INSTITUTE OF OCEANOGRAPHIC SCIENCES

R.R.S. DISCOVERY
CRUISE 82

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Upwelling off N.W. Africa and total water column sampling around 20°N 21°W.

Cruise Report No. 59

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SCIENTIFIC PERSONNEL

M.V. Angel	IOS Wormley	Left at Dakar	PSO for Leg 1
A. de C. Baker	IOS Wormley	PSO for Leg 2	
D.S.M. Billett	IOS Wormley		
J. Badcock	IOS Wormley		
R.M. Carson	IOS Wormley	Left at Dakar	
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M.J.R. Fasham	IOS Wormley		
P.R. Pugh	IOS Wormley		
D.M. Shale	IOS Wormley		
J. Smithers	IOS Wormley	Left at Dakar	
R.A. Wild	IOS Wormley		
B.W. Lewis	IOS Barry	Left at Dakar	
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H.S.J. Roe	IOS Wormley	" " "	
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SHIP'S OFFICERS AND PETTY OFFICERS

	Leg 1		Leg 2
Master	M. Harding		P.J. McDermott
Chief Officer	P.J. McDermott		S.D. Mayl
Second Officer		S. Tilbury	
Third Officer		M. Putman	
Catering Officer	R. Cornford		R. Overton
Chief Engineer	J.A. Lennox		P.E. Stone
Second Engineer	P.E. Stone		P.J. Byrne

	Leg 1	Leg 2
Third Engineer	J.R. Richardson	
Extra 3rd Engineer	F.J. Richards	
Fifth Engineer	J. Landry	
Senior Electrical Officer	F.P. Sharpe	
Boatswain	T. Leonard	
Netman	R.G. Burt	
Carpenter	L. Cromwell	
Bosun's Mate	D.S. Knox	

OBJECTIVES

The objectives of leg 1 was to locate a patch of water distinctive for its biological chemical and physical characteristics. To study the distribution of these characteristics both within and outside the patch and the time scale of change in these characteristics. An alternative objective was to study these characteristics across frontal systems. The area of study chosen was between 20°N and 23°N off the north-west African coast as both newly upwelled patches of water could be expected, and the frontal systems in the area are clearly defined and their physical structure well documented.

On leg 2 a return was made to the position at 20°N 21°W which had been worked during cruise 79, to resample the bottom fauna at 4000m and to sample the midwater organisms from the surface to just above the sea-bed.

ITINERARY

Leg 1. The ship sailed from Gibraltar at 0830 on 21 March. As the E.M. Log calibrations were considered to be suspect at the end of Cruise 81, two high speed runs were made along the measured distance at Zahara near Cape Trafalgar. Discovery then steamed southward following the line of the shelf break of the Moroccan coast. The PES fish was streamed as soon as the shipping lanes leading to the Straits were cleared. By the evening of the 22nd March underway sensors were on line into the computer for measuring near surface temperature, salinity, fluorescence and nitrate levels. These underway sensors subsequently proved most useful in mapping areas of interest. On the 23rd March some preliminary trials with the Lowestoft high speed net sampler showed that it could be successfully towed at full speed from the large boom on the fore-deck and retrieved and launched using the capstan on the poopdeck.

At 1350 on 24th March a search pattern of courses zig-zagging across the shelf was begun to gain a rough picture of the hydrographic conditions on the shelf. At 1600 when the ship was in deep water well off the shelf a trial with the bat-fish and <u>in situ</u> fluorometer was conducted and various faults in the system diagnosed. On completion of the trial the ship had to divert at full speed to Las Palmas to land a mentally sick crewman.

By 0900 on 25th March we were leaving Las Palmas and setting course back to the work area. A further batfish trial was conducted during the afternoon which was more successful but still the system involving the in situ fluorometer was not performing satisfactorily. Throughout 26th March a zig-zag course was followed across the shelf, and in the early hours of 27 March a series of high speed net samples was taken running off the shelf. During the day underway observations were continued but at 1426h the ship hove to while repairs were effected to both the computer and the TS profiler. The underway survey suggested the existence of a small cold water patch, low in fluorescence but high in nutrients, so the batfish was launched at 0330 on the 28th March. The fluorometer still failed to function and the control of the batfish was irregular, but even so two traverses of the patch were completed. At 1130 on crossing the shelf break, cable tensions, flat depth traces and finally loss of all sensor readings, resulted in the termination of the run. On retrieval the batfish was found to be damaged, fortunately not irretrievably, by hitting the bottom. It was clear that the depth indicator was a factor of two out. The ship then steamed south along the shelf break to locate any further patches. One was located at 1800 but it was decided to return to the original patch. So the ship steamed north again and a south-north transect of high speed net samples was taken through the patch. At 0830 on 29 March the ship was once again in the centre of the cold water patch close to 23°N 17°W, and a flotilla of eighteen dhan buoys was deployed with parachute drogues set at 10m. At 1206 a water sample was collected from the vicinity of the dhan launching position and a CTD station begun. This was aborted as the CTD failed and the bow thruster failed. The positions of the dhans were checked at 1700-1900h and the ship moved 20 miles to the west to clear the shipping lanes so the main engines could be taken out of loop and the bow thruster repaired. The repairs were completed soon after midnight and the ship returned to relocate the dhan buoys making a west-east series of high speed nets into the patch. The search begun for the dhans at dawn on the morning of 30th March in bad conditions. Despite the heavy seas and force 8 winds four dhans were located to the south west of the original position. At midday the search was abandoned and a bathymetric survey to the north of the patch begun to establish if the patch related to any features in bottom topography. At 1700 the Captain informed me that the second steward had fallen backwards down a stairway and after wirelessing for medical advice the ship's course was set for Nouadhibou Mauretania to land the injured man.

The ship docked at Nouadhibou at 0900 31st March and sailed again at 1130. When the shelf break had been crossed the batfish was launched without the fluorometer, to follow the hydrographic changes occurring just outside the shelf-break and a series of high speed net samples was collected in conjunction with this survey. At midnight the controls failed on the batfish and it was brought inboard. The failure was caused by a clip fouling the hydraulics. The series of high speed nets was continued. At 0500 1st April the ship steered out away from the shelf break to the predicted position of the dhan buoys, but despite a four hour search none was found. At 1300 a CTD dip to 1000m was followed by an attempt to pump profile, which after a series of minor mishaps was finally abandoned when the pump was found to have a cable fault. At 1840 the batfish was again launched to survey the patch of cold water. Weather conditions improved for the first time since the ship had been diverted to Las Palmas. The patch was still identifiable as a cold, nutrient rich body of water, but the lack of a marked increase in chlorophyll may have resulted from the depth of the wind mixed layer reaching 150m just off the shelf. The patch was bounded by a complex of fronts, possibly the result of its decay through the encroachment of warm surface water as the wind died down to almost nothing. The batfish was brought inboard at 1300 on 2nd April and the ship returned to the original dhan launch site and another was set out drogued at 50m. The first of a series of profiling stations along the axis of the movement of the original batch of dhans was carried out. The CTD and light meter with the pump intake attached was lowered at 0.1m s^{-1} to 110m. The pump outlet was tapped for fluorometers, an autoanalyser with channels for nitrate, nitrite, silicate and phosphate, a particle counter and filters for zooplankton. A further CTD dip was made, this time using the rosette bottle sampler to obtain nutrient samples from below the maximum depth for the pump system. The ship then checked the position of the newly released dhan buoy and the bathymetric survey abandoned on 29th March was completed. At 0600 3 April the ship returned to fix the dhan buoy's position and during the day another dhan drogued at 100m was set out and three profiling station were completed.

During the early hours of 4th April the original region of cold water was re-surveyed with underway sensors and high-speed nets. In the morning the two dhans were re-fixed and two of the original dhans appeared in the vicinity and their positions were also fixed. During the day three more pump stations were completed. The ship then steamed back to the shelf for two more pump profile stations during the early hours of 5th April. The ship returned to the estimated position of the dhan buoys and steered 200°. The outer front system was located and the dhans with deep drogues were recovered out beyond the front. Steering due south the ship followed the line of the front and four of the original buoys were recovered. The most distant one was over fifty miles south of the original release position. The front gradually converged with the shelf break and some lines of underway surveying were run just to the north-west of Cap Blanc. On the night of 5/6 April there was another unsuccessful attempt to tow the batfish with the in situ fluorometer. So transects of underway observations were run out from the shelf to try and establish the position of the outer front. It soon became clear that there were more frontal systems than would be expected according to the classical upwelling situation of an inner and an outer front. Instead there appeared to be a succession of bands of upwelled and non-upwelled water. A transect of pump profiles was run in from the outermost front located to over the shelf at a depth of 60m. The nutrient profile at the innermost station proved particularly interesting in relation to the massive chlorophyll maximum produced by an intense diatom bloom in the thermocline. Once the transect was completed by 1600/7 April, the ship steamed to the shelf edge and the batfish with in situ fluorometer was launched. A couple of transects were run including the line of the pump profiles. As a fitting reward for persistent sweat and toil by those concerned, the system worked perfectly. The batfish was brought inboard at 1156/8 April and the CTD unit from the batfish and the fluorometer were mounted onto the vertical wire for cross calibration with the laboratory fluorometers while making a pump profile. This inter-calibration was unsuccessful since the in situ fluorometer developed a fault. However the system was calibrated later using water collected while making a pump profile.

The ship left the work area at 1700/8 April. During the run into Dakar more high speed net samples were taken and the underway sampling showed another area worth investigation in the canyon area to the south of Cap Blanc. The ship docked in Dakar at 1000/10 April.

Leg 2. The ship sailed from Dakar at 1130 on 12 April and set course for 20°50'N 18°13'W where a BN1.5 had been fished in 2000m during cruise 79. The camera had failed on the previous occasion and a repeat haul was needed. During the passage north the LNHS/18 was fished three times (Stns. 9537-39). The BN1.5 position was reached at 0820/14 and an echo sounder survey of the proposed track of the net and the net was shot at 0852 and recovered at 1203 (Stn 9540). A course was then set for 20°N, 21°W where the major part of the programme was to be carried out. At 1950/14 the 3rd engine was put on as this would allow sufficient time to fish a BN1.5 before midday of 15th over which it was intended to test the low level photometer. The position was reached and both operations completed satisfactorily by 1440/15. A second BN1.5 was fished during the afternoon of 15th and this was followed by a CTD to 4000m combined with a calibration and release test of the net monitor to be used for the deep RMT Hauls which would follow. The 16th April was devoted to fishing two hauls with the semi-balloon trawl. During the night of 16-17 April the RMT was fished for material for bioluminescence studies and the day of 17th April from before dawn to after sunset was used for RMT hauls in conjunction with the low-level photometer. At 2030/17 the first of a series of deep RMT hauls close to the bottom in 4000m was started but trouble with the net monitor resulted in the night being used to try and improve the seal on the mouth of the RMT 8 when closed. Between 0600/18 and 0730/23 the RMT 1+8 + DN was fished at various depths from close to the bottom up to the surface so that the whole water column was sampled. In total eleven successful hauls were made, 5 of which lasted approximately 12 hours each. The series was completed with a final CTD and monitor calibration to 4000m.

At 1100/23 the passage home was started. It was planned that any time made up on the journey north would be used for testing a multiple RMT and obtaining material for bioluminescence work. A very slow passage (ca 8 kts) against a 20-30 kt head wind was made over the first two days and at 1200/25 the third engine was put on. The weather improved north of the Canary Is. and good time was then made. On 27 April the Master was informed that the ship would be refitting in South Shields and as it was thought that this would add two days to the passage time and the ship was required to enter the dry dock as early as possible no time could be made available for further scientific work. A call was made into Plymouth on 1 May to pick up charts of the North Sea and to land a seaman with a head injury and a greaser with a back injury. Fair weather up the Channel and the east coast allowed good speed to be made and the ship docked in South Shields at 1530 on 3rd May.

1. HORIZONTAL PROFILING

During most of the cruise the IBM 1800 computer was used to sample readings of surface temperature and salinity (obtained from the Moorey probe), fluorescence and nitrate concentrations (obtained by continuously sampling water from the ship's pure seawater supply with a Turner fluorometer and the auto-analyser). These values were plotted out on the computer in chart form and proved invaluable in identifying upwelling events and studying their evolution. One particularly conspicuous event was found in the area of 22° 50'N, 17°20'W which appeared to be fairly stable in space, while wind speeds remained high ($> 25\ m\ s^{-1}$). The event had a temperature anomaly of -1°C and was typified by high nitrate and low chlorophyll values and occurred in an area where the 200-500m bottom contours showed some small canyon-like features. There was some evidence of a chlorophyll ring structure surrounding the temperature minimum. During the trip south to Nouadhibou the wind speed dropped to around 10 $m\ s^{-1}$ and on returning to the original area the low temperature/high nitrate region could no longer be clearly identified as it was breaking up into a series of small frontal regions.

A frontal system over deep-water was identified in the area of 22°50'N and 17°40'W on a number of profiles and there is some evidence of a coupling between this front and the upwelling area.

M. Fasham

2. ANALYSIS OF INORGANIC NUTRIENTS

An autoanalytical system, based on a Chemlab colorimeter with 50mm flow cells and two Ismatec pumps, was set up for continuous measurements of nitrate, nitrite, inorganic phosphate and reactivity silicate. Surface and sub-surface (down to 110m) water was sampled from the outflow of a fluorometer. For analysis of water from greater depths, discrete samples were collected with a multisampler. Reaction delay times were NO_3 7, NO_2 6.5, Si 10.5, and PO_4 20 minutes. Data from the nitrate channel only were fed into the computer.

Baseline (reagent blank) responses were checked daily, using distilled water as a reference. Calibration was carried out by adding known quantities of each nutrient to samples of nutrient-poor sea water and showed variations in response of $<1\%$ over the period of the cruise. Complete records were obtained for NO_3 NO_2 and Si, apart from brief periods necessary for cleaning the flow cells and replacement of tubing. However, some difficulties were experienced with the PO_4 analyses, apparently caused by absorption effects which led to poor resolution of rapid changes in concentration (e.g. as encountered during profiling work).

Areas of recently upwelled water were relatively cold, poor in chlorophyll and rich in nutrients, particularly during or just after periods of strong winds. On each profile the concentrations of NO_3, Si and PO_4 increased with depth across the pycnocline, although anomalously low values were occasionally observed at intermediate depths. The maximum concentrations recorded at 110m (or bottom), for the northern and southern sections respectively, were NO_3 13.8, 19.0; Si 7.0, 13.0; PO_4 0.94, 0.68 μg-at l^{-1}. Nitrate to silicate ratios for surface water varied between 0.3 and 5.9, and at stations 9529 and 9531 differences in the gradients of these two nutrients with respect to the chlorophyll maximum suggested that silicate rather than nitrate was limiting phytoplankton growth. The highest nitrite levels (1.38μg-at l^{-1}) were recorded at station 9531.

R.N. Head

3. STUDIES ON PHYTOPLANKTON

The level of chlorophyll a in surface water was monitored throughout the cruise by continuous in vivo measurements of fluorescence, using two Turner Model III fluorometers connected to the ship's pumping system. At 18 stations, located along two lines running out from the coast (see Fig. 1), vertical profiles of chlorophyll fluorescence were obtained by lowering and raising the inlet of a hose, which was attached to a submersible pump, between 3m and 110m (or bottom). These records were calibrated from spectrophotometric and fluorometric determinations of chlorophyll a and phaeopigments in 90% acetone extracts of some filtered water samples.

For identification and cell counts of the phytoplankton samples were preserved with Lugols iodine, formalin-hexamine and formalin acetic acid solutions. At 11 stations rates of photosynthetic $^{14}CO_2$ fixation were measured in a laboratory incubator under light saturating conditions. To assess the relative importance of the nanophytoplankton, pigment and primary production determinations were made with water filtered through a 10μm-aperture net.

In the upwelling region surface chlorophyll a values ranged between 0.5 and 10 mg m^{-3}. Sub-surface chlorophyll maxima, associated with nutrient gradients across the pycnocline, were observed on several profiles. These were particularly intense in shallow water, and at station 9529 the chlorophyll a concentration at 10m exceeded 70 mg m^{-3}. Phaeopigment levels varied between 0 and 6 mg m^{-3} and, relative to chlorophyll, were generally highest in nutrient-poor water with a low standing crop of phytoplankton. The most abundant algae were colonial and chain-forming diatoms, although at some offshore stations dinoflagellates were dominant in samples collected on the 10μm net. In terms of chlorophyll a the proportion of nanophytoplankton ranged from $<$ 5% in diatom-rich water to > 80% in regions of low chlorophyll concentrations.

P.M. Holligan

4. VERTICAL PROFILING OF CHLOROPHYLL A FLUORESCENCE AND NUTRIENTS

Vertical profiling, using the CTD/pump system, was carried out at twenty stations during the first leg of the cruise. The operating procedure was for the CTD unit, together with a light meter at stations made during the day, to be lowered on a vertical wire at a rate of ca. 0.1m $s.^{-1}$ The inlet probe of the pumping system was also lashed onto the unit and 400' of 2" bore tubing were deployed between this and the Flygt submersible pump, which was suspended from a ship's boom a metre or so below the water surface. This length of tubing was sufficient to allow profiling down to a depth of ca. 110m. The water was brought onto deck at a rate of ca. 0.15 m^3 min^{-1}, and the majority of this water was either used for zooplankton collections or run to waste. Such a flow was necessary, however, to reduce as much as possible the mixing of water in the hosing and its residence time, calculated as approximately 2.5 min. After initial trials, three 0.5" bore bleeds were taken off the main hosing and were used to supply a) a Turner fluorometer, to measure the chlorophyll a fluorescence; b) the Hiac particle counter and c) via an additional Mono pump, another fluorometer and the autoanalyser equipment situated in the chemistry laboratory on the deck above.

Initial problems were experienced with the cable for the submersible pump but these were quickly rectified and a better system for switching the pump introduced. Zooplankton sampling was accomplished by feeding the main water flow into a selector valve which directed the flow alternately into two powder funnels. These funnels provided a simple means of reducing the flow rate of the water so as to reduce the damage to the zooplankton when it was collected on a screen of netting (170μm mesh) stretched across the wider end of the funnel. Samples were usually collected for one minute and then each funnel was removed in turn and the sample backwashed onto a smaller disk of netting which was then preserved in 5% formalin.

The parameters which were recorded continuously during each vertical profile were temperature, conductivity, depth, fluorescence, irradiance, nitrate, nitrite, phosphate and silicate; with a particle count and a zooplankton sample every minute. In general the chlorophyll a fluorescence profile showed considerable agreement with the physical structure of the water column. There was usually a peak of fluorescence in the pycnocline, as most easily seen from the temperature structure. However, on one or two occasions there was a pronounced temperature inversion in the water column, which had no obvious effect on the fluorescence structure, as it was usually balanced by a change in the salinity such that the water column remained stable. These results still have to be looked at in detail. The nutrient profiles (reported elsewhere) also showed interesting correlations with the physical and fluorescence structures in the water column. At one station the CTD was maintained at the approximate level of the chlorophyll maximum for 2.25hr and interesting changes in all parameters measured were noted mainly in association with the effects of internal waves. The relationship of the chlorophyll a profile to that of the nutrients nitrate and silicate was also studied in detail at another station where semi-continuous "yo-yoing" of the CTD and pump was carried out. The phytoplankton/nutrient relationships were noted to be the opposite of those seen previously in the English Channel.

P.R. Pugh and R. Pingree

5. SESTON PARTICLE COUNTING

Further trials of a new particle counter, a Hiac Model PC 320 automatic particle size analyser were carried out during the cruise. The operating principle of the machine is based on the interruption, by a particle, of a light beam shining onto a photodiode, thereby causing a drop in the output voltage of the latter which is proportional to the projected surface area of the particle. Two sensors were used which would react to particles in the 1-60μm (CMB1.0) and 10-600μm (CMB10.0) size ranges. The counter unit records pulses in nine channels which can be set up to cover any of the size ranges within the overall responsive size range of the sensor. On a previous cruise the instrument had been set up so that, using the two sensors alternately, counts in the 10-60μm range could be compared. The results seemed to indicate a certain inconsistency between the counts obtained from the two sensors and so this feature was investigated further. Previously, only a continuous flow-through system, designed at Wormley, had been used and variations in the flow rate through this system may have contributed towards the anomalies in the observed counts. On the present cruise an Automatic Bottle Sampler was also used, which had been kindly lent to me by David Northey of Northey International Systems Inc. Individual water samples are placed into this unit and, using excess pressure, the sample is passed through the sensor at a constant rate.

Two photoelectric cells trigger the start and finish of the counts and by adjusting their positions on a metering tube a set volume of sample can be counted. Unfortunately it was not possible to obtain an adequate flow rate through the larger sensor using this system, the maximum rate being ca 200 ml min^{-1}, whereas the manufacturer's recommended rate is 900± 450 ml min^{-1}. It was thought that such a slow flow rate might seriously affect the calibration of the instrument, but later calibrations showed that this was not necessarily the case.

Using the Bottle Sampler, experiments comparing the counts from the two sensors gave encouraging results. There were certain difficulties involved in the taking of individual samples, e.g. it was necessary to ensure that there were no air bubbles in the system or else these would have been counted, and it was also necessary to keep the sample well stirred to prevent the sedimentation of the particles. Replicate counts were made using both sensors and with eight of the channels set to count various size ranges within the 10-60μm region. Above 15μm the counts for both sensors were similar, but in the 10-15μm range of the larger sensor there appeared to be additional noise, probably due to base-level noise. Thus the anomolous counts obtained on the previous cruise may have been due to inconsistencies in the flow rate of the flow-through system or to a change in the calibration of the instrument depending on the flow rate.

This latter point was found not to be the case when, on the second leg of the cruise, the sensors were calibrated using polystyrene balls, obtained from Coulter Electronics Ltd., of three sizes, namely 9.12, 40.8 and (for CMB10.0 only) 75.3μm. The Bottle Sampler was used in the calibration of the CMB1.0 and for preliminary tests with the CMB10.0. Further calibrations of the larger sensor were carried out using the continuous flow-through system, where the calibration standards were recycled through the sensor. Calibrations were carried out over a range of flow rates from 150 to 600+ ml min^{-1}. The conjecture that the calibration of the sensor changed at lower flow rates in such a way that smaller particles (i.e. $<$ 10μm) were being counted was not necessarily confirmed for the 9.12μm particles seemed to appear at the same voltage level whatever the flow rate. However, there was a moderate amount of background noise at this level which may have masked any slight variation in the calibration, although it was hoped that sufficient corrections had been applied to account for this. Certain anomalies were still evident, however, in that the counts obtained per unit time at the slower flow rates did not appear to be significantly different from those at the higher rates. This effect was only noted, however, for the very small particles (10-15μm).

After initial trials using the Bottle Sampler, the larger sensor (CMB10.0) was placed in the continuous flow-through system and this was connected to the ship's sea water supply. The nine channels were set to count particles in the following size ranges; 10-20, 20-40, 40-60, 60-80, 80-110, 110-145, 145-200, 200-300, and 300-600 μm. The recycle timer was set so that the particles in the sea water were counted for 60 sec every 5 min. The flow rate was set to approximately 375 ml min^{-1} which, although below that recommended as a minimum flow rate, was nontheless convenient and, from later results, did not seriously affect the calibration of the instrument. The first results were very encouraging and there appeared to be a striking correspondence between the changes in the particle counts in the first five or six size ranges (i.e. 10-145μm) with changes in the phytoplankton fluorescence. This sytem was then left running for the remainder of the first leg of the cruise, with occasional breaks to flush out the system with fresh water to prevent corrosion. Although the results have not been looked at in detail, many interesting features were noted. For instance, although there appeared to be a general similarity between the changes in the fluorescence level and changes in the particle counts in the lower size ranges, on certain occasions this was not found to be the case. Intermittent observations on concentrates of phytoplankton seemed to indicate that in the former case the phytoplankton was mainly dominated by diatoms and other larger cells, while in the latter case, where there was no significant change in the particle counts even though the fluorescence was changing, the phytoplankton mainly consisted of flagellates and other nannoplankton cells which were below the size range of sensitivity of the instrument.

Experiments using the CMB1.0 sensor were less successful for, at present, a suitable method for screening off the > 60μm particles has not been found. Netting of two mesh sizes (60 and 121μm) was tried out but it was difficult to obtain a sufficient pressure to accomplish the necessary flow rate (8 ml min^{-1}) with the finer mesh, while the other was too coarse so that within a few hours the sensor had become clogged with particles. The sensor was not used on a regular basis after this.

During pumping stations for the vertical profiling of chlorophyll a and nutrients, attempts were also made to use the particle counter. Counts were made over a 50 sec period every minute, and in general the results were consistent with the changes in the fluorescence level. At one station the pump inlet was maintained in and around the chlorophyll maximum for a period of ca. 2.25hr. Both the chlorophyll a level and particle counts were extremely high. During this experiment the fluorescence level varied periodically over a threefold range whereas the total particle counts did not show such a wide variation. In fact, the counts in the 10-20μm range appeared to have an inverse relationship with the fluorescence, while the counts in the 20-145 (and sometimes up to 600) μm range showed a reasonable correlation with the variations in the chorolophyll a level.

A large amount of data was collected during the cruise and it should be possible to produce maps of the horizontal distribution of the various size classes for the area which was worked and to compare these with the distributions of the other parameters routinely sampled. The evidence from the individual phytoplankton samples taken throughout the first leg of the cruise should also help in establishing what species are present in each of the size classes.

P.R. Pugh

6. BATFISH AND UNDERWATER FLUOROMETER

This was the first attempt at combining the Variosens underwater fluorometer with the Batfish. Due to problems with the fluorometer the first three batfish runs were made without it. Some initial problems were experienced with the new batfish hydraulics but after this the whole system worked very reliably. Twenty-six hours of profiling were made around the upwelling crest at 23°N, 17°20'W and the visual temperature records showed interesting changes in vertical structure on passing through the patch of upwelled water. One long south-north profile was made on the return from Nouadhibou from 20°50'N, 17°40'W to 21°40'N 17°29'W.

The Variosens fluorometer initially caused innumerable problems resulting from the very low signal noise ratios. These were eventually traced to a combination of faulty components and cycling of the sample-hold power supply caused by the fluorometer temperature compensation circuit. The latter problem was solved by AC coupling the fluorometer and sample-hold circuit. A successful batfish plus fluorometer run of 17 hours was then made both on and off the shelf around 21°20'N. The chart recorder data showed up a number of interesting correlations between temperature and fluorescence vertical structure but detailed computer analysis will be required before definite conclusions can be made.

M. Fasham

7. HIGH SPEED NET SAMPLING

Two high speed nets (LNHS/18) were loaned by MAFF Lowestoft. Excluding initial trials, these nets were used 72 times, each tow being of about 30 min duration, usually at 8-8.5 kt ship's speed.

The body was towed from a bridle 50m long attached to the fully extended forward boom (6m over side) on the starboard side. All handling operations were conducted aft. For this, a line was shackled to the forward end of the fibre-glass which ran through a block on the short aft boom (shelter deck deck-head) and was hauled or paid out using the capstan. A fore and aft handling line was also attached to the body to facilitate shooting and recovery.

The net was towed at speed of 5-12 kt and as a rule its behaviour was more dependent upon sea state and direction than speed. In calm conditions the net could be towed at 12 kt with stability but in rougher sea conditions, even at lower speeds the body often veered to left or right, either diving and hitting the ship's side or else moving outwards and breaking the surface. Although to a certain extent the veering could be controlled by "playing" the handling line, this instability caused early problems. It resulted in the loss of a fin, a fibre-glass nose cone and the almost irreparable fracture of another. A further problem was caused by the depressor, which tended to crash, against the fibre-glass body particularly during recovery, and caused some body fracturing. This was remedied by the addition of a thin metal plate over the body fracture area. The original fibre-glass nose cones were replaced by a pair of make-shift "top-hats", each of which comprised of brass tubing of the same diameter as the original cone aperture, mounted on a pvc base. These proved very robust and were used throughout the remainder of the cruise. Time and weather did not allow the flow characteristics of these and the original cones to be compared.

The condition of the collected material was good, irrespective of speed of tow. The cod-end, however, was difficult to wash through. The nets provided had 60 meshes/in^2 and in sampling areas of high productivity tended to clog. Each net was therefore hosed down and thoroughly cleaned between tows. The original nets were replaced for leg 2 by nets with 54 meshes/in^2.

Many of our problems originated from the use of the LNHS 18 at ship's speeds in excess of the design speed of 6 knots. Only minor modifications of strengthening the body of the net were needed to make this net a most valuable additional sampler. On this cruise it amply demonstrated its value in providing material and samples while on passage.

J. Badcock

8. DHAN BUOYS

On 29 March 1977, 18 dhan buoys were released between 0839 and 0855 at a position 22°56'N, 17°07'W, on the shelf, in a depth of water ranging between 133 to 158m. Each dhan buoy was drogued to a depth of 10m by an 8m parachute. 10hrs after release the initial tight cluster of dhans had spread over an area of about 1 sq nautical mile and drifted in a direction 250° (about 30° to the right of the wind) over the shelf break at an average speed of 0.5 kt. On 30 March, the dhan positions were again surveyed and the drift was calculated to be similar, 245° at 0.6kt. The dhans were now 15 nautical miles from the original release point.

Unfortunately,RRS Discovery was then obliged to make a 200 mile detour to Cap Blanc, Mauretania, and on returning to the most likely position for the dhans two days later none could be found. The exercise was repeated with two further dhans drogued at 40m and 100m and similar results were obtained.

This simple picture of surface drift had to be abandoned when two of the original dhan buoys turned up in the working area within a mile of each other on 4 April, a week after release. A further dhan was found on passage to Dakar 4 days later about 50 miles away from the release site. This dhan appeared to have drifted initially off the shelf and then in a direction 200° approximately parallel with the shelf break at an average speed of 5 nautical miles a day.

R.D. Pingree

9. E.M. LOG CALIBRATION

Reports of the unreliability of the E.M. log calibrations during cruise 81, encouraged us to undertake two high speed runs over the measured distance at Zahara near Cape Trafalgar. Two runs were made with the engine revs set at 155 giving a speed of about 11.5kts. It was concluded from these runs that a) the bridge distance run indicator was correct; b) the bridge E.M. log

log display was 1.3% low; c) the plotting office E.M. log display was 1.5% low d) the port E.M. log was reading 5% low, so the fore/aft and port/starboard computer calibrations were altered to 0.06825 and 0.04468 respectively e) the starboard log was reading 2% low, so the fore/aft and port/starboard computer calibrations were altered to 0.07536 and 0.06096 respectively.

These alterations appeared to be effective and the E.M. log gave D.R.'s which were reasonably comparable with the satellite fixes.

M.J.R. Fasham

10. SCATTERING LAYERS

Throughout leg 1 continuous observations on scattering layers were made with the precision echo-sounder set at a constant gain setting of -24db whenever possible. The 10 Khz sounder showed very heavy scattering at the shelf break, further offshore the intensity diminished rapidly. During the period of high winds when the surface layers were well mixed by the wind and active upwelling was in progress, scattering tended to be in diffuse wide bands. Later on when the winds died and the patch of cold water began to collapse, the scattering patterns were variable. A relationship between these scattering patterns and the temperature structure could be seen during the batfish tows. This was particularly clear in areas where the temperature profile had a step structure as the scattering was organised into discrete layers. Fronts were often marked by a shallowing or thickening of the scattering. The response by the scattering layer at a depth of 100-150m was always offset from the front observed by the surface towed temperature/salinity probe. A problem in the analysis of these results will be the mismatch between the wave-lengths observable by the frequency of the batfish undulations and the much shorter wave-lengths of many of the undulations of the scattering layer.

M.V. Angel

11. VISUAL OBSERVATIONS

Throughout leg 1 there was an abundance of birds and whales whenever the ship was working on or close to the shelf. Numerous schools of white-sided dolphins were seen over the shelf break generally moving south. In contrast sperm whales were more often migrating to the north. At 1130/3 April when the ship was working at the shelf break (sounding 200m) 5 sperm whales were sighted migrating north. Within a few minutes a massive school of dolphins passed the ship moving south. The dolphins went into a feeding frenzy close by the ship, within minutes large flocks of immature gannets, pomarine skuas, sabine gulls and sandwich terns gathered. The gannets started to dive about 50m off the ship and were seen to be catching small squid estimated to be 10-20cm long.

Two bull sperm whales were seen at 1700/5 April again moving north close to the shelf break (sounding 614m). At 1520/6 April a school of 25-30 sperm whales were sighted. It appeared to be a harem of cows with well grown calves. When the ship was a mile short of the school a large whale seen sounding may have been the accompanying bull. The school, otherwise was idling at the surface and took no notice of the ship's approach. One was struck a glancing blow by the bow. A couple of miles further on a large squid tentacle was seen floating at the surface.

Whenever the ship was working on the shelf, the number of birds to be seen increased. Terns (Sandwich, Caspian and common), mostly in immature plumage became much commoner inshore. Turtles were seen on several occasions, usually in the surface slicks formed at the fronts which developed once the wind had moderated late on in the cruise.

M.V. Angel

12. PRESERVATION

All samples were initially fixed in 5% formalin in sea water using concentrated formalin (40% formaldehyde buffered with 5g per litre of borax). Eight of the samples were checked 30 minutes after fixation and the pH was found to have dropped to 6. This pH had been maintained when the samples were rechecked 24h and 48h after fixation. The samples were then transferred into fresh preservative, the midwater samples into formalin seawater again and benthic samples into 80% ethyl alcohol. A further check on the midwater samples showed that the acidity had once again dropped to pH 6.

R. Larcombe

13. DEEP SEA PHOTOMETER

Since Cruise 77 the LLP has been modified to include temperature compensating circuits which, it was hoped, would remove the ambiguous low light records experienced last summer. A test on the vertical wire to 1000m showed that these modifications were successful and there is now no appreciable temperature effect and a definite cut off point below which the record stays constant. The disappointing aspect of this test, and the subsequent net hauls, was the opaqueness of the water. Compared to cruise 77 the light level was one order of magnitude lower by 100m depth. This difference was maintained so that when the photometer stopped working it was only at 500m depth instead of 700m last summer.

Five hauls were made with the LLP mounted on the RMT 1+8 between 500m and the surface. An attempt was made to determine the optimum angle of the photometer by varying the ship's speed but the results were inconclusive due to the varying cloud cover and waves. The second objective, to fish a narrow light band throughout the day from before sunrise to after sunset was successful. It proved possible to keep the net within a narrow light limit representing some 10-20m depth even when following the light up and down over dusk and dawn. Except for the dawn haul, when the net was believed to have malfunctioned, the catches were large and uniform. They consisted mainly of euphausiids, *Lampanyctus pusillus*, juvenile *Systellaspis*, and *Diaphus rafinesquei*. Compared to a subsequent 500-0m haul there were far more fish and euphausiids in the hauls made using the light meter.

H.S.J. Roe

14. DEEP MIDWATER HAULS

A number of very deep hauls were fished to a depth of 4040m, the main emphasis on being to sample as close to the bottom as possible and to continue with a series of hauls up to 1000m above the bottom. The device used to achieve the first objective was a system of bottom indicator switches. This consisted of a protected conductivity cable running from the net monitor, down the side wires of the nets to a fixed point on the weight bar. The first bottom indicator (a mercury switch in a protective sheath - a section of streamlined stainless steel, with a fin attached) was 12m below the weight bar, the second indicator 26m below the first (a total of 38m below the weight bar). The conducting cable is extremely buoyant and has a high drag and the depths of the indicators were therefore estimated to be 5m and 20m below the bottom bar respectively.

The first two hauls (9541#18 and #19) were fished using the bottom indicator to keep the bottom bar of the RMT 8 between 5 and 20m off the bottom (i.e. the net monitor was about 11m above the bottom at its closest point and 26m above the bottom when the lower indicator made contact). The fishing procedure was somewhat different from previous hauls with the combination net, in that the depth indicated by the monitor was secondary: the main point of reference was the bottom and the relationship between the indicator switches and the bottom was of prime importance. This was of particular importance since a depth error of about +40m was present in the monitor (i.e. it indicated a depth 40m greater than the actual depth).

The method was as follows - when the net had reached the desired depth, it was allowed to stabilise before opening so that it did not rise above the desired horizon when opened. Warp was then paid out until the bottom indicator made contact, causing a shift in the net indicator trace on the mufax; warp was further paid out until the upper indicator made contact - ideally with a "make and break" situation, when the trace on the mufax appeared as a series of dashes. At this point the net was just maintaining its minimum height above the bottom. The net was then allowed to rise until the upper indicator left the bottom and the make and break point of the lower indicator reached. The bottom bar was then 20m above the bottom.

The duration of the hauls was 6 hours for samples up to 1000m above the bottom and for hauls greater than 1000m above the bottom (9541#26: 2510-3000m and #27: 2000-2500m) fishing time was 4 hours. For these latter samples the surface was the point of reference and absolute monitor depths used with no correction allowed for.

The samples from station 9541#18 and #19 were 5-20m above the bottom, #19 on a reciprocal course. The haul from 9541#21 was 20-100m above the bottom but the depth of closure was uncertain; also a fault in the bottom indicator switch for 9541#22 meant that those depth relative to the seabed were uncertain. Depths of samples from station 9541# 24 & 25 were calculated trigonometrically from values for wire out and mean soundings.

A recorder was connected up to the dynamometer output for these hauls and for the OTSB and BN hauls. While the arrangement was not entirely satisfactory for the accurate measurement of the loads involved when fishing the various nets as a relative measurement it was interesting to see that the touching down of the BN and the opening and closing of the RMT could be detected even in 4000m with up to 8000m wire out.

D.M. Shale

15. BENTHIC GEAR

Five benthic samples were taken, three with the BN1.5 and two with the OTSB. The positions fished were repeats of stations fished on cruise 79. Station 9540 was intended as a repeat of St. 9133#5. This was an area that appeared to have the greatest abundance of the anemone Actinoscyphia. When this station was previously sampled the camera failed to operate, while at station 9134 where the sample was similar but less rich, Actinoscyphia were extremely clear in the photographs. It was hoped that the photographs taken in a richer area would yield useful information on spatial distribution.

The other four benthic hauls were taken at approximately 4000m and were also repeats of hauls taken on cruise 79. On initial inspection, the catches were rather poor although there was every indication that the gear had worked perfectly well. These four samples were part of a programme to sample the total water column and to attempt to study the interrelationship between benthic and pelagic animals. On this cruise the camera was used for the first time using colour reversal film. Problems with external switching of the camera were initially overcome by using the 64 minute delay, but the fault was later found to be in the camera's logic system. The external switch could be made to operate by first running the camera on a continuous 15 second cycle and then switching to the external mode between frames.

The garden roller device, designed and made by Mr. R. Wild, to measure the distance run by the gear over the bottom, was used on all hauls. The distances measured approximated to the theoretical distances fished and it can therefore be assumed that the roller gives reasonably accurate results.

R.G. Aldred

16. BENTHIC FAUNA

The epibenthic sledge trawled at station 9540 (2000m) yielded a similar catch qualitatively to that obtained on cruise 79 (station 9133#5). Once again the anemone Actinoscyphia aurelia dominated the catch with two species of spatangoid sea-urchin Pourtalesia miranda and Brissopsis lyrifera. Both sea-urchins were believed to be strictly infaunal but photographs taken from a camera mounted on the sledge showed many Pourtalesia walking about on the surface. Quantitatively however, the catch was much smaller than that encountered on cruise 79. This was probably partly due to a tear in the net. It was also evident from the photographs, although the majority of them were obscured by mud disturbed by the sledge, that the net had not fished satisfactorily. Other animals at this station included a number of Ophiomusium lymani, one Pelopatides gigantea (Holothuroidea), and one fish Coryphaenoides guntheri.

Both epibenthic sledges trawled at station 9541 (4000m) produced sparse catches, dominated by hyalonematid sponges and Crustacea including Pontophilus abyssi and Willemoesia leptodactyla. The macrourid Lionurus occurred as well as a number of bivalves and a synallactid holothurian. The two otter trawls at this station also produced small catches. Fish were well represented by Chalinura, Ericara, Lionurus, Bathypterois, Bathytyphlops Bathyonous and the rare species Rinoctes nasutus. Several large decapod Crustacea, Plesiopenaeus, were present as well as hyalonematid sponges, with spicule stalks up to 30cm long, and the holothurians Pseudostichopus, Paroriza, Benthodytes and Psychropotes. The surprising absence of Xenophyophores from the catch despite their abundance in the photographs was probably the result of the rough handling these delicate organisms received by the gear and sorting technique.

D.S.M. Billett

17. FISHES

In view of the small mouth area of the LNHS/18, the catches of fishes taken on the first leg were not great. Eggs and larvae of clupeids and the sternoptychid Maurolicus comprised the larger part of the sampled icthyofauna and of the mesopelagic adult fauna only those lanternfish that migrated to the surface at night were caught. In the upwelling study areas, the principal lanternfishes were Myctophum punctatum, Symbolophorus veranyi, Hygophum benoiti and Diaphus dumerili. M. punctatum and S. veranyi show common geographic features, being widespread across the N. Atlantic north of c. 35°N and extending southwards in a narrow tongue along the N.W. African coast. H. benoiti is also widespread in the N. Atlantic, but north of c. 25°N, and extends southerly along the African coast in a much broader band. All three species occur in the Mediterranean. D. dumerili is common south of the sampling area, generally associated with the mainstream currents. The population sampled is part of one that extends northwards in a narrow tongue along the African coast. Although the sampling area was small, the sampling coverage not great, some apparent differences in the distribution of these species were noted in the course of sampling. H. benoiti extended the most seaward of the species, inhabiting water columns of the greatest depths, whilst M. punctatum and S. veranyi were common over water columns c. 1000-300m depth, occasionally in shallower ones. D. dumerili occurred only in a narrow band along the shelf-break, generally in a 300-100m water-column, and most often to the exclusion of other surface reaching lanternfishes.

The total water column sampling made at 21°N 20°W showed the so-called bottom dwelling and pelagic species as distinctly living apart. OTSB 14 sampling of the bottom in c. 4000m depth provided catches of benthopelagic species such as the abundant rat-tails Lionurus carapinus, Chalinura profundicula and the ophidiid Bathyonus. Of particular interest were the several alepocephalid specimens of Rinoctes nasatus taken, as well as the large synaphobranchid eel Synobranchus (Histiobranchus) sp. which was caught somewhere between the bottom and 20m off it by the RMT 8. Otherwise, from the bottom to 3000m depth, few, if any, specimens were taken that could be shown convincingly as inhabiting the depths sampled i.e. were not midwater contaminants. Fishes typically of the midwater realm thus occurred in 0-3000m and apparently extended no deeper.

J. Badcock

18. COPEPODA

Surface plankton hauls were kept alive in shallow bowls for behavioural observations. Males and females of the cyclopoid Oncaea venusta were observed forming mating pairs and approximately 120 of these pairs were isolated and preserved. Study of the mating pairs should help to determine the taxonomic status of the two size morphs of this species, the large O. v. forma typica and the small O.v. forma venella. Several individuals of a large species belonging to the aberrant order Misophrioida were noted in the deepest of the RMT 1 hauls. They possess mouthparts characteristic of the Gymnoplea and body segmentation characteristic of the Podoplea.

G.A. Boxshall

19. OSTRACODA

The abundance of the planktonic ostracods paralleled the change in the displacement volume and hence the biomass of the total samples. There was a sharp decrease at 2000m with only a very slight decline from there to close to the sea-bed. There was some indication of an increase in numbers in the samples taken closest to the bottom. The species richness of the deep samples was high and a very large proportion of the species are clearly new. For example the genus Bathyconchoecia, which was only first described in 1968, was represented by at least 15 species of which two thirds are new to science.

The deep samples also illustrate that contamination with shallow-living species which is trivial and unimportant in shallower hauls, becomes a more serious problem when fishing sparsely populated depths. The greater length of time involved in shooting and recovering the nets allows a greater opportunity for contamination to occur.

M.V. Angel

20. BIOLUMINESCENCE

Observations on the luminescence of euphausiids were continued, and the spectral composition of the light recorded from several species for comparison with previous results. A number of animals were frozen for later chemical investigation of the luminescent system, and other specimens fixed for histological purposes. The presence of unusual concentrations of Pleuromamma sp. at the surface at night provided the opportunity for collecting a considerable amount of this copepod, which was deep-frozen for later analysis of its chemistry. Preliminary experiments showed that the animals have an extractable luciferin-luciferase system, which does not cross-react with that of Cypridina. Studies of the luminous gland distribution were undertaken, using fluorescence microscopy, and records of the luminous flashes of individual specimens were also obtained.

Other observations included those on the cephalopods Ommastrephes pteropus and O. barstrami, various bathypelagic decapods and the ophiuroid Ophiomusium lymani. Spectra were obtained from several of these species.

P.J. Herring

21. COMPUTING

The first leg of the cruise made heavy demands on the computing facilities aboard the ship. The navigation was of paramount importance and the CTD/Batfish project came a close second. Daily track charts and profile plots were provided as a routine.

The CTD data was successfully interfaced to the computer but with some data errors. The Batfish data was not succesfully inputted to the computer because of a system executive fault.

There was also a requirement to provide sampling facilities for the biological nutrients phosphate, nitrate, nitrite and silicate as well as a second fluorometer. The temperature profiler analogue signal was routed through to the After Bio. Lab. for display on a chart recorder. Frequent use was made of the meteorological data printed out on the Plotting Office printer, in particular the wind and water current speed and direction and the temperature and salinity profilers.

The second leg of the cruise was less intense, and accurate navigation was the main requirement. A large amount of computer time was therefore spent in processing and plotting the previous legs CTD and fluorescence data. There was also a requirement for depth recording during the deep RMT trawls when the net was only a few metres from the sea bed.

J. Burnham

GEAR USED	ABBREVIATION IN STATION LIST
Batfish	BATFISH
Bottom camera (attached to bottom net)	BCAM
Bottom Net 1.5m^2 closing with 5mm mesh	BN1.5/5C
Conductivity/Temperature/Depth Probe	CTD
Dinoflagellate Net (attached to RMT 1+8)	DN
Fluorometer deck mounted	FL
Fluorometer submersible (mounted in Batfish)	UFL
Light meter on net monitor	LLP
Light meter, photo-diode profiler	LMD
Lowestoft Net High Speed (18cm diameter)	LNHS 18
Nutrient profiling with auto-analyser	AUTO-A
Otter Trawl, semi-balloon 14m headline	OTSB 14
Rectangular midwater trawl 1m^2	RMT 1 } fished in combination
Rectangular midwater trawl 8m^2	RMT 8 }
Rosette multi sampler	MS
Submersible pump	PUMP
Water bottle 30 litre	WB 30

STN.	DATE 1977	POSITION LAT	LONG	GEAR	DEPTH (M)	FISHING TIME GMT	REMARKS	MEAN SOUND M.
9498 # 0	26/ 3	25 13.7N 25 8.9N	15 57.0W 15 58.1W	LNHS/18	0- 4	0343-0413 NIGHT		105
9499 # 1	27/ 3	23 19.6N 23 17.7N	17 18.4W 17 14.2W	LNHS/18	0- 4	0127-0157 NIGHT		985
9499 # 2	27/ 3	23 17.1N 23 15.2N	17 12.8W 17 8.5W	LNHS/18	0- 4	0207-0237 NIGHT		784
9499 # 3	27/ 3	23 14.7N 23 12.7N	17 7.8W 17 3.5W	LNHS/18	0- 4	0244-0314 NIGHT		477
9499 # 4	27/ 3	23 12.5N 23 10.6N	17 3.0W 16 58.9W	LNHS/18	0- 4	0319-0349 NIGHT		110
9499 # 5	27/ 3	23 10.0N 23 8.1N	16 57.8W 16 53.8W	LNHS/18	0- 4	0357-0427 NIGHT	NOSE-CONE LOST	72
9500 # 0	28/ 3	22 48.2N 22 52.9N	17 11.4W 17 5.9W	BATFISH	0- 0	0345-1202	DEPTH LIMITS UNCERTAIN	
9501 # 1	28/ 3	22 32.3N 22 36.1N	17 16.6W 17 16.8W	LNHS/18	0- 4	2258-2328 NIGHT		547
9501 # 2	28/ 3	22 36.8N 22 40.3N	17 16.8W 17 17.0W	LNHS/18	0- 4	2335-0005 NIGHT		583
9501 # 3	29/ 3	22 41.8N 22 45.5N	17 17.1W 17 17.4W	LNHS/18	0- 4	0017-0047 NIGHT		731
9501 # 4	29/ 3	22 46.2N 22 50.1N	17 17.4W 17 17.7W	LNHS/18	0- 4	0054-0126 NIGHT		811
9501 # 5	29/ 3	22 57.8N 23 1.2N	17 18.0W 17 17.5W	LNHS/18	0- 4	0235-0305 NIGHT		755

STN.	DATE 1977	POSITION LAT	LONG	GEAR	DEPTH (M)	FISHING TIME GMT	REMARKS	MEAN SOUND M.
9501 # 6	29/ 3	23 2.0N 23 5.6N	17 17.4W 17 16.8W	LNHS/18	0- 4	0311-0341 NIGHT		958
9501 # 7	29/ 3	23 6.2N 23 10.4N	17 16.7W 17 16.0W	LNHS/18	0- 4	0346-0416 NIGHT		1095
9502 # 0	29/ 3	22 55.8N 22 56.0N	17 7.3W 17 8.0W		0- 0	0837-0900 DAY	DHAN BUOY EXP. SEE CRUISE REPORT	
9503 # 0	29/ 3	22 37.9N 22 35.1N	17 1.6W 17 0.8W	WB 30	10- 10	1206-1224 DAY	C14 EXPT. 1 + PHYTOPLANKTON	
9504 # 1	30/ 3	22 52.4N 22 53.7N	17 43.2W 17 38.5W	LNHS/18	0- 4	0054-0124 NIGHT		1685
9504 # 2	30/ 3	22 54.0N 22 55.4N	17 37.4W 17 32.8W	LNHS/18	0- 4	0134-0204 NIGHT		1438
9504 # 3	30/ 3	22 55.6N 22 55.5N	17 26.5W 17 21.8W	LNHS/18	0- 4	0248-0318 NIGHT		989
9504 # 4	30/ 3	22 55.5N 22 55.4N	17 21.2W 17 16.5W	LNHS/18	0- 4	0324-0354 NIGHT		723
9504 # 5	30/ 3	22 55.2N 22 55.3N	17 10.9W 17 6.2W	LNHS/18	0- 4	0434-0504 NIGHT		244
9505 # 1	31/ 3	20 51.4N 21 40.7N	17 41.0W 17 29.1W	BATFISH	0- 150	1600-0009	C14 EXPT. 2 + PHYTOPLANKTON	
9505 # 2	31/ 3	20 52.6N 20 56.5N	17 40.1W 17 39.6W	LNHS/18	0- 4	1706-1736 DAY		209
9505 # 3	31/ 3	20 58.8N 21 2.2N	17 38.2W 17 35.6W	LNHS/18	0- 4	1800-1830 DAY		260

STN.	DATE 1977	POSITION LAT	LONG	GEAR	DEPTH (M)	FISHING TIME GMT	REMARKS	MEAN SOUND M.
9505 # 4	31/ 3	21 5.5N 21 9.1N	17 34.1W 17 32.3W	LNHS/18	0- 4	1900-1930 DUSK		216
9505 # 5	31/ 3	21 12.5N 21 16.2N	17 32.3W 17 32.2W	LNHS/18	0- 4	2000-2030 NIGHT		265
9505 # 6	31/ 3	21 19.5N 21 23.2N	17 32.3W 17 32.4W	LNHS/18	0- 4	2100-2130 NIGHT		362
9505 # 7	31/ 3	21 26.4N 21 29.9N	17 32.0W 17 31.6W	LNHS/18	0- 4	2200-2230 NIGHT		424
9505 # 8	31/ 3	21 33.0N 21 36.4N	17 30.9W 17 30.1W	LNHS/18	0- 4	2300-2330 NIGHT		415
9505 # 9	1/ 4	21 39.7N 21 41.1N	17 29.3W 17 29.0W	LNHS/18	0- 4	0001-0012 NIGHT		361
9505 # 10	1/ 4	21 44.9N 21 48.3N	17 28.2W 17 27.5W	LNHS/18	0- 4	0101-0131 NIGHT		472
9505 # 11	1/ 4	21 51.1N 21 54.6N	17 26.9W 17 26.1W	LNHS/18	0- 4	0200-0230 NIGHT		496
9505 # 12	1/ 4	21 57.6N 22 1.0N	17 25.4W 17 24.7W	LNHS/18	0- 4	0300-0330 NIGHT		103
9505 # 13	1/ 4	22 4.3N 22 8.0N	17 24.2W 17 23.7W	LNHS/18	0- 4	0400-0430 NIGHT		149
9506 # 1	1/ 4	22 39.9N 22 40.3N	17 43.7W 17 43.6W	CTD MS	0-1000	1327-1435 DAY		1722
9506 # 2	1/ 4	22 40.6N 22 41.5N	17 43.9W 17 44.5W	CTD LMD PUMP FL	0- 10	1527-1700 DAY	PUMP MALFUNCTIONED-C14 EXPT.3+PHYTO.	

STN.	DATE 1977	POSITION LAT	LONG	GEAR	DEPTH (M)	FISHING TIME GMT	REMARKS	MEAN SOUND M.
9507 # 1	1/ 4	22 43.7N 22 56.6N	17 44.6W 17 17.2W	BATFISH	12- 365	1925-1245	C14 EXPT.4 + PHYTO. (SAMPLED @ 1325)	
9507 # 2	1/ 4	22 44.1N 22 45.6N	17 44.5W 17 41.3W	LNHS/18	0- 4	1930-2000 DUSK		1738
9507 # 3	1/ 4	22 46.0N 22 47.6N	17 40.4W 17 36.2W	LNHS/18	0- 4	2009-2039 NIGHT		1705
9507 # 4	1/ 4	22 47.8N 22 49.0N	17 35.3W 17 30.7W	LNHS/18	0- 4	2046-2116 NIGHT		1443
9507 # 5	1/ 4	22 50.1N 22 51.6N	17 26.2W 17 21.3W	LNHS/18	0- 4	2202-2232 NIGHT		1007
9507 # 6	1/ 4	22 53.5N 22 55.2N	17 15.6W 17 10.7W	LNHS/18	0- 4	2312-2342 NIGHT		692
9507 # 7	2/ 4	23 2.6N 22 58.7N	17 15.1W 17 18.4W	LNHS/18	0- 4	0109-0139 NIGHT		744
9507 # 8	2/ 4	22 56.3N 22 55.3N	17 16.4W 17 12.0W	LNHS/18	0- 4	0215-0245 NIGHT	NOSE CONE CRACKED	573
9507 # 9	2/ 4	22 52.3N 22 53.8N	17 13.0W 17 18.1W	LNHS/18	0- 4	0328-0358 NIGHT	METAL NOSE CONE USED FROM NOW ON	644
9507 # 10	2/ 4	22 57.9N 23 0.2N	17 25.7W 17 21.6W	LNHS/18	0- 4	0509-0539 NIGHT		970
9507 # 11	2/ 4	23 0.0N 23 4.9N	17 13.1W 17 13.1W	LNHS/18	0- 4	0650-0720 DAY		631
9508 # 1	2/ 4	22 54.9N	17 7.1W		0- 0	1630- DAY	DHAN BUOY EXP/CRUISE REPORT. C14 S+P	

STN.	DATE 1977	POSITION LAT	LONG	GEAR	DEPTH (M)	FISHING TIME GMT	REMARKS	MEAN SOUND M.
9508 # 2	2/ 4	22 55.0N 22 55.0N	17 7.5W 17 7.8W	CTD LMD PUMP FL	3- 108	1655-1742 DAY		285
9508 # 3	2/ 4	22 54.7N 22 54.7N	17 7.5W 17 7.5W	CTD LMD MS	0- 133	1900-1921 DUSK		135
9508 # 4	2/ 4	22 54.6N 22 54.6N	17 7.6W 17 7.6W	CTD LMD	Q- 128	1930-1937 DUSK		133
9508 # 5	2/ 4	22 54.1N 22 53.8N	17 7.7W 17 8.0W	CTD LMD PUMP FL	3- 107	2050-2205 NIGHT	AUTO-ANALYSER	164
9509 # 1	3/ 4	23 5.3N 23 0.5N	17 5.7W 17 9.1W	LNHS/18	0- 4	0326-0356 NIGHT		473
9509 # 2	3/ 4	23 4.3N 22 59.7N	17 3.4W 17 6.2W	LNHS/18	0- 4	0527-0557 NIGHT		177
9509 # 3	3/ 4	22 58.5N 22 53.6N	17 7.1W 17 8.6W	LNHS/18	0- 4	0605-0635 DAWN		206
9510 # 1	3/ 4	22 54.7N 22 54.5N	17 8.1W 17 7.9W	CTD LMD PUMP FL	3- 107	0909-1002 DAY	AUTO-ANALYSER -C14 EXPT. 6 + PHYTO.	179
9510 # 2	3/ 4	22 54.1N 22 53.9N	17 8.5W 17 8.7W	CTD MS	0- 187	1102-1126 DAY		262
9511 # 1	3/ 4	22 51.5N 22 51.0N	17 12.0W 17 12.8W	CTD LMD PUMP FL	3- 107	1408-1459 DAY	AUTO-ANALYSER.	636

STN.	DATE 1977	POSITION LAT	POSITION LONG	GEAR	DEPTH (M)	FISHING TIME GMT	REMARKS	MEAN SOUND M.
9511 # 2	3/ 4	22 49.7N 22 49.3N	17 13.5W 17 14.4W	CTD MS	0- 668	1551-1653 DAY	PHYTOPLANKTON SAMPLE	817
9512 # 0	3/ 4	22 48.5N 22 48.5N	17 17.3W 17 17.5W		0- 0	1746-1755 DAY	DHAN BUOY EXP. SEE CRUISE REPORT.	
9513 # 1	3/ 4	22 46.7N 22 46.4N	17 17.4W 17 18.1W	CTD PUMP FL AUTO-A	3- 107	1859-1953 DUSK	PHYTOPLANKTON SAMPLE	897
9513 # 2	3/ 4	22 46.4N 22 46.5N	17 18.4W 17 18.9W	CTD MS	0- 884	2018-2108 NIGHT		897
9514 # 1	3/ 4	22 49.9N 22 54.5N	17 7.5W 17 6.6W	LNHS/18	0- 4	2332-0002 NIGHT		117
9514 # 2	4/ 4	22 54.8N 22 49.8N	17 8.8W 17 10.0W	LNHS/18	0- 4	0051-0121 NIGHT		390
9514 # 3	4/ 4	22 49.3N 22 53.6N	17 12.3W 17 11.5W	LNHS/18	0- 4	0207-0237 NIGHT		594
9514 # 4	4/ 4	22 52.7N 22 47.7N	17 14.5W 17 15.6W	LNHS/18	0- 4	0341-0411 NIGHT		661
9514 # 5	4/ 4	22 49.4N 22 53.8N	17 17.6W 17 16.7W	LNHS/18	0- 4	0455-0525 NIGHT		717
9514 # 6	4/ 4	22 53.7N 22 48.2N	17 18.7W 17 20.7W	LNHS/18	0- 4	0606-0636 DAWN		800
9515 # 1	4/ 4	22 41.3N 22 41.0N	17 27.0W 17 27.3W	CTD LMD PUMP FL	3- 100	1010-1103 DAY	AUTO-ANALYSER -PHYTOPLANKTON SAMPLE	1039

STN.	DATE 1977	POSITION LAT	LONG	GEAR	DEPTH (M)	FISHING TIME GMT	REMARKS	MEAN SOUND M.
9515	4/ 4	22 40.9N	17 27.4W	CTD	0- 502	1115-1153		1097
# 2		22 40.8N	17 27.5W	MS		DAY		
9516	4/ 4	22 34.7N	17 37.9W	CTD	3- 105	1331-1429	AUTO-ANALYSER -C14 EXPT. 7 + PHYTO.	1520
# 1		22 34.4N	17 38.4W	LMD		DAY		
				PUMP				
				FL				
9516	4/ 4	22 34.4N	17 38.5W	CTD	0- 499	1446-1515		1557
# 2		22 34.3N	17 38.7W	MS		DAY		
9517	4/ 4	22 31.0N	17 45.4W	CTD	3- 105	1626-1739	AUTO-ANALYSER -PHYTOPLANKTON SAMPLE	2038
# 1		22 31.3N	17 45.5W	LMD		DAY		
				PUMP				
				FL				
9517	4/ 4	22 31.5N	17 45.6W	CTD	0- 492	1756-1816		2052
# 2		22 31.5N	17 45.8W	MS		DAY		
9518	5/ 4	22 54.1N	17 14.1W	LNHS/18	0- 4	0034-0105		448
# 0		22 57.0N	17 9.5W			NIGHT		
9519	5/ 4	23 1.8N	17 2.6W	CTD	3- 95	0220-0309	PHYTOPLANKTON SAMPLE	99
# 0		23 1.7N	17 3.3W	PUMP		NIGHT		
				FL				
				AUTO-A				
9520	5/ 4	23 1.7N	16 53.1W	CTD	3- 54	0504-0536	PHYTOPLANKTON SAMPLE	60
# 0		23 1.7N	16 53.3W	PUMP		NIGHT		
				FL				
				AUTO-A				
9521	6/ 4	21 18.7N	17 44.0W	LNHS/18	0- 4	0553-0623		533
# 0		21 19.0N	17 38.9W			NIGHT		
9522	6/ 4	21 8.8N	17 52.2W	CTD	2- 105	1831-1938	AUTO-ANALYSER -C14 EXPT. 8 + PHYTO.	1248
# 0		21 8.4N	17 52.5W	LMD		DUSK		
				PUMP				
				FL				

STN.	DATE 1977	POSITION LAT	LONG	GEAR	DEPTH (M)	FISHING TIME GMT	REMARKS	MEAN SOUND M.
9523 # 0	6/ 4	21 6.3N 21 6.1N	17 54.1W 17 53.8W	CTD PUMP FL AUTO-A	3- 107	2045-2136 NIGHT	PHYTOPLANKTON SAMPLE	1453
9524 # 0	6/ 4	21 5.3N 21 5.1N	17 59.3W 17 59.1W	CTD PUMP FL AUTO-A	3- 102	2307-2352 NIGHT	PHYTOPLANKTON SAMPLE	1739
9525 # 0	7/ 4	21 4.2N 21 4.0N	18 9.4W 18 9.5W	CTD PUMP FL AUTO-A	3- 106	0128-0214 NIGHT	PHYTOPLANKTON SAMPLE	2246
9526 # 0	7/ 4	21 8.9N 21 8.5N	17 45.8W 17 46.0W	CTD PUMP FL AUTO-A	3- 105	0521-0611 NIGHT	PHYTOPLANKTON SAMPLE	780
9527 # 0	7/ 4	21 8.6N 21 8.4N	17 33.2W 17 33.3W	CTD PUMP FL AUTO-A	3- 107	0807-0839 DAY	C14 EXPT. 9 + PHYTO.	226
9528 # 0	7/ 4	21 9.0N 21 9.0N	17 25.9W 17 26.0W	CTD PUMP FL AUTO-A	2- 77	1002-1024 DAY	C14 EXPT. 10 + PHYTO.	85
9529 # 1	7/ 4	21 9.5N 21 9.6N	17 18.5W 17 18.6W	CTD LMD PUMP FL	0- 54	1207-1242 DAY	AUTO-ANALYSER -C14 EXPT. 11 + PHYTO.	60
9529 # 2	7/ 4	21 9.6N 21 9.7N	17 18.6W 17 18.6W	CTD LMD PUMP FL	8- 8	1250-1301 DAY	AUTO-ANALYSER.	60.

STN.	DATE 1977	POSITION LAT	LONG	GEAR	DEPTH (M)	FISHING TIME GMT.	REMARKS	MEAN SOUND M.
9529 # 3	7/ 4	21 10.5N 21 11.0N	17 18.4W 17 18.3W	CTD LMD PUMP FL	3- 52	1440-1546 DAY	AUTO-ANALYSER.	60
9530 # 1	7/ 4	21 15.7N 21 6.3N	17 31.3W 17 18.7W	BATFISH	0- 60	1820-1137		
9530 # 2	8/ 4	21 9.6N 21 9.8N	17 40.1W 17 44.6W	LNHS/18	0- 4	0125-0155 NIGHT		539
9530 # 3	8/ 4	21 8.2N 21 3.5N	18 8.7W 18 8.6W	LNHS/18	0- 4	0450-0520 NIGHT		2085
9531 # 0	8/ 4	21 7.5N 21 9.1N	17 19.2W 17 19.5W	CTD PUMP FL MS	2- 47	1506-1642 DAY	AUTO-ANALYSER -OXYGEN + PHYTO.	60
9532 # 0	8/ 4	20 35.7N 20 31.0N	17 18.0W 17 18.6W	LNHS/18	0- 4	2020-2050 NIGHT	SOUNDING APPROXIMATE	40
9533 # 0	9/ 4	19 44.4N 19 40.2N	17 19.5W 17 20.0W	LNHS/18	0- 4	0137-0207 NIGHT		1056
9534 # 0	9/ 4	19 8.5N 19 4.2N	17 22.0W 17 22.1W	LNHS/18	0- 4	0519-0549 NIGHT		
9535 # 0	9/ 4	16 36.1N 16 31.4N	17 27.5W 17 27.3W	LNHS/18	0- 4	2020-2050 NIGHT		
9536 # 0	10/ 4	15 59.2N 15 54.6N	17 29.6W 17 30.0W	LNHS/18	0- 4	0004-0034 NIGHT		

STN.	DATE 1977	POSITION LAT	LONG	GEAR	DEPTH (M)	FISHING TIME GMT	REMARKS	MEAN SOUND M.
9537 # 0	13/ 4	16 31.9N 16 36.4N	17 47.5W 17 48.0W	LNHS/18	0- 4	0202-0232 NIGHT		2612
9538 # 0	13/ 4	17 1.1N 17 5.1N	17 50.3W 17 50.9W	LNHS/18	0- 4	0533-0603 NIGHT		2697
9539 # 0	13/ 4	19 10.2N 19 14.9N	18 7.2W 18 7.6W	LNHS/18	0- 4	2022-2052 NIGHT	0.32 MM MESH SIZE USED FROM NOW ON.	2504
9540 # 0	14/ 4	20 55.8N 20 56.2N	18 9.6W 18 9.1W	BN1.5/5C BCAM	2005-2009	1002-1038 DAY	NET TORN.	
9541 # 1	15/ 4	20 7.0N 20 7.7N	21 25.3W 21 25.1W	BN1.5/5C BCAM	3850-3854	0912-0946 DAY		
9541 # 2	15/ 4	20 10.7N 20 10.8N	21 24.6W 21 25.4W	LLP	0-1000	1230-1440 DAY	LIGHT METER TEST ON VERTICAL WIRE.	
9541 # 3	15/ 4	20 8.1N 20 8.6N	21 41.2W 21 40.8W	BN1.5/5C BCAM	3910-3912	1940-2012 NIGHT		
9541 # 4	15/ 4	20 10.4N 20 10.8N	21 39.2W 21 39.6W	CTD	0-3944	2242-0130 NIGHT	MONITOR CALIBRATION.	3950
9541 # 5	16/ 4	20 16.8N 20 18.5N	21 30.9W 21 28.5W	OTSB 14	3936-3943	0610-0736 DAWN	TOW LENGTH UNCERTAIN - SEE BIO LOG.	
9541 # 6	16/ 4	20 9.6N 20 10.9N	21 43.4W 21 41.4W	OTSB 14	3929-3929	1644-1758 DAY		
9541 # 7	17/ 4	20 13.6N 20 11.8N	21 35.1W 21 30.5W	RMT 1 RMT 8 DN	610- 800	0050-0250 NIGHT	FLOW DIST. 7.19 KM.	3937
9541 # 8	17/ 4	20 11.0N 20 9.4N	21 28.9W 21 25.7W	RMT 1 RMT 8 DN	525-1000	0345-0533 NIGHT	FLOW DIST. 5.80 KM.	3897

STN.	DATE 1977	POSITION LAT	POSITION LONG	GEAR	DEPTH (M)	FISHING TIME GMT	REMARKS	MEAN SOUND M.
9541 # 9	17/ 4	20 8.1N 20 6.0N	21 23.6W 21 20.5W	RMT 1 RMT 8 DN LLP	120- 400	0643-0843 DAWN	FLOW DIST. 6.74 KM.	
9541 # 10	17/ 4	20 5.1N 20 2.5N	21 19.3W 21 16.5W	RMT 1 RMT 8 DN LLP	400- 520	1011-1211 DAY	FLOW DIST. 6.52 KM.	
9541 # 11	17/ 4	20 1.4N 19 58.6N	21 15.3W 21 12.3W	RMT 1 RMT 8 DN LLP	430- 510	1305-1505 DAY	FLOW DIST. 6.92 KM.	
9541 # 12	17/ 4	19 58.6N 19 59.7N	21 12.9W 21 16.7W	RMT 1 RMT 8 DN LLP	440- 500	1608-1736 DAY	FLOW DIST. 5.25 KM.	
9541 # 13	17/ 4	20 0.6N 20 3.0N	21 19.0W 21 22.4W	RMT 1 RMT 8 DN LLP	60- 405	1846-2020 DUSK	RMT 1 NET TORN. FLOW DIST. 6.75 KM.	
9541 # 14	17/ 4	20 6.5N 20 7.7N	21 26.0W 21 27.6W	RMT 1 RMT 8	0- 100	2336-0018 NIGHT	LEAKAGE TEST. 0.5 HR AT 151 M.W.O.	
9541 # 15	18/ 4	20 7.9N 20 8.8N	21 28.0W 21 29.7W	RMT 1 RMT 8	0- 100	0029-0112 NIGHT	LEAKAGE TEST. RMT 8 COD-END LOST.	
9541 # 16	18/ 4	20 10.5N 20 11.5N	21 28.1W 21 29.9W	RMT 1 RMT 8	0- 100	0403-0444 NIGHT	LEAKAGE TEST. 0.5 HR AT 150 M.W.O.	
9541 # 17	18/ 4	20 12.0N 20 12.0N	21 30.7W 21 31.0W	RMT 1 RMT 8	85- 130	0513-0519 NIGHT	MONITOR TEST. FLOW DIST. 0.44 KM.	

STN.	DATE 1977	POSITION LAT	POSITION LONG	GEAR	DEPTH (M)	FISHING TIME GMT	REMARKS	MEAN SOUND M.
9541 # 18	18/ 4	20 18.5N 20 20.8N	21 41.2W 21 53.0W	RMT 1 RMT 8 DN	3790-4020	1025-1625 DAY	FLOW DIST. 17.57 KM.	4036
9541 # 19	18/ 4	20 19.7N 20 18.4N	21 51.3W 21 40.5W	RMT 1 RMT 8 DN	3970-4040	2239-0439 NIGHT	DN NET TORN. FLOW DIST. 16.70 KM.	4060
9541 # 20	19/ 4	20 17.8N 20 17.7N	21 36.1W 21 34.5W	RMT 1 RMT 8	0- 650	0702-0758 DAY	LEAKAGE TEST. MONITOR FAILED.	
9541 # 21	19/ 4	20 20.5N	21 31.3W	RMT 1 RMT 8	0-3920	1557- DAY	DEPTH AT CLOSE UNCERTAIN.	3955
9541 # 22	20/ 4	20 8.9N 20 12.5N	21 25.0W 21 37.7W	RMT 1 RMT 8	3740-3870	0945-1545 DAY	FLOW DIST. 18.86 KM.	3890
9541 # 23	20/ 4	20 14.4N 20 16.7N	21 42.7W 21 43.9W	RMT 1 RMT 8 DN	0- 700	1837-1946 DAY	HAUL ABORTED.	3983
9541 # 24	21/ 4	20 20.1N 20 25.4N	21 45.0W 21 56.3W	RMT 1 RMT 8 DN	3520-3940	0023-0623 NIGHT	FLOW DIST. 18.36 KM.	4078
9541 # 25	21/ 4	20 23.6N 20 13.8N	21 56.4W 21 48.0W	RMT 1 RMT 8 DN	3020-3520	1123-1723 DAY	DN COD-END TORN. FLOW DIST. 19.73 KM.	4100
9541 # 26	21/ 4	20 11.4N 20 12.4N	21 40.9W 21 31.3W	RMT 1 RMT 8	2510-3000	2135-0135 NIGHT	FLOW DIST. 13.57 KM.	3925
9541 # 27	22/ 4	20 9.9N 20 5.3N	21 26.0W 21 17.8W	RMT 1 RMT 8 DN	2000-2500	0602-1002 DAY	FLOW DIST. 14.00 KM.	3845

STN.	DATE 1977	POSITION LAT	LONG	GEAR	DEPTH (M)	FISHING TIME GMT	REMARKS	MEAN SOUND M.
9541 # 28	22/ 4	20 3.0N 20 1.2N	21 12.9W 21 9.6W	RMT 1 RMT 8 DN	510-1000	1236-1436 DAY	FLOW DIST. 7.15 KM.	3780
9541 # 29	22/ 4	20 1.5N 20 1.5N	21 10.8W 21 15.9W	RMT 1 RMT 8 DN	10- 500	1548-1748 DAY	FLOW DIST. 8.43 KM.	3775
9541 # 30	22/ 4	20 1.8N 20 1.3N	21 19.8W 21 29.0W	RMT 1 RMT 8 DN	995-1500	1921-2321 NIGHT	FLOW DIST. 14.50 KM.	3810
9541 # 31	23/ 4	20 0.6N 20 1.3N	21 35.8W 21 44.7W	RMT 1 RMT 8 DN	1515-2000	0221-0621 NIGHT	FLOW DIST. 14.56 KM.	3848
9541 # 32	23/ 4	20 0.4N 19 59.9N	21 46.5W 21 47.7W	CTD	0-3852	0821-1043 DAY	MONITOR CALIBRATION.	3860
9542 # 0	23/ 4	21 13.6N 21 17.5N	21 12.2W 21 10.0W	LNHS/18	0- 4	2046-2116 NIGHT		2264
9543 # 0	24/ 4	21 38.6N 21 42.3N	20 58.3W 20 56.2W	LNHS/18	0- 4	0001-0031 NIGHT		
9544 # 0	24/ 4	22 19.3N 22 22.6N	20 36.3W 20 34.5W	LNHS/18	0- 4	0537-0607 NIGHT		
9545 # 0	24/ 4	23 59.6N 24 3.1N	19 34.6W 19 32.6W	LNHS/18	0- 4	2059-2129 NIGHT		
9546 # 0	25/ 4	24 22.7N 24 26.5N	19 21.8W 19 19.7W	LNHS/18	0- 4	0016-0046 NIGHT		
9547 # 0	25/ 4	27 24.6N 27 29.5N	17 36.4W 17 33.7W	LNHS/18	0- 4	2115-2145 NIGHT		

STN.	DATE 1977	POSITION LAT	POSITION LONG	GEAR	DEPTH (M)	FISHING TIME GMT	REMARKS	MEAN SOUND M.
9548	26/ 4	28 1.6N	17 7.6W	LNHS/18	0- 4	0052-0122		
# 0		28 6.6N	17 4.1W			NIGHT		
9549	26/ 4	31 17.5N	15 26.1W	LNHS/18	0- 4	2038-2108		
# 0		31 22.7N	15 24.0W			NIGHT		
9550	27/ 4	32 10.7N	15 3.9W	LNHS/18	0- 4	0159-0229		
# 0		32 15.5N	15 1.9W			NIGHT		
9551	27/ 4	35 10.5N	13 46.5W	LNHS/18	0- 4	2101-2131		
# 0		35 15.1N	13 44.5W			NIGHT		
9552	28/ 4	35 41.0N	13 32.8W	LNHS/18	0- 4	0020-0050		
# 0		35 45.5N	13 30.7W			NIGHT		
9553	28/ 4	35 2.8N	13 23.3W	LNHS/18	0- 4	0246-0316		
# 0		35 7.6N	13 21.5W			NIGHT		
9554	28/ 4	36 22.6N	13 15.7W	LNHS/18	0- 4	0502-0532		
# 0		36 26.7N	13 14.7W			DAWN		

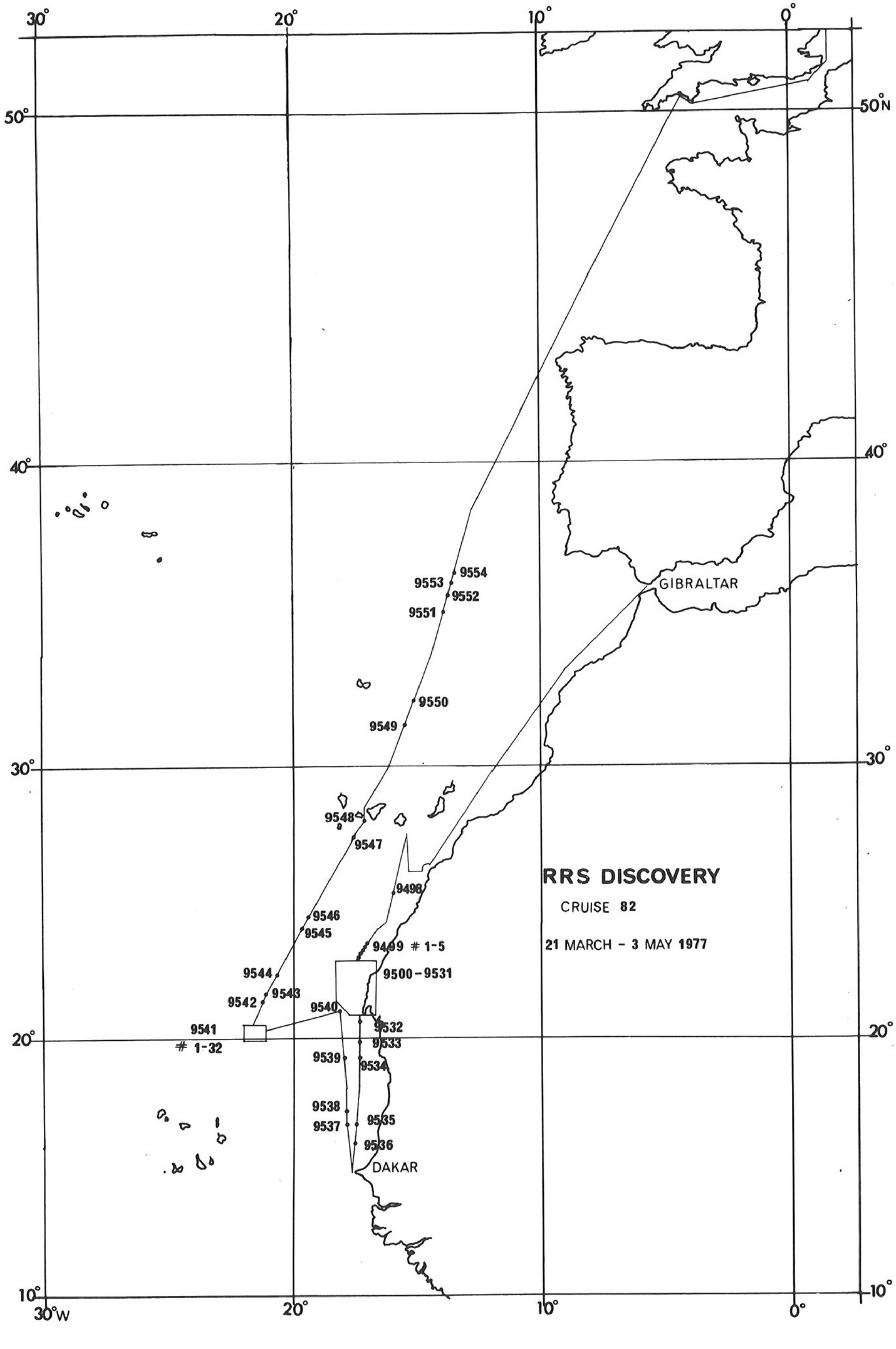

Figure 1. Track Chart

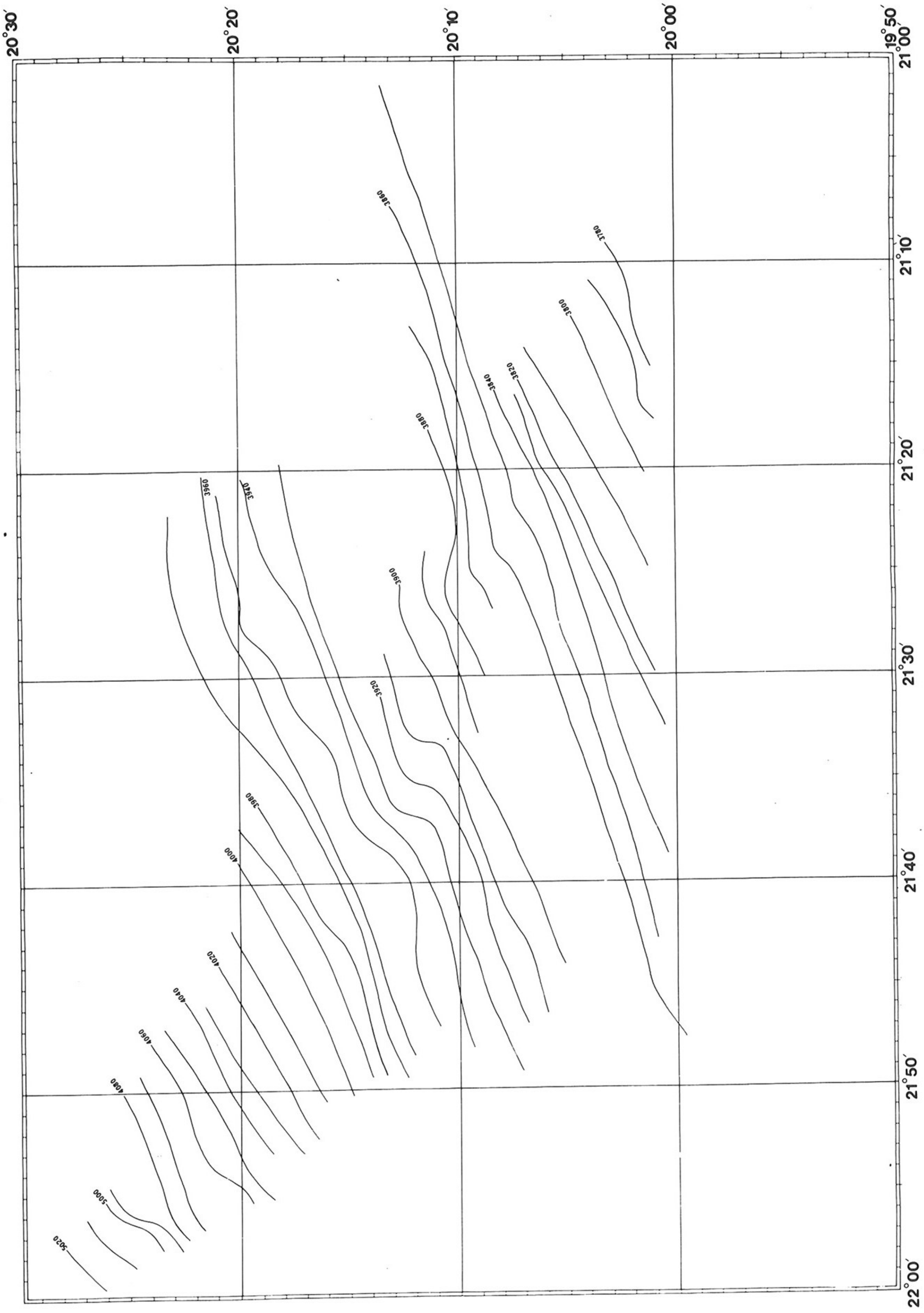

Figure 2. Bathymetry in the vicinity of 20°N 21°W.