R.R.S. DISCOVERY

CRUISE 77

15 JULY - 31 AUGUST 1976

DISTRIBUTION AND PHYSIOLOGY OF PLANKTON AND BENTHOS IN THE REGION OF THE CANARY ISLANDS

CRUISE REPORT No. 46

1976

NATURAL ENVIRONMENT RESEARCH COUNCIL

INSTITUTE OF OCEANOGRAPHIC SCIENCES

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*Left at Santa Cruz

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ABBREVIATIONS

RMT1	1m^2 Rectangular Midwater Trawl (0.33mm mesh)
RMT8	8m Rectangular Midwater Trawl (5mm mesh)
	The RMT1 and RMT8 were always used in combination.
RMT25/20	25m^2 Rectangular Midwater Trawl (20mm mesh)
DN	Dinoflagellate Net. Always used in combination with the RMT1+8 system.
NN	Neuston Net
BN2.4/5	2.4m^2 Bottom Net (5mm mesh).
Trap B	Bottom Trap
OTSB14	14m Otter Trawl (Semi-Balloon)
CTD	Conductivity, Temperature and Depth probe
MS	Multisampler
FL	Fluorometer
UFL	Underwater Fluorometer
LMD	Photo-diode Light Meter
LLP	Deep-sea photometer
PUMP	Pump sampler

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INTRODUCTION

The aims of Cruise 77 were to combine the collection of live material for shipboard physiological and/or biochemical investigation with the specific sampling requirements of the I.O.S. Wormley biological programme. The first of the two main sampling programmes involved 72 hours of continuous tows at two depths, in order to follow the vertical migration and feeding patterns of fish and decapod crustaceans. The second programme consisted of a transect of bottom tows, using sledge net and otter trawl at each station, at 600m depth intervals from 600m to 3600m. Within this general framework an opportunity was provided for extensive fishing trials of the otter trawl, tests of a deep-sea photometer on the combination net (RMT1+8) continuously recording on one of the net monitor channels, and trials of a pop-up fish trap system. Additional experimental fishing with the RMT25/20/was included in the programme, and, in the second leg, tests of, and experience with, the combined CTD, multisampler, lightmeter and *in situ* fluorometer, as well as pump-sampling experiments for the investigation of microstructure.

The physiological and biochemical programmes concentrated largely on studies of bioluminescence and eye structure and function in a wide variety of both midwater and benthic animals. They also included studies on lipid metabolism and echinoid biology.

Cruise 77 was the first lengthy cruise since Discovery's major refit in 1976, and it was intended that the limited demands of the basic programme on computer time would allow the data-logging, navigational and other programmes to be tested and refined for routine availability on subsequent cruises.

ITINERARY

Leg 1: Barry to Santa Cruz, Tenerife

Discovery sailed from Barry at 1000 hrs July 15. The port electromagnetic log soon began giving erroneous values and the starboard one was utilised instead for the rest of the cruise. The IBM 1800 came on line on 16th July and the

PES fish was streamed at 1530 16th July. Clocks were retarded by one hour to GMT and all ships times were in GMT throughout the cruise. On arrival at 44°N 13°W a series of repeat tows with the RMT 1+8 combination net was initiated as part of the seasonal coverage of this position. Difficulty with the net monitors was experienced during the night tows and only two of the three intended hauls were achieved, but the three subsequent day hauls were all successful. The ship departed from the position at 1730 18th July, when regular echo sounding watches were initiated. Two material hauls were made daily during passage to the 72 hour series position, which was reached at midnight 23rd July. A vertical series of fourteen combination net hauls was made to determine the approximate depth distribution of the species in the area, and, on the basis of these hauls, it was decided that the two depths to be fished during the 72 hour series would be 900-800m and 500-400m. This series was begun 0720 25th July, and 35 hauls were made over the next three days, the series being completed at 0826 28th July. Unfortunately Dr. A.T. Barnes became ill and the ship had to be diverted to Tenerife. The ship left at 0830 28th July, arriving off Santa Cruz breakwater at 1104 29th July. Dr. Barnes was disembarked and the ship left Santa Cruz at 1143. In view of our position, and the relative paucity of the fauna at the 72 hour series position, a programme of RMT25/20 hauls for physiological purposes was begun just north of Tenerife. After six tows it became apparent that the small catches obtained probably resulted from release gear failure, and the RMT 1+8 nets were utilised instead. Eight additional hauls were made, interspersed with tests of the deep-sea photometer, ending at 2300 31st July. The ship then steamed back to the northerly position for the transect of benthic stations, and the transect commenced at 1337 2nd August. Otter trawls and bottom nets at each station continued until 1605 5th August and were successful at all but the deepest position (3773m) at which the trawl failed to reach the bottom. Two additional otter trawls were fished on August 6th, and a pop-up fish trap was laid and successfully recovered in 925m. A moonlight test of the deep-sea photometer and a midwater tow with the otter trawl preceded the passage to Santa Cruz, which commenced at 0400 7th August. Two RMT 1+8 hauls were fished during the passage, and the ship came alongside in Santa Cruz at 0844 9th August.

At Santa Cruz Dr. Anderson, Dr. Clarke, Prof. Denton, Dr. Land, Mr. Maddock, Dr. Morris and Mr. Phillips left the ship. At the same time Captain Selby-Smith and the second mate, Mr. Coombs, were relieved by Captain Bowen and Mr. Pilgrim.

Dr. Bertelsen, Dr. Campbell, Dr. Fasham, Mr. Flewellen, Dr. Morin, Dr. Pugh and Mr. Smithers joined the scientific complement in Santa Cruz.

Leg 2: Santa Cruz to Barry

Discovery left Santa Cruz at 1600 11th August and headed south in an attempt to find a more varied midwater fauna. A trawling programme was initiated at 0720 10th August, whose aims were to sample the upper layers (to 700m) at night and the deeper layers (600-1000m) by day, in 100m intervals, with the RMT 1+8 combination net. Additional 100m horizons were fished between 1000 and 1500m with less concern for the time of day. Initial problems with the net monitor were soon overcome, and a total of 21 trawls were made, covering the intended depth ranges. Two RMT 25/20 trawls were made subsequently, with the net open after the bridles again pulled out of the release gear jaws during an initial trial.

The midwater hauls were completed at 2350 15th August and Discovery proceeded up the channel between the Canaries and the African coast for a series of experimental bottom tows with the OTSB14 and BN2.4/5. These began at 0957 16th August and continued until 1530 19th August, during which time 7 otter trawls and 6 bottom nets were fished, as well as two tows with the deep-sea photometer on the RMT1+8. Four more combination net tows were made on the passage back to the transect positions of the first leg, and a CTD test was carried out. Either otter trawls or bottom net repeat tows on the 1200m, 1800m, 2400m and 3600m transect positions were carried out, commencing at 2105 20th August. The OTSB14 failed to reach the bottom at the deepest station. Two material hauls were made with the combination net, and a CTD, fluorometer and pump-sampling station was undertaken, ending at 2215 22nd August, so completing this phase of the programme.

The vessel sailed to the Seine abyssal plain for a successful BN2.4/5 in 4450m on 23rd August, and then began a gradual homeward passage. A deep oblique combination net was fished between 1500 and 3000m on 24th August, and two final combination nets for material during the night of 24th/25th August. An echo-sounding survey of a portion of the Coral Patch Seamount was made with a view to fishing some bottom nets, but no suitable area was encountered and the attempt was abandoned. The vessel sailed for Galicia Bank instead, arriving on station at 0200 26th August, having stopped en route for a CTD calibration dip to 1000m. Three bottom nets were fished, but during the third tow the net hit an obstacle and the eye-splice in the main warp parted, resulting in loss of the gear. The fishing programme on Galicia Bank was therefore terminated and the ship sailed northwards on 27th August for a benthic station at 47°N 11°W. CTD, fluorometer and light meter work was carried out on Galicia Bank between the benthic stations and again on passage to the northerly position. This position was reached at 0750 28th August and a BN2.4/5 fished with 8500 metres of wire out, but failed to reach the bottom. An attempt was made to find a shallower area for a bottom net, but a short run over the Mariadzek Terrace failed to reveal any suitable region. In view of the deterioration in the weather and the failure of the electric winch for the CTD, passage for Barry was made at 0530 29th August, and Discovery came alongside at 9030 31st August.

GEAR

1. RMT NETS (D.M. Shale and R.A. Wild)

RMT 1+8

A total of 107 tows were made with the combination nets. Seventy-five on the first leg, of which 35 constituted three consecutive 24-hour series. Most tows were in the upper 1000m; only three were taken below 2000m, two of which were to 3000m. The gear functioned throughout without mechanical failure, the only replacements necessary were three changes of release gear strops and RMT 8 polypropylene bar inserts. Brass RMT 8 side wire discs are now standard, replacing the original polypropylene discs. Stainless steel release gear clamping bands have replaced the short strops and are a great improvement both in safety and for the adjustment of bridle lengths.

For the first 24 hauls the conventional cod-end system was used on the RMT 1, but subsequently an experimental cod-end tube of rigid PVC was used. The two halves of the tube are locked together by 4 clamps, trapping the liner, which has an 'O' ring sewn into the mouth. The tube was given extensive testing (83 hauls) and was found to be reliable and easy to operate.

Closing Cod-End

This was fitted to the RMT 8 for only four hauls. The closing mechanism operated prematurely on the first two hauls (Stns 8964 & 8997) and the liner was trapped between the closing plates on the third (Stn 9004). The mechanism was rechecked and the release trigger tension increased, before it was used again at station 9013 where it operated correctly, but on recovery the water temperature in the upper two-thirds of the bucket was in excess of 21°C and only the very bottom was still cold. The indication was that slopping of the water occurred during hauling and recovery and that some form of collar-sealing device is therefore necessary.

Dinoflagellate Net

This was used on thirteen hauls with the combination net. The first three used the original net from Cruises 64 and 65, 1974. This, however, proved to be inadequate and a new net was constructed of 61µm mesh nylon. It has a triangular mouth, which is laced between the closing bridles of the RMT 1. A non-porous flap is fitted into the mouth of the net with 'Velcro', forming an effective, leak-free seal to the net when paying out. A line attached to the flap passes to the ring of the opening bridle of the RMT 8, so that when the latter opens, the flap is pulled away from the mouth of the DN, opening the net.

The main problem, however, was leakage on hauling, but this was cured by reinforcing the mouth with a section of brass rod.

The cod-end consists of two polypropylene discs, between which filtration discs of netting are clamped. On recovery the discs are removed and preserved with the sample left intact upon them.

RMT25/20

Eight hauls were made with the RMT 25, but the catches were all disappointingly small. The net closed prematurely (Stn 8954) when the bridles pulled out of the release gear (previous RMT 25 hauls were considered suspect for the same reason). On examination of the release gear, the long release arms were found to be badly deformed and were replaced. The net was fished again at Stn 9005 but the bridles again pulled out. A load test on the open net indicated a $\frac{1}{2}$ ton strain on the closing bridle at 2 knots - this is too great a load for the present RMT release gear system. The conditions of fishing were ideal with a calm sea and little surging and snatch on the main warp. Thus, if the RMT25/20 is to be operated as an opening/closing trawl, a modified release gear has to be considered to take these high loadings.

The net was finally fished open with no monitor and release gear (a strop linked the closing bridle directly to the cross), but the catch was still disappointing.

2. Bottom Net (D.M. Shale)

The BN2.4/5 was fished 17 times in depth of water ranging from 610-4700m. The bottom bar weak links broke on six of the hauls and the towing bridle weak links on two of these. The catches which were mostly for physiological material, were varied and from a number of types of substrate. Pteropod ooze was probably the commonest, but at Stn 9015 a very large haul of coral had to be lifted inboard by crane. The most abundant invertebrates were holothurians, especially at the deeper stations (8972, 8976, 9009, 9010) where the bottom was soft and muddy. Synaphobranchid eels were numerically important fish.

Extreme difficulty was experienced at the very deep station (9035: 4435-4457m) where no indication was given of the net reaching the bottom. A maximum of 8500m of wire was paid out and the net was finally hauled in. On recovery, a small but very interesting catch mainly of holothurians including Deima sp. was present: the distance run indicator showed that the net had travelled more than 4000m over the bottom.

The net was lost at Station 9042 when the main warp talurit failed. The pinger indicated that the net turned over, probably after hitting an obstruction, and a sudden strain of over 6 tons was observed on the dynamometer.

A second net was used for Stn 9046 and as the depth was 4700m extra weight was added to the skids. A maximum of 8500m of wire was paid out but there was no evidence of bottom contact, and the net was recovered without fishing.

A bottom counter was made, originally for use with the OTSB14, but later was attached to the BN2.4. The roller had a circumference of 50cm & counted incrementally irrespective of the direction of rotation. The figures obtained for ground covered on each haul (2 revolutions = 1m of ground covered), the time on the bottom and the figures for distance run computed from the navigation data, at the three shallowest stations are shown in the table below.

Station	Time on bottom (min)	Distance run (navigation)	Roller counter
9015	39	1.89km	1728m
9016	45	2.66km	1409m
9020	50	2.90km	1811m

The counter was unfortunately lost at station 9044 but a replacement is to be constructed on the basis of the results obtained.

3. OTSB14 (N.R. Merrett)

The semi-balloon otter trawl (14m headline length) was operated on 18 occasions in soundings of 742-3773m. With experience of only 5 previous operations of this net, this cruise gave good opportunity to test the gear fully. The net fished successfully on 16 occasions down to 3035m depth. The two failures occurred in soundings of 3447 and 3773m when insufficient warp was paid out to enable the trawl to reach the bottom. On the second occasion, the full extent of the main warp was used. The scope required for the net to operate successfully was found to vary from 1.4 to 2.5 times the depth and to be unrelated to the sounding, over the range fished. In the course of the fishing operations, the pendulum contact meter and the pinger mounting on the headline of the net were discarded as impracticable. Finally, the pinger was found to be most successful when mounted on the upper sweepline, between one door and the wing end of the net. These sweepline extensions of 25 feet length were added halfway through the cruise. They generally decreased the amount of substrate collected and considerably increased the catch of larger benthopelagic organisms. The distance the net dragged over the seabed was measured by a roller counter attached to the codend of the net. The load on the warp rarely exceeded 1 ton whilst trawling and $1\frac{1}{2}$ tons during hauling, even on the few occasions when the net took large quantities of sediment.

This trawl is fished on a single warp from 2 x 50m bridles. To shoot the net, the latter are taken up on the warp on the wing drums, on either side of the main drum of the winch. The doors are permanently shackled to these bridles and paid out until the bridle eyes are just outboard of the sheaves on either 'A' frame. Meanwhile, the codend of the net is put outboard, followed by the remainder with its attached lazyline throttling rope, which is previously flaked down and its far end tied to one of the doors. The bridle on the windward side is then stopped off at the 'A' frame on a short strop. The warp to this wing drum is disconnected from the bridle and removed. The main warp is next led through the sheaves and outboard around the stern, where its swivel is connected into the eye of the leeward bridle. Warp is then paid out on this wing drum, so transferring the strain onto the main warp and thus back across the stern. By hauling on the main warp, the swivel is brought up to the windward 'A' frame for the windward bridle to be connected. Once the temporary stopper and the now slack warp from the leeward wing drum are unshackled, the main warp can be paid out to fish the net.

The ship speed for the above operation is 2 kts, which is increased to 3kts as the net is first paid out. This is maintained until about 500m of warp are out. It is then decreased to $2\frac{1}{4}$ knots and later further cut to 2 kts once the net reaches the bottom. The warp is paid out at 0.5m s^{-1} until the net is approximately 100m from the bottom when it is reduced to 0.3m s^{-1}. On bottom contact, extra warp equal to about 20% of the sounding is paid out, sufficient to ensure that the net remains on the bottom. Hauling is started also at 0.3m s^{-1} and when the net has left the bottom this is increased to 0.5 - 0.7m s^{-1}, depending on the dynamometer load. The retrieval of the net is essentially the reverse of the shooting technique, except that the codend is brought inboard on the lazyline by the crane.

4. Deep Sea Photometer (H.S.J. Roe)

Apart from 2 vertical tests on Cruise 76 the telemetering photometer was tested for the first time. Four vertical wire trials were made with an unsilvered and silvered light collector, by day and night, but changing conditions prevented a satisfactory comparison between the two. In both cases clouds were detected at depths greater than 600m, and in one test the photometer recorded to 1000m although it is at present impossible to assess the amount of instrument noise at very low light levels. After these wire tests it was found that the photometer was very sensitive to temperature, its base level depending on the surrounding temperature.

Four hauls were made with the instrument mounted on the net monitor, and apart from difficulties with the range switch, it worked very well. Depths to 595m were fished before the photometer "locked" and it proved possible to fish a narrow light band as it moved up over sunset. The photometer is very sensitive to changes in net angle and is probably not, at present, mounted at the optimum angle for towing. Generally the instrument was a great success but problems remain, notably in the temperature effect, the angle of attachment to the monitor and the interpretation of the record at low light levels.

5. CTD, Fluorometer and Light Meters (M.J.R. Fasham, J. Smithers)

This cruise was the first time the CTD has been interfaced to the IBM 1800 and a large number of software and hardware problems had to be overcome before successful operation was achieved. The main hardware problems were caused by a faulty CAMAC crate controller and a noisy mains plug in the electronics laboratory. There appears to be one remaining software problem in that the system occasionally hangs up during sampling. This is thought to be due to some interactions with the 1800 routine data sampling as the problem disappears if the latter is suspended. The existing STD data reduction and plotting package was successfully modified for use with the CTD.

The CTD system was augmented with the addition of a Plessey underwater light meter and a Variosens in situ fluorometer. The light meter interface to the CTD sampling system worked successfully but the fluorometer interface may need some modification to remove a slight oscillation of the output signal. Two dips to 100m were made with the Variosens fluorometer and the Pugh pump system connected to the CTD. The pump output was passed through a Turner fluorometer to enable the two fluorometers to be compared. The two fluorescence profiles obtained showed no agreement but at the time this was thought to be due to the low fluorescence levels which were possibly below the lower detection limit of the Variosens. However, we later obtained some high fluorescence samples which confirmed that the Variosens was not working and it is likely that the readings obtained during the 100m dips were caused by temperature effects, as yet unidentified. It was not possible, in the few remaining days of the cruise, to diagnose the fault.

Three deep dips were made with the CTD and Multisampler for calibration purposes. The thermometer was found to be correct to $\pm$ 0.01°C while the water bottle salinities have not yet been measured.

Assuming that the sampling hang-up problem can be overcome, the CTD system can be used routinely on future biological cruises.

6. Chlorophyll *a* fluorescence profiling and seston particle counting (P.R. Pugh)

The Turner Model 111 Fluorometer was run throughout the cruise measuring the chlorophyll *a* present in the surface waters (*ca* 4m) as derived from the ship's clean sea water supply. Most of the time the levels were very low *ca* 0.1 mg/m^3 or less, and no major frontal systems were noted, although there was some rise in the Fuerteventura Channel. Samples of seawater were also filtered for measurement of the chlorophyll *a* by spectrophotometric methods, in order to calibrate the fluorometer.

Two vertical profiles of chlorophyll *a* were carried out down to 110m using the submersible pump system. The first of these (St. 9034) at about 33°N 11°30'W showed only a small rise in fluorescence below the thermocline, reaching a peak at a depth of 95m. The second dip (St. 9045) was further north (45°N 11°23'W) and was more interesting. There was a massive peak in the fluorescence at about 50-55m at the base of the thermocline with levels reaching more than 1mg/m^3, with further minor peaks at deeper depths. It was hoped to compare these results with an *in situ* fluorometer, but the latter was not functioning correctly.

A new particle size analyser was tried out during the cruise. The principle of operation is based on the interruption of a light beam to a photodiode causing a drop in the voltage output proportional to the surface area of the particle. Mr. Wild had spent a lot of time prior to and during the cruise developing a flow system whereby it was hoped to monitor continuously the changes in particle distribution in the surface waters. This part functioned excellently after some initial floods.

Because the flow rate through the sensing heads was critical to their calibration it was necessary to develop some means of measuring it, and Mr. Bunting and Mr. Wild had managed to construct some EM flow meters for this purpose. Lack of time prior to the cruise prevented their accurate calibration and it appeared that they were too sensitive, going off-scale at the correct flow rates. Later a leak developed in one sensor which resulted in none of the electronics functioning correctly.

The results from the particle counter itself were rather puzzling. Two sensor heads were used, which were alternately sampled. Since one was set up to count particles in the range 1-60μm (in nine stages), and the other from 10-600μm, there were certain levels where the ranges overlapped. However the corrected counts emanating from each counter were by no means consistent with one another. The sensor heads were also sensitive to vibration, and more basic work into their functioning is clearly necessary.

7. Computer Operations (D. Heathershaw, J. Burnham, A. Collier)

During Cruise 77 the shipborne computer facilities were required mainly to provide accurate navigation and permanent records of the ship's track.

The new integrated satellite navigation system, comprising the Magnavox receiver and Hewlett Packard 2100 computer, was still in the proving stage and not yet connected up to the 1800 computer. The HP 2100 had spurious hardware faults which caused intermittent failures throughout the cruise. Disregarding the hardware problems, the system was found to be more flexible and to offer more facilities than the 1800 system. The relative accuracies of the two were found to be comparable, although the Hewlett-Packard system produced more fixes over a wider range of elevations. The Navigating Officers found the facility of a bridge teletype particularly useful as it allowed direct access to the navigational facilities.

The suite of programmes on the 1800 system which produces 'live' track plots on a visual display unit was used to enhance the navigational facilities and hard copy charts were produced on the IBM Incremental Plotter.

In addition to the standard meteorological instrument sampling, the IBM 1800 system continuously logged the Turner Fluorometer Mark III and the temperature and salinity profiler signals. In reponse to several requests, various plots were produced of solarimeter, soundings, fluorescence and temperature and salinity profiler data against time. The meteorological data was inspected and edited each day, and a track chart produced of that day's movements.

The biological station data entry suite of programmes was used to produce standard formatted descriptions of the various trawls and stations.

During the second leg, the IBM 1800 computer was used to record one-second samples from the CTD system. This was achieved using the standard computer interface 'CAMAC'. A series of hardware and software problems were encountered most of which were eventually overcome.

Many hardware problems were encountered on the 1800 system, some of which have been overcome and others which require further attention. Several modifications were made to the software, either to overcome known problems or to improve the system.

MIDWATER FISHES (J.R. Badcock, E. Bertelsen & N.B. Marshall)

Few fishes of particular note were taken. Going south, a change in species' composition occurred at about 37°N marked by the dropping out of such species as Benthosema glaciale and Argyropelecus olfersi and a general increase in animal diversity. About 50 species were taken in the mini-series at 32°N. Vertically the distributions of the various species were as would be anticipated but species' depth ranges were more similar to those previously found off Fuerteventura (28°N) than at 30°N: 23°W; that is they were shallower than found at the latter position.

A collection of the post-larvae of certain sternoptychid fishes was started, ultimately for a study on the development of compound light organs.

Material was collected for a study of the structure of the escae of deep-sea angler-fishes (Ceratioidea) with special regard to the complicated light transmitting structures of these organs. Escae of three species, representing two families and three genera, were obtained.

A collection of common species for later work on the Mauthnerian System was made, which should give some insight into those best adapted to avoid enemies and nets.

Studies on Cyclothone were made. Work begun on Cruise 45 (1972) on species with a gas-filled swimbladder (braueri and pseudopallida) was continued. Measurements of swimbladder dimensions in just buoyant individuals and observations on the structure and dimensions of the rete mirabile and gas gland were made. The expectation is that C. braueri, C. pseudopallida, C. alba and C. signata are prominent, non-migratory, sound scatters at mid- to lower mesopelagic levels over much of the ocean, particularly between 40°N and 40°S.

With regard to sexual dimorphism, it is now clear that male Cyclothone have an extensive layer of red fibres over the entire surface of the muscle segments, which must largely account for the much better developed gill system in the males.

BOTTOM FISHES (N.R. Merrett)

The bottom fishes collected on the transect, fished by both the OTSB14 and the BN2.4 between 600 and 3600m, on the first leg, provided an insight into the depth distribution of the slope fauna of the area. More widespread sampling on the second leg, with both nets, served to confirm the overall pattern. In biomass, the OTSB14 collected a total 252kg of fish, with the largest catches coming from soundings shallower than 2100m. The dominant groups represented were bathygadine macrourids and alepocephalids, synaphobranchid eels and halosaurs. Shallower than 800m Hoplostethus and Mora were characteristic. The bathygadine macrourids (predominantly Bathygadus macrops, B. favosus and Gadomus longifilis) ranged from around 900 to 1600m, while the alepocephalids (mainly Rouleina and Leptoderma) were most abundant in 900-2500m depth. The eel, Synaphobranchus, was numerous from 900m, again, to about 2100m. The halosaurs were most abundant below soundings of 2000m, where Halosauropsis macrochir predominated, but they also extended up the slope to about 1000m. Of special interest among the catches were several Bathysaurus agassizii, the stephanoberycid, Acanthochaenus, aphyonids and brotulids.

CEPHALOPODA (M.R. Clarke)

Catches of cephalopods during the first part of the cruise were rather disappointing and were most unusual in having very few cranchiids (4). Only 77 specimens comprising 27 species were caught in nets. Of these, 1 *Rossia*, 1 specimen of the rare *Choanoteuthis mollis*, 1 specimen of *Opisthoteuthis depressa* and a very large *Vampyroteuthis infernalis* were caught in bottom trawls. The skin of a large *Pholidoteuthis* and bits of *Todarodes sagittatus* were regurgitated by fish caught in the bottom trawl. The rarest species caught in the midwater trawls was *Neoteuthis*. Statoliths were collected from all species for later study. Observations were made on the buoyancy of 15 species.

ECHINOIDS (A.C. Campbell)

Work was carried out on board as part of an ongoing programme of investigations into the behaviour, physiology and structure of echinoid (sea-urchin) appendages. A number of species were obtained in the benthic samples which have been provisionally identified as:

Cidaris cidaris (Linnaeus)
Poriocidaris purpurata (Wyv. Thomson)
Phormosoma placenta Wyv. Thomson
Araeosoma hystrix (Wyv. Thomson)
Araeosoma fenestratum (Wyv. Thomson)
Hygrosoma petersii (A. Agassiz)
Sperosoma grimaldii Koehler
Salenocidaris profundi (Duncan)
Echinus alexandri Danielssen & Koren
Echinocyamus macrostomus Mortensen

When taken from the trawl the echinoids were reasonably intact though a few had been very roughly handled. The test appendages were however too moribund to permit physiological studies. A wide range of material was fixed for investigation with the light and electron microscopes.

A collection of mid-water and benthic material was made for teaching purposes at Queen Mary College.

EYE STRUCTURE OF FISHES (N.A. Locket)

Work during the cruise has been concerned mainly with the eyes of fishes. These have been examined in the fresh state, using the dissecting microscope and the ophthalmoscope, obtaining information about the orientation of the eyes with respect to the body of the fish, and of the extent of the monocular and binocular visual fields. Many eyes have also been fixed, dissected and embedded for study of their structure by optical and electron microscopy in the future.

Among the anatomical features studied has been the tapetum lucidum, a reflecting or scattering layer situated external to the retina. The nature of this layer varies with species, and elucidation of its structure and function require correlated observations on the fresh intact animal and by microscopy.

The occurrence of multiple banks of rods and of rods of exceptional length, are well known in deep-sea fishes, but information on their functional significance is scanty. Examples of retinae with these features have been collected for further study, including a size range of Chauliodus in which it is hoped to follow the changes in the retina with growth of the fish.

A number of deep-living fishes with degenerate eyes were taken during the cruise, and these eyes have been fixed for further study, including comparison with the small eyes of the common mesopelagic Cyclothone spp.

A variety of fixative mixtures has been tried, and the qualities of these will be compared at the optical and electron microscopy levels. It is hoped that a fixative may be developed which could be used by busy or unskilled people at sea, and which would yield material adequately fixed for electron microscopy.

VISUAL PIGMENTS OF DEEP-SEA FISHES (E.J. Denton & N.A. Locket)

The spectral absorbance of the retina has been determined for a number of species of both midwater and benthic fishes. This is part of a preliminary study of the photosensitive pigments in some of the multi-layer and other retinal systems found in deep-sea fishes.

OPTICS OF THE EYES OF MID-WATER CRUSTACEANS (M.F. Land)

Crustacean eyes are usually divided into two kinds: apposition eyes in which each rhabdome (receptor cluster) receives its image from only one optical element, and superposition eyes where many elements combine to form the image. The latter arrangement provides a bigger "pupil" and is usually thought of as being an adaptation to nocturnal - or deep sea - light conditions. Although the apposition/superposition distinction is certainly valid, the way the two kinds of images are produced is poorly understood, and the studies on this cruise were undertaken to try to sort out the optical bases for image formation in different subdivisions of the Crustacea. Because light is scarce at depths of a few hundred metres, interesting adaptations are common, and mid-water animals often provide extreme examples of mechanisms that are easier to interpret than those of shallow water animals.

The first study was of the eyes of the amphipod *Phronima sedentaria*. These animals have double eyes; a small "wide-angle" ventral pair and an enormously elongated dorsal pair containing very long (5mm) threads connecting the eye surface to the retina. A dark "pseudopupil", typical of insects with apposition eyes, is visible when the eye is viewed from above, but only over an angle of 10-11° - the field of view of these eyes. Each thread, which acts as a light-guide, ends at the cornea in a conical structure with a low refractive index (1.36), this is so low in fact as to preclude image formation by conventional spherical surface refraction. However, the low index is sufficient *in itself* to restrict the angle over which rays can enter each thread (and hence each rhabdome). This acceptance angle is determined partly by the "critical angle" above which light will escape from the thread ($\pm 11.5^\circ$) and partly by the taper of the cone ($\pm 10^\circ$). The net effect should be an acceptance angle of 3°, and this is nearly the same as the angle subtended by the pseudopupil. This correspondence confirms the hypothesis that these are apposition eyes, in which directional sensitivity is achieved by the intrinsic selectivity of low refractive index light guides, not by curved surface optics. A similar situation is found in the ventral eyes (but with less cone taper and correspondingly larger fields of view per rhabdome - about 10°), and in the less obviously double eyes of the other clear-eyed amphipod species (*Phrosina, Parathemisto* and *Streetsia* spp).

The mid- and deep-water decapods are quite different. Typically they have large spherical eyes which show a strong orange glow when examined from the direction of illumination. This feature is shared by the superposition eyes of insects (especially moths) and indicates a similar optical mechanism. Superposition images were observed in lightly fixed eyes of Oplophorus spinosus when these were cut in half and illuminated from the side. However, the mechanism of image formation is not the same as that described in insects by Exner in his classic study. There are no high refractive index "lens cylinders" (as in moths and fireflies) but instead the light is bent to a focus by an array of mirrors - the highly reflecting surfaces of the transparent "cones" which form a square array just below the cornea. The disposition and dimensions of these mirror faces are such as to bring nearly all light from a particular direction to a single point within the rhabdome layer. This principle appeared to hold for all the decapods examined, including a benthic species (Metapenaeus sp.) with eyes five times as large as those of Oplophorus. It seems likely that this is the usual method of image formation in decapod Crustacea.

BIOLUMINESCENCE

COELENTERATES (J.G. Morin)

Most of the coelenterate species that were taken on this cruise were tested for their ability to produce light. Tests were done by mechanical and/or freshwater stimulation and the animals observed visually and/or photometrically. Using a fluorescence microscope, these same organisms were examined for the appearance and distribution of luminescent cells (photocytes). Where possible, and in collaboration with Dr P.J. Herring, luminescent emission spectra were also obtained. Finally representative material was preserved in formalin or deep frozen to be taken back to UCLA for identification, further histological examination of the luminescent tissues, and biochemical extractions (frozen material). Luminescence was found in all of the pennatulaceans and many of the gorgonians, zoanthids, scyphozoans and siphonophores. No madreporarians or actinians showed luminescence. Although luminescence is known in some hydropolyps, none was found in the species collected.

LUMINOUS BACTERIA (J.G. Morin)

The bacterial light organ from several specimens of opisthoproctid (midwater) and macrourid (benthic) fishes were plated out on a standard marine bacteria agar culture medium. Good growth of only luminescent bacteria was achieved from almost all of these samples (16). Individual clones of these bacteria were then isolated and stabbed into culture media in individual vials. These samples, totalling 304 isolates, will be taken back to UCLA and given to Dr. Ken Nealson, a microbiologist from Scripps Institution of Oceanography for exact identification utilizing about 150 biochemical, morphological and physiological tests on each sample. From these data it will be possible to determine the specificity and variability of the bacteria in these bacteria-fish interrelationships.

In order to determine whether fish, which do not have a close symbiotic relationship with luminous bacteria, do in fact carry luminous bacteria as part of their intestinal flora, material was plated out (using the same culture medium used above) from the intestine and in some cases mouth and stomach from midwater sternoptychids and myctophids (total sample: 27 individuals from 9 species). The results almost invariably showed either 1) essentially no growth (15), 2) many luminescent bacteria and almost no other bacteria (10), or 3) a few non-luminous bacteria and no luminous ones (2). No cases were found of good growth of non-luminous bacteria. Isolated clones (111) were taken (as above) for later identification. These experiments will demonstrate whether these bacteria are substantially "free-living" and different from the symbiotic forms.

FILTER PIGMENTS IN PHOTOPHORES (E.J. Denton, P.J. Herring)

Coloured pigments are associated with the photophores of many animals, and the light produced by the photogenic material has to pass through these filters. In the ventral photophores of midwater animals many of these filters are reddish or purplish in life. For two animals with such photophores, *Argyropelecus aculeatus* and *Opisthoproctus grimaldii* the emission spectra of the light produced were found and the filters were studied by qualitative and quantitative microspectrometry. It was shown that the filters have the property of making the emitted light correspond very closely in spectral composition to the daylight at the animals normal depth. For Chauliodus sloanii, Valenciennellus tripunctulatus, Histioteuthis sp. and a Sergestes sp. absorption spectra of the filters were found. The filters of these animals clearly differ chemically but all have a transmission band in the blue (wavelengths around 475nm) and absorptions which would inevitably make the light emitted approximate more closely to that of their daylight environment. The transmission of red light which mainly determines the colour of these filters, and which makes them so attractive, is irrelevent to their function. These results give very strong support to the hypothesis that a large fraction of the photophores possessed by luminescent mid-water animals are used for producing camouflaging lights.

In the fish Diaphus rafinesquei the light produced by the photogenic material of the ventral photophores is reflected by mirrors which have a narrow band of reflectivity in the blue. These mirrors evidently serve the same purpose as the filters of other animals.

ANGULAR DISTRIBUTION IN ARGYROPELECUS (E.J. Denton & R.G. Maddock)

The angular distribution of light produced by Argyropelecus aculeatus was found for the whole fish and for different regions along its length. All give distributions corresponding closely to that of light in the sea. The close match of these lights in colour and angular distribution is not however maintained in the polarisation of the light, for the pattern of polarisation differs from that of the daylight around the fish in life.

CHEMISTRY OF DECAPOD AND DIAPHUS SYSTEMS (J.M. Anderson)

Large collections of hepatopancreases were made from several decapods in order to learn more about the chemical nature of bioluminescence in the decapods. The main emphasis was on making extracts of the hepatopancreas for later determination of the complete chemical structure of the luciferin involved in light production. The major amount of material came from Heterocarpus grimaldii, Acanthephyra purpurea, and Systellaspis debilis. Smaller collections of Acanthephyra eximia, Oplophorus spinosus, Gnathophausia ingens and Hymenodora species were also made.

Part of the collected hepatopancreases were frozen for later extraction of the luciferase (the enzyme involved in the bioluminescent reaction). Separation of the luciferase from the luciferin will allow comparative studies with the luciferins and luciferases of other bioluminescent animals.

The structure of the luciferin involved in decapod bioluminescence has the basic structure of an imidazole pyrazine. The luciferins from both coelenterates and *Cypridina*, a crustacean, are also imidazole pyrazines. The differences between the various groups of luciferins are side groups which allow for enzyme recognition. The cross reactivity of decapod luciferin was tested with the luciferase from *Renilla reniformis*, a coelenterate, and from *Cypridina*. A strong cross reaction was found using *Renilla* luciferase but no cross reaction with *Cypridina* luciferase. This result was true for all of the decapods collected.

The bioluminescent secretion from *Oplophorus spinosus* can be made reasonably free of luciferin by aeration. The *Oplophorus* luciferase remains. After adding back a small amount of decapod luciferin a strong light producing reaction is produced. A synthetic luciferin (coelenterate type) also produces a light reaction but with much slower kinetics. *Cypridina* luciferin produced only a very feeble light production in cross reaction with *Oplophorus* luciferase. The tentative conclusion of the tests made is that the decapods contain a luciferin which is very similar, but not the same, as that found in coelenterates.

Luciferin extracts were also made from the light organs of *Diaphus* species. The luciferin acted in a manner similar to the luciferins from decapods in various cross reactions.

GENERAL OBSERVATIONS ON BIOLUMINESCENCE (P.J. Herring)

Specimens of both midwater and benthic animals were examined for bioluminescence, and several new examples have been found. The oceanic apogonid fish *Howella* was found to have luminescent pyloric caeca, and the luminous tissues were fixed for subsequent histological examination. Several species of searsid fishes were obtained, and secreted material from these animals has been examined with the fluorescence microscope and fixed for electron microscopy. The appearance of the luminous exudate differs significantly in Platytroctes and Searsia.

Luminescence observations on cephalopods have included specimens of Ctenopteryx, Heteroteuthis, Histioteuthis, Spirula, Leachia and Vampyroteuthis. It is probable that the latter species is able to evert its large posterior light organs so that they protrude some way from the side of the body. The organisation of the photophores of Histioteuthis spp. suggests that they are capable of emitting light either through the 'filter' pigment, or ventrally through an aperture in the pigment cap surrounding the photogenic material.

A considerable number of luminescent echinoderms were examined, including holothurians, asteroids, ophiuroids and one species of crinoid. The luminescence of the ophiuroids was observed to coincide with the appearance of green fluorescence at the luminous loci when viewed in blue light in the fluorescence microscope. No such fluorescence was observed in the other echinoderm species. Fluorescence observations were also made on the luminescent tissues of polynoids, the amphipod Scina, and the decapod Sergestes.

In conjunction with Dr. N.A. Locket work was continued on the photophores of euphausiids. Live specimens were treated with tritiated leucine, and fixed at various intervals for subsequent radio-autography of the photogenic region, with a view to following the fate of the amino-acid in this structure. Other non-labelled spe cimens were fixed in a variety of ways (by Dr. Locket) for further microscopy.

BIOLUMINESCENT EMISSION SPECTRA (P.J. Herring, A. Collier)

A grating monochromator system linked to a programmable Hewlett-Packard desk calculator has been used for the first time for the determination and display of bioluminescence emission spectra from a wide variety of oceanic animals. The spectral acanning system worked well, though several initial problems were experienced with the programming. These were largely overcome during the course of the cruise, and the major limitation of the system is currently the noise levels at very low light levels.

Spectra were obtained from more than 40 species, including coelenterates, polychaetes, echinoderms, euphausiids, cephalopods and fishes. Most species exhibited narrow-band single-peaked spectra, with maxima in the blue region, but a greener emission was observed in several cases, and wide half-band widths in some echinoderms. Double-peaked spectra were obtained from two species of searsid, the relative peak intensities changing with time. A very short wavelength emission maximum ($<$ 400nm) was observed in one peak of a double-peaked spectrum of an unidentified gorgonian; this peak decayed rapidly relative to the longer wavelength emission maximum.

Data from the measured emission spectra have been used for determination of the effects of photophore filters and reflectors in a number of species (see above).

STN.	DATE 1976	POSITION LAT	LONG	GEAR	DEPTH (M)	FISHING TIME GMT	REMARKS
8936	17/ 7	44 54.6 N	12 1.4W	RMT 1	0- 900	1210-1445	TRACE DISAPPEARED - FAILED TO CLOSE
# 0		44.52.2 N	12 8.3W	RMT 8		DAY	
8937	17/ 7	43 59.1N	13 1.4W	RMT 1	0- 0	2120-2215	NET FAILED TO OPEN
# 1		43 56.6N	13 3.4W	RMT 8		NIGHT	
8937	17/ 7	43 53.0N	13 6.2W	RMT 1	400- 500	2348-0211	FLOW ESTIMATED - DIFFICULT TO CLOSE
# 2		43 48.0N	13 11.4W	RMT 8		NIGHT	FLOW DIST. 9.82 KM.
8937	18/ 7	43 46.1N	13 13.4W	RMT 1	295- 400	0306-0445	FLOW ESTIMATED - DIFFICULT TO CLOSE
# 3		43 42.8N	13 16.7W	RMT 8		NIGHT	FLOW DIST. 5.79 KM.
8937	18/ 7	43 58.0N	13 0.5W	RMT 1	500- 600	0846-1048	REPEAT SERIES 12
# 4		43 54.5N	13 3.3W	RMT 8		DAY	FLOW DIST. 7.41 KM.
8937	18/ 7	43 52.7N	13 4.7W	RMT 1	395- 500	1143-1343	REPEAT SERIES 12
# 5		43 48.1N	13 8.3W	RMT 8		DAY	FLOW DIST. 7.82 KM.
8937	18/ 7	43 45.9N	13 10.3W	RMT 1	300- 400	1442-1642	REPEAT SERIES 12
# 6		43 41.7N	13 14.8W	RMT 8		DAY	FLOW DIST. 8.53 KM.
8938	18/ 7	42 23.8N	13 17.8W	NN	0- 0	2352-0004	TEST RUN
# 0		42 22.4N	13 17.9W			NIGHT	
8939	19/ 7	40 56.4N	13 19.3W	RMT 1	505-1000	0943-1202	
# 0		41 1.2N	13 22.0W	RMT 8		DAY	FLOW DIST. 8.32 KM.
				DN			
8940	20/ 7	39 17.0N	13 20.6W	RMT 1	100- 375	0036-0215	
# 0		39 20.9N	13 23.9W	RMT 8		NIGHT	FLOW DIST. 8.16 KM.
				DN			
8941	20/ 7	37 41.2N	13 17.9W	RMT 1	500-1000	1319-1525	D.N. FAILED TO CLOSE PROPERLY
# 0		37 46.4N	13 22.5W	RMT 8		DAY	FLOW DIST. 8.79 KM.
				DN			

LOCAL TIME GMT

STN.	DATE 1976	POSITION LAT	LONG	GEAR	DEPTH (M)	FISHING TIME GMT	REMARKS	LOCAL TIME GMT
8942	21/ 7	36 19.9N	13 13.5W	RMT 1	105- 300	0037-0215		
# 0		36 24.2N	13 16.6W	RMT 8		NIGHT	FLOW DIST. 7.33 KM.	
8943	21/ 7	34 41.2N	13 3.7W	RMT 1	0- 600	1222-1536	FLOW ESTIMATED NET WOULD NOT CLOSE	
# 0		34 48.9N	13 6.8W	RMT 8		DAY	FLOW DIST. 13.69 KM.	
8944	22/ 7	33 26.9N	12 20.7W	RMT 1	90- 400	0017-0220		
# 0		33 31.4N	12 21.3W	RMT 8		NIGHT	FLOW DIST. 8.89 KM.	
8945	22/ 7	32 5.1N	11 23.6W	RMT 1	100- 600	1217-1417		
# 0		32 8.1N	11 28.3W	RMT 8		DAY	FLOW DIST. 6.46 KM.	
8946	23/ 7	31 40.3N	11 11.9W	RMT 1	170- 400	0019-0219		
# 0		31 44.5N	11 14.5W	RMT 8		NIGHT	FLOW DIST. 9.14 KM.	
8947	23/ 7	32 16.2N	11 37.4W	RMT 1	495- 600	0715-0915		
# 1		32 20.4N	11 41.9W	RMT 8		DAY	FLOW DIST. 7.97 KM.	
8947	23/ 7	32 23.6N	11 45.9W	RMT 1	900-1000	1049-1249		
# 2		32 27.3N	11 51.4W	RMT 8		DAY	FLOW DIST. 8.00 KM.	
8947	23/ 7	32 27.5N	11 50.4W	RMT 1	805- 900	1433-1633		
# 3		32 25.5N	11 46.3W	RMT 8		DAY	FLOW DIST. 8.67 KM.	
8947	23/ 7	32 24.7N	11 45.2W	*RMT 1	50- 510	1722-1938	RMT 1 LINER DETACHED	
# 4		32 22.3N	11 40.9W	RMT 8		DUSK	FLOW DIST. 8.88 KM.	
8947	23/ 7	32 20.6N	11 38.0W	RMT 1	420- 500	2047-2247		
# 5		32 16.1N	11 36.4W	RMT 8		NIGHT	FLOW DIST. 8.25 KM.	
8947	23/ 7	32 16.5N	11 37.4W	RMT 1	300- 400	2353-0153		
# 6		32 20.1N	11 41.8W	RMT 8		NIGHT	FLOW DIST. 7.62 KM.	
8947	24/ 7	32 22.0N	11 42.4W	RMT 1	200- 300	0238-0438		
# 7		32 27.0N	11 43.1W	RMT 8		NIGHT	FLOW DIST. 6.92 KM.	

STN.	DATE 1976	POSITION LAT	LONG	GEAR	DEPTH (M)	FISHING TIME GMT	REMARKS	LOCAL TIME GMT
8947	24/ 7	32 28.5N	11 49.0W	RMT 1	600- 700	0723-1232		
# 8		32 20.2N	11 42.4W	RMT 8		DAY	FLOW DIST. 7.98 KM.	
8947	24/ 7	32 23.5N	11 44.1W	RMT 1	690- 800	1032-1232		
# 9		32 20.2N	11 42.4W	RMT 8		DAY	FLOW DIST. 7.86 KM.	
8947	24/ 7	32 17.9N	11 41.0W	RMT 1	418- 505	1342-1542		
# 10		32 14.6N	11 38.6W	RMT 8		DAY	FLOW DIST. 7.46 KM.	
8947	24/ 7	32 15.4N	11 40.1W	RMT 1	1015-1250	1703-1900		
# 11		32 18.9N	11 44.4W	RMT 8		DAY	FLOW DIST. 7.25 KM.	
8947	24/ 7	32 22.2N	11 48.5W	RMT 1	500- 600	2039-2139		
# 12		32 24.1N	11 50.4W	RMT 8		NIGHT	FLOW DIST. 3.72 KM.	
8947	24/ 7	32 25.8N	11 51.5W	RMT 1	100- 200	2222-0022		
# 13		32 30.7N	11 55.6W	RMT 8		NIGHT	FLOW DIST. 8.87 KM.	
8947	25/ 7	32 30.3N	11 54.0W	RMT 1	950-1500	0129-0531	DEPTH TRACE FAILED AT END OF HAUL	
# 14		32 24.9N	11 46.3W	RMT 8		NIGHT	FLOW DIST. 14.35 KM.	
8948	25/ 7	32 23.6N	11 44.4W	RMT 1	800- 900	0758-0858	24 HOUR SERIES NUMBER 1	
# 1		32 25.8N	11 46.4W	RMT 8		DAY	FLOW DIST. 2.75 KM.	
8948	25/ 7	32 25.3N	11 45.9W	RMT 1	800- 900	1023-1123	24 HOUR SERIES NUMBER 2	
# 2		32 23.3N	11 44.7W	RMT 8		DAY	FLOW DIST. 3.90 KM.	
8948	25/ 7	32 21.4N	11 43.7W	RMT 1	810- 910	1227-1327	24 HOUR SERIES NUMBER 3	
# 3		32 19.9N	11 42.2W	RMT 8		DAY	FLOW DIST. 3.43 KM.	
8948	25/ 7	32 20.2N	11 44.1W	RMT 1	800- 900	1446-1546	24 HOUR SERIES NUMBER 4	
# 4		32 21.5N	11 46.8W	RMT 8		DAY	FLOW DIST. 3.56 KM.	
8948	25/ 7	32 24.0N	11 49.1W	RMT 1	790- 900	1659-1759	24 HOUR SERIES NUMBER 5	
# 5		32 25.9N	11 51.5W	RMT 8		DAY	FLOW DIST. 3.32 KM.	

STN.	DATE 1976	POSITION LAT	POSITION LONG	GEAR	DEPTH (M)	FISHING TIME GMT	REMARKS	LOCAL TIME GMT
8948	25/ 7	32 26.3N	11 51.8W	RMT 1	800- 900	1907-2007	24 HOUR SERIES NUMBER 6	
# 6		32 24.9N	11 49.9W	RMT 8		DUSK	FLOW DIST. 3.22 KM.	
8948	25/ 7	32 23.4N	11 47.4W	RMT 1	800- 900	2120-2220	24 HOUR SERIES NUMBER 7	
# 7		32 21.9N	11 45.3W	RMT 8		NIGHT	FLOW DIST. 3.55 KM.	
8948	25/ 7	32 20.0N	11 43.2W	RMT 1	800- 900	2328-0028	24 HOUR SERIES NUMBER 8	
# 8		32 18.5N	11 41.5W	RMT 8		NIGHT	FLOW DIST. 3.90 KM.	
8948	26/ 7	32 18.7N	11 42.3W	RMT 1	800- 900	0155-0255	24 HOUR SERIES NUMBER 9	
# 9		32 20.5N	11 44.6W	RMT 8		NIGHT	FLOW DIST. 3.28 KM.	
8948	26/ 7	32 22.9N	11 47.5W	RMT 1	800- 900	0413-0513	24 HOUR SERIES NUMBER 10	
# 10		32 24.7N	11 49.8W	RMT 8		NIGHT	FLOW DIST. 3.09 KM.	
8948	26/ 7	32 24.7N	11 49.2W	RMT 1	800- 900	0629-0729	24 HOUR SERIES NUMBER 11	
# 11		32 23.2N	11 47.2W	RMT 8		DAWN	FLOW DIST. 3.73 KM.	
8948	26/ 7	32 18.2N	11 41.3W	RMT 1	400- 500	0959-1059	24 HOUR SERIES NUMBER 12	
# 12		32 16.5N	11 39.3W	RMT 8		DAY	FLOW DIST. 4.43 KM.	
8948	26/ 7	32 16.2N	11 39.1W	RMT 1	403- 500	1151-1251	24 HOUR SERIES NUMBER 13	
# 13		32 17.5N	11 41.1W	RMT 8		DAY	FLOW DIST. 2.92 KM.	
8948	26/ 7	32 19.2N	11 43.4W	RMT 1	400- 500	1344-1444	24 HOUR SERIES NUMBER 14	
# 14		32 21.0N	11 45.4W	RMT 8		DAY	FLOW DIST. 3.68 KM.	
8948	26/ 7	32 22.7N	11 46.9W	RMT 1	403- 500	1532-1632	24 HOUR SERIES NUMBER 15	
# 15		32 24.7N	11 48.8W	RMT 8		DAY	FLOW DIST. 3.55 KM.	
8948	26/ 7	32 24.7N	11 48.3W	RMT 1	400- 510	1716-1816	24 HOUR SERIES NUMBER 16	
# 16		32 23.2N	11 46.3W	RMT 8		DAY	FLOW DIST. 3.86 KM.	
8948	26/ 7	32 21.7N	11 44.3W	RMT 1	390- 500	1910-2010	24 HOUR SERIES NUMBER 17	
# 17		32 20.3N	11 42.0W	RMT 8		DUSK	FLOW DIST. 4.34 KM.	

LOCAL TIME GMT

STN.	DATE 1976	POSITION LAT	LONG	GEAR	DEPTH (M)	FISHING TIME GMT	REMARKS
8948	26/ 7	32 19.2N	11 40.8W	RMT 1	400- 500	2048-2148	24 HOUR SERIES NUMBER 18
# 18		32 17.3N	11 39.0W	RMT 8		NIGHT	FLOW DIST. 3.81 KM.
8948	26/ 7	32 18.0N	11 39.3W	RMT 1	400- 500	2247-2347	24 HOUR SERIES NUMBER 19
# 19		32 19.9N	11 40.8W	RMT 8		NIGHT	FLOW DIST. 3.09 KM.
8948	27/ 7	32 21.9N	11 42.3W	RMT 1	400- 500	0037-0137	24 HOUR SERIES NUMBER 20
# 20		32 23.9N	11 43.8W	RMT 8		NIGHT	FLOW DIST. 3.28 KM.
8948	27/ 7	32 26.4N	11 45.9W	RMT 1	400- 500	0240-0340	24 HOUR SERIES NUMBER 21
# 21		32 28.3N	11 48.2W	RMT 8		NIGHT	FLOW DIST. 3.92 KM.
8948	27/ 7	32 28.3N	11 47.5W	RMT 1	405- 500	0426-0526	24 HOUR SERIES NUMBER 22
# 22		32 27.2N	11 45.3W	RMT 8		NIGHT	FLOW DIST. 4.16 KM.
8948	27/ 7	32 26.3N	11 43.3W	RMT 1	405- 500	0609-0709	24 HOUR SERIES NUMBER 23
# 23		32 25.2N	11 41.3W	RMT 8		DAWN	FLOW DIST. 4.25 KM.
8948	27/ 7	32 24.3N	11 39.4W	RMT 1	400- 520	0751-0851	24 HOUR SERIES NUMBER 24
# 24		32 22.6N	11 37.7W	RMT 8		DAY	FLOW DIST. 4.43 KM.
8948	27/ 7	32 22.5N	11 39.0W	RMT 1	800- 900	1000-1100	24 HOUR SERIES NUMBER 25
# 25		32 23.6N	11 42.0W	RMT 8		DAY	FLOW DIST. 2.70 KM.
8948	27/ 7	32 25.2N	11 45.8W	RMT 1	790- 905	1221-1321	24 HOUR SERIES NUMBER 26
# 26		32 26.6N	11 48.5W	RMT 8		DAY	FLOW DIST. 3.59 KM.
8948	27/ 7	32 25.9N	11 48.1W	RMT 1	810- 900	1432-1532	24 HOUR SERIES NUMBER 27
# 27		32 24.6N	11 46.6W	RMT 8		DAY	FLOW DIST. 3.28 KM.
8948	27/ 7	32 23.5N	11 45.4W	RMT 1	800- 900	1630-1730	24 HOUR SERIES NUMBER 28
# 28		32 22.2N	11 43.9W	RMT 8		DAY	FLOW DIST. 3.19 KM.
8948	27/ 7	32 20.8N	11 42.3W	RMT 1	400- 500	1822-1922	24 HOUR SERIES NUMBER 29
# 29		32 19.0N	11 40.4W	RMT 8		DUSK	FLOW DIST. 3.59 KM.

STN.	DATE 1976	POSITION LAT	LONG	GEAR	DEPTH (M)	FISHING TIME GMT	REMARKS	LOCAL TIME GMT
8948	27/ 7	32 19.8N	11 41.8W	RMT 1	400- 500	2043-2143	24 HOUR SERIES NUMBER 30	
# 30		32 21.7N	11 43.1W	RMT 8		NIGHT	FLOW DIST. 3.09 KM.	
8948	27/ 7	32 22.7N	11 43.9W	RMT 1	400- 500	2216-2316	24 HOUR SERIES NUMBER 31	
# 31		32 24.8N	11 45.8W	RMT 8		NIGHT	FLOW DIST. 3.73 KM.	
8948	28/ 7	32 24.6N	11 46.0W	RMT 1	395- 500	0005-0105	24 HOUR SERIES NUMBER 32	
# 32		32 23.0N	11 44.7W	RMT 8		NIGHT	FLOW DIST. 4.00 KM.	
8948	28/ 7	32 22.1N	11 44.0W	RMT 1	395- 500	0138-0238	24 HOUR SERIES NUMBER 33	
# 33		32 20.4N	11 42.9W	RMT 8		NIGHT	FLOW DIST. 3.68 KM.	
8948	28/ 7	32 19.6N	11 43.3W	RMT 1	400- 500	0406-0506	24 HOUR SERIES NUMBER 34	
# 34		32 17.9N	11 41.8W	RMT 8		NIGHT	FLOW DIST. 3.55 KM.	
8948	28/ 7	32 18.9N	11 42.8W	RMT 1	800- 900	0635-0800	24 HOUR SERIES NUMBER 35	
# 35		32 21.8N	11 45.7W	RMT 8		DAWN	FLOW DIST. 4.80 KM.	
8949	29/ 7	29 18.1N	16 0.4W	RMT 25/20	100-1000	1720-1920		
# 0		29 16.1N	15 55.1W			DAY	FLOW DIST. 7.70 KM.	
8950	29/ 7	29 15.7N	15 53.8W	RMT 25/20	100- 500	1941-2141		
# 0		29 13.2N	15 48.8W			DUSK	FLOW DIST. 8.15 KM.	
8951	29/ 7	29 13.0N	15 48.2W	*LLP	0- 700	2222-2350	LIGHT METER TEST	
# 0		29 12.9N	15 48.3W			NIGHT		
8952	30/ 7	29 12.2N	15 46.8W	RMT 25/20	0- 500	0043-0255	MONITOR SWITCHED OFF DEPTH ESTIMATED	
# 0		29 9.3N	15 42.3W			NIGHT		
8953	30/ 7	29 8.7N	15 41.6W	RMT 25/20	470- 600	0321-0721		
# 0		29 3.6N	15 37.9W			NIGHT	FLOW DIST. 10.39 KM.	
8954	30/ 7	29 1.5N	15 35.5W	RMT 25/20	750-1300	0905-1120		
# 0		29 0.5N	15 29.1W			DAY	FLOW DIST. 8.16 KM.	

STN.	DATE 1976	POSITION LAT	LONG	GEAR	DEPTH (M)	FISHING TIME GMT	REMARKS	LOCAL TIME GMT
8955	30/ 7	29 0.3N	15 27.8W	LLP	0- 400	1223-1401		
# 0		29 0.0N	15 28.8W			DAY		
8956	30/ 7	28 59.9N	15 28.6W	RMT 25/20	0- 500	1426-1642	NET PROBABLY CLOSED PREMATURELY	
# 0		28 56.3N	15 24.4W			DAY	FLOW DIST. 8.34 KM.	
8957	30/ 7	28 54.4N	15 19.6W	RMT 1	40- 500	1821-2015	UPPER DEPTH ESTIMATED	
# 0		28 52.8N	15 15.1W	RMT 8		DUSK	FLOW DIST. 7.55 KM.	
8958	30/ 7	28 52.5N	15 13.9W	RMT 1	60- 300	2044-2242		
# 0		28 50.4N	15 9.5W	RMT 8		NIGHT	FLOW DIST. 8.62 KM.	
8959	31/ 7	28 49.0N	15 7.4W	RMT 1	1000-2000	0052-0522	TRACES FEINT. FLOW INCALCULABLE.	
# 0		28 44.0N	14 56.5W	RMT 8		NIGHT		
8960	31/ 7	28 43.0N	14 53.8W	RMT 1	130- 600	0634-0834		
# 0		28 40.9N	14 49.4W	RMT 8		DAY	FLOW DIST. 8.15 KM.	
8961	31/ 7	28 40.5N	14 48.5W	RMT 1	500-1000	0906-1115		
# 0		28 38.9N	14 43.8W	RMT 8		DAY	FLOW DIST. 7.70 KM.	
8962	31/ 7	28 38.3N	14 42.2W	LLP	0-1000	1203-1401		
# 0		28 38.2N	14 43.4W			DAY		
8963	31/ 7	28 38.2N	14 43.3W	RMT 1	50- 400	1420-1618		
# 0		28 35.8N	14 39.2W	RMT 8		DAY	FLOW DIST. 8.19 KM.	
8964	31/ 7	28 36.8N	14 36.7W	RMT 1	900-1100	1734-1934	CLOSING COD-END USED ON RMT 8	
# 0		28 39.5N	14 32.4W	RMT 8		DAY	FLOW DIST. 7.56 KM.	
8965	31/ 7	28 42.2N	14 30.7W	RMT 1	50- 500	2051-2251		
# 0		28 45.8N	14 26.8W	RMT 8		NIGHT	FLOW DIST. 9.91 KM.	
8966	2/ 8	31 21.0N	10 41.5W	OTSB14	686- 742	1423-1526	DISTANCE RUN 4.66 KM.	
# 0		31 22.0N	10 39.2W			DAY		

STN.	DATE 1976	POSITION LAT	LONG	GEAR	DEPTH (M)	FISHING TIME GMT	REMARKS	LOCAL TIME GMT
8967 # 0	2/ 8	31 25.9N 31 26.3N	10 53.7W 10 50.8W	OTSB14	1140-1222	2125-2230 NIGHT	DISTANCE RUN 4.81 KM.	

STN.	DATE 1976	POSITION LAT	LONG	GEAR	DEPTH (M)	FISHING TIME GMT	REMARKS
8968	3/ 8	31 35.0N	11 2.0W	OTSB14	1767-1846	0524-0625	DISTANCE RUN 3.98 KM.
# 0		31 36.4N	11 0.2W			NIGHT	
8969	3/ 8	31 23.2N	10 56.1W	BN 2.4/5	1184-1230	1118-1148	BRIDLE & BOTTOM BAR WEAK LINKS BROKE
# 0		31 23.4N	10 54.9W			DAY	
8970	3/ 8	31 30.4N	11 4.4W	BN 2.4/5	1910-1932	1720-1750	BOTTOM BAR WEAK LINKS BROKEN
# 0		31 30.0N	11 3.8W			DAY	
8971	4/ 8	31 47.5N	11 10.2W	OTSB14	2432-2538	0002-0102	DISTANCE RUN 4.74 KM.
# 0		31 48.8N	11 8.6W			NIGHT	
8972	4/ 8	31 48.2N	11 7.5W	BN 2.4/5	2355-2386	0554-0624	
# 0		31 48.3N	11 6.8W			NIGHT	
8973	4/ 8	32 2.0N	11 19.7W	BN 2.4/5	3003-3008	1154-1241	TOWING BRIDLE WEAK LINK BROKEN
# 0		32 1.8N	11 19.0W			DAY	
8974	4/ 8	32 3.5N	11 19.4W	OTSB14	3029-3035	1653-1755	DISTANCE RUN 4.52 KM.
# 0		32 4.7N	11 18.1W			DAY	
8975	5/ 8	32 51.6N	11 53.0W	OTSB14	3762-3773	0603-0734	NET DIDN'T REACH BOTTOM - 7052 MWO
# 0		32 53.2N	11 49.3W			NIGHT	
8976	5/ 8	32 54.6N	11 40.4W	BN 2.4/5	3610-3646	1244-1405	BOTTOM BAR WEAK LINK BROKEN
# 0		32 54.4N	11 38.5W			DAY	
8977	6/ 8	31 26.1N	10 47.8W	OTSB14	974-1032	0319-0428	DISTANCE RUN 5.00 KM.
# 0		31 26.7N	10 45.6W			NIGHT	
8978	6/ 8	31 29.6N	10 41.5W	TRAP B	925- 925	0724-1730	ONLY 3 HETEROCARPUS IN TRAP
# 0		31 29.3N	10 40.5W			DAY	
8979	6/ 8	31 23.4N	10 46.2W	OTSB14	865- 918	1938-2043	DISTANCE RUN 4.66 KM.
# 0		31 24.0N	10 44.2W			DUSK	

LOCAL TIME GMT

STN.	DATE 1976	POSITION LAT	LONG	GEAR	DEPTH (M)	FISHING TIME GMT	REMARKS	LOCAL TIME GMT
8980	6/ 8	31 24.7N	10 42.7W	LLP	0- 600	2226-2347		
# 0		31 24.6N	10 43.8W			NIGHT		
8981	7/ 8	31 25.0N	10 42.9W	OTSB14	0- 350	0015-0400	NO DEPTH LIMITS AVAILABLE, 350 MWO	
# 0		31 28.5N	10 34.4W			NIGHT		
8982	7/ 8	30 4.3N	11 53.2W	RMT 1	100-1040	1455-1841	NEW DINOFLAGELLATE NET USED	
# 0		30 15.7N	11 52.5W	RMT 8		DAY	FLOW DIST. 13.56 KM.	
				DN				
8983	8/ 8	28 14.9N	13 32.4W	RMT 1	100- 700	0821-1122	UPPER DEPTH ESTIMATED	
# 0		28 19.7N	13 26.0W	RMT 8		DAY	FLOW DIST. 10.44 KM.	
				DN				

LOCAL TIME GMT

STN.	DATE 1976	POSITION LAT	LONG	GEAR	DEPTH (M)	FISHING TIME GMT	REMARKS
8984 # 0	12/ 8	25 48.8N 25 52.9N	17 9.6W 17 8.0W	RMT 1 RMT 8 DN	500- 600	0745-0946 DAY	FLOW DIST. 6.99 KM.
8985 # 0	12/ 8	25 54.3N 25 57.8N	17 7.0W 17 4.3W	RMT 1 RMT 8 DN	600- 700	1044-1247 DAY	FLOW DIST. 6.69 KM.
8986 # 0	12/ 8	26 0.5N 26 3.6N	17 2.2W 16 59.7W	RMT 1 RMT 8	405- 500	1422-1622 DAY	FLOW DIST. 6.60 KM.
8987 # 0	12/ 8	26 6.9N 26 15.8N	16 55.8W 16 47.8W	RMT 1 RMT 8	0-1800	1833-2340 NIGHT	LOWER DEPTH IS METRES OF WIRE OUT
8988 # 0	12/ 8	26 15.9N 26 25.5N	16 47.7W 16 36.3W	RMT 1 RMT 8	0-3000	2345-0555 NIGHT	LOWER DEPTH IS METRES OF WIRE OUT
8989 # 0	13/ 8	26 25.6N 26 26.7N	16 36.0W 16 32.2W	RMT 1 RMT 8 DN	0- 400	0600-0740 DAWN	LOWER DEPTH IS METRES OF WIRE OUT
8990 # 0	13/ 8	26 27.4N 26 28.9N	16 28.4W 16 20.6W	RMT 1 RMT 8 DN	0-1500	0915-1245 DAY	LOWER DEPTH IS METRES OF WIRE OUT
8991 # 0	13/ 8	26 30.1N 26 32.3N	16 18.1W 16 13.8W	RMT 1 RMT 8	800- 900	1348-1548 DAY	FLOW DIST. 6.38 KM.
8992 # 0	13/ 8	26 33.5N 26 37.6N	16 11.4W 16 4.2W	RMT 1 RMT 8	1000-1100	1703-2003 DUSK	FLOW DIST. 11.33 KM.
8993 # 0	13/ 8	26 39.9N 26 39.6N	15 59.5W 15 53.8W	RMT 1 RMT 8 DN	500- 640	2211-0011 NIGHT	NET FAILED TO FISH FLOW DIST. 7.83 KM.
8994 # 0	14/ 8	26 42.7N 26 47.1N	15 51.4W 15 48.4W	RMT 1 RMT 8 DN	500- 600	0144-0344 NIGHT	FLOW DIST. 7.75 KM.

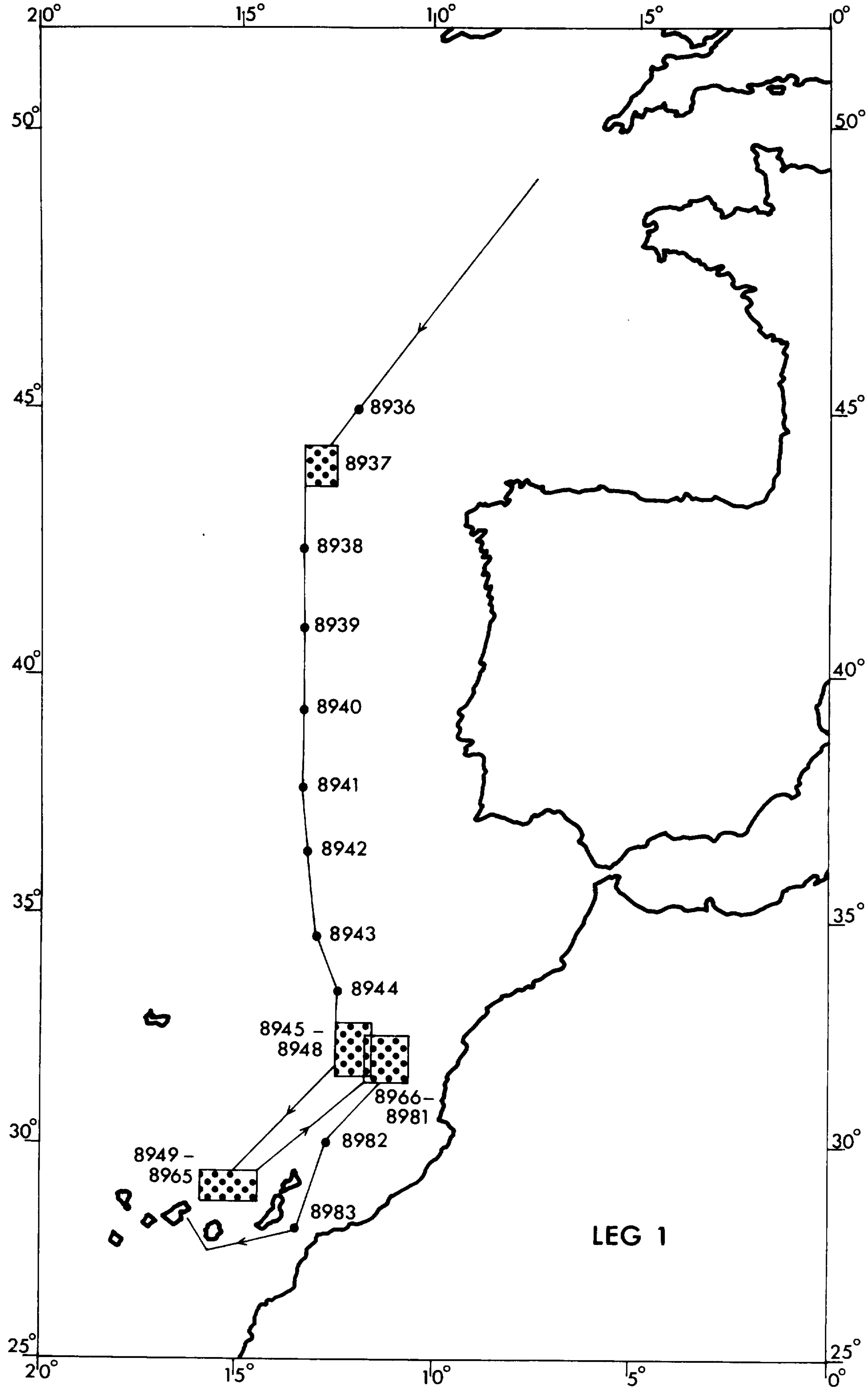
STN.	DATE 1976	POSITION LAT	LONG	GEAR	DEPTH (M)	FISHING TIME GMT	REMARKS	LOCAL TIME GMT
8995 # 0	14/ 8	26 49.1N 26 53.9N	15 47.8W 15 47.2W	RMT 1 RMT 8 DN	380- 500	0439-0639 NIGHT	FLOW DIST. 7.55 KM.	
8996 # 0	14/ 8	26 57.9N 27 3.6N	15 47.5W 15 53.5W	RMT 1 RMT 8	1100-1200	0805-1105 DAY	FLOW DIST. 11.63 KM.	
8997 # 0	14/ 8	27 6.6N 27 9.8N	15 56.6W 16 0.7W	RMT 1 RMT 8	900-1020	1240-1440 DAY	CLOSING COD-END USED ON RMT8 FLOW DIST. 7.10 KM.	
8998 # 0	14/ 8	27 12.0N 27 13.3N	16 3.9W 16 11.5W	RMT 1 RMT 8	1400-1500	1612-1912 DAY	FLOW DIST. 10.92 KM.	
8999 # 0	14/ 8	27 13.5N 27 14.5N	16 12.4W 16 6.1W	RMT 1 RMT 8	1300-1405	2104-0004 NIGHT	FLOW DIST. 10.35 KM.	
9000 # 0	15/ 8	27 15.8N 27 17.9N	16 3.7W 16 0.4W	RMT 1 RMT 8	300- 400	0136-0336 NIGHT	FLOW DIST. 6.69 KM.	
9001 # 0	15/ 8	27 18.8N 27 21.6N	15 58.9W 15 54.3W	RMT 1 RMT 8	200- 300	0422-0622 NIGHT	FLOW DIST. 7.37 KM.	
9002 # 0	15/ 8	27 22.8N 27 23.4N	15 51.9W 15 44.4W	RMT 1 RMT 8	1200-1300	0731-1031 DAY	FLOW DIST. 11.10 KM.	
9003 # 0	15/ 8	27 22.7N 27 20.6N	15 41.6W 15 36.6W	RMT 1 RMT 8	150- 300	1142-1342 DAY	FLOW DIST. 8.35 KM.	
9004 # 0	15/ 8	27 18.7N 27 17.4N	15 30.6W 15 27.5W	RMT 1 RMT 8 LLP	395- 550	1528-1645 DAY	CLOSING COD-END USED ON RMT 8 FLOW DIST. 5.10 KM.	
9005 # 0	15/ 8	27 14.6N 27 9.7N	15 21.2W 15 13.6W	RMT 25/20	0- 700	1849-2130 DUSK	LOWER DEPTH IS METRES OF WIRE OUT	
9006 # 0	15/ 8	27 9.5N 27 6.0N	15 13.4W 15 9.7W	RMT 25/20	0-1500	2138-2350 NIGHT	LOWER DEPTH IS METRES OF WIRE OUT	

STN.	DATE 1976	POSITION LAT	POSITION LONG	GEAR	DEPTH (M)	FISHING TIME GMT	REMARKS	LOCAL TIME GMT
9007	16/ 8	27 53.6N	13 54.8W	OTSB 14	1654-1699	1131-1322	DISTANCE RUN 7.09 KM.	
# 0		27 50.8N	13 52.6W			DAY		
9008	16/ 8	28 15.8N	13 31.4W	OTSB 14	1251-1259	2025-2127	DISTANCE RUN 4.65 KM.	
# 0		28 17.6N	13 30.2W			NIGHT		
9009	17/ 8	28 18.5N	13 29.2W	BN 2.4/5	1238-1244	0024-0109		
# 0		28 19.3N	13 28.7W			NIGHT		
9010	17/ 8	28 18.6N	13 16.0W	BN 2.4/5	1027-1029	0457-0542		
# 0		28 19.4N	13 15.6W			NIGHT		
9011	17/ 8	28 40.1N	13 9.0W	OTSB 14	906- 936	1012-1215	NO BOTTOM ECHO FROM PINGER, 9.76 KM.	
# 0		28 44.3N	13 6.1W			DAY		
9012	17/ 8	28 49.3N	13 2.2W	OTSB 14	1045-1061	1508-1608	DISTANCE RUN 4.48 KM.	
# 0		28 51.1N	13 0.7W			DAY		
9013	17/ 8	28 55.0N	12 56.2W	RMT 1	125- 450	1857-2016		
# 0		28 56.8N	12 53.6W	RMT 8		DUSK	FLOW DIST. 4.69 KM.	
				LLP				
9014	17/ 8	28 56.9N	12 51.7W	RMT 1	300- 500	2106-2306		
# 0		28 55.3N	12 46.7W	RMT 8		NIGHT	FLOW DIST. 7.73 KM.	
				LLP				
9015	18/ 8	28 46.8N	12 47.4W	BN 2.4/5	610- 637	0156-0235		
# 0		28 46.0N	12 46.8W			NIGHT		
9016	18/ 8	28 55.7N	12 37.1W	BN 2.4/5	873- 895	0732-0817		
# 0		28 56.8N	12 36.0W			DAWN		
9017	18/ 8	29 7.1N	12 41.2W	OTSB 14	1341-1394	1140-1310	DISTANCE RUN 6.93 KM.	
# 0		29 9.7N	12 38.4W			DAY		
9018	18/ 8	29 20.3N	12 35.1W	OTSB 14	1635-1658	1725-1900	DISTANCE RUN 6.98 KM.	
# 0		29 22.6N	12 31.5W			DAY		

STN.	DATE 1976	POSITION LAT	LONG	GEAR	DEPTH (M)	FISHING TIME GMT	REMARKS	LOCAL TIME GMT
9019	18/ 8	29 24.4N	12 24.7W	BN 2.4/5	1682-1686	2201-2308	BOTTOM BAR WEAK LINK BROKEN	
# 0		29 24.6N	12 22.6W			NIGHT		
9020	19/ 8	29 53.7N	11 58.4W	BN 2.4/5	2017-2028	0638-0728	BOTTOM BAR WEAK LINK BROKEN	
# 0		29 55.2N	11 57.4W			DAWN		
9021	19/ 8	30 4.2N	11 51.7W	OTSB 14	2122-2173	1134-1305	DISTANCE RUN 6.76 KM.	
# 0		30 7.2N	11 49.1W			DAY		
9022	19/ 8	30 12.3N	11 41.2W	RMT 1	2000-2200	1717-2117		
# 0		30 17.8N	11 33.5W	RMT 8		DUSK	FLOW DIST. 12.08 KM.	
9023	19/ 8	30 21.6N	11 30.1W	RMT 1	200- 690	2312-0245		
# 0		30 28.5N	11 26.2W	RMT 8		NIGHT	FLOW DIST. 13.51 KM.	
9024	20/ 8	31 4.7N	10 59.6W	RMT 1	1000-1230	0753-1023		
# 0		31 9.3N	10 55.1W	RMT 8		DAY	FLOW DIST. 9.23 KM.	
9025	20/ 8	31 12.5N	10 52.2W	RMT 1	500- 595	1202-1402		
# 0		31 15.5N	10 48.5W	RMT 8		DAY	FLOW DIST. 7.24 KM.	
				LLP				
9026	20/ 8	31 22.0N	10 42.4W	CTD	0- 700	1556-1709	MS FAILED TO TRIGGER CORRECTLY	
# 0		31 21.6N	10 42.5W	MS		DAY		
9027	20/ 8	31 24.7N	10 54.8W	CTD	0- 500	1924-1938	FLUOROMETER CASING PRESSURE TEST	
# 0		31 24.5N	10 54.9W			DUSK		
9028	20/ 8	31 26.1N	10 52.8W	OTSB 14	1166-1229	2105-2246	DISTANCE RUN 7.22 KM.	
# 0		31 28.1N	10 50.3W			NIGHT		
9029	21/ 8	32 14.3N	11 2.8W	BN 2.4/5	1835-1886	0640-0755		
# 0		32 14.1N	11 2.5W			DAWN		
9030	21/ 8	31 44.2N	11 12.5W	OTSB 14	2516-2543	1520-1650	DISTANCE RUN 4.96 KM.	
# 0		31 42.0N	11 16.2W			DAY		

STN.	DATE 1976	POSITION LAT	LONG	GEAR	DEPTH (M)	FISHING TIME GMT	REMARKS	LOCAL TIME GMT
9031	22/ 8	32 15.9N	11 43.4W	RMT 1	675-1000	0105-0405		
# 0		32 22.5N	11 48.7W	RMT 8		NIGHT	FLOW DIST. 12.17 KM.	
9032	22/ 8	32 24.3N	11 49.8W	RMT 1	110- 600	0448-0730		
# 0		32 30.9N	11 52.4W	RMT 8		DAWN	FLOW DIST. 11.25 KM.	
9033	22/ 8	32 34.1N	11 50.5W	OTSB 14	0-3460	0848-1839	NET DID NOT REACH BOTTOM, 8500 MWO.	
# 0		32 50.5N	11 35.5W			DAY		
9034	22/ 8	32 54.5N	11 34.7W	CTD	0- 110	2122-2215		
# 0		32 55.9N	11 34.4W	HEL		NIGHT		
				PUMP				
				FL				
9035	23/ 8	34 6.0N	11 55.5W	BN 2.4/5	4453-4457	0813-0915	NO BOTTOM TRACE. TIMES ESTIMATED	
# 0		34 6.2N	11 54.8W			DAY		
9036	23/ 8	34 46.0N	11 51.1W	CTD	0-1000	1645-1816	MS MALFUNCTIONED	
# 0		34 47.0N	11 50.7W	MS		DAY		
9037	24/ 8	37 0.7N	11 49.6W	RMT 1	1500-3000	0914-1329	NO FLOW	
# 0		37 12.1N	11 48.9W	RMT 8		DAY		
				DN				
9038	24/ 8	38 17.5N	11 46.2W	RMT 1	200- 400	2116-2316		
# 0		38 21.7N	11 44.4W	RMT 8		NIGHT	FLOW DIST. 6.56 KM.	
9039	24/ 8	38 22.6N	11 44.1W	RMT 1	100- 500	2348-0148		
# 0		38 29.2N	11 43.2W	RMT 8		NIGHT	FLOW DIST. 8.25 KM.	
9040	25/ 8	40 50.8N	11 30.6W	CTD	0-1000	1604-1718		
# 0		40 52.2N	11 30.1W	MS		DAY		
9041	26/ 8	41 55.4N	11 14.5W	BN 2.4/5	2373-2392	0141-0312		
# 0		41 53.7N	11 12.9W			NIGHT		

STN.	DATE 1976	POSITION LAT	LONG	GEAR	DEPTH (M)	FISHING TIME GMT	REMARKS	LOCAL TIME GMT
9042	26/ 8	42 15.0N	11 22.0W	BN 2.4/5	1541-1662	1005-1220		
# 0		42 17.8N	11 19.7W			DAY		
9043	26/ 8	42 19.5N	11 18.7W	CTD	0- 200	1356-1430		
# 1		42 19.5N	11 19.1W	UFL		DAY		
9043	26/ 8	42 19.4N	11 19.2W	CTD	0- 200	1438-1545	SAMPLING TRIAL	
# 2		42 19.2N	11 19.5W	UFL		DAY		
				LMD				
9044	26/ 8	42 31.7N	11 42.0W	BN 2.4/5	974- 974	2056-2109	TALURIT BROKEN - GEAR LOST	
# 0		42 31.9N	11 42.8W			NIGHT		
9045	27/ 8	45 2.7N	11 23.3W	CTD	0- 110	1448-1528	PUMP SAMPLING	
# 0		45 3.4N	11 23.6W	UFL		DAY		
				FL				
				LMD				
9046	28/ 8	46 58.5N	11 0.6W	BN 2.4/5	0-4700	0752-1454	NET DID NOT REACH BOTTOM, 8500 MWO.	
# 0		47 13.9N	11 2.5W			DAY		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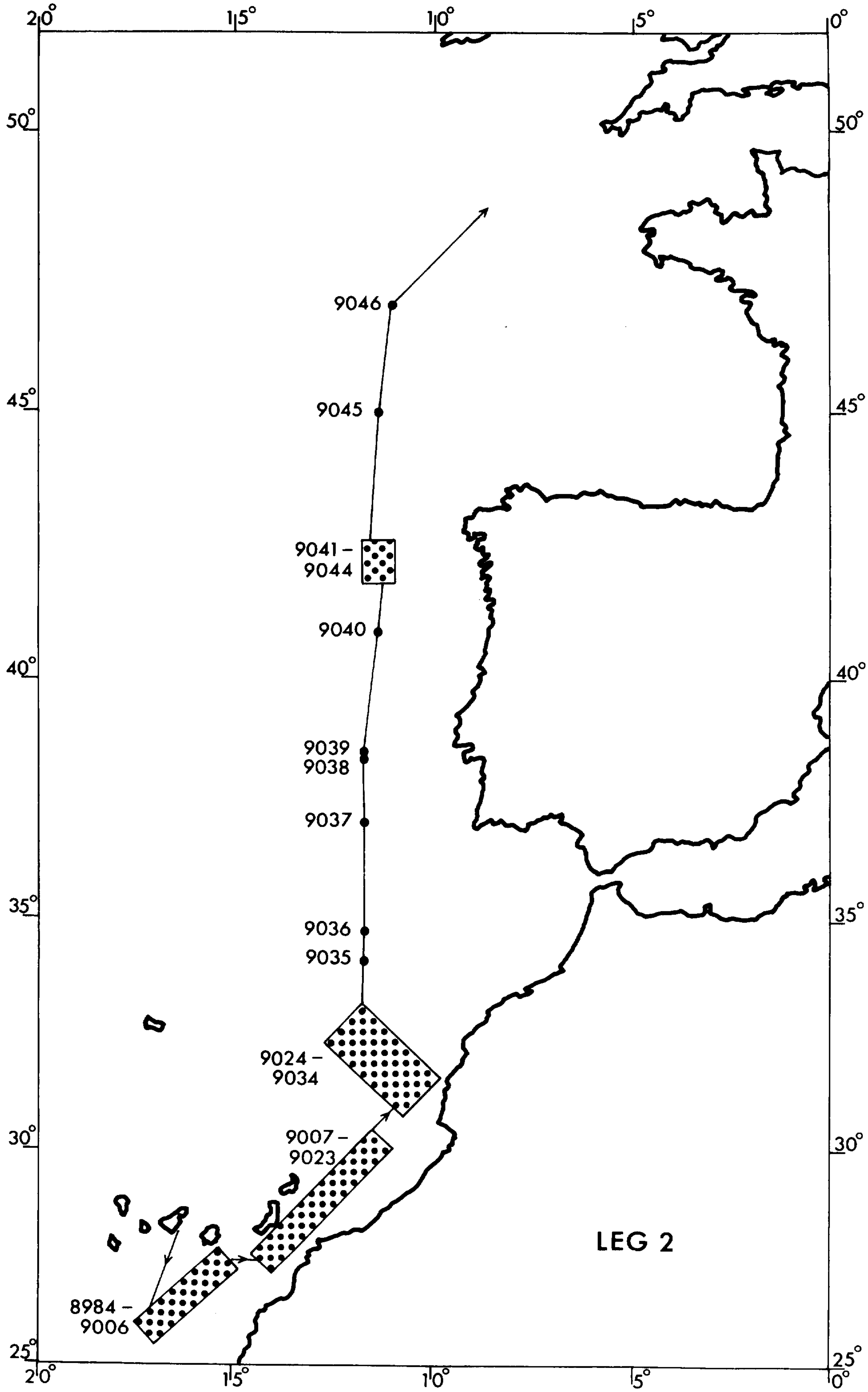
LEG 1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9007 –
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8984 –
9006
LEG 2

CRUISE REPORTS

CRUISE No. and/or DATE		REPORT No.
	R.R.S. "DISCOVERY"	
1	(International)	Published and
2	(Indian Ocean)	distributed by the
3	(Expedition)	Royal Society
		NIO CR[1]
4	February – March 1965	4
|		|
37	November – December 1970	37
38	January – April 1971	41
39	April – June 1971	40
40	June – July 1971	48
41	August – September 1971	45
42	September 1971	49
43	October – November 1971	47
44	December 1971	46
45	February – April 1972	50
46	April – May 1972	55
47	June – July 1972	52
48	July – August 1972	53
49	August – October 1972	57
50	October 1972	56
51	November – December 1972	54
52	February – March 1973	59
53	April – June 1973	58
		IOS CR[2]
54	June – August 1973	2
55	September – October 1973	5
56	October – November 1973	4
57	November – December 1973	6
58	December 1973	4
59	February 1974	14
60	February – March 1974	8
61	March – May 1974	10
62	May – June 1974	11
63	June – July 1974	12
64	July – August 1974	13
65	August 1974	17
66	August – September 1974	20
68	November – December 1974	16
73	July – August 1975	34
74	Leg 2 } Sept. Oct. 1975	33
74	Leg 1 & 3 } Sept. Oct. 1975	35
75	October - November 1975	43

[1] NIO CR — National Institute of Oceanography, Cruise Report.

[2] IOS CR — Institute of Oceanographic Sciences, Cruise Report.

CRUISE REPORTS

CRUISE No. and/or DATE	REPORT No.
R.R.S. "CHALLENGER"	
August – September 1974	IOS CR 22
R.V. "EDWARD FORBES"	
October 1974	IOS CR 15*
January – February 1975	IOS CR 19
April 1975	IOS CR 23
May 1975	IOS CR 32
May – June 1975	IOS CR 28
July 1975	IOS CR 31
July – August 1975	IOS CR 36
August – September 1975	IOS CR 41
R.R.S. "JOHN MURRAY"	
April – May 1972	NIO CR 51
September 1973	IOS CR 7
March – April 1974	IOS CR 9
October – November & December 1974	IOS CR 21
April – May 1975	IOS CR 25
April 1975	IOS CR 39
October – November 1975	IOS CR 40
N.C. "MARCEL BAYARD"	
February – April 1971	NIO CR 44
M.V. "RESEARCHER"	
August – September 1972	NIO CR 60
R.V. "SARSIA"	
May – June 1975	IOS CR 30
August – September 1975	IOS CR 38
R.R.S. "SHACKLETON"	
August – September 1973	IOS CR 3
January – February 1975	IOS CR 18
March – May 1975	IOS CR 24
February – March 1975	IOS CR 29
July – August 1975	IOS CR 37
M.V. "SURVEYOR"	
February – April 1971	NIO CR 38
June 1971	NIO CR 39*
August 1971	NIO CR 42*
D.E. "VICKERS VOYAGER" and "PISCES III"	
June – July 1973	IOS CR 1

*Not distributed