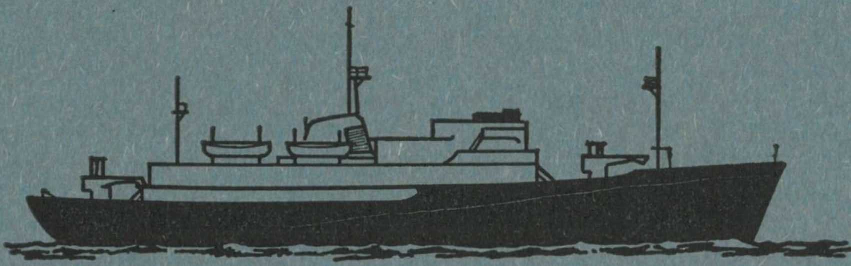
NATIONAL INSTITUTE OF OCEANOGRAPHY
WORMLEY, GODALMING, SURREY



R. R. S. DISCOVERY

CRUISE 36 REPORT

SEPTEMBER — NOVEMBER 1970

PLANKTON INVESTIGATIONS AT 40° N 20° W

N. I. O. CRUISE REPORT No. 36
(Issued January 1971)

NATIONAL INSTITUTE OF OCEANOGRAPHY

Wormley, Godalming, Surrey.

R.R.S. DISCOVERY
CRUISE 36 REPORT

SEPTEMBER - NOVEMBER 1970

PLANKTON INVESTIGATIONS AT 40°N 20°W

N.I.O. CRUISE REPORT SERIES: CR.36

JANUARY 1971

Contents

SCIENTIFIC PERSONNEL

R.G. Aldred	N.I.O.	
J.R. Badcock	N.I.O.	
A. de C. Baker	N.I.O.	
J.R. Berry	N.I.O.	
M.R. Clarke	N.I.O.	
P.M. David	N.I.O.	(Scientist in charge)
T.J.P. Gwilliam	N.I.O.	Left at Ponta Delgada
M.J. Harris	N.I.O.	" " "
C.R. Hayes	N.I.O.	
P.J. Herring	N.I.O.	
A. Locket	Institute of Ophthalmology, London.	
M.R. Longbottom	N.I.O.	
A.F. Madgwick	N.I.O.	Joined at Ponta Delgada
N.R. Merrett	N.I.O.	
R. Morris	N.I.O.	
J.R.G. Phillips	N.I.O.	Joined at Ponta Delgada
H.S.J. Roe	N.I.O.	
B.K. Rowbury	N.I.O.	Left at Ponta Delgada
R. Spencer	N.I.O.	Joined at Ponta Delgada
P. Thornton James	N.I.O.	
M.H. Thurston	N.I.O.	
R. Wild	N.I.O.	

ABBREVIATIONS

RMT 1 Rectangular midwater trawl with a sampling area of 1sq.m (Mesh size 0.32mm).

RMT 1 Spec. Rectangular midwater trawl with sampling area of 1sq.m (Mesh size 0.23mm).

RMT8/5 Rectangular midwater trawl with sampling area of 8sq.m (Mesh size 4.5mm).

RMT8/150 Rectangular midwater trawl with a sampling area of 8sq.m (Mesh size 150mm).

RMT8/BN Rectangular midwater trawl with sampling area of 8sq.m with a beam trawl fitted below for bottom sampling.

RMT1/8 (=RMT 1 + 8) Standard combination of nets RMT 1 (Mesh size 0.32mm) and RMT8/5 (Mesh size 4.5mm).

RMT25 Rectangular midwater trawl with a sampling area of 25sq.m

BN 2.4 Bottom net with a sampling area of 2.4m width.

BLL Bottom longline.

PDL Pelagic dropline.

BC Bottom camera.

TSD Temperature, salinity, depth probe.

WB Water bottle (Standard N.I.O.)

INTRODUCTION

Cruise 36 was planned to extend the survey of the vertical distribution of oceanic zooplankton and micronekton another 10° North to 40°N latitude. On previous cruises day and night vertical net haul series had been made at 11°N, 18°N and 28°N. The position chosen for the present cruise, 40°N 20°W, had been visited by Discovery II on several occasions and material, albeit collected by rather different methods, had been in part examined and was available in the collections for comparative purposes.

In addition further collections with the bottom longlines were planned and a series of hauls at various depths with the bottom net. A new opening/closing net of approximately 25 sq m had been made and was to be tested. A number of smaller projects were also planned.

ITINERARY

R.R.S. Discovery left Southampton at 1300 hrs on 26 September, cleared the Needles at 1500 hrs and set course for a position 40°N 20°W, where she arrived in the evening of 30 September. After an oblique haul from 1000-0m with the RMT1/8 to ensure that nets were correctly rigged the day and night vertical series commenced.

The series continued until 0900 on 11 October apart from a break due to bad weather from 0200 7 October to 0700 9 October. By 0900 11 October the series was complete apart from the day time 2000-1500 net though some of the deeper hauls would have been repeated if conditions had been suitable. On the 11 October however weather conditions were worsening and the weather charts held out no promise of anything other than a prolonged period hove to before being able to resume work so it was decided to steer towards Sao Miguel in the Azores. Due to contrary winds and sea the 300 mile passage took 49 hours.

At midday on the 13 October to the South of Sao Miguel conditions were suitable for working nets and the new RMT 25 was launched. A series of hauls were made with it until the early morning of the 16th, some RMT1/8 hauls were also done during this period for comparison. A run to calibrate the net monitor flowmeter was made in deteriorating weather on the 16th and by the early morning of the 17th a full gale was blowing from the East. To avoid being caught on a lee shore in the event of the wind backing to the South Discovery worked round to the North of the island. By the forenoon of the 18 October the wind had dropped to 12 knots and although there was a heavy swell it was possible to find shelter from it off Capellas on the North coast of Sao Miguel so that a series of tests could be made with the inclinometer for measuring the angle of attack of the RMT nets at various speeds. These tests were completed by midnight and the ship then proceeded North in calm conditions to make more net hauls with the RMT 25 and RMT1/8. This work was completed early on the 20th and Discovery then proceeded to Ponta Delgada arriving at 0900 (1000 local time) 20 October. Messrs Rowbury, Harris and Gwilliam were discharged for U.K. and Messrs Madgwick, Spencer and Phillips joined the ship. The Naval Officer in charge Azores visited the ship as did a party of officers from some Portuguese gunboats lying further along the mole.

At 1800 hrs 22 October the ship sailed for the second part of the cruise. From 0300 23 October to about 0500 25 October a series of bottom net hauls were made in depths between 960 and 2600m in an area about 60 miles to the West of Sao Miguel.

On 25 October the deteriorating weather and heavy swell prevented further work and passage was made to a lee off the island of Pico where despite a series of depressions passing close to the westward it was possible to continue work safely in wind speeds sometimes greater than 30 knots due to an almost complete absence of swell. RMT 1/8 and RMT 25 nets were fished at depths down to 1350m and some bottom nets were also fished. When the weather permitted longlines were fished to the East and West of the islands at depths from 696 to 1253 metres which yielded on occasions good catches mainly of deep sea sharks. On 3 November the ship left the Pico area and proceeded towards 40°N 20°W, stopping to do bottom net in 2078m and a bottom longline on the way. The position was reached in the morning of 6 November and work began with RMT 1/8 nets to complete the vertical series and to repeat some deep net hauls that had not been adequately done in the first part of the cruise. Preliminary analyses of the series showed that one net haul seemed anomalous in comparison with those above and below it and subsequent work off the Azores confirmed the doubt so a repeat was made of this haul. A series of hauls for Dr. Wiseman of the Natural History Museum (Dept. of Mineralogy) were made and a TSD to 2000 as well as a short series of water bottles. All the hauls were successful and no repeats were needed which was fortunate as the weather which had been perfect on the 6 November began to deteriorate in the evening of the 7th and by the morning of the 8th was too bad for further work. As the weather maps showed persistent NE wind from 40°N 20°W right up across the Bay of Biscay it was decided after heaving to for a while to set course for Barry. During the 8th and 9th the ship was making about 6½ knots against strong winds and heavy seas but conditions improved late on the 9th and on the 10th. R.R.S. Discovery berthed alongside at Barry in the forenoon of the 13th.

Copepods

Compared to previous horizontal series the RMT 1 series at 40°N 20°W was conspicuous for a great reduction in the numbers of species caught. There was also apparently a decrease in the total numbers caught, but a great increase in numbers of individual northerly species, particularly *Pareuchaeta norvegicus* and *P. barbata*. The conspicuous numerical maximum at 500m depth in the SOND cruise was absent in this series, apparently because of the relative absence of *Calanus spp*. The extensive diurnal migrants in the SOND cruise, *Undeuchaeta major*, *U. plumosa*, and *Chirundina streetsi*, showed a vertical migration of over 400m in the present series. Relatively high numbers of very large copepods were caught in the deep RMT 8 hauls and in the bottom net, and perhaps the most notable copepods taken were two very large specimens of *Hemirhabdus sp*. caught in the RMT 8 2500-2000m haul.

Further observations on colour showed that not only can the same species be a variety of colours but that larval stages can be a different colour from the adults. Egg bearing females of Valdiviella insignis were kept alive for three weeks, but the eggs failed to develop further than those kept last year. Specimens of five deep water species were picked out for future chemical analysis (by R.J.M.) and several different species were preserved for future electron microscopy of the luminous organs (by P.J.H.).

Euphausiids

The number of species of euphausiid taken on the cruise was 22 and others may be found on analysis. This is close to the number taken off Fuerteventura where 28 were found. However the great majority of the species were present only in very small numbers, the bulk of the euphausiid catch being made up of four species, Meganyctiphanes norvegica, Euphausia krohnii, Nematoscelis megalops and Nematobrachion boopis. Off Fuerteventura 10 species were moderately abundant. Most of the 22 species were taken in the Pico - St. George Channel but only eight during the vertical series at St. 7406, (it is probable that some of the smaller Stylocheiron spp. will turn up during detailed analyses). One of the larger, non-migrant species, N. boopis, occurred in very much larger numbers than it has been found during other N. Atlantic cruises (hundreds instead of tens) and the impression obtained was that, while the lower limit of its vertical distribution was much the same as at Fuerteventura the upper limit was much shallower. The daytime 600-500m haul (# 8) contained approximately 27 litres of M. norvegica and it is presumed that the net passed through a very dense shoal. A further daytime sample was taken at this depth (# 32) later in the series and only very small numbers of M. norvegica were caught.

Mr. James successfully used a technique for coating euphausiids with a thin layer of silver in order to show up details of surface structure. This is particularly useful for showing up such structures as the thelycum and petasma.

Amphipods

The area worked during this cruise, i.e. between 37°N and 40°N, appears to be a critical one for the distribution of pelagic amphipods.

The numbers of species and individuals of Hyperiidea Curvicornia, primarily a warm water group, obtained at 38°N in the Pico Channel were very low when compared with the results of the 1965 Fuerteventura series at 28°N. At 40°N 20°W those numbers were reduced to an even lower level and the Curvicornia formed an insignificant proportion of the total amphipod catch.

Some evidence of a boreal element in the fauna was seen. Parathemisto, characteristically a cold water genus, was present in many hauls, though rarely in large numbers. Metacyphocaris helgae occurred in most hauls below 800m. Neither of these genera were met with off Fuerteventura.

Catches from below 1000m were dominated by cyphocarids

(Gammaridea: Lysianassidae) and Hyperiidea Physosomata, particularly the genera Lanceola and Scina.

About 20 Cystisoma were obtained, mainly in the RMT 25. Most of these specimens were in good condition, and some were still alive when brought on board.

Eurythenes was found in small numbers in most of the deep hauls. None of the specimens examined appeared sexually mature. Observations confirm that members of this genus are carnivorous. Individuals were frequently seen clinging to, and actively feeding on moribund and injured fish. Similar, though fewer, observations suggest that M. helgae may feed in the same way.

As in 1969, a comparison between catches of RMT 8 and RMT 1 showed that the RMT 8 caught more amphipods than would be expected on the basis of relative effective catching areas. The RMT 25 catches, however, were rather disappointing as regards numbers.

Decapod Crustacea

Of primary interest to us on this cruise was the intensive series of hauls carried out at St. 7406 in the area of 40°N 20°W on the first leg of the cruise. This series was undertaken to investigate the vertical distribution and diurnal migration of the macroplankton and micronekton (including decapods) in order to compare this area with others in which series had already been completed (Fuerteventura 1965, 11°N 1968, 18°N 1969).

Provisional results indicate certain marked differences between this series and previous ones. In hauls between 0-1000m the sparsity of animals both in numbers of species and numbers of individuals was striking. Numerically the shallow mesopelagic penaeid Funchalia villosa was by far the most abundant adult animal a total of 99 being taken in day hauls and 28 at night. Other penaeids such as members of the genera Sergestes and Gennadas were badly represented. Even the common carideans Acanthephyra purpurea and A. pelagica were rarely present in double figures in any one sample.

In deeper hauls (1000-2000m) the decapods were much better represented. A noticeable feature of the complete series and especially of these deeper tows was the abundance of members of the family Pasiphaeidae relative to numbers caught on previous cruises. This was true of hauls throughout the cruise. Many Parapasiphaë sulcatifrons were taken and a number of a species of Pasiphaea thought to be P. hoplocerca. A single large specimen about 7 inches long of another species of Pasiphaea was caught at St. 7421 in a shallow (600-0) RMT 25 haul.

From the night hauls it looked as though both Acanthephyra purpurea and A. pelagica were more diffusely distributed through the water column with population peaks occurring at deeper levels than normal though the small numbers of animals taken may be a little misleading.

The decapods were more abundant in RMT 25 hauls carried out around Sao Miguel. This net took good catches of larger animals which the RMT 8 may have been missing at 40°N.

Hauls with the bottom net (BN 2.4) on the second leg between 2500 and 1000m south of Tierciera but mainly in the Pico/St. Jorges Channel took large catches consisting primarily of three large decapod species. These were a pink Heterocarpus sp., a very large deep red penaeid species (Plesiopenaeus edwardsianus) and a number of Polycheles sp. In addition a small number of an unidentified Acanthephyrid were taken (eg St. 7423) and also a larger number of another Acanthephyra sp. thought to be A. eximia (eg St. 7436). RMT 8 hauls in this area yielded a decapod fauna rather similar to that at 40°N.

Overall the absence or near absence of certain species was apparent. Not one individual of Physetocaris microphthalma was caught while only one specimen of Notostomus "longirostris" was taken (St. 7411). A single specimen of the rare Notostomus compsus was caught at St. 7480 this being only the second recorded Discovery specimen.

Cephalopods

On the whole the catch of cephalopods was very disappointing there being only 134 which were obvious enough to be picked out and of these only 9 were taken during the vertical series at 40°N 20°W. Although few were caught compared with the recent years there were over 30 species which included the following genera which have been uncommon at lower latitudes: Taningia, Lepidoteuthis, Taonius, Discoteuthis, Joubiniteuthis, Galiteuthis and Bathothauma. The most commonly caught genera were Pterygioteuthis (13) Mastigoteuthis (21) and Heteroteuthis (35).

The frequently employed RMT 1 + 8 combination net caught 91 cephalopods while the RMT 25 did better by catching 27 in 11 hauls. The high speed RMT 8 caught 3 in its only haul and a standard RMT 8 towed at 4 knots caught 4 in one haul. The bottom net caught Heteroteuthis (1) Bathyteuthis (1) and Cirroteuthis (4) and at least the two latter genera were very probably caught on the bottom. Bottom fish stomachs yielded 4 species and a Centroscymnus yielded large pieces of Architeuthis, Taningia and Tetronychoteuthis, all recorded from stomachs of sperm whales taken near the Azores.

Midwater fishes

The focal point of the cruise was the vertical distribution series down to 2000m depth made at 40°N 20°W. The RMT 8 catches were analysed on board. Gonostomatids, sternoptychids and myctophids formed a high proportion of the catches. Some 5000 specimens were taken during the series, but of these approximately 75% belonged to one species, Cyclothone braueri. Generally, the catch numbers of other species were low. Species diversity was comparatively low. Only twelve gonostomatid species, three sternoptychid species and twenty-three myctophid species were represented in the upper 1000m. Noticeable absentees from the catches were the melanostomiatids and the hatchet fish Sternoptyx. Although six Cyclothone species were represented only two, C. braueri and C. microdon, could be considered as abundant. In most cases distributions can be assigned only upon a basis of presence or absence. In general, the gonostomatids appeared as non-migrants or perhaps partial migrants at night. The migrant myctophids tended to be caught only in the upper 100m. The most interesting indicated distribution pattern was that of Benthosema glaciale. Shown as deep water myctophid during the day, with a distribution extending down to 1500m depth, this species was caught at 0-300m and 600-1000m depth at night.

Perhaps the most outstanding specimens caught were of the genera Leucobrotula and Parabrotula. Two specimens of of the former were caught whilst over forty of the latter were captured, all by closing nets.

Fish from bottom net catches

The fish sampled by the bottom net were numerous and interesting. On each occasion that the net was used they formed a considerable proportion of the catch. Preliminary examination of the hauls showed that synophobranchid eels were the most numerous and ubiquitous fish taken. The macrourids, Coelorhynchus, Gadomus and Coryphaenoides, and the halosaurs, Aldrovandia and Halosaurus, were also abundant. Several specimens of Bathypterois dubius were caught, and also of the alepocephalid genera Leptoderma and Alepocephalus. Two specimens of the deep-sea eel, Simenchelys parasitacus, were also taken. This conspicuous fish is said to feed by burrowing in the musculature of fish considerably larger than itself.

Pelagic droplines

Pelagic droplines were fished on 3 occasions, bearing a total of 46 hooks. With the increase size of the paternosters since the gear was last used, tangling of the hooklines with the main line was much reduced. Mackerel were used as bait, and lasted well on the hooks for the duration of the operation. Only the first line to be fished made any catch. Two blue sharks (Prionace glauca) were hooked, on the two hooks nearest to the surface, but the first fish was lost. The fourth hook from the surface on this line was lost. The bait remained intact on all the other hooks fished.

Bottom longlines

Seven bottom longline operations were carried out during the cruise. All but one were successful; in the first operation, however, the main line parted while hauling in heavy weather, and all the ground line was lost. Of the rest, 64 fish were caught from 268 hooks fished, giving an overall catch rate of 23.9 per 100 hooks. The best single catch was from the last line, with 20 fish taken from 44 hooks: a catch rate of 45.4%. The lines were laid in depths ranging from 696m to 1472m, in the area around Pico-San Jorge islands.

The catches were composed of 1 Hexanchus griseus, 1 Pseudotriakis microdon, 1 Centrophorus squamosus, 2 Centroscymnus crepidater, 20 C. coelolepis, 9 Deania calcea, 1 rajid ray, 21 Mora moro, and 5 Helicolenus dactylopterus. Added to this were 1 C. crepidater, 1 M. moro, and 1 unidentified shark which were lost at the surface on hauling. Only a small proportion of the mackerel baits remained intact when the line was hauled; and 3 M. moro and 1 D. calcea were found to be severely damaged, probably by sharks.

The most notable capture was the specimen of Pseudotriakis microdon. It is about the 14th specimen recorded, and one of the smallest in size. Among its stomach contents were bones of possible cetacean origin. Moreover, contents of the stomachs of two other fish in the same catch suggest cetacean origin. One C. coelolepis stomach contained a block of muscle thought to be from an odontocete, while another of the same species contained cephalopod remains from individuals of a size too large to be caught by this size of shark.

Bottom net

The bottom net was basically similar to that fished during cruise 30. The skids had a width of 12" (previously 6"), the increased width reduced the amount of extra weight required, with 20lb added to the front and rear of each skid. In all the hauls, the net fished the correct way up, and with the entire length of the skids on the bottom. Depth to wire out ratios varied between 1:1.4 and 1:2.0. The bottom back bar was supported by 4mm wire strops and fitted inside the frame; weak links between eyes at the end of the bar and on the frames holding the bar in position. This enabled the net to be fished closer to the substratum. Two tickler chains were fitted between the front of the skids. The net, of 2.4m width and 6m length, was constructed of 4.5mm netting with a cod end of approximately 0.75mm netting. The canvas mouth was strengthened in the corners with leather to take the additional strain of a full net. Carbine hooks held the sides of the net to the bottom bar strops. A coarse mesh chafer, sewn to the net, protected all the cod end and the bottom of the rest of the net. Plastic netting was fitted to the sides and top of the frame. A 'F' type pinger was attached 200m up the warp from the net, and a towed hydrophone used. Reasonable signals were obtained during hauls over hard substrata, but those over deep soft sediments were very weak. The net was towed at 1.5kt.

Twelve hauls were made between 960m and 2602m, the majority of the sediments consisting largely of pteropod remains and small pumice pebbles. Fish (including several Bathypterois, halosaurs, eels, etc.), decapods and echinoderms constituted the major elements of the fauna at most stations. Amongst the echinoderms, were numerous soft holothurians (including several elasopods in excellent condition), asteroids, ophiuroids, cidaroids and several examples of Echinothuriidae in which the flexible test had not collapsed. The coelenterates were largely represented by various pennatulaceans (Umbellula, virgularids and pennatulids) and large sea-anemones. Examples of Cirroteuthis were taken in 3 nets from 2000m or deeper. At station 7432, in a 60 minute trawl, approximately 250l of material (mainly pumice pebbles) were collected, the fauna including numerous large penaeid decapods. The net failed to reach the bottom at station 7476, but of interest was the small amount of midwater material that was collected during the $4\frac{1}{2}$ hours the net was in the water.

The (RMT 8)BN collected a very large amount of mud at station 7465 which contained, amongst other animals, numerous Dentalium, several pennatulids and asteroids.

The bottom camera was operated at 3 stations, but in only 7 cases out of 38 frames exposed, did the flash operate.

Studies on eyes

Dr. N.A. Locket has furthered his studies on the eyes of deep-sea fishes begun on the 1966 cruise. He has concentrated on those aspects which demand fresh material, and which thus require to be done at sea. The major part of his work has been to fix and embed samples of retina for electron and optical microscopy and he has covered a large range of species from different habitats in this way. Attempts have been made to impregnate retinae by the Golgi technique, which has not previously been used on deep-sea material. The technique is notoriously capricious, but impregnation has certainly taken place in some of the blocks, and interesting results are expected. Other methods of preservation have also been used, with a view to further studies of the intact eyes and their relations to the fish as a whole. Fresh specimens have been examined ophthalmoscopically and information obtained about the colours of the fresh retinae and the fields of view served by the various regions. Ophthalmoscopy has also determined the function of the so called lens pad in scopelarchid fishes, whilst fixed material will elucidate its structure. Notes made have been supplemented by photographs of fishes and their eyes, and some retinal samples have been frozen for visual pigment extraction.

Pigments

Several specimens of about 15 species of decapod crustaceans, from various depth horizons, have been collected and deep-frozen for subsequent laboratory analysis of their pigment composition and concentration. This collection is expected to complete a series of similar analyses of the pigments of other decapods and euphausiids undertaken with material from previous cruises. Samples of the eggs of some of the species have also been collected for analysis of the lipid content and yolk pigments. Results from shipboard extraction of fish material show that deep-freezing does not appear to have any deleterious effects upon the yolk pigment protein. Density determinations on the eggs have been made to establish the relationship between size, density and lipid content, and the work extended to the eggs of a few species of copepod, ostracod and mysid.

Specimens of the deep-water medusae Atolla and Periphylla have been collected for analysis of their characteristic purple-brown pigment.

Bioluminescence

Records have been made of the general physical parameters of the bioluminescent responses to artificial stimulation of species of coelenterate, crustacean, squid and fish, and the angular distribution of light from a few species of euphausiid determined. Particular attention has been paid to establishing suitable chemical, mechanical or electrical stimuli for different species, in order to ensure a reliable and readily obtained response for future work. While luminescent responses have been studied from about 30 species several are of particular interest. The nature of the suggested ventral photophores of the fish Benthabella has been unequivocably demonstrated. The luminescence of the squid Heteroteuthis has been observed in some detail, enabling the method whereby it achieves an apparently particulate slight secretion to be clarified, as well as its alternative mode of steady luminescence. The operation of the thoracic photophores of the decapods Parapandalus and Sergestes has been investigated, and some preliminary observations made on their pharmacology. Further observations on drug-induced luminescence of species of the amphipod Scina have shown an apparently cholinergic mediating system, providing support for other work suggesting a nervous control of the photocytes.

Collection of fish material and of two species of siphonophore, the luminous secretion of the decapod Oplophorus and a searsiid fish,and of Sergestes organs of Pesta have been made for investigation of the chemical nature of the luminescent systems. In addition the luminous organs of several species of squid, decapod, amphipod and copepod have been fixed for subsequent light and electron microscopy.

Preliminary observations have been made on the operation of the eyes of the ostracod Gigantocypris. Specimens have also been collected for light and electron microscopy (with N.A.L.), and for chemical analysis of the reflector system.

Biochemistry

A collection of a wide range of marine fauna was made for subsequent biochemical analysis. Of special interest were the Crustacea, and several species were collected to investigate the effects of sex and maturity on the biochemical composition of individual species, and of environmental depth on closely related species.

Also of interest were deep-living Medusa and the livers from deep-living sharks.

A separate collection of euphausiids and myctophids was made for preservation experiments.

RMT nets

The RMT 1 + 8 combination net was again used extensively on this cruise. In all, 83 hauls were made, 48 of them at 40°N 20°W in a day and night vertical series from the surface to 2000m. Of these hauls, 5 were repeats made necessary by failure of the gear (3), by a small tear in the RMT 1 (1) or by human error (2). This performance was a great improvement over previous attempts to do a vertical series. Several small series for specific purposes were completed and tests were made on performance. These included a haul during which the net was opened at the extreme depth limit of the pressure transducer at 2500m and with 6000m of wire out, hauls which established that the net can be fished quite easily within horizons 25m thick even at 1000m depth, and hauls which showed that leakage is minimal. The great improvement in the net monitor's performance was largely due to the use of a towed hydrophone streamed behind the ship and more sensitive scrolls set at a different angle to the monitor's body. Various modifications to the nets themselves greatly improved their wearing properties and handling was easier than previously. Two hauls were made from the boom with the RMT 1.

In 1969, when the RMT 1 was used from the 20' boom to sample the 10-0m horizon, difficulty was found in estimating the depth. This year a pressure transducer was attached to the upper bar and a lead taken to a chart recorder on board. This gave satisfactory depth readings to within 1 m. A further improvement in the technique for fishing this net was the addition of two lucas weights to the upper bar so that the net fished further forward.

The RMT 25, the largest opening/closing net with a fishing mouth area of 25 sq. metres was used successfully on 8 occasions. It certainly caught more and rather larger animals than the RMT 8 but the difference was not as pronounced as expected, possibly because of the general scarcity of the plankton which was obvious from all net hauls.

The high speed RMT 8 was used on one occasion at 5 knots but proved very disappointing and a standard RMT 8 was tried immediately afterwards at 4 knots with a depressor for comparison. It too caught little more than if it had been towed at 2 knots. This may suggest a scaring action by the depressor.

A special bottom trawl was used directly beneath a standard RMT 8 and a large haul of mud was taken. This combination clearly has potential but must be stronger to enable handling with large amounts of contained mud.

Stn.	Date	Position Lat. °N	 Long. °W	Gear	Depth (m)	time(hrs)	Sounding(m)
7404	30.9.70	40°5.2' 40°5.2'	20°4.3' 20°4.3'	(RMT 1 (RMT8/5	0-1000	1902-2115	4895
7405	30.9.70	40°5.9' 40°5.2'	20°4.2' 20°4.2'	(RMT 1 (RMT8/5	100-200	2350-0008	0 *
7406							
# 1	1.10.70	40°2.5' 39°59.1'	20°7.9' 20°7.9'	(RMT 1 (RMT8/5	110-205	0842-1042	0
# 2	1.10.70	39°59.9' 40°4.2'	20°8.3' 20°8.3'	(RMT 1 (RMT8/5	210-300	1147-1347	0
# 3	1.10.70	40°0.9' 39°55.9'	20°7.7' 20°7.5'	(RMT 1 (RMT8/5	910-1000	1559-1759	0
# 4	1.10.70	39°55.7' 39°57.7'	20°12.8' 20°15.3'	(RMT 1 (RMT8/5	990-990		0 **
# 5	1.10.70	39°58.3' 39°54.7'	20°16.7' 20°15.9'	(RMT 1 (RMT8/5	110-195	2335-0135	0
# 6	2.10.70	39°57.6' 40°2.2'	20°18.2' 20°20.8'	(RMT 1 (RMT8/5	910-1000	0327-0529	0
# 7	2.10.70	40°3.0' 39°58.9'	20°20.8' 20°19.3'	(RMT 1 (RMT8/5	760-900	0843-1043	0
# 8	2.10.70	39°55.4' 39°50.7'	20°8.0' 20°7.0'	(RMT 1 (RMT8/5	510-600	1309-1509	0
# 9	2.10.70	39°49.8' 39°52.4'	20°7.8' 20°13.2'	(RMT 1 (RMT8/5	310-400	1601-1801	0
#10	2.10.70	39°54.1' 39°54.1'	20°16.7' 20°16.7'	(TSD (	0-1500	1923-2115	0
#11	2.10.70	39°53.0' 39°49.8'	20°16.1' 20°15.2'	(RMT 1 (RMT8/5	810-900	2211-0011	0
#12	3.10.70	39°49.8' 39°53.4'	20°15.5' 20°18.2'	(RMT 1 (RMT8/5	52-100	0124-0324	0

Stn.	Date	Position Lat. °N	Position Long. °W	Gear	Depth(m)	Time(hrs)	Sounding(m)
7406 #13	3.10.70	39°53.4' 39°48.5'	20°18.1' 20°16.0'	(RMT 1 (RMT8/5	30-50	0352-0550	0
#14	3.10.70	39°56.9' 40° 0.0'	20°7.5' 20°12.5'	(RMT 1 (RMT8/5	710-800	0858-1058	0
#15	3.10.70	40°0.9' 39°57.0'	20°13.5' 20°15.0'	(RMT 1 (RMT8/5	25-50	1145-1345	0
#16	3.10.70	39°57.0' 40°1.7'	20°15.3' 20°19.4'	(RMT 1 (RMT8/5	50-100	1400-1600	0
#17	3.10.70	40°2.3' 40°7.0'	20°19.8' 20°23.4'	(RMT 1 (RMT8/5	10-25	1613-1813	0
#18	3.10.70	40°2.6' 39°58.7'	20°10.1' 20°9.5'	(RMT 1 (RMT8/5	700-790	2051-2251	0
#19	4.10.70	39°59.4' 40°2.9'	20°11.4' 20°13.7'	(RMT 1 (RMT8/5	10-27	0108-0308	0
#20	4.10.70	40°1.3' 39°56.9'	20°13.8' 20°14.0'	(RMT 1 (RMT8/5	210-300	0416-0616	0
#21	4.10.70	39°57.4' 40°1.8'	20°10.8' 20°16.0'	(RMT 1 (RMT8/5	410-500	0838-1038	0
#22	4.10.70	40°3.4' 40°0.4'	20°18.6' 20°16.3'	(RMT 1 (RMT8/5	610-700	1229-1429	0
#23	4.10.70	39°59.4' 39°59.5'	19°57.5' 19°57.4'	TSD	0-1800	1727-1906	4877
#24	4.10.70	39°57.9' 39°53.5'	19°57.0' 19°56.8'	(RMT 1 (RMT8/5	610-700	2026-2226	0
#25	4.10.70	39°53.0' 39°55.4'	19°59.4' 20°5.0'	(RMT 1 (RMT8/5	500-590	0001-0201	0
#26	5.10.70	39°55.7' 39°52.8'	20°6.0' 20°3.8'	(RMT 1 (RMT8/5	310-400	0311-0511	0

Stn.	Date	Position Lat. °N	Long. °W	Gear	Depth (m)	Time(hrs)	Sounding(m)
7406 #27	5.10.70	40°1.5' 40°2.5'	20°0.6' 20°5.0'	(RMT 1 (RMT8/5	810-900	0826-1026	0
#28	5.10.70	40°2.9' 40°1.6'	20°5.4' 19°59.9'	(RMT 1 (RMT8/5	410-500	1138-1338	0
#29	5.10.70	40°0.6' 39°59.3'	20°0.9' 20°5.7'	(RMT 1 (RMT8/5	805-900	1506-1706	0
#30	5.10.70	39°55.6' 39°56.2'	20°10.9' 20°6.4'	(RMT 1 (RMT8/5	410-500	2055-2255	0
#31	6.10.70	39°56.3' 39°55.4'	20°7.0' 20°11.7'	(RMT 1 (RMT8/5	400-500	0101-0301	0
#32	6.10.70	39°57.5' 39°54.0'	20°2.3' 20°6.8'	(RMT 1 (RMT8/5	502-610	0851-1051	0
#33	6.10.70	39°49.9' 39°44.2'	20°13.1' 20°20.4'	(RMT 1 (RMT8/5	990-1250	1320-1721	0
#34	6.10.70	39°47.2' 39°47.5'	20°9.4' 20°2.4'	(RMT 1 (RMT8/5	1010-1265	2054-2314	0
#35	7.10.70	39°48.7' 39°48.7'	19°56.9' 19°56.8'	(RMT 1 (RMT8/5	400-440	0145-0148	0
#36	8.10.70	39°58.8' 39°58.8'	19°58.3' 19°58.3'	(RMT 1 (RMT8/5	740-741	1409-1411	0
#37	9.10.70	40°0.9' 40°4.2'	20°1.8' 20°5.3'	(RMT 1 (RMT8/5	460-550	0818-1018	0
#38	9.10.70	40°14.1' 40°18.4'	20°16.4' 20°20.4'	(RMT 1 (RMT8/5	550-655	1502-1700	0
#39	9.10.70	40°12.9' 40°17.2'	20°15.0' 20°19.6'	(RMT 1	0-10	1430-1630	0
#40	9.10.70	40°2.6' 39°59.5'	20°3.5' 20°3.7'	(RMT 1 (RMT8/5	920-1125	2044-2244	0

Stn.	Date	Position Lat. °N	 Long. °W	Gear	Depth (m)	Time(hrs)	Sounding(m)
7406 #41	10.10.70	40°0.3' 40°6.3'	20°6.8' 20°15.8'	(RMT 1 (RMT8/5	1260-1500	0102-0500	0
#42	10.10.70	39°59.3' 40°1.8'	20°5.4' 20°9.3'	(RMT 1	0-10	0010-0210	0
#43	10.10.70	39°54.5' 39°48.5'	20°18.6' 20°22.1'	(RMT 1 (RMT8/5	1250-1500	0821-1221	0
#44	10.10.70	39°48.7' 39°52.7'	20°21.1' 20°16.2'	(RMT 1 (RMT8/5	650-745	1413-1613	0
#45	10.10.70	39°55.4' 39°57.3'	20°13.2' 20°6.8'	(RMT 1 (RMT8/5	0-650	1954-2154	0
#46	10.10.70	40°0.6' 40°7.1'	20°0.0 19.50.2'	(RMT 1 (RMT8/5	1500-2000	0025-0425	0
7407	13.10.70	37°37.6' 37°34.7'	25°21.1' 25°28.6'	(RMT25	470-525	1519-1823	1135 ≠
7408	13.10.70	37°35.0' 37°38.9'	25°28.3' 25°16.5'	(RMT25	100-200	2018-0018	1150
7409	14.10.70	37°38.7' 37°36.4'	25°16.3' 25°23.4'	(RMT25	210-300	0201-0550	0
7410	14.10.70	37°32.6' 37°34.3'	25°22.1' 25°12.1'	(RMT25	800-900	0955-1355	0
7411	14.10.70	37°30.2' 37°36.2'	25°13.5' 25°4.8'	(RMT25	890-1000	1836-2236	0
7412	15.10.70	37°35.6' 37°38.8'	25°27.6' 25°17.4'	(RMT 1 (RMT8/5	210-300	0217-0617	0
7413	15.10.70	37°32.5' 37°30.5'	25°23.1' 25°32.5'	(RMT 1 (RMT8/5	795-900	0912-1312	0
7414	15.10.70	37°34.4' 37°35.7'	25°36.5' 25°29.6'	(RMT 1 (RMT8/5	475-525	1523-1753	942

Stn.	Date	Position Lat. °N	 Long. °W	Gear	Depth (m)	Time(hrs)	Sounding(m)
7415	15.10.70	37°16.8' 37°16.7'	25°30.6' 25°28.7'	(RMT25	0-500	0045-0118	0
7416	18.10.70	37°52.4' 37°54.8'	25°30.4' 25°26.4'	(RMT 1 (RMT8/5	0-175	1154-1330	0
7417 ≠ 1	18.10.70	37°53.6' 37°59.9'	25°35.6' 25°29.5'	(RMT 1 (RMT8/5	0-255	1735-2125	0 *
≠ 2	18.10.70	38°0.7' 38°6.1'	25°28.9' 25°24.4'	(RMT 1 (RMT8/5	0-160	2147-0016	0 *
7418	19.10.70	37°56.5' 37°58.8'	25°33.7' 25°31.4'	(RMT 1 (RMT8/5	0-130	0142-0253	0 *
7419	19.10.70	38°0.8' 38°5.1'	25°31.8' 25°26.7'	(RMT 1 (RMT8/5	0-495	0450-0645	0
7420	19.10.70	37°58.1' 38°6.3'	25°32.0' 25°34.5'	(RMT25	960-1750	1131-1531	0
7421	19.10.70	38°10.2' 38°2.0'	25°37.5' 25°42.7'	(RMT25	80-610	1911-0200	2254
7422	23.10.70	37°50.8' 37°51.0'	27°2.5' 27°1.1'	(BN 2.4	2287-2287	0428-0529	2287
7423	23.10.70	37°50.8' 37°50.2'	27°4.0' 27°7.9'	(BN 2.4	2283-2283	0907-1107	2283
7424	23.10.70	37°27.4' 37°25.4'	26°51.8' 26°54.9'	(BN 2.4	2565-2602	1953-2153	2602
7425	24.10.70	37°58.9' 37°58.5'	27°1.9' 27°2.5'	(BLL	2212-2212	0533-0920	0
7426	24.10.70	38°14.8' 38°15.2'	27°7.4' 27°3.2'	(BN 2.4	1419-1528	1321-1521	1458
7427	24.10.70	38°22.4' 38°21.0'	27°24.1' 27°21.3'	(BN 2.4	1576-1576	2041-2235	0

Stn.	Date	Position Lat. °N	 Long. °W	Gear	Depth (m)	Time(hrs)	Sounding(m)
7428	25.10.70	38°26.2' 38°26.8'	27°8.8' 27°7.3'	(BN 2.4	960-1082	0240-0327	0
7429	25.10.70	38°26.9' 38°29.6'	27°7.0' 27°8.0'	(PDL	457-457	1105-1505	709
7430	25.10.70	38°28.0' 38°29.2'	27°5.7' 27°7.3'	(PDL	457-457	1135-1605	743
7431	26.10.70	38°50.7' 38°50.4'	28°49.5' 28°44.2'	(BN 2.4	1425-1453	0333-0533	1435
7432	26.10.70	38°45.1' 38°44.0'	28°35.6' 28°33.4'	(BN 2.4	1227-1233	1050-1207	0
7433	26.10.70	38°41.2' 38°40.8'	28°27.8' 28°26.8'	(BN 2.4	1240-1251	1449-1519	0
7434	26.10.70	38°44.5' 38°44.7'	28°32.2' 28°32.3'	(BC	1237-1248	1756-1905	0
7435	26.10.70	38°40.4' 38°40.6'	28°26.5' 28°26.7'	(BC	1255-1257	2045-2117	0
7436	26.10.70	38°42.7' 38°45.4'	28°30.5' 28°36.2'	(BN 2.4	1240-1255	0000-0045	1420
7437	27.10.70	38°36.9' 38°36.4'	28°18.4' 28°16.3'	(BN 2.4	1240-1259	0436-0536	0
7438	27.10.70	38°35.0' 38°32.1'	28°10.2' 28°5.4'	(RMT 1 (RMT8/5	810-1000	1013-1213	1271
7439	27.10.70	38°36.2' 38°33.2'	28°14.2' 28°8.8'	(RMT 1 (RMT8/5	610-800	1512-1712	0
7440	27.10.70	38°39.7' 38°37.4'	28°23.9' 28°16.9'	(RMT 1 (RMT8/5	100-300	2007-2209	0
7441	27.10.70	38°39.8' 38°36.4'	28°23.8' 28°16.8'	(RMT 1 (RMT8/5	25-100	0007-0208	0

Stn.	Date	Position Lat. °N	Position Long. °W	Gear	Depth (m)	Time (hrs)	Sounding (m)
7442	28.10.70	38°36.2' 38°36.2'	28°18.1' 28°18.1'	(RMT 1 (RMT8/5	0-1000	0318-0542	0
7443	28.10.70	38°50.3' 38°50.9'	28°40.4' 28°40.0'	(BLL	1472-1472	0950-1330	0
7444	28.10.70	38°48.2' 38°46.8'	28°41.9' 28°43.5'	(RMT 1 (RMT8/5	100-100	1103-1140	0
7445	28.10.70	38°38.7' 38°39.1'	28°20.4' 28°21.4'	(PDL	100-450	1730-1900	0
7446	28.10.70	38°37.5' 38°32.4'	28°18.6' 28°8.0'	(RMT 25	975-1350	2037-0037	0
7447	29.10.70	38°38.1' 38°34.1'	28°20.2' 28°10.4'	(RMT 25	105-300	0322-0722	0
7448	29.10.70	38°17.9' 38°19.0'	27°48.9' 27°50.8'	(BLL	696-696	1202-1535	0
7449	29.10.70	38°19.1' 38°17.7'	27°50.8' 27°52.2'	(RMT 25	170-210	1340-1432	0
7450	29.10.70	38°33.7' 38°31.3'	28°7.5' 28°1.1'	(RMT 1 (RMT8/5	300-400	2030-2230	0
7451	30.10.70	38°36.2' 38°33.7'	28°15.1' 28°8.7'	(RMT 1 (RMT8/5	173-200	0117-0320	1265
7452	30.10.70	38°32.8' 38°29.9'	28°5.4' 27°58.6'	(RMT 1 (RMT8/5	470-503	0420-0620	0
7453	30.10.70	38°40.6' 38°37.8'	28°24.5' 28°18.6'	(RMT 1 (RMT8/5	650-700	1044-1244	0
7454	30.10.70	38°36.1' 38°33.5'	28°14.0' 28°7.5'	(RMT 1 (RMT8/5	600-650	1410-1610	0
7455	30.10.70	38°39.6' 38°35.9'	28°19.6' 28°14.8'	(RMT 1 (RMT8/5	950-1000	2008-2208	0

Stn.	Date	Position Lat. °N	 Long. °W	Gear	Depth(m)	Time(hrs)	Sounding(m)
7456	31.10.70	38°38.5' 38°35.7'	28°20.3' 28°14.7'	(RMT 1 (RMT8/5	900-950	0116-0316	0 ø
7457	31.10.70	38°33.6' 38°33.6'	28°11.4' 28°12.8'	(BLL	1246-1246	0515-1010	0
7458	31.10.70	38°33.3' 38°31.8'	28°10.8' 28°6.5'	(RMT 1 (RMT8/5	510-600	1236-1436	0
7459	31.10.70	38°33.1' 38°30.3'	28°7.6' 28°1.2'	(RMT 1 (RMT8/5	500-550	1635-1835	0
7460	31.10.70	38°38.9' 38°37.9'	28°21.0' 28°18.2'	(RMT8/BN	1255-1261	2247-2347	0
7461	1.11.70	38°35.2' 38°33.8'	28°12.9' 28°9.7'	(RMT8/BN	1258-1266	0333-0434	0
7462	1.11.70	38°34.5' 38°33.9'	28°11.3' 28°11.2'	(BLL	1253-1253	0725-1030	0
7463	1.11.70	38°32.5' 38°29.4'	28°9.9' 28°3.6'	(RMT 1 (RMT8/5	400-500	1235-1436	0
7464	1.11.70	38°32.7' 38°30.1'	28°8.0' 28°2.8'	(RMT 1 (RMT8/5	310-400	1617-1817	0
7465	1.11.70	38°39.7' 38°39.4'	28°24.0' 28°23.0'	(RMT8/BN	1248-1248	2202-2302	0
7466	2.11.70	38°43.8' 38°44.3'	28°24.6' 28°24.6'	(BLL	998-1102	0505-0845	0
7467	2.11.70	38°39.3' 38°37.8'	28°23.2' 28°18.0'	(RMT 1 (RMT8/5	310-400	1129-1329	0
7468	2.11.70	38°36.2' 38°33.1'	28°15.1' 28°9.3'	(RMT 1 (RMT8/5	207-300	1430-1630	0
7469	2.11.70	38°39.9' 38°40.1'	28°23.7' 28°23.5'	(BC	1266-1266	1855-1932	0

Stn.	Date	Position Lat. °N	Position Long. °W	Gear	Depth (m)	Time(hrs)	Sounding(m)
7470	2.11.70	38°37.9' 38°34.3'	28°19.6' 28°10.0'	(RMT8/150	0-1223	2119-2325	0
7471	3.11.70	38°35.8' 38°32.2'	28°13.6' 28°5.6'	(RMT8/5	0-300	0227-0427	0
7472	3.11.70	38°37.5' 38°35.7'	28°18.9' 28°12.4'	(RMT 1 (RMT8/5	105-200	0901-1101	0
7473	3.11.70	38°35.2' 38°32.6'	28°11.2' 28°5.1'	(RMT 1 (RMT8/5	50-100	1125-1325	0
7474	3.11.70	38°32.1' 38°30.0'	28°4.0' 27°59.4'	(RMT 1 (RMT8/5	0-50	1340-1540	0
7475	4.11.70	37°27.4' 37°27.4'	25°41.9' 25°41.9'	(BLL	746-752	1048-2015	1532
7476	4.11.70	37°20.2' 37°19.9'	25°21.2' 25°18.1'	(BN 2.4	2078-2093	1435-1535	0
7477							
# 1	6.11.70	40°3.2' 40°5.6'	19°58.6' 19°59.5'	(RMT 1 SPEC. (RMT8/5	490-510	0315-0415	0
# 2	6.11.70	40°7.7' 40°10.2'	20°0.2' 20°0.7'	(RMT 1 SPEC. (RMT8/5	240-255	0500-0600	0
7478							
# 1	6.11.70	40°10.8' 40°4.1'	19°58.9' 19°55.0'	(RMT 1 (RMT8/5	1460-2000	0852-1252	0
# 2	6.11.70	40°1.9' 40°1.0'	19°55.9' 20°1.1'	(RMT 1 (RMT8/5	605-700	1442-1642	0
# 3	6.11.70	39°53.9' 39°52.2'	20°6.8' 19°56.9'	(RMT 1 (RMT8/5	1010-1250	1943-2343	0

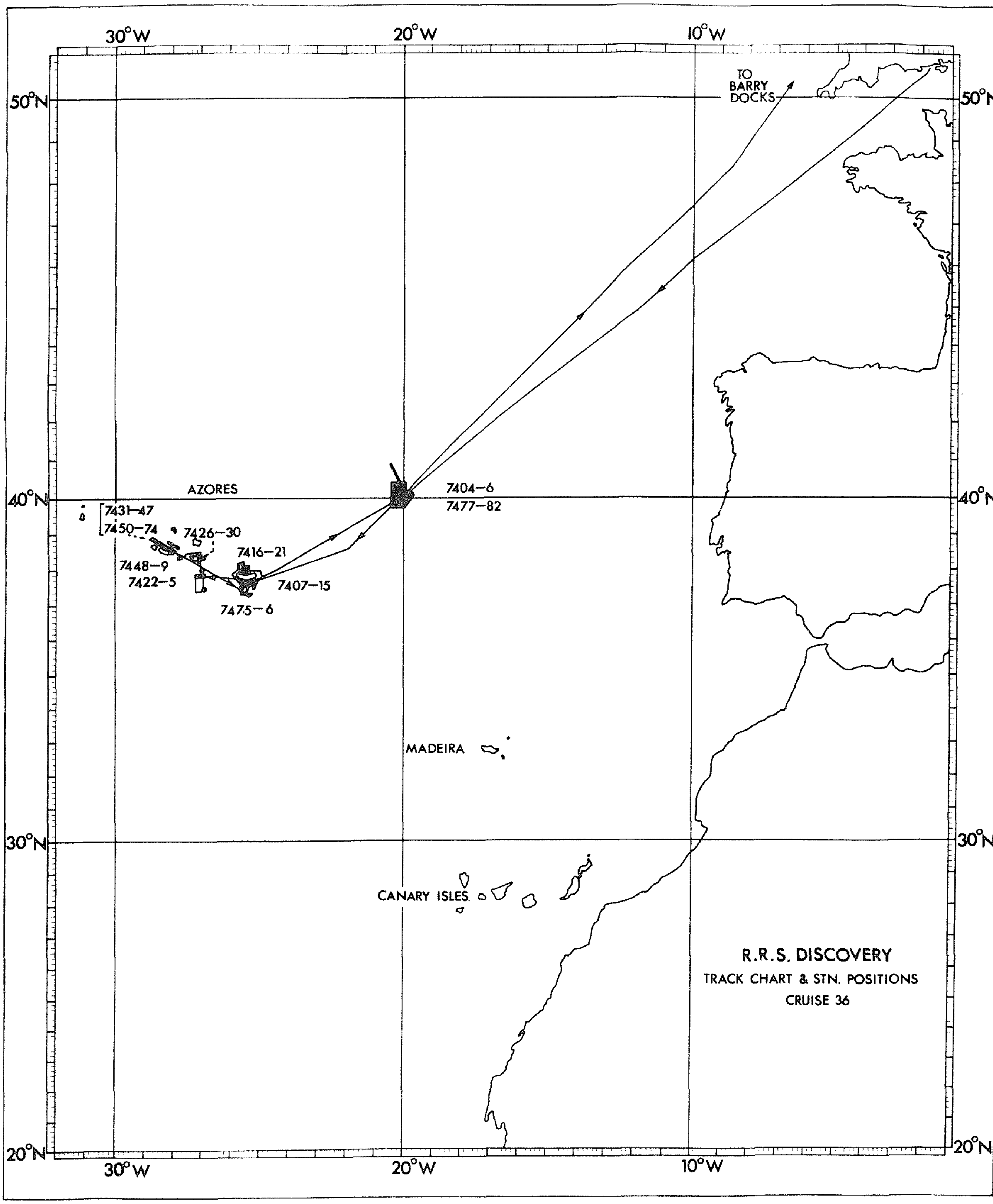
Stn.	Date	Position Lat. °N	Position Long. °W	Gear	Depth(m)	Time(hrs)	Sounding(m)
7479 ≠ 1	7.11.70	39°51.2' 39°50.4'	19°58.5' 20°1.8'	(RMT 1 SPEC. (RMT8/5	990-1020	0146-0251	0
≠ 2	7.11.70	39°50.0' 39°49.8'	20°5.2' 20°8.0'	(RMT 1 SPEC. (RMT8/5	47-60	0350-0450	0
≠ 3	7.11.70	39°49.9' 39°49.5'	20°9.5' 20°11.8'	(RMT 1 SPEC. (RMT8/5	0-0	0523-0623	0
7480	7.11.70	39°55.2' 39°51.8'	20°7.4' 19°55.7'	(RMT 1 (RMT8/5	1250-1510	0921-1321	0
7481	7.11.70	39°50.4' 39°51.5'	19°53.3' 19°55.8'	(TSD (WB	0-1987	1513-1941	0
7482	7.11.70	39°51.5' 39°50.0'	20°3.7' 20°23.9'	(RMT 1 (RMT8/5	2000-2500	2212-0412	0

* Total time

** Net did not open

≠ Open net: horizontal to oblique
(Oblique - 1519-1553 and 1823-1903)

ϕ Net failed to close - all in at 0406hrs.



30°W
20°W
10°W
50°N
40°N
30°N
20°N
TO
BARRY
DOCKS
AZORES
7404–6
7477–82
7431–47
7450–74
7426–30
7416–21
7448–9
7422–5
7407–15
7475–6
MADEIRA
CANARY ISLES
R.R.S. DISCOVERY
TRACK CHART & STN. POSITIONS
CRUISE 36

FIG. 1