International Commission for the Northwest Atlantic Fisheries

NORWESTLANT Surveys 1-3: April-July 1963

U.K. NATIONAL REPORT

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CONTENTS

1. NORWESTLANT 1

The Research Vessel ERNEST HOLT participated in NORWESTLANT 1 and was in the survey area during the period 9 April-1 May. The stations worked are shown in Figure 1 and they are listed in Table 1. The amount of time available was insufficient to allow the ship to work the whole of the three sections which fell within her sector of operation viz. Sections IV-VI: See Guide Book to the NORWESTLANT Surveys at 3.1.1. It was therefore decided to work the whole of Section V, but only the Greenlandic ends of Sections IV and VI. In the event rough weather prevented the south-eastern end of Section V from being worked. Shortage of time, rough weather and the position of the ice edge prevented the scheduled grid of egg/larvae stations; (See Guide Book to the NORWESTLANT Surveys at 2.1.3) from being completed and a modified grid was carried out.

1.1. Hydrography

1.1.1. Sections IV-VI: Temperature and salinity: The temperature distributions on Sections IV-VI are given in Figures 2-4. The core of the Irminger Current along the East Greenland continental slope is seen between the surface and 300 m depth and it has a maximal temperature of 5.6°C on Section IV and this decreases southwards to 5.1°C on Section VI. The area of cross-section with a temperature above 5°C decreases greatly between Sections IV and V. On the East Greenland shelf the temperature at all depths shallower than 250 m falls rapidly and sub-zero water of the East Greenland Current was observed at the surface on Section VI. Proceeding south-eastwards from the core of the Irminger Current, the temperature falls only slowly and a cold dome centred some 150 n.mi. from the Greenland coast is a distinctive feature of all three sections, particularly of Sections V and VI. To the south-east of this dome temperatures in depths shallower than 500 m rise again in the North Atlantic Drift system. A further feature of the temperature distribution on Sections IV and V is a secondary cold dome between the main one and the Irminger Current at a distance of some 50 n.mi. from the East Greenlandic continental slope.

The salinity distributions on Sections IV-VI are given in Figures 5-7.

The rapid change in the characteristics of the core of the Irminger Current between Sections IV and V is now shown by the reduction in the area of cross-section with a salinity above 35.0°/oo. The maximal salinity value decreases from 35.1°/oo on Section IV to 35.0°/oo on Section VI. On the East Greenland Shelf salinity falls rapidly and on Section VI salinity below 33.5°/oo was observed in the East Greenland Current. The primary cold dome to the east of the Irminger Current is seen to be an area with salinity less than 34.95°/oo, and the secondary cold dome is also occupied by lower salinity water.

1.1.2. Horizontal temperature distributions: The temperature distributions at 0, 50, 100 and 200 m are shown in Figures 8-11. The subsurface charts are based on the water bottle casts made at the hydrographic stations and on bathythermograph lowerings made at various plankton stations. The distribution at 0 m is based on records obtained over the whole of the track covered by R.V. ERNEST HOLT during NORWESTLANT 1 using a distant-reading thermograph with a mercury-in-steel bulb situated at a depth of 4.5 m. The track of R.V. ERNEST HOLT is not shown in Figure 8 but it can be derived from Figure 1. The position of the ice-edge is also given with this distribution. In each of Figures 8-11 the cold dome south-east of Greenland can be seen: at 100 and 200 m depth the secondary dome is also apparent. The surface temperature chart shows a sharp temperature front on the East Greenland shelf at the boundary between the sub-zero water of the East Greenland Current and the warm (above 5°C) water of the Irminger Current. This front is found down to 200 m to some extent, but by then it is not so sharp.

1.1.3. Currents: The dynamic topography of the sea surface using the 1000 dbar surface as a reference level is shown in Figure 12. The observations made by the R.V. THALASSA in the sector to the northward of that worked by the R.V. ERNEST HOLT have been incorporated in this chart in order to assist in drawing the contours and in order to allow the dynamic topography to be compared with the GEK observations made by our colleague Mr; David Ellett aboard R.V. THALASSA. GEK observations were also made by R.V. ERNEST HOLT but, whereas in the case of the R.V. THALASSA observations the electrode signal was measured at particular points on each of two courses at right angles to each other, the R.V. ERNEST HOLT measurements were made on single courses only as the ship proceeded along Sections IV-VI. The results of the R.V. ERNEST HOLT observations are therefore shown as arrows which represent the current component normal to the ship's track on these sections, whilst the THALASSA measurements are shown as arrows which give the direction of flow relative to geographic co-ordinates at each of the observation points. To convert the electrode signals into knots a K factor of 2.6 has been used over the East Greenland shelf area. This was derived from two comparisons between electrode signal and ship's drift made by R.V. ERNEST HOLT in the area in April 1962 and during NORWESTLANT 3 respectively. In the deep sea away from the shelf a K factor of 1.1 has been used following Von Arx (1962).

The dynamic topography in the area off South-East Greenland indicates an anticlockwise circulation around the cold dome with the Irminger Current flowing southwards on its north-western side and part of the North Atlantic Drift system flowing north-eastwards on its south-eastern side. Further north in the R.V. THALASSA's sector the flow is mainly towards the north or north-east except where two eddies occur.

The GEK observations made by R.V. ERNEST HOLT are broadly in agreement with the dynamic topography, except over the eastern half of Section V. This section was worked after at least 24 hours of strong west to north-west winds and these may have been responsible for much of the increased south-westerly flow found over most of this section compared with the other two sections, which were worked after spells of north-east to east winds. The observations made by R.V. THALASSA also agree on the whole with the dynamic topography although some notable exceptions do occur. They do show the existence of cyclonic eddy to the south-west of Iceland and suggest that there is a south-going current to the west of the Iceland shelf. They also indicate a flow away from the East Greenland shelf between 64° and 65°N, but a movement on to the shelf further south in a position where the dynamic topography also shows such a flow. The GEK observations indicate speeds of flow of up to 100 cm/sec. on the East Greenland shelf and of up to 60 cm/sec. in the deep

Irminger Sea. The dynamic topography gives much slower rates of flow, 6 cm/sec., at the most in the Irminger Sea.

To get some idea of the current speeds to be expected on the East Greenland shelf two parachute drogues were tracked over a period of 13¾ hours in the Fylkir Bank area. The tracks of the drogues were determined by radar fixes on the East Greenland coast. The two drogues were at a depth of 29 m and they were released in position 62°34'N, 40°36.5'W where the bottom depth was 210 m at 0930 hours G.M.T. on 29 April. The track of the drogues is shown in Figure 13 and it can be seen that, with the exception of the period 1500-1800 hours, the two drogues moved steadily to the south-west. The average drift over the whole period was 46 cm/sec (0.9 knots) towards 217° (true).

Drift bottles were released from both R.V. ERNEST HOLT and R.V. THALASSA. To date 10 bottles have been recovered. The positions at which bottles were liberated and recovered are shown in Figure 14. The tracks of the recoveries are in agreement with the dynamic topography in Figure 12, in that bottles liberated near East Greenland travelled southwards, rounded Cape Farewell and were recovered in Disko Bay, and that bottles liberated further to the east in the Irminger Sea travelled north-eastwards and were recovered in Iceland. Two bottles liberated to the south-west of Iceland travelled to Norway and were recovered there about a year after liberation. Of the bottles recovered in Disko Bay, taking the one recovered after the shortest time out we obtain a speed of drift of 5.0 n. mi. (10 cm/sec.) from East Greenland, assuming that it followed the shortest possible route and that it was found as soon as it stranded. Of the bottles recovered in Iceland, proceeding in the same way we obtain a speed of drift of 2.8 n.mi./day (6cm/sec.) from a position south-east of Cape Farewell.

1.1.4. Dissolved Oxygen (also see 3.1.): The distribution of dissolved oxygen between the surface and 100 m depth along Sections IV-VI is shown in Figure 15. The dissolved oxygen of the Atlantic water in the Irminger Current is somewhat lower than that of the cold water of the East Greenland Current to the west of it and of the water above the cold dome to the east of it. For example, on Section IV dissolved oxygen contents below 6.5 ml/L occur in the Irminger Current, whereas on Section VI contents above 8 ml/L found in the East Greenland Current and on all three sections contents above 7 ml/L are found in the vicinity of the cold dome. On all three sections the contours are nearly vertical indicating homogeneity of the water column down to 100 m.

1.1.5. Phosphate (also see 3.1.): The distribution of ~~silicate~~ phosphate between the surface and 100 m depth along Sections IV-VI is shown in Figure 16. The contours on all the sections are nearly vertical and there is no horizontal stratification. The highest phosphate values, more than 1 µg at /L, occur in the region of the primary and secondary cold domes.

1.1.6. Silicate (also see 3.1.): The distribution of ~~phosphate~~ silicate between the surface and 100 m depth along Sections IV-VI is shown in Figure 17. Again there is no horizontal stratification. The East Greenland Current with below 7 µg at /L appears to have a lower silicate content than the Irminger Current, but the highest contents, more than 8 µg at /L, again occur in the region of the two cold domes.

1.1.7. Chlorophyll a: Chlorophyll a determinations have been carried out by Mr. J. H. Steele of the Marine Laboratory, Aberdeen, on a series of water samples taken at 20 m depth. A sample was taken at each hydrographic station. The results are shown in Figure 18. The general level of chlorophyll a is low, but along all three sections the higher values are found at the stations in the deep sea away from the continental shelf. Further, the general level along any particular section increases the later in time that section was worked. Section VI was worked first, then Section IV and finally Section V: the chlorophyll a values as a whole are highest on Section V and lowest on Section IV.

1.2. Plankton (For method see 3.2.)

1.2.1. Cod eggs and larvae (Table 2. Figures 19 and 20): Some cod eggs were found at all stations over the East Greenland shelf between Cape Mosting and Cape Farewell. The main concentrations were on the Fylkir and Cape Bille banks in the north and between Cape Discord and Cape Farewell in the south.

The eggs were staged according to the work of Apstein (1911). Apstein's 22 stages were grouped as follows:-

1- 4	IA
5- 8	IB
9-11	II
12-15	III
16-19	IV
20-22	V

The percentage of each stage at each station is shown in Table 2 from which it can be seen that the majority are stages I, II and III, which would be less than about 14 days old at about 3°C. Figure 20 shows the areas with the largest numbers of stage IA eggs which will be less than 2 days old at 2-4°C. Thus the main spawning is in the area of greatest egg abundance on Fylkir and Cape Banks and off Prins Christians Sund. The few cod larvae caught were mostly off Prins Christians Sund.

1.2.2. Redfish larvae: A few were caught at the easternmost two stations on each of Sections IV and V.

Station	Larvae/M^2	Larvae/10M^3
52	20	2.0
53	4	0.4
66	52	5.2
67	8	0.8

1.2.3. *Calanus finmarchicus* (Figures 21 and 22): All stages of *Calanus* were counted, but only stage VI and stages I and II are charted. Adults were most abundant at the oceanic stations and also in the areas over the East Greenland shelf where the most cod eggs were found. The only considerable numbers of stages I and II were over the cod spawning areas of Fylkir and Cape Bille Banks. (It should be noted that stations in this northern area were worked 8 or more days later than those off Cape Farewell). The fine net samples have not yet been examined for nauplii.

1.2.4. Other copepods: Very few other copepods were found: the commonest were Pseudocalanus and Oithona, with a few Metridia longa at some stations on the shelf.

1.2.5. Euphausiids (Figure 23): Adult Thysanoessa longicaudata were caught at all stations off the East Greenland shelf and at stations over the shelf in the Cape Bille area. A few euphausiid eggs were found in the latter area. The larger Meganyctiphanes norvegica and Thysanoessa inermis would not be expected in the vertical nets.

1.2.6. Spiratella (Figure 24): Some S. retroversa were found at most stations, with the largest numbers over deep water off the shelf.

1.2.7. Medusae: Aglantha digitale was present in small numbers at all stations except 1, 2, 3 and 45. Too few other medusae were caught to be worth comment.

1.2.8. Chaetognaths (Table 3): Table 3 shows that Sagitta elegans occurs at a few stations over the shelf: S. maxima is found at most of the stations just off the edge of the shelf and Eukhronia hamata is found at these stations and also at most of the oceanic stations.

1.2.9. General: The relation between the plankton and hydrography has not been studied in detail. The most notable feature is over the Fylkir and Cape Bille banks, where the main cod spawning and the earliest spawning of Calanus and Euphausiids occur at a point where the warmer oceanic water pushes on to the shelf.

2. NORWESTLANT 3

The Research Vessels ERNEST HOLT and EXPLORER participated in NORWESTLANT 3 and were in the survey area during the period 30 June - 24 July. The stations worked are shown in Figure 25 and they are listed in Table 4. The position of the ice-edge again prevented the scheduled grid of egg/larvae from being completed and a modified grid was carried out.

2.1 Hydrography

2.1.1 Sections I-III: Temperature and salinity: The temperature distributions on Sections I-III are given in Figures 26-28. On Section I there is a certain amount of thermal stratification near the surface, particularly off the west coast of Iceland. Over the whole of the section the temperature is above 6°C, except near the East Greenland shelf where a steep temperature front occurs, and the cold water of the East Greenland Current is found down to 100 m and the overflow of the Iceland-Greenland Ridge by cold Norwegian Sea deep water is apparent in the bottom layers. The thermal stratification of the surface layers is also present on Section II. On this section in the region of the Reykjanes Ridge the influence of a north-going arm of the warmer North Atlantic Drift system is clearly seen. Otherwise the whole of the section shallower than 500 m depth is occupied with water warmer than 5.5°C except over the East Greenland shelf. The core of the Irminger Current as it turns southward between Iceland and Greenland is seen between Stations 23 and 25, and to the east of it a weak cold dome appears. Section III is similar in many respects to Section II, but the south-going warm Irminger Current off the East Greenland continental slope is now more clearly seen and to the east of it a well defined cold dome similar to that found further south during NORWESTLANT 1 is found. The main features of Section III are repeated in Sections IV and V, and on all five sections the overflow of cold Norwegian Sea deep water into the Irminger Sea can be seen on the East Greenlandic slope, getting deeper as it proceeds southwards.

The salinity distributions on Sections I-III are shown in Figures 29-31. On Section I the salinity is everywhere above $35.0^{\circ}/oo$ except on the East Greenland shelf where the East Greenland Current gives rise to salinity values below $33.5^{\circ}/oo$ and the overflow of Norwegian Sea deep water to values in the range 34.9-35.0°/oo. Near the Iceland coast the highest values occur, viz. above 35.15°/oo. Section II shows an arm of the North Atlantic Drift system with salinity values above 35.2°/oo in the vicinity of the Reykjanes Ridge, the core of the Irminger Current with a salinity above 35.1°/oo, and the East Greenland Current with salinity values below 33.0°/oo. These features are also prominent on Section III, but here the salinity in the core of the Irminger Current is now less than 35.1°/oo and further reduction in the salinity of this current can be seen in Sections IV and V. The salinity distributions for Sections I-V all show the presence of the overflow of Norwegian Sea deep water on the East Greenland slope, and those for Sections II-V show that the cold domes eastward of the Irminger Current are areas of lower salinity.

2.1.2 Horizontal temperature distributions: The temperature distributions at 0, 50, 100 and 200 m are shown in Figures 32-35. They were derived in the same way as Figures 8-11. The temperature distribution at the sea surface is at a maximum, above 10°C, in the east and at a minimum, below 0°C, in the East Greenland Current close to the ice edge. The temperature front along the boundary of the East Greenland Current is sinuous and thus indicates the presence of a number of small eddies in that area. The temperature distribution at 50, 100 and 200 m all show the anti-clockwise movement around the cold dome of warm water comprising the north-going arm of the North Atlantic Drift system in the neighbourhood of the Reykjanes Ridge and the west- and then south-going Irminger Current in the north and west. This warm water has an initial temperature in the east of over 10°C at 50 m and of about 9°C at 200 m. Off southern Greenland in the Irminger Current this temperature is reduced to a level of 7-8°C at 50 m and 5.5-6.5°C at 200 m. Along the East Greenland shelf the sinuous front between the Irminger Current and the cold East Greenland Current with temperatures below 2°C is apparent even at 200 m depth.

2.1.3 Currents: The dynamic topography of the sea surface with the 1000 dbar surface as a reference level is shown in Figure 36. GEK observations were again made by R. V. ERNEST HOLT, and on this occasion the electrode signal was measured at particular points on each of two courses at right angles to each other, so that the results are now shown as arrows giving the direction of flow relative to geographic co-ordinates. The K factors used were as for

NORWESTLANT 1 in the East Greenland shelf area and over the deep Irminger Sea. Over the banks west of Iceland a K factor of 1.5 was used following the experience of Von Arx (1962) on Georges Bank and of Vaux (in press) in the North Sea and Barents Sea.

The dynamic topography of the sea surface shows that over the eastern part of the area surveyed the flow is north-eastwards on a broad front, and that to the south-west of Iceland there is an eddy beyond which the flow is north-westwards. In the western part of the area the flow is south-westwards in the Irminger Current, and some eddies occur in this narrow zone. The current directions as determined by GEK over the deep sea agree on the whole with the dynamic topography. Over the East Greenland shelf where the dynamic topography cannot be determined they present a complicated picture, which taken as a whole shows a narrow south-west going East Greenland Current with a north-east going countercurrent on its western side close to the ice-edge and a number of eddies on its eastern side between it and the Irminger Current. In the area to the west of Iceland the observations must contain a tidal component in the region of the shallower banks, but as on NORWESTLANT 1 westward of these banks there does seem to be a south-going flow along the edge of the Iceland shelf. On the East Greenland shelf the GEK observations indicate speeds of 130 cm/sec and of 200 cm/sec in one locality near the ANTON DOHRN bank: over the Irminger Sea they indicate speeds up to 60 cm/sec. The maximum speed of flow to be derived from the dynamic topography is 13 cm/sec. Drift bottles were again liberated by R. V. ERNEST HOLT during NORWESTLANT 3, but to date only one has been recaptured as is shown in Figure 14. This was liberated off East Greenland in about 64°N and it was recovered in Disko Bay 123 days later. This gives a speed of drift of 8 n. mi./day (17 cm/sec) if we make the same assumptions as in 1.1.3 above.

2.1.4. Dissolved Oxygen (Also see 3.1): The distribution of dissolved oxygen between the surface and 100 m depth along Sections I-III is shown in Figure 37. On all sections the dissolved oxygen content is highest in the surface layers, i.e. at depths shallower than 30-40 m. This is particularly so near Iceland on Section I and on the East Greenland shelf on all three sections. This increase in the surface layers is partly due to phytoplankton production, but on the East Greenland shelf it is also partly due to the cold water of the East Greenland Current which has a higher dissolved oxygen content than the Atlantic water which it to some extent overlies.

2.1.5 Phosphate (Also see 3.1): The distributions of phosphate between the surface and 100 m depth along Sections I-III is shown in Figure 38. On all sections the amount of phosphate in the uppermost 50 m is lower than that in the deep layers. On Section I it has been reduced below the 0.25 μg at /L level over most of the section and this is also the case at the East Greenland ends of Sections II and III.

2.1.6 Silicate (Also see 3.1): The distributions of silicate between the surface and 100 m depth along Sections I-III is shown in Figure 39. As in the case of phosphate, the amount of silicate in the uppermost 50 m is lower than that in the deeper layers and over much of all three sections it is less than 1.0 μg at /L near the surface.

2.1.7. Chlorophyll a: As for NORWESTLANT 1 chlorophyll a determinations have been carried out by Mr. J. H. Steele on samples collected at 20 m depths. The results are shown in Figure 40 and it can be seen that the highest values occur off the west coast of Iceland on Section I and along the edge of the East Greenland shelf on Sections I-V with the values in this area decreasing from north to south. The whole of the Irminger Sea has rather a low level of chlorophyll a but greater quantities are found near the Reykjanes Ridge. The distribution of chlorophyll a on Sections I-III is such that the greater amounts occur where phosphate and silicate levels in the surface layers are low and the dissolved oxygen content is high.

2.2 Plankton. For methods see 3.2

2.2.1 Cod larvae and eggs. (Chart 42, Tables 5 and 6): From chart 42 it is seen that most of the cod larvae were caught between Faxa Bay and Angmagssalik, and none were found south of C. Mosting. The length range is from 7 to 61 mm, with most between 10 and 40 mm, and modes at about 19 mm, 27 mm and 33 mm (Table 5). The food of the larvae in different areas is summarised in Table 6. Most of those examined were feeding on *Calanus finmarchicus* of one stage or another.

A few cod eggs were found in the 2 metre net in two areas. Late stage eggs were present at several stations along the edge of the shelf from west of the Anton Dohrn Bank to C. Mosting: and some early stages were found off Faxa Bay at stations 89, 90 and 111.

2.2.2 Redfish larvae. (Chart 43, Tables 7, 8 and 9). Redfish larvae were scattered throughout the oceanic area, with the largest numbers near the edge of the continental shelf. Surprisingly few were caught at the oceanic stations of the hydrographic sections. The size distribution is given in Table 7. At the ERNEST HOLT stations in the north the range was from 6 to 35 mm, with the modes at about 11 and 20 mm. At the EXPLORER stations further south the range was from 10 to 32 mm, with modes at about 14 mm (mainly St. 133) and 22 mm (mainly St. 110).

Tables 8 and 9 give a summary of the feeding of the larvae: the main food all over the area is early stages of *Calanus finmarchicus*, with a few other copepods, chiefly *Oithona*. Feeding was least in the area of fewer small copepods towards the Denmark Straits. No reliable evidence can be gathered from these cruises about the effect of light on feeding as there was no real darkness.

2.2.3 Other fish larvae and eggs: The larvae of thirteen other species of fish and the eggs of three of these were identified from the samples. Only the commoner species are mentioned here. A few late stage haddock eggs were found over the shelf between Angmagssalik and C. Mosting, and a few larvae in the Denmark Straits. The most widely occurring larvae were those of capelin, at most stations on the shelf between Faxa Bay and Angmagssalik and myctophids at most of the oceanic stations. Eggs of *Drepanopsetta* were found at several stations on the shelf between Angmagssalik and C. Mosting and larvae at many stations between Angmagssalik and Faxa Bay. A few larvae of Reinhardtius occurred at stations between the Anton Dohrn Bank and C. Mosting.

2.2.4 Calanus finmarchicus (Charts 44 and 45): All stages were counted in the Hensen net samples, but only adults and stages I and II are charted, although at many stations stages III and IV were the most numerous. Adults were commonest at the oceanic stations, on the Icelandic side of the Denmark Straits and in the C. Bille area. At many stations on the East Greenland shelf, particularly between Angmagssalik and C. Mosting and off C. Farewell none were found, but it should be noted that these were the earliest stations worked by the two ships. Early copepodite stages were common all along the East Greenland shelf and were particularly abundant in the area off extreme south-east Greenland where adults were scarce.

2.2.5 Other copepods (Chart 46): The commonest of the other copepods was Oithona, which was particularly abundant on the East Greenland shelf in the C. Bille area, and again in the south eastern part of the oceanic area. Pseudocalanus was present at most stations on the Greenland shelf.

2.2.6 Euphausiids (Charts 47 and 47A): Most of the calyptopis and furcilia stages caught in the Hensen nets were those of Thysanoessa longicaudata. Some were present at most stations except off Faxa Bay. They were most abundant along the shelf between C. Mosting and C. Farewell. The adults and late furcilia stages of T. longicaudata caught in the tow nets were most abundant in the oceanic area and near the edge of the shelf in several places. The two charts suggest earlier spawning in the oceanic area.

Meganyctiphanes norvegica adults occurred sporadically near the edge of the shelf. Two very large catches were made by R. V. ERNEST HOLT at stations 72 and 73 near the Anton Dohrn Bank. In the EXPLORER samples furcilia were numerous near C. Farewell and at several stations along the hydrographic section IV.

(There is a suggestion in the EXPLORER results that the 1 metre net was more efficient than the 2 metre net, both for Euphausiids and other species.)

2.2.7 Spiratella (Chart 48): The distribution of Spiratella spp in the Hensen nets was similar to that of young Euphausiids, with few off Faxa Bay and most over the southern part of the Greenland shelf.

2.2.8 Medusae: Some *Aglantha* were found at most stations, although it was absent from stations on the shelf off Faxa Bay and in the Denmark Straits. In the R. V. ERNEST HOLT's sector it was most abundant at the oceanic stations typified by 35, 96, 98, 101 and 104, and also at some stations near the edge of the shelf, such as 50, 59, 68 and 71. In the R. V. EXPLORER's sector it was most abundant at stations near the shelf edge and less so at the oceanic stations.

Periphylla occurred at some oceanic and shelf edge stations in both sectors. *Halopsis* was found at several stations along the outer part of the shelf. *Beroe* was found at most of the shelf stations and some oceanic ones.

(There has not been time for a more detailed discussion of the distribution of these indicator species and their relation to the hydrography.)

2.2.9 Chaetognaths

Sagitta elegans occurred at a few stations on the shelf, being most abundant at ERNEST HOLT station 74 in the Denmark Straits.

S. maxima occurred at most of the oceanic stations, with a few near the edge of the shelf. It was most abundant at ERNEST HOLT stations 98, 101 and 104 and EXPLORER stations 1-7, 22, 24 and 27.

Eukhronia hamata had a similar distribution to *S. maxima*, but was more widespread near the edge of the shelf, particularly in the south. It was most abundant at ERNEST HOLT station 35 and EXPLORER stations 1-9, 110, 132-134 and 21-27.

2.2.10 Settled volume (Table 10): This has been recorded for R.V. EXPLORER's stations only, and shows the greatest volumes at stations near the shelf edge off south-east Greenland, south of 61°N.

2.2.11 General: A first appraisal of the plankton results suggests that there are several areas of high standing stock of zooplankton, notably the northern oceanic part of the area, the Greenland side of the Denmark Straits near the Anton Dohrn Bank, off C. Bille and off C. Farewell. Poor areas are the Icelandic shelf off Faxa Bay and the East Greenland shelf between Angmagssalik and C. Mosting. However a more detailed study, taking account of the hydrography and phytoplankton is necessary before conclusions about the productivity can be made.

3. METHODS

3.1. Hydrography: The methods used aboard R.V. ERNEST HOLT during NORWESTLANT 1 and 3 were as follows:-

	Sampling bottle	Filter	Standing time before analysis	Method	Photometer cell length	Average blank	Standard
S^o/oo	NANSEN TYPE BOTTLES UNCOATED	-	3-5 weeks	Conductivity Auto-Lab. Salinometer	-	-	Copenhagen water
Temp.	NANSEN TYPE BOTTLES UNCOATED	-	-	Reversing thermometer	-	-	-
O_2	NANSEN TYPE BOTTLES UNCOATED	-	Preserved immediately Titrated after 2-14 days	Winkler	-	0	Bi-iodate .005 N
$PO_4^{\equiv}$	NANSEN TYPE BOTTLES UNCOATED	Whatman GF/C < 1μ	6-36 hours	Murphy and Riley	Unicam SP 500 10 cm	0.017	NORWESTLANT standard Supplied by U.K.
$SiO_3^{=}$	NANSEN TYPE BOTTLES UNCOATED	Whatman GF/C < 1μ	6-36 hours	Strickland's manual	Unicam SP 500 10 cm	0.026	NORWESTLANT standard Supplied by U.K.
Chlorophyll	NANSEN TYPE BOTTLES UNCOATED	Whatman GF/A < 1μ	Filtered immediately after collection	Analysed at Marine Laboratory, Aberdeen	See methods used by Marine Laboratory, Aberdeen		

3.2. Plankton

3.2.1. NORWESTLANT 1: At sea

The nets used on the egg survey were the Hensen Net and a 1-metre silk net with 40 meshes/inch. The Hensen Net was used on the southern part of the survey to station 33 with two hauls per station, and the 1-metre net from station 34 onwards with one haul per station. Each net was hauled vertically from 100 metres: each was fitted with a flowmeter in the centre of the mouth, and the flowmeter reading and wire angle were recorded for each haul. Vertical hauls from 100 metres were also made at some of the oceanic stations on the hydrographic sections with a Nansen Net and with the 40 cm net used on British Ocean Weather Ships. The Fine International net was used from 50 metres at hydrographic stations. Because of bad weather tow nets were not used.

3.2.2. NORWESTLANT 1: In the laboratory

Fish eggs and larvae were first picked out of each sample and counted. The larger animals were then picked out and counted, and in a few cases all the animals in the sample were counted: the remainder of the sample was subsampled using a whirling flask and Stempel pipette, and 1/24 (or occasionally 1/30) of the sample counted.

The results were originally tabulated as numbers per haul. These have been converted to numbers under 1 square metre by multiplying by 2.6 for the Hensen Net and Nansen Net, 1.3 for the 1-metre silk net and 8 for the "Weather Ship" net. These numbers have been used for the charts in this report. Calculation of cod egg numbers using the flow-meter readings are presented in column 10, Table 1. It will be seen that they are in most cases lower than those calculated without the flowmeter: but the pattern of distribution is the same.

In drawing the charts the relative areas of the circles represent the relative numbers.

3.2.3. NORWESTLANT 3: At sea

(a) R.V. EXPLORER

Four types of net were used. The Hensen Net was hauled vertically from 100 metres, taking 5 minutes, at all plankton stations. The 2-metre stramin net was lowered to a nominal 50 metres depth with the ship proceeding very slowly or drifting, so that the net would be fishing both down and up: the depth reached was known afterwards from a Kelvin tube. Any attempts at a constant speed of tow were impossible as the rings supplied buckled under quite a small strain. Depths are therefore not constant. At 19 stations (130, 132-6, 110, 18-29) severe damage to the 2-metre ring made it necessary to use a 1-metre net made of silk of 26 meshes/inch. This was lowered to 250 metres at 2 knots and hauled, making an oblique haul, fishing both down and up. The Icelandic High Speed Sampler was towed at each station at 5 knots for 30 minutes, plus 4 minutes for shooting. Log distances were recorded for the tow nets. Flowmeters were not used.

(b) R.V. ERNEST HOLT

The Hensen Net was hauled vertically from 100 metres at each plankton station: a flowmeter was always used. The 2-metre stramin net was used at each plankton station from station 24 onwards. An N.I.O. Depth Telemeter (Bowers and Tucker, 1962) was used with the 2-metre net: the net was shot quickly until a depth of 50 metres was reached, and then hauled in slowly while the ship steamed at 2 knots, taking about 30 minutes. A Kelvin tube was also used as a check; the length of warp required was usually about 250 metres. The Nansen net, "Weather Ship" net and Fine International net were used at all stations on hydrographic sections II and III, as described for NORWESTLANT 1. The Icelandic High Speed Sampler was towed at 12 stations, but the catches were so small that its use was abandoned to save time.

3.2.4. <u>NORWESTLANT 3: In the laboratory</u>

(a) Aberdeen

The Henson Net and Icelandic High Speed Sampler catches were first examined complete and the larger animals counted: the catch was then sub-sampled using a Stempel pipette, and 1/60 counted. The fish larvae and larger animals were sorted out of the 2-metre and 1-metre net catches and counted: the rest of the catch was sub-sampled using a plankton sample splitting device (McEwen, Johnson and Folsom, 1954): the sub-sample varied from 1/2 to 1/512.

Hensen net counts were multiplied by 2.6 to give numbers/square metre. Two-metre and 1-metre net counts were corrected to a 30 minutes tow. Icelandic High Speed Sampler counts were corrected to a tow of 2.5 miles.

(In drawing the charts the 1-metre net counts were multiplied by 4 to make them comparable with the 2-metre net.)

(b) Lowestoft

The Hensen net catches were dealt with as for NORWESTLANT 1: the sub-sample counted was usually 1/30 but, for denser samples, was occasionally 1/60 or even 1/150. The fish larvae and eggs have been sorted out of all the 2-metre net and Icelandic High Speed Sampler catches. The larger animals have been counted from about 2/3 of the 2-metre net catches. Counting of the other species in these samples and the examination of the samples from the other nets is not yet complete. The 2-metre net counts have been adjusted to a 30-minute tow. The charts have been drawn as for NORWESTLANT 1 and the EXPLORER and ERNEST HOLT data are combined.

4. SOUNDINGS

During NORWESTLANT 1-3 a number of the participating research vessels ran lines of soundings. Figure 41 is a summary of these based on the 1:1 Million Plotting Sheets which have reached Mr. Lee so far. These sheets are now being passed to the appropriate GEBCO authorities.

5. References

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Table 1: NORWESTLANT 1: R. V. ERNEST HOLT: Stations

Station No.	Date 1963	Lat. N.	Long. W.	Corrected Depth (m)
1	9 April	56°32'	38°40'	2973
2		57°17'	39°52'	3006
3	10 April	58°03'	41°05'	3277
4		58°35'	41°53'	2878
5		58°30'	43°00'	2613
6		58°45'	42°14'	2538
7	11 April	59°00'	42°38'	1901
8		59°15'	43°02'	1362
9		59°30'	43°27'	0219
10		59°37'	43°41'	0170
11	12 April	59°38'	42°40'	1084
12		59°38'	42°21'	1845
13		59°48'	42°40'	223
14		60°00'	42°40'	183
15		60°00'	42°20'	320
16	13 April	60°00'	42°00'	1661
17		60°00'	41°40'	1959
18		60°20'	41°20'	1940
19		60°24'	41°58'	1143
20		60°20'	42°20'	459
21		60°20'	42°33½'	459
22		60°40'	42°20'	413
23	14 April	60°40'	42°00'	554
24		60°40'	41°40'	1569
25		60°40'	41°20'	1904
26	15 April	61°00'	40°58'	1962
27		61°00'	41°40'	234
28		61°00'	41°55'	379
29		61°20'	41°44'	207
30		61°20'	41°20'	894
31		61°20'	40°58'	1756
32		61°40'	41°35'	225
33	16 April	61°40'	40°53'	1180
34	19 April	62°38½'	39°55½'	1459
35		62°30'	40°17½'	1608
36		62°20'	40°40'	534
37		62°10'	40°19'	1300
38		62°00'	40°42'	1534
39		62°00'	41°04'	203
40		62°00'	41°24'	243
41		62°10'	41°02'	516
42	20 April	62°20'	41°02'	669
43		62°30'	41°02'	543
44		62°30'	40°40'	179
45		62°40'	40°40'	761
46		62°50½'	40°19'	1494
47		62°55½'	40°39'	633
48		63°04'	40°23½'	234
49		63°12'	40°09½'	452
50		63°06'	39°50'	1551
51	24 April	63°23'	26°48'	1278
52	25 April	60°59½'	34°00½'	3094
53	26 April	61°30½'	35°50'	2982
54		62°10'	37°27½'	2598
55		62°25½'	38°02'	2428
56		62°40½'	38°41'	2249
57	28 April	62°53'	39°13½'	1848
58		63°06'	39°56½'	1402
59		63°11'	40°06'	387

Table 1 (Continued): NORWESTLANT 1: R. V. ERNEST HOLT: Stations

Station No.	Date 1963	Lat. N.	Long. W.	Corrected Depth (m)
60A	28 April	62°27½'	40°40'	212
60		62°27½'	40°42'	254
61	29 April	62°34'	40°36½'	210
62	30 April	61°00'	41°45'	241
63		60°49½'	41°19'	2006
64		60°35'	40°39'	2424
65		60°11'	39°45'	2651
66	1 May	59°31'	38°16'	3211
67		58°55'	36°56'	3226

TABLE 2: NORWESTLANT 1: R.V. ERNEST HOLT: Cod eggs and larvae

1	2	3	4	5	6	7	8	9	10	11
Station	Nets	Egg stages % Age						Eggs/M²		Larvae total catch
		IA	IB	II	III	IV	V	No F.M.	With F.M.	
1-7	H.2.							0	0	
8	"				25	38	38	21	19	
9	"	6	9	52	31	2	1	438	342	1
10	"	8	32	41	16	2	1	120	83	
11	"	55	10	17	9	7	1	90	63	
12	"							0	0	
13	"		8	23	54	15		17	10	
14	"	15	12	48	22	3		85	43	2
15	"	18	19	41	17	3	2	488	303	1
16	"	1	10	40	33	10	6	231	136	3
17	"			50	25		25	5	3	
18	"							0	0	
19	"	16	40	32	12			33	26	
20	"	36	40	15	5	3		229	131	
21	"	21	54	17	7	1	1	157	90	
22	"	11	36	43	11			36	22	
23	"	27	18	37	15	3	1	229	122	
24	"	23	22	31	17	5	2	178	101	
26	"							0	0	
27	"	5	18	43	30	5		57	28	
28	H.1.			50	50			21	13	
29	H.2.	5	15	60	15	5		26	19	
30	"	17	30	30	18	2	4	126	84	1
31	"							0	0	
32	"		48	41	11			35	19	
33	"			25	75			5	3	
34	1M.S.							0	0	
35	"							0	0	
36	"	4	24	27	39	4	2	516	223	
37	"		5	50	40	5		26	15	
38	"			24	35	24	18	22	9	
39	"	2	13	38	37	5	6	131	75	
40	"	4	15	35	39	7		125	75	
41	"	7	9	37	41	3	3	117	70	
42	"	3	18	36	35	6	3	525	309	
43	"	45	18	23	10	2	2	78	52	
44	"	33	21	34	9	2		353	139	
45	"	25	52	16	3	3	1	1203	516	
46	"	13	67	21				31	15	
47	"	34	14	18	25	8	1	100	60	
48	"	71	7	14	7			18	13	
49	"			100				1	1	
50	"							0	0	
52-57	VAR							0	0	
58	1M.S.							0	0	
59	"		33	60	7			20	13	
61	"	51	30	15	3	1		209	134	
62	"	27	16	19	26	11		114	143	
63	"	40	60					7	8	
64	"	100						1	1	
65-67	VAR							0	0	

Key to Table 2

Column 1:	H.2. Hensen net, 2 hauls from 100 metres.
	H.1. Hensen net, 1 haul from 100 metres.
	1M.S. 1 metre silk net (40 meshes/inch) 1 haul from 100 metres.
	VAR. Various vertical net hauls.
Columns 3-8:	Stages are from Apstein (see notes).
Column 9:	No F.M. not using flowmeter readings.
Column 10:	F.M., using flowmeter readings.

TABLE 3: NORWESTLANT 1: R.V. ERNEST HOLT: Chaetognaths presence or absence

Station	Sagitta elegans	Sagitta maxima	Eukhronia hamata
1			
2			
3			
4			
5			+
6			
7			
8	+	+	+
9	+		
10			+
11			
12			
13			
14			
15	+		
16	+		+
17			+
18		+	+
19			
20			
21			
22			
23	+		
24	+		
26		+	+
27			
28			
29			
30			
31			
32	+		
33	+	+	+
34		+	+
35		+	+
36			+
37		+	+
38		+	+
39			
40			
41	+		
42	+		
43	+		+
44	+		
45	+		+
46			+
47			
48			+
49			
50		+	+
52			+
53			+
54			+
55		+	+
56			
57		+	+
58			+
59		+	
61			
62			
63		+	+
64		+	+
65			+
66			+
67			+

Table 4: NORWESTLANT 3: R. V. ERNEST HOLT and R. V. EXPLORER: Stations

R. V. ERNEST HOLT

Station No.	Date 1963	Lat. N.	Long. W.	Corrected Depth (m)
1A	27 June	58°30'	09°58'	1821
2	30 June	65°53'	28°08'	561
3		65°49'	27°48'	704
4		65°43'	27°33'	608
6	1 July	65°34'	27°08'	378
7		65°22'	26°36'	175
8		65°12'	25°58'	140
9		64°59'	25°20'	146
10		64°48'	24°46'	193
11	2 July	64°09'	23°01'	73
12		64°08'	24°06'	296
13		64°10'	25°23'	278
14	3 July	64°03'	26°32'	351
15		64°01'	27°44'	1185
16		64°00'	28°54'	1554
17		63°53'	30°06'	2228
18		63°51'	31°11'	2752
19		63°50'	32°30'	2696
20		63°45'	33°40'	2564
21		63°44'	34°56'	2228
22	4 July	63°39'	36°13'	2129
23		63°36'	37°21'	315
24		63°33½'	37°44'	267
25		63°53'	38°12'	240
26		64°05½'	38°35'	305
27		63°58'	38°28'	258
28		63°50'	37°32'	315
29		63°46'	37°10½'	324
30	5 July	63°50½'	36°15'	1478
31		63°58'	36°30'	333
32		64°03'	36°44'	373
33		63°57'	36°07'	1236
34		64°01'	35°39'	1785
35		63°28'	33°49½'	2695
36		63°43'	34°18'	2377
37	6 July	63°59'	34°44'	2037
38		64°15'	35°10'	1570
39		64°22'	35°18'	378
40		64°27'	35°26'	369
41		64°41'	35°42'	497
42		64°51'	35°57½'	332
43	7 July	64°30'	34°28'	1523
44		64°41½'	33°53'	1309
45		64°49'	34°09'	1033
46		64°58'	34°25'	816
47		65°03'	34°39'	333
48		65°17'	33°54'	271
49		65°10'	33°41'	688
50	8 July	64°54'	33°12'	1719
51		65°05'	32°33'	1772
52		65°22½'	33°08'	633
53		65°38'	33°26'	267
54		65°35½'	32°18'	287
55		65°29'	32°10'	843
56		65°23'	31°57'	1108
57	9 July	65°08'	31°31'	1624
58		65°09'	31°28'	1636
59		64°51'	31°00'	2185

Table 4: NORWESTLANT 3: R. V. ERNEST HOLT and R. V. EXPLORER: Stations (Continued)

Station No.	Date 1963	Lat. N.	Long. W.	Corrected Depth (m)
60	10 July	64°32½'	30°36'	2414
61		64°49'	30°57'	2167
62		65°23'	31°05'	797
63		65°30'	30°30'	379
64		65°24'	30°21'	724
65		65°15½'	30°08'	1346
66		65°10'	29°36'	1679
67	11 July	65°04'	29°00'	1421
68		65°19'	29°30'	1403
69		65°29'	29°50'	797
70		65°39'	30°02'	369
71		65°31'	28°57'	1181
72		65°41'	29°09'	779
73	12 July	65°42'	28°24'	1017
74		65°53½'	28°01'	687
75		65°49'	27°52'	715
76		65°42'	27°36'	651
77		65°31'	27°49'	706
78		65°37'	27°15'	497
79		65°25'	26°34'	179
80A		65°27'	26°35½'	198
80		65°16'	26°42'	190
81A		65°16'	26°40'	190
81		65°11'	26°39'	183
82	14 July	65°09'	26°55'	240
83		65°10'	27°41'	779
84		64°51½'	27°40'	737
85		64°50½'	26°55'	287
86		64°50'	26°10'	203
87	15 July	64°50'	25°25'	185
88		64°48'	24°44'	207
89		64°25'	24°15'	185
90		64°20½'	24°55'	214
91		64°18'	25°40½'	315
92		64°11'	26°25'	351
93		64°06'	27°06'	834
94	16 July	63°53'	28°59'	1704
95		63°03'	31°24'	2716
96		62°43'	32°07'	2962
97		62°21'	31°27½'	2659
98		62°05'	30°36'	2284
99	17 July	61°44½'	29°54'	2180
100		61°25'	29°05'	1435
101		60°43½'	27°33'	1536
102		61°21'	26°55'	1611
103	18 July	61°58'	26°19'	647
104		62°34'	25°46'	643
105		62°52'	26°30'	1379
106		63°13'	27°20'	1239
107		63°25'	26°25'	1017
108		63°32'	25°41'	342
109	19 July	63°41'	25°01'	444
110		63°49'	24°20'	351
111		63°55½'	23°46'	150

R. V. EXPLORER

Station No.	Date 1963	Lat. N.	Long. W.	Corrected Depth (m)
1	2 July	55°30'	29°25'	2979
2		56°10'	30°45'	2821
3		56°51'	32°15'	2499
4	3 July	57°31'	33°43'	1348
5		58°12'	35°15'	2622
6		58°53'	36°46'	2637
7	4 July	59° 34'	38° 16'	2990

Table 4: NORWESTLANT 3: R. V. ERNEST HOLT and R. V. EXPLORER: Stations (Continued)

Station No.	Date 1963	Lat. N.	Long. W.	Corrected Depth (m)
8	4 July	60°12'	39°45'	2434
9		60°35'	40°40'	2363
10		60°50'	41°18'	1832
11	5 July	61°00'	41°45'	453
12		61°05'	41°51'	453
116		61°00'	41°40'	
117		61°00'	40°58'	
118		60°40'	41°20'	
119		60°40'	41°40'	
120		60°40'	42°00'	
124		60°20'	41°20'	
123		60°20'	42°00'	
122		60°20'	42°40'	
128		60°00'	42°20'	
127	7 July	60°00'	42°00'	
126		60°00'	41°40'	
125		60°00'	41°20'	
131		59°38'	42°00'	
130		59°38'	42°40'	
136		59°30'	43°22'	
135		59°15'	43°02'	
134	8 July	59°00'	42°38'	
133		58°45'	42°14'	
132		59°20'	42°00'	
110	9 July	61°20'	40°38'	
108		61°40'	40°53'	
109		61°40'	40°12'	
103		62°00'	40°42'	
102		62°00'	40°20'	
101		62°00'	39°58'	
100		62°10'	39°55'	
95		62°20'	39°55'	
99		62°10'	40°40'	
96		62°19'	40°34'	
93		62°26'	40°18'	
94		62°30'	39°55'	
86	11 July	62°40'	39°55'	
16		63°09½'	40°03'	1010
17		63°06'	39°50'	1357
79		63°34'	39°31'	
75		63°42'	38°50'	
76		63°33'	38°37'	
77		63°25'	38°24'	
78		63°14'	39°00'	
18	12 July	62°53'	39°15'	1683
19	13 July	62°40'	38°40'	2125
20		62°25'	38°02'	2337
21		62°10'	37°27'	2468
22		61°30'	35°50'	2861
23	14 July	60°53'	34°10'	2899
24		60°12'	32°30'	2412
25	15 July	59°30'	30°53'	1488
26		58°50'	29°10'	2064
27		58°05'	27°30'	2243
28	16 July	60°04'	26°10'	2190
29		61°52'	24°15'	1668

Table 5: NORWESTLANT 3: Length of cod larvae in mm

Length	No.
5- 9	2
10-14	19
15-19	63
20-24	70
25-29	62
30-34	46
35-39	17
40-44	15
45-49	1
50-54	2
55-59	0
60-65	1

Table 6: NORWESTLANT 3: Feeding of COD larvae

Stations	Size Range mm	Number of Stomachs Examined	Stomach contents
86-111	18-61	21	Mixed: including Cal. fin. V + ♀ Oithona, Amphipod juv. and Spiratella retroversa.
74-83	11-43	49	Mainly: Cal. fin. IV + ♀ but also I-III and nauplii. Some: Oithona, Euphausiid furcilia, Amphipod juv.
69-73	18-52	14	Spiratella helicina and S. retroversa: some: Cal. fin. III-V.
55-67	11-42	29	Mainly: Cal. fin. I-IV, also V + ♀ and nauplii. Some: Euphausiid furcilia, Amphipod juv., Paracalanus.
48-54	7-28	4	Very little

Table 7: NORWESTLANT 3: Length of REDFISH larvae in mm

Length	Number	
	E. HOLT	EXPLORER
5- 9	37	
10-14	110	54
15-19	85	61
20-24	124	118
25-29	13	11
30-34	1	1
35	1	
Total	371	245

Table 8: NORWESTLANT 3: Feeding of REDFISH larvae: (ERNEST HOLT stations)

Stations	Size Range mm	Number of Stomachs Examined	Stomach contents
96-106	8-35	15	Cal. fin. I-V. Oithona: some copepod nauplii
72-93 107-115	8-26	36	Mostly EMPTY: few copepod nauplii
58-71	6-26	24	Copepod nauplii: Cal. fin. I some empty
43-52	7-26	32	Cal. fin. II-III Some: Copepod nauplii, Euphausiid furcilia: amphipod juvs.
29-38	7-27	43	Cal. fin. I-II and nauplii: some: Cal. fin. III-IV: few Euphausiid nauplii.

Table 9: NORWESTLANT 3: Feeding of REDFISH larvae (EXPLORER stations)

Average number of food organisms per stomach in four categories (including empty stomachs)

Number of Larvae	Size Range mm	Copepod eggs	Copepod Nauplii	Copepodites and Adults	Misc.	% Age Empty Stomachs
41	< 15	1.7	1.0	0.9	0.05	44
40	16-20	2.7	1.4	3.2	0.1	35
23	21-25	0.3	0.6	2.3	0.3	35
>	> 26	0.6	0.3	3.8	0.8	0

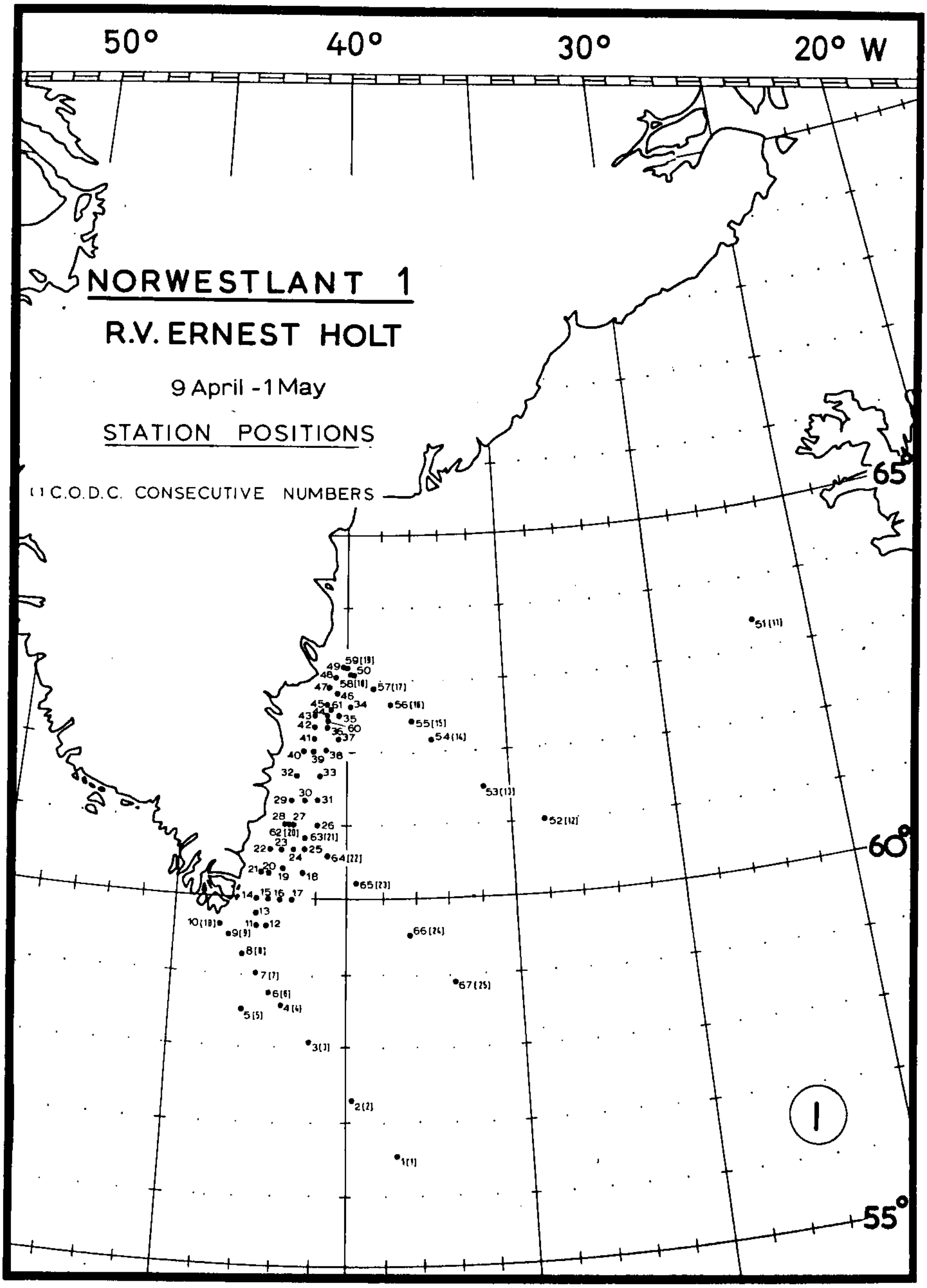
Table 10: NORWESTLANT 3 : Settled volumes (cc) of Hensen and I.H.S.S. samples (EXPLORER stations)

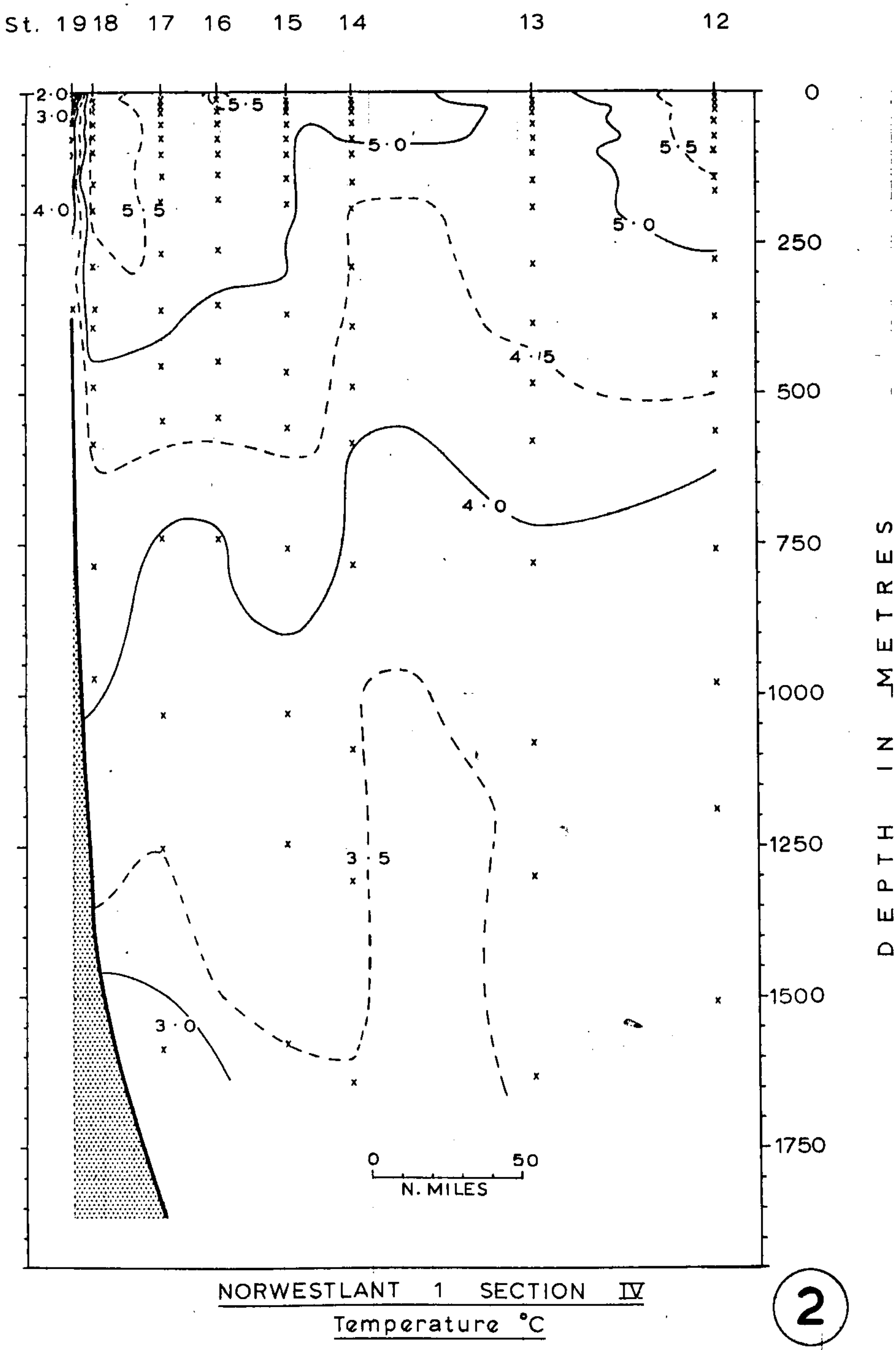
HENSEN

Station number	Settled volume (cc)	Station number	Settled volume (cc)
1	55	110	35
2	60	108	45
3	55	109	35
4	55	103	55
5	45	102	35
6	65	101	50
7	35	100	25
8	25	99	30
9	55	96	40
10	55	93	35
11	60	94	55
115	20	86	25
116	85	16	25
117	85	17	95
118	40	79	30
119	80	75	15
120	80	76	20
124	35	77	60
123	10	78	45
122	20	18	50
128	45	19	55
127	60	20	75
126	85	21	No sample
125	105	22	No sample
131	20	23	No sample
130	30	24	50
136	95	25	50
135	50	26	25
134	80	27	15
133	85	28	30
132	95	29	45

I.H.S.S.

Station number	Settled volume (cc)	Station number	Settled volume (cc)
1	40	110	35
2	40	108	45
3	35	109	45
4	35	103	35
5	25	102	15
6	20	101	50
7	30	100	70
8	25	99	15
9	35	96	15
10	25	93	15
11	35	94	10
115	20	86	55
116	10	16	5
117	55	17	5
118	20	79	5
119	35	75	30
120	45	76	5
124	10	77	5
123	15	78	15
122	30	18	35
128	5	19	15
127	35	20	10
126	55	21	5
125	45	22	10
131	10	23	20
130	5	24	15
136	10	25	15
135	15	26	15
134	70	27	20
133	30	28	25
132	35	29	30

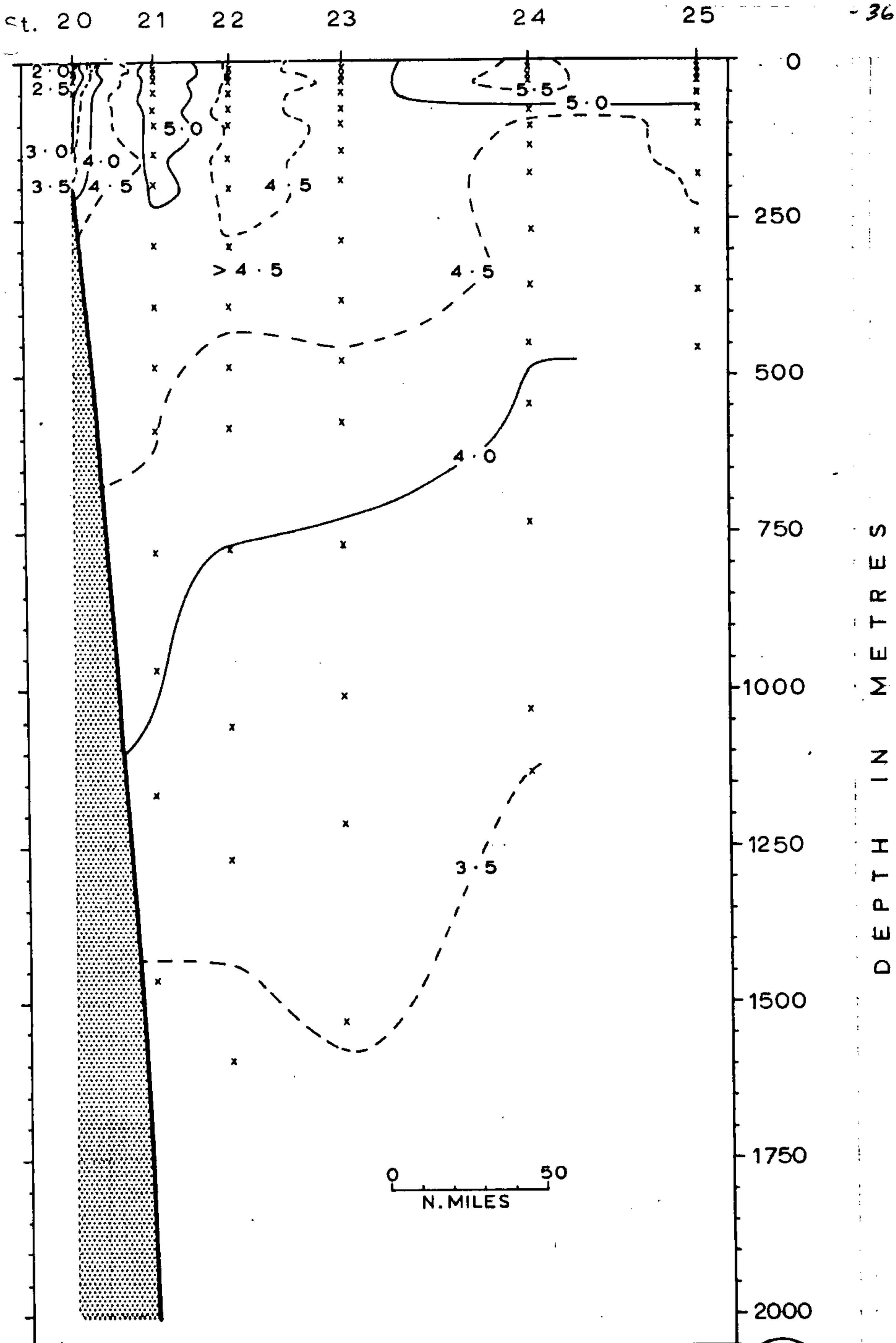

50°
40°
30°
20° W
NORWESTLANT 1
R.V. ERNEST HOLT
9 April - 1 May
STATION POSITIONS
( ) C.O.D.C. CONSECUTIVE NUMBERS
65°
60°
55°
1



NORWESTLANT 1 SECTION IV

Temperature °C

25 — 28 APRIL 1963

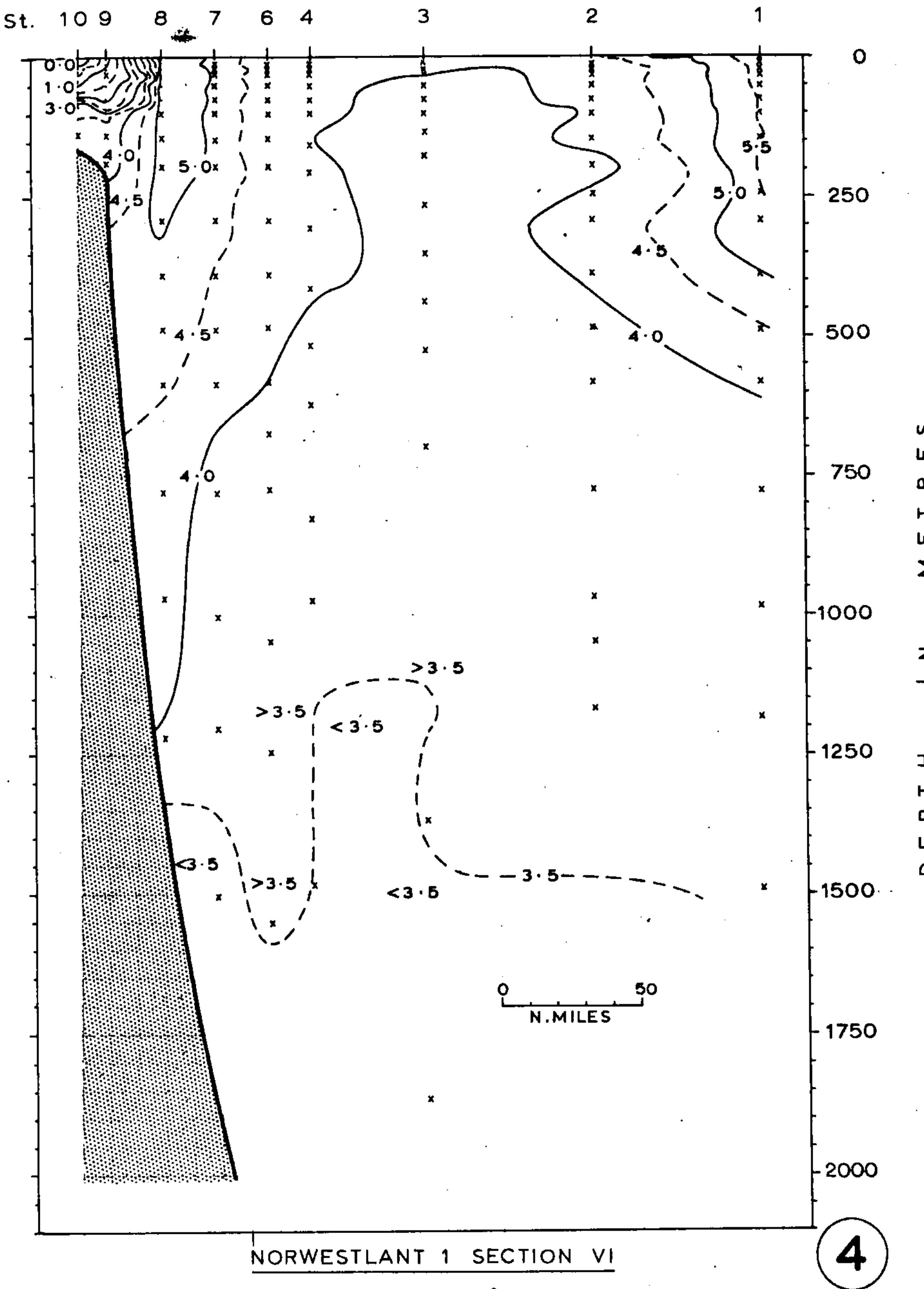


3

NORWESTLANT 1 SECTION V

Temperature °C

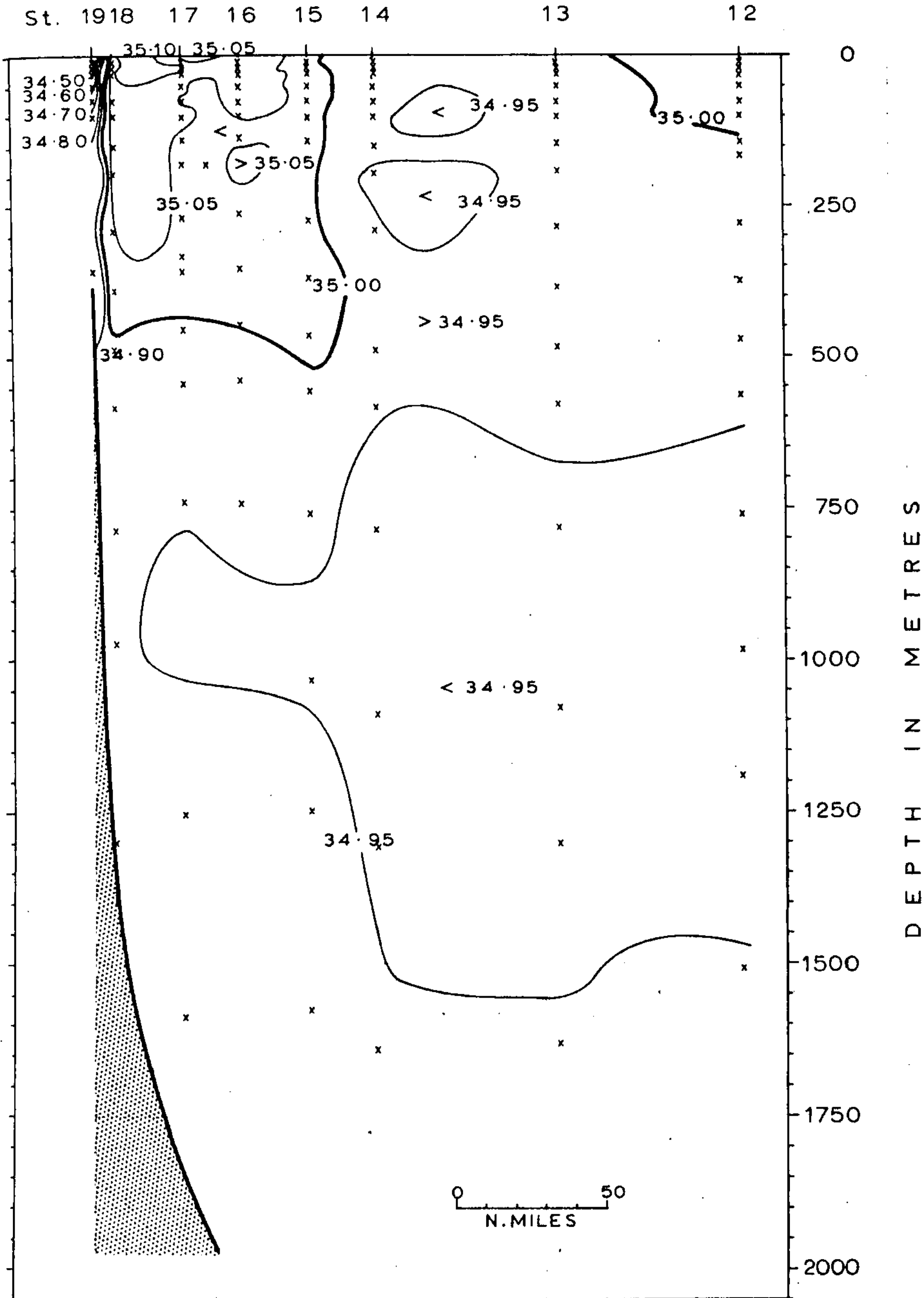
30 APRIL — 1 MAY 1963



NORWESTLANT 1 SECTION VI

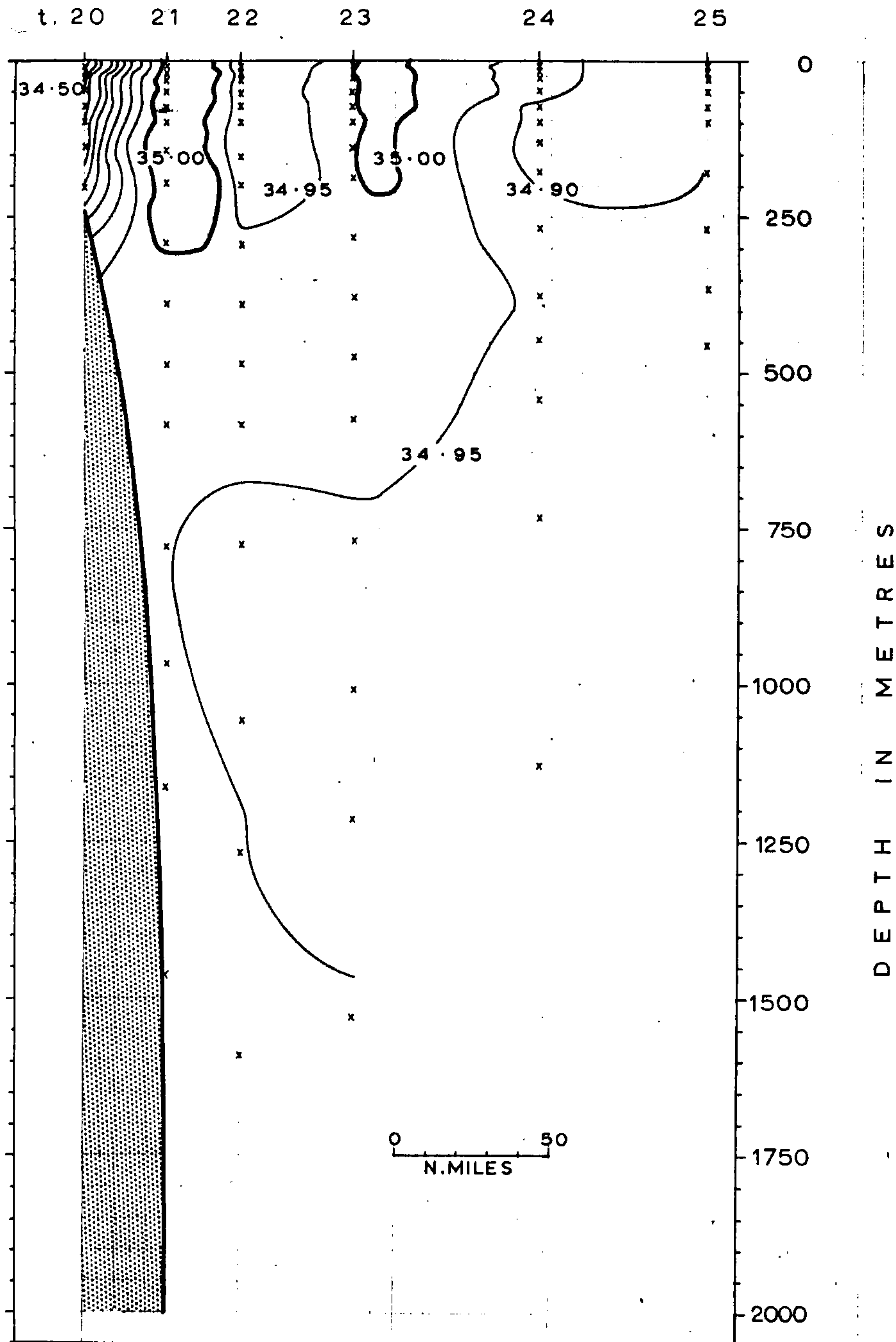
Temperature °C

9 – 11 APRIL 1963



NORWESTLANT 1 SECTION IV
Salinity ‰
25—28 APRIL 1963

5

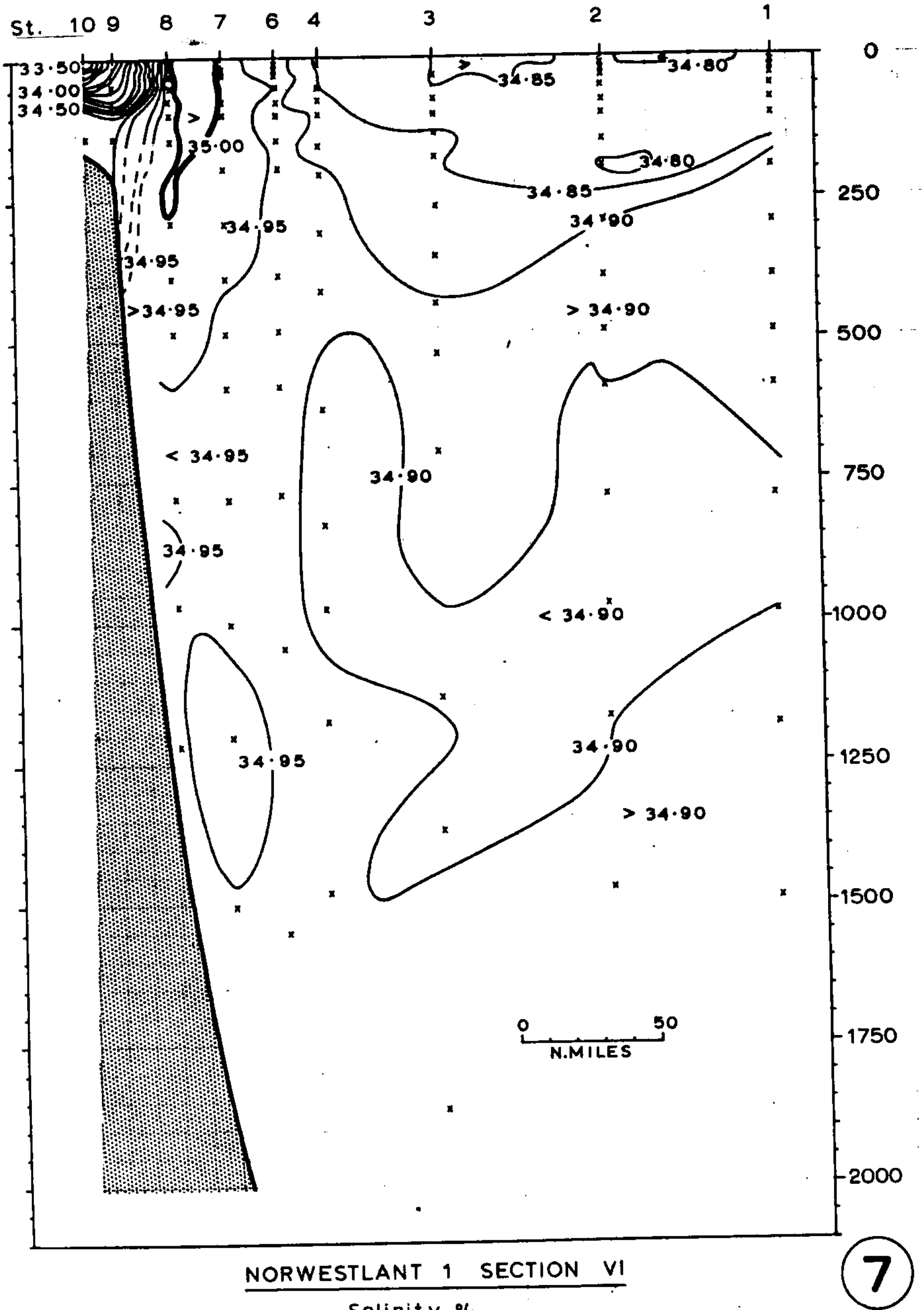


NORWESTLANT 1 SECTION V

Salinity ‰

30 APRIL — 1 MAY 1963

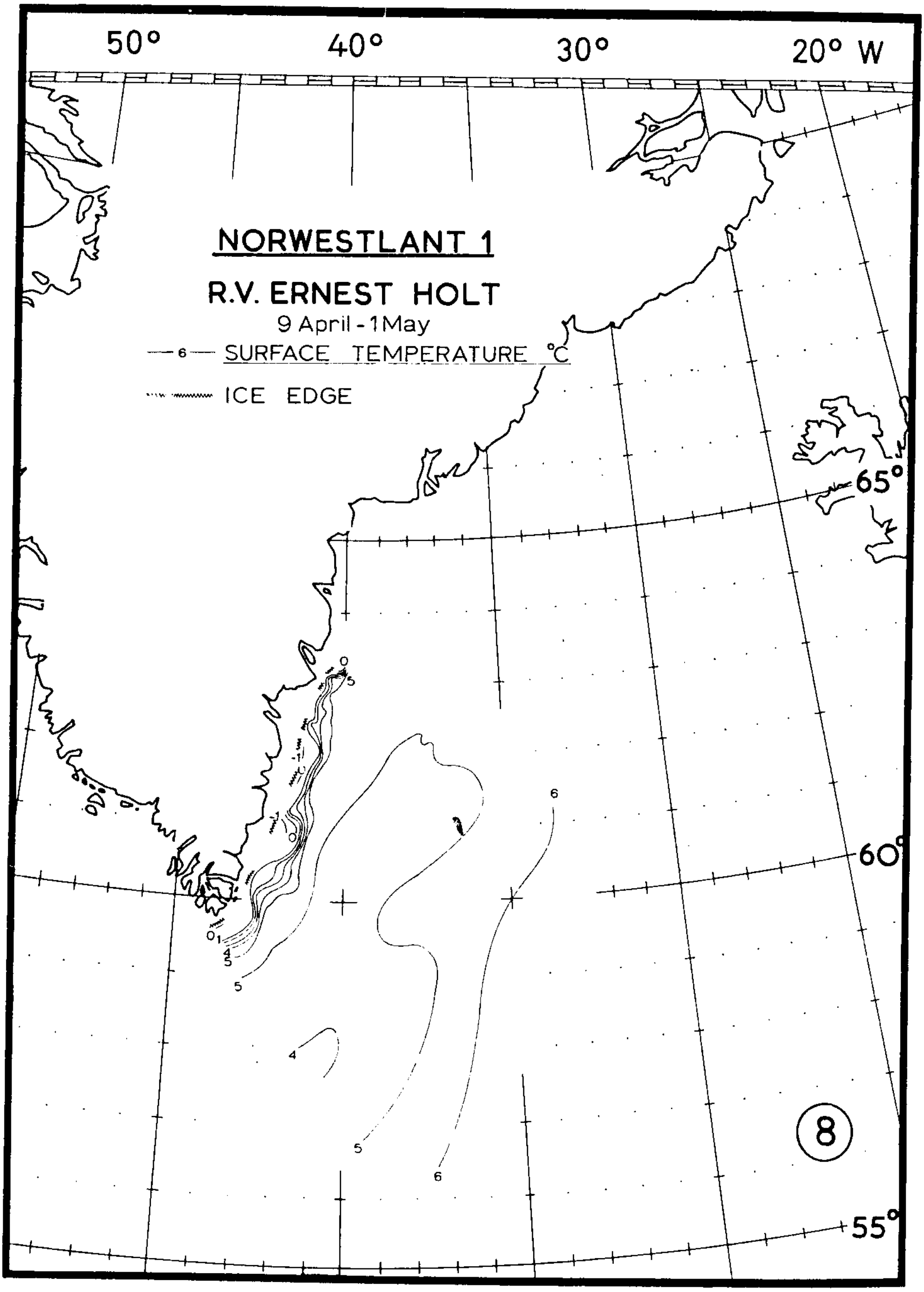
6

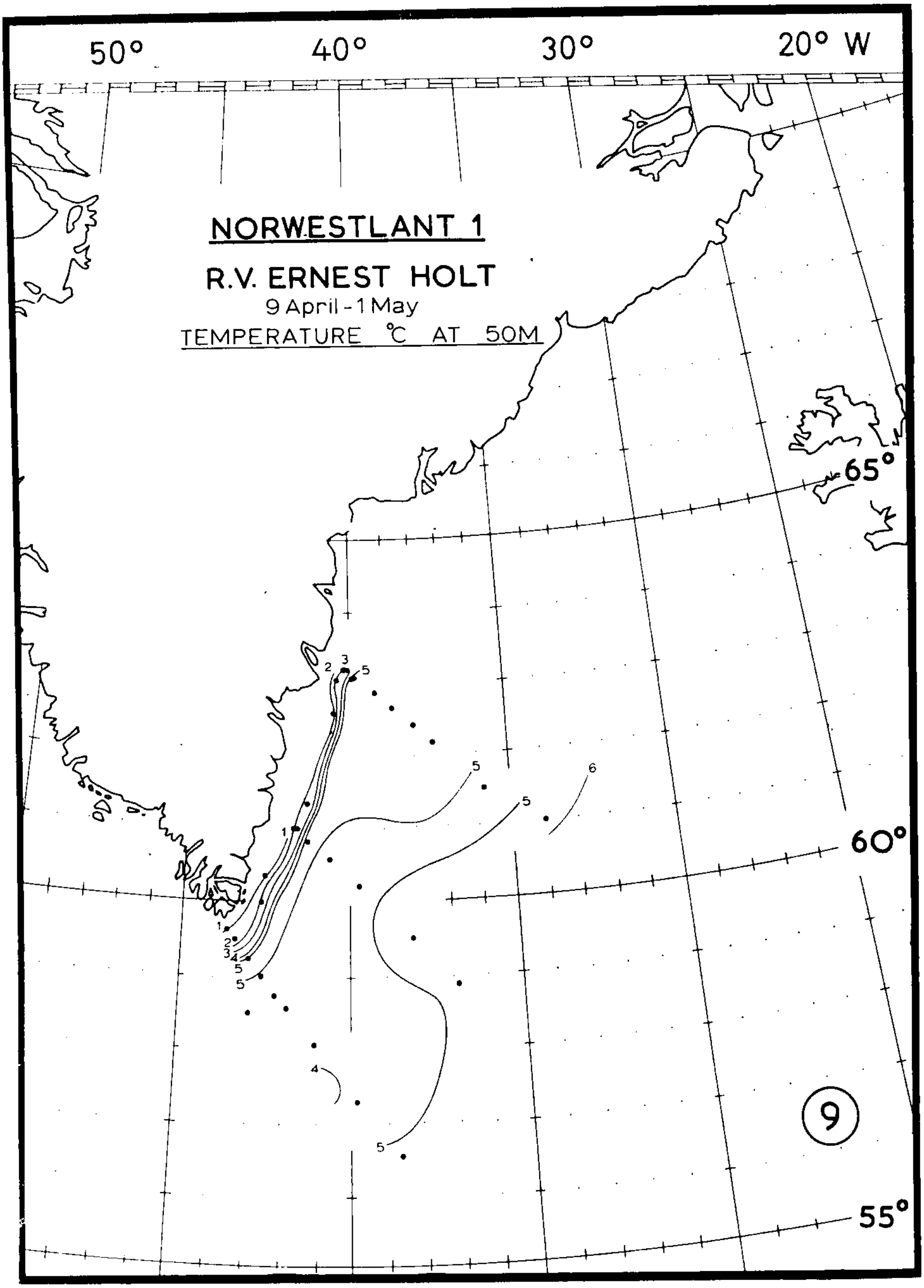


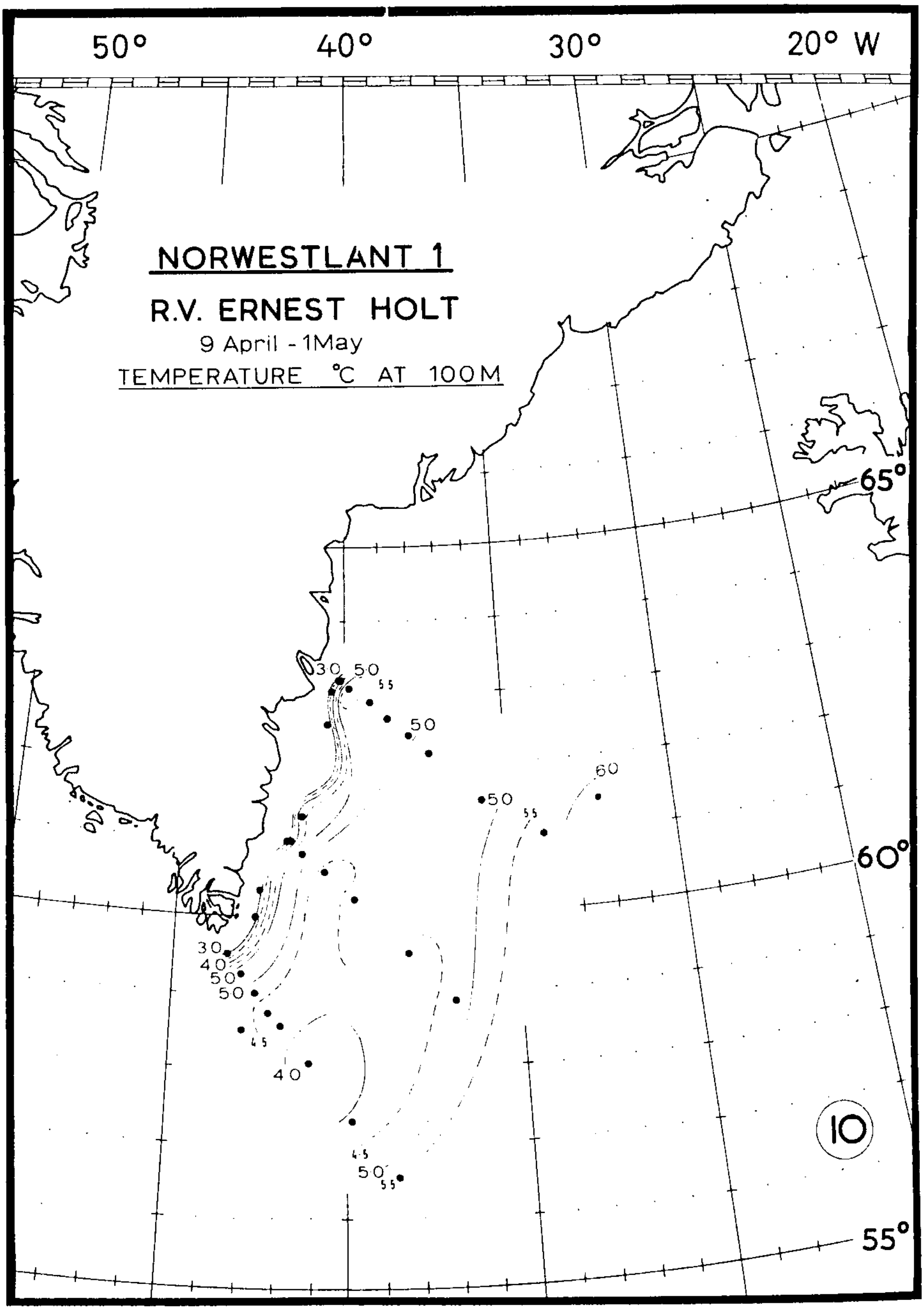
NORWESTLANT 1 SECTION VI

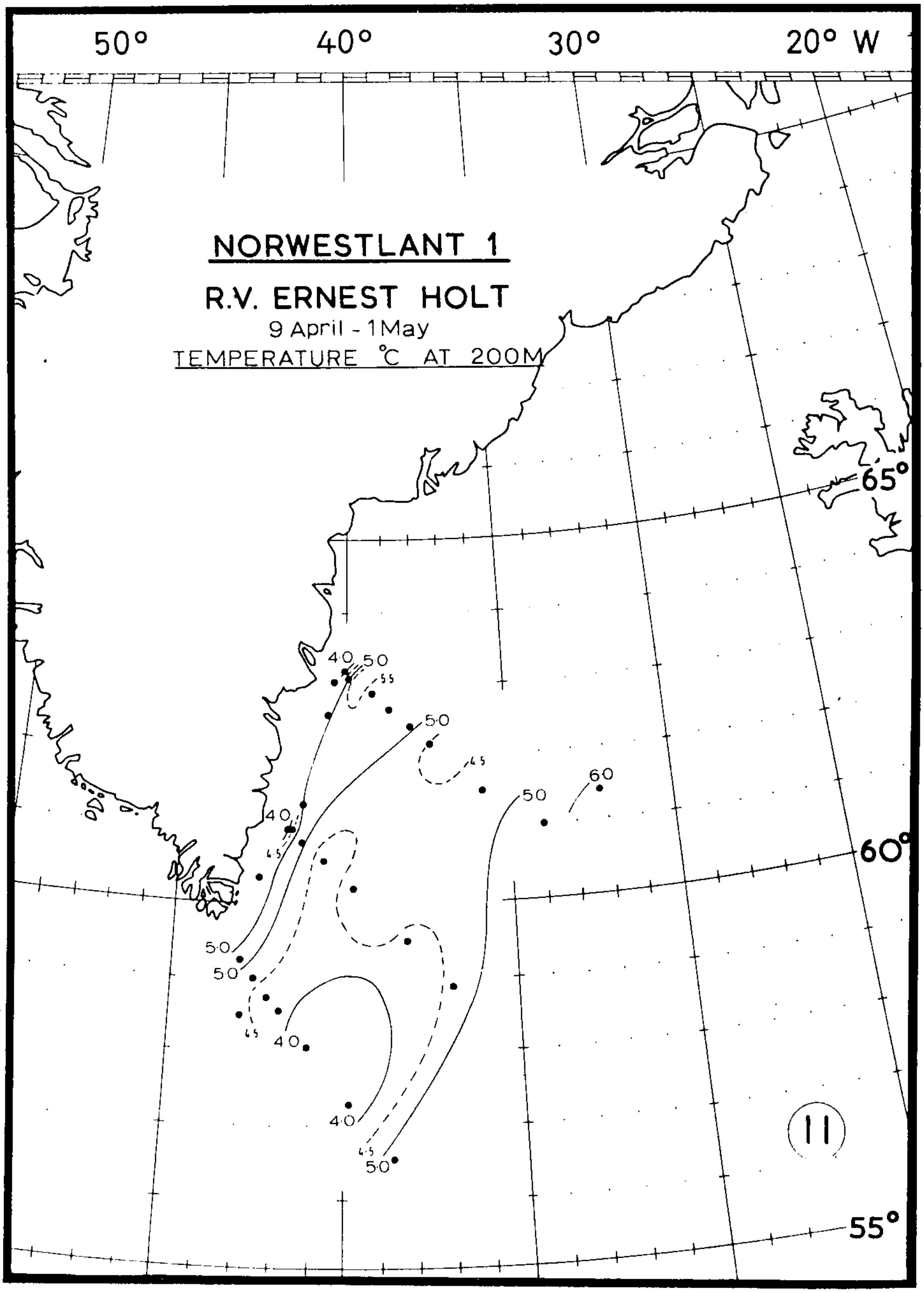
Salinity ‰

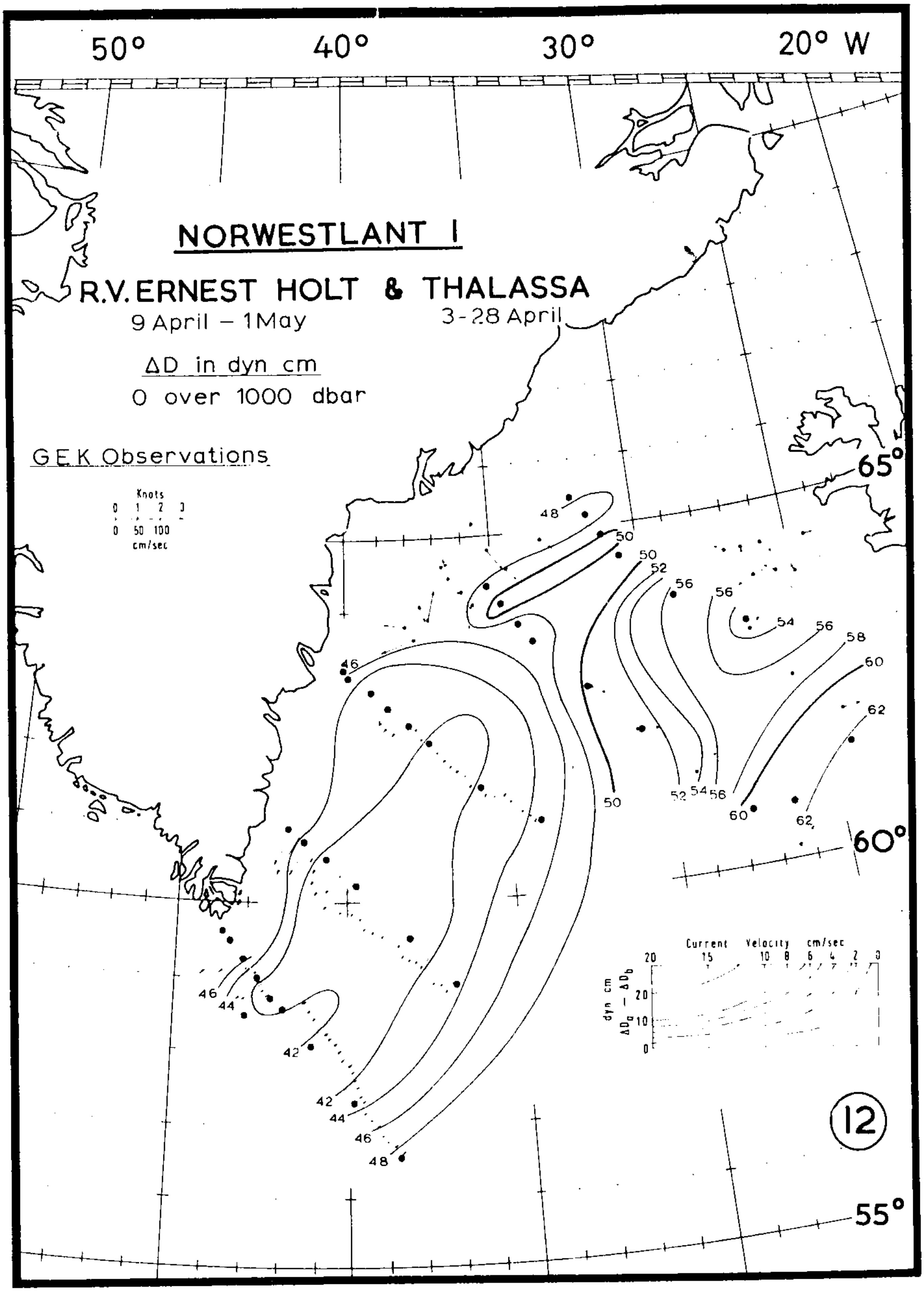
9 – 11 APRIL 1963


50°
40°
30°
20° W
NORWESTLANT 1
R.V. ERNEST HOLT
9 April - 1 May
— 6 — SURFACE TEMPERATURE °C
ICE EDGE
65°
60°
55°
0
5
0
0
1
4
5
5
4
5
6
6
8


50°
40°
30°
20° W
NORWESTLANT 1
R.V. ERNEST HOLT
9 April - 1 May
TEMPERATURE °C AT 50M
65°
60°
55°
9


50°
40°
30°
20° W
65°
60°
55°
NORWESTLANT 1
R.V. ERNEST HOLT
9 April - 1May
TEMPERATURE °C AT 100M
10

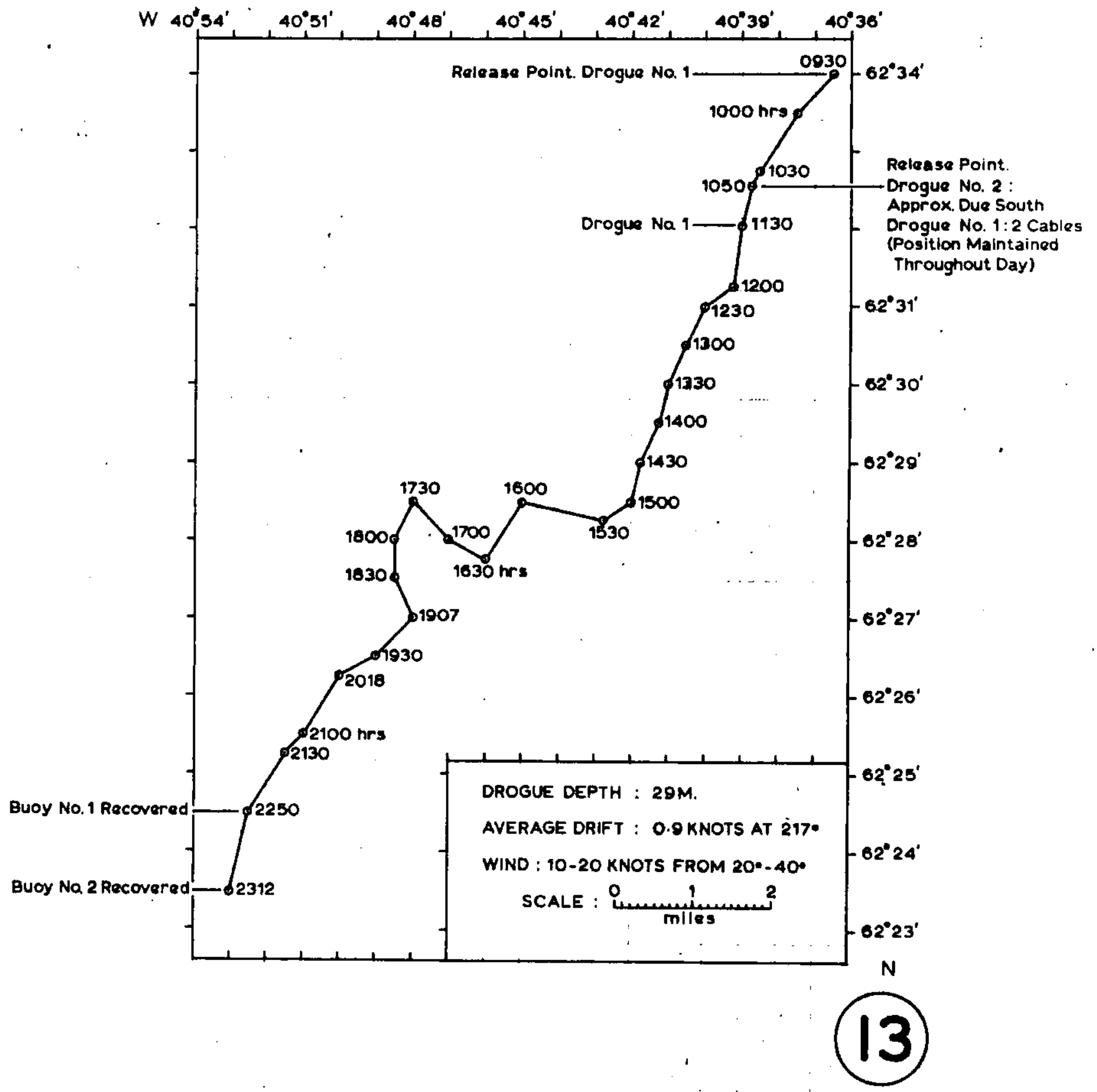

50°
40°
30°
20° W
NORWESTLANT 1
R.V. ERNEST HOLT
9 April - 1 May
TEMPERATURE °C AT 200M
65°
60°
55°
4·0
5·0
6·0
11


50°
40°
30°
20° W
NORWESTLANT I
R.V. ERNEST HOLT & THALASSA
9 April – 1 May
3-28 April
ΔD in dyn cm
0 over 1000 dbar
GEK Observations
Knots
cm/sec
65°
60°
55°
Current Velocity cm/sec
12

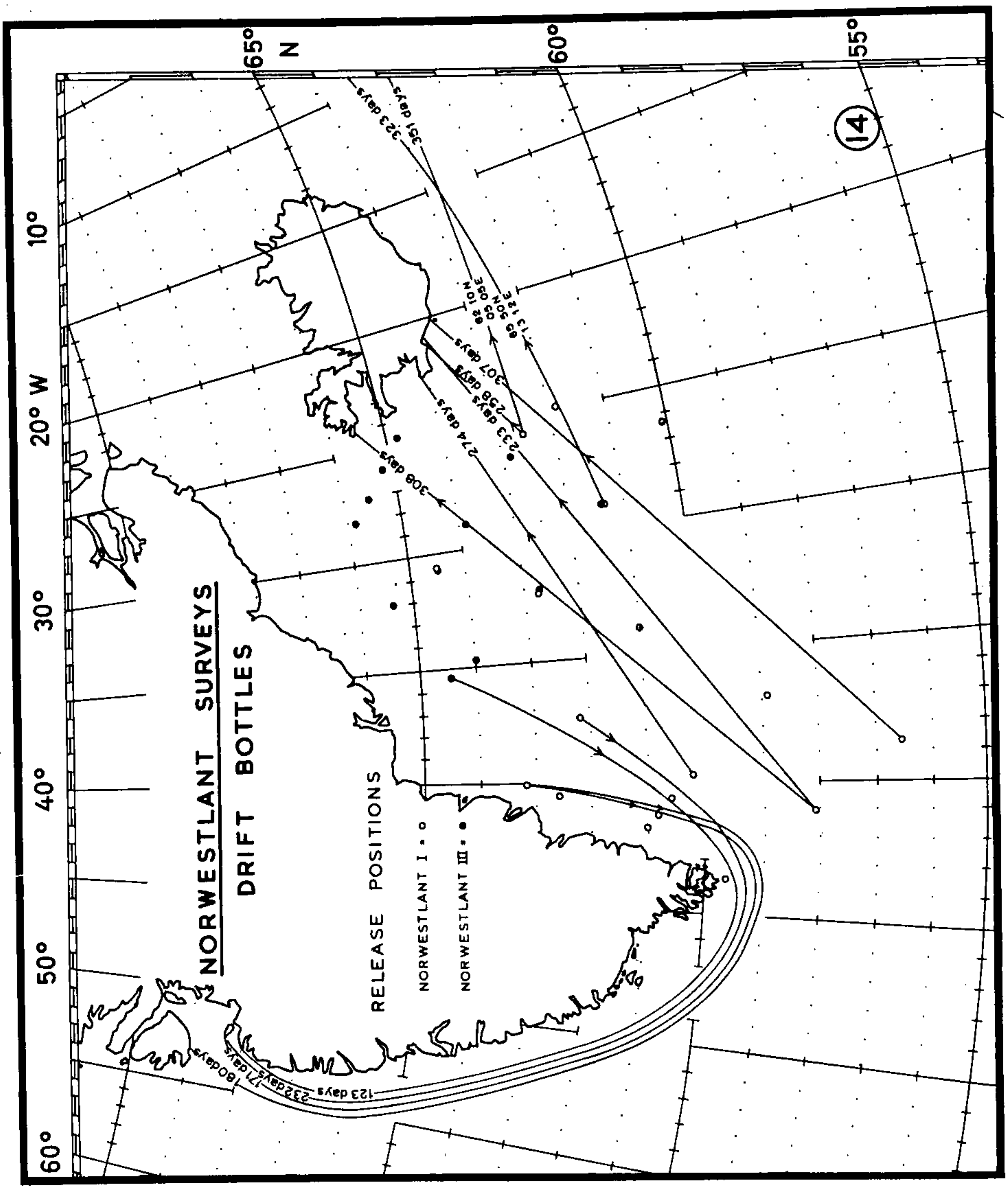
NORWESTLANT 1 R.V. ERNEST HOLT

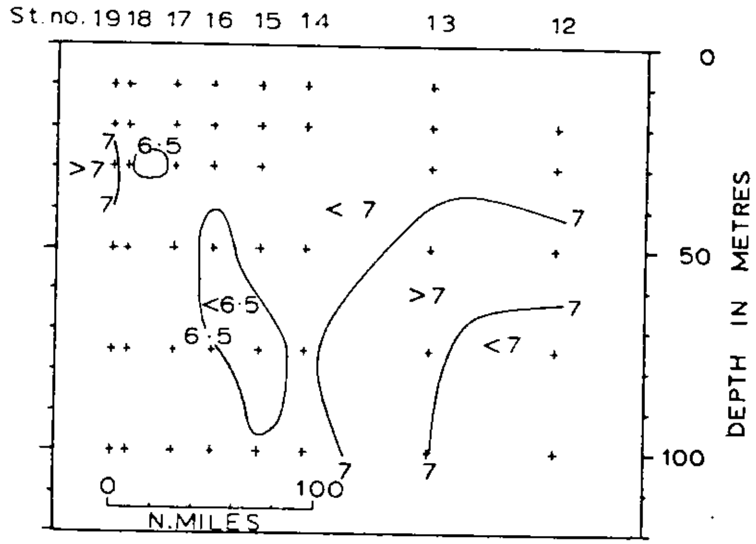
CURRENT OBSERVATIONS USING PARACHUTE DROGUES

APRIL 29th 1963

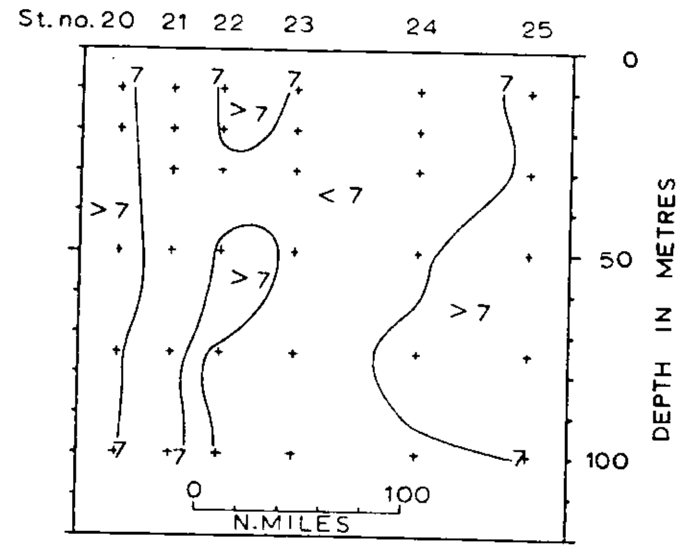


13

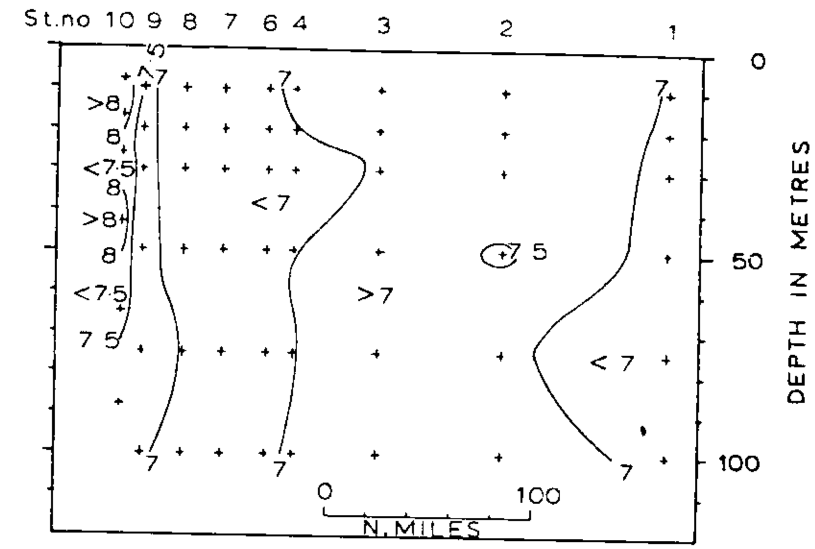

NORWESTLANT SURVEYS
DRIFT BOTTLES
RELEASE POSITIONS
NORWESTLANT I • o
NORWESTLANT III • ●
14
65° N
60°
55°
10°
20° W
30°
40°
50°
60°
351 days
323 days
307 days
258 days
233 days
274 days
308 days
123 days
232 days
171 days
180 days



SECTION IV
25-28 APRIL



SECTION V
30 APRIL – 1 MAY

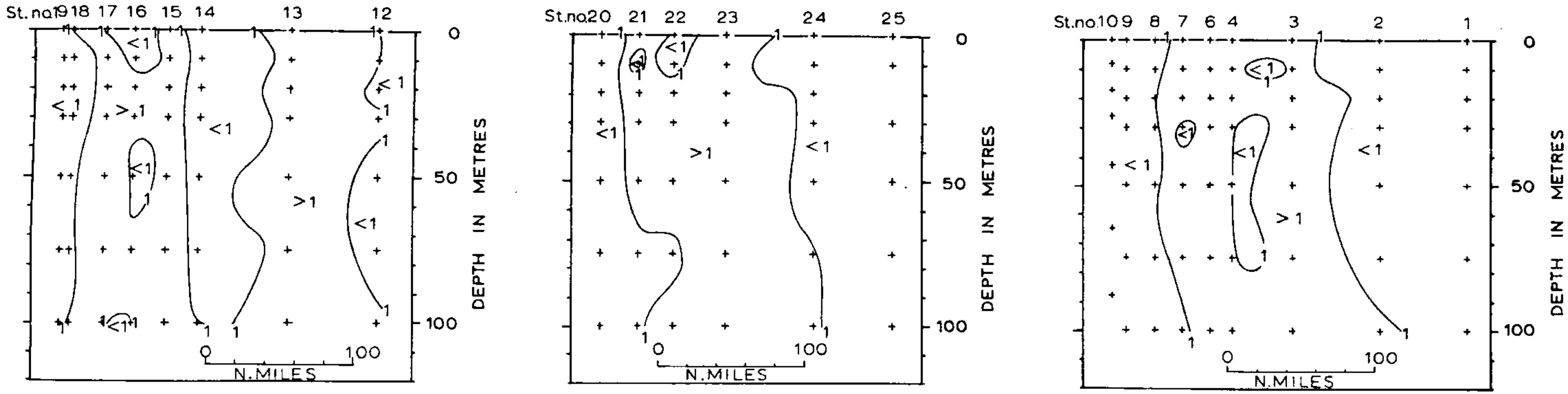


SECTION VI
9 – 11 APRIL

15

NORWESTLANT 1

DISSOLVED OXYGEN - ml O_2/L_{20}



SECTION IV
25 - 28 APRIL

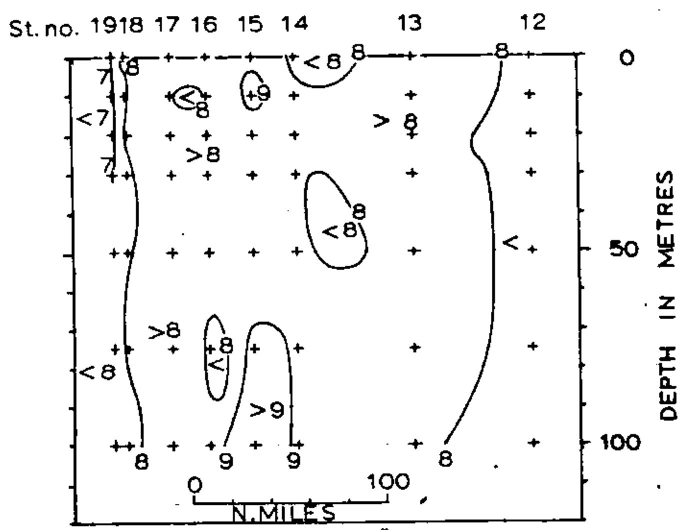
SECTION V
30 APRIL - 1 MAY

SECTION VI
9 - 11 APRIL

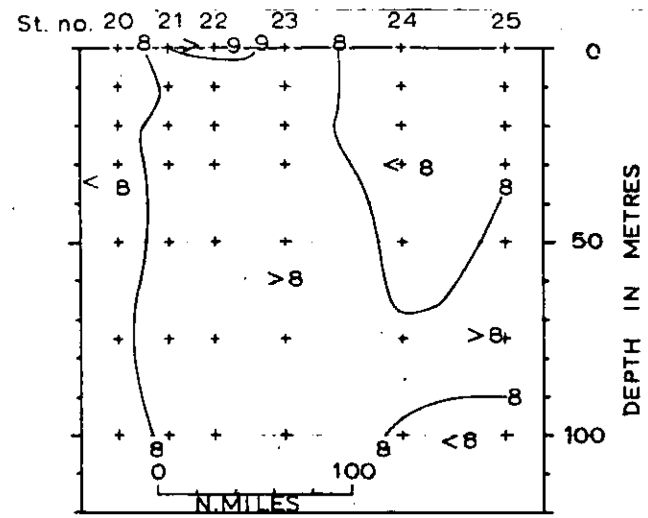
16

NORWESTLANT 1

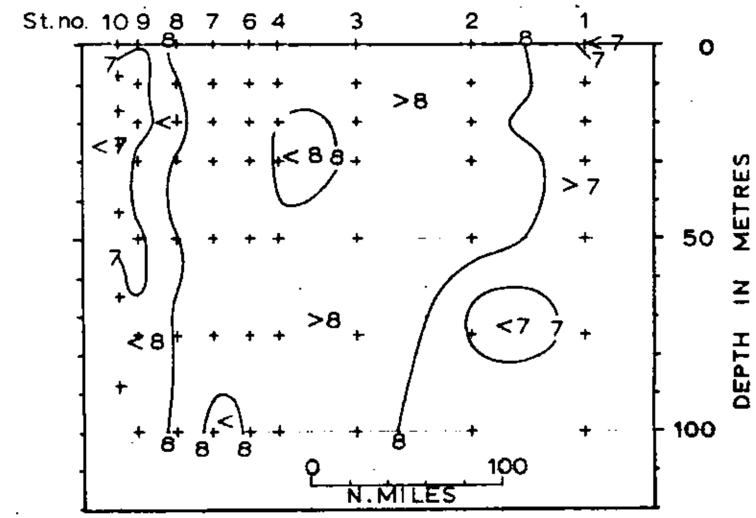
PHOSPHATE PO_4 - P µg at/L



SECTION IV
25–28 APRIL



SECTION V
30 APRIL – 1 MAY

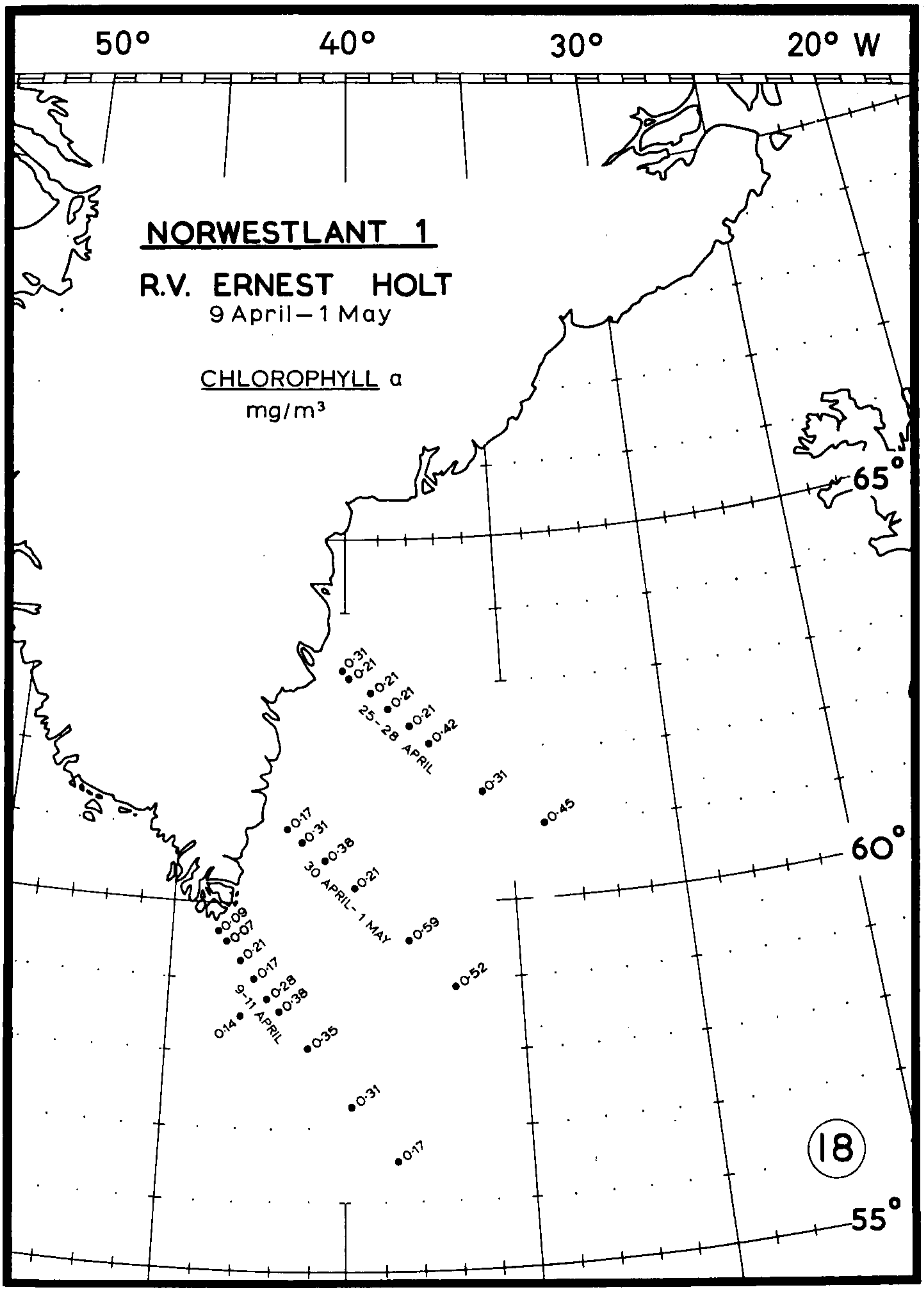


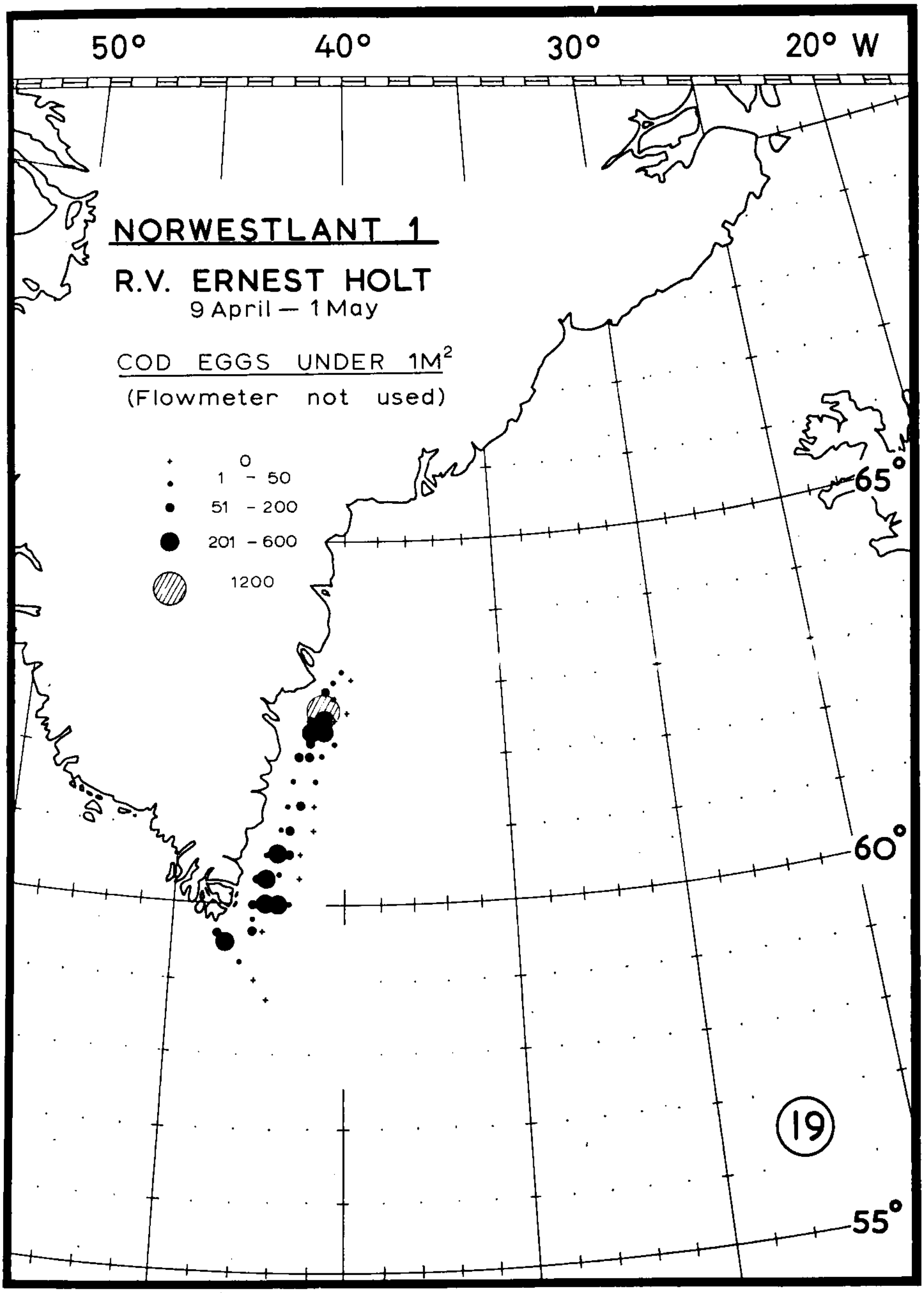
SECTION VI
9–11 APRIL

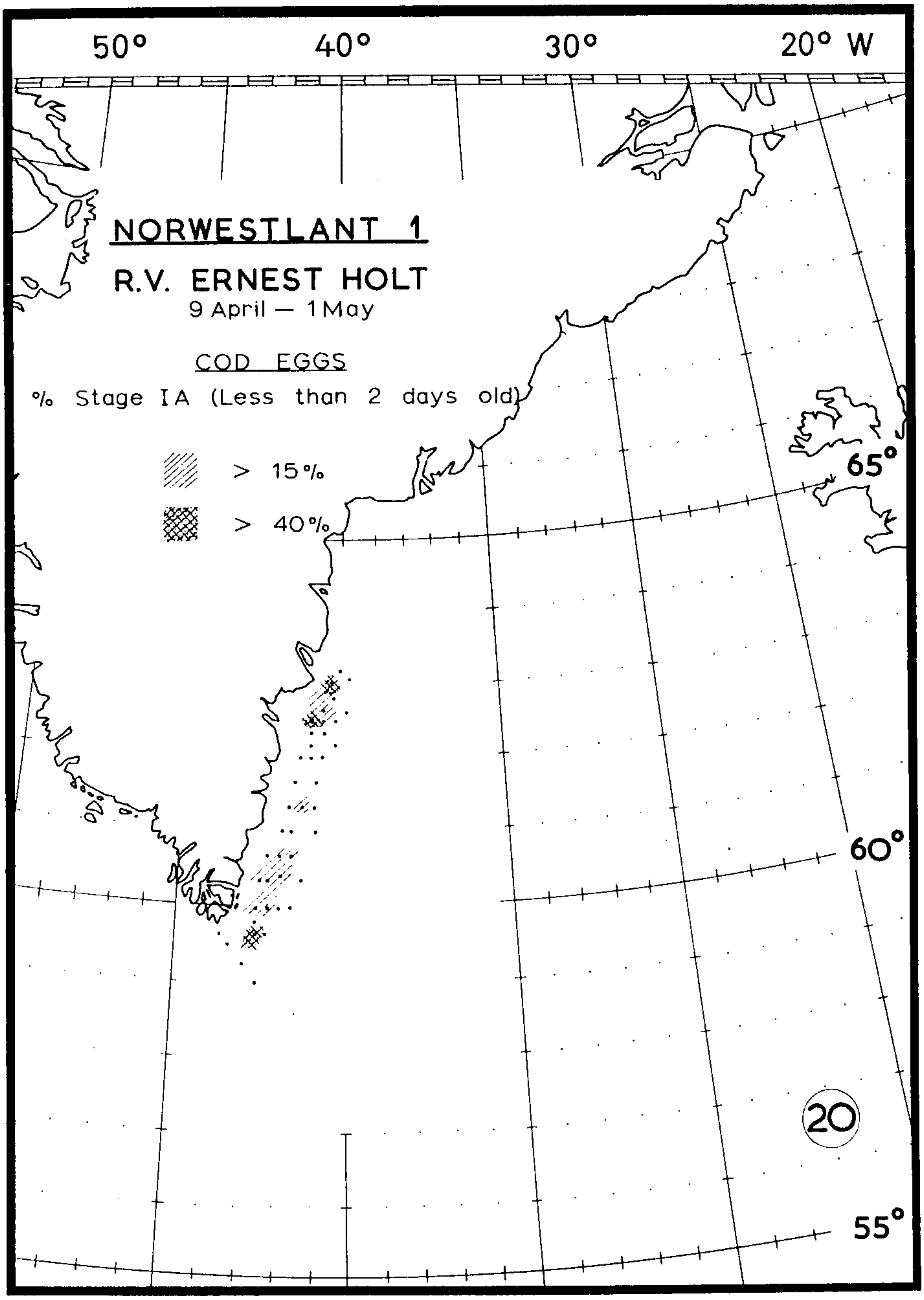
17

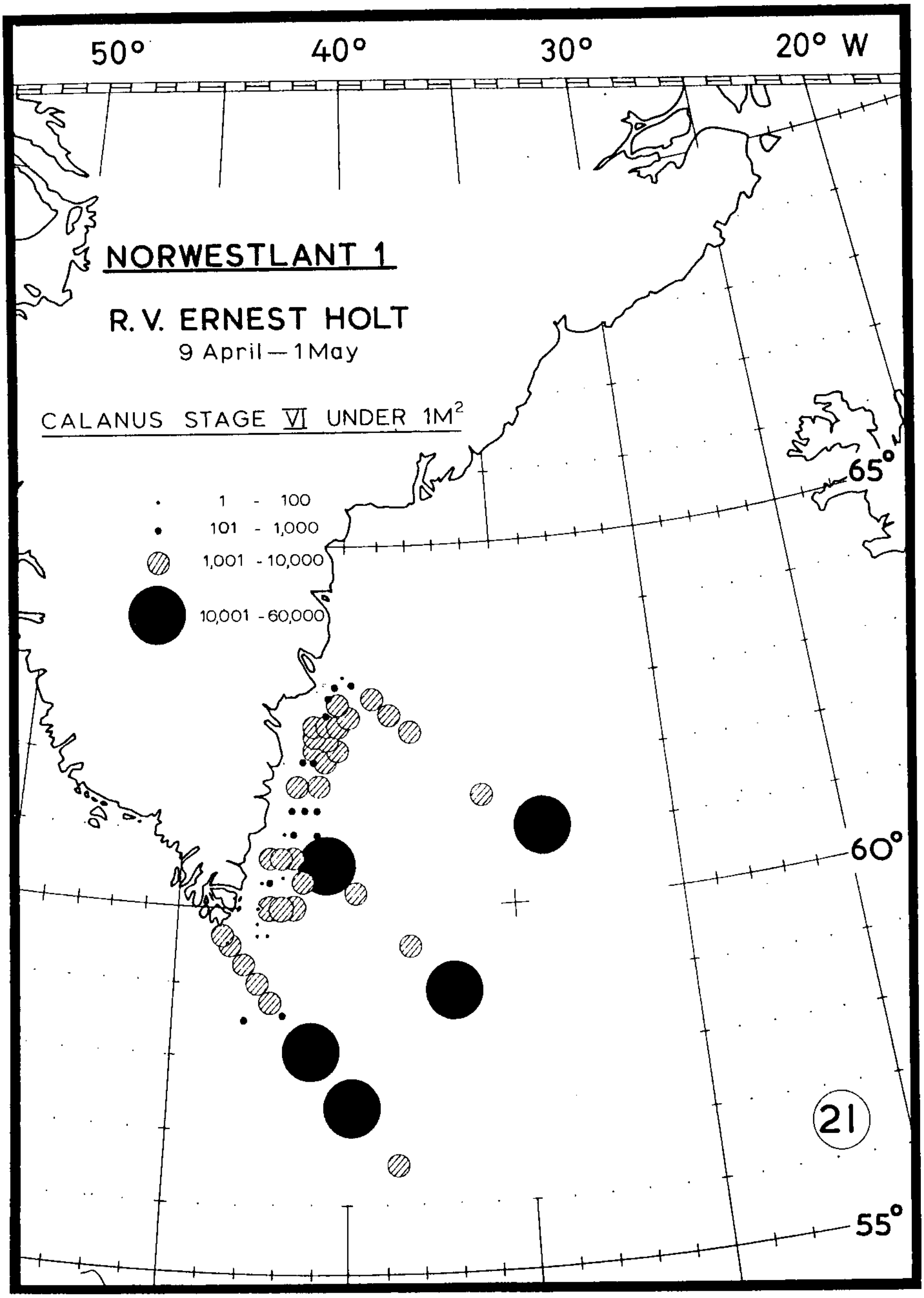
NORWESTLANT 1

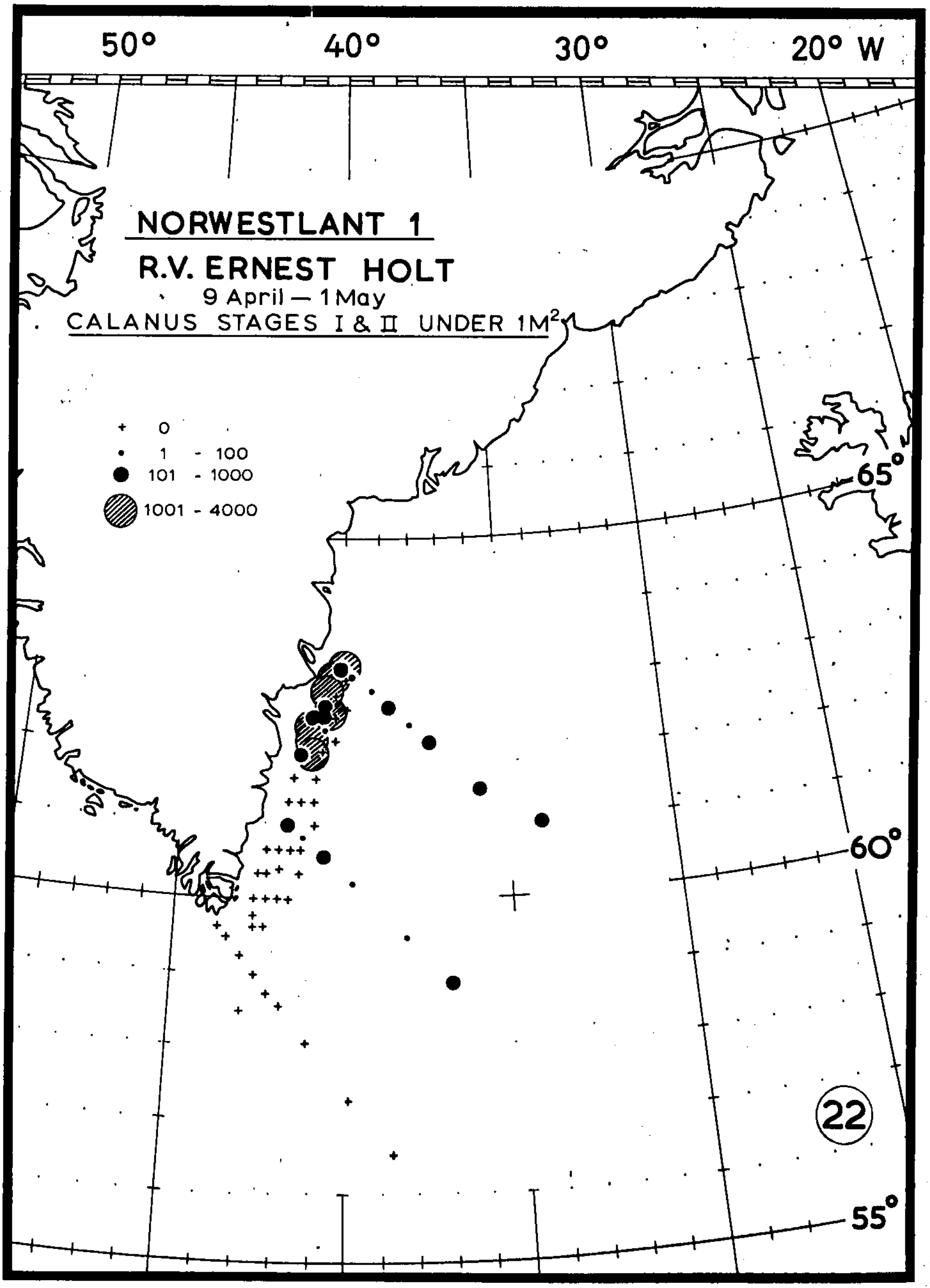
SILICATE - SiO_3-Si μg at/L

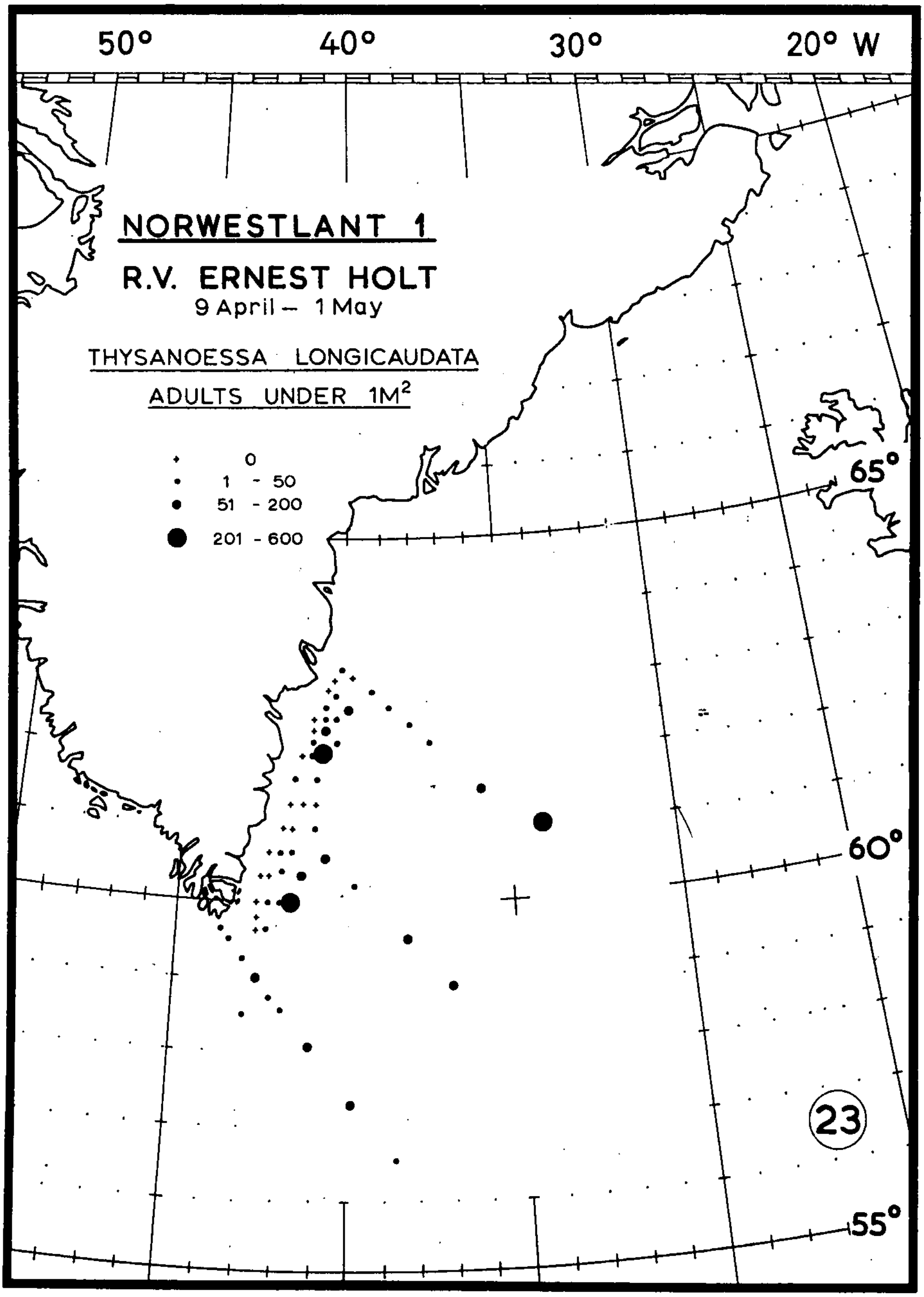

50°
40°
30°
20° W
NORWESTLANT 1
R.V. ERNEST HOLT
9 April – 1 May
CHLOROPHYLL a
mg/m³
65°
60°
55°
25 – 28 APRIL
30 APRIL – 1 MAY
9 – 11 APRIL
0·31
0·21
0·21
0·21
0·21
0·42
0·31
0·45
0·17
0·31
0·38
0·21
0·59
0·52
0·09
0·07
0·21
0·17
0·28
0·38
0·14
0·35
0·31
0·17
18

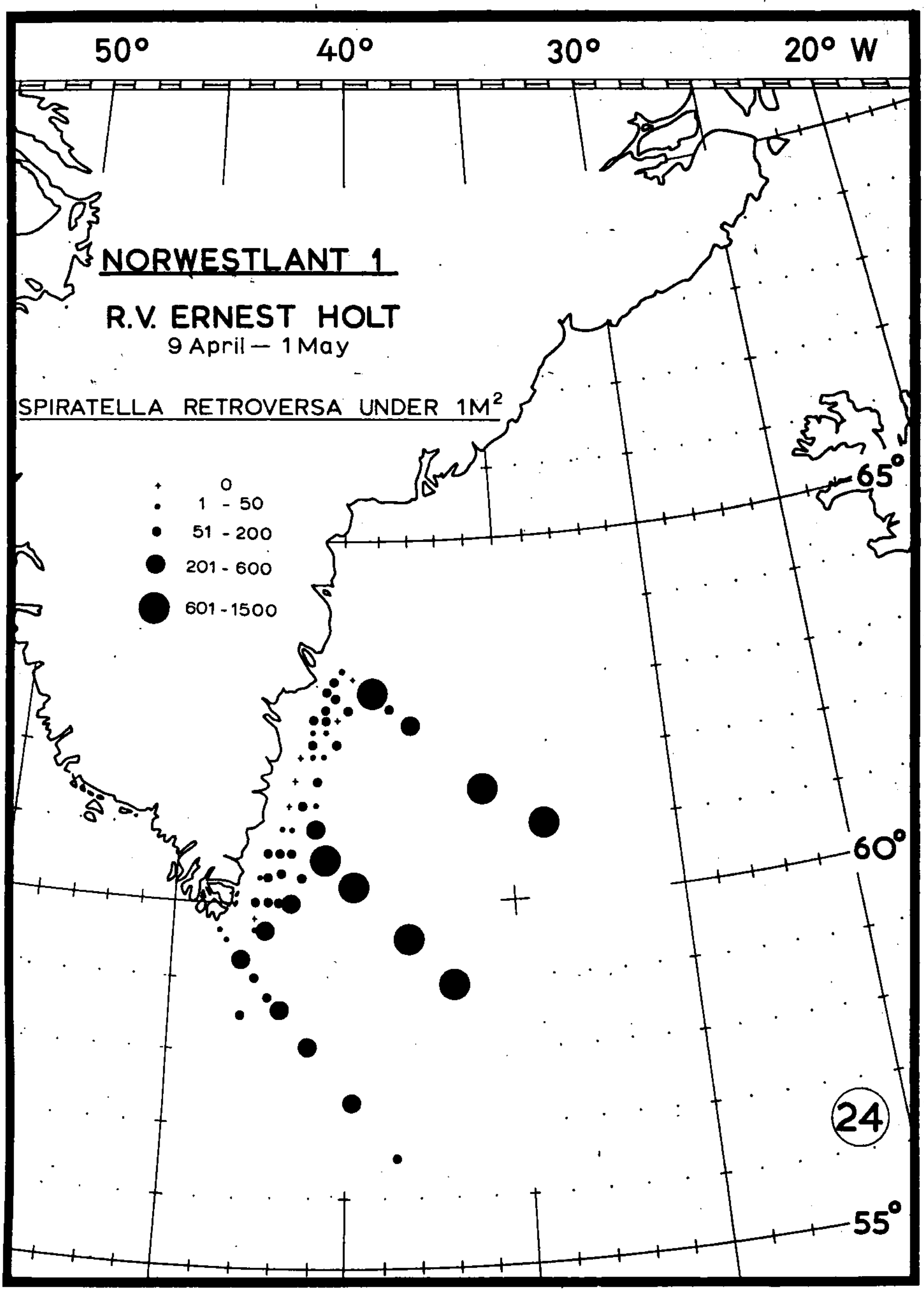

50°
40°
30°
20° W
NORWESTLANT 1
R.V. ERNEST HOLT
9 April — 1 May
COD EGGS UNDER 1M²
(Flowmeter not used)
0
1 - 50
51 - 200
201 - 600
1200
65°
60°
55°
19

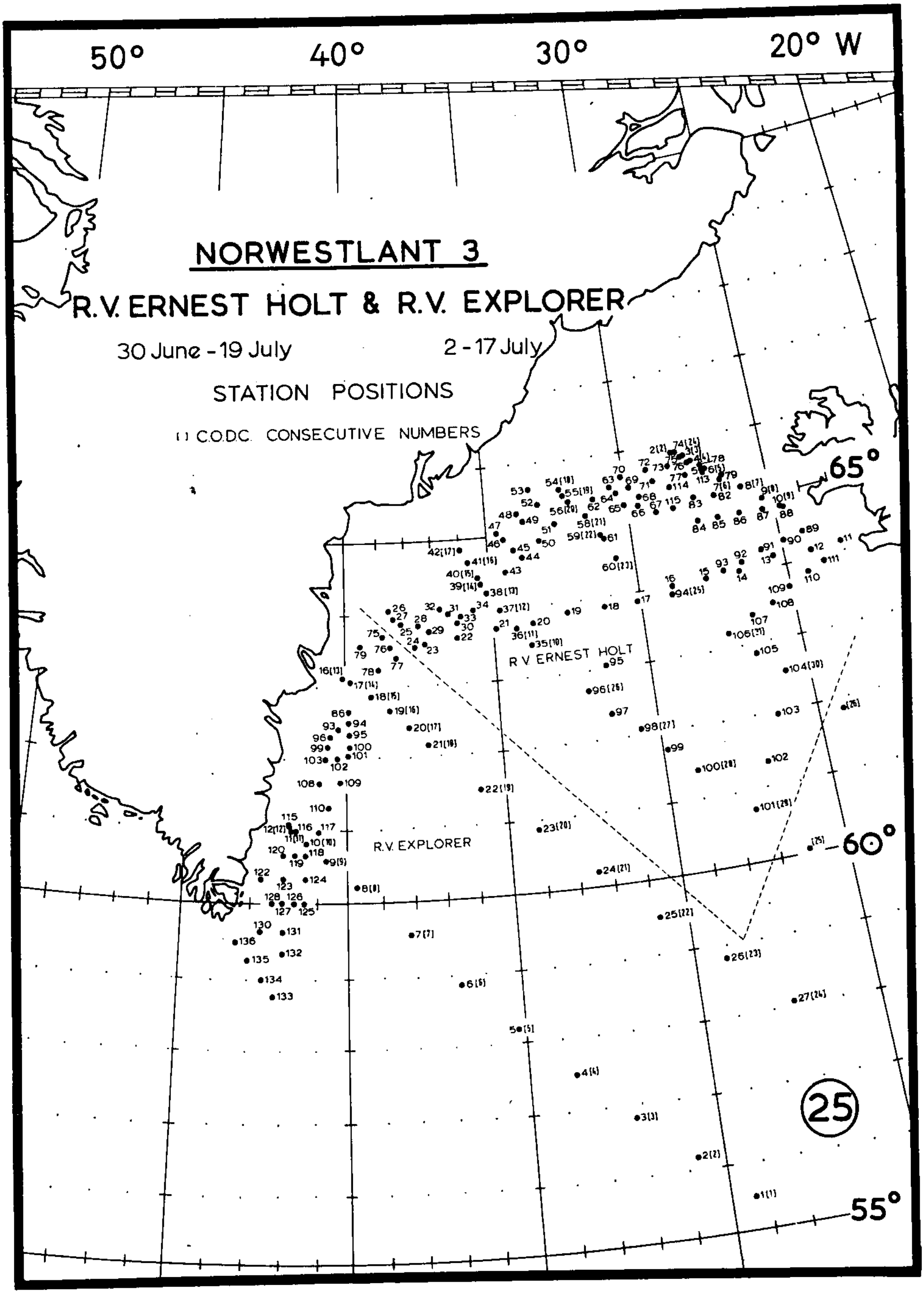

50°
40°
30°
20° W
NORWESTLANT 1
R.V. ERNEST HOLT
9 April — 1 May
COD EGGS
% Stage IA (Less than 2 days old)
> 15%
> 40%
65°
60°
55°
20

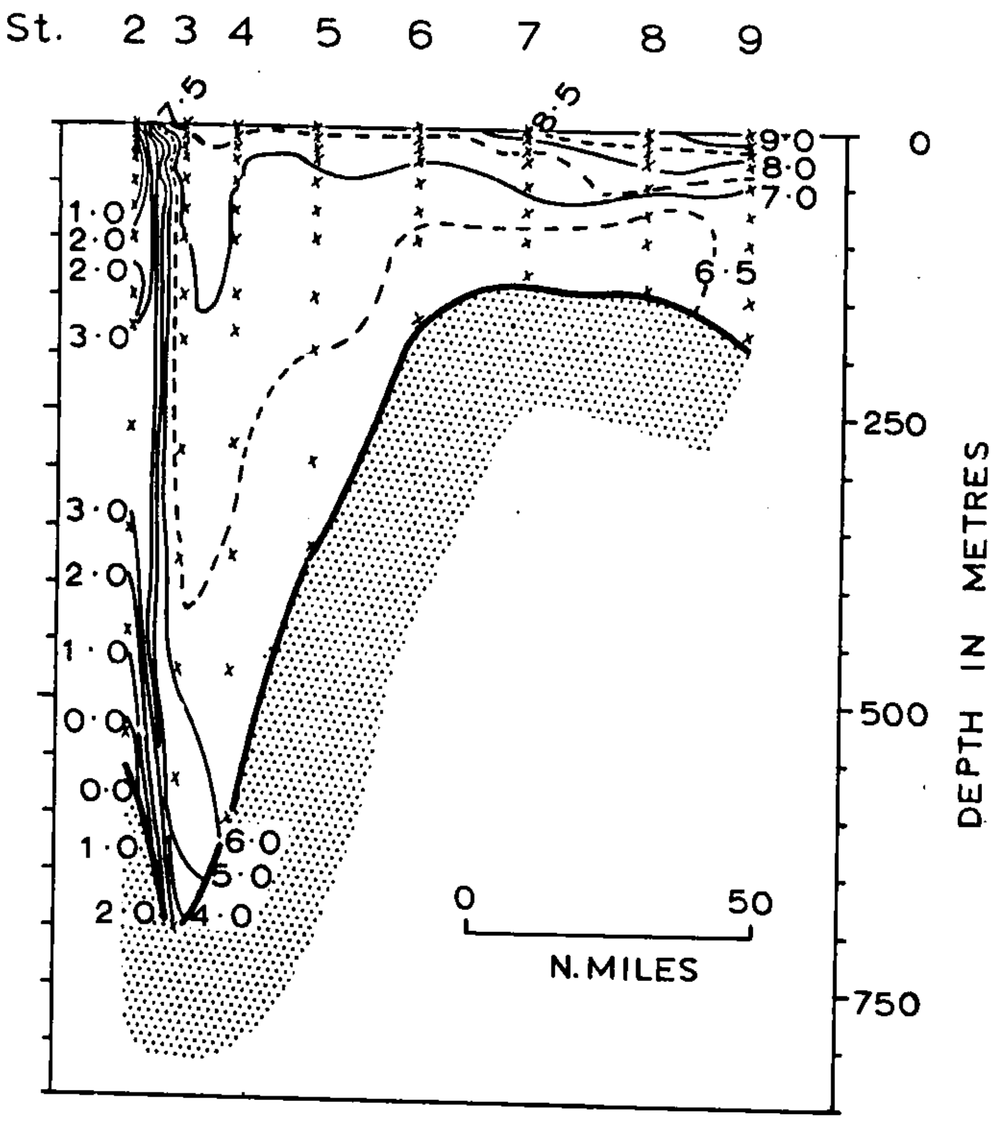

50°
40°
30°
20° W
NORWESTLANT 1
R.V. ERNEST HOLT
9 April — 1 May
CALANUS STAGE VI UNDER 1M²
1 - 100
101 - 1,000
1,001 - 10,000
10,001 - 60,000
65°
60°
55°
21


50°
40°
30°
20° W
NORWESTLANT 1
R.V. ERNEST HOLT
9 April — 1 May
CALANUS STAGES I & II UNDER 1M²
+ 0
• 1 - 100
● 101 - 1000
1001 - 4000
65°
60°
55°
22


50°
40°
30°
20° W
NORWESTLANT 1
R.V. ERNEST HOLT
9 April – 1 May
THYSANOESSA LONGICAUDATA
ADULTS UNDER 1M²
0
1 - 50
51 - 200
201 - 600
65°
60°
55°
23


50°
40°
30°
20° W
NORWESTLANT 1
R.V. ERNEST HOLT
9 April — 1 May
SPIRATELLA RETROVERSA UNDER 1M²
0
1 - 50
51 - 200
201 - 600
601 - 1500
65°
60°
55°
24


50°
40°
30°
20° W
NORWESTLANT 3
R.V. ERNEST HOLT & R.V. EXPLORER
30 June - 19 July
2 - 17 July
STATION POSITIONS
( ) C.O.D.C. CONSECUTIVE NUMBERS
R.V. ERNEST HOLT
R.V. EXPLORER
65°
60°
55°
25

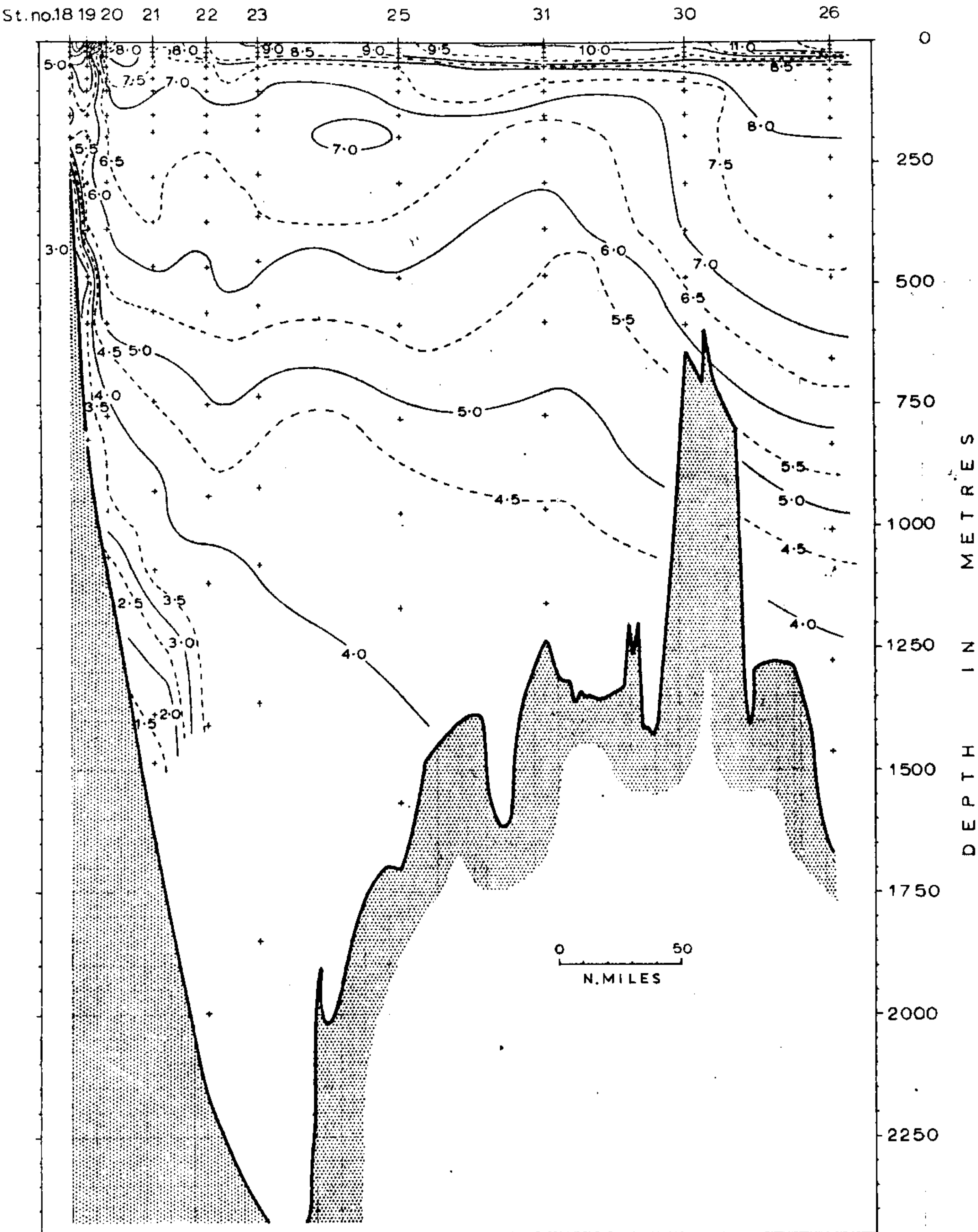


NORWESTLANT 3 SECTION I

Temperature °C

30 JUNE - 1 JULY

(26)

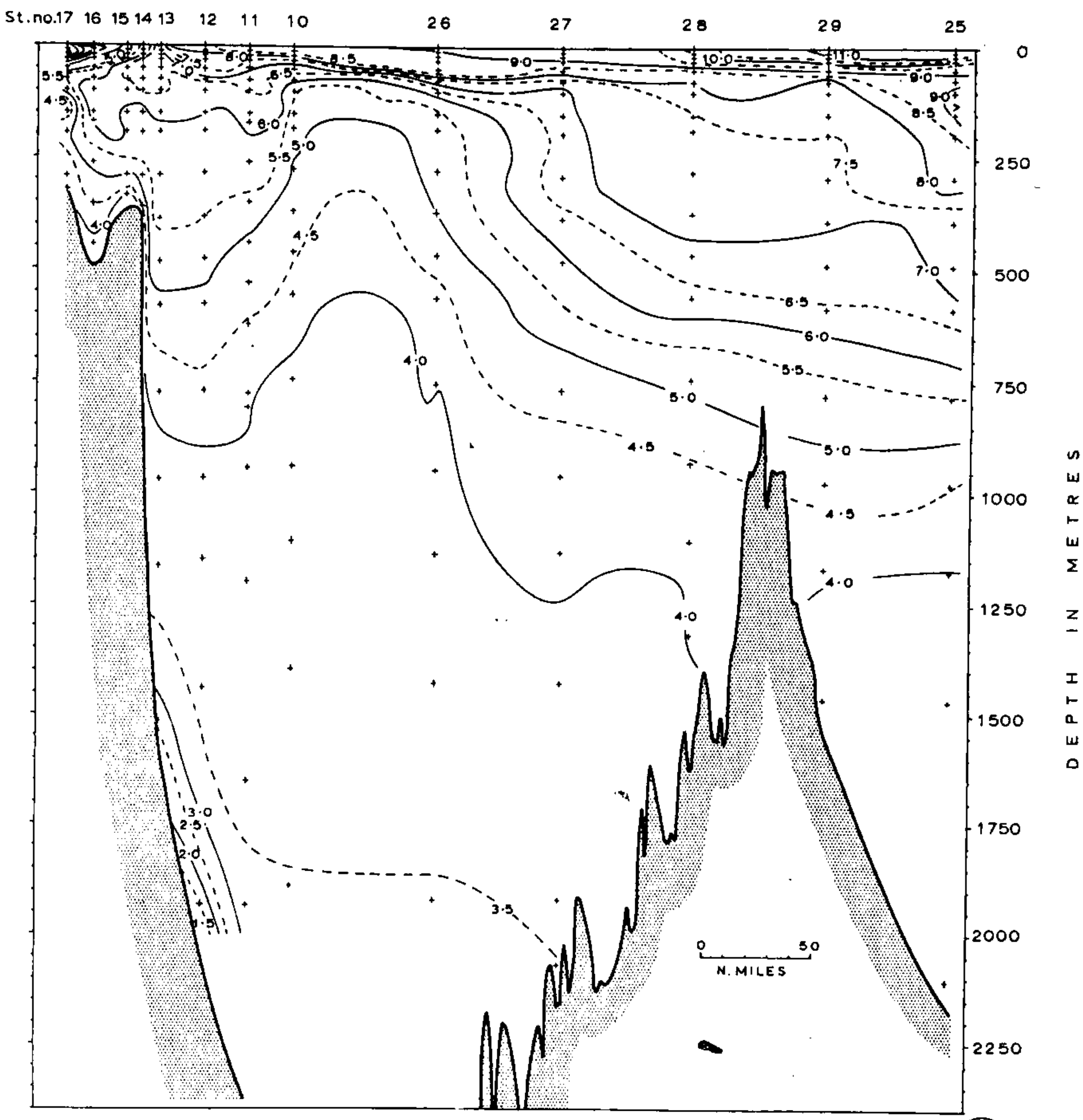


NORWESTLANT 3 SECTION II

Temperature °C

8 – 18 JULY

27

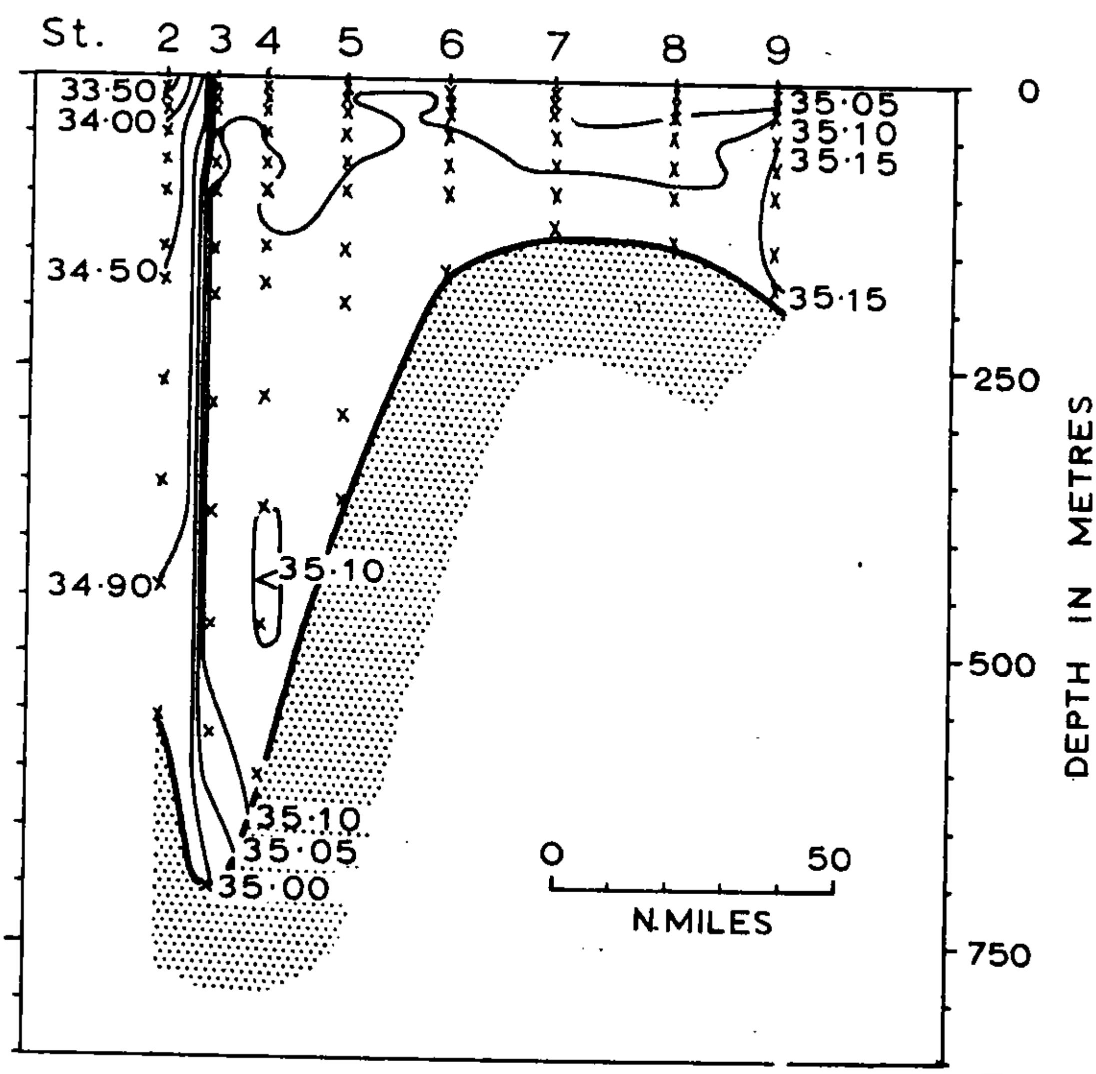


NORWESTLANT 3 SECTION III

Temperature °C

5–17 JULY

28

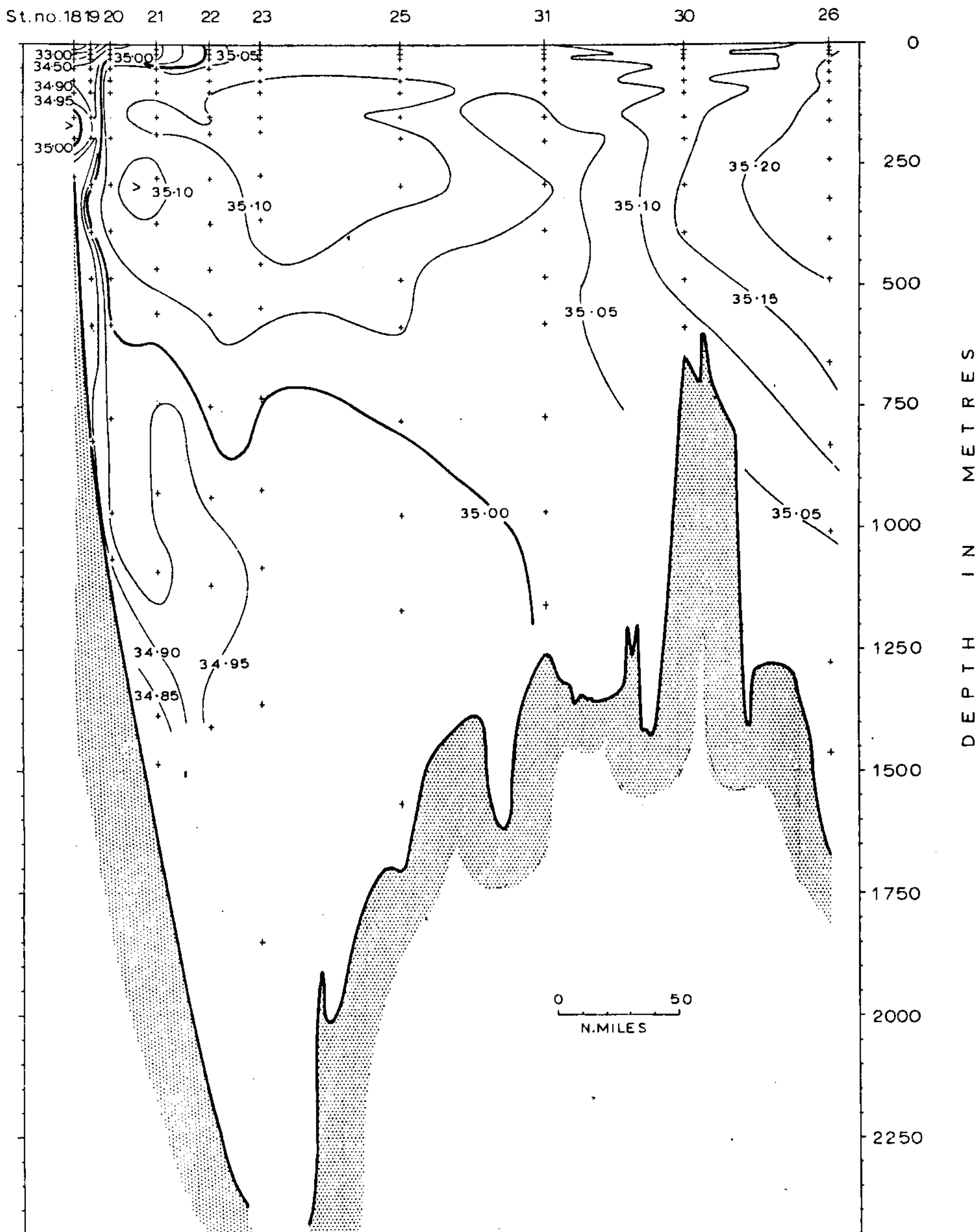


NORWESTLANT 3 SECTION I

Salinity ‰

30 JUNE-1 JULY

29

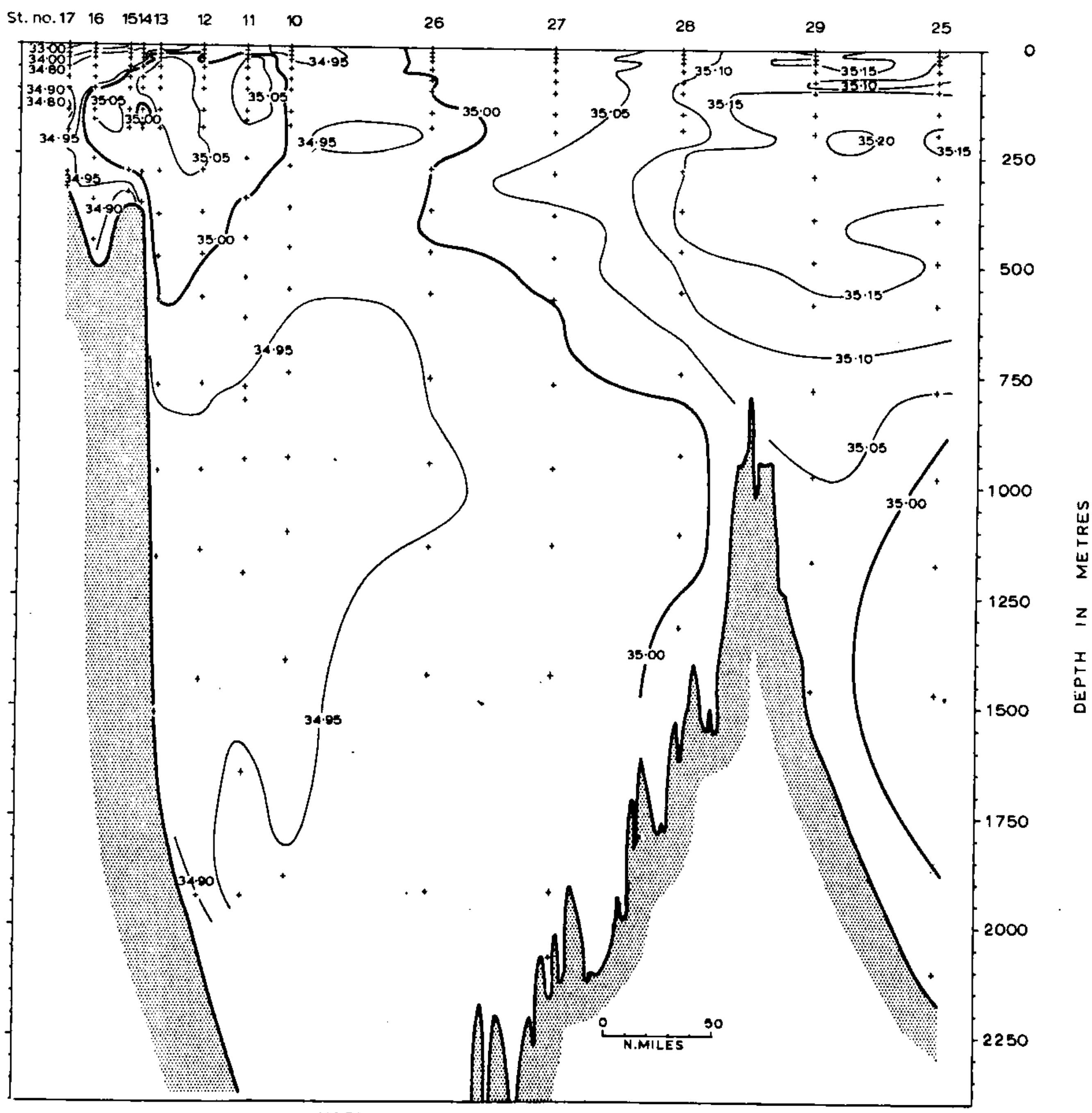


NORWESTLANT 3 SECTION II

Salinity ‰

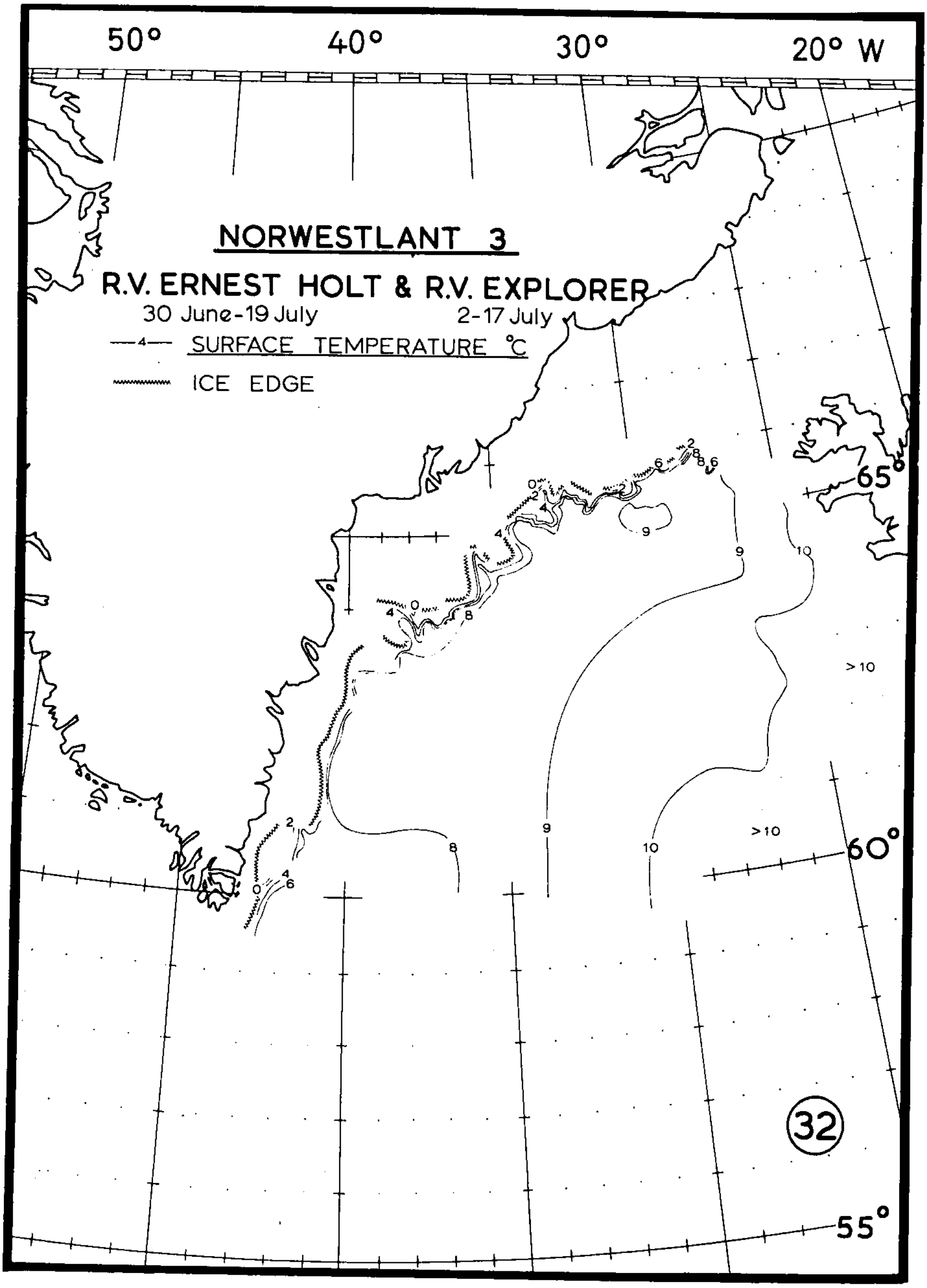
8-18 JULY

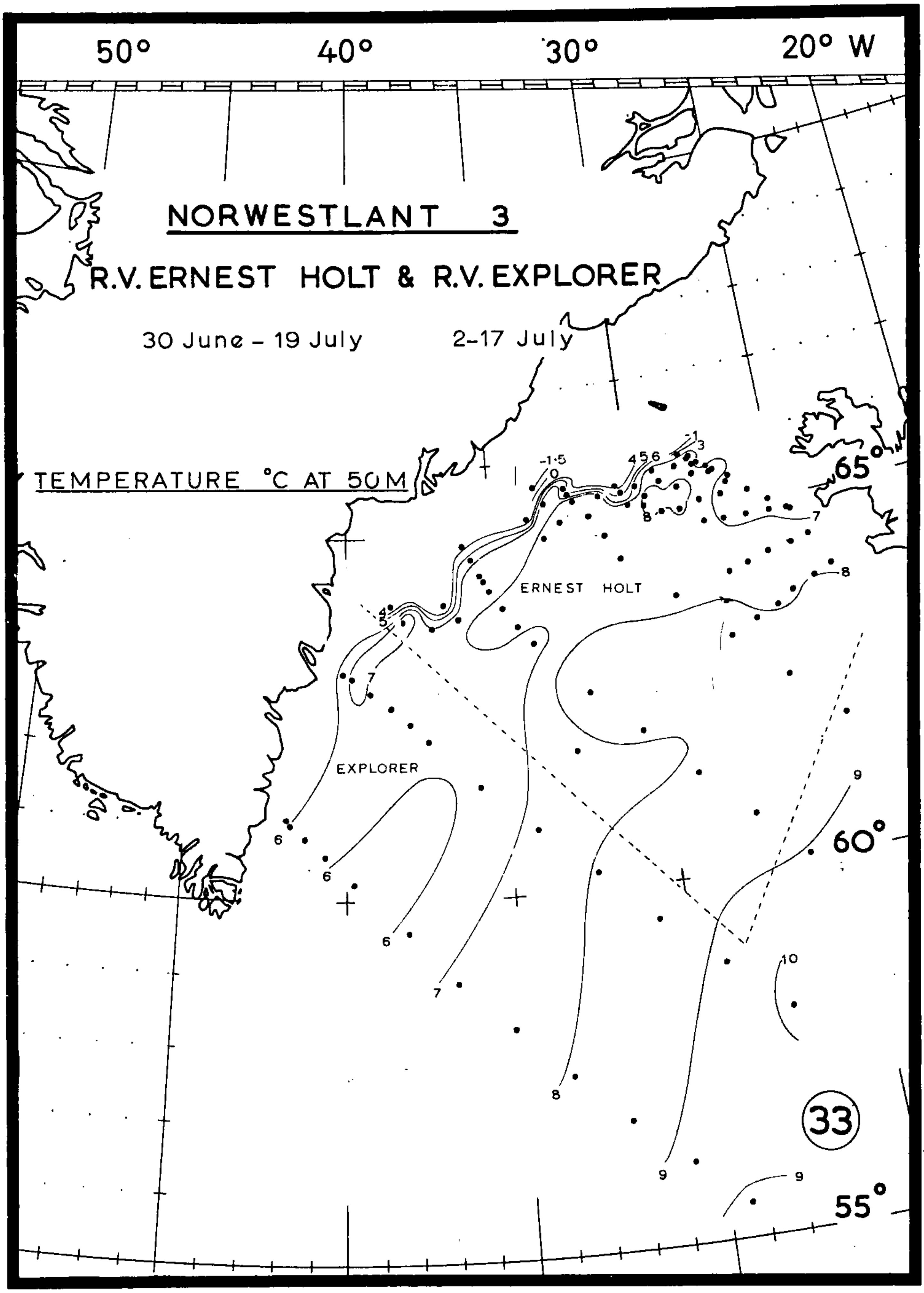
30

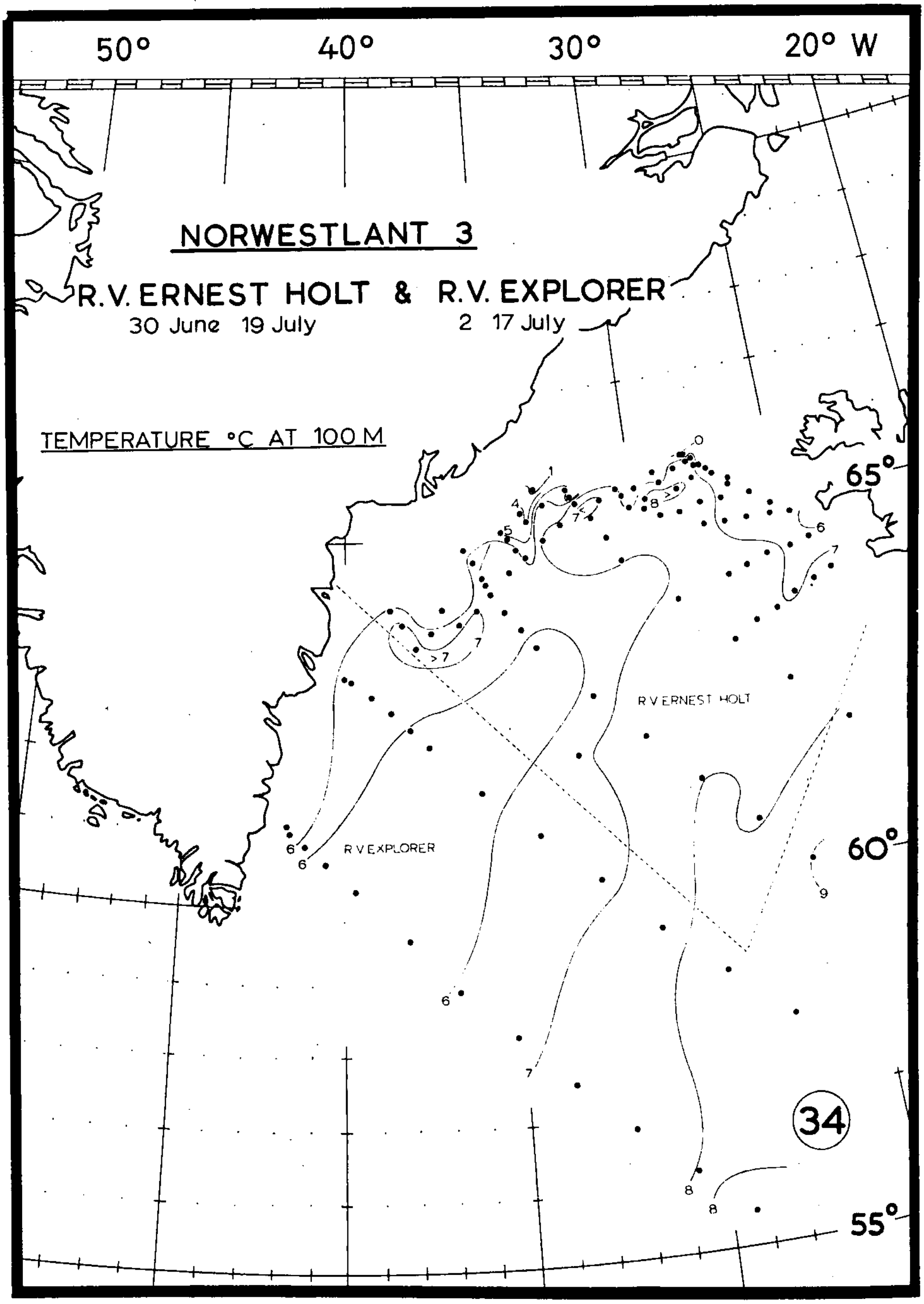


NORWESTLANT 3 SECTION III
Salinity ‰
5-17 July

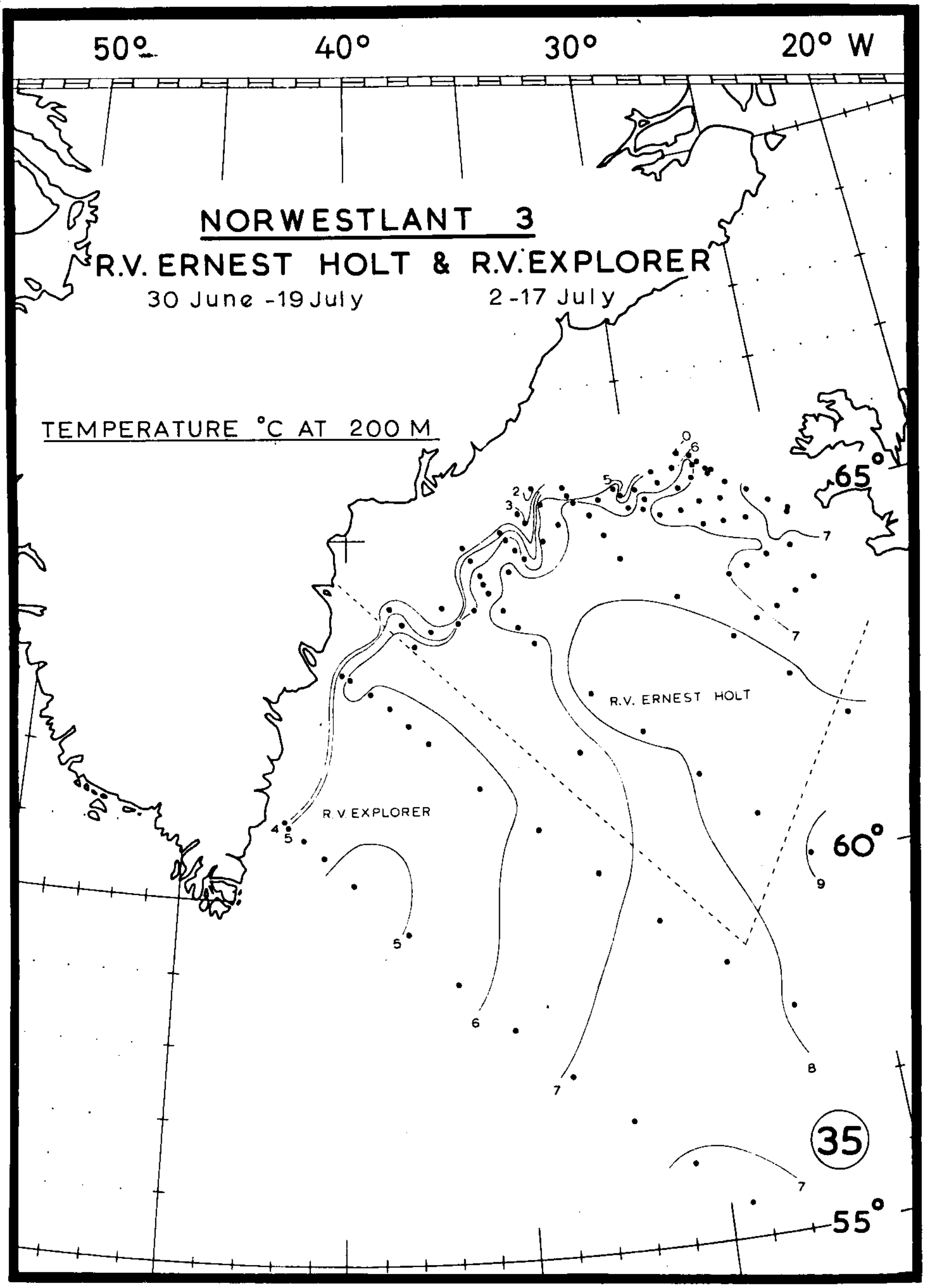
(31)

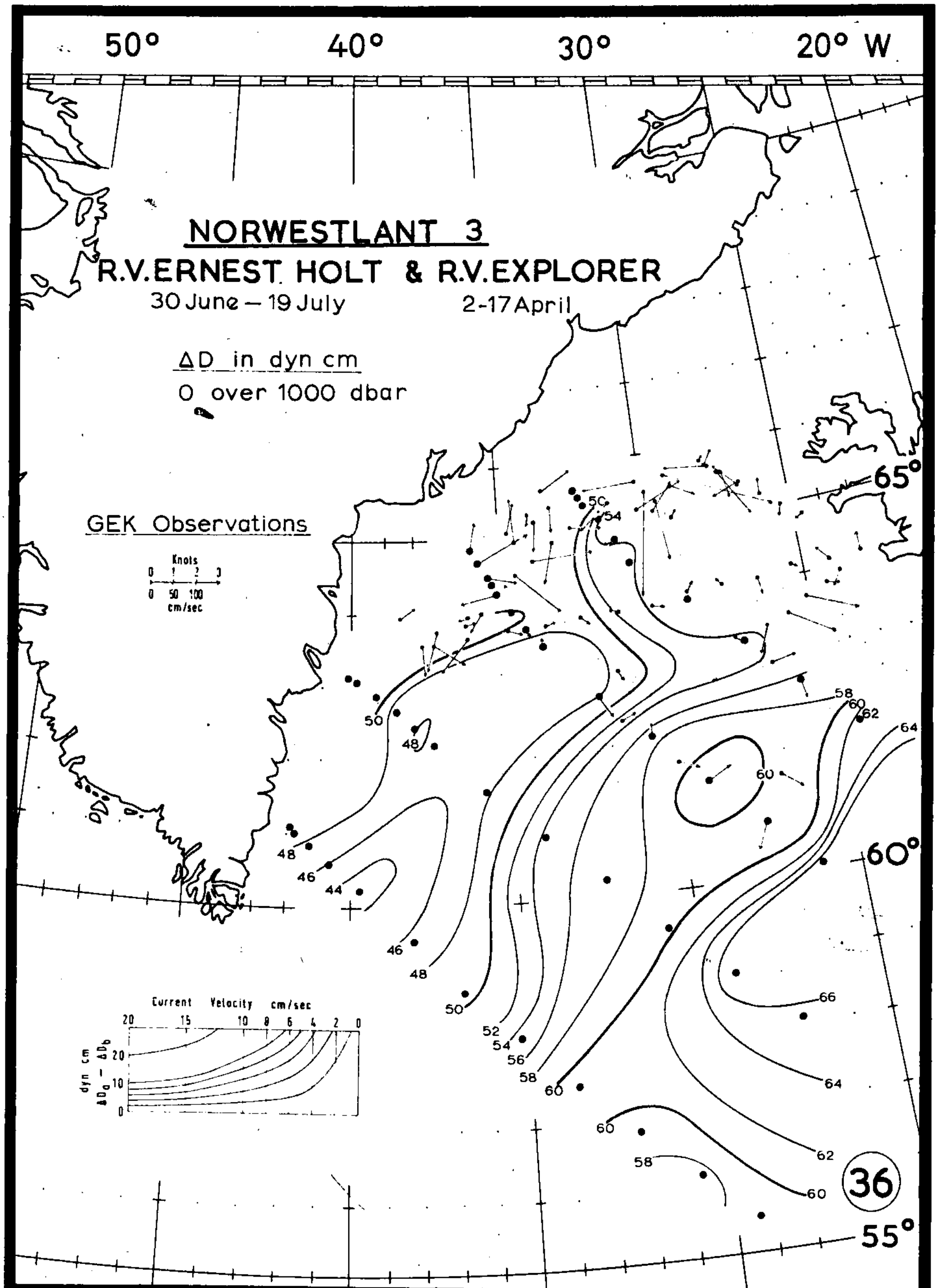

50°
40°
30°
20° W
NORWESTLANT 3
R.V. ERNEST HOLT & R.V. EXPLORER
30 June-19 July
2-17 July
SURFACE TEMPERATURE °C
ICE EDGE
65°
60°
55°
>10
9
10
8
32

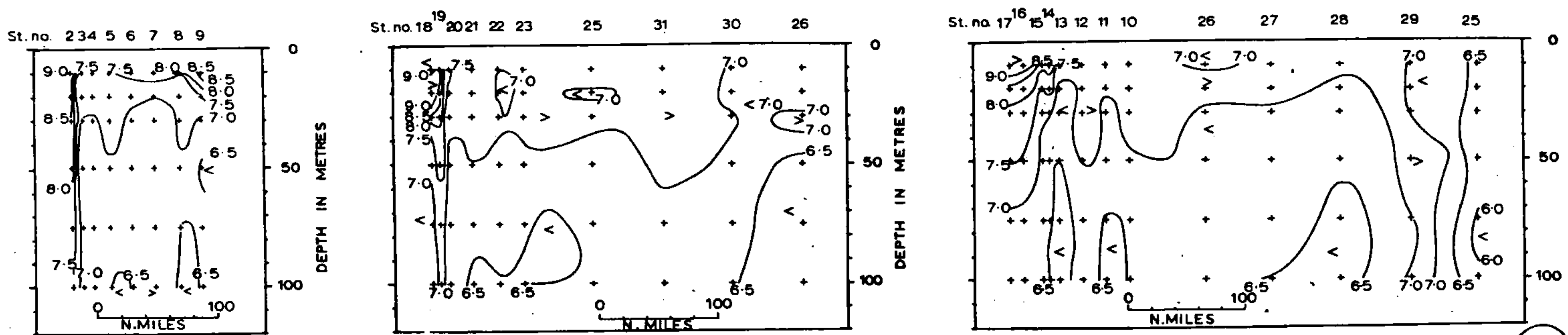

50°
40°
30°
20° W
NORWESTLANT 3
R.V. ERNEST HOLT & R.V. EXPLORER
30 June - 19 July
2-17 July
TEMPERATURE °C AT 50M
ERNEST HOLT
EXPLORER
65°
60°
55°
33



50°
40°
30°
20° W
NORWESTLANT 3
R.V. ERNEST HOLT & R.V. EXPLORER
30 June 19 July
2 17 July
TEMPERATURE °C AT 100 M
R V ERNEST HOLT
R V EXPLORER
65°
60°
55°
34


50°
40°
30°
20° W
NORWESTLANT 3
R.V. ERNEST HOLT & R.V. EXPLORER
30 June - 19 July
2 - 17 July
TEMPERATURE °C AT 200 M
R.V. ERNEST HOLT
R.V. EXPLORER
65°
60°
55°
35


50° 40° 30° 20° W
NORWESTLANT 3
R.V. ERNEST HOLT & R.V. EXPLORER
30 June – 19 July 2-17 April
ΔD in dyn cm
0 over 1000 dbar
GEK Observations
Knots
0 1 2 3
0 50 100
cm/sec
Current Velocity cm/sec
20 15 10 8 6 4 2 0
dyn cm
ΔDa − ΔDb
65°
60°
55°
36



SECTION I
30 JUNE-1 JULY

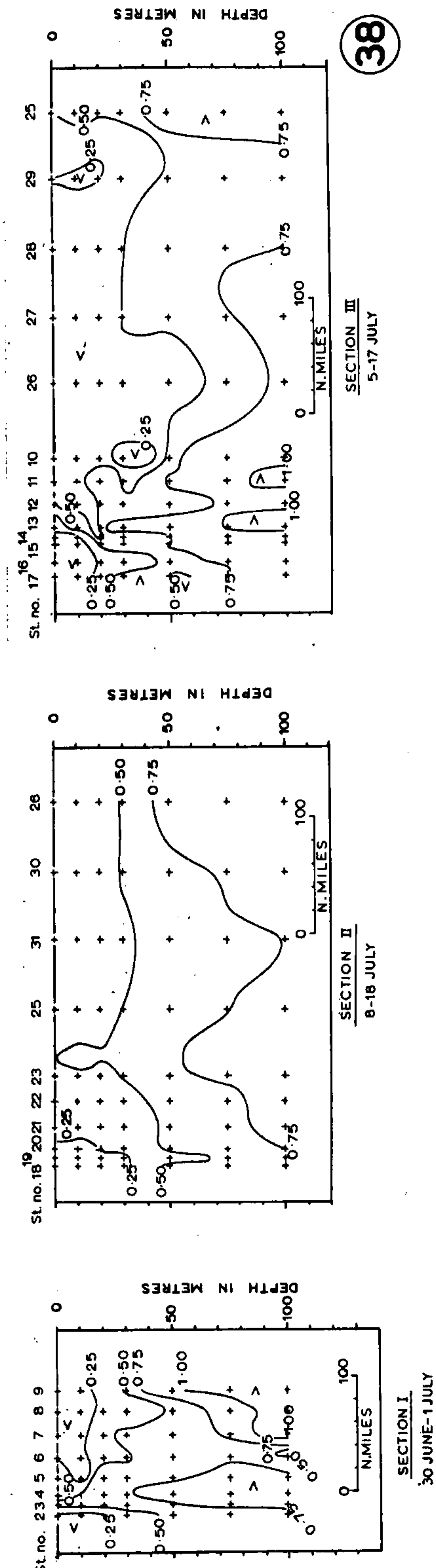
SECTION II
8-18 JULY

SECTION III
5-17 JULY

37

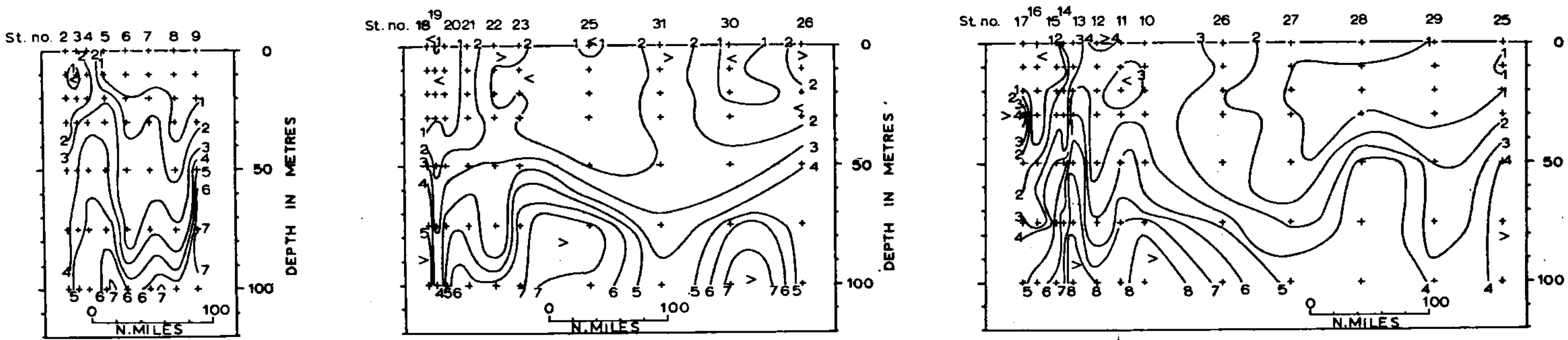
NORWESTLANT 3

DISSOLVED OXYGEN - $ml.O_2/L_{20}$



NORWESTLANT 3

PHOSPHATE PO_4 P μgat/L



SECTION I
30 JUNE-1 JULY

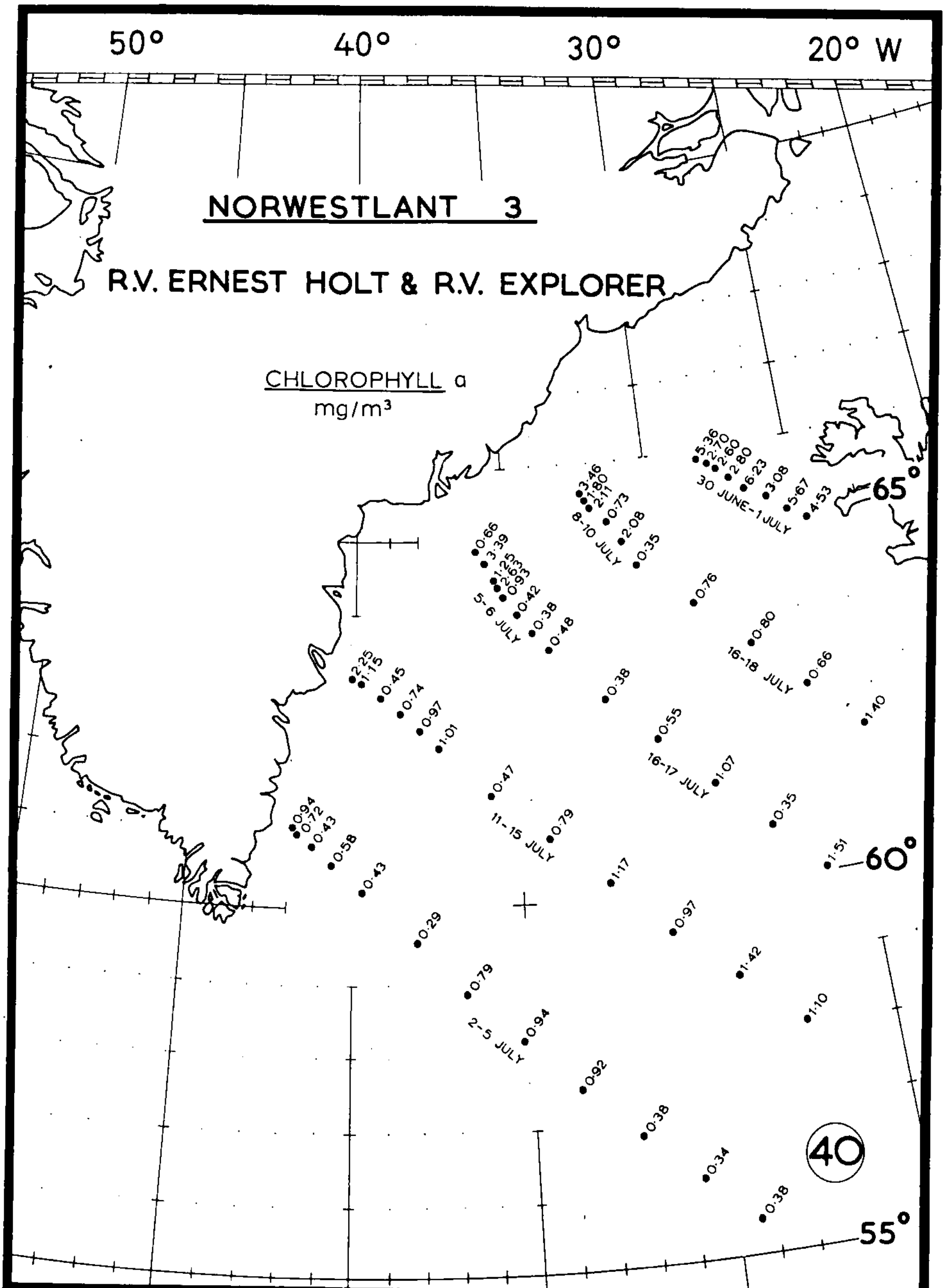
SECTION II
8-18 JULY

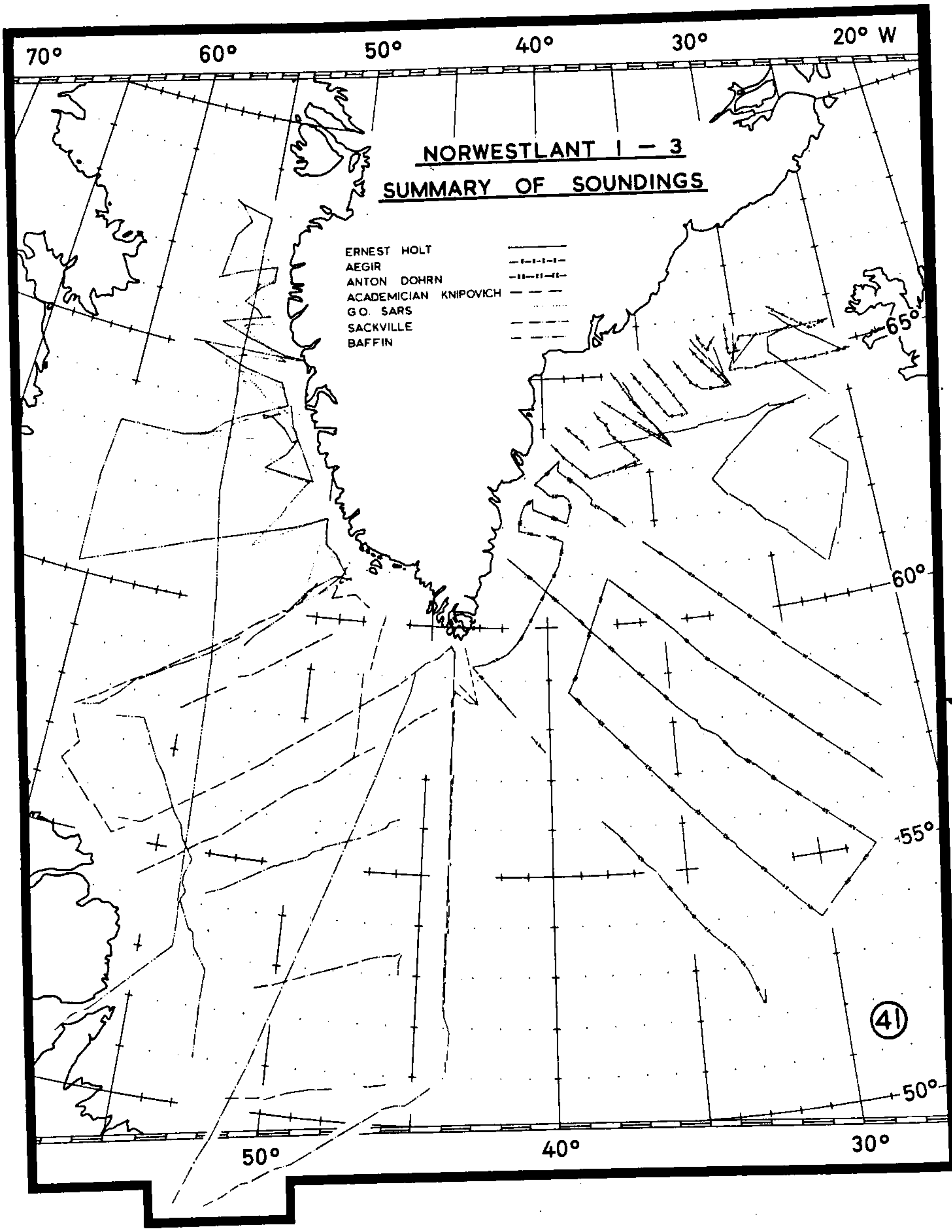
SECTION III
5-17 JULY

39

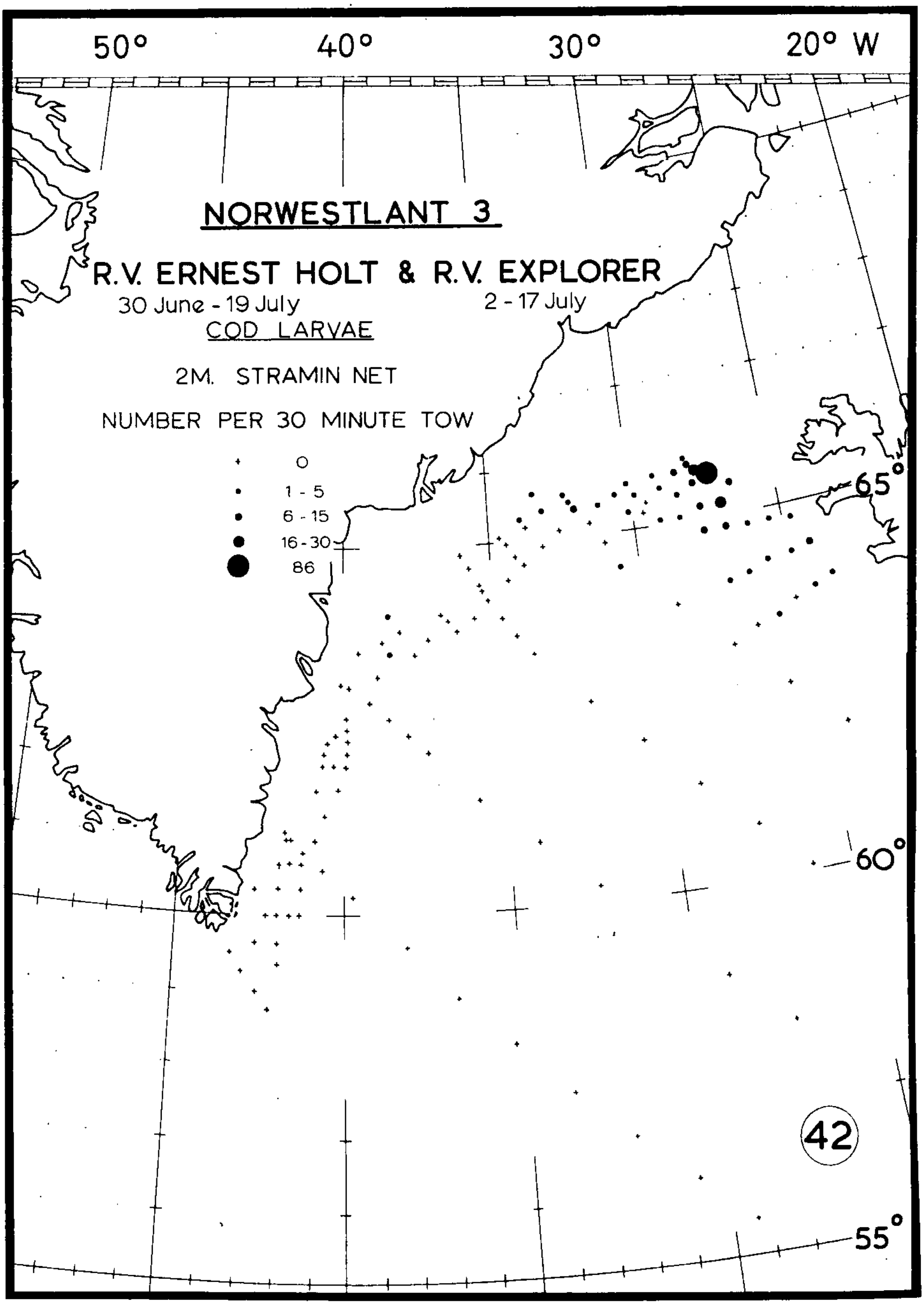
NORWESTLANT 3

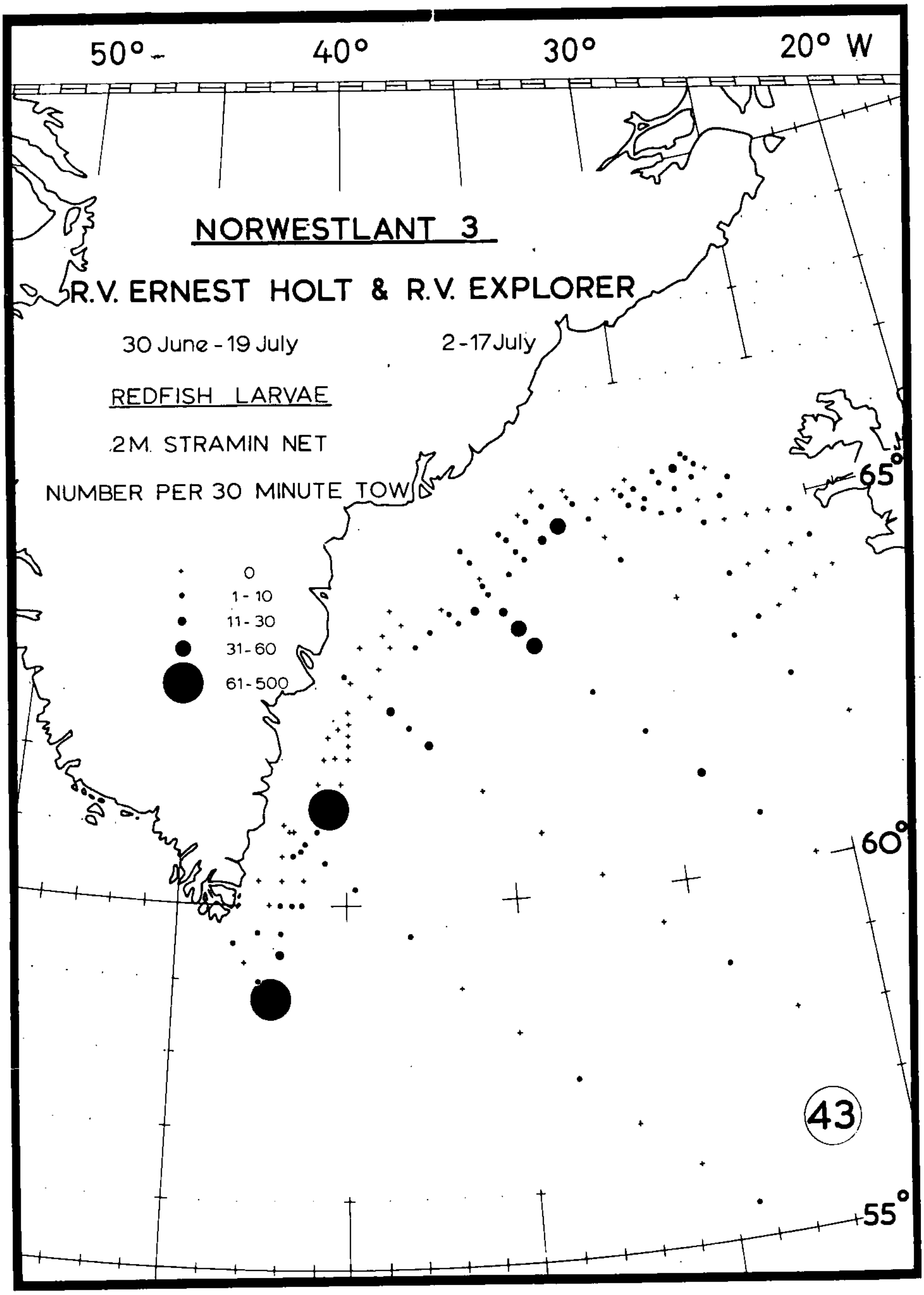
SILICATE - SiO_3-Si μg at/L

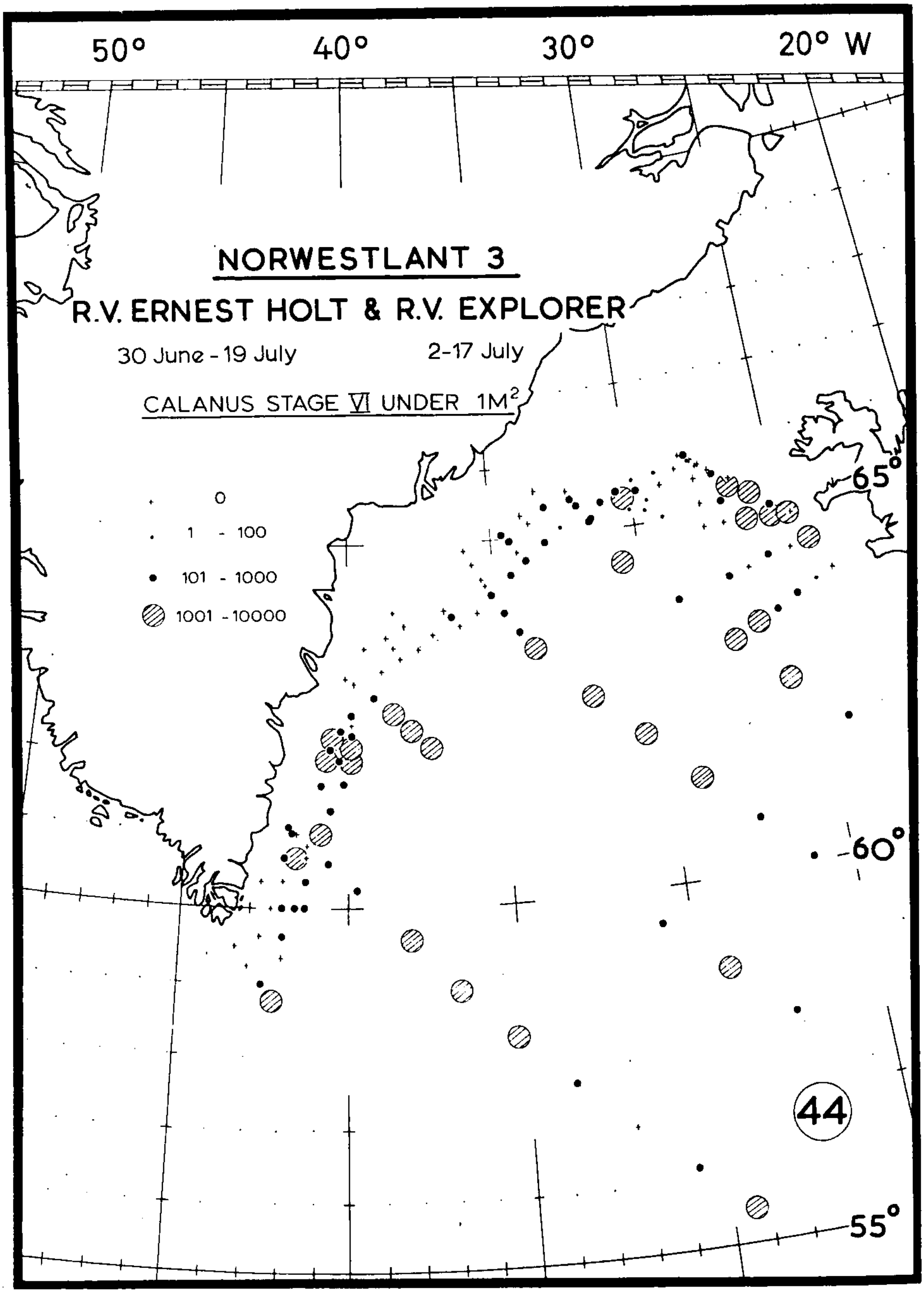

50°
40°
30°
20° W
NORWESTLANT 3
R.V. ERNEST HOLT & R.V. EXPLORER
CHLOROPHYLL a
mg/m³
65°
60°
55°
30 JUNE-1 JULY
8-10 JULY
5-6 JULY
16-18 JULY
16-17 JULY
11-15 JULY
2-5 JULY
40

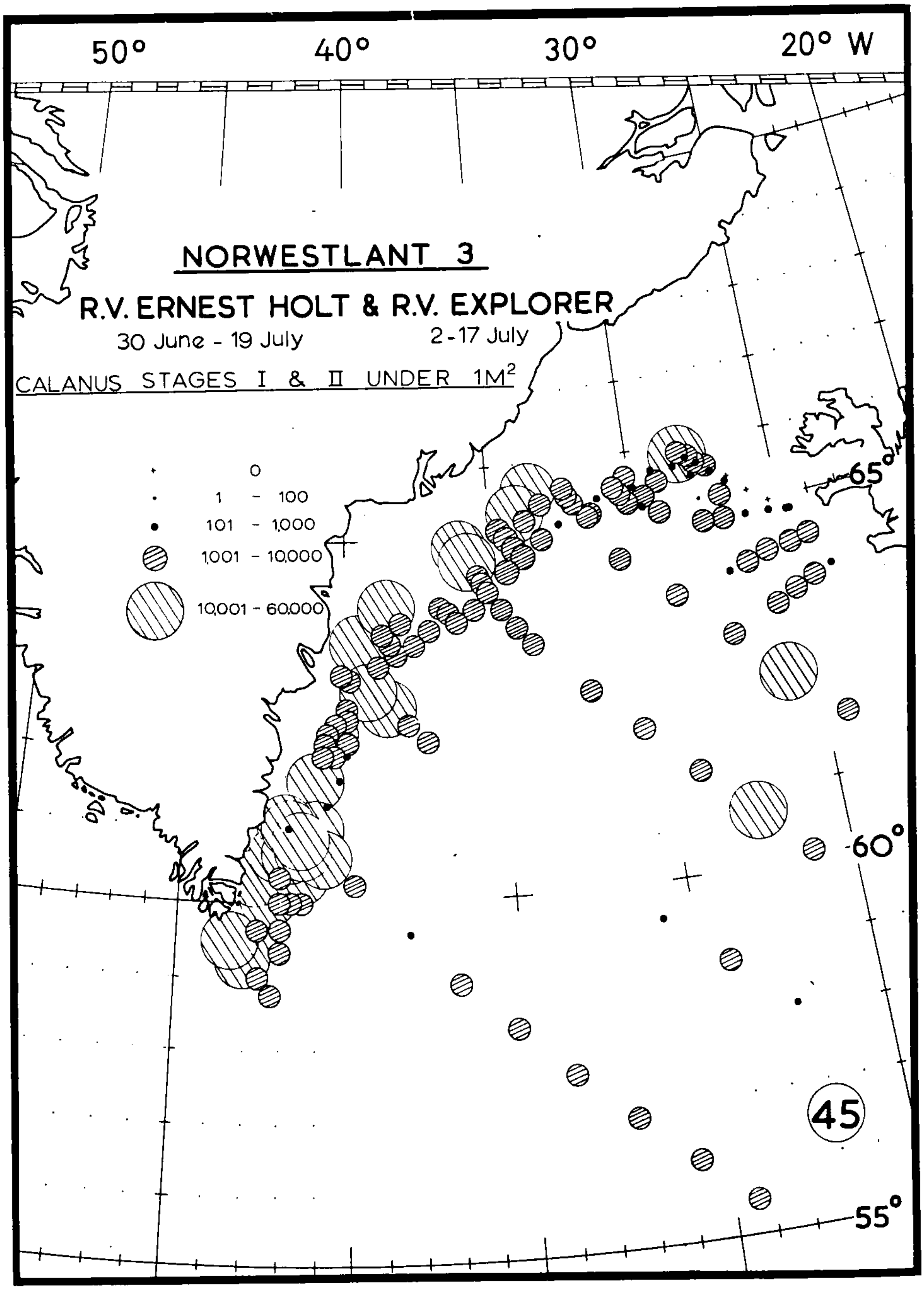

NORWESTLANT I - 3
SUMMARY OF SOUNDINGS
ERNEST HOLT
AEGIR
ANTON DOHRN
ACADEMICIAN KNIPOVICH
G.O. SARS
SACKVILLE
BAFFIN
70°
60°
50°
40°
30°
20° W
65°
60°
55°
50°
41

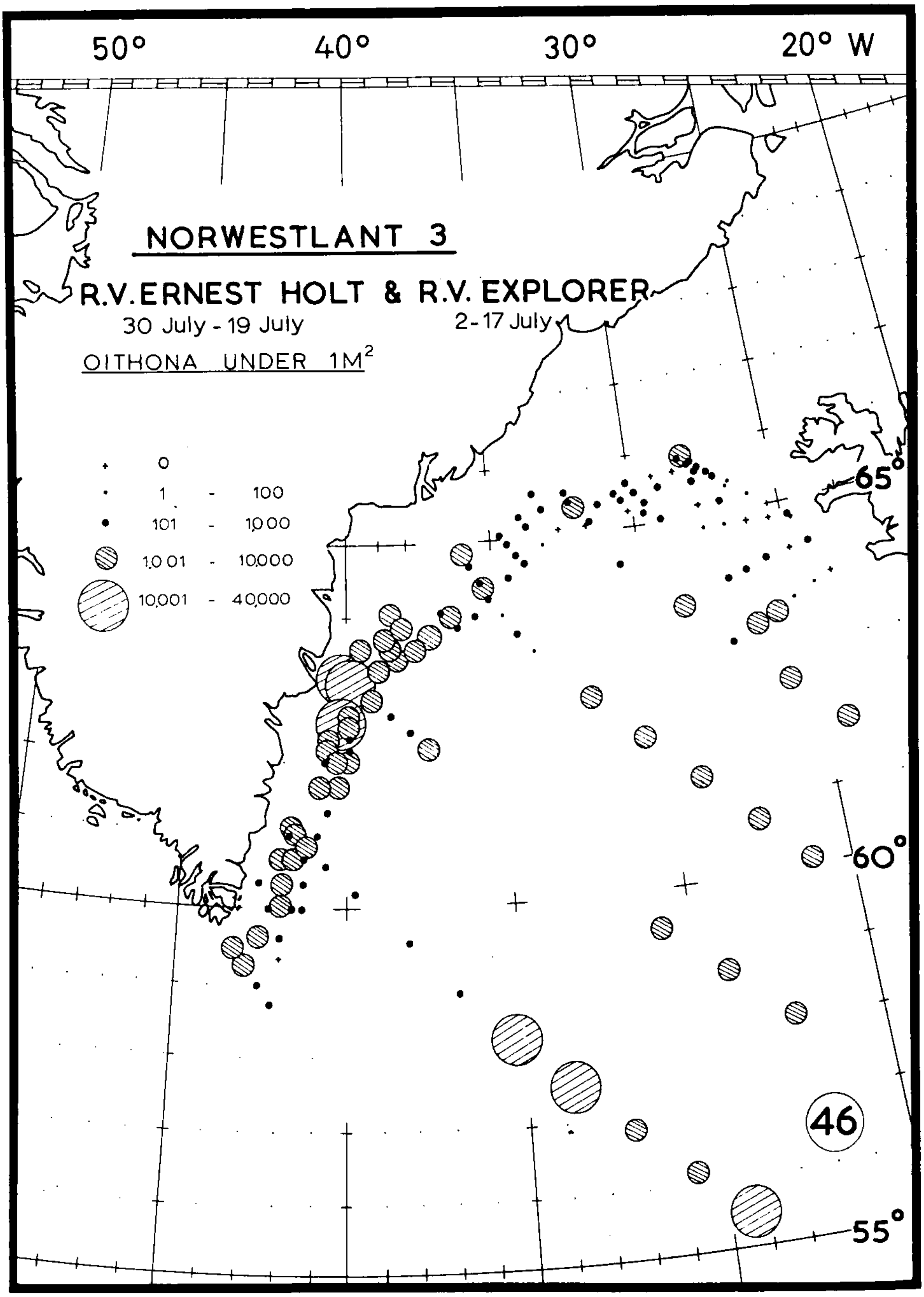
F 5


50°
40°
30°
20° W
NORWESTLANT 3
R.V. ERNEST HOLT & R.V. EXPLORER
30 June - 19 July
2 - 17 July
COD LARVAE
2M. STRAMIN NET
NUMBER PER 30 MINUTE TOW
0
1 - 5
6 - 15
16 - 30
86
65°
60°
55°
42

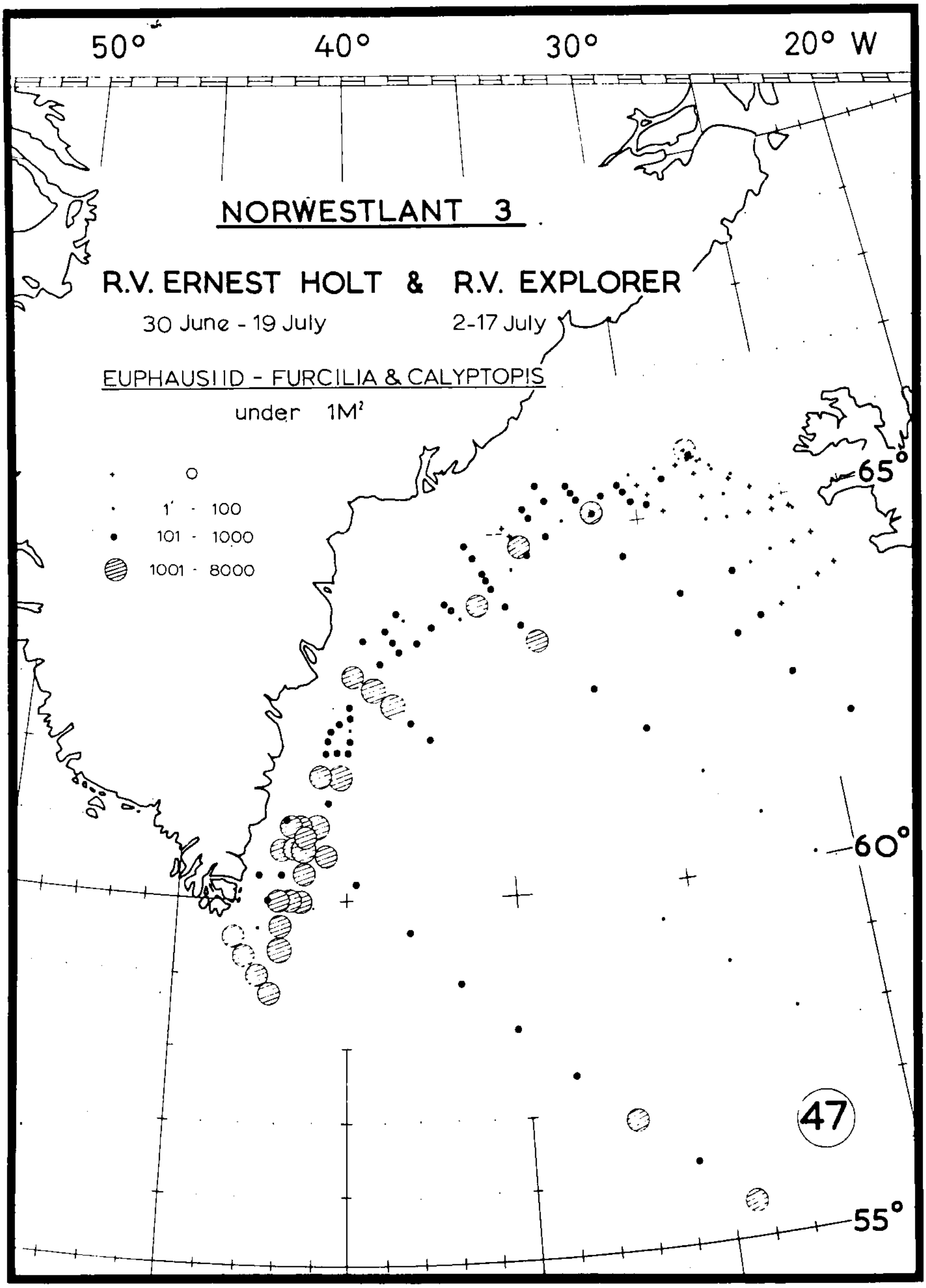

50°
40°
30°
20° W
NORWESTLANT 3
R.V. ERNEST HOLT & R.V. EXPLORER
30 June - 19 July
2 - 17 July
REDFISH LARVAE
2M. STRAMIN NET
NUMBER PER 30 MINUTE TOW
0
1 - 10
11 - 30
31 - 60
61 - 500
65°
60°
55°
43

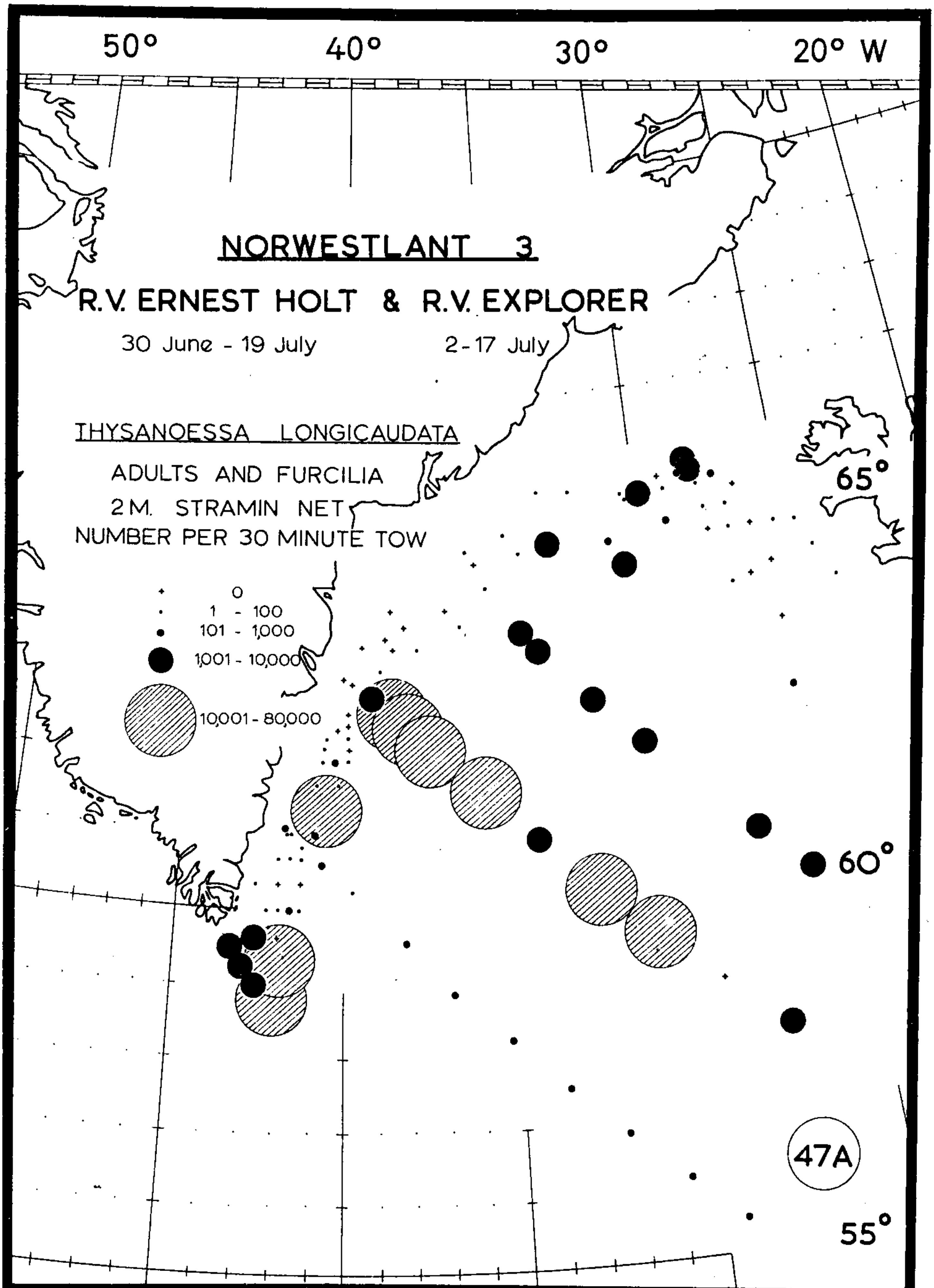

50°
40°
30°
20° W
NORWESTLANT 3
R.V. ERNEST HOLT & R.V. EXPLORER
30 June - 19 July
2-17 July
CALANUS STAGE VI UNDER 1M²
0
1 - 100
101 - 1000
1001 - 10000
65°
60°
55°
44

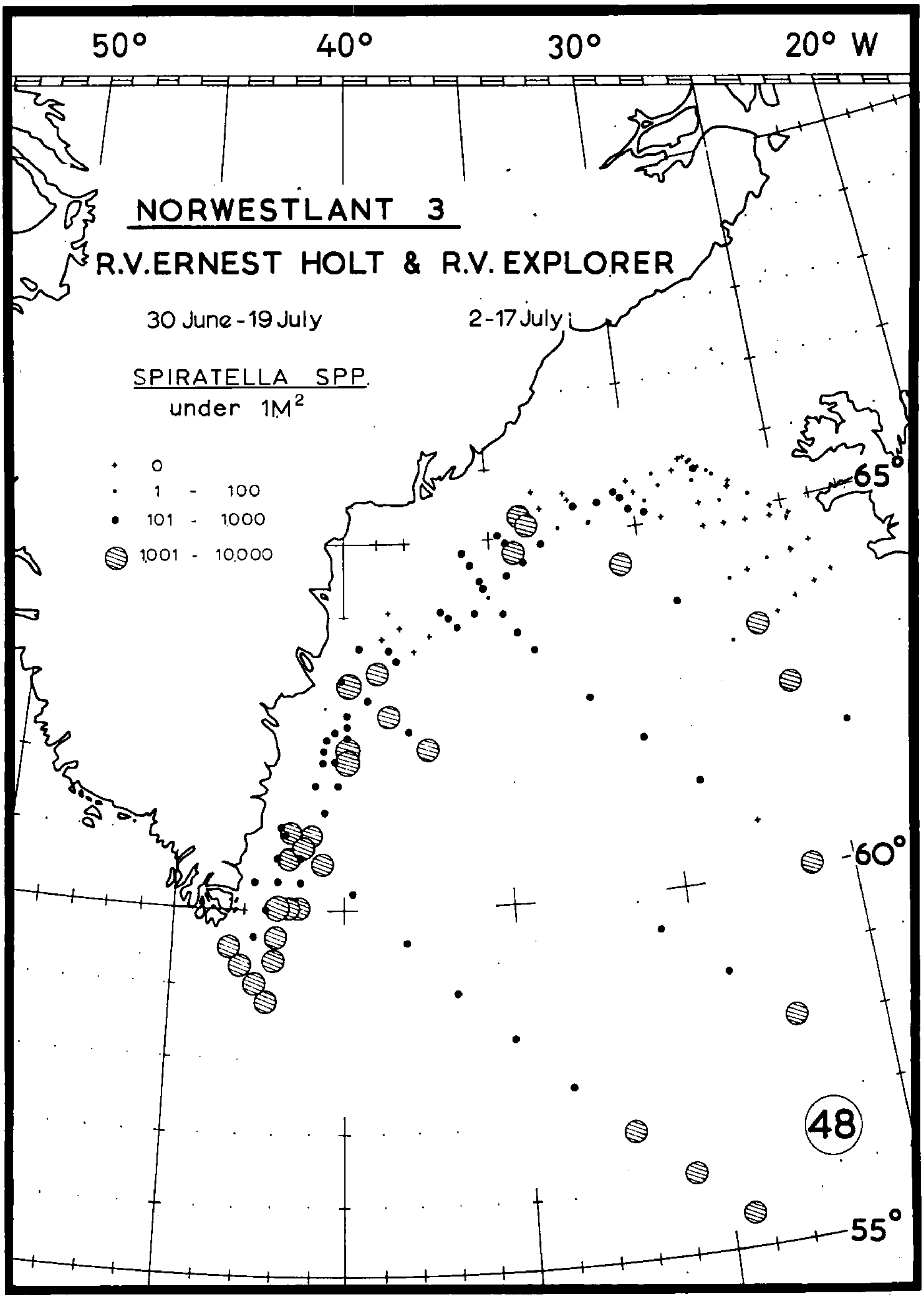

50°
40°
30°
20° W
NORWESTLANT 3
R.V. ERNEST HOLT & R.V. EXPLORER
30 June - 19 July
2-17 July
CALANUS STAGES I & II UNDER 1M²
0
1 - 100
101 - 1,000
1,001 - 10,000
10,001 - 60,000
65°
60°
55°
45


50°
40°
30°
20° W
NORWESTLANT 3
R.V. ERNEST HOLT & R.V. EXPLORER
30 July - 19 July
2-17 July
OITHONA UNDER 1M²
0
1 - 100
101 - 1000
1001 - 10000
10001 - 40000
65°
60°
55°
46

F 10


50°
40°
30°
20° W
NORWESTLANT 3
R.V. ERNEST HOLT & R.V. EXPLORER
30 June - 19 July
2-17 July
EUPHAUSIID - FURCILIA & CALYPTOPIS
under 1M²
O
1 - 100
101 - 1000
1001 - 8000
65°
60°
55°
47


50°
40°
30°
20° W
NORWESTLANT 3
R.V. ERNEST HOLT & R.V. EXPLORER
30 June - 19 July
2-17 July
THYSANOESSA LONGICAUDATA
ADULTS AND FURCILIA
2 M. STRAMIN NET
NUMBER PER 30 MINUTE TOW
0
1 - 100
101 - 1,000
1,001 - 10,000
10,001 - 80,000
65°
60°
55°
47A


50°
40°
30°
20° W
NORWESTLANT 3
R.V. ERNEST HOLT & R.V. EXPLORER
30 June - 19 July
2-17 July
SPIRATELLA SPP.
under 1M²
0
1 - 100
101 - 1000
1001 - 10000
65°
60°
55°
48