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RRS DISCOVERY CRUISE 39 REPORT

April - June 1971

Plankton Investigations at 60°N 20°W and 53°N 20°W.

N.I.O. Cruise Report No. 40

(Issued October 1971)

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Abbreviations

RMT 1	Rectangular midwater trawl with a sampling area of 1 sq m (mesh size 0.32mm).
RMT 1+8	Standard combination of nets RMT 1 (mesh size 0.32mm) and RMT8/5 (Rectangualr midwater trawl with sampling area of 8 sq m; (mesh size 4.5mm).
RMT8/150	Prototype high speed net, mouth area 8 sq m, mesh size 150mm.
RMT 25	Rectangular midwater trawl with a sampling area of 25 sq m.
BN 2.4	Bottom net with mouth area 2.4m.
NN	Neuston net.
N113	Ring net with mouth area of 1 sq m, (mesh size 0.32mm).
BLL	Bottom longline.
BC	Bottom camera.
TSD	Temperature, salinity, depth probe.
WB	Water Bottle (Standard N.I.O.).

Introduction

Cruise 39 extends our survey of the vertical distribution of the oceanic pelagic fauna into more northerly latitudes of the eastern North Atlantic. On previous cruises day and night series of opening closing net hauls had been made at 11°N, 18°N 28°N and 40°N. During the present cruise observations were made firstly at 60°N,20°W in the Iceland Basin some 250 miles south of Iceland and secondly at 53°N,20°W lying 380 miles west of Ireland just south of the southern edge of the Rockall Plateau. The depth of water at both positions exceeds 2500m and at each the water column down to 2000m was successfully fished in a series of discrete depth horizons.

While on passage echo-sounding watches were routinely kept providing data not only on the bathymetry but also on the occurrence and intensity of midwater scatters. Simultaneously a continuous profile of temperature and salinity at the depth of the PES towed fish was obtained.

Our course to and from 60°N,20°W was arranged to pass over an area of Rockall Bank of particular geological interest and this was surveyed using short range side-scan sonar.

Two outside laboratories had requested special collections from 60°N and 53°N and in a large measure their needs were met.

Narrative

Left Barry	1730A/21	April
Arr. 60°N,20°W (Stn 7709)	1000Z/25	April
Left " "	1030Z/9	May
Arr. Galway	1800A/12	"
Left Galway	1830A/14	"
Arr. 53°N,20°W (Stn 7711)	1345Z/16	"
Left " "	0430Z/2	June
Arr. Falmouth	0800A/6	"
Left Falmouth	1600A/6	"
Arr. Southampton	0700A/7	"

Leg. 1 (fig. 1)

R.R.S. Discovery left Barry Dock at 1730A/21 and anchored off Barry Harbour to lower and test the Side-Scan Sonar. After disembarking Mr. R. Stubbs and Mrs P. Edwards the ship got underway at 2230. Fastnet was cleared at 1900Z/22 and a course set for the southern end of Rockall Bank which we surveyed with side-scan sonar during our crossing on the 24th. Course was then set for 60°N,20°W which was reached, after trials with the RMT 1+8 on the 24th, at 1000Z/25. The day and night series of RMT 1+8 hauls commenced and continued until the evening of May 3rd when bad weather imposed a temporary cessation of fishing. Heavy swell on the 4th made net hauls impossible but a TSD dip and three hauls with bottom camera were made. By midnight fishing was again possible, the series was resumed, and continued until the completion of the day series on the 6th and the night series on the 8th of May. The RMT 25 was then rigged and used successfully to make an abbreviated day series from 1000-200m fishing in 200m horizons.

After the early completion of the day series a number of other activities were pursued. The bottom net (BN 2.4) was fished on 5 occasions backed up by dips with the bottom camera (BC). The bottom longline (BLL) was shot on the 6th in a depth of 2715m and on the 7th in 2700m. On the second occasion we were unable to relocate the dhan buoy inspite of a 4hr search in ideal visibility. The area was searched again on the 8th but to no avail. It is presumed that the buoy had been dragged below the surface by the 2 knot southeasterly current in which it had inadvertently been laid (see below). Water samples requested by I.G.S. for heavy metal analysis were collected at the surface and at 5 depths down to 2000m. Special plankton collections requested by the Fisheries Laboratory, Aberdeen were taken at the surface, 500-400m, and 1000-900m and frozen for later chemical analysis. Neuston net hauls and two oblique tows with the RMT 1+8 were also made at this position.

To monitor hydrological conditions at 60°N,20°W 7 TSD dips to a depth of 2000m were made during the period 25th April to 9th June. Comparison of the profiles for the 25th and 30th April (fig. 2) showed that unexpectedly large changes had occurred, the water column to a depth of about 1000m having become isothermal and isohaline. At the same time a strong south-easterly surface current of up to 2 knots had developed in the north-eastern sector of the area - the magnitude and direction being established from surface current vectors computed from satellite and DR fixes (fig. 3). These features prompted us to make a section of 7 TSD dips across the presumed axis of the surface current, the stations being 5 nautical miles apart. The gradients of potential temperature, salinity, and sigma t (fig. 4) confirm the presence of a deep south-easterly current extending probably to a depth of about 1000m. From these measurements and the surface current vectors it is concluded that we were working across the north eastern edge of an anticyclonic gyre of Gulf Stream origin. It is presumed that the gyre moved into the area sometime after April 25, was centred on 60°N,20°W on April 30, and subsequently shifted some 30 miles to the southwest. The majority of the net hauls were made in the sector influencedby the strong south easterly current.

Work at this position finished at 2230/8 when course was set once again for the southern end of Rockall Bank which was surveyed with side-scan sonar from 2230Z/9 to 1230Z/10 when work had to be discontinued due to bad weather conditions and an unfavourable forecast for our passage to Galway. We anchored in Galway Bay on the evening of the 11th finally docking at 1830A/12 after delay due to fog.

In Galway Messrs. Harris and James were disembarked and Messrs. Badcock, Phillips and Pugh embarked.

During our visit to Galway great interest was shown in the ship and her work not only by the staff and students of University College Galway, but also by local civic dignitaries and townspeople all of whom were most generous in their welcome and hospitality. Throughout the Friday prior to sailing we received an unprecedented number of visitors, in excess of 200, who were conducted over the ship by officers and scientists.

Leg 2 (Fig. 1)

R.R.S. Discovery sailed from Galway at 1739A/14, the E.S. fish was streamed at 1930 and E.S. watches commenced at 0800Z/15. It was originally intended to make our next series of observations in the region of O.W.S. "J" but consideration of the bathymetry of the area showed that a more northerly position presented a better topography for fishing bottom nets. After a preliminary oblique tow with the RMT 1+8 on the 15th, course was therefore set for 53°N,20°W which was reached at 1345Z/16. Hauls with the RMT 1+8 commenced and the first TSD dip was made at dusk followed by net hauls through the night until 1700/17 when bad weather terminated fishing. During this spell further water samples were taken for I.G.S. as at 60°N,20°W and dips with the bottom camera were made. The RMT 1+8 series recommenced at 0600Z/18 and continued until 0440Z/21 when bad weather once more prevented fishing. A small TSD survey was made during this period the stations being spaced 10 nautical miles apart in a triangular grid. RMT 1+8 hauls were eventually resumed at 2213Z/22 and continued in good weather - the day series being completed on the 24th and the night series on the 28th.

Throughout our stay at 53°N the fishing of shallow nets was considerably hampered by a massive swarming of the salp Salpa fusiformis. In an attempt to reduce catch size tows were of short duration but even so some of the collections exceeded 20 litres in volume and resort had on occasion to be made to subsampling.

As at 60°N,20°W the early completion of the day series permitted various other activities to be pursued. The RMT 25 was fished during the period 28-31 May, its use finally having to be discontinued when the top bar became bent. Bottom nets, bottom camera, neuston net hauls, tows with the Longhurst-Hardy Sampler and gear trials were all conducted at this position. Special plankton collections were made at the surface, 500-400m and 1000-900m for the Fisheries Laboratory, Aberdeen.

Six TSD dips to 2000m at the central position during the period 16th May to 1st June showed that although the extent and depth at which inversions occurred showed some variation the situation was relatively stable compared to conditions at 60°N,20°W.

Work at 53°N,20°W concluded at 0430Z/2 and a course was set for shallower water for bottom longlines. After an RMT 1+8 on the night of June 2nd we arrived on position 51°39.9'N, 14°17.5'W at 0537Z/3. The bottom longline was shot and recovered successfully with a good catch, and a tow with the Longhurst-Hardy Sampler made. Having moved into slightly deeper water the bottom longline was again fished on the 3rd. We then steamed east making some neuston net hauls, into deeper water where the RMT 1+8 was fished and then a bottom longline laid. Further neuston net hauls were made before leaving this position at 1900/4 and again later that evening. Course was then set for Falmouth where we arrived at 0800A/6 to take on a C.O.I. Film Unit who spent until 1600 on board filming, before they were disembarked.

R.R.S. Discovery then proceeded to Southampton where she docked at 0700A/7 BST.

Biological Observations

Siphonophores

Only catches from the second half of the cruise at 53°N,20°W were examined. Large numbers of calycophoran siphonophores were taken druing this time, although the number of species was limited. No cystonect siphonphores were noted and only occasional physonects, an exception being a night time haul from 1500-680m (#50) of which half of the large RMT8/5 catch consisted of fragments of several specimens of Halistemma ?n. sp. This was one of the few deep water siphonophores and was noted in other hauls. The calycophoran species were most abundant in the 100-400m depth zone, and the daytime haul (#15) from 200-100m caught a vast number of specimens. The predominant siphonophores were species of the prayid genus, Rosacea. Vogtia glabra and V. spinosa were also common together with species of the diphyid genus Lensia and Chuniphyes multidentata.

The only other physonect species noted were Agalma okeni and A. elegans, whose nectophores appeared occasionally.

Ostracods

The number of specimens and variety of species of Ostracoda were apparently much smaller than in the other series. At 60°N there was a complete absence of species from the surface 100m. The most abundant species were as expected C. borealis, C. elegans and C. obtusata. However, Gigantocypris was very abundant at around 1000m and several other species eg. C. ametra C. hyalophyllum, and C. brachyaskos also appeared in quite large numbers. All these latter species were present in the Fuerteventura series at 28°N. At 53°N the number of species was larger with the appearance of C. haddoni, C. daphnoides, C. loricata etc. Even so, the number of specimens was relatively small, despite the very large numbers of Gigantocypris caught at 800-1000m. Macrocypridina castanea rather surprisingly only occurred in the 100-50m samples and cannot at these latitudes be considered a deep living species.

C. borealis was observed to bioluminesce, and specimens of C. haddoni were fixed for further electron-microscope investigations of the frontal organs.

Large numbers of a Myodocopid ostracod, probably a Azygocypridina species were caught in the bottom net samples. Less than twenty specimens of this rare genus have been recorded in the literature. Rough sorting of the bottom net samples has more than doubled this number.

Copepoda

Compared to previous horizontal series the RMT 1 series at both 60°N and 53°N was very poor in the numbers of species caught. At 60°N,20°W two species dominated the copepod catch - Calanus finmarchicus, present in very large numbers in the upper 100m with a distinct nocturnal migration into the surface layer, and Paraeuchaeta norvegica, which was abundant between 600-400m by day and also migrated to the surface layers at night. Spinocalanus magnus was the commonest species in the

deeper hauls

At 53°N,20°W both numbers of species and numbers of individuals were very low. Surprisingly, C. finmarchicus was virtually absent and the most abundant species by day were Pleuromamma robusta between 400-300m and P. norvegica between 500-400m. Nocturnal movements were masked by the very high concentration of salps in the surface layers by night.

The NN showed a very marked nocturnal migration over sunset by C. finmarchicus at 60°N, and at 50°45'N,12°55'W, Stn 7718, the Oxfam caught very large numbers of Anomalocera patersoni at night. The most notable copepods caught were some very large Centraugaptilus sp. taken between 2000-1525m at 60°N, and the myctophid Benthosema sp. at both 60°N and 53°N was found to have a very high incidence of infection by a parasitic Lernaeid.

Amphipods

The further extension to the north of positions at which vertical series have been worked has shown a further reduction in the number of planktonic amphipod species. This reduction is particularly evident in the Sub-Order Hyperiidea which at 60°N was represented by only 12-13 species, most of which are Physosomata. In general, numbers of species and individuals were rather low.

At 60°N,20°W Parathemisto spp. were abundant in shallow hauls, and present in small numbers throughout the water column sampled. The genus was less abundant at 53°N,20°W although still sufficiently numerous to be the co-dominant amphipod with Hyperia in shallow hauls. Hyperia was generally present in small numbers but was occasionally common, being particularly so in those shallow hauls which contained large numbers of Pelagia. Eurythenes obesus showed a wider depth range at 60°N and 53°N than it does further south where it is rarely found above 400m. This species in contrast to most amphipods, shows a considerable variation in colour, ranging from grey-white through orange to deep cherry red. As on previous occasions, active feeding on dead and dying fish and decapods was observed, and it may be that the colour variation is affected by food. In hauls from below 200-300m cyphocarids (Lysianassidae: Gammaridea) such as Cyphocaris anonyx, Metacyphocaris helgae and Crybelocephalus spp. were usually the commonest amphipods, although species of Lanceola and Scypholanceola may be relatively abundant.

Neuston net catches at 60°N frequently contained large numbers of Parathemisto, often to such an extent that the genus was dominated numerically only by Calanus. At the southern station, Parathemisto rarely reached these levels of abundance, and when common was often represented by small juvenile specimens.

Some amphipods have been picked out of the bottom net samples. One of the most striking features of this material was the much larger numbersof species and individuals from 60°N than from 53°N. The five hauls at 60°N contain between them at least 50 species, whereas seven hauls at 53°N have so far yielded only about 20 species.

Baited traps were attached to bottom longlines fished at 420m and 681m, and at least 3 species of lysianassid were

obtained. Traps set at 2100m caught nothing but an improvement in design may overcome this failure in the future.

Specimens of the aberrant lysianassid genera Thoriella, Danaella and Chevreuxiella have been obtained, and show puzzling morphological variations in antennae, peraeopods and body form. Sufficient material has been obtained to clarify the position of these rare and poorly known monotypic genera. All three species have been shown to luminesce strongly. There is some slight evidence to suggest that they may be parasitic on large scaled fish such as Bathylagus.

Euphausiids

As was expected very few species of euphausiids were taken in either vertical series. At 60°N,20°W, in the upper 500m the dominant species were Thysanoessa longicaudata and Meganyctiphanes norvegica and below 500m Nematobrachion boopis and Thysanopoda acutifrons. Other species, which occurred in very small numbers were Stylocheiron maximum, Nematoscelis megalops and Bentheuphausia amblyops. Two specimens of Thysanoessa inermis were taken at the surface in an Oxfam net but the species is not thought to be represented in the vertical series. At night T. longicaudata was most abundant at 200-300m and M. norvegica in the upper 200m but during the day neither species showed clear patterns of distribution.

At 53°N,20°W nearly the same species were present except that T. longicaudata was replaced by Euphausia krohnii and Stylocheiron elongatum was added. However, the euphausiid fauna was extemely poor at this station, the upper 200m being virtually devoid of any euphausiids either by day or by night. E. krohnii and S. maximum occurred in small numbers between 200m and 400m during the day, N. boopis below 200m and T. acutifrons and B. amblyops below 400m. At night the last three species were taken but shallower living species occurred only as isolated specimens. Salps were extremely abundant at 53°N and this may have had some effect on the distribution of those species which normally occupy the upper 200m at night.

Decapod Crustacea

Catches of decapods in the day/night RMT8 series at both 60°N and 53°N were of moderate size and generally similar in species compositon. Not unexpectedly only a few species were present. In the day series there was a clear vertical succession of species with Sergestes arcticus dominant from 400-600m, Parapasiphaea sulcatifrons from 600-700m and Acanthephyra pelagica, Gennadas elegans, and Meningodora vesca from 700-1000m. Below 1000m there was a reduction in total catch, Hymenodora sp. becoming common together with Ephyrina benedicti and Systellaspis braueri in much smaller numbers. Species of Sergia were remarkably absent except for a few S. japonicus in the deeper hauls at 60°N and also at 53°N where they occurred with juvenile S. robustus. A single specimen of Physetocaris microphthalma taken in the 1250-1010m haul at 60°N is of particular note since this is the most northerly record of this uncommon species, which is usually thought to have a subtropical and tropical range.

Comparison of the day and night collections clearly demonstrates

that many species including S. arcticus, P. sulcatifrons, A. pelagica and G. elegans undergo extensive vertical migrations.

Cephalopods

A total of 355 cephalopods were removed from the net hauls, of these 323 were from the two vertical series at 60°N and 53°N. Only 96 cephalopods were found in the 60°N vertical series and these all belonged to three species, the most common being Gonatus fabricii (69%). Taonius megalops represented 28% of the catch and the third species Mastigoteuthis schmidti was represented by only 2 animals. At 53°N 227 cephalopods were removed from the vertical series hauls. Here again Gonatus (73%) and Taonius (23%) were by far the most common species. The other species were Histioteuthis eltaninae (3); Mastigoteuthis schmidti (2); Brachioteuthis riisei (3) and Alloposus mollis (1).

Although Taonius and Gonatus extended down to about 1000m in both vertical series their most common depth during the day and at night was approximately between 200-10m. There appeared to be little vertical migration of either species.

At 53°N in addition to the other species the RMT25 caught 2 Todarodes sagittatus over 50cm in mantle length and 1 Mastigoteuthis flammea. The BN 2.4 caught 1 cirroteuthid when fished on the bottom at 2714m.

Bioluminescence was observed on the eye of a large specimen of Taonius.

Mesopelagic Fishes

Preliminary examination of the catches from the RMT8 net fished during the vertical series at both 60°N and 53°N were carried out onboard. At both stations the catches were moderate in size, although the number of species represented were few. At the former position 7400 specimens were caught, of which 94% were represented by 5 species of myctophid and 8 species of gonostomatid. The most numerous myctophid, Benthosema glaciale, comprised 35% of the total, while the gonostomatids, Cyclothone microdon and C. braueri provided 38% and 11% respectively.

The series carried out at 53°N yielded 6100 fish. Here, 91% were myctophids (16 species) and gonostomatids (8 species). Once again B. glaciale, C. microdon and C. braueri were the three most abundant species. They made up 25%, 44% and 17% of the total catch respectively.

Diurnal variations in the catches from both areas indicated that the myctophids carried out considerable vertical migrations. Conversely, the gonostomatids were shown to be making little or no vertical migration. Most notable among the myctophids was B. glaciale which, although taken in small numbers down to 2000m by day and night, altered its depth of peak abundance by some 400m to enter the surface 25m at night. Of the less numerous species in the catches at 60°N and 53°N, 2 species of Argyropelecus were moderately abundant, but no Sternoptyx was caught. The interesting myctophid, Heirops arctica was fairly common, as was the melamphaeid Scopelogadus sp., and Bathylagus sp. (Bathylagidae). Specimens of the rare zoarcid fishes Parabrotula

and Leucobrotula were also caught at both stations. At 53°N a single specimen of an apparently unreported opisthoproctid fish was caught.

Bottom Fishes

Bottom longlines were fished on 5 occasions during the cruise. Two were carried out on the first leg in the northerly area. Neither operations caught fish; no bait was even damaged when the line was fished at 2700m. A second line was shot in a similar depth, and was never recovered despite several hours searching in perfect conditions. Subsequently, it was found that the line was laid by chance in an area where the current was in excess of 2 knots.

Fishing in the southerly area was more successful. A line of 49 hooks fished in 420m caught 5 Phycis blennoides, greater fork-beard, and 1 Galeus melastomus, black-mouthed dogfish. Another in 690m took 11 gadoids, Mora moro, 3 P. blennoides, 2 G. melastomus, and 1 squalid shark, Scymnodon ?ringens - giving a total catch rate of 38%. The last line fished was in 2180m, when 2 gadoids, Antimora sp. were caught from 55 hooks. The bait used in each operation was a mixture of squid and mackerel.

Epibenthos

The bottom net (BN 2.4) used was similar to that fished during cruise 36, with modifications to the bottom bar and the pinger. To increase the weight and facilitate the return to position if the weak links were broken, the bar was made solid. The pinger, mounted on one of the skids inside the frame, was a modified 'B' type fitted with mercury switches, the period between pulses changing when the net hit the bottom. The weak link on the towing bridles broke during many of the hauls, usually when the net was clear of the bottom and preventing the net from fishing during hauling. The net was fished 5 times at 60°N between depths of 2636m and 2714m, and 7 times at 53°N, between depths of 2380m and 2744m. In both areas the sediments were relatively soft; at 60°N consisting mainly of silt with some sand and pteropod shells whilst those at 53°N contained a large amount of dead material, possibly the remains of holothurian alimentary canals. The catches from both areas consisted of typical soft sediment fauna and superficially, there appeared to be as much variance between samples within one area as there was between the two areas. Large numbers of the polychaete Ophelina sp. were present at 60°N and to a lesser extent at 53°N. Present in the majority of hauls, and also in several of the bottom camera photographs, were deep red discoid alcyonaceans. Individual samples at 53°N were dominated by: comatulid crinoids and elasipods (2), very small elasipods and some comatulid crinoids (1), sponge and bright yellow stalked crinoids (Isocrinidae) (1), ophiuroids, medium sized elasipods and pteropod shells (1), and purple spatangoid echinoids (1). Relatively few fish were caught at either area, those present being mainly Nomatonurus, Chalinura and Antimora, with a few halosaurs. Other groups of interest represented in the hauls included septibranch bivalves, brachiopods, very large holothurians, bottom decapods (Polycheles, galatheids, etc.) pycnogonids (including 1 large ?Colossendeis), Echinothuroidea, and large polynoids.

Neuston

Several series of neuston hauls were made at 60°N,20°W, one dusk series, 4 dawn series and a number of daytime hauls to demonstrate the presence of animals in the neuston layer and arrival and departure of migratory forms. The dominant species were Parathemisto sp. and Calanus finmarchicus, the latter exhibiting a dramatic nocturnal migration. The dawn series were smaller in numbers, the dominant forms probably having left the surface layer very early. Some of the dawn hauls contained individuals of Periphylla, Gonatus fabricii and Hyperia sp. The day hauls were all rather small in size and were represented by only two species - Parathemisto sp. and Anomalocera patersoni. Periphylla was seen in large numbers at the surface at night but they were not caught by the neuston net.

Two night hauls were made at 53°N,20°W, the sampling time reduced to 6 minutes, Salpa fusiformis and Pelagia noctiluca being extremely abundant and dominating the catch. The dusk series at 53°N,20°W was abandoned when the Salpa migrated to the surface layer and made sampling impracticable.

The samples taken at 50°45'N,12°55'W (Station 7718) were large and contained some interesting animals, the dominant species were Velella velella and Anomalocera patersoni: other groups present were fish, protozoa, Coelenterata, Crustacea and Mollusca, being represented by eggs and juvenile gadoids. Foraminifera, medusae, Parathemisto sp. juveniles and decapod zoea larvae, and the pteropod Euclio sp. respectively.

Bioluminescence

The general parameters of the bioluminescence of a number of species of animal have been determined, with particular emphasis paid to the intensity and temporal characteristics of the luminescent response of each species to various stimuli. Attempts have also been made to culture the putative bacterial source of the light of certain species using artifical culture media (with N. Dilly). Although bacterial cultures have been obtained from several species such cultures have been self-luminescent in only two cases. Further work with media more nearly approaching the characteristics of the natural environments is clearly necessary.

Among the luminescent species investigated certain groups of animal have been of particular interest. Among the decapod crustaceans secretion of luminescent material into the surrounding sea water appears to be a common occurrence, and observations of this behaviour in a number of genera and species have confirmed the hepatopancreas as the source of the material. Luminescence of the copepod family Megacalanidae has been extended to include the genius Bathycalanus, and among the amphipods to species of the Chevrexiella - Danaella - Thoriella group (with M. Thurston), whose luminescent characteristics may perhaps assist in delineation of their systematic relationships. Observations on the luminescence of cephalopods has been largely restricted to that of the large ocular photophores of Taonius megalops (with N. Dilly). The luminescent organs and responses of Chauliodus and Stomias have been investigated and morphological comparisons made with the luminescent bodies in other stomiatoid fishes. Observations have also been made on the mode of action of the lures of certain angler fishes and of

the caudal plates and ventral photophores of several species of Myctophidae. Perhaps the most interesting extensionsto known records of bioluminescent capability have been among the bottom-living echinoderms, luminescence having been observed in the classes Crinoidea, Asteriodea and Holothuroidea, in addition to further examples among the Ophiuroidea.

Ship-board observations of the chemical nature of some of the above systems will be extended by analysis of deep-frozen material, and material from many species has been fixed for subsequent light and electron microscopy.

Buoyancy of crustacean eggs.

The density of the eggs of three species of decapod has been determined to supplement previous analyses of the relationship between size, lipid content and egg size.

Special Investigations

Dr. N. Dilly conducted a number of special investigations that required the ready availability of freshly caught animals.

Cephalopods: The specimens were usually obtained from hauls that for various technical reasons were not suitable to form part of the vertical series of nets.

These animals have been used for investigations and fixation techniques that demand fresh, and if possible living animals, and have therefore of necessity had to be undertaken at sea. They include:

1. The primary study has been an attempt to produce a standard repeatable technique and apparatus for photographing live cephalopods. The aims and objects of this study are initially two fold. Firstly to produce a photographic record of live cephalopods, that will be useful to other workers in this field, and secondly to establish a photographic record of the distribution and physiological activity of the chromatophores, and to investigate the influence of external physical factors upon their activity.

2. Specimens of cephalopod brains and eyes have been fixed for electron microscopy.

3. Some special fixation and post fixation treatments have been undertaken for non routine histology.

4. An attempt has been made to preserve the visual and other pigments for photomicrospectroscopy.

5. It has been possible to make significant studies on the behaviour of two species of squids.

Decapod Crustacea: A collection of eyes from different species of decapods have been fixed for electron microscopy and photomicrospectroscopy. The collection has been arranged to include specimens usually found at specific depths throughout the net haul series. The objective being to determine any possible receptor and photopigment modifications associated with the varying depths.

Photogenic bacteria: Attempts have been made to establish

cultures of photogenic bacteria on Agar substrates fortified with differing additives in the hope of establishing the optimum conditions for photogenic bacterial growth, and also the chemical nature of materials essential for their continued photogenic activity.

Ornithology

Bird observations have been made as and when other duties permit. On average, 1-1½ hours a day has been devoted to these observations.

The position of 60°N,20°W is cloe both to the migratory route of birds on passage to Iceland and also to the Ocean Weather Ship Station India. The northern position was occupied from April 25 to May 8 inclusive and during this period a total of 35 species were identified. Sixteen of these species were sea birds. Fulmar and kittiwakes were present at virtually every observation. They were generally not very abundant, but occasionally over 100 individuals were counted. The number of dark phase Fulmars was low; only a few per cent of the total seen. The gradual decrease in proportion of adult to juvenile kittiwakes over the period was noticeable. Gannets were seen fairly frequently, usually single adult birds. The occurrence of Black-headed Gulls was erratic, but a flock of about 100 was seen on April 26. The most notable sighting at this position, and indeed for the whole cruise, was a Ross's Gull in full summer plumage early on the morning of April 30. For the short time it was around the ship, it was in the company of a mixed flock of kittiwakes and Black-headed Gulls. Ross's Gull is a resident of NE Siberia and has been recorded in Europe less than 20 times A northerly movement of skuas was noted, there being a trickle of Great and Arctic Skuas throughout the period, augmented by Pomarine and Long-tailed skuas in early May. No storm petrels were seen.

The species of birds other than sea birds seen at 60°N, 20°W were, for the most part, species recorded at Station India (59°N,19°W) in 1967. During the night of April 26-27, just prior to the new moon period, and in heavily overcast conditions, the floodlights aft attracted large numbers of birds. There was a fall of meadow pipits, Wheatears and Redwings, and at first light a mixed flock of waders was seen circling the ship for an hour. Calls heard during the night suggested that some or all of these birds had arrived between midnight and 0200 on April 27. The flock contained ca 400 birds, mostly Redshanks, but also smaller numbers of Black-tailed Godwits, Snipe, Turnstone, Purple sandpiper and Golden Plover.

The pattern of species seen at 53°N,20°W was quite different to that on the first leg of the cruise. Not only was the second leg past the peak of the migration period, but it was to a position away from any land bird passage route. As a consequence there were only 3 species of land birds among the total of 22 species identified. Fulmar and Kittiwakes were present throughout the period of occupation of the station (ie. May 16 - June 1). Gannets were present in greater numbers than at 60°N,20°W, and more immature birds were seen. First year birds were seen only on passage from 53°N,20°W towards Falmouth. Small numbers of Greater and Sooty Shearwaters were recorded towards the end of the period, often following in the wake of schools of Pilot Whales. Skuas were seen regularly, the Long-tailed skua being most abundant. Many of these birds were on migration. Some storm petrels were seen but specific identification proved impossible.

After leaving 53°N,20°W bottom longline stations were worked. The oily slick produced by the bait as it entered the water attracted storm petrels, and up to 30 British storm petrels were seen on one occasion. One Wilson's storm petrel was also recorded.

The overall impression of this cruise compared with previous cruises to more southerly areas is one of much greater variety of species and far higher numbers of individuals.

Gear

RMT Nets

RMT 1+8. In the two vertical series and in miscellaneous sampling the RMT 1+8 was used for 103 opening/closing hauls. A number of modifications have been made to the nets, both before and during the cruise. During the 1970 cruise the bars carrying the RMT 1 side wires tended to bend at the welded bracket when used in bad weather. These bars have now been made stronger and the welded brackets replaced by clamps and no sign of bending was detected. The bridles and side wires are now made of more flexible wire as they tended to become very stiff after prolonged use. Wear on the RMT 8 side wires was still considerable, they sometimes had to be changed after only 4 hauls in bad weather but Mr. R.A. Wild designed and fitted polypropylene inserts to the eye-bolts at the ends of the sliding bars with the result that one set of wires lasted for 44 hauls. In the course of these hauls some of the inserts required replacing on only 5 occasions. Mr. Wild also expermented with clamping devices on the weight bar which would hold the opening bar down and possibly reduce vibration in the system and also further reduce the wear on the wires.

This was the first cruise on which re-chargeable batteries were used in the net monitor and they generally worked very satisfactorily, the number of battery changes required was greatly reduced. The insertion of a waterproof bulkhead in the monitor enabled battery changes to be made on deck without taking the monitor out of the gimbal frame.

The failure rate was higher than on Cruise 36 but at times the gear was necessarily worked in severe weather conditions. The reason for failure were varied, some were due to the net monitor (internal and external leads becoming disconnected and a fault in the battery charger) and some to the nets. A fault experienced in 1970 was the fouling of the RMT 8 closing bridles on the RMT 1 bar, this re-occurred but was corrected by an alteration to the brackets on this bar.

Except when trying to shoot the net open, little difficulty was experienced in handling the gear in bad weather and it can probably now be worked in any weather conditions which permit the use of the crane.

Catches were generally in good condition except when large Periphylla, which were abundant, were caught.

RMT 25. The RMT 25 was fished on 10 occasions. The net has had the long cod-end removed since the last cruise and catches were in good condition, extremely little becoming caught up in the netting. The net was remarkable for the small amount of leakage when closed as shown by a haul in which it

opened and closed simultaneously. The seal seems to be even better than on the RMT 8.

It was intended to experiment with 10001b instead of 5001b on the weight bar in order to steepen the angle of presentation and increase the mouth area. However the closing bar was found to be bent before this could be done. It is possible that this bar is subject to stress because of a short rope down the upper panel of the net.

Longhurst-Hardy Plankton Sampler

A new experimental system was tested, utilising the facilities of the net monitor to open the net and turn on the sampler at depth. The aim of this sampling was to investigate the effects of the micro-layering of the physical structure of the water column on the micro-distribution patterns of the plankton. Several attempts were made to fish the inversions at 600-550 and 800-750m at station 7711. Minor gear malfunctions resulted in only 77 and 49 subsamples being collected at these depths. Finally at station 7715 a fully successful series of 115 subsamples was collected at a depth of 620-550m.

Bottom Camera

The flash gun and power pack were incorporated in one unit, and functioned efficiently. Several faults were experienced with the camera (the bottom switch breaking, faulty relay, the motor shaking out of gear, faulty leads, etc.) and less than 40 usable frames were exposed, mainly at 53°N. These showed the discoid alcyonaceans, crinoids, asteroids, Umbellula etc.

STATION LIST

TSD's are numbered separately from net hauls, thus (2)
TSD (1) was a test of the gear to 100m on 23.4.71
Day (D) or Night (N) hauls are indicated only where relevant
Positions are for the start and finish of fishing except when gear failed to operate, then a single position is given for the time gear entered the water and no depths or times are shown.

STN.	DATE 1971	POSITION LAT °N LONG °W	GEAR	DEPTH (M)	FISHING TIME	REMARKS
7708	24:4	57°59.0',17°21.7' 58°1.0' ,17°24.9'	RMT 1+8	25-1000	1904-2017	Oblique tow, paid out closed.
7709						
± 1	25:4	60° 3.1',19°59.0' 60° 8.1',20° 1.3'	RMT 1+8	110-200	1045-1245(D)	
± 2	"	60°11.6',20° 2.0' 60°17.2',20° 4.1'	RMT 1+8	205-300	1431-1631(D)	
(2)	"	59°59.9',19°58.7' 60° 0.1',19°58.8'	TSD	0-650	1916-1951	
(3)	"	60° 0.4',19°59.2' 60° 0.8',19°58.5'	TSD	0-2000	2102-2219	
± 3	"	60° 3.5',19°58.5' 60° 8.5',19°59.3'	RMT 1+8	495-590	2331-0131(N)	
± 4	26:4	60°11.6',19°58.4' 60°16.8',19°58.3'	RMT 1+8	105-200	0226-0426(N)	
± 5	"	60° 2.3',19°57.2' 60° 7.5',19°57.1'	RMT 1+8	290-390	0722-0922(D)	
± 6	"	59°58.8',19°56.9'	RMT 1+8	———	———	
± 7	"	60° 2.5',20° 1.0' 60° 6.1',20° 0.1'	RMT 1+8	410-500	1740-1940(D)	
± 8	"	60° 6.6',20° 0.1' 60° 5.9',20°0.3'	NN	0	2013-2025	Fished over dusk period

STN.	DATE	POSITION LAT °N LONG °W	GEAR	DEPTH (M)	FISHING TIME	REMARKS
7709						
* 9	26:4	60° 5.6',20° 0.4' 60° 4.6',20° 0.7'	NN	0	2028-2040	Fished over dusk period.
±10	"	60° 4.0',20° 0.9' 60° 3.2',20° 1.2'	NN	0	2043-2055	" " " "
±11	"	60° 2.8',20° 1.3' 60° 2.0',20° 1.5'	NN	0	2057-2109	" " " "
±12	"	60° 1.5',20° 1.6' 60° 0.6',20° 1.9'	NN	0	2113-2125	" " " "
±13	"	60° 0.2',20° 2.0' 59°59.4',20° 2.2'	NN	0	2127-2139	" " " "
±14	"	59°59.0',20° 2.3' 59°58.2',20° 2.5'	NN	0	2141-2153	" " " "
±15	"	59°58.0',20° 2.5' 59°57.1',20° 2.8'	NN	0	2154-2206	" " " "
±16	"	59°57.7',20° 1.6' 60° 1.8',19°59.1'	RMT 1+8	50-95	2236-0036(N)	
±17	27:4	60°4.6' ,19°58.0' 60° 8.2',19°55.9'	RMT 1+8	900-1000	0156-0356(N)	
±18	"	60° 0.6',19°55.2'	RMT 1+8	———	———	
±19	"	60° 7.4',19°55.4'	RMT 1+8	———	———	Test of opening/closing. No catch
±20	"	60° 7.2',19°55.1'	RMT 1+8	———	———	
±21	"	60°10.0',19°53.5' 60°14.1',19°57.7'	RMT 1+8	710-800	1634-1834(D)	
±22	"	60° 2.2',19°59.0' 60° 6.3',20° 2.9'	RMT 1+8	800-900	2231-0037(N)	
±23	28:4	60° 9.3',20° 4.5' 60°11.5',20° 7.5'	RMT 1+8	405-500	0208-0408(N)	
±24	"	60° 2.1',20° 0.5' 60° 5.7',20° 5.4'	RMT 1+8	910-995	0657-0857(D)	

STN.	DATE	POSITION LAT °N LONG °W	GEAR	DEPTH (M)	FISHING TIME	REMARKS
7709						
#25	28:4	60° 7.6',20°12.2' 60° 8.3',20°19.4'	RMT 1+8	810-900	1101-1301 (D)	
#26	"	60° 8.5',20°18.7' 60° 7.9',20° 6.3'	RMT 1+8	600-700	1436-1636 (D)	
#27	"	60° 8.7',19°59.9' 60°11.0',19°51.5'	RMT 1+8	500-600	1751-1951 (D)	
28	"	60°16.3',19°53.7' 60°16.2',19°58.4'	RMT 1+8	705-800	2238-0038 (N)	
#29	29:4	60°15.6',20° 1.3' 60°14.4',20° 3.5'	RMT 1+8	300-400	0153-0356 (N)	
#30	"	60°13.6',20°3.6' 60°12.8',20° 3.0'	NN	0	0423-0435	Fished over dawn period
#31	"	60°12.4',20° 2.9' 60°11.5',20° 2.4'	NN	0	0437-0449	" " " "
#32	"	60° 8.1',19°58.1'	RMT 1+8	———	———	
#33	"	60°10.0',20° 7.2' 60°11.5',20° 9.6'	RMT 1+8	55-100	0847-1047 (D)	
#34	"	60° 9.2',19°59.8' 60° 9.0',19°56.0'	RMT 1+8	50-650	1253-1336 (D)	
#35	"	60° 8.2',19°45.5' 60°15.2',19°41.5'	RMT 1+8	1010-1250	1554-1954 (D)	
#36	"	60°13.5',19°56.5' 60°10.3',19°46.7'	RMT 1+8	600-700	2250-0050 (N)	
#37	30:4	60°10.3',19°43.0' 60°15.6',19°39.7'	RMT 1+8	205-300	0150-0350 (N)	
#38	"	60°16.5',19°40.0' 60°15.7',19°40.7'	NN	0	0416-0428	Fished over dawn period
#39	"	60°15.5',19°40.8' 60°14.6',19°41.2'	NN	0	0429-0441	" " " "

STN.	DATE	POSITION LAT °N LONG °W	GEAR	DEPTH (M)	FISHING TIME	REMARKS
7709						
#40	30:4	60°14.3',19°41.3' 60°13.5',19°41.5'	NN	0	0442-0454	Fished over dawn period
#41	"	60°13.3',19°41.5' 60°12.4',19;41.8'	NN	0	0455-0507	" " " "
#42	"	60°12.1',19°41.8' 60°11.2',19°42.1'	NN	0	0508-0520	" " " "
#43	"	60°11.1',19°42.1' 60°10.2',19°42.3'	NN	0	0521-0533	" " " "
#44	"	60° 7.6',19°39.5' 59°58.0',19°32.0'	RMT 1+8	1250-1500	0648-1048(D)	
#45	"	59°57.5',19°32.3' 60° 4.5',19°35.5'	RMT 1+8	1525-2000	1337-1737(D)	
(4)	"	60° 0.4',20° 1.3' 59°59.5',20° 0.1'	TSD	0-2000	2022-2139	
#46	"	59°59.2',19°57.4' 59°59.0',19°47.7'	RMT 1+8	9-25	2224-0024(N)	
#47	"	59°59.2',19°55.8' 59°59.2',19°50.8'	RMT 1	0-8	2246-2346(N)	Fished from boom. 1 hr tow.
#48	1:5	59°58.9',19°47.4' 59°57.5',19°54.6'	RMT 1+8	25-50	0051-0251(N)	
#49	"	59°58.1',19°54.2' 59°58.6',19°53.1'	NN	0	0319-0331	Fished over dawn period.
#50	"	59°58.8',19°52.6' 59°59.3',19°51.6'	NN	0	0332-0344	" " " "
#51	"	59°59.4',19;51.3' 59°59.9',19°50.3'	NN	0	0345-0357	" " " "
#52	"	60° 0.1',19°49.8'	NN	———	———	

STN.	DATE	POSITION LAT °N LONG °W	GEAR	DEPTH(M)	FISHING TIME	REMARKS
7709						
*53	1:5	60° 0.7',19°48.6' 60° 1.2',19°47.5'	NN	0	0411-0423	Fished over dawn period.
*54	"	60° 1.3',19°47.2' 60° 1.8',19°46.1'	NN	0	0425-0437	" " " "
*55	"	60° 2.0',19°45.6' 60° 2.5',19°44.6'	NN	0	0439-0451	" " " "
*56	"	60° 2.8',19°44.2' 60° 3.3',19°43.1'	NN	0	0453-0505	" " " "
*57	"	60° 3.8',19°42.2' 60° 4.4',19°41.2'	NN	0	0510-0522	" " " "
*58	"	60° 4.1',19°38.7' 60° 5.0',19°38.4'	RMT 1+8	25-50	0646-0846(D)	
*59	"	60° 4.1',19°37.0' 59°59;4',19°27.0'	RMT 1+8	10-25	0926-1126(D)	
*60	"	60° 2.8',19°34.8' 60° 0.4',19°29.1'	RMT 1	0-9	1000-1100(D)	Fished from boom. 1 hr tow.
*61	"	59°59.0',19°27.4' 59°59.6',19°29.4'	RMT 1+8	0-1000	1155-1335(D)	Oblique tow.
*62	"	59°58.8',19°59.4' 59°58.8',20° 0.1'	BN 2.4	2714-(0)	1706-1806	
*63	"	60° 0.6',20° 0.0') 60° 6.4',20° 0.3')	RMT 1+8 OXFAM	1000-1250 0	2307-0308(N) 2330-0045(N)	Samples frozen
(5)	2:5	59°56.9',20° 7.1' 59°56.6',20° 5.4'	TSD	0-2000	0542-0657	
(6)	"	59°59.5',19.59.6' 59°58.8',19°56.1'	TSD	0-2000	0735-0906	
(7)	"	60° 3.4',19°53.3' 60° 2.6',19°51.3'	TSD	0-2000	0956-1114	

STN.	DATE	POSITION LAT °N LONG °W	GEAR	DEPTH (M)	FISHING TIME	REMARKS
7709 (8)	2:5	60° 7.1',19°47.3' 60° 6.2',19°43.8'	TSD	0-2000	1213-1342	
(9)	"	60°11.1',19°38.1' 60°11.4',19°35.3'	TSD	0-2000	1502-1630	
(10)	"	59°52.5',20° 9.6' 59°52.8',20° 7.4'	TSD	0-2000	1939-2055	
(11)	"	59°47.8',20°15.4' 59°47.8',20°13.0'	TSD	0-2000	2247-0005	
*64	3:5	59°48.0',20°11.7' 59°47.4',20°06.4'	BC WB	2743-2745 10-2000	0056-0145 0224-0340	
(12)	"	60° 0.6',20° 2.1' 60° 0.3',20° 0.5'	TSD	0-2000	0908-1027	
*65	"	59°59.6',19°58.9' 60° 0.1',19°55.3'	BC	2712	1150-1320	
*66	"	59°58.7',19°53.5' 59°56.6',19°53.6'	BN 2.4	2712-(0)	1543-1643	
(13)	4:5	60° 0.1',19°58.7' 59°59.2',19°56.4'	TSD	0-2000	0906-1026	
*67	"	59°58.9',19°54.9' 59°58.4',19°53.0'	BC	2714-2716	1117-1233	
*68	"	59°57.0',19°47.2' 59°56.8',19°47.1'	BC	2705-2707	1525-1534	
*69	"	59°56.6',19°52.5' 59°56.5',19;52.4'	BC	2706	2351-2356	
*70	5:5	59°56.5',19°50.5' 60° 0.1',,19°48.7'	RMT 1+8	55-100	0055-0255(N)	
*71	"	60° 0.5',19°48.2' 60° 4.5',19°44.5'	RMT 1+8	0-1000	0313-0532	Oblique tow.

STN.	DATE	POSITION LAT °N LONG °W	GEAR	DEPTH (M)	FISHING TIME	REMARKS
7709						
*72	5:5	60° 6.9',19°42.4' 60° 8.3',19°41.3'	BN 2.4	2649-2663-(0)	0713-0814	
*73	"	60° 7.1',19°30.3' 60° 6.1',19°24.8'	BN 2.4	2636-2646-(0)	1242-1410	
*74	"	60°2.2',19°22.3' 60° 1.2',19°27.3'	RMT 1+8	310-400	1636-1836(D)	Repeat of *5.
*75	"	60° 0.6',19°29.4' 59°59.0',19;33.4'	RMT 1+8	25-100	1922-2056	Part of RMT 1 catch in special preservative.
*76	"	59°59.2',19;37.9' 60° 1.3',19°46.4'	RMT 1+8	1250-1500	2240-0240(N)	
*77	6:5	60° 1.9',19°50.4' 60° 1.7',19°51.8'	NN	0	0347-0359(N)	
*78	"	59°58.3',19°57.3' 59°57.5',19°54.2'	BLL	2715	0612-0905	
(14)	"	59°56.8',20° 0.0' 59°57.0',19°57.1'	TSD	0-2000	0646-0757	
*79	"	60° 0.1',19°48.2' 60° 2.9',19°45.1'	RMT 1+8	905-1020	1235-1435(D)	Samples frozen.
*80	"	60° 5.5',19°41.6' 60° 9.2',19°34.7'	RMT 1+8	400-500	1558-1758(D)	Samples frozen.
*81	"	60° 9.6',19°34.7' 60° 7.9',19°37.4'	RMT 1+8	30-580	1924-2105(D)	Part of RMT 1 catch in special preservative.
*82	"	60° 5.6',19°42.8' 60° 5.2',19°46.5'	RMT 1+8	0-1600	2349-0109(N)	Depths estimated.
*83	7:5	60° 3.6',19°49.7' 60° 2.6',19°50.9'	RMT 1+8	430-700	0247-0348(N)	Part of RMT 1 catch in special preservative.
*84	"	60° 0.0',19°52.3'	BLL	2700		

STN.	DATE	POSITION LAT °N LONG °W	GEAR	DEPTH (M)	FISHING TIME	REMARKS
7709						
*85	7:5	59°57.7',19°55.0' 59°57.1',19°56.0'	BN 2.4	2708-(0)	0835-0907	
*86	"	59°54.5'19°59.3' 59°55.2',19°58.2'	NN	0	1130-1142(D)	
*87	"	59°56.0',19°57.0' 59°56.7',19°55.8'	NN	0	1151-1203(D)	
*88	"	59°57.0',19°55.4' 59°57.7',19°54.3'	NN	0	1205-1217(D)	
*89	"	59°58.0',19°53.9' 59°58.7',19°52.8'	NN	0	1220-1232(D)	
*90	"	59°57.4',19°47.5' 59°48.6',19°45.2'	RMT 25	210-400	1757-2058(D)	3 hr tow
*91	8:5	59°50.4',19°54.6' 59°49.2',20° 8.5'	RMT 1+8	1520-2000	0115-0415(N)	3 hr tow
*92	"	59°48.3',20°12.9' 59°47.9',20°25.1'	RMT 25	810-1000	0612-0912(D)	3 hr tow
*93	"	59°49.6',20°22.9' 59°52.2',20° 9.3'	RMT 25	615-800	1117-1417(D)	3 hr tow
*94	"	59°53.2',20° 1.9' 59°54.2',19°45.1'	RMT 25	400-585	1536-1836(D)	3 hr tow
(15)	"	60° 0.0',19°59.1' 59°59.8',19°58.9'	TSD	0-2000	2104-2225	
7710	15:5	52°30.2',15°23.0' 52°24.8',15°34.6'	RMT 1+8	25-1000	1701-2105(D)	Oblique tow
7711						
* 1	16:5	52°57.4',20° 3.7' 52°53.7',20° 8.3'	RMT 1+8	900-1000	1456-1659(D)	
(16)	"	53° 0.7',19°59.5' 53° 0.9',19°59.9'	TSD	0-2000	1903-2032	

STN.	DATE	POSITION LAT °N LONG °W	GEAR	DEPTH (M)	FISHING TIME	REMARKS
7711						
* 2	16:5	52°59.2',20° 7.2' 52°56.3',20°14.5'	RMT 1+8	900-1000	2232-0032(N)	
* 3	17:5	52°54.5',20°19.9' 52°51.7',20°26.3'	RMT 1+8	310-400	0150-0350(N)	
* 4	"	52°55.0',20° 8.8' 52°57.1',20° 3.2'	RMT 1+8	800-900	0616-0816(D)	
* 5	"	52°59.5',19°58.1' 52°59.9',19°57.0'	RMT 1+8	675-800	0951-1011(D)	
* 6	"	52°59.6',19°57.6' 52°55.4',20° 0.9'	RMT 1+8	410-500	1134-1335(D)	
* 7	"	52°54.6',19°59.8' 52°54.5',19°53,2'	RMT 1+8	300-400	1448-1648(D)	
		53° 0.4',19°58.9' 53° 0.2',20° 0.1'	WB	2490	1845-2050	
* 8	18:5	52°56.6',20° 1.9' 52°53.1',20° 6.3'	RMT 1+8	700-805	0721-0921(D)	
* 9	"	52°50.5',20°9.3' 52°46.6',20°13.4'	RMT 1+8	605-700	1037-1237(D)	
*10	"	52°45.6',20°12.6 52°47.1',20° 4.9'	RMT 1+8	505-600	1340-1540(D)	
*11	"	52°47.8',20° 1.9' 52°49.3',19°53.2'	RMT 1+8	205-300	1625-1825(D)	
(17)	"	53° 0.8',20° 0.3' 53° 1.1',20° 1.0'	TSD	0-2000	2015-2139	
*12	"	53° 0.6',20° 1.4'	RMT 1+8	———	———	
*13	"	52° 55.0',20° 0.7' 52°50.5',20° 9.4'	RMT 1+8	800-900	0035-0237(N)	
*14	19:5	52°48.6',20° 9.3' 52°48.5',20° 9.3'	BC	2619	0421-0436	

STN.	DATE	POSITION LAT °N LONG °W	GEAR	DEPTH (M)	FISHING TIME	REMARKS
7711						
#15	19:5	52°52.4',20° 9.3' 52°53.8',20° 1.3'	RMT 1+8	110-200	0607-0807(D)	
#16	"	52°54.9',19°58.7' 52°56.0',19°55.8'	RMT 1+8	50-100	0850-0950(D)	1 hr tow
#17	"	52°56.6',19°54.6' 52°57.8',19°51.9'	RMT 1+8	25-50	1012-1112(D)	1 hr tow
#18	"	52°58.3',19°50.8' 52°59.5',19°47.8'	RMT 1+8	10-25	1131-1231(D)	1 hr tow
#19	"	52°59.4',19°47.4'	RMT 1+8	———	———	
#20	"	52°54.0',19°54.0' 52°53.3',19°54.5'	RMT 1+8	1050-1150	1552-1607	Depths estimated
#21	"	53° 0.7',19°56.6' 53° 1.3',19°55.7'	RMT 1+8	55-100	2049-2117	Only squid retained
#22	"	53° 1.4',19°55.7'	RMT 1+8	———	———	
#23	"	52°57.1',20° 0.0' 52°53.1',20° 3.4'	RMT 1+8	200-300	2342-0142(N)	
#24	20:5	52°52.0',20° 4.2' 52°50.0',20° 5.0'	RMT 1+8	50-102	0210-0310(N)	1 hr tow
#25	"	52°59.7',20° 0.0' 53° 4.8',19°51.7'	RMT 1+8	1010-1250	0612-1012(D)	see log
#26	"	53° 3.5',19°52.2' 52°55.3',19°55.2'	RMT 1+8	1260-1500	1217-1617(D)	see log
#27	"	52°52.8',19°56.5' 52°52.8',19°56.5'	BC	2743-2746	1816-1901	
#28	"	52°54.6',19°55.5' 52°59.6',19°56.5'	RMT 1+8	700-800	2215-0016(N)	see log
#29	21:5	53° 3.5',19°57.0' 53° 7.5',19°57.7'	RMT 1+8	610-700	0201-0401(N)	see log

STN.	DATE	POSITION LAT °N LONG °W	GEAR	DEPTH (M)	FISHING TIME	REMARKS
7711						
(18)	21:5	52°54.3',20° 5.6' 52°53.9',20° 6.0'	TSD	0-2000	0908-1027	
(19)	"	53° 3.1',19°59.2' 53° 2.8',19°59.9'	TSD	0-2000	1301-1435	
(20)	"	53° 2.5',20°17.3' 53° 2.0',20°18.4'	TSD	0-2000	1613-1733	
(21)	"	52°54.0',20° 5.8' 52°53.6',20° 5.9'	TSD	0-2000	1928-2050	
*30	"	52°56.2',20° 4.0' 52°58.7',20° 1.5'	RMT 1+8	710-800	2219-2355(N)	1hr 36 min tow
*31	22:5	52°59.5',20° 0.1' 52°55.2',19°58.9'	RMT 1+8	100-200	0145-0345(N)	
*32	"	52°54.7',20°12.6' 52°56.5',20° 7.7'	RMT 1+8	605-700	2249-0049(N)	
*33	23:5	52°58.1',20° 4.8' 53° 0.2',20° 0.0'	RMT 1+8	410-500	0159-0359(N)	see log
*34	"	52°57.2',20° 4.5' 52°53.1',20° 9.8'	RMT 1+8	0-1580	0623-0830(D)	
*35	"	52°51.6',20° 5.0' 52°52.4',19°47.9'	RMT 1+8	1525-2000	1056-1555(D)	see log
*36	"	52°52.6',19°46.3' 52°52.5',19°32.2'	RMT 1+8	25-1000	1617-2018(D)	oblique tow
*37	"	52°52.8',19°41.3' 52°51.2',19°48.8'	RMT 1+8	500-600	2225-0025(N)	
*38	24:5	52°50.6',19°54.2' 52°49.7',20° 0.7'	RMT 1+8	400-500	0144-0344(N)	
*39	"	52°48.0',20° 9.3' 52°43.6',20°21.5'	RMT 1+8	1520-2000	0634-1034(D)	

STN.	DATE	POSITION LAT °N LONG °W	GEAR	DEPTH (M)	FISHING TIME	REMARKS
7711						
*40	24:5	52°54.8',20°22.1' 52°52.1',20°11.4'	RMT 1+8	1010-1250	1408-1808(D)	
*41	24:5	52°51.2',20° 8.3' 52°51.5',20° 8.3'	BC	2738	2010-2034	
*42	"	52°52.5',20° 6.1' 52°52.2',20° 2.3'	RMT 1+8	25-50	2213-2316(N)	1hr tow
*43	"	52°52.3',20° 0.4' 52°52.5',19°57.0'	RMT 1+8	10-25	2344-0044(N)	1 hr tow
*44	25:5	52°52.5',19°55.2'	RMT 1+8	———	———	
*45	"	52°53.0',19°51.7' 52°53.0',19°52.3'	NN	0	0217-0223(N)	6 minute tow
*46	"	52°53.1',19°53.0' 52°53.1',19°53.6'	NN	0	0225-0231(N)	6 minute tow
*47	"	52°57.4',20° 9.9' 53° 5.6',20° 8.0'	RMT 1+8	1260-1500	0608-1008(D)	
*48	"	53° 5.7',20° 8.0' 53° 6.6',20° 7.7'	RMT 1	0-10	1009-1039(D)	30 minute tow. Fished from boom
(22)	"	53° 0.3',19°59.5' 52°59.7',20°00.0'	TSD	0-2000	1228-1347	
*49	"	53° 1.4',19°56.9' 53° 3.8',19°52.9'	LHS	530-580	1724-1924(D)	
*50	"	53° 3.4',19°49.6' 52°51.5',19°53.9'	RMT 1+8	680-1500	2349-0502(N)	
*51	26:5	53° 1.1',19°50.5' 53° 0.6',19°50.6'	RMT 1	0-11	0020-0035(N)	15 minute tow. Fished from boom
*52	"	52°53.3',19°52.4' 52°52.5',19;52.4'	BN 2.4	2734-2742-(0)	0845-0918	
*53	"	52°53.3',19;52.4' 52°53.1',19;52.7'	BC	2742-2744	1239-1328	

STN.	DATE	POSITION LAT °N LONG °W	GEAR	DEPTH (M)	FISHING TIME	REMARKS
7711						
#54	26:5	52°53.1',19°50.5' 52°53.5',19°44.5'	LHS	750-800	1513-1713(D)	
#55	"	52°53.8',19°43.1' 52°53.3',19°49.9'	RMT 1+8	400-500	1845-2045	Samples frozen
#56	"	52°52.7',19°57.1' 52°49.9',20°11.6'	RMT 1+8	1250-1500	2237-0247(N)	4hr 10min haul
#57	27:5	52°48.7',20° 3.7' 52°48.4',20° 4.6'	BN 2.4	2656-2658-(0)	0639-0709	
#58	27:5	52°47.7',20° 5.0' 52°47.4',20°6.3'	BN 2.4	2615-2621-(0)	1149-1219	
#59	"	52°47.6',20° 5.5' 52°47.2',20° 5.8'	BC	2589-2602	1532-1629	
#60	"	52°49.2',20°4.5' 52°53.3',20° 2.1'	LHS	735-810	1805-2005(D)	
#61	"	52°58.9',20° 0.6' 53° 5.8',20° 1.4'	RMT 1+8 OXFAM	1500-2000 0	2246-0246(N)	Samples frozen
#62	28:5	52°50.0',20° 2.8' 52°49.9',20° 3.8'	BN 2.4	2720-2727-(0)	0840-0910	
#63	"	52°51.3',20° 8.9' 52°57.6',20°9.5'	RMT 25	800-1000	1227-1627(D)	
#64	"	52°59.5',20°10.8' 53° 2.0',20° 9.9'	RMT 1+8	290-400	1934-2100	
#65	"	53° 5.8',20° 8.6' 53°13.1'20° 1.6'	RMT 1+8	1020-1250	2247-0247(N)	
#66	29:5	53°11.2',20° 5.1' 53°11.6',20° 3.9'	BN 2.4	2380-2432-(0)	0627-0705	
#67	"	53°10.3',20° 1.4' 53° 0.0',20° 1.8'	RMT 25	605-800	0958-1358(D)	
#68	"	52°58.4',19°59.8' 53° 0.2',19°55.5'	RMT 25	520-600	1541-1706(D)	Haul terminated, deteriorating weather

STN.	DATE	POSITION LAT °N LONG °W	GEAR	DEPTH (M)	FISHING TIME	REMARKS
7711 (23)	29:5	52°59.6',20° 0.3' 52°59.2',20° 1.5'	TSD	0-2000	1937-2050	
*69	"	53° 0.4',20° 0.0'	RMT 1+8	———	———	
*70	"	53° 5.5',19°52.2' 53° 6.9',19°49.9'	RMT 1+8	910-1000	0043-0143(N)	Samples frozen
*71	30:5	53° 7.8',19°48.2' 53° 0.1',19°47.8'	RMT 1+8	25-1000	0244-0611(N)	Oblique tow
*72	"	52°55.9',20° 7.8' 53° 1.7',20° 4.8'	RMT 25	1020-1500	1643-2043(D)	
*73	"	53° 3.6',20° 3.6' 53° 3.2',20° 2.3'	NN	0	2145-2157	Fished over dusk period
*74	"	53° 3.0',20° 2.0' 53° 2.5',20° 0.6'	NN	0	2159-2211	" " " "
*75	"	53° 2.4',20° 0.3' 53° 1.9',19°59.2'	NN	0	2213-2225	" " " "
*76	"	53° 1.7',19°59.3' 53° 1.5',19°58.9'	NN	0	2227-2233	" " " " (6 minute tow)
*77	"	53° 2.7',20° 3.3' 53° 5.8',20°16.8'	RMT 25	1500-2010	0035-0438(N)	Extremely small catch
*78	31:5	53° 9.8',20°14.7' 53°10.8',20°14.0'	BN 2.4	2425-2430-(0)	0832-0907	
*79	"	53° 6.9',20° 5.6' 53° 7.0',19°59.2'	LHS	640-700	1438-1638	
*80	"	53° 0.7',20° 0.1' 53° 0.9',20° 1.5'	NN	0	2126-2138	Fished over dusk period
*81	"	53° 1.1',20° 2.1' 53° 1.4',20° 3.9'	NN	0	2140-2152	" " " "
*82	"	53° 1.5',20° 4.6' 53° 1.8',20° 6.2'	NN	0	2154-2206	" " " "

STN.	DATE	POSITION LAT °N LONG °W	GEAR	DEPTH (M)	FISHING TIME	REMARKS
7711						
#83	31:5	53° 1.9',20° 6.9' 53° 2.0',20° 7.5'	NN	0	2208-2214	Fished over dusk period 6 minute tow
#84	"	53° 2.5',20° 6.7'	RMT 25	———	———	
#85	1:6	53° 5.8',19°55.7' 53° 5.8',19°57.3'	BN 2.4	2626-2652-(0)	0750-0820	
#86	"	53° 6.3',20° 6.7' 52°59.8',19°54.7'	RMT 8/150	0-1175	1423-1750(D)	
(24)	"	53° 0.2',20° 0.2' 53° 0.2',20° 0.4'	TSD	0-2000	2045-2200	
#87	"	53° 0.2',20° 0.7'	RMT 1+8	———	———	
#88	2:6	52°55.9',19°54.7' 52°53.7',19°50.8'	RMT 1+8	25-1010	0152-0406(N)	Oblique tow
7712	"	51°47.6',15°49.4' 51°41.8',15°48.7'	RMT 1+8	20-1000	2020-2313	Oblique tow
7713	3:6	51°33.6',14°17.9' 51°33.5',14°18.7'	BLL	420	0623-0900	
7714	"	51°27.2',13°39.4' 51°27.5',13°40.5'	BLL	688	1345-1600	
7715	"	51°25.4',13°38.9' 51°21.0',13°37.3'	LHS	550-620	1816-2016(D)	
7716						
# 1	"	51° 1.6',13° 7.7' 51° 0.6',13° 7.1'	RMT 1+8	800-1000	0050-0120(N)	
# 2	4:6	50°57.7',13° 5.5' 50°52.0',13° 1.9'	RMT 1+8	0-1000	0239-0533	Oblique tow
# 3	"	50°54.3',13° 3.8' 50°54.0',13° 3.5'	NN	0	0423-0435(N)	Fished at 2 knots
7717	"	50°51.6',13° 1.4' 50°51.8',13° 1.4'	BLL	2180	0950-1305	

STN.	DATE	POSITION LAT °N LONG °W	GEAR	DEPTH (M)	FISHING TIME	REMARKS
7718						
# 1	4:6	50°49.5',13° 1.6' 50°47.7',13° 1.4'	RMT 1+8	645-700	1615-1715(D)	
# 2	"	50°45.8',12°59.8' 50°45.6',12°58.4'	NN	0	1810-1822(D)	200 mesh net
# 3	"	50°45.5',12°57.9'	NN	———	———	
# 4	"	50°45.1',12°55.6' 50°44.8',12°54.2'	NN	0	1839-1851(D)	54 mesh net
# 5	"	50°44.8',12°53.7' 50°44.5',12°52.3'	NN	0	1853-1905(D)	
7719	"	50°37.4',12° 8.3' 50°36.9',12° 7.2'	NN	0	2200-2212(N)	

Captions

Figure 1. Track chart

Figure 2. TSD records (smoothed) at 60°N,20°W on (a) April 25th and (b) April 30th.

Figure 3. Surface current vectors in the area of 60°N,20°W, deduced from satellite fixes and computed DR positions during the period April 25th to May 8th 1971. Positions of TSD stations 5 to 11 are shown.

Figure 4. Sigma t section based on the TSD stations shown in figure 3.

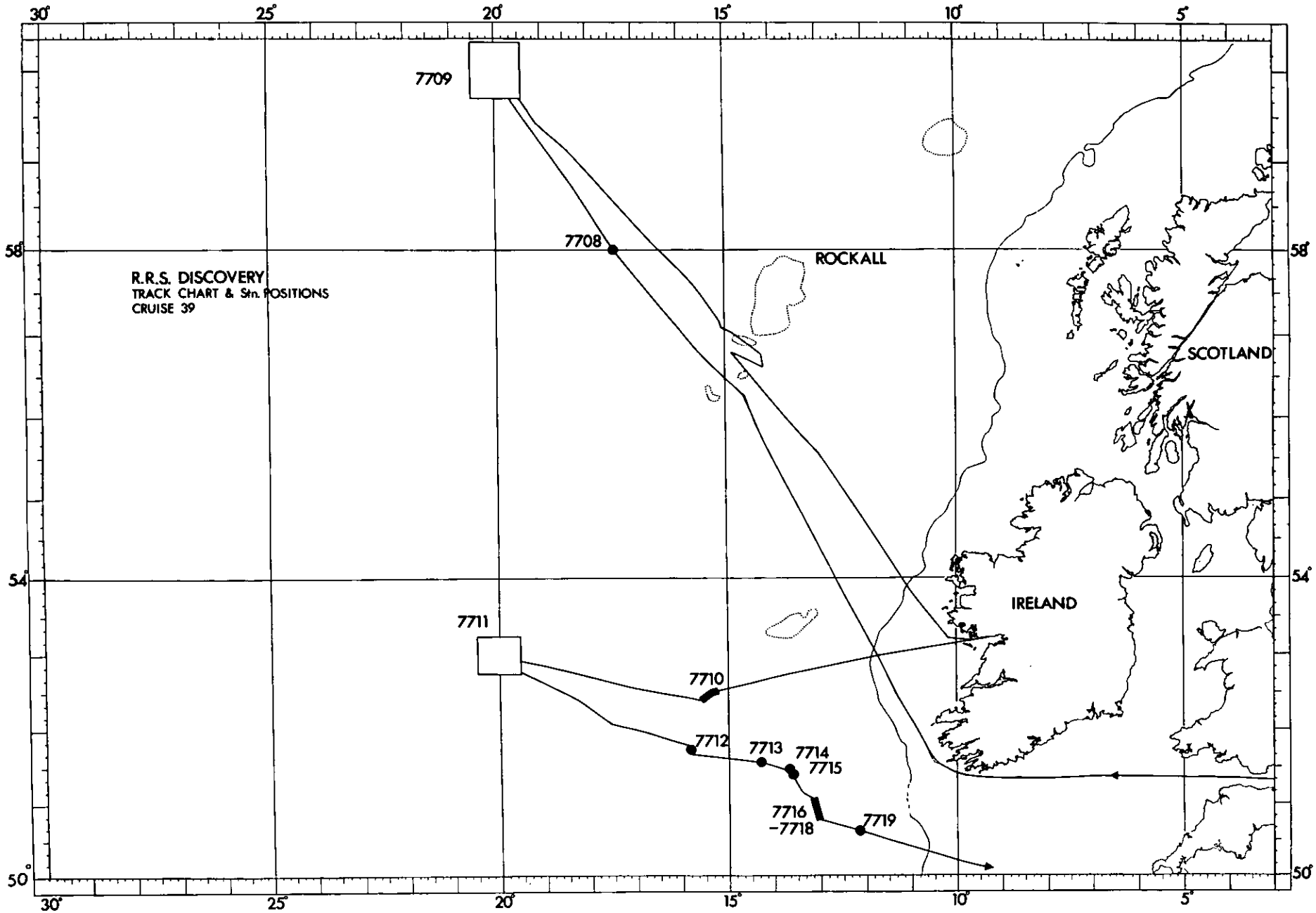
30°
25°
20°
15°
10°
5°
58°
54°
50°
R.R.S. DISCOVERY
TRACK CHART & Stn. POSITIONS
CRUISE 39
7709
7708
ROCKALL
SCOTLAND
IRELAND
7711
7710
7712
7713
7714
7715
7716
-7718
7719

FIG. 1

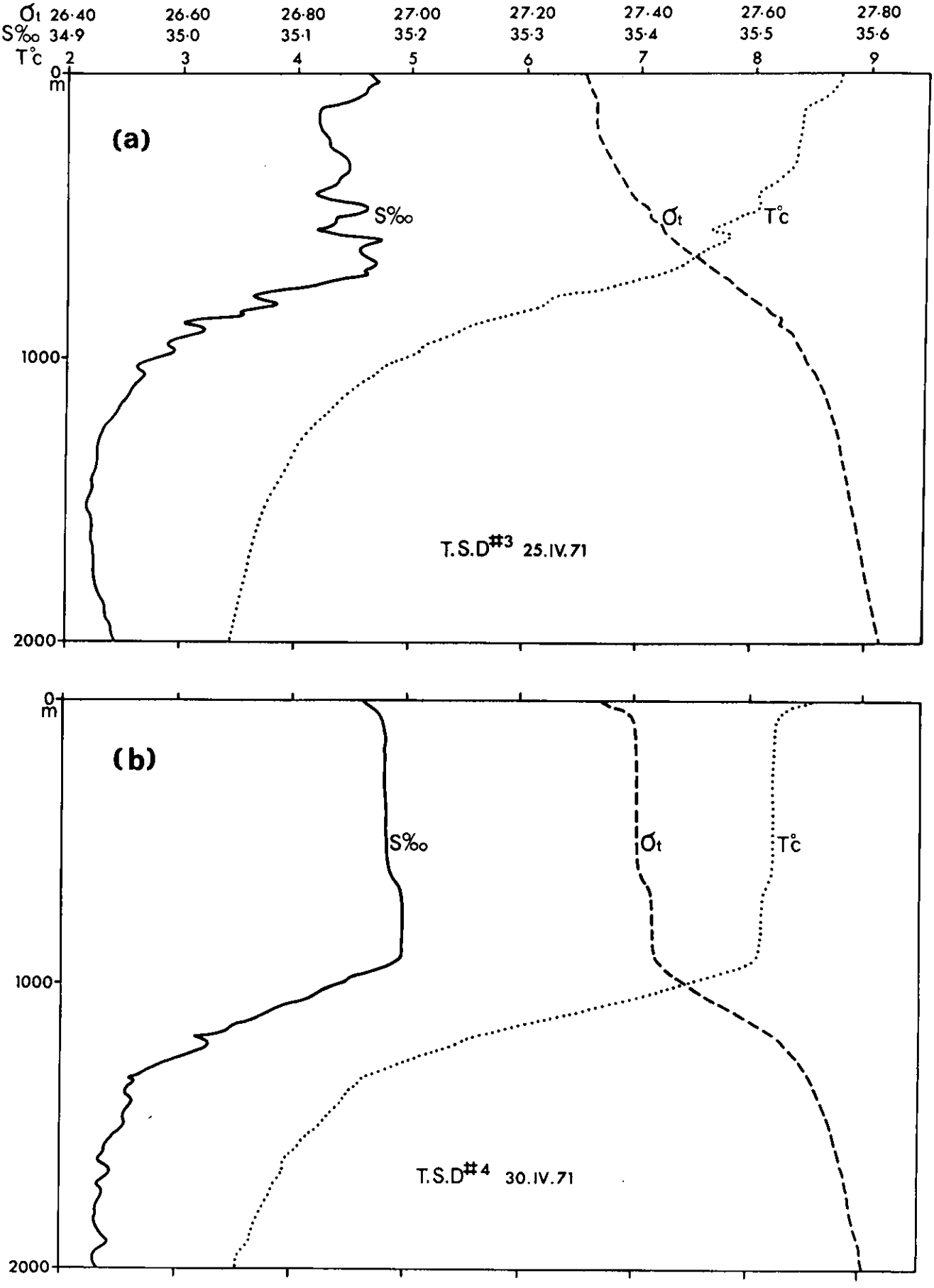
σt 26·40 26·60 26·80 27·00 27·20 27·40 27·60 27·80
S‰ 34·9 35·0 35·1 35·2 35·3 35·4 35·5 35·6
T°c 2 3 4 5 6 7 8 9
0 m
(a)
S‰
σt
T°c
1000
2000
T.S.D#3 25.IV.71
0 m
(b)
S‰
σt
T°c
1000
2000
T.S.D#4 30.IV.71

FIG. 2

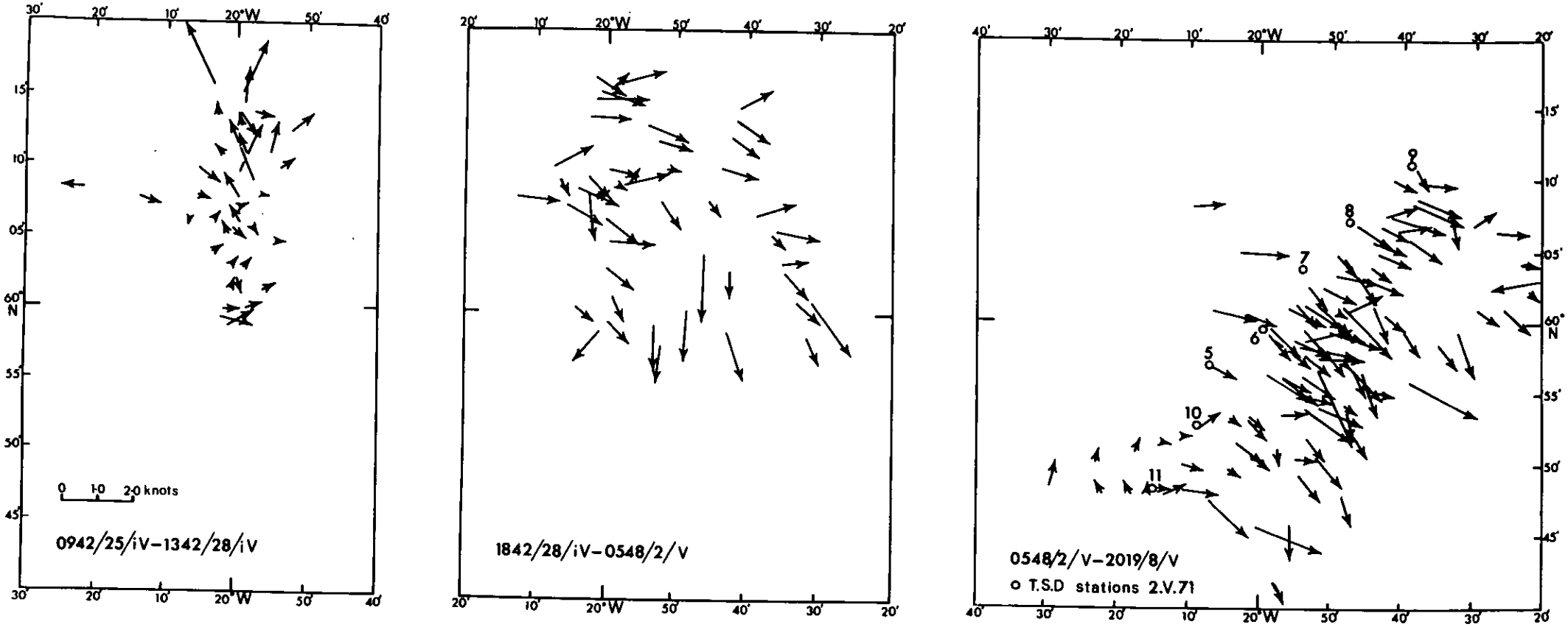
0 1·0 2·0 knots
0942/25/iV–1342/28/iV
1842/28/iV–0548/2/V
0548/2/V–2019/8/V
o T.S.D stations 2.V.71

FIG. 3

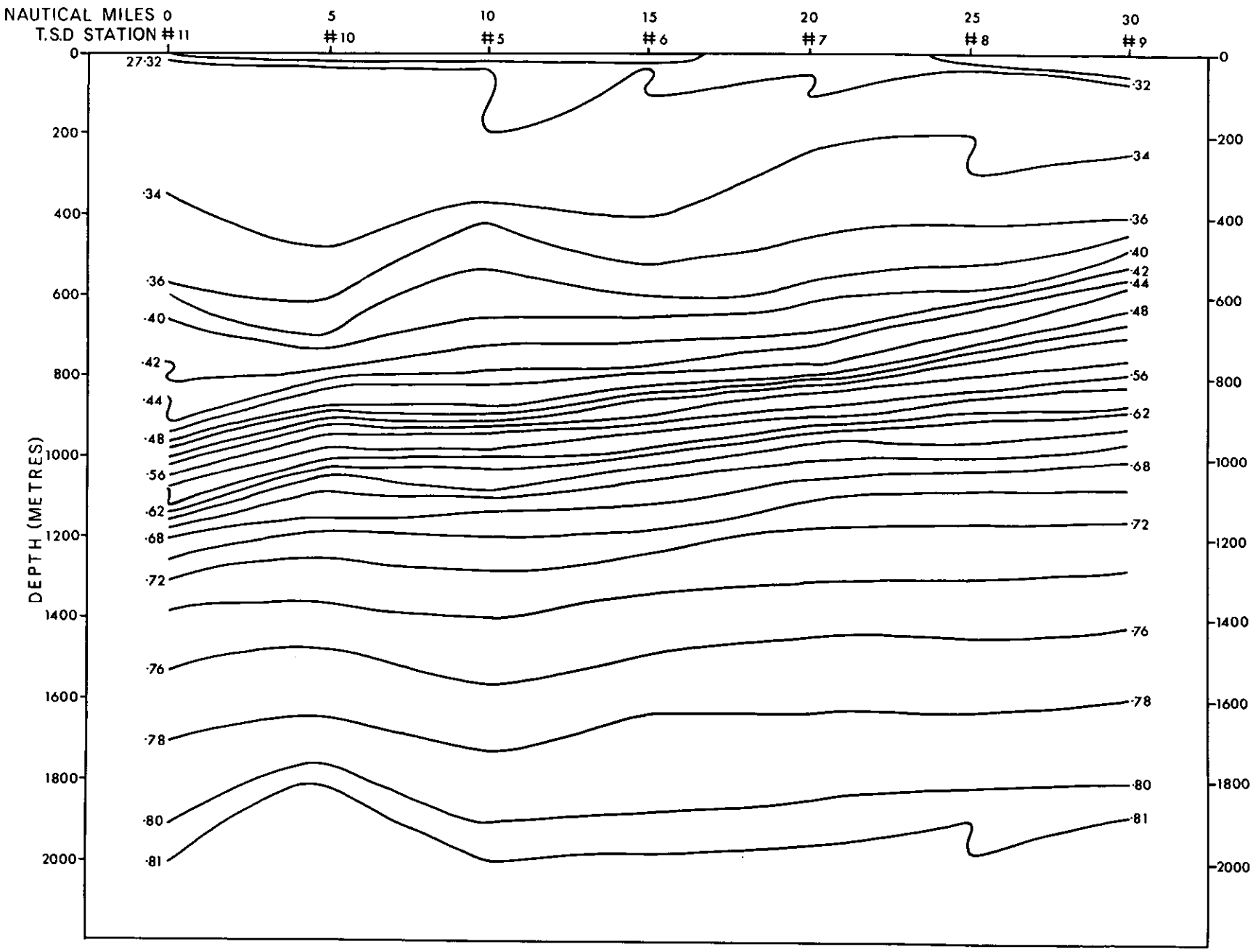
NAUTICAL MILES 0
5
10
15
20
25
30
T.S.D STATION #11
#10
#5
#6
#7
#8
#9
DEPTH (METRES)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
27·32
·32
·34
·36
·40
·42
·44
·48
·56
·62
·68
·72
·76
·78
·80
·81

FIG. 4