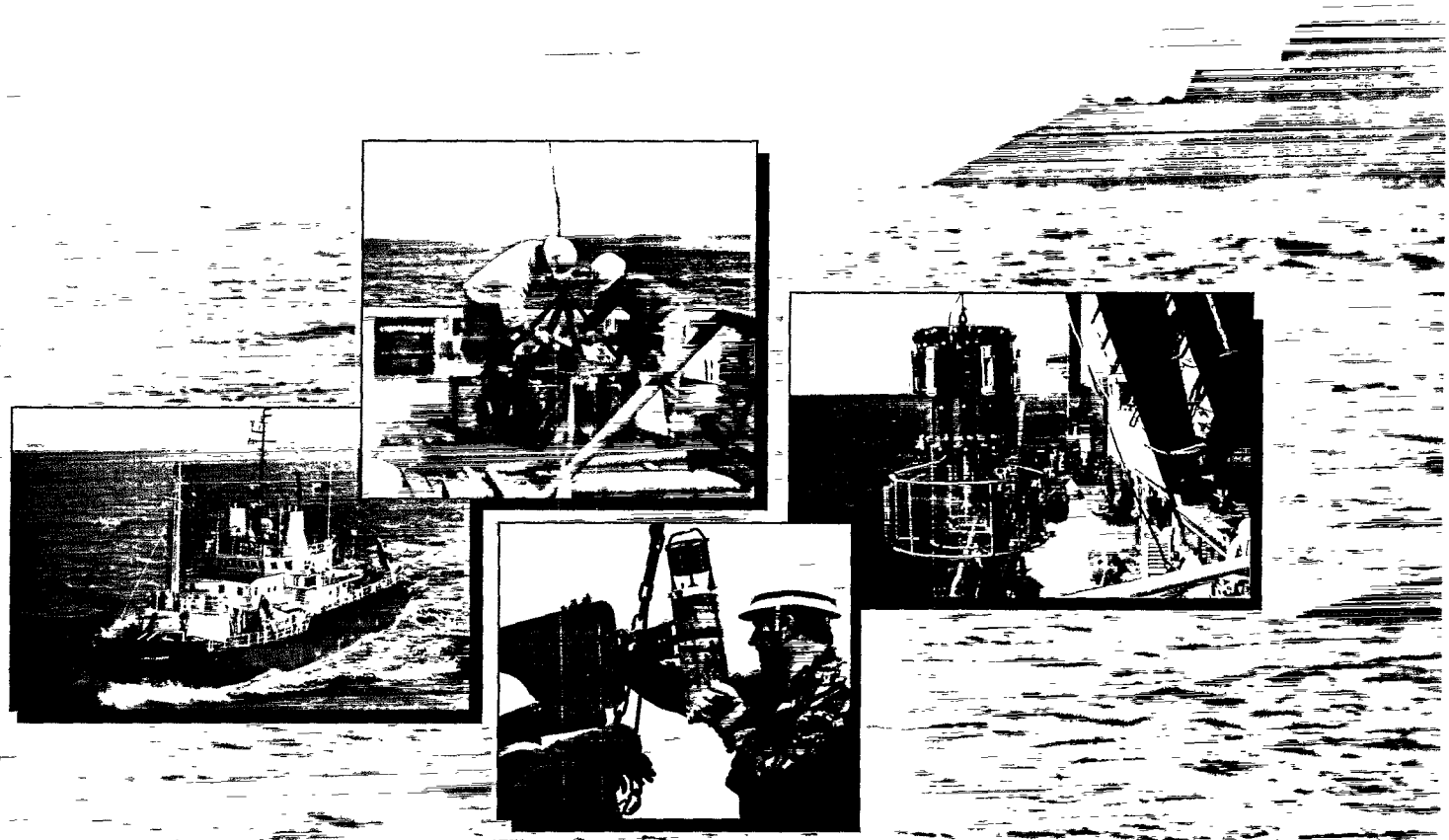
Southampton
Oceanography
Centre

Cruise Report



Natural
Environment
Research
Council

University
of Southampton

SOUTHAMPTON OCEANOGRAPHY CENTRE

CRUISE REPORT No. 19

RRS *CHALLENGER* CRUISE 135
15 OCT - 30 OCT 1997

BENGAL
High resolution temporal and spatial study of the
BENthic biology and Geochemistry of a
north-eastern Atlantic abyssal Locality

Principal Scientist
D S M Billett

1998

Challenger Division for Seafloor Processes
Southampton Oceanography Centre
Empress Dock
European Way
Southampton SO14 3ZH
UK
Tel: +44 (0)1703 596354
Fax: +44 (0)1703 596247

DOCUMENT DATA SHEET

AUTHOR	*PUBLICATION DATE*
BILLETT, D S M et al	1998

TITLE

RRS *Challenger* Cruise 135, 15 Oct-30 Oct 1997. BENGAL: High resolution temporal and spatial study of the BENthic biology and Geochemistry of a north-eastern Atlantic abyssal Locality.

REFERENCE

Southampton Oceanography Centre Cruise Report, No. 19, 49pp.

ABSTRACT

Challenger Cruise 135 was the fourth of a series of cruises funded by the European Commission's Marine Science and Technology III (MAST III) Programme as part of the BENGAL project (MAS3 CT 950018). Sampling commenced in September 1996 to assess changes in benthic systems over a period of one and a half years at a single, abyssal locality in the NE Atlantic (48° 50'N, 16° 30'W). It is hoped that changes within a year (seasonal) and between years (inter-annual) will be detected.

Challenger Cruise 135 replaced a longer cruise planned for the vessel *Atalante*, which had to be cancelled as a result of a strike by the crew of that vessel. *Challenger* Cruise 135 was planned at extremely short notice with the aim of undertaking a reduced sampling programme and recovering vital moorings that had been in place on the seabed for periods of up to 1 year. Samples of the benthos and overlying water column were collected using a multiple corer, box corer, trawl and CTD. Two activities planned for the *Atalante* cruise, sampling of benthopelagic fauna using the University of Hamburg MOCNESS net system and photographing the seabed using the Southampton Oceanography Centre WASP system, could not be undertaken.

KEYWORDS

ABYSSAL PLAINS, BENGAL, BENTHIC COMMUNITIES, BIOTURBATION, BOTTOM PHOTOGRAPHY, *CHALLENGER*, CORING, CRUISE 135 1997, CTD, CURRENT METERS, MICROBIOLOGY, MOCNESS, MOORINGS, NORTHEAST ATLANTIC, RESPIROMETRY, SEDIMENT GEOCHEMISTRY, SEDIMENT TRAPS, THERMISTOR CHAIN, TRAWLING, WASP, WATER SAMPLING

ISSUING ORGANISATION

Southampton Oceanography Centre
Empress Dock
European Way
Southampton SO14 3ZH
UK

Director: Professor John Shepherd

Copies of this report are available from: **National Oceanographic Library, SOC** *PRICE*: £11.00

Tel: +44(0) 01703 596116 Fax: +44(0) 01703 596115 Email: nol@soc.soton.ac.uk

CONTENTS

Itinerary

Sail Southampton	1000A Wednesday 15 October 1997
Arrive work area	48° 50'N 16° 30'W 0700Z Saturday 18 October 1997
Depart work area	0615Z Monday 27 October 1997
Arrive Southampton	1000Z Thursday 30 October 1997

SCIENTIFIC PERSONNEL

BILLETT, David S.M.	Southampton Oceanography Centre, UK (P S)
BOORMAN, Ben	Southampton Oceanography Centre, UK
CARTON, Michael W.	University College, Galway, Ireland
CRASSOUS, Philippe	IFREMER, Brest, France
DRUON, Jean-Noel	IUEM, Brest, France
GALERON, Joelle	IFREMER, Brest, France
GINGER, Michael	University of Liverpool, UK
KIRIAKOULAKIS, Kostas	University of Liverpool, UK
LAMONT, Peter	Scottish Association for Marine Science, Oban, UK
L'HENORET, Pascal	CFR, Gif-sur-Yvette, France
LLOYD, Robert	Research Vessel Services, UK
PHIPPS, Richard	Research Vessel Services, UK
VANREUSEL, Ann J.C.	University of Gent, Belgium
WITBAARD, Rob	NIOZ, Texel, Netherlands
WYNAR, John	Research Vessel Services, UK

SHIP'S PERSONNEL

LONG, G.M.	Master
NODEN, J.D.	Chief Officer
MORSE, J.T.	2nd Officer
HOLMES, J.C.	3rd Officer
HOLT, M.	Chief Engineer
DEAN, S.	2nd Engineer
PERRIAM, R.	3rd Engineer
TREVASKIS, M.	Bosun
BENNETT, P.R.	Bosun's Mate
COOPER, G.	Rating
ALLISON, P	Rating
DEAN, P.	Rating
HEBSON, H.	Rating
ELLIOT, C.	Senior Catering Manager
DANE, J.	Chef
LINK, W.J.T.	Steward
STEPHAN, R.	Steward
HEALY, A.	Motorman

INTRODUCTION

This cruise was the fourth in a series of cruises to the Porcupine Abyssal Plain over a period of one and a half years to study the temporal and spatial variability of benthic organisms and the geochemistry of sediments. The relationship between the biological and geochemical variables was to be investigated both in relation to each other and in relation to seasonal changes in the environment, particularly the deposition of phytodetritus in the summer months. The work is part of the BENGAL programme funded by the European Commission's Marine Science and Technology III (MAST III) Programme. All the work occurred around 48° 50.00'N, 16° 30.00'W.

This cruise replaced a cruise scheduled on the French research ship *Atalante* from September 23 to October 22. The crew of that vessel went on strike at the very hour the ship should have left port (Brest). Following a week of negotiations, and with no sign of a settlement in the dispute, the scientific party left the *Atalante*. However, all the equipment that had been mobilised for the cruise had to remain on board. As the strike was still in force following a further week of negotiations, it was decided to reschedule the cruise for RRS *Challenger*. The ship was made ready to leave Southampton within 12 days.

The crew of the *Atalante* were still in negotiations with their management when the *Challenger* returned on 30 October 1997.

The station numbers used on this cruise followed the Southampton Oceanography Centre biological station (BIOSTATION) convention of assigning non-*Discovery* cruises with their own particular 5 digit number code followed by a series (#) number. Station numbers refer to a particular locality and series numbers to the activities undertaken at that station. The first three digits identify the cruise. All non-*Discovery* cruises start with the digit "5". This was the 43rd cruise since this convention was adopted in the late 1970s by the Institute of Oceanographic Sciences, so the first three digits of any station number for *Challenger* Cruise 135 start "543". The precise station on a cruise is then identified by the next two digits. Only one station was occupied on this cruise so all activities on *Challenger* Cruise 135 have the same station number "54301". Changes in activities are then recorded by the sequence of series numbers.

SPECIFIC OBJECTIVES OF *CHALLENGER* CRUISE 135.

1. To recover a NIOZ sediment trap mooring laid on *Discovery* Cruise 229 (July 1997).
2. To recover an IFREMER Module Autonome de Colonisation (MAC) laid on *Discovery* Cruise 229 (July 1997).
3. To recover an IFREMER Module Autonome Pluridisciplinaire (MAP) laid on *Discovery* Cruise 222 Leg 1 (August 1996).

4. To recover the sediment incubation experiment BIOFEED for SOC, University of Liverpool, University College, Galway and the University of Gent.

5. To obtain samples of the seabed and the sediment-water interface using a multiple corer, for meiofauna studies and for sediment chemistry.

6. To obtain samples of the seabed for macrofauna using a plain box core (for IFREMER) and a vegematic box core (for Scottish Assocation for Marine Science).

7. To obtain samples of epibenthic megafauna and demersal fish using the semi-balloon otter trawl (OTSB).

8. To obtain large volume samples of water overlying the sediment surface, and to obtain profiles of the water column structure, using a CTD and water bottle multisampler. Samples for water column nutrients, chlorophyll and particulate material were taken.

NARRATIVE

Wednesday 15 October

The ship sailed at 1000A from the Southampton Oceanography Centre in fine weather. Mobilisation had occurred during the previous two days and the scientific personnel had embarked on Tuesday 14 October. Following a health and safety meeting at 0900A the day was spent preparing equipment in the laboratories and enjoying fine views of the Needles, the Isle of Wight and the south coast of England. The ship raced past Portland at some 14 kts (with the tide).

Thursday 16 October

Weather conditions were still favourable at 0900A when we were within sight of the Bishop Rock lighthouse. The Isles of Scilly could be seen on the radar. However, weather conditions became steadily worse during the day. The ship sailed steadily into a gale, and by midnight the ship's speed had dropped to some 6 kts. Clocks were put back one hour to Greenwich Mean Time (Z) during the night.

Friday 17 October

Weather conditions improved during the day and the first scientific meeting was held at 1500Z to discuss the programme of work. The events of the previous 24 hours had impressed those on board just how dependent successful work would be on the weather. Two activities in particular, the recovery of the moorings and the use of the box core, could be carried out only in calm conditions.

One task that needed to be accomplished early during the cruise was the tensioning of the coring warp. This wire had been wound on the ship in the previous two days, but because of the speed of mobilisation it had not been possible to wind the wire onto the drum under

tension. Consequently the wire would have to be streamed with a quarter ton weight on the end; an activity that would take about 8 hours.

With a forecast of continuing calm weather, at least for a few hours, it was decided to delay the tensioning of the coring wire and steam as fast as possible to the work site and to start picking up the moorings.

Saturday 18 October

The vessel arrived at the NIOZ sediment trap site (*Discovery* Station 13200#97) at 0700Z and the sediment trap was released at 0712Z. The rig was spotted immediately it broke the surface at 0817Z and the sediment trap was inboard by 0840Z. The sediment trap had worked perfectly and 12 good samples had been collected, some at weekly intervals and some (the last 4) at daily intervals.

The Precision Echo Sounder (PES) fish was deployed at 0848Z.

The vessel then moved to the IFREMER Module Autonome de Colonisation (MAC) site (*Discovery* Station 13200#5), arriving at 0920Z. The MAC was released at 0923Z and reached the surface at 1150Z. The absence of a lazy line caused a few problems in transferring the mooring line to the aft deck, but once this was achieved the MAC was brought on board at 1220Z. The experiment, once again, had proved to be successful.

With the fine weather showing signs of deterioration, and following discussions with the Captain regarding the weather forecast, the vessel then moved to the BIOFEED mooring position (*Discovery* Station 13200#65). We were on station by 1310Z and the incubation rig was released from the seabed at 1337Z. It reached the surface at 1531Z and was sighted within a couple of minutes. The mooring was all inboard at 1600Z with 12 good, undisturbed cores.

With weather conditions getting steadily worse it was decided that the safest way for the scientific programme to continue would be to conduct a CTD. The vessel proceeded to the Central Station (48° 50.00'N, 16° 30.00'W).

The CTD (with transmissometer, fluorometer, and water bottle sampler) was deployed at 1813Z (Station 54301#1). Problems with the mid-ships A-frame sheave were encountered almost immediately and the CTD was recovered at 1826Z while repairs were effected. The CTD was re-deployed at 1852Z. Weather conditions continued to get worse and it was not possible to "see" the pinger on the CTD with any accuracy because of the amount of ambient noise. The altimeter on the CTD was not working, so the plan to take the CTD within 10m of the seabed was aborted. An attempt to take a sample of water some 100m above the bottom was made (unsuccessful) and water was then collected at a number of depths shallower than 3000m. The CTD was inboard at 2350Z.

Scientific operations were suspended at 2354Z owing to adverse weather conditions.

Sunday 19 October

I was reminded in the morning by my French colleagues of an old Breton saying - "nothing works on a Sunday".

With an improvement in the weather by early morning the vessel made her way towards the Central Station once more. It was decided to use this period of moderate weather to stream the coring wire and to tension it.

To avoid recovering moored instruments during trawling operations the area under study had been divided into zones for trawling and zones for moorings. As the wind was in the northeast, and some 5800m of wire would have to be streamed, the vessel proceeded to the southwest corner of the trawling zone. The vessel turned head to wind and the wire was streamed starting at 0900Z.

At a couple of thousand metres wire out loose turns started to form on the drum. The wire coming of the drum was now under tension and was biting into the layers below. As the wire freed itself sparks flew about all over the place. At 3990m wire out a large bang was heard and veering was ceased while the damage was inspected. The wire was deformed in a small area on the drum, but pulled back into shape. Veering was continued until 4660m when a large knot formed. Several attempts were made to free the wire, but they were unsuccessful, and so streaming of the wire was abandoned at 1119Z.

The coring wire was now useless for operations at the depths we were working in. Emergency calls were made to Research Vessel Services (RVS) management staff to reach a solution that involved using the main trawl wire for coring. This wire was of a smaller diameter than the coring wire and consequently had lower safe working loads.

The vessel arrived back at the Central Station at 1510Z and a multiple corer (Station 54301#2) was deployed at 1536Z. On recovery at 1945Z only 2 of the 12 subcores had taken a sample. The bungy used to close the top seals of the cores was re-tensioned to provide a better seal. The corer was redeployed (Station 54301#3) at 2023Z, but fared no better with only one core in 12 being recovered at 0030Z (20 October). Close examination of the top seals showed two further problems. First, the rubber seals needed some modification and second some cores had an irregular shape at the top. These two factors combined, meant that the cores were sealing poorly or not at all. Repairs were made.

Agreement was reached with RVS by early evening that the main warp on board could be used for box coring. Steps were taken to limit the depth of penetration of the box corer, and hence the maximum "pull out" tension that might be exerted on the wire.

Monday 20 October

While repairs were made to the multiple corer, the box core was prepared and deployed at 0129Z (Station 54301#4). It was unsuccessful. It seems that the old Breton

saying needs to be extended to cover Mondays too. Box coring from aft decks, rather than midships, is always a risky affair, so the lack of a core was disappointing but not surprising. A vegematic box core was deployed at 0720Z (Station 54301#5) following repositioning back on the Central Station. It failed too and was recovered at 1106Z.

With weather conditions deteriorating it was decided to conduct an otter trawl as there was little hope of suitable coring weather within the next 12 hours. The vessel moved to just beyond the southwest corner of the designated trawling area and the trawl was deployed at 1710Z (Station 54301#6). Although the net was shot in moderate sea conditions, a sudden and severe storm developed just after the net reached the seabed at 2105Z with 11800m of wire out. As the trawl proceeded, weather conditions deteriorated rapidly and the Captain terminated the trawl at 2230Z. The net stayed on the seabed for a further 110 minutes rising off the bottom at 0020Z (21 October).

With difficulty in controlling the ship with so much wire out, the hauling rate was increased to 60 metres per minute and at 500 metres wire out hauling was stopped (0412Z). The trawl was kept at depth until 0830Z when hauling was resumed and the trawl was brought inboard by 0910Z. The net was recovered with a large swell still running. A good catch was found, if in rather poor condition. Many of the more fragile animals, such as the holothurian *Amperima rosea*, had been compressed onto the mesh of the net, and it took many hours of laborious work to extricate them.

Tuesday 21 October

Weather conditions were too poor to attempt any further work, but the ship made its way back to the central position and at 1329Z a CTD was started (Station 54301#7), going to a depth of 3010 and then taking water bottle samples on the upcast. Weather conditions were still unsuitable for coring so the vessel made its way to the southwest corner of the designated trawling area and the otter trawl was shot at 1945Z (Station 54301#8).

Wednesday 22 October

The trawl was completed in moderate weather conditions, but even so the signals from the pinger were lost even with the beam steering unit in operation. The indications of the trawl arriving on and leaving the seabed, as seen from the tension on the wire, were not as clear as in previous hauls. The trawl was recovered by 0844Z in calm conditions. Unfortunately some of the catch had caught up in the net in front of the cod end. As the net was brought inboard 8 *Coryphaneoides armatus* were seen floating away. Despite the presence of a number of seabirds waiting for breakfast, the fish floated by them; it seems birds have similar problems to humans in eating things that look unfamiliar to them. Despite the problems with the fish, the catch was quite large and was as diverse as on previous cruises.

With good weather the ship proceeded to release the IFREMER Module Autonome Pluridisciplinaire (MAP) from the seabed. The MAP had been laid on 30 July 1996 on *Discovery* Cruise 222 Leg 1 (*Discovery* Station 12913#2). The vessel arrived at the site at 1132Z and the MAP was released from the bottom at 1135Z. It was spotted soon after it broke the surface at 1317Z and recovery on the aft deck began at 1341Z. The mooring was some 150m in length with current meters and a thermistor chain (130 to 30m above the bottom) above a 650kg block of syntactic foam with a benthic lander system below. On the benthic lander was a sediment trap, camera, nephelometer and current meter. Problems were experienced in attaching to the mooring below the syntactic foam. A special strop had to be made up. With some rich language the whole mooring was finally inboard at 1440H.

Most of the equipment on MAP appeared to have performed well, with the exception of the camera which, sadly, was found to be flooded. The sediment trap bottles confirmed the observations from the NIOZ sediment trap that flux of detritus started in July.

Securing all the equipment took some time and at 1533Z we were finally able to move back to the Central Station arriving at 1647Z. A coring programme was now started in calm conditions.

First in the water was the new improved multiple corer with tight seals at the top of the cores. The corer was on the seabed at 1833Z and recovered 11 good cores out of 12 (Station 54301#9). There was winnowing of one core from the bottom because the core catcher did not quite fit into place. This was followed by another successful multiple corer on the bottom at 2204Z, again with 11 successful cores out of 12 (Station 54301#10).

Thursday 23 October

Attention was now turned to the box corer. The vegematic design used by the Scottish Association for Marine Science (SAMS) was deployed at 0039Z, reaching the bottom at 0222Z (Station 54301#11). A special plate that restricted its depth of penetration to 25cm was placed on the corer. This was a precaution against placing too much tension on the wire during the pull out of the core from the sediment. It did not take a core.

After much scratching of heads the limiter plate was changed to the normal depth limitation of 35 cm. The data on tension from the multiple corer operations indicated that it was unlikely we would exceed the maximum tensions allowed for operations using the main warp. The box core was re-deployed with a plain (non-vegematic) box at 0505Z (Station 54301#12). On recovery at 0842Z, it too was found to have failed.

The vessel re-positioned on the central site and the plain box core was repeated again, reaching the bottom at 1055Z (Station 54301#13). The 35cm limiter plate was in position again. This time the spade box arm did not close even though the trigger mechanism had

released the arm. The ferrule on the cocking lanyard had fouled on the box core superstructure. A new lanyard was made and re-positioned on the core to overcome this fault.

While this work was in progress the multiple corer was used again at 1352Z, achieving near-perfect success with 11 out of 12 cores (Station 54301#14). Weather conditions now took a turn for the worse again and although the multiple corer was deployed in moderate conditions at 1815Z (Station 54301#15), by the time it reached the bottom at 2002Z the sea was very rough and only one core was suitable for analysis.

When the weather had eased a bit another multiple corer was attempted at 2242Z (Station 54301#16) with rather better success, but by no means perfect (6 out of 12 cores).

Friday 24 October

By the time the vessel had re-positioned itself at the central site the weather conditions were much better, so a plain box core was deployed at 0330Z (Station 54301#17). No core was obtained from this same corer that had worked perfectly three months earlier on *Discovery* Cruise 229. After much head-scratching it was decided to change the position of the triggering mechanism so that there was less likelihood of the box core pre-triggering. It was thought that the box corer might be pre-triggering in the rougher conditions it was experiencing on *Challenger* than on *Discovery*.

While staff rested to consider the changes to be made to the box corer, we continued to use the multiple corer. A large swell was running by this time and the corer reached the bottom (1136Z) at a time when a set of large swell waves were passing the vessel (Station 54301#18). 5 cores out of 12 were successful in taking mud, but only 2 were fit for analysis. Another multiple corer followed (Station 54301#19), but problems were encountered with the winch as the corer approached the bottom (1549Z), so that although 10 out of 12 core tubes worked only 7 were fit for analysis.

In fairly calm conditions it was decided to obtain water samples from just above the sediment using the CTD and multisampler water bottle rosette (Station 54301#20). Six bottles were fired at a depth of about 4818m, some 17m above the seabed, and another sample was taken 100 m above the bottom. Other water samples were taken at various depths on the way up. There had been problems on previous cruises in obtaining water bottles at depths greater than 4000m. The seven deep water bottle samples therefore were considered to be a significant success.

Saturday 25 October

With continuing calm conditions another multiple corer was attempted, reaching the seabed at 0038Z (Station 54301#21). Rather curiously the core needed about an extra 100m to take the sample and when it was retrieved it was obvious that the core had penetrated the sediment at a rather extreme angle. Seven cores were used for analyses.

Weather conditions were deteriorating once more so the box corer was deployed once more with its latest modification (Station 54301#22). To avoid pre-triggering the release mechanism was re-sited further up the central column of the box core. The limiter was also removed so that deep penetration of the corer into the sediment could be expected. The core reached the seabed at 0518Z, but there was no obvious pull-out from the sediment and the corer was recovered with its usual sample of mud-free water.

Weather conditions were now getting worse quickly and developed into a full gale. The scientific programme had to be suspended for 24 hours.

Sunday 26 October

With time running out the coring programme was continued with the multiple corer while further modifications were made to the box corer. The first multiple corer reached the seabed at 1037Z (Station 54301#23) and collected 11 cores, although 3 of these had slipped, so that only 8 were useful for analysis. This was followed by a quick, shallow dip of the CTD and water bottle rosette for nutrient and chlorophyll samples (Station 54301#24).

Another attempt to get the box corer to work was made (Station 54301#25) with special plates welded in place to try to reduce the movement of the box corer within its gimbal. It did not work and the familiar site of a mud-free box corer greeted us once more on its arrival on deck at 1713Z. This effectively put an end to the IFREMER macrofauna sampling programme with none of the 8 requested box cores accomplished.

Rather than continue with an ailing piece of gear - part of the base of the box core was now broken - consultations with SAMS took place to see what could be salvaged from their sampling programme that required the use of the vegematic box corer. It was obvious that the box corer could not be relied upon, and in the 12 hours or so that remained an emergency and opportunistic sampling programme using the multiple corer was initiated. A series of 3 cores was run to collect macrofauna samples, equivalent to about 9 sub-divisions in a vegematic box core. The whole of the scientific team was involved in slicing cores at odd times of the night with the first cores arriving on deck at 2142Z (Station 54301#26).

Monday 27 October

Two further multiple corer drops were made with sampling times on the bottom of 0004Z (Station 54301#27) and 0406Z (Station 54301#28). These 3 multiple corers produced some of the best cores we had had all cruise.

With the recovery of the PES fish at 0600Z, and the stowing of the scientific equipment, the scientific programme was terminated at 0615Z and we headed for Southampton. There was a slight detour for an hour or so when the ship deviated in its course towards the nearest landfall (Cork, Ireland) when it was thought we might have to make emergency repairs to the main engine bearing. It had been overheating. However, the

problem was soon brought under control and the ship continued its course towards Southampton heading into a fresh easterly breeze.

Tuesday 28 October

The fresh easterly breeze turned into an easterly gale and a very uncomfortable day was spent writing cruise reports and rescuing wave-damaged containers from the aft deck.

Wednesday 29 and Thursday 30 October

Wednesday was a better day with first sight of the Isles of Scilly on the radar at about 1000Z. The ship steamed along the south coast of England as we continued to pack, arriving at the Southampton Oceanography Centre in glorious sunshine at 1000Z /30.

GEAR AND TOPIC REPORTS

Multiple corer (multicorer)

After some initial problems in operating the multiple corer (54301#2, #3), and some repairs to the top seals on the tubes, the corer worked moderately well in the rather bad weather conditions in which most operations were conducted. Table 1 shows the successful multiple corer deployments, the range of the core lengths, the number of cores suitable for analysis and a short description of their visible characteristics. In addition to these samples, three further deployments of the multiple corer were made for macrofauna samples following the disappointing performance of the box corer (see report on spade box corer).

Table 1. Successful multiple corer deployments

Deployment	length cm	cores	remarks
54301 # 9	23.5 - 30.0	11	no phytodetritus aggregates no obvious biological structures
54301 # 10	23.0 - 35.0	11	no phytodetritus aggregates 1 or 2 Xenophyophores
54301 # 14	31.0 - 37.0	11	no phytodetritus aggregates 2 Xenophyophores 1 worm cast, several holes
54301 # 15	30.0	1	no phytodetritus aggregates
54301 # 16	20.0 - 25.0	6	no phytodetritus aggregates several Xenophyophores some small holes
54301 # 19	31.0 - 32.0	7	no phytodetritus aggregates no obvious biological structures
54301 # 21	25.0 - 32.0	7	all cores look disturbed at surface
54301 # 23	25.0 - 31.0	8	no phytodetritus aggregates several cracks beneath surface

All the deployments were at the central site. There was no evidence of phytodetritus or of large aggregates on the surface of any of the cores, although some cores in the BIOFEED experiment (see under moorings) did show some evidence of phytodetritus. A few individual organisms and biological structures, such as Xenophyophores, worm casts and small holes were observed, but were not as common as previously encountered during sampling in September 1996.

The cores were used by different groups in order to perform biological, biochemical and radiochemical analyses.

Multiple corer samples for metazoan meiofauna analysis (University of Gent)

From two deployments (#9 and #10) two cores each covering a sediment area of 25.52 cm^2 were collected for metazoan meiofauna analysis. Each core was sectioned into slices of 5 mm for the first centimetre, and 1 cm slices down to 5 centimetre depth in the sediment. The 5 to 10 cm horizon was collected also. From the second core from each deployment two sub-samples of 1 ml were taken from each slice respectively for estimating bacterial densities (University College Galway), and for the analysis of organic carbon content. The sectioned samples from each core were fixed to a final concentration of 3% formaldehyde. The sub-samples for organic carbon were stored in the freezer at -20° C.

From two deployments (#14 and #16) only one core was available for metazoan meiofauna analysis. These cores were sliced and preserved in the same way as described for the previous cores. However, each slice was sub-sampled only for organic carbon analysis. All cores preserved in formalin will be used for estimating metazoan meiofaunal composition, densities, biomass and size spectra.

ANN VANREUSEL

Multiple corer samples for foraminiferan analysis (Southampton Oceanography Centre)

From four deployments (#9, #10, #14 and #21) one core was collected for analysis of foraminiferan communities by Southampton Oceanography Centre. The overlying water (2 to 3 cm above the sediment surface) was collected separately together with the superficial water-sediment contact layer. One greenish phytodetritius-like aggregate that was associated with a xenophyophore-like structure on the core of deployment #10 was preserved separately. The sediment was sectioned into slices of 5 mm for the first two centimetres. The core was then sectioned into slices of 1 cm down to depth of 15 centimetres. The 15 to 20 cm layer was sliced into two sections of 2.5cm. All cores were fixed to a final concentration of 3% formaldehyde.

ANN VANREUSEL

Multiple corer samples for phytopigment analysis (Netherlands Institute for Sea Research

From four multiple corer deployments 3 cores each were taken and sliced. The topmost millimetre was skimmed off using a syringe. Other layers sampled were 1-5 mm, 6-10 mm and four deeper slices of 1 cm each. Thus the top 5 cm of each core was used. The samples will be analysed for phytopigment composition and its depth distribution within the sediment. The results will be compared with the bottom water phytopigment composition obtained from the CTD water bottle sample as well as the gut contents from the holothurians sampled by the trawl.

ROB WITBAARD

Multiple corer samples for microbiological studies (University College, Galway)

The multiple corer samples taken by UCG included sediment and sediment contact water (SCW) (BENGAL tasks 52, 53). Sediment samples were sectioned at 1 cm intervals down to a depth of 5 centimetres. Sub-samples of 1cc were taken from each 1 cm section and preserved at 4° C in 2% formalin for determination of bacterial numbers by epifluorescence microscopy. Four cores were sampled in this manner; one each from deployments 54301 #09, #10, #14 and #16.

Samples taken for bacterial community structure analysis via nucleic acid based techniques were immediately frozen and held at -20° C. SCW samples were also collected from these same cores using a siphon. 40 ml samples were taken and preserved at 4° C in formalin (final conc. 2%) for bacterial enumeration as above. The combined overlying SCW of 10 cores (5 litres) from 54301#14 was filtered at 4° C using a Sterivex 0.2 µm filter. This was then preserved in 1.8 ml lysis buffer (EDTA, NaCl, Sucrose) and frozen for bacterial community structure analyses in the laboratory.

MICHEAL CARTON

Multiple corer samples for porewater analyses (Institut Universitaire Europeen de la Mer)

Five core samples were taken for porewater analysis by the Institut Universitaire Europeen de la Mer (IUEM). Each core was sliced in three depth horizons as follows:

- 8 slices each 0.5 cm thick from the sediment surface down to 4 cm
- 6 slices each 1.0 cm thick from 4 cm down to 10 cm
- 9 slices each 2.0 cm thick from 10cm down to 28 cm.

After 20 minutes of centrifugation at 5000 rpm (at 4° C), the porewater of each slice was collected, filtered on 0.2 µm, and maintained at 4° C. The sediment was frozen.

IUEM will measure profiles of biogenic silica (Bsi) in the sediment and dissolved silica in the porewater. The aim of this work is to understand how Bsi, which marks the incoming flux of particulate organic matter (POM) to the bottom, dissolves in the sediment. A numerical model will be developed and the data may, in part, help to validate the model.

JEAN-NOEL DRUON

Multiple corer samples for organic chemical analyses (Liverpool University)

Sediment and porewater samples from 7 multiple corer deployments (1 or 2 cores per deployment) were taken (Table 2). The cores used for sediment sampling were sectioned as follows: 0-5 mm, 5-10 mm, 10-20 mm, 20-30 mm, 30-40 mm, 40-50 mm, 50-60 mm, 60-100 mm, 100-150 mm, 150-200 mm. However, the sections taken for pore water sampling were 0-10 mm, 10-20 mm, 20-30 mm, 30-40 mm, 40-60 mm and 60-80 mm.

The sediment samples were put in pre-washed (Dekon; 24 h) and solvent rinsed (dichloromethane) glass jars and stored in the freezer at -70° C. The sections taken for porewater analyses were put in acid-washed plastic centrifuge tubes and centrifuged for 15 min at 2500 rpm at 4° C). The supernatant porewaters were then transferred, using a rinsed (milli-Q water) glass pipette into pre-washed glass vials and stored in a -20° C freezer. With respect with the initial aims of the cruise, 2 fewer cores were collected than planned for porewater analyses owing to the limits of time and the bad weather.

Table 2. Multiple corer sample details for organic chemistry and pore water analysis

Date	Deployment	Depth (m)	Use
19-10-97	54301#2	4839	sliced sediment
22-10-97	54301#9	4843	pore waters
22-10-97	54301#9	4843	sliced sediment
23-10-97	54301#14	4839	sliced sediment
23-10-97	54301#14	4839	pore waters
24-10-97	54301#18	4843	pore waters
24-10-97	54301#19	4843	sliced sediment
25-10-97	54301#21	4840	sliced sediment
26-10-97	54301#23	4843	pore waters
26-10-97	54301#23	4843	sliced sediment

KOSTAS KIRIAKOULAKIS, MICHAEL GINGER

Multiple corer samples for organic chemical analyses (University of Ancona)

Although it was hoped to collect 10 cores from seven deployments (1 core from the first six and four cores of the seventh deployment) at the start of the cruise only 1 core from 4 deployments were sectioned for the University of Ancona (Table 3), because of the reduced sampling time available on this cruise. Those cores that were collected were stored at -70° C. The sectioning of the cores was as described above for the analyses undertaken by the University of Liverpool.

Table 3. Multiple corer sample details for University of Ancona

Date	Deployment	Depth (m)	Use
22-10-97	54301#9	4843	sliced sediment
23-10-97	54301#14	4839	sliced sediment
24-10-97	54301#19	4843	sliced sediment
25-10-97	54301#21	4840	sliced sediment

KOSTAS KIRIAKOULAKIS, MICHAEL GINGER

Multiple corer samples for organic chemical analyses (University of Patras)

Two cores from 4 multiple corer deployments were sectioned for the University of Patras (8 in total) and stored at -20° C (Table 4). The sectioning of the cores was as described above for analyses undertaken by the University of Liverpool. The initial objective for this task, to collect 2 cores from each of 6 deployments, was not possible owing to the reduced sampling time on the cruise. Additionally, filtering water from certain depths, as requested by the University of Patras was not possible due to limited use of the CTD during the cruise.

Table 4. Multiple corer sample details for the University of Patras

Date	Deployment	Depth (m)	Use
22-10-97	54301#9	4843	sliced sediment
22-10-97	54301#9	4843	sliced sediment
23-10-97	54301#14	4839	sliced sediment
23-10-97	54301#14	4839	sliced sediment
24-10-97	54301#19	4843	sliced sediment
24-10-97	54301#19	4843	sliced sediment
25-10-97	54301#21	4840	sliced sediment
25-10-97	54301#21	4840	sliced sediment

KOSTAS KIRIAKOULAKIS, MICHAEL GINGER

Multiple corer samples for radionuclide studies (CFR Gif-sur-Yvette)

Four cores were collected using the multiple corer for the study of bioturbation rate and seasonal variation in naturally-occurring radionuclides. The samples were sliced and kept in centrifuge tubes (to 13 cm depth) or in plastic bags (below 13 cm).

Station number	Number of cores
54301 # 10	2
54301 # 16	1
54301 # 19	1

Three cores were also collected for the study of the sediment porewater. Porewaters were recovered after centrifuging at 5000 rpm. They were then filtered on 0.2 µm filter and acidified with HCl to 4/1000 final concentration. The samples were stored at 4° C. The solid phase was frozen at -20° C.

Station number	Number of cores
54301 # 3	1
54301 # 10	1
54301 # 16	1

Two cores from station 54301#23 were sampled for radionuclides and organic carbon content at the sediment/water interface using a pipette. Three cores from stations 54301#10, #16 and #19 were frozen for further processing.

PASCAL L'HENORET

Spade Box Corer

Sea time at the BENGAL central station during the *Challenger* cruise was shorter and slightly later in the season than originally planned with the French research vessel *Atalante*. In addition the principal means of sampling macrofauna, the USNEL box core had to be deployed from the stern of the *Challenger* rather than the much more stable amidships position of the larger research ships such as RRS *Discovery* and the *Atalante*. Therefore, the chances of obtaining successful box cores were considered to be low prior to the cruise.

Nevertheless the complete failure of the box core to take any sample was unexpected and no single explanation could be determined. This was in spite of numerous modifications and repairs.

USNEL box corer performance

Use of the trawl warp, which has a lower load rating than the coring warp, made the fitting of a penetration bracket to the central column on the boxcore an advisable precaution in

order to limit pullout loads. Accordingly new brackets were fabricated and fitted limiting the possible penetration of the corer into the sediment to about 25 cm.

After the first deployment, the base of the box core door was bent outwards in the middle by some 20 mm, possibly because of clinker jamming between the spade and the box base, although there was no sign of clinker (or sediment) in the corer on retrieval. The corer from this first deployment was also recovered with the frame jammed at its extreme against the corer column, because the outer gimbal frame had been forced behind one of the gimbal stop blocks. Four of the eight bolts holding the outer gimbal frame together were missing and had to be replaced.

The corer was deployed for a further three times, all without success. The combination of the weather and the necessity of coring from the aft A-frame were thought to be the factors causing problems in obtaining a sample. However, on recovery of the fourth box core it was found that the spade had not closed even though the triggering mechanism had worked. A fault in the operation of the small "cocking" cable or lanyard used to withdraw the locking bar was found. This prevented the efficient triggering of the spade mechanism. This fault had been encountered also in September 1996 on *Discovery* Cruise 222 Leg 2 with a different box corer (made of stainless steel). It was suggested that the reason for the failure of the box core up to this point on the cruise might have been due to the cocking cable catching within the box core release mechanism. It was thought the box core was penetrating the sediment, but that the spade did not close until sometime after the corer had left the seabed. Broken outer wires on the corer spade arm strop were also a cause of concern after the fourth deployment and so this strop and the cocking cable were replaced for the fifth deployment of the box corer, still with no success.

Wear of the yellow paint on the corer progressed during deployments and indicated several scenarios. One was that the corer frame had been twisting at extreme angles with respect to the corer column, as abrasion was observed on the frame tubing caused by the underside of the spade. It was suspected that the frame might have oscillated sufficiently to catch the release hook. Consequently the release hook was moved to a higher mounting point on the column.

Paint worn off on the central column indicated that the frame had been riding up the column. In addition, it was observed that frame cracking in several places and repaired with welds. In a final attempt to get the box corer to work, short brackets were welded across at the four outer gimbal frame corners limiting lateral movement of the frame relative to the corer coloum. This would prevent the spade catching on the bottom frame.

None of these measures resulted in a successful core and the best that was obtained was a small amount of sediment on the bottom of the box indicating that the spade had closed on a cloud of suspended sediment. The corer was recovered from its final deployment with

the lower frame broken between the tubing and the angle iron section. Altogether, considering the paint wear and beaten metal surfaces, it was clear the box corer had been experiencing considerable forces.

Sea state

Although the conditions during some deployments were marginal for the box core, and under different circumstances sampling with this equipment might not have been attempted, many deployments were made in otherwise suitable sea states.

In order to quantify the sea state some observations of the ship's stern were made from the winch cab and the rate of rise and fall estimated by timing the movement of the A frame against the horizon. The larger swings were selected over periods of twenty minutes in order to provide an idea of the maxima likely to be encountered by the gear (video film from the vertical WASP deployments during *Discovery* 222 leg 2 showed that the gear followed the rise and fall of the ship on the swell even when the gear was at a depth of 5 km). Results (Table 5) indicated that at winch veering rates of 40 m/min, the boxcore could have been experiencing downward speeds of up to 120 m/min switching within half a second to upward movement at 40 m/min over periods of around six seconds.

Table 5. Summary of stern rise and fall rate estimates (means of twenty observations).

DATE	TIME (GMT)	SWING (m)	PERIOD (sec.)	RATE (m/ min)	RATE (m / sec)	MAX (m / min)
24/10/97	16:00	1.6	2.7	36.2	0.6	49
25/10/97	11:15	2.6	3.0	51.1	0.9	79
25/10/97	14:15	3.2	3.1	61.9	1.0	80
26/10/96	09:00	2.6	3.2	49.7	0.8	81
26/10/97	14:00	2.1	3.1	41.0	0.7	63

Macrofauna samples (SAMS, IFREMER)

All other size classes of fauna had been sampled during the cruise with the exception of the macrofauna and it was decided to use the last deployments of the multiple corer for macrofauna samples despite the problems of comparability. During the three previous BENGAL cruises macrofauna sampling had been carried out exclusively with the USNEL box corer. On average eight plain (undivided) boxcore samples and five 'vegematic' samples of 25 subcores each were obtained on the three cruises.

Three deployments of the multiple corer were made specifically for comparison of macrofauna with vegematic samples from the previous cruises (Table 6). These deployments resulted in some of the best cores of the cruise and out of a possible 36 cores, a total of 31 were obtained. On these cores two sampling protocols were used: 1) the top ten centimetres of sediment

were retained to provide some comparison with vegematic box core sub-core samples from previous BENGAL cruises, and 2) the cores were sub-sectioned vertically into horizons corresponding to the layers 0-1 cm, 1-2 cm, 2-3 cm, 3-5 cm and 5-10 cm. These samples were taken to compare with box core macrofauna samples taken on other BENGAL cruises with the same vertical distribution of samples.

Table 6. Multiple corer samples taken for macrofauna

	54301#26	54301#27	54301#28
1	0 – 10 cm	0 - 10 cm	0 - 10 cm
2	sub-sectioned	0 - 10 cm	*tube empty*
3	sub-sectioned	sub-sectioned	*tube smeared*
4	sub-sectioned	sub-sectioned	sub-sectioned
5	sub-sectioned	sub-sectioned	sub-sectioned
6	0 – 10 cm	*tube empty*	sub-sectioned
7	0 – 10 cm	0 - 10 cm	0 - 10 cm
8	0 – 10 cm	sub-sectioned	0 - 10 cm
9	0 – 10 cm	0 - 10 cm	0 - 10 cm
10	*core tube lost*	0 - 10 cm	*tube smeared*
11	0 – 10 cm	0 - 10 cm	0 - 10 cm
12	0 – 10 cm	0 - 10 cm	sub-sectioned

Some fauna observed on the core surfaces were removed and placed in separate vials. These included three xenophyophores and a mushroom-shaped foraminiferan, possibly *Ocultammina*. All sediment samples were placed directly in 10% buffered formalin (4% formaldehyde) and were sieved later on both 300 and 250 micron sieves.

The arrangement of cores in the multiple corer array may yield information on spatial dispersion of the macrofauna, provided that numbers are high enough for meaningful statistical analyses.

The multiple corer could not be used as a substitute for the planned IFREMER plain box core sampling programme as direct comparison of box core and multiple corer samples for abundance and biomass of macrofauna is not possible. First, the multiple corer is fitted with 12 tubes, each of 56 mm in diameter and each sampling 25 cm^2, so that 9 multicore deployments would be required to sample the same area of sea bed as one 0.5 x 0.5 m box core. Second, there are quantitative differences between the two gears because the multiple corer's hydraulically damped coring action provides consistently less-disturbed sediment surfaces and consequently higher numbers of surface-dwelling animals than the box corer.

PETER LAMONT, JOELLE GALERON, RICHARD PHIPPS

Otter Trawl

Two otter trawl hauls were undertaken during the cruise. The first (54301#6) was launched in moderate sea conditions, but during the haul a sudden and violent storm blew up. With rapidly deteriorating sea conditions the Captain was forced to terminate the haul earlier than planned, but in the event the trawl took another 110 minutes to come off the seabed. With the weather getting worse by the minute the hauling rate was increased and the net was brought back in at a faster rate than normal. Hauling was stopped with 500m of wire out and the net was left at depth until the sea conditions had ameliorated (5 hours). Recovery of a good, if battered, catch was made.

The second trawl was less eventful thankfully. Sea conditions were moderate, but they were severe enough at the start of the haul that use of coring gear was out of the question. The weather improved throughout the haul and the trawl was recovered in the best weather we had had all cruise. Unfortunately, some of the catch had hung up in the net in front of the cod end, including the entire catch of *Coryphaenoides armatus* and all these fish and some of the invertebrates were lost as the net was recovered.

The composition of both catches were as found previously at this locality in recent years. Holothurians dominated once again, most notably *Amperima rosea*, *Oneirophanta mutabilis*, *Psychropotes longicauda*, two species of *Pseudostichopus* (*P. villosus*, and *P. aff marenzelleri*), and *Paroriza prouhoi*. Many of the gelatinous holothurians, such as *A. rosea*, were caught up on the mesh of the net, particularly in the first trawl and great care was taken to remove as many of these specimens as possible. This yielded a good catch of the apodid holothurian *Protankyra brychia* as well. This species appears to be particularly susceptible to being caught on the net because of its anchor-shaped spicules. Eight other species of holothurian were taken also.

Notable in the catches were the variety of asteroids and of actiniarians, and a number of large (and small) *Umbellula* (pennatulids). Actiniarians included *Actinauge*, *Amphianthus*, *Iosactis*, *Doantaesia*, *Segonzactis* and *Kadosactis*. The asteroids were dominated by the mud-swallowing porcellanasterids *Hyphalaster inermis*, and *Styracaster* (at least 2 species), as well as *Freyella elegans* and *Dytaster grandis*.

In the first trawl there many natant decapod crustaceans, mainly midwater species, the result of towing the net for 5 hours at c. 300m water depth. Of those crustaceans normally found, *Munidopsis* and *Stereomastis* were common. There were many worm tubes, polychaetes, echiurans, and sipunculids. A number of bottles and cans, and loads of clinker were collected and in the first trawl there were also two large cirrate octopods.

Holothurians were taken by the University of Liverpool, University College Galway, and NIOZ groups from each of the two otter trawls. Specimens were either frozen

immediately or dissected as described below. All dissections were carried out at 4° C, and animals were kept in cold water prior to their dissection. The weights and lengths of all the animals taken were recorded (Tables 7 and 8).

Table 7. Holothurians dissected and/or frozen from OTSB trawl 54301#6

Sp. name	Weight (g)	Body Length (cm)	Institute/Experiment
Oneirophanta mutabilis	80	4.5	UL – Chemical
Oneirophanta mutabilis	145	5	UCG - Counts & Nucleic acids
Oneirophanta mutabilis	120	5	UCG - Counts & Nucleic acids
Oneirophanta mutabilis	135	5	UL – Chemical
Oneirophanta mutabilis	100	4	UL- Frozen
Oneirophanta mutabilis	110	5	UL – Frozen
Oneirophanta mutabilis	135	4.5	UCG – Frozen
Oneirophanta mutabilis	90	4	UCG – Frozen
Oneirophanta mutabilis	70	8	NIOZ phytopigments
Oneirophanta mutabilis	100	9.8	NIOZ phytopigments
Oneirophanta mutabilis	140	12.5	NIOZ phytopigments
Oneirophanta mutabilis	100	12.8	NIOZ phytopigments
Psychropotes longicauda	570	9	UCG - Counts / UL – Chemical
Psychropote longicaudas	705	9	UCG - Counts / UL – Chemical
Pseudostichopus villosus	100	6	UL – Chemical
Pseudostichopus villosus	520	9	UL – Chemical
Pseudostichopus villosus	125	6	UL – Chemical
Pseudostichopus villosus	190	5.5	UCG - Counts & Nucleic acids
Pseudostichopus villosus	130	4.5	UCG - Counts & Nucleic acids
Pseudostichopus villosus	120	4.5	UL – Chemical

At Station 54301#6 UCG carried out dissections of the four gut regions and took samples of gut contents for bacterial counts (where indicated) as well as preserving gut contents in 40% glycerol for Nucleic acid based analyses of bacterial communities. Two *Oneirophanta* were also frozen whole for analyses. At this same station UL carried out dissections of the 4 gut regions for chemical analyses of the gut contents and gut walls as well as on the body wall, and gonads. Several animals were also frozen for this reason.

Of the holothurians noted in Table 7 and used for University of Liverpool (UL) chemical studies, two *Oneirophanta mutabilis* and two *Pseudostichopus villosus.* were frozen whole. One *O. mutabilis* was dissected for the body wall, gonads and the gut walls and the contents of all the sub-sections of the gut (oesophagus, anterior gut, posterior gut and rectum). All gut and body wall sections were wrapped in foil and stored at -20°C. One specimen of *Psychropotes longicauda* was dissected for anterior gut wall and contents, rectum wall and contents, gonads and body wall. A second *P. longicauda* was dissected for anterior

gut wall and contents, posterior gut wall and contents, rectum wall and contents, gonads and body wall.

Table 8. Holothurians dissected and/or frozen from OTSB trawl 54301#8

Sp. name	Weight (g)	Length (B) cm	Institute/Experiment
Oneirophanta mutabilis	120	5	UL – Activity
Oneirophanta mutabilis	100	5	UL – Activity
Oneirophanta mutabilis	120	5	UL – Activity
Oneirophanta mutabilis	80	4.5	UL – Activity
Oneirophanta mutabilis	135	12	UCG – Counts & Nucleic acids
Oneirophanta mutabilis	190	16.5	UL – Chemical
Oneirophanta mutabilis	110	11	UCG – Counts & Nucleic acids
Oneirophanta mutabilis	70	10	UL – Chemical
Psychropote longicauda	250	15	UCG – Counts & Nucleic acids
Psychropote longicauda	500	17	UL – Chemical
Psychropote longicauda	190	14	UL – Frozen
Psychropote longicauda	183	14.5	NIOZ phytopigments
Psychropote longicauda	280	14	NIOZ phytopigments
Psychropotes longicauda	350	17.5	NIOZ phytopigments
Psychropotes longicauda	575	14	NIOZ phytopigments
Pseudostichopus villosus	170	17	UL – Chemical/ UCG – Counts
Pseudostichopus villosus	280	17.5	UCG – Counts & Nucleic acids
Pseudostichopus villosus	220	17	UCG – Counts & Nucleic acids
Pseudostichopus villosus	270	17	UL – Frozen

At station 54301#8 UCG carried out dissections of the four gut regions and took samples of gut contents for bacterial counts (where indicated) as well as preserving gut contents in 40% glycerol for Nucleic acid based analyses of bacterial communities. UL carried out dissections of the 4 gut regions for chemical analyses of the gut contents and gut walls as well as on the body wall, and gonads. Several animals were also frozen for this reason.

Of the holothurians used for University of Liverpool (UL) chemical studies at station 54301#8, one *Psychropotes longicauda* and one *O. mutabilis* were frozen whole. One *P. longicauda* was dissected for the walls of the oesophagus, anterior gut, posterior gut, rectum, gonads and body wall. The gut contents from this animal were taken by UCG for bacterial DNA analysis. One other *O. mutabilis* was dissected for gonads, body wall and the gut walls and contents of all the sub-divisions of the gut (see above). Two *Pseudostichopus villosus* were also dissected in a similar way to the specimen *of O. mutabilis* except that in one specimen the gut walls had ruptured filling the body cavity and so the gut contents were discarded.

The body wall, various subsections of the gut wall, and gonad samples of the *Psychropotes longicauda*, *Oneirophanta mutabilis* and *Pseudostichopus villosus* were stored

at -20° C for subsequent biochemical analysis for lipid, protein, carbohydrate composition using GC/MS, HPLC, and spectrophotometric methodologies.

DAVID BILLETT, MICHAEL GINGER, MICHEAL CARTON

Holothurian nutrition studies (University of Liverpool)

The gut contents from four specimens of *Oneirophanta mutabilis* were pooled and used in an assay of leucine aminopeptidase activity. This work formed part of an ongoing project in which, together with assimilation efficiencies for lipid and protein uptake from the gut, estimates for the minimum gut residence time of abyssal holothurians should be obtained. These estimates will allow us to determine the effect that holothurians at the PAP site have on the bioturbation of sediment and carbon remineralisation at the benthic boundary layer. It is also possible that quantifiable changes in the biochemical content of holothurians collected at different times of year might be helpful in interpreting the impact that these animals have on the remineralisation of carbon at the seafloor. Detailed analysis of the holothurian lipids by mass spectrometry could indicate which compounds are obtained from the diet, and which are the products of holothurian biosynthesis.

The method employed for the leucine aminopeptidase assay, which measures the rate of cleavage for a fluorogenic substrate, leucine-aminomethylcoumarin (Sigma), was the same as that described for *Discovery* Cruise 229. The gut sediment which was recovered from four *O. mutabilis* was diluted with an equal volume of artificial seawater (NaCl 3.5% w/v) in order to facilitate pippetting. A sample of 0.8 ml (0.12-16 mM) of the substrate was placed into sterile plastic bags and then 1ml aliquots of the diluted gut sediment were added. The bags were heat-sealed, and incubated under *in situ* conditions (480 bar, 4° C) for six hours. Once the incubation was complete the reactants were transferred to Eppendorf tubes whereon the reaction was stopped by heat-treatment (65° C, 20 min), and the sediment removed by centrifugation (2,500 rpm, 20 min). Fluorescence was measured using an excitation wavelength of 375 nm and an emission wavelength of 455 nm . In order to take these measurements 10 ml of the supernatant was added to 2 ml sodium tetraborate buffer (4.77 g per 500 ml H_2O, pH adjusted to 10.0 with NaOH).

One set of assays was carried out using *O. mutabilis* collected from the second trawl. Owing to poor weather conditions and time constraints a third otter trawl was not possible, and so the opportunity to repeat the assay, and collect further holothurian specimens for natural product analysis was sadly lost.

MICHAEL GINGER

Microbiology of holothurian gut contents (University College, Galway)

Samples of gut contents and gut walls (to be treated as per objective 2: BENGAL task 68a) were taken by University College Galway from four regions of gut for each of three species of holothurian from both OTSB trawls on this cruise (see table above). The three species chosen were *Oneirophanta mutabilis*, *Psychropotes longicauda* and *Pseudostichopus villosus*. The gut was divided into four sections; the oesophagus, anterior intestine (foregut), posterior intestine (midgut) and the rectum (hindgut). In all cases the samples were preserved in glycerol (40% v/v) and frozen for laboratory analyses of bacterial community structure using nucleic acid based techniques. Subsections of 1 cm^3 of each gut region were preserved in a final concentration of 2 % (v/v) formalin and held at 4° C for bacterial enumeration using epifluorescence microscopy. Samples of the gut wall from all four regions were preserved in glycerol for fluorescent *in situ* hybridisation studies.

It had been hoped to take gut content samples of the holothurian *Amperima rosea* for Queen's University Belfast, but there were no suitable specimens for such work in either of the two trawls. Furthermore, because the trawls had been in warm surface waters for several hours before being hauled on deck the samples were unsuitable for enzyme activity assays.

MICHEAL CARTON

Phytopigment analyses of gut contents (Netherlands Institute for Sea Research)

Four specimens of *Oneirophanta mutabilis* and four *Psychropotes longicauda* were taken from stations 54301#6 and 54301#8 respectively by NIOZ (see Tables 7 and 8), and were dissected for their gut contents and their body walls. Three sections were taken from *O. mutabilis*: anterior gut, mid-gut, and posterior gut. The rectum was also sampled separately from *P. longicauda* specimens in addition to the anterior, mid-, and posterior gut samples. Gut content samples will be analysed for phytopigment content, and the body walls will be analysed for its RNA/DNA ratio in order to determine whether this biochemical parameter can be used to monitor seasonal differences in growth and metabolic activity.

ROB WITBAARD

CTD and water bottle samples

The first CTD cast was at the "Central Station" and started at 1852Z (18/10/97). Owing to the rough sea conditions, the echosounder display proved to be too noisy to see a clear acoustic signal from the pinger mounted on the CTD frame, and hence the height of the CTD above the seabed could not be determined with great confidence. As the altimeter on the CTD did not function it was decided not to lower the CTD closer to the seafloor. The cast was halted approximately 100m from the seabed at a CTD depth of 4767m. Water samples were taken at various depths on the upcast although, unfortunately, the deepest sample (100

metres above the bottom) was not taken because of a misfire in the rosette sampler. The CTD was on deck again at 2355Z.

The second CTD cast was deployed at 1329Z (21/10/97) and was limited to a depth of 3000m because of time constraints on the scientific programme. The maximum depth attained was 3006m. Water samples were again taken during the upcast with all the required depths sampled successfully. The CTD was returned on deck at 1630Z.

The third CTD cast was another attempt to collect near-bottom water at the Central Station site. Deployment was at 1826Z (24/10/97) and this time, because of calmer conditions, the pinger on the CTD frame was visible on the waterfall display and could be seen clearly as the CTD approached the bottom. This gave a good indication of the height of the CTD above the seabed. The seafloor was approached to within 17m in a water depth of 4844m with a maximum reading of wire out of 4850m. Six water samples were taken at this depth and the remaining six bottles used at various other depths on the upcast. The CTD was inboard at 2220Z.

The fourth cast was in the water at 1302Z (26/10/97) and reached its maximum depth of 202m at 1310Z. Water samples were taken on the upcast and the CTD was recovered on deck at 1327Z.

Table 9. Water bottle samples

Cast number	1	2	3	4
Station	54301#1	54301#7	54301#20	54301#24
	3	3		
				5
	15	15		15
	30	30		30
				40
	50	50		50
				60
	75	7		
				80
	100	100		100 (4 samples)
	200	200	200	200
	300		300	
	500	500	500	
	1000	1000	1000	
	3000	3000 (3 samples)	3000	
	100 (mab)		100 (mab)	
			17 mab (6 samples)	

At the end of each cast, small samples were taken from one or more rosette bottles to keep a check on the CTD conductivity calibration. The salinity of each sample was measured on board using a 8410 Guildline portable salinometer (see below).

Water bottle samples were taken at the following nominal depths (m) in each of the CTD casts as detailed in Table 9:

JOHN WYNAR

Nutrient analyses (Institut Universitaire Europeen de la Mer)

From most of the water bottles, and certainly from all the samples shallower than 100m, 1.5 litres of water was filtered for biogenic silica (Bsi), and 1.5 litres for chlorophyll *a* (Chl *a*). At each depth of all the CTD casts, water was collected for the measurement of nitrate (stored at -20° C) and silicate (stored at +4° C).

The profiles were collected to provide a good time distribution over the duration of the cruise. These data will be used to validate a coupled biogeochemical-physical model for the area of Central Station. The model will be used to estimate the exportation flux of POM at 250 m or 500 m water depth. A model of water column, from 500 m to the bottom, needs to be developed to provide a connection to models of the sediment. This will give a better estimation of POM flux at the sediment-water interface.

JEAN-NOEL DRUON

Microbiology of water column and sediment contact water (University College, Galway)

The CTD rosette was used to collect water column and sediment contact water (SCW) samples (BENGAL task 52). These were then filtered through a Sterivex 0.2 um filter at 4° C using a peristaltic pump. The depths sampled were: 100m (20 litres filtered from station 54301#24), 3000m (20 litres filtered from #7), 100m above the bottom (mab) (5 litres filtered from #20) and 17mab (20 litres filtered from #20). To each sample 1.8 ml of lysis buffer (EDTA, NaCl, Sucrose) was added to the filter which was then frozen. In each case, the samples was held at -20° C for nucleic-acid based analyses in the laboratory.

40 ml of each sample was preserved in formalin (2% final concentration) for bacterial enumeration using epifluorescence microscopy.

MICHEAL CARTON

Particulate material in near-bottom water (Netherlands Institute for Sea Research)

Owing to bad weather conditions and the sampling time available on this reduced cruise, it was not possible to take more than one near-bottom water sample. Approximately 25 litres of water were collected at 17 metres above the seafloor and filtered through 0.45 micron cellulose acetate filters. The particulate material collected in this way will be analysed for its

phytopigment composition. Together with the pigment distributions obtained from multicore samples and from the gut contents of *Psychropotes longicauda* and *Oneirophanta mutabilis,* insight will be obtained into the links between food availability, food utilisation and re-suspension processes on the deep ocean bottom.

ROB WITBAARD

Moorings recovery

MAC Module Autonome de Colonisation (IFREMER)

The MAC is composed of four big plastic arrays. In each array there are four small sample containers which contain a mix of glass beads (diameter 40-70 microns) and fish flour at different concentrations. This flour is a proxy for organic matter and glass beads act as a proxy for the sediment. There are four sample containers with only glass beads, four with glass beads and five grams of fish flour, four with glass beads fifteen grams of fish flour and four with glass beads and fifty grams of fish flour. Each array is covered with a plastic grid with a mesh of 5 mm to prevent the entry of adult animals.

The MAC recovered on this cruise had been deployed during *Discovery* Cruise 229, on the 5 July 1997, at 0741Z. The position was : 48° 55.02' N, 16° 27.93' W. It was recovered on the 18 October 1997. The rig was released from the seabed at 0923Z and reached the surface at 1155Z. The full rig was recovered on the deck by 1228Z.

The bacterial mats that had formed on the surface of sediment in each of the sample containers, but particularly in the trays with 15 and 50 grams of organic matter, was less than had been encountered in the two previous MAC experiments recovered respectively in March 1997 (after 7 months on the bottom) and in July (after 4 months on the seabed). Similarly, the large macrofauna usually found in these incubation experiments (for example, large polynoid polychaetes and large amphipods) appeared to be less abundant.

A sub-sample of each sample container was taken for analysis of organic carbon and then the contents of each container were sieved at 250 microns and preserved in buffered formalin for further laboratory analysis of macrofauna.

PHILIPPE CRASSOUS

MAP Module Autonome Pluridisciplinaire (IFREMER)

The objectives of the long term MAP mooring was to collect simultaneous observations at the water-sediment interface in order to understand the effect of the physical environment on the near-bottom particle supply and on the benthic animal behaviour. These observations lasted more than one year in order to identify the seasonality of these processes.

The MAP was moored during the ALIPOR cruise on *Discovery* Cruise 222 Leg 1 on 30 July 1996 at 0550Z. The position was 48° 56.10' N, 16° 31.88' W. It was recovered on 22 October 1997. The rig was released at 1135Z, reaching the surface at 1317Z and the whole mooring was on deck by 1440Z.

The mooring was composed of the MAP, a lander system which sits on the bottom, above which there is a current meter at 15 meters above the bottom, a thermistor chain c. 100m long between 30 and 140m above the bottom equipped with 10 thermistors (10 meters apart), and finally another current meter 140 meters above the bottom.

On the MAP frame there was a camera with a flash which was programmed to take a picture every 12 hours, a nephelometer which made measurements every half hour, a MORS current meter, and a sediment trap. The sediment trap sampling protocol was constructed to overlap sampling periods used by SOC for the sediment trap mooring deployed on cruise D222 Leg 2. The current meters above the bottom and the thermistor chain sampled every hour.

The sampling of sediment trap started on the 18 August 1996 and the twelve bottles sampled for different periods of time as detailed in Table 10.

Table 10. Sample details for each bottle on IFREMER sediment trap

Duration	Start Date	End date
28 days	18.08.96	15.09.96
28 days	15.09.96	13.10.96
56 days	13.10.96	08.12.96
56 days	08.12.96	02.02.97
42 days	02.02.97	16.03.97
28 days	16.03.97	13.04.97
14 days	13.04.97	27.04.97
14 days	27.04.97	11.05.97
21 days	11.05.97	01.06.97
21 days	01.06.97	22.06.97
21 days	22.06.97	13.07.97
56 days	13.07.97	07.09.97.

Initial observations of dry weight of the material collected in the sediment trap indicates that the maximum flux of organic matter started to rise at the end of April to reach a maximum in June and July. The last and the first samples (the dates of the first are included in those of the last) gave the same flux value. Sadly, the camera was found to be flooded and had not worked.

PHILIPPE CRASSOUS, ANNICK VANGRIESHEIM

BIOFEED (University College, Galway; Southampton Oceanography Centre; University of Liverpool; University of Gent)

The recovery of the long-term BIOFEED mooring which was deployed during *Discovery* Cruise 229 in mid-July 1997 was successful, with all 12 cores recovered in good condition, undisturbed and with significant amount of phytodetritus resting on them (60-80% coverage by visual estimate). However. as far as one could see, the 6 enriched cores (A1-3 and D1-3), did not show any difference to those of the non-enriched cores (B1-3 and C1-3).

Four different areas of research will be carried out by four different institutes on the cores from BIOFEED. The microbiology will be studied by the University College Galway, the study of foraminifera by the Southampton Oceanography Centre, the metazoan meiofauna by the University of Gent and the organic chemistry by the University of Liverpool. This required a rather complex method in splitting the contents of each of the layers within each of the cores as detailed in Table 11.

Table 11. Sample details for BIOFEED experiment

Enriched cores			**Controls**		
Cores	**Participants**		**Cores**	**Participants**	
A1	Galway	Liverpool	B1	Galway	Liverpool
A2	Galway	Gent	B2	Galway	Gent
A3	Galway	SOC	B3	Galway	SOC
D1	Liverpool	Gent	C1	Liverpool	Gent
D2	Liverpool	SOC	C2	Liverpool	SOC
D3	SOC	Gent	C3	SOC	Gent

University College Galway participated in the BIOFEED experiment (BENGAL tasks 64, 65) in order to enumerate the bacteria present in the various samples. For this purpose, subsections of 1cc were taken from each of the sections of cores shared with other groups. These samples were preserved at 4° C in a final concentration of 2% microbial-free formalin for epifluorescent microscopy in the laboratory.

KOSTAS KIRIAKOULAKIS, ANN VANREUSEL, MICHEAL CARTON

Sediment trap (Netherlands Institute for Sea Research)

A single NIOZ sediment trap was deployed on 26 July 1997 at 48° 56' N 16° 27' W to sample the flux of particles about 5m above the seabed. During the first period of operation it sampled in 8 periods of one week each, followed by four samples at 24 hour intervals. The latter arrangement was chosen because fresh material was needed and the sediment trap was planned to be recovered early during the, now aborted, *Atalante* cruise. Unfortunately, even though the recovery of the NIOZ sediment trap was the first activity completed on *Challenger*

Cruise 135, the sediment trap was not released until 18 October 1997, some 3 weeks later than planned.

The recovery of the sediment trap mooring went smoothly. It was released from the seabed at 0712Z and took 88 minutes before the mooring was on deck.

All sa mples were in excellent condition and although only small quantities were caught, it was demonstrated that there was a steady rain of particulate material until the end of August / first week of September. Thereafter the flux of particulate material became less. It should be noted that even in the four final daily samples recognisable amounts of organic material were present.

With the successful recovery of this mooring NIOZ completed a series of trap deployments which started during *Discovery* Cruise 226 in March 1997. During that cruise, and the following cruises, fresh material was collected at 48 hour intervals and without the use of fixatives so that the phytopigment composition of the particulate material could be analysed.

In sediment traps left on the seabed between cruises, however, as in this case, 6% formalin was used as fixing agent in the sediment trap collecting cups. These samples will be used for qualitative descriptions and as far as possible to quantify the amount of material. Altogether, a detailed sedimentation record has been obtained for the PAP site between March and September 1997.

ROB WITBAARD

Optical measurements of irradiance at the sea surface

A portable optical instrument (SIMBAD) was used to measure incident and reflected irradiance at specific wave lengths at the sea surface, particularly those of Chl *a* absorption and emission. The purpose was to make simultaneous *in situ* measurements of these optical parameters and of Chl *a* concentration at the sea surface each day around 1200Z, a time which corresponds to the measurement of surface Chl *a* made by the ocean colour sensor SeaWiFS in this area. The data will help to calibrate the satellite sensor in the North-East Atlantic. SeaWiFS has a spatial resolution of 800 m, and can take one chlorophyll picture of any ocean surface per day. SeaWiFS was launched in mid-August 1997.

JEAN-NOEL DRUON

Ornithology

No systematic bird observations were carried out but, as expected for this time of year, a number of migrants arrived on board. Easterly winds for an extended period accounted for some of the arrivals.

Birds observed :

A. Seabirds

Storm petrel, fulmar, gannet, great skua, pomarine skua, kittiwake, sabine's gull, lesser blackback gull, bonaparte's gull, greater shearwater.

B. Migrants (approximate numbers)

Common thrush (2), blackbird (1) male, starling (8), robin (1), chaffinch (10), greenfinch (5), siskin (3), skylark (15), blue headed wag tail (1), white wagtail (1), redstart (1), fieldfare (1), dunlin (1), unidentified wader.

Seabirds including greater shearwaters were abundant at the start of operations at the BENGAL site and were present in flocks of up to two hundred birds. These disappeared only to reappear at departure of RRS *Challenger* from the site on the morning of Monday 27 October.

Other seabirds were much less numerous than the shearwaters. Gannets were mainly represented by sub-adults. As usual, small groups of seabirds were attracted by our trawling and coring operations, and skuas were obviously aware of the possibility to catch migrants. A lesser blackback gull was also observed trying to catch a finch on the bridge wing. A British storm petrel was found in the well at the door of the cold room one evening in an uninjured condition. It was placed in a cardboard box for two hours before being left in a quiet corner of the foredeck from where it had gone in the morning.

Migrants occurred in greater variety compared to *Discovery* Cruise 222 (September 1996) with 15 species being observed. Some attempts were made to feed these migrants. A grey wagtail came into the main lab and settled in a corner in an exhausted state. This was easily picked up and we succeeded in force feeding it some chopped, soaked raisins. It was fed twice more with the addition of banana and a small proportion of sausage meat before escaping from a hole at the end of the box in which it was kept. This bird was one of a pair and was seen for several days afterwards sometimes coming in to the main lab again and into the companionways. Its mate disappeared within a day or two.

Three finches trapped in the companionways were released into the confines of the small wet lab, unused at the time, where they could rest undisturbed during a spell of bad weather. They fed readily from food left out in a small dish on the floor and remained in the wet lab for an hour or two the next day until disturbed, even though the outer door to the deck had been opened. They were part of a flock of about 10 and survived more successfully than other species as they readily accepted food items left out. One was observed still alive on Wednesday 29 October continuing to feed, less than 36 hours from port.

A pair of unidentified green warblers arrived on the 23 October, one of which was in an exhausted state and was easily picked up. These are very small birds and force feeding required two people. Once again soaked raisins was tried, supplemented with small fragments of cheese at

a second feed two hours later, but the bird subsequently died. Apart from exhaustion, handling shock is difficult to avoid with these small birds, but unlike the finches, they would not feed otherwise. This and other dead specimens were frozen and stored in ethanol for identification and biometric measurements.

PETER LAMONT, ROB WITBAARD

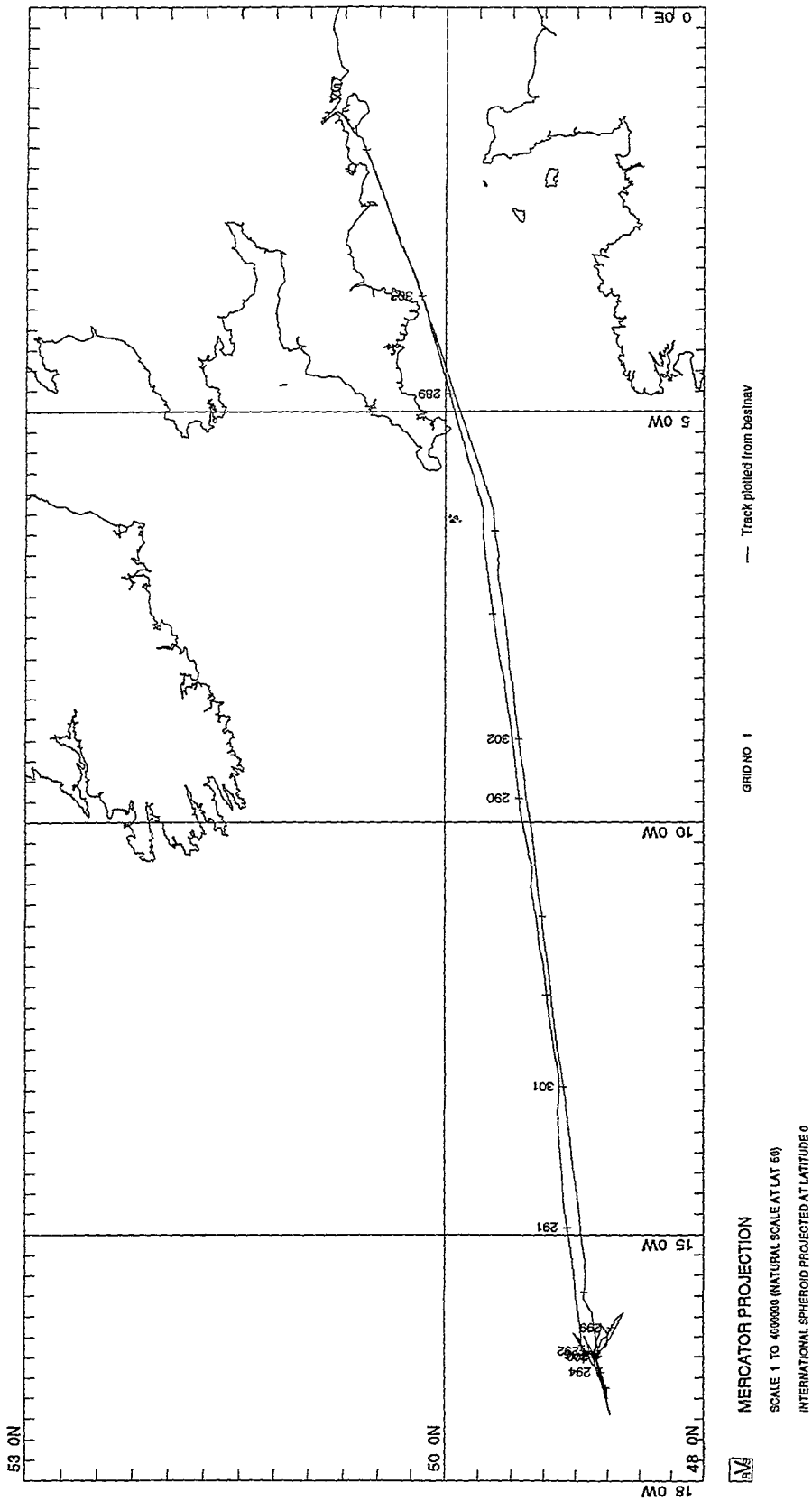


Figure 1. RRS *Challenger* cruise 135. Track chart.

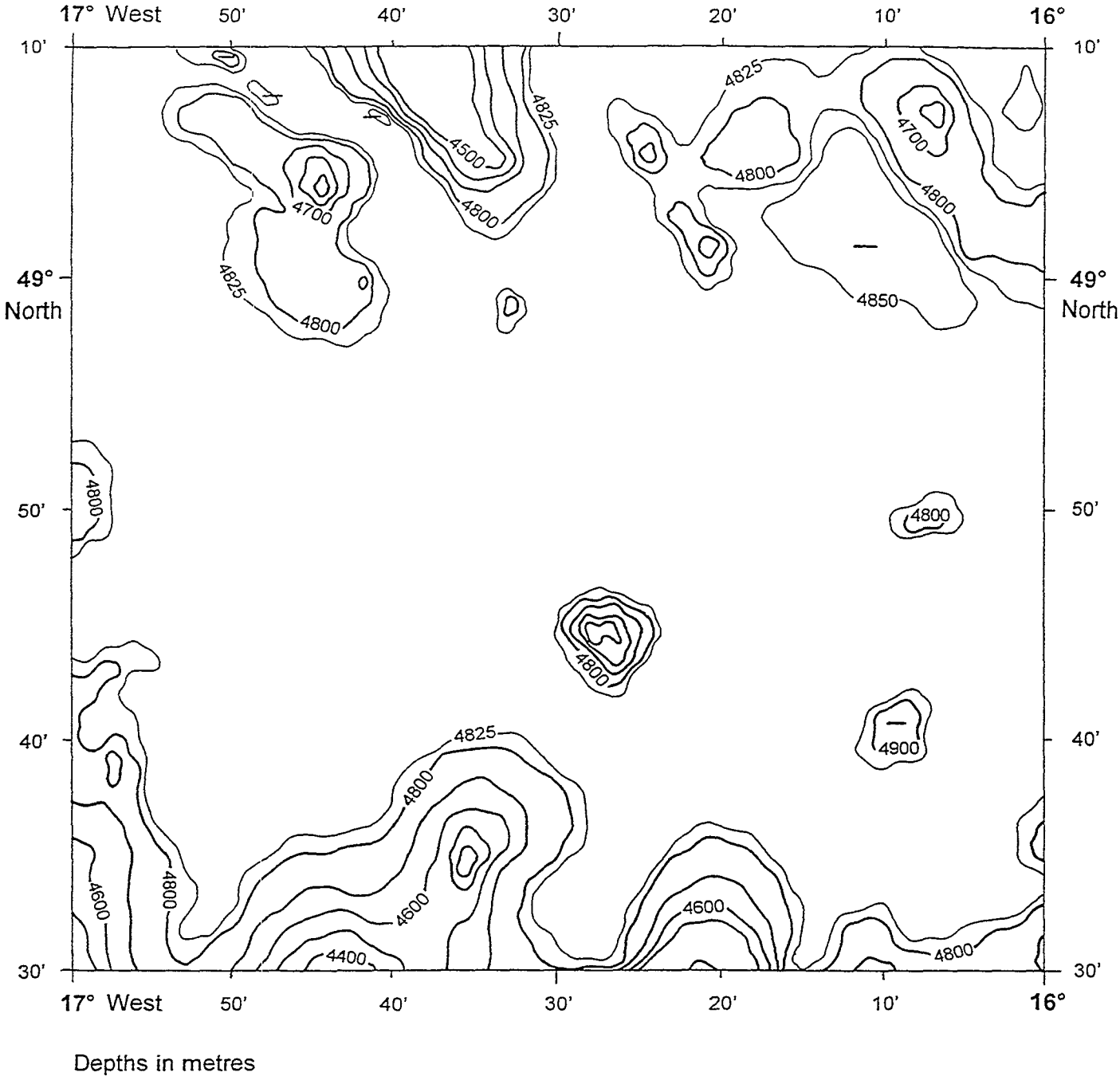


Figure 2. Bathymetry of the Porcupine Abyssal Plain in the vicinity of the BENGAL study site, based on data collected up to and including *Discovery* cruise 222. [*We are grateful to Peter Hunter for providing this up to date version of the bathymetric chart.*]

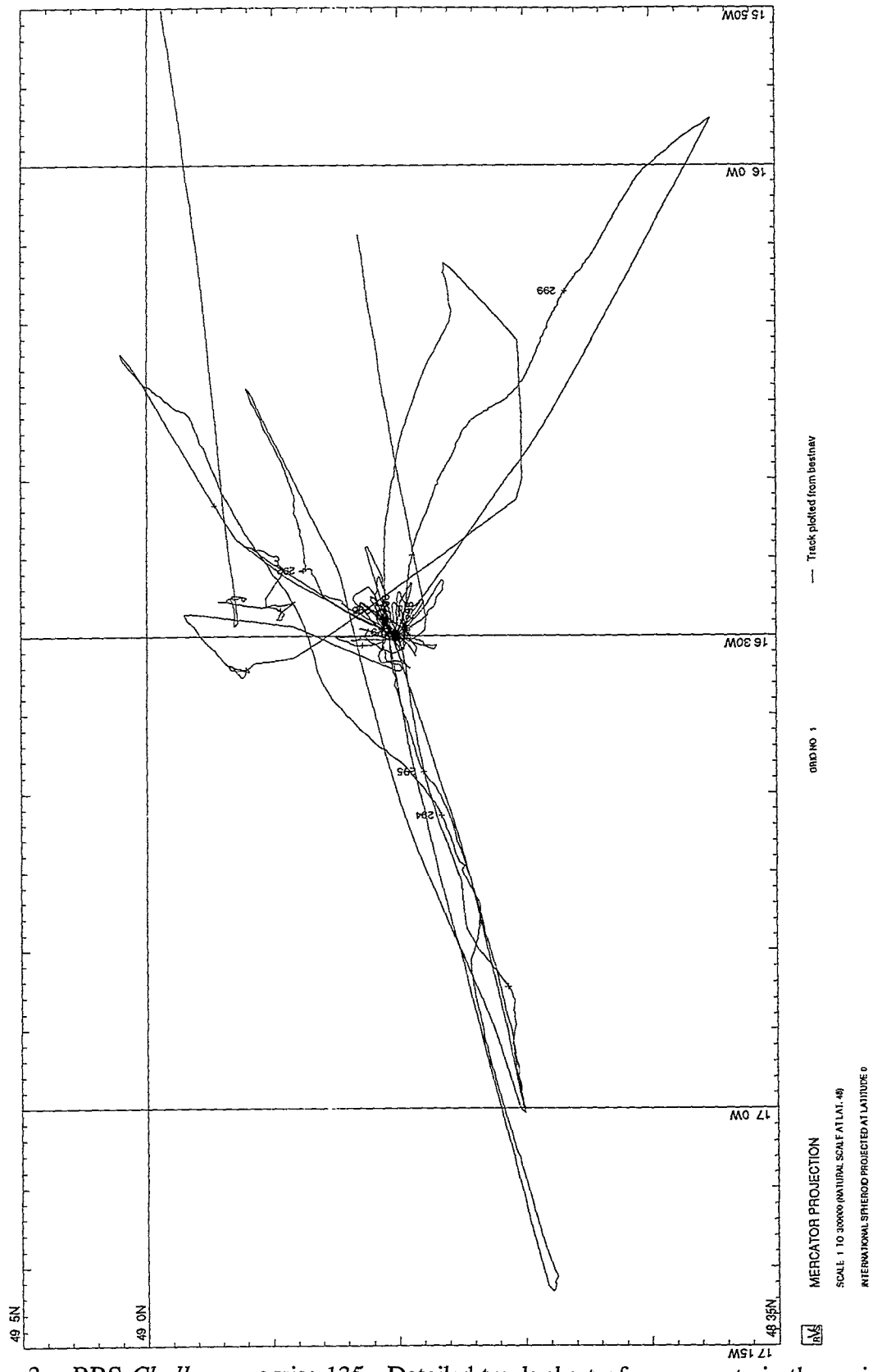


Figure 3. RRS *Challenger* cruise 135. Detailed track chart of movements in the main work area. Track chart shows two trawl (OTSB) tracks to southwest of the Central Station. Tracks to the north relate to mooring activities. Tracks to south east of Central Station caused by bad weather.

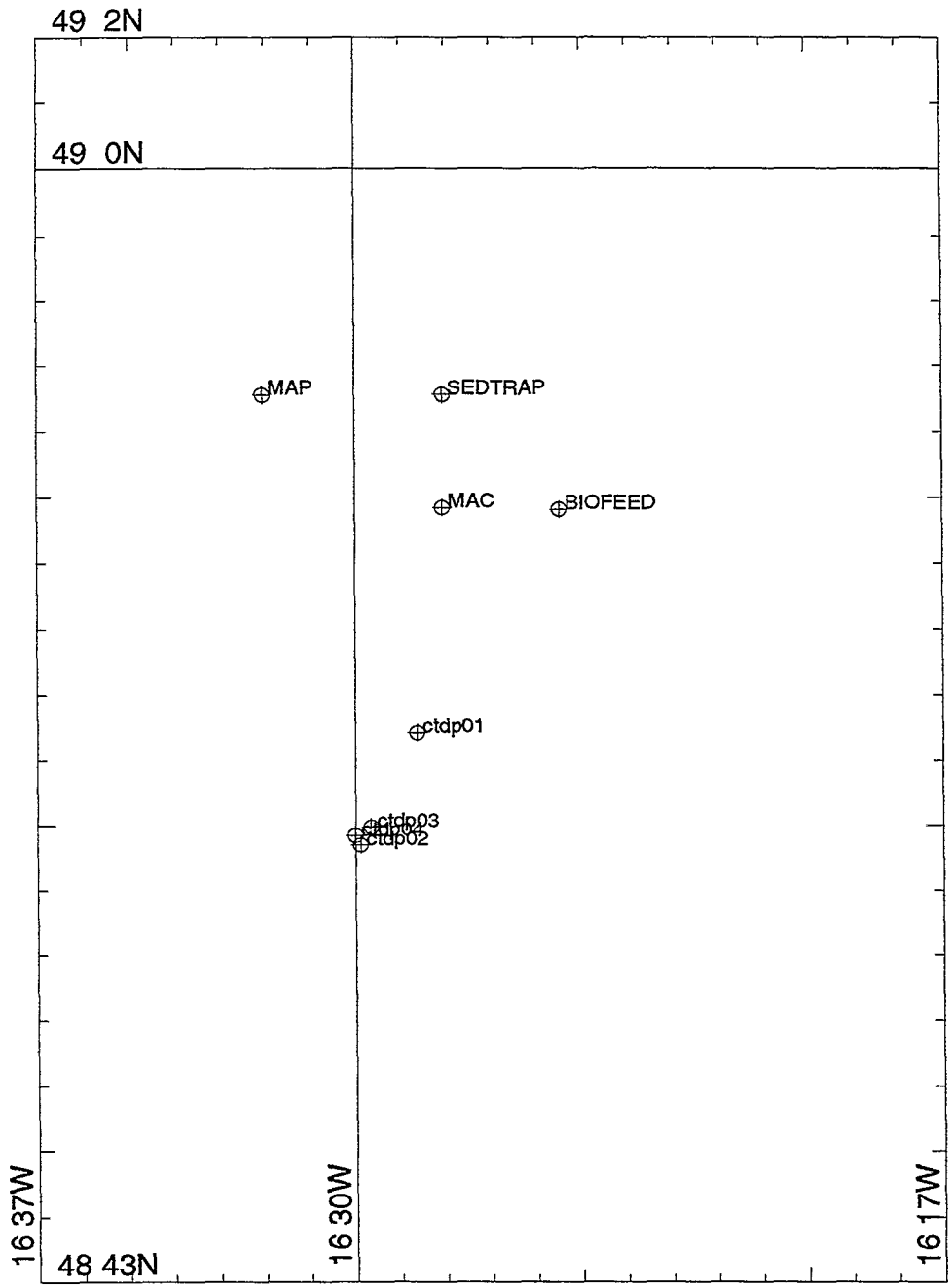


Figure 4. RRS *Challenger* cruise 135. Position of moorings and CTD stations.

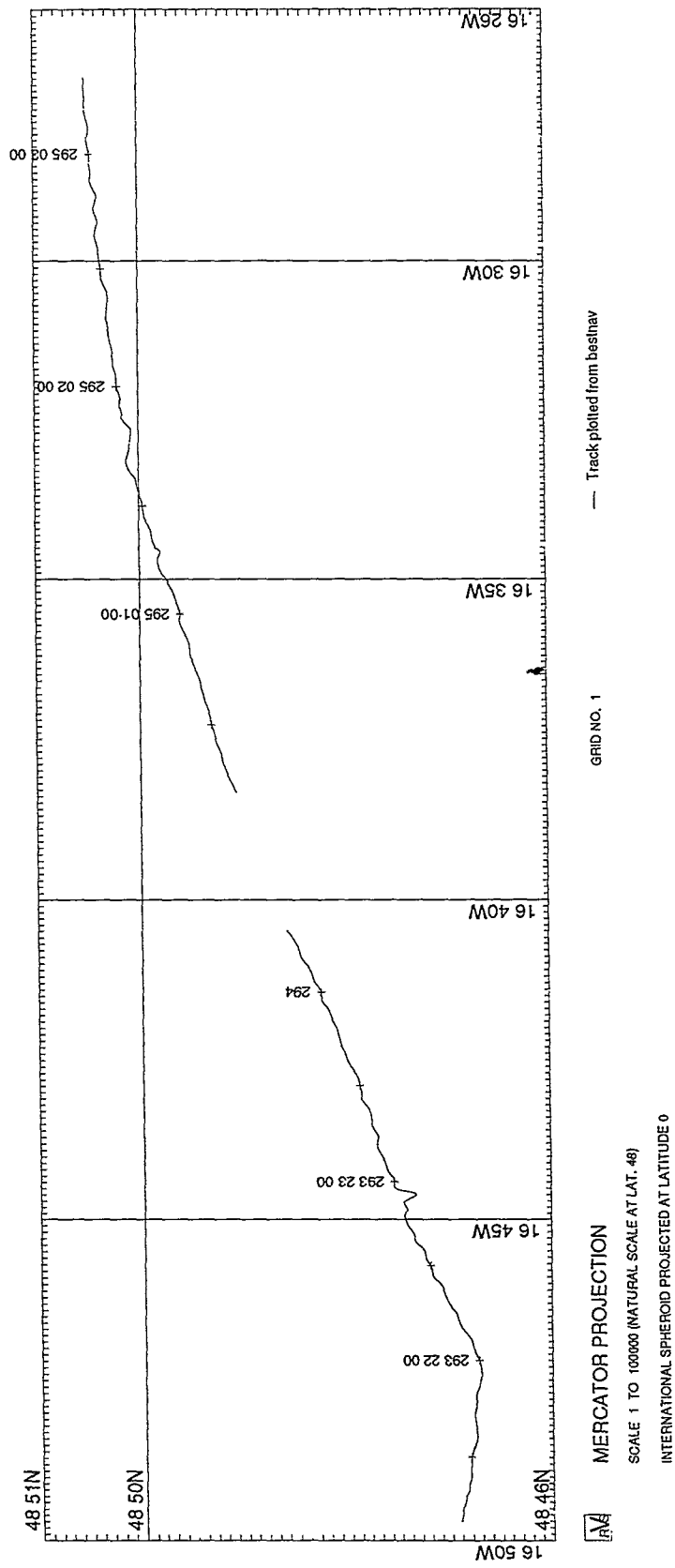


Figure 5. Bottom tracks of two OTSB trawls.

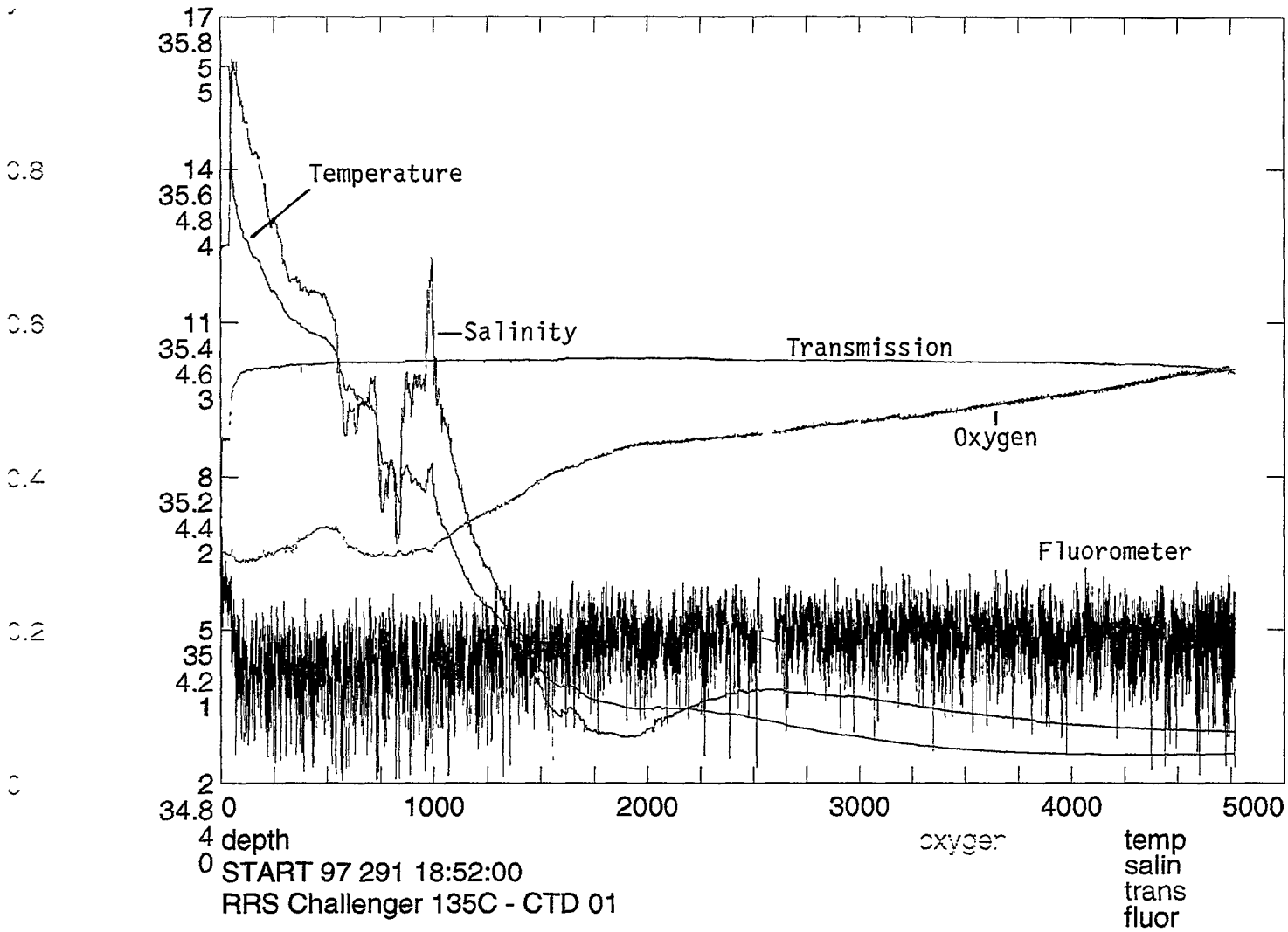


Figure 6. CTD plot (station 54301#1) showing temperature, salinity, transmission, fluorometer, and oxygen.

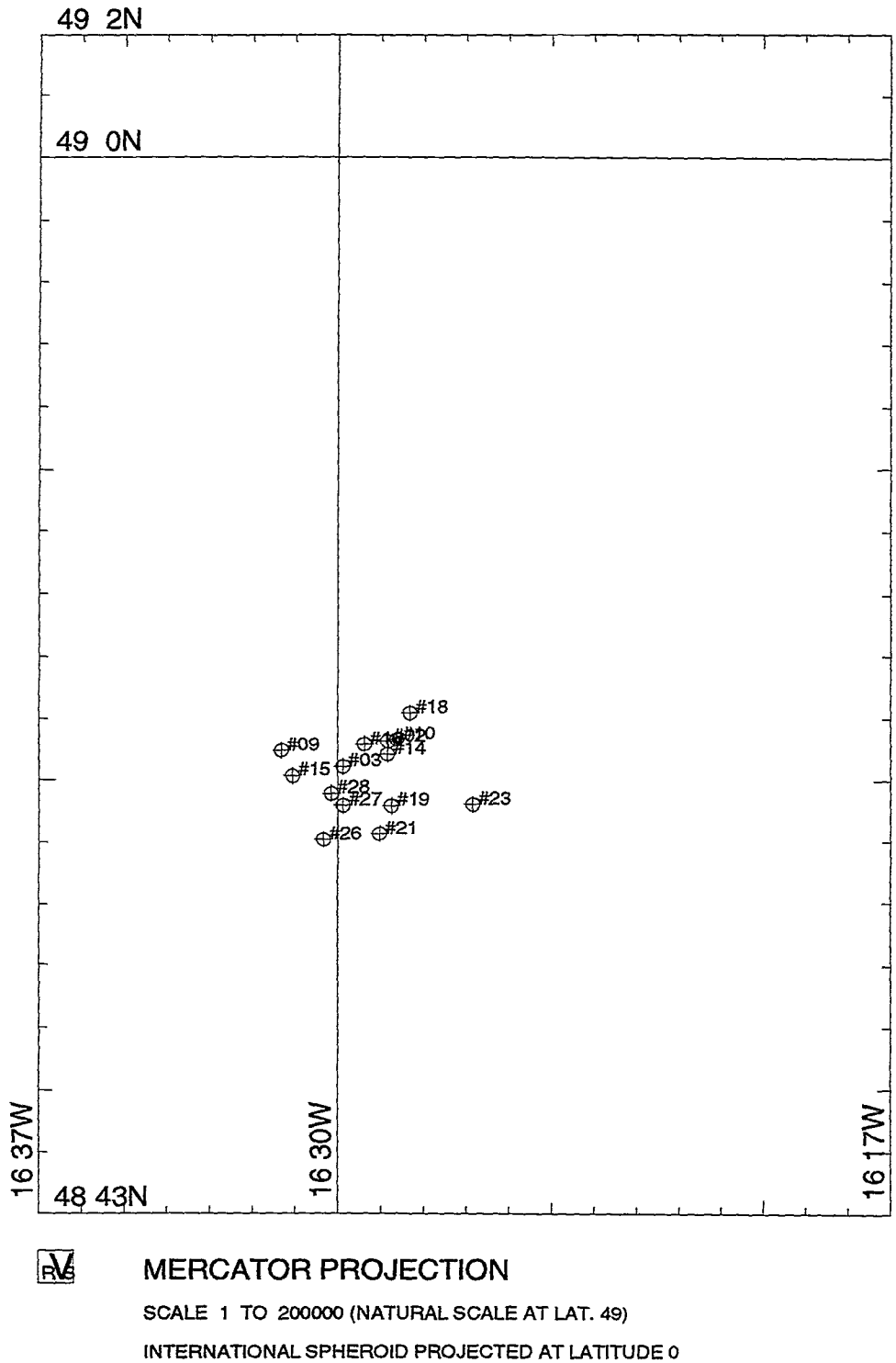


Figure 7. Positions of multiple corer deployments.

GEAR CODES USED IN STATION LIST

BIOFEED	Long-term enrichment experiment based on multiple corer samples
BOX CORER	Spade box corer (0.25m^2) modified USNEL type, fitted with plain box.
CTD	Conductivity-temperature depth probe
MAC	Module Autonome de Colonisation: long-term enrichment and recolonisation experiment.
MAP	Module Autonome Pluridisciplinare; long term, current meter, thermistor chain, time-lapse camera, sediment trap, transmissometer deployment.
MLT CORER	Multiple corer, Barnett pattern, using 12 57mm i.d. core tubes
MS	Multisampler; 10 litre water bottle rosette mounted on CTD frame
OTSB14	Semi-balloon otter trawl with 14m headline, effective fishing width 8.6m
SED TRAP	NIOZ version with one carousel, 12 bottles, 5mab.
VEGBOXC	Spade box corer (0.25m^2) modified USNEL type, fitted with vegematic box

STN.	DATE 1997	POSITION LAT.	LONG.	GEAR	DEPTH (M)	TIMES GMT	COMMENT	MEAN SOUND. (M)
12913 # 2	30/ 7 22/10	48 56.1N	16 31.9W	MAP	4840-4840	0550-1135	Started July 1996, camera failed	4840
13200 # 5	5/ 7 18/10	48 55.0N	16 27.9W	MAC	4844-4844	0911-0923	Good samples	4844
13200 #65	18/ 7 18/10	48 54.9N	16 24.8W	BIOFEED	4849-4849	0605-1337	Good samples	4849
13200 #97	26/ 7 18/10	48 56.4N	16 27.5W	SED TRAP	4851-4851	1927-0712	Good samples	4851
54301 # 1	18/10	48 51.4N 48 53.8N	16 28.6W 16 25.9W	CTD MS	0-4767	1852-2352	11 bottles between 6 and 3000m	4843
54301 # 2	19/10	48 50.6N	16 28.8W	MLT.CORER	4839-4839	1728-	2 cores out of 12	4839
54301 # 3	19/10	48 50.2N	16 29.9W	MLT.CORER	4842-4842	2212-	1 core out of 12	4842
54301 # 4	20/10	48 50.6N	16 28.8W	BOX CORER	4839-4839	0324-	Limiter(25cm), No core, very rough	4839
54301 # 5	20/10	48 50.7N	16 31.5W	VEGEBOX	4843-4843	0913-	Limiter(25cm), No core, large swell	4843
54301 # 6	20/10 21/10	48 46.9N 48 48.6N	16 49.7W 16 40.5W	OTSB14	4837-4846	2105-0020	Good clean catch Tow dist. 11.728 km.	4846
54301 # 7	21/10	48 49.7N 48 50.4N	16 29.9W 16 28.1W	CTD MS	0-3010	1329-1630	12 bottles between 7 and 3010m	4843

STN.	DATE 1997	POSITION LAT.	POSITION LONG.	GEAR	DEPTH (M)	TIMES GMT	COMMENT	MEAN SOUND. (M)
54301 # 8	22/10	48 49.1N 48 50.5N	16 38.4W 16 27.0W	OTSB14	4839-4844	0007-0320	8 macrourids lost at surface Tow dist. 14.103 km.	4844
54301 # 9	22/10	48 50.5N	16 31.3W	MLT.CORER	4843-4843	1833-	12 good cores	4843
54301 #10	22/10	48 50.7N	16 28.6W	MLT.CORER	4843-4843	2204-	12 good cores	4843
54301 #11	23/10	48 49.8N	16 29.3W	VEGEBOX	4839-4839	0222-	No core	4839
54301 #12	23/10	48 50.5N	16 30.1W	BOX CORER	4842-4842	0647-	No core	4842
54301 #13	23/10	48 50.4N	16 29.9W	BOX CORER	4842-4842	1055-	No core	4842
54301 #14	23/10	48 50.4N	16 28.8W	MLT.CORER	4839-4839	1532-	11 good cores	4839
54301 #15	23/10	48 50.1N	16 31.1W	MLT.CORER	4843-4843	2002-	1 core, disturbed cores	4843
54301 #16	24/10	48 50.6N	16 29.4W	MLT.CORER	4842-4842	0032-	6 reasonable cores	4842
54301 #17	24/10	48 49.7N	16 29.6W	BOX CORER	4839-4839	0517-	No core	4839
54301 #18	24/10	48 51.1N	16 28.3W	MLT.CORER	4843-4843	1136-	2 cores, large swell	4843

STN.	DATE 1997	POSITION LAT.	LONG.	GEAR	DEPTH (M)	TIMES GMT	COMMENT	MEAN SOUND. (M)
54301 #19	24/10	48 49.6N	16 28.8W	MLT.CORER	4843-4843	1549-	6 cores, winch problems	4843
54301 #20	24/10	48 50.0N 48 49.9N	16 29.7W 16 28.1W	CTD MS	0-4819	1826-2220	All samples from 17m above seabed	4839
54301 #21	25/10	48 49.1N	16 29.0W	MLT.CORER	4840-4840	0038-	5 poor cores	4840
54301 #22	25/10	48 49.5N	16 30.0W	BOX CORER	4839-4839	0518-	No core	4839
54301 #23	25/10	48 49.6N	16 26.8W	MLT.CORER	4843-4843	1037-	8 good cores, 3 slipped	4843
54301 #24	26/10	48 49.8N 48 49.8N	16 30.0W 16 29.9W	CTD MS	0- 202	1302-1327	Samples for nutrients, chlorophyll	4843
54301 #25	26/10	48 49.9N	16 28.8W	BOX CORER	4840-4840	1526-	No core	4840
54301 #26	26/10	48 49.0N	16 30.3W	MLT.CORER	4842-4842	1954-	11 good cores for macrofauna	4842
54301 #27	27/10	48 49.6N	16 29.9W	MLT.CORER	4837-4837	0004-	11 good cores for macrofauna	4837
54301 #28	27/10	48 49.8N	16 30.1W	MLT.CORER	4840-4840	0406-	9 good cores for macrofauna	4840

Southampton Oceanography Centre
European Way
Southampton S014 3ZH
United Kingdom
Tel:+44(0) 1703 596666
Fax:+44(0) 1703 596667