VESSEL: RRS FREDERICK RUSSELL

CRUISE PERIOD: 27 June - 8 July 1983

PERSONNEL:

P H BURKILL	Principal Scientist
R F C MANTOURA	
N J P OWENS	
M B JORDAN	
E M S WOODWARD	
J A STEPHENS	
C A LLEWELLYN	
C A SIMPSON	

ITINERARY: See attached chart

Sun 26 June	Travelled to Falmouth, loaded gear.
Mon 27 June	Sailed at 0900 for Crow Sound, Scillies to await scientific supplies.
Tue 28 June	Depart Crow Sound for CS2, towing UOR on transect and mini-grid around CS2.
Wed 29 June	Arrived CS2 (50° 30'N; 07°00W) at 0415. Drogue buoy launched at 0434. Commenced 36h vertical profile time series of nitrogen cycling components (chloropigments and carotenoids, bacteria, microzooplankton, phytoplankton, particulate nitrogen, particle size and abundance nutrients) with profiles at 0730, 1220, 1820; each profile preceded by in situ chlorophyll fluorescence drops. In-situ incubation rig deployed at 1037 and recovered at 2136 for primary production and nitrogen assimilation/regeneration experiment. Sedimentation rig deployed at 1310. Thymidine incorporation experiment.
Thurs 30 June	Vertical profiling time series continued with drops at 0002, 0710, 1223 and 1815. In-situ rig incubations carried out (0953-2135) for ^{14}C primary production and ^{15}N nitrogen assimilation/regeneration determination. Thymidine incorporation experiment.
Fri 1 July	30-L bottle hydrocast at 0534 to provide water for experiments. Size fractionated algal biomass estimates from hydrocast water. In-situ rig incubations carried out (0725-2014) for phytoplankton viability ^{14}C chlorophyll a experiments. New pump check out and deployed for fine resolution vertical water sampling. Simulated in situ primary production and respiration experiments by oxygen technique. Microzooplankton grazing experiment.
Sat 2 July	Intercomparison trials between pump and water bottles (0630-1055). In-situ rig incubations carried out (0902-1910) for ^{15}N nitrogen preference index of phytoplankton. Vertical light profile measurements (1204-1234). Trials of pumping while underway (1305-1436). Sedimentation trap and drogue buoy recovered (1615 and 1858). Set course for GL7 on south westerly transect (1910), towing UOR from 2100. Working watches transect for T/S, Turner fluorometer, nutrients, coulter, chloro-

pigment $^{14}N/^{15}N$ natural abundance, Acridine and Lugol's samples at 30 minute intervals

Sun 3 July — On transect between CS2 and GL7 continuing sampling programme as above. Catching up sample analysis backlog. UOR recovered at station GL7 (48°N 0940'W) at 1413. Pumping system deployed (1438) to collect water for experiments for euphotic zone characterization; completed 2330.

Mon 4 July — In-situ rig incubation (0936-2137) for ^{14}C primary production and ^{15}N assimilation/regeneration experiments. In-situ chlorophyll fluorescence profile (0952-1015); hydrocast to 1500 metres (1038-1200) for analysis of particulate size and abundance, $^{14}N/^{15}N$ natural isotope ratio, oxygen, nutrients, chloropigments and particulate nitrogen. Vertical profiles of light obtained (1221-1257; 1511-1600). Di-nitrogen fixation experiment. Quit GL7 at 2315 towing UOR for CS2.

Tues 5 July — En route to CS2, towing UOR. Sample backlog analysis.

Wed 6 July — Arrived CS2 (0510). Vertical profiling of chlorophyll fluorescence and 30-L bottle drop (0630-0908; 2028-2046) for experiments and in-situ oxygen. In-situ rig deployed (1112-1320) for $^{15}N\text{-}NH_4$ kinetics ^{14}C methylamine kinetics experiment. Thymidine incorporation experiment. Di-nitrogen fixation experiment. Cartoenoid photophysiology experiment. Microzooplankton grazing experiment. Simulated in-situ photosynthesis/respiration oxygen experiment. Inter comparison of pumped water with bottle water (1415-1650).

Thur 7 July — Vertical profile of in situ chlorophyll fluorescence (0610-0630) and hydrocast (0700-0735) for experimental purposes and in-situ oxygen profiles. Photosynthetic quotient $^{14}C\text{-}O_2$ experiment. Quit C22 at 0800 for Plymouth.

Fri 8 July — Lock in at Plymouth at 0300. Unload gear and disperse.

OBJECTIVES:

1) To continue investigations of nitrogen cycling processes in the euphotic pelagic microbial food web in stratified oligotrophic shelf waters.

a) To measure vertical gradients of trace dissolved nitrogen (NH_4, NO_3, NO_2), particulate nitrogen and microbial nitrogen (phytoplankton, bacteria and microzooplankton).

b) To measure nitrogen assimilation by phytoplankton and their primary production.

c) To measure nitrogen regeneration by bacteria and microzooplankton, and bacterial production.

d) To measure microzooplankton grazing on bacteria and phytoplankton.

e) To measure microplankton community photosynthetic and respiratory activity.

f) To measure sedimentation rates from the euphotic zone.

2) To continue a seasonal study of phytoplankton at Station A1 (co-operative IMER/MBA project).

PROCEDURES AND METHODS

The objectives were met by a variety of measurements of states and rates of nitrogen fluxing performed largely by experiments in situ or on board ship. To acheive continuity between measurements of water column constituents, a drogue buoy was deployed at the station to provide a sampling marker. The vertical gradients of trace dissolved nitrogen were determined by shipboard autoanalysis techniques while particulate and microbial nitrogen were fixed or frozen for later analysis at Plymouth. The vertical fluxing of particulate nitrogen across the thermocline was measured using DAFS, Aberdeen sedimentation traps situated above and below the thermocline for a 3-day period. Nitrogen assimilation and primary production were determined using in-situ incubations of natural samples spiked with ^{15}N and ^{14}C; samples were size fractionated (>5µm; 5-0.8µm; 0.8-0.2µm) after incubation to provide characterization of autotrophy. Nitrogen remineralization by bacteria and microzooplankton were estimated by ^{15}N isotope dilution techniques simultaneously with nitrogen assimilation. Bacterial production was determined by ^{3}H-thymidine incorporation while microzooplankton grazing was estimated by dilution response incubations of natural communities. Microplankton photosynthesis and respiration rates were determined using microprocessor controlled photometric Winkler titrations of dissolved oxygen.

To provide comparison with the thermally stratified stable water column at CS2, a less stable shelf break station (GL7) was also investigated.

EQUIPMENT PERFORMANCE

Three new systems involving complex laboratory equipment (microprocessor controlled photometric titration system; photopigment HPLC; Varian GC) were taken to sea for the first time and all can be considered sea-commissioned. During the early part of the cruise, operational procedures of the titration system had to be considerably modified since only ca 50% of titrations could be satisfactorily concluded; these problems were later ironed out.

The absence of any thermosalinograph paper and the breakage of some glassware in transit from Plymouth to Falmouth necessitated a delay of 1 day in the Scilly isles to await supplies. On station, the majority of equipment performed well; exceptions were the intermittent malfunctioning of both the in-situ chlorophyll fluorescence sensor and the UOR. Of 5 tows of the UOR, the temperature system failed for 2½ tows and the chlorophyll system failed for 3½ tows. The trace nitrogen chemiluminescence analyser (NO_x) and the temperature channel of the thermosalinograph were completely non-functional. The drogue was found to be missing on recovery of the marker buoy at CS2; it is not known when this occurred. One set back that was not discovered until our return to Plymouth concerned the ^{14}C stocks used for primary production and other incubations which proved to be of dubious quality. It is not yet known how reliable the ^{14}C data will be.

The Principal Scientist would particularly like to thank Mr A Nutty (MBA) for his skillful glasswork and Dr J Davies (DAFS Aberdeen) for the loan of sedimentation traps for this cruise.

PRELIMINARY RESULTS

The water columns at CS2 and GL7 differed considerably in terms of their vertical structure. At CS2, a strong thermocline with temper-

ature gradients up to 1.5°C.m^{-1} between 25 and 35 metres, dominated the base of the euphotic zone; at the GL7, the temperature gradient was an order of magnitude lower and the bottom of the weak thermocline was indistinct, indicative of stronger vertical mixing. At both sites, phytoplankton biomass in the euphotic zone was low typically 0.3-0.4µg.l^{-1} at CS2 and often below the detection capability of the in-situ fluorometer at GL7. At CS2, the phytoplankton showed a characteristic thinly distributed maximum (3-6µg chl-a l^{-1}) situated within the thermocline at ca 11°C. Sedimentation traps situated at ca 25 and 50M depth revealed that considerable quantitities of material were settling out from the thermocline region with little settlement occurring into the upper trap situated above the chlorophyll maximum. This pattern of differential settlement would occur if there is growth and/or grazing of phytoplankton at the chlorophyll maximum. Vertical profiles of oxygen show a maximum (ca 8500-9500 µgO_2.l^{-1}) at 30M suggesting that autotrophic production predominates over heterotrophy at this depth. This implies strongly that the deep chlorophyll maximum is actively growing. Oxygen flux experiments support this idea since they suggest that the compensation depth for the microplankton population occurs at ca 35M ie below the chlorophyll maximum. These O_2 flux incubations reveal a balance strongly in favour of autotrophy at depths between 30 and 5 metres; heterotrophy predominates at 1M partly due to severe photo respiration by phytoplankton under the very sunny conditions experienced. The implications for nitrogen cycling processes suggest assimilation of nutrients between 5 and 30 M while net remineralization would be anticipated in surface waters and below the phytoplankton maximum.

CRUISE SUCCESS

The cruise was highly successful, particularly bearing in mind the nature of the research undertaken. The weather was very favourable throughout. The rearrangement of the cruise to start from Falmouth (instead of Plymouth) resulted in our work at Station A1 being dropped from the cruise programme.

Prepared by: P.H. Burkill
Approved by: B.L. Bayne
Date: 3 Nov 1983

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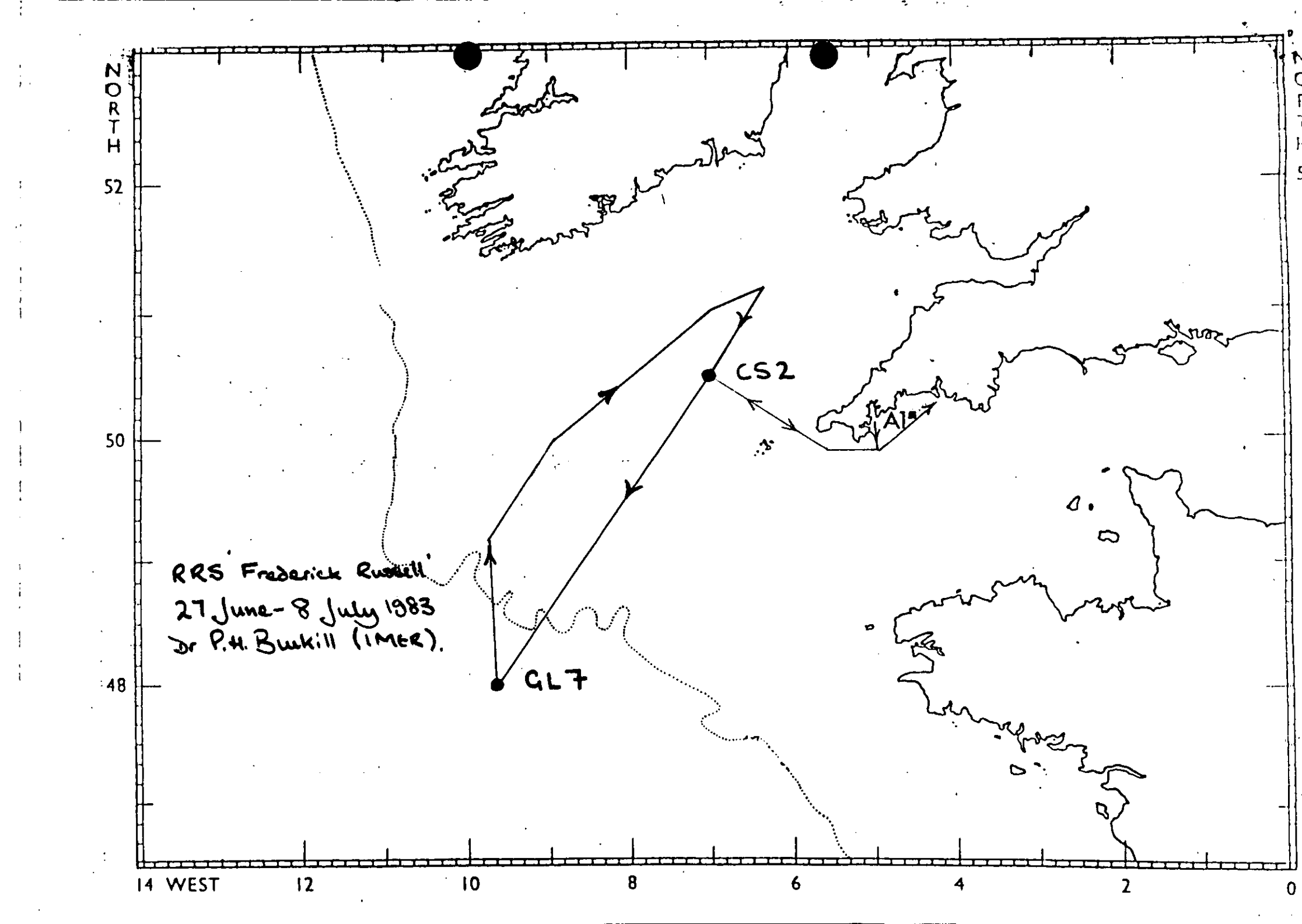
NORTH
52
50
48
14 WEST
12
10
8
6
4
2
0
CS2
A19
GL7
RRS Frederick Russell
27 June - 8 July 1983
Dr P.H. Burkill (IMER).