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International Council for the Exploration of the Sea

C.M. 1977/F:31
Demersal Fish (Northern) Committee
Ref.: Hydrography Cttee

INVESTIGATIONS ON DEMERSAL JUVENILE COD (AGE GROUPS 0-IV) IN ICELANDIC WATERS IN 1976

by

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Digitalization sponsored by Thünen-Institut

Introduction

Of all demersal fish species in Icelandic waters the cod (Gadus morhua (L)) has been the most important one for the fisheries in these waters. At the turn of this century considerable research was done on the juvenile stages of cod and other species, whereas later on the exploited part of the stock became the main object of research. Since 1970, with the beginning of the international 0-group surveys (Vilhjálmsson and Friðgeirsson 1976), marine research has been directed again more towards the juvenile stage of the fishes in the Icelandic waters.

In 1976 a research program was initiated at the Marine Research Institute in Reykjavík on the biology of juvenile cod in Icelandic waters. This program will continue for the next 4-6 years. "Juvenile cod" is here defined as the benthic or semi-benthic phase of the cod until its 5th year of life. As the benthic phase of the cod in Icelandic waters begins approximately in September in its first year of life (0-group), the juvenile phase covers approximately 4 1/4 years.

The main nursing grounds of I-group and II-group cod in Icelandic waters are found in the waters north of the northwest peninsula and the western part of the north coast (Fig. 1). These groups are less abundant off the northeast coast and particularly so off the east coast and they are virtually absent off the mid north coast and off the west coast.

Material and Methods

Approximately 80 stations (Fig. 1) provide a fair coverage for sampling in the above mentioned area. They were carried out in February, May, August-September and in November 1976. Biological material was sampled with ordinary bottom trawl with 65 feet headline and codend mesh-size of 120-135 mm. The codend and 4 fathoms of the belly was covered by a net of 32 mm mesh-size.

Approximatelu 7 otolith samples were collected at 7 different stations in the study area. Age analysis and length distribution have been used to construct an age-length key, where a certain length range is ascribed to each age group. The abundance of each specific age group is expressed as numbers per nautical mile towed.

The calculations of year class strength are based on a more or less constant number of stations on the nursing grounds, at approximately fixed positions (Fig. 1). The abundance of each year class on each station is assumed to reflect the situation in the surrounding area. Extra stations, which were worked for one reason or another, but not count as fixed stations, are averaged with the next fixed station. The average number of fish per nautical mile for all fixed stations is regarded as an index of the year class strength of the respective year class (abundance index).

The vertical distribution can be described by the average number of fish of each age group per nautical mile for various depth ranges. This will be calculated for the depth ranges 25-100 m, 75-150 m, 125-200 m, 175-250 m, 225-300 m, 275-350 m and 325-400 m or more and will be expressed in percentages together with average temperatures in the same depth ranges (Figs. 24-27).

During the investigations on juvenile cod dealt with in this paper a relatively good coverage of the near-bottom temperatures was obtained by means of reversing thermometers. The coverage in the shelf area north and east of Iceland is likely to be the best ever obtained during limited time periods. The density of the stations can be seen in Figures 3-6, showing the near-bottom temperatures in February, May, August-September and November 1976. As shown no or only few temperature observations were made in the waters west and south of Iceland.

Stefánsson and Jónsdóttir (1974) have previously dealt with near-bottom temperatures around Iceland where they include all available data up to 1973. They select data from different months and depths and present them in Tables and Figures. About 74% of their material was collected

during the months May-August, and only 22% during the months January-April and September, and < 4% in October-December. Thus due to limited data it was only possible to draw mean charts of the whole area around Iceland for the months May-August. The data in the present paper thus contribute additional information about the distribution of near-bottom temperatures in the shelf area around Iceland both as regards time and space of observations as well as coverage in north and east Icelandic shelf water during all seasons.

The near-bottom temperatures were used for describing the horizontal and vertical distribution of the near-bottom temperatures in different areas and seasons (Figs. 3-6 and 24-28). It is convenient to divide the whole study area NW, N and E of Iceland into three subareas (Fig. 28). These are 1) the area NW of Iceland to 22°W, where the inflow of warm Atlantic water dominates; 2) the area from 22°W to 18°W, with coastal and arctic water and 3) the area NE and E of Iceland from 18°W to 65°N off the east coast, also with coastal and arctic watermasses.

The deviation in North Icelandic waters at 18°W is due to conditions of the bottom topography; a deep trench across the shelf and a submarine ridge just east of it (Eyjafjarðaráll and Kolbeinsey Ridge (Fig. 2)). In general all topographic features like deeps and valleys in the shelf influence the curvature of the near-bottom isotherms. Comparative data do not allow any statements on questions about how far the water temperatures are lower or higher than "normal", which also is out of the scope of the hydrography in this paper, which deals with the horizontal and vertical distribution of the near-bottom temperatures in different areas and seasons during the investigations on juvenile cod in 1976.

RESULTS

I. Survey in February/March

Hydrography

Only 28 observations on near-bottom temperatures were made in February (Fig. 3), all off the northwest, north and east coast of Iceland. In the Atlantic water off the northwest peninsula temperatures above 4°C were observed at about 200 m depth, and decreasing values were observed eastwards and with decreasing depth (100 m; 1-2°C), as shown in Figure 28. Farther east between 22° and 18°W the temperatures were slightly above 1°C and mostly independent of depth (100-240 m), except

in the Atlantic water of about 3°C at 200 m (Hornbanki and Skagagrunn; Fig. 2). East of 18°W and north of 65°N the near-bottom temperatures in the shelf area were about 1.6°C and independent of depth (80-260m) except in the submarine valleys where cold arctic water only slightly above 0°C was observed at 320 m depth.

Distribution and abundance

This first survey took place on 1-27 February. Due to unfavourable weather conditions the results are not considered wholly representative and therefore material from a short survey during 15-17 March in the area around Reykjafjarðaráll has been included.

I-group This distribution of the I-group (year class 1975) is shown in Figure 7. This age group was mainly found off the northwest coast and in limited areas off the north, northeast and east coasts. Abundance index: 1.5 (average number of fish per one nautical mile tow).

II-group This age group (year class 1974) was mainly found on the continental shelf, down to depths of more than 200 m (Fig. 8) from Ísafjarðardjúp to Skagagrunn. Other areas had less extensive distribution. Abundance index: 2.1.

III-group The III-group (year class 1973) was distributed throughout the survey area (Fig. 9). Off the western north coast a dense distribution was found in a rather large area. Other areas with some abundance were off the eastern north coast, at the edge of the continental shelf off the northeast coast (Rifsbanki - Langanesgrunn), and off the east coast (Glettinganesgrunn). Abundance index: 14.7.

IV-group This age group (year class 1972) was distributed throughout the survey area (Fig. 10). The highest abundance was observed off the western north coast. Other areas with some abundance were observed off the eastern north coast, at the edge of the continental shelf off the northeast coast and off the east coast. Abundance index: 9.3.

Vertical distribution (Fig. 24)

The I-group was rather evenly distributed throughout the various depths, except below 300 m, where its relatively abundance was quite low (4%). The vertical distribution pattern of the II-group was most extensive in intermediate and deeper layers, i.e. between 150 and 300 m approximately, with minima in shallower and deeper waters. The vertical distribution pattern of the III-group showed a clear peak around 250 m and minima in deeper and shallower waters. The vertical distribution

pattern of the IV-group showed a slow increase in abundance with depth leading to the densest distribution in the deepest layers. The vertical distribution of near bottom temperature showed (at least in the western areas) a maximum around 200 m, with rather rapid decrease in temperature into deeper waters and slower decrease into shallower waters.

In general the vertical distribution pattern of the juvenile cod was more or less limited to the intermediate and deeper layers with clear minima in the shallower and the deepest depth ranges. However, exceptions to this were found as regards the I-group and the IV-group. The characteristic near bottom temperature of the intermediate and deeper waters were approximately 2-3.5°C.

II. Survey in May

Hydrography

In May 74 observations were made on near-bottom temperatures all around Iceland except off the south coast (Fig. 4). The Atlantig water of the northwestern peninsula had temperatures from 4-5°C at about 200 m, with decreasing values eastwards and decreasing slightly with depth of 100 m, or to 3.5°C, and also with increasing depth seawards of 240 m towards 0°C. Farther east between 22° and 18°W the temperatures were 3-4°C at 100-230 m depth, slightly increasing with depth and again decreasing at greater depths of 300-400 m towards 0°C (Húnaflóadjúp). East of 18°W and north of 65°N the temperatures in the shelf area were about 1-3°C, with slightly decreasing values eastwards and with depth (100-200 m) and a decrease towards 0°C at depth below 200 m. South of 65°N the temperatures in the boundary between the arctic water of the East Icelandic current and the Atlantic water were 2-6°C.

Distribution and abundance

The second survey took place on 7-30 May and included 119 stations around Iceland. As can be seen in Figures 11-14 very few cod were recorded outside the main nursing grounds.

I-group The distribution pattern of the I-group was rather patchly and the abundance very low (Fig. 11). This group was mainly recorded off the northwest, north and northeast coasts and just a few fish were found south of latitude 66°N off the east coast. Abundance index: 0.9.

II-group Roughly the distribution of the II-group was continuous from the northwest to the east coast (Vopnafjarðargrunn), although the

abundance was low (Fig. 12). This group was most numerous around Kolbeinsey and Reykjafjarðaráll. Abundance index: 2.8.

III-group The III-group was distributed throughout the survey area, with the exception of the stations with the greatest depth (Fig. 13). Areas with the highest abundance were found around Kolbeinsey, on Vopnafjarðargrunn off the northeast coast and also in shallower waters along the east coast. Abundance index: 13.1.

IV-group This group was distributed over the area from the northwest coast to the southern east coast (Fig. 14). It was generally absent from the deepest waters. The highest abundance was recorded in areas off the east coast and around Kolbeinsey. Abundance index: 5.9.

Vertical distribution (Fig. 25)

The I-group and II-group show practically normal distribution around 160 m depth. The II-group, however, has a lower peak at this depth and its curve is smoother. The vertical distribution pattern of the III-group shows peaks at 110 and 210 m, whereas the IV-group has one peak at 110 m depth.

In general almost no juvenile cod were observed below 310 m in May and relatively few below 260 m as well as in the uppermost depth ranges. The juvenile cod therefore seem to have preferred the depth ranges between 100 and 200 m in May 1976, a depth characterized by near bottom-temperature of 2-3°C.

III. Survey in August-September

Hydrography

In August- September 58 observations were made on near-bottom temperatures northwest, north and east of Iceland (Fig. 5). In the Atlantic water off the northwest peninsula temperatures of 5-7°C were observed at about 100-200 m depth, with the highest temperatures at Strandagrunn, and with slightly decreasing temperatures with depth down to 200 m, and then a decrease towards 0°C at 260 m. Farther east between 22° and 18°W the temperatures were 4.5-6°C at 100-200 m depth, with decreasing values with depth towards 0°C at 300 m. East of 18°W and north of 65°N the temperatures in the shelf area were very variable, form 7-9°C at about 100 m depth to 1-2°C at 300 m depth and 0°C at 400 m depth (Þistilfjarðardjúp). South of 65°N the temperatures in the boundary zone were 4-7°C.

Distribution and abundance

The third survey took place on 18 August to 5 September and included 81 stations around Iceland.

0-group The 0-group was recorded at 10 stations, mainly off the southern east coast (no Figure). Abundance index: 0.2.

I-group The I-group had a rather scattered distribution, mostly limited to shallower depths of the shelf area from the northwest coast to the northeast coast (Fig. 15). The abundance was always less than 6 individuals per nautical mile except in Ísafjarðardjúp, where it was 28 individ./n.m. Abundance index: 0.7.

II-group The II-group was more or less continuously distributed from the northwest coast to the northeast coast (Fig. 16). Very few individuals were recorded south of Langanes. The main distribution area seems to have been off the western north coast. Abundance index: 2.0.

III-group The III-group was distributed throughout the survey area (Fig. 17). The main areas, however, were off the northwest and north coasts into depths of approximately 200 m and around Kolbeinsey. Abundance index: 10.6.

IV-group The IV-group was distributed throughout the survey area (Fig. 18). It was most abundant off the eastern north coast and around Kolbeinsey. Abundance index: 6.2.

Vertical distribution (Fig. 26)

More than 50% of the I-group was recorded at depths of approximately 110 m (75-150 m). The other half was evenly distributed through other depth ranges down to 310 m. The II-group and III-group showed vertical distribution patterns, with two peaks at depth of 110 and 210 m. These age groups were recorded only infrequently below 250 m. The IV-group was evenly distributed over the shallower part of the depth range down to approximately 230 m. In general the juvenile cod was distributed over the shallower part of the depth range, with a maximum around 110 m. This depth level was characterized by temperatures of 4-8°C.

IV. Survey in November

Hydrography

In November 67 observations were made on near-bottom temperatures all around Iceland except at the west coast (Fig. 6). In the Atlantic water at the northwest peninsula temperatures of 5.5.-7.5°C were observed

at 60-200 m depth, decreasing to 4°C at 260 m depth. Farther east between 22° and 18°W the temperatures were 4.5-6.5°C at 60-200 m depth, with decreasing temperatures with increasing depth towards 0°C at 300 m. East of 18°W and north of 65°N the temperatures in the shelf area were 3-5°C at 80-240 m depth, decreasing temperatures with increasing depth. South of 65°N the boundary between the arctic water and the Atlantic water was not very pronounced, but the temperatures in the area were 5-7°C.

Distribution and abundance

The fourth and last survey in 1976 took place on 4-26 November and included 73 stations around Iceland.

0-group The 0-group was mainly recorded off the northeast and east coasts and also of the northwest coast (Fig. 19). Despite the unusual strenght of this year class in the 0-group survey in August (Anon. 1976, a) its abundance was very low in November. Abundance index: 1.0.

I-group The I-group was distributed over a wide area off the north coast and off the northeast coast (Fig. 20). A smaller area of distribution was located off the east coast. The abundance was very low in all areas, but highest off the eastern north coast. Abundance index: 1.2.

II-group The II-group was mainly recorded off the north coast (Fig. 21). Smaller areas were located elsewhere. This group was most abundant in the eastern fjords of the north coast. Abundance index: 2.3.

III-group The III-group was distributed throughout the survey area (Fig. 22). The greatest abundance was, however, observed in the coastal waters of the north coast and in the area around Kolbeinsey. This group was also recorded in some numbers in deeper waters off the northwest and eastern north coasts. Abundance index: 9.2.

IV-group The IV-group was somewhat evenly distributed throughout the survey area (Fig. 23). The highest abundance was recorded in the area around Kolbeinsey, off the northeast coast and in two fjords of the eastern north coast (Eyjafjörður and Skjálfandi). Abundance index: 5.4.

Vertical distribution (Fig. 27)

The vertical distribution pattern of the 0-group was rather similar at the various depths, except around 110 m (6%) and around 310 m (0%). The I-group was less abundant at intermediate depths compared to shallower

or deeper levels. The vertical distribution patterns of the other age groups was similar; they all have a maximum just below 100 m and a minimum below 200 m, followed by increased numbers in deeper and colder layers.

V. Seasonal variations of the near-bottom temperatures

In the three subareas studied, northwest, north and northeast and east of Iceland the seasonal variations in 1976 were different in magnitude. As expected these variations decrease with depth (Fig. 28).

In the Atlantic water northwest of Iceland the near-bottom temperature values were 2-4°C in February, 4-5°C in May, 6-7°C in August as well as in November. The seasonal variations were thus 3-4°C, with a minimum in February and maximum between August and November.

In North Icelandic waters between 22° and 18°W the temperature values in February were 1-2°C, in May 2-4°C, except in the submarine valleys, in August-September 4-8°C and in November 4-6°C. The variations were thus 3-6°C increasing shorewards and had a minimum in February and a maximum in late summer.

In the shelf waters northeast and east of Iceland the temperature values in February were 1-2°C, in May 1-3°C, in August-September 4-8°C and in November 4-5°C. The seasonal variations were thus about 3-6°C, increasing shorewards and with a minimum in February and a maximum in late summer.

VI. Concluding remarks on the near-bottom temperatures

It can be concluded that the near-bottom temperatures northwest, north, and northeast and east of Iceland are controlled by different conditions. In the northwest the inflow of warm Atlantic water dominates the conditions. In the north the relatively deep submarine valleys as off Húnaflói and Eyjafjörður allow cold arctic water to penetrate into the shelf area. In the northeast and east also the bottom topography and the cold watermasses of the East Icelandic current dominate the conditions. As a whole it can be stated that in deeper layers than 300-400 m near-bottom temperatures in the study area north and east of Iceland have a value around or below 0°C. This is in great contrast to the water south and west of Iceland, where warm Atlantic water of the Irminger current dominates, and temperatures of 6-7°C are found at this same depth of 300-400 m, as well as in the spawning areas on the outer shelf in winter.

DISCUSSION

Quarterly variations

Having described the distribution of juvenile cod in each quarter of the year 1976, it seems useful to look for changes in the distribution of each age group with time (quarters) and discuss possible explanations for changes if any.

The 0-group (year class 1976) was hardly recorded until in November and in very low numbers.

The I-group (year class 1975). One obvious change in the distribution pattern of the I-group is the much wider distribution in the last quarter (November) than in the other 3 quarters. According to the vertical distribution this group seems to have migrated into shallower waters in the second and the third quarters and to some extent returned to deeper waters in the fourth quarter.

The II-group (year class 1974) is distributed over a larger area in the first two quarters of the year. In the third and the fourth quarters it seems to have left the grounds off the east coast and northeast coast to a considerable extent.

The III-group (year class 1973) seems to have migrated into shallower (and warmer) waters in the second, third and even in the fourth quarter of the year. Furthermore, it is possible that some migration has taken place in the course of the year from the northeast and east coasts to the north coast.

The IV-group (year class 1972) has possibly migrated to some extent from the east coast to the northeast coast in the course of the year. A migration into shallower waters also appears to have occurred in the second and third quarters of the year.

In general it appears that all age groups (0-group excluded) have migrated into shallower waters in the course of the year, which is probably related to changes in hydrographic conditions, i.e. increased near-bottom temperature in spring and summer in the shallower areas. There are also indications of migrations of the three oldest age groups (II-IV) from the east or northeast coasts to other parts of nursing grounds in the course of the year.

Year class strength (preliminary results)

The method of calculating the abundance index was described earlier. The abundance index is the average catch per unit effort, the unit effort

being one nautical mile towed. By relating the abundance index of a year class to an abundance value in absolute terms derived by another method, a raising factor can be derived to calculate the absolute abundance of the other year classes.

The strength of the year class 1972, calculated by VPA-method (Anon., 1976, b), is estimated 249 millions of 3 year old recruits. This figure has not yet been recalculated on the basis of the material from 1976. It seems, however, that it will be somewhat lower or closer to an average year class (220 millions; S.A.Schopka, personal communication).

The abundance indices of the cod year classes 1972-76 are shown in the following table.

Table 1. Abundance indices of the cod year classes 1972-1976 in 1976 and in March 1977.

Year class 1972	age (years)	4.16	4.38	4.65	4.88	5.19
	index	9.3	5.9	6.2	5.4	6.3
Year class 1973	age (years)	3.16	3.38	3.65	3.88	4.19
	index	14.7	13.1	10.6	9.2	14.6
Year class 1974	age (years)	2.16	2.38	2.65	2.88	3.19
	index	2.1	2.8	2.0	2.3	4.9
Year class 1975	age (years)	1.16	1.38	1.65	1.88	2.19
	index	1.5	0.9	0.7	1.2	38.4
Year class 1976	age (years)			0.65	0.88	1.19
	index			0.2	1.0	2.3

Material from a survey in March 1977 has been added to the material samples in 1976.

Year class 1972 As can be seen in Table 1 the overall trend in the abundance indices of this year class is decline. Compared to the subsequent year classes the year class 1972 seems to be more or less fully recruited to the survey area.

Year class 1973 The abundance indices in 1976 fit an exponential curve quite well whereas the valus from March 1977 shows a considerable increase. This suggests that the year class is still recruiting to the survey area in winter 1976/77.

Year class 1974 The abundance indices of this year class remain more or less constant in 1976, whereas the value for March 1977 is more than twice the mean value in 1976. This suggests a recruitment to the survey area from other nursery grounds in winter 1976/77.

Year class 1975 The abundance indices remain more or less constant in 1976. In March 1977, however, an enormous increase has occurred. The distribution of this year class in March 1977 was very patchy indeed as 89% of the catch of this year class was recorded on 2 stations out of 78. Leaving these 2 stations out of the calculations would yield an abundance index of 4.0, which is still a considerable increase. Therefore it seems obvious that the year class 1975 has recruited to the survey area in winter 1976/77.

Year class 1976 The abundance indices of this year class show a continuous increase from August/September 1976 to March 1977.

On the basis of this material it seems that a pronounced recruitment of juvenile cod to the survey area takes place in winter, i.e. in the period November-March. However, this increased abundance in the beginning of the year could possibly also be explained by other causes such as higher vulnerability of the juvenile cod to the gear in this season. A more definite answer to this and other questions must await further investigations in coming years.

The calculation of year class strengths on the basis of this material is thus obviously difficult and the material is hardly adequate for detailed calculations. Nevertheless it seems to be worthwhile to present preliminary results. The results are based on the following assumptions:

1) Strength of year class 1972: 220 millions of 3 year old recruits.
2) Mortalities of the year classes 1972 and 1973 up to the ages of 4 years are the same.
3) Year classes are fully recruited at the age of 4 years.

The abundance index of the year class 1972 at the age of 4 years is 9.3. The fraction of the year class strength at the age of 3 years (220 millions) for this index gives a raising factor $= \frac{220 \times 10^6}{9.3} = \underline{23.7 \times 10^6}$

Strength of year class 1973 = $14.6 \times 23.7 \times 10^6 = \underline{346 \times 10^6}$, which would be a very good year class.

As can be seen in Table 1 the year class 1973 has the same abundance index at the age of 3.16 years and 4.19 years. If this can also be expected in the case of the year class 1974, its strength would

be = 4.9 x 23.7x10^6 = $\underline{116x10^6}$, which would be a very poor year class.

Because of the extremely patchy distribution of the year class 1975 in March 1977, its very high abundance index of 38.4 seems most uncertain. Discussion of the strength of this year class as well as the year class 1976 must therefore await further investigations.

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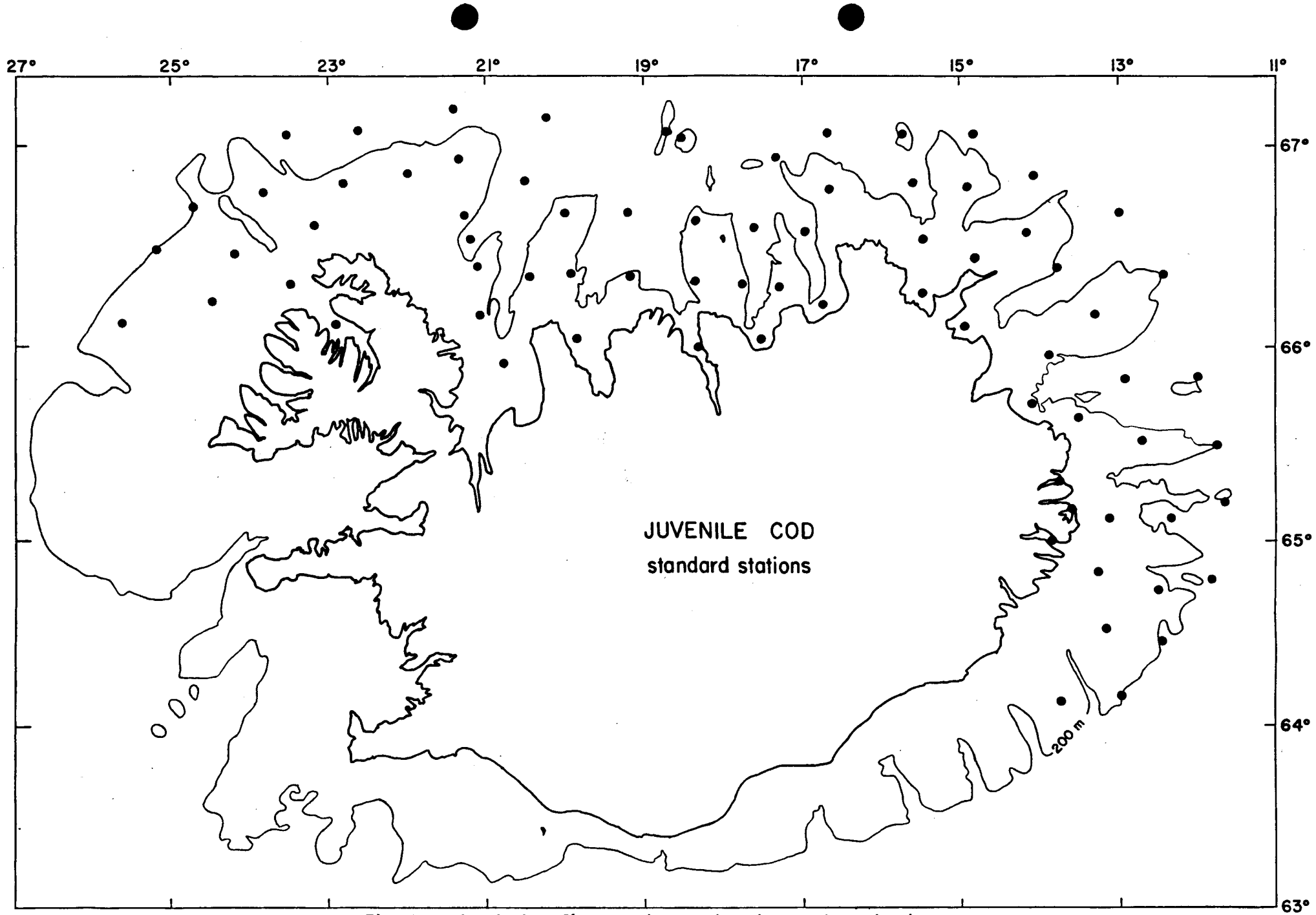

Fig. 1. Standard or fixed stations of juvenile cod investigation in the waters around Iceland in 1976.

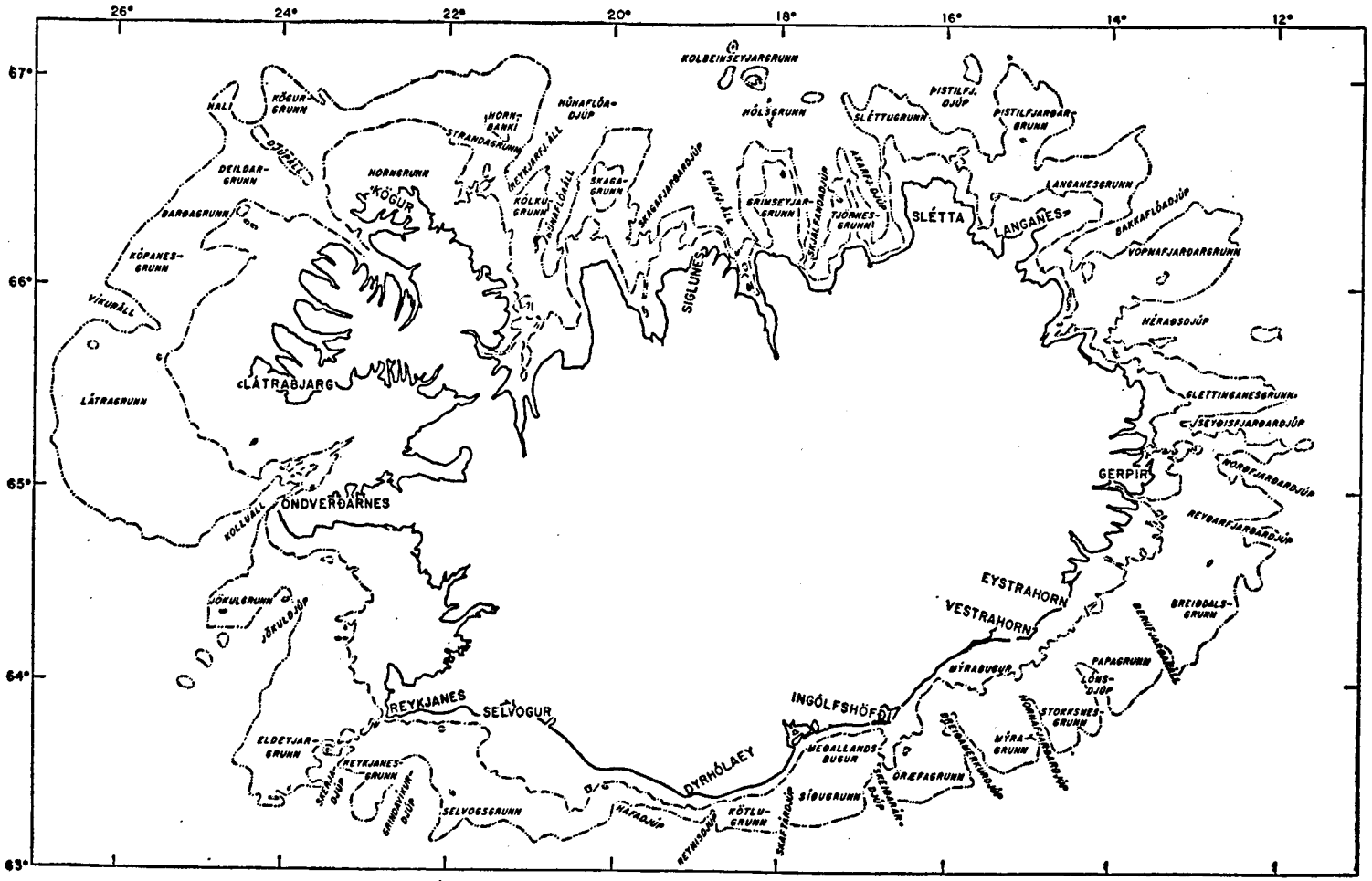

Fig. 2. Names of the prinsipal bathymetrical features of the Icelandic coastal regions. Depth curves for 100 and 200 meters (Stefánsson and Jónsdóttir 1974).

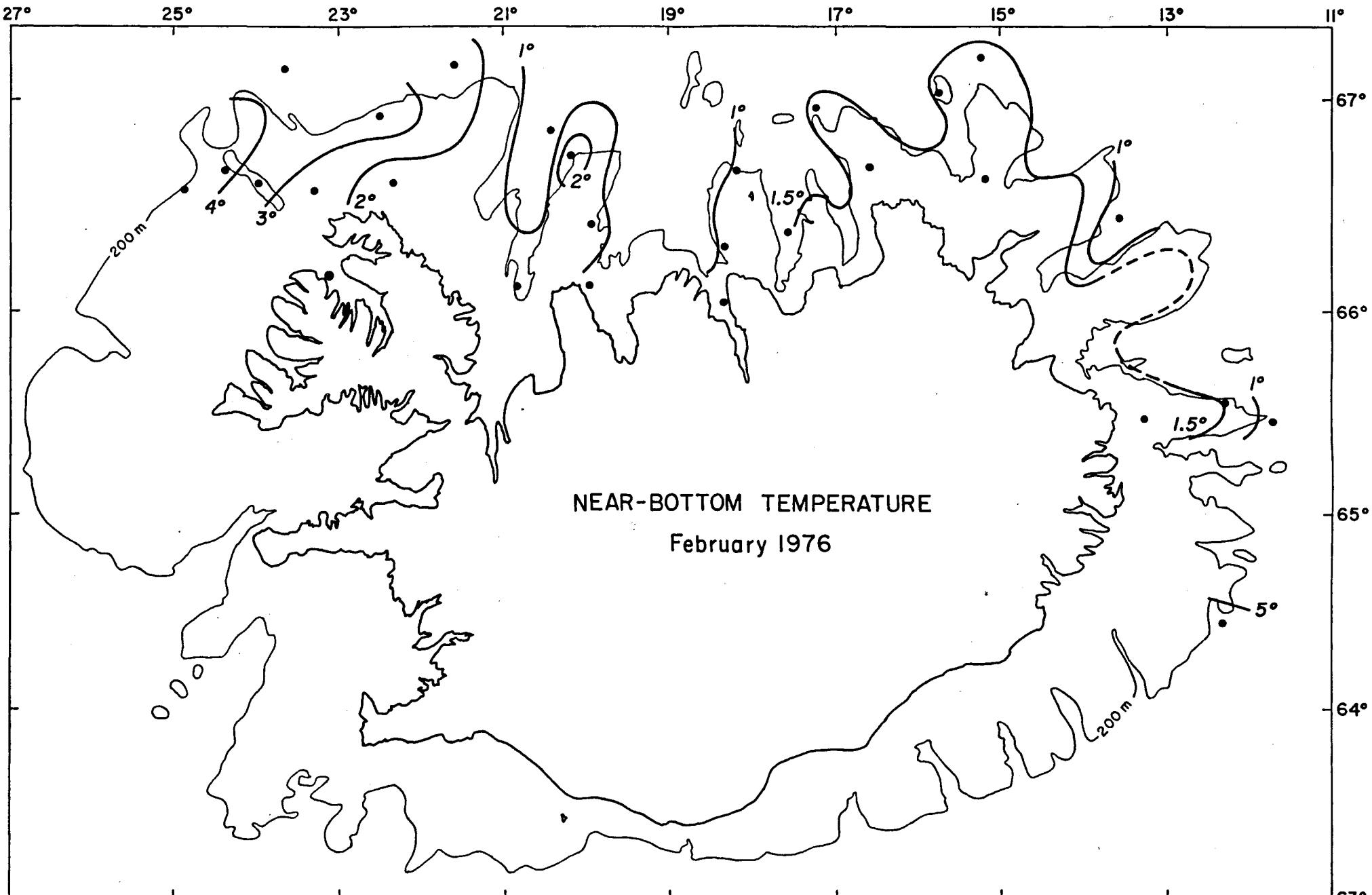

Fig. 3. Near-bottom temperature in February 1976.

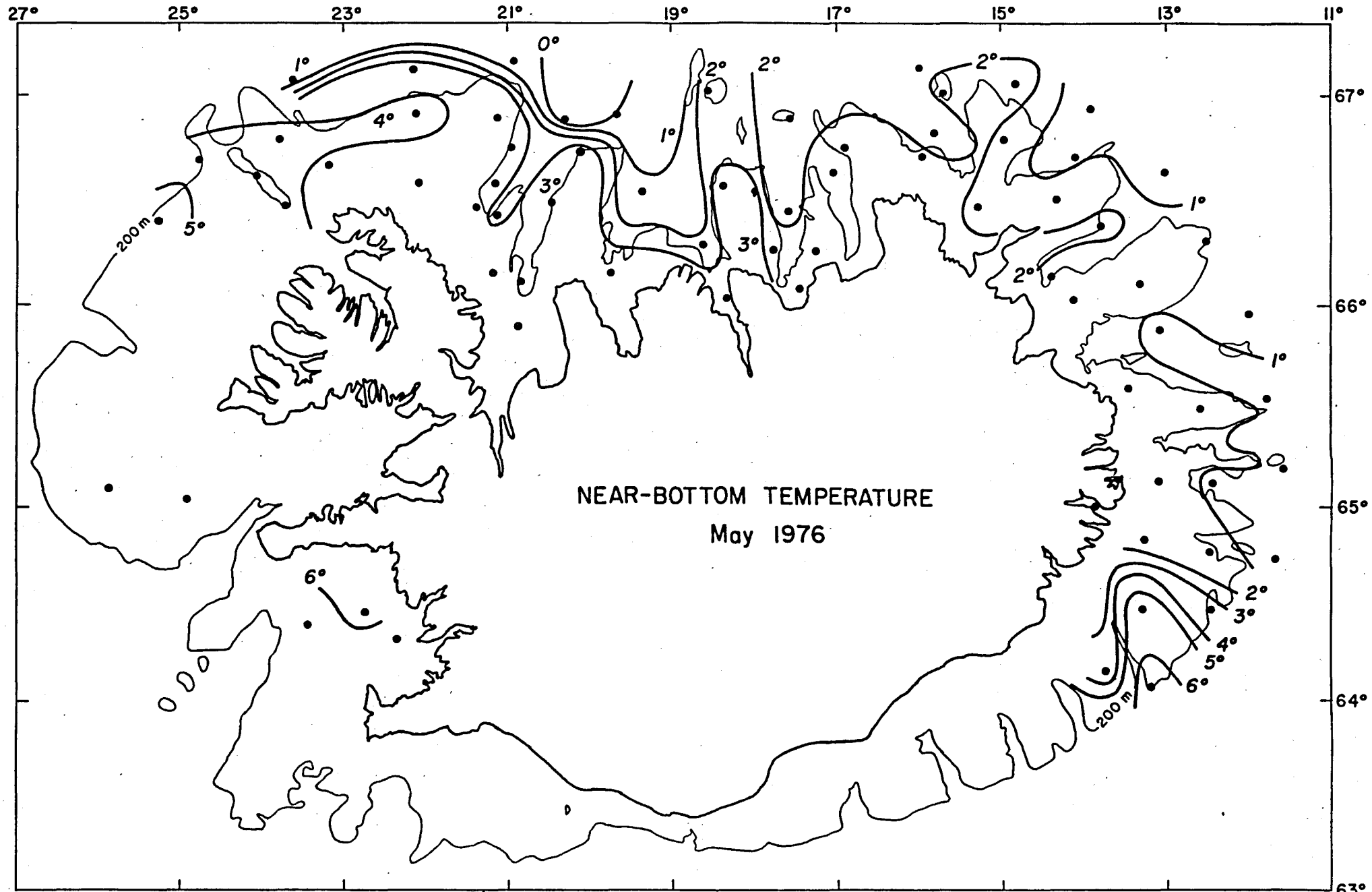

Fig. 4. Near-bottom temperature in May 1976.

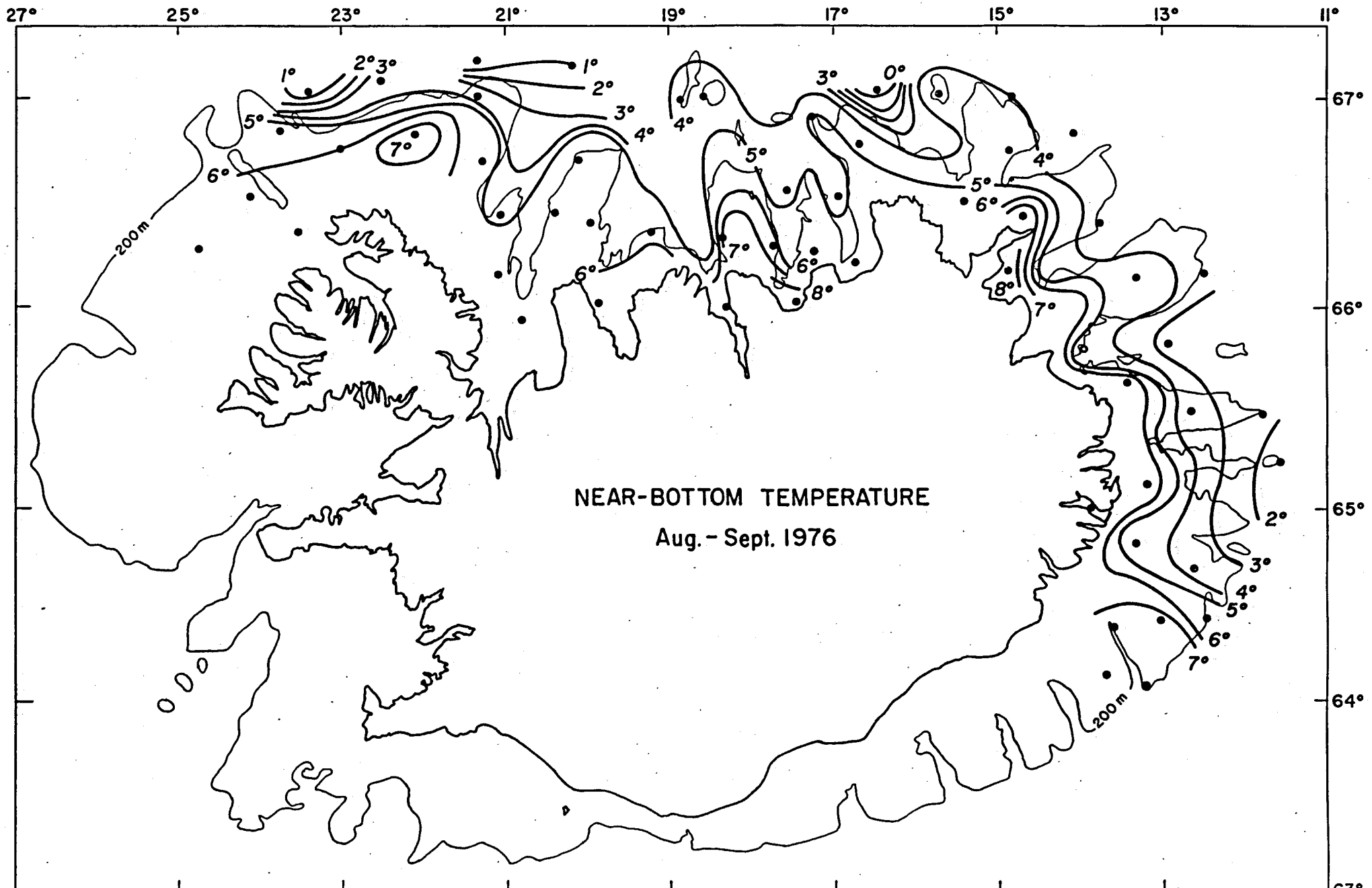

Fig. 5. Near-bottom temperature in August-September 1976.

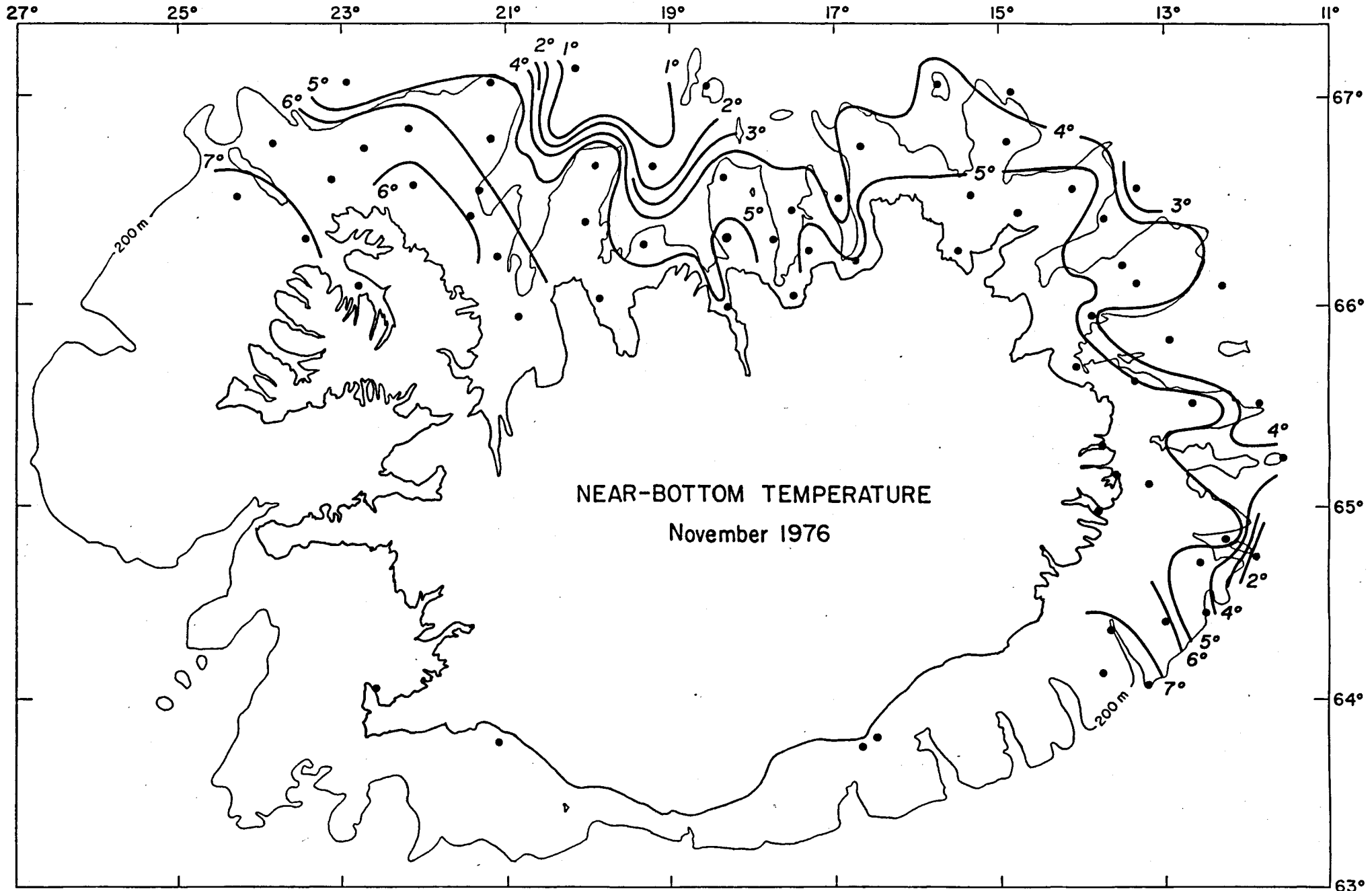

Fig. 6. Near-bottom temperature in November 1976.

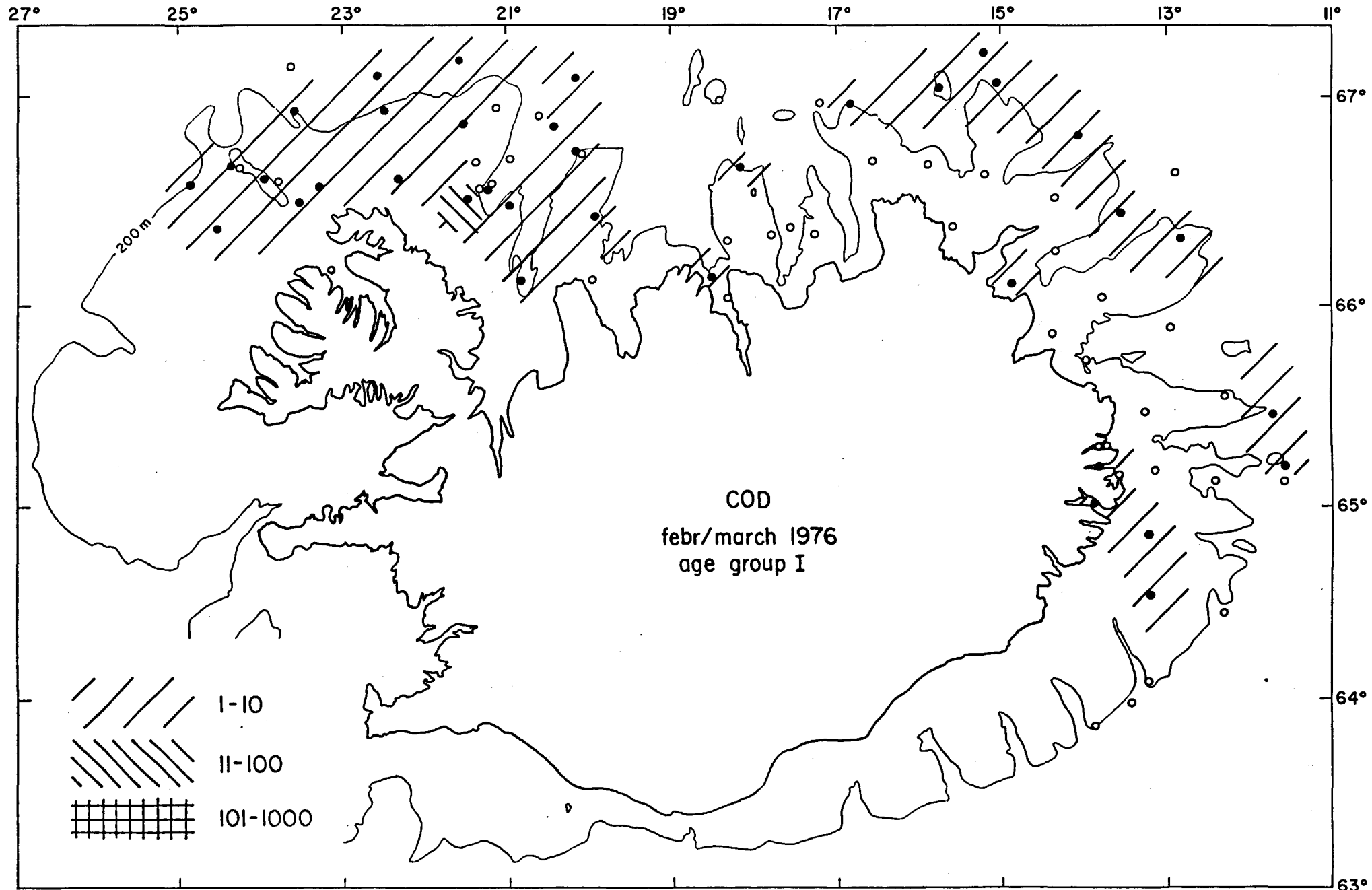

Fig. 7. Abundance of juvenile cod - group I - in February 1976.

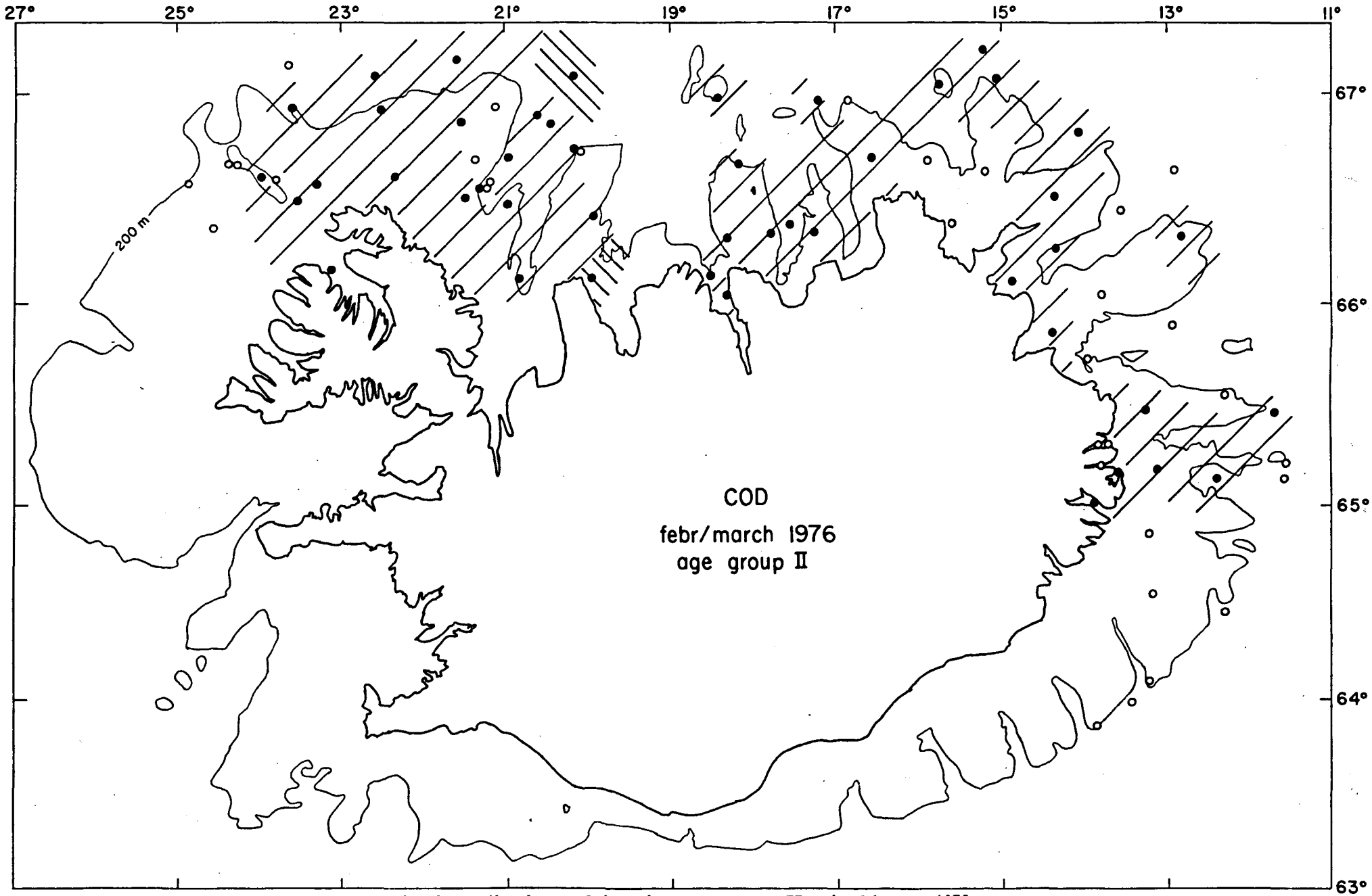

Fig. 3. Abundance of juvenile cod - group II - in February 1976.

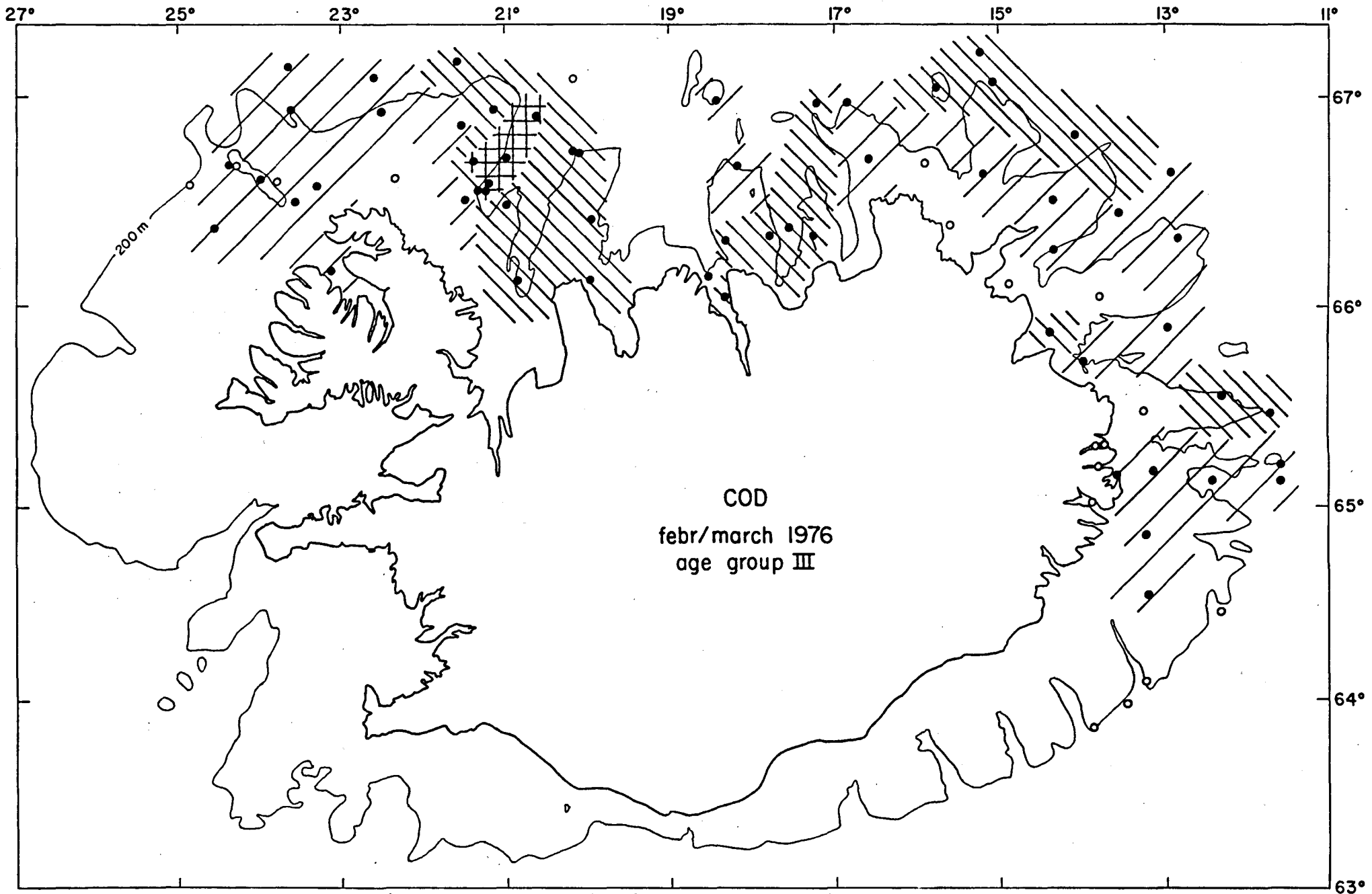

Fig. 9. Abundance of juvenile cod - group III - in February 1976.

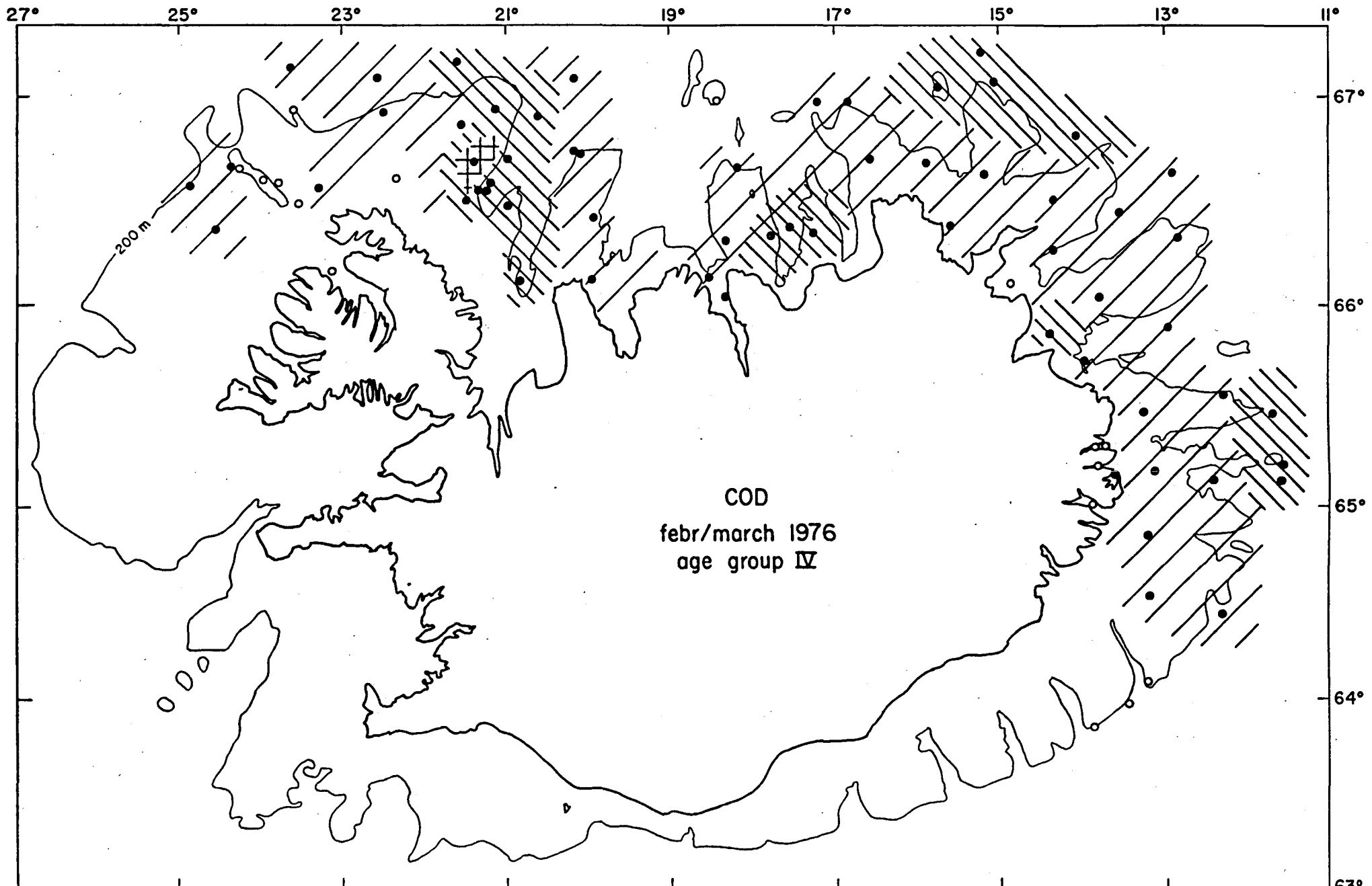

Fig. 10. Abundance of juvenile cod - group IV - in February 1976.

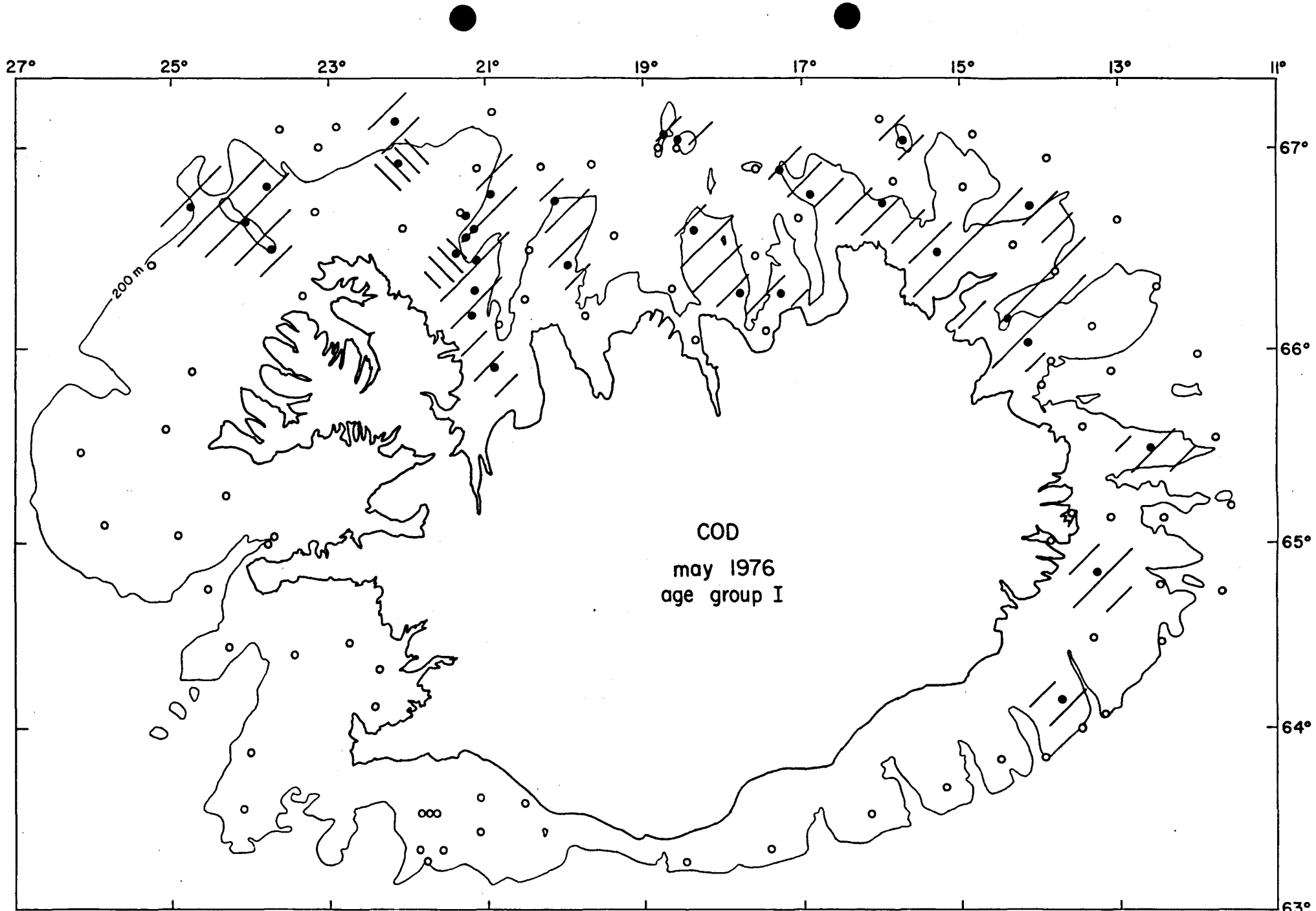

Fig. 11. Abundance of juvenile cod - group I - in May 1976.

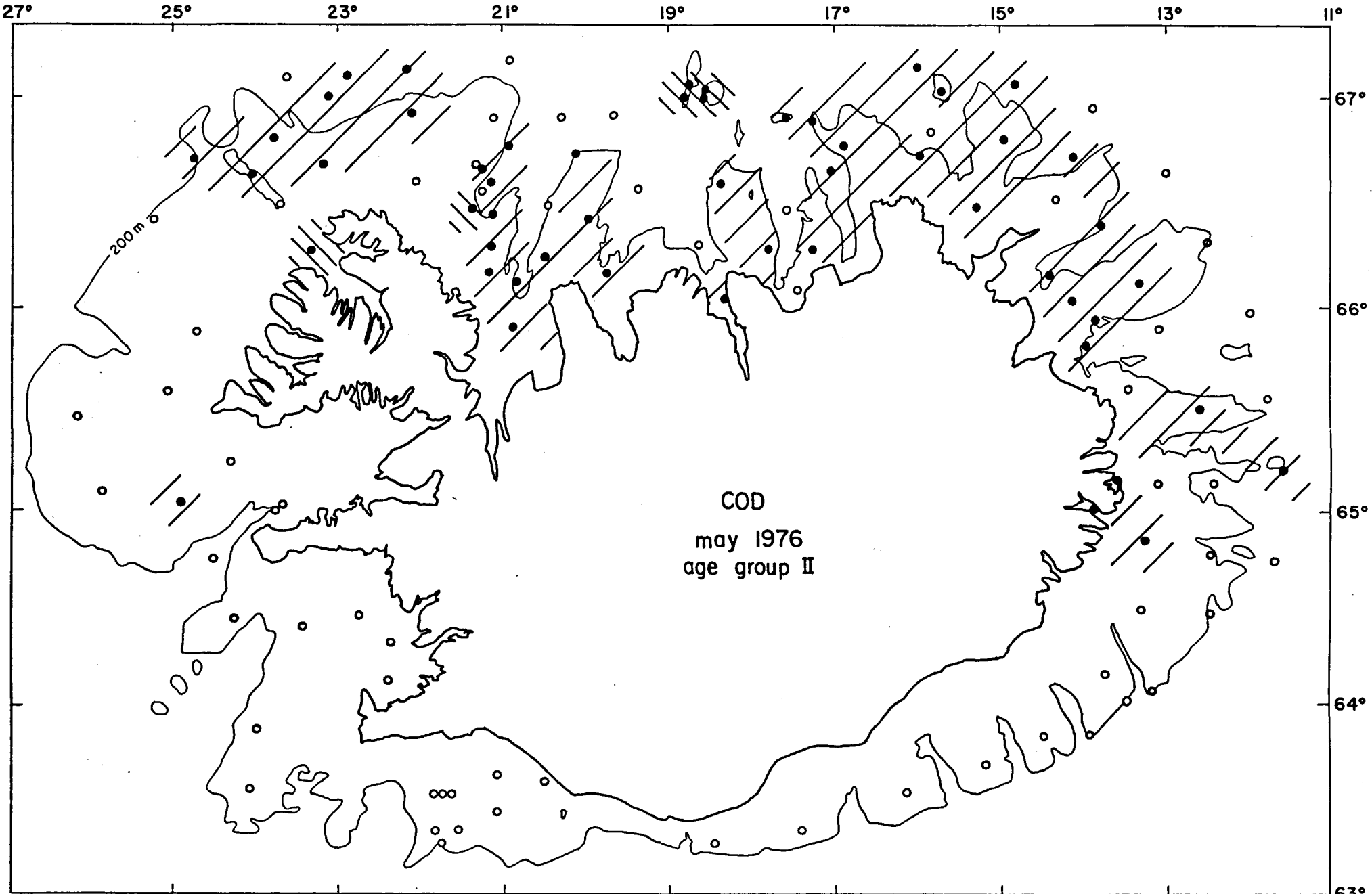

Fig. 12. Abundance of juvenile cod - group II - in May 1976.

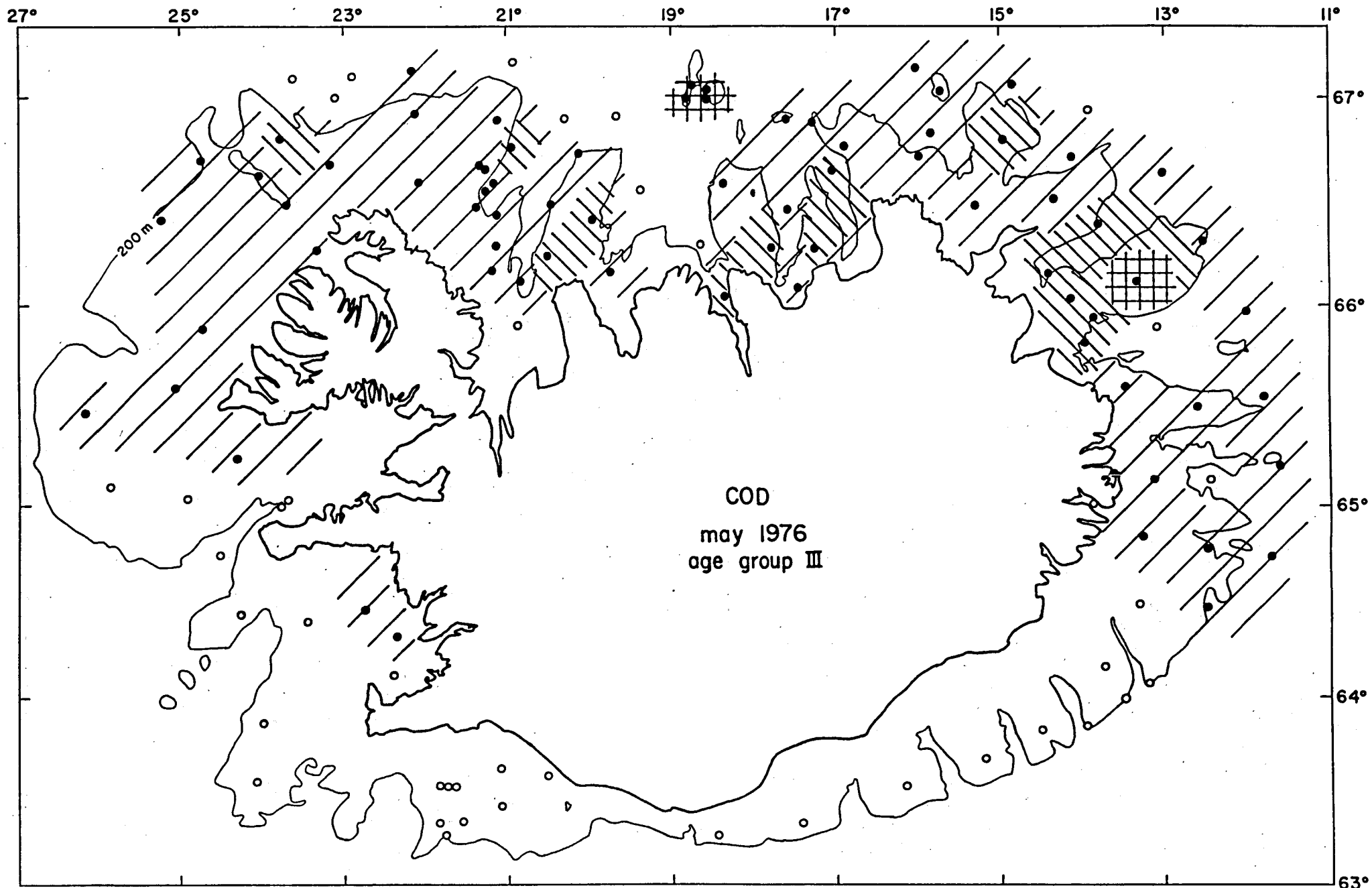

Fig. 13. Abundance of juvenile cod - group III - in May 1976.

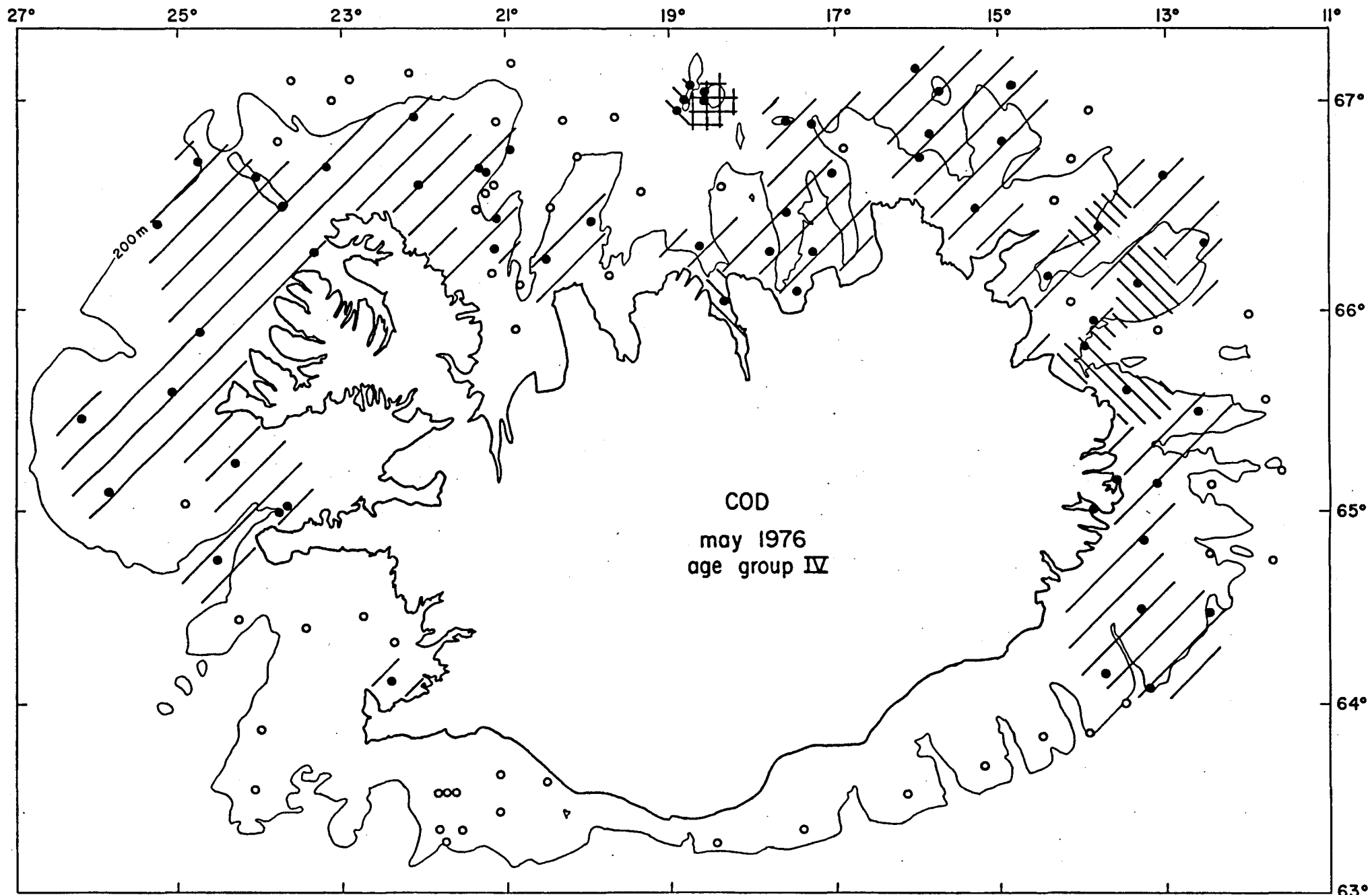

Fig. 14. Abundance of juvenile cod - group IV - in May 1976.

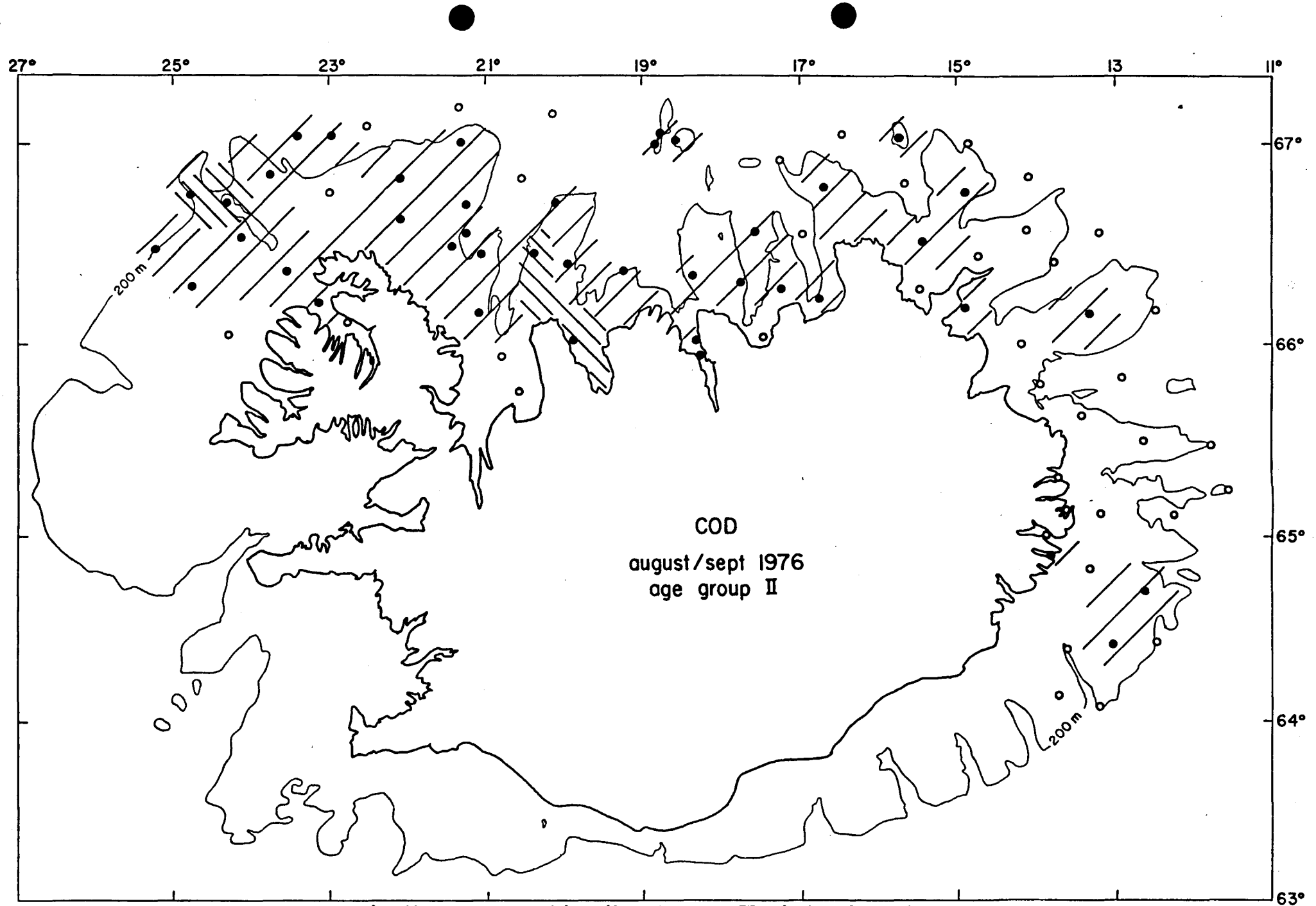

Fig. 16. Abundance of juvenile cod - group II - in Aug.-Sept. 1976.

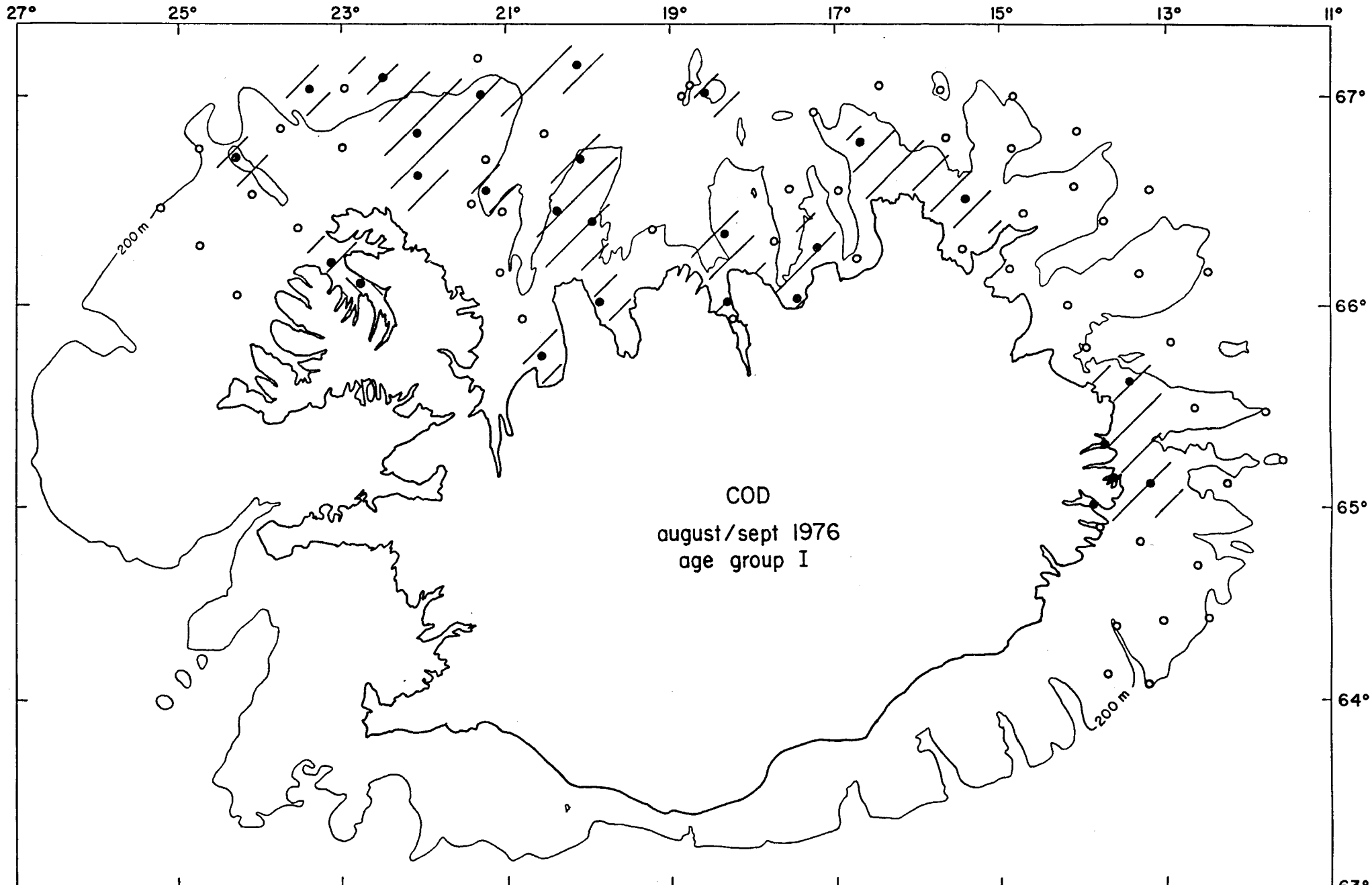

Fig. 15. Abundance of juvenile cod - group I - in Aug.-Sept. 1976.

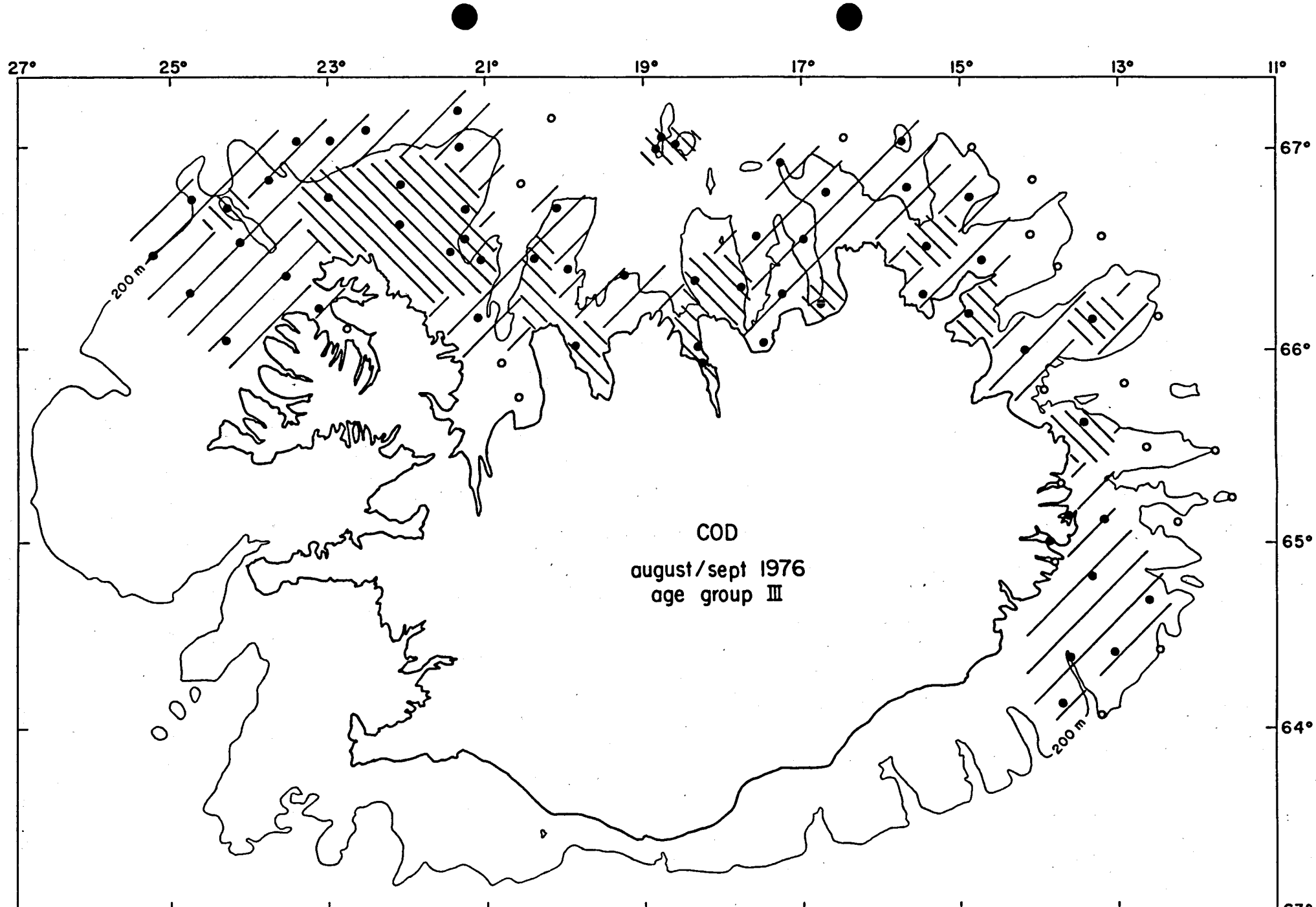

Fig. 17. Abundance of juvenile cod - group III - in Aug.-Sept. 1976.

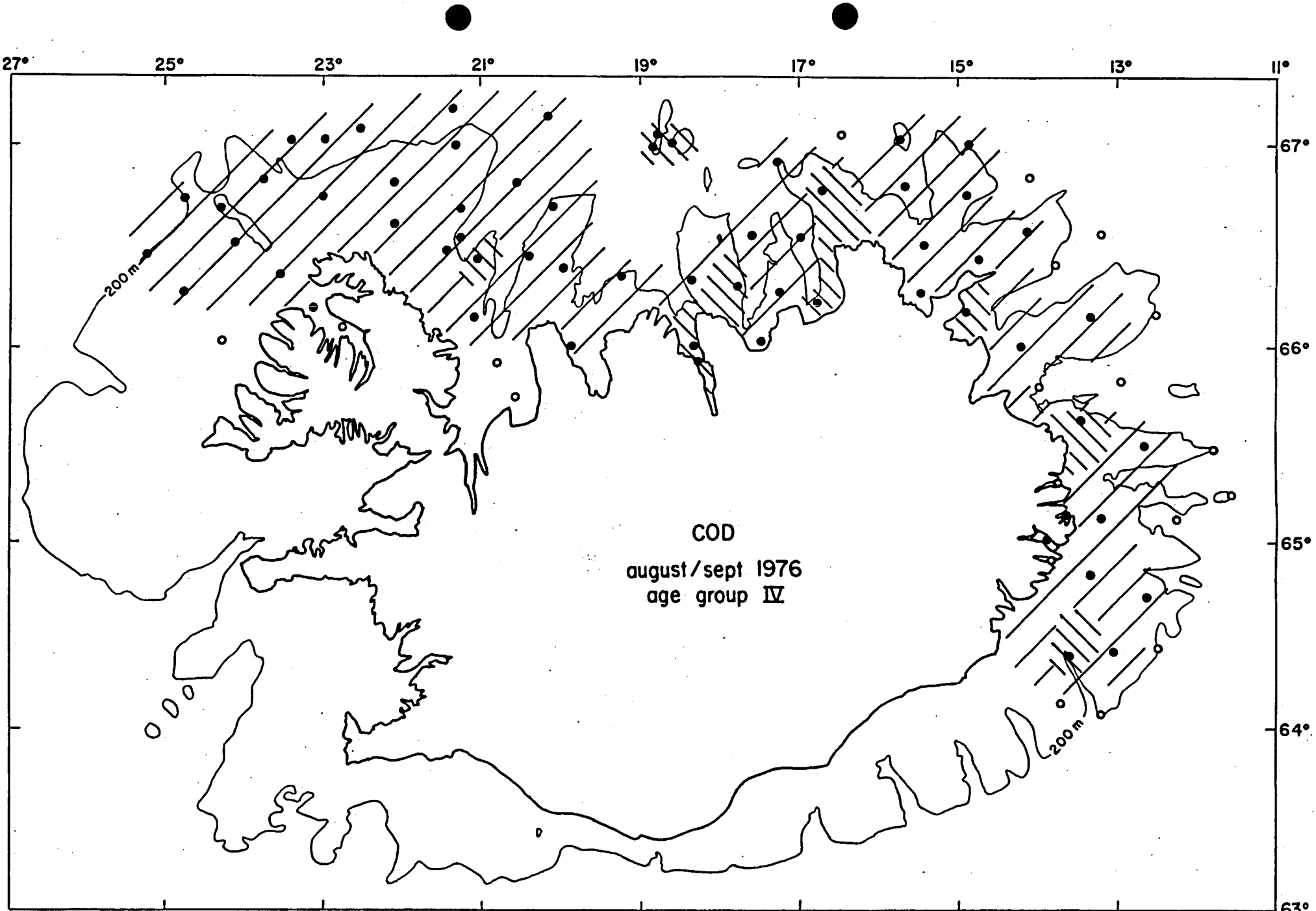

Fig. 18. Abundance of juvenile cod - group IV - in Aug.-Sept. 1976.

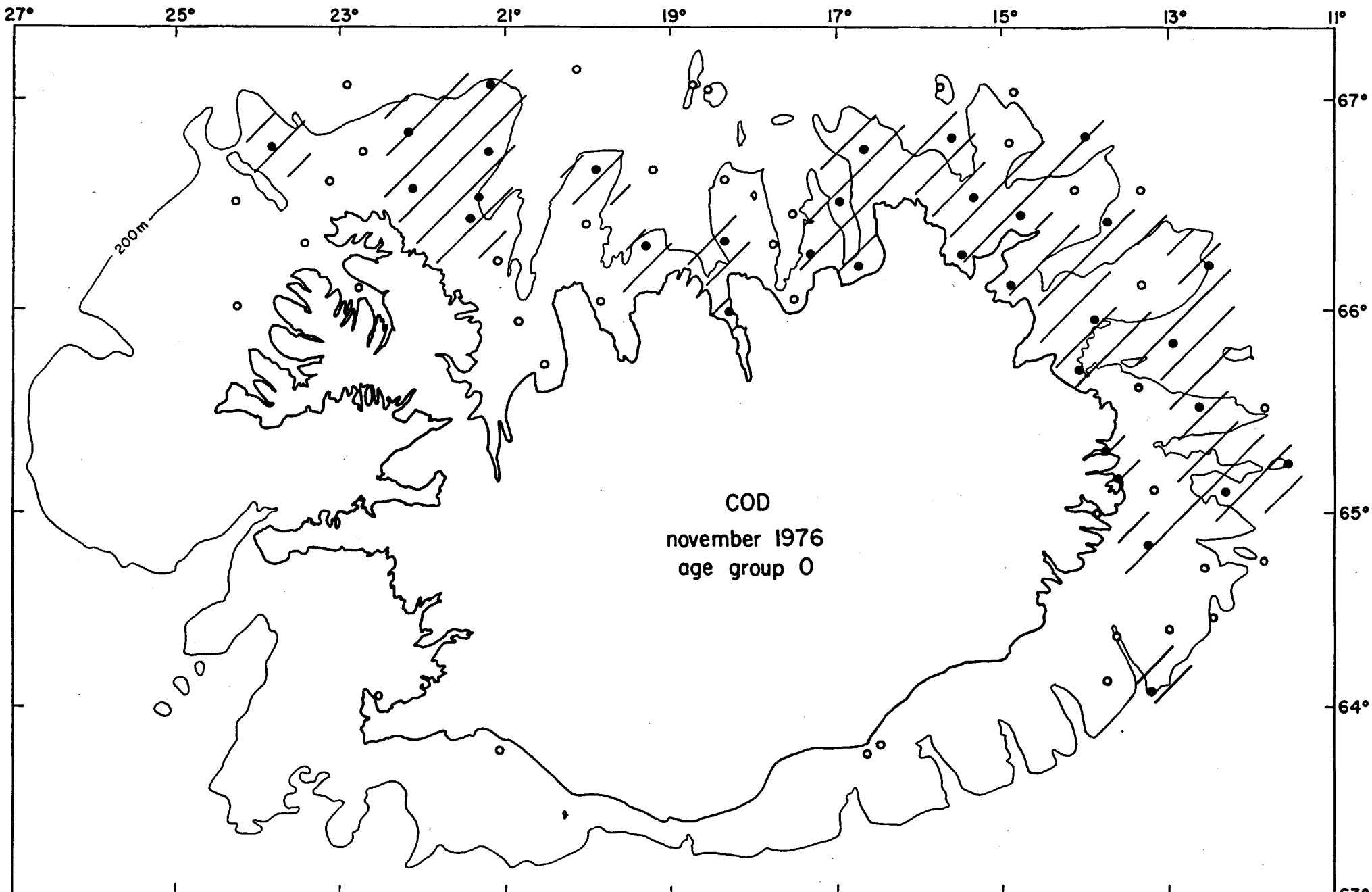

Fig. 19. Abundance of juvenile cod - group 0 - in November 1976.

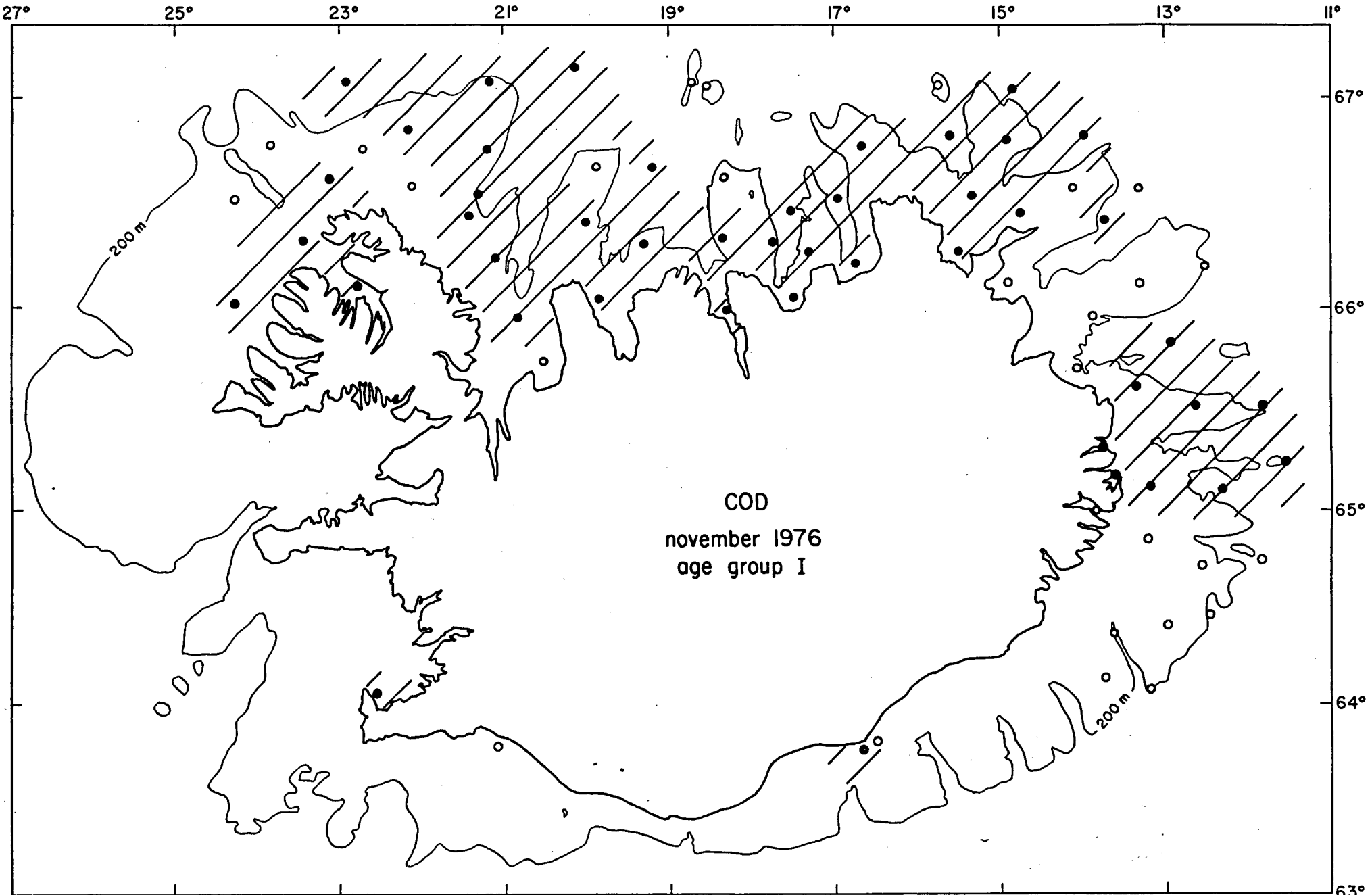

Fig. 20. Abundance of juvenile cod - group I - in November 1976.

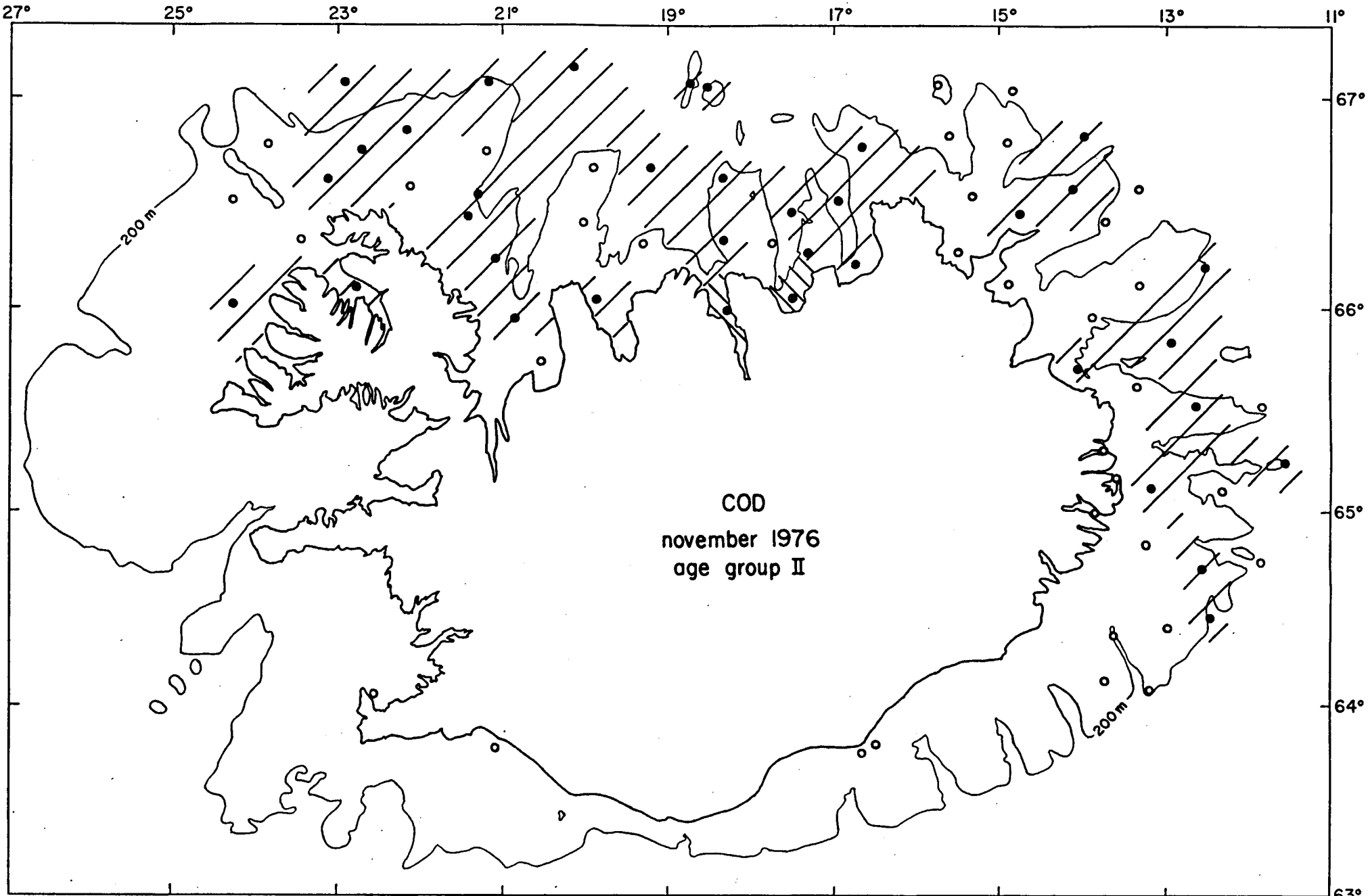

Fig. 21. Abundance of juvenile cod - group II - in November 1976.

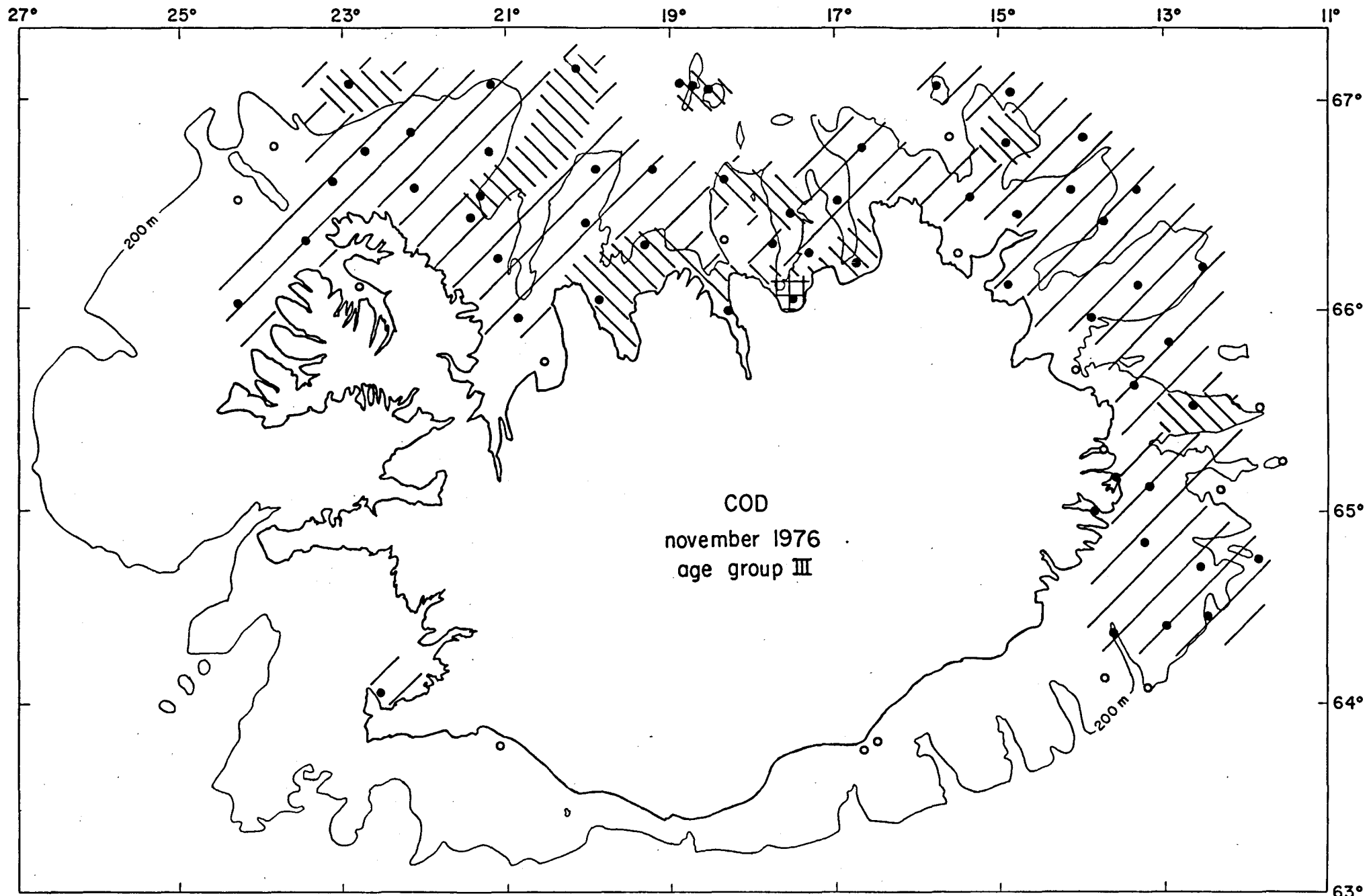

Fig. 22. Abundance of juvenile cod - group III - in November 1976.

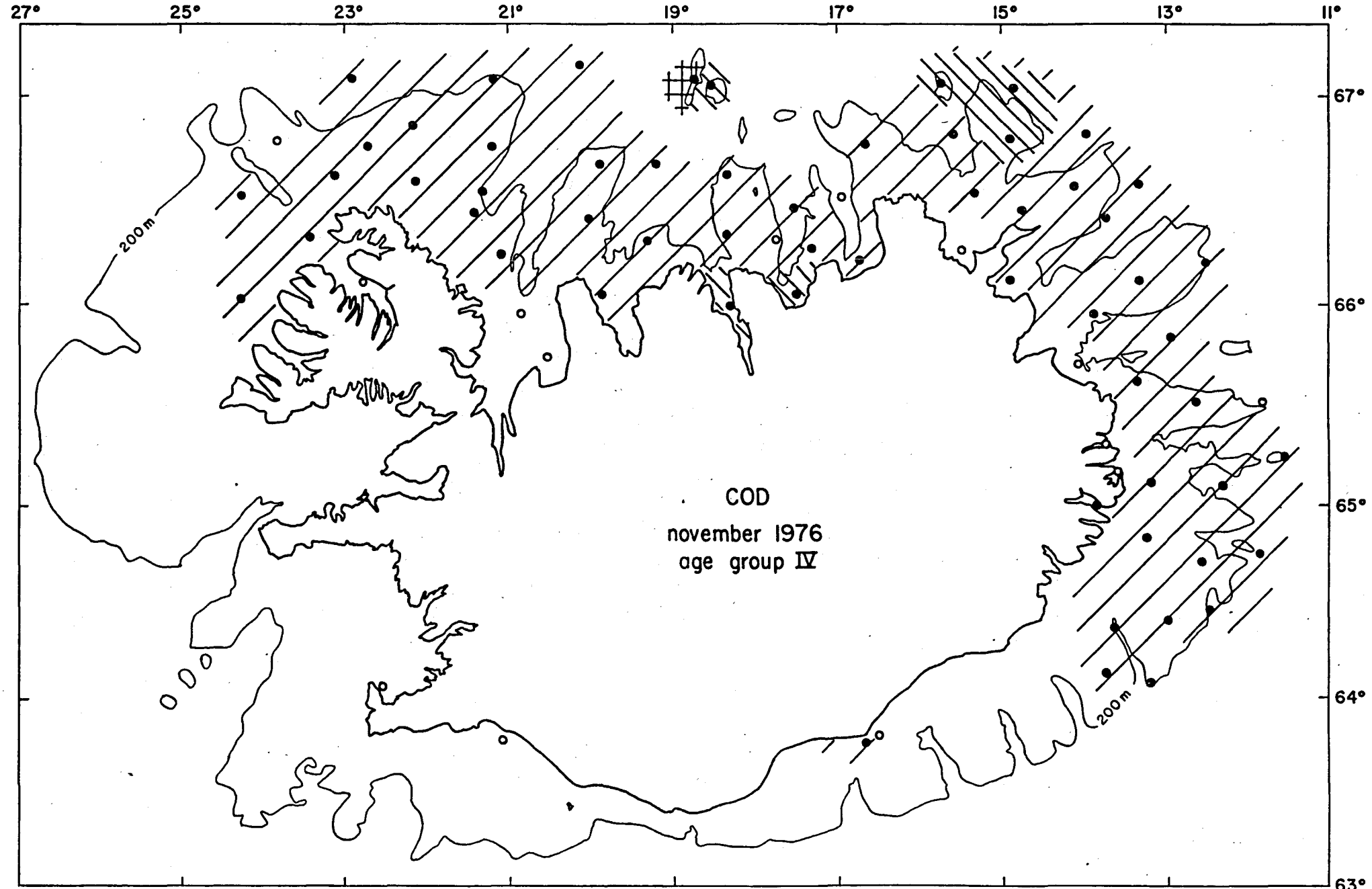

Fig. 23. Abundance of juvenile cod - group IV - in November 1976.

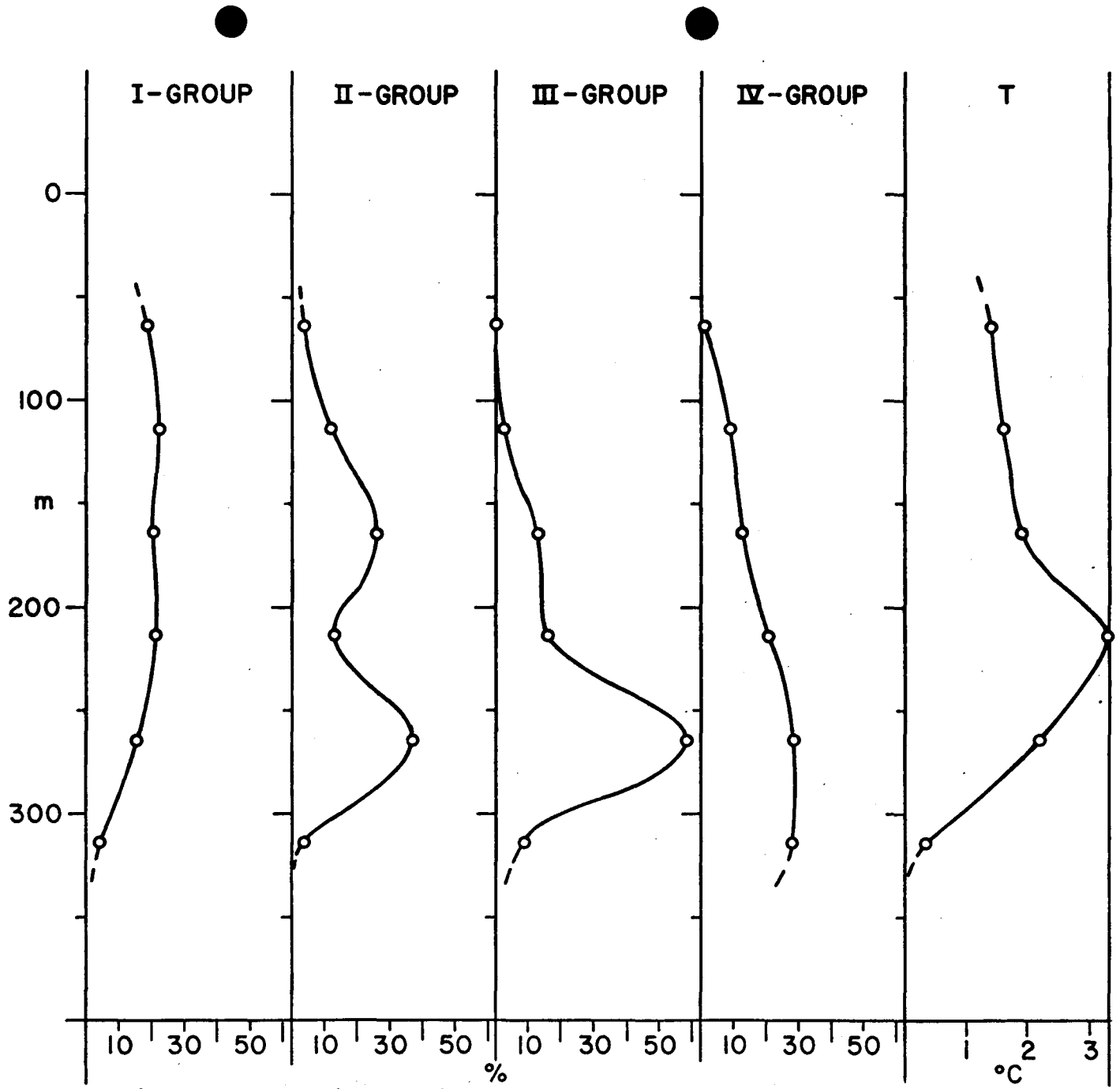

Fig. 24. Relative vertical distribution of juvenile cod and near-bottom temperature in February 1976.

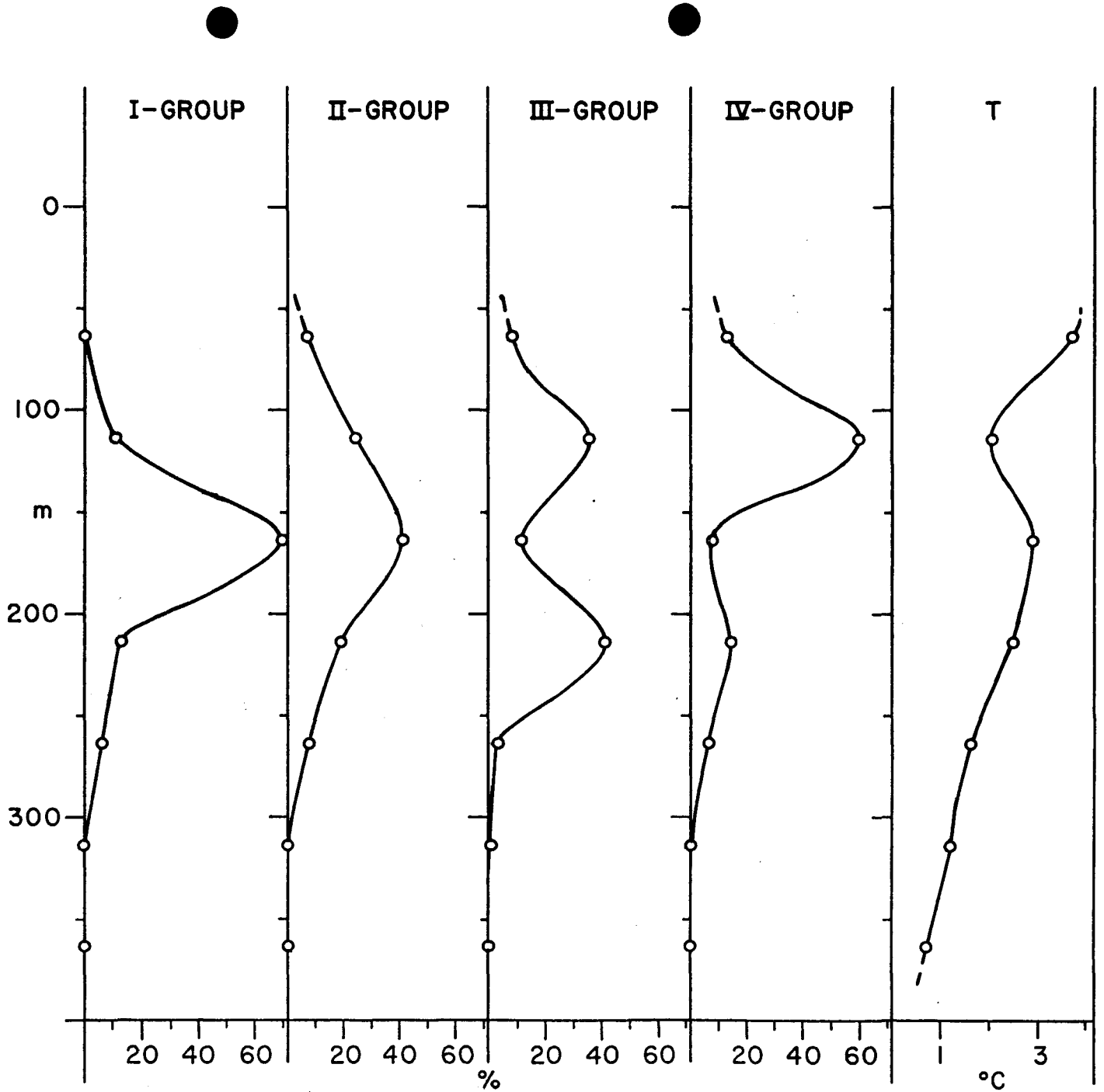

Fig. 25. Relative vertical distribution of juvenile cod and near-bottom temperature in May 1976.

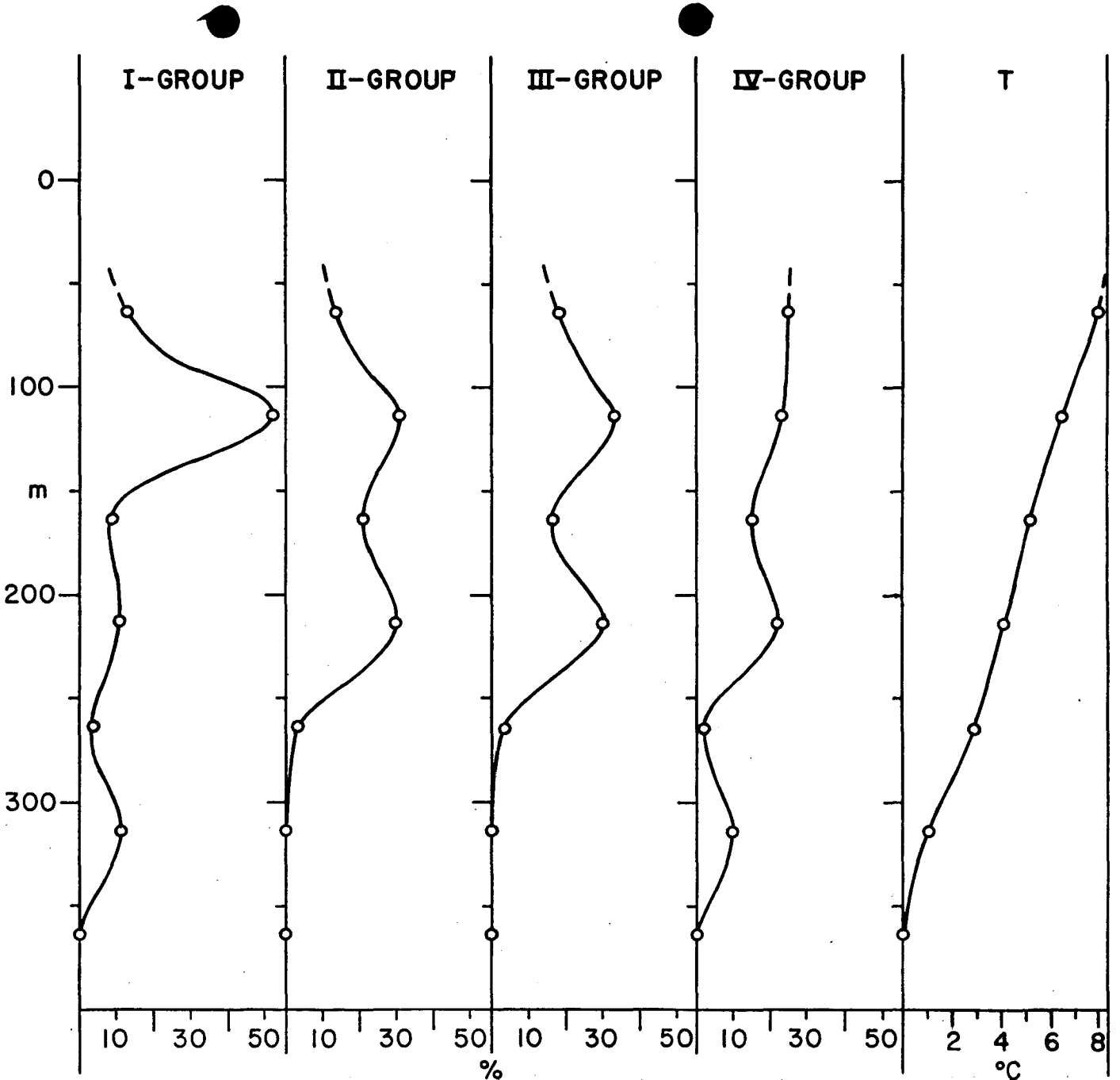

Fig. 26. Relative vertical distribution of juvenile cod and near-bottom temperature in Aug.-Sept. 1976.

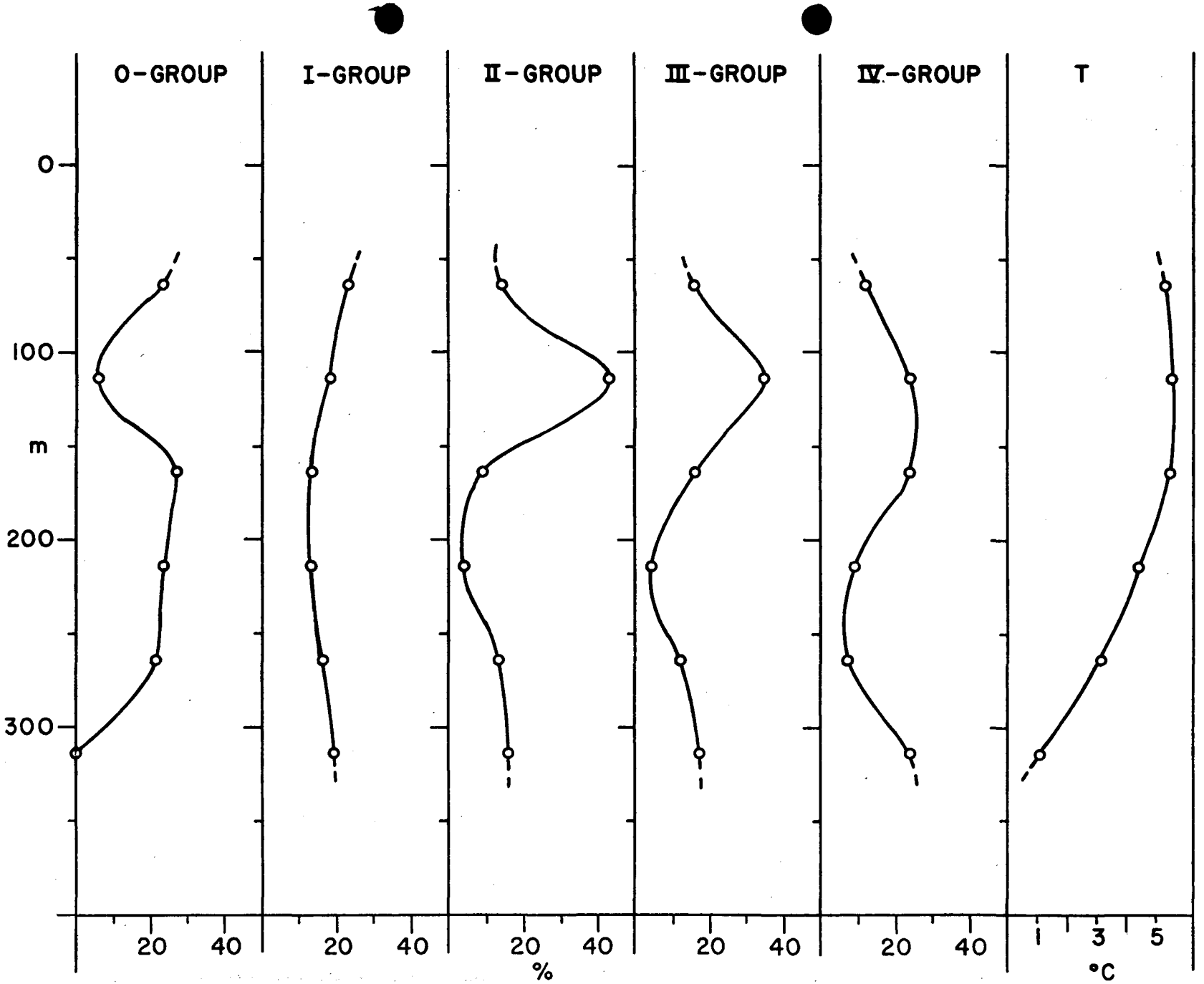

Fig. 27. Relative vertical distribution of juvenile cod and near-bottom temperature in November 1976.