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REPORT OF THE BLUE WHITING PLANNING GROUP

Lowestoft, 12-16 March 1979

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1. Introduction

The Blue Whiting Planning Group met at the Fisheries Laboratory, Lowestoft during 12-16 March 1979. The terms of reference were set by the Council's resolution passed at its 66th Statutory Meeting (C. Res. 1978/2:31) to:

(a) collate and evaluate the results of the 1978 blue whiting surveys and co-ordinate the surveys for the remainder of 1979;

(b) discuss and standardise age determination techniques by means of an otolith reading exercise;

(c) standardise sampling methodology (including determination of maturity stages).

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It was again considered most unfortunate that some countries known to fish for blue whiting and to carry out survey work were not represented at the meeting. In particular it was noted that there was no representative from the USSR despite the fact that the USSR has taken the highest national blue whiting catches in 1977 and 1978. It was agreed that the Chairman should once again contact the Laboratories concerned and urge them to participate in the ICES effort to co-ordinate blue whiting research.

2. Review of the 1978 surveys

The Group reviewed the "Summary Report on the ICES Co-ordinated Blue Whiting Surveys during the First Half of 1978" (J Jakobsson, ICES C.M. 1978/H:65) and supplemented it with new information submitted to the ICES annual meeting 1978 and to the March 1979 Blue Whiting Planning Group meeting. In the following, an augmented version of the above report is presented.

2.1 January-February

The main objective of these surveys was to monitor the southward migration of blue whiting towards the spawning grounds. The surveys were carried out by vessels from the Faroes, the Federal Republic of Germany, the Netherlands, Norway, Poland and Scotland. In January the main concentrations were to the northeast and north of the Faroes. Aggregations were noticeably less dense on the northeast slope of the Iceland-Faroe ridge, while blue whiting were not detected on the ridge and to the west (Schoene, 1978). In early February there were still considerable concentrations north of the Faroes (SCOTIA) although the highest densities had shifted to the southeast edge of the Faroe plateau and in the Faroe-Shetland channel. During February the Polish vessel AMAREL located dense concentrations further south on the northeastern edge of Porcupine Bank. At the same time juvenile blue whiting (15-20 cm) were located in the Norwegian Deeps by JOHAN HJORT.

The results of the echo-integrator survey carried out in early February indicated that between 3 and 6 million tons (target strength -34 dB per kg) of blue whiting were present in the Faroe-Shetland and west of Scotland areas (Walsh *et al*, 1978).

2.2 March-April

The main aim of these surveys was to study the abundance and distribution of blue whiting during the spawning season. Acting upon a request from the Planning Group CIROLANA and SCOTIA carried out echo abundance surveys in the main spawning area. The CIROLANA survey (Figure 1) was conducted from 2-9 April (Pawson *et al*, 1978) from west of Shetland (60°N) to a position west of Fastnet (51°30'N). Blue whiting occurred mainly at 400-500 m in the Rockall Channel but shoaled to 300-400 m over the Wyville-Thomson ridge and 250-300 m south of Porcupine Bank. An abrupt change in the mean length of fish in midwater trawl samples was observed at around 53°N, with smaller fish to the south. A spawning stock biomass of 12 million tons was estimated (target strength -31.3 dB per Kg), and there was a marked absence of high densities along the eastern side of the Rockall Channel. The SCOTIA survey (Figure 2) took place during the period 8-25 April (Walsh *et al*, 1978), and indicated an abundance of over 8 million tons (target strength -34 dB per Kg) in the northern part of the spawning area. The mean fish density estimates were similar to those obtained in 1977 and 1976.

As reported by Giedz (1978) the Polish vessel RYBAK MORSKI located high densities of blue whiting on the northeast part of the Porcupine Bank in April. During the period 29 March-15 April the Norwegian research vessel G. O. SARS carried out an echo survey off western Norway from Stadt to Lofoten. Blue whiting were observed as very thin, scattered registrations at the edge of the continental shelf.

During a redfish survey carried out on the Icelandic research vessel BJARNI SAEMUNDSSON, spawning blue whiting were located and caught in a bottom trawl south west of Reykjanes Iceland as reported by Magnusson (1978). According to these first observations on spawning blue whiting in this area the concentrations were very small.

2.3 May-June:

The main objective of these surveys was to monitor the northward post spawning migration of the blue whiting. Several countries participated in these surveys two of which were quantitative echo abundance surveys as reported by Jakupsstovu (1978) and Walsh *et al*, (1978), using a target strength of -34 dB per kg. Jakupsstovu found that in early May at least 2 million tons were migrating northwards in Faroese waters. The areas of high densities were mainly located at the south west edge of the Faroe plateau although considerable concentrations were also located at the south eastern side of the plateau and in the Faroe-Shetland Channel. The SCOTIA survey carried out in early June indicated that the blue whiting abundance in the Faroe area had decreased to about 1 million tons. This is in good agreement with observations made during Norwegian and Icelandic surveys that the migration had at that time reached higher latitudes than surveyed by the SCOTIA.

The results of a survey carried out 3-25 May by the German Democratic Republic ship EISBAR show that dense concentrations of blue whiting were recorded east of Faroes and a catch rate of about 9 tons per fishing hour (t/h) was obtained. During a survey 1-31 May the Polish vessel RYBAK MORSKI observed dense concentrations of blue whiting with catch rates of 5-30 t/h in the area between Rosemary Bank and the edge of the continental shelf west northwest of the northern Hebrides (Giedz, 1978).

Although these is ample evidence from the co-ordinated surveys that large concentrations of post spawning blue whiting migrated north eastwards through the Faroe-Shetland Channel, the Faroese abundance estimates (Jakupsstovu, 1978) as well as the location of the commercial fishery in May, indicate that the densest concentrations migrated northwards on the western side of the Faroes. It should be noted that scattered blue whiting were reported over wide areas in the Norwegian Sea (up to 69°N) in late May (Anon, 1978) while the main northward migration was still at Faroes. Even earlier than this the results of an acoustic survey carried out on the Norwegian research vessel G. O. SARS from 17 April to 11 May show that in this period some blue whiting concentrations were located 40-90 n.m. SSW of Bear Isle.

In early June the results of both Icelandic and Norwegian surveys indicated that the blue whiting had dispersed as the migration left the northern edge of the Faroe plateau and continued northwards. It was possible, however, to distinguish the cores of two migrations, one at about 64°N between 10 and 11°W, the other between longitudes 6 and 8°W at latitude 64°N.

The results of a Norwegian survey carried out on the HAVDRON (29 May-29 June) showed that during late June scattered registrations of large blue whiting were in the polarfront area between Jan Mayen and Bear Isle. The blue whiting in this area were in very good condition, had large, fat livers, and were feeding on *Calanus*, Euphausids and small Squids.

It should be noted that blue whiting concentrations were located at the Dohrn Bank between Iceland and Greenland in late May and in early June 1978. These concentrations consisted mainly of immature fish.

2.4 July-August

The main objective of these surveys was to investigate the summer distribution of blue whiting in the feeding areas in the Norwegian Sea and in the waters between Faroe and Iceland. The surveys were carried out by France, German Democratic Republic, Norwegian and Polish research vessels.

The area between northern Norway, Jan Mayen and Spitzbergen was covered by 4 Norwegian surveys in that period. Scattered blue whiting were observed in the entire area and dense concentrations suitable for industrial fishing were not located. However, higher densities were located at the eastern edge of the Polar Fronts in the Jan Mayen-Spitzbergen area at a depth of between 30 and 50 m. Further east, blue whiting were scattered between 100 and 400 m.

The Polish survey covered the central Norwegian Sea and the south-east and east of Jan Mayen. Fairly dense concentrations were recorded between 30 and 50 m in these latter areas. About 90% of the fish had full or partly filled stomachs.

The surveys of the German Democratic Republic covered the Norwegian Sea, Spitzbergen and Bear Island areas and the Norwegian Deep. Dense concentrations of blue whiting were located in the central part of the Norwegian Sea around 67°N and 6°W. Scattered blue whiting and occasional shoals were recorded in other parts of the survey. In the Norwegian Sea, blue whiting were mainly observed at depths between 30 and 130 m. Distinct diurnal migration was observed south of 65°N but not north of 68°30'N.

The French survey covered areas to the north of the Faroe Islands and east of Iceland. Most dense concentrations were found over grounds 40 to 60 n. miles east of Iceland.

Immature blue whiting were only observed in Rosengarten (south-east of Iceland) and in the Norwegian Deep. In all other areas, only adult fish (> 25 cm) were observed.

2.5 September-October

As for the former period, two Norwegian surveys covered the area between Jan Mayen and Spitzbergen. Scattered blue whiting were observed over most of the area but no dense concentrations were located.

A survey by the Federal Republic of Germany was carried out over a wide area including the Shetland, Faroe, Denmark Strait, Jan Mayen and Spitzbergen areas. The densest concentrations were found south east of Iceland (64°10'N 8°30'W). In all other areas mainly scattered blue whiting were recorded between 60 and 350 m depth, in temperatures of 2 to 5°C; in the latter half of the period they were mainly located in the deeper range (300 m). In the Spitzbergen-Bear Island area large (30-40 cm) females predominated, as they did (up to 45 cm) in bottom trawl catche north east of the Faroes at a depth of 500 m. Juvenile blue whiting were caught in shallower water by bottom trawl north-east of Faroe and on the Shetland shelf.

2.6 November-December

A Norwegian survey covered the Norwegian Deep and the western part of the Skagerrak. Juvenile blue whiting (15.5 to 22 cm) were observed in most of the area but the densest concentrations were located off Bergen.

A Federal Republic of Germany survey covered the same area as in the previous period. The densest concentrations were observed between south-east Iceland and north of Faroe. Only very scattered blue whiting were recorded in the Spitzbergen area, indicating a southward migration.

2.7 DISCUSSION AND CONCLUSIONS

The increase in research effort on blue whiting anticipated at the 65th Statutory Meeting was evident during 1978, particularly in the large number of exploratory fishing and acoustic surveys in the first five months, and in the surveys of the feeding areas until October. Unfortunately the autumn movements of prespawning fish and the occurrence of residual populations in the winter were less extensively investigated.

The early 1978 surveys revealed a southward movement of prespawning blue whiting to the east of the Faroes. During a Federal Republic of Germany survey in February 1979 this southward migration was confirmed and fish were also located to the west of Faroes. Although the southward migrating fish were not as easily caught as those in the post-spawning concentrations, their high quality suggests that a fishery for human consumption may be more feasible than an extension of the developing industrial fishery, at this time. The occurrence of aggregations of ripe blue whiting near Porcupine Bank in February 1978 (Giedz, 1978), well in advance of the main pre-spawning migration, was reported again in 1979 during a Federal Republic of Germany survey. In addition to the usual acoustic abundance surveys carried out in the main spawning area in March and April, it is of interest to note that two such surveys of the post-spawning migration were also completed.

In June and July blue whiting were dispersed throughout the Norwegian Sea, usually in the upper 100 m, with higher concentrations beginning to aggregate along the Polar Front. These fish were feeding and in good condition, but were usually insufficiently dense to support industrial fishing. This situation persisted until October, when the southward migration probably started, often at greater depths.

Daily co-ordination of participating vessels at sea was not at as high a level as the Planning Group had desired, but where this had been possible it had been very valuable. The overall distribution of adult blue whiting was well covered in 1978, although the relationship of fish found to the south of Porcupine Bank, West of Iceland and at Spitzbergen and Bear Island to the main NE Atlantic spawning population, remains unsolved. Despite the large research effort the distribution of juvenile fish is still not well known, and emphasis must be placed on this aspect in the future.

3. Exploratory fishing:

3.1 January to June 1978 (Jakobsson, 1978)

3.1.1 Faroes: The Faroese fishing experiments during February were carried out using two ships, POLARFISK, a 1000 h.p. sterntrawler and LEIVUR OSSURARSON, a 1500 h.p. sidetrawler, while in March only the POLARFISK participated. The fishery was confined to the area near the Faroese shelf edge and the Wyville-Thomson Ridge. Due to diurnal vertical migration of the blue whiting, the scouting and the fishery experiments were only conducted during daylight.

The experimental fishery in the spawning area west of the British Isles in the second half of March failed due to adverse weather conditions.

At the beginning of February quite reasonable catches (1.5 t/h) were taken near Fugloyarbank east north east of the Faroes. A few days later some catches (up to 7 t/h) were taken on the Wyville-Thomson Ridge while most of the catches in late February were taken near the southeast edge of the Faroe plateau. In that area ($60^{o}20'N$, $6^{o}W$) catch rates of up to 25 tons per hour were obtained at the beginning of March, but in general catch rates were much lower, and far too low for successful industrial fishing. For a fishery for human consumption the catch rates were satisfactory.

3.1.2 German Democratic Republic: The experimental fishing of the GDR research vessel EISBAR was carried out in May. The best catches were taken east of the Faroes where 15 hauls yielded catch rates between 6.5-10.9 t/h. Further northeast (65°N, 0-2°W) the catches were less than 1 t/h.

3.1.3 Netherlands: The experimental fishing by Dutch vessels took place in January-March, when 6 ships participated, each with engine power ranging from 2000-2700 h.p. The main purpose was to catch blue whiting for human consumption and the catches were deepfrozen in boxes of 25 kg. When the maximum freezing capacity of 30-50 tons per day was reached, the fishery was terminated for the remainder of that day.

No catches were obtained in January in the Hebrides-West of Ireland area, but some catches (mainly small fish) were taken in the Bay of Biscay (45°40'N, 3°30'W). In late February the highest catch rates of 8.8 t/h were obtained between the south east edge of the Faroe plateau and the Wyville-Thomson Ridge. On 13-14 March good catches of 7.4 t/h were still being taken in that area, whilst catch rates northwest of St Kilda were considerably lower. Good catches were also taken northwest of Black Rock (54°39'N, 11°W) in late March, towards the end of the experimental fishing.

3.1.4 Poland: The Polish exploratory fishing was carried out from 13 January to 4 March and again from 4 April to 17 June, when two factory trawlers were used (Giedz, 1978). During the first period a mean catch rate of 2.6 t/h was obtained which fell to 2.1 t/h during the second period. It is of interest that in the period January-March the Polish experiments took place in the area west of Ireland and on the Porcupine Bank, i.e. much farther south than the Faroese and the Dutch experiments.

3.2 Exploratory fishing: July to December 1978 (see Table 1, and Figure 3)

3.2.1 July-August: Exploratory fishing was carried out in east Iceland by Faroese, French and Icelandic vessels. High catch rates (up to 40 t/hour) were recorded by Faroese and Icelandic vessels which had about 2500 bhp and were using large meshed pelagic trawls. The French catches did not exceed 4.5 t/h with a more conventional trawl corresponding to a power of 800 bhp.

Other exploratory fishing was carried out by a Polish vessel mainly east and south-east of Jan Mayen where the average catch ranged from 0.5 to 2 t/h and German Democratic Republic pair trawling in the same area yielded about 2 t/h/vessel. Catches made by German Democratic Republic research vessels with a rope trawl reached about 3 t/h in the Norwegian Deep when fishing for juvenile blue whiting (22 to 24 cm).

Catches up to 1.5 t/h were taken by a Norwegian Research vessel when towing in scattered layers just above the thermocline in the Jan Mayen-Spitzbergen Polar Front area.

3.2.2 September-October: Catches up to 4 t/h were obtained by a Faroese side trawler (1500 bhp) when fishing on disperse concentrations between Faroe and Iceland.

A chartered trawler (3200 bhp) of the Federal Republic of Germany made catches up to 7 t/h off south east Iceland with an "Atlas" rope trawl. In the Spitzbergen area and east of Jan Mayen the catches ranged around 3 t/h. Bottom trawling north of Faroe yielded catches of between 1 to 5 t/h, whereas on Dohrn Bank the catches did not exceed 1 t/h.

In early September, east of Jan Mayen, Polish catches were about 1.5 t/h.

3.2.3 November-December: Catches made by the Federal Republic of Germany trawler ranged between 1 to 5 t/h east of Iceland. In all other areas, catch rates were much lower.

3.3 Gear Technology

Different gears have been used or tested by either commercial or research vessels, including both bottom and pelagic trawls. In recent years there has been a trend to design pelagic trawls with ropes or very big meshes in their foreparts. This has made it possible for less powerful vessels to fish successfully on scattered blue whiting, (although good catches have been taken with a capelin type trawl). For example, a Faroese trawler (1500 bhp) using such a pelagic trawl designed in France with meshes of up to 16 m, obtained catches up to 4 t/h in experimental fishing.

4. Blue whiting catches

The total international blue whiting catches for 1977 and the preliminary figures for 1978 are given in Tables 2 & 3 according to ICES areas and countries.

In 1977 the total international catch was 257 000 tons. Of these approximately 60 000 tons were taken in Faroese waters during the northward post spawning migration in spring. The catches on the spawning grounds west of the British Isles (VIa&b) were approximately 47 000 tons whereas around 61 000 tons were taken during a summer fishery in sub-areas IIa and Vb.

In 1978 the preliminary figures show that the total international catches more than doubled (548 000) as compared with 1977. The post spawning fishery at Faroes increased to 135 000 tons while the catches on the spawning grounds VIa&b were 71 000 tons. Perhaps the most spectacular increase took place in the summer and autumn fishery in sub-areas IIa and Vb where some 200 000 tons were taken (preliminary figures) as compared with about 61 000 tons in 1977. In both years the major part of the catches in these areas was taken by USSR vessels. There were also sharp increases in some other areas, e.g. at Iceland Va and in the Northern North Sea IVa.

5. Historical reviews and additional biological findings

5.1 Historical reviews

In compliance with the recommendation of the Blue Whiting Planning Group during its first meeting (November 1977), several reviews of historical data were presented in October 1978.

Coombs and Pipe (1978) described the distribution and abundance of blue whiting eggs and larvae along the edge of the continental shelf between the Bay of Biscay and the Faroes during the period 1948-1977. In the spawning area numbers of larvae at 10 m depth increased from 1948 to the mid-1960s and declined to the early 1970s, after which there was a recovery. Numbers of larvae showed a general decrease around the Faroes while concurrently increasing in the south. Larvae were taken from January to June, yolk-sac larvae being most common between 300 and 400 m while older larvae were found above 100 m.

Magnusson (1978) reviewed the distribution of blue whiting in the Irminger Sea on the basis of scouting cruises with bottom trawls conducted mainly from May to September during the years 1955 to 1964. Blue whiting were observed from southeast Iceland along the south, southwest and west coasts of Iceland,

and off East Greenland. Similar results were described by Sahrhage (1978) from research vessel data. His data, subdivided into the periods 1955-1959, 1960-1969 and 1970-78, and covering the waters between the Bay of Biscay, East Greenland and Spitzbergen, were in accord with present ideas concerning the overall distribution of blue whiting in the northeast Atlantic. The same paper provided a description of the development of the German Federal Republic blue whiting fishery for human consumption, and a similar account of the Spanish trawl fishery was given by Robles and Porteiro (1978). Catches in this fishery contain mainly small blue whiting of age-groups I-III, with highest yields in April/May and October/November. Length-weight and selectivity data were also included. Bailey (1978) used the Scottish age composition data from the last 11 years to obtain an estimate for the total mortality coefficient.

5.2 Parasitology

Several papers were presented at the 1978 Annual ICES Meeting which dealt with the implications of the parasitic infestation of blue whiting, most emphasis being placed on the nematode *Anisakis*. A contribution by Gaevskaya (1978) described two main groups of blue whiting parasites; those having a direct development cycle and those associated with planktonic crustaceans in their development. Combined infection by nematodes, cestodes and monogeneans was common. Results published by Bussmann and Ehrich (1978) and Smith and Wootten (1978) on *Anisakis* infestation in fish from the Faroe-Shetland area and the waters to the north and west of Scotland indicated a general increase in infestation with length and age, with signs of a decline in the oldest fish. No correlation was observed between infestation rate and the biological condition of fish. However, while the German authors found a higher infestation rate in males, no sex-specific variation was observable from the Scottish data. Regarding geographical variation in infestation rate, it is noteworthy that Schultz *et al* (1978) recorded a level of infection in fish from Spitzbergen which was 2-3 times higher than that at Faroe. Similar conclusions were reached by Schultz (Working Paper 1979) and Schoene (Working Paper 1979), who contrasted data from the Bear Island/Spitzbergen area with that from the southern Norwegian Sea and Faroe.

From results obtained from Faroe and the west coast of Scotland, McKenzie (1978) described a higher rate of infestation by the protozoan liver parasite *Eimeria* in female blue whiting, and also found a correlation between condition factor and infestation rate. Infection was progressively greater with advancing age, no juveniles but all adults being parasitised.

5.3 Meristic differences

Also presented to the 1978 ICES annual meeting was a contribution by Andersen and Jakupsstovu (1978) demonstrating sexual dimorphism in blue whiting (the pelvic fins of males being longer than those of females) and describing morphological and meristic differences between samples of fish from the Norwegian Sea and the spawning area west of the British Isles.

6. Age determination

From an earlier otolith exchange programme reported to the 1978 Statutory Meeting it was clear that quite unacceptable variability occurred between the age determinations made by otolith readers from different countries. At this meeting, therefore, a preliminary comparison was made between the otolith readers present by arranging for them to read a series of 80 otoliths, both sectioned and broken. The results once again showed the tremendous variation between readers.

By discussion in front of video monitoring equipment, an attempt was made to explain these large differences, in the hope of reducing variability in future. There was general agreement that blue whiting otoliths are very difficult to read for the following reasons:

(a) there is considerable variation in the clarity of the first hyaline zone;

(b) this variation is so gradual that it is impossible to define criteria to decide which zone should be counted as the first one;

(c) in some otoliths, both small and large, there may be one to several very indistinct hyaline rings close to the nucleus which are difficult to interpret;

(d) divided rings are frequent.

Discrimination of the outer rings in large otoliths, however, did not appear to be a major source of discrepancies.

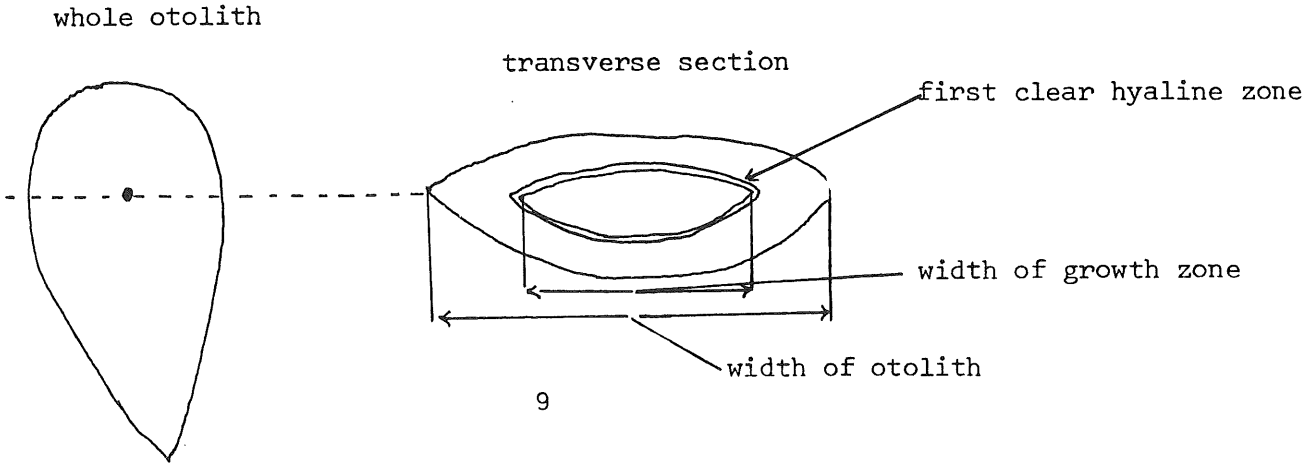
6.1 Otolith reading technique

The accuracy of age determinations did not appear to be primarily a function of the otolith reading technique since the variation was as wide in sectioned otoliths as it was in broken ones. Nevertheless, the group felt that it was important to remove all unnecessary sources of variation and therefore recommend that age determination should be carried out using otoliths sectioned through the nucleus, and to ensure uniformity of the examined surface and of the light intensity used to examine the otolith. An acceptable alternative, however, may be to cut the otolith smoothly through the nucleus with a diamond saw. Mr Schoene agreed to circulate information about this latter method to group members.

Smooth cutting or sectioning through the nucleus was recognised to be essential in those cases where measurements of otolith or zone diameters were to be made.

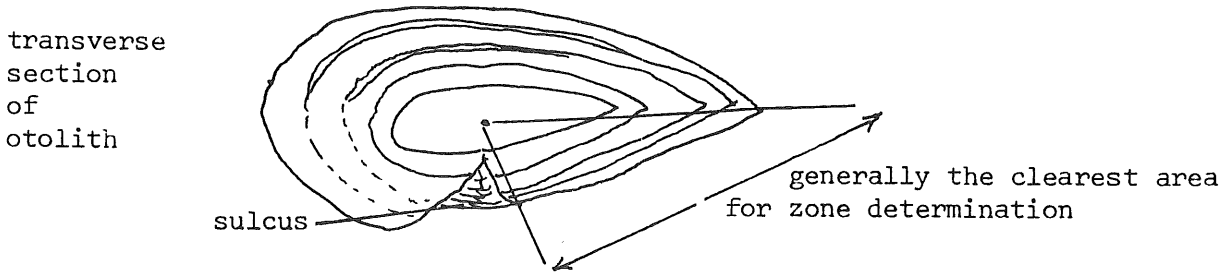
The group was, nevertheless, unable to demonstrate that sectioning results in the most reliable otolith reading technique, and indeed a comparison of 25 otoliths preserved in seawater and read both as whole otoliths and sectioned showed no bias due to technique. The group therefore recommends, in addition, that a comparison of different techniques be made by national laboratories to assess the relative reliability of each. For ease of comparison it may be best to make the comparisons against the sectioning technique. Comparisons need to be made to establish both whether there is a bias in one method, and whether the variance of individual readings is wider using one method than another.

Measurement of otoliths in relation to fish length and measurement of growth zones should be made on the surface of the section of the otolith. Measurements should be taken along the longest axis and in the case of growth zones, the inside diameter should be measured (see diagram).



6.2 Interpretation of growth zones

The group agreed that otoliths are generally easiest to read along the axis of maximum length at the pointed end of the section, and that growth zones there should be checked by comparison with those anterior to the sulcus (see diagram below). Elsewhere, zones may become fused or indistinct.



As pointed out above, it is frequently impossible to decide which zone should be counted as the first hyaline zone and this is a problem in both large and small otoliths. Nevertheless, the group were able to agree in the majority of cases, and it is therefore recommended for uniformity, that the inner indistinct zones close to the nucleus should be disregarded and the first clear hyaline zone be counted. It is recognised that this is not a first criterion, but in the present state of knowledge about the growth of blue whiting and its variability it is not possible to give any more precise criteria. For this reason, it is also recommended that measurements should be made of the inner diameter of the first clear hyaline zone to determine by back calculation the length at which it was laid down. When the growth of blue whiting is better understood, it may then be possible to determine from this measurement whether the zone was formed in the first winter of life.

By observing otoliths from widely dispersed areas it became apparent that there are geographical differences in the clarity of the zones. In general those from area VIII seemed easier to read than those from the northern areas. This indicates that studies on the interpretation of growth zones and their seasonal formation needs to be done throughout the geographical distribution of blue whiting.

6.3 Interpretation of the first growth zone

Pelagic concentrations of 0-group blue whiting have been reported in the area northwest of the UK in the summer, and at that time (June-July) appear to range in size from 6-12 cm. In the autumn, a new recruitment of small blue whiting enters the Norwegian mixed industrial fishery in the northern North Sea, the fish ranging in length from 9-17 cm, with a mode at around 14 cm in August. A similar pattern is found in the Icelandic industrial fishery. By April of the following year the length range is 12-20 cm with a mode at about 17-18 cm. The otoliths of fish caught in autumn show some indication of indistinct hyaline growth checks but no distinct hyaline zone, and it seems logical to conclude that they are 0-group fish. The growth rate indicated by this interpretation is very high.

In addition to 6-12 cm fish, another size group has also been recorded west of Scotland in June ranging from 12-16 cm, also with no hyaline zone. The interpretation of these fish is that they are either very fast-growing members of the local spawning population (peak spawning late March-early April), members of a population from further south which spawn earlier, or 1-group blue whiting which have not formed a first winter hyaline ring.

There is at present no way to determine which interpretation is correct, but the last interpretation raises the possibility that at least a proportion of the population forms no first-winter ring. In addition it indicates that some of the immature fish caught in the industrial fisheries may be 1-group and not 0-group. If so, then age readings of these fish will not be comparable with those of fish that form a first winter ring. The only way in which this problem can be resolved is if samples can be obtained from the main body of the 0-group population as it moves away from the spawning area west of the British Isles.

6.4 Future checks of reliability

As a result of discussion using the video equipment to enable all otolith readers to view an otolith at the same time, a considerable measure of agreement was reached between otolith readers in their interpretation of otoliths. Since new people may become involved in this work and in order to maintain and further this measure of agreement, it is necessary for future checks to be made on the reliability of age reading in blue whiting.

To some extent this may be possible by arranging exchanges of otoliths. However, this method is more useful to establish differences than to resolve them, and it therefore seems more realistic to recommend that further meetings be arranged between otolith readers, either jointly at an ICES-co-ordinated meeting or by local meetings of two or more national experts.

To establish whether there is better agreement between otolith readers it is recommended that a further otolith exchange including reference photographs be organised by Mr Jakuppstovu in co-operation with the Lowestoft Laboratory.

6.5 Research objectives

The following recommendations for research are made:

(a) that otolith width measurements should be made to compare with fish length on the complete size range of blue whiting in all parts of its geographic distribution, to establish a scale for back calculation;

(b) that measurements be made of the width of the first clear hyaline zone;

(c) that comparisons be made of the reliability of different otolith reading techniques;

(d) that differences in zone formation be investigated in different geographical areas;

(e) otoliths from fish < 10cm should be collected whenever possible.

7. Gonad maturity stages

The group agreed to adopt a uniform system of classifying the maturity stages of blue whiting gonads, shown in Table 4. Juvenile fish can usually be sexed by examination of the pelvic fins, the outer rays of which are approximately twice as long in males as in females, reaching to the cloaca. It is thought that the final stages of maturation leading to running fish are quite rapid, and that expansion of the swimbladder on hauling often causes extrusion of ripe gametes. Each individual should be squeezed externally to determine if

it is running before the gonads are examined. In view of the difficulty in distinguishing the gonads of fish beginning to mature for the first time from those of some recovering spent fish, these categories are grouped together. A set of slides and prints showing these maturity stages can be obtained from the Lowestoft Laboratory.

8. Survey plans for 1979

Proposed cruises for 1979 with their cruise dates, main objectives and areas are given in Table 5. Figures 4a-f show the expected distribution of research effort in two-month periods in 1979.

8.1 Acoustic intercalibration

In view of the importance of the echo abundance surveys and in order to make the results comparable between ships, it is recommended that SCOTIA, J C SVABO and the RYBAK MORSKI should attempt an intercalibration exercise in the St Kilda-Wyville-Thomson ridge area on or around 15 April 1979. Radio contact should be established after 10 April at 0900 h GMT each day on 2056 kHz, trying 2182 kHz if unsuccessful after 5 mins. A similar exercise should be attempted between J C SVABO and MICHAEL SARS later in April.

8.2 Subsidiary spawning areas

MICHAEL SARS should search for evidence of spawning aggregations of blue whiting along the edge of the continental shelf to the northeast of Shetland, towards the end of her cruise of 18.4-5.5.79.

W. HERWIG will try if possible to investigate possible spawning areas off southwest Iceland during the period 18.4-23.5.79.

8.3 '0' group and juvenile surveys

The Faroese survey for '0' group blue whiting will cover an area north and west of the Hebrides in May, and should be backed up by other research cruises in June and July. It is recommended that wherever possible a small midwater trawl should be fished (with additional floats) near the surface, even in the absence of echo traces. CIROLANA will attempt to survey the Shetland-Faroe channel in July, and it is recommended that all '0' group gadoid surveys are extended beyond the edge of the continental shelf, for this purpose. In particular MICHAEL SARS, 26.7-15.8; JOHAN HJORT, 31.10-15.12 and G O SARS, 8.11-15.12.

8.4 Additional surveys in late 1979, early 1980

The relationship of the blue whiting which spawn near Porcupine Bank in March to less mature fish still entering the main spawning area from the north is not understood, and it is recommended that surveys should be carried out in January and February to determine the origin of these fish. Similarly the relation (if any) between the blue whiting in the area between Iceland and East Greenland and the main stock is not known. It is therefore recommended that surveys of this and adjacent areas be carried out especially during the spring in order to establish whether there are any substantial spawning concentrations.

9. Other research objectives and recommendations

It should be noted that many of the recommendations made by the Planning Group in 1977 have not yet been fully carried out, and the Group emphasises the necessity for doing so in 1979 and 1980.

9.1 Stock assessment

In view of the rapid escalation in blue whiting catches it is recommended that ICES establishes a Blue Whiting Assessment working group which will meet early in 1980. Its main task will be to assess the state of the blue whiting stock or stocks, and to recommend appropriate management measures. In addition the terms of reference of the Planning Group should be adopted by the Assessment Working Group.

9.2 Biological Sampling

To enable an assessment to be made in 1980 the Planning Group recommends that samples necessary for stock assessment are now a prerequisite. All countries are urged to sample commercial catches for length and age, and arrangements should be made to obtain such samples from vessels carrying out processing at sea. Length, weight, age and maturity data are required for both sexes. Information on food, fecundity, liver condition, parasite infestation, meristic parameters and serology should be obtained if possible. France and the Federal Republic of Germany have already had some success using eye lens and serological material for stock separation purposes, and it is recommended that A Maucorps and B Bussmann circulate the results of this work and detail a sampling procedure of the appropriate tissues as soon as possible.

9.3 Acoustic survey techniques

If, as seems likely, the primary estimates of abundance of adult blue whiting will depend on acoustic surveys in the spawning area, the group recommends that a meeting of participants in these surveys be held in 1979 in order to:

(a) co-ordinate cruise times and survey areas in 1980

(b) compare calibration procedures and target strength determination, such that a programme of relevant studies may be implemented

(c) discuss previous survey results.

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Table 1 Blue whiting catch rates during exploratory fishing

Country	Vessel	Month	Area	Catch rate (t/hour)		Total catch	
				Range	Mean	(t)	
Poland	M/T AMAREL	January	Porcupine (N of 53°N)	0- 3.10	0.31	8.40	
			Bank (S of 53°N)	0- 0.14	0.02	0.65	
	"	February	Porcupine (N of 53°N)	0- 9.38	2.81	273.68	
			Bank (S of 53°N)	0-20.68	1.98	84.05	
	"	March	Porcupine Bank (N of 53°N)	0.11-11.05	2.70	373.80	
	RYBAK MORSKI	April	Porcupine Bank (N of 53°N)	0-40.00	2.83	303.5	
	"	"	Rockall Bank (55-58°N)	0- 6.08	1.24	33.2	
	"	May	W & NW of Hebrides (S of 60°N)	0.10-20.00	2.85	438.4	
	"	"	N of Hebrides and Scotland (N of 60°N)	0.04-15.23	1.85	337.85	
	"	June	N of Hebrides and Scotland (N of 60°N)	0.03- 4.22	0.84	39.55	
	"	July	E & NE of Iceland	0- 3.33	0.46	66.10	
	"	August	E & SE of Jan Mayen	0.65-11.43	2.02	1079.1	
	"	September	SE of Jan Mayen	0- 4.65	1.39	158.6	Depth range (m)
German Dem. Rep.	RV EISBÄR	Mid-May	E Faroe		9		250-400
			NE Faroe (65°N)		< 1		
	Factory trawler	May/June	E Faroe-NW Shetland		2.5-4.5		300-450
			NE Faroe		2.5-4.5		100-300
	Stern trawler	August	E Jan Mayen (6°W-2°E)		1.7		20- 60
	"	Early Sept.	E Jan Mayen (6°W-2°E)		1.2		20- 60
	" (pair fishing)	Aug/Sept.	E Jan Mayen (6°W-2°E)		1.7 (per vessel)		20-300
Iceland	GRINDISKINGUR	July	E Iceland	1.7 -32.0	9.1	1240	
		August	E Iceland	4.4 -31.9	12.5	1725	
Faroe	KRUNBORG	July	E Iceland	5.5 -40.0	18.7	1800	
	"	August	E Iceland	0-28.9	10.3	610	
	L. OSSURSSON	August	E Iceland	0.3 -17.0	3.6	319	
	"	September	SE Iceland/NW Faroe	0.2 - 3.5	1.3	89	
	"	October	N Faroe	0.5 - 4.0	1.8	55	
	"	November	N Faroe	0.2 - 0.3	0.3	4	

Table 2 Landings (t) of blue whiting from each ICES area in 1977

Country	I	IIa	IIb	IIIa	IVa&b	Va	Vb	VIa&b	VIIb-e	VIIg-k	VIII+IX	XIVa&b	Total
Denmark				4043	6156		*	18250					28449
Faroe						593	22816	5966					29375
German Dem. Rep.			2031				1094						3125
Germany (Fed. Rep. of)		386	6064		76		1	3259				327	10113
Iceland (directed fishery)						4113	5172					683	9968
Iceland (mixed fishery by-catch)						5838							5838
Netherlands													0
Norway (dir. fish.)					1894		23347	14188	172				39601
Norway (m.f.b-c)		2836			17066								19902
Poland			1536+		838+		3700+	296+		169+			6539
Portugal											1744+		1744
Spain								167+	16+	629+	19452		20264
Sweden					151		3961	1615	815				6542
UK England & Wales	24		122		3		691	620					1460
UK Scotland							549	2452					3001
USSR	746+	34486+	3997+		1900+		26160+		4+	2983+	751+		71021
TOTAL	770	37708	13750	4043	28084	10544	87491	46813	1007	3781	21947	1010	256948

Sources: information presented by planning group members

* included in VIa

+ from advance release to "Bulletin Statistique".

Table 3 Landings (t) of blue whiting from each ICES area in 1978

Country	I	IIa	IIb	IIIa	IVa&b	Va	Vb	VI a&b	VIIb-e	VIIg-k	VIII+IX	XIVa&b	Total
Denmark				8331	21222		9482	10611					49646
Faroe						2810	25880	14500					34190
German Dem. Rep.		7285	16		988		1714						10003
Germany (Fed. Rep. of)		7702	13		1496		622	5617	344	25		712	16531
Iceland (directed fishery)						17746	7537					10	25293
Iceland (mixed fishery by-catch)						9484							9484
Netherlands					112			901			15		1028
Norway (dir. fish.)				181	38244		82348	32622					153395
Norway (m.f.b-c)					14500								14500
Poland		5083			601		591	487		1444			8206
Portugal													+
Spain											24615		24615
Sweden							3305	2736					6041
UK England and Wales			2				2326	2374					4702
UK Scotland							676	924					1600
USSR		120000*					59852*						179852
TOTAL		140070	31	8512	77163	30040	194333	70772	344	1469	24630	722	548086

Sources: information presented by planning group members

* information provided to Faroe Islands

+ no information.

Table 4 Staging system of blue whiting gonad maturity

Category	Description	Length as proportion of body cavity	Stage
Immature/juvenile +	♀ ovaries translucent white, no eggs visible	$<\frac{1}{4}$	1
	♂ testes thin translucent ribbons, almost undetectable	$<\frac{1}{4}$	
Recovering spent/ first maturation	♀ ovaries translucent orange/red, rather flaccid	1/3	2
	♂ testes translucent pink/white, slightly lobed	$\frac{1}{2}$	
Maturing	♀ ovaries orange/pink, opaque eggs just visible	$\frac{1}{2}$	3
	♂ testes becoming opaque white/pink, some blood vessels, lobed, coiled and crumbles where squeezed	2/3	
Maturing	♀ ovaries firm, ovoid orange/pink, opaque eggs clearly visible	2/3	4
	♂ testes opaque white, swollen, sticky when squeezed	$\frac{3}{4}$	
Maturing/ripe	♀ ovaries pink/orange, swollen, turgid with some hyaline eggs	$>\frac{3}{4}$	5
	♂ testes opaque creamy white, tightly convoluted lobes	1	
Running	♀ ovaries pink/white, mainly hyaline eggs, easily extruded	1 *	6
	♂ testes opaque creamy white, milt easily extruded	1	
Spent	♀ ovaries flaccid, pink/red, blood-shot, a few residual eggs	$<\frac{1}{2}$	7
	♂ testes yellow/white, blood-shot, crinkled narrow band	$<\frac{3}{4}$	

+ Pelvic fins of males have some straight rays reaching cloaca; those in females are approximately half as long and curved inwards.

* If gametes extruded on hauling these gonads may be smaller; test for ripe gametes by squeezing.

Table 5 Blue whiting cruises, 1979. Asterisk denotes blue whiting as subsidiary objective.

Period	Ship	Nationality	Area	Main objective
22 January-22 March	L.OSSURSSON	Faroe	Faroese waters	Exploratory fishing; Gear research
1 February-30 March	WALTER HERWIG	Germany (Fed. Rep. of)	Faroe-Shetland , W British Isles, Porcupine Bank	Biological investigation; Gear technology
10-22 February	SCOTIA	Scotland	Faroe-Shetland area, Wyville-Thomson Ridge	Echo abundance survey
15-30 March	HAVDRØN	Norway	W British Isles	Acoustic survey
March-June	RYBAK MORSKI	Poland	Porcupine Bank-Faroe	Biological sampling; Echo abundance survey
March-June	J. C. SVABO	Faroe	Faroe-Shetlands	Echo abundance survey
31 March-20 April	SCOTIA	Scotland	Faroe-Purcupine Bank	Echo abundance survey; Biological sampling
April-June	ORKA	Poland	W British Isles-Faroe	Biological sampling
18 April-5 May	MICHAEL SARS	Norway	W British Isles-Faroe	Echo abundance survey; Biological sampling
* 18 April-13 May	G. O. SARS	Norway	Lofoten-Bear Island	Redfish distribution
* 18 April-23 May	W.HERWIG	Germany (Fed. Rep. of)	Irminger Sea, E Greenland	Biological sampling; Acoustic survey
* April	HAFTHOR	Iceland	Irminger Sea	Biological sampling; Acoustic survey
5 May-2 June	MICHAEL SARS	Norway	Faroe-Iceland area	Gear technology
* 15 May-20 July	AKHILL KNIPOVICH	USSR	Norwegian Sea	Environmental monitoring; Fish distribution
* 15 May-20 June	B.SAEMUNDSSON	Iceland	N & E Icelandic waters	Environmental monitoring; Fish distribution
* 8-28 May	CIROLANA	England	North Sea-West Britain	Biological sampling
* 15 May-9 June	CORELLA	England	Northern North Sea	Biological sampling
22 May-late August	URAN	Poland	Faroese waters-Norwegian Sea	Biological sampling; Acoustic survey
May-September	J. C. SVABO	Faroe	Faroe-Shetland area	0 group fish surveys
* 6-27 June	W.HERWIG	Germany (Fed. Rep. of)	Shetland-Biscay Shelf	Deep sea fishing
4-30 June	M.SARS	Norway	Norwegian sea	Echo abundance survey
* 11 June-20 July	JOHAN HJORT	Norway	Northern North Sea	0 group gadoid survey
* 26 July-15 August	M.SARS	Norway	Western Norway	0 group fish survey
* 10-29 July	CIROLANA	England	Northern North Sea-Faroe	Biological sampling
* 10 July-15 August	W.HERWIG	Germany (Fed. Rep. of)	Norwegian Sea-Spitzbergen	Groundfish survey
July-August	RYBAK MORSKI	Poland	Norwegian Sea	Biological sampling
Mid July-mid Sept.	EISBAR	German Dem. Rep.	Norwegian Sea-Norwegian Deep	Acoustic survey; Biological sampling
* 7 Sept-15 Oct.	M.SARS	Norway	Jan Mayen	Gear technology
September	HAFTHOR	Iceland	Denmark Strait	Exploratory fishing
* 15 Sept-5 Oct.	W.HERWIG	Germany (Fed. Rep. of)	W British Isles	Gear technology
September-December	RYBAK MORSKI	Poland	Norwegian Sea	Echo abundance survey; Biological sampling
September-December	ORKA	Poland	Norwegian Sea	Acoustic survey; Biological sampling
* 2 October-2 Nov.	G.O.SARS	Norway	Bear Island-Spitzbergen	Fish distribution
31 October-20 Nov.	CIROLANA	England	Celtic Sea	Juvenile mackerel and blue whiting survey
* 31 October-15 Dec.	JOHAN HJORT	Norway	North Sea	0 group fish survey
8 November-15 Dec.	G.O.SARS	Norway	North Sea	0 group blue whiting distribution and abundance
* 28 November-17 Dec.	CIROLANA	England	Northern North Sea	Biological sampling

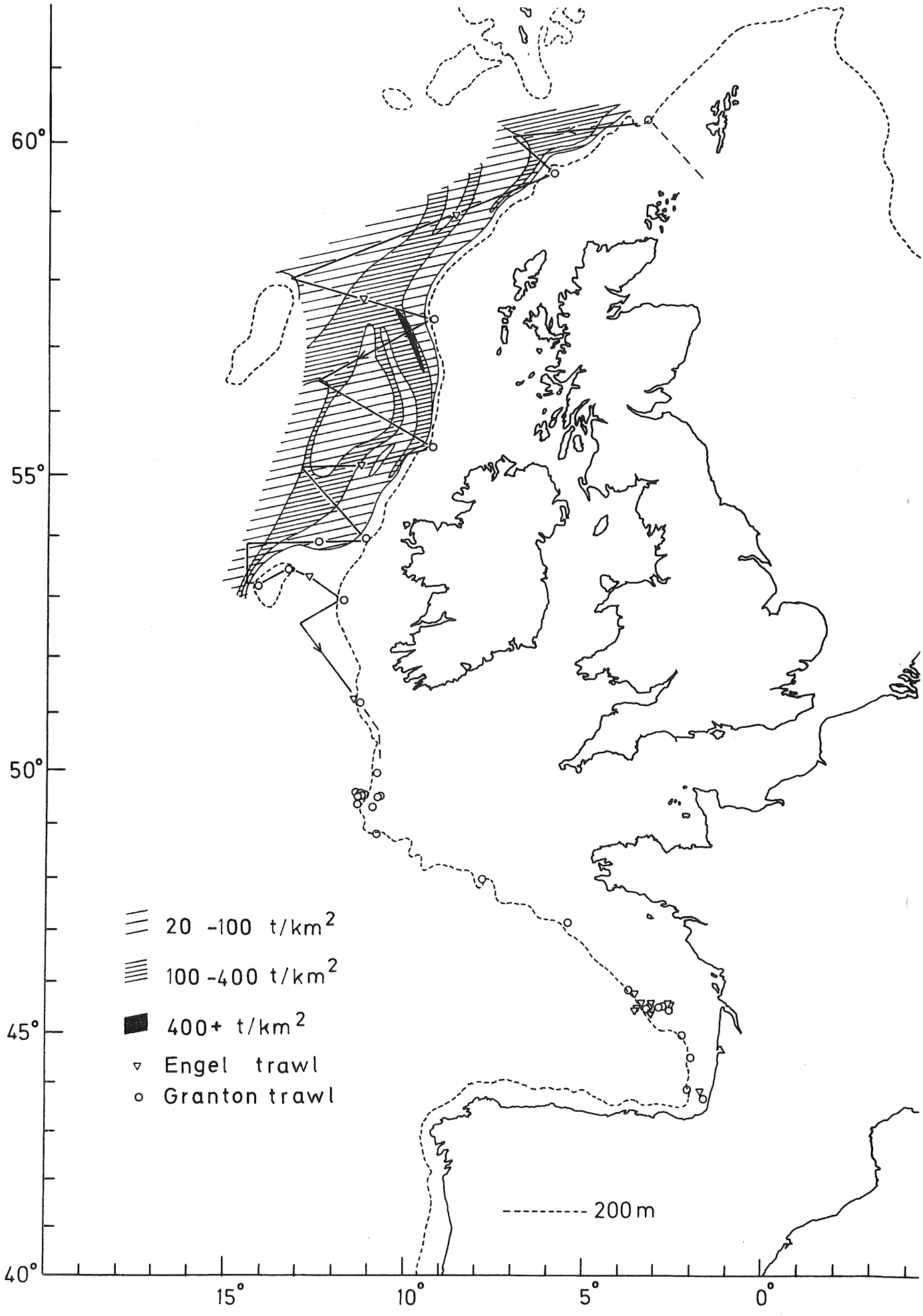


Figure 1 The distribution of blue whiting during 2-9 April, 1978, from Pawson *et al* (1978).

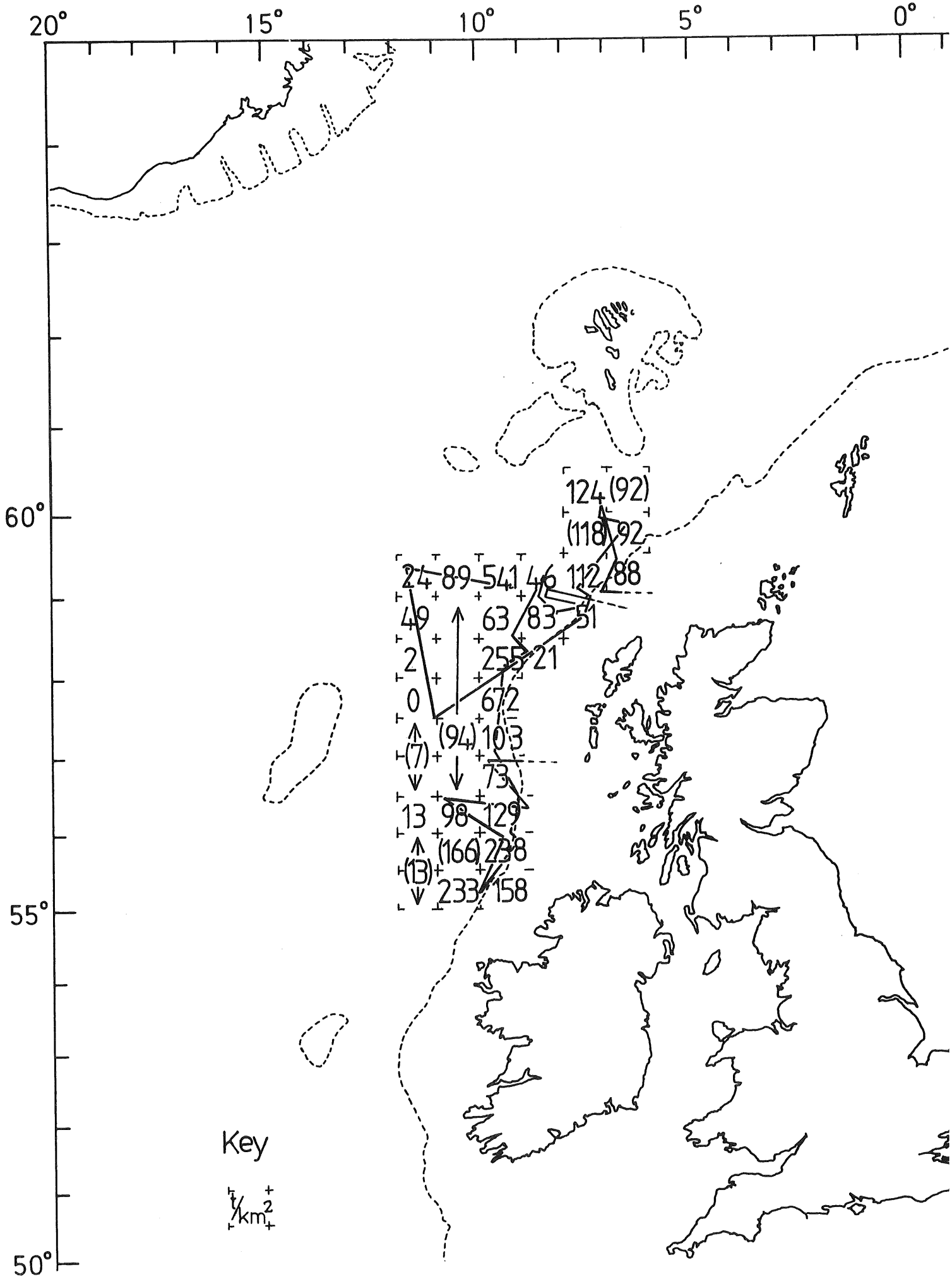


Figure 2 The distribution of blue whiting during 8-25 April, 1978, after Walsh *et al* (1978).

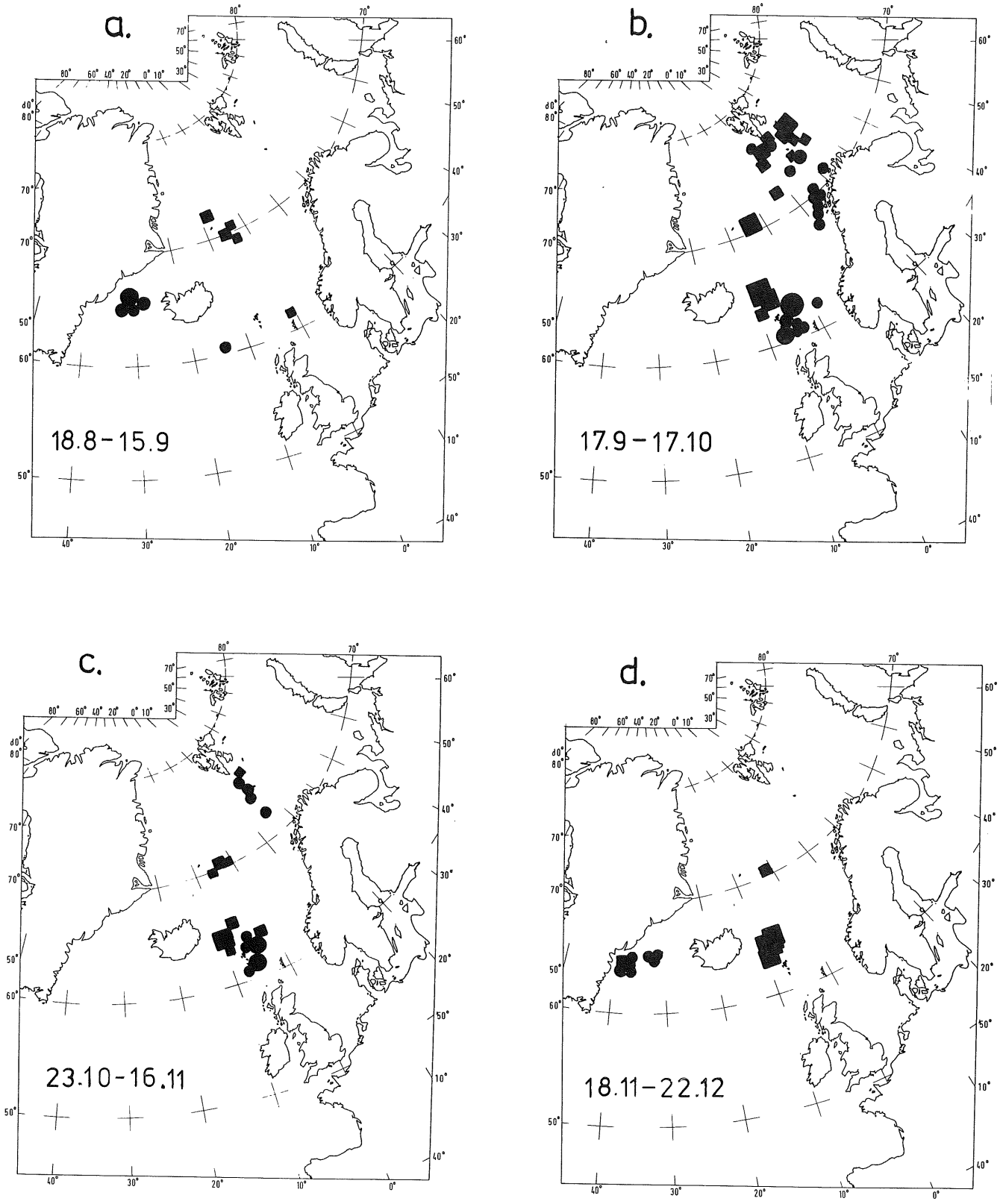
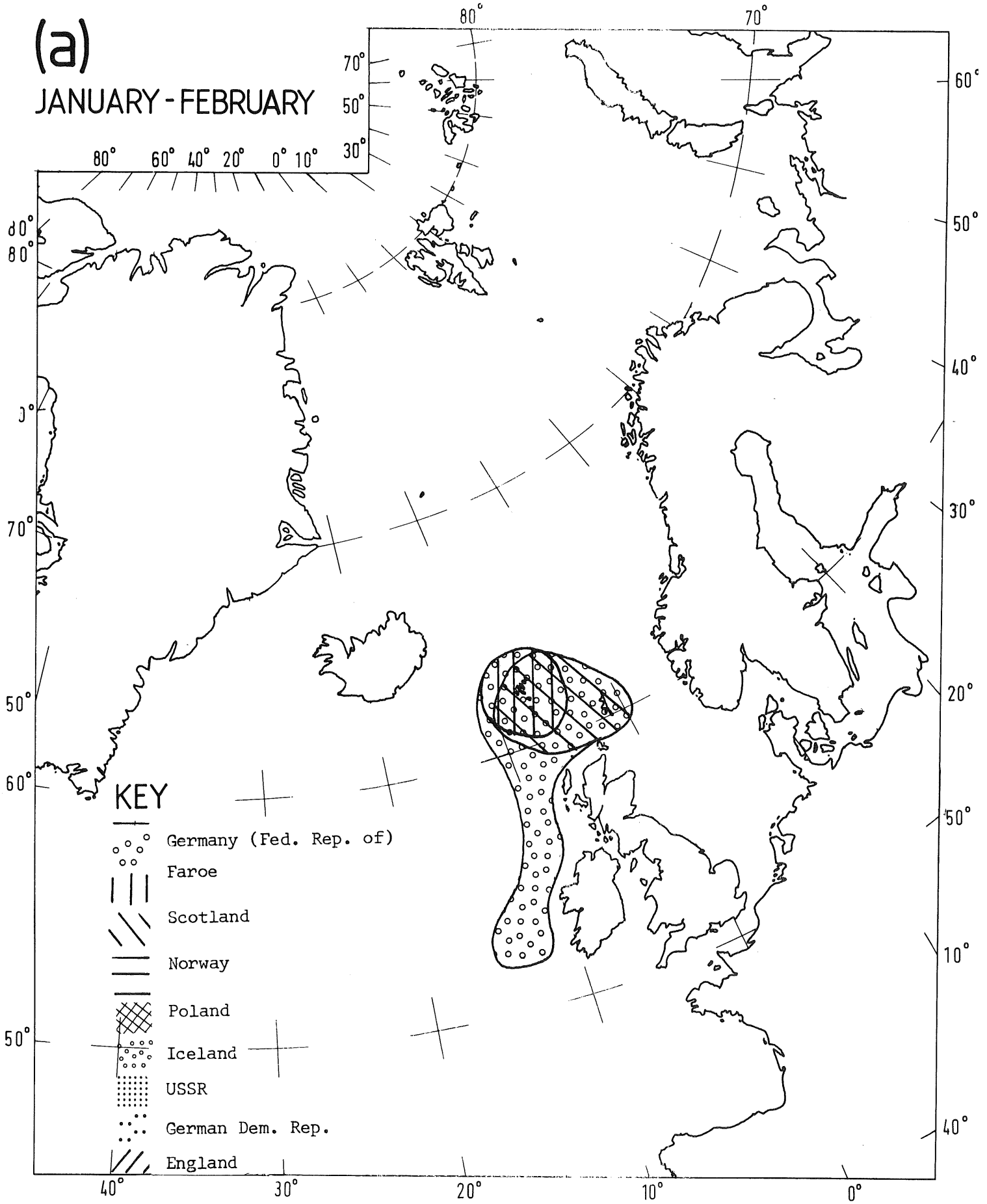
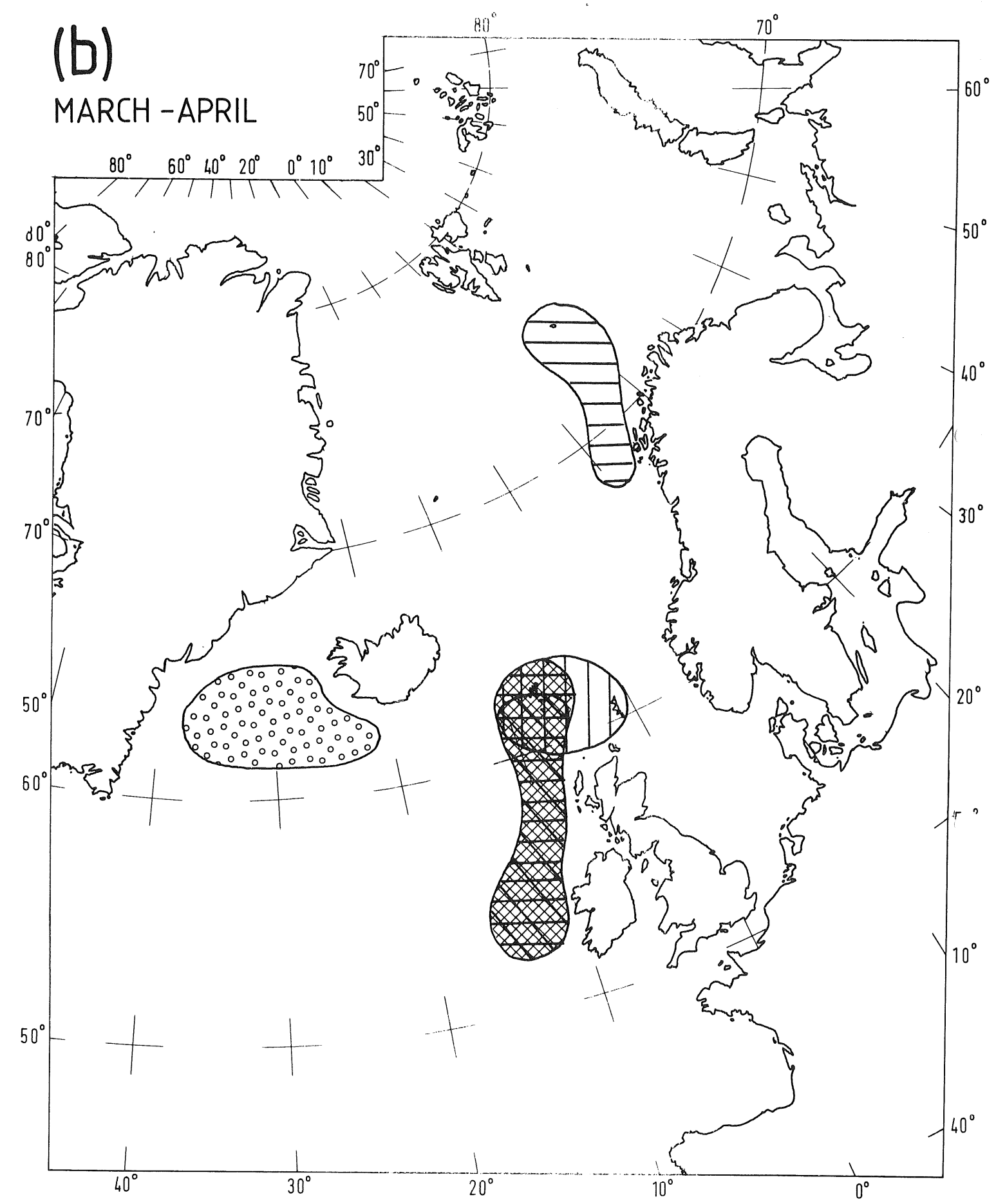


Figure 3a-d Blue whiting catch rates of stern trawler MARBURG (German Federal Republic) using bottom (BT) and pelagic (PT) trawls during 1978

Figure 4 a-f Expected distribution of blue whiting research effort in 1979.

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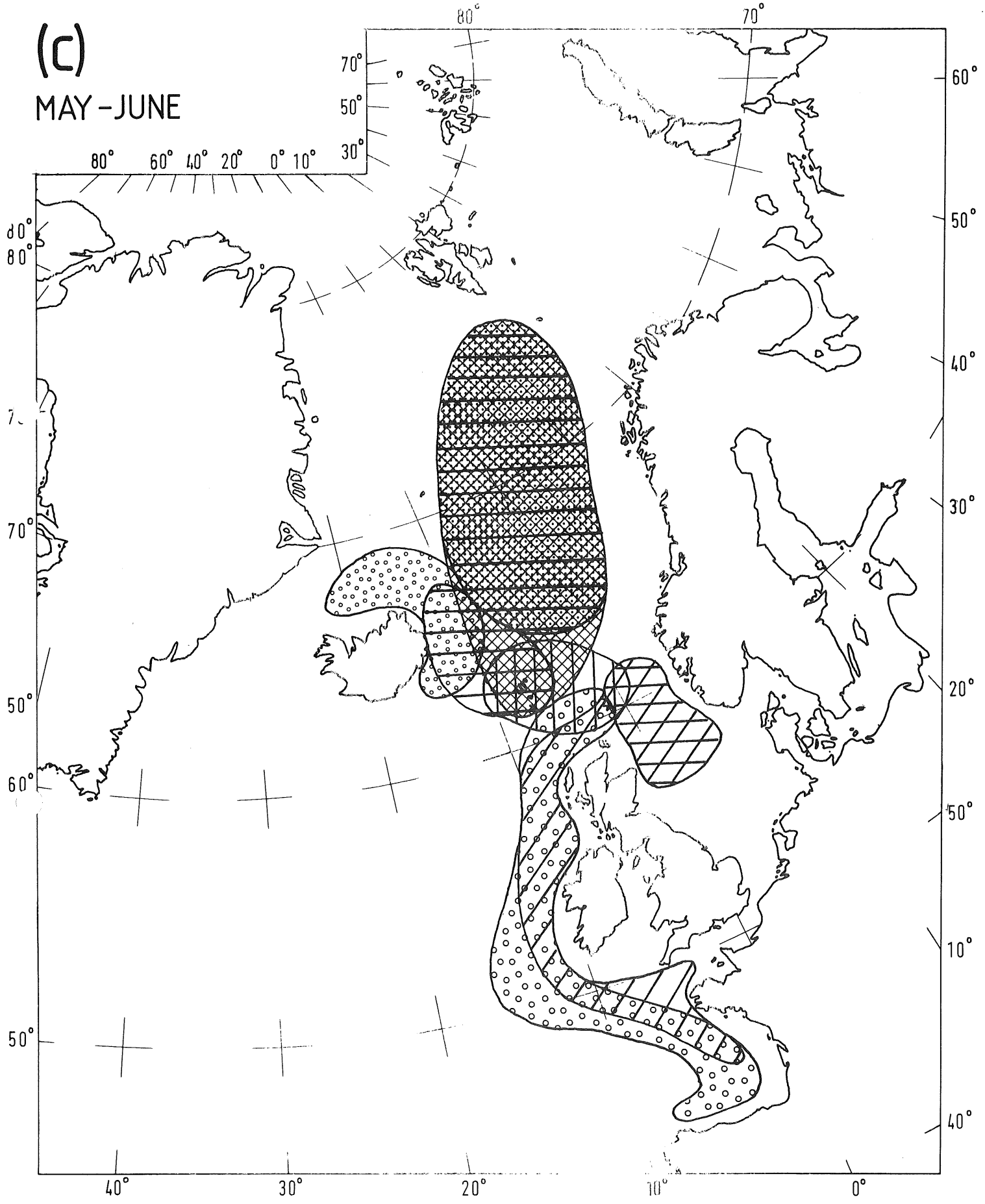
60°
50°
40°
30°
20°
10°
0°



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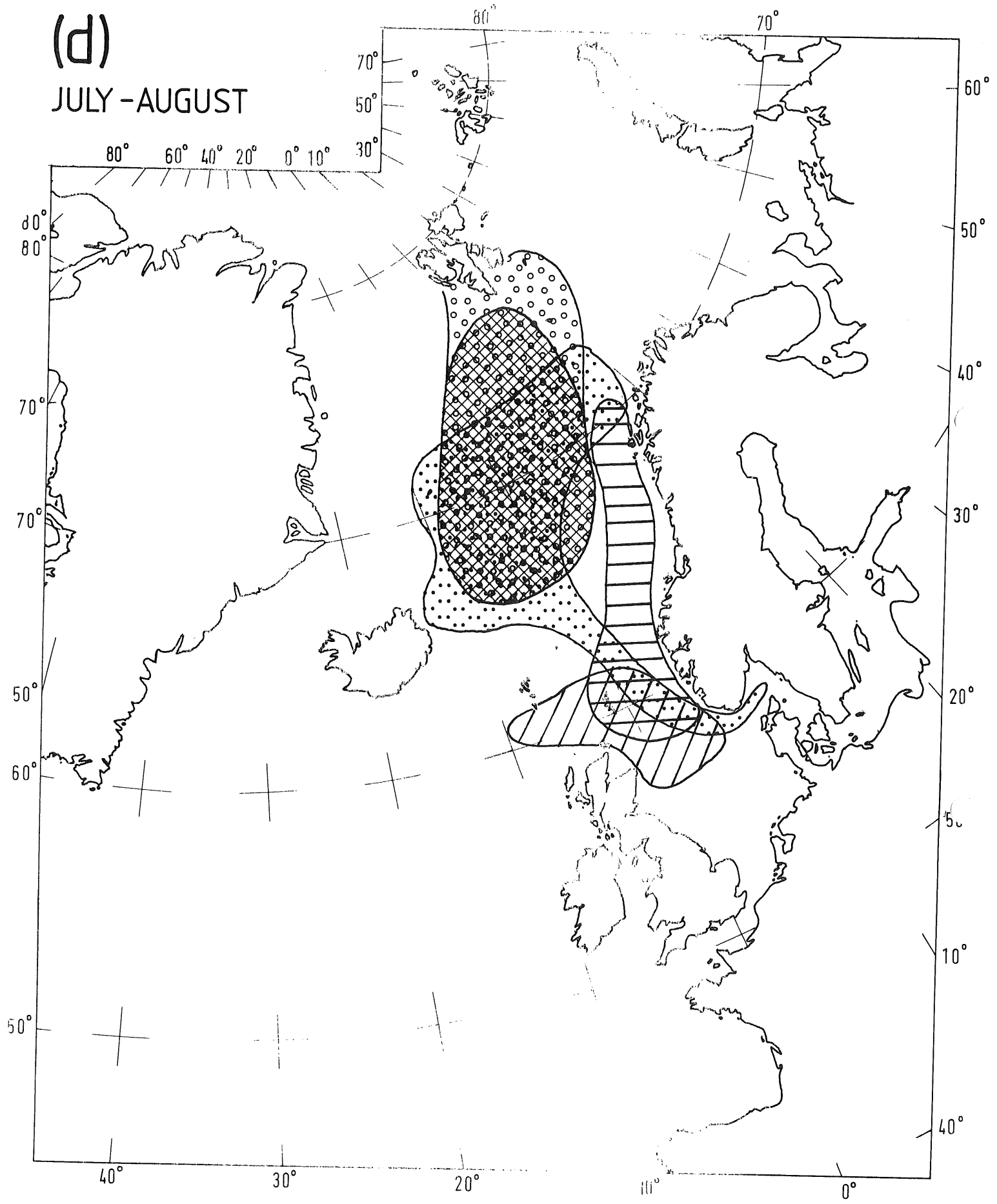

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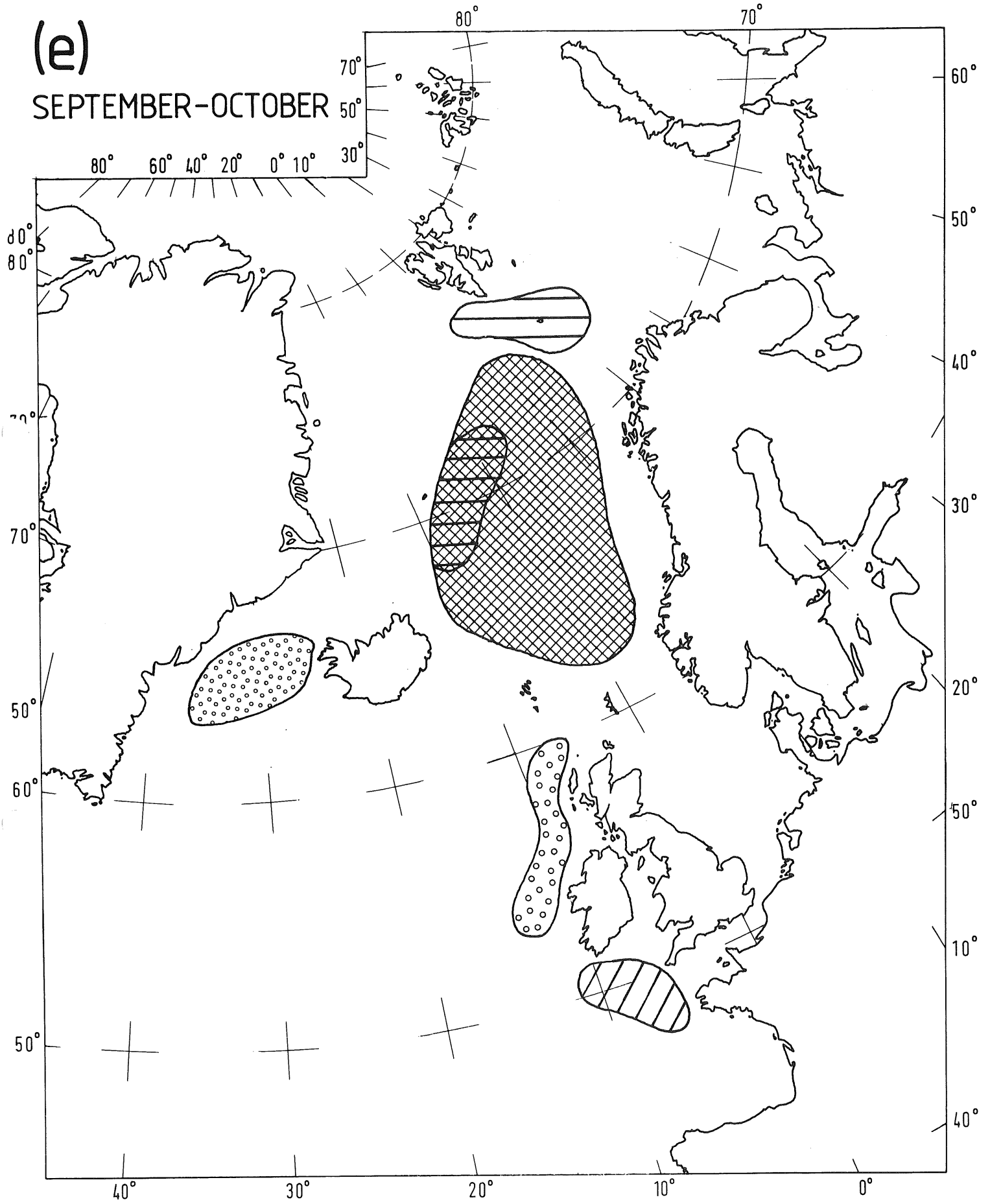
(e)
SEPTEMBER-OCTOBER
80°
70°
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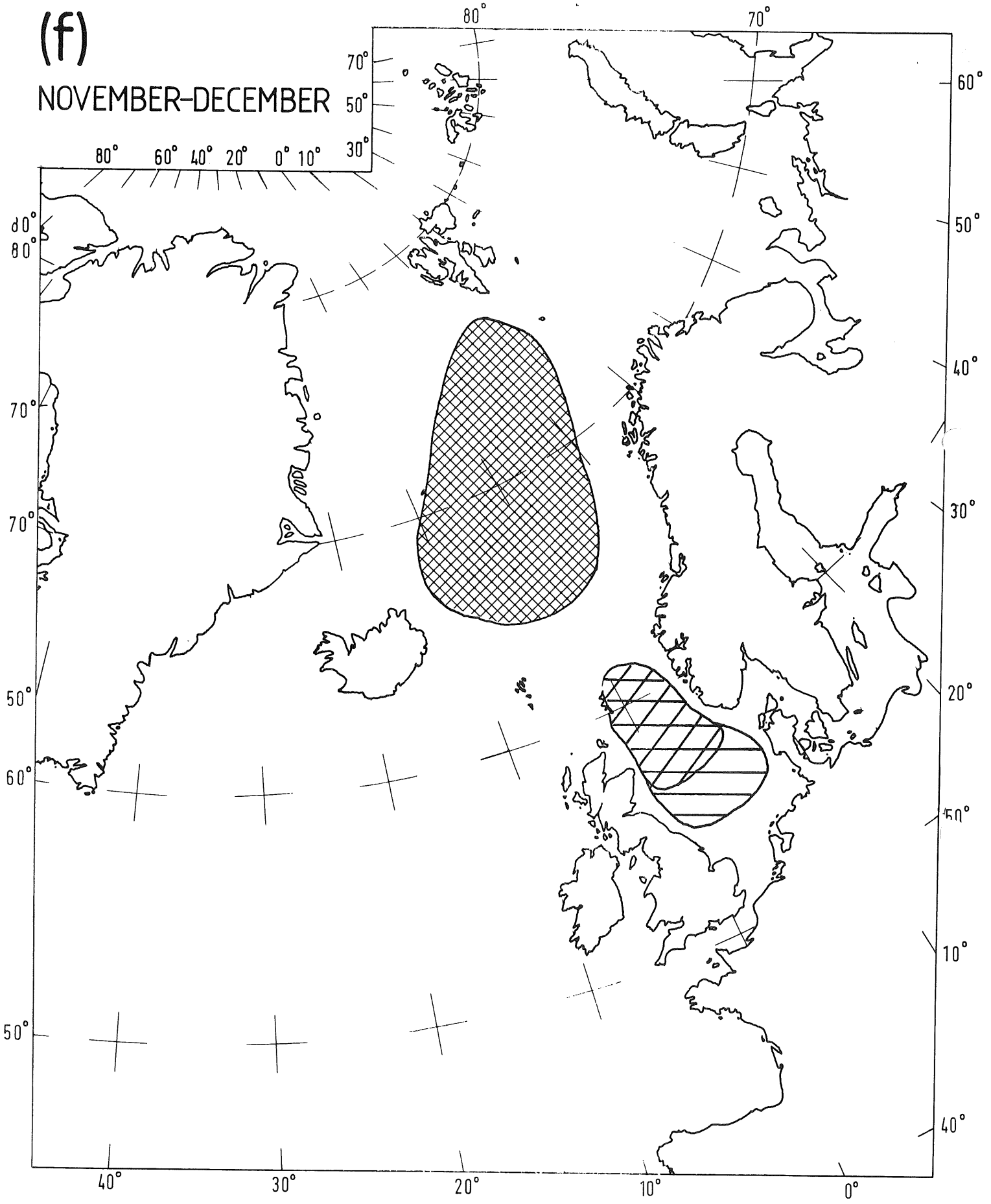

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