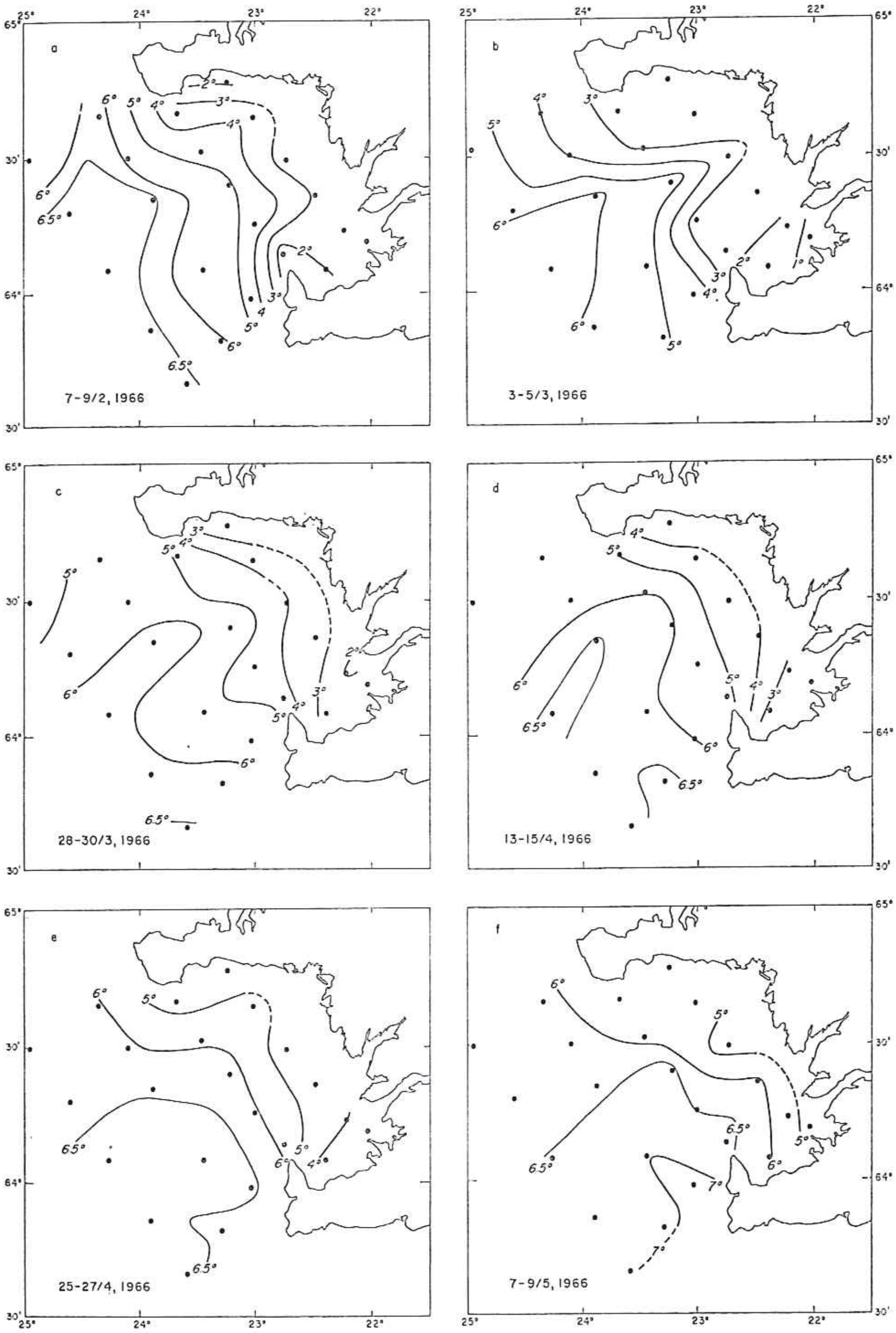

Fig. 11. *Near–bottom temperature distribution in the Faxaflói region in winter and spring of 1966. a) 7-9/2 1966, b) 3-5/3 1966, c) 28-30/3 1966, d) 13-15/4 1966, e) 25-27/4 1966, f) 7-9/5 1966.*

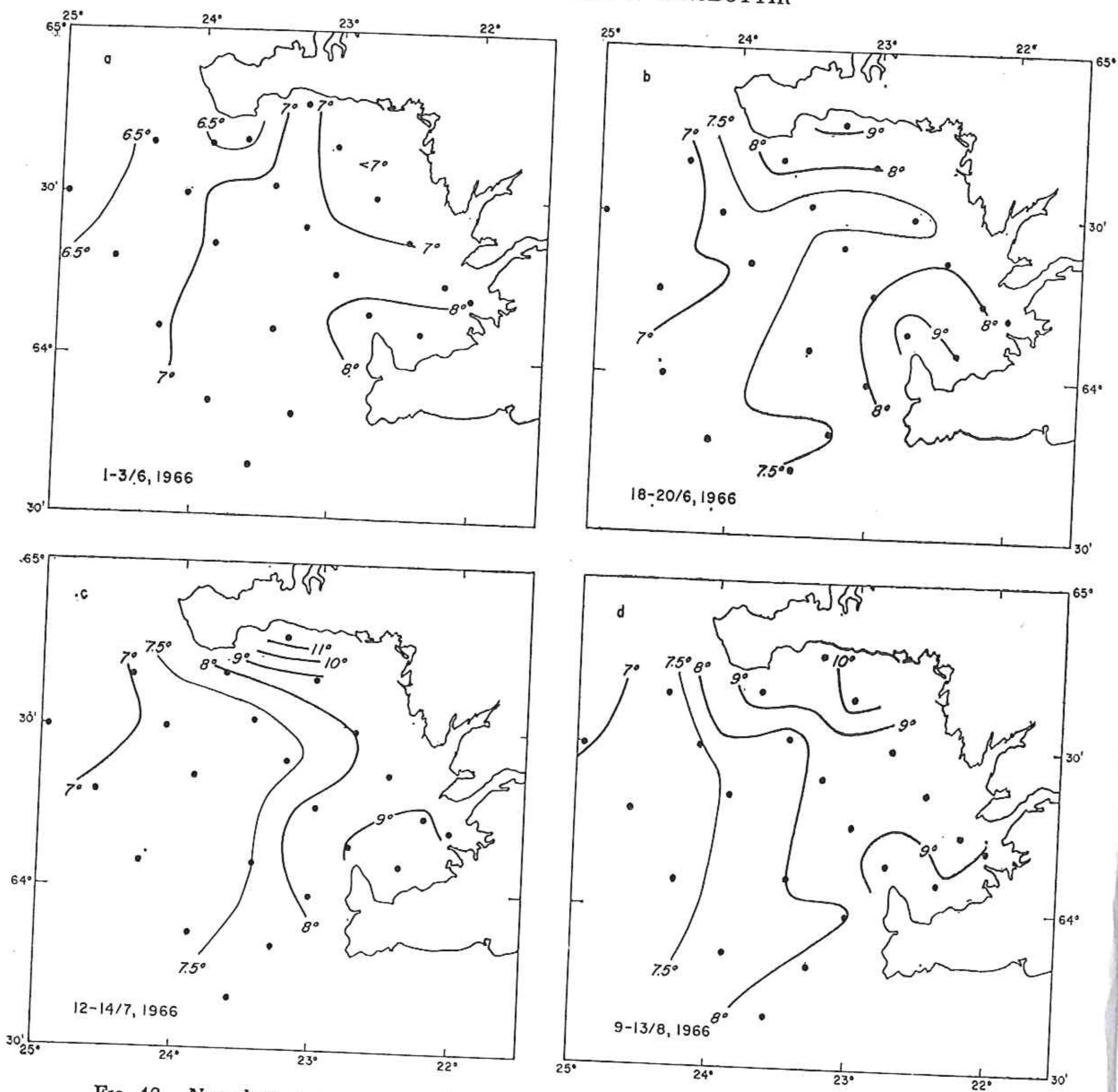

FIG. 12. *Near-bottom temperature distribution in the Faxaflói region in the summer of 1966. a) 1-3/6 1966, b) 18-20/6 1966, c) 12-14/7 1966, d) 9-13/8 1966.*

tom temperature was observed in February-March, irrespective of depth. It will be noted, however (Figs. 15—18), that at many of the deeper stations a secondary temperature minimum occurred at a later date. If the time of this secondary minimum (when existing, otherwise the time of lowest temperature) is plotted against depth a linear relationship holds approximately. On the average the occurrence of the temperature minimum is delayed by about 45 days per

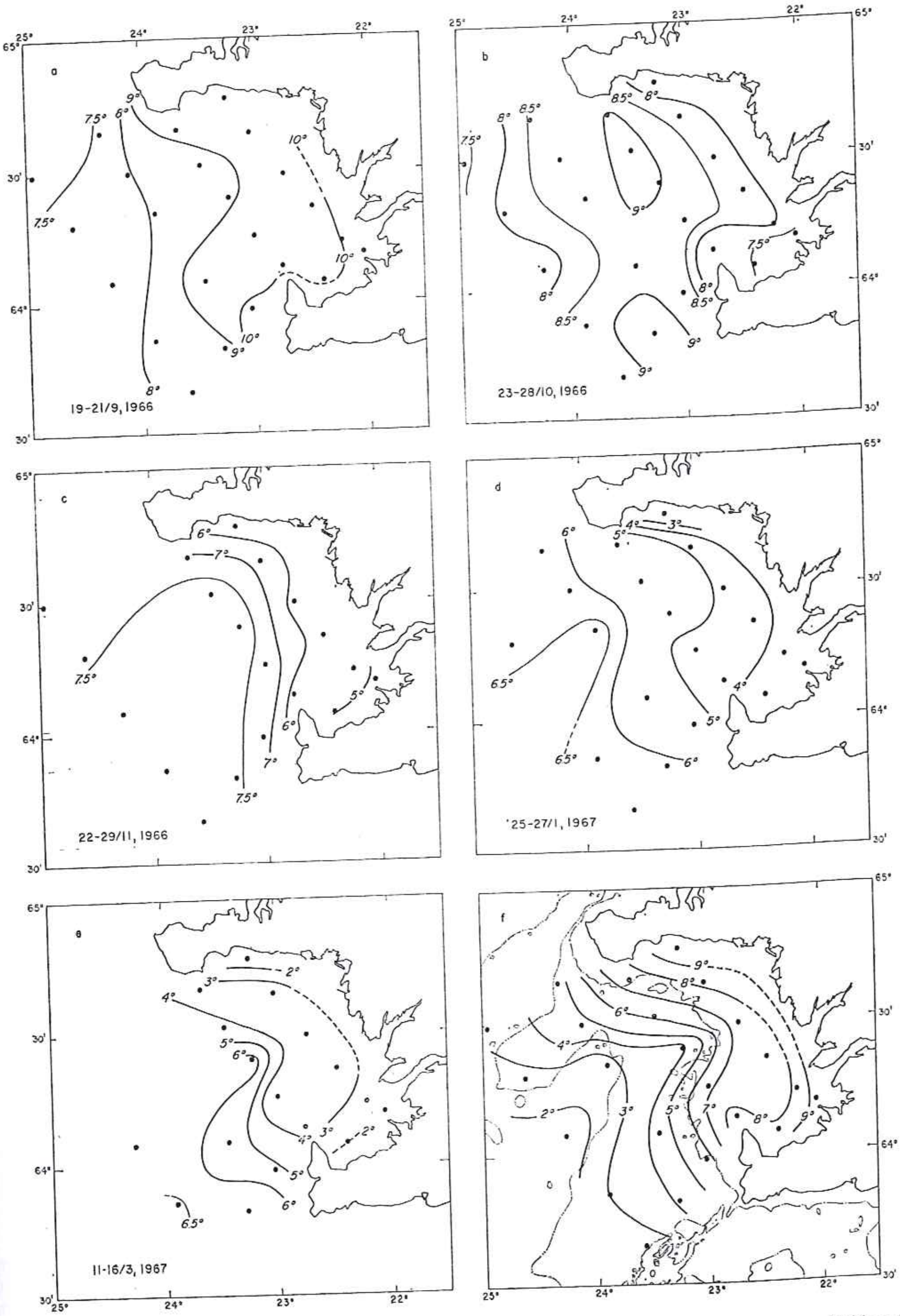

FIG. 13. *Near–bottom temperature distribution in the Faxaflói region in the autumn 1966 and winter 1967 and the annual temperature range. a) 19-21/9 1966, b) 23-28/10 1966, c) 22-29/11 1966, d) 25-27/1 1967, e) 11-16/3 1967, f) difference between highest and lowest temperature in the period February 1966 to March 1967.*

100 m increase in depth (Fig. 19 a). A similar delay applies to the occurrence of the temperature maximum which at the deepest stations occurred in October-November (Fig. 19 b). It is suggested that the first (principal) minimum is chiefly due to convection or advection, while the secondary minimum may be more related to the effects of vertical diffusion.

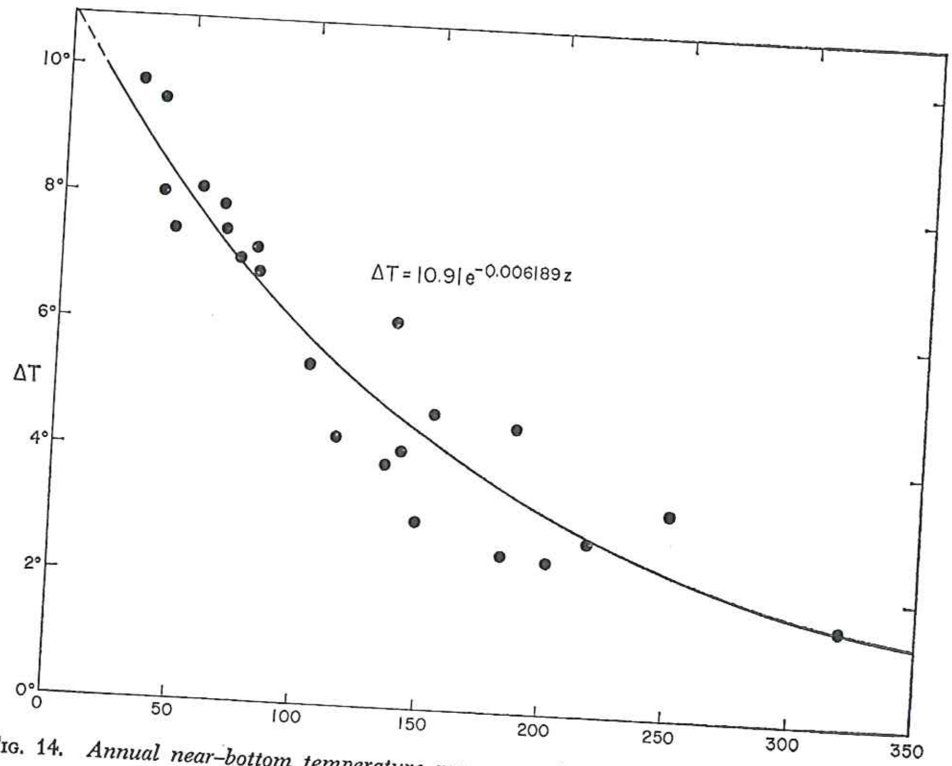

FIG. 14. *Annual near-bottom temperature range as a function of station depth for the 23 stations occupied in the Faxaflói region February 1966 to March 1967. The curve was determined by the method of least squares.*

During the coldest part of winter, convection plays an important role as evidenced by almost uniform temperature distribution in the upper layers at the offshore stations, often down to 100—150 meters. Below this depth there is generally a significant although sometimes only a slight temperature change, indicating the effect of other processes, including diffusion and advection. At the shallow stations where the depth is 50 meters or less, a temperature change was also frequently observed in the bottom layer in February and March, either an increase or decrease. At these inshore stations the conditions might in addition to advection be complicated by tidal currents.

It is well known that the coastal current around Iceland has in most places a residual movement in a clockwise direction around the country (HERMANN and THOMSEN 1946, STEFÁNSSON 1962). Recent measurements in Faxaflói (MALM-

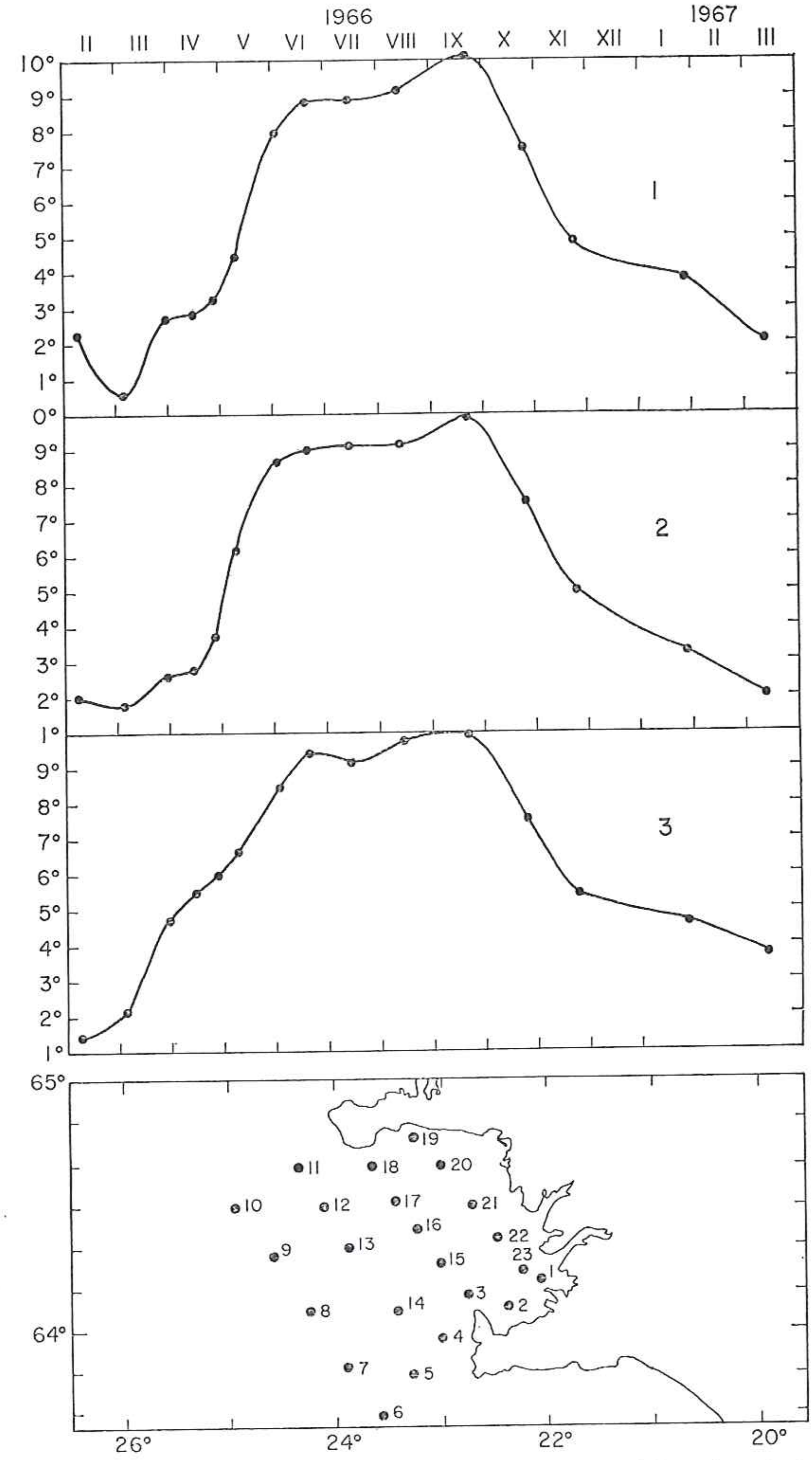

FIG. 15. *Seasonal variations in near-bottom temperature at Faxaflói stations 1—3. Station locations are shown on the map at the bottom of the illustration. Station 1 was worked at the beginning and the end of each cruise and the mean values are used.*

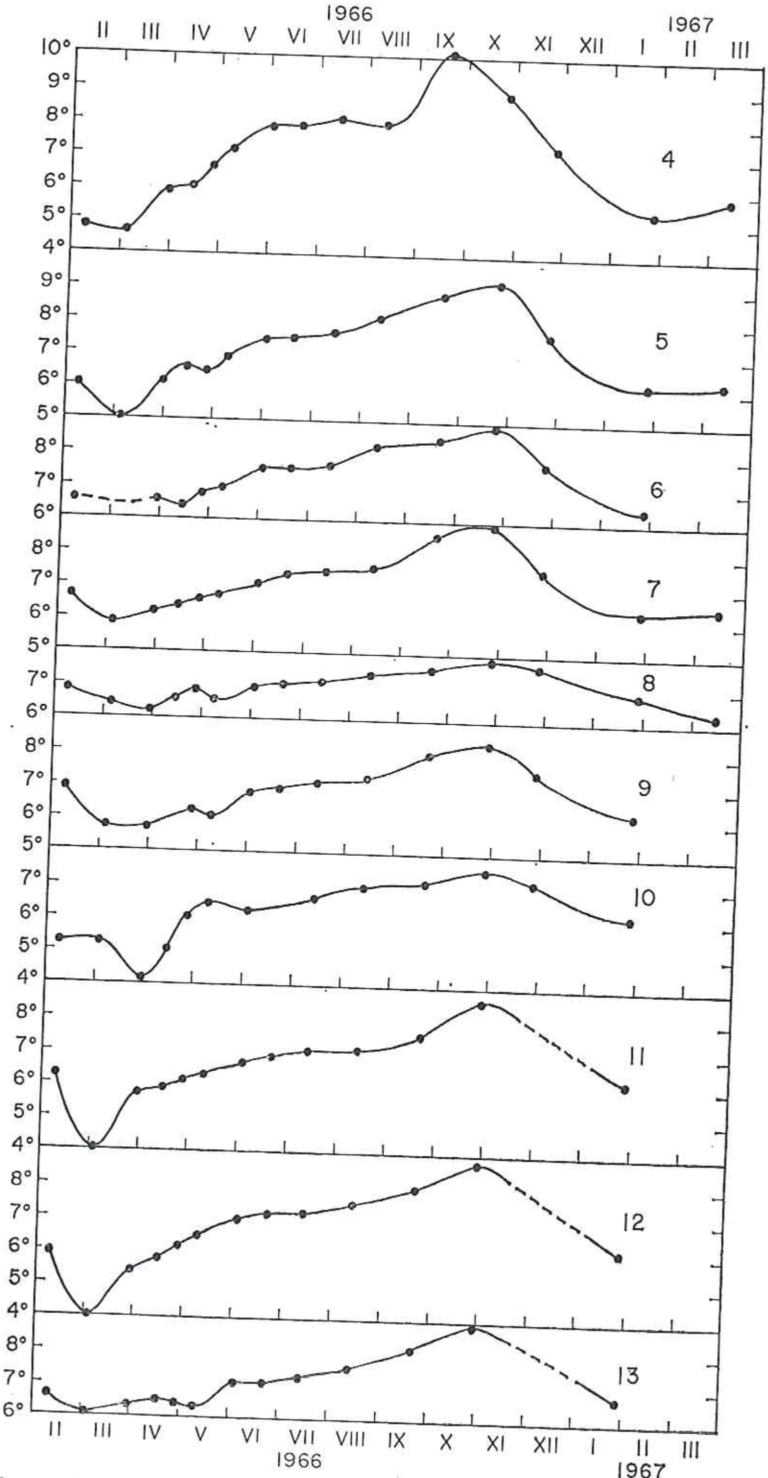

FIG. 16. *Seasonal variations in near-bottom temperature at stations 4—13. For location of stations see Fig. 15.*

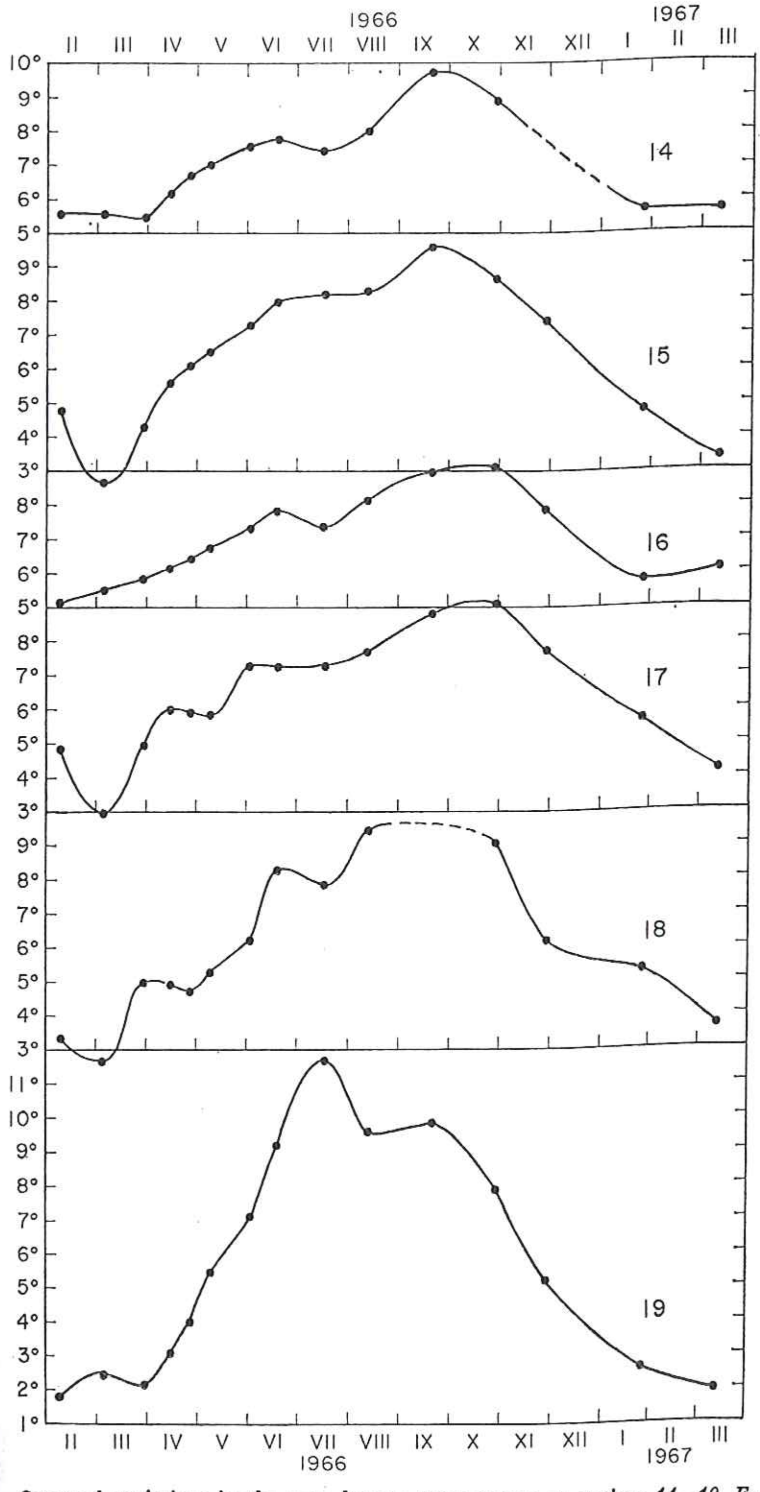

Fig. 17. *Seasonal variations in the near-bottom temperature at stations 14—19. For location of stations see Fig. 15.*

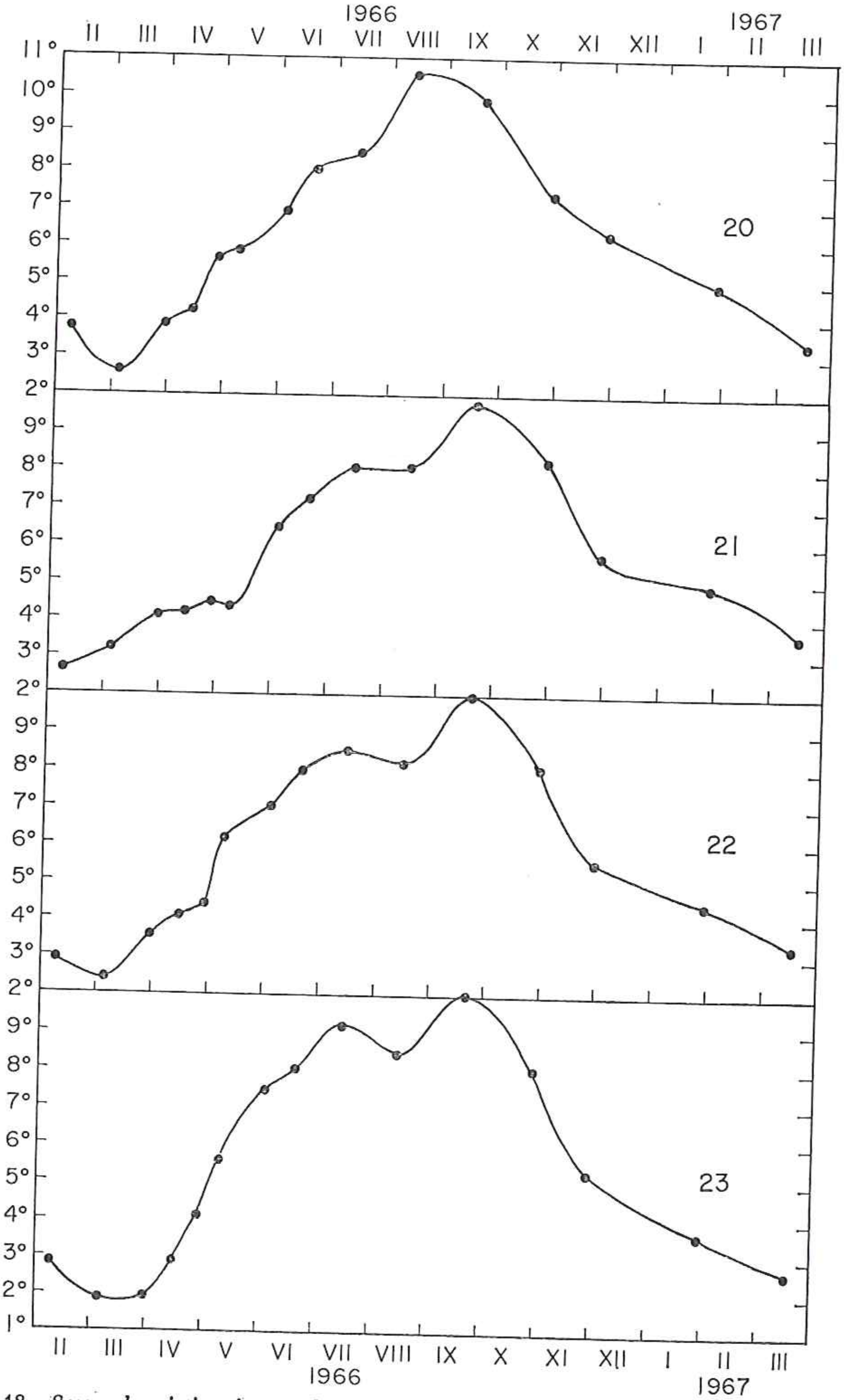

FIG. 18. *Seasonal variations in near-bottom temperature at Faxaflói stations 20—23. For locations see Fig. 15.*

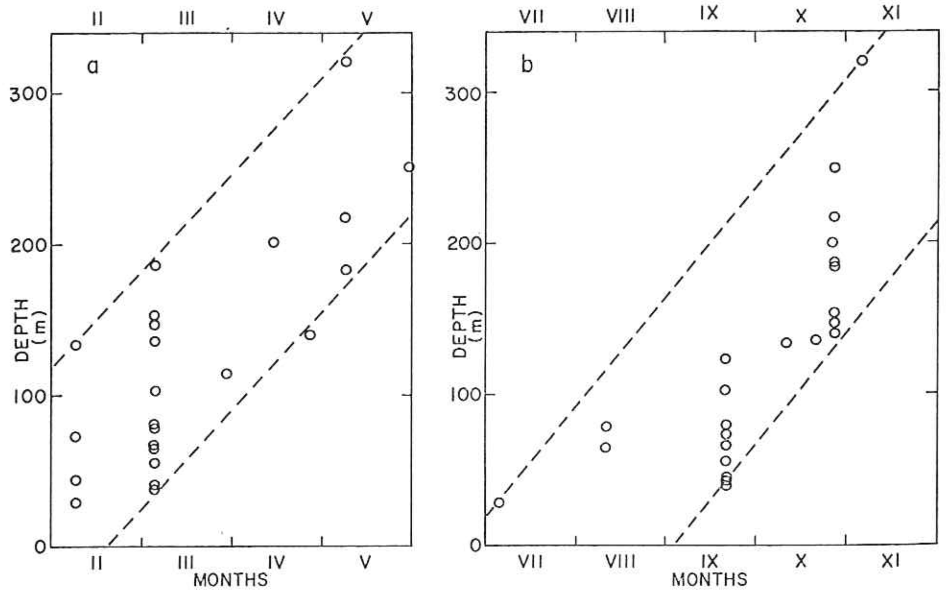

FIG. 19. *a) Time of bottom temperature minimum (later minimum if two) plotted against station depth. b) Time of bottom temperature maximum plotted against depth.*

BERG 1969) indicate that in summer the surface currents have an average velocity of 5 nautical miles per day and the bottom currents a velocity of 0.5 miles per day in the same direction. The mean currents during the winter season are less known, but studies of the seasonal changes in the density distribution in the Faxaflói region (STEFÁNSSON and GUDMUNDSSON 1969) suggest that the northgoing geostrophic current is very much weaker in the winter season than in summer.

In addition to these horizontal currents along the coast or parallel to the isobaths there is evidence of water movement alternatively offshore and inshore, i.e. perpendicular to the isobaths. This well known phenemenon of lateral oscillation of the coastal water is characterized by offshore spreading of surface water in summer with compensating movement of deep water towards the coast, whereas in winter the reverse movement may take place with cascading down the continental slope (cf. COOPER and VAUX 1949). The available data resulting from the Faxaflói investigations 1966—1967 provide strong evidence for this process. Contrary to what is observed in summer the density surfaces slope downwards during the winter months in offshore direction, and consequently the density decreases along the bottom in direction of increasing depths (Fig. 20 a-b). This density distribution in winter favours advection of water down the continental slope. The occurrence of such an advection is supported by the salinity distribution (Fig. 20 c-d) which reveals significantly lower near-bottom

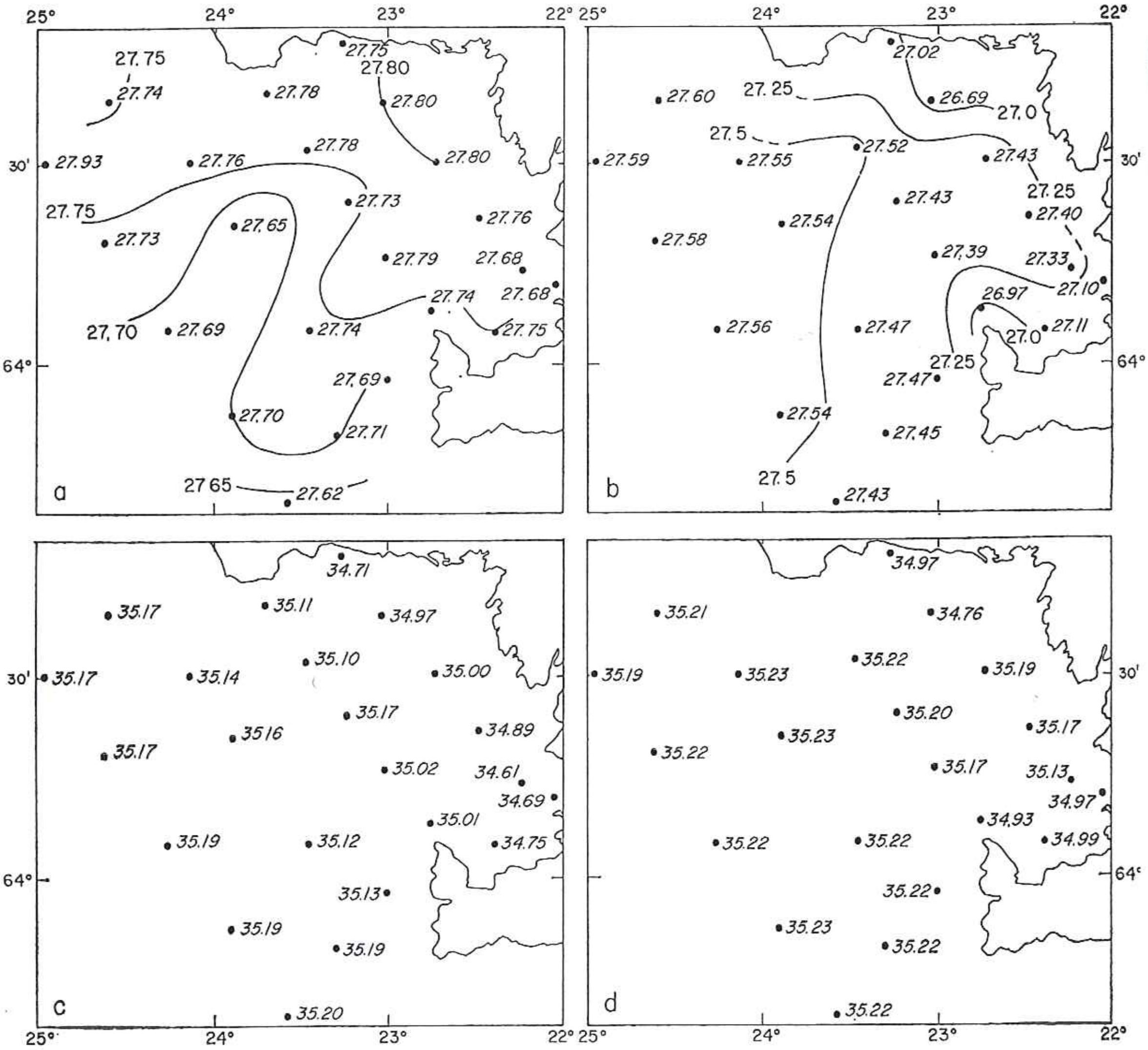

FIG. 20. *a) Near-bottom density (σ_t) distribution 28-30/3 1966. b) Near-bottom density (σ_t) distribution 9-13/8 1966. c) Near-bottom salinity (‰) distribution 28-30/3 1966. d) Near-bottom salinity (‰) distribution 9-13/8 1966.*

salinities at the deeper stations in winter than in summer, presumably due to admixture of cold water of relatively low salinity moving offshore. It is postulated that winter cascading, as here described may have an important effect on seasonal variations in the deeper layers over the outer part of the shelf and contribute significantly to the cooling of the bottom waters.

Data from stations north of Iceland (Table II, 6—13) suggest that annual ranges in near-bottom temperature resemble those found in Faxaflói at comparable depths. However, the available material is not sufficient to determine the time of occurrence of maxima and minima as a function of depth. On the Selvogsbanki (Table II, 1—3) the annual temperature ranges are much smaller than found in the Faxaflói region at comparable depths. This must be ascribed to relatively small effects from land in the open and unsheltered area south of Iceland and to strong oceanic influence prevailing throughout the year due to currents and turbulent mixing.

YEAR-TO-YEAR VARIATIONS

At several fixed stations southwest, west and north of Iceland observations have been carried out occasionally during the last 50 years (Appendix II). Although incomplete, this material makes it possible to compare the magnitude of the year-to-year bottom temperature variations for different months and regions (Table 2). The following main features are revealed:

a) The smallest standard deviations occur at the three Selvogsbanki stations. The variations are markedly greater in Faxaflói (Skagi and Akranes stations), off Kögur and Siglunes, but reach the higest values east of Langanes.

b) For each region (section) the variations generally decrease with increasing depth, although there are several exceptions from this rule.

c) There is no systematic seasonal trend in the magnitude of the variations, although in Faxaflói they appear to be higher in late winter than in summer, and east of Langanes they seem to be smaller in November than during the summer months.

The relatively small variations on Selvogsbanki are explained by the fact that one water mass, Atlantic water, dominates in the shelf area south of Iceland, leading to uniform conditions over the shelf. Thus this area, except for the shallowest inshore zone, remains relatively oceanic in character, where temperature effects from land or due to climatic changes are small. Even at the shallowest station, Selvogsbanki I, practically undiluted Atlantic water is found at the bottom throughout the year. In the shallower part of Faxaflói, on the other hand, effects from land are considerably greater and the influence of Atlantic water more variable. Consequently, year-to-year changes in air temperature and wind regime modify the conditions inside the bay to a greater extent than south of Iceland. Similar considerations apply to the region north and northeast of Iceland, where the temperature distribution depends not only on local meteorological conditions, but also on the relative proportions of Atlantic and arctic waters. It has been found (STEFÁNSSON 1962) that due to a seasonal cycle in the inflow of Atlantic water to the north Icelandic shelf area the temperature difference between the western and the eastern part of the area reaches a maximum in late winter, remains appreciable (2—4°C) during spring and summer, while in late autumn when the vernal influx has reached beyond Langanes the temperature conditions tend to become equalized throughout the area. In late summer, after the maximum influx is reached, the quantity of Atlantic water at intermediate depths in the easternmost part of the region may be quite variable from year to year, depending upon the strength of the influx. This may explain the relatively great temperature variations east of Langanes in summer and appreciably smaller variations in November. In addition, the recent climatic changes associated with increased distribution of drift ice have

TABLE 2.

Standard deviation of the bottom temperature in different months and at different localities.

Locality		Latitude N	Longitude W	Depth (m)	March No of obs	March Std dev	May No of obs	May Std dev	June No of obs	June Std dev	July No of obs	July Std dev	August No of obs	August Std dev	November No of obs	November Std dev
Selvogsbanki	I	63°41′	20°40′	46	10	0.40	11	0.38					5	0.75	5	0.50
”	II	63°31′	20°52′	87	11	0.50	11	0.53	4	0.69			6	0.78	5	0.44
”	III	63°21′	21°04′	141	12	0.36	10	0.42	4	0.48			4	0.69	6	0.41
Skagi		64°08′	22°46′	49	13	1.16	17	0.75	14	0.54	11	0.52	11	0.75	5	0.84
Akranes		64°15′	22°13′	55	9	1.48	10	0.84	9	1.19	6	0.46	9	0.32		
Kögur	I	66°30′	23°00′	52	4	0.72	13	1.12	21	0.81	14	1.39	15	0.94	4	0.37
”	II	66°41′	23°09′	79	4	1.18	10	1.21	21	0.67	15	0.83	13	0.73	4	0.62
”	III	66°53′	23°19′	226			8	0.63	15	1.16	13	1.39	11	0.43	4	1.40
Siglunes	I	66°16′	18°50′	74			10	1.14	24	1.36	13	1.24	18	0.75		
”	II	66°24′	18°50′	435			7	0.93	16	0.83	7	0.39	10	1.65		
Langanes	I	66°22′	14°22′	57			7	1.03	16	1.35	8	1.85	22	2.08	4	0.64
”	II	66°22′	14°01′	143			7	1.62	13	1.29	4	1.04	15	1.06	4	0.24
”	III	66°22′	13°35′	281			6	1.05	11	0.95	4	0.84	13	0.99	4	0.79

greatly affected the temperature conditions north of Iceland as we shall see in the following.

Near-bottom temperatures in different years at the fixed stations referred to above are given in Appendix II. A few examples of deviations for different years from the monthly mean values are illustrated in Figs. 21—25. Based on these data the main features of the year-to-year variations in the Selvogsbanki region, in Faxaflói, off Kögur, off Siglunes and off Langanes will now be summarized.

At the Selvogsbanki stations the bottom temperatures only rarely deviated more than 1° from the monthly mean. Similar variations are found at all three stations. The coldest years of those with observations are 1951 (August), 1953 (March, May), 1962 (February, March) and 1973 (March, April), but the warmest 1957 (May), 1961 (February), 1964 (April, June) and 1972 (May). There is no evidence of temperature decrease during the decade 1960—1970, although it should be noted that very few observations exist from the years 1967—1970, which have been found to be the coldest years in other regions. However, the year 1966, also a cold year off Siglunes and Langanes, was above normal in the Selvogsbanki region.

At the Skagi station the following years were relatively cold: 1932 (April), 1948 (May), 1953 (June), 1966 (February, March) and 1971 (August). Relatively warm were 1928 (March, May, August), 1950 (August), 1957 (April, May) and 1964 (January). At the Akranes station the following years were relatively cold: 1932 (May, but warm in June), 1936 (March), 1948 (February) and 1966 (March, April), and 1953 exceptionally cold in June, while 1930 (March), 1939 (April) and 1958 (May) were relatively warm.

Prior to 1953 temperatures at the Kögur stations were exceptionally cold in May—June 1924, 1926 and 1952 and exceptionally warm in 1936. The period 1954—1964 was characterized by relatively high bottom temperatures in May-June, while practically all of the years in the period 1965—1973 had temperatures below normal at Kögur stations I and II. At Kögur station III the bottom temperatures were close to normal during the last decade. In July and August the temperature variations were more irregular; the years 1949 and 1951 were exceptionally cold and 1957 exceptionally warm.

The effect of the recent climatic change is quite apparent at Siglunes station I. In the period 1947—1964 most years had positive anomalies, but were all exceptionally cold in May-June 1966—1971, 1968 being the coldest year. The years 1972 and 1973 were close to normal. The only year in past decades with bottom temperature comparable to the recent cold period was 1924. In July and August the variations at Siglunes I were more random than in May—June; the year 1964 was the warmest, 1968 by far the coldest. All years with observations after 1964 had negative anomalies, although this lowering of temperature in the sixties was less conspicuous in July—August than in May—June. At station Siglunes II the year-to-year variations are irregular. The year 1939 stands out

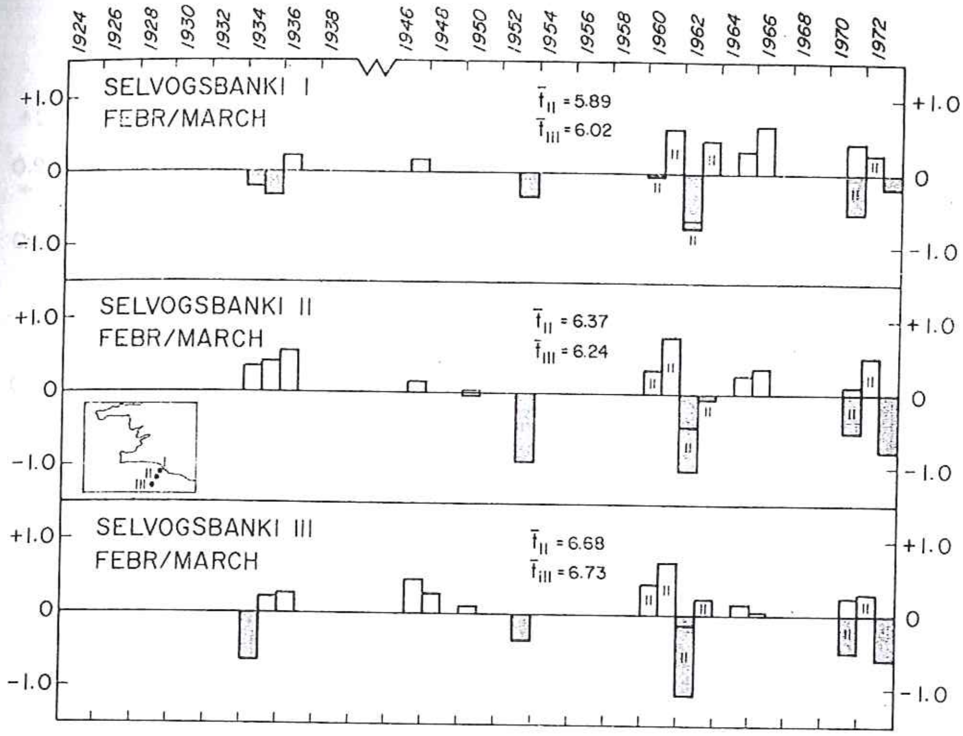

FIG. 21. *Deviations from mean bottom temperature at Selvogsbanki stations I, II and III for February—March. February observations indicated by the numeral II. Location of stations shown on inset map.*

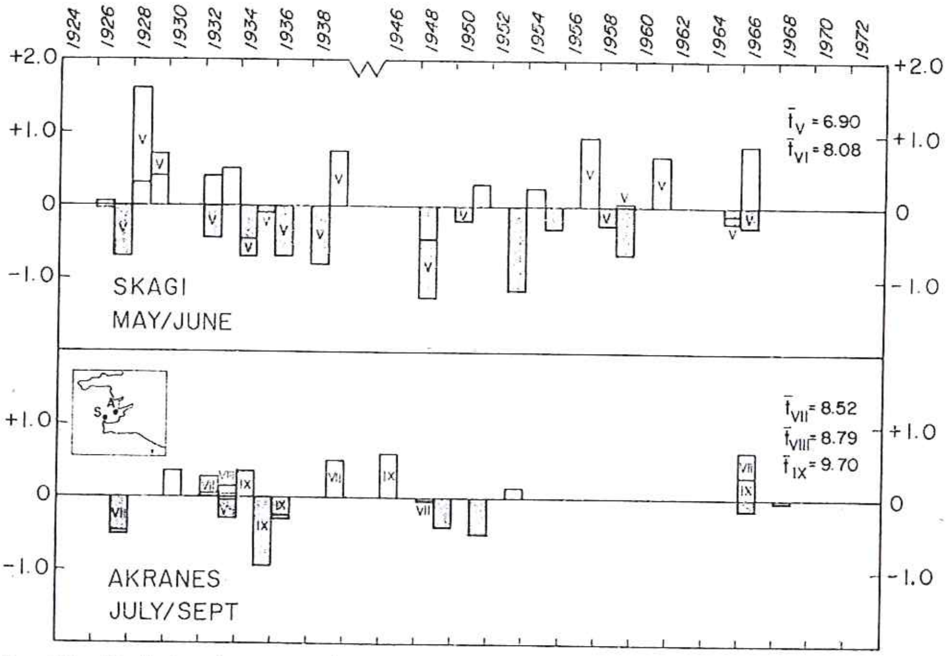

FIG. 22. *Deviations from mean bottom temperature at Skagi station (S on inset map showing location) in May—June and at Akranes station (A on inset map) in July—September. May observation indicated by the numeral V, July and September observations indicated by VII and IX.*

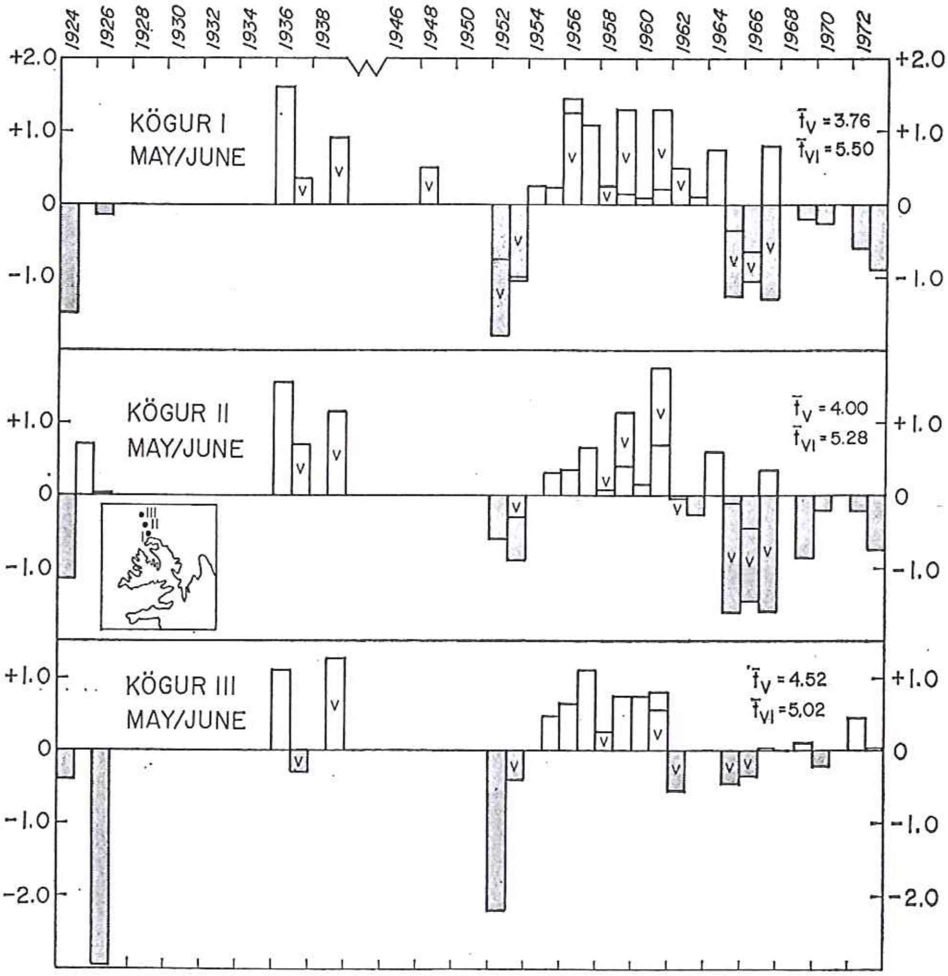

FIG. 23. *Deviations from mean bottom temperature at Kögur stations I, II and III for May—June. May observations indicated by the numeral V. Location of stations shown on inset map.*

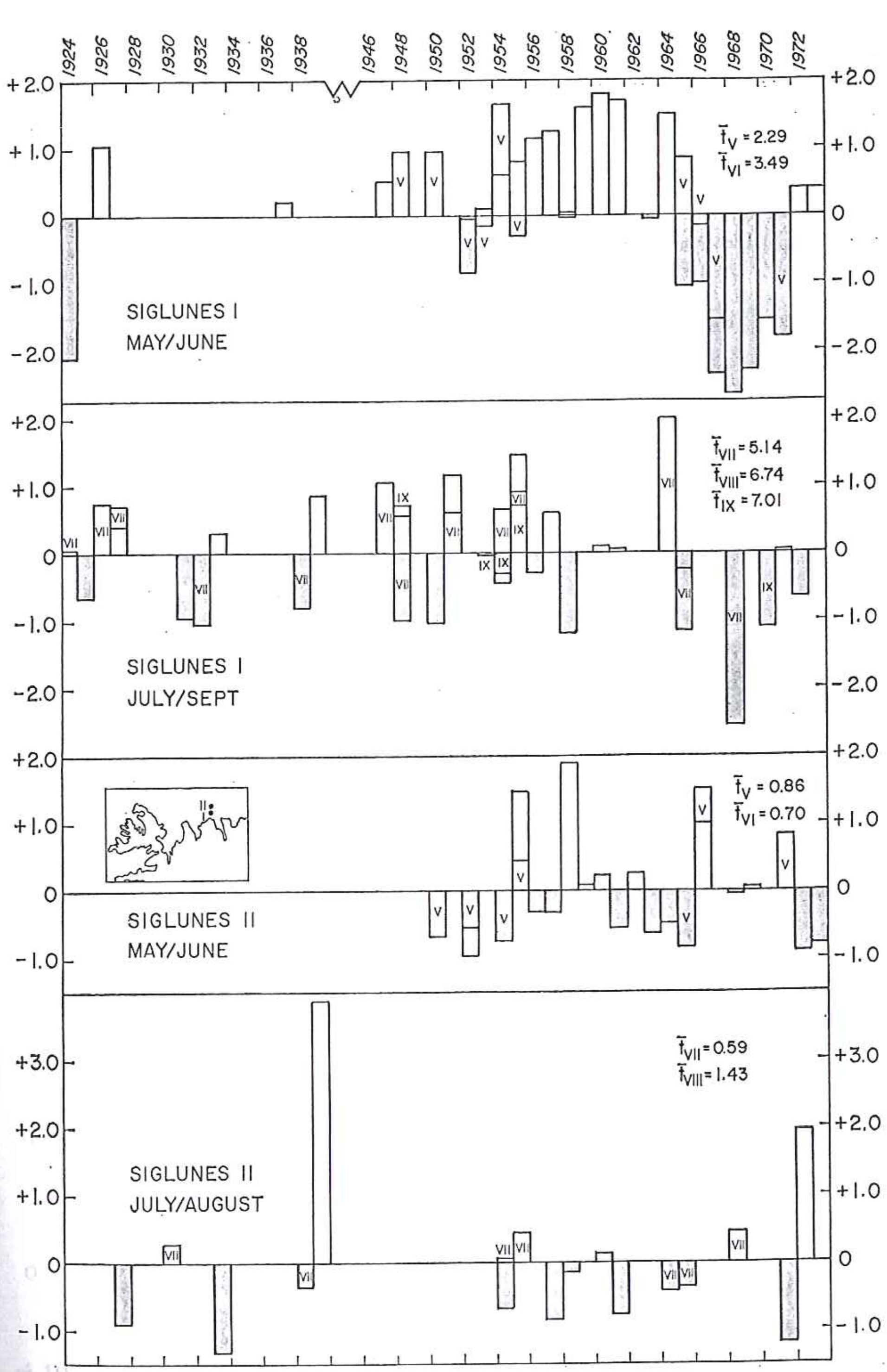

FIG. 24. *Deviations from mean bottom temperature at Siglunes I in May—June and July—September; May, July and September observations indicated by the numerals V, VII and IX respectively. Deviations from mean bottom temperature at Siglunes II in May—June and July—August; May and July observations indicated by the numerals V and VII. Location of stations shown on inset map.*

as an exceptionally warm year, probably due to unusually strong influx of Atlantic water which was observed over most part of the North Icelandic shelf area in the summer of that year. There is no definite trend towards lowering of bottom temperature at this station during the last decade.

East of Langanes the bottom temperature variations in May—June show the same main features as those found at Siglunes station I, viz. a marked lowering

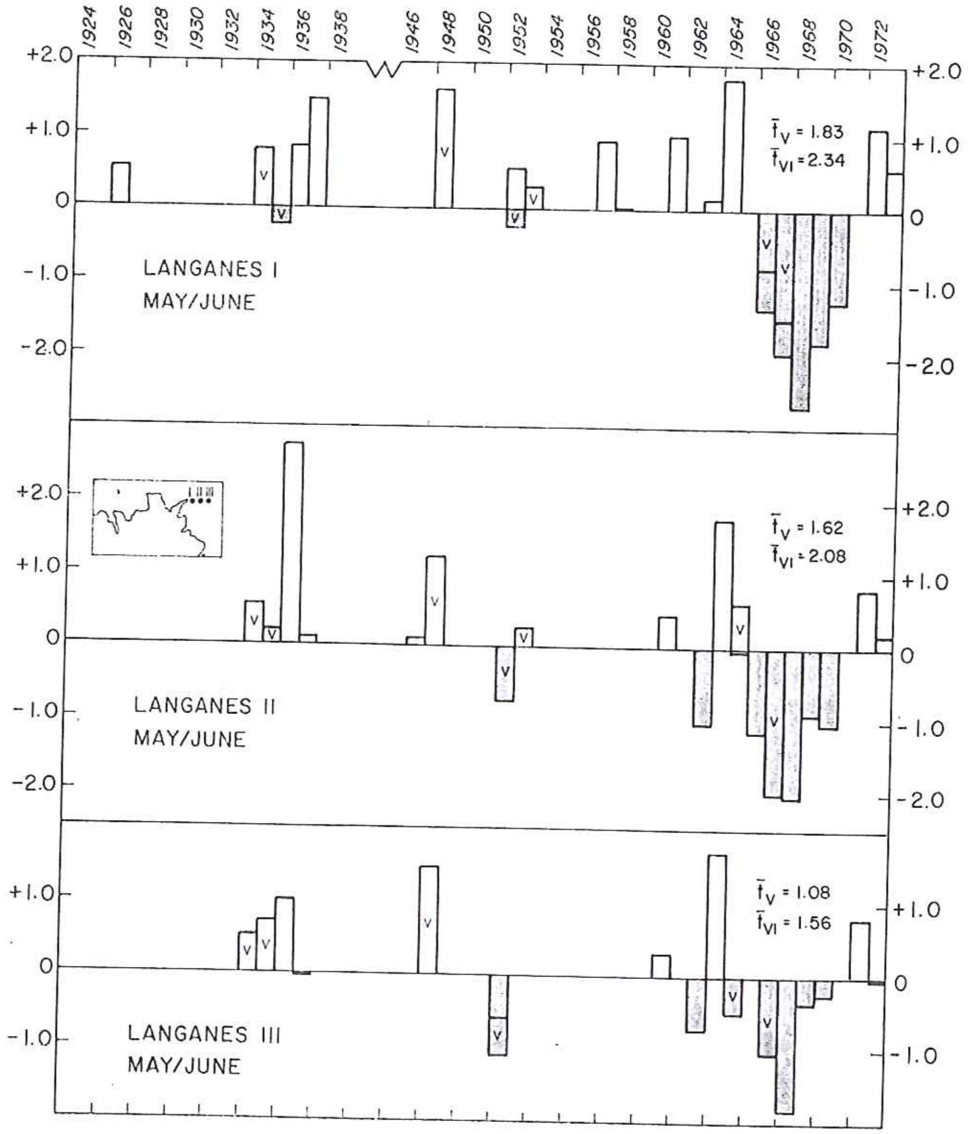

FIG. 25. *Deviations from mean bottom temperature at Langanes stations I, II and III in May—June. May observations indicated by the numeral V. Location of stations shown on inset map.*

in temperature in the years 1966—1970. The lowest temperature was found in June 1968. It is interesting to note that these negative temperature deviations predominate at all three stations, i.e. down to a depth of almost 300 m. The warmest years in May—June in this area were 1936 and 1964. In July—September the bottom temperature is very variable in this region. The difference between the warmest (1947) and the coldest (1949) year in August amounted to more than 6.5° at Langanes I. Other relatively cold summer months occurred in July 1908 and 1951, and in August 1962 (Langanes I), whereas in 1935, 1936, 1947 and 1964 the August bottom temperatures were relatively high. Observations at the Langanes stations are lacking for the months July—September for the period after 1965, but judged from data for the Siglunes station I and Kögur stations I-II, it must be assumed that similar if not greater negative deviations predominated east of Langanes during this period.

We can conclude that the climatic change of the last decade which was reflected in decrease of the air temperature, greater extension of drift ice and increased distribution of polar water in the region north and northeast of Iceland, led to marked lowering of the bottom temperature in the North Icelandic shelf area. These changes were more marked in the eastern part of the region than in the western part and can be traced down to a depth of about 300 m east of Langanes. This temperature decline culminated in 1968. On the basis of available material, no such trend in bottom temperature can be detected south of Iceland and only to a small extent in Faxaflói.

ÁGRIP Á ÍSLENZKU

Í inngangi þessarar ritgerðar er fjallað um mikilvægi hitastigs í vistfræði sjávar og ýmis dæmi nefnd um áhrif sjávarhita á útbreiðslu og vaxtarhraða fisktegunda, einkum við Ísland. Í því sambandi er sérstaklega bent á, að í kjölfar hitabreytinga í hafi og lofti á norðurslóðum á þessari öld hafa orðið stórfelldar breytingar á útbreiðslu og hrygningarsvæðum fiskistofnanna hér við land.

Það svæði, sem tekið er til meðferðar, er landgrunn Íslands milli 63° og 67°30' n. br. og 11° og 27° v.l. Stuðzt er við öll tiltæk gögn fram til ársins 1967, bæði íslenzk og erlend, en auk þess íslenzkar mælingar á allmörgum hefðbundnum athuganastöðum á árunum 1968—1973. Alls er byggt á meira en 6000 hitamælingum nærri botni, en af þeim er yfir 94% frá landgrunnssvæðunum innan 300 metra dýptarlínunnar. Reiknuð voru meðaltöl fyrir hverja ½ breiddargráðu og 1 lengdargráðu innan dýptarmarkanna 0—100 m, 101—200 m, 201—300 m og meira en 300 m, og meðallagskort dregin fyrir mánuðina febrúar-marz, apríl, maí, júní, júlí, ágúst og september. Frá ýmsum svæðum og ýmsum árstímum eru upplýsingar fáar og ófullnægjandi, og þyrfti að auka við þær á næstu árum. T.d. eru aðeins tiltölulega fáar athuganir til frá Breiðafirði, flóum og fjörðum norðanlands og landsgrunnssvæðinu út af austanverðri suðurströndinni. Þá eru mjög fáar mælingar til frá vetrarmánuðunum á svæðunum norðanlands og austan.

Árstíðabreytingar hitans eru mismunandi, ekki aðeins eftir landshlutum heldur einnig dýpi. Eftir því sem dýpið vex minnkar árssveiflan, en miðað við tiltekið dýpi er hún minnst á svæðinu sunnan Íslands, þar sem óblandaður Atlantssjórinn nær upp undir landsteina og landrænna áhrifa gætir yfirleitt lítið. Þá koma árstíðabreytingar einnig fram í láréttri hitadreifingu við botn. Þannig er botnhitinn á veturna að jafnaði lægstur uppi við land en fer hækkandi út frá ströndinni. Á sumrin er þessu öfugt farið: tiltölulega hæstur á grunnum næst landi og fer lækkandi út frá ströndinni. Þar af leiðandi skapast þannig ástand á vissum tímum vor og haust, að botnhitinn breytist mjög lítið út frá ströndinni, en yfirleitt hafa jafnhitalínurnar tilhneigingu til að fylgja útlínum strandarinnar og dýptarlínum botnsins. Undantekning frá þessari almennu reglu kemur þó fram á svæðinu út af Suðausturlandi á skilum milli hins hlýja Atlantssjávar og hins svala blöndunarsjávar úr norðri. Á þessum stað liggja jafnhitalínur venjulega nokkurn veginn hornrétt út frá ströndinni, jafnt sumar sem vetur.

Á Faxaflóasvæðinu og í Jökuldjúpi voru gerðar þéttar og tíðar athuganir á tímabilinu 1966—1967. Eru þau gögn hentug til að kanna árstíðabreytingar á mismunandi dýpi. Rannsakaðir voru þeir helztu þættir, sem slíkum breytingum valda, þ.e. lóðrétt blöndun og láréttir og lóðréttir straumar. Lóðrétt blöndun (turbulent diffusion) virðist miklu ráða, og kemur fram í því, að árssveiflan fylgir í aðalatriðum einföldu lögmáli, þ.e. lógariþminn af árssveiflunni minnkar í réttu hlutfalli við vaxandi dýpi. Hámörk og lágmörk hitans við botn verða ávallt síðar en við yfirborð og því síðar sem dýpið er meira. Lætur nærri að sú seinkun nemi að meðaltali um það bil einum og hálfum mánuði fyrir hverja hundrað metra aukningu á botndýpi.

Nokkrar athuganir hafa verið gerðar á stutttímabreytingum botnhitans (á nokkrum klukkutímum eða dögum). Slíkar breytingar virðast vera litlar á mestum hluta landgrunnsins, en geta skipt miklu máli nálægt hitaskilunum á svæðunum suðaustan og norðvestan landsins

Mismunur á botnhita einstakra ára er minnstur á Selvogsgrunni, mun meiri í Faxaflóa og á Norðurlandssvæðinu vestanverðu, en mestur út af Langanesi. Kuldaskeið síðasta áratugs leiddi til mikillar lækkunar á botnhita norðanlands, einkum á mið- og austursvæðinu, þar sem kólnunar gætti niður á 300 m dýpi. Kaldasta ár tímabilsins var 1968 og var þá hitastig við botn á grynnri hluta landgrunnsins 2—3° undir meðallagi. Aftur á móti verður ekki séð af tiltækum gögnum að áhrif kuldaskeiðsins hafi náð til Selvogsgrunnssvæðisins og þeirra gætti að litlu leyti í Faxaflóa.

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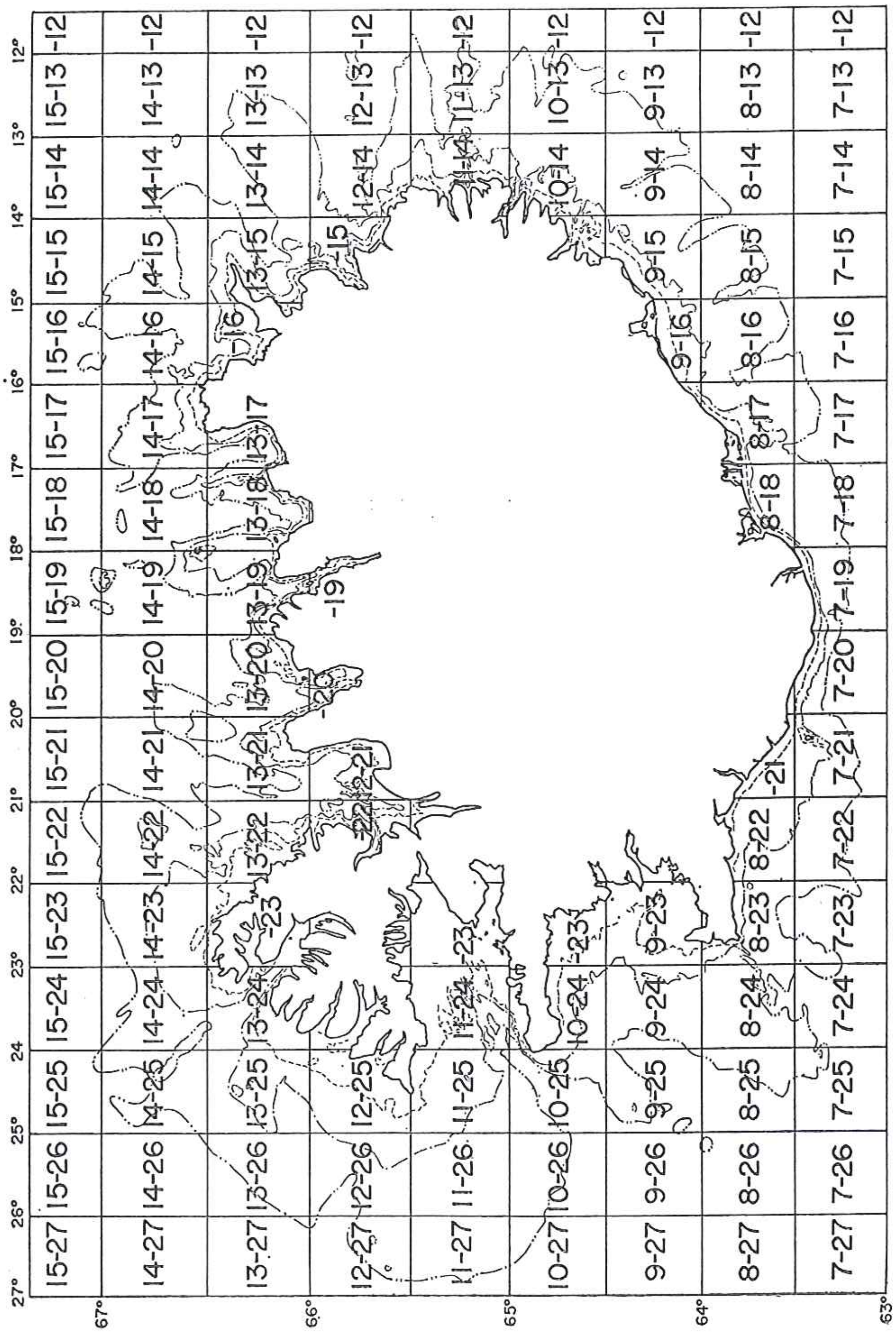
APPENDIX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63°

APPENDIX I.

TABLE I, 1.

Areal Means of Near-Bottom Temperatures — January

Depth range	0–100 m			101–200 m			201–300 m			> 301 m		
Area	t° Mean	No. of obs.	No. of years	t° Mean	No. of obs.	No. of years	t° Mean	No. of obs.	No. of years	t° Mean	No. of obs.	No. of years
7–17				*7.2*	3	2						
7–18				*7.2*	1	1						
7–19	*6.8*	1	1	*7.4*	1	1						
7–20				*7.1*	5	2						
7–21	*6.8*	6	2	*6.8*	15	4				*7.7*	1	1
7–22	*7.2*	1	1	*6.6*	15	5	*7.1*	6	4			
7–23				*6.7*	1	1	*7.0*	7	3			
8–13										*5.2*	1	1
8–14				*4.5*	1	1						
8–15				*5.5*	1	1						
8–16				*6.8*	1	1						
8–17	*6.2*	1	1	*7.0*	2	1						
8–21	*6.2*	10	3									
8–22	*6.2*	17	4	*6.7*	15	4						
8–23	*5.9*	5	3	*6.3*	24	5						
8–24	*5.4*	1	1	*6.4*	18	4	*7.1*	1	1			
8–25				*6.6*	1	1						
8–26										*6.9*	1	1
9–12										*1.4*	2	1
9–13										*3.7*	1	1
9–15				*3.7*	1	1						
9–23	*4.0*	20	6									
9–24				*6.1*	15	5	*6.7*	1	1			
9–25				*6.2*	4	3	*6.6*	3	2			
9–26							*6.2*	1	1			
10–12							*1.1*	1	1	*–0.3*	1	1
10–14				*1.6*	1	1						
10–23	*4.8*	2	2									
10–24	*5.0*	10	4	*5.7*	4	4						
10–25	*6.1*	1	1	*6.1*	5	4	*6.4*	1	1			
10–26				*5.8*	1	1						
10–27				*5.8*	1	1						
13–19	*4.0*	2	2									
14–19										*–0.1*	3	2
14–23	*3.8*	2	1									
14–24				*4.7*	1	1						

TABLE I, 2.

Areal Means of Near-Bottom Temperatures — February

Depth range	0–100 m			101–200 m			201–300 m			> 301 m		
Area	t° Mean	No. of obs.	No. of years	t° Mean	No. of obs.	No. of years	t° Mean	No. of obs.	No. of years	t° Mean	No. of obs.	No. of years
7–17							7.5	1	1			
7–18				7.1	4	1	7.3	1	1			
7–19	6.6	1	1	6.9	2	1						
7–20	7.0	1	1	7.0	5	1	7.5	1	1			
7–21							7.5	1	1			
7–22	5.9	1	1	6.8	20	4	7.1	6	4	6.3	1	1
7–23							6.7	7	2			
7–24							6.5	3	2	7.3	1	1
7–25				6.6	2	2	6.8	3	3			
8–15				4.6	1	1	7.1	1	1			
8–16				6.6	1	1						
8–18				6.8	1	1						
8–21	6.2	18	5									
8–22	6.1	17	3	6.3	10	3						
8–23	5.6	6	4	5.9	17	3	6.6	2	2			
8–24				6.6	12	5	6.1	1	1			
8–25				6.5	2	2	6.6	1	1			
8–26							7.0	2	1			
9–13							3.5	1	1			
9–14							3.7	1	1			
9–15				5.7	2	1						
9–22	2.3	16	3									
9–23	4.2	28	12									
9–24	5.9	2	2	5.8	9	4	6.6	4	3			
9–25				6.2	5	3	6.3	7	4			
9–26							6.5	2	2			
10–23	4.6	1	1									
10–24	3.9	6	2	5.3	2	2						
10–25				6.3	1	1	6.6	1	1			
12–20	2.1	1	1									
13–14							0.9	2	2			
13–15	1.2	2	2	1.7	2	2						
13–19	3.2	1	1							0.1	2	2
14–19										−0.2	2	2

TABLE I, 3.

Areal Means of Near-Bottom Temperatures — March

Depth range	0–100 m			101–200 m			201–300 m			> 301 m		
Area	t° Mean	No. of obs.	No. of years	t° Mean	No. of obs.	No. of years	t° Mean	No. of obs.	No. of years	t° Mean	No. of obs.	No. of years
7–21	*6.9*	12	4	*6.8*	9	3	*7.1*	1	1	*7.3*	1	1
7–22				*6.7*	12	8	*7.1*	9	6	*6.9*	1	1
7–23							*6.6*	4	2			
7–24										*6.4*	1	1
8–15	*6.4*	25	10									
8–22	*6.0*	13	3	*6.1*	6	3						
8–23	*6.1*	7	5	*6.4*	16	7						
9–15	*3.6*	1	1	*6.4*	3	2						
9–22	*3.7*	5	1									
9–23	*3.9*	58	16									
9–24	*5.9*	1	1	*5.7*	11	2	*6.1*	1	1			
9–25							*4.7*	2	1	*6.3*	3	2
10–15	*3.0*	1	1									
10–23	*4.3*	2	2									
10–24	*3.6*	14	4	*4.7*	5	4						
10–25				*4.9*	2	1						
13–14							*-0.5*	1	1			
13–19	*2.5*	1	1							*0.1*	2	1
13–21							*2.9*	1	1			
13–23	*1.3*	1	1									
13–24	*1.9*	1	1									
14–19										*-0.2*	1	1
15–21							*3.0*	1	1			
15–23							*1.3*	1	1			
15–24							*3.4*	2	1			

TABLE I, 4.

Areal Means of Near-Bottom Temperatures — April

Depth range	0–100 m			101–200 m			201–300 m			> 301 m		
Area	t° Mean	No. of obs.	No. of years	t° Mean	No. of obs.	No. of years	t° Mean	No. of obs.	No. of years	t° Mean	No. of obs.	No. of years
7–21	*7.1*	10	3	*7.5*	28	4	*7.8*	2	1			
7–22				*6.9*	11	5	*7.2*	5	3			
7–23							*7.0*	2	2			
7–25							*6.7*	1	1			
7–26										*6.4*	3	1
8–21	*6.8*	18	5									
8–22	*6.6*	9	2	*6.7*	5	2						
8–23	*6.3*	7	5	*6.4*	10	6	*7.4*	1	1			
8–24				*6.3*	24	8						
8–25				*6.4*	4	3						
8–26							*6.0*	1	1	*6.1*	1	1
9–15	*6.2*	4	4	*6.3*	1	1						
9–16	*6.7*	1	1				*1.7*	1	1			
9–22	*3.4*	9	2									
9–23	*4.6*	60	18	*5.4*	1	1						
9–24	*5.1*	3	3	*5.8*	9	5	*6.5*	2	1			
9–25				*6.1*	4	2	*6.2*	5	2			
10–13				*1.3*	1	1						
10–23	*4.1*	5	4									
10–24	*4.2*	13	5	*5.6*	6	4						
10–25	*3.6*	1	1	*5.6*	3	2						
11–14	*2.3*	1	1									
12–13							*0.9*	1	1			
13–14							*1.8*	2	1			
13–15	*2.1*	1	1	*1.9*	1	1						
13–19	*3.1*	2	2							*–0.1*	1	1
14–19										*–0.3*	2	1
14–20										*–0.5*	1	1
14–23	*3.2*	1	1	*2.1*	1	1						
14–24	*4.0*	1	1	*3.4*	1	1	*5.0*	1	1			

TABLE I, 5.

Areal Means of Near-Bottom Temperatures — May

Depth range	0–100 m			101–200 m			201–300 m			> 301 m		
Area	t° Mean	No. of obs.	No. of years	t° Mean	No. of obs.	No. of years	t° Mean	No. of obs.	No. of years	t° Mean	No. of obs.	No. of years
7–12										0.7	1	1
7–13										2.7	1	1
7–17				7.5	1	1						
7–18	7.6	1	1	7.0	5	3						
7–19	7.4	3	2	7.2	6	4						
7–20	7.2	8	5	7.7	2	2						
7–21	7.7	17	8	7.6	13	4	8.0	2	2			
7–22				7.4	10	10	7.4	9	9			
7–23				7.0	1	1	7.1	1	1			
7–25				7.3	2	2						
7–26										6.6	3	2
8–14										3.5	1	1
8–15				6.7	9	6				7.4	1	1
8–16				5.8	1	1						
8–17	6.8	10	7	6.7	8	3						
8–18	7.3	1	1	7.2	3	3						
8–21	7.4	27	12									
8–22	6.9	12	5	6.4	9	7						
8–23	6.9	9	6	6.6	9	7	7.6	1	1			
8–24	6.9	1	1	6.7	18	9	7.0	1	1			
8–25							6.3	3	3	6.4	2	2
8–26				6.3	1	1	6.2	9	6			
8–27							6.6	2	2	6.2	3	3
9–12										2.5	1	1
9–13										3.1	1	1
9–14				2.8	4	3						
9–15	5.1	11	8	6.2	11	5						
9–16	6.6	7	6									
9–22	6.4	7	2									
9–23	6.3	64	23									
9–24	6.5	6	6	6.6	14	7	6.3	1	1			
9–25				6.3	5	4	6.3	3	2	6.5	2	2
9–26							6.0	5	4			
9–27							6.4	1	1	6.3	2	1
10–12							0.6	6	4	0.6	1	1
10–13				1.6	3	3						
10–14	2.0	5	5	2.1	9	4						
10–15	2.5	1	1									
10–23	6.2	5	4									
10–24	6.0	10	6	6.1	6	5						
10–25	6.1	4	4	6.2	6	6	6.1	4	4			
10–26				5.8	8	6	5.8	1	1			
10–27				5.4	6	6	5.6	4	4			
11–13				1.4	2	2	1.8	2	2			

contin.

TABLE I, 6, contin.

Areal Means of Near-Bottom Temperatures — June

Depth range	0–100 m			101–200 m			201–300 m			> 301 m		
Area	t° Mean	No. of obs.	No. of years	t° Mean	No. of obs.	No. of years	t° Mean	No. of obs.	No. of years	t° Mean	No. of obs.	No. of years
12–15	3.0	1	1	3.0	2	2						
12–19	3.0	4	3	2.9	1	1						
12–21	3.6	2	2	4.2	3	3						
12–22							4.8	4	2			
12–24	3.2	2	2									
12–25	6.5	15	8									
12–26	6.5	4	4	5.6	10	8	5.3	1	1			
12–27				6.0	2	2	5.7	3	3	5.8	1	1
13–12							2.0	1	1	-0.7	1	1
13–13				1.3	4	4	1.7	3	3	1.3	2	2
13–14	2.0	2	2	2.2	13	9	1.9	10	9	1.5	2	2
13–15	2.6	29	20	2.2	9	9	2.4	2	2			
13–16	2.3	1	1	2.9	3	2						
13–18	3.2	6	6				2.5	1	1			
13–19	3.9	28	20	3.9	4	4	4.6	1	1	0.8	11	11
13–20	4.3	1	1	4.1	4	3	3.6	1	1			
13–21	4.4	6	5	4.7	23	12	4.7	8	6	3.6	2	2
13–22	5.7	1	1	4.9	8	7	5.1	3	3			
13–23	5.4	18	15									
13–24	5.3	10	8	5.0	13	11						
13–25	5.4	7	6	5.9	6	5						
13–26				5.4	5	5	5.5	2	2			
13–27										-0.2	1	1
14–14				2.3	6	4	2.3	9	8			
14–15				2.2	17	13	2.2	9	8			
14–16	3.5	3	3	2.7	9	8	2.9	4	4			
14–17	3.1	13	12	2.6	9	6	3.0	10	6	1.9	5	5
14–18	3.0	1	1	3.7	1	1	3.3	3	2	3.5	1	1
14–19				3.3	4	4	3.1	7	5	0.4	19	11
14–20	4.1	1	1	4.9	6	6	2.5	2	2			
14–21	5.6	2	2	4.5	6	4	3.1	6	6	1.8	4	3
14–22	5.1	9	6	5.0	15	9	5.0	3	3	2.3	1	1
14–23	5.6	12	9	5.1	4	4	5.1	1	1			
14–24	5.5	20	18	5.4	15	7	4.5	15	11			
14–25				5.5	10	7	6.1	1	1	-0.4	1	1
14–26										-0.6	1	1
14–27										0.4	1	1
15–14										-0.8	1	1
15–15										0.5	1	1
15–16				2.1	3	2	2.5	2	2			
15–17							3.3	1	1	0.6	5	5
15–18							2.9	2	2			
15–19	4.3	1	1				2.9	2	2	0.4	4	3
15–20							0.5	3	3			
15–21				4.2	1	1	1.6	8	6	-0.6	1	1
15–22				4.1	1	1	2.1	8	5			
15–23							4.9	3	3	0.3	1	1
15–24							2.6	9	6	-0.6	3	3

TABLE I, 7.

Areal Means of Near-Bottom Temperatures — July

Depth range	0–100 m			101–200 m			201–300 m			> 301 m		
Area	t° Mean	No. of obs.	No. of years	t° Mean	No. of obs.	No. of years	t° Mean	No. of obs.	No. of years	t° Mean	No. of obs.	No. of years
7–15				*8.4*	2	1						
7–17				*7.8*	2	1						
7–18				*8.2*	1	1						
7–19				*8.2*	1	1				*5.2*	1	1
7–20	*9.2*	6	6	*8.0*	1	1	*7.5*	1	1			
7–21	*7.9*	1	1	*7.7*	4	4						
7–22				*8.0*	6	4						
7–23							*7.6*	1	1			
7–24										*7.3*	1	1
8–12										*4.3*	1	1
8–14							*7.9*	1	1			
8–15				*8.6*	3	2						
8–16	*7.9*	1	1	*7.1*	2	1						
8–17	*8.2*	6	6	*8.2*	1	1						
8–18				*7.7*	1	1						
8–21	*9.3*	13	8									
8–22	*8.7*	4	3	*7.5*	2	2						
8–23	*8.7*	4	4	*7.8*	10	9	*7.4*	2	2			
8–24				*7.6*	6	3						
8–25				*7.5*	1	1						
9–12										*2.4*	1	1
9–13				*5.2*	3	3	*2.3*	1	1	*1.7*	3	3
9–14				*6.4*	11	6						
9–15	*6.8*	14	8	*8.0*	8	6						
9–16	*7.7*	3	3									
9–17				*8.1*	1	1						
9–22	*8.7*	6	3									
9–23	*8.5*	82	20									
9–24	*8.2*	5	4	*7.6*	11	8	*7.1*	3	3			
9–25				*7.0*	4	3	*6.8*	3	2			
9–26							*7.0*	1	1			
10–12							*2.0*	3	3			
10–13				*2.2*	21	8	*2.2*	2	2			
10–14	*5.5*	14	8	*3.6*	10	6						
10–15	*4.9*	2	1									
10–23	*8.3*	2	2									
10–24	*8.8*	13	7	*7.5*	5	5						
10–25	*7.7*	13	10	*6.9*	12	11	*6.3*	5	5			
10–26				*6.3*	5	3	*5.6*	1	1			
10–27				*5.6*	1	1	*6.0*	3	2			
11–12				*1.1*	1	1	*0.9*	8	4	*0.2*	1	1
11–13				*1.7*	16	9	*1.9*	15	7			
11–14	*3.8*	30	15	*3.6*	14	9	*1.6*	2	2			
11–15	*4.7*	3	3	*3.9*	1	1						
11–24	*7.5*	2	1	*7.5*	1	1						
11–25	*7.7*	26	15	*7.4*	1	1						
11–26	*7.5*	3	2	*6.7*	2	2						
11–27				*6.9*	1	1	*6.2*	1	1			
12–12				*1.9*	1	1	*2.1*	10	5			

contin.

TABLE I, 8, contin.

Areal Means of Near-Bottom Temperatures — August

Depth range	0–100 m			101–200 m			201–300 m			> 301 m		
Area	t° Mean	No. of obs.	No. of years	t° Mean	No. of obs.	No. of years	t° Mean	No. of obs.	No. of years	t° Mean	No. of obs.	No. of years
12–20	*6.8*	5	4	*4.5*	3	2						
12–21	*7.4*	2	1	*5.7*	5	4						
12–22				*5.8*	1	1	*6.1*	4	4			
12–23	*8.5*	1	1									
12–24	*9.1*	1	1									
12–25	*9.4*	8	6									
12–26				*6.0*	1	1	*6.6*	1	1			
12–27							*6.6*	1	1			
13–12				*6.4*	1	1						
13–13				*3.2*	15	9	*3.2*	4	3	*-0.4*	2	2
13–14				*2.8*	13	9	*2.9*	19	15	*1.9*	1	1
13–15	*5.9*	37	25	*4.3*	26	20						
13–16	*5.8*	5	5	*4.7*	6	5						
13–17	*6.3*	1	1	*4.6*	2	2						
13–18	*6.4*	16	9	*5.4*	10	6	*5.1*	2	2			
13–19	*6.6*	29	20	*6.0*	9	7	*5.7*	3	3	*1.3*	13	12
13–20				*5.8*	5	5	*5.9*	1	1			
13–21	*7.3*	7	5	*6.0*	14	11	*5.6*	9	7			
13–22	*7.1*	4	4	*6.2*	7	6	*6.5*	1	1			
13–23	*8.4*	16	14	*7.0*	1	1						
13–24	*8.5*	6	6	*7.0*	7	5						
13–25				*6.5*	1	1						
13–26				*6.7*	1	1				*-0.5*	1	1
13–27										*-0.4*	1	1
14–14				*3.0*	6	5	*2.9*	2	2			
14–15				*3.9*	8	5	*2.8*	6	4			
14–16	*5.0*	5	4	*3.9*	9	5	*3.9*	3	2			
14–17	*5.5*	11	11	*4.5*	15	11	*4.5*	7	6	*3.2*	1	1
14–18				*5.6*	1	1	*5.4*	6	2			
14–19	*6.3*	4	3	*5.1*	5	4	*5.1*	5	4	*0.9*	25	15
14–20				*6.0*	3	3	*4.5*	2	2			
14–21				*4.8*	5	4	*4.4*	8	6			
14–22	*6.2*	5	4	*5.9*	12	9	*4.4*	1	1			
14–23	*6.9*	4	4	*6.1*	4	4						
14–24	*7.2*	17	4	*6.5*	4	4	*6.3*	8	7			
14–25				*5.4*	5	1	*6.0*	1	1	*0.3*	1	1
15–14										*-0.5*	2	2
15–15							*4.6*	1	1			
15–16				*4.3*	4	3	*4.9*	1	1			
15–17							*1.8*	1	1	*1.0*	4	4
15–18										*0.8*	2	1
15–19							*3.2*	2	2	*0.3*	3	2
15–21				*5.3*	1	1	*2.8*	6	6			
15–22							*3.9*	3	1	*-0.3*	1	1
15–24							*2.7*	5	4	*-0.5*	3	3

TABLE I, 9.

Areal Means of Near-Bottom Temperatures — September

Depth range	0–100 m			101–200 m			201–300 m			> 301 m		
Area	t° Mean	No. of obs.	No. of years	t° Mean	No. of obs.	No. of years	t° Mean	No. of obs.	No. of years	t° Mean	No. of obs.	No. of years
7–14										7.2	1	1
7–18				8.1	1	1						
7–19				7.8	2	2						
7–20	9.4	3	3	7.6	1	1						
7–21	8.7	5	2	8.1	15	5						
7–22				8.3	6	4	8.2	3	3			
7–23							8.2	1	1			
8–14				8.6	4	4						
8–15				8.9	4	4	8.4	1	1			
8–16				8.2	1	1						
8–17	8.0	3	3	8.2	1	1						
8–18	8.2	1	1	8.7	2	2						
8–21	9.5	14	7									
8–22	8.4	5	2	8.1	4	4						
8–23				7.7	8	4						
8–24				8.3	10	2						
9–13				5.7	3	3				5.2	2	1
9–14				8.1	1	1						
9–15	8.4	2	2	8.2	2	2						
9–16	8.3	3	3									
9–23	9.3	30	12									
9–24	8.8	2	2	8.5	5	2	8.1	1	1			
9–25				8.0	2	1	7.1	1	1			
10–12				1.6	1	1				1.4	2	1
10–13	6.7	2	1	4.3	6	3	2.4	1	1			
10–14	6.6	1	1	5.5	2	2						
10–15	6.6	2	1									
10–23	9.9	1	1									
10–24	8.7	5	3	8.4	2	2						
10–25				7.5	1	1	7.0	1	1			
10–26							7.1	1	1			
10–27							6.9	3	1			
11–12				2.8	2	2	1.3	3	3	−0.4	1	1
11–13	6.7	1	1	3.6	5	4	2.6	2	2			
11–14	6.6	1	1									
11–15	6.6	1	1									
12–12							0.8	2	2			
12–13	5.6	1	1	4.4	1	1	4.0	1	1			
12–14				6.1	1	1						
12–15	6.7	1	1	4.4	1	1						
12–21				6.5	1	1						
12–22							6.6	1	1			
12–26				6.3	1	1						
12–27							6.2	2	2			

contin.

TABLE I, 11.

Areal Means of Near-Bottom Temperatures — November

Depth range	0–100 m			101–200 m			201–300 m			> 301 m		
Area	t° Mean	No. of obs.	No. of years	t° Mean	No. of obs.	No. of years	t° Mean	No. of obs.	No. of years	t° Mean	No. of obs.	No. of years
7–21	7.6	8	2	7.9	23	2						
7–22				8.0	4	4	8.2	2	2			
7–24							7.6	1	1			
8–21	7.7	7	3									
8–23				7.5	2	1						
8–24				7.5	11	2	7.7	3	2			
9–23	6.6	18	7									
9–24	6.8	1	1	7.9	1	1						
9–25	7.5	1	1	7.5	1	1	7.3	2	1	7.6	1	1
9–26							7.0	1	1			
10–12										-0.6	1	1
10–24	5.9	1	1	7.7	1	1						
10–25	7.5	1	1				7.4	1	1			
12–25	6.8	1	1									
12–26	7.2	1	1									
12–27				6.8	1	1				6.9	1	1
13–14							2.5	5	5			
13–15	5.0	4	4	5.3	4	4						
13–23	5.2	3	3									
14–24	5.5	3	3				3.8	3	3			

TABLE I, 12.

Areal Means of Near-Bottom Temperatures — December

Depth range	0–100 m			101–200 m			201–300 m			> 301 m		
Area	t° Mean	No. of obs.	No. of years	t° Mean	No. of obs.	No. of years	t° Mean	No. of obs.	No. of years	t° Mean	No. of obs.	No. of years
7–21	6.7	3	1	7.1	14	2	8.1	1	1			
7–22				7.0	1	1	7.4	1	1			
8–21	6.5	9	2									
8–22	6.4	5	1									
8–23	6.4	1	1									
9–22	2.3	5	1									
9–23	5.3	7	3									
9–24				7.3	1	1						
10–13				4.2	1	1				2.1	1	1
10–23	6.8	1	1									
10–24	6.9	2	1									
11–12							2.0	1	1			
13–14				3.4	1	1						
13–19	4.5	1	1							0.1	1	1
14–19							1.6	1	1	-0.2	1	1
14–21							3.1	1	1	0.0	1	1

APPENDIX II.

TABLE II, 1.

Near-bottom Temperature at Selvogsbanki I (depth 46 m)

Year	Jan.	Febr.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1934			5.81		7.17	7.12			10.14	9.54		
1935			5.70		7.55				10.62		7.54	
1936			6.23		7.38		9.39		10.09			
1938						7.50						
1946									10.65			
1947			6.16									
1948				6.28	7.27			10.32				
1949								10.68				
1950					7.19							
1951				6.30				8.89				
1953			5.68		6.72							
1956					7.52							
1957					7.86						7.06	
1958					7.54							6.38
1960		5.85*										
1961		6.49										
1962	5.37	5.13	5.38									
1963	6.29	6.33										6.25
1964				7.60*					10.01		8.29	
1965			6.32					10.15				
1966			6.66									
1968											8.19	
1971		5.35	6.42		7.48			9.26		9.52	7.81	5.54
1972		6.16		6.96	8.20		9.92			8.71		
1973	6.47		5.84	5.76		6.98						
Mean	(6.04)	5.89	6.02	6.58	7.44	(7.20)	(9.66)	9.86	10.30	(9.26)	7.78	(6.06)

*) Mean of 2 observations

TABLE II, 4.

Near-Bottom Temperature at Skagi (depth 49 m)

Year	Jan.	Febr.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1926		5.32	5.45*	6.33		8.08*	8.29					
1927	3.93	5.59		5.92	6.19*		8.96	9.14				
1928			6.13		8.48	8.38	8.93	11.28				
1929		5.31		6.90*	7.59	8.50	8.98	10.30				
1930			5.48	5.50				9.81*				
1931							8.09					
1932		5.26	4.79	3.34	6.45	8.50	8.95*	9.48				
1933				4.96		8.57	9.34	9.11	9.62			
1934			4.79		6.18	7.63			10.12		6.01	
1935			4.05		6.82				9.49		7.33	
1936			4.38		7.22				10.09			
1937				6.22								
1938					6.10		8.58					
1939				5.40	7.64		9.66					
1946									9.68			
1947			2.28	3.40								
1948	4.30	5.68	6.48	4.04	5.64	7.61						
1949								9.50				
1950					6.71		9.77	10.80				
1951				4.38		8.37		9.60				
1952				5.80								
1953		5.07	5.16			6.95		9.76				
1954						8.34						
1955						7.80						
1957				6.40	7.85						7.38	6.44
1958					6.64							
1959					6.94	7.44						
1960		4.60										
1961					7.59							
1964	6.54											
1965					6.68	7.98						
1966		1.42	3.43*	5.72*	6.64	8.91*	9.13		9.91	7.51	5.44	
1967	4.74		3.72									
1968												4.38
1971		3.79	5.52	5.92				8.78	9.06		6.72	4.51
Mean	4.88	4.67	4.74	5.38	6.90	8.08	8.97	9.78	9.71	(7.51)	6.58	(5.11)

*) Mean of 2 observations

TABLE II, 5.

Near–Bottom Temperature at Akranes (depth 55 m)

Year	Jan.	Febr.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1925						7.25*						
1926		3.07*	3.72*	4.51		7.60*						
1927							8.05	8.28				
1930			5.29	3.53				9.13*				
1931					4.06							
1932		4.18	4.97	4.24		8.50	8.24	8.85				
1933				4.17	4.78	8.16	8.20	8.93*	9.70			
1934			4.81		6.32	6.71			10.07		5.48	
1935			2.85		5.49				8.74		6.60	
1936			1.42		5.95				9.41			
1939				5.11	6.12		9.00					
1946									10.30			
1947												3.91
1948		2.50		4.60*	4.54		8.44					
1949								8.41				
1950					5.88							
1951						7.15		8.30				
1953		3.89	5.13			4.34		9.84				
1954						6.92						
1957						7.38						6.72
1958					6.41							
1960		2.50										
1966		2.84	1.90*	2.88	5.60	7.70*	9.18	8.62	10.01	8.05	5.28	
1967	3.66		2.68									
1968								8.75				
Mean	(3.66)	3.16	3.64	4.15	5.52	7.17	8.52	8.79	9.70	(8.05)	(5.79)	(5.32)

*) Mean of 2 observations

TABLE II, 6.

Near-Bottom Temperature at Kögur I (depth 52 m)

Year	Jan.	Febr.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1924						3.99	5.52*					
1925								8.02				
1926						5.33	7.53					
1927							8.97	8.27				
1931							7.17					
1932							6.44					
1933								10.20				
1934								7.24			4.81	
1935			1.30					8.89			5.30	
1936						7.10*		7.26			5.66	
1937					4.10				8.01		5.53	
1938		1.68					6.08*		8.44			
1939					4.66			8.60				
1947							7.94					
1948		1.49			4.26		7.67	9.56				
1949							7.42	7.58				
1950							7.26					
1951							3.96	7.84				
1952					1.98	4.74						
1953					2.76	4.44						
1954			1.87	3.25		5.72		7.26				
1955						5.72		9.45				
1956					5.00	6.96						
1957						6.59	9.13*					
1958					4.02			7.55				
1959					5.08	5.63						
1960						5.59		8.07				
1961					5.06	5.67						
1962					4.26							
1963						5.57						
1964						6.24						
1965					2.52	5.16						
1966					2.69	4.86						
1967					2.46	6.29	6.51					
1968	1.02			1.63*			5.58					5.61
1969						5.31						
1970						5.22						
1971	1.84		0.28	4.26				9.12				
1972	3.02	3.42				4.88						
1973	2.71		0.55			4.58						
Mean	2.15	(2.20)	1.00	(3.05)	3.76	5.50	6.94	8.33	(8.23)		5.32	(5.61)

*) Mean of 2 observations

TABLE II, 7.

Near-Bottom Temperature at Kögur II (depth 79 m)

Year	Jan.	Febr.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1924						4.12	5.28*					
1925						5.94						
1926						5.27	6.67					
1927							7.00	6.51				
1931							6.25					
1932							5.92					
1933								7.73				
1934								6.75			5.23	
1935			2.60					7.69			5.40	
1936						6.83		6.69			6.61	
1937					4.68				7.21		5.84	
1938		2.74					5.74*		7.67			
1939					5.16			7.74				
1947							7.58					
1948		2.06					5.84	7.52				
1949							6.44	6.45				
1950							6.20					
1951							6.26*	6.68				
1952						4.64						
1953					3.72	4.34						
1954			3.54	3.98				6.57				
1955						5.58		8.85				
1956						5.62		6.92				
1957						5.92	8.12					
1958					4.12*			6.48				
1959					5.17	5.68						
1960						5.40	7.40					
1961					5.75	5.97						
1962					3.99							
1963						5.00						
1964						5.85						
1965					2.43	5.14						
1966					2.63	4.83						
1967					2.39	5.63	5.92*					
1968	1.42			2.43*			5.23					7.01
1969						4.43						
1970						5.08						
1971	1.99		0.72	4.26								
1972	3.56	4.10				5.08*						
1973	4.71		2.09			4.52						
Mean	2.92	(2.97)	2.24	(3.56)	4.00	5.28	6.39	7.12	(7.44)		5.77	(7.01)

*) Mean of 2 observations

TABLE II, 8.

Near-Bottom Temperature at Kögur III (depth 226 m)

Year	Jan.	Febr.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1924						4.59	5.12					
1926						2.05	6.16					
1927							5.98	6.22				
1933								6.63				
1934								6.58			2.40	
1935			4.30					6.44			5.70	
1936						6.07		6.45			3.35	
1937					4.23				6.27		3.42	
1938		4.94					5.39		6.49			
1939					5.78			6.68				
1947							6.49					
1948							6.16	6.56				
1949							1.43	5.99				
1950							5.94					
1951							5.43*					
1952						2.79						
1953					4.14							
1954				3.44								
1955	4.74					5.48		5.16				
1956						5.66						
1957						6.08	6.62					
1958					4.76			6.25				
1959						5.76						
1960						5.76	4.77					
1961					5.05	5.79						
1962					3.97							
1965					4.06							
1966					4.15							
1967						5.00	5.01					
1968	3.55			3.27			3.80					
1969						5.10						
1970						4.78						
1971	3.13		3.03	4.76				6.52				
1972	2.28	4.99				5.45						
1973	5.57		2.49			5.01						
Mean	3.85	(4.97)	(3.27)	(3.82)	4.52	5.02	5.25	6.32	(6.38)		3.72	

*) Mean of 2 observations

TABLE II, 9.

Near-Bottom Temperature at Siglunes I (depth 74 m)

Year	Jan.	Febr.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1924						1.41	5.19					
1925								6.10				
1926						4.55	5.88*					
1927							5.83	7.11				
1931								5.80				
1932							4.07	7.04				
1937						3.69						
1938							4.32					
1939								7.58				
1947						4.00*	6.19**					
1948					3.26		4.13	7.28	7.72			
1950					3.26			5.69				
1951							5.73*	7.88				
1952					1.46	3.46						
1953					2.43	3.58			6.96	6.01		4.48
1954	4.26	3.16	2.54	3.32	3.95	4.11	5.80*	6.28	6.73	5.14	4.34	
1955	3.81		2.04		2.00	4.28	6.02	8.20	7.74			
1956						4.63*		6.44				
1957				2.90		4.72		7.34*				
1958						3.49*		5.54				
1959						5.09						
1960						5.29		6.84				
1961						5.18		6.79				
1963						3.45						
1964						4.97	7.14					
1965					3.14	2.44	3.97	6.49				
1966					2.15	2.50						
1967					0.74	1.15						
1968	1.62					0.85	2.59					5.59
1969						1.20						
1970						1.95			5.91		4.20	
1971			0.08		0.51			6.75				
1972		3.59				3.88		6.10				
1973		2.39				3.87						
Mean	(3.23)	(3.05)	(1.55)	(3.11)	2.29	3.49	5.14	6.74	7.01	(5.58)	(4.27)	(5.04)

*) Mean of 2 observations **) Mean of 3 observations

TABLE II, 10.

Near-Bottom Temperature at Siglunes II (depth 435 m)

Year	Jan.	Febr.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1927								0.51				
1930							0.85					
1933								0.10				
1938							−0.37					
1939								5.30				
1950					0.19							
1952					0.31	−0.26						
1953										−0.09		0.08
1954	−0.29	−0.01	0.10	−0.11	0.12		0.63*	0.76	0.44			
1955	−0.02	0.29			1.30*	2.16	1.02		0.44			
1956						0.38						
1957						0.37		0.58*				
1958						2.59		1.27				
1959						0.79*						
1960						0.93		1.54				
1961						0.15		0.66				
1962						0.96						
1963						0.07						
1964						0.22	0.17					
1965					0.03		0.22					
1966					2.37	1.70						
1968						0.66	1.04					0.81
1969						0.76						
1970											0.41	
1971			0.92		1.68			0.23				
1972		1.31				−0.18		3.37				
1973						−0.08						
Mean	(−0.16)	(0.53)	(0.51)	(−0.11)	0.86	0.70	0.59	1.43	(0.44)	(−0.09)	(0.41)	(0.44)

*) Mean of 2 observations

TABLE II, 11.

Near-Bottom Temperature at Langanes I (depth) 57 m)

Year	Jan.	Febr.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1908							1.40					
1925								6.44				
1926						2.86		6.07				
1927							4.49	6.73				
1931								5.18				
1932							2.17					
1933							6.66					
1934					2.62			6.06			4.12	
1935		0.70			1.60			7.53			5.50	
1936						3.16*		7.52			5.46	
1937						3.82			6.89		5.13	
1938			1.88				3.94	5.49				
1939				2.13				6.53				
1947							4.49	8.75				
1948		1.73			3.46		4.10	4.72	7.16			
1949								2.21*				
1950								4.94				
1951							1.18					
1952					1.58	2.87						
1953					2.14				6.69			
1954								5.64				
1956								7.16				
1957						3.28		5.26				
1958						2.36		5.15				
1960								6.35				
1961						3.35		5.71				
1962								3.13				
1963						2.50		5.58				
1964						4.13		7.18				
1966					1.04	1.00						
1967					0.35	0.41						
1968	2.28					-0.32						4.16
1969		1.21				0.55						
1970						1.10						
1972						3.48						
1973						2.91						
Mean	(2.28)	(1.21)	(1.88)	(2.13)	1.83	2.34	3.55	5.88	(6.91)		5.05	(4.16)

*) Mean of 2 observations

TABLE II, 12.

Near-Bottom Temperature at Langanes II (depth 143 m)

Year	Jan.	Febr.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1934					2.16			3.10			5.11	
1935		1.50			1.81			4.71			5.50	
1936						4.83		4.53			5.56	
1937						2.19			4.79		5.11	
1938			1.88				2.81	3.68				
1939				1.90				3.79				
1947						2.18	2.81	6.20				
1948		1.83			2.84		3.24*	3.77				
1949								1.50				
1950								4.36				
1951							0.92	3.81				
1952					0.85							
1953					1.86				4.80			
1957								4.76				
1960								5.15				
1961						2.52		4.73				
1962								4.64				
1963						1.04						
1964						3.84		4.71				
1965					2.22	2.06						
1966						0.92						
1967					−0.38							
1968	1.58					0.05						4.97
1969						1.18						
1970			0.20			1.05						
1971		0.55	0.81									
1972		2.37				2.90						
1973						2.27						
Mean	(1.58)	1.56	(0.96)	(1.90)	1.62	2.08	2.44	4.23	(4.80)		5.32	(4.97)

*) Mean of 2 observations

TABLE III, 13.

Near-Bottom Temperature at Langanes III (depth 281 m)

Year	Jan.	Febr.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1934					1.60			1.94			1.96	
1935		0.40			1.80						1.20	
1936						2.56		1.87			3.11	
1937						1.53			4.02		2.11	
1938			-0.47				2.10	3.26				
1939				0.47				3.11				
1947							2.34					
1948		1.44			2.55		3.15	2.73				
1949								1.18*				
1950								1.04				
1951							1.12*	1.98				
1952					-0.02	0.97						
1957								3.44				
1958								1.92				
1961						1.87						
1962								2.59				
1963						0.82		2.58				
1964						3.25		4.64				
1965					0.51							
1967					0.02							
1968	0.21					-0.28						1.31
1969		0.59				1.20						
1970			0.27			1.32						
1971			-0.16									
1972		2.31				2.36						
1973						1.55						
Mean	(0.21)	1.18	(-0.12)	(0.47)	1.08	1.56	2.18	2.48	(4.02)		2.10	(1.31)

*) Mean of 2 observations