NATURAL ENVIRONMENT RESEARCH COUNCIL
INSTITUTE FOR MARINE ENVIRONMENTAL RESEARCH

CRUISE REPORT
IMER/2/84
RVS Ref FR9/84

VESSEL — RRS FREDERICK RUSSELL

CRUISE PERIOD — 19 May to 2 June 1984

PERSONNEL
R Williams (Principal Scientist)
I R Joint
S H Coombs
D V P Conway
D B Robins
A J Pomroy
C M Hoyle
T D Griffin

ITINERARY

Friday 18 May	Loaded equipment
Saturday 19 May	1900 departed Falmouth and set course for 49° 15'N 06° 00'W 2100 UOR trials.
Sunday 20 May	0100 UOR trials completed. 0700 Station 1. Commenced station work. (Fig. 1)
Monday 21 May	0200 Completed station work. 0600 Shot UOR and commenced a transect at 8.5 kts to 13° 00'W.
Tuesday 22 May	1400 Completed transect at Station 2. (49° 15'N 13° 00'W) and started station work. 1700 Completed Station work and set course. for Station 3 at 49° 15'N 09° 30'W.
Thursday 24 May	0800 Commenced Station work.
Saturday 26 May	2200 Completed work on Station 3 set course for Penzance.
Sunday 27 May	1300 Scientist put ashore with Penzance pilot boat. Set course for 09° 30'W. 1620 Shot UOR.
Monday 28 May	0930 UOR inboard at Station 3. Commenced sampling. 1000 Completed station work deployed UOR and set course for 49° 15'N 10° 30'W, Station 4. 1400 Arrived station 4 recovered UOR and started station work for one hour. 1550 Deployed UOR and set course for 11° 30'W. 2017 UOR recovered and set course for station 4. 2330 Arrived station 4 commenced station work.
Wednesday 30 May	2100 Completed work at Station 4. Set course for 11° 30'W.
Thursday 31 May	1230 UOR deployed at 49° 15'N 11° 30'W for transect to 07° 00'W.
Friday 1 June	0825 UOR inboard set course for Plymouth.
Saturday 2 June	1800 Docked Plymouth
Monday 4 June	Unloaded equipment.

OBJECTIVES

We postulate from gut analysis of mackerel larvae taken on previous cruises that recently metamorphosed larvae, as well as feeding on phytoplankton, feed intensively on zooplankton faecal pellets. We suggest that the nocturnal feeding migration of zooplankton to the surface results in a concentrated pulse of faecal material sedimenting (25 - 75m d^{-1}) through the water column in the early hours of the morning when mackerel larvae are known to be actively feeding. We shall attempt to quantify this diel pulse of material and investigate the validity of our proposal.

a) To determine the horizontal and vertical distribution of eggs and larvae of mackerel (Scomber scombrus) across the shelf, shelf-break and open ocean and relate their distribution to environmental variables.

b) To determine the food and feeding rhythm of mackerel larvae (from gut analysis) over 24 hour periods and to relate their vertical distribution and migration to food availability.

c) To determine rates of phytoplankton and bacterial production and relate these to the production and flux of organic matter by various components of the pelagic system.

d) To relate primary production to the vertical structure, behaviour and feeding processes of the herbivorous zooplankton.

e) To quantify and qualify the faecal pellets produced within the euphotic zone and their sedimentation rate.

f) To investigate, by laboratory experiments onboard the feeding by mackerel larvae on concentrations of natural particulates, cultured diatoms and various size ranges of faecal pellets.

PROCEDURES AND METHODS

See Cruise Programme IMER C2/84

EQUIPMENT AND OPERATIONAL FAILURES

Heavy sea conditions and winds (6-9) from 20 to 26 May restricted the use of the in situ ^{14}C production equipment and made laboratory experimental work difficult.

UOR IMER

1) the side hatch cover on the UOR was lost - possibly during recovery when the recorder struck a floating object.

2) NBA sensor 2 - conductivity head found sheared from body on recovery on the same tow as 1).

3) Both NBA conductivity/temperature head underwater cable connectors leaked causing signal drift during tows. Manual correction to the output from these sensors will enable ~90% valid data recovery at the expense of considerable effort. Both probes must be re-housed with improved style cable connectors.

RVS

1) Winch and davit fitted to the ship for deployment of UOR was a great improvement but it is still inadequate for the towing of the UOR. The calliper brake is insufficient to hold the UOR and a spooling arrangement is required to prevent build-up of cable 'loose turns'. After a few tows the main towing cable was severely

damaged and had to be replaced. The brake calliper worked loose after a few hours of towing. Operations were transferred to the hydro-winch using an unsatisfactory arrangement of lead blocks to the Schatt davit.
RMT 1 net
Monitor 2 - intermittent fault, the system switched off when it was tightened into its pressure case or the signal faded shortly after deployment of the net.
Chlorophyll Sensor - Sensor 02 the back-up system was completely inoperative.
RVS equipment - XBT. Of the ∿48 probes used only 26 profiles were recorded (Table 1) of which only 2/3 were good. The recorders were not 100% reliable and many of the XBT probes drew wire off the spool in clumps. Were they old probes?
Thermosalinograph - the temperature record was faulty over the last UOR transect. We did not have time to investigate the fault.

RESULTS

UOR Sampling Three transects were completed during the cruise Table 2. Fish eggs were sampled on 2 transects; temperature and chlorophyll on all three. Of the ∿800 miles towed the undulation control of the UOR was 96% successful. The egg sampling was completely successful with preliminary analysis confirming the expected peak of spawning towards the shelf-edge. The recovery of data from the tapes was ∿90% complete although intermittent faults are still occurring with the replay; however these were only serious on the replay of the data from one tow.

Various trial tows were completed during the cruise, these include; 1) modifications to the wing/ bridle configuration enabling improvement of depth capability, 0-70m. 2) tests with a larger tail plane gave improved control over dive and climb profiles 3) comparison of alternator and flow meter control of undulation cycle. The flowmeter modification gave significantly improved sampling with equal volumes of water being filtered in each depth stratum; which would benefit sampling for eggs.

High-Frequency echo sounder - this system operated satisfactorily along the three UOR transects. Profiles of plankton at the thermocline are clearly shown oscillating between 20 and 80m depth. The profiles will be used for comparison with the t °C and chlorophyll records from the UOR.

Longhurst-Hardy Plankton Recorder - Thirteen LHPR oblique hauls were taken, haul 6 was rejected because of sand contamination in the sampler when it hit the sea bed (Table 3). A total of 340 (280μm coarse net) and 191 (53μm fine net) samples were taken.

Chlorophyll sensor - the chlorophyll sensor worked satisfactorily for the entire cruise. On some deployments up to 50% of the data was lost due to faults in the data record/play back unit, however, because of the short sampling period adequate profiles can be recovered. The light meter adapted for the use with the LHPR and chlorophyll sensor, to relate depth of fish larvae and zooplankton to illuminaton; was entirely successful. The sensor was used for 13 LHPR hauls and 14 vertical profiles.

Vertical profiles - Fourteen vertical profiles were taken (nine depths) and samples collected for salinity, nutrients, chlorophyll a, bacteria, micro-flagellates, phytoplankton, particle sizes and particulate carbon distributions. Water samples were filtered through 20μm mesh net for identification of faecal pellets on seven profiles at station 4. The surface temperature at Station 1 (Figure 1) was 11.8°C with a ∿2°C thermocline between 14 and 30m and a temperature of 9.6°C at 105m. The thermocline was less steep and deeper further west we profiled. At Station 2 (49° 15'N 13° 00'W) the surface temperature was ∿13°C decreasing to 12°C at 60m and 9.6°C at 900m.

Particle size analysis - The output from the TA II Coulter Counter (3 tube analysis) was analysed in real-time using the new software package for the interphased microcomputer. The results from 4 vertical profiles taken at Station 3 (Fig.2.) show an even distribution of particles in the smaller size fraction (25-40μm) and what we have assumed to be a pulse of faecal pellets in the larger size fraction (81-102μm). This size fraction will include faecal pellets of Calanus. Faecal pellets sink at a rate ∿25 to 75m d^{-} and we hope to qualify and quantify this pulse of particulate material observed in these profiles. The particulates in the smaller fraction were present at 2×10^4 ℓ^{-1} and 4×10^3 ℓ^{-1} in the larger fraction giving a total particulate volume (TPV) in the profiles of $\sim 4.0 \mu m^3 \times 10^6$ ml^{-1}.

Collection of Mackerel larvae - The RMT 1 opening and closing system and the 'tin tow' net were used successfully to sample larvae for gut contents. Some were analysed aboard others were preserved. Stomach contents of ∿ 100 mackerel larvae were examined. Specimens were selected by size, time of day and depth sampled in an attempt to detect periodicity in feeding. Approximately 50 photomicrographs were taken to record morphological features of the gut and fluorescence in addition to visual examination of the larvae. Green contents were present in the guts of larvae (up to 5mm in length); fluorescense microscopy confirmed this material to be of plant origin. Copepod faecal pellets were present in the guts of the larvae, with highest numbers being observed in samples taken later in the day. Specimens (∿50) were dried for CHN analysis to determine size at onset of feeding and completion of yolk sac absorption. A further 50 specimens were preserved in glutaraldehyde for electron microscope examination of gut contents. Specimens were also deep frozen for pigment analysis of gut contents.

Experimental feeding of Mackerel larvae - Three batches of ∿1000 eggs each were incubated for provision of larvae for experimental feeding trials. Egg mortality was ∿ 70%. Newly hatched larvae were removed to separate containers to provide daily batches of larvae. Larval mortality was > 50% and no specimens survived to completion of yolk sac absortion (after 6 days) when feeding experiments could be started.
*It was recognised from the planning stages that experimental work at sea on relatively delicate fish larvae had a low chance of success. Potential causes of high mortality were problems with water quality and mechanical damage, due to severe ship motion in bad weather, and handling of the larvae.

Primary production experiments - Both on deck and in situ primary production incubation experiments with ^{14}C were carried out and bacterial production experiments using ^{3}H thymidine (Table 4). Chlorophyll samples were size fractionated and the numbers of cyanobacteria in the water column were determined by epifluorescense (Table 4).

Prepared by : R Williams
Approved by : B Bayne
Date : 29 June 1984.

Circulation

Internal

B Bayne
All Cruise Personnel
Notice Board
File Ves 2.9

External

NERC Foxton (Swindon)
RVS Skinner (Barry)
IOS M Angel
Mrs Edwards (MIAS) Wormley
MBA Denton
DAFS McIntyre
MAFF Harden-Jones

Table 1

XBT's RRS 'Frederick Russell' 19 May - 27 June, 1984

XBT No	Date	Time (GMT)	Position
1	20.5.84	0730	49°15.5'N 07°00.2'W
2	21.5.84	1150	49°14.9'N 08°18.7'W
3	21.5.84	1430	49°14.5'N 08°49.3'W
4	21.5.84	1925	49°15.1'N 09°20.4'W
5	21.5.84	2136	49°14.7'N 09°44.3'W
6	21.5.84	2350	49°14.1'N 10°13.9'W
7	22.5.84	0228	49°15.4'N 10°46.7'W
8	22.5.84	0415	49°15.3'N 11°09.2'W
9	22.5.84	0514	49°14.6'N 11°22.6'W
10	22.5.84	0641	49°14.7'N 11°39.1'W
11	22.5.84	0733	49°15.1'N 11°50.9'W
12	22.5.84	0858	49°14.6'N 12°07.2'W
13	22.5.84	0929	49°15.4'N 12°14.8'W
14	22.5.84	0949	49°15.3'N 12°19.4'W
15	22.5.84	1008	49°15.3'N 12°24.2'W
16	22.5.84	1130	49°15.2'N 12°39.3'W
17	22.5.84	1220	49°15.2'N 12°49.8'W
18	22.5.84	1355	49°17.0'N 13°01.8'W
19	22.5.84	1704	49°19.1'N 12°46.1'W
20	22.5.84	1742	49°18.5'N 12°35.7'W
21	22.5.84	1945	49°16.7'N 12°06.2'W
22	22.5.84	2111	49°16.8'N 11°44.1'W
23	27.5.84	2235	49°14.9'N 07°13.3'W
24	28.5.84	0420	49°13.8'N 08°31.9'W
25	28.5.84	0430	49°14.0'N 08°34.4'W
26	28.5.84	0947	49°14.8'N 09°40.9'W

Table 2

Undulating Oceanographic Recorder tows

RRS 'Frederick Russell' 19 May - 2 June, 1984

Transect	Date	Time (GMT)	Position shot	Position hauled	No. tows for fish eggs	Continuous measurements Chla	Continuous measurements t°c
1	21 May	05.07	49°15'N 07°01'W		12	✓	✓
	22 May	13.09		49°15'N 13°00'W			
2	27 May	15.22	C 36.6 B63.2		—	✓	✓
	28 May	19.17		49°14'N 11°29'W			
3	31 May	11.34	49°14'N 11°30'W		9	✓	✓
	1 June	07.25		49°15'N 07°00'W			

Table 3

Longhurst Hardy Plankton Recorder hauls

RRS 'Frederick Russell' 19 May - 2 June, 1984

	Haul No.	Date	Time (GMT)	Position Lat.(N)	Long.(W)	Max. depth(m)	LHPR samples Coarse	fine
St.1	1	20 May	12.51	49°14'	06°59'	100	24	28
St.1	2	21 May	00.02	49°13'	06°59'	100	24	18
St.2	3	22 May	13.24	49°15'	13°00'	956	53	-
St.3	4	24 May	22.57	49°15'	09°30'	100	41	-
St.3	5	25 May	03.17	49°15'	09°30'	100	23	-
St.3	6	"	10.00	49°15'	09°30'	Sampler hit bottom	gauze jammed	
St.3	7	"	16.16	49°14'	09°29'	100	23	-
St.4	8	28 May	22.38	49°15'	10°33'	70	25	8*
St.4	9	29 May	01.15	49°15'	10°30'	80	28	30
St.4	10	"	06.20	40°14'	10°24'	71	22	20
St.4	11	"	10.22	49°13'	10°26'	98	26	25
St.4	12	"	15.19	49°13'	10°28'	78	26	30
St.4	13	"	19.49	49°12'	10°24'	105	25	32**
						total	340	191

*2 min sampling interval **'fine' net damaged during descent

Table 4

Phytoplankton experiments

RRS 'Frederick Russell' 19 May - 2 June, 1984

Date	Stn. No.	Procedure 1	2	3	4	5	6	7	8	9	10
20 May	1	✓	✓	–	✓	✓	✓	✓	✓	✓	✓
22 "	2	–	–	–	–	✓	–	✓	✓	✓	–
24 "	3	–	✓	✓	✓	✓	✓	✓	✓	✓	✓
25 "	3	–	✓	–	✓	✓	–	✓	✓	✓	–
27 "	3	–	✓	✓	✓	✓	–	✓	✓	✓	✓
28 "	4	–	–	✓	✓	✓	✓	✓	✓	✓	–
29 "	4	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
30 "	4	✓	✓	✓	✓	✓	✓	✓	✓	✓	–
Total No. of incubations or profiles sampled		3	6	5	7	8	5	8	8	8	4

Procedures	No. of depths/profile
1) In situ primary production measurements with ^{14}C.	(9 depths)
2) On deck primary production incubation using ^{14}C.	(4 depths)
3) Bacterial production determinations using ^{3}H thymidine.	(9 depths)
4) Chlorophyll determinations on size fractional samples.	(9 depths)
5) Chlorophyll profiles by bottle drops, with chlorophyll sensor.	(9 depths)
6) Determination of cyanobacteria number by epifluorescence microscopy.	(9 depths)
7) Samples preserved with glutaraldehyde for determination of bacteria/flagellates.	(9 depth
8) Samples preserved with Lugol's iodine.	(9 depths)
9) Samples frozen for nutrient analysis.	
10) Light profiles with 'quantum' sensor.	

Fig. 1

RRS FREDERICK RUSSELL : CRUISE 9/84

10 MAY - 2 JUNE 1984

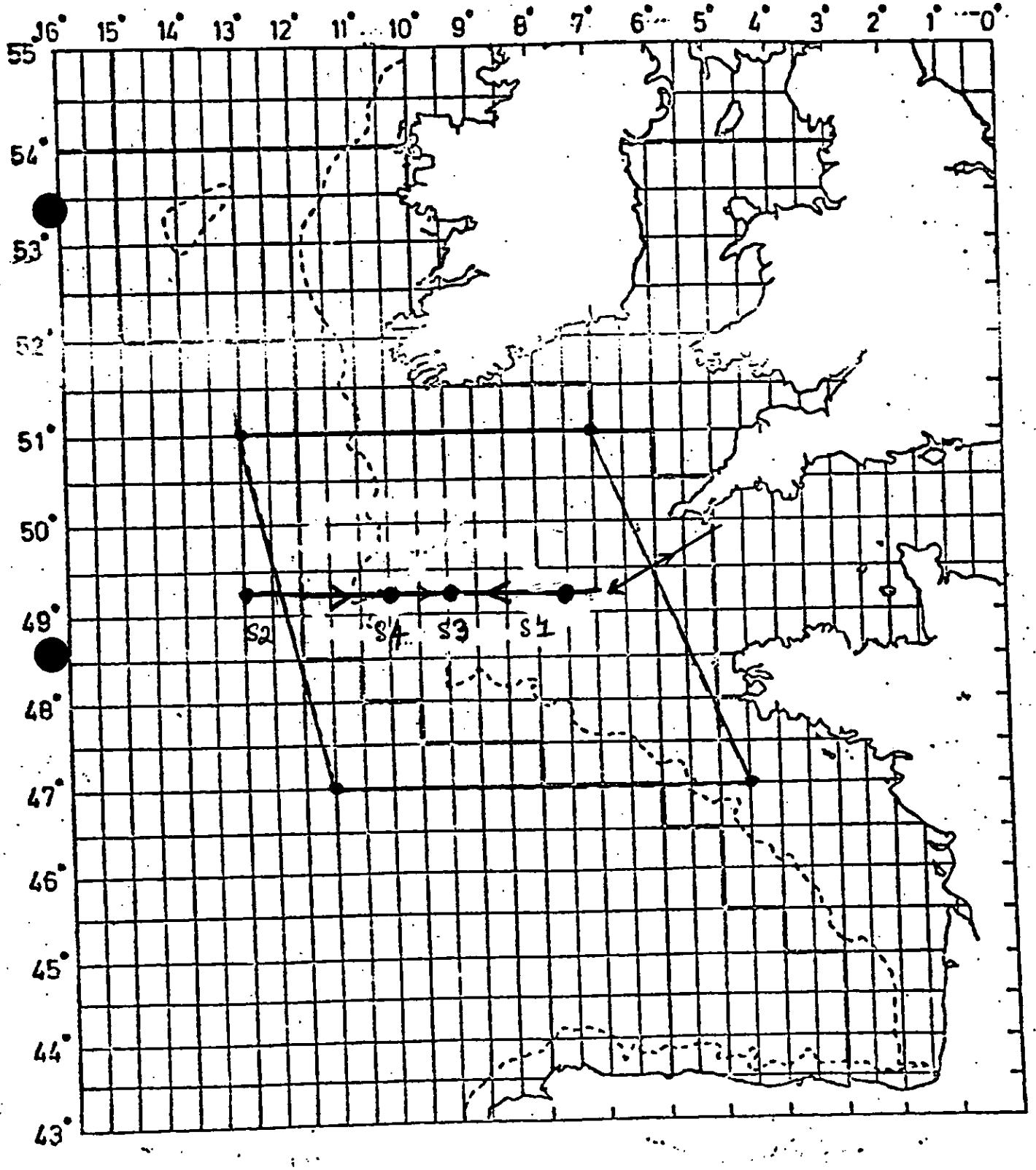

Fig. 2. 'Frederick Russell' 19 May – 2 June 1984

Particulate profiles in 4 size classes. Nos. l^{-1}