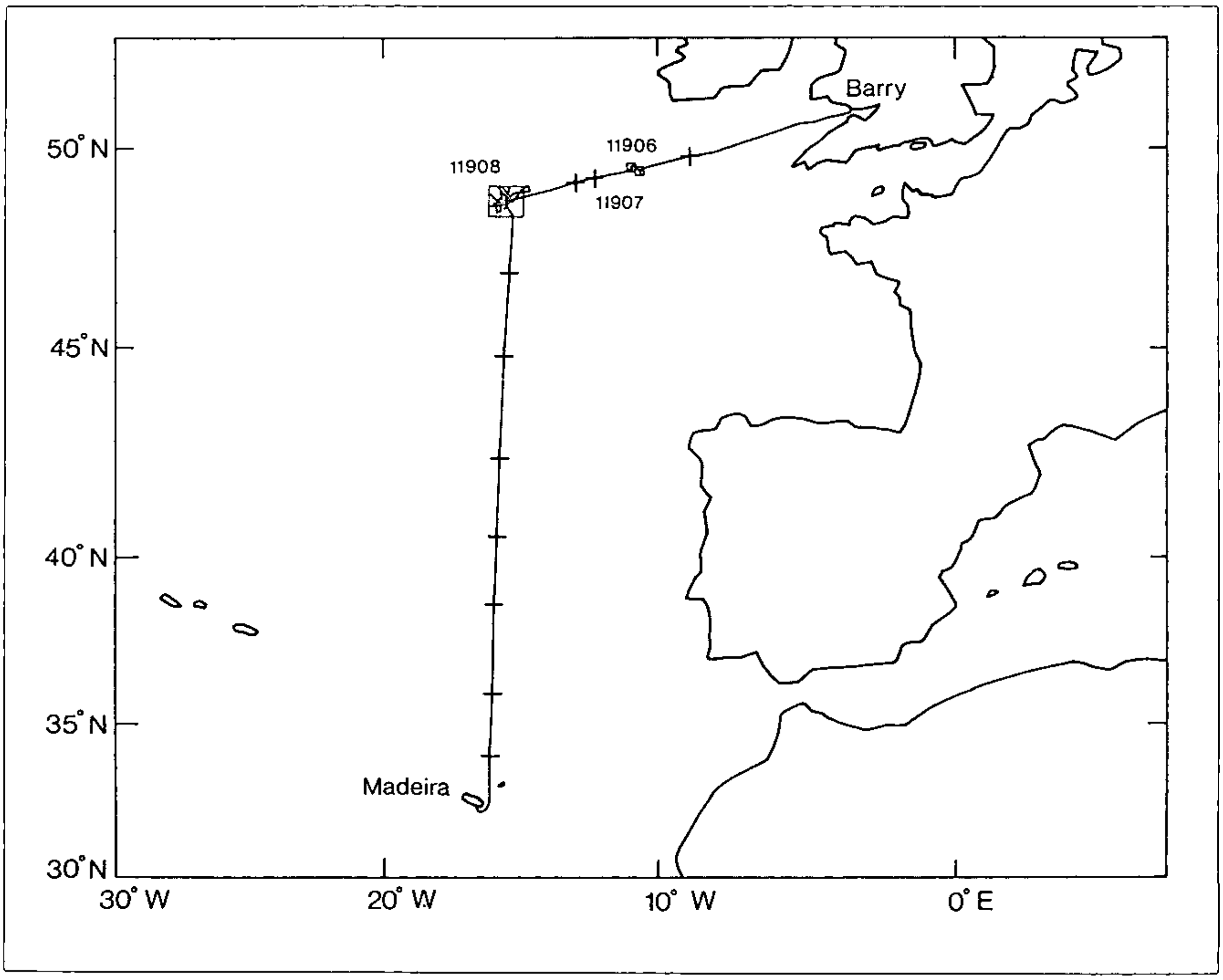
Institute of
Oceanographic Sciences
Deacon Laboratory

RRS Discovery Cruise 185

18 Aug - 17 Sep 1989

Abyssal benthic biology at the European Community Station (48°50'N 16°30'W)

Cruise Report No 217 1990



Natural Environment Research Council

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CRUISE REPORT NO. 217

RRS DISCOVERY CRUISE 185
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Abyssal benthic biology at the
European Community Station (48°50'N 16°30'W)

Principal Scientist
A L Rice

1990

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ABSTRACT

Discovery Cruise 185 was concerned primarily with an investigation of the numbers and biomass of benthic organisms at the European Community site at 48°50'N 16°30'W in the North Atlantic Ocean (depth c. 4850m). Studies covered a wide size range of organisms, and concentrated on bacteria, nanobiota, meiofauna, xenophyophores and foraminifers, macrofauna and megafauna. Investigations were undertaken on phytodetritus, the trophic ecology of deep sea holothurians, the parasitic helminths of abyssal fishes, and in addition, the biomass and activity of water column bacteria. A few samples to support the second of these investigations were taken at bathyal depths on the Goban Spur (c. 49°40'N 12°00'W). A series of experiments was conducted at the EC site to monitor behaviour, local movement and sound production of deep sea benthic fishes.

KEYWORDS

ABUNDANCE
ABYSSAL ZONE
ATLANTIC(NE)
BACTERIA
BEHAVIOUR
BENTHOS
BIOLOGICAL NOISE
DISCOVERY/RRS - cruise(1989)(185)
BIOMASS
FISH
HOLOTHURIANS
LOCOMOTION
MACROFAUNA
MEGAFAUNA
MEIOFAUNA
NANOBIOTA
PARASITES
PHYTODETRITUS
TROPHIC STRUCTURE
XENOPHYOPHORES

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HESLOP, R.	Motorman
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INTRODUCTION

This was the first cruise in the new IOSDL Laboratory Research Programme 4, the aim of which is to compare the benthic and bentho-pelagic communities under two contrasting mid-water regimes, one with a highly seasonal supply of organic matter, and the second with little or no seasonal signal in the supply of organic matter.

ITINERARY

Sailed Barry 18 August 1989

Goban Spur (c49°40'N 12°00'W) 20-21 August

European Community Site (c48°50'N 16°30'W) 22 August - 13 September

Arrived Funchal 17 September.

OBJECTIVES

1) To obtain a series of benthic and benthopelagic samples at two abyssal localities in the North Atlantic, one at 48°50'N: 16°30'W and one at 31°N: 20°W, using the multiple corer, box corer, epibenthic sledge, otter trawl and multiple rectangular midwater trawl.

2) To deploy a Bathysnap and IOSDL sediment trap mooring for about two weeks at the northern locality and to leave both rigs for a long term deployment at the southern locality.

3) To make a minimum of 10 deployments of the University of Aberdeen baited fish camera rig at each of the two main stations.

4) To make two CTD casts covering the whole water column at each of the main stations and a series of casts to 2000m at c. 100nm intervals on the passage between them.

5) To obtain a series of benthic samples on the Goban Spur, including a test of the refurbished fine-meshed IOS epibenthic sledge.

6) To obtain two epibenthic sledge samples close to the Isles of Scilly.

Associated with the main sampling programme, a series of specific investigations were to be conducted during the cruise. These were to include water column and benthic microbiology, holothurian feeding morphology and bacterial associates, and fish parasitology.

NARRATIVE

Discovery was due to sail from Barry on the morning of 18 August, but the loading and stowing of gear for cruises 186 and 187, in addition to that for 185, was not completed in time and sailing was delayed until 1700h (all times are GMT). The vessel anchored in Barry Roads to secure gear before proceeding at 2100h.

Owing to the delay in sailing, the proposed work in the vicinity of the Isles of Scilly was abandoned and the ship made directly for the Goban Spur, arriving on station at 0740/20.

A successful haul with the newly modified fine meshed epibenthic sledge at a depth of about 1000m (11906#1), was followed by an equally successful semi-balloon otter trawl (OTSB) haul at a depth of about 1300m (11907#1). Two box coring attempts at this station failed to obtain samples, presumably because of the considerable swell from 20kt westerly winds. No further attempts to obtain box core samples at this position were made and the vessel proceeded to the proposed main northern station, centred on 48°50'N: 16°30'W, arriving there at 0915/21.

Echo-sounding as we approached the station on a more of less westerly course revealed a flat and featureless bottom with depths ranging from 4846m to 4853m, consistent with the only available bathymetric charts of the area. This impression was soon to be proved erroneous, and our soundings over the next three weeks demonstrated that while where are wide expanses of flat seafloor to the east and west of the central position, the general area has a liberal scattering of abyssal hills, particularly to the northwest, northeast and south (Fig.). One of these, centred at about 49°06'N: 16°38'W, is especially impressive, rising more than 800m above the abyssal floor, and was ultimately to cause the first epibenthic sledge haul at this station to come to grief. However, this mishap was still some hours away, by which time the cruise had already established its proclivity for disaster.

On reaching the central station position the first task was to deploy the bottom transponder array for gear navigation. One of the transponders was to be retrievable and deployed on a Bathysnap due to be recovered at the end of work at this station. Accordingly, a Bathysnap and transponder were launched successfully at 1313/21 (11908#1). However, 30 minutes later, after the monitor had timed out, it could not be restarted. At this stage it was still conceivable that the release would respond to a release signal and that the Bathysnap could be recovered. However, rather than attempting to pop it up at this point, the rig was allowed to reach the bottom in the hopes that it would obtain photographic data and also form part of the navigation system. At this stage the deck unit of the navigation system was still not finished. Later, when it was completed, no response could be obtained from the transponder on the Bathysnap and, with great reluctance, this part of the intended programme was abandoned.

This early set back was followed immediately by several more. First, a major earthing problem was discovered on one of the two motors of the ship's main propulsion system. Over the next six days this problem hung over the cruise, threatening its very continuance and resulting in several periods of tests, each lasting up to eight hours, during which the propeller was not available. At 1500/28 the fault was traced to an earthed ammeter and rectified. By this time, however, the continuation of the cruise had been threatened by yet another major fault, in this case involving the trawling winch. But the discovery of the winch failure was still two days and several minor crises away.

As we had approached the main station, John Patching discovered that he had been supplied with only half the radio-labelled thymidine necessary for his bacteriological work. Accordingly, during the afternoon of 22 August contact was made with IOSDL to begin the overtures to the RAF which ultimately resulted in a successful Nimrod drop at 1300/29. By that time, the initial request for the delivery of a small package of thymidine weighing a few grams had increased to several tens of kilograms and included the data loggers for the sediment trap carousels and a replacement for a faulty optical switch in the carousel control mechanisms.

Before we had been at the main station for twelve hours we had received initial warning of the major winch problem, though the potential seriousness of the problem was not recognised at the time. During a box corer deployment (11908#2) the winch overheated as the corer approached the sea floor and the gear had to be left on the bottom for several minutes before it could be retrieved. As a consequence the corer failed to obtain a sample despite the good weather conditions. Whether this was so or not, subsequent experience taught us that the corer returned to the surface without a sample more often than not, despite what seemed to be excellent sea conditions.

A multiple corer drop (11908#3) produced only 5 reasonable cores, but this turned out to be because of faulty preparation and, once this was corrected, the corer, as in the past, generally produced much better samples.

The first epibenthic sledge haul at this station (11908#4) was now undertaken, using the modified fine mesh sledge tested successfully on the Goban Spur. The first attempt at deployment, at 0200/23 had to be aborted because the sledge turned over with 600 mwo. During retrieval the weak links parted and the upper front bar was badly bent against the ship's transom. The sledge was relaunched at 0415 after the damaged bar had been straightened, the towing bridles and safety strops replaced and about 30kg of lead weights removed from the front part of the left hand skid in an effort to prevent the sledge turning over once more. However, the gear again turned over with about 500 mwo, but this time it was decided to attempt to right the sledge by adjusting the ships speed and pay-out rate. This appeared to work and the sledge reached the bottom with almost 7000 mwo at 0830/23. Nevertheless, extreme difficulty was experienced in picking up good signals from the monitor and echo-sounding was stopped in order to improve the signal quality, the assumption being that the flat bottom registered during the approach to the station, and during the early part of this haul, was typical of the area. Unfortunately, as noted above, this was not so and the sledge came fast on an abyssal hill to the northwest of the main station position at 0936, the tension increasing rapidly to 12 tons and equally rapidly falling once more as the gear was lost. On retrieval, the safety strops were found to have parted after the breakage of the weak link, one strop having sustained damage resulting in a flattened area suggesting heavy strain against a very hard object.

During the passage back to the Bathysnap position we learned that the RVS response to the information about the main motor would involve an indeterminate period of testing during which the propeller would not be available. Consequently, it was decided to institute a programme of vertical wire work which could be accomplished with the bow thrust only. By 2000 the suggested tests had proved to be inconclusive so that work involving the propeller could be recommenced.

During the same period we received news of hurricane Erin which threatened to engulf us within the succeeding 48 hours. Similar warnings were received periodically throughout the cruise, but none came to fruition and the weather was generally superb.

Two further multiple corer casts (11908#5 and #6) were completed by 0010/24, both producing almost complete sets of cores, but with several of them disturbed. While the samples from the second of these casts were being dealt with, the ship moved some miles south of the main station position to echo-sound for an otter trawl haul to be made on a roughly northerly course. A flat abyssal bottom was encountered during this run and the trawl (11908#7) was shot on a course of 020° at 0245/24. However, at 0600h, with about 9000 mwo, the edge of an abyssal hill was encountered. The trawling course was accordingly altered slowly to the east and the net was eventually fished on a level bottom from about 49°04'N: 16°06'W to c. 49°05'N: 15°52'W. The invertebrate catch was reasonable, with quite a few holothurians, but the fish catch was extremely disappointing, consisting entirely of mid-water contaminants. It transpired, after this haul and the succeeding two trawl hauls, that one of the doors had been wrongly rigged (see separate report) so that the net had fished inefficiently and the catch did not reflect the true benthic fish community.

Because of the need to manoeuvre the trawl during its descent, the haul was not completed until 1700/24. *Discovery* now headed for the central station position, but with the intention of deploying the fish camera rig about one hour away from this position. Accordingly, the fish camera (11908#8) was deployed at 2125/24 at approximately 48°56'N: 16°11'W, where it reached the bottom at 2306/24.

At 0100/25, after a further period of inconclusive tests on the main engine during which the propeller was not available, *Discovery* returned once more to the centre of the station for a third multiple corer cast, this time with the IOSDL corer. This cast (11908#9), which was completed at 0840/25, obtained 11 reasonably good samples, but during the deployment the trawl winch began to surge increasingly badly because of what ultimately turned out to be the failure of one of the three electric motors providing the hydraulic pressure for the system (see separate report). Left with only two motors, the maximum veering and hauling rate was reduced to 0.5m/sec, making hauls with the towed gears quite impossible and virtually doubling the length of corer casts from about three hours to almost six hours. This situation threatened the continuation of the cruise since no replacement motor could be located in the UK and a repair would have taken two weeks. Following this dire news, the winch problem was overcome finally six days later as a result of the stalwart efforts of the scientific technicians and the ship's engineers in stripping the faulty motor, cleaning the rotor and re-installing it in difficult conditions.

Since the fish camera rig was due to be recovered between 1700 and 2300h there was time only for a CTD to within 20m of the bottom (11908#10), collecting water samples for mid-water bacteriology on the return cast up to 2000m depth, followed by an unsuccessful attempt to recover the Bathysnap. The fish camera was released successfully at 1730 and recovered on board by 2000/25.

Discovery now returned to the central position for two box corer casts. The first (11908#11) failed to trigger, and the second (11908#12), having been fitted with a weaker weak-link, brought back a partial sample, one corner being complete and the remainder badly slumped. During this cast one of the gimbal pin welds broke and the pin was lost, a problem which recurred several times during the cruise, generally the result of pre-triggering in mid-water. Repairs required a major strip-down and reassembly job.

A multiple corer cast (11908#13) between 1040 and 1660h/26 retrieved only 4 reasonable cores, after which scientific work was curtailed awaiting the completion of yet another round of tests on the main motor.

During the previous two days several contacts had been made with the FS *Meteor*, working at the JGOFS station at 47°N: 20°W and due to pass close to our working area during the morning of 27 August on her passage back to Hamburg. A rendezvous was arranged for 0700/27 at 48°40'N: 16°30'W, that is 10nm south of our main position. The original intention was core in that position for some hours before the arrival of *Meteor*, having deployed the fish camera rig nearby. However, the motor tests took considerably longer than expected and a box core cast (#14) was therefore begun to the north-east of the central station position at 1930/26. At 2200h, shortly after the box core left the bottom and with 4100 mwo, all motive power, including the bow thrust, was lost, for some minutes! The box corer was retrieved at 2354 without a sample.

Once the main propulsion was available, the fish camera (#15) was deployed to the southeast of the central station position at 0120/27, and reached the seafloor at 0324. An echo-sounding run was made to, and in the vicinity of, the rendezvous position.

A successful and pleasant rendezvous was completed by 0830, four *Discovery* scientists having spent about one hour aboard the *Meteor*. *Discovery* now returned to the centre station position where a multiple corer cast (#16) was completed by 1440, retrieving 11 good cores.

Discovery now returned to the fish camera position for a proposed release at about 1800h. In the meantime, a CTD cast to collect water from the upper 2000m of the water column was undertaken (#17). During this cast, the temporary sheave with which the midships winch had been furnished during the previous cruise began to make very sick noises and was ultimately found to have greaseless and very worn bearings, quite useless for future CTD casts and, until fixed, removing one more option from an already severely restricted list!

Attempts to release the fish camera rig between 1750 and 2000/27 were unsuccessful, for while the release monitor would switch into release mode, the rig refused to leave the bottom. A further attempt to release the rig was planned for 2300-2400h, before the tape recorder began to overwrite data, while in the meantime yet another attempt to release the Bathysnap, some 7nm away, was made. During this operation, a possible fault on the PES fish or cable was detected. (It was subsequently discovered that both towing cables on board had ruptures in the outer sleeving and both fish had the transducer cables incorrectly wired up.) As an attempt to release the Bathysnap using the hull transducer instead of the PES fish was beginning, the radio direction finder for the camera rig began bleeping, indicating that it was already on the surface. Accordingly, the ship returned to the camera rig position and recovered it successfully at 2345/27.

Discovery now returned to the Bathysnap position and a box corer cast was made (#18) with the pinger mounted on the corer frame, instead of 50m up the wire as before, and with a tilt switch fitted to the spade arm to detect pretriggering. An excellent sample was obtained.

A further unsuccessful attempt to pop up the Bathysnap was followed by a multiple corer cast (#19) which produced 11 good cores and one that was slightly disturbed.

Immediately after the multiple corer cast the ship lay to for the engineers to check an earthed ammeter as a possible explanation of the earlier problems. This was found to be the case, and one more of the cruise's many swords of Damocles was thus removed.

A box corer cast (#20) was completed by 2240/28, producing a second good sample. However, the winch stopped during the haul when the main engines went off the board and restarting the winch motors took more than an hour because the breakers refused to stay in, apparently caused by overloading the two remaining motors.

The fish camera rig was now deployed some 4 nm west of the main station position (#21) and the ship returned to the central position. Here a multiple corer cast (#22) was completed by 0600/29, but retrieved only five cores, none very good.

A box corer cast between 0615 and 1135/29 produced an excellent sample and was completed in good time for the Nimrod drop scheduled for mid-day. The Nimrod reached us on time, but made two abortive passes in very variable visibility before finally succeeding in dropping three cannisters very close to the ship at 1310h; these were successfully retrieved by 1330.

A multiple corer cast (#24), between 1400 and 1900/29, retrieved 12 cores, but the overlying water was cloudy.

An attempt to release the fish camera rig between 2030 and 2130 was unsuccessful, so that a return to the position was planned for about 1700/30 by which time the magnesium releases should have worked. Accordingly the ship moved back to the central position for more coring. The first of these, a box corer cast (#25), produced an excellent sample, while the second, a multiple corer cast (#26), produced 12 excellent cores, including overlying phytodetritus. During the deployment of the next multiple corer (#27), however, the crystal on the monitor failed and the corer was therefore fished 'blind' and retrieved only two good cores.

At 1700/30, during the second multiple corer cast, the fish camera rig was detected by the direction finder and was subsequently recovered successfully at 2120. By this time the sea conditions, while by no means rough, were considered too bumpy for the box corer and, since there were minor problems with the multiple corer (see above), a short echo-sounding survey was undertaken overnight to the west of the main station position in the hope of an improvement in the weather by the morning. The hoped for improvement seemed to materialise and a box corer cast (#28) was made between 0630 and 1220/31. Probably we were over optimistic, for the corer failed to retrieve a sample and the pinger, along with its bracket, were lost, presumably wiped off by the wire paid out after the gear reached the bottom.

Over the next 18 hours, two further multiple corer casts (#29 and 31) produced bad cores, while a box corer cast (#30) produced no sample at all. Clearly things were not going well and, coupled with the news from RVS during the afternoon of the 31st that no replacement winch motor could be located, the future looked bleak. By now the faulty motor had been dismantled and the resistance of the rotor significantly improved by cleaning, so that there was every possibility of a ship-board repair. The restricted programme staggered on.

The fish camera rig was deployed by 1030/1 some 7 nm north of the central station position (11908#32), and an echo-sounding survey in preparation for the anticipated towed gear work was undertaken while the repaired motor was refitted.

By 1700/1 the refurbished winch motor had been refitted and run successfully for an hour. However, when it was coupled into the hydraulics system a valve failed. Ultimately this turned out to be because of dirt in the hydraulic fluid, but the fault was not found and corrected until 0600/2.

In the meantime an echo-sounding survey was undertaken to the north of the central station position. During the course of this survey, at 0330/2, the fish camera radio direction finder began to bleep, indicating that the rig was at the surface some 8.5 nm away. At 0500, although the RDF signal had been lost for an hour owing to flat batteries, the rig was successfully retrieved.

As a final straw in the main winch saga, the cooling water system was disturbed during the refitting of the motor, resulting in serious leaks. Consequently, the system had to be dismantled, cleaned and re-assembled, causing a further five-hour delay! Finally, with the winch now operating normally once more, a multiple corer cast (11908#33) was completed by 1450/2, in exactly three hours, and retrieved 12 excellent cores!

By 1800/2 a box corer cast was completed. However, the sample was disturbed and the three remaining original gimbal pin welds were found to be broken.

Between 2220/2 and 1100/3 the otter-trawl was fished successfully (11908#35), obtaining a moderate catch containing numerous holothurians.

At 1409/3 the fish camera rig was deployed some 4 nm southeast of the central station position (#36), after which the vessel returned to the main position for a multiple corer cast (#37) which was completed by 2018/3, obtaining 12 good cores.

Discovery now moved 10 nm south of the main station position for an epibenthic sledge haul on a northerly course. Subsequently this haul (11908#38) was found to have obtained 200+ excellent photographs, but both weak links on the bottom bar were broken and the catch was very small. Following this experience the bottom bar was fastened with shackles for the subsequent hauls.

On completion of the sledge haul at 0800/4 the ship moved back to the fish camera position and successfully retrieved the rig by 1200.

Two successful multiple corer casts at the main station position (#39 and 41) were separated by an epibenthic sledge haul (#40) which obtained a good sample and an excellent series of colour photographs. However, a box corer cast (#42), completed by 1150/5, obtained a disturbed sample.

The fish camera rig was deployed again to the southeast of the main station (#43) and an OTSB haul (#44) on a northerly course was begun from some 15nm to the southwest. Having corrected the rigging of the trawl doors, this haul, which was completed at 0612/6, obtained an excellent catch, including 55kg of fish, mainly large *Nematonurus*. *Discovery* now returned to the fish camera position and completed a successful retrieval of the rig by 1239/6.

At the main station position a shallow CTD (#45) was followed by a box corer cast (#46) which retrieved another disturbed sample, half of which was processed - more or less in desperation!

Discovery now moved some 12 nm to the east to fish the epibenthic sledge on a westerly course. Completed at 0322/7, this haul (#47) obtained a mediocre catch. When it arrived on board the camera was running continuously, but this fault must have developed very late in the haul since almost 200 good colour photographs were obtained.

After returning to the main station position, a successful box corer cast was obtained (#48).

Having lost so much sampling time because of the various malfunctions, the decision had by now been taken to abandon the southerly station and to devote all of the remaining time to improving the data set at the northerly station. Accordingly, an attempt was made to deploy a short-term (c 24h) Bathysnap with the acoustic release backed up by a soluble magnesium link. However, an intermittent camera fault was discovered during the assembly of the Bathysnap so that the deployment had to be delayed. Instead, the fish camera rig was deployed once more to the southeast of the main station position, but rather further away (#49), and a shallow CTD cast (#50) for water from 150m was made during the camera rig descent.

An otter trawl haul (#51) was completed by 0636/8; the catch was good, though part of it was lost beyond the lazy deckie during retrieval.

The Bathysnap had been assembled once more during the otter trawl haul for an intended deployment prior to the recovery of the fish camera rig. However, the camera fault re-appeared during the final pre-launch checks and the deployment was postponed again. Since the fault was still unrectified after the fish camera had been recovered at 1245/8, *Discovery* returned to the main station position for two further box corer attempts (#52 and 53), neither of which succeeded in obtaining a sample.

During these hauls the Bathysnap camera system problem seemed to have been identified, though not rectified. Apparently, the fault was in the flash unit and developed only if the camera was on its shortest cycling period. Accordingly, the Bathysnap was set up and tested on an eight minute cycle and appeared to be working perfectly when it was deployed eventually at 2330/8.

A successful epibenthic sledge haul (#55), between 0048 and 0925/9, obtained a catch similar to the previous one, together with about 200 good b/w photographs.

At 1215/9 the fish camera rig was deployed to the southeast of the main station position once more. Since it was fitted with a 12-hour magnesium link, retrieval would have to be accomplished by 0300/10 allowing insufficient time for a towed haul. Accordingly, two box corer casts were made at the main position. The first of these (#57) failed to retrieve a sample, possibly the result of pre-tripping in mid-water, and the pinger and tilt switch were therefore refitted to the corer for the next attempt. This time (#58) the corer pretripped at 250 mwo in rather moderate weather conditions and, in so doing, tore out its gimbal pins once more!

A short echo-sounding survey was made to the southeast of the main position prior to the successful retrieval of the fish camera rig at 0340/10. The Bathysnap was released and brought on board by 0700/10, but the camera was no longer working. When the film was developed it transpired that the camera had stopped cycling during the descent and no bottom photographs had been obtained.

Discovery now moved some 15 nm southwest of the main station position to fish the multiple RMT system close to the bottom. However, as a test haul, the nets were first fished in the 0-50, 50-100 and 100-150m horizons where very strong echoes had been seen periodically over the previous few days and were apparent at the time of this haul (#59-61). The haul was successful and all three sets of nets recovered large numbers of the amphipod *Themisto*, but some difficulty was experienced in detecting the net trace towards the end of the haul. The fault could not be traced and the problem recurred during the attempted near-bottom deployment (#62-64). Consequently, although the three nets had opened and closed by the time the gear was recovered, it was impossible to say when these events had happened and all sets of nets contained organisms uncharacteristic of the theoretical fishing depth. Since the fault still could not be traced, further RMT work was abandoned.

The fish camera rig was now deployed for the last time on this cruise (#65), and was followed by a final epibenthic sledge haul, this time with fine meshed nets and colour film. This haul (#66) was completed successfully by 1312/11, retrieving a small, but reasonable, catch.

Discovery now returned to the fish camera position, and the rig was released at 1430/11. During its ascent a shallow CTD cast was undertaken to collect water from 150m depth (#67) and the fish camera was taken aboard at 1710.

A final OTSB haul (#68) was now undertaken between 1950/11 and 0930/12, this time on an east - west course through the main station position.

The vessel now returned to the main station position for a final series of coring attempts before the departure for Funchal. Two box corer casts (#69 and 71) and one multiple corer cast (#70) all retrieved excellent samples.

At 0050/13 *Discovery* got underway for Funchal via a way point at 48°30'N: 16°00'W to obtain some additional soundings in the southeastern part of the sampling area. After an uneventful passage she docked at 0800/17.

Despite the many problems which arose during the cruise and the amount of time which was lost, much work was achieved. Considerable efforts were made by members of the scientific party both for their own individual programmes and for those of others. All this work would have been of little avail without the unstinting help given to us by Captain Coverdale and his crew. Relief winch driving by deck staff proved critical on many occasions. Our thanks go to them all.

ALR

OPERATING AND MONITORING SYSTEMS

Ship's systems

After hydraulic ring main

Soon after arrival at the EC station a spade box corer haul (11908#2) was interrupted by an overheating problem on one of the three electric motors supplying power to the aft hydraulic ring main. The ring main is the source of power for the traction winch, Schatt davit and auxiliary winches. The overheating problems got worse, and three days later, on 25 August, the motor became non-functional. The ship's electrician inspected the motor and diagnosed a short circuit from rotor to earth and a badly burnt slip ring, requiring shore side repairs. The remaining two motors were used to drive the davit and traction winch for spade box core and multiple core deployments. Less than half of the normal full speed could be achieved, resulting in vertical deployments requiring six hours rather than less than three, and precluding completely any towed gear work. Later the Chief Engineer suggested removing the rotor for possible repairs at sea. This advice was followed. The ships engineers cleaned off a build-up of carbon from the rotor and repaired wires which had been broken during the difficult removal from the casing. Meanwhile RVS technicians machined the damaged slip ring. The repairs and cleaning were successful, but another of the motor-pump units was failing to deliver any pressure. This was traced to foreign particles in two of the pressure control valves, which had to be stripped and cleaned. In addition, several of the joints of the cooling system were leaking badly and had to be taken apart and re-sealed. When all this work was completed the whole system functioned satisfactorily. These repairs took three and a half days to complete, during which time scientific options were severely constrained or precluded entirely.

CTD winch and A-frame

The first CTD dip of the cruise was delayed by a failure of the winch to start despite the forward ring-main running up correctly. Previous experience suggested faulty electrical switches on the control console. Replacement of three switches resulted in normal function. On lowering the CTD for the second drop, it became evident, from grinding noises, that all was not well with the A-frame sheave. This sheave was a temporary replacement for the original one, which had been left at Barry for repairs. On removal and dismantling it was found that the bearings had long since disintegrated. A new spindle was made and the needle roller bearings were replaced by bronze bushes. The sheave was load-tested on board.

Electric hydrographic winch

While the CTD was out of commission an attempt was made to use the electric winch. Although a missing diverter sheave was replaced by another sheave which had to be modified for the purpose, the winch never ran because of an unresolved electrical fault.

RP

IOSDL systems

PES Mk IV

This is a recent major development of the precision echo-sounder system which has been used routinely for a wide range of purposes over many years. The new system consists of a "Waverley" thermal recorder, video scrolling display, and a deck control unit providing beam steering and acoustic control for echo-sounding and IOS telemeters. The menu-driven scrolling display provided a simple, user-friendly means of recording water depth and data telemetered from samplers.

In general the system performed well, although there were problems with the beam steering unit. These problems were rectified ultimately but fault finding was hampered by the prototype state of the system. Despite its early development stage, the system was very well accepted and, with further development, will provide a powerful package for acoustic monitoring.

DE

RVS PES fish

Two fish were supplied by RVS, and both required general servicing during the cruise. The two towing cables provided were damaged, each having ruptures in the outer sleeving as a result of previous use. In addition, the transducer cables were connected incorrectly. This caused severe initial problems when using the IOS Mk 4 beam steering unit, and resulted in serious difficulties in picking up monitor traces from towed gears.

DE

10kHz acoustic telemetry

Spade box corer. During spade box corer deployments, a 10KHz beacon was attached to the wire 50m above the swivel in order to monitor height of gear above the bottom. The corer failed to take samples on a number of occasions, and pretriggering was suspected as a likely cause. Several drops were made with the beacon attached to the corer frame and a tilt switch on the spade arm. Triggering of the corer and the consequent reorientation of the spade arm would activate the tilt switch and cause the beacon to double pulse. This configuration was used for several deployments until the beacon was lost as a result of entanglement with a bight of wire at the start of hauling. If the technique is to be used in the future, the beacon must be protected from bights of wire.

Epibenthic sledge. The sledge monitor functioned perfectly but was lost when the sledge came fast (11908#4). A second monitor was prepared and this, too, functioned without problems.

Otter trawl. The otter trawl monitor operated without problems except for a depleted battery on one haul, which resulted in weak or non-existent signals.

Midwater nets. The multiple RMT1+8 was to be used for near-bottom hauls, so a 35KHz near-bottom echo-sounder was provided. Prior to the deep hauls, a shallow deployment was made to test nets and monitor. This was marred by the failure of the net open/close indicator while fishing the third net. No fault could be found on inspection in the laboratory, and a temperature related problem was assumed. The fault reoccurred near the surface on the proposed deep deployment. The decision was made to continue with the deployment, and use the rise of the gear as an indication that the first net had opened. No rise was observed. The haul was continued, and the net opening closing signals repeated several times during recovery as a safeguard against non-operation at depth. On recovery, all nets were closed and the system appeared to have functioned satisfactorily. However, catches were thought to have come from shallower than 2000m. Again, no fault could be found in the monitor.

DE

10kHz acoustic navigation

In order to locate precisely the relative sampling positions of vertical and towed gears, it was planned to deploy an array of three transponders and to operate with a remote interrogator. Because of the short development time not all of the elements of the system had been built before the cruise, but a transponder was ready for the first Bathysnap deployment. It failed to transpond. After tests using the deck unit, the sensitivity of the filters of the second transponder was increased but still it failed to transpond on wire tests, although it would transpond with and lock on to an adjacent 10kHz beacon. The beacon failure and subsequent loss of the Bathysnap rig (see release report below), together with the problems with transponders, resulted in the abandonment of acoustic navigation. Gear positions were based on satellite navigation positioning.

A menu-driven software package for use on a personal computer had been developed for calculating and plotting ship and remote positions from acoustic travel times. Failure of the hardware left the software untested.

DW, DE

Releases

Two IOSDL releases (2431, 2432) were used on Bathysnap deployments, and two RVS releases (2369, 2468) were employed on the Aberdeen University fish camera rig, mainly in conjunction with RVS-supplied retractors.

Bathysnap deployments. 11908#1 utilized release 2431 (operating frequencies 317-320/277-280) which had been wire tested to 3000m. The package started its descent at 1312/22. The beacon timed out correctly during descent but could not be reactivated. While working in the vicinity on 25 August, the release beacon was observed in the release (double pinging) mode. It was interrogated for 30 minutes on the release frequency with no response; there was no response to 320 either. After problems with the PES fish (see above), we returned to the Bathysnap, still double-pinging, for a second attempt at recovery. Both fish and hull transducers were used, also both Mk4 and Mk3 deck command units. During the interrogation the beacon broke down and started pinging at a fast rate of about 0.5s which is symptomatic of battery failure. After a further two hours there was no sign of the rig at the surface, and the beacon was still weakly audible, implying the possibility that it was still on the bottom.

11908#54 utilized release 2432 (operating frequencies 316-320/256-260) which had been wire tested to 3000m. A 30-hour magnesium soluble link was incorporated into the rig. The beacon transmitted initially in a fast-pinging mode which corrected itself near the bottom and did not recur. At the end of the deployment a long period of transmission was required to effect release (over 2 hours of 10, 15 and 20 second bursts). This may not have been a fault in the release, as the releases used for the fish camera required much longer periods of transmission than normal before firing. The problem may have been attributable to the PES fish which had problems transmitting FM signals.

Fish camera deployments. Release 2468 had a very quick firing cycle initially but this was lengthened to allow the firing capacitors longer to charge up.

The first three deployments entailed a long delay between the relay firing and the vehicle rising. This was traced eventually to the retractors sticking. Shoulders had worn on the plastic pins at the point of contact with the restraining bulge in the titanium housing. In two cases the pins, when clean and dry, could be pushed back and the retractor reassembled with the titanium pin retracted. The plastic pins were trimmed where necessary, reassembled with a smear of vaseline and not left in the assembled state until shortly before deployment. All worked satisfactorily thereafter.

DW

Time-series sediment traps

The electronics were tested on deck prior to deployment when a sensor was found to have blown. A similar part was given most generously by the electronics group on FS *Meteor*, and with this fitted the trap worked satisfactorily for short-term test purposes. The loggers and a spare sensor, which had been left at Wormley, were air dropped by an RAF Nimrod aircraft. The sensor was fitted to bring the trap mechanism to a standard state. The traps were not deployed because of mechanical problems and a shortage of time.

DW

Cameras

Several fairly minor faults occurred in the camera systems. All were remedied with very little trouble once diagnosed, but an incomplete familiarity with the systems caused some delay in identifying the source of the problem.

On one epibenthic sledge haul, the camera was still operating when the gear was recovered. This problem was traced to a short circuit caused by corrosion in an Oceanics connector. On another occasion, a haul was delayed by a non-functional flash unit. This was traced to a fault in the camera which was not supplying the correct trigger level. Modifications to attenuate the trigger pulse eliminated the problem. A special flash unit for long term deployments (ie one with power saving circuitry) caused problems initially. With the camera set at a 30 sec interval, the flash electronics were inhibited until the unit was discharged manually. A minor modification rectified this fault.

DE

Computer support

During the cruise the RVS Shipborne Computer System was used to provide track charts based upon data from the ship's navigation aids (gyro compass, electromagnetic log, satellite navigation, global positioning system). Data from four CTD dips were collected and processed, along with the standard meteorological observations. Depth information taken from the PES system was collected and processed against the navigation data for Carter area correction, and later used to produce a contour map of the work area. The computer system, with such a light work load, has completed its processing tasks very quickly and, as expected, there have been no through-put problems. All data collected were archived in GF3 format and passed to the PSO.

AF

GEAR

Multiple corer

Despite various components being badly corroded and the frame showing signs of distortion, the RVS gear was used for the first three multiple corer deployments. It obtained five to eleven usable cores per drop. The overlying water of most cores was cloudy, indicating some degree of disturbance. Subsequent drops were made with the IOS model which gave a more rapid turn-round time because of its simpler tube retention system. Operation of the IOS corer was not trouble-free: on four occasions only a few short, useless core samples were retained. This problem resulted from incorrect tension of the core-catcher springs. Once these were tightened, (11908#33 onwards) consistently good performance was attained. However, some individual cores showed evidence of minor surface disturbance, and cloudy overlying water remained something of a problem. It is probable that these traces of disturbance were a result of the very soft superficial sediments at the EC station. Eleven of the eighteen deployments yielded ten or more usable samples.

Cores were dealt with in a variety of ways (see Table 1). 1) The top 20cm, or top 5cm, were sliced into horizontal layers (1cm thick down to 5cm, 5cm thick thereafter) and fixed in 5% formaldehyde; these samples will be examined for metazoan and foraminiferal meiofauna. 2) 20ml syringe subcores were frozen, sliced into 1 cm thick layers and fixed as above for forminiferal studies. 3) Whole cores were sectioned into 1cm thick layers (0-1, 1-2, 2-3, 3-4, 4-5, 7-8, 12-13, 17-18cm) for granulometric analysis. 4) Cores were frozen whole for chemical analysis. 5) A few small surface samples were taken for the study of bacteria and nanobiota.

Phytodetritus was present in variable quantities on the surfaces of most cores. Aggregates were removed routinely with forceps and fixed in 2.5% cacodylate buffered gluteraldehyde for forminiferal and other studies. Material from a number of cores was removed as rapidly as possible and frozen at -70°C for a proposed study of C^{14} partitioning between foraminiferal test and protoplasm. A few samples were also frozen for chemical analysis.

Table 1. Subsamples taken from multiple cores

11908 series	Usable cores	Core L (mm)	Subsamples: Syringe subcore	0-1 cm	0-5 cm	0-20 cm	Chem	Gran	Phytodetritus for isotopes
3	5	ND	1	-	-	3	1	-	-
5	11	295-440	5	-	2	3	-	1	-
6	9	285-335	2	-	-	2	-	-	-
9	10	180-245	4	-	-	3	1	-	-
13	2	100-170	1	-	1	-	-	-	-
16	10	265-350	3	-	1	4	-	1	1
19	10	330-370	4	-	2	3	-	-	1
22	4	80-165	1	-	1	2	-	-	-
24	12	260-355	5	-	2	3	1	1	1
26	12	290-375	5	-	2	3	1	1	-
27	2	<150	-	-	2	-	-	-	-
29	2	<150	-	-	2	-	-	-	-
31	-	-	-	-	-	-	-	-	-
33	12	275-390	4	-	2	3	1	-	1
37	12	340-450	4	-	2	3	1	1	1
39	11	305-380	4	-	2	3	-	-	3
41	12	270-355	-	5	2	3	1	1	1
70	12	320-345	-	5	2	3	1	-	-

AJG, RP

Spade box corer

The first five drops with the RVS box corer were unsuccessful. Some small modifications were made, including changes to frame and arm designed to provide a better seal between spade and core box. In addition a pinger was attached to the frame and a tilt switch to the spade arm. Initially the corer had been allowed to sit on the sea bed for up to two minutes after paying out extra wire. With the feed-back obtained from the above equipment and less time was spent on the sea bed, before retrieval of the corer was begun.

However, after recovering the gear from a drop in less favourable sea conditions, it was discovered that two gimbal pins had been lost. The original welds holding them had cracked allowing the pins to "work out". New pins were made and welded in place. This happened on two more drops with the remaining two pins, in similar weather conditions. In addition, several bolts sheared off and required replacement. This damage is presumed to have been caused by a combination of violent 'kiting' during descent and pre-triggering. During this period the gear did not return any cores and is known to have pretriggered at least once. It failed to work again until the last two drops, when the sea conditions had improved and additional seizing wire was threaded through the frame and corer, in an attempt to prevent pretriggering.

In all, the box corer was deployed 22 times. Both deployments on the Goban Spur (Station 11907) failed. Only seven of the twenty deployments at the EC station, were successful. Some material was salvaged from two other cores which were too badly disturbed to be of use for intended purposes.

The box corer samples were taken to provide material for size spectra and biomass analysis of large meiofauna and small macrofauna within the IOSDL Laboratory Research Programme. On recovery, the supernatant water was drained and/or siphoned off as quickly as possible, usually after the core box had been removed from the frame, and filtered through 300µm and 40µm sieves. Subsampling tubes for meiofauna (60mm diameter) and granulometric analysis (25mm diameter) were emplaced prior to sectioning the main core. Chemically clean 60mm diameter tubes were used to take subsamples for geochemical analysis from two of the box cores. Because of the very soft nature of the superficial layers of the sediment, it was necessary to leave the subsampling tubes in place until the main core had been sectioned.

Six layers (0-1, 1-3, 3-5, 5-10, 10-15, 15-20cm) were removed and washed through 1000µm, 500µm and 300µm sieves using filtered seawater. Residues were fixed in formalin. Material from deeper than the 20cm horizon was discarded as it was largely or wholly deoxygenated. In addition the deep part was of such a consistency that, even if meiofaunal or greater sized organisms had been present, their successful extraction was improbable. The meiofauna core was cut into layers corresponding with those used for multiple corer samples, ie 0-1, 1-2, 2-3, 3-4, 4-5, 5-10, 10-15 and 15-20cm. Material from each layer was disaggregated separately by gentle agitation in 10% formalin. Sedimentological cores were cut horizontally and samples from the 0-1, 1-2, 2-3, 3-4, 4-5, 7-8, 12-13 and 17-18 cm layers retained, either frozen or chilled, for future analysis. The insertion of the 25mm diameter tubes tended to compress the soft superficial layers so the sampled layers do not reflect the true vertical position of the samples in the sediment. Future use of a 60mm diameter tube will reduce this problem.

RP, MHT

Epibenthic sledge

Two versions of the epibenthic sledge were used during the cruise, the Mk I sledge which has been fished successfully many times in the past, and the Mk II sledge which had been modified to sample macrofauna from the top centimetre or so of the sediment. The top and sides of the sledge were encased with 1mm stainless steel mesh and a bar armed with a cutting edge was bolted rigidly to the back of the sledge. Three 1mm mesh nets were attached to this bar and strapped together across the back of the sledge. Three small nets were used rather than one large mesh net in order to increase the filtration area and to allow easier retrieval of the nets once the sledge was inboard. A test trawl with the new sledge was undertaken at a depth of 1040m on the Goban Spur (St. 11906#1) and a camera mounted under the sledge was used to check the performance of the cutting bar. The doubts about the stability of the sledge fitted with the 1mm steel mesh, proved to be unfounded. The net behaved well in the water and was towed across the seabed for some 175m (odometer reading) or 432m (calculated from ship's position). All three nets were full of mud and the photographs showed that the bottom bar slicing off the surface of the sediment. The nets could not be hauled in by hand without first hooking onto a ring half-way down the net. The right-hand net had 2 to 3 times more sediment than either of the other nets.

The second deployment of the Mk II sledge proved to be a different story. The sledge was unstable in midwater, and also when it reached the seabed, the latter possibly a result of rough topography. The sledge had come face to face with an uncharted seamount in an otherwise flat abyssal plain, and eventually gave up the unequal struggle, parting at the safety strops below the swivel.

The Mk I sledge was used successfully on four occasions, three times with a single coarse mesh net and the fourth time with three fine mesh nets. No problems were encountered except for the odometer, which caught up on its bracket during one haul, and the perennial camera problems. Colour film was used during two hauls and showed clearly the presence of phytodetrital patches on the seabed.

DSMB

Otter trawl

Three successful trawls of the OTSB were made at the abyssal site in 48°50'N: 16°30'W, after three malfunctions, one at 1200m on the Goban Spur and two at Stn 11908 where fish catches were quite unrepresentative. The rig of the net used hitherto was modified at the start of the cruise with a view to improving sampling reliability. The length of the bridles from the net to the main warp swivel was increased from 50 m to 100m and the scope of the warp reduced to around 2.5 times the soundings. By these means it was hoped that the swivel would be lifted above the bottom, to reduce the possibly adverse effect of diverging sediment clouds on fish located in the path of the net. The OTSB was towed a total of some 23 miles along the sea bed in 4839-4877m soundings during the successful hauls.

NRM

Bathysnap

One short term and two long term deployments of this gear were planned. On the first, short term, deployment it was fitted with a transponder, but no current meter. This rig was deployed without incident, but the monitor timed out during descent and could not be reactivated. Subsequent attempts to release the system failed, and the gear was lost (see telemetry report).

Later in the cruise a second short term deployment was attempted with a rig including current meter and with a back-up magnesium soluble link below the release. The deployment was delayed by a resolved but unexplained fault in the flash unit. Eventually the rig was put out and later recovered without further incident. The current meter appeared to have worked satisfactorily but the camera had failed and only a short length of film had been exposed.

BB

Sediment traps

Two deployments of the IOSDL sediment traps fitted with carousels were planned using a buoyancy first launch technique. Late in the preparations for the first deployment the collecting cups were found to be leaking preservative through the top seal. Modifications were attempted but the problem was not overcome, which suggests that redesign is required. A weight first deployment from the bow was proposed so the traps could remain vertical, but time limitation prevented this going ahead.

BB

RMT nets

The RMT 1+8M system was to be fished 10 to 25 metres off the bottom using the near bottom echo-sounder. As this deep haul would otherwise have been the first deployment of the system, a near surface trial was carried out between 50 and 150m. The nets appeared to open and close correctly and all worked well until just before hauling commenced when the net open/close trace disappeared from the monitor (see IOSDL systems report). It was decided to fish the gear without this trace and to look for a decrease in the depth to indicate the opening of the first net. No such indication was observed and the net was brought in after firing the opening/closing sequence close to the sea floor. On recovery the nets were found to have operated and had taken a small catch. However, the catch was made up of pelagic animals found normally at 1500-2000m, and was both too large and contained too many large animals to be explained by leakage. No adequate explanation can be given for this failure but possibilities are that the net was wrongly rigged and the bridles caught up, or that there was an acoustic/release gear failure.

BB

BIOLOGICAL OBSERVATION

Phytodetritus

All successful multiple-corer deployments yielded some phytodetritus. Usually, these were between a few and 20-30 gelatinous aggregates on the surface of individual cores. A few samples were devoid of phytodetritus while, at the opposite extreme, two cores (from 11908#16, 26) were covered with an almost complete layer several millimetres thick. The distribution of phytodetritus was sometimes extremely patchy, with adjacent cores in the same set containing very different amounts of material.

The aggregates were brownish green in colour and ranged in size from a few millimetres to almost 20mm. Examined microscopically, the phytodetritus closely resembled material from the BIOTRANS area. It contained numerous brownish minipellets, the remains of planktonic organisms such as tintinids, crustacean moults, foraminiferal tests, dinoflagellates, coccolithophorids, radiolarians, silicoflagellates and a variety of indeterminate structures. Examination under the epifluorescence microscope (green illumination) revealed numerous cyanobacteria (orange autofluorescence). Chlorophyll (red autofluorescence) was present in planktonic components such as dinoflagellates.

Several phytodetrital aggregates from different samples were examined for live benthic Foraminifera (Table 2). At least eight species were present, six of them recorded previously from phytodetritus obtained in the BIOTRANS area. Although very limited, these preliminary data provide some indication that phytodetritus-dwelling foraminifers may be patchily distributed. Thus six specimens of *Tinogullmia riemanni* occurred in a single aggregate from series #26, while none was observed in three aggregates from series #6.

All foraminifers examined contained protoplasm which showed strong autofluorescence under the epifluorescence microscope. Green illumination evoked orange autofluorescence and careful focussing revealed bright orange specks, identical to cyanobacteria, within the protoplasm of several species (Table 2). Under UV illumination the protoplasm autofluoresced a blue-green colour. In several species, the red autofluorescence characteristic of chlorophyll was observed, usually confined to earlier chambers and often as small discrete patches. These observations support the suggestion, already published, that phytodetritus-dwelling foraminifers ingest cyanobacteria and small algal cells. Some species, for example, *Epistominella exigua*, apparently feed on both cyanobacteria and algae while *T. riemanni*, which never displayed red autofluorescence in the specimens examined, seems to avoid ingesting algal cells.

Table 2. Phytodetritus-dwelling benthic Foraminifera

	11908				Ingested particles	
Species	#6	#9	#26	#35^{x}	Cyanobacteria	Chl-bearing
ROTALIINA						
**Alabaminella weddellensis*	2	-	-	-	+	?
**Bulimina* sp	-	1	-	-	+	+
?*Cibicides* sp.	1	-	-	-	-	?
**Epistominella exigua*	8	2	2	-	+	+
Indet	-	-	1	-	-	+
MILIOLINA						
**Pyrgoella* sp.	-	-	-	2	-	+
TEXTULARIINA						
Saccammina sp.	-	1	1	1	-	+
**Trochammina* sp.	2	-	-	1	-	+
ALLOGROMIINA						
**Tinogullmia riemanni*	-	1	6	-	+	-
Aggregates examined	3	2	1	1		

*Species also present in BIOTRANS phytodetritus samples

^{x} Sample from gut of *Peniagone diaphana*

It is hoped that a TEM investigation of gluteraldehyde fixed material collected during this cruise will yield further information on the diets of these species.

AJG, CWS

Bacterial biomass and activity

Work carried out on this cruise had the following objectives:

1) to collect samples of deep water and sediment for subsequent determination of bacterial numbers and biovolume. These studies form part of IOSDL Laboratory programme LRP4:

2) to continue studies commenced on *Meteor* cruise 6 on the *in situ* growth rates of bacteria in the deep water column and to investigate the effects of pressure and temperature. Since previous studies had shown that bacteria in water samples from intermediate depths possessed activity at the lower limit of sensitivity for our technique, a tangential flow filtration system was to be used in an attempt to concentrate such samples without loss of activity.

Bacterial numbers and biovolume will be determined subsequently in the laboratory by epifluorescence microscopy, photomicroscopy, and measurement of the photographic images. Samples for this purpose were taken from the following CTD rosette casts:

Station	Depths (mwo)
11908#10	4000, 3300, 2700
11908#17	1500, 1000, 875, 750, 500

Three sediment cores were obtained from a multicorer deployment (11908#6). These were sectioned at 1cm intervals over the top 5cm. All samples were preserved in formalin. It should be noted that number/biovolume determinations are carried out routinely on samples taken for growth rate studies. Therefore results will be available in addition for water from 150m and 2000m, 12m above the bottom, and immediately overlying the sediment.

Bacterial productivity was determined by measuring the incorporation of tritium labelled thymidine into DNA synthesized *de novo* during growth. The use of pressure vessels and a pumping system designed and constructed by IOSDL and a constant temperature container made it possible to carry out experiments under ambient temperature and pressure and also to examine the effects of these parameters on the growth rate of the natural community. The scope for the latter was somewhat limited for logistical reasons (the need to incubate large subsamples to maximise sensitivity, the limited capacity of the pressure vessels, and the availability of only one incubation temperature at a time). Samples of water were taken from 150m (St. 11908 #45, 67), 2000m (St. 11908 #10, 17, 50) and 12m above the bottom (St. 11908#10). Water immediately overlying the sediment was obtained from multicorer hauls (St. 11908 #6, 33, 70).

Full calculation of biomass specific productivity will only be possible following laboratory measurements of population size, but it is possible to present some preliminary findings here. At *in situ* temperature (2.5°C) the growth rate of the community immediately overlying the sediment was approximately twice as fast at *in situ* pressure (480 ats) than at surface pressure (1 at). This confirms the existence of a previously unreported barophilic (depth adapted) community which was also noted during the *Meteor* cruise.

In contrast, the midwater community from a depth of 150m when incubated at *in situ* temperature (11.5°C) showed an incorporation rate at 1 atmsophere which was approximately 10 times that found under 480 ats pressure. Previous studies on board *Meteor* suggested that activity at 2000 and 4000m would be below the sensitivity of the technique, but a decrease in blank values on this cruise resulting from a change to Nucleopore type filters made it possible to obtain measurements from the unconcentrated 4000m (but not 2000m) sample. At *in situ* temperature (2.5°C) this community had an incorporation rate at 480 ats which was roughly 0.7 of that found at 1 at. Overall incorporation rates at 4000m were relatively low. For example, the rate at 480 ats was about 0.05 of that of the community in the overlying sediment water 12m below.

In an attempt to measure activity at 2000m, a tangential flow system was used to concentrate the sample. Tangential flow systems are large area filters whose surface is constantly swept by the concentrate, which avoids clogging and consequent damage to the bacteria. An initial attempt to use this system resulted in a high level of non barophilic activity (high at 1 at, low at 200 at, undetectable at 480 at). Extrapolation from this result suggested that such activity should be detectable in unconcentrated samples. Microscopical studies on samples taken during this experiment may explain this anomaly. Contamination of the sample during concentration is one possibility. Repetition of the experiment after extensive cold sterilisation of the system with gluteraldhyde produced similar results, though incorporation rates were considerably reduced.

Some studies were made on the incorporation rates of the 150m and core water communities at other temperatures. Decreasing the incubation temperature for the 150m community to 2.5°C reduced uptake at 1 at by approximately an order of magnitude and stopped all uptake at 480 ats. Increasing the incubation temperature for overlying core water to 11.5°C caused a doubling of the uptake rate at 480 ats. This is interesting in view of the suggestion that one reason for the failure to isolate barophils from the deep ocean is their sensitivity to rises in temperature. Curiously, uptake rates at 1 at were the same at both temperatures. This may be the result of biomass differences between samples and may be elucidated after they have been examined in the laboratory.

JWP

Nanobiota

Several methods for concentrating and observing nanobiota (organisms, mainly Protozoa, 2-42µm in size) were tried when time permitted. All material was taken from the surface of multiple-corer samples.

1) Surface sediment was mixed with a Percol-Sorbitol mixture and centrifuged according to the methods described by Schwinghamer and Alongi. Part of the supernatant was fixed in 2.5% cacodylate-buffered gluteraldehyde, stained with DAPI, concentrated on a 0.2µm nucleopore filter and examined under the epifluorescence microscope. One ml aliquots of the remaining supernatant were placed in a Sedgewick-Rafter counting cell and examined for larger (>20µm) nanobiota under a dissecting microscope.

2) Sediment slurry, diluted with 0.2μm filtered core tube water (total volume about 20ml) was fixed in 2.5% buffered gluteraldehyde, stained with DAPI and filtered onto 0.1μm nucleopore filters. The filters were mounted on a slide in immersion oil and examined under the epifluorescence microscope.

3) A small volume of unfixed, unstained sediment was examined using bright field and epifluorescence microscopy.

Nanobiota were not observed in any of these samples. The only organisms noticed were occasional nematodes and juvenile planktonic foraminiferal tests in the Percol-Sorbitol supernatant, bacteria-like particles in DAPI-stained sediment, and possible cyanobacteria (orange autofluorescence under green illumination) in the unstained sediment sample.

AJG

Xenophyophores and larger foraminifers

Incidental observations were made of specimens visible on the surface of box-corer and multiple-corer samples. Xenophyophores appear to be less numerous than in the BIOTRANS area, although some species are common to both sites. The following were observed: *Reticulammina labyrinthica* (4 specimens), *Galatheammina* sp. (4 specimens), *Psammina* sp. (1 specimen), *Occultammina* sp. (fragments) and *Aschemonella* sp. The *Aschemonella* was particularly interesting, being probably the first more or less complete specimen ever collected. It consisted of a branching sequence of chambers, two ends of which emerged above the sediment surface.

Branching tubes of *Rhizammina algaeformis* occurred on the surface of some box-cores. However, this species was noticeably less abundant than in the BIOTRANS area and never formed clumped masses. Hemispherical mudballs which protruded from the sediment surface were fairly common. These proved to be komokiaceans of the genera *Lana* and *Edgertonia*. Finally, a large lump of clinker from 11908#25 was encrusted with foraminifers which included several calcareous specimens (? *Cibicides* sp.) and a variety of agglutinated forms such as *Telammina*, *Trochammina*, *Ammodiscus* and anastomosing grey tubes. The foraminifers on this piece of clinker resembled the encrusting assemblages observed on erratic stones from the BIOTRANS area.

AJG

Macrofauna

Although the diversity of macrofaunal organisms in the deep sea is very high, numbers of individuals tend to be low. As a consequence, only the smaller animals occur at densities sufficient to be sampled adequately by a 0.25m^2 box corer. The larger macrofaunal organisms can be sampled in statistically valid numbers only by towed gears covering larger areas of the sea floor.

A very cursory examination has been made of material from box core samples retained on a 1000μm mesh. Organisms of this size occur at a density of 50-80/m^2 with polychaetes forming an important part of the fauna. These findings correspond closely with data obtained from the BIOTRANS site (47°N 20°W) during *Meteor* Cruise 6-7B in 1988.

In an attempt to improve the macrobenthos sampling efficiency of the epibenthic sledge, the Mk II version had been modified with a fine mesh tunnel and new bottom bar (see epibenthic sledge report). Subjective impressions of a haul using this sledge made on the Goban Spur (St. 11906) suggest that the modifications have improved the ability of this net to sample the macrofauna. The loss of this sledge during its first deployment at the EC station was a major blow. The single subsequent haul using 1mm mesh nets (station 11908#66) was made with the unmodified Mk I sledge frame. Although a good catch was obtained, any biomass estimate obtained from it must be considered minimal.

MHT

Megafauna

A wide range of invertebrate taxa were obtained from the otter trawl and epibenthic sledge hauls. One fine mesh epibenthic sledge (St. 11906#1) was trawled at a depth of 1090m on the Goban Spur and produced a sample dominated by the holothurians *Laetmogone violacea* and *Bathyplotes natans*, the echinoids *Phormosoma placenta*, *Cidaris cidaris* and *Spatangus raschi*, and the asteroid *Psilaster andromeda* and *Zoroaster fulgens*. The catch was also notable for crangonid crustaceans and the crab *Rochinia carpenteri*, as well as a richer catch of infaunal macrofauna than has been obtained in the past thanks to the new design of bottom net bars used with the Mk II sledge (see epibenthic sledge report).

An otter trawl was deployed close by on the Goban Spur (St. 11907#1), but at a slightly greater depth, ca. 1300m, and produced a sample dominated by the sponge *Pheronema carpenteri*, a species known to occur in great abundance in the north west of the Porcupine Seabight but not on the Goban Spur. Many smaller animals were associated with the sponge including sipunculids, pectinid bivalves, ophiuroids and the crab *Dorynchus thomsoni*. Otherwise, the catch was notable for actiniarians, madreporarians, tunicates, various crustaceans including crangonids, eryonids, *Munida tenuimana*, *Nephropsis atlantica* and small *Geryon trispinosus*, and the holothurians *Benthogone rosea* and *Bathyplotes natans*, the echinoids *Echinus* sp. and *Phormosoma placenta*, and above all the asteroids *Henricia* sp. and *Zoroaster fulgens*.

At the abyssal station sampled repeatedly by the epibenthic sledge and otter trawl, the catches were essentially the same except that the sledge sampled smaller fauna including bivalves, gastropods, zoanthid zoantharians and ophiuroids. The larger invertebrates were dominated by a wide range of echinoderms. Holothurians were most abundant, *Oneirophanta mutabilis* and *Peniagone diaphana* being most numerous, but with good numbers of *Psychropotes longicauda, Benthodytes sordida, Deima validum, Amperima rosea, Molpadia blakei, Mesothuria candelabri, Paroriza prouhoi* and several species of *Pseudostichopus*. The asteroids *Dytaster grandis, Hyphalaster inermis* and several *Styracaster* species were also common, although surprisingly only one specimen of *Freyella elegans* was found and another brisingid *Freyastera sexradiata* was present in greater abundance.

Several specimens of the pennatulid *Umbellula* sp. were recovered, two at least attached to the trawl doors rather than in the net. Otherwise the catches were also notable for echiurids, sipunculids, annelids, actiniarians including *Sicyonis*, tunicates including *Culeolus*, small hexactinellid sponges, madreporarians, crinoids (?*Bathycrinus gracilis*) and a wide range of crustaceans including natants such as *Plesiopenaeus*, eryonids and the galatheids *Munidopsis crassa* and *M. parfaiti*. Individuals of the latter two species were found to be feeding almost exclusively on phytodetritus or one species of small bivalve, but the choice of diet was not species dependent. In addition, otter trawl catches contained several large cirrate octopods, mostly in excellent condition.

DSMB

Photography

Two IOS Mk IV underwater cameras were taken for use with the epibenthic sledge, together with Mk IVA (half-frame) cameras for use on Bathysnap deployments.

One of the Mk IV cameras was used successfully in the backward-looking mode on the shallow deployment of the modified fine meshed epibenthic sledge (11906#1) and confirmed that the modifications worked well. Unfortunately, this camera was lost on the first deep deployment of this sledge (11908#4).

With relatively minor problems (see IOSDL systems report), the second Mk IV camera worked well on five epibenthic sledge deployments at the deep station (11908), two of these using FP4 black and white film (#38 and 55) and three employing Ektachrome colour reversal film. A total of more than 1000 usable frames was obtained (400+ b/w, 600+ colour), providing good data on megafaunal abundances and graphic evidence for the presence of abundant, but patchy, phytodetritus on the sea-floor, thus corroborating the corer results.

No Bathysnap photographs were obtained. One Mk IVA camera and flash was lost on the unrecovered Bathysnap deployment, while the second system failed during the descent of the short-term Bathysnap (11908#54).

ALR

Trophic ecology of deep-sea holothurians

This work is part of an ongoing research programme investigating nutrient resource partitioning in deep-sea holothurians in collaboration with D.S.M. Billett (IOSDL). Major objectives during this cruise were:
1) to acquire additional freshly preserved tentacle and gut material for functional studies with a range of fixatives and treatments to be employed in an attempt to maximise the likelihood of good fixation for ultrastructural studies;

2) to screen fresh and fixed tentacles and body wall of as many species as possible for associated bacteria by means of epifluorescence microscopy;

3) to conduct experimental work on holothurian tissues to investigate potential roles of putatively symbiotic bacteria;

4) to fix material for X-ray microanalysis;

5) to collect tissue samples for electrophoretic studies.

Tentacle and body wall samples from 17 species have been fixed. Some of these have been embedded and sectioned and appear to be well fixed and in good condition. However, the condition of the fine detail of the surface layer, which is critical for these studies, will only be revealed under electron microscopy.

The use of epifluorescence microscopy to screen for bacteria in tissue sections was unsuccessful, largely as a result of a great deal of autofluorescence in the holothurian tissue and the staining properties of DAPI and Acridine orange. The use of more specific bacteriological staining techniques should alleviate this problem.

Four experiments in collaboration with J. Patching (UCG) and D.S.M. Billett were carried out. These involved comparison of elaspodid and aspidochirotid tentacles from a slope site at 1400m (*Benthogone rosea* and *Bathyplotes natans*) and an abyssal site at 4800m (*Oneirophanta mutabilis* and *Pseudostichopus* sp.). *B. rosea, B. natans* and *Pseudostichopus* are believed to have subcuticular bacteria in their tentacles. The aim of the experiment was to investigate potential involvement of these bacteria in parenteral nutrient transport in holothurians. The experimental rationale involved *in vitro* incubation of holothurian tissues in C14 labelled substrates in the absence and presence of antibiotics (Vancomycin, Streptomycin sulphate) at ambient temperature and pressure. Selected substrates included glutamic acid and bicarbonate as potential bacterial metabolites and alanine which should be directly available to animal tissue. All experiments appeared to work well in that they were set up within one hour of the catch being onboard, and tissues appeared to be intact at the end of a 20h experimental period. Preliminary experimental work of this kind on *Meteor* in 1988 revealed that *Oneirophanta* tentacles survive well for at least 24h under these experimental conditions.

A large and diverse catch of holothurians in OTSB haul 11908#51 provided replicate samples of nine species from this single sample for X-ray microanalysis. It is essential that material for X-ray microanalysis is processed to resin as soon as possible. All these samples were embedded in TAAB resin and will be processed at a later date in Belfast without any risk of deterioration.

Replicate samples (n = 3-25) of body wall tissues of all holothurian species found during the cruise have been deep frozen (-70°C), in some cases from a single catch. These will be examined electrophoretically in Belfast. Apart from those species with a very high body water content, protein patterns will be easy to resolve. As well as helping resolve taxonomic problems (eg N. Atlantic species of *Pseudostichopus*), these electrophoretic data can be used to address problems in population biology and biogeography as data from other areas become available.

Treatment of material collected

Samples	TEM/LM			SEM		X-ray micro-	Electro-
	tent	BW	gut	tent	gut	analysis	phoresis
Species							
ELASIPODA							
Benthogone rosea	x	x	x	x	x	x	x
Laetmogone violacea	x	-	x	x	x	x	x
Psychropotes longicauda	x	-	x	x	x	x#51	x
Oneirophanta mutabilis	x	x	x	x	x	x#51	x
Peniagone diaphana	x	-	x	x	x	x#51	x
Benthodytes sordida	x	-	x	x	-	x	x
Deima validum	x	-	x	x	x	x#51	x
Amperima rosea	x	-	-	x	x	x#51	x
MOLPADIDA							
Molpadia blakei	x	-	x	x	x	x	x
APODIDA							
Protankyra sp.	-	x	-	x	x	-	x
ASPIDOCHIROTIDA							
Mesothuria candelabri	-	x	-	-	-	x#51	x
Paroriza prouhoi	x	-	x	x	x	-	x
Bathyplotes natans	x	-	x	x	x	-	x
Pseudostichopus atlanticus	x	-	x	x	x	x#51	x
Pseudostichopus marenzelleri	-	-	-	-	-	-	x
Pseudostichopus sp.	x	-	x	x	x	x#51	x

Approximately 600 samples, which include >1500 individual specimens, have been collected (see Table above). Even with a 50% wastage, which can be expected in material collected from the deep sea for ultrastructural work, this material represents a considerable resource for the study of feeding in deep sea holothurians. Material collected for electrophoresis and X-ray microanalysis will provide useful bases respectively for population studies and mineral processes in deep-sea holothurians.

Thanks are extended to all shipboard colleagues and personnel for invaluable support at sea, to QUB for funding and to NERC for shipboard facilities on RRS *Discovery*.

DR

Deep-sea demersal fishes

The three successful otter trawl hauls yielded 110 fish weighing all together 121kg. Sampling seemed relatively constant within the range of fish biomass and density of 0.25-0.40 kg/1000m^2 and 0.21-0.31 fish/1000m^2 respectively.

Eight species, representing five families, were collected. Four of these were rattails (Macrouridae) and one, *Coryphaenoides (Nematonurus) armatus*, dominated the samples in both number (47% total catch) and biomass (88%). Other species common to all three hauls were the synaphobranchid eel, *Histiobranchus bathybius*, and the macrourids, *C. (Chalinura) leptolepis* and *C. (C.) profundicolus*. Two species, the synodontid, *Bathysaurus mollis*, and the macrourid, *Echinomacrurus mollis*, were new records among IOSDL samples taken previously at these soundings on the Porcupine Abyssal Plain.

As well as routine data collected for each individual, tissue samples were collected for DNA (at the BM(NH)) and electrophoretic analysis (at Queen's University, Belfast) for racial studies. Parasites were also collected from these fishes with the same aim in view (see parasite section).

NRM

Parasitic helminths of abyssal benthic fishes

Abyssal fishes from OTSB stations 11908#44, 51 and 68 and from epibenthic sledge stations 11908#35, 55 and 66 were examined. Fifty-two specimens of 8 species, either fresh or frozen, were dissected and the helminth parasites removed. Further fish specimens were frozen or fixed in formalin for later examination. No helminths were harboured by the species *Bathypterois longipes* (2 specimens) and *Echinomacrurus mollis* (1 specimen). All specimens of all other species harboured at least one helminth. Cestode larvae (Tetraphyllidea and Trypanorhyncha) were found most frequently, at a prevalence of 87%. Digenea of several families (mainly Opecoelidae, Fellodistomidae and Derogenidae) showed an overall prevalence of 48%. Nematodes (probably ascarids) occurred with a prevalence of 25%. No acanthocephalans or monogeneans were found in fish from abyssal sites. The major helminth groups were recovered from the fish species in the following proportions:

Fish host	n	% prevalance Cestoda	Digenea	Nematoda
Coryphaenoides (Nematonurus) armatus	32	94	47	31
C. (Chalinura) profundicolus	8	100	62	37
C. (C.) leptolepis	4	50	100	-
Bathysaurus mollis	3	67	33	-
Histiobranchus bathybius	2	100	-	-
?*Bellocia* sp.	1	100	-	-

It is probable that some of the cestode larva infestations are cumulative and may well have been acquired by the fish when significantly younger and in shallower waters. However, the relatively high prevalence of diageneans suggests that some life-cycles are maintained at abyssal depths.

RAB

Movements of deep-sea benthic fishes

The experiments made on this cruise formed part of a study under NERC Grant no. GR3/6611 the stated aims of which are:

"Measurements will be made of movements of deep-sea fish in relation to bottom current, foraging and energetic strategies. A foraging model developed for benthic rat-tails in the deep Pacific Ocean (4000-6000m depth) will be tested in the North Atlantic."

The specific practical objectives of this cruises were:

1. To test a new pop-up camera vehicle on which are mounted the ATEX and SCATEX acoustic fish tracking systems.

2. To determine whether N. Atlantic benthic fish will ingest acoustic transmitters placed in baits on the sea floor within view of the camera.

3. To track range of fish which ingest transmitters using the ATEX system mounted on the camera vehicle.

4. To track direction of fish which ingest transmitters in relation to compass and current direction using the SCATEX scanning system.

5. To record sounds of deep sea benthic fishes. (A trial experiment with Dr. A.D. Hawkins, Marine Laboratory, Aberdeen).

6. To undertake a minimum of 10 camera vehicle deployments at the northerly station and some exploratory deployments in the south.

The pop-up camera vehicle was a totally new instrument never previously deployed. After departure from Barry assembly was completed incorporating hardware supplied by RVS, a current meter, strobe light and acoustic release mechanism. A trial deployment and recovery were carried out successfully on 21 August without ballast allowing the system to drift at the sea surface for 30 minutes to check camera and current meter function. Satisfactory protocols for handling of gear from the foredeck were established.

Following arrival at the northerly station the first deployment to depth was made on 24 August with successful recovery the following day. On this first deployment the current meter housing flooded so that no data were obtained and the current meter could not be used again during this cruise. Thereafter a continuous cycle of deployment and recovery of the camera vehicle was maintained during the 21 days on station completing 9 deployments in total. It became apparent that, allowing time for development of films, recharging of batteries and preparation of hardware, 24h were necessary between recovery and the next deployment. Twelve to 30h were required for the experiment on the sea floor so one deployment every 2 days proved to be the maximum rate achievable. Completion of 9 out of a theoretical possible 10.5 deployments, was as good as could be expected taking into account the need to schedule other ship's work.

A soluble Mg release was used as a back-up in case of acoustic release (IOS retractor type) failure. This proved unnecessary, although in one instance the Mg release brought the vehicle to the surface prematurely. Nevertheless, there were some problems with delayed function of the acoustic release mechanism. In the worst case (#21) the vehicle arrived at the sea surface 21h 49min after the release command had been triggered. It became apparent that retractors can jam in the locked state. Mr. D. White of IOS operated the releases for us and we are grateful for his skills in nursing the releases through 9 successful recoveries. Use of a Mg or other kind of back-up release is still to be recommended. A radio beacon and the RDF mounted on the ship proved to be of immense value in retrieving erratically surfacing deployments. The radio beacon could be detected at a range of over 7 nm enabling the ship to proceed with other work whilst maintaining a radio watch. In one instance (#32) another ship was successfully warned off as it approached our flashing beacon at night.

Good photographs of fish behaviour were obtained for 8 of the 9 deployments with one camera intervalometer failure. Rat-tails, *Nematonurus (Coryphaenoides) armatus* were readily attracted to our baits and ingested transmitters. It is remarkable that arrivals at our baits were very much dominated by this one species which comprised only about 25% of trawl catches (N.R. Merrett). Ingestion of transmitters and departure of fish was rapid compared with more oligotrophic sites we have studied with Prof. K.L. Smith Jr. in the Pacific Ocean. Preliminary analysis indicates that all fish departed from the bait source within 8 hours. The ATEX system tracked range and radial swimming speed of 14 fish in total. On three occasions the system failed to function for technical reasons and some loss of transmitters was experienced during deployments.

The SCATEX scanning system was deployed on 6 occasions and provided compass data which will enable us to interpret current direction from indicators in view of the camera. The SCATEX scanner suffered mechanical seal failure in early deployments. This damaged vital components. Modifications were necessary to provide a new system of direction encoding and directional tracks were obtained for 5 fish. Preliminary analysis indicates that fish departed in different directions in relation to the current and, by 10h after bait deployment, were over 1 to 2km away from the food source.

The fish sounds experiment was new, and following apparent interference with our ATEX system on the first deployment, was omitted from subsequent deployments until the final deployment (#65). The fault had been traced by this time and a good recording of sounds on the sea floor was obtained. A periodic low level clicking sound was detected apparently correlated with fish presence at the bait.

All the aims of the work at the northern station were achieved. Individual fish were tracked for the first time at abyssal depths in the North Atlantic. A substantial body of new data has been collected on behaviour of *N. (C.) armatus* which is directly comparable with our previous data for *N. (C.) armatus* and *N. (C.) yaquinae* at two stations in the Pacific Ocean. This will provide the basis for the further generalisation of our deep sea fish foraging model. Substantial technical progress was made in operation of a new camera vehicle system and realisation of a deep-sea directional fish tracking system.

We are grateful to our scientific colleagues and the ship's company for making this work possible.

IGP, JDA

Ornithology

Ornithological observations were made as and when other duties permitted. In all, 191 ten minute observations were made during the period 19 August - 16 September. The cruise falls naturally into three parts: the passage out to the European Community Station at 48°50'N 16°30'W (19-21 August, 3 days), the EC station (22 August - 12 September, 22 days), and the passage south to Madeira (13-16 September, 4 days)

Eleven species of seabirds were recorded on the passage out to the EC station. Greater shearwaters (*Puffinus gravis*) were seen during most observation periods and were most frequent in the Celtic Sea. Lesser black-backed gulls (*Larus fuscus graellsii*) showed a similar pattern although in this case none were seen in the middle of the passage, indicating, perhaps, an inshore post-breeding population and an offshore group of non-breeders.

During the 22 days spent at the EC Station, the weather was good with mainly light to moderate winds, usually from the southwest, west or northwest. On 7 September winds of up to 30 knots were recorded, and thereafter, although moderating, were predominantly northerly or northeasterly. Fifteen species of seabirds were recorded during the 157 observation periods undertaken at the EC Station. Only four species, fulmar (*Fulmarus glacialis*), Cory's shearwater (*Calonectris diomedea*), greater Shearwater and Wilson's storm petrel (*Oceanites oceanicus*) were seen at more than 10% of these observations. Greater shearwaters were seen most frequently (109 observations, 69%) and in greatest numbers. About 1000 birds, mostly flocked on the water, surrounded the ship in windless conditions on 5 September. Cory's shearwaters occurred during 58 observations (37%) with maximum numbers of c.180 on 27 August. Fulmars and Wilson's storm petrels were seen during 21 observations (13%) with maximum numbers of ten and six respectively.

The latter part of the time spent at the EC Station appeared to coincide with the changeover from the late summer seabird community to the winter one. Up to and including 8 September, Cory's and greater shearwaters were seen regularly, often in large numbers. From 9 September onwards these species were absent (Cory's shearwater) or present only in very low numbers. In contrast, occurrences and numbers of fulmars increased at the same time. These changes may have been affected by the switch from a SW-NW wind regime to a N-NE one, although this occurred on 7 September, a day or two before. Changes in meteorological conditions are known to have marked effects on the migration of landbirds, and it seems probable that they may affect seabirds in a similar way. Bird occurrences and numbers recorded during the present cruise contrast with those obtained in November-December 1986 (Challenger Cruise 8/86) when kittiwakes (*Rissa tridactyla*) and fulmars dominated the avifauna, and in April-May 1988 (*Meteor* Cruise 6 leg 7B) when the same two species, together with lesser black-backed gulls (*Larus fuscus graellsii*), i.e. were most abundant.

The passage south from the EC station to Madeira was undertaken in fine weather with mainly light winds between west and south. Only two seabirds were seen during the first three days of the passage, and even on the last day numbers were low. Seven species were recorded during the four days.

Throughout the cruise as a whole nineteen species Of seabird were seen. of these there were southern hemisphere breeders (greater shearwater, sooty shearwater *Puffinus griseus*, and Wilson's storm petrel), two were low latitude North Atlantic breeders (Cory's shearwater and Bulwer's petrel *Bulweria bulweria*) and the remaining fourteen boreal species which migrate to warm temperate regions or beyond or undergo a dispersal after the breeding season.

Two birds, a Wilson's storm petrel and a Leach's storm petrel (*Oceanodroma leucorhoa*), were found on board and ringed before release.

Non-seabird sightings were infrequent. Turnstones (*Arenaria interpres*) were seen on several occasions during all three phases of the cruise. Other species seen at the EC Station, usually singles at one observation or a few observations on a single day, included ringed plover (*Charadrius hiaticula*), common sandpiper (*Actitis hypoleucos*) and white and pied wagtails (*Metacilla a. alba* and *M. a. yarrelli*).

MHT

Whales

A combination of fine weather and a 22 day occupancy of the European Community Station centred on 48°50'N 16°30'W, provided an unusual opportunity to record whales in one area over an extended period of time.

Sightings of large rorquals were made on eleven days and on six occasions were confirmed as fin whales (*Balaenoptera physalus*). Several reports were of a group of three or four animals including one smaller individual. Thus it is probable that at least some sightings were of the same group which was resident in the area over a period of at least twelve days. Most of these rorqual sightings were at times when dense patches of scattering at depths down to 400m were being picked up by the echo-sounder. Only one midwater haul with the RMT1+8M system was completed successfully. This was made when the scattering was much in evidence and catches between 25m and 150m consisted entirely of the hyperiid amphipod *Themisto compressa*. Although the large rorquals feed mainly on euphausiids, there are many records of these whales taking *Themisto*, both in northern and southern latitudes.

Among the small Cetacea, hourglass dolphins (*Delphinus delphis*) were recorded most frequently and in greatest numbers, up to 40 being seen on each of six days. Frequently these dolphins were observed to be feeding on fish in which case flocks of shearwaters (greater, *Puffinus gravis* and Cory's, *Calonectris diomedea*) were invariably present. Small groups of striped dolphins (*Stenella coerulealba*) and pilot whales (*Globicephala melaena*) were recorded once each.

MHT

STATION LIST

Abbreviations used in station list

BN1.5/C	-	Epibenthic sledge (coarse mesh net)
BN1.5/3F	-	Epibenthic sledge (fine mesh net)
BSNAP	-	Bathysnap free-fall camera module
CTD		Neil Brown conductivity/temperature/depth instrument
FC		Aberdeen University fish camera
MC	-	Multiple corer
OTSB14	-	Semi-balloon otter trawl
RMT1+8M	-	Multiple rectangular midwater trawl
SBC	-	Spade box corer

1	-	for free fall gear (BSNAP, FC), the time given is the observed or estimated time of arrival on the sea floor, but position is based on position of ship when gear began descent.
2	-	All times GMT
3	-	CTD calibration not agreeing with PES or net monitors

Station no.	Date 1989	Day	Gear position (start) N	Gear position (start) W	Gear position (end) N	Gear position (end) W	Gear[1]	Depth (m. corr.)	Time[2]	Remarks
11906#1	20.8	232	49°35.7'	11°56.5'	49°35.7'	11°56.9'	BN1.5/3F	1085-1090	1201-1211	Distance run by odometer 175m, by calculation 432m
11907#1	20.8	232	49°40.3'	12°08.2'	49°37.8'	12°08.8'	OTSB14	1315-1295	1855-1954	Distance run by log 4260m, by calculation 4680m
11907#2	21.8	233	49°36.8'	12°13.0'			SBC	1328	0025	No sample
11907#3	21.8	233	49°37.6'	12°13.0'			SBC	1334	0218	No sample
11908#1	22.8	234	48°51.0'	16°30.9'			BSNAP	4846	1448	Descent rate 0.83m/s. Release failed to respond after time out. Gear lost
11908#2	22.8	234	48°52.7'	16°30.0'			SBC	4846	1813	No sample
11908#3	22.8	234	48°55.2'	16°29.7'			MC	4847	2220	Six cores of which five usable
11908#4	23.8	235	49°04.5'	16°36.2'	49°05.9'	16°37.4'	BN1.5/3F	4870-4120	0823-0926	Tension up to 12t. Bridles parted and sledge lost
11908#5	23.8	235	48°51.2'	16°29.9'			MC	4843	1756	Eleven good cores
11908#6	23.8	235	48°51.0'	16°27.0'			MC	4851	2206	Nine good cores
11908#7	24.8	236	49°03.8'	16°04.3'	49°05.0'	15°52.5'	OTSB14	4847-4789	0936-1200	Distance run by log 14300m, by calculation 14500m
11908#8	24.8	236	48°55.8'	16°10.7'			FC	4851	2308-1733/25	Surface 2108/24, bottom 2308/24, descent rate 0.67m/s. Released 1733/25, surface 1855/25, ascent rate 0.99m/s
11908#9	25.8	237	48°50.3'	16°30.1'			MC	4846	0555	Ten good cores
11908#10	25.8	237	48°51.8'	16°30.5'			CTD	4917-1985[3]	1306-1404	3 bottles at 4917m, 1 at 4001m, 1 at 3300m, 1 at 2695m and 3 at 1985m
11908#11	26.8	238	48°50.3'	16°30.0'			SBC	4851	0046	No sample. Failed to trigger
11908#12	26.8	238	48°53.2'	16°28.9'			SBC	4851	0740	No sample
11908#13	26.8	238	48°53.4'	16°26.6'			MC	4847	1307	Five cores only two good
11908#14	26.8	238	48°56.4'	16°27.5'			SBC	4847	2136	No sample
11908#15	27.8	239	48°57.2'	16°25.8'			FC	4851	0326-2030/28	Surface 0120/27, bottom 0326/27, descent rate 0.64m/s. Released 2030/28, surface 2200/28, ascent rate 0.90m/s
11908#16	27.8	239	48°51.9'	16°29.3'			MC	4847	1227	Eleven cores of which 10 good
11908#17	27.8	239	48°57.1'	16°25.3'			CTD	1997-147	1718-1822	Six bottles at 1997, and 1 each at 1499, 997, 871, 748, 498 and 147m
11908#18	28.8	240	48°52.3'	16°31.2'			SBC	4847	0306	Good core
11908#19	28.8	240	48°50.1'	16°30.0'			MC	4847	1159	Twelve cores retained, 10 good

Station no.	Date 1989	Day	Gear position (start)		Gear position (end)		Gear[1]	Depth (m. corr.)	Time[2]	Remarks
			N	W	N	W				
11908#20	28.8	240	48°51.6'	16°28.9'			SBC	4849	1911	Good core
11908#21	29.8	241	48°51.7'	16°32.2'			FC	4851	0134-1600/30	Surface - 2354/28, bottom 0134/29, descent rate 0.81m/s. Release triggered 2054/29, but stuck, gear rising spontaneously to surface at 1730/30
11908#22	29.8	241	48°50.1'	16°28.4'			MC	4847	0318	Six cores retained, 4 good
11908#23	29.8	241	48°50.8'	16°28.9'			SBC	4844	0917	Good core
11908#24	29.8	241	48°53.9	16°25.7'			MC	4847	1628	Twelve good cores
11908#25	30.8	242	48°50.9'	16°28.6'			SBC	4847	0100	Good core
11908#26	30.8	242	48°51.2'	16°28.0'			MC	4845	0731	Twelve good cores
11908#27	30.8	242	48°51.1'	16°30.1'			MC	4847	1716	Only 2 cores obtained, both good
11908#28	31.8	243	48°51.6'	16°32.7'			SBC	4849	0908	No sample
11908#29	31.8	243	48°50.7'	16°30.3'			MC	4845	1532	Five cores retained, 2 good
11908#30	31.8	243	48°51.1'	16°32.9'			SBC	4847	2121	No sample
11908#31	1.9	244	48°51.0'	16°30.1'			MC	4847	0316	Only 4 cores retained all disturbed
11908#32	1.9	244	48°57.0'	16°30.3'			FC	4847	1241	Deployed 1036/01, bottom 1241/01, descent rate 0.65m/s. Released 0200/02, surface 0330/02, ascent rate 0.90m/s
11908#33	2.9	245	48°49.7'	16°27.3'			MC	4847	1317	Twelve good cores
11908#34	2.9	245	48°50.3'	16°25.2'			SBC	4847	1634	Badly disturbed sample discarded
11908#35	3.9	246	48°53.4'	16°18.0'	48°50.1'	16°28.3'	OTSB14	4843-4847	0300-0600	Distance run by log 14100m, by calculation 13700m
11908#36	3.9	246	48°47.6'	16°26.7'			FC	4844	1651	Deployed 1411/03, bottom 1651/03, descent rate 0.51m/s. Released 0948/04, surface 1105/04, ascent rate 1.05m/s
11908#37	3.9	246	48°51.4'	16°29.3'			MC	4847	1841	Twelve good cores
11908#38	4.9	247	48°46.8'	16°34.3'	48°49.6'	16°34.1'	BN1.5/C	4844-4846	0232-0402	Distance run by odometer 2200m, by calculation 5200m
11908#39	4.9	247	48°49.9'	16°30.1'			MC	4845	1415	Eleven cores retained, all good
11908#40	4.9	247	48°47.6'	16°35.9'	48°50.4'	16°35.5'	BN1.5/C	4866	2133-2306	Calculated distance run 5230m
11908#41	5.9	248	48°50.4'	16°28.8'			MC	4845	0517	Twelve good cores
11908#42	5.9	248	48°50.7'	16°30.7'			SBC	4847	1007	Badly disturbed sample; 0-10cm layer sieved

Station no.	Date 1989	Day	Gear position (start) N	Gear position (start) W	Gear position (end) N	Gear position (end) W	Gear[1]	Depth (m. corr.)	Time[2]	Remarks
11908#43	5.9	248	48°47.8'	16°28.9'			FC	4844	1446	Deployed 1258/05, bottom 1446/05, descent rate 0.75m/s. Released 0953/06, surface 1132/06, ascent rate 0.82m/s
11908#44	5.9	248	48°47.3'	16°29.9'	48°56.8'	16°27.6'	OTSB14	4843-4849	2057-0018/6	Distance run by log 16100m, by calculation 17800m
11908#45	6.9	249	48°50.3'	16°29.7'			CTD	148	1329	Twelve bottles fired at 148m
11908#46	6.9	249	48°51.2'	16°28.4'			SBC	4847	1622	Sample badly disturbed, half of core sieved
11908#47	6.9	249	48°50.5'	16°23.0'	48°50.4'	16°26.4'	BN1.5/C	4860	2313-0035/7	Distance run by odometer 2540m, by calculation 4130m
11908#48	7.9	250	48°49.5'	16°28.5'			SBC	4851	0655	Good sample
11908#49	7.9	250	48°46.9'	16°27.5'			FC	4843	1453-1005/8	Deployed 1236/07, bottom 1453/07, descent rate 0.59m/s. Released 1005/08, surface 1142/08, ascent rate 0.83m/s
11908#50	7.9	250	48°47.0'	16°27.7'			CTD	2000	1402	Twelve bottles fired at 2000m
11908#51	7.9	250	48°45.5'	16°32.2'	48°51.0'	16°29.4'	OTSB14	4839-4854	2200-0012/8	Distance run by log 10600m, by calculation 10800m
11908#52	8.9	251	48°50.7'	16°30.2'			SBC	4847	1546	No sample
11908#53	8.9	251	48°50.8'	16°29.4'			SBC	4851	1958	No sample
11908#54	9.9	252	48°47.0'	16°27.8'			BSNAP	4847	0128	Deployed 2328/08, bottom 0128/09, descent rate 0.67m/s. Released 0431/10. Camera failed prior to arrival on sea floor
11908#55	9.9	252	48°47.8'	16°35.0'	48°49.6'	16°34.4'	BN1.5/C	4860	0516-0624	Distance run by log 4630m, by calculation 3560m
11908#56	9.9	252	48°46.6'	16°22.4'			FC	4845	1416-0039/10	Deployed 1215/09, bottom 1416/09, descent rate 0.67m/s. Released 0039/10, surface 0218/10, ascent rate 0.82m/s
11908#57	9.9	252	48°50.3'	16°30.6'			SBC	4847	1631	No sample
11908#58	9.9	252	48°51.0'	16°30.2'			SBC	4847	(2112)	Pretriggered at 250m, gimbals broken
11908#59	10.9	253	48°34.3'	16°38.3'	48°34.7'	16°37.2'	RMT1+8M1	25-50	0927-0957	
11908#60	10.9	253	48°34.7'	16°37.2'	48°35.3'	16°36.2'	RMT1+8M2	50-100	0957-1027	
11908#61	10.9	253	48°35.3'	16°36.2'	48°35.6'	16°35.7'	RMT1+8M3	100-150	1027-1044	
11908#62-64	10.9	253	?	?	?	?	RMT1+8M	?	?	Haul aborted after apparent failure of nets to open

Station no.	Date 1989	Day	Gear position (start) N	W	Gear position (end) N	W	Gear[1]	Depth (m. corr.)	Time[2]	Remarks
11908#65	11.9	254	48°46.9'	16°23.7'			FC	4843	0323-1430	Deployed 0123/11, bottom 0323/11, descent rate 0.6m/s. Released 1430/11 surface 1609/11, ascent rate 0.82m/s
11908#66	11.9	254	48°41.7'	16°39.2'	48°42.5'	16°39.6'	BN1.5/3F	4865	0850-0925	Distance run by odometer 900m, by calculation 1610m
11908#67	11.9	254	48°46.9'	16°24.7'			CTD	148	1452	All 12 bottles fired at 148m
11908#68	12.9	255	48°52.0'	16°24.1'	48°47.6'	16°36.1'	OTSB14	4853-4877	0048-0406	Distance run by log 15600m, by calculation 16700m
11908#69	12.9	255	48°49.2'	16°29.8'			SBC	4847	1453	Good sample
11908#70	12.9	255	48°49.5'	16°30.4'			MC	4847	1811	Twelve good cores
11908#71	12.9	255	48°51.0'	16°30.3'			SBC	4843	2257	Good sample

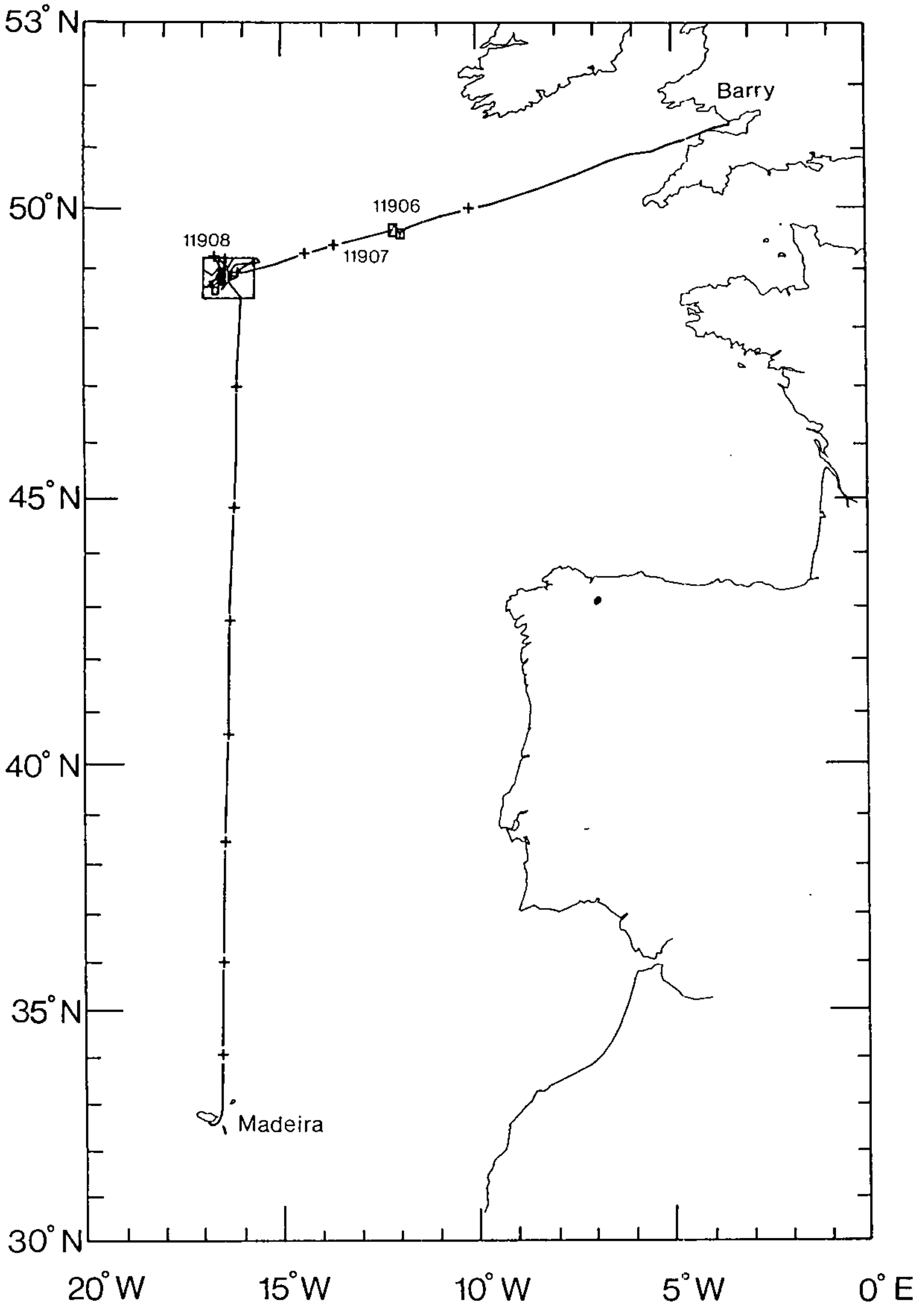

Figure 1. RRS *Discovery* Cruise 185 18 August - 17 September 1989 track chart and station positions

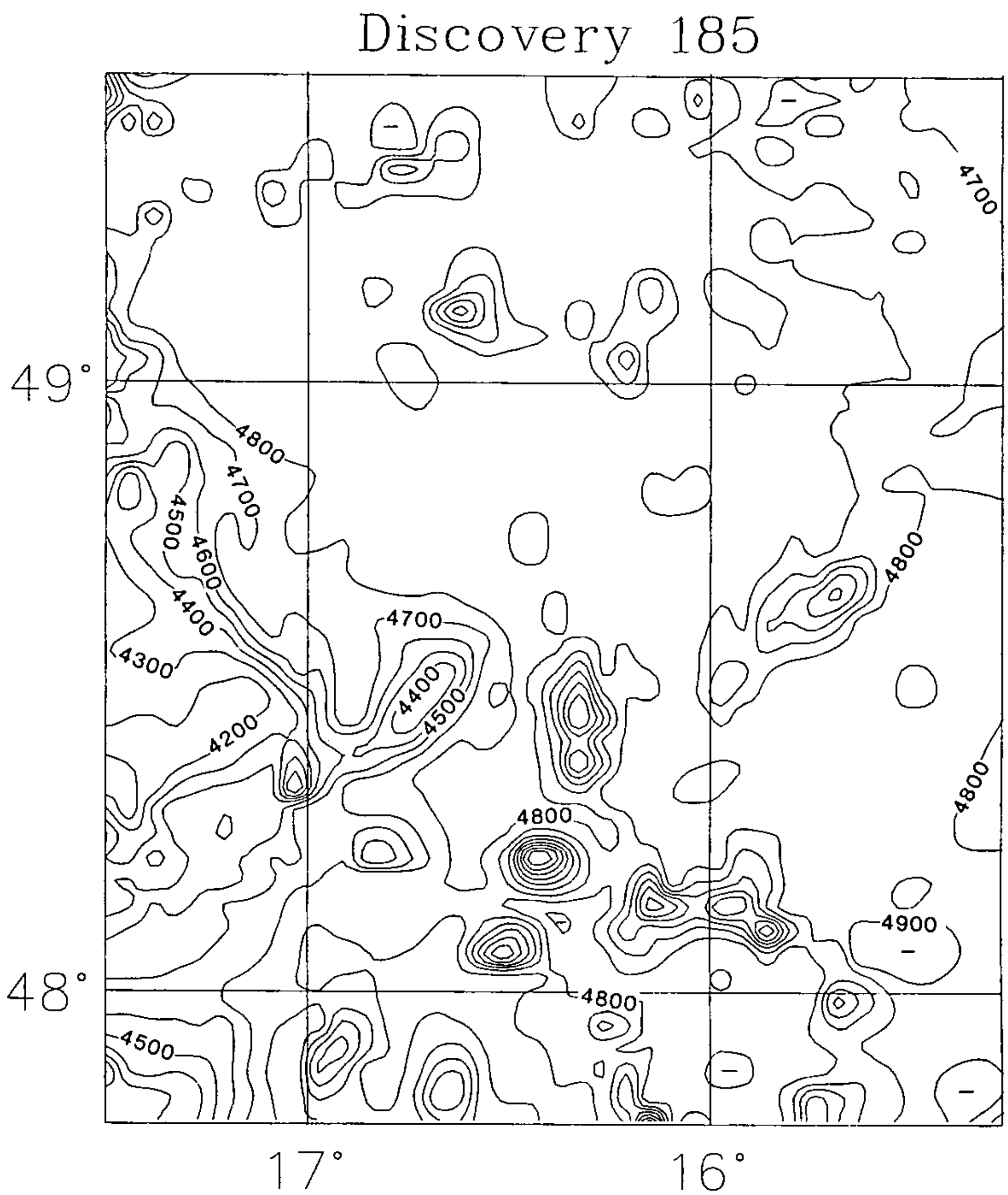

Figure 2. Preliminary computer-generated chart of European Community Station bathymetry

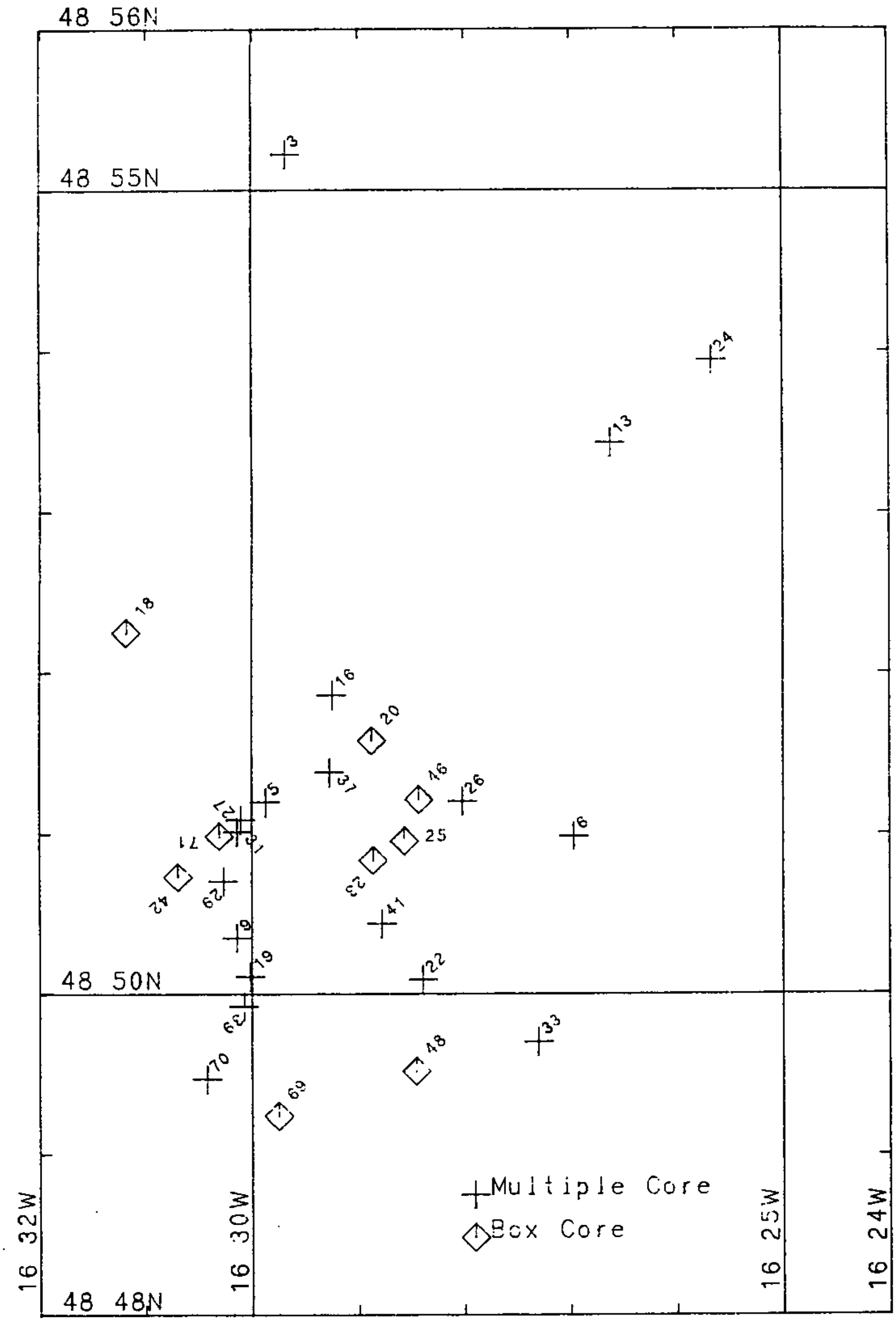

Figure 3. Station 11908. Multiple corer and box corer positions.

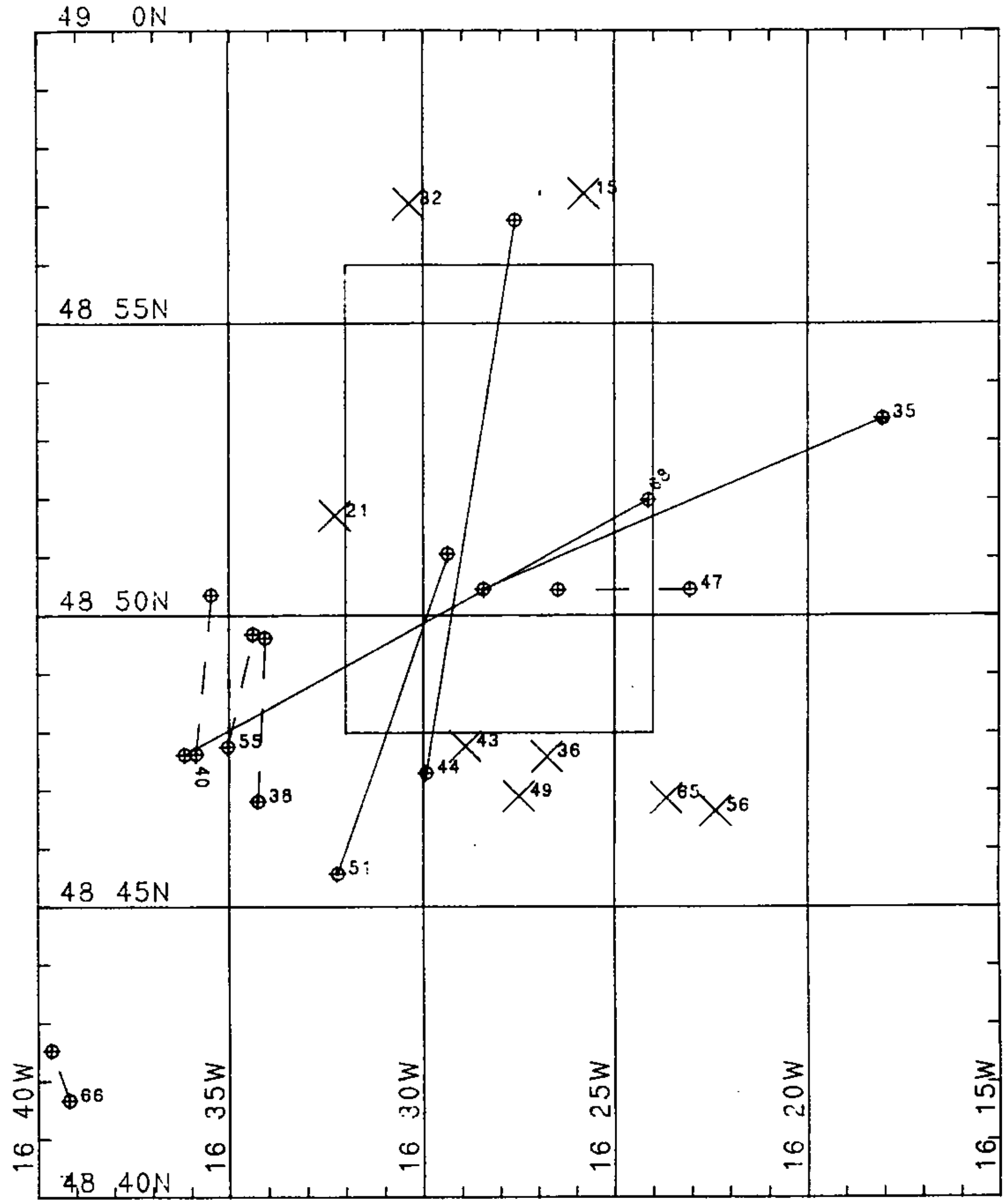

Figure 4. Station 11908. Tracks of towed gear (OTSB14 - solid lines, BN 1.5 - dashed lines) and positions of fish camera deployments (X). Box encloses Multiple Corer and Box Corer positions shown in Fig. 2.