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R.R.S. DISCOVERY
CRUISE 21 REPORT

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UPWELLING OFF N.W. AFRICA, AND PLANKTON DISTRIBUTION
11°N. 20°W.

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C O N T E N T S

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ABBREVIATIONS

N113	Net with mouth = 1 sq. m.
NN	Neuston net
FRN 15	Free rise net with mouth = 15 ft. diameter
7.4 W/B	7.4 l. water bottle
CDBE	Catch dividing bucket with pressure switch
CDBA	Acoustic catch dividing bucket
PES	Precision echo sounder
TMT8/5	Tucker Midwater Trawl with a sampling area of 8 sq. m.
TMT90	Tucker Midwater Trawl with a sampling area of 90 sq. m.
DTP	Depth telemetering pinger
BLL	Longline with hooks on bottom.
BN	Bottom net. The suffixes 330 and 5 indicate a net mesh of 0.33 mm and 5.0 mm respectively. This is followed by the mouth area of the net in m^2.
TST	Temperature, salinity, depth probe.

INTRODUCTION

Cruise 21 had four main objects; first, to continue investigations into the vertical distribution of zooplankton by a programme of day and night sampling with depth monitored opening/closing nets at a position far enough south to examine a fauna quite distinct from that examined at the Fuerteventura position. Second, to make observations at the Fuerteventura position at a different season of the year. Third, to try to discover the whereabouts of the faunal boundary between the 'southern' fauna and that found at Fuerteventura, and fourth, to make a preliminary survey of the upwelling regions of the NW African continental shelf to compare the vertical distribution of plankton in upwelling and non-upwelling areas.

ITINERARY

"Discovery" sailed from Millbay Dock, Plymouth, at 1600 hours on 14th January, 1968. Fuel was taken on at Falmouth on 15th and at 1630 hours on the same day the ship sailed towards a position, 40°N 20°W, which was reached at 0500 hours on 20th.

Calibration and testing of gear continued throughout the day and until 0600 hours on 21st. During this period a haul to 1000 m. was made with the TMT8/5 and a series of samples taken for Chlorophyl measurement.

As repairs and alterations to the depth pingers and acoustic control system were needed it was decided to proceed southwards stopping to test gear when it became available. A series of tests were made on 22nd and the results were encouraging.

A slight alteration of course took the ship across Dacia bank on the morning of 24th where the inclined Asdic was used and at 2040 hours on the same day work commenced on the first line of stations off the NW African Coast (Figs. 1 & 2). This line, the Puerto Cansado line (Stns 6547-6559) was completed by 2100 hours on 25th and the ship proceeded to C. Leven stopping at approximately 50 mile intervals to make a standard set of observations. The TSD was used at each station and the inclined Asdic was operated continuously while the ship was in shallow water.

The C. Leven line commenced at 1600 hours on 27th January and was completed at 0200 hours on 29th (Stns 6566-6584 Fig. 3). The ship then proceeded to the Isoletta Virginia line which commenced at 0618 hours on 30th January and continued until 0815 hours on 2nd February (Stns 6589-6620 Fig. 4). The next line, from C. Blanc commenced at 2315 hours on 2nd February and was completed at 0122 hours on 4th February (Stns 6623-6633 Fig. 4).

"Discovery" then went southwards to deeper water where seven hauls were made with the TMT8/5 to test the opening and closing mechanisms, other hauls were made in this area with N113 and TMT90. The bottom net was also tried at rather greater depths than previously. On 8th-9th February a series of N113 hauls were made to investigate animal distribution in relation to the thermocline. Later on 9th a line of TSD stations was made out from the coast in the latitude of St. Louis, this was completed at 2050 hours on 9th (Stns 6657-6661). The ship then steamed direct to Dakar arriving at 0400 hours on the morning of 10th, the inclined Asdic was used while on passage.

"Discovery" was opened to visitors from 1000-1700 hours on Sunday, 11th February and a number came aboard including scientists from local marine laboratories and from the University.

Messrs. Harris, Belderson and Driver left the ship for U.K. on 11th and Messrs. Foxton and Moorey joined on the same day.

"Discovery" sailed from Dakar at 1700 hours on 12th for a position 12°N 20°W which was reached on 13th, the wind was blowing fairly strongly and it was decided to steam a further degree to the south arriving at 11°N 20°W at 2000 hours on 13th. There a streamlined dhan buoy attached to 1000 m of 5/8" polypropylene rope with a 150 lb sinker was launched and the subsequent series of net hauls were made while keeping station on the drifting buoy which moved southwards at an average rate of 3 miles per day.

Day and night series of opening/closing TMT8/5 nets were made until 21st February (Stns 6662 # 1 - # 38) in 100 m horizons to 1000 m and between 1200-1000, 1500-1200 and 2000-1500. Considerable difficulties were encountered with both the electronics and the releases but these were gradually corrected. A TSD haul and a set of chlorophyll measurements were made at Stn 6663 and on 22nd February a day and night series of N113 hauls with catch dividing bucket began (Stn 6665 # 1 - # 39), this was completed on 27th. A series of TMT8/5 hauls were then made using the acoustically controlled opening/closing mechanism in conjunction with a catch dividing bucket in order to examine certain depth horizons in greater detail (Stns 6666 # 1-8, Stn 6669, Stn 6670). The TSD probe was used at Stn 6668 and again at 6671 both on 29th February. A set of chlorophyll measurements were also made. During the period at the 11°N 20°W position a number of hauls were made with both TMT8/5 and N113 to depths greater than 2000 m. At 0600 hours on 1st March the ship set course for the C. Verde Islands.

At 2000 hours each evening while on passage an oblique TMT8/5 and N113 were fished from 1000-0 m. At 0500 hours on 3rd March the ship reached the channel between the islands of Fogo and San Jago where two bottom long lines were set on a very irregular bottom, the entire hook line was lost from the first set but the subsequent hauls gave little trouble. Long lining continued until 2210 hours on the 4th, when a course was set towards the NW islands. At 0750 hours on 5th March a daylight series of N113 CDBA hauls were made for pigment analysis (Stn 6682) the series was completed at 1938 hours and was followed by a TMT8/5 haul from 1000-0 m. At 0445 hours on 6th March the ship was to the NW of San Antao island and a series of bottom long lines were laid, some difficulty was encountered due to the very irregular bottom and at 1642 hours it was decided to proceed towards Tenerife. At 2005 hours a TMT8/5 and N113 haul was made from 1000-0 m, a similar haul was made at 2015 hours on 7th March. During daylight on 8th an attempt was made at a series of TMT8/5 CDBA hauls but trouble with the release gear prevented its completion. On the following day long lines were set on Endeavour Bank and the bottom net was fished, the lines were finally brought aboard at 0646 hours on 10th March and the ship then sailed direct to Santa Cruz de Tenerife, arriving at 0800 hours.

Dr. Herring left for U.K. and Mr. R.J.H. Beverton and Dr. J. Allen joined. "Discovery" sailed at 1800 hours on 12th towards the Fuerteventura position arriving there at 0700 hours on 13th March. A modified day and night series with the TMT8/5 was made during the next two days. On the 15th Dr. Allen began his dredge programme at a position between Fuerteventura and the African coast. During the night of 15/16th long lines were set and while these were fishing the ship returned to Fuerteventura to complete the last of the day and night series of the TMT8/5 hauls. On the morning of 16th one bottom line was recovered but the other could not be found. More dredging took place during the afternoon on a line towards the SW. A bottom net was fished in 2234 m at Stn 6703 and dredging continued during daylight on 17th. The bottom net was fished during the night of 17/18th and two more dredge hauls on 18th. During the afternoon of 18th the free rise net was fished three times at a position to the south of Grand Canary Island. Dredging then continued until 2048 hours on 19th. Trials were made with the acoustic camera and the bottom net was fished again at Stn 6713. A dredge was fished to 2301 m on 20th, followed by two hauls with the TMT90. On 21st the dredge was put down to 3500 m but weather conditions were bad and the catch was washed out on the way up. The night of 21/22nd was taken up with making a passage to the NW of Tenerife where another dredge was fished. The ship then proceeded

to a lee under the SW side of Tenerife where the TMT8/5 and N113 were fished from 750-0 followed by TMT90, the trawl was inboard at 0600 hours on 23rd and the ship then sailed for Santa Cruz de Tenerife arriving at 1430 hours.

Mr. Beverton and Dr. Allen left for U.K. on 24th. A number of scientists from "Discovery" took part in the ICES Symposium at La Laguna on 25th, 26th and 27th March during which period the ship was visited by participants in the symposium and by personnel from the research vessel "Thalassa". At 1530 hours on 27th "Discovery" sailed from Santa Cruz towards Plymouth and arrived in Plymouth Sound at 2300 hours on 1st April.

THE N.W. AFRICAN COAST SURVEY

This survey was planned to examine the vertical distribution of zooplankton in upwelling and non-upwelling regions. A temperature/salinity/depth recorder was used at each station and at selected stations plankton hauls were made with a bottom net, a neuston net and an obliquely towed N113. Also at selected stations the N50V phytoplankton net and chlorophyll samples were taken. A small grab was used at most of the stations on the shelf.

The first line of stations (6547-6559 Fig. 2) was worked in towards the coast off Puerto Cansado. The TSD traces showed what appeared to be active upwelling in progress (see Fig. 6), with strongly mixed water inshore; however, the very large quantities of phytoplankton in all the net hauls suggested that the area had been enriched for a considerable time. Part of the section was then repeated with the TSD and the results showed that the hydrological conditions at the edge of the shelf had changed over a period of 15 hours.

The next line was off Leven Head commencing inshore and working out to beyond the shelf (Stns 6566-6584 Fig. 3) before returning inshore. Conditions were very similar to those encountered on the Puerto Cansado line with intense mixing inshore and fluctuating conditions at the shelf edge. Phytoplankton was abundant. A large fishing fleet was observed on the inshore part of the line.

The ship then proceeded further down the coast to work off Isoletta Virginia (Fig. 4), here three parallel lines of stations (6589-6620) were made, the centre line being repeated three times. Results from the previous lines suggested that the hydrological fluctuations at the shelf edge might be semi-diurnal and so at station 6618 a dhan buoy was moored and repeated TSD observations were made over a 14 hour period, keeping station on the moored buoy. The observations were made hourly from 1000 hours to 2100 hours and then at more frequent intervals until 0018 hours. The temperatures are shown in Fig. 7. The final line of the survey was made from Cap Blanc (Fig. 4) and part of this section was repeated (Stns 6623-6633). It was apparent that throughout the whole area surveyed the inshore waters were well mixed and had been mixed for some time, the area at the edge of the shelf was in every section hydrologically confused and it seems possible that internal waves were breaking on the shelf edge and transporting nutrient rich water onto the shelf at frequent intervals perhaps twice a day. An attempt was made to plot the surface isotherms for the region from the continuous thermograph records but it proved impossible in many places to correlate records taken over the same route at different times.

The winds encountered (Fig. 5) were mainly from the N and NE and while they may well play a part in causing the upwelling it seemed that internal waves were more important at the time of our survey.

The plankton appeared to be spread fairly uniformly throughout the water column at each station and indeed the surface net caught diatoms which are normally found living on the bottom.

ZOOLOGY

1. Chaetognatha

Observations were made on the deep water chaetognaths taken at the 11°N 20°W position. Eukrohnia fowleri was very abundant and the first recorded specimens with fully developed intact seminal vesicles were caught.

Below about 1500 m E. bathyantarctica was fairly abundant. This observation confirms that of Fagetti (in press) who found the species in deep water hauls from the Gulf of Mexico, and shows that the species is not confined to the Antarctic as was previously supposed. No specimens of E. proboscoidea were seen which suggest that the species may be curiously preserved specimens of E. fowleri. S. macrocephala was much less abundant than it is farther north although it occurred at much the same depth horizons. Large mature specimens of S. planctonis were abundant and often had greenish brown coloured ovaries, some specimens also were found with small patches of dark blue pigment randomly scattered over the surface of the skin. It was noted that whereas the orange pigment in E. bathyantarctica is confined to the gut it is widely spread throughout the tissues of E. fowleri.

2. Ostracods

At 11°N the planktonic ostracod fauna was almost entirely different from that found at Fuertoventura. The few species that were commom to both areas were caught at shallower depths at 11°N e.g. Gigantocypris which is seldom caught above 1000 m off Fuertaventura, had the centre of its distribution at 800 m at 11°N. The very deep N113 hauls taken at 11°N were rich sources of specimens of little known and possibly new species. Culturing experiments were a little more successful than on previous cruises, specimens of Conchoecia atlantica were kept alive for 41 days, and specimens of C. subarcuata survived over 14 days. Both these species fed actively on pieces of fish flesh and small copepods. Material was fixed for histological study.

3. Copepods

Very little identification below generic level could be done on board but the horizontal series of N113 HCDBA taken at 11°N will enable a detailed investigation into the vertical distributions of the various species, and these can be compared with similar series done further north in previous years. The oblique N113B hauls between 10°32'N 19°57'W and the Cape Verde islands, and from there to Tenerife, will allow some examination of the horizontal distribution of the species occurring between 1000-0 m.

The NN and NNP hauls taken during the cruise show changes in the horizontal distribution of the pontellid copepods. Off the NW African coast the predominant species were Anomalocera patersoni, Pontellopsis villosa and P. regalis. Pontellina plumata was present with these species further south, but there was a gradual replacement of all these species by Labidocera acutifrons until this was virtually the sole pontellid represented in the catches taken from south of Dakar and the Cape Verde islands. Off Fuertoventura Pontellopsis villosa was the dominant species, the only other common one being Pontella atlantica. A very dense swarm of L. acutifrons was encountered for two nights at 11°N, a NN haul on the second night gave a density of 186.34 ccs/100 m^3 which was almost entirely composed of this species.

A very preliminary investigation into the possible use of colour as a means of identification indicated that this method should be useful, possibly to generic level, and a more detailed study will be made on future occasions. An interesting parasite was found attached to each cornea of two specimens of Hydrolagus affinis taken on the BLL. Pleuromamma piseki, taken on several occasions at the surface, during the night, was seen to have a brilliant blue luminescence.

4. Euphausiids

Detailed analyses of the euphausiids in the large samples obtained were not possible on board and the following comments are based only on brief preliminary examinations.

The dominant euphausiid of the shelf water of the African coast was the neritic species Nyctiphanes capensis. This species has not previously been recorded from north of 23°S., south of that latitude it is known to be abundant. All stages of development were present, many samples containing large numbers of early and late larvae. Young stages of Nematoscelis were also abundant in the shelf water, the adults and adolescents being found offshore on the slope.

Another species which has been recorded only twice before in these latitudes is Euphausia hanseni. Adults occurred in the offshore water at Stn 6642 and early adolescents at 11°N in the repeated series of TMT8/5 hauls.

The Euphausia species showed the greatest changes with latitude in the samples obtained between 11°N and the Canary Is. The characteristic species at 11°N were E. americana, E. mutica, E. tenera, E. pseudogibba and E. gibboides. E. tenera and E. mutica were not found north of 16°N and between 20°N and 24°N E. americana was largely replaced by the closely related species E. krohnii, and E. pseudogibba was replaced by E. hemigibba. E. gibboides occurred throughout the oceanic area studied but was more abundant in the southern part of the region.

5. Decapoda

Three main sampling programmes were completed. Two of these, one at 11°N and the other at Fuerteventura consisted of a day and night series with the TMT8/5 sampling discrete depth horizons at intervals of 100 m with the object of defining patterns of vertical distribution and diurnal migration. The third was a series of standard oblique tows from 1000 m to the surface at 7 positions between 11°N and Fuerteventura planned to investigate the existence or otherwise of a faunistic boundary at about 20°N.

This intensive sampling with the TMT8/5 yielded decapod catches of exceptional richness and variety including numerous uncommon species. Only a preliminary analysis of these large catches has so far been possible and so the results given here must be considered provisional.

Vertical distribution

At 11°N the day and night series confirmed once again the existence within the adult decapod fauna of marked vertical stratification and extensive diurnal migration. This was strikingly demonstrated by the species of the important genus Acanthephyra that were a dominant feature of the catches. Taking the day catches first; A. sexspinosa occurred between 500 and 800 m, A. acanthitelsonis between 700 and 1000 m. and A. curtirostris at depths below 900 m. The night catches revealed an

upward migration of the three species with A. sexspinosa occurring at 100 m, A. acanthitelsonis at 300 m and A. curtirostris at 700 m.

Species of other genera including Systellaspis, Sergestes and Gennadas perform similar migrations but over different vertical ranges.

The limited series of hauls at Fuerteventura provide a comparison with 11°N and give additional seasonal data for an area that has been investigated on a number of previous cruises. The genus Acanthephyra can be used to illustrate some of the similarities and differences that were found. Only the deeper living species A. curtirostris and A. stylorostrata were common to both positions, A. sexspinosa and A. acanthitelsonis of 11°N being replaced at Fuerteventura by A. purpurea and A. pelagica. The vertical distribution of the species was similar except that A. purpurea had its day time upper limit of distribution at 600 m compared with 500 m for A. sexspinosa, while A. pelagica was not taken above 900 m compared to the 700 m upper limit of A. acanthitelsonis.

Faunal change at 20°N

In his analysis of the "purpurea" group of the genus Acanthephyra, Dr. Stanley Kemp deduced that in the Atlantic Ocean A. purpurea had its southern limit of distribution at about 20°N where it was replaced in the southerly fauna by A. sexspinosa. This was confirmed by catches made between 11°N and Fuerteventura. Both A. sexspinosa and A. acanthitelsonis were taken in substantial numbers at 17°30'N, 25°01'W (Stn 6686) but were completely absent at 20°37.4'N, 22°56.1'W (Stn 6687) where A. purpurea was abundant. It is too early to say whether species of other decapod genera are similarly limited in distribution or whether changes occur in other groups but clearly for Acanthephyra spp. this is an important zone of faunal change warranting future, more detailed investigation.

Notable decapods

Catches from the TMT8/5 and other nets provided a number of uncommon species of which mention should be made of Acanthephyra brevirostris, A. eximia (?), Notostomus miccylus and Systellaspis braueri.

The most exciting find however was undoubtedly four specimens of the rare and unusual Caridean Physetocaris micropthalma Chace, known previously from two specimens taken at Bermuda. Of the three females one was gravid bearing three eggs from which two larvae were subsequently hatched by Dr. P. Herring. The remaining specimen was a male which is the first recorded for this species. Observations were made on one of the living females which survived for three days under laboratory conditions.

Use of the bottom net (BN1.75 and BN5) provided catches of benthic decapods that hitherto we have not sampled, including Nematocarcinus longirostris, Benthesicymus hjorti, Aristeomorpha sp. and Plesiopenaeus sp. A haul on Endeavour Bank (depth 335 m) yielded some fine living Plesionika sp. (probably longirostris) which were kept for several weeks in the laboratory. Living larvae were hatched and two adults moulted.

Miscellaneous

Other work on decapods included the measurement of respiration rates at varying temperatures, the collection of material for biomass estimation and biochemical analysis, and the hatching of larvae from the eggs of gravid females.

6. Cephalopoda

924 cephalopods representing over 60 species were caught and identified. They include a number of very rare species as well as four species which are apparently new; one of these is an Ommastrephid and three are taonine cranchids. A number of the species caught on this cruise have been absent from catches made on previous North Atlantic cruises of "Discovery" which have not ventured so far South. The species most common in this collection are Mastigoteuthis flammea (comprising 11.4% of all identified cephalopods) and Liocranchia rheinhardti (10.9%). Rare octopods taken include Vitreledonella (3 specimens), Vampyroteuthis infernalis (22), a cirroteuthid (1) and Alloposus mollis (14). Rare squids include probable Architeuthis larval stages (3), Tetronychoteuthis (5), Chiroteuthis imperator (1), Mastigoteuthis schmidti (1), M. talismani (1), Lepidoteuthis grimaldii (1), Grimalditeuthis bonplandi (2), and Galiteuthis armata (4).

The vertical distribution of Mastigoteuthis flammea based on 105 specimens was determined. Useful additional information on the vertical distribution of Vampyroteuthis infernalis has been obtained. Evidence regarding vertical distribution is sparce but some species are clearly rather limited in their vertical distribution e.g. Pyrgoposis pacifica while others are found over a great range of depths e.g. Japetella diaphana, Bathyteuthis absysicola, Liocranchia rheinhardti, Taonidium pfefferi.

A number of specimens were preserved for an expansion of the work on buoyancy of cephalopods being undertaken by Professor E.J. Denton and collaborators (described in Cruise Report No. 18).

Representatives of a number of species were preserved for chemical analysis by F. Culkin and R. Morris of the NIO.

A few squids were kept alive for as long as possible and one larva survived for 4½ days. An egg mass of a pelagic octopod was kept alive for several weeks by Dr. P. Herring and development from the undifferentiated egg to a stage just prior to hatching was observed.

7. Salps

On a number of occasions during the cruise masses of salps were encountered and although detailed studies were not attempted samples were taken, the species and state of swarming determined, and collections made for special purposes.

The tropical species Salpa cylindrica occurred at 11°N and although the solitary form dominated the catches it was concluded from the state of the stolon and the presence of some chains of aggregates that this was a swarm in the early stages of development. This species is typically characterised by a bluish pigmentation of the mantle and stolon but these specimens were not so striking as those collected on previous occasions in the Caribbean.

At Fuerteventura two species were swarming although at different stages of development. Pegaea confoederata was actively swarming and immense chains of 3-4' length were seen on calm days near the surface. Specimens of the solitary form with mature stolons were taken while many of the aggregates were characterised by having embryos at a late stage of development. Large numbers of Salpa maxima were also taken but only in the aggregate form. Their large size and the absence of embryos suggests that these were the remnants of a previous massive swarming.

Other species, including Thetys vagina, Thalia democratica and Salpa fusiformis were also taken but in small numbers.

8. Fish

The TMT8/5 : N113 series run in the 11°N, 20°W area down to 2000 m provided a much varied ichthyofauna and promises some good data on vertical distribution.

As would be expected, below 500 m Cyclothone was by far the most abundant fish genus. About six species were encountered: C. braueri C. pseudopallida (?), C. pallida, C. livida, C. acclinidens and C. obscura, with C. acclinidens the most abundant below 800 m. Apart from Cyclothone, very few gonostomatid genera were represented in the catches. Vinciguerria (mainly V. nimbaria) was caught in quite large numbers in the shallower depths, and Gonostoma elongatum and Bonapartia pedaliota were quite often brought up. Among the other stomiatoid groups, Stomiatidae were well represented by Stomias spp., and Chauliodontidae by Chauliodus sloani and C. schmidti. Polyipnus, Argyropelecus hemigymnus, and A. affinis constituted the major part of the sternoptychid catch. Compared with Fuerteventura catches of earlier cruises, the number of black stomiatoids was small, and of these Photostomias guernei and Aristostomias were caught most often. The melanostomiatids were very poorly represented, being mainly Eustomias spp. and Flagellostomias boureei. At least three specimens of Pachystomias were caught.

Myctophids were comparatively few in this series, and certainly did not approach 50% of the fish catch as is often the case in the Canaries.

Quite a variety of whalefish were caught, the most outstanding of these being a specimen of Barbourisia rufa. This bright orange fish was in excellent condition, and still alive. An attempt was made to keep it alive, but after 18 hours, it died.

At a superficial glance, the catches of the TMT8/5 series run off Fuerteventura demonstrated a vertical distribution very much in agreement with the 1965 SOND cruise findings. An example of Rhadinesthes was caught here. In one haul, a very active Searsia koefoedi was caught, which gave off a deep blue, particulate luminescent cloud from the shoulder organs.

A collection of night surface fish was made throughout the cruise.

9. Larval development

The eggs of a number of species of decapod crustacea have been successfully hatched in vitro both on board ship and subsequently in the laboratory in a study of the structural changes and time course of the embryonic development of different species. Larvae have been hatched from the eggs of 15 species, the larvae of many of which have not previously been described.

In addition to the immediate observations on embryonic development, eggs and developing embryos have been collected from four species of Acanthephyra for subsequent determination of the gross pigment and protein changes.

A number of larvae of other groups, including amphipods and cephalopods, have also been hatched or reared in vitro for various periods.

10. Carotenoid pigments

A large collection has been made of the eggs of decapods and mysids of deep-water origin in order to compare the properties of the red and purple carotenoproteins characteristic of this environment with the green and blue pigments characteristic of crustacea of shallower water. Collections have also been made of several surface living species, particularly Labidocera acutifrons and Lepas fascicularis and it is hoped to be able to compare the blue neuston carotenoproteins with the variously pigmented crustacean egg lipoproteins.

Plankton hauls from known depths, comprising a vertical series down to 900 m, have been made for analysis of the carotenoid and lipid content, thus providing additional information to that gained from a number of similar hauls on previous cruises. Numbers of several species of pontellid copepod have also been collected for a comparison of their pigment content with that of copepods from deeper water.

Continued collections of the isopod Idothea metallica have been made for comparison of its carotenoid metabolism with that of littoral species of the same genus.

11. Bioluminescence

The bioluminescence of species of Sergestidae has been investigated in some detail, with particular emphasis upon the pharmacological and biochemical aspects, and compared with the bioluminescence of other crustacea, particularly euphausiids and decapods. The influence of drugs particularly 5-hydroxy-tryptamine, has been investigated, and it is clear that many species of crustacea with complex light organs are stimulated to luminesce by low concentrations of the latter drug. Amphipod material has been preserved for subsequent histological and histochemical study.

12. Experimental work with Euphausiids

Moulting

Euphausiids taken in a N113 towed at the surface for periods of half an hour at night were found to survive exceptionally well in 100 ml. jars at a temperature of 14°-15°C.

The following species have been kept at least until their first moult and 23 specimens have moulted more than once allowing estimates of their intermoult periods to be made.

Species	Maximum survival (days)	Maximum number moults	Inter-moult period (days)	Number of specimens
Nyctiphanes capensis	7.5	2	4	2
Euphausia mutica	11.7	3	4-5	3
E. americana (adults)	6.2	2	2-4	6
E. americana ? (post larvae)	46	12	2-4	8
E. krohnii	4.7	1	-	2
E. brevis	23	4	3-5	8
E. hemigibba	3.5	1	-	2
E. gibboides (adults)	3.5	1	-	1
E. gibboides ? (post larvae)	19.1	4	2-4	4
Thysanopoda tricuspidata	3.7	1	-	1
Nematoscelis sp. (atlantica/microps)	17.5	3	5-10	3
Meganyctiphanes norvegica ? furcilia	14.5	2	2.5-3.5	1

The ranges given for the intermoult periods is wide since there is a tendency for the first determinable intermoult period in captivity to be longer than subsequent ones. It is assumed that the moulting cycle is upset to some extent during the first few days of culture since on eleven occasions the time from capture to the first moult was considerably longer than later intermoult periods, sometimes as much as twice as long.

Some species carry their eggs on the thoracic legs and it seemed probable that during that period moulting would have to be suppressed. This was borne out by three specimens of Nematoscelis carrying eggs. These did not moult except for one which discarded its eggs and moulted within 15 hours. No such inhibition seems to occur in female Euphausia brevis and E. mutica carrying spermatophores as these moulted at approximately the same intervals as unmated females. On moulting the spermatophore is lost. Spermatophores carried in the ejaculatory ducts of males are, however, retained. The lining of the gastric mill, along with any food contained in it, is moulted at the same time as the exoskeleton.

Feeding

Specimens of all the species listed above, with the exception of Nematoscelis sp. were found to feed satisfactorily on Artemia nauplii. This was determined by keeping the Artemia in a dilute solution of lithia carmine in sea water. When subsequently fed to the euphausiids the faeces appeared red in the gut. However, little or no growth appears to have been made on a diet of Artemia. Specimens of Nematoscelis survived for prolonged periods apparently without feeding; one, a gravid female, living for 17 days during which time the ovary was reduced to a few small follicles.

When more than one specimen of Euphausia were kept in the same container they were found to be cannibals, usually eating the pleopods and eyes. Thus those species which are normally considered to be primarily filter feeders are capable of tackling organisms of their own size.

Development

A female Nyctiphanes capensis carrying pseudometanauplii in the egg sac released them on being examined and the development was followed. From the time of release to the first moults, i.e. to 1st Calyptopes, took 3 days and all had become 1st Calyptopes after 3 days 17 hours. Only one specimen survived to moult to 2nd Calyptopis and this took place slightly under 8 days from the time of release. It lived for a further $3\frac{1}{2}$ days without moulting to the 3rd Calyptopis.

Sinking rate of Euphausia eggs

The rate at which 2 and 4 celled stage eggs of E. hemigibba sank was measured in sea water with a specific gravity of 1.02456. The mean of 11 experiments gave a sinking rate in this water of approximately 100 m./day.

13. A parasite on Euphausia americana

Three living specimens of the Dajid isopod, Heterophryxus appendiculatus parasitic on euphausiids, were taken during the cruise, one in a neuston net at Stn. 6619 and two in a surface N113 at Stn 6687. The host in each case was Euphausia americana, the first an adult female and the other two adult males.

These parasites, which in the earlier stages of their development attach to the host solely by means of chelae around the eyestalks, were all adult females and lying attached to the dorsal surface of the host carapace with the tubular mouthparts inserted into the host immediately above the heart. A

continuous pumping movement, possibly respiratory, was observed at the anterior of the parasite. It was produced by two flat plates assumed to be modified maxillae.

The first specimen had already released eggs into the brood chamber and another did so shortly after the host died. Eggs in the brood chamber were subjected to a curious pulsating movement so that they moved round inside it in two counter-rotating elipses.

It had been thought that these parasites probably prevented the hosts from developing sexually since only sexually immature infected specimens have been found previously. These, however, were all mature, the female with a well developed ovary and the males carrying spermatophores in the ejaculatory ducts.

An observation of considerable interest was the moulting of one of the hosts. As the parasite is attached anteriorly by the mouthparts and four pairs of thoracic legs it was thought that moulting of the host caracpace could not take place without dislodging the parasite. However, the moult of the carapace was accomplished successfully, presumably by means of the parasite reattaching itself to the eyestalks and withdrawing the mouthparts. The host died shortly afterwards. The moulted carapace was found to have a small hole in a depression on the dorsal surface where the mouthparts penetrated, with two strands of unidentifiable tissue protruding from it.

One parasite survived for 24 hours after the death of the host, another for 10 hours. Female Heterophryxus have parasitic males attached to the abdomen. One of these became detached and survived independently for two days, however, attempts to get it to attach to a young Euphausia americana were unsuccessful.

14. Barnacles

Large swarms of Lepas cyprids were caught off the African shelf. The larvae settled readily in glass jars in the laboratory and were kept alive for two months until the end of the cruise. Under natural conditions settlement occurred on floating weed, Sepia bones, and Spirula shells. Later in the cruise adults of the same species Lepas fascicularis occurred in large number at 11°N. It is interesting to note that no adult colonies were observed north of the Cape Verde Islands, and this could indicate the direction of flow the surface water upwelled on the African shelf. However, all the adults found had originally settled on fuel oil and then secreted their bubble floats around the oil. Specimens were fixed to study the gas secretion by the foot of this species. Large numbers of Conchoderma virgata were found to have settled and developed almost to maturity on the buoy used at 11°N. Since the buoy was out for only 19 days it will be possible to get an accurate estimate of the growth rate and time of maturation for this species. In all, four species of barnacle were cultured, to breed out the larvae and to ascertain their moulting frequencies.

GEAR

1. TMT8/5

A new TMT8/5 net was used extensively during the cruise. It differed from the TMT8 used on Cruise 18 in having 4.5 mm mesh, an acoustic opening and closing device and a depth telemetering pinger which records the opening and closing operation as well as the depth. The net incorporated a new release gear and a new device for measuring the angle of the net mouth during fishing.

A total of 95 hauls were made including 85 in which an attempt was made to open and close the net mouth. Of the opening and closing hauls 24 (28%) were failures. 7 (8%) failures were caused by pinger faults and 17 (20%) by faults in the opening and closing system. The net failed to open 9 (10%) times and failed to close 8 (9%) times. It was not always possible to determine the cause of failure of the release system but faulty rigging of the net resulted in two failures and it is thought that electrical failures resulted in nine and mechanical failures resulted in six faulty hauls. The failure rate decreased in the latter half of the cruise as difficulties were overcome and the overall failure rate is not considered unduly high for prototype gear.

Early in the cruise the net was improved in several ways. Handling of the gear was improved by threading the weights onto the bottom bar instead of hanging them from the ends of the bar and the acoustic release and pinger units were concentrated on a steel cross which could be lifted outboard with the net. The condition of the catch was greatly improved by perforating the bucket of the net and by putting a fine mesh net just in front of the bucket.

Although comparisons with the IKMT are difficult because most of the work was done in different areas during this cruise, there seems little doubt that the TMT8/5 catches more animals than the IKMT and the condition of the animals is generally better. The new net can be handled very easily over the stern and the ratio of wire out to depth is good (about 2-1.5 : 1). For quantitative studies it is important to know the mouth area and therefore the angle of the mouth of the net at various speeds. In two trials the angle meter showed the mouth to be 45° at 2.2 knots. The net is designed to fish at this angle and speed when it has a mouth area of 8 sq. metres. A better means of mounting the angle meter on the net must be found so that continuous records may be made during standard hauls.

Leakage through the closed mouth of the net was found to occur in a few tests but the clear stratification of animals seen in the vertical series shows that leakage is not a serious problem and it can be eliminated entirely by slight changes to the rig of the net.

Three successful tests were made with the CDBE on the TMT8/5. These showed that a TMT8 100 m haul can be divided by a CDBE into two 50 m parts. Such an arrangement could not only halve the time taken over a series but could also be used to sample layers thinner than 50 m. Such a combination should be very useful in the future.

2. TMT90

A new TMT90 having a uniform mesh size of 2 cm x 2 cm was used for the first time on this cruise. A total of nine hauls were made. The catches were very variable. Three hauls off the Senegal coast gave good catches which included fish and cephalopods as large as any taken with the Engel's midwater trawl. Two hauls off Grand Canary Island gave very poor catches indeed but the paucity of the catch is thought to be a reflection of the paucity of animals in the water rather than a failure of the net. A single haul off the south of Tenerife gave a moderate catch of fish, decapods and squid - none of very large size.

The net, which it is hoped, will replace the Engel's trawl for sampling the large fauna, proved very easy to handle once a few initial

difficulties were overcome. It was fished at 1.5 knots and only registered a maximum of three tons load. The catch was in good condition.

3. Free Rise Net

A 15 foot diameter net with 1 mm mesh was fished from 1000 m to the surface on three occasions. While launching of the net was relatively easy, and the operation of the release gear was successful, the catch of the net proved rather disappointing. The poor catch was very probably due to the net having too little bouyancy and therefore a slow rate of rise to the surface. Specimens in the catch were in very good condition.

The drag co-efficient for the net was over 2.0.

4. Bottom net

The purpose of the bottom net was to sample the plankton living a few inches off the bottom.

The net frame consists of two side hoops 5' 6" long by 2' 6" high with 6" wide skids attached to their undersides. The skids curve up at the front of the hoops and extend about 1' behind them. The hoops are held approximately 8' apart by two fixed bars at the top and a moveable bar at the bottom. The bottom bar can be moved up in steps so as to fish varying distances from the bottom, each step altering the mouth area by 0.25 m^2, the maximum mouth area being 1.75 m^2. The net used for the majority of the hauls was 20' long and made of 0.33 mm mesh. A piece of 3" x 4" timber is attached to the front upper bar to help to keep the net the right way up. The towing bridles were fitted with a weak link which should break and allow the net to turn over if it became snagged.

Twentythree hauls were made during the survey of the African coast. The first fourteen were made with a mouth area of 1.25 m^2. Although moderately large catches were obtained, by comparing them with the N113B catches it was decided that a considerable amount of the catch was being taken during the oblique tow to the surface. In addition to the normal tow two oblique tows were made from 10 m above the bottom to the surface at Stn 6586 to try to estimate the relative volumes of the horizontal and oblique parts of the catch. The volumes were as follows:

Normal tow	180 ml.
Oblique tow 1	46 ml.
Oblique tow 2	90 ml.
N113B	74 ml.

The first oblique tow produced approximately half the volume and the second almost the same volume as the N113B per m^2 of mouth area. In this instance half to three quarters of the catch could be assumed to have come from near the bottom.

From Stn 6587 the bottom bar was lowered to 4" from the bottom and two lucas weights added but the catches were so dense in phyto-plankton that no real assessment of the zooplankton volume was possible.

Up to Stn 6632 the amount of wire paid out was approximately 1.5 times the sounding. At that station twice as much wire as depth was used allowing more wire to drag along the bottom and the catch

was considerably larger containing decapods and fish presumably disturbed by the wire. This method was subsequently used, except for very deep hauls with the result that good catches of fish and decapods were obtained consistently.

Two hauls were made on Endeavour Bank at Stns 6692 and 6694. The first of these was very successful catching large decapods in very good condition in spite of a large sample of sand being taken as well. The second haul, although apparently on the same type of bottom, resulted in the bolts holding the bottom bar sheering and the whole bar and net being torn away. Although these bolts were of high tensile steel the 6 mm wire weak link did not break.

After this the net was completely rerigged with the top of the netting attached to the back upper bar and the lower bar set behind the hoops. 6 mm wire strops passed from the top to the bottom bar and the latter was held in place by nylon lashings so that on snagging these would break allowing the bar to swing backwards and upwards. Two more lucas weights were added. The net was made of 5 mm mesh and was 12' long.

The net was used in this form at three stations in depths between 2000 m and 3100 m. The catches from these depths consisted of worms, holothurians, brittle stars, copepods, mysids, sponges and fish, including three Halosaurs.

5. Bottom Long-lining

Some twelve lines were laid: eight in the vicinity of the Cape Verde Islands; two on Endeavour Bank and two in the vicinity of the Canaries.

In the Cape Verde Islands area the lines were laid from 2866 m to 377 m depth. Of the eight lines laid, three caught nothing. These three apart, the lines were generally only moderately successful; four lines catching between five and eight fish each; one catching twentytwo fish. The lack of success was probably due to line entanglements caused by currents. The variety of fish was not very great and included Hydrolagus affinis, Etmopterus spinax, Centrophorus, Coryphenoides, Sebastes, rays and eels.

Both the Endeavour bank lines were broken. One was possibly bitten through. However, from the total of 43 hooks returned on the two lines, seven fish were caught: Centrophorus, Sebastes, and eels.

Only one line laid in the Canary area was retrieved, this bearing seven fish: Hydrolagus affinis, Centroscymnus coelolepis, Centroscyllium fabricii (?).

6. CDBE Flowmeter

This instrument which was designed by Mr. Roy Bowers, is intended to provide a relative measure of the flow of water through the deep leg of the catch dividing bucket. Preliminary trials in conjunction with the N113 were only partially successful because the counting rate was too high. Nevertheless the principle of operation was shown to be sound and with only minor modification the meter will provide a valuable aid to our fishing technique.

7. Surface temperature/salinity probe

This instrument worked very well though the method of towing needs to be reconsidered. It consists of a conductivity bridge and a thermistor

mounted in a streamlined body and towed 50 cms beneath the surface. As a first attempt it was mounted on an 8' spar which had a stabilising keel on it and towed from an 11' boom projecting out on the port side at the level of the foremast. It was found to run too close to the ship and to roll excessively. The spar was cut in two and the two pieces connected together so as to make a sort of catamaran, the keel was retained on one hull and the probe mounted on the other. The vehicle was then towed like a neuston net with bridles of unequal length so that it kited out far enough to run in undisturbed water. In sea states up to about force 5 this was satisfactory at speeds up to 8 kts. In calm weather it was once towed at 10 kts. With a following or quarter sea the vehicle is apt to capsize.

Unfortunately the apparatus was not in full working order until late in the work on the African coast and only two significant runs were made with it, these were approaching C. Blanc and for part of the 1st C. Blanc line (until bad weather strained the towed vehicle so that it was unsafe to use) and on the short line out from St. Louis where it was used between stations. The electrical and recording side worked most satisfactorily.

8. The Acoustic Rangefinder Camera

This apparatus was used on three occasions and excellent echoes were observed, but nothing recognisable appeared on the film. It is probable that the lens was of too short focal length (3.5 cms) to record very small objects distinctly at 10 ft range. It is undoubtedly a most promising device which could yield valuable data about animal behaviour and distribution and should be developed further.

9. Preservation

17 different preservation treatments were used on two lots of plankton samples, to assess their possible value as alternatives to the present standard preservation procedure using 7% formol.

Stn.	Position Lat. N.	Long. W.	Date (1968)	Sounding	Times	Sampling programme
6541	40°00'	20°00'	20/1	-	0750-1110	DTP No. 1 200 m. head DTP No. 1 600 m. head DTP No. 1 300 m. head DTP No. 1 1200 m. hea
				-	2158-0122	TMT8/5 + N113B 1000-0 m. est.
			21/1	-	0530-0550	(6) 7.4 W/B to 100 m.
6542	38°39'	19°11.7'	"	-	1316-1328	NNP 0 m.
6543	37°36'	18°30'	"	-	1957-2020	NNP 0 m.
6544	35°32'	17°12'	22/1	-	0930-1215	TMT8/5 100-0 m. est. Test of angle-meter + changes of net angle with speed.
6545	35°26'	17°12'	"	-	1910-2331	TMT8/5 905 m.
6546	32°17.8'	15°04'	23/1	-	2000-2030	NNP 0 m.
6547	28°47.5'	12°20'	24/1	109 m.	2100-2114	TSD to 100 m.
						NNP 0 m.
					2132-2224	BN330 1.25, 109-(0) m.
					2246-2309	N113B 92-0 m.
					2327-2339	NN 0 m.
6548	28°35.3'	12°12.2'	25/1	102 m.	0043-0055	NN 0 m.
					0105-0120	TSD to 95 m.
					0120-0130	N50V 90-0 m.
					0140-0150	(6) 7.4 W/B to 100 m.
					0200-0252	BN330 1.25, 102-(0) m.
					0310-0324	N113B 90-0 m.
6549	28°17'	12°07'	"	45 m.	0524-0536	NN 0 m.
					0540-0546	TSD to 40 m.
					0547-0552	N50V 40-0 m.
					0555-0606	(5) 7.4 W/B to 40 m.
					0614-0653	BN330 1.25, 45-(0) m.
					0703-0718	N113B 35-0 m.
6550	28°27'	12°11'	"	-	0900-0907	TSD to 55 m.
6551	28°36'	12°15'	"	-	1025-1041	TSD to 100 m.
6552	28°41'	12°18'	"	-	1138-1148	TSD to 100 m.
6553	28°47.6'	12°21'	"	-	1233-1250	TSD to 110 m.
					1254-1321	(6) 7.4 W/B to 100 m.
					1352-1335	N50V 100-0 m.
6554	28°52.2'	12°23.6'	"	-	1416-1440	TSD to 340 m.
6555	28°56.8'	12°25.9'	"	-	1524-1603	TSD to 592 m.
6556	29°02'	12°32'	"	-	1647-1747	TSD to 1080 m.
6557	28°55'	12°30'	"	-	1840-1852	NN 0 m.
6558	28°47'	12°20'	"	-	2011-2024	TSD to 106 m.

Sta.	Position Lat. N.	Long. W.	Date (1968)	Sounding	Times	Sampling programme
6559	28°41'	12°18'	25/1	-	2102-2114	TSD to 96 m.
6560	28°08.6'	12°59.5'	26/1	68 m.	0200-0242	BN330 1.25, 68-(0) m.
					0258-0311	N113B 65-0 m.
					0321-0350	(6) 7.4 W/B to 60 m.
					0357-0409	N50V 60-0 m.
					0419-0434	TSD to 70 m.
					0440-0452	NN 0 m.
6561	27°28'	13°30'	"	75 m.	0933-0945	NN 0 m.
					0955-1002	TSD to 70 m.
					1008-1028	(6) 7.4 W/B to 60 m.
					0955-1005	N50V 75-0 m.
					1029	Shipek grab. 75 m.
					1049-1133	BN330 1.25, 75-(0) m.
					1050-1151	NNP 0 m.
					1141-1151	N113B 75-0 m.
6562	26°45'	13°52'	"	64 m.	1735-1741	TSD to 62 m.
					1744-1755	TSD to 62 m. (repeat)
					1750-1802	N50V 60-0 m.
					1810-1831	(6) 7.4 W/B to 60 m.
					1833-1837	Shipek grab. 64 m.
					1848-1854	N113B 55-0 m.
					1710-1722	NN 0 m.
6563	26°20'	14°37'	"	128 m.	2313-2325	NN 0 m.
					2336-2357	TSD to 130 m.
					0002-0007	N50V 100-0 m.
				147 m.	0012-0015	Shipek grab. 147 m.
	26°16.4'	14°42.5' (at 0030 hrs.)			0020-0045	(6) 7.4 W/B to 100 m.
				151 m.	0058-0152	BN330 1.25, 151-(0) m.
	26°17.5'	14°41.9'		173 m.	0200-0226	N113B 150-0 m.
6564	25°33.5'	15°00'	27/1	79 m.	0652-0736	BN330 1.25, 79-(0) m.
	25°31.8'	14°59' (at 0716 hrs.)		75 m.	0747-0757	N113B 70-0 m.
					0815-0819	Shipek grab. 75 m.
					0811-0822	TSD to 70 m.
					0845-0850	TSD (repeat)
					0823-0830	N50V 65-0 m.
					0834-0849	(6) 7.4 W/B to 60 m.
					0859-0911	NN 0 m.
6565	25°07'	15°10'	"	45 m.	1118-1130	NN 0 m.
					1138-1144	TSD to 40 m.
					1145-1150	N50V 40-0 m.
					1154-1157	Shipek grab. 45 m.
					1159-1210	(5) 7.4 W/B to 40 m.
					1218-1224	N113B 35-0 m.
					1235-1311	BN330 1.25, 45-(0) m.
6566	24°45.2'	15°37'	"	32 m.	1610-1622	NN 0 m.
					1631-1706	BN330 1.25, 32-(0) m.
					1716-1718	N113B 28-0 m.
					1728-1733	TSD to 28 m.
					1730-1732	Bottom W/B.
					1739-1741	Shipek grab. 32 m.

Sta.	Position Lat. N.	Long. W.	Date (1968)	Sounding	Times	Sampling programme
6567	24°49.5'	15°45.5'	27/1	45 m.	1848-1855	TSD to 40 m.
					1853-1856	Shipek grab. 45 m.
					1858-1901	Bottom W/B.
6568	24°55'	15°54.7'	"	64 m.	2014-2021	TSD to 57 m.
					2019-2021	Shipek grab. 64 m.
					2024-2026	Bottom W/B.
6569	25°00.5'	16°03.4'	"	75 m.	2145-2155	TSD to 70 m.
					2146-2149	Bottom W/B.
					2152-2155	Shipek grab. 75 m.
6570	25°06'	16°12.4'	"	211 m.	2301-2322	TSD to 205 m.
					2302-2310	Shipek grab. 211 m.
					2312-2319	Bottom W/B.
6571	25°08.8'	16°17'	28/1	379 m.	0010-0030	Bottom W/B.
					0020-0047	TSD to 380 m.
6572	25°11.5'	16°21.4'	"	-	0131-0221	TSD to 800 m.
6573	25°16.6'	16°30.8'	"	1402 m.	0339-0444	TSD to 1222 m.
					0448-0522	Shipek grab. 1402 m.
6574	25°11.5'	16°21.7'	"	830 m.	0635-0721	TSD to 810 m.
					0723-0746	Shipek grab. 830 m.
6575	25°08.9'	16°17.3'	"	-	0843-0920	TSD to 360 m.
6576	25°06.2'	16°12.6'	"	-	0952-1019	TSD to 220 m.
6577	25°03.3'	16°08.2'	"	-	1059-1111	TSD to 90 m.
6578	24°58.3'	15°58.7'	"	-	1225-1233	TSD to 64 m.
6579	24°52.7'	15°49.5'	"	-	1342-1350	TSD to 56 m.
6580	24°47.2'	15°40.5'	"	-	1459-1504	TSD to 37 m.
6581	24°41.4'	15°31'	"	-	1613-1617	TSD to 26 m.
					1614-1617	Shipek grab.
					1622-1625	Shipek grab.
					1627-1636	Dredge.
					1637-1712	Dredge.
6582	24°47'	15°40'	"	43 m.	1831-1836	TSD to 38 m.
					1837-1841	N50V 35-0 m.
					1846-1855	(4) 7.4 W/B to 30 m.
	24°47.9'	15°38' (at 1900 hrs.)			1905-1941	BN330 1.25, 43-(0) m.
					1952-1956	N113B 40-0 m.
					2004-2016	NN 0 m.
6583	24°53'	15°49'	"	62 m.	2135-2159	(6) 7.4 W/B to 60 m.
					2136-2146	TSD to 62 m.
					2202-2206	N50V 60-0 m.
					2212-2254	BN330 1.25, 64-(0) m.
					2258-2309	N113B 55-0 m.

Sta.	Position Lat. N.	Long. W.	Date (1968)	Sounding	Times	Sampling programme
6584	24°58.2'	15°58'	29/1	75 m.	0029-0034	TSD to 70 m.
					0031-0049	(6) 7.4 W/B to 60 m.
					0050-0055	N50V 60-0 m.
					0111-0155	BN330 1.25, 75-(0) m
					0118-0134	N113B 65-0 m.
					0203-0215	NN 0 m.
6585	24°10.9'	16°17'	"	58 m.	0735-0742	TSD to 52 m.
					0738-0755	(6) 7.4 W/B to 50 m.
					0758-0804	N50V 50-0 m.
					0817-0855	BN330 1.25, 58-(0) m
					0917-0925	N113B 50-0 m.
					0935-0947	NN 0 m.
6586	24°06'	16°40'	"	94 m.	1213-1252	BN330 1.25, 94-(0) m
	24°06.1'N at 1318 hrs.				1305-1316	BN330 1.25, B 84-0 m
					1326-1335	BN330 1.25, B 84-0 m
					1345-1358	N113B
					1413-1420	N113B 75-0 m.
6587	23°44'	16°35'	"	49 m.	1632-1644	NN 0 m.
					1652-1656	TSD to 40 m.
					1654-1657	Shipek grab. 49 m.
					1702-1715	(5) 7.4 W/B to 40 m.
					1719-1724	N50V 40-0 m.
					1738-1817	BN330 1.75, 49-(0) m
					1823-1827	N113B 50-0 m.
						N113H 10-(0) m.
						BN330 1.75, 0 m.
6588	23°00'	16°56'	"	60 m.	2237-2249	NN 0 m.
					2259-2306	TSD to 55 m.
					2302-2320	(6) 7.4 W/B to 50 m.
					2321-2324	Shipek grab. 60 m.
					2327-2331	N50V 50-0 m.
					2338-0018	BN330 1.75, 60-(0) m
					0031-0039	N113B 50-0 m.
6589	22°10.3'	16°55'	30/1	40 m.	0622-0627	TSD to 37 m.
					0624-0626	Shipek grab. 40 m.
6590	22°10.5'	17°06.3'	"	55 m.	0734-0742	TSD to 50 m.
					0734-0736	Shipek grab. 55 m.
6591	22°10.5'	17°16.5'	"	75 m.	0845-0850	Shipek grab. 75 m.
					0846-0851	TSD to 67 m.
6592	22°11'	17°22'	"	92 m.	0944-0949	TSD to 85 m.
					0951-0955	Shipek grab. 92 m.
6593	22°11'	17°27'	"	752 m.	1036-1115	TSD to 730 m.
					1115-1134	Shipek grab. 752 m.
6594	22°10.8'	17°37.9'	"	1259 m.	1250-1400	TSD to 1200 m.
	22°11.6'N at 1323 hrs.				1404-1432	Shipek grab. 1259 m.
					1456-1623	TMT8/5 100 m.
6595	22°18'	17°50.1'	"	2028 m.	1905-2150	TMT8/5 425-410 m.
6596	22°25'	17°56.6'	"	-	2300-2554	TMT8/5 50-53 m.

Sta.	Position Lat. N.	Long. W.	Date (1968)	Sounding	Times	Sampling programme
6597	22°10.5'	17°46.0'	31/1	-	0314-0427	TSD to 1200 m.
6598	22°11'	17°26.5'	"	738 m.	0634-0722	TSD to 736 m.
6599	22°10.5'	17°22'	"	100 m.	0806-0813	TSD to 90 m.
6600	22°10.5'	17°16.8'	"	79 m.	0857-0906	TSD to 76 m.
6601	22°10.5'	17°06.6'	"	58 m.	1021-1025	TSD to 53 m.
6602	22°10.8'	16°54.6'	"	41 m.	1138-1142	TSD to 37 m.
6603	22°01.5'	16°59'	"	34 m.	1256-1300	TSD to 30 m.
6604	22°01.5'	17°09.2'	"	60 m.	1411-1417	TSD to 56 m.
6605	22°01.5'	17°19.5'	"	77 m.	1525-1534	TSD to 74 m.
6606	22°01.5'	17°28'	"	90 m.	1637-1647	TSD to 86 m.
6607	22°11.6'	17°22'	"	83 m.	1802-1809	TSD to 79 m.
6608	22°17'	17°15.3'	"	81 m.	1917-1925	TSD to 77 m.
6609	22°19'	17°10.5'	"	83 m.	2017-2024	TSD to 78 m.
6610	22°19'N	17°01'W	"	80 m.	2136-2141	TSD to 50 m.
6611	22°19'	16°50'	"	42 m.	2250-2255	TSD to 35 m.
6612	22°10.4'	16°54.4'	1/2	38 m.	0013-0016	TSD to 30 m.
6613	22°10.5'	17°05.3'	"	55 m.	0128-0133	TSD to 45 m.
6614	22°10.5'	17°11'	"	-	0215-0219	TSD to 55 m.
6615	22°10.5'	17°16.5'	"	-	0300-0307	TSD to 75 m.
6616	22°10.5'	17°22'	"	165 m.	0343-0354	TSD to 155 m.
6617	22°10.5'	17°27'	"	-	0436-0507	TMT8/5 50 m.
					0440-0655	NNP 0 m.
6618	22°10.5'	17°22'	"	93 m.	1000-1007	TSD to 89 m.
					1000	7.4 W/B 0 m.
					1015-1030	NNP 0 m.
				91 m.	1100-1107	TSD to 87 m.
					1100	7.4 W/B 0 m.
					1108-1130	NNP 0 m.
				93 m.	1200-1207	TSD to 89 m.
					1200	7.4 W/B 0 m.
					1208-1230	NNP 0 m.
					1300	7.4 W/B 0 m.
				93 m.	1304-1311	TSD to 89 m.
	22°11'N (at 1324 hrs.)				1313-1330	NNP 0 m.
				103 m.	1412-1421	TSD to 99 m.
					1412	7.4 W/B 0 m.
					1420-1435	NNP 0 m.
				94 m.	1512-1519	TSD to 90 m.
					1515	7.4 W/B 0 m.

Sta.	Position Lat. N.	Long. W.	Date (1968)	Sounding	Times	Sampling programme
6618 (contd.)			1/2		1520-1530	NNP 0 m.
					1617	7.4 W/B 0 m.
				96 m.	1619-1628	TSD to 92 m.
					1625-1640	NNP 0 m.
				94 m.	1706-1715	TSD to 90 m.
					1708	7.4 W/B 0 m.
					1716-1731	NNP 0 m.
					1805	7.4 W/B 0 m.
				94 m.	1807-1816	TSD to 90 m.
					1826-1841	NNP 0 m.
				92 m.	1907-1913	TSD to 85 m.
					1907	7.4 W/B 0 m.
					1916-1931	NNP 0 m.
					2025-2031	7.4 W/B 0 m.
				95 m.	2028-2033	TSD to 85 m.
				"	2040-2055	NNP 0 m.
				"	2120-2127	TSD to 85 m.
				"	2146-2153	TSD to 85 m.
				"	2202-2209	TSD to 85 m.
				"	2217-2224	TSD to 85 m.
				"	2235-2241	TSD to 85 m.
				"	2256-2304	TSD to 85 m.
				"	2317-2324	TSD to 85 m.
				"	2346-2353	TSD to 85 m.
				"	2355-0015	(6) 7.4 W/B to 90 m.
			2/2	107 m.	0017-0024	TSD to 85 m.
6619	22°10.5'	17°35'	"	-	0235-0244	TMT8/5
					0305-0335	NNP 0 m.
6620	22°10.5'	17°40'	"	-	0522-0551	TMT8/5 35 m.
					0557-0627	TMT8/5 40 m.
					0634-0707	TMT8/5 30 m.
					0719-0755	TMT8/5 160 m.
6621	21°38.8'	17°18.7'	"	75 m.	1235-1314	BN330 1.75, 75-(0)m.
					1355-1359	N113B 60-0 m.
					1410-1418	(6) 7.4 W/B to 50 m.
				64 m.	1411-1418	TSD to 60 m.
					1420-1424	N50V 50-0 m.
				68 m.	1428-1432	Shipek grab 68 m.
	21°39.7'	17°15.7' (at 1475 hrs.)			1440-1452	NN 0 m.
6622	21°11'	17°15.8' (at 1846 hrs.)	"	45 m.	1846-1858	NN 0 m.
	21°10.3'	17°15.8' (at 1907 hrs.)			1907-1911	TSD to 40 m.
					1907-1909	Shipek grab 45 m.
					1912-1916	N50V 40-0 m.
					1920-1930	(5) 7.4 W/B to 40 m.
	21°07'	17°15.7 (at 1933 hrs.)			1934-2011	BN330 1.75, 45 m.
					2021-2027	N113B 35-0 m.
6623	20°47'	17°10.4'	"	34 m.	2320-2324	TSD to 27 m.
					2330-2334	Shipek grab 34 m.
6624	20°46'	17°21'	3/2	57 m.	0116-0124	Shipek grab 57 m.
					0117-0122	TSD to 48 m.

Sta.	Position Lat. N.	Long. W.	Date (1968)	Sounding	Times	Sampling programme
6625	20°46'	17°31.3'	3/2	79 m.	0250-0257	TSD to 69 m.
					0251-0258	Shipek grab. 79 m.
6626	20°46'	17°36.8'	"	96 m.	0342-0350	TSD to 86 m.
					0344-0350	Shipek grab. 96 m.
6627	20°47'	17°42'	"	573 m.	0436-0513	TSD to 570 m.
				578 m.	0512-0522	Shipek grab 578 m.
6628	20°47'	17°47'	"	902-925 m.	0603-0703	TSD to 895 m.
				921 m.	0655-0715	Shipek grab 921 m.
6629	20°47'	17°57'	"	1293 m.	0837-0948	TSD to 1200 m.
6630	20°47'	18°17'	"	1893 m.	1153-1345	TSD to 1875 m.
6631			"	94 m.	1746-1758	NN 0 m.
					1817-1859	BN330 1.75, 94-(0) m.
					1917-1923	N113B 80-0 m.
	20°48.5'	17°38.3'			1920-1940	N50V 70-0 m.
					1944-1959	(6) 7.4 W/B to 60 m.
				98 m.	1945-1954	TSD to 94 m.
6632	20°47'	17°29'	"	68 m.	2050-2102	NN 0 m.
					2112-2130	(6) 7.4 W/B to 60 m.
				70 m.	2117-2122	TSD to 65 m.
					2133-2142	N50V 60-0 m.
				72 m.	2148-2227	BN330 1.75, 72-(0) m.
					2238-2248	N113B 60-0 m. est.
6633			"	45 m.	2345-2357	NN 0 m.
	20°47' (Lat. only at 0010)		4/2		0011-0013	N50V 40-0 m.
					0011-0015	TSD to 32 m.
					0018-0027	(5) 7.4 W/B to 40 m.
	20°49.2' (at 0038 hrs.)	17°19.3'			0035-0103	BN330 1.75, 45-(0) m.
6634	19°07'	17°04'	"	1496 m.	1131-1422	TMT8/5 285-265 m.
6635	18°58'	17°24'	"	-	1509-2124	TMT8/5 1500 m.
6636	18°54.5'	17°34'	"	-	2212-0044	TMT8/5 85-75 m.
6637	18°52'	17°40.0'	5/2	-	0058-0329	TMT8/5 105-(10) m.
6638	18°46.1'	17°53.9'	"	-	0347-0901	TMT8/5 1000 m. est.
6639	18°40.4'	18°05'	"	-	0954-1347	TMT8/5 600-500 m.
6640	18°45.7'	18°13'	"	-	1512-1937	TMT8/5 500-440 m.
6641	18°49.0'	18°12'	"	-	2020-2055	TMT8/5 100-50 m.
6642 # 1	18°48'	18°08.3'	"	-	2215-0250	N113H 1560-(0) m.
# 2	18°45'	18°31.5'	6/2	-	0258-0635	N113H 1000-(0) m.
6643	18°45.4'	16°42.0'	"	173 m.	1841-1949	BN330 1.75, 173-(0) m
6644	18°45'	16°48'	"	352 m.	2100-2232	BN330 1.75, 352-(0) m

Sta.	Position Lat. N.	Long.W.	Date (1968)	Sounding	Times	Sampling programme
6645	18°48.5'	16°50'	6/2	-	2329-0230	TMT8/5 205-150 m.
6646	18°48' (at 0331 hrs.) 18°47' (at 0712 hrs.)	16°50.3' 16°58'	7/2	-	0343-0702	TMT8/5 160-65 m.
6647	18°41'	17°08.9'	"	-	1011-1645	CDBE calibration with DTP.
6648	18°45.7'	16°51'	"	-	1924-2239	TMT90 100-(0) m. est.
6649	18°50.0'	16°50.8'	"	-	2244-0311	TMT90 130-(0) m. est.
6650	18°52.6'	16°50.5'	8/2	-	0353-0953	TMT90 170-(0) m. est.
6651	17°25'	17°00'	"	1503 m.	1904-1928	TSD to 202 m.
6652	17°25'	17°00.5'	"	-	1945-2131	N113H CDBE 70-45 m. dp. 50-0 m. sh. N113H CDBA 50-30 m. dp. 33-0 m. sh. N113H 35-(0) m.
6653	17°24'	17°04'	"	-	2148-2315	N113H CDBE 60 m. dp. 60-0 m. sh. N113H CDBA 50-(0) m. N113H 35-(0) m.
					2336-2348	NN 0 m.
6654	17°24'	17°04'	"	-	2359-0124	N113H CDBE 70-60 m. dp. 67-0 m. sh. N113H CDBA 55 m. dp. 100-0 m. sh. N113H 35-(0) m.
6655	17°23.5'	17°12'	9/2	-	0138-0258	N113H CDBE 75-60 m. dp. 60-0 m. sh. N113H CDBA 55-50 m. dp. 50-0 m. sh. N113H 35-(0) m.
				2130 m.	0314-0323	TSD to 100 m.
6656	17°23.5'	17°12'	"	-	0341-0457	N113H CDBE 57 m. dp. 57-0 m. sh. N113H CDBA 37-33 m. dp. 33-0 m. sh. N113H
6657	15°53.8'	16°42'	"	41 m.	1354-1358	TSD to 37 m.
6658	15°53.8'	16°52'	"	89 m.	1521-1530	TSD to 84 m.
6659	15°53.8'	16°58'	"	286 m.	1624-1646	TSD to 280 m.
6660	15°53.8'	17°02.4'	"	950 m.	1729-1827	TSD to 970 m.
6661	-	17°12.5'	"	-	2017-2049	TSD
	On passage to Dakar - 10/2 - 12/2 in Dakar.					
6662 # 1	10°58'	20°00'	13/2	-	2119-2350	TMT8/5 195-(0) m.

Sta.	Position Lat. N.	Long. W.	Date (1968)	Sounding	Times	Sampling programme.
6662						
# 2			14/2	-	0159-0441	TMT8/5 200-100 m.
" 3			"	-	0526-0637	TMT8/5 100-(0) m.
" 4	10°59.3'	19°57' D.B. posn.	"	-	0741-1050	TMT8/5 1000-930 m.est.
" 5			"	-	1329-1612	TMT8/5 290-210 m. est.
" 6			"	-	1713-1837	TMT8/5 105-(0) m.
" 7	11°00'	19°56.8' D.B. posn.	"	-	1937-0024	TMT8/5 800-710 m.
" 8			15/2	-	0058-0439	TMT8/5 985-910 m.
			"	-	0458-0510	NN 0 m.
" 9	10°58'	19°55.4' D.B. posn.	"	-	0741-1129	TMT8/5 995-(0) m.
" 10			"	-	1200-1444	TMT8/5 410-320 m.
" 11	10°57.2'	19°56' D.B. posn.	"	-	1518-1932	TMT8/5 590-510 m.
" 12			"	-	2009-0012	TMT8/5 900-690 m.
" 13			16/2	-	0036-0352	TMT8/5 600-505 m.
" 14			"	-	0409-0712	TMT8/5 500-400 m.
" 15			"	-	1021-1435	TMT8/5 695-600 m.
" 16			"	-	1903-2305	TMT8/5 890-810 m.
" 17			"	-	2355-0336	TMT8/5 650 m.
" 18			17/2	-	0415-0646	TMT8/5.
" 19	10°53.1'	19°56.6' D.B. posn.	"	-	0806-1103	TMT8/5 500-405 m.
" 20			"	-	1153-1635	TMT8/5 900-810 m.
" 21	10°50.8'	19°54.9' D.B. posn.	"	-	1915-2255	TMT8/5 700-(0) m.
" 22			"	-	2349-0311	TMT8/5 680-610 m.
" 23			18/2	-	0353-0701	TMT8/5 415-320 m.
" 24			"	-	0803-1101	TMT8/5 1000-(0) m.
" 25			"	-	1144-1319	TMT8/5.
" 26			"	-	1433-1708	TMT8/5 800-670 m.
" 27			19/2	-	0035-0322	TMT8/5 300-205 m.
" 28	10°46.5'	19°54.3' D.B. posn.	"	-	0401-0834	TMT8/5 1250-1000 m.est
" 29			"	-	0945-1216	TMT8/5 205-110 m.
" 30			"	-	1301-1559	TMT8/5 795-730 m.
" 31			"	-	1922-0024	TMT8/5 1570-(0) m.
" 32			20/2	-	0209-0624	TMT8/5 1450-1210 m.
" 33			"	-	0726-1147	TMT8/5 960-950 m.
" 34			"	-	1233-1726	TMT8/5 1040-900 m.
" 35			"	-	2105-0143	TMT8/5 1680-1300 m.
" 36			21/2	-	0252-0831	TMT8/5 1900-1520 m.
" 37			"	-	1001-1405	TMT8/5 1300-1060 m.
" 38			"	-	1507-1936	TMT8/5 1700-1300 m. es
6663			"	4764 m.	2018-2255	TSD to 2450 m.
					2305-2340	(6) 7.4 W/B to 100 m.
6664	10°28'	19°43' D.B. posn.	"	-	2358-0738	TMT8/5 3140-(0) m.
6665						
# 1			22/2	-	1033-1116	N113H CDBA 100-(0) m.
" 2			"	-	1390-1402	N113H CDBA 200-105 m.(
						120-0 m. sl
" 3			"	-	1411-1536	N113H CDBA 300-190 m.(
						215-0 m. sl

Sta.	Position Lat. N.	Long. W.	Date (1968)	Sounding	Times	Sampling programme
6665 # 4			22/2	-	1559-1731	N113H CDBA 400-295 m. dp. 340-0 m. sh.
	10°32.7'	19°57.4' D.B. posn.				
" 5			"	-	2035-2105	N113H CDBA 100-0 m. Flap test.
" 6			"	-	2115-2154	N113H CDBA 200-100 m. dp. 100-0 m. sh.
" 7			"	-	2205-2322	N113H CDBA 295-205 m. dp. 205-0 m. sh.
" 8			"	-	2350-0119	N113H CDBA 395-300 m. dp. 300-0 m. sh.
" 9			23/2	-	0248-0433	N113H CDBA 500-400 m. dp. 500-0 m. sh.
" 10	10°31.3'	19°58' D.B. posn.	"	-	0447-0643	N113H CDBA 600-500 m. dp. 500-0 m. sh.
" 11			"	-	0853-1031	N113H CDBA 500-405 m. dp. 420-0 m. sh.
" 12			"	-	1041-1220	N113H CDBA 600-510 m. dp. 510-0 m. sh.
" 13			"	-	1224-1428	N113H CDBA 710-600 m. dp. 600-0 m. sh.
" 14			"	-	1444-1719	N113H CDBA 810-700 m. dp. 810-0 m. sh.
" 15			"	-	1918	DTP calibration E3.
					2013-2159	N113H CDBA 700-605 m. dp. 700-0 m. sh.
" 16			"	-	2209-0015	N113H CDBA 795-700 m. dp. 795-0 m. sh.
" 17			24/2	-	0035-0246	N113H CDBA 900-780 m. dp. 820-0 m. sh.
" 18			"	-	0306-0545	N113H CDBA 1060-960 m. dp 1060-0 m. sh.
" 19			"	-	0843-1044	N113H CDBA 900-805 m. dp. 810-0 m. sh.
" 20			"	-	1102-1318	N113H CDBA 1000-905 m. dp 905-0 m. sh.
" 21			"	-	1432-1800	N113H CDBA 1175-1000 m. d 1175-0 m. sh.
" 22			"	-	2049-2300	N113H CDBA 990-885 m. dp. 910-0 m. sh.
" 23			25/2	-	0013-0336	N113H CDBA 1250-1050 m. d 1110-0 m. sh.
" 24			"	-	0404-0835	N113H CDBA 1490-1260 m. d 1445-0 m. sh.
" 25			"	-	1025-1130	N113H CDBA 850-(0) m.
" 26			"	-	1221-1555	N113H CDBA 1420-1250 m. d 1400-0 m. sh.
" 27	10°19'	19°51'	"	-	1648-1842	N113H CDBA 800-710 m. dp. 710-0 m. sh.
	10°18'	19°49'	"	-	1918-2025	CDB(E); flowmeter trials (2).
" 28			"	-	2146-0157	N113H CDBA 2120-1520 m. d 1560-0 m. sh.
" 29	10°16'	19°49'	26/2	-	0415-0503	N113H CDBA 103-90 m. dp. 103-0 m. sh.
" 30	10°16'	19°47'	"	-	0517-0602	N113H CDBA 53-50 m. dp. 50-0 m. sh.

Sta.	Position Lat. N.	Long. W.	Date (1968)	Sounding	Times	Sampling programme
6665						
# 31	-	-	26/2	-	0611-0650	N113H CDBA 25 m. est. dp. 25-0 m. sh.
" 32	-	-	"	-	0858-1255	N113H CDBA 2000-1500 m. d 1500-0 m. sh.
" 33	-	-	"	-	1356-1445	N113H CDBA 100 m. dp. 100-0 m. sh.
" 34	-	-	"	-	1452-1528	N113H CDBA 75 m. dp. 75-0 m. sh.
" 35	-	-	"	-	1545-1626	N113H CDBA 50 m. dp. 50-0 m. sh.
" 36	-	-	"	-	1637-1715	N113H CDBA 25 m. dp. 25-0 m. sh.
			"	-	1900-2004	CDB + Flowmeter trials.
" 37	10°17'	19°51'	"	-	2019-2112	Flowmeter + N113H CDBA 75 m est. dp. 75-0 m. sh.
" 38	10°11'	19°33'	"	-	2123-0645	N113H CDBA 3600-1800 m. d 3600-0 m. sh.
" 39	-	-	27/2	-	0928-1826	N113H CDBA 2400-0 m.
6666						
# 1	-	-	"	-	2058-2306	TMT8/5 trials 55-(0) m.
" 2	-	-	"	-	2319-0127	TMT8/5 trials 55-(0) m.
" 3	-	-	28/2	-	0142-0309	TMT8/5 trials 500-220 m.
" 4	-	-	"	-	0334-0520	TMT8/5 trials 220-500 m.
" 5	10°22'	20°16'	"	-	0545-0621	TMT8/5 trials 45-(0) m.
" 6	-	-	"	-	0703-0812	TMT8/5 trials 45-(0) m.
" 7	10°14.6'	20°19.3'	"	-	1008-1352	TMT8/5 CDBE trial 400-350 m. dp. 300-350 m. sh.
" 8	-	-	"	-	1419-1805	TMT8/5 CDBE trial 600-550 m. dp. 500-550 m. sh.
6667	10°14'	20°55'	"	-	1921-0722	TMT8/5 + N113H 3760-(0) m
6668	10°09.5'	20°41.5'	29/2	-	0905-1030 0905-0915	TSD to 1200 m. (6) 7.4 W/B to 100 m.
6669	10°09.6'	20°41.6'	"	-	1043-1410	TMT8/5 CDBE 820-800 m. dp 800-700 m. sh
6670	10°16.0'	20°37.5' (est)	"	-	1449-1840	TMT8/5 CDBE 875-800 m. dp 800-725 m. sh
6671	10°19.5'	20°07' (est)	"	4881 m.	1920-2043	TSD to 1200 m.
6672	10°20'	20°06.3'	"	-	2052-2205	TMT8/5 100-50-(0) m.
6673	10°20'	20°04.0'	"	-	2219-0410	TMT8/5 1700-1300-(0) m.
6674	11°35'	21°26.5'	1/3	-	1947-2023	TMT8/5 + N113B 1000-0 m.
6675	14°26'	23°33.5'	2/3	-	1947-2118	TMT8/5 + N113B 1000-0 m.
6676	15°01'	23°57'	3/3	1842 m.	0540-1413	BLL
6677	15°01	24°01.6'	"	2866 m.	0925-1755	BLL
6678	14°59.5'	24°04'	"	2783 m.	1945-0635	BLL

Sta.	Position Lat. N.	Long. W.	Date (1968)	Sounding	Times	Sampling programme
6679	15°03.1'	23°56.8'	3/3	1650 m.	2325-0930	BLL
6680	15°21.1'	23°36.6'	4/3	1400 m.	1430-2100	BLL
6681	15°21.5'	23°33.6'	"	410-377 m.	1550-2310	BLL
6682						
# 1	-	-	5/3	-	0756-0839	N113H CDBA 100-90 m. dp. 100-0 m. sh.
" 2	-	-	"	-	0847-0944	N113H CDBA 200-190 m.dp. 200-0 m. sh.
" 3	-	-	"	-	0958-1056	N113H CDBA 300-290 m.dp. 300-0 m. sh.
" 4	-	-	"	-	1102-1207	N113H CDBA 420-385 m.dp. 400-0 m. sh.
" 5	-	-	"	-	1215-1328	N113H CDBA 500-480 m.dp. 500-0 m. sh.
" 6	-	-	"	-	1338-1507	N113H CDBA 610-580 m.dp. 600-0 m. sh.
" 7	16°24.2'	25°00.7'	"	-	1517-1715	N113H CDBA 710-690 m.dp. 700-0 m. sh.
" 8	16°27'	25°10'	"	-	1726-1940	N113H CDBA 910-875 m.dp. 905-0 m. sh.
6683	16°27'	25°10'	"	-	2154-0012	TMT8/5B 890-0 m.
6684	17°11'	25°22.1'	6/3	1468 m.	0045-1430	BLL
6685	17°13.5'	25°18.5'	"	1311 m.	0650-1538	BLL
6686	17°30'	25°01'	"	-	2019-2248	TMT8/5 + N113B 1000-0 m.
6687	20°37'	22°56.1'	7/3	-	2012-2252	TMT8/5 + N113B 1000-0 m.
6688						
# 1	21°52'	22°00'	8/3	-	0826-1115	TMT8/5 CDBE 420-350 m.dp 350-0 m. sh.
" 2	-	-	"	-	1159-1530	TMT8/5 CDBE 605-550 m.dp 550-0 m. sh.
" 3	-	-	"	-	1610-1755	TMT8/5 CDBE 710 m.
6689	22°30'	21°31'	"	-	2017-2338	TMT8/5 + N113B 1000-0 m.
6690	25°00'	19°36'	9/3	-	1637-1908	TMT8/5 + N113B 1000-0 m.
6691	25°24.7'	19°26'	"	-	2212-0545	BLL
6692	25°23'	19°27'	"	339 m.	2321-0045	BN330 1.75, 377-365-(0)
6693	25°25.3'	19°27.6'	10/3	377 m.	0105-0643	BLL
6694	25°21.9'	19°24.1'	"	301 m.	0231-0347	BN330 1.75, 301-(0) m.
			10/3 - 12/3 in Tenerife.			
6695						
# 1	28°05.8'	14°09.3'	13/3	-	0744-0846	TMT8/5 517-502 m.
" 2	28°07.5'	13°59.8'	"	-	0944-1245	TMT8/5 500-400 m.
" 3	-	-	"	-	1256-1603	TMT8/5 595-500 m.

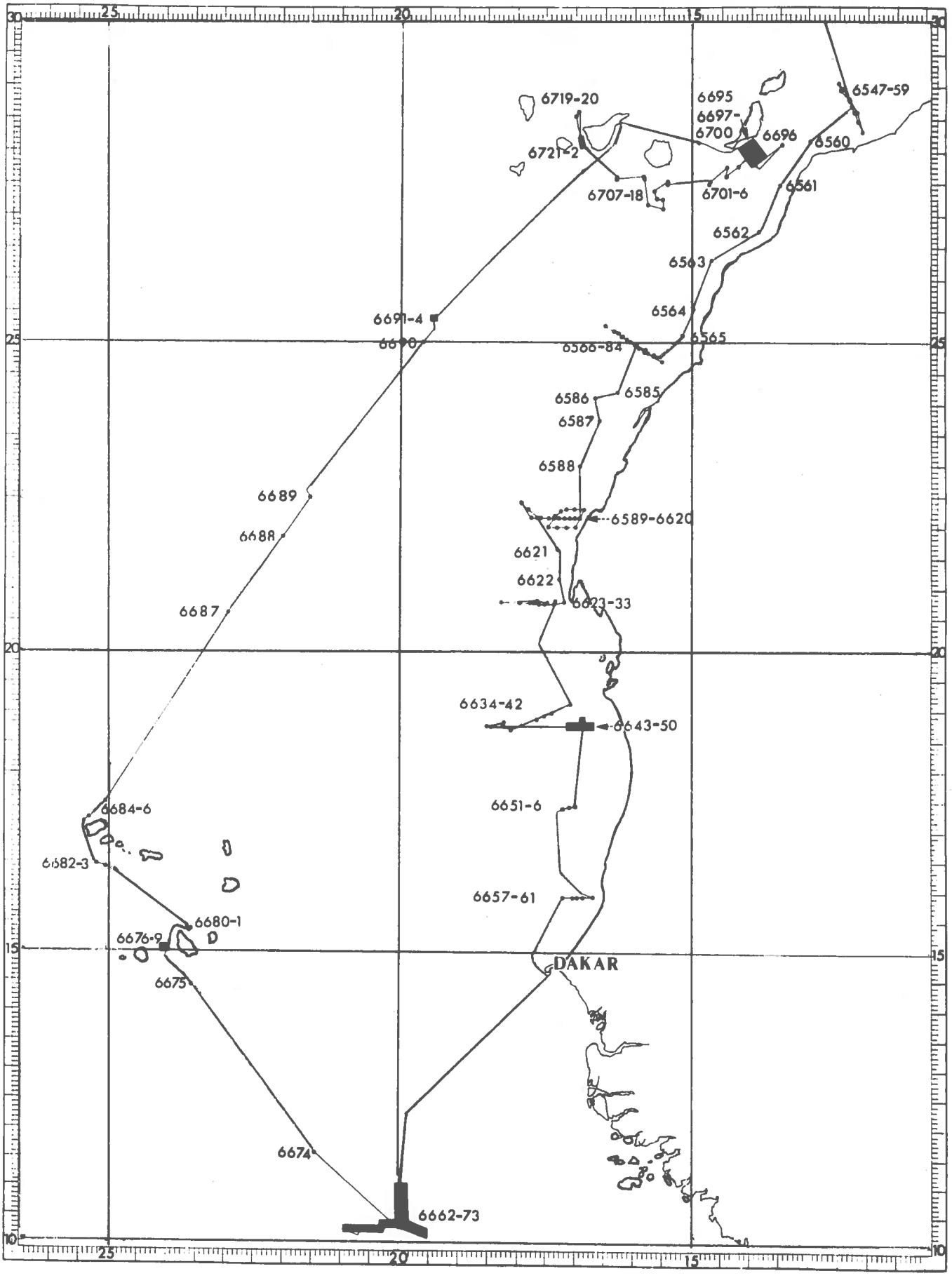
Sta.	Position Lat. N.	Long. W.	Date (1968)	Sounding	Times	Sampling programme
6695						
# 4	28°00.6'	13°52'	13/3	-	1640-1948	TMT8/5 700-610 m.
" 5	-	-	13/3	-	2005-2305	TMT8/5 500-410 m.
" 6	-	-	13/3	-	2315-0240	TMT8/5 600-510 m.
" 7	27°56.5'	13°55.5'	14/3	-	0253-0707	TMT8/5 700-(0) m.
" 8	-	-	14/3	-	0755-1147	TMT8/5 810-700 m.
" 9	28°02.3'	14°08.5'	14/3	-	1201-1535	TMT8/5 900-800 m.
" 10	-	-	14/3	-	1547-1811	TMT8/5 400-300 m.
	28°00'	14°10.2'	14/3	-	2000-2023	(6) 7.4 W/B to 100 m.
					2024-2030	N50V 100-0 m.
" 11	-	-	14/3	-	2051-0110	TMT8/5 700-600 m.
" 12	27°46.7'	14°00'	15/3	-	0019-0400	TMT8/5 810-700 m.
" 13	-	-	15/3	-	0410-0745	TMT8/5 900-800 m.
6696	28°06'	13°28'	15/3	1184 m.	1309-1552	Dredge 1184 m.
6697	27°57'	13°46.2'	15/3	1564 m.	1839-2157	Dredge 1564 m.
6698	28°01.1'	13°56'	15/3	1605 m.	2330-0855	BLL
6699	28°01.1'	13°52.6'	16/3	1582 m.	0100-Lost	BLL
6700	28°06.3'	14°07'	16/3	-	0354-0618	TMT8/5 400-300 m.
6701	27°45.2'	14°13'	16/3	1934 m.	1415-1730	Dredge 1934 m.
6702	27°36'	14°27'	16/3	2255 m.	1931-2309	Dredge 2255 m.
6703	27°36'	14°27'	16/3	2234 m.	2319-0405	BN5 1.75, 2234-(0) m.
6704	27°44.9'	14°25'	17/3	2129 m.	0419-0846	Dredge 2129 m.
	27°31'	14°43'			1104-1116	NN 0 m.
6705	27°29.5'	14°43.5'	17/3	2503 m.	1126-1535	Dredge 2503 m.
	27°32'	14°42'	17/3	2450 m.	1546-1835	Dredge 2450 m.
6706	27°33.2'	14°41.5' (est.)	17/3	2410 m.	2007-0015	BN5 1.75, 2366-2347-(0) m.
6707	27°29.2'	15°26.5'	18/3	2593 m.	0700-1124	Dredge 2593 m.
6708						
# 1	-	-	18/3	-	1406-1649	FRN15 1030-0 m.
" 2	27°31.5'	15°24'	18/3	-	1744-1915	FRN15 1070-0 m.
" 3	27°32'	15°25.7'	18/3	-	1937-2200	FRN15 1050-0 m. est.
6709	27°32.2'	15°25.6'	18/3	2351 m.	2225-0340	Dredge 2351 m.
6710	27°23.6'	15°39.6'	19/3	2670 m.	0624-1030	Dredge 2670 m.
6711	27°14.9'	15°36.3'	19/3	2988 m.	1418-2050	Dredge 2988 m.
6712						
# 1	27°15'	15°31'	19/3	-	2100-2112	NN 0 m.
" 2	-	-	19/3	-	2115-2127	NN 0 m.
6713	27°06'	15°30.8'	20/3	3166 m.	0050-0822	BN5 1.75, 3138-(0) m.
6714	27°13'	15°41'	20/3	3301 m.	0947-1625	Dredge 3301 m.
6715	27°33'	15°50.5'	20/3	-	2119-2325	TMT90 115-(0) m.

cp. 21

Sta.	Position Lat. N.	Long. W.	Date (1968)	Sounding	Times	Sampling programme
6716	27°37'	15°51'	20/3	-	2338-0715	TMT90 265-(0) m.
6717	27°35'	16°19'	21/3	3500 m.	1144-1840	Dredge 3500 m.
6718	27°38'	16°18'	21/3	3302 m.	2045-2300	(3) 7.4 W/B to 3200 m.
6719	28°32.2'	16°59.8'	22/3	2390 m.	0638-1115	Dredge 2390 m.
6720	28°36.5'	16°57'	22/3	2840 m.	1200-1325	(4) 7.4 W/B to 2700 m.
6721	28°05'	16°53.5'	22/3	-	1722-2024	TMT8/5 + N113B 750-0 m.
6722	28°11.5'	16°55.8'	22/3	-	2344-0556	TMT90 160-(0) m.

22/3 - 27/3 in Tenerife

27/3 - 2/4 on passage to Plymouth.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6697-
6700
6696
6547-59
6721-2
6560
6707-18
6701-6
6561
6562
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6564
6691-4
6690
6565
6566-84
6586
6585
6587
6588
6689
6589-6620
6688
6621
6622
6687
6623-33
6634-42
6643-50
6684-6
6651-6
6682-3
6657-61
6680-1
6676-9
DAKAR
6675
6674
6662-73
30
25
20
15
10

FIG. 1.

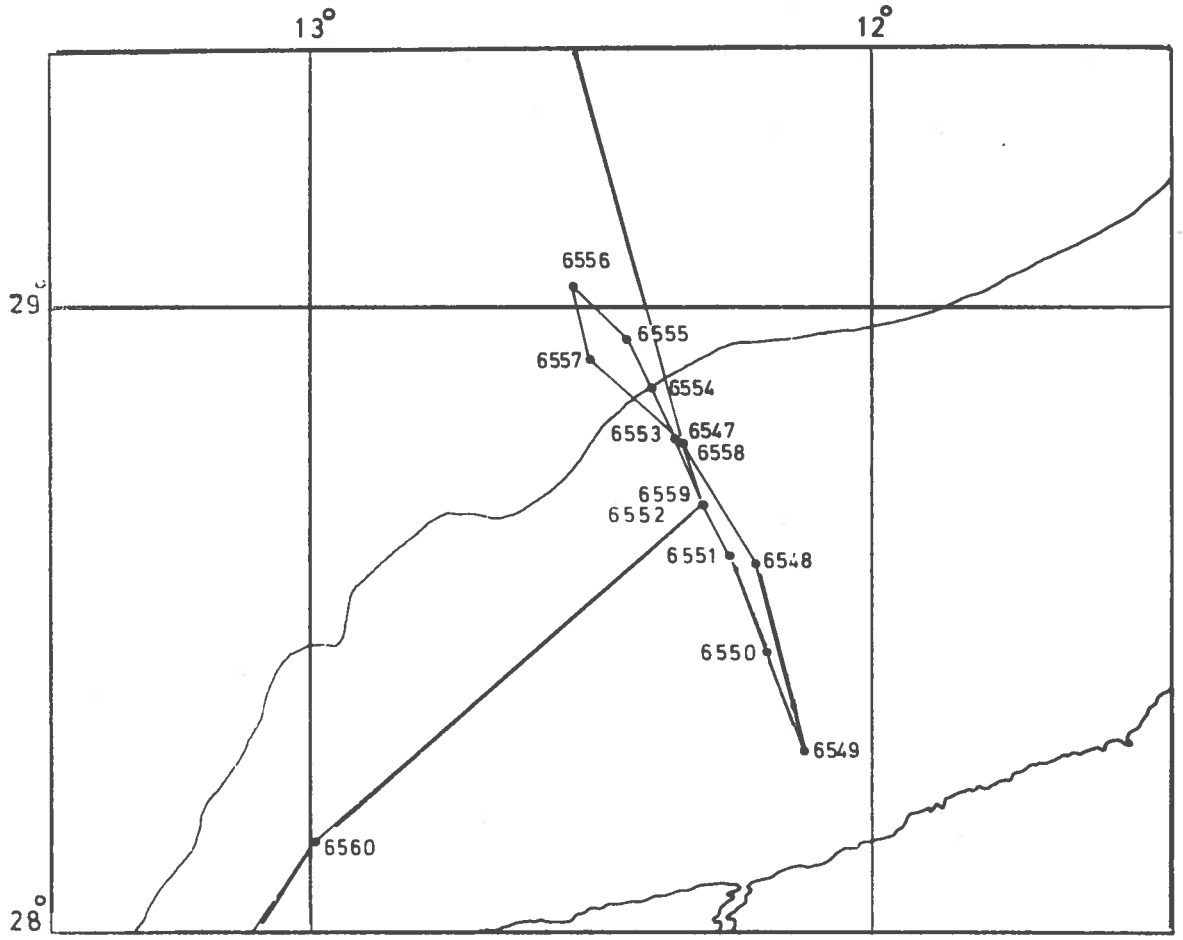

13°
12°
29°
28°
6556
6555
6557
6554
6553
6547
6558
6559
6552
6551
6548
6550
6549
6560

FIG. 2.

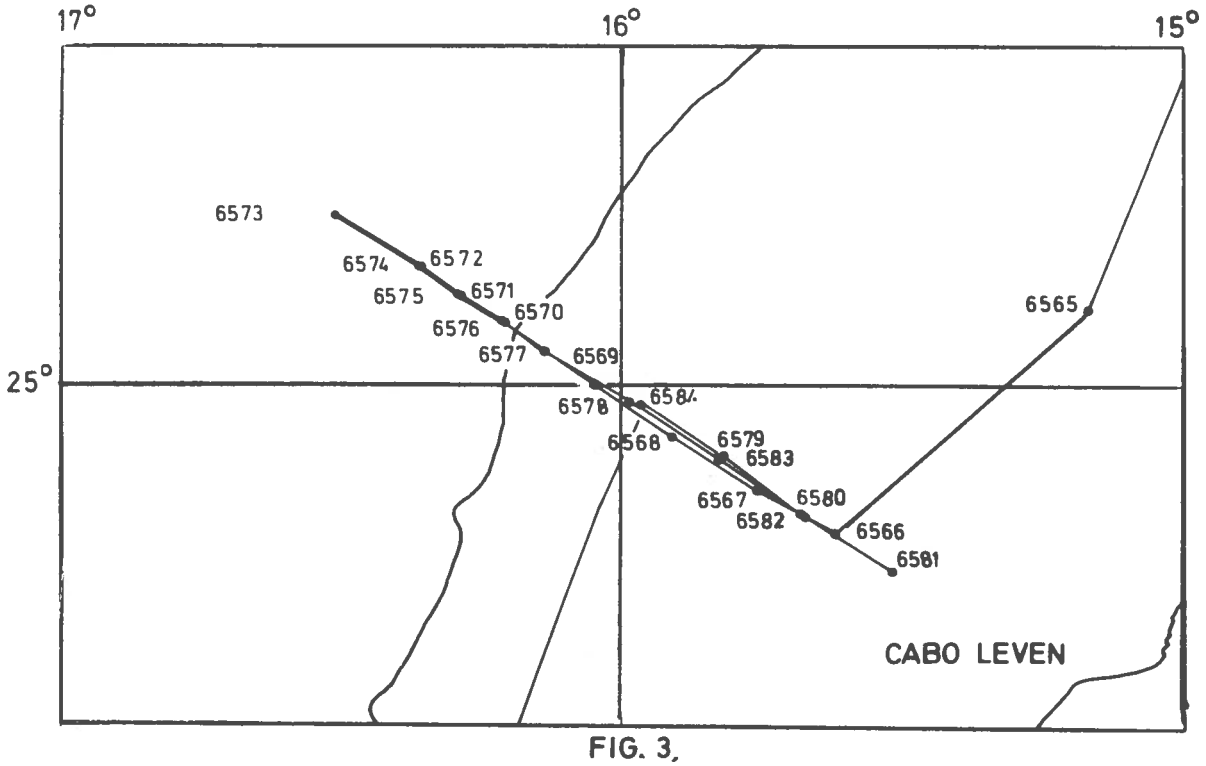
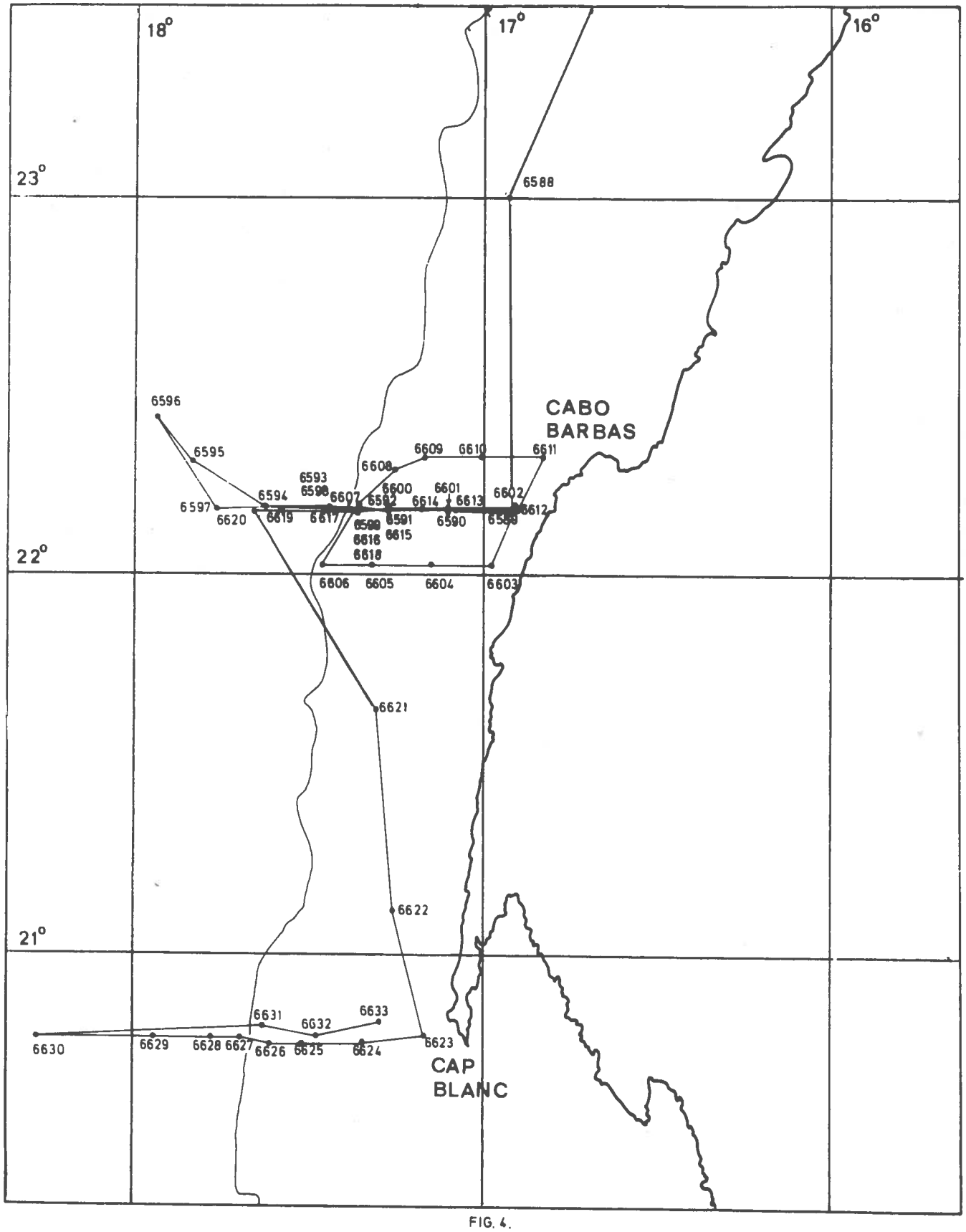

17°
16°
15°
25°
6573
6574
6572
6575
6571
6570
6576
6577
6569
6578
6568
6579
6583
6567
6580
6582
6566
6581
6565
CABO LEVEN

FIG. 3.


18°
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16°
23°
22°
21°
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6596
6595
6597
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6594
6593
6598
6619
6617
6607
6608
6609
6610
6611
6600
6601
6602
6592
6614
6613
6612
6599
6591
6590
6589
6616
6615
6618
6606
6605
6604
6603
6621
6622
6631
6632
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6630
6629
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6627
6626
6625
6624
6623
CABO
BARBAS
CAP
BLANC

FIG. 4.

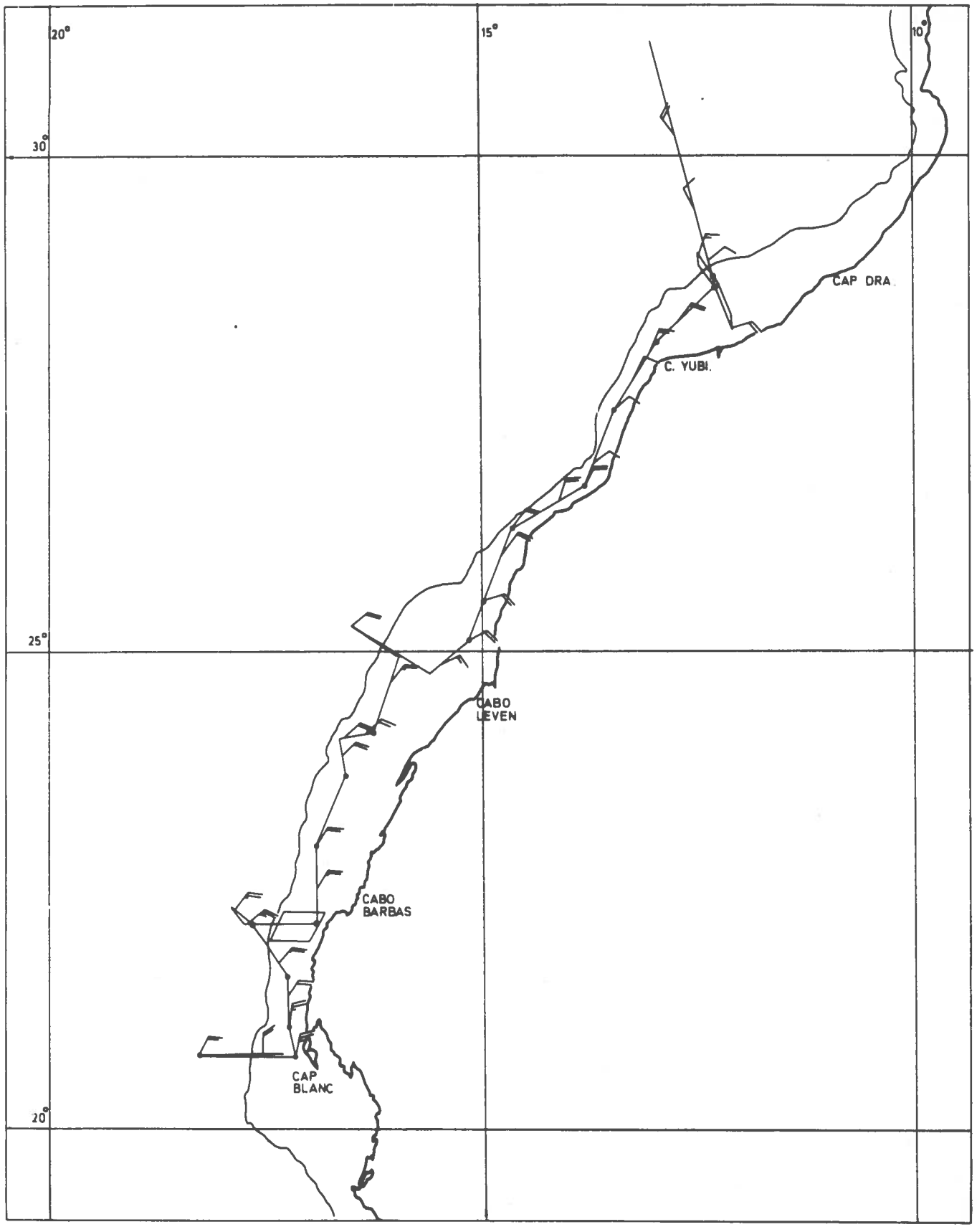
20°
15°
10°
30°
CAP DRA
C. YUBI.
25°
CABO
LEVEN
CABO
BARBAS
CAP
BLANC
20°

FIG 5

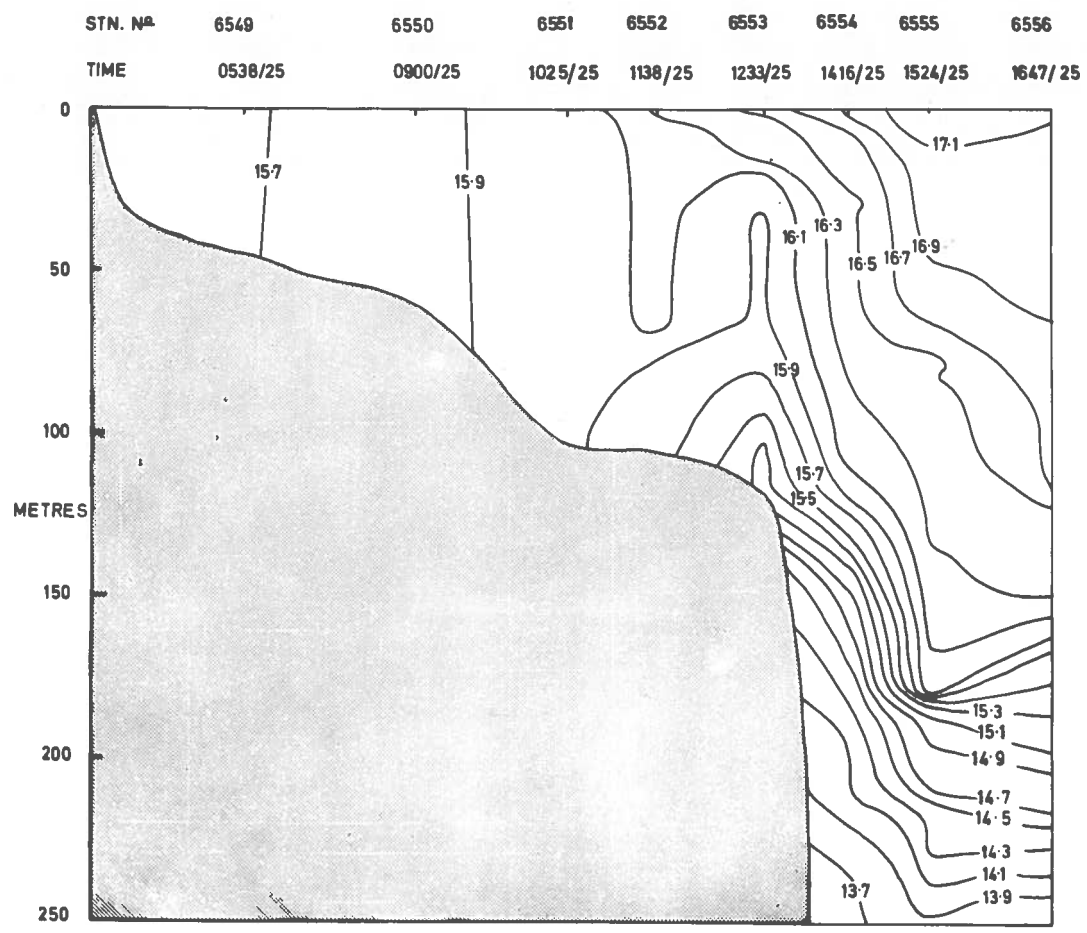

FIG. 6A. DISTRIBUTION OF TEMPERATURE (°C) JANUARY 1968

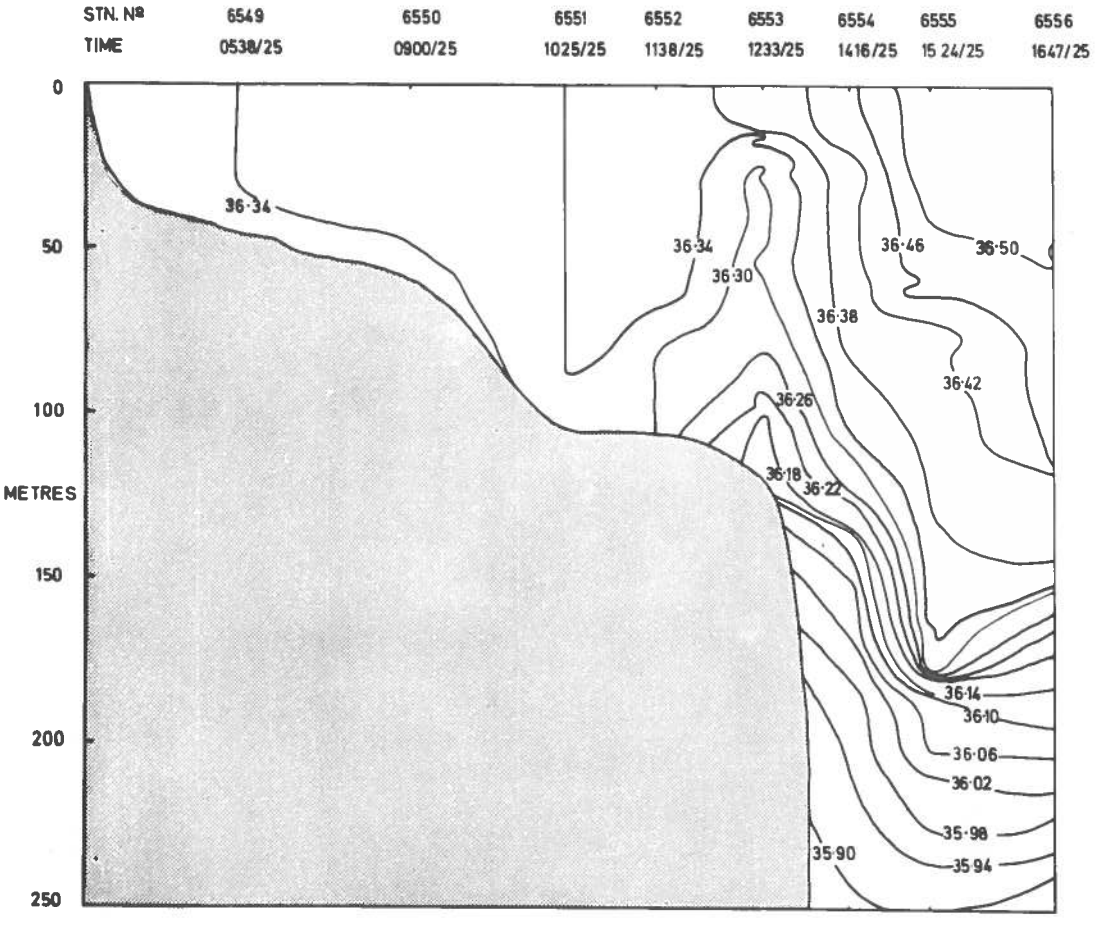

FIG. 6B. DISTRIBUTION OF SALINITY(‰) JANUARY 1968

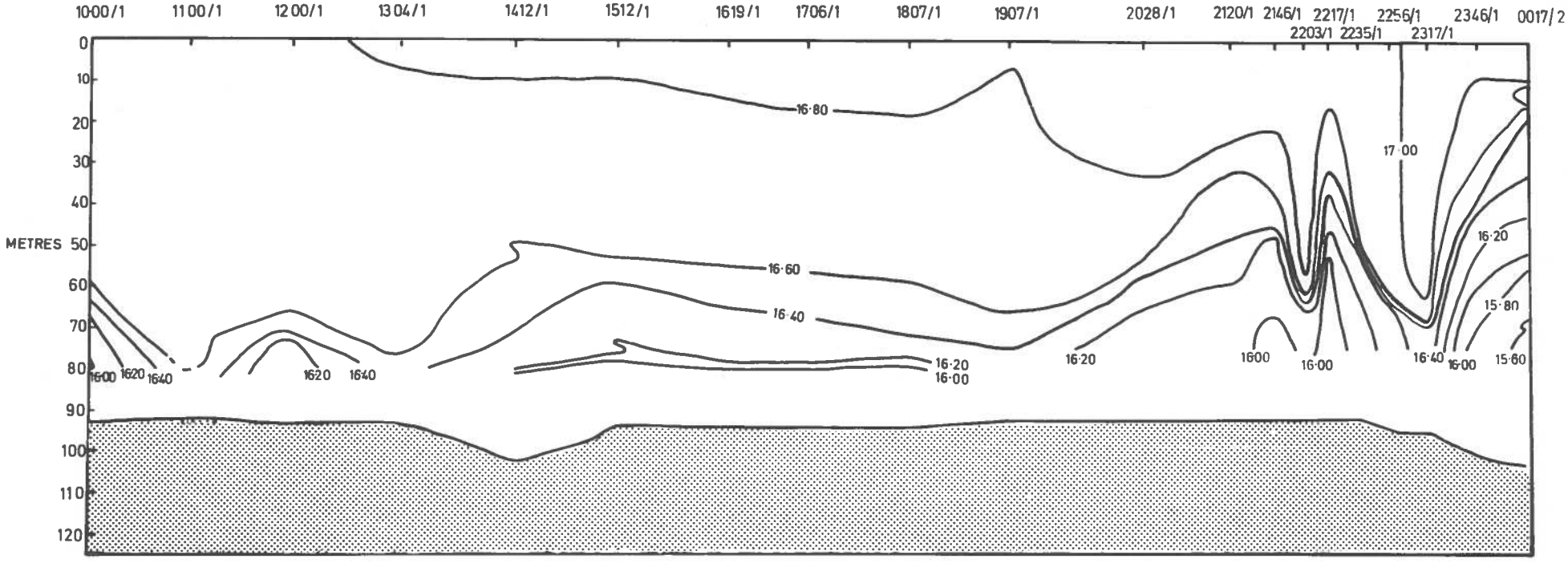

FIG.7. DISTRIBUTION OF TEMPERATURE °C STN. 6618
FEBRUARY. 1968.