MINISTRY OF AGRICULTURE, FISHERIES AND FOOD
FISHERIES LABORATORY, LOWESTOFT, SUFFOLK, ENGLAND

1990 RESEARCH VESSEL PROGRAMME

REPORT: RV CIROLANA : Cruise 4

STAFF:

J H Nichols	
B Riches	
L E Woolner	
A B Thompson	
G M Haynes	
I R Joint	Plymouth Marine Laboratory
S H Coombs	"
D V P Conway	"
D B Robins	"
N C Halliday	"
C Smith	"
R Knust	Alfred Wegner Inst., Bremerhaven

DURATION:
10-24 April

LOCALITY:
North Sea

AIMS:

1. To determine size fractionated rates of primary production and bacterial production in different light regimes for comparison with similar measurements in previous years from the Irish Sea.

2. To determine the horizontal and vertical distribution of micro and mesozooplankton including fish eggs and larvae in relation to hydrographic conditions.

3. To assess the quantity, composition and quality of the various particle size fractions available as food for fish larvae.

4. To measure zooplankton egg production rate as an index of secondary production.

5. To preserve cod and sprat larvae for subsequent determination of gut contents and RNA/DNA, histochemical, biochemical and lipid analyses.

6. To relate primary production, phytoplankton biomass and species composition to the vertical structure, behaviour and feeding of the herbivorous zooplankton.

NARRATIVE:

RV CIROLANA sailed from Lowestoft at 0945 h, 10 April and steamed to the first working area off the north-east coast of England, testing the Undulating Oceanographic Recorder (UOR) and the Plymouth Marine Laboratory (PML) 50 cm sampler, on route. All working areas, UOR tows and incubation rig sites, subsequently referred to in the text, are shown in figure 1.

Work began in the West Sole area at 1908 h, 10 April, with the first of a series of three UOR transects. The final transect was completed at 1407 h, 11 April and was followed by a standard plankton survey with the Lowestoft 76 cm sampler which was completed at 0509 h, 12 April. The PML primary production rig was launched at 0640 h, 12 April at 53°20'N; 00°55'E. Sampling, with the two square metre Methot Isaacs Kidd trawl (MIKt), the 53 cm sampler and the double Longhurst Hardy Plankton Sampler (LHPR), was carried out in the vicinity of the rig until the rig was recovered at 1819 h. Further plankton samples and larvae collection tows were taken in this area before moving to the second site in the west-central North Sea at 2309 h, 12 April.

After water collection with the CTD rosette, the primary production rig was launched again at 0615 h, 13 April (54°35'N; 01°02'E). A similar pattern of sampling and collection tows was worked at this site, culminating in a final CTD profile and double LHPR hauls at 2306 h on the same day. The UOR was then towed, on route to the central North Sea area, from 2311 h to 0556 h, 14 April. A deck incubation for primary production was started at 0600 h south of the north-east spit of the Dogger Bank (54°49'N; 03°34'E). After a two and a half hour delay for engine repair, a standard, 76 cm sampler, plankton survey of the area began at 1000 h. On completion of this survey, including a CTD profile and LHPR haul, at 2305 h, a 45 nautical mile UOR transect was run northwards across the north-east corner of the Dogger Bank from 0001 h to 0403 h, 15 April. Further sampling and collection tows, using the 76 cm sampler, dual LHPR, MIKt, CTD and 1 metre ring net were made at a selected site on the Dogger Bank throughout the day until 2301 h. The UOR was then towed on a further transect to a site on the northern side of the Dogger Bank where the primary production rig was again launched at 0604 h, 16 April (55°51'N; 03°13'E). A similar routine of sampling and larvae collection tows was worked at this site until recovery of the rig at 1819 h on the same day. After further collection tows and an LHPR haul RV CIROLANA moved south-east of the Dogger Bank to begin a plankton survey of the area out to 06°00'E. A primary production deck incubation for this area was set up with water collected at 55°07'N; 04°44'E. Two MIK trawl, collection tows were also done within this area, at a position where the highest numbers of cod larvae had been recorded on the plankton survey (55°03'N; 05°07'E). The plankton survey was completed at 0327 h, 18 April and the vessel then steamed to the first of two sampling transects in the Danish Bight. Sampling on the most northerly transect began at 0511 h, 18 April (55°49'N; 06°05'E) with a CTD rosette deployment used to set up a primary production deck incubation. The UOR was then towed on a straight transect eastwards for 45 nautical miles. A series of seven plankton samples was then taken whilst returning along this transect and further water sampling and LHPR sampling carried out at the end of the leg.

The UOR was towed on route to the second transect, arriving at the start at 0430 h, 19 April (55°22'N; 07°06'E). The primary production rig was launched at this position, followed by a repeat of the previous day's sampling routine on this transect ending with an LHPR tow at the rig site at 2250 h.

The vessel then steamed overnight to the final working area in the German Bight arriving at the first CTD sampling position, 54°49'N; 06°00'E at 0504 h, 20 April. The UOR was then towed in a series of five legs to a position just off the mouth of the river Elbe (53°58'N; 08°06'E). A CTD profile was taken at the end of each UOR leg. Sampling with the 76 cm sampler was then carried out at 5 nautical mile intervals back along the UOR track to select a site for the rig deployment on the following day. The primary production rig was deployed at 54°05'N; 07°48'E at 0530 h, 21 April. Sampling tows and larvae collection tows were taken in the vicinity of the rig until it was recovered at 1810 h on the same day. Sampling with the 76 cm sampler was then continued

along the original UOR transect to select a study site for the final rig deployment on the following day. The rig was deployed again at 0558 h, 22 April at 54°36'N; 06°34'E. The remainder of the day was spent sampling across the temperature and salinity boundaries in the vicinity of the rig site. A final CTD profile and LHPR haul was taken at 2136 h and RV CIROLANA then set course to return to the first working area off the north-east coast of England.

On arrival at a position 35 nautical miles east of Whitby at 1348 h, 23 April sampling with the 76 cm sampler began on a line of stations extending southwards through the area worked at the start of the cruise. These nine stations were completed by 2041 h, 23 April when course was set for Lowestoft. RV CIROLANA arrived in Lowestoft at 0845 h, 24 April.

RESULTS

1. At each day on station, the rate of primary production by different size fractions of phytoplankton was determined by *in situ* and on deck incubations. Water samples for 9 depths in the euphotic zone were incubated with ^{14}C-bicarbonate for 24 hours. At the end of the incubation period, the samples were filtered through 5 µm, 1 µm and 0.2 µm Nuclepore filters to determine the productivity of micro-, nano- and picoplankton. The biomass of the various size fractions was estimated from chlorophyll content and samples were preserved in Lugol's iodine and glutaraldehyde for subsequent analysis in the laboratory.

Bacterial productivity was measured on the same water samples that were incubated for primary productivity estimation. Samples were incubated with ^{3}H thymidine to measure the replication rate of the bacterial DNA. The biomass of bacteria will be assessed in the laboratory by epifluorescence microscopy of glutaraldehyde-fixed water samples.

All rate measurements will be related to solar radiation, temperature and physical conditions at each station; the contribution of phytoplankton cells will be related to the particle distribution measured by Coulter Counter.

2. Vertical distribution sampling was carried out by LHPR hauls at 13 stations of which 10 were day/night pairs to provide information on diel migration and net avoidance. At all stations vertical profiles were completed with the LHPR set-up in double net configuration with 200 µm aperture mesh and 53 µm aperture mesh. At ten of the stations a second haul was taken using a 20 µm aperture mesh fitted to the fine net system.

Intermittent electronic faults in the transmission of the fine mesh flowmeter signal have compromised the validity of some of the data, although it will be possible to recover valid data from most of these. On the final deployment, gauze advance problems with the fine mesh cod-end unit gave similar problems of interpretation.

A total of 105, 76 cm sampler tows, 26, 50 cm sampler tows and 18 MIK trawl hauls were made in support of the PML production processes programme. These were used to describe the horizontal distribution of plankton and in particular fish eggs and larvae in the selected study areas. Specimens of cod larvae and sprat larvae were also taken from these samples for subsequent condition analyses.

Very few fish larvae were found in the area off the north-east coast of England and the abundance of cod larvae in particular was much lower than that found at the same time in 1976. Those that were taken were much larger than

expected suggesting that spawning may have been earlier than in 1976. Similarly, in the central North Sea, the historic data sets proved to be misleading. Most of the cod larvae found were > 8 mm, and more abundant in night hauls with the MIKt than in the standard sampler. Fish larvae generally were more numerous in the Danish and German Bight, with sprat, dab and flounder dominant particularly in the German Bight.

A total of eight UOR transects (24 deployments) were ran through the four study areas. On all tows temperature, chlorophyll 'a' concentration and salinity data were obtained. Validity of some parts of the salinity data is suspect due to signal errors.

Results from the UOR tows showed that marginal stratification (< 1°C) had developed in deeper water areas adjacent to the Dogger Bank, off the Danish coast, north of Flamborough Head and in the German Bight in association with a superficial low salinity layer. Elsewhere in the sampled areas the water column was fully mixed. Chlorophyll a concentration was generally less than 3 mg m^{-3} with higher values (~ 10 mg m^{-3}) recorded in the outer region of the low salinity influence in the German Bight. On return to the Flamborough area, at the end of the cruise, thermal stratification of ~ 1°C was established through the whole area.

3. The volume and number of natural particulates was measured using a Coulter Counter model TAII. Analysis of samples was performed on 2 orifice sizes; 400 µm with a dynamic range of 10-200 µm and 100 µm with a dynamic range of 2-40 µm.

A total of 30 (CTD) vertical profiles were analysed for particle size/numbers and over 100 surface samples associated with UOR or TTN tows.

Preliminary results show:-

Area 1 (Flamborough Head). There were no horizontal and vertical structures and no obvious size modes. Total particle volume:- 100 µm (2-40 µm) < 1 ppm, 400 µm (10-200 µm), < 1 ppm.

Area 2 (on and off Dogger Bank). Both South and North of the Bank had very low Total Particulate Volumes (TPV) of about 0.5 ppm for both tube sizes (100 µm + 400 µm). However, particle size distribution and volume changed significantly on the Bank with TPVs increasing; 100 µm (2-40 µm) up to 1-1.5 ppm and the 400 µm (10-200 µm) reading 2-3 ppm. Associated with the increase in TPV were clear size modes of 6-12 µm and 20-80 µm.

Area 3 (Danish coast). Trends in the particulates in this area were not dissimilar to Flamborough Head (Area 1) with average TPV values of about 1 ppm. However, there was a horizontal pattern with TPV dropping from offshore to inshore, but increasing again close inshore in the shallow water.

Area 4 (German Bight). There were two distinct areas of particulates. At the NW end of the sampling area, TPV for both size ranges was about 1-1.5 ppm, however, closer inshore in the area around Helgoland, the TPV increased to about 5 ppm for the 400 µm orifice (10-200 µm) and to 1-2 ppm for the 100 µm (2-40 µm) orifice. In the larger size range there was a single broad peak of 40-200 µm.

The Lowestoft 'Elzone' particle counting and sizing system, using a 600 µm orifice tube, was also used. The 'Elzone' measured particles from 40-500 µm, with high counts in the 100-300 µm ESD size range occurring when phytoplankton

was abundant. This was particularly noticeable in a Coscinodiscus patch off Flamborough and in mixed centric diatoms in the Danish and German Bight.

Comparison of the results of the 'Coulter' and 'Elzone' counts will be undertaken at a later date.

4. A total of eight egg production experiments were performed. The original intention was to use two copepod species for this work. However, it was not possible to do this in all 4 areas for the same 2 species. Therefore, a total of 4 species were used. *Calanus* was used for all experiments, *Centropages* at the first (Area 1), *Pseudocalanus* Areas 2 and 3 and *Temora* Area 4. *Calanus* was the only species that gave consistent egg production with egg per female (24 hours) over the range 1.5-4.5. In fact this represents a few females liberating 10-50 eggs each and others not releasing eggs.

No obvious geographical pattern was observed. Animals were sorted into 1 litre bottles containing surface sea water (filtered through 80 µm gauze) to a density of ~ 10 l^{-1}. Bottles were then rotated on a wheel, kept at constant, ambient temperature for 18-24 hours. Egg production was therefore per bottle and did not reflect individual variability.

5. Larvae of cod and sprat were preserved for CHN, lipid, histochemical, gut contents and otolith daily growth ring analysis for determination of nutritional condition. Results from the subsequent analyses will be used for comparison with hydrographic conditions and microplankton food availability in different regions. Occasional additional plankton samples were preserved for chemical analysis to investigate pollutant load as a co-factor determining condition of fish larvae. Sampling was distributed throughout the cruise area with particularly detailed transects being worked across mixed/stratified regions for cod larvae in the Dogger Bank area and for sprat larvae in the German Bight.

6. The data obtained on phytoplankton biomass and productivity will be used to assess the suitability of phytoplankton in different water masses for zooplankton grazing and growth. In the laboratory the phytoplankton species composition will be determined from preserved water samples. Egg production is a good integrator of the food available and consumed by copepods and the data on phytoplankton species composition biomass and productivity will provide valuable information on the "quality" of the food available to copepods. Not all phytoplankton cells are suitable food species, and these data will allow us to test, in a field situation, some of the relationships which have been established for laboratory cultures of copepod.

GENERAL

The 24 kHz transponding acoustic tag was used on four of the incubation rig deployments. Good results were achieved with ranges up to 3 km. This

proved invaluable in re-locating the rig after periods away from it. Useful experience was also gained in using the SM600 sonar by both marine and scientific staff.

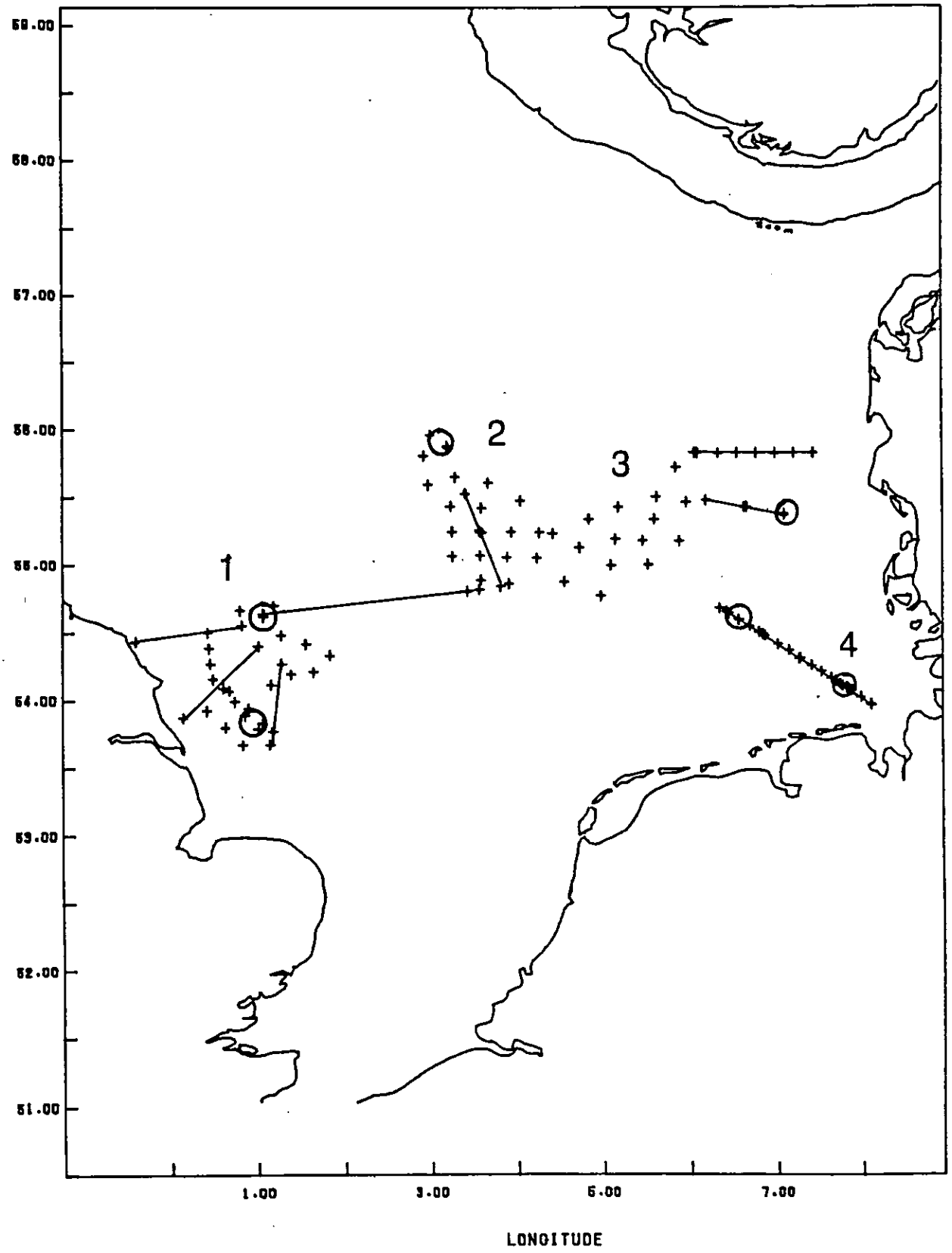
J H Nichols
Scientist in Charge
1 May 1990

SEEN IN DRAFT:
G S
J H

INITIALLED:
J G S

DISTRIBUTION:
Basic List +
J H Nichols
B Riches
L E Woolner
A B Thompson
G M Haynes
I R Joint
S H Coombs
D V P Conway
D B Robins
N C Halliday
C Smith
R Knust

SHOWING :
STATION POSITION
COASTLINE



Four working areas on CIROLANA 4/1990

Plankton sampling stations +

Undulating Oceanographic Recorder transects ————

Primary production rig deployments O