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CRUISE 5|85

CRUISE REPORT
IMER: MICRON 5 (C2-85)
RVS: CD 2/85

VESSEL RRS Charles Darwin
PERIOD 23 July - 3 August 1985

PERSONNEL

R F C Mantoura (Principle Scientist)	
N J P Owens (First Scientist)	
P H Burkill	
R Williams	
D Robins	
D V P Conway	
E M S-Woodward	
C A Llewellyn	
J Morris	
C Turley	
P Monteiro	
S Miller	
I Bellan	
P Statham	(SUDO)
A Tappin	(IOS-SUDO CASE Student)
J Taylor	(RVS)
B Barrett	(RVS)
W Miller	(RVS)

OBJECTIVES

To investigate the biogeochemical cycling of Nitrogen in contrasting ocean waters along a SW section of the UK Continental Shelf.

To test the deployment, behaviour, structural integrity and recovery of an experimental mesocosm bag (MB) intended for capture of the microbial ecosystem and tracking the passage of N in the microbial loop.

To characterize the SW shelf section in terms of nutrient distribution, pigments, N cycling microbes. To measure fine scale vertical distribution of above parameters at thermocline region of CS-2.

To measure rates of size-fractionated assimilation and regeneration of N species in euphotic,thermocline and deep waters.

To measure the distribution, production and degradation of photosynthetic pigments in various size fractions using HPLC.

To measure the impact of microzooplankton grazing on bacterial and phytoplanktin populations and its effect on N cycling.

To obtain shelf section of dissolved trace metals (Al, Mn, Cu, Cd, Ni, Zn, Pb) distribution and their biogeochemical associations with Nitrogen cycling.

REPORT

* 20 July: IMER personnel and equipment travel to Falmouth. Equipment transfer to RRS Charles Darwin. Arrival of SUDO RVS personnel. Complete installation of additional benching and equipment location.

* 21 July: Final installation and verification of equipment performance including UOR, LHPR, HPLC, O_2 titration, Coulter Counter, Epifluorescence Microscopes ,NO_x, Auto Analyzer, Liquid Scintillation Counter. Assembly of bottle racks. Briefing of Captain on Mesocosm Operations.

* 22 July: 0822 forecast Gale force 8 Irish Sea Lundy Fastnet and Plymouth. TSW Filming cancelled .Bilge pump delivered. Quench curves for LSC completed. Installation of CTD Rosette system and thermosalinograph. Commissioning of incubation systems in CT Room. IMER fume hood and SUDO laminar flow hood commissioned.

* 23 July: 0900 (all times BST) depart Falmouth Dock. Bridge compass calibration. 1000 set on coarse for GL9.Complete calibration and plumbing of thermosalinograph. 1430 UOR deployed using mini winch on aft gantry because main warp not available; undulations down to 35m .UOR recovery 1835 Non toxic sea water supply leak in engine room repaired.

* 24 July:0618 UOR deployed at variable ship speed, recovered 0930. Mesocosm assembly.Replacement of a damaged ring on the mesocosm with a weighted chain.1730 on station GL-9. CTD-Rosette bottle trigger tests completed successfully. Vertical 100m UOR profile.

  CTD-Rosette Deep Profile Trace Metals, nutrients and oxygen (GL-9 VP-1); overboard 2014, inboard 2139; depths : 5,20,30,50,75,100,148,200,400,600, 800 and 1000 m.

  Standard Profile (GL-9 VP-2) comparative chlorophyll, carotenoids and phycobiliproteins profile .Bacterial counts,Lugols (2); depths: 5,10,20,30,40,50,75,100 m. Depart station GL-9 2248 proceeding to GL-7.

* 25 July: Arrive GL-7 0730.Vertical UOR profile 100m,0745 O/B, 0836 I/B. Vertical Hydrocast (GL-7 VP-1)of 7 1 NIO's at 1,5,10,20 and 50 m for primary production using ^{14}C and oxygen . ^{14}C rig deployed 1012.
  0905 60 l hydrocast (GL-7 VP-2) from 5 m for microzooplankton grazing experiment 1012 Trial deployment of dialysis bag rig. PES fish O/B 1100.LHPR deep haul

from midships gantry O/B 1023,I/B 1330. XBT 1400. 1423 Standard Hydrocast (GL-7 VP-3),Nutrients, oxygen, chlorophylls, carotenoids, phycobiliproteins, POC/N, bacterial counts, thymidine production.Depths sampled: 1,5,10,20,30,40,50,75,100,150,200,300,500,1000 m.I/B 1559. 1835 CTD Rosette trace metal oxygen and nutrient hydrocast (GL-7 VP-4) at depths 5,10,20,30,50,100,200,,400,600,800 and 1000 m. I/B 1943. recovery of ^{14}C rig 2040.

* July 26: LHPR Deep Tow, O/B 0011, I/B 0142.DEPART GL-7 (1030) FOR YA-1 monitoring S, T, Fluor, size fractionated continuous filtration . At YA-1 (1500) CTD trace metals, nutrients oxygen vertical profile at 10, 20, 30, 40, 50, 60, 75, 85, 100, 115, 135, 150, 155m. Proceed to YA-2/3 (49° 40.7'N, 08° 00.4'W) arrive (2325) and repeat vertical profiling for similar parameters as in YA-1 at the following depths:10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 105, 111m.

* July 27: Depart YA-2/3 (0029) monitoring S,T,Chlo,size-fractionated continuous filtration. Arrive CS-2 (0710). Vertical hydrocast using the UOR (O/B 0840, I/B 0844). Bottle hydrocast 2 x 30 l surface water for microzooplankton grazing experiment. Hydrocast at 10,30,50 m for preliminary assessement of pigment content.

  Launch mesocosm bag using the midships HIAB crane (1045) and the Zodiak rubber dinghy. Scientists transfered to mesocosm for monitoring the stability and general performance characteristics of the floating collar. Buoyed line connected from stern to mesocosm to simulate tethered sampling lines and providing a means of testing the vessels ability to maintain beam position relative to the mesocosm. Deterioration in weather and visibility halted further experimentation on mesocosm. Mesocosm successfully recovered (1525).

  1600 repetitive hydrocasts using JZ bottles (10,30, and 60m) for microzooplankton dialysis bag experiments and plankton netting for faecal pigment experiments .

* 28 July: Deployed dialysis rig tethered to the stern (0140).Heavy swells and strong winds halted mesocosm deployment.Nutrient analyses of accumulated hydrocast water samples. (0939)Haul in dialysis rig for sampling and release of the rig from the stern(1009). Hydrocast for chlorophyll and phycobiliproteins (1019) from 5, 10, 15, 20, 30, 40, 50m.

  High resolution vertical profiling at CS-2 using the CTD-Rosette and UOR combination to obtain detailed profile of depth, salinity, temperature, fluorescence ,nutrients, pigments (HPLC),oxygen, bacterial counts and activity, ammonifiers, ^{14}C phytoplankton assimilation

,microzooplankton grazing,with emphasis at the thermocline Depths sampled: 1, 5, 10, 15, 20, 23, 24, 26, 27, 28, 29, 30, 31, 32, 34, 35, 36, 38, 40, 45, 50, 60, 70, and 90 m.

Two drops were obtained for the complete hydrocast (CS-2 V01 1430-1520; and CS-2 V02 1700-1804).

Dialysis rig fowled on the PES Fish. Recovered rig. Rig released untethered with Dhan buoy attached.
Trace metal CTD hydrocast (CS-2, V03) , nutrients, oxygen sampled at 5, 10, 17, 22, 27, 31, 40, 50, 60, 70, 80, 95m. O/B 1969, I/B 2036. Haul in dialysis rig for sampling then stern release (2057,2236). JZ hydrocast at 2236.

* 29 July: Weather and seastate unsuitable for deployment of the mesocosm.Recover dialysis bag rig for sampling (0900). Continue laboratory experiments , chemical analyses and data work up. Rig fouled on rudder. One dialysis cradle lost during preceeding incubation. Rig released (2319) anchored to chain clump and dhan buoy.

* 30 July : Winds and seastate marginal for deployement of mesocosm. Commenced CB Leg (0603), CTD hydrocast at stations YA-4 (1030) sampled at depths 10, 24, 30, 40, 59, 73, 85m. YA-5 (1415, depths 10, 19, 30, 40, 50, 62m) and YA-6 (1830 depths 3, 6, 9, 15, 17, 25, 30m), for trace metals, nutrients and oxygen. At CB (1915) collected 2 x 30 l water samples for microzooplankton grazing experiment, pigments and oxygen. Return leg to CS-2, towing UOR from station YA-5.Continuous size fractionated filtration along way.

* 31 July :At CS-2 (0724) discovered the dialysis rig which had parted from the Dhan buoy; both recovered (0811) and after sampling both were reattached and released from the stern (0900). Weather and sea state assessement (0600) favourable for launching of mesocosm. Zodiak launched and mesocosm successfully launched O/B 0912.Bag fully open at 1230 commenced vertical characterization of temperature, chlorophyll and light using repetitive dips of the UOR sensor at 1230, 1830, 2030 and 1230 (1 August). LHPR oblique tow through CS2 at 2 kts 2300-2408.

* 1 August. Final recovery if dialysis rig (0913) followed by JZ hydrocast. Bag retraction into collar was not possible . The bag was therefore lassoed and attached to a clutch of buoys and then detached from the floating collar. The collar was then winched in board (1254) and the bag was trawled in board from the stern (1438). Completed laboratory experiments on pigment grazing and defecation by copepods. CTD trace metal and nutrient hydrocast CS2 V04 (1920 at depths 5, 10, 17, 21, 25, 33, 35, 50, 60, 70, 85, 98m.

* 2 August. Depart from CS 2 (0546) for Falmouth. Equipment dissassembly and packing. Arrive at Falmouth dockside (1648).

* 3 August. Transfer scientific equipment into IMER vehicles.Equipment and personnel travel to Plymouth for unloading and returning of hired vehicles .

STATION POSITIONS OCCUPIED (see Fig. 1)

GL9	47°00'N	12°00'W
GL7	48°00'N	10°oo'W
YA1	48°40'N	09°12'W
YA2/3	49°40'N	08°00'W
CS2	50°30'N	07°00'W
YA4	50°550N	06°09'W
YA5	51°19'N	05°18'W
CB	51°36'N	04°32'W

OUTLINE OF PROCEDURES AND PRELIMINARY RESULTS

A combination of state and rate variables were measured at three reference stations in contrasting waters of the shelf break (GL-7), stratified shelf waters (CS-2) and tidally mixed coastal bay waters (CB).In addition five stations were occupied along a SW-NE transect between 12°W in 4800 m of water and the Bristol Channel (see Chart 1).

1. Biogeochemical Section of the Shelf.A biogeochemical oceanographic section of the deep, shelf edge and continental shelf waters (see Chart 1) was obtained by vertical CTD-Rosette profiling for S, T, NO_3, NO_2, PO_4, Si and NH_4 which were determined by auto analyzer techniques . The oligotrophic levels (≤ 0.1 µM) of NO_3 and NO_2 which were found in mixed surface stratified waters were determined by NO_x chemiluminescence techniques. Dissolved O_2 was determined by computer controlled Winkler titrations. Improved clean sampling techniques which were used for trace metals consisted 12x2.5l Teflon-coated GO-FLO bottles. Samples were pressure filtered and preserved by acidification for subsequent analyses for Al, Cd, Cu, Mn, Ni, Pb and Zn. The vertical distribution of pigments at all stations was determined by ship-board analyses for chlorophylls a, b, and c , their degradation products and the carotenoid pigments using high performance liquid chromatography (HPLC).LHPR tows were carried out at GL-7 and CS-2 for vertical distributions of macrozooplankton dry weghts and pigment partition in the ≥20 µm and 200 µm size fractions. Finally, the concentration of cyanobacterial phycobiliprotein pigments were determined at GL-9, GL-7 and CS-2 using an enzymatic extraction and fluorescence assay. Results are still being worked out.

2. Mesocosm Deployment. Initial results obtained during a 24-hour deployment in the thermally stratified waters of the Celtic Sea showed that the structure of the thermocline including small scale 'inflections ' is trapped and retained almost exactly as that measured outside the enclosure.There was little evidence of a breakdown of the thermocline

over the deployment period which would have been suggestive of a 'pumping' of sub surface water into the surface mixed layer. Two hours after deployment, the chlorophyll fluorescence maximum present at 30 m was also present inside the enclosure although the absolute level was reduced by approximatively 75 %.During subsequent profiles this maximum declined , and elevated fluorescence levels were observed in 5-15 m region. There was no evidence of sedimentation during this period and we consider that the difference in fluorescence was induced by reduced underwater light regime inside the enclosure.During this deployment, a constriction at the surface caused by a failure of a near surface support ring reduced the light penetration inside the enclosure such that the the 1% light level was at ~10 m, rather than at ~30 m observed outside the enclosure.

3.Microzooplankton Trophodynamics:The diurnal cycle of microzooplankton grazing on natural populations of bacteria maintained at near ambient conditions was determined in dialysis bag incubations deployed at 4, 30, and 60 m depths at CS-2. The impact of added grazers on the bacterial production was also assessed by the introductiuon of cultured ciliates into some of the dialysis bags. In parallel to these experiments, the rates of microzooplankton grazing on natural populations of phytoplanton and cyanobacteria was also quantitated in dialysis tank and bottle incubations using the grazing dilution concept together with HPLC determinations of pigment changes.

4. Faecal Pigments and Macrozooplankton Grazing: Natural populations of copepods were incubated in controled grazing experiments on cultured diatoms .Grazing rates were quantitated using classical Coulter particle analyses and HPLC pigment attrition rates measurements and compared to the faecal pigments produced during the incubation. Preliminary results indicate a good agreement between these two independent techniques and that up to 57 % of the chlorophyll a was assimilated by the copepods. The defecated pigments were mostly degraded into pheaophorbide a and pyrochlorophyll a. A similar pattern of degraded pigments were found to maximize at the thermocline indicating that macrozooplankton grazing also occurs near the thermocline.

5. Bacterial Nitrogen Regeneration: Studies into the role of bacterial regeneration of nitrogen as NH_4 were carried out at GL-7 and CS-2. Results are shown in Fig 2 . The temperature profile at GL-7 shows the thermocline to be diffuse , covering a depth range of 50 m. Ammonia concentrations along with numbers of ammonifying bacteria were found to be low in the surface waters. Total bacterial activity and ammonia concentrations increase slightly but there was no significant change in the numbers of ammonifying bacteria observed. In contrast, CS-2 showed a well defined thermocline at 20-30 m. An ammonia peak is apparent at the thermocline and this correlated with peaks seen in the total bacterial activity and ammonifying bacteria. A marked decrease in ammonia in the surface euphotic waters despite increases in total bacterial activity and ammonifying bacteria suggest that ammonia utilization by phytoplankton is far greater than ammonia production.

EQUIPMENT PERFORMANCE

All the major objectives were achieved. The marginal weather conditions limited the opportunities for deploying the mesocosm but did not affect hydrowire operations and the deployment of the UOR and incubation rigs. The BBC-controled CTD system worked very well but we found switching of hydrowires from the conducting CTD wire to the standard hydrowire very cumbersome since it took as much as two hours to complete the respooling, resheathing and tentioning of the wires. We request that the hydrowire winch have a parallel drum capacity as in the RRS Frederick Russel in order to allow rapid change over from CTD to standard hydrowire. The exclusion of sea water from the main laboratories due to the permeable nature of the floor was found to be very restrictive to our chemical and microbiological analyses and experiments which invariably involve handling seawater samples. For future cruises, it is essential that sea water samples be handled in the main and the CT Laboratories. Finally, leakage of the non toxic sea water via stainless steel piping should be rectified.

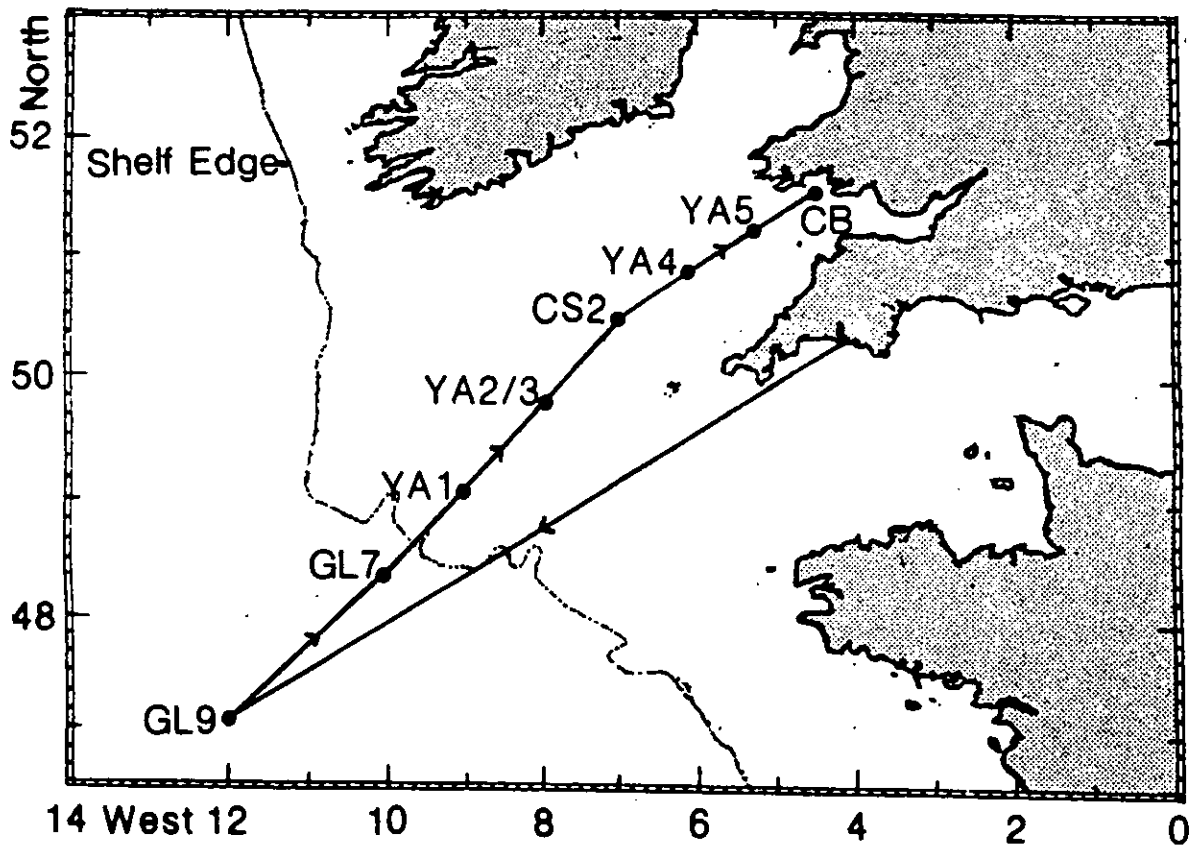
We would like to thank the RVS personnel for their excellent support on the winch and CTD operations, and also the Captain, Officers and Crew for their most successful introduction to the RRS Charles Darwin.

Prepared by R.F.C. Mantoura

Approved by B.L.Bayne

Date: 20 November 1985

Circulation	INTERNAL	EXTERNAL
	B L Bayne	Foxton (NERC-Swindon)
	Cruise personnel (18)	IOS MIAS
	R Warwick	McIntyre (DAFS)
	Notice Board	Skinner (RVS) x2
	File	Denton (MBA)
		Harden-Jones (MAFF)



CB — Carmarthen Bay

Fig 1

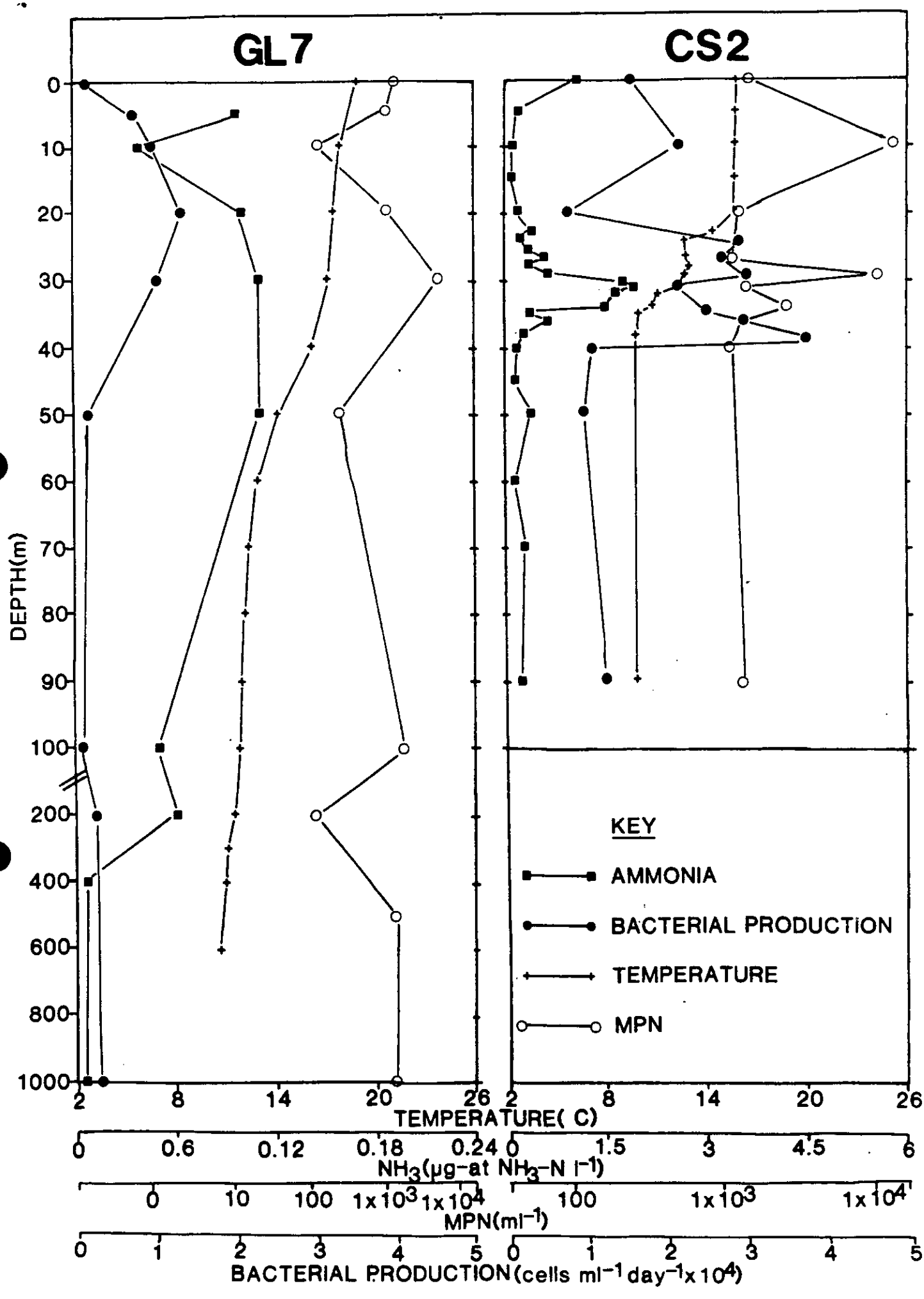

GL7
CS2
DEPTH(m)
0
10
20
30
40
50
60
70
80
90
100
200
400
600
800
1000
KEY
AMMONIA
BACTERIAL PRODUCTION
TEMPERATURE
MPN
2
8
14
20
26
TEMPERATURE(C)
0
0.6
0.12
0.18
0.24
1.5
3
4.5
6
NH3(µg-at NH3-N l-1)
10
100
1x10^3
1x10^4
MPN(ml-1)
1
2
3
4
5
BACTERIAL PRODUCTION(cells ml-1 day-1x10^4)

Fig 2