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CRUISE REPORT
IMER C4/84 MICRON IV 86

NATURAL ENVIRONMENT RESEARCH COUNCIL
INSTITUTE FOR MARINE ENVIRONMENTAL RESEARCH

RVS FR. 17/84

VESSEL — RRS FREDERICK RUSSELL

CRUISE PERIOD — N J P OWENS (PRINCIPLE SCIENTIST)
R F C MANTOURA
P H BURKILL
R WILLIAMS
D V P CONWAY
E M S-WOODWARD
C A LLEWELLYN
J MANNING

ITINERARY

Monday 24 September/ Tuesday 25 September — Load and set up equipment

Depart Plymouth 1745. Set course for GL7

26 September — Passage. Continued setting up equipment

27 September — Arrived GL7 0500

0610 Water bottle cast for in situ rate experiments

0700 Deep LHPR Tow

1100 Deployed in situ rig for simultaneous measurement of ^{14}C, $^{15}NH_4$ and $^{15}NO_3$ assimilation and NH_4 remineralisation and community respiration and photosynthesis by ΔO_2 measurement

1319 Deep water bottle cast (1250m) for standard state variables. Samples taken for nutrients, particulate carbon and nitrogen, chlorophyll, O_2, phytoplankton species identification salinity and ^3H-Thymidine incorporation.

2140 Diurnal time series experiment started

2230 Commenced GL7 - CS2 transect

28 September — Continued GL7 - CS2 transect. Vertical profiles at :-

YA1	48°40.0'N	09°12.0'W	0521
YA2	49°19.9'N	08°25.1'W	1302
YA3	49°59.1'N	07°37.9'W	1928

at each station 11 depths were sampled for standard state variables

29 September

0031 Arrived CS2 ended transect

0530 Water bottle cast for rate measurements

0647-0728 LHPR

0757 in situ rig deployed

0845-0940 High resolution vertical profile

1635 in situ enclosure deployed

2000 in situ enclosure recovered

30 September — Hand netting at intervals for Acantharia Nitrogen and Phosphorus stimulation (ΔO_2) experiments performed. Water bottle casts at intervals for rate experiments.

1 October

0845 Surface water bottle cast for experimentation

1135 Vertical profile for Acantharia distribution. Hand netting at intervals μ-zooplankton grazing experiment

	1300 deployed in situ enclosure 1430 recovered in situ enclosure
2 October	Hand netting at intervals. Size fractionated ΔO_2 and NH_4 remineralisation (isotope dilution experiment commenced. Autotrophic uptake of ^{14}C, $^{15}NH_4$ and $^{15}NO_3$ and photosynthesis and respiration (ΔO_2) experiment commenced on Acantharians 1930 commenced diurnal time series experiment 1930 commenced CS2 - BC transect.
3 October	Continued CS2 - BC Transect Vertical profiles at :- YA4 50°55.0'N 06°08.9'W 0105 YA5 51°19.3'N 05°18.0'W 0657 1330 completed CS2 - BC transect. Anchor in Carmarthen Bay. Completed rate experiments
4 October	0515 Vertical profile for rate and state measurements 0715 Deployed in situ rig. μ-zooplankton feeding experiment Nitrogen and phosphorus stimulation (ΔO_2) experiment 1900 recover in situ rig. Set course for Falmouth
5 October	Termination of 24-hour rate experiments 0930 Dock Falmouth Dock and prepare for return to Plymouth
6 October	1030 Disembarked Falmouth and returned to Plymouth

OBJECTIVES 1) To investigate the role of the microbiota in primary production and nutrient recycling processes in contrasting shelf waters.

(a) To measure the vertical and horizontal gradients of major and trace inorganic nutrients

(b) To measure size-fractionated nitrogen assimilation, nutrient regeneration and respiration processes

(c) To measure the vertical and horizontal distribution of photosynthetic pigments using HPLC.

(d) To measure the fine scale vertical distribution of inorganic nutrients, oxygen and the biota.

(e) To measure the relative biomass of macro and microzooplankton

(f) To measure the variations in natural abundance of ^{15}N and ^{13}C in trophic compartments in contrasting shelf waters

(g) To investigate the feasability of the deployment and recovery of large (3m diameter x 40m depth) enclosures at sea.

OUTLINE OF PROCEDURES AND METHODS

A combination of rate and state variables were measured at three major stations in contrasting shelf waters :- shelf break, shelf and inshore coastal. In addition five stations were established along a transect running approximately SW-NE between the shelf break and the Bristol Channel (see chart).

At each station major state variables were measured on water samples obtained by water bottle casts. At the majority of stations 10-15 depths were sampled, however, at CS2 21 depths were sampled in a high resolution vertical profile. Measurements included : NO_3, NO_2, SiO_4, PO_4 and NH_4 (by standard colourimetric techniques) and at CS2, NO_3 and NO_2 by chemiluminescence techniques; O_2 by high precision Winkler titration and photosynthetic pigments by HPLC. All the above variables were measured on board the vessel. Samples were also obtained for the later analysis of algal species, salinity, particulate carbon and nitrogen and bacterial biomass. A total of 97 water samples were analysed in this way.

At the three major stations occupied, simultaneous in situ rate measurements of ^{14}C - HCO_3 assimilation, $^{15}NH_4$, and O_2 production and removal and NH_4-regeneration (by ^{15}N isotope dilution) were also carried out. 5 depths, 0-25m, were investigated. In these incubations the particulate material was size fractionated (< 5µm, <5>0.8 and <0.8>0.2 µm) after the incubation period.

A number of other experiments were also performed. These included the grazing of natural concentrations of bacteria by microzooplankton. The effect of the addition of NH_4, NO_3 and PO_4 on O_2 production and consumption and simultaneous respiration and NH_4 regeneration in size-fractionated samples. At CS2 the eco-physiology of the Acantharian - algal assemblage was investigated further by a series of dual ^{14}C and ^{15}N isotope and Δ O_2 experiments. Diurnal variations (~30-48h duration) in nutrient concentration and O_2 production and consumption were investigated using 1000 l tanks held on deck.

Macro-zooplankton (200µm) abundance was estimated by oblique LHPR hauls. At G 7 the LHPR haul was from 1000m to the surface with 30m discrimination from 1000m to 80m and ~6m from 80m (24 samples). At CS2 (110m - surface) the haul consisted of 35 samples with 5m discrimination from 110m to 40m and 2m discrimination thereafter to the surface. All samples were washed off the nylon gauze at sea and immediately divided using a Folsom splitter to provide aliquots for preservation (83 samples) and derivation of dry weights (52 samples).

In addition to on-site investigations, a 310 nautical mile transect from the shelf break (~2000m depth) to shallow coastal water (~20m depth) was also carried out. A number of continuous measurements were made on surface waters. These included : T°c, S°/oo, nutrients (CS2 - BC only) chlorophyll fluorescence. A new 'on-line' system for continuous particle size fractionation was also commissioned. Twenty-one stations were sampled from the shelf break to the Bristol Channel. 251 were filtered at each station with a reduction to 51 at the Bristol Channel stations.

EQUIPMENT PERFORMANCE & OVERALL CRUISE SUCCESS SUCCESS

All major objectives were achieved. No time was lost due to bad weather although at times sea conditions were moderately rough. All IMER equipment worked satisfactorily, including the new on-line filtration system, apart from one submersible-pump switch which

became waterlogged. RVS equipment performed satisfactorily apart from an initial problem with NIO water bottles; this was rectified with IMER spares. The deep LHPR haul was hampered because there was no PES III fish available for this cruise.

IMER's in situ enclosure was deployed and recovered successfully on two occasions (see plates). The first recovery was achieved with some difficulty due to the collapse of support-hoops; this can be rectified easily by relatively straight-forward modifications. It is felt that the enclosure is a viable proposition for future research projects.

The assistance of the Master, Officers and crew was excellent and is gratefully acknowledged. The assistance of the DAFS laboratory for the loan of a flotation collar is also gratefully acknowledged.

PRELIMINARY RESULTS

Temperature structure was apparent between GL7 and YA4-YA5. This was most marked at CS2 where a 5°C thermocline existed over a narrow depth range (30-38m - see figure 1). A slight temperature inversion at the thermocline at CS2 was also apparent (see inset figure 1) indicating the onset of thermocline breakdown expected at this time of year. The thermal structrue was less marked at the shelf break where a 3°c thermocline was observed over 50m. Temperature structure broke down between YA4 and YA5, however, this was not manifest by a marked change in temperature at the surface. This was masked by the effect of a relatively warm water, low salinity discharge from the Bristol Channel.

Coinciding with the vertical temperature structure were marked variations in many of the state variables (see figures 2,3, and 4). Nutrient depleted conditions typical of summer months were still in evidence at CS2. The mean NO_3 and NO_2 concentrations for the euphotic zone (0-30m) were, respectively, 8 nmoles NO_3-Nl^{-1} and 2 nmoles NO_2-Nl^{-1}. These low values imply potential, severe nitrogen limitation of the phytoplankton. These concentrations are below the detection limit of 'classical' colourimetric techniques.

The vertical distribution of photosynthetic pigments in phytoplankton at CS2 is shown in Figure 3. The broad chlorophyll a maximum spread over the 30-40m thermocline is mainly associated with chlorophyll b indicating the dominance of Chlorophyceae and Prasinophyceae a less pronounced contribution from chlorophyll c1 and c2 containing diatoms and dinoflagellates. Phaeophorbide a which is a breakdown product of zooplankton grazing on phytoplankton, also shows maxima at the thermocline.

O_2 concentrations also exhibited a fine-scale structure at the thermocline at CS2 (see figure 4). A slight elevation of O_2 was apparent at the surface followed by a relatively constant O_2 concentration to the thermocline. At the upper thermocline margin a marked decrease in oxygen concentration was observed suggesting a localised area of enhanced respiration compared with the waters above. Below the thermocline O_2 concentrations fell markedly and were relatively constant. This profile is similar to O_2 profiles obtained during summer months.

More information will be obtained when these data are converted to percentage saturation by taking into account temperature. The results of an in situ production experiment are shown in Table 1. These data show that photosynthesis occurred throughout the water column to 25m and that even at 25m positive net production occurred.

Dry weight profiles from the two LHPR tows are shown in figure 5 and are compared with the temperature structure. In terms of dry weight there was approximately 2-3 times the biomass of zooplankton at CS2 compared with the shelf break. Also, at CS2 considerably more variation was observed in the surface waters than at GL7. This may be a reflection of the finer resolution of sampling at CS2. At both stations the surface waters were dominated by copepods. The secondary maximum observed at CS2 (~70m) was also comprised predominantly of copepods. A secondary dry weight maximum was also observed at GL7 (130m-260m - not shown) but was due to the abundance of euphausiids.

PREPARED BY N. J. P OWENS

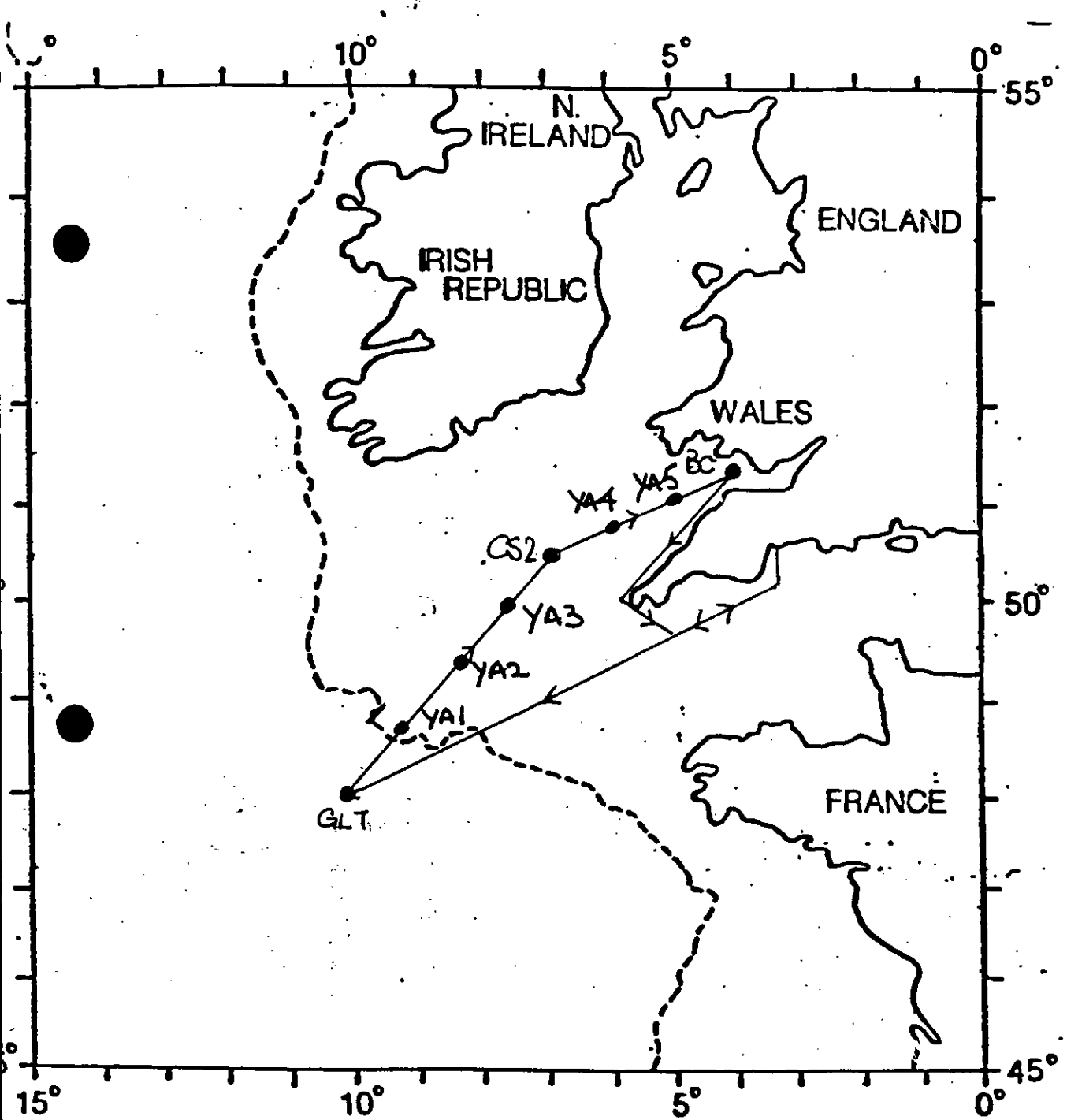
APPROVED BY B. L. Bayne

DATE 1 November '84

CIRCULATION:

INTERNAL	EXTERNAL
B L Bayne	Foxton (NERC- Swindon)
Cruise Personnel (8)	Mrs Edwards (IOS - MIAS)
I R Joint	McIntyre (DAFS)
R Warwick	Skinner (RVS) - (2)
Notice Notice Board	Denton (MBA)
File	Harden-Jones (MAFF)

RRS FREDERICK RUSSELL FR 17/84 25th SEPT - 6 OCT. 1984
NJ POWELL



STATION POSITIONS:

GL7 48° 00'N 10°00'W

CS2 50° 30'N 7°00'W

BC ~ SWANSEA BAY -

PLATES 1 & 2. IMER OFFSHORE ENCLOSURE. WHEN DEPLOYED AND FULLY EXTENDED ENCLOSURE MEASURES 3M DIAMETER, 40M LENGTH.

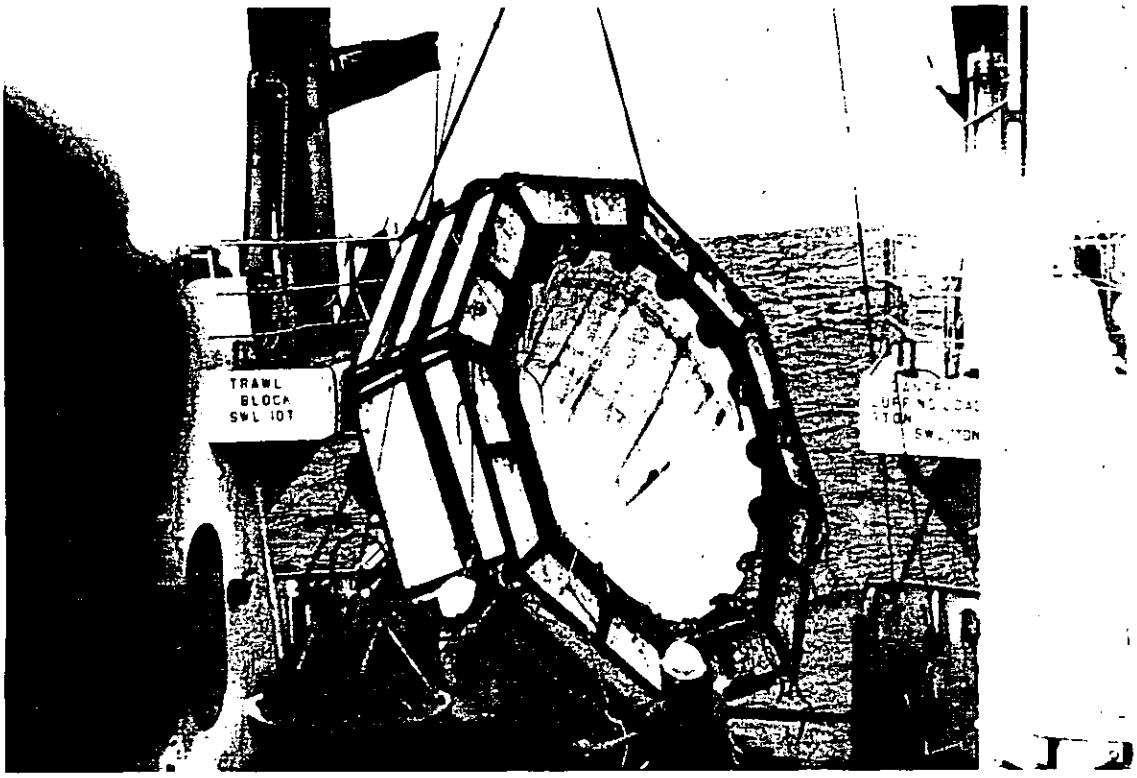


Table 1. A depth profile of gross and net photosynthesis determined by high precision O_2 system on 27 September 1984 at station GL7 (48°00'N 10°00'W). Bottles were incubated between 1145 and 1900 at the depths indicated on the in-situ rig

Depth (m)	Gross Photosynthetic Rate ($\mu M\ O_2 . h^{-1} . h^{-1}$)	Net Photosynthetic Rate ($\mu M\ O_2 . L^{-1}\ h^{-1}$)
0.5	1.481	1.181
5	1.926	1.551
10	1.375	1.199
15	0.774	0.462
20	1.224	0.889
25	0.927	0.767

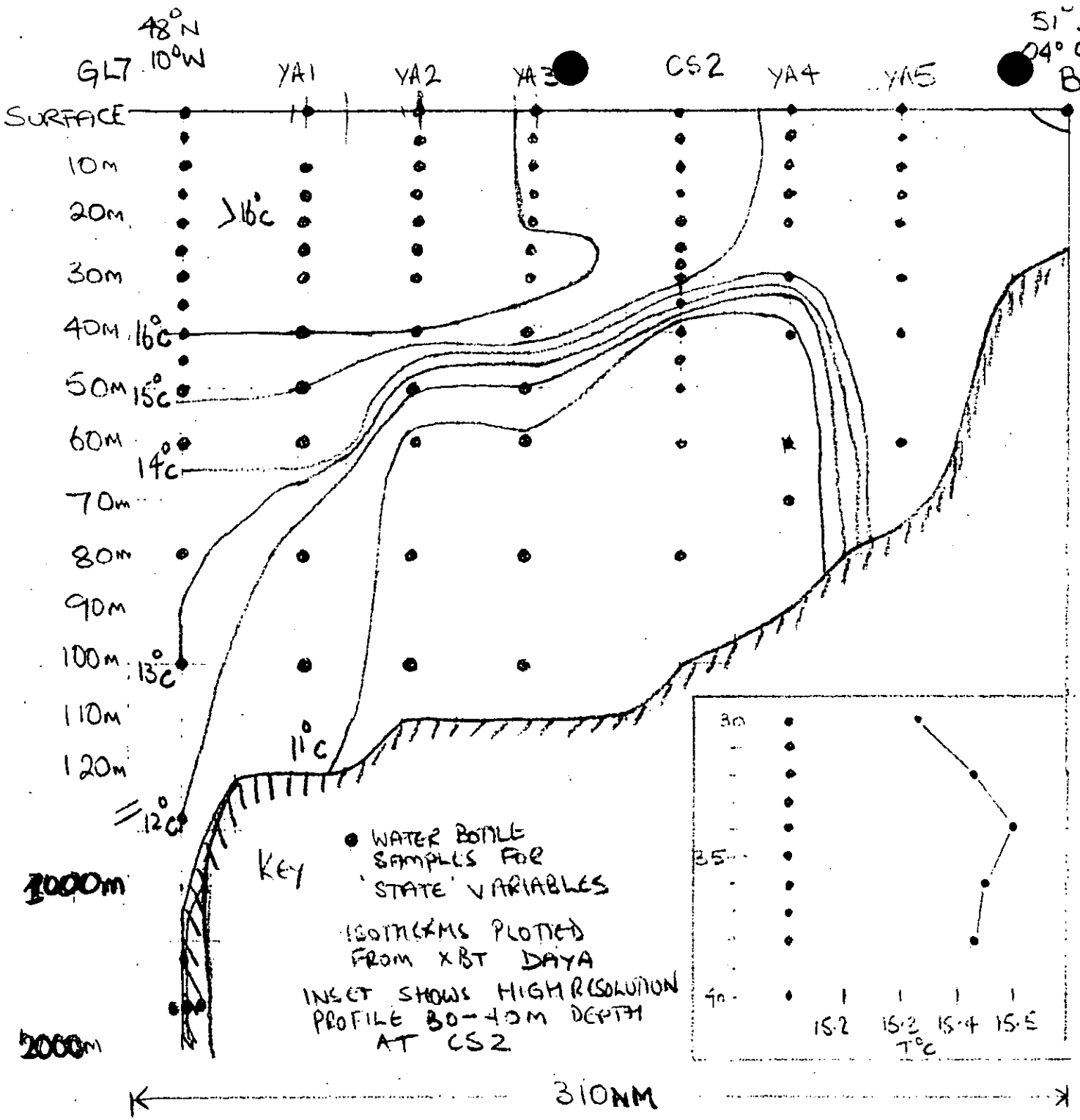


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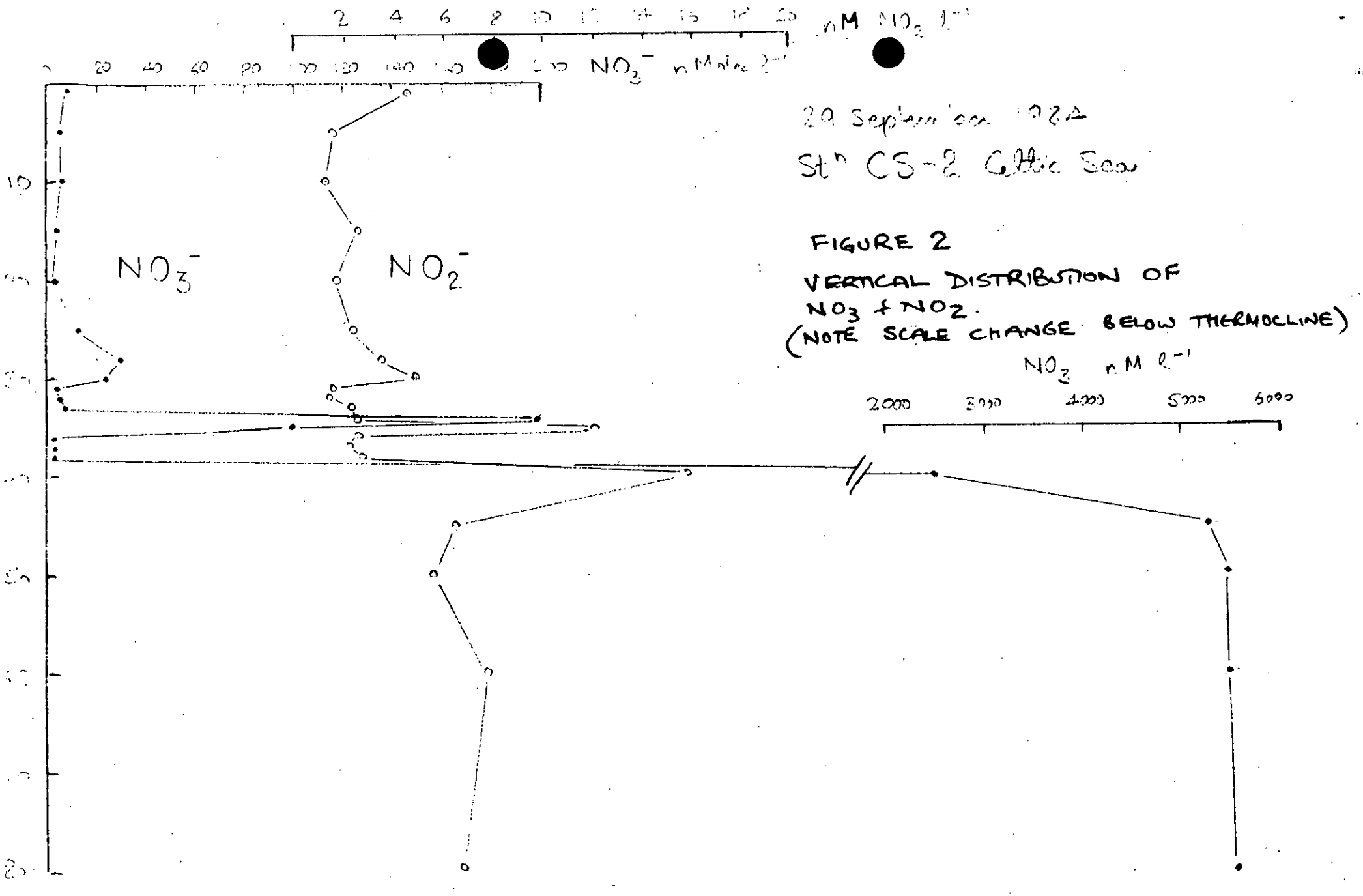
FIGURE 1.

TEMPERATURE STRUCTURE ON TRANSECT GL7 → BRISTOL CHANNEL.

27 SEPT – 3 OCT 1984.

INSET SHOWS FINE STRUCTURE AT CS2.



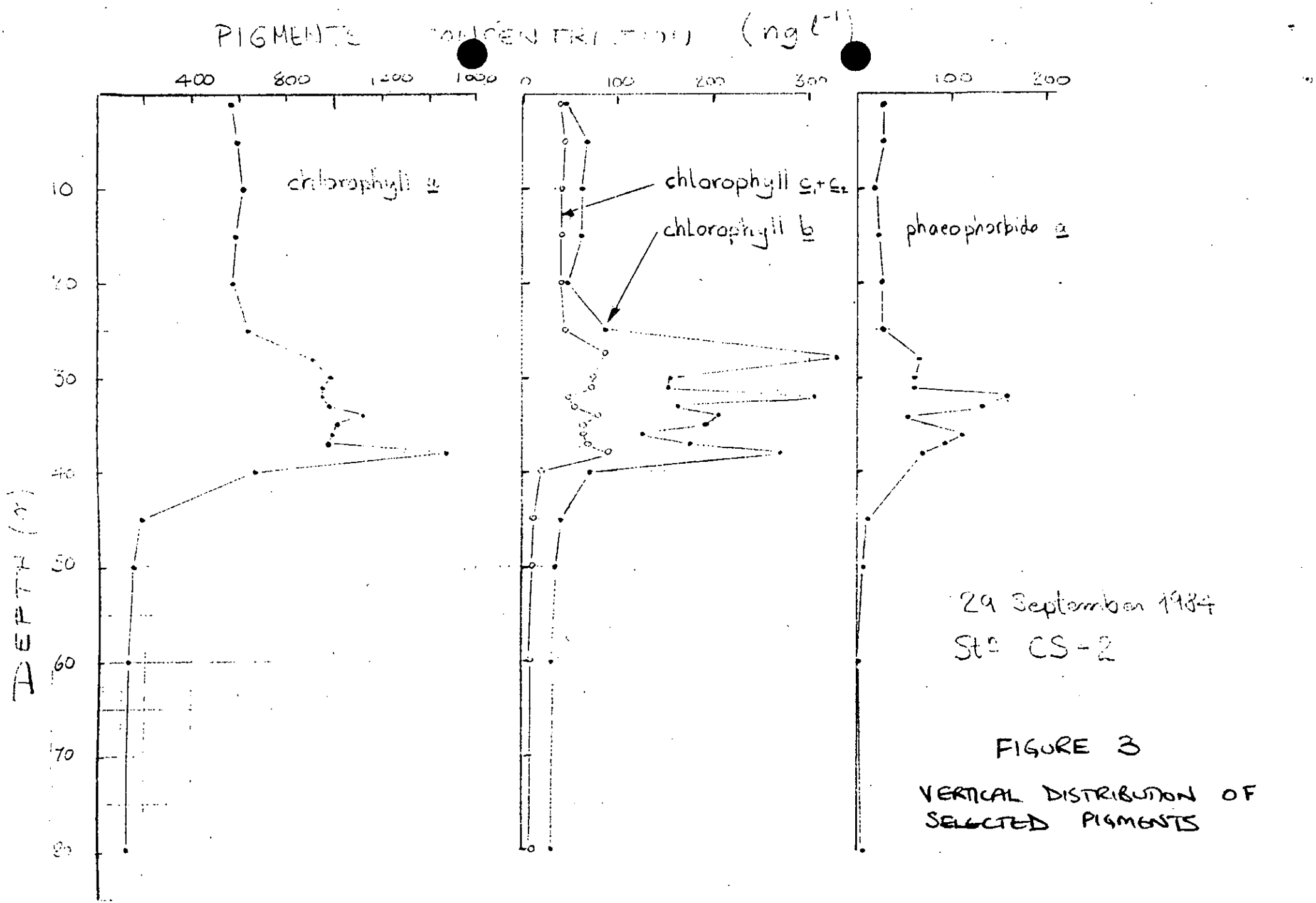
29 September 1974

St^n CS-2 Celtic Sea

FIGURE 2

VERTICAL DISTRIBUTION OF NO_3 & NO_2.

(NOTE SCALE CHANGE BELOW THERMOCLINE)

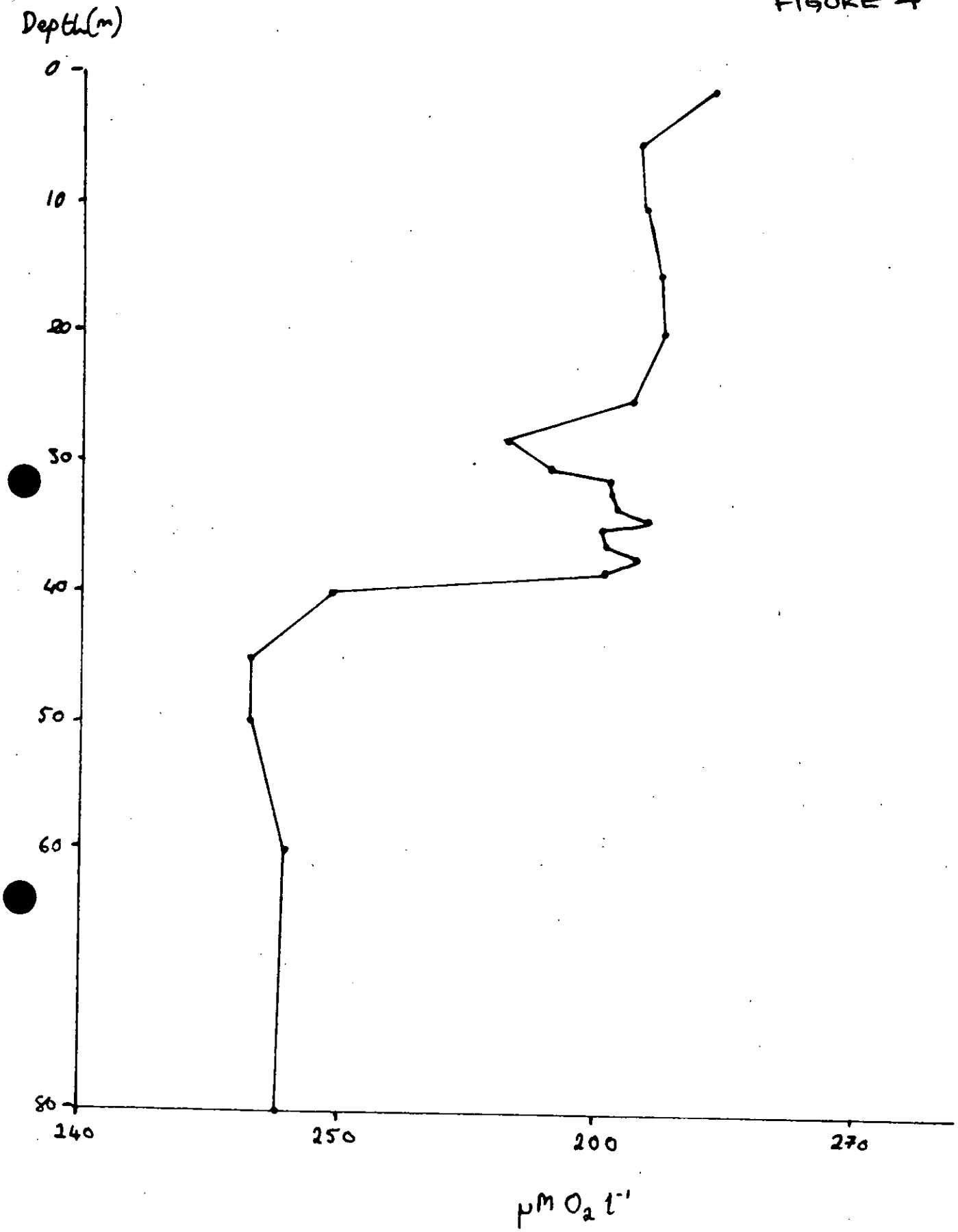


29 September 1984
Stn CS-2

FIGURE 3

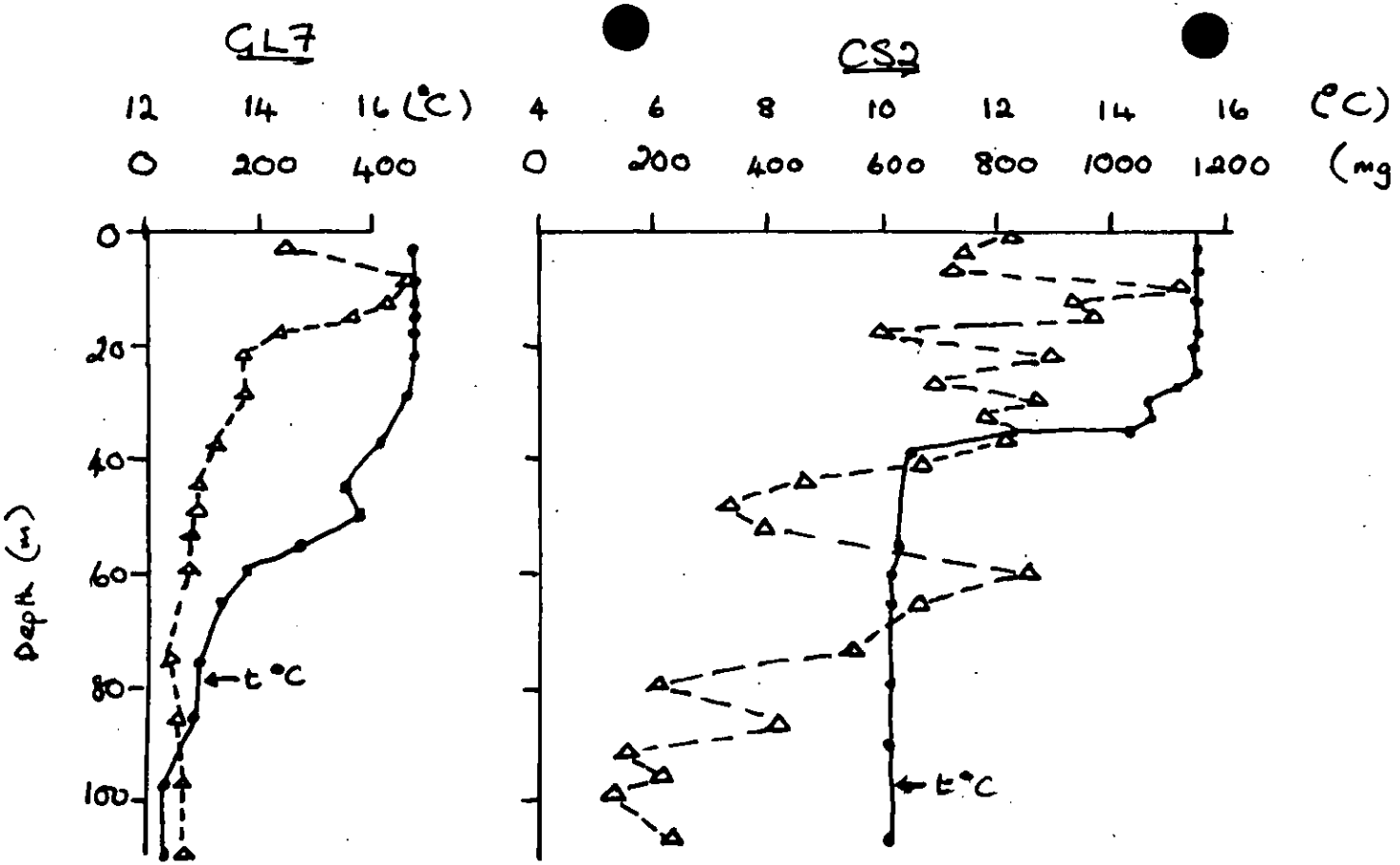
VERTICAL DISTRIBUTION OF SELECTED PIGMENTS

FIGURE 4



VERTICAL DISTRIBUTION OF OXYGEN CONCENTRATION
29 SEPTEMBER 1984 STATION CS 2

FIGURE 5



VERTICAL DISTRIBUTION OF >200μm ZOOPLANKTON DATA EXPRESSED AS TOTAL DRY WEIGHT AT STATIONS GL7 and CS2