

SCOTTISH MARINE BIOLOGICAL ASSOCIATION

Dunstaffnage Marine Research Laboratory

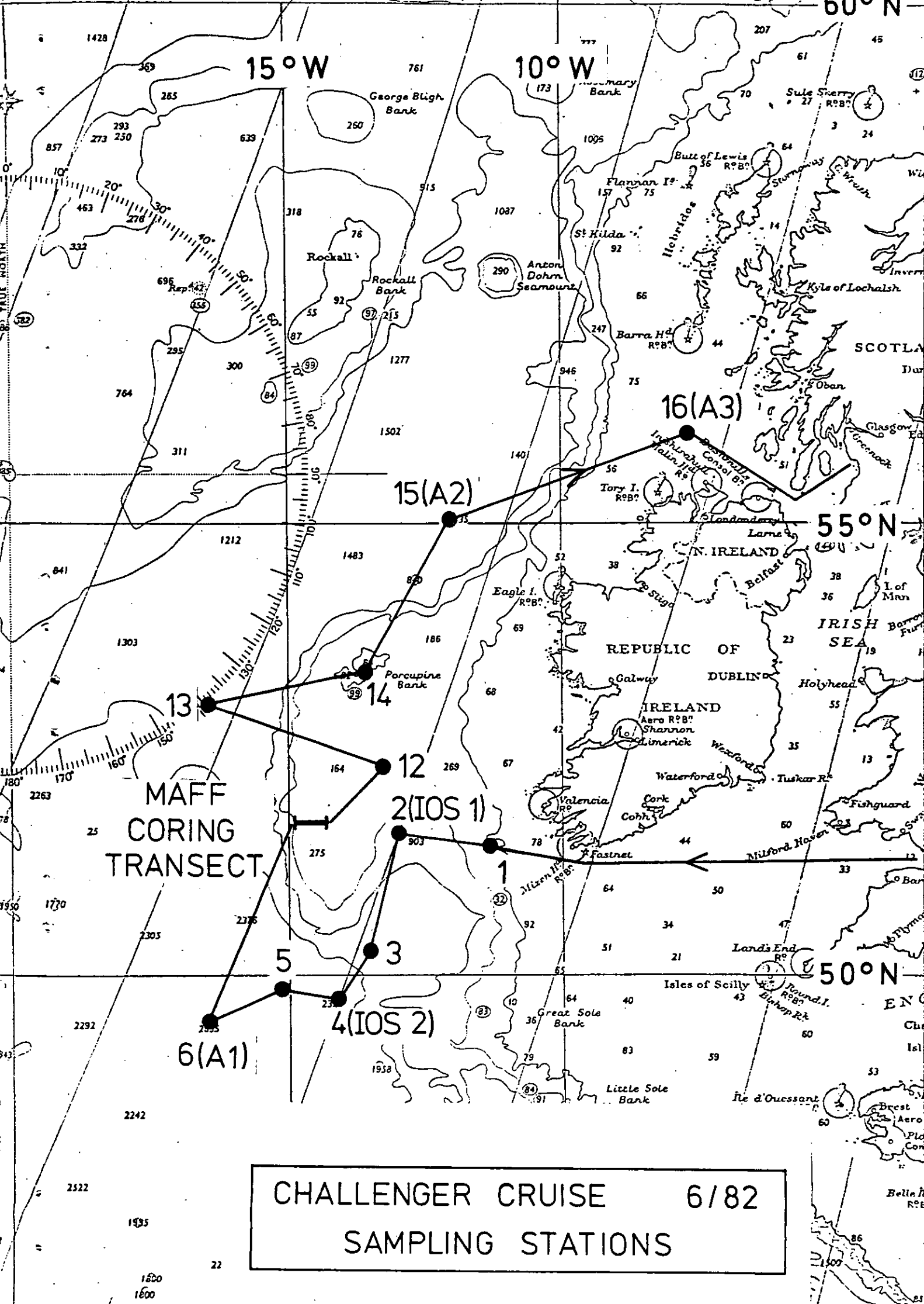
CRUISE REPORT

R.R.S. CHALLENGER

Cruise 6/82

8th - 20th April

1982



CHALLENGER CRUISE 6/82  
SAMPLING STATIONS

1. Duration of Cruise

09.00 hrs 8th April (Barry) until 11.00 hrs 20th April  
(Ardrossan). All times are British Summer Time.

2. Localities

Porcupine Seabight, Porcupine Abyssal Plain, Porcupine  
Bank, Rockall Trough and continental shelf west of Scotland.  
Station positions are listed in Table 3.

3. Scientific Party

Dr. B.L.S. Hardy, S.M.B.A., Principal Scientist.

Mr. J. Watson, S.M.B.A.

Dr. A. Gooday, Institute of Oceanographic Sciences, Wormley.

Dr. O. Pfannkuche, Institute of Oceanographic Sciences, Wormley.

Mr. P.S. Meadows, Glasgow University.

Miss M. Kirkham, Glasgow University.

Dr. J. Patching, University College, Galway, Ireland.

Dr. R. Raine, University College, Galway, Ireland.

Mr. G. Dear, Heriot-Watt University, Edinburgh.

Mr. N. Holmes, University College of Wales, Aberystwyth.

4. Scientific programme

(i) Studies of microbial activity in the deep sea and  
shelf sediments, in the water overlying these sediments and in

surface waters, using the SMBA multiple corer, NIO water bottles and pump samples (University College, Galway, Glasgow University and Heriot-Watt University).

(ii) Studies of the microbiological, chemical and physical properties of deep sea sediments, using the SMBA multiple corer (Glasgow University).

(iii) Sampling of meiofauna and benthic foraminifera of the deep sea, Porcupine Seabight and shelf sediments, using the SMBA multiple corer (SMBA and IOS).

(iv) Studies of the distribution of planktonic foraminifera by means of vertical tow nets, pump samples and cores. Two pump sample transects to plot the distribution of planktonic foraminifera between the Porcupine Bank and Rockall Trough (University College of Wales, Aberystwyth).

(v) A transect of five stations from 750 m to 385 m across the southern shoulder of the Porcupine Bank, along latitude  $51^{\circ}42'N$ , to investigate the possibility of a localised erosion zone at 460 m. The samples to be sectioned and processed onboard ship for later studies of sediment and fauna at the Lowestoft Laboratory of the Ministry of Agriculture, Fisheries and Food.

Four cores to be collected at each of the five stations along this transect.

Core 1: to be kept intact and stored upright at 3-4°C.

Core 2: the top 1 cm to be sliced off and stored at 3-4°C,  
the remainder of the core to be stored upright at  
3-4°C.

Core 3: the top 1 cm to be sliced off and preserved in  
formalin, the remainder of the core to be stored  
upright at 3-4°C.

Core 4: to be sliced into 1 cm sections throughout its  
length and stored at 3-4°C.

In addition the supernatant liquid of one core from each  
station to be filtered through a millepore filter with 10  
micron pore size.

5. Weather.

Excellent throughout the cruise with fine to moderate  
winds. The programme was affected by weather conditions on  
only one occasion, at St. 7 in the early hours of 15th April,  
when winds, increasing to 20 knots and combined with a heavy  
swell, made coring difficult. On this occasion coring  
operations were suspended until daylight.

6. Narrative.

Two of the scientific party joined the ship on 6 April  
and the remainder on 7 April. Challenger sailed from Barry at  
09.00 hrs BST on 8 April.

Throughout 8 April the ship steamed towards St. 1 in the Porcupine Seabight. At 11.00 hrs the non-toxic seawater supply was switched on so that pump samples could be collected. At 12.15 hrs Dr. Patching and Dr. Raine started collecting pump samples for their study of geographic variations in microbial activity, sampling continued at approximately 12 hr intervals throughout the cruise (p. 24 ). At 21.00 hrs Mr. Holmes started collecting pump samples for planktonic foraminifera, sampling continued periodically throughout the cruise (p. 21 ).

St. 1, at 217 m on the NE edge of the Porcupine Seabight (Fig. 1, Table 3), was reached at 19.10 hrs on 9 April and the PDR fish was launched - to be towed beside the ship for the remainder of the cruise. Three multiple corer hauls were made, on the first haul twelve core tubes were fitted to the corer but all returned empty. The following two hauls contained eight core tubes each but only three short cores of fine sand were obtained for IOS meiofauna studies. Three core tubes and two holding rings were lost, presumably due to suction when pulling out of the compacted sand bottom. Sampling was curtailed at 2015 hrs and the ship steamed for St. 2.

St. 2 (IOS 1), at 1330 m in the Porcupine Seabight, was located at 0330 hrs on 10 April. Nine multiple corer hauls were made (see Table 3). Six 8-tube hauls provided 44 cores for IOS studies, one core for Mr. Holmes and three empty core tubes. Three 12-tube hauls provided 35 cores for microbiological/

sediment studies by Mr. Meadows and Miss Kirkham, one tube returned empty. Coring finished at 1315 hrs and was followed by two vertical plankton hauls (500 m to surface) for Mr. Holmes. Sampling at this station was completed at 1510 hrs and the ship steamed for St. 3.

Challenger arrived at St. 3, 1800 m in the Porcupine Seabight, at 2353 hrs on 10 April. Coring began at 0004 hrs on 11 April and continued until 0730 hrs. Five multiple corer hauls were completed and twelve good cores of bottom material were obtained from each haul. Two hauls provided bottom samples for IOS meiofauna/foraminifera studies while the other three hauls were for microbiological/sediment studies by Mr. Meadows and Miss Kirkham. On completion of coring Challenger steamed for St. 4.

St. 4 (IOS 2), at 4100 m in the Porcupine Seabight, was located at 1218 hrs on 11 April. One vertical plankton haul (500 m to surface) was carried out for foraminifera studies (Mr. Holmes), followed by six multiple corer hauls. The corer was fitted with ten core tubes for each haul and 56 good cores were obtained, one core tube on each of four hauls was recovered empty - possibly because of improper seating of the valves. Two cores were for Heriot-Watt microbiological studies and one for planktonic foraminifera studies (Mr. Holmes), the remainder were for IOS meiofauna/benthic foraminifera studies. Sampling at St. 4 was completed at

0048 hrs on 12 April, the ship then proceeded to St. 5.

St. 5, at 4500 m in the Porcupine Abyssal Plain, was reached at 0445 hrs on 12 April. The multiple corer was used only once at this station, it was fitted with ten core tubes and ten good cores of bottom material were obtained for IOS meiofauna/benthic foraminifera studies. Coring finished at 0635 hrs and the Challenger steamed for St. 6 (A1).

Challenger arrived at St. 6 (A1), the SMBA routine sampling station at 4805 m on the Porcupine Abyssal Plain, at 1300 hrs on 12 April. Two vertical plankton hauls (500 m to surface) were carried out for foraminifera studies (Mr. Holmes), followed by nine multiple corer hauls. The corer was fitted with twelve core tubes for each haul and 106 good cores were obtained, one tube from each of Hauls 7 and 8 was empty on recovery. Three hauls were for microbiological/sediment studies by Mr. Meadows and Miss Kirkham, one haul provided nine cores for IOS meiofauna/benthic foraminifera studies and three cores for University College, Galway. The remaining five hauls were for SMBA meiofauna studies with the exception of three cores for microbiological studies (two for Heriot-Watt University, one for University College, Galway). In Haul 8, the multiple corer was used for in situ respiration studies of benthic sediments. After collecting cores of bottom material the corer was left suspended at a depth of about 100 m above the bottom for 20 hrs before being brought back to the



surface. The oxygen concentration in the water overlying these cores was determined (Dr. Patching and Dr. Raine) and the sediments were retained for SMBA meiofauna studies. Haul 8 was completed at 0530 hrs on 14 April, after which one NIO water bottle haul was carried out to provide a water sample from 10 m for microbiological studies by Heriot-Watt University. Haul 9 with the multiple corer was completed at 0822 hrs. Challenger then proceeded towards the MAFF transect of stations, located across the southern shoulder of the Porcupine Bank at  $51^{\circ}42'N$ .

On reaching latitude  $51^{\circ}42'N$  the Challenger steamed east until a depth of 750 m was located at 0021 hrs on 15 April. This position was established as St. 7 (MAFF 1). Four hauls with the multiple corer were carried out at this station, eight core tubes were fitted for each of the first two hauls whereas only four were fitted for the remaining hauls. Three cores were obtained from Haul 1, two were short and badly disturbed, the third core was preserved for SMBA meiofauna studies. Only one short, badly disturbed core was obtained from Haul 2 while Haul 3 was blank. Haul 4, however, produced four good cores of fine muddy sand which were processed for MAFF (p. 2 ). An increase in wind strength to 20 knots combined with a heavy swell created difficulties in handling the corer at this station, especially during the hours of darkness and it is thought that the heavy swell was responsible for the poor performance of the corer at this station. Corer operations were suspended, therefore, until daylight, by which time the swell

was beginning to subside. Challenger left St. 7 at 0835 hrs and proceeded east along  $51^{\circ}42'n$  to St. 8.

St. 8 (MAFF 2), at a depth of 600 m on the Porcupine Bank transect, was located at 0935 hrs on 15 April. Two hauls with the multiple corer were carried out. Haul 1, with four tubes fitted to the corer, provided four good cores of muddy sand (27.5 to 30 cm long) for MAFF studies. Haul 2, carrying six tubes, gave five good cores which were preserved for SMBA meiofauna studies. On completion of coring the Challenger hove to on station until 1135 hrs, while the samples were processed, before steaming on to St. 9.

St. 9 (MAFF 3), at a depth of 460 m on the Porcupine Bank transect, was located at 1230 hrs on 15 April. Five multiple corer hauls were carried out. In Haul 1 the corer was fitted with six core tubes and provided six good cores, four for MAFF studies, one for IOS studies of benthic foraminifera and one for planktonic foraminifera studies (Mr. Holmes). Twelve core tubes were fitted in each of the subsequent four hauls and four full sets of muddy sand cores were obtained, these provided 36 cores for microbiological/sediment studies by Mr. Meadows and Miss Kirkham and 12 cores for SMBA meiofauna studies. On completion of coring the Challenger hove to on station until 1640 hrs, while the samples were processed, before steaming on to St. 10.

St. 10 (MAFF 4), at a depth of 400 m on the Porcupine Bank transect, was located at 1715 hrs on 15 April. Two hauls with the multiple corer were carried out, each with six core tubes. Six

good cores of muddy sand were obtained from the first haul and five from the second. Four cores from the first haul were processed for MAFF studies and the remaining cores were preserved for SMBA meiofauna studies. On completion of coring the Challenger hove to on station until 1900 hrs, while the samples were processed, before moving on to St. 11.

St. 11 (MAFF 5), at a depth of 385 m on the Porcupine Bank transect, was reached at 2010 hrs on 15 April. Two hauls were made with the multiple corer, each with six core tubes, and twelve good cores of muddy sand were obtained. Four cores from the first haul were for MAFF studies, one provided material for planktonic foraminifera studies (Mr. Holmes) while the sixth core was accidentally lost on deck. The cores from the second haul were for SMBA meiofauna studies. Coring at St. 11 and the MAFF transect was completed at 2100 hrs and the ship proceeded to St. 12 on the Porcupine Bank.

St. 12, at 500 m on the Porcupine Bank, was reached at 0345 hrs on 16 April. The multiple corer was used only once at this station, it was fitted with eight core tubes and eight long cores were obtained for IOS studies. Coring was completed at 0406 hrs and the Challenger then proceeded to the plankton transect and St. 13.

On route to St. 13, plankton pump sampling was carried out by Mr. Holmes to determine the distribution of planktonic foraminifera as the ship proceeded from the Porcupine Bank outover the Rockall Trough. Challenger arrived at St. 13,  $53^{\circ}00'N$ ,  $16^{\circ}30'W$  in the Rockall

Trough at 1800 hrs on 16 April, and one vertical plankton haul (500 m to surface) was taken for planktonic foraminifera.

Sampling at St. 13 was completed at 1825 hrs and the ship then headed for St. 14. On route plankton sampling by Mr. Holmes was continued as the ship steamed from the Rockall Trough towards the shallowest part of the Porcupine Bank.

St. 14, at 160 m on the Porcupine Bank, was reached at 0600 hrs on 17 April and three hauls were made with the multiple corer. The corer was fitted with six core tubes for the first haul and four tubes for each subsequent haul but only one core of coarse sandy sediment was obtained from each haul. These provided bottom material for IOS meiofauna studies (2 cores) and sediment studies by Mr. Meadows and Miss Kirkham (one core). On completion of coring, one vertical plankton haul was taken for planktonic foraminifera (Mr. Holmes). Sampling at St. 14 was completed at 0745 hrs and the ship proceeded to St. 15 (A2) in the Rockall Trough.

Challenger arrived at St. 15 (A2), 2880 m in the Rockall Trough at 1900 hrs on 17 April and eight hauls were taken with the multiple corer. The first six hauls each had a full set of twelve core tubes and provided four sets of twelve good cores, a set of eleven and one of ten. These were preserved for SMBA meiofauna studies with the exception of four cores for Heriot-Watt microbiological studies. Haul 7, with six core tubes fitted, provided four cores of bottom sediment for microbiological studies

by Dr. Patching and Dr. Raine. Haul 8 was used for in situ respiration studies of benthic sediments. The corer was fitted with eight core tubes and obtained seven good cores of bottom material. After collecting the sediment the corer was left suspended at a depth of about 100 m above the bottom for 15 hrs before being brought back to the surface. The oxygen concentration in the water overlying these cores was determined (Dr. Patching and Dr. Raine) and the sediments provided material for microbiological/ sediment studies (Mr. Meadows and Miss Kirkham). Three samples of bottom water, for comparison with water overlying the cores, were obtained for Dr. Patching and Dr. Raine by attaching an NIO water bottle to the multiple corer framework on each of three separate hauls. Coring was completed at 2315 hrs on 18 April and the Challenger moved back onto station position, from which it had drifted during the 15 hrs. One NIO bottle haul was taken at 0025 hrs on 19 April to provide a water sample from 10 m for microbiological studies (Heriot-Watt University). This was followed by one vertical plankton haul (500 m to surface) for foraminifera studies (Mr. Holmes). Sampling at St. 15 (A2) was completed at 0105 hrs on 19 April and the ship proceeded to St. 16.

St. 16 (A3), at 158 m on the continental shelf west of Scotland, was reached at 1750 hrs on 19 April and seven hauls were taken with the multiple corer. For the first four hauls the corer was fitted with twelve core tubes, these gave two sets of eleven

good cores, one set of ten and one set of nine. Only eleven core tubes were fitted for the following three hauls because of a broken tube-holding ring, two sets of ten cores and one of eight were obtained. Four hauls were for microbiological/sediment studies by Mr. Meadows and Miss Kirkham together with one core for IOS benthic foraminifera. Two hauls were for SMBA meiofauna studies while one haul provided five cores for Heriot-Watt microbiological studies, two cores for IOS benthic foraminifera and one core for Mr. Meadows and Miss Kirkham. Plankton and hydrographic samples were taken between the second and third corer hauls, at 1827 and 1840 hrs respectively. A single vertical plankton haul (140 m to surface) was for planktonic foraminifera (Mr. Holmes) while one NIO bottle haul provided a water sample from 10 m for microbiological studies (Heriot-Watt).

Sampling at St. 16 (A3) was completed at 2020 hrs on 19 April and the ship proceeded to Ardrossan, where it docked at 1100 hrs on 20 April. Some of the scientific party left the ship later that day while the remainder left on 21 April.

#### 7. Results.

The main emphasis of this cruise was on core sampling, using the SMBA multiple corer to obtain samples of bottom sediment for microbiological, foraminifera, meiofauna and sediment studies. In addition extensive use was made of the ships non-toxic seawater supply to obtain samples of surface plankton along the cruise

route. Vertical plankton hauls and water bottle hauls were also taken.

Coring in the Porcupine Seabight and at stations 5, 12 and 14 were mainly for IOS studies of meiofauna and benthic foraminifera, coring at St. 6 (A1), St. 15 (A2) and St. 16 (A3) was for SMBA harpacticoid copepod studies and for microbiological studies while coring at stations 7 to 11 across the southern shoulder of the Porcupine Bank was for MAFF studies of sediment and fauna, St. 13 was a plankton station, one vertical plankton haul being taken for plankton foraminifera.

a. Coring for all projects (Dr. B. Hardy and Mr. J. Watson).

The SMBA multiple corer worked well throughout the cruise and provided samples of bottom material from all the coring stations. The number of core tubes used with the multiple corer assembly varied according to the scientific requirements and the compactness of the sediment. A full quota of twelve core tubes being used normally when sampling the softer globigerina ooze whereas for the harder sandy sediments the number of tubes were sometimes reduced to six or even occasionally four in order to facilitate the penetration of the sediment.

A high percentage recovery of core samples were obtained with the multiple corer. For most stations 90 to 100% recovery of cores was obtained, poor recovery occurred at three stations. At St. 1 the bottom consisted of a hard packed sand and penetration was poor

due to insufficient weight on the corer. In addition the rings on some new core tubes broke and a number of tubes were pulled out by bottom suction and lost. The nature of the sediment was also apparently the cause of poor core recovery at St. 14, in 160 m on the Porcupine Bank, here the few cores recovered were short (less than 10 cm long) and consisted of coarse shell sand. Sediment nature, however, was apparently not the cause of decreased coring efficiency at St. 7 on the Porcupine Bank, where the bottom consisted of a fine muddy sand. When sampling this station, an increase in wind strength combined with a heavy swell is thought to have caused the corer to bounce on the bottom and to have reduced its operating efficiency.

(b) SMBA meiofauna studies (Dr. B. Hardy and Mr. J. Watson).

Samples were collected with the multiple corer from the SMBA routine sampling stations (A1, A2 and A3) in the Porcupine Abyssal Plain, Rockall Trough and on the continental shelf west of Scotland. Sampling at these three stations provided 55, 65 and 20 cores respectively, which were sectioned and preserved for examination at the Dunstaffnage Laboratory.

Additional meiofauna core samples were collected from the five MAFF transect stations on the Porcupine Bank. One and five cores were collected respectively from Stations 7 and 8 (MAFF 1 and 2) at the deep end of the transect (750 and 600 m), twelve cores were



collected from St. 9 (MAFF 3) in the centre of the transect (460 m) while six cores were collected from each of stations 10 and 11 (MAFF 4 and 5) at the shallow end of the transect (400 and 385 m).

Core samples provide bottom sediments for SMBA meiofauna studies, with special reference to the systematics, distribution and seasonal changes of benthic harpacticoid copepods in the deep sea.

(c) IOS Meiofauna investigations (Account by Dr. O. Pfannkuche)

The meiofauna of the Porcupine Seabight was studied during Challenger cruises 8/81 and 14/81 on two transects from 500 to 4000 m depth. During this cruise additional samples were taken in the Porcupine Seabight, on the Porcupine Abyssal Plain and on the Porcupine Bank to get a more comprehensive view on the structure, abundance and biomass (ash free dry weights) of the meiobenthos in the Porcupine Seabight area.

At each station four cores from the multiple corer were subsamples with syringes of  $\sim 4 \text{ cm}^2$  surface area down to 5 cm depth. To study the small scale variation in meiofauna communities at two stations (IOS-1  $\sim 1300$  m, IOS-2  $\sim 4000$  m) the multiple corer was deployed six times at each station. Three subsamples of  $1 \text{ cm}^2$  surface (down to 5 cm depth) were taken at each station for the analysis of chloroplastic pigments (chlorophyll a, phaeophytins) to get a view on the amount of sedimented phytoplankton. Previous investigations in the N.E. Atlantic (off Morocco) exhibited a positive correlation between meiofauna abundance and the amount of chloroplastic pigments.

Four subsamples were taken at each station to analyse the content of organic carbon in the uppermost 5 mm of the sediment.

Table 1

Samples collected for IOS meiofauna studies were given IOS - numbers as follows:-

Station	Haul	Corresponding IOS - no.
1	2	515 - 01 # 2
2	1	515 - 02 # 1
2	2	515 - 02 # 2
2	4	515 - 02 # 4
2	5	515 - 02 # 5
2	6	515 - 02 # 6
2	8	515 - 02 # 8
3	2	515 - 03 # 2
4	1	515 - 04 # 1
4	2	515 - 04 # 2
4	3	515 - 04 # 3
4	4	515 - 04 # 4
4	5	515 - 04 # 5
4	6	515 - 04 # 6
5	1	515 - 05 # 1
6	6	515 - 06 # 6
12	1	515 - 07 # 1
14	2	515 - 08 # 2

(d) IOS studies of agglutinating Foraminifera and benthic rhizopods (Account by Dr. AJ. Gooday).

(i) Benthic rhizopods

Throughout the Cruise, observations were made on large, epibenthic species belonging to two groups of test-building, rhizopod protozoa: the Foraminifera and the Xenophyophorea. Where possible, representative specimens were carefully extracted and preserved and, in some cases, examined under a binocular microscope. The multiple corer is a particularly valuable gear for the study of such organisms because it provides information, otherwise difficult to obtain, on their life orientation and relationship to the sediment, and also captures intact those fragile species which are always damaged, or even completely destroyed, during dredging.

(ii) Foraminifera.

Agglutinating or tectinous foraminifera, lying on or projecting above the sediment surface, were noted at all stations sampled with the multiple corer with the exceptions of those shallower than about 400 m (Stations 1, 10, 14, 16) and the deepest (Station 6, 4805 m). The following are among the more interesting morphologies observed.

1) Arborescent forms in which a "trunk" divides distally into branching arms (460-1310 m). Microscopic examination of a large specimen (height above sediment approximately 2 cm) from 460 m (Station 9) showed that the trunk expands below the sediment surface

into a basal bulb from which arise short, twisted "roots". A small polychaete was noted amongst these "roots". A similar specimen occurred at 1330 m (Station 2). These are clearly members of the Notodendrodidae, a group recently described from the Antarctic. Smaller, bush-like forms without the "trunk" were also observed in the same depth range.

2) Small, straight, stick-like tests, projecting above the sediment surface, were fairly common around 1330 m (Station 2) and in many cases were inclined at an acute angle to the surface. These inclined specimens had a blob of ? sediment around the apertural end, suggesting some form of suspension feeding. They were identified microscopically as Rhabdammina aff. linearis Brady. The bulb-like initial chamber is situated towards one end, below the sediment/water interface. Rather similar straight tubes, possibly belonging to another species of Rhabdammina, were found at 4100 m (Station 4) but these were always positioned horizontally, just below the surface.

3) "Mud-balls", apparently Komokiacean foraminifera (? Edgertonia), occurred rather commonly on the sediment surface at 2800 m (Station 3).

4) Specimens of the tread-like Rhizammina aff. algaeformis Brady were fairly frequent at 4100 m (Station 4) and also at 1330 m (Station 2), 2800 m (Station 3) and 4500 m (Station 5). They were draped across the sediment surface and did not extend into the overlying water. Some specimens were extremely long, measuring as

much as 82 mm with side branches up to 24 mm. This species is exceedingly fragile and is dredged only as small fragments.

(iii) The xenophyophores. These poorly-known protozoa, which are closely related to the Foraminifera, occupy a separate subclass of the Rhizopoda. Epibenthic sledge hauls taken in the Porcupine Seabight have yielded fairly abundant material of the xenophyophore Reticulammina labyrinthica Tendal, but this fragile species is always heavily fragmented. The capture by the multiple corer of seven intact individuals from the Seabight, five from 2800 m (Station 3), two from 4100 m (Station 4), was therefore of considerable interest. By contrast, the 80 cores taken at 2860 m in the Rockall Trough (Station 15) failed to produce a single obvious xenophyophore. The tests were exposed above the sediment surface although the basal was, in all cases, buried. The specimens vary in maximum dimension from 1 cm to 2 cm, a range comparable with data from sea-floor photographs. They show considerable morphological diversity with some hint of a developmental sequence.

(e) Planktonic Foraminifera Studies (Account by Mr. N. Holmes).

Further to work carried out on the Challenger cruises 8/80 and 12/81 sediment and plankton samples were taken regularly along the present cruise tract, to continue and extend the investigation into the planktonic foraminiferal distribution of the N.E. Atlantic.

To extend the coverage of sediment samples, cores were taken at Stations 2, 4, 6 (A1), 9 and 11. For this study, the top 1 cm of each core will be examined.

Living planktonic Foraminifera were collected in nets with mesh size of 148  $\mu$  by two methods:

1) From vertical hauls, 500 m to the surface, using a conventional plankton net, the following hauls were made.

No. of hauls	Time (B.S.T.)	Date	Position
2	1347-1506	10/4	St. 2 (IOS 1)
1	1221-1150	11/4	St. 4 (IOS 2)
2	1316-1432	12/4	St. 6 (A1)
1	1759-1825	16/4	St.13
1*	0612-0621	17/4	St.14
1	0030-0103	18/4	St.15 (A2)
1*	1827-1836	19/4	St.16 (A3)

\*Due to the depth (< 500 m) these hauls were taken from 140 m to the surface.

2) Using the constant flow, non-toxic pump, sea water was filtered using 2 interchangeable bag-shaped nets. Each sample was taken after 1 hour of filtering, except at St. 15 (A2) where both samples were of 2 hours duration with the flow-rate reduced. Throughout the entire course of sampling the flow-rate was monitored. Water was pumped from a depth of 5 m.

While the ship was moving samples were taken to provide an extensive coverage for determining planktonic foraminiferal distribution. Samples were taken from the following areas during the cruise:

Samples	Area
1-5	Southern edge of Ireland
6-11	Porcupine Seabight
12-13 and 38-40	Vicinity of St. 6 (A1)
41-45 and 51	Porcupine Bank
46-50	Rockall Trough
52-53 and 56-58	Between the Porcupine Bank and St. 16 (A3).

While the ship was stationary at Stations 6 (A1) and 15 (A2) samples were taken to investigate diel vertical variations in abundance. At St. 6 (A1) a complete run of 24 one-hour samples (14-37) were taken from 1300 hrs on April 12th to 1300 hrs on the 13th. The preliminary results from these samples confirm those from Challenger Cruise 8/80, with a night-time increase in the numbers of some species of planktonic Foraminifera. Two 2-hour samples were taken at St. 15 (A2) between 2300 and 0100 hrs on the 17th and 18th and 1100-1300 hrs on the 18th, for a straight comparison of night and day numbers.

Along the cruise tract, surface temperatures and salinity samples were collected.

(f) Microbiology: Heriot-Watt University (Account by Mr. G. Dear).

The aim of the cruise was to measure microbial activity in the sediments of sites 6 (A1), 15 (A2) and 16 (A3) by assaying the relative levels of nitrate reduction at each site. The presence of bacteria in both the sediments and surface water, at each of the above sites, with the ability to grow in the presence of heavy metals and quaternary ammonium compounds was studied using direct plating. An 'in situ' experiment at site 15 (A2) to measure nitrate reduction over a period of 15 hours was also studied.

Nitrate Reductions

Eight x 2 ml samples of the top centimetre of sediment were added to universal bottles, four of which contained 2 mgs  $\text{KNO}_3$  and four had no addition. After 'on board' incubation in the cold room for 24 hours, the samples were frozen until assayed for nitrite. The relative levels of nitrite at each site giving a measure of microbial activity.

At site 15 (A2) a further sample was done as above except that the incubation period was reduced to 15 hours as a direct comparison against the results of the 'in situ' experiment.

15 hour Incubation

Using the special injection equipment, 5 ml of a 1 mg/ml  $\text{KNO}_3$  solution was injected onto the surface of the core and incubated



'in situ' for 15 hours after which 2 ml samples of the top centimetre of the core were frozen until assayed.

Unfortunately the equipment was damaged before used and the  $\text{KNO}_3$  was injected approximately 4 cms above the core surface.

#### Direct Plating

Sediments - At each of the three sites a 10 ml sediment sample (top cm) was diluted  $10^{-1}$ ,  $10^{-2}$ ,  $10^{-4}$  and  $10^{-6}$  with sterile 0.4 M saline. From these, 0.1 ml volumes of each dilution were spread on the surface of the following media -

Marine Agar

Marine Agar + 10 ppm Quat

Marine Agar + 100 ppm Quat

Marine Agar + 0.5 mM  $\text{Cu SO}_4$

Marine Agar + 1 mM  $\text{Cu SO}_4$

Marine Agar + 0.5 mM  $\text{Hg Cl}_2$

The plates were incubated in the cold room and the relative numbers of bacteria will be counted and some will be identified.

Water - At each of the three sites a 10 metre (from surface) water sample was taken using an NIO bottle and 0.1 ml volumes of  $10^0$ ,  $10^{-1}$ ,  $10^{-2}$  and  $10^{-3}$  dilution were spread as above.

A comparison will be made against water borne and sediment bacteria at each site and their abilities to grow on the various media.

### Sulphate Reducing Bacteria

Core samples from 16 (A3) were stored in the cold room for investigation into the presence of sulphate reducing bacteria in the sediments at this site.

Overall, the cruise was highly successful, and apart from the reduced time period of the 'in situ' incubation and the damaged injection apparatus, the work programme was carried out in full.

(g) Microbiology: University College, Galway . (Account by Dr. J. Patching and Dr. R. Raine).

Work carried out by us falls into 2 categories, surface water studies using the non-toxic pumped seawater supply, and sediment studies.

#### 1) Surface water studies

Surface seawater was sampled (as far as possible) at approximately 12 hourly intervals (midday and midnight) and analysed in an attempt to detect geographical variations in microbial activity. The following were measured: water temperature, location, total bacterial count, chlorophyll content, and community respiration (as measured by dark bottle oxygen uptake). Measurement of bacterial count and chlorophyll content will be completed subsequently. Table 2 shows the immediately available results.

Table 2

Date	Time (BST)	Location		Water Temp ( $^{\circ}$ C)	Respiration ug O <sub>2</sub> /l/day
		N	W		
8th	12.15	51 <sup>o</sup> 20'	4 <sup>o</sup> 01'	8.7	311
9th	00.25	51 <sup>o</sup> 19'	6 <sup>o</sup> 44'	9.2	121
9th	12.00	51 <sup>o</sup> 14'	9 <sup>o</sup> 29'	9.8	303
10th	1.00	51 <sup>o</sup> 32'	12 <sup>o</sup> 28'	11.2	79
10th	12.00	51 <sup>o</sup> 36'	13 <sup>o</sup> 00'	11.7	37
11th	00.10	50 <sup>o</sup> 17'	13 <sup>o</sup> 30'	11.4	64
11th	12.00	49 <sup>o</sup> 46'	14 <sup>o</sup> 07'	11.6	48
12th	00.00	49 <sup>o</sup> 46'	14 <sup>o</sup> 07'	12.0	133
12th	12.00	49 <sup>o</sup> 34'	16 <sup>o</sup> 17'	11.7	106
14th	00.10	49 <sup>o</sup> 25'	16 <sup>o</sup> 37'	12.5	62
14th	12.30	50 <sup>o</sup> 02'	16 <sup>o</sup> 10'	12.2	96
15th	00.10	51 <sup>o</sup> 42'	14 <sup>o</sup> 59'	11.8	109
15th	12.00	51 <sup>o</sup> 42'	14 <sup>o</sup> 45'	11.6	59
16th	00.00	52 <sup>o</sup> 05'	13 <sup>o</sup> 53'	11.2	209
16th	12.00	52 <sup>o</sup> 45'	15 <sup>o</sup> 07'	11.25	133
17th	00.00	53 <sup>o</sup> 14'	15 <sup>o</sup> 06'	11.4	182
17th	12.05	54 <sup>o</sup> 06'	12 <sup>o</sup> 56'	10.5	93
18th	12.15	55 <sup>o</sup> 00'	12 <sup>o</sup> 07'	11.1	49

2) Sediment Studies

All sediment studies were carried out at sites 6 (A1) and 15 (A2). At each site cores were taken and sectioned for subsequent analysis in the laboratory. 2 cores per site were preserved for organic carbon and nitrogen determinations and 2 for total bacterial counts (by epifluorescent microscopy). In addition the suspended corer technique was used to determine in situ benthic respiration and ammonia fluxes across the sediment water interface. Initial analysis of results suggests that ammonia fluxes are insignificant. Respiration results are as follows

<u>Site</u>	Respiration (mg O <sub>2</sub> /m <sup>2</sup> /day)
6 (A1)	48
15 (A2)	153

[Further details are given in the 'Challenger Report' by the Department of Microbiology, University College, Galway - Dr. J.W. Patching].

- (h) Microbiological, Chemical and Physical Properties of Deep-Sea Marine Sediments - Account by Mr. P.S. Meadows and Miss M. Kirkham.

The project plan was to characterise deep-sea sediments in terms of physical and biological parameters including some work on

sediment chemistry and microbial populations.

Five sample sites were chosen on the basis of water depth, sediment type and position in relation to the continental slope, with a view to obtaining the widest range of sediment features.

Using the SMBA Multiple corer, 36 cores were obtained from each of the following sites:

Challenger Station

<u>Station No.</u>	<u>Synonym</u>						
2	(IOS1)	51°36'N	13°00'W	1330 m	Glob. ooze	] transect down the continental slope	
3		51°16.8'N	13°30.1'W	2800 m	" "		
6	(A1)	49°30'N	16°30'W	4805 m	" "		Abyssal plain.
9	(MAFF)	51°42'	14°39.2'W	460 m	Silty fine sand.		Shelf
16	(A3)	56°01.4'	7°39.2'	158 m	Sandy mud close		Clyde Sea Area

Redox potential readings of both seawater and sediment were taken immediately. 12 cores, to be used in animal abundance/biomass studies, were stored and stained in 4% formaldehyde/Rose Bengal. 12 cores were separately bulked for laboratory testing of physical properties.

The remaining 12 cores were subsampled at 2.5 cm intervals, to a maximum in all cases of 15 cm. Various tests on moisture content, particle size and sediment strength were conducted on these subsamples. It is also hoped that an estimate of sedimentation rate

history can be found using  $^{14}\text{C}$  dating.

Bacterial counts of aerobes and anaerobes were undertaken using 0.1 ml aliquots of serially diluted sediment suspensions, spread on pre-poured plates of 75% sea water nutrient agar. Pure cultures were isolated and are being maintained on plates for future identification.

#### Acknowledgements

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21 May, 1980.

Table 3 Challenger Cruise 6/82  
Summary of Sampling Stations

Station and date	Gear and Haul No.	Position		Depth (m)	Bottom water		Remarks	
		N	W		Temperature °C	Salinity ‰		
St. 1 9 April	Multiple Corer 1	51°26.4'	11°18.7'	217			Blank (12 tubes used) 2 cores (8 tubes used) 1 core (8 tubes used) ] All for IOS	
	2	51°26.3'	11°18.7'					
	3	51°26.3'	11°18.7'					
St. 2 (IOS 1) 10 April	Multiple Corer 1	51°36.1'	13°00.0'	1330			6 cores (8 tubes used) for IOS 8 cores (8 tubes used) for IOS, 1 for Aberystwyth. 11 cores (12 tubes used) for Glasgow University. 7 cores (8 tubes used) for IOS 8 cores (8 tubes used) for IOS 8 cores (8 tubes used) for IOS 12 cores (12 tubes used) for Glasgow University. 8 cores (8 tubes used) for IOS 12 cores (12 tubes used) for Glasgow University.	
	2	51°36.2'	12°59.5'					
	3	51°36.0'	13°00.0'					
	4	51°36.1'	13°00.0'					
	5	51°36.1'	12°59.9'					
	6	51°36.1'	12°59.9'					
	7	51°35.9'	12°59.8'					5.63
	8	51°35.9'	12°59.9'					5.60
	9	51°35.9'	13°00.0'					
	Plankton net (Vertical haul) 1	51°36.1'	12°58.9'	500 to surface			2 hauls for planktonic foraminifera studies (Aberystwyth).	
2	51°36.2'	12°58.5'	500 to surface					

Table 3 (Cont.)

Station and date	Gear and Haul No.	Position		Depth (m)	Bottom water		Remarks
		N	W		Temperature °C	Salinity ‰	
St. 3  11 April	Multiple Corer 1	50°16.9'	13°29.7'	2800	2.85		12 cores (12 tubes used) for Glasgow University.
	2	50°16.8'	13°30.1'				12 cores (12 tubes used) for IOS
	3	50°16.8'	13°30.1'				12 cores (12 tubes used) for Glasgow University.
	4	50°16.8'	13°30.2'				12 cores (12 tubes used) for IOS
	5	50°16.9'	13°29.9'				12 cores (12 tubes used) for Glasgow University.
St. 4 (IOS 2) 11 April	Plankton net (Vertical haul)	49°45.4'	14°08.4'	500 to surface			1 haul for planktonic foraminifera studies (Aberystwyth)
	Multiple Corer 1	49°45.5'	14°07.7'	4100			9 cores (10 tubes used) for IOS
	2	49°44.9'	14°08.0'				10 cores (10 tubes used) for IOS, 1 for Heriot-Watt.
	3	49°45.5'	14°07.6'				9 cores (10 tubes used) for IOS, 1 for Aberystwyth.
	4	49°45.0'	14°08.3'				9 cores (10 tubes used) for IOS
	5	49°45.5'	14°07.3'				9 cores (10 tubes used) for IOS, 1 for Heriot-Watt.
	6	49°45.5'	14°07.4'				10 cores (10 tubes used) for IOS.
St. 5 12 April	Multiple Corer 1	49°52.5'	15°07.5'	4500			9 cores (10 tubes used) for IOS



Table 3 (Cont.)

Station and date	Gear and Haul No.	Position		Depth (m)	Bottom Water		Remarks			
		N	W		Temperature °C	Salinity ‰				
St. 6 (A1) 12-14 April	Plankton net (Vertical haul) 1	49°29.4'	16°30.9'	500 m to surface	2.58		2 hauls for planktonic foraminifera studies (Aberystwyth).			
	2	49°28.8'	16°32.1'	500 m to surface						
	Multiple Corer 1	49°30.0'	16°29.9'	4805			34.912	12 cores (12 tubes used) for Glasgow University.		
	2	49°29.2'	16°31.1'						12 cores (12 tubes used) for SMBA, 1 for Heriot-Watt	
	3	49°30.1'	16°29.7'						12 cores (12 tubes used) for Glasgow University.	
	4	49°30.0'	16°29.6'						34.891	12 cores (12 tubes used) for SMBA.
	5	49°29.5'	16°30.0'						12 cores (12 tubes used) for Glasgow University.	
	6	49°29.4'	16°30.1'						12 cores (12 tubes used) for IOS, 3 for U.C. Galway.	
7	49°28.9'	16°31.7'		34.935	11 cores (12 tubes used) for SMBA 1 for U.C. Galway					

Table 3 (Cont.)

Station	Gear and Haul No.	Position		Depth (m)	Bottom Water		Remarks
		N	W		Temperature °C	Salinity ‰	
St. 6 (A1) 12-14 April	Multiple Corer 8	49°30.0'	16°29.5'				11 cores (12 tubes used) suspended 100 m above bottom for 20 hrs to estimate O <sub>2</sub> consumption <u>in situ</u> . Core sediments for SMBA meiofauna studies.
	9	49°29.6'	16°30.4'		2.59		12 cores (12 tubes used) for SMBA, 1 for Heriot-Watt.
	Water bottle haul	49°29.9'	16°30.0'	10			1 haul for Heriot-Watt
St. 7 (MAFF 1) 15 April	Multiple Corer 1	51°41.9'	14°56.4'	750			3 cores (8 tubes used), 1 for SMBA, 2 disturbed.
	2	51°42.4'	14°56.4'				1 core (8 tubes used), core very disturbed.
	3	51°42.4'	14°56.4'				Blank (4 tubes used)
	4	51°42.3'	14°56.4'				4 cores (4 tubes used) for MAFF.
St. 8 (MAFF 2) 15 April	Multiple Corer 1	51°41.6'	14°51.7'	600			4 cores (4 tubes used) for MAFF.
	2	51°41.6'	14°51.7'				5 cores (6 tubes used) for SMBA.

Table 3 (Cont.)

Station and date	Gear and Haul No.	Position		Depth (m)	Bottom Water		Remarks
		N	W		Temperature °C	Salinity ‰	
St. 9 (MAFF 3) 15 April	Multiple Corer 1	51°42.3'	14°39.1'	460			6 cores (6 tubes used) 4 for MAFF, 1 for IOS, 1 for Aberystwyth.
	2	51°42.2'	14°39.1'				12 cores (12 tubes used), for Glasgow University.
	3	51°42.1'	14°39.2'				12 cores (12 tubes used), for Glasgow University.
	4	51°42.0'	14°39.2'				12 cores (12 tubes used) for Glasgow University.
	5	51°41.4'	14°38.1'				12 cores (12 tubes used) for SMBA.
St. 10 (MAFF 4) 15 April	Multiple Corer 1	51°41.9'	14°29.5'	400			6 cores (6 tubes used) for MAFF, 1 for SMBA, 1 lost on deck.
	2	51°41.9'	14°29.5'				5 cores (6 tubes used) for SMBA.
St. 11 (MAFF 5) 15 April	Multiple Corer 1	51°41.8'	14°18.0'	385'			6 cores (6 tubes used) for MAFF, 1 for Aberystwyth, 1 lost on deck.
	2	51°41.6'	14°18.0'				6 cores (6 tubes used) for SMBA.
St. 12 16 April	Multiple Corer 1	52°20.3'	13°15.8'	500			8 cores (8 tubes used) for IOS.

Table 3 (cont.)

Station and date	Gear and Haul No.	Position		Depth (m)	Bottom Water		Remarks
		N	W		Temperature °C	Salinity ‰	
St. 13 16 April	Plankton net (Vertical haul) 1	53°00.0'	16°30.1'	500 to surface			1 haul for planktonic foraminifera studies (Aberystwyth).
St. 14 17 April	Multiple Corer 1	53°21.0	13°36.1'	160			1 core (6 tubes used) for Glasgow University.
	2	53°21.0	13°35.9'				1 core (4 tubes used) for IOS.
	3	53°21.1	13°35.8'				1 core (4 tubes used) for IOS.
	Plankton net (Vertical haul) 1	53°21.0'	13°35.9'	140 to surface			1 haul for planktonic foraminifera studies (Aberystwyth).
St. 15 (A2) 17-19 April	Multiple Corer 1	55°03.4'	12°03.3'	2880			10 cores (12 tubes used) for SMBA.
	2	55°03.2'	12°03.4'				12 cores (12 tubes used) for SMBA.
	3	55°03.4'	12°03.7'		2.76		12 cores (12 tubes used) for SMBA, 2 for Heriot-Watt.
	4	55°03.5'	12°03.7'				12 cores (12 tubes used) for SMBA.
	5	55°03.0'	12°03.7'		2.67		12 cores (12 tubes used) for SMBA.

Table 3 (cont.)

Station and date	Gear and Haul No.	Position		Depth (m)	Bottom Water		Remarks
		N	W		Temperature °C	Salinity ‰	
St. 15 (A2) 17-19 April	Multiple Corer 6	55°03.2'	12°03.4'		2.66		11 cores (12 tubes used) for SMBA, 2 for Heriot-Watt.
	7	55°03.3'	12°03.6'				4 cores (6 tubes used) for U.C. Galway.
	8	55°02.4'	12°05.0'				7 cores (8 tubes used) suspended 100 m above bottom for 15 hrs to estimate O <sub>2</sub> consumption <u>in situ</u> . 5 core sediments for Glasgow University., 2 for Heriot-Watt.
	Water bottle (attached to corer)	55°03.2'	12°03.4'	2880			3 hauls for University College, Galway.
	Water bottle haul	55°03.5'	12°03.4'	10			1 haul for Heriot-Watt.
	Plankton net (Vertical haul)	55°03.5'	12°03.5'	500 to surface			1 haul for planktonic foraminifera studies (Aberystwyth).

Table 3 (Cont.)

Station and date	Gear and Haul No.	Position		Depth	Bottom Water		Remarks
		N	W		Temperature °C	Salinity ‰	
St. 16 (A3) 19 April	Multiple Corer	1	56°01.4'	7°39.0'	158	8.96	9 cores (12 tubes used) for SMBA.
		2	56°01.4'	7°38.9'			11 cores (12 tubes used) for Glasgow University, 1 for IOS.
		3	56°01.4'	7°39.0'			10 cores (12 tubes used) for Glasgow University.
		4	56°01.4'	7°39.0'			11 cores (12 tubes used) for SMBA.
		5	56°01.4'	7°38.8'			10 cores (11 tubes used) for Glasgow University.
		6	56°01.4'	7°39.2'			8 cores (11 tubes used), 5 for Heriot-Watt, 2 for IOS, 1 for Glasgow University.
		7	56°01.3'	7°38.9'			10 cores (11 tubes used) for Glasgow University.
	Plankton net (Vertical haul)	56°01.4'	7°39.0'	140 to surface	1 haul for planktonic foraminifera studies (Aberystwyth).		
	Water bottle haul	56°01.4'	7°39.0'	10	1 haul for Heriot-Watt.		