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Charter vessel MV 'British Enterprise III' H01

REPORT

9-29 January 1990

Personnel

M Heath	PSO (in charge)
A Hawkins	CSO (part 2)
R Mitchell	SSO
D Seaton	SSO
J Dunn	HSO
C Hall	HSO
S Hay	HSO (part 1)
J McKie	HSO
P Rankine	HSO
G Slesser	HSO
A Matthews	SO
L Cargill	ASO
S Heaney	ASO
J Turriff	ASO
A Macdonald	HPTO (9-11 January)
J Hunter	PTO
W Leiper	PTO (9-11 January)
D Stuart	PTO
L Burren	(Visitor) Aberdeen University
E MacDonald	(Temporary ASO)
I McCarthay	(Visitor) Aberdeen University (part 1)
D Plummer	(Visitor) Plymouth Marine Laboratory
A Rees	(Visitor) Plymouth Marine Laboratory
M Woodward	(Visitor) Plymouth Marine Laboratory

Objectives

1. To determine the horizontal distribution of herring larvae in the northern North Sea, in relation to the boundary between the North Sea water, the Norwegian Coastal Current, and the deep inflow of Atlantic water from the north.

2. To accurately map the boundary of the Coastal Current, and the core of the inflow using temperature, salinity and nitrate as tracers, and with reference to satellite photographs.

3. To investigate the 3-dimensional structure of water currents along a section of the current boundary and inflow region using the Acoustic Doppler Current Profiler.

4. To investigate the 3-dimensional distribution of herring larvae and zooplankton along a section of the current boundary and in the inflow region using LOCHNESS and ARIES, and estimate the exchange rate of larvae between the North Sea and Coastal Current waters.

5. To investigate the vertical migration behaviour of herring larvae and zooplankton using LOCHNESS and ARIES.

6. To obtain samples of herring larvae for estimation of growth rate and biochemical condition indices.

7. To carry out prey selection experiments on herring larvae.

8. To compare the productivity and composition of the zooplankton and phytoplankton in the North Sea and Norwegian Coastal Current waters, and assess the relative suitability of the two water types for supporting the growth of herring larvae.

Narrative

The vessel mobilised in Aberdeen harbour during 9 and 10 January, sailing at 1800 on the 10th. Gear trials were carried out off Fraserburgh during 10-11 January, and staff connected with the trials disembarked by pilot boat at 1700. The vessel then commenced a programme of sampling at fixed stations along a line eastwards across the North Sea. Stormy weather prevented work on 12, 15 and 16 January although the vessel was able to maintain station at sea awaiting moderation of conditions. However, on 17 January the ship was forced to shelter in a fjord due to exceptionally strong winds.

Due to the persistent bad weather the mid-trip break was brought forward, and the vessel docked in Stavanger at 1900 on 17 January, sailing again at 1230 on 19 January following exchange of scientific personnel. Bad weather continued on 19 and 20 January, but water bottle and underway sampling was carried out in a 40 mile x 40 mile area off Stavanger. Weather conditions allowed deployment of towed gear on 21 January, but conditions deteriorated again on 22 and 23 January when the majority of the time was dedicated to underway sampling.

During 23 January, a small (1.6 m x 1.6 m) version of the MIKT was manufactured from the remains of a damaged MIKT and steel pipe. The new gear proved easier to deploy in poor sea conditions than the full size net, so extensive sampling was carried out during 24 and 25 January. Approximately 12 hours of working time were lost during 25-26 January during a severe storm, but a line of sampling stations westwards across the North Sea to the Orkney Isles was completed on 27 January. Additional sampling was carried out close inshore off the Orkneys and Caithness and the vessel then headed for Aberdeen, docking at 0230 on 29 January.

Results

The sampling programme was divided into two parts to meet different aspects of the objectives. During the first half and some of the second half of the cruise, sampling was carried out at predetermined locations covering a wide area of the northern North Sea to determine the large scale distribution of plankton, herring larvae, physical and chemical parameters. Most of the second part of the cruise was spent in small scale surveying of waters off the Norwegian coast to investigate the dynamics of eddies in the edge of the Norwegian Coastal Current and the relationship with chemical and biological parameters. The small scale investigations were to have been directed to the most appropriate areas by inspection of satellite images of sea surface temperature, but in the event none were available due to the extensive cloud cover.

Surface (4-10 m) hydrographic parameters, fluorescence and transparency were measured throughout the surveys by a sensor array deployed on a towing wire alongside the ship. Water was pumped up a pipe strapped to the tow wire and analysed for nitrate, phosphate, silicate, ammonia and nitrite with a continuous flow autoanalyser. Maps of parameters recorded from this system were prepared during the cruise and used to direct further sampling effort. Simultaneous on-line measurements of current velocities were recorded with the Acoustic Doppler Current Profiler (ADCP) (Fig. 1).

Herring larvae sampled with the MIKT (Fig. 2) were widespread in the northern North Sea, but at lower concentrations than were found in a similar investigation at the same time of year in 1988. The highest concentrations were in the western North Sea, but significant numbers were also caught off the southwest of Norway in waters shallower than 150 m (ie in North Sea shelf waters). Low numbers of larvae were caught at sampling locations in the deep (>250 m) Norwegian trench at salinities less than 34.0. Specimens of larvae from each station were measured and preserved in liquid nitrogen for RNA/DNA analysis, alcohol for otolith examination or in formaldehyde for stomach contents analysis. Copepod biomass determined from towed nets (ARIES or Gulf III) (Fig. 2) was low in the open waters of the North Sea but increased concentrations of zooplankton were found in the coastal areas. Calanus was the dominant species in all areas, but substantial numbers of Metridia and Euchaeta were found in the Norwegian coastal waters. During the wide area surveying, zooplankton egg production, ammonia excretion and samples for gut fluorescence were measured at seven locations. Water samples were incubated on deck to measure daily primary production by ^{14}C and ^{15}N uptake at four sites. In addition, relative bacterial and primary production was determined at every sampling location by laboratory incubation of samples with ^{14}C, ^{15}N and labelled thymidine.

The small scale surveying and investigations were focused in the Norwegian Coastal waters to investigate eddies in the boundary between open North Sea water and the northerly flowing lower salinity coastal waters. The boundary was detected with the towed sensors as a 1.5 ppt change in salinity, 2°C change in temperature and approximately 3 µM change in nitrate over a distance of 2–4 miles, the coastal water being colder and having lower salinity and nitrate. An eddy was located and mapped with the towed sensors and ADCP over a two day period immediately upon sailing from Stavanger. The eddy was anticyclonic, injecting high salinity (>34.7) water across the north flowing, low salinity (<34.0) coastal waters. During the following days, two further coverages of the eddy were carried out, each lasting two days, together with a high resolution, undulating tow survey of the boundary area with ARIES. During the surveys, the eddy propagated northwards at a rate of approximately 10 km/day.

The adverse weather restricted the biological sampling of the eddy. However, 15 tows with the MIKT and Gulf III equipped with CTD and other sensors were completed, together with sampling at six sites for zooplankton, phytoplankton and bacterial production rate measurements. All the larvae caught were measured and preserved in liquid nitrogen for RNA/DNA analysis, in alcohol for otolith examination, or in formaldehyde for stomach analysis. Relative phytoplankton and bacterial production was measured at approximately 15 mile intervals along the survey tracks. The results indicated that herring larvae were very closely associated with the high salinity water injected across the Norwegian trench, and were not found in the low salinity waters. However, it appeared that these larvae must have been introduced into the coastal current system to the south of the study area and carried north with the eddy, since no larvae were found immediately to the west of the current boundary. Zooplankton biomass was higher in the low salinity coastal waters than in the injected high salinity water, but no egg production was detected in either water type. Bad weather prevented deployment of LOCHNESS and investigation of the vertical distribution of larvae and macroplankton in the eddy system.

Weather conditions suitable for attempting capture of live herring larvae coincided with the vessel being in an area of appreciable concentrations of larvae on only one occasion. Vertical hauls with the MIKT were carried out off the Orkney Isles, but only the more robust organisms survived capture. One herring larva was caught in the vertical hauls but it did not survive.

M Heath

16 February 1990

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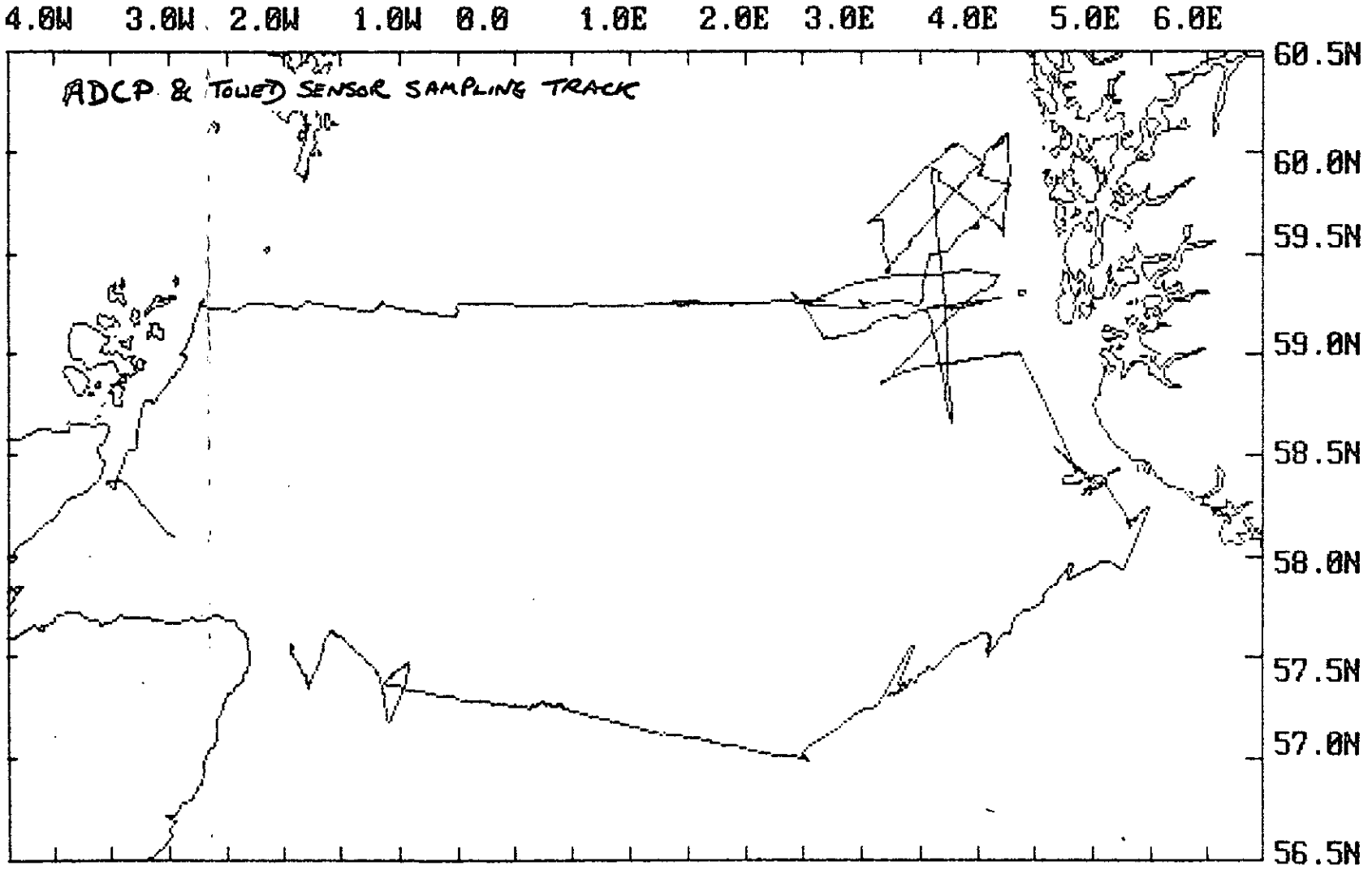
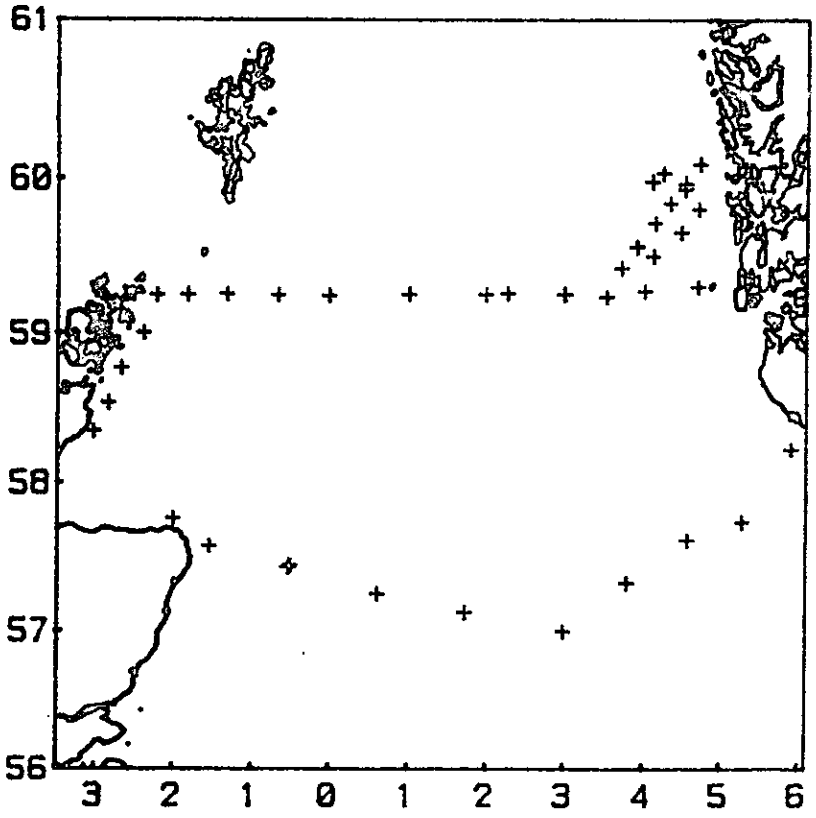


FIGURE 1.

FIGURE 2.



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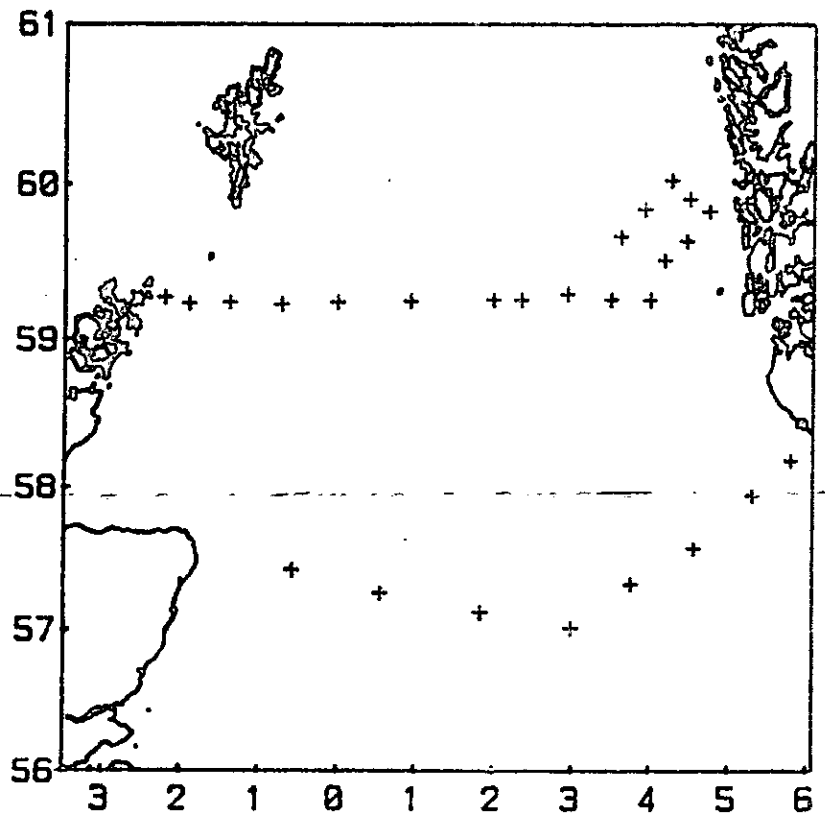
MIKT SAMPLING POSITIONS



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ARIES/GULF III SAMPLING POSITIONS