I.O.S.

RRS DISCOVERY
CRUISE 158
12 APRIL – 12 MAY 1986

AN INVESTIGATION OF PHYTODETRITAL SEDIMENTATION IN THE PORCUPINE SEABIGHT

CRUISE REPORT NO. 189
1987

NATURAL ENVIRONMENT RESEARCH COUNCIL
INSTITUTE OF OCEANOGRAPHIC SCIENCES

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WORMLEY

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An investigation of phytodetrital sedimentation in the Porcupine Seabight

Principal Scientist

A.L. Rice

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Contents

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OBJECTIVES

A. This cruise was specifically designed to exploit the joint expertise of IOS and IMER in a study of the seasonal deposition of phytodetritus to the sea floor in the Porcupine Seabight. Because of the importance in such a study of covering the complete development of the spring phytoplankton bloom, the original application had been for 50 days of sea time, from early April to late May. This proved to be impossible and the more restricted period allocated to the cruise did not permit us to achieve the main objectives outlined below.

Knowledge of the phytodetrital phenomenon prior to the cruise may be summarised as follows:

1. Aggregated phytodetrital material sinks rapidly from the euphotic zone to abyssal depths.

2. The principal deposition occurs shortly after the spring phytoplankton bloom, but smaller pulses may arrive on the sea floor derived from subsequent smaller blooms.

3. The material arrives in a very fresh condition, at least to bathyal depths, and preliminary results suggest that it has neither passed through metazoan guts nor undergone significant bacterial degradation.

The general objectives of cruise 158 were therefore:

(a) to monitor the development of the spring bloom and to study the processes of aggregation resulting in the fast-sinking phytodetritus,

(b) to collect the sinking material during its passage through the water column and to study the changes taking place during this passage and to quantify the flux, and

(c) to investigate the significance of the material to the mid-water and benthic communities.

More specifically, the objectives were to be pursued by:

1. The use of Seasoar and CTD to study the hydrography of the area throughout the cruise period.

2. The study of the development of the phytoplankton bloom using primary productivity measurements, sub-surface and surface light metering, underway fluorometry and nutrient analysis.

3. Particulate detection and collection using 7 litre and 30 litre water bottles, free-floating and moored sediment traps, forward-scattering laser systems, and mid-water cameras.

4. Onboard analysis of particle size distributions using a multi-channel Coulter counter and pigment analysis by HPLC.

5. Plankton collection using the LHPR system, and the RMT with a closing cod-end to collect living material for shipboard experiments.

6. Benthic studies using Bathysnap, the SMBA multiple corer and the IOS epibenthic sledge.

7. *In situ* benthic respirometry using the IOS/Galway corer respirometer.

B. In addition to these primary objectives, back up programmes included:

1. The study of the nephels leaving the Porcupine Bank reported by Dickson and McCave and also encountered during *Challenger* cruise 6/83.

2. The use of the IOS photosledge to extend existing coverage into the 400-700m depth range.

3. The analysis of holothurian gut contents for comparison with the associated sediments.

NARRATIVE

Leg 1

Discovery sailed from Falmouth at 1000h (GMT) on 12 April 1986 for the DB 2 site at 48°43.5'N: 8°56.3'W to recover three moorings laid during Cruise 157.

Within three hours of our departure it was discovered that the water bottles for the CTD rosette had been left behind at Wormley and, since these were essential for the cruise, we would have to return to Falmouth to collect them. However, since it would take at least twelve hours, and possibly longer, to get the bottles to Falmouth, the vessel proceeded towards DB 2 and arrangements were made to have the bottles at Falmouth by 0800/14, to be brought to the ship by launch.

The DB 2 site was reached at 0530/13 and the first mooring, a near-surface current measuring array, was successfully recovered on the foredeck by 0850. The second mooring, which included a ten metre spar-buoy, had to be landed at least partly on the poop because of the excessively long lift required. As the spar was being lifted aboard, the line to the sub-surface buoyancy, itself carrying ten Polox spheres, became entangled in the propeller. The rope outboard of the propeller was successfully grappled and the sub-surface float together with the ballast chain was retrieved, but a section of the rope wrapped around the propellr was cut free. After several unsuccessful attempts to retrieve an end of the cut rope, the propellor was manoeuvred ahead and astern and, since there was no evidence of damage to the oil seal, it was decided to proceed as normal but to have the propeller examined on our return to Falmouth. Accordingly, the third (Aries) mooring was recovered successfully by 0730/14 and the vessel returned to Falmouth, arriving at about 1000/14.

The missing water bottles having been collected, and divers having cleared the obstruction from the propeller, Discovery left Falmouth for the Porcupine Seabight at 1430 and deployed the PES fish at 1530.

The first station was intended to be at a depth of about 400m at 51°25'N: 11°33'W on the eastern side of the Seabight, but during the outward passage the wind speed increased to 40-50kts and it was clear that work would be impossible by the time we reached this position. The vessel therefore continued slowly in a roughly north-westerly direction to be closer to the main proposed working area at about 51°35'N: 13°00'W, at a depth of about 1350m, when the weather improved. Throughout the 16 April the vessel was hove to but the water moderated overnight on 16/17 and Discovery finally reached the proposed work site at 0850/17.

The first station (11263) was occupied until 1720/18 with very mixed fortunes. The first series, a 7 litre water bottle cast to 100m, was achieved moderately sucessfully, though it transpired that half of the bottles had clamps for 4mm wire and half for 6mm wire!

The second series, a test of the forward-scattering laser system, failed, but the instrument worked satisfactorily during a second trial later during this station.

Series 3 was originally intended to be simply a buoyancy test of the IMER sediment trap array, but since it went so smoothly the array was deployed at 1440/17 with the intention of recovering it the following evening.

Series 4 and 5, a shallow CTD to 300m and a deep one to 600m, revealed that the water column was thoroughly mixed to at least this depth, with only the slightest indication of a thermocline at about 450m. This disappointing, but unexpected, result indicated that a Seasoar survey at this time would be pointless.

Two multiple corer samples were obtained (series 6 and 7), the first producing 12 good cores and the second only four. A further two core drops were to have been made at this station but delays of various kinds, including problems with the main trawling winch, meant that the second cast was not completed until 0030/18 by which time the two available winch drivers had already worked an excessively long day and it was deemed imprudent to continue to occupy them.

Accordingly, work was stopped until 0330/18 when a 7 litre water bottle cast was made (series 8) to provide water for a primary productivity deployment. Because of the clamp problems on the water bottles the 6mm wire was used for this cast but the 4mm clamps proved to be quite unsatisfactory on this wire, resulting in the loss of one bottle and the kinking of the wire some 15m above termination. Subsequently, the water bottles were all fitted with 6mm clamps or had their existing clamps modified.

Series 8, the primary productivity deployment, was laid close to the previously deployed sediment trap mooring (series 3) by 0640/18.

The LHPR was deployed at 1030 for an intended oblique haul from 900m to the surface, but at 1120 the back tension control on the storage drum of the trawl winch, ultimately traced to a fault in the controlling solenoid, was lost and the winch was stopped until 1240, the gear being finally brought inboard at 1317, but having obtained no usable samples.

A successful buoyancy test of the respirometer/corer was made before the vessel returned to the mooring positions to recover the deployed arrays. The primary productivity array was brought inboard successfully at 1540, but as the dhan buoy of the sediment trap array was being brought aboard on the double-barrelled capstan the line between it and the sub-surface float was sucked into the inlet opening to the bow thrust and the remainder of the rig was lost.

The vessel now made for the position of a deployed Bathysnap on the Goban Spur with the intention of deploying the primary productivity rig on the way. This station, 11264, at about 49°30'N: 12°57'W, was reached at 0530/19 and a 7 litre water bottle cast (#1) and a primary productivity deployment (#2) were completed by 0620.

Discovery now continued to the position of the Bathysnap (52217#1), deployed at a depth of 1481m on the Goban Spur from the Challenger in June 1985. The locality was reached at 0700/19, but despite repeated attempts to fire the releases, the rig refused to respond and the attempt was finally abandoned at 0930.

A multiple core, shallow CTD and epibenthic sledge haul were completed at this locality by 1700 (11265) after which the vessel returned to the primary productivity rig (11264#2) which was successfully retrieved by 1910.

Discovery now moved north to return to the main station at 51°35'N: 13°00'W, but during the night of 19/20 the westerly wind increased to more than 40kts, producing a considerable beam sea and resulting in a very uncomfortable course. By 0500/20 it was obvious that no work would be possible for some time and the ship was accordingly hove to for the remainder of the day.

By 0830/21 conditions had improved sufficiently to allow some work, although the wind was still gusting to 35-40kts, and the vessel therefore made for the main station, arriving at noon.

A 7 litre water bottle cast to 200m (11266#1) was followed by an LHPR haul (#2) and a second water bottle cast (#3). An intended mid-water video camera test at this station had to be abandoned as the gear was about to be deployed when it was discovered that a plug had been broken while the camera had been stored on deck.

The next intended work was a water bottle cast in the early morning of 22 for a primary productivity deployment but at 2200/21 the compressor motor for the braking system on the electric winch was burnt out. A temporary repair was effected late on 22 by connecting the compressor cylinder to the ship's high pressure air supply, but in the meantime the electric winch could not be used.

Accordingly, the ship made for a locality at a depth of about 1400m for multiple core and epibenthic sledge samples to compare superficial sediments with holothurian gut contents, as at station 11265. The multiple corer (11267#1) and the epibenthic sledge haul (#2) were followed by a CTD cast (#3), a second free-floating sediment trap deployment (#4) and an RMT 8 haul between 1050 and 860m (#5).

Discovery now made for a station at about 51°35'N: 13°10'W to extend into shallower water the photographic coverage of the bottom obtained between 1600m and 760m during Challenger cruise 5/84 (Stns 52011, 52015 and 52022). On arrival at this position the video camera was first deployed and good recordings were made between the surface and 100m (11268#1).

The epibenthic sledge was now deployed as a photosledge with the conventional Mk IV camera loaded with thin-based film. This should have given the system a capacity of well over 700 frames and a bottom duration of about 6 hours with a 30 second frame interval. However, the light sensor gave no indication of any photographs having been taken when the gear reached the bottom and the haul was therefore aborted after only ten minutes on the bottom. When the gear was landed at 0330/23 it was discovered that the flash unit batteries were flat.

As the sledge was being brought aboard, the lower sheave on the Schatt davit, serviced at Falmouth immediately before the cruise, developed a bad squeak, ultimately traced to a loose bolt catching on the sheave mounting. This clearly needed attention before the davit could be used again.

The vessel therefore made for the expected position of the deployed sediment traps (11265#4) to confirm that we could still find the rig for recovery later in the day. However, no contact was made as the position was approached and, after a CTD cast (11269#1) an extensive search between 0900 and 1200h revealed no sign of the rig.

The Schatt davit was by now repaired and the ship therefore moved south-east into deeper water to test, and possibly deploy, the corer respirometer at a depth of about 1500m. During this passage two CTD casts were made, one (11270) to within 15m of the bottom in a depth of about 1000m and the second (11271) to 1100m in a depth of about 1300m.

The 1500m station was reached at 1830/23 and the corer respirometer was deployed on the main warp at 1843 (11272#1). This was intended as a test of the acoustic command system and of the corer's ability to collect cores. However, with only about 30mwo the instrument simply fell off the end of the wire, apparently due to mechanical failure of the main release jaw (see detailed report) and only the main weight was retrieved. The vessel remained in the immediate vicinity for a further two hours to ensure good fixes on the gear in case of future opportunities of retrieval. During this period a further cast of the mid-water video camera was made (11272#2).

Discovery now resumed the search for the sediment trap array, in the hope that the light on the surface buoyancy would enable it to be found in darkness. The search was centred on an estimated position based on a vector summation of the surface currents experienced since the deployment. However, a three hour search revealed no sign of the array and it was abandoned at 0230/24.

The ship now moved towards the Porcupine Bank once more for a second attempt to obtain a photosledge transect from about 800m upwards. The gear was eventually shot at 0500/24 (11273#1) but after only about five minutes of normal operation on the bottom the record of exposures became erratic and eventually ceased altogether. The haul was therefore aborted and the gear was brought inboard at about 0740. The station was completed by a 7 litre water bottle cast (11273#2).

Discovery continued towards the 1350m station, the last locality to be worked before the passage to Cobh, but interrupted this move for an RMT 8 haul between 0910 and 1210h. During this haul we were able to contact an RAF Nimrod aircraft whic flew overhead and most obligingly carried out an extensive radar and visual search for the sediment trap array centred on our best estimated position for it. Unfortunately, this search was unsuccessful.

On completion of the RMT 8 haul the ship proceeded directly to the 1350m station where a 7 litre water bottle cast (11275#1) was followed by a multiple corer drop (#2) and a shallow CTD (#3). Finally, the PES fish was brought inboard and the vessel left for Cobh at 1730, arriving at the anchorage at 1100/25.

Mid-cruise port call

In addition to the exchange of personnel at Cobh (see list), we were visited by Unicam engineers from Dublin to fix a fault in the IMER spectrophotometer and by an RVS engineer to fix the computer.

A visit had also been arranged for interested scientists from Irish institutions and we had a pleasant, and hopefully valuable, visit from Geoffrey O'Sullivan of the National Board for Science and Technology, Prof. Brian Bary, Dr. John Patching from UCG, Dr. Alan Myers from UCC and Michael Geoghegan from the Geological Survey of Ireland.

The length of port call, initially scheduled around flights to Cork from Heathrow and Plymouth, was actually determined by the repair to the computer and the ship finally left the anchorage at 2000/25.

Leg 2

The results obtained during the first leg had almost consistently failed to give any indication of the development of the bloom, very low levels of chlorophyll and high levels of nutrients being found in the surface waters and no more than a 0.1°C range of temperature in the upper 100m of the water column. However, the last CTD before our departure from the Seabight had indicated a slight improvement in the situation, with a 0.2°C difference between the surface and 100m temperatures, while a small increase in chlorophyll had also been encountered.

During our absence from the Seabight the weather had been fair and bright and we hoped that some significant progress in the stratification of the water column and the development of the bloom would have occurred in our absence.

Accordingly, we intended fishing the Seasoar from soundings of about 400-500m on the eastern side of the Seabight and to carry out a survey of a 40 x 40km area centred on the 1350m station. However, when the Seasoar was deployed at 1500/26 the termination was damaged and the system had to be recovered for repair.

The vessel therefore proceeded towards the 1350m station and stopped for a CTD cast on the way at about 51°40'N: 12°27'W (11276). The results were very disappointing, for the temperature change in the upper 100m had decreased to about 0.1°C. We were already experiencing 25kt winds, with a further deterioration forecast, and it was clear that no significant development of the bloom was to be expected in the Seabight for some days to come.

Consequently, it was decided to complete the intended coring work at the 1350m station and then to move south to find an area of bloom conditions where at least some of the cruise objectives could be achieved.

Cores from two complete or near complete drops were required, but of three casts made at station 11277 only one worked satisfactorily, the other two collecting no cores. Since the problem, ultimately traced to distortion of the main spindle of the coring head, could not be identified readily, the station was abandoned with the hope that the sampling could be completed later in the cruise.

Discovery now moved south, making towards a position at about 45°14'N: 13°11'W, NNW of Cape Finistere, where soundings of about 2000m are recorded on the navigational charts (none of the relevant IOS charts being aboard). If bloom conditions at this locality were found to be suitable we might have been able to deploy the sediment trap array here, whereas the array could not be deployed to north and south of this locality since the soundings are much greater.

A CTD cast was made at 0900/28 at 45°45'N: 13°157W with no evidence of a significant thermocline or or a chlorophyll increase (11278). Consequently, although reasonable soundings were obtained slightly south of the expected position of the shoal area, this CTD result and the underway fluorometry and nutrient determinations indicated that we would have to go considerably further south to find significantly higher chlorophyll levels. Discovery therefore proceeded to 44°00'N: 13°12'W where a CTD cast was made (11279). The water column was once more found to be well mixed, with only a slight decrease in the nutrient levels. The vessel therefore continued south towards a locality at about 42°N: 14°W which was reached at 0700/29. Here the CTD revealed a temperature difference of 0.5°C between the surface and 100m associated with a significant depletion of surface nutrients. Accordingly, this station (11281) was occupied until breakfast time on 1 May by which time a Seasoar survey of the area had been conducted, five CTD casts and five 7 litre water bottle casts had been made, together with an LHPR haul, a successful deployment and recovery of the IMER primary productivity and sediment trap rigs, and two deployments of the mid-water video camera. Finally, four successful casts of the transparent 30 litre water bottle were made. The only significant failure at this station was the use of the RMT 8 with the closing cod-end which failed because it had been rigged incorrectly.

Having exhausted the immediate possibilities of this station, and in the hope that bloom development in the Seabight had begun in our absence, the ship moved north once more with the intention of using Seasoar during at least part of this passage. The Seasoar was deployed at 0830/1 and recovered at 0815/2 at about 45°05'N. During this period the surface chlorophyll minimum, typical of the 42°N position, gradually disappeared so that, as might be expected, we appeared to be moving into earlier stages in the development of the bloom. Towards the end of the run the thermocline also tended to disappear, and a water bottle cast to 100m (11282#1) revealed much higher nutrient levels than at 42°N, but significantly lower than those encountered in the Seabight before moving south. A transparent water bottle cast to depths of 40 and 50m revealed no evidence of aggregates.

The northerly Seasoar run was resumed at 1145/2 and the fish was retrieved at 1000/3 at about 47°N because of a problem with the diving control system.

Discovery now made direct for the unrecovered Bathysnap on the Goban Spur (52217#1), arriving at 2330/3. The intention was to locate the lost instrument before deploying a new Bathysnap in the same area so that the two rigs would not be confused if the French submersible Cyana were to attempt a recovery of the lost one. After a 1½ hour fruitless search for the rig it seemed certain that it had left the bottom in our absence. Since this might have been due to the presence of insufficient buoyancy to pull the instrument clear of the ballast weights after release, an additional sphere and extra weights were added to the Bathysnap about to be deployed. However, at 0200/4, as the rig was being launched in a fairly heavy swell, the gear was lowered into the sea insufficiently rapidly and it was smashed into the side of the ship with the consequential loss of the flash unit and compass and the destruction of the frame.

The vessel now returned to the 2000m station at c. 51°N: 13°W to see what changes had taken place during our absence. A deep CTD at 1700-1800/4 (11284#1) revealed virtually no temperature stratification in the upper 100m but did demonstrate the existence of a distinct nepheloid layer at about 940m.

Overnight a photosledge run (11285) was made from a depth of about 925m into shallow water on the Porcupine Bank to extend a series of similar runs made during Challenger cruise 520. After retrieval of the sledge at 0500/5 Discovery once more returned to the 2000m station.

At this station (11286) two shallow CTD casts, two 7 litre water bottle casts and an LHPR haul were completed by 1800/5. During the previous 24 hours the IOS sediment trap mooring had been prepared for deployment, but in order to position the upper trap close to the surface the mooring rope had to be stretched under load. Having completed this task by 2130 the available winch drivers had already been working for an excessively long period and it was deemed prudent to delay the trap deployment until the following morning. Accordingly, the vessel was hove to until 0400/6 when a 7 litre water bottle cast was made (11286#7) and the primary productivity and free-floating sediment trap rigs were deployed (#8 and 9).

The time series sediment trap array (#10) was deployed by noon/6 in a depth of 2042m, but from the rate of descent of the floatation sphere it was clear that the rig was not as negatively buoyant as had been intended (see later).

A shallow CTD (#11) showed little evidence of phytoplankton development, agreeing with the high nutrient levels obtained from the water bottle samples taken earlier at this station.

By this time the vessel was some 6 miles to the north-east of the position of station 11284 and a deep CTD (11286#12) revealed the presence of a nepheloid layer at about 750m compared with 940m at 11284. We therefore decided to return to 51°N: 13°W (close to the position of 11284), to determine the depth of the nepheloid layer, and then to fish the LHPR in and close to this layer between the two positions. The new deep CTD (11287) showed a nepheloid layer at a similar depth to that at 11286#12, suggesting that the change since 11284 was due to internal waves.

By the time this CTD was completed (1700/6) there was insufficient time to fish the LHPR before the primary productivity and free-floating sediment trap rigs were to be retrieved. The rigs were therefore recovered first and the LHPR (11288) was then fished back towards 51°N: 13°W, obtaining markedly green samples within the nepheloid layer compared with those from immediately above and below.

Since there was still no evidence of the imminent build-up of the bloom we decided to investigate the nepheloid layers coming off the Porcupine Bank and the ship therefore moved to the north-west to begin a series of deep CTD stations from shallow water back towards the 2000m station. Initially, these were carried out at 100m depth intervals from 400m to 700m and revealed a strong nepheloid layer detaching itself from the bottom at a depth of about 580m (11289-11292). In the next station, however, in a sounding of 923m, the attenuation peak on the transmissometer trace was much weaker and very similar to the situation previously encountered in the centre of the Seabight. The ship's course was therefore retraced to obtain a CTD at 800m (11294), revealing a more or less intermediate situation between those found at 11292 and 11293. When the particle size spectra from the water-bottle samples on these casts were examined later it was clear that the nephel encountered at the deeper station was not simply a development of those at the shallower localities, but had been derived from a quite different event. This was not, however, appreciated at the time and, since there seemed little point in continuing the CTDs at the 2000m station since the nephel situation there had already been encountered at a sounding of 900m, an attempt was made to determine the lateral extent of a nephel. Accordingly, a further CTD close to, but slightly deeper than, 11293, was obtained (11295) together with a second one at about the same depth but some miles to the North-east (11296). These casts revealed quite different nephels from each other and from that at 11293 indicating a far more complex situation than had been anticipated. One further CTD cast was obtained at a depth of about 750m (11297) and the ship then returned to the position of 11291, at a sounding of about 600m, for deployment of the primary productivity and sediment-trap rigs at first light.

The water bottle samples (11298#1 and 2) for the primary productivity rig were obtained somewhat later than intended because of a minor winch problem, but both rigs were deployed by 0620/8.

A photosledge was now fished with the intention of covering the depth range from 400 to 700m to link up with 11285. However, the first attempt (11299#1) was aborted because of a camera system malfunction and the second attempt (#2) was terminated at 1337, after about 3 hours on the bottom, by which time the gear had reached a depth of only 490m. The photographs obtained during this haul were subsequently found to be almost totally obscured by phytodetritus in suspension. At the same time, the suprabenthic net collected the only sample of phytodetritus obtained during the cruise, but the principal scientist negated its value for biochemical analysis by preserving it in formalin!

The ship now moved downslope towards the primary productivity and sediment trap rigs and a lightmeter cast and deep CTD were obtained in a depth of about 650m. However, an attempt to use the multiple corer, hopefully to obtain a phytodetritus sample, failed because the coring head did not penetrate the sediment owing to distortion of the main supporting column. (This was to be the last opportunity to obtain such a sample since by the time the corer was repaired the weather had worsened and the cruise had to be terminated.)

The primary productivity and sediment trap rigs were now recovered by 1945/8 and an LHPR (11301) was fished to a depth of 571m in soundings of about 600m to sample the nepheloid layer.

The intention was now to fish the Seasoar back to the 2000m station at 51°N: 13°W to recover the time-series sediment trap. The Seasoar (run 4) was deployed at 2354/8 but had to be recovered at 0120/9 with a suspected cable failure and Discovery continued to the sediment trap position, arriving at 0800/9. No sign of the trap was found and it seemed likely that it had "bounced" along the bottom because of its insufficient negative buoyancy (see above). Since the total length of the mooring was 1900m it was expected to ground at this depth having probably drifted to the north-west since this was the direction taken by the other rigs deployed during the cruise. The ship therefore sailed due west to the 1900m isobath and then followed this isobath to the north and east. The sediment trap was located and grappled at 1427/9 some 17 n.m. from its deployment position and was successfully brought inboard at 1616.

During the sediment trap search and recovery the south westerly wind had freshened to 30-40kts making an intended RMT haul for live animals impossible. Discovery therefore made for the 1350m station at 51°35'N: 13°W where a further multiple corer sample was required. When this locality was reached at 2100/9 the weather was worse and the ship continued towards the position of 11291 again to obtain a core sample. At 0830/10, having reached the position, the weather conditions had further deteriorated and, with a worsening forecast, the cruise was terminated. Discovery therefore made direct for Falmouth, arriving at 0800/12.

A.L. Rice

SEASOAR AND CTD SURVEYS

i) Seasoar runs

Altogether 4 Seasoar runs were made during the cruise, all of them with the Chelsea in situ fluorometer as well as the Neil Brown shallow CTD. Because of the absence of stratification and any consequent phytoplankton growth during the first part of the cruise in the Porcupine Seabight, no Sesoar runs were made until we had moved to the southerly station at 42°N. The first Seasoar run was made on the 29th of May and consisted of a box survey, in the area of 42°N: 14°W, to obtain an estimate of the scale of spatial patchiness. The second and third runs were part of a long transect from the southerly station (42°25'N: 14°30'W) to a position to the south of the Porcupine Seabight (47°45'N: 13°35'W). During this run regular samples were taken from the pumped sea water supply for nutrient, phytoplankton and gravimetric samples. The last Seasoar run was made on the 8/9 May and was intended to be a transect from the Seabight onto the Porcupine Bank. Unfortunately a cable problem caused this run to be abandoned after only 1½ hours.

Considerable problems were experienced with the new RVS computer sampling system during the Seasoar runs. It became apparent that the level C system could not keep up with the data input from the level B data logger, with the result that the system lagged with respect to real time by some hours. This problem combined with problems with the plotting software meant that we were not able to produce contoured sections of the Seasoar runs, as was possible with the PDP 1134 system used previously. It has not therefore yet been possible to interpret any of the Seasoar sections.

ii) Shallow CTD dips

Altogether 10 shallow CTD dips were made, 8 in the Porcupine Seabight and 2 at the southerly station (42°N). An oxygen sensor, the Chelsea in situ fluorometer, Plessey underwater irradiometer and Seatek transmissometer were also deployed at all shallow CTD dips.

The first shallow CTD dip was made on the 17th April in the Porcupine Seabight and showed a water column totally mixed down to 400m with a uniform chlorphyll a concentration of about 0.4mg m^{-3}. By the 19th April some slight stratification had taken place in the top 100m and there was evidence of some small consequent phytoplankton growth. Over the next few days the combination of storms and reduced insolation prevented any permanent stratification developing and chlorophyll a concentrations never exceeded 0.6mg m^{-3} in the surface 50m.

The shallow CTDs carried out at the southerly station (42°N) showed a well developed thermocline at around 30m with a subsurface chlorophyll maximum of around 1.2mg m^{-3} chlorophyll a within this thermocline.

On returning to the Seabight on 5th May, it was found that there had been very little further development of stratification and chlorophyll a concentrations had still not risen above 1.6mg m^{-3}. The only place where higher chlorophyll levels were observed was at the shallow stations on the Porcupine Bank, where the spring bloom was obviously more advanced than in the deeper water of the Seabight Unfortunately due to the breakdown of the Seasoar on run 4 and to the fact that the section of CTDs across the bank was made with the deep CTD, we have no detailed chlorophyll a profiles in this area.

iii) Deep CTD dips

Twenty-four deep CTD dips were made during the cruise, 18 in the Porcupine Seabight and Porcupine Bank areas, 4 at the station at 42°N and two at intermediate latitudes. An oxygen probe and a Seatek transmissometer was also deployed at all these stations. The transmissometer measurements provided valuable information on near bottom and midwater nepheloid layers, which showed up as peaks in beam attentuation.

On the first leg a deep CTD made in water of 1000m (11270#1) depth showed a pronounced nepheloid layer at 890m and also a near bottom layer. However, station 11271#1 (water depth 1300m) showed a whole series of intermediate nepheloid layers between 600 and 1000m. On the second leg a number of deep CTDs were made in the deeper water of the Bight and these showed nepheloid layers at various depths between 700 and 1000m, some of which were correlated with oxygen peaks suggesting a fairly recent origin.

In order to investigate more fully the relationship between nepheloid layers in the Bight and the presumed source material on the Porcupine Bank, two CTD traverses were made from the Bank into the deeper water of the Bight (11269-11294 and 11295-11297). The two shallowest stations (11289, 11290) showed a pronounced increase in beam attenuation within 30-50m of the bottom. At the 613m station (11291) this attenuation peak had lifted clear of the bottom and could be traced through to the 800m station (11294). The potential density of the water at the depth of this intermediate nepheloid layer was the same as that of the bottom water on the Bank. Also the attenuation peaks were often correlated with oxygen peaks. However, between the 800m and 900m station (11293), there was a marked reduction in the attenuation peak (from a value of $0.64m^{-1}$ to $0.44m^{-1}$). Measurements of the particle size spectra from the depth of the attenuation peaks, made by Bob Williams, showed that this reduction was due to a loss of small particles less than 10μm diameter (see Table 1 and Fig. 1). This is a surprising result if the attenuation peak at the 900m station is derived by downslope advection from the 800m station. We are not at present able to explain these results.

M.J.R. Fasham

PRIMARY PRODUCTIVITY MEASUREMENTS

Objectives

1. To investigate (a) the development of the spring phytoplankton bloom using <u>in situ</u> and laboratory measurements of primary production, and (b) the proportion of carbon fixed as carbohydrate or protein in order to test the hypothesis that nutrient limitation results in a shift from protein synthesis to storage products.

2. Determination of phytoplankton sinking rates during course of spring bloom using fluorometry.

3. Rates of production of heterotrophic bacteria.

Results

1. _In situ_ rig was deployed on 5 occasions when sea conditions permitted. Bottles were incubated at 1, 2, 5, 7, 10, 15, 20, and 30 metres and samples taken after c. 24 hours for rates and products of primary production, although conditions of nutrient limitation did not occur during the cruise. Seven laboratory experiments were completed successfully to determine the relationship between primary production and irradiance, using phytoplankton from various depths. Subsamples of water used in both _in situ_ and laboratory experiments will be analysed for chlorophyll, bacterial and microflagellate concentrations and phytoplankton numbers and species composition.

2. No measurements of phytoplankton sinking rates were made due to the late development of the spring bloom and low chlorophyll concentrations.

3. Production of heterotrophic bacteria was determined on 5 occasions using ^{3}H-thymidine at up to eight depths from 1 to 300 metres. A further 6 incubations were completed on the 7 May 1986 during the CTD survey of the nepheloid layers.

I.R. Joint and A.J. Pomroy

LHPR, RMT AND PARTICLE-SIZE ANALYSES

LHPR - Six LHPR hauls were taken, the first four with the double net system (220μm and 20μm mesh nets), and the last two with the fine mesh net only. Because of the slow pay-out speed of the _Discovery_ coring winch (0.9-1.0m s^{-1}) a symmetrical 'V' shaped towing profile was obtained. This was a benefit on two of the hauls (11266#2 and 11286#4) where large fish (>10cm) jammed the cod-end filtering mechanism. In both cases the descent profiles were used and the ascent samples rejected. The ship's winch failed during 11263#10 and the

Cruise Report No. 189, 1987.

Page 25 missing

Cruise Report No. 189, 1987.

Page 26 missing

PIGMENT ANALYSES

Due to poor weather the primary objective of the pigment work, to follow the change in chloropigments before during and after the bloom with emphasis on the formation of phytodetritus, could not be followed.

Many interesting results associated with pigments were however obtained.

1. LHPR Pigment Results

For each tow two mesh sizes were used; 22µm and 200µm. Total particulates (GF/F) and size fractions 0.2-0.8µ, 0.5-5µ and >5u (Nuclepore) were measured in conjunction.

The analysis of pigments from these samples provides information on 1) the predominant zooplankton (200µm mesh); 2) the phytoplankton being grazed and their approximate size (total particulates and size fractionated); 3) the faecal pigments produced, which gives us an insight into the efficiency of grazing and the preference of algae grazed (> 22µm mesh).

Tows

18.4.86	LHPR (1)	(11263)	-	aborted -animal samples retrieved.
21.4.86	LHPR (2)	(11266)	+	total particulates (no size fractionation)
29.4.86	LHPR (3)	(11281)	+	total particulates + size fractionation
5.5.86	LHPR (4)	(11286)	+	total particulates + size fractionation
6.5.86	LHPR (5)	(11288)	-	(no total particulates or size fractionation) - nepheloid layer samples.

As yet most of the data have not been worked up, but a brief look at the samples from station 11281 shows interesting results. The size fractions show dramatic changes in pigment composition; the 0.2-0.8 and 0.8-5µ fractions contain chlorophyll b lutein associated with Chlorophyceae or Prasinophyceae, whilst the >5µ contains very little chlorophyll b and lutein and is dominated by chlorophyll c and fucoxanthin and antheraxanthin (to be confirmed) associated with Bacillariophyceae and Chrysophycea respectively. The >5µ fraction also contains a much higher proportion of the phaeophorbides which is reassuring because I have often wondered whether the phaeophorbides were sometimes associated with very small particles and were therefore lost through a glass fibre filter. Phaeophorbide pigments, degradation products of chlorophyll normally resulting from grazing, are found in faecal material and dominate in fluff and sediment pigment samples. The >22µm LHPR sample is dominated by fucoxanthin and the phaeophorbides, ie by diatoms >22µ in size (or by faecal material containing undigested diatoms) and faecal material.

2. Nepheloid Layer Pigments

Although there were increased levels of particulates and an increase in size of particulates in the nepheloid layer samples, the levels of pigments did not increase compared with values above and below the layer where only 2 litres of total particulate water was filtered onto a GF/F glass fibre filter paper. Significant differences, however, were observed in the LHPR >22µ mesh samples in and adjacent to the nepheloid layer at Stn 11288 where larger volumes of water were filtered. These samples have not as yet been quantified.

Levels of phaeophorbide relative to chlorophyll a were no higher in the nepheloid layer compared with the rest of the water column. In this respect the nepheloid layer is quite different in pigment composition compared with previously analysed fluff samples (1982) and with surface sediment material.

3. Sediment Cores. Surface sediments and holothurian gut contents

a. Sediment cores.

Two cores were analysed for pigments in detail (11267#1 and 11277#2). They showed similar results with the fingerprint of pigments remaining the same down to 200 mm (the deepest depth analysed). There were no transformations in the pigments, only a gradual decrease in all the pigments with depth. A cluster of phaeophorbide peaks dominated the chromatograms with chlorophyll a persisting down to 70mm, below which it was beyond detection limit. An exciting finding was the appearance of large amounts of a lutein like carotenoid in the 70mm region found in both cores. 70mm corresponds to the oxidised, reduced boundary. The sudden appearance of this carotenoid was not paralleled with any increase in the chloropigments. A parallel core has been retained for dating.

b. Holothurian gut contents compared with surface sediment samples.

There were no qualitative changes in pigments between the surface sediment and gut contents of the holothurian. Concentrations of pigments were, however, in many gut samples at least ten times that found in the surface sediment (top 1mm). This would support previous carbon data which found similar increases in concentration in holothurian guts and which suggested that holothurians were selective feeders. No changes were observed in the pigments found in the oesphagus region of the gut compared with the cloaca region indicating that the pigments pass through the gut unchanged.

C. Llewellyn

LIGHT METERING

1. Recording Light Meter Array

This was deployed on two occasions (30/4/86 and 6/5/86) and both times unsuccessfully. On the first occasion the plug on the battery box had pulled adrift from the mounting and shorted out the supply, the reason for the second failure has not yet been discerned.

2. Hand-held Scalar Light Meter

The new 'over the side' version of the irradiance meter was used very successfully on 8/5/86. At this station a) the 1% light level was at 35m, b) the scalar light exceeded the net vector light by between 10% and 30% depending on the depth, c) the gross absorption coefficient (of Photosynthetic Active Radiation) decreased from 0.13 at the surface to 0.05 at 50m. This should reflect the pigment distribution (yet to be analysed).

3. Spectral Absorption Coefficients

On four days, water bottle samples from nine depths down to 30m were analysed using a scanning Unicam spectrophotometer to study the relative absorption by the soluble and particulate fractions of the sample. This data has yet to be analysed fully but it is apparent, for the Porcupine Seabight station, that the absorption by the soluble fraction, definitely, and the non-chlorophyllous particulate fraction, probably, is considerably lower than when it was last measured in June/July 1985. The specific absorption coefficient of the pigments has yet to be calculated.

4. On-deck Light

Except at the southernmost stations, the flux of P.A.R. was very low. This data, together with that measured by the in situ primary production rig, will be used to assess any difference in the Total Water Column Light Utilization Index (Ψ) at the 42°N station and the Porcupine Seabight station.

M.B. Jordan

NUTRIENTS (Tables 4 and 5)

A "Chemlab" continuous flow analysis system interfaced with a "Commodore PET" microcomputer was used to analyse water bottle samples for nitrate-nitrite, phosphate and silicate (Table 4). The system was also attached to a continuous flow seawater supply via a filler block on two occasions (1840 to 2240h 28.iv.86; 0922h 1.v.86 to 0923h 2.v.86) to provide data on surface seawater nitrate-nitrite and silicate concentrations. During the southerly excursion to 42°N from 27.iv to 4.v.86 spot samples from the non-toxic supply were also analysed for evidence of nutrient utilization (Table 5).

Difficulties were experienced with the system surging particularly on the phosphate and nitrate-nitrite lines. The problems were partially solved by clearing a blockage near the sampling head, by passing 1M NaOH down the phosphate line and by re-packing the copper-cadmium column used to reduce the nitrate to nitrite as this appeared to be too dense to allow a smooth passage of the sample. It was not possible to use the PET computer programme designed for the "Chemlab" system because of problems in synchronizing the computer readings with the arrival of the sample peaks. All the nutrient concentrations were calculated manually from a chart-recorder printout.

The nitrate-nitrite system is best used for deep water and sediment pore water nutrient concentrations with values in excess of 10µM. The low nitrate-nitrite concentrations of surface seawater necessitated the use of standards ranging between 2.5 and 10µM. This resulted in an increase in the "noise" of the baseline and an erratic sample peak leading to less precision in the determination of nitrate-nitrite concentrations. In order to increase the sensitivity of the colorimeter for the low concentrations of silicate encountered in surface seawater, a 810nm filter was used which gave a linear working range up to 12.5µM.

J.J. Taylor, D.S.M. Billett

MULTIPLE CORER

The newly acquired multiple corer made in Germany to the SMBA design was deployed nine times. On one occasion the core tube valves triggered before reaching the seabed (Stn 11277#1) and on the last two deployments (Stns 11277#3, 11300#3) they did not trigger at all. It was found that the central rod of the coring assembly was slightly bent preventing the complete passage of the rod through the central tube. Consequently although the core tubes penetrated into the sediment, the core tube valves failed to release. A few samples remained in the core tubes but were lost when the corer was lifted clear of the water. No phytodetritus was evident on any of the cores taken.

Two sets of cores were obtained from the eastern side of the Porcupine Bank (Stn 11263#6, #7) to study the within-station and between-station variability of Foraminifera. The cores will complement samples taken at this station on previous cruises to study the effect of the seasonal deposition of phytodetritus on Foraminifera populations. Of the twelve cores taken on the first deployment, two were disturbed, one was donated to Dr. R. Williams (IMER) for work on radionuclides with Dr. E. Hamilton, five were sub-cored for Foraminifera, and the rest were used for specimens of Rhizammina which were preserved intact in glutaraldehyde for TEM analysis. Only four good cores were retained on the second drop owing to a slight displacement in the positon of the plastic collar on some core-tubes which prevented the complete closure of the core tube valves. Several of the core tubes were modified at sea to overcome this problem. The four cores were all sub-cored for Foraminifera.

Two sets of cores were obtained for (i) comparisons of superficial sediment with holothurian gut contents (see next section) and (ii) a detailed analysis of chloropigments in the sediment down to a depth of 20cm. One sample was taken on the Goban Spur (Stn 11265#3) at a station sampled previously when phytodetritus was present on the seabed (Stn 52218#2, 3: Challenger cruise 6A/85), and the other was taken on the eastern side of the Porcupine bank (Stn 11267#1). Samples were taken for organic carbon, nitrogen and chloropigment analyses.

Two sets of cores were taken for a collaborative study with the British Museum (Natural History) on macrofauna and metazoan meiofauna at a station on the eastern side of the Porcupine Bank. This station has been extensively sampled for meiofauna in the past. It was intended to sample before and after the deposition of phytodetritus but this did not prove possible. On the first deployment (Stn 11275#3) 3 cores were subdivided into horizons to study the vertical distribution and small-scale variability of metazoan meiofauna. The supernatant water was passed through a 20μm filter to retain any meiofauna that had been suspended during the handling of the core. The sediment was subdivided into 1cm horizons down to a depth of 7cm and then a single horizon between 7 and 15cm was taken. The top 15cm of the remaining cores from the first deployment and all 12 cores of the second deployment were preserved in 10% formalin for macrofaunal analysis

D.S.M. Billett, R.S. Lampitt, K.Martyn, R. Raine, A.L. Rice

BATHYSNAP

This was not a happy bathysnapping cruise. It was intended to recover one module and to redeploy this and two others. None of this was achieved.

An instrument was deployed in June 1985 on Challenger 6A/85 (52217#1) specifically to examine the degradation of holothurian faecal casts. The instrument did not however separate from the seabed when interrogated on

19.4.86. On return to the station 14 days later, however, it had disappeared and is presumed to have popped up in the intervening period. This was particularly disappointing as there was a possibility of recovering it using the French submersible Cyana.

As one module was already lost the number of potential deployments was reduced to two. It was intended to launch one as a standard Mk V and the other at the base of a 400m long sediment trap mooring. Both were to record the arrival and degradation of the phytodetritus on the seabed. During the launch of the standard instrument it collided with the side of the ship destroying the frame with the loss of the flash unit. This was a direct result of insufficient expertise on the part of the crane driver and it is expected that unless crane drivers are given appropriate training a future accident will cause serious injury to personnel. Because of problems with sediment traps and ultimately bad weather on the last day of the cruise, it was not possible to launch the last of the Bathysnap modules.

R.S. Lampitt

MOORED SEDIMENT TRAPS

Objective

The object of deploying these sediment traps was to provide time series data on the vertical flux of particulate material at 4 depths throughout a 2000m water column during the cruise and during the 7 months subsequent to it. These samples were to be compared with those collected by the free drifting sediment traps deployed for only 24 hours at a time (see following section).

Traps

The traps of mouth area $0.14m^2$ (420mm I.D.) fitted with honeycomb baffles have a carousel of 9 sample bottles which rotate at preset time intervals. The sample bottles of volume 200 ml are filled with 10 ml HPLC grade chloroform as preservative and 190 ml of filtered seawater prior to deployment.

Mooring

A mooring of nearly 2000m would lean over in the currents expected such that its lower part would be at a steep angle. This is undesirable as the traps are not gimballed and it was decided therefore to put traps 100 and 800m below the surface on one mooring of 1950m length and two other traps at 10 and 400m above the seabed on a short mooring of 450m. Because the traps were not operational until the last week of the cruise, the first deployment was considered a test of the trap function and only one mooring was therefore needed. The wire and kevlar were stretched using a 600kg weight and then measured onto the double barrel capstan on the foredeck. The metering wheel appeared to overestimate the mooring length by 1.3%. 3 traps were incorporated in the mooring at altitudes (height above bottom) of 22m (Trap III) 1140m (Trap IV) and 1884m (Trap I). An Aanderaa recording current meter was placed 5m below the top trap and a 1.2m diameter steel buoyancy sphere was 31m above it. Ballast was provided by 600kg of chain and 1116m of 8mm wire beneath trap IV.

Results

The hold down force for the mooring was insufficient and it drifted 27km up the slope until the buoyancy broke surface. From the current meter data this appears to be ca. 48 hours after deployment.

Material was present in all the sample cups at each depth but on two of the traps the carousel was in a different position to that expected. As a result of this failure and poor weather on the last day of the cruise, the traps were not redeployed.

The material collected at each altitude (the depth is variable) has been examined superficially using the light microscope. The top trap contained many crustacean zooplankton, some intact diatom chains (*Chaetoceros* sp. and *Rhizosolenia* sp) and a quantity of unidentified material. Material collected by the middle trap is almost entirely in the form of faecal pellets many of which are very robust. Also present are diatom species probably of the same species as in the top trap. The lowest trap collected very little material but such as it is, it comprises planktonic Foraminifera and a few unidentified particles.

Cruise Report No. 189, 1987.

Page 35 missing

Cruise Report No. 189, 1987.

Page 36 missing

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P.C. Reid

MIDWATER PHOTOGRAPHY

The material which sinks rapidly to the seabed at the end of phytoplankton blooms is probably in the form of aggregates 1-10mm diameter. Such aggregates may not be sampled adequately by the transmissometer because of their rarety and two photographic techniques were adopted to asses their distribution. One was a video camera and the other a 35mm stills camera attached to the CTD frame.

Video

A black and white Sony video attached to 200m of conducting cable in a 400m depth rated pressure case was deployed on the forward hydrowire on 4 occasions. Apart from on the first deployment, the focus was set at 67cm in seawater (50cm in air) and orthogonal illumination was provided by a 110v submersible flood light. This was 20cm from the point of principal focus and was therefore only 10cm outside the field of view. At the focal point the field of view was 19 x 26cm and the volume photographed was about 8 litres. Resolution was estimated at 1mm.

The equipment was difficult to handle as the conducting cable and attached safety rope had to be taped onto the hydrowire at 2.5m intervals during deployment and this had to be cut off and the wire flaked on deck while heaving.

Large numbers of particles could be readily seen and there was considerable variability both in size and quality of particles over the 100m depth surveyed. It was obvious from their activity that some of the particles were zooplankton and at certain depths, large numbers were attracted to the light source. Although a good video signal reached the recording unit, on playback the picture broke up every 2 or 3 seconds. This was thought to be due to the "dirty" AC supply on Discovery although a voltage stabiliser did not improve matters. This is a serious problem if the films are to be analysed fully and should be resolved if video recordings are to be made on the ship in future.

35mm still camera

On 8 of the CTD deployments, a Mk IV IOS camera was attached to the CTD frame. The flash was positioned 30cm ahead of the camera window 56cm to the side and pointing in almost the same direction as the camera. Camera focus was set at 1.0m and photographs were taken every 15 seconds.

Many large particles are visible in the photographs with substantial changes both in particle size and number throughout the water column. Because the volume of water illuminated is not well defined large errors will apply to the size distributions of these particles but in spite of this, the observations will add substantially to the transmissometer data obtained simultaneously and to the analyses of water bottle samples.

R.S. Lampitt

OXYGEN MEASUREMENTS/RESPIRATION RATES

Water samples taken with the CTD were analysed for dissolved oxygen concentration in order to calibrate the oxygen sensor. Results showed that the CTD reading was ca. 0.15 ml O_2/l too high.

Respiration rates were made on samples taken inside and outside the nepheloid layers. Outside the layers the respiration rate was 3.2μl $O_2.l^{-1}.(24\ hours)^{-1}$ based on one measurement. Inside the layer, measurements of respiration rate were 12 (11289, 410m) and 9 (11294, 720m)μl $O_2.l^{-1}.day^{-1}$ showing significantly higher metabolic activity inside the nephels.

R. Raine

EPIBENTHIC SLEDGE - MULTIPLE NET

Two samples were taken with the epibenthic sledge, one on the Goban Spur (Stn 11265#3) and the other on the eastern flank of the Porcupine Bank (Stn 11267#2). The guts from holothurians from both catches were dissected out and the oesophageal and intestinal contents were frozen on glass fibre filters for organic carbon, nitrogen and chloropigment analyses. At both stations a multiple core sample was taken for a comparison of the superficial sediment with the holothurian gut contents. The aims were to study the effect of holothurian feeding on the pigment composition, to assess whether holothurians feed selectively, and to assess the assimilation efficiency of holothurians on the superficial sediment before the deposition of phytodetritus. The results from the latter study will be compared with sediment and gut content samples taken at the same station (Goban Spur) on Challenger cruise 6A/85 (Stn 52218#1) when phytodetritus was present on the seabed. Some samples were analysed by High Performance Liquid Chromatography onboard ship (see section on pigment analyses).

The sample from Stn 11265#3 (1450-1470m) was dominated by the holothurian Benthogone rosea and contained quite a lot of clinker. The echinoderms also dominated the sample at Stn 11267#2, notably the holothurians Laetmogone violacea and Bathyplotes natans, the echinoid Phormosoma placenta and the asteroids Plutonaster bifrons and Zoroaster fulgens.

D.S.M. Billett

COMPUTING

The computing system successfully logged navigation, CTD and surface irradiance. The hardware problems on Leg 1 (disc drive) was corrected at anchor off Cobh. The CTD data collected on the first leg were processed and plotted once minor corrections to the new software were made. No further problems with the data disc were encountered. During the leg it was found that a significant backlog of data occurred when using the Seasoar; however no data were lost due to the buffering capacity of the Level B computer. Early in the Leg the high speed data link (Cambridge Ring) failed and the use of a standby slow link may have contributed to the loss of speed; although a subjective assessment of the processing load on the system prior to the failure suggested that even then backlog could develop. The opportunity was taken to investigate and develop the interface between the RVS database and the IOS PSTAR processing package. Problems were encountered here with the large size of the intermediate files and much work was done on the use of magnetic tape as a transfer medium. Small amounts of data were plotted using PSTAR.

R. Lloyd

CONCLUSIONS

The cruise was very disappointing for two main reasons.

1. The climatic conditions in the spring of 1986 were such that the stratification of the water column and the development of the spring bloom were unusually late. The cruise period therefore did not coincide with the phenomenon which it was designed to investigate and the principal objectives were therefore not achievable.

2. Gear losses and malfunctions were distressingly high. The most serious of these was the loss of the corer/respirometer, but also included the loss of two free-floating sediment trap arrays, the destruction of a Bathysnap during deployment and the failure to retrieve a previously deployed Bathysnap, and the disappointing performance of the time series sediment traps.

Nevertheless, considerable potential valuable information was obtained as summarised in the detailed reports. The most important of these was undoutbtedly the investigation of the nepheloid layers, suggesting that the nephels may have a significant role in the phytodetritus phenomenon.

Table 1 Discovery 158 Comparison of attenuation and Coulter counts

Station	Depth (m)	Trans	Attenuation	ppm (1-128µm)	ppm (1-10µm)
11270/1	948	67.8	0.388	0.156	0.105
"	880	62.1	0.477	0.174	0.125
"	750	67.1	0.399	0.189	0.124
11276/1	20	59.6	0.518	0.696	0.470
"	996	68.2	0.383	0.118	0.085
"	882	67.2	0.398	0.118	0.067
"	765	68.0	0.386	0.086	0.059
11281/2	2000	68.5	0.378	0.382	0.083
"	1300	68.7	0.375	0.232	0.051
"	1000	68.8	0.374	0.072	0.032
11281/13	1	48.9	0.715	1.027	0.558
"	5	48.9	0.714	1.004	0.501
"	10	48.0	0.733	1.120	0.489
"	15	48.0	0.732	1.247	0.475
"	25	49.2	0.710	0.909	0.353
"	50	60.8	0.498	0.479	0.206
11284/1	1510	68.5	0.378	0.191	0.121
"	950	66.8	0.404	0.151	0.094
"	850	68.4	0.380	0.168	0.105
11289/1	410	39.8	0.922	1.009	0.764
"	10	42.8	0.847	2.161	0.843
11290	500	54.4	0.609	0.857	0.269
"	350	67.8	0.389	0.254	0.129
"	211	57.9	0.546	1.009	0.286
11291/1	595	61.7	0.482	0.213	0.158
"	566	55.2	0.594	0.387	0.310
11291/2	350	67.6	0.392	0.125	0.059
"	80	57.9	0.546	0.753	0.204
11293	350	68.4	0.380	0.255	0.125
"	750	64.6	0.437	0.196	0.115
"	912	64.9	0.432	0.216	0.144
11294	350	68.2	0.382	0.299	0.075
"	720	52.6	0.642	0.341	0.259

Table 2 Water bottle casts - particle size analysis, chlorophyll a pigment analysis, amino acids.

Date 1986	Station	Time (GMT)	Position N	W	Depths (m)
17.4	11263#1	10.23 10.56	51°35.6'	13°01.1'	1, 10, 20, 30, 40, 50, 60, 70, 80, 90
21.4	11266#1	12.27 12.53	51°14.6'	13°23.1'	1, 10, 20, 40, 60, 80, 100, 200
24.4	11273#2	08.12 08.21	51°56.7'	13°16.9'	1, 10, 20, 40, 60, 80, 100, 150
29.4	11281#4/5	21.47 22.56	42°06.2'	14°09.3'	1, 5, 10, 20, 30, 40, 60, 100, 200, 400
2.5	11282#1	08.50 09.10	45°06.0'	14°00.9'	1, 5, 10, 20, 40, 75, 100
5.5	11286#3	11.49 12.58	51°00.7'	12°58.8'	1, 5, 10, 20, 40, 60, 100, 200, 400, 800

Table 3 Particle size analysis CTD profiles

Date 1986	Station	Time (GMT)	Position N	W	Depth (m)
23.4	11270	13.21 14.07	51°41.8'	13°12.2'	750, 880, 948
26.4	11276#1	17.15 18.12	51°40.7'	12°26.7'	1, 10, 20, 765, 882, 996
29.4	11281#1	19.41 20.00	42°06.2'	14°08.5'	1000, 1300, 2000
30.4	11281#13	15.10 15.35	42°14.1'	14°22.4'	1, 5, 10, 15, 25, 50
4.5	11284	17.09 18.06	51°01.1'	12°59.0'	850, 950, 1510
6.5	11289	07.08 07.32	51°41.6'	14°00.0'	10, 408
7.5	11290	08.50 09.18	51°35.8'	13°51.9'	3, 21, 348, 489
7.5	11291#1	10.48 11.30	51°30.7'	13°44.8'	3, 80, 350, 595
7.5	11292	13.10 13.44	51°28.2'	13°39.0'	3, 303, 497, 657
7.5	11293	15.04 15.49	51°22.7'	13°31.1'	3, 359, 759, 923
7.5	11294	17.35 18.17	51°25.1'	13°35.3'	3, 359, 728
8.5	11300#2	15.47 16.15	51°35.2'	13°40.7'	3, 200, 585

Table 4. Nutrient results from water bottle samples

Station	Depth (m)	Nutrient concentration µM Si	NO_3	PO_4
11263#1	50	4.1	9.1	1.03
	100	4.1	9.3	0.83
	200	4.0	9.0	0.75
	250	3.9	9.2	(1.67)
	300	3.8	10.0	0.71
11265#1	10	3.4	9.1	0.80
	50	3.4	9.3	0.65
	100	3.4	9.3	0.69
	150	3.5	9.5	0.76
	200	3.6	9.6	0.72
	250	3.6	10.2	0.70
	300	3.7	10.3	0.75
11271#1	10	3.5	9.4	0.70
	50	3.7	9.7	0.67
	100	3.6	9.3	0.70
	200	3.6	9.5	0.72
	400	3.8	10.6	0.90
	600	4.6	11.5	0.93
	800	8.2	15.8	1.24
11281#1	1	0.64	2.7	0.18
	5	0.63	2.7	0.17
	10	0.67	2.7	0.20
	20	0.67	2.7	0.22
	25	0.65	2.7	0.21
	30	0.81	3.5	0.23
	40	1.3	4.3	0.28
	60	2.1	5.2	0.35
	100	1.7	5.4	0.35
	200	2.6	7.3	0.44
	400	5.3	12.8	0.97
	1000	9.3	16.1	0.97
	1300	10.5	17.1	1.04
11282#1	1	2.4	8.2	0.42
	5	2.4	7.6	0.44
	10	2.4	8.0	0.42
	20	2.4	7.9	0.49
	40	2.4	8.1	0.50
	75	2.8	8.6	0.52
	100	3.1	9.5	0.56
11286#1	1	3.8	10.0	0.51
	5	3.7	9.8	0.47
	10	3.8	9.8	0.48
	20	3.8	9.8	0.49
	40	3.8	9.8	0.51
	60	3.8	9.8	0.49
	100	3.8	9.6	0.47

Table 4 contd.

	200	4.1	10.3	0.52
	400	4.3	11.7	0.55
	800	8.7	17.3	0.91
11289#1	10	1.9	8.6	0.40
	410	6.3	12.6	0.65
11290#1	211	2.6	9.2	0.50
	350	4.9	11.3	0.70
	500	6.1	11.9	0.63
11291#1	1	0.9	7.1	0.39
	566	6.2	11.7	0.65
11291#2	80	3.0	9.3	0.55
	350	5.2	11.5	0.63
11292#1	305	2.0	9.2	0.51
	500	4.9	10.8	0.63
	660	6.5	12.1	0.72
11293#1	1	3.3	8.6	0.39
	350	4.3	10.3	0.53
	750	6.8	13.3	0.78
	912	10.1	16.7	0.92
11294#1	1	3.1	8.9	0.43
	350	4.6	10.5	0.61
	720	5.8	11.0	0.60
11295#1	500	4.2	10.2	-

Table 5 Surface water nutrients from non-toxic suppy. Individual samples.

Date	Time	Nutrient concentration µM Si	No_3	PO_4
27.iv.86	2200	3.1	8.3	0.56
28.iv.86	0830	2.4	6.9	0.43
	1240	1.6	5.7	0.43
	1605	1.6	5.0	0.35
1.v.86	1800	1.4	4.8	0.34
	2200	0.97	4.2	0.42
	2357	2.1	6.5	0.50
2.v.86	0203	2.2	6.3	0.46
	0610	2.3	6.5	0.46
	0900	2.4	6.9	0.45
	1400	1.9	6.6	*0.25*
	1602	1.8	6.4	0.29
	1754	1.5	5.5	0.23
	2002	2.7	7.4	0.34
	2207	2.4	6.9	0.29
3.v.86	0000	2.5	7.2	0.31
	0605	3.5	8.7	0.42
	1235	2.0	7.6	0.38
	1355	2.8	8.1	0.35
	1600	3.7	9.0	0.42
	2130	3.1	8.3	0.39
4.v.86	0806	3.7	9.9	0.48
	1100	3.7	9.4	0.45

*Concentration of PO_4 detected changed following cleaning of PO_4 line with 1M NaOH on 2 May.

STATION NO	DATE	LAT. (N)	LONG (W)	GEAR	TIME (GMT)	DEPTH	SOUNDING	COMMENTS
	1986			(see key)		(Gear)	(m)	
11263#1	17.iv	51°35.6	13°1.0	7L WB	1023-1056	0-100	c.1350	
#2	17.iv	51°36.1	13°2.2	FSL	1151-1159			
#3	17.iv	51°37.2	13°3.2	FFST	1236-1438			Trap balance and deployment
	18.iv	51°41.1	13°3.7		1720			Recovery; lost in bow-thrust
#4	17.iv	51°36.7	13°3.9	CTD (shallow)	1526-1558	0-300		
#5	17.iv	51°37.1	13°4.6	CTD (deep)	1622-1642			
#6	17.iv	51°34.5	13°1.4	MC	1921-1922	1320	1320	12 cores
#7	17.iv	51°32.6	13°1.1	MC	2346-2347	1370	1370	4 cores
#8	18.iv	51°38.5	13°1.3	7L WB	0330-0404	0-100		
#9	18.iv	51°37.9	13°3.2	PPR	0652			Deployment
		51°38.2	13°4.4		1540			Recovery
#10	18.iv	51°37.8	13°5.8	LHPR	1017	900-0		Winch failure. Coarse 70, fine 74.
		51°44.3	13°22.5		1317	intended		Samples frozen (-20°C)
11264#1	19.iv	49°31.4	12°57.3	7L WB	0524-0545	0-100		
#2	19.iv	49°30.9	12°56.3	PPR	0620			Deployment
		49°37.0	12°57.4		1910			Recovery
11265#1	19.iv	49°26.8	12°51.3	MC	1051-1053	1440	1440	
#2	19.iv	49°26.8	12°49.7	CTD (shallow)	1211-1235	0-300		
#3	19.iv	49°24.7	12°52.3	BN1.5/3M	1502	1450		
*ships posn		49°43.8	12°52.9		1556	1470		
11266#1	21.iv	51°14.6	13°23.1	7L WB	1227-1253	0-200	c.1370	

STATION NO	DATE	LAT. (N)	LONG (W)	GEAR	TIME (GMT)	DEPTH	SOUNDING	COMMENTS
#2	21.iv	51°14.9	13°23.1	LHPR	1315	700		Coarse 40s (net torn), fine 75s
		51°17.1	13°36.3		1536	0		(fish jammed system at sample 35)
#3	21.iv	51°17.1	13°36.6	7L WB	1544-1612	0-200		
11267#1	22.iv	51°35.6	12°57.1	MC	0702	1420	1420	
#2	22.iv	51°38.3	13°4.5	BN/P	1016	1270		Both weak links parted
		51°38.7	13°6.3		1047	1240		
#3	22.iv	51°40.0	13°4.6	CTD (shallow)	1218-1235	0-300	c.1450	
#4	22.iv	51°39.2	13°15.2	FFST	1316-1441			Balance and deployment (rig lost)
#5	22.iv	51°36.2	13°4.6	RMT 8	1746	1050		
		51°36.6	13°9.4		1852	860		
11268#1	22.iv	51°54.8	13°11.4	MWC	2255-2355	0-100		
#2	23.iv	51°58.5	13°16.2	BN/P	0220	670		Haul aborted - batteries flat
		51°58.9	13°16.8		0230	670		
11269	23.iv	51°38.9	13°15.4	CTD (shallow)	0820-0836	0-300	c.1100	
11270	23.iv	51°41.8	13°12.2	CTD (deep)	1321-1407	0-c.990	1004	
11271	23.iv	51°37.6	13°4.8	CTD (deep)	1546-1632	0-1100	c.1300	
11272#1	23.iv	51°31.8	12°55.4	CR	1844-1915		1515	Test deployment; gear lost
#2	23.iv	51°31.1	12°56.7	MWC	2130-2215	0-100		
11273#1	24.iv	51°55.4	13°14.5	BN/P	0537	750		Haul aborted at 0624 when photographic
		51°56.9	13°17.5		0646	710		system stopped.
#2	24.iv	51°56.7	13°16.9	7L WB	0812-0821	c.700	c.750	
11274	24.iv	51°56.0	13°14.6	RMT 8	0955	550		
		51°58.3	13°18.6		1139	400		

STATION NO	DATE	LAT. (N)	LONG (W)	GEAR	TIME (GMT)	DEPTH	SOUNDING	COMMENTS
11275#1	24.iv	51°35.6	13°0.2	7L WB	1455-1514		c.1350	
#2	24.iv	51°35.8	13°0.5	MC	1559-1601	1323	1323	
#3	24.iv	51°35.9	13°1.3	CTD (shallow)	1655-1706	0-300	1320	
11276	26.iv	51°40.7	12°26.7	CTD (deep)	1715-1812	1007		
11277#1	26.iv	51°34.7	12°59.8	MC	2156-2158	1369	1369	No cores
#2	26.iv	51°34.1	13°0.5	MC	2329-2333	1365	1365	Good cores
#3	27.iv	51°34.1	13°1.6	MC	0121-0124	1352	1352	No cores; did not release
11278	28.iv	45°44.8	13°14.6	CTD (deep)	0902-9014	0-300		
11279	28.iv	44°0.2	13°11.8	CTD (deep)	1932-1946	0-300		
11280#1	29.iv	42°0.9	14°0.4	7L WB	0645-0703			
11280#2	29.iv	42°1.4	14°0.8	CTD (deep)	0749-0801	0-300		
SEASOAR 1	29.iv	42°1.6	14°3.2		0905			Course 270°
		42°2.0	14°34.5		1212			A/C 180°
		41°42.5	14°35.1		1436			A/C 090°
		41°41.9	14°31.4		1458			A/C 040°
		42°3.5	14°7.7		1828			Sampling stopped
		42°5.6	14°8.1		1918			
11281#1	29.iv	42°6.2	14°8.5	CTD (deep)	1941-2000	0-50x3	c.2000	
#2	29.iv	42°6.3	14°8.6	CTD (deep)	2003-2114	0-2000	2023	
#3	29.iv	42°6.2	14°9.3	CTD (deep)	2144-2200			Aborted - transmissometer not cleaned
#4	29.iv	42°6.2	14°9.3	7L WB	2147-2150			
#5	29.iv	42°6.0	14°9.7	7L WB	2252-2256			
#6	29.iv	42°6.9	14°10.5	LHPR	2328	0-1000		Coarse net 77s, fine 84s

STATION NO	DATE	LAT. (N)	LONG (W)	GEAR	TIME (GMT)	DEPTH	SOUNDING	COMMENTS
	30.iv	42°15.9	14°14.1		0200	0		
#7	30.iv	42°16.9	14°15.5	MWC	0302-0408	0-80-0		
#8	30.iv	42°17.1	14°16.9	7L WB	0450-0505			
#9	30.iv	42°17.2	14°17.1	7L WB	0507-0529			
#10	30.iv	42°13.1	14°18.4	PPR/LIR	0650			Deployment
	30.iv	42°14.8	14°23.2		1942			Recovery
#11	30.iv	42°13.5	14°19.6	FFST	0815			Deployment
	30.iv	42°14.8	14°23.1		1918			Recovery
#12	30.iv	42°14.2	14°21.3	CTD (shallow)	1057-1138	70-70		0-300-5-150-0m
#13	30.iv	42°14.1	14°22.4	CTD (shallow)	1510-1535			
#14	30.iv	42°14.2	14°22.0	7L WB	1628-1642			
#15	30.iv	42°16.7	14°22.0	RMT 8 + CCE	2225			Closing cod-end failed; incorrectly
		42°17.5	14°21.6		2245			rigged
#16	1.v	42°14.2	14°23.2	TWB	0110			20, 40, 60, 100m
		42°14.9	14°24.9		0324			
#17	1.v	42°15.1	14°26.2	MWC	0500-0550	0-100-0		
SEASOAR 2	1.v	42°25.7	14°30.6		0928			Deployment
	2.v	45°5.3	14°2.9		0725			Recovery
11282#1	2.v	45°6.0	14°0.9	7L WB	0850-0910	0-100		
#2	2.v	45°5.9	14°1.8	TWB	1015-1107	40 & 50		
SEASOAR 3	2.v	45°8.2	14°1.5		1218			Deployment
	3.v	47°45.4	13°35.2		0935			Recovery
11283	4.v	49°27.7	12°57.5	B/SNAP	0212			Wrecked during launch

STATION NO	DATE	LAT. (N)	LONG (W)	GEAR	TIME (GMT)	DEPTH	SOUNDING	COMMENTS
11284	4.v	51°1.1	12°59.0	CTD (deep)	1709-1806			
11285	5.v	51°26.1	13°25.7	BN/P	0030	925		
		51°33.3	13°34.7		0406	715		Camera stopped at 0406
		51°33.7	13°37.8		0456	665		
11286#1	5.v	51°0.4	12°58.9	7L WB	0950-1020		c.2000	
#2	5.v	51°0.6	12°58.0	CTD (shallow)	1116-1140	0-600	c.2000	
#3	5.v	51°0.7	12°56.8	7L WB	1149-1258		c.2000	
#4	5.v	51°1.1	12°55.0	LHPR	1322		c.2000	Fine net 80s, coarse 65s, before fish blocked net
		51°10.0	13°07.9		1611			
#5	5.v	50°54.4	12°51.3	CTD (shallow)	1751-1807	0-300	c.2000	
#6		51°0.2	12°58.9	TSST	1820-2146			Rope-stretch
#7	6.v	51°0.5	13°0.1	71 WB	0348-0433		c.2000	
#8	6.v	51°0.7	12°58.3	PPR/LIR	0544		c.2000	Deployment
		51°5.4	12°41.2		1842		c.2000	Recovery
#9	6.v	51°0.1	12°57.3	FFST	0638		c.2000	Deployment
		51°5.2	12°41.5		1924		c.2000	Recovery
#10	6.v	51°0.9	12°58.0	TSST	1150		2042	Deployment
	9.v	51°16.2	12°48.5		1616		1900	Recovery
#11	6.v	51°2.6	12°53.4	CTD (shallow)	1258-1319	0-300	c.2000	
#12	6.v	51°3.2	12°50.4	CTD (deep)	1402-1447	0-1250	c.2000	
11287	6.v	51°1.0	12°58.9	CTD (deep)	1623-1658	0-1000	c.2000	
11288	6.v	51°4.9	12°42.1	LHPR	1950			Fine net 98s (no coarse net)
		50°59.8	12°57.6		2312			Descent samples in Lugols & formalin

STATION NO	DATE	LAT. (N)	LONG (W)	GEAR	TIME (GMT)	DEPTH	SOUNDING	COMMENTS
11289	7.v	51°41.6	14°0.0	CTD (deep)	0708-0732		420	To 10m off bottom
11290	7.v	51°35.8	13°51.9	CTD (deep)	0850-0918		510	To 10m off bottom
11291#1	7.v	51°30.7	13°44.8	CTD (deep)	1048-1130		613	To 10m off bottom
#2	7.v	51°30.9	13°44.3	CTD (deep)	1154-1213		c.600	
11292	7.v	51°28.2	13°39.0	CTD (deep)	1310-1344	690	c.715	To 25m off bottom
11293	7.v	51°22.7	13°31.1	CTD (deep)	1504-1549	916	927	To 10m off bottom
11294	7.v	51°25.1	13°35.3	CTD (deep)	1735-1817	780	790	To 10m off bottom
11295	7.v	51°21.8	13°30.1	CTD (deep)	1940-2115	950	955	To c. 5m off bottom
11296	7.v	51°28.3	13°26.8	CTD (deep)	2132-2204	915		
11297	7.v	51°28.2	13°35.8	CTD (deep)	2311-2346	745		
11298#1	8.v	51°30.0	13°44.6	7L WB	0435-0450			
#2	8.v	51°30.0	13°44.5	7L WB	0452-0455			
#3	8.v	51°30.1	13°44.0	PPR	0540			Deployment
		51°37.1	13°36.1		1855			Recovery
#4	8.v	51°29.9	13°43.9	FFST	0619			Deployment
		51°36.1	13°37.2		1943			Recovery
11299#1	8.v	51°42.3	14°04.8	BN1.5/P	0930	375	c.380	Camera system failed, haul aborted
		51°42.0	14°04.2		0940	380		
#2	8.v	51°40.5	13°59.7	BN1.5/P	1046	400		
		51°38.6	13°49.8		1337	490		
11300#1	8.v	51°35.0	13°41.4	LM	1512-1523			
#2	8.v	51°35.2	13°40.7	CTD (deep)	1547-1615	644		
#3	8.v	51°36.1	13°39.2	MC	1710-1714	662	662	No cores; column bent

STATION NO	DATE	LAT. (N)	LONG (W)	GEAR	TIME (GMT)	DEPTH	SOUNDING	COMMENTS
11301	8.v	51°35.7	13°36.9	LHPR	2015	0-571	c.600	Fine net 60s (no coarse net)
		51°32.9	13°49.1		2227	-0		Samples retained by IOS
SEASOAR 4	8.v	51°39.9	13°58.8		2354			
	9.v	51°31.9	13°45.7	0122				Run aborted; cable problem

KEY

7L WB	7 litre water bottle cast
FSL	Forward-scattering laser system
FFST	Free-floating sediment traps
MC	Multiple-corer
LHPR	Longhurst-Hardy Plankton Recorder
MWC	Mid-water video camera
CR	Corer respirometer
PPR	Primary productivity rig
RMT 8	Rectangular midwater trawl $8m^2$
CCE	Closing cod-end
TWB	Transparent 30 L water bottle
TSST	Time-series sediment traps
LM	Light meter

Figure 1. Track Chart and station positions

Box A 11285
11291#1, #2
11292
11293
11294
11295
11296
11297
11298#1, #2, #3, #4
11300#1, #2, #3
11301

Box B 11284
11286#1, #2, #3, #4, #5,
#6, #7, #8, #9, #10, #11, #12
11287
11288

Box C 11280#1, #2
11281#1-17

Box D 11263#1-10
11267#1-5
11269
11270
11271
11272#1, #2
11272#1, #2, #3
11277#1, #2, #3

Box E 11268#1, #2
11273#1, #2
11274

Box F 11264#1, #2
11265#1, #2, #3
11283

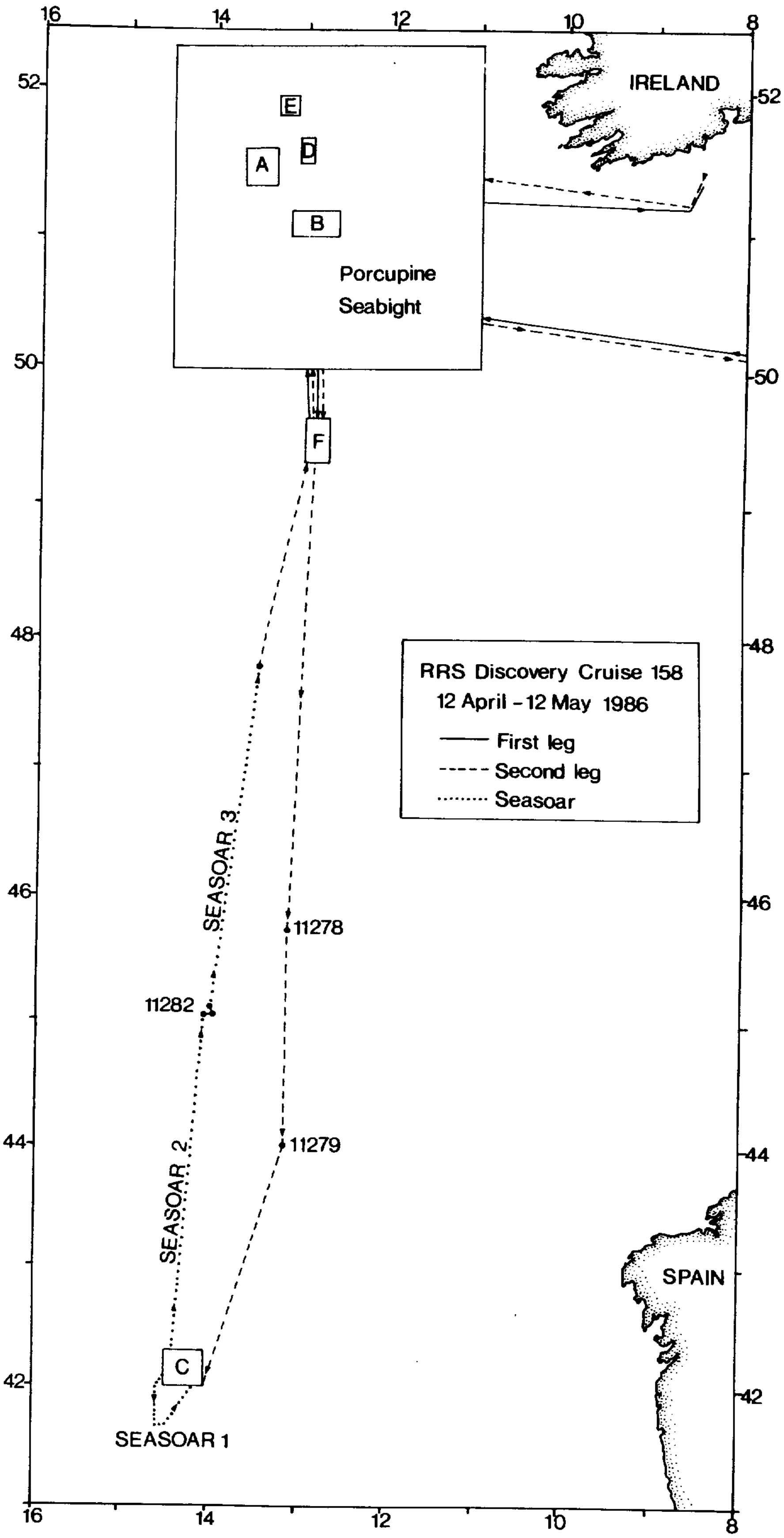
16
14
12
10
8
52
50
48
46
44
42
IRELAND
E
A
D
B
Porcupine
Seabight
F
RRS Discovery Cruise 158
12 April - 12 May 1986
First leg
Second leg
Seasoar
SEASOAR 3
11278
11282
SEASOAR 2
11279
SPAIN
C
SEASOAR 1

Figure 1.

Figure 2. Expanded section from Figure 1. Details of stations in boxes A, B, D and E are listed in Figure 1 caption.

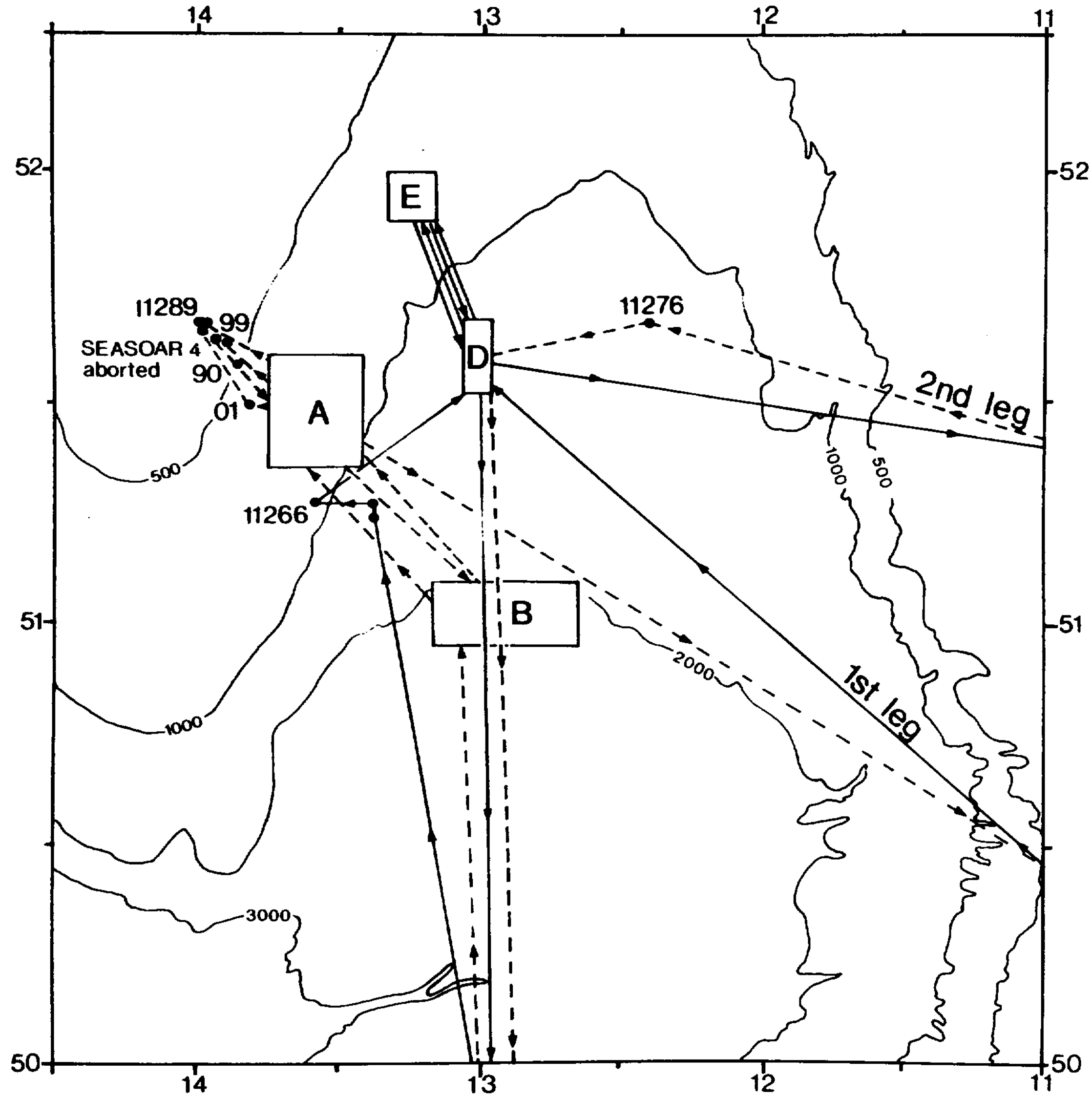
14
13
12
11
52
51
50
E
D
A
B
11289
99
SEASOAR 4
aborted
90
01
11276
11266
2nd leg
1st leg
500
1000
2000
3000

Figure 2.

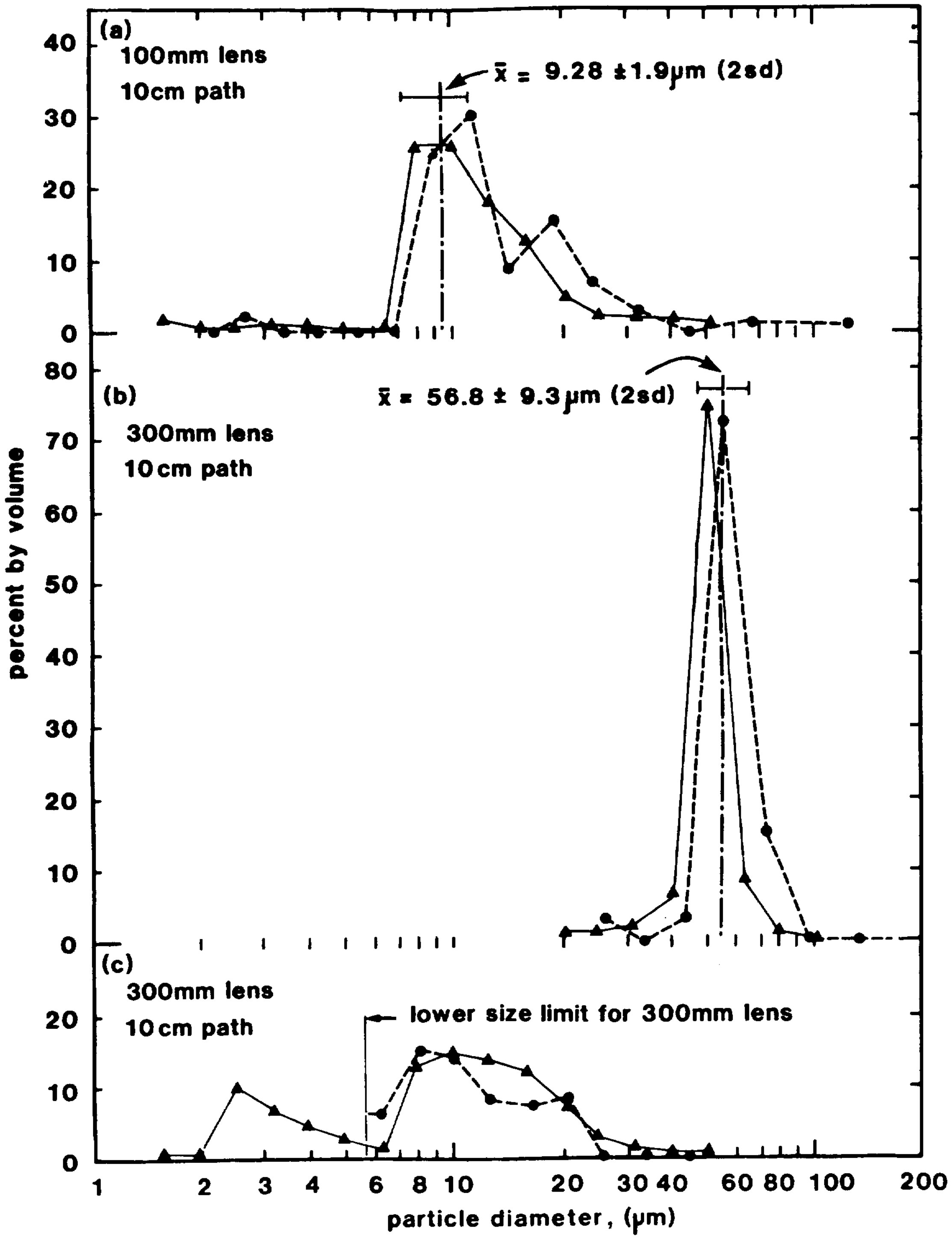

FIGURE 3 - see section on In situ Particle Size Measurements