SCOTTISH MARINE BIOLOGICAL ASSOCIATION

Dunstaffnage Marine Research Laboratory

and

UNIVERSITY OF DUNDEE

Department of Biological Sciences,

with collaboration from

INSTITUT FUR MEERESFORSCHUNG

Bremerhaven

and

NATIONAL UNIVERSITY OF IRELAND

Department of Microbiology,

University College, Galway.

CRUISE REPORT
R.R.S. CHALLENGER

Cruise 6/79

27 April - 7 May, 1979.

1. Duration:

0900 hrs 27 April (Barry) until 0800 hrs 7 May (Ardrossan). All times G.M.T.

2. Localities:

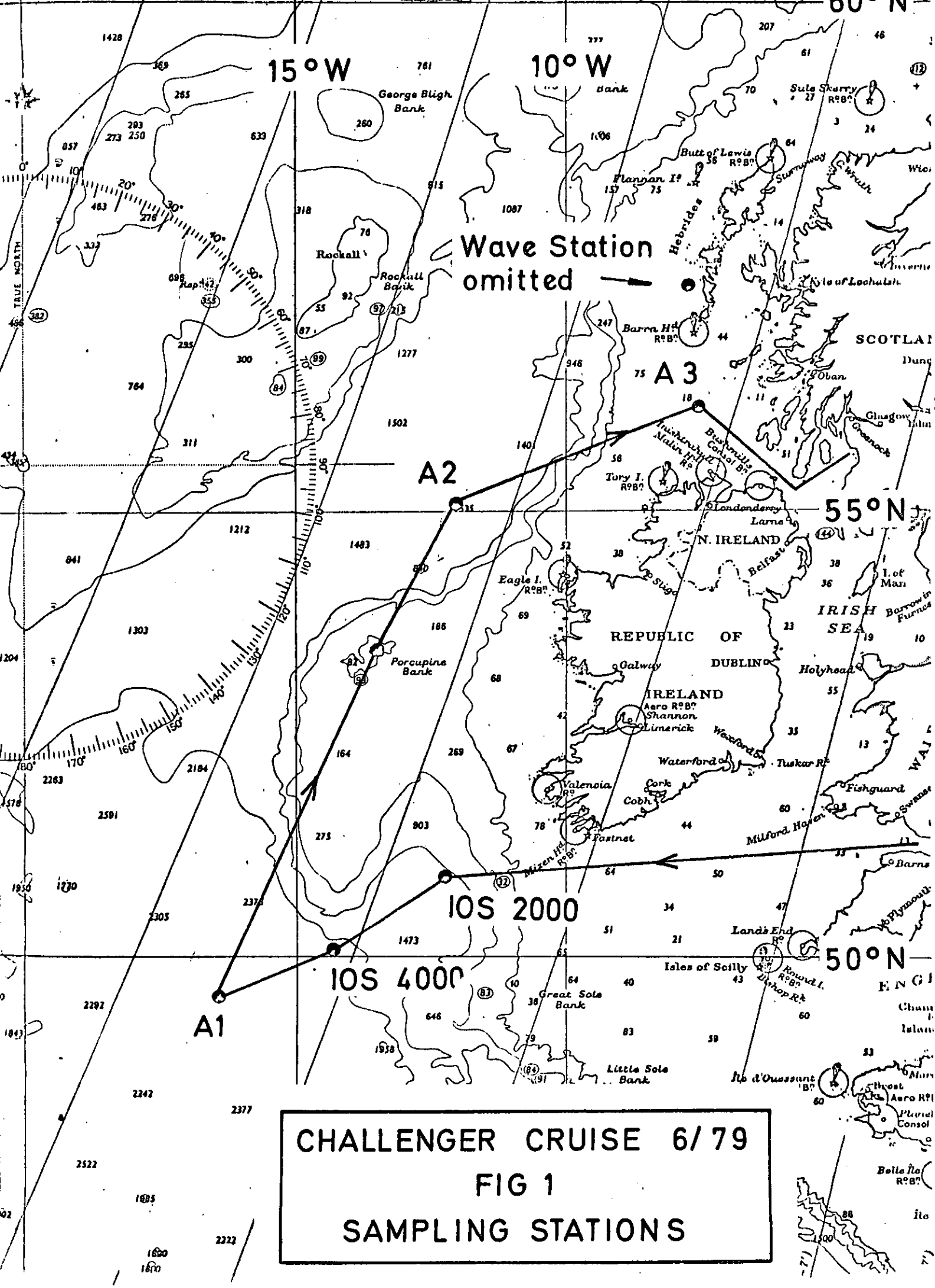
Porcupine Seabight, Porcupine Abyssal Plain, Rockall Trough and continental shelf west of Scotland. (Fig. 1).

3. Scientific Staff:

Dr P.R.O. Barnett, Principal Scientist	S.M.B.A.
Dr B.L.S. Hardy, Mr J. Watson, Mr S. Malcolm	S.M.B.A.
Dr C.M. Brown, Mr N. Wardell	Department of Biological Sciencies, Univ. of Dundee
Dr A. Gaertner, Dr K. Shaumann, Frau R. Klaus	Institut fur Meeresforschung, Bremerhaven
Dr J. Patching, Mr R. Raine	Dept. of Microbiology, University College, Galway.

4. Aims:

(i) Study of the bacteria, lower and higher fungi present in sediments and in the water overlying the sediments using the S.M.B.A. multiple corer. Particular attention to be paid to the organisms concerned with organic degradation and nitrate reduction in the deep sea and shelf



CHALLENGER CRUISE 6/79

FIG 1

SAMPLING STATIONS

sediments. Analysis of water and sediment pore water for organic and inorganic nutrients. Rates of oxygen uptake, the uptake of selected carbon substrates and ATP levels measured. Continuous flow enrichment cultures using sediments from 5,000 m were planned to be set up as soon as possible and to continue for the duration of the cruise in a study of bacterial growth on inert surfaces at low nutrient concentrations.

(ii) Sampling of the meiofauna of deep sea and shelf sediments using the SMBA multiple corer. Bottom photography of the corer in operation.

(iii) Bottom photographs of the wave energy station off South Uist, if time permitted at the end of the cruise.

5. Weather:

Strong northwesterly winds, Force 5-7, for most of the cruise. Heavy swell from the northwest for the first week. Wind and swell prevented work for 10 hours on 1-2 May. Calm for the final day.

6. Narrative:

The Scientific party joined the ship at Barry on 26 April and Challenger sailed at 0900 hrs G.M.T. on 27 April.

The first sampling station, the IOS 2,000 m station in the Porcupine Seabight (Fig. 1, Table 1), was reached at 0045 hrs on the 29 April, when the PDR fish was launched

for the rest of the cruise. Three hauls were made with the multiple corer but each time it was virtually empty and further attempts were abandoned until the next station. However, the core tubes contained sufficient mud and water from 2,000 m to allow Dr Brown and Mr Wardell to start their chemostat cultures at an early stage of the cruise. The intention had been to use material from the 4,800 m station (A1) but it was decided to take advantage of material obtained earlier from 2,000 m to allow a longer incubation period before the end of the cruise.

The multiple corer also provided bottom water samples for Dr Gaertner's studies of the lower fungi.

Water bottle sampling with the hydrographic wire at the surface, 500 m and 1,000 m was then carried out for Dr Gaertner and at 1300 m for Dr Patching and Mr Raine. At 0926 hrs, after almost 9 hours work, the ship then steamed for the IOS 4,000 m station where she arrived at 1918 hrs on the same day.

The sampling at 4,000 m was a repetition of the previous station. Three unsuccessful coring hauls with the multiple corer in difficult swell conditions, were followed by water bottle sampling at the surface, 500 m and 1000 m. The multiple corer, despite its failure to take cores, provided bottom water samples for Drs Geartner, Patching and Mr Raine. The station was completed at 0640 hrs on 30 April after 11 hours.

Challenger arrived at Station A1 on the Porcupine Abyssal Plain at 1930 hrs on 30 April. Multiple coring was started immediately in fairly good weather conditions when three successive hauls were completely successful with the recovery of 12 good cores in each haul. By this time (0530 hrs, 1 May), the increasing NW wind and swell was too much for further coring and water bottle samples were taken on the hydrowire at the surface, 500 m and 1000 m. Sampling then ceased until 1710 hrs on the same day when the wind and sea had moderated sufficiently to allow multiple coring to start again. A further three successful hauls, with 12 cores each, were made and the station completed at 0120 hrs 2 May after 30 hours.

There was a long steam north for 360 miles to the next station, A2, at 2,900 m in the Rockall Trough. Whilst passing over the Porcupine Bank the opportunity was taken to try and obtain cores for meiofauna distribution studies at 1320 hrs, 3 May. It was anticipated that the bottom would be coarse and stony and the single core Craib corer was used on the hydrographic wire. Despite four trials, no cores were obtained, but evidence of some sediment in the core tube confirmed that the bottom was probably too coarse for coring. Surface water samples were taken for Dr Gaertner, and at 20, 40, 60 and 80 m above the bottom for Dr Patching and Mr Paine. The station was completed at 1600 hrs.

Challenger arrived at Station A2 at 0553 hrs, 4 May when multiple coring commenced. The wind was variable,

Force 2-5, but with a large swell running. Six hauls were made with the corer to provide 66 cores out of a possible 66. The final haul was made with only six tubes to allow greater penetration and provide longer cores for Mr Malcolm, Dr Gaertner and Dr Shaumann.

Water bottle samples were then taken at the surface for Dr Gaertner and at 20, 40, 60 and 80 m above the bottom for Dr Patching, and this stage of the A2 sampling was completed at 1800 hrs.

A preliminary experiment was then carried out in which the multiple corer was used in an attempt to measure the rate of benthic community respiration at that depth (2,900 m). Fitted with 8 core tubes the multiple corer was lowered to the bottom to obtain cores. It was then hauled up to a depth ranging from 50 - 100 m above bottom and left suspended for a 24 hour period. On recovery on board ship the corer had taken eight good core samples and the overlying water was analysed for oxygen content by Dr Patching and Mr Raine for comparison with hauls taken earlier at the station which had been hauled to the surface immediately. The station was finally completed at 1940 hrs, 5 May, after a total of 37.5 hours.

With decreasing wind from the northwest to north, Challenger steamed for the final station, A3, on the continental shelf west of Islay. It had been decided earlier to abandon the visit to the wave station near South Uist since delays due to coring failures in the

Porcupine Seabight and bad weather at Station A1 had delayed the programme.

Station A3 (158 m) was reached at 1300 hrs, 6 May. The first multiple corer haul provided six cores from eight tubes, two of the tubes becoming partially detached from their holders during extraction from the sediment. The second haul provided 10 good cores out of 10 possibles whilst the third haul provided 11 cores out of 12.

Weather conditions were excellent during this last station, and water bottle sampling at the surface and at 10, 20, 30 and 40 m above the bottom was completed at 1448 hrs. The Craib corer was tested at this station, but failed to produce any cores in two hauls, although it was known that this corer usually worked well at this station. Further trials were prevented when the spooling gear of the hydrographic winch started malfunctioning.

Challenger left the station at 1516 hrs and sailed for Ardrossan where she arrived at 0800 hrs on 7 May.

7. Results:

Despite the coring failures at the first two stations in the Porcupine Seabight the cruise was very successful. Stations A1, A2 and A3 (Fig. 1), were the most important sampling stations, being sites which had originally been sampled for microbiological work on Challenger Cruise 5/75. The present cruise was a continuation and extension of the microbiological work of 1975.

Only one station was missed. The proposed visit to the Wave Station off South Uist was cancelled due to lack of time at the end of the cruise.

a. Coring for all projects (Barnett, Hardy & Watson).

All the multiple coring at Stations A1, A2 and A3 for both the microbiological and meiofauna work was very successfully completed. The multiple corer was used with a 12-core assembly for most of the hauls. At Station A1 (4,800 m) it collected 71 cores out of a possible 72 in 6 hauls. At Station A2 (2,900 m), 60 cores were collected in five hauls and a further haul was made with only 6 core tubes, to provide longer cores, and was also successful. At Station A3 (158 m), the corer provided 27 cores out of a possible 30 in three hauls.

At the first two stations in the Porcupine Seabight, at 2,000 and 4,000 m depth, coring was attempted with the multiple corer, but was unsuccessful. The intention had been to obtain cores for meiofaunawork at these two stations, which are being samples by IOS Wormley as part of their benthic and water column programme. Some small faults in various mechanisms on the corer were rectified on both stations, but failed to remedy the trouble. It is thought that the nature of the bottom at these two stations may have been partly responsible by preventing the supporting framework of the corer from settling evenly, with the possibility of the corer falling on its side before penetration. A contributory factor could have been the heavy swell, although this did not prevent very

successful coring on the flat Procupine Abyssal Plain or in the Rockall Trough.

Despite the failuresat these two stations, the corer provided sufficient bottom sediment and bottom water at 2,000 m to start Dr Brown's chemostat cultures at an early stage of the cruise. Furthermore, the corer provided bottom water samples from both stations for Dr Gaertner's studies of the lower fungi.

Whilst steaming between stations A1 and A2 the opportunity was taken of coring for meiofauna on the Porcupine Bank with the small Craib corer. No cores were obtained despite several trials and small amounts of sediment recovered suggested a very coarse and probably rocky bottom.

No bottom photography of the multiple corer operating on the bottom was carried out at any stations, as intended, due to the heavy swell for much of the cruise. It was thought that the Shipek camera mounted on the corer would prove too unstable whilst being lowered to the bottom in the heavy swell.

b. Bacteriological studies (Dr C. Brown and Mr N. Wardell).

In order to carry the enrichment and isolation of bacteria from deep sea sediments and especially those able to grow attached to surfaces by continuous culture methods, chemostats were inoculated with water and sediment from station IOS 2,000 m in the Porcupine Seabight. 4 culture vessels each of 1 l capacity, each culture carbon-limited with carbon sources acetate (2), benzoate and lactate were run successfully for 9 days at sea and terminated at the end of the cruise. Samples

were taken for plating onto bacteriological media at 12 hr intervals and incubated at $4^{0}C$ in the ship's constant temperature room. Plates inoculated on days 1-3 of the experiment showed visible bacterial growth at the end of the cruise. The remainder will be incubated on shore and the bacterial distribution determined.

Sediment and bottom water samples from stations A1, A2 and A3 were used for:

a) the attempted isolation of a range of actinomycetes from deep sea sediments,

b) a study of nitrate reduction and nitrate reducing bacteria,

c) a study of the relative numbers of bacteria present in sediments and able to grow in the absence of marine concentrations of NaCl. The experiments will be completed on shore.

At all stations use was made of the SMBA multiple corer which enabled undisturbed samples of surface sediments to be obtained. Sections of such cores (at 1 cm intervals) were taken for experiments on shore to determine the distribution of spores of the bacterial genera Bacillus, Clostridium and Thermoactinomyces in deep sea sediments.

c. Respiration and metabolic activity of deep-sea sediments. (Dr J. Patching and Mr R. Raine).

The objective was to attempt to estimate the respiration and metabolic activity using the following methods:

(i) Measurement of gradients of ammonia concentration within interstitial water and in the water column immediately above the sediment. From these, we shall attempt to estimate amounts of ammonia released from the sediments. The breakdown of organic material in the sediment may then be estimated, assuming that ammonia release is equal to ammonia production.

Interstitial gradients of ammonia were recorded at Stations A1 and A2. Organic carbon and nitrogen levels were also measured. Gradients in overlying water (obtained by hydrographic casts) were investigated at Stations A1, A2 and on the Porcupine Bank. In conjunction with this, the water salinity, temperature and oxygen concentrations were also recorded.

(ii) Direct measurement of oxygen consumption by sediment cores.

Oxygen levels were measured by the precise whole bottle Winkler method of Bryon, Riley and Williams. Two systems were used:-

1. An onboard system in which water was recirculated over cores in a constant temperature room. This system was used at Station A1 where no detectable consumption was found, and at Station A3.

2. An <u>in situ</u> method. Cores were taken and suspended 50 - 100 m above the bottom at Station A2 (2,900 m) to maintain the environmental temperature and pressure (see 6. Cruise Narrative). After 24 hours the corer was

hauled in and the oxygen level of the overlying water measured. This was compared with the oxygen level in cores which had been hauled in immediately after sampling. Measureable oxygen consumption was recorded.

Sediment samples were taken at Statinns A2 and A3 for total bacterial counts.

Drift bottles were released at 14 locations off the Irish coast, in conjunction with water current studies being carried out by Dr Monahan, Department of Oceanography, University College, Galway.

d. Geochemical studies (Mr S.J. Malcolm).

As part of a project studying the microbiological basis of geochemical cycling, at the SMBA, two 20 cm long cores were collected at each of 3 stations (A1, A2 and A3), in the eastern north Atlantic. One core from each station was split into 1 or 2 cm sections and squeezed to remove interstitial water. The low pressure "squeezers" employed were not entirely suitable with resultant low water recovery. Up to 10 ml of water was collected from a 1 cm section of carbonate ooze.

Titration alkalinity was measured immediately after squeezing using a potentiometric end point determination. The samples were frozen on board for transportation to Oban where analysis of low molecular weight fatty acids, iodine and barium will be carried out on the pore waters. The solids will be analysed for iodine, barium, organic carbon and nitrogen.

The SMBA multiple corer employed provided excellent samples

for the geochemical work where collection of the sediment/ water interface is very important.

e. Studies of lower and higher marine fungi (Dr A. Gaertner, Dr K. Shaumann and Frau R. Klaus).

Two different types of marine fungi were investigated during the cruise.

i) Lower marine fungi, especially of the thraustochytriaceous group.

ii) Higher marine fungi, including yeasts.

i) Lower marine fungi were investigated in surface water and water from 500 m, 1,000 m and from immediately above the bottom.

The sediment samples taken with the multiple corer were investigated in four stages: top 1 cm, 3-4 cm, 9-10 cm and 15-16 cm layers.

To examine these samples quantitively for the lower fungi, the following were set up:-

20 water samples with 1200 subsamples of Meplats culture bottles.

20 sediment samples with 1000 Meplats culture bottles.

ii) Higher marine fungi.

These were sampled only in the sediment and in the water immediately above the bottom.

34 subsamples were taken from four cores and prepared in surface agar plates and pour plates (total of 558 plates). The core subsamples were taken at sediment depths of 1 cm, 2 cm, 3-5 cm, 6-10 cm, 11-15 cm, 16-20 cm and 21-25 cm. pH values were measured in these samples. In addition, 9 samples of

near-bottom water were set up using the same method. The agar plates were kept cool in the constant temperature room at 2°C during the cruise.

All the material will be worked on in the laboratory in Bremerhaven.

The multiple corer proved to be a very successful tool for taking undisturbed layers of sediments, together with the overlying water.

The Bremerhaven party is grateful for the opportunity of being able to participate in the cruise and of working with the other groups.

f. Meiofauna studies (Dr P. Barnett, Dr B.L.S. Hardy and Mr J. Watson).

As part of the continuing study by SMBA of the meiofauna, particularly benthic harpacticoid copepods, of the deep sea, multiple core samples were taken at Stations A1, A2 and A3. The last two stations have been visited regularly since 1975. in a continuing sampling programme designed specifically to investigate the seasonal and longer term changes in harpacticoid copepods on the continental shelf and in the deep sea. The sampling at the deepest station, A1 (4,800 m), was the third such visit since 1975 and has provided further valuable material for the study of harpacticoids at this abyssal station.

Acknowledgements

We would like to acknowledge with gratitude the willing and able help provided by Captain G. Long and the officers and crew of RRS Challenger, without which we could not have achieved so much.

Finally, we record our warmest thanks to R.V.S., Barry, particularly to Mr C. Adams and Mr I. Innes, for very willing help in the organisation of the cruise.

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10th May 1979.

Table 1 Challenger Cruise 6/1979

Summary of sampling stations

Station and Date	Gear and Haul No.	Position N	Position W	Depth (m)	Bottom Water Temperature °C	Bottom Water Salinity °/oo	Remarks
IOS 2000 m	Multiple corer 1	50°55.2'	12°19.4'	2065	4.56°C		No cores
29 April	2	50°55.6'	12°18.3'				No cores, bottom water sample, lower fungi
	3	50°56.5'	12°20.5'				No cores, small amt. sediment for chemosta
	Water bottles	50°57.0'	12°19.7'	Surface			
				500			Samples for investigations of lower fungi.
				1,000			
				1,300			Chemical studies by U.C. Galway
IOS 4000 m	Multiple corer 1	49°51.0'	14°00.3'	3,950			No cores
	2	49°51.1'	14°02.4'				No cores
	3	49°53.5'	13°55.7'				No cores
	Water bottles	49°53.0'	13°57.9'	Surface			
				500			Samples for investigations of lower fungi.
				1,000			

Table 1(Ctd) Challenger Cruise 6/1979

Summary of sampling stations

Station	Gear and Haul No.	Position N	Position W	Depth (m)	Bottom water Temperature °C	Bottom water Salinity °/oo	Remarks
A1	Multiple corer 1	49°29.7'	16°30.6'	4,920			12 cores for bacterial, fungal and sediment chemistry studies.
30 April - 2 May	2	49°29.5'	16°30.9'			34.894	
	3	49°29.5'	16°30.1'		2.58	34.948	
	4	49°28.6'	16°28.1'				59 cores for meiofaunal studies
	5	49°29.8'	16°29.9'				
	6	49°29.8'	16°28.0'				
	Water bottles	49°28.5'	16°32'	Surface			Samples for investigations of lower fungi
				500			
				1,000			

Table 1 (Ctd) Challenger Cruise 6/1979

Summary of sampling stations

Station	Gear and Haul No.	Position N	Position W	Depth (m)	Bottom water Temperature °C	Bottom water Salinity °/oo	Remarks
Porcupine Bank 3 May	Craib corer 1	53°25.1'	13°25.2'	166			
	2	53°24.6'	13°23.7'				No cores for meiofauna studies
	3	53°24.6'	13°23.6'				Bottom probably too coarse
	4	53°24.5'	13°23.5'				
	Water bottles	53°25.3'	13°24.8'	Surface			Water samples for lower fungi
				86			
				106			20, 40, 60 and 80 m above bottom.
				126			Ammonia analyses.
				146			

Table 1 (Ctd) Challenger Cruise 6/1979

Summary of sampling stations

Station	Gear and Haul No.	Position N	Position W	Depth (m)	Bottom water Temperature °C	Bottom water Salinity °/oo	Remarks
A2	Multiple corer 1	55°03.7'	12°04.0'	2,880			12 cores for meiofauna
4 - 5 May	2	55°03.7'	12°03.9'				12 cores for bacterial, fungal studies, Sediment chemistry.
	3	55°03.6'	12°03.5'				24 cores for meiofauna
	4	55°03.8'	12°04.2'			34.976	
	5	55°04.0'	12°04.0'		2.76		6 long cores for sediment chemistry
	6	55°03.6'	12°03.0'				12 cores for meiofauna
	7	55°03.1'	12°04.7'	2,880		34.978	Cores suspended 50-100 m above bottom for 2 hrs, to estimate O_2 consumption at environmental temp. and pressure.
	Water bottles 1	55°03.7'	12°03.8'	Surface			Lower fungi studies
	2	55°03.7'	12°03.4'	2,800			
				2,820			
				2,840			20, 40, 60 and 80 m above bottom for ammonia analyses
				2,860			

Table 1 (Ctd) Challenger Cruise 6/1979

Summary of sampling stations.

Station	Gear and Haul No.	Position N	Position W	Depth (m)	Bottom water Temperature °C	Bottom water Salinity °/oo	Remarks
A3 6 May	Multiple corer 1	56°02.4'	07°39.4'	158			6 cores (8 possible. Bacterial and fungal studies, pore water chemistry
	2	56°02.6'	07°38.4'	158			10 cores (10 possible). Ditto.
	3	56°01.6'	07°38.4'	158	8.01	35.273 (Core 6) 35.255 (Core 7)	11 cores (12 possible). Meiofaunal studies
	Water bottles 1	56°01.7'	07°37.7'	118			10, 20, 30, 40 m above bottom. Ammonia analyses
				128			
				138			
				148			
	2	56°01.8'	07°37.6'	Surface			Studies of lower fungi
	Craib corer 1	56°01.8'	07°37.5'	158			Trials. No cores. Sampler
	2	56°01.8'	07°37.5'	158			Defective