CHALLENGER 54 mrs P Edwards

Plymouth Marine Laboratory
United Kingdom

RVS Ref. No. CH.54/89

CRUISE REPORT

VESSEL RRS *Challenger*

CRUISE PERIOD 9 June - 22 June 1989

PERSONNEL

From PML:
I R Joint (Principal Scientist)
S H Coombs
D V P Conway
M Jordan
J A Lindley
D B Robins
J A Stephens
N C Halliday
Begoña Bautista
I Madariaga
D Plummer (also SUDO)

From RVS:
A Jones
P Mason

From Alfred-Wegener Institute, Bremerhaven, FRG.
G Vallencuela

CRUISE PROCEEDINGS

Challenger sailed from Great Yarmouth at midday on 9 June and steamed to Helgoland (FRG), transferring personnel and equipment from the German Research Vessel, *Victor Hensen*, on 10 June. Both ships were then involved in two days of intensive sampling in a two ship exercise (Fig.1); *Challenger* made CTD profiles to determine the physical conditions likely to be favourable for fish larvae, and *Victor Hensen* sampled at the identified depths with specialist fish larval sampling gear. The two ship exercise was considered to be highly successful by the scientific parties on both ships. Sampling continued in the German Bight for most of the rest of the cruise (Fig. 2), with two final stations in the central and southern North Sea.

On 14 June, *Challenger* surveyed a grid 20 x 10km as sea truth for the European Imaging Spectroscopy Campaign (EISAC), conducted by the European Space Agency and the Joint Research Centre, Ispra. The survey was done with the UNDULATOR, equipped with light, chlorophyll, temperature and depth sensors. In addition, data were obtained from pumped surface samples with a number of instruments, including a transmissometer, fluorometer, thermosalinograph, particle counter and

spectrophotometer. The aircraft surveyed 3 transects (Fig. 3). Line 1 was the central line of the grid; it was hoped that *Challenger* would be on this line as the aircraft flew over. However, the timing of this was difficult to achieve, given the large difference between the speed of an aircraft and a ship and Line 2 was flown over the actual position of the ship. Line 3 included a "red tide" which was sampled by *Challenger* 3 hours after the overflight was completed.

The cruise was very successful, with over 85 CTD profiles and 80 plankton hauls. All objectives were achieved. The weather was excellent throughout the cruise with wind speeds of Force 4 or less; this no doubt contributed to the attainment of all programme goals.

RESULTS

1. UNDULATOR tows Ten tows were completed and plankton samples were taken on four of these. As found on the previous *Victor Hensen* cruise clogging of the net by phytoplankton was a problem in all areas sampled. Temperature stratification extended from the central North Sea into the German Bight south of Helgoland. The coastal frontal zone between stratified and mixed water was confined to a narrow band within 5 miles of the coast. Off East Anglia the water column was fully mixed. Higher levels of chlorophyll *a*, as indicated by UNDULATOR results, of 10-20 mg m^{-3} extended some distance into the stratified region where there was still a strong influence of lower salinity water in the surface layer. Further towards the central North Sea a second area of relatively high chlorophyll *a* (~ 10 mg m^{-3}) was associated with a thermocline of about 4°C at around 20 m depth (Fig. 4).

2. CTD Transects Two transects (W-E) and (N-S) were worked in collaboration with RV *Victor Hensen* in the area south of Helgoland. *Challenger* concentrated on physical mapping and particle characterisation in a series of CTD profiles along the transects. Immediately following the vertical profile, *Victor Hensen* sampled for sprat larvae with a multinet system in five discrete depth layers based on data from *Challenger* on temperature, chlorophyll *a* fluorescence, turbidity, salinity, oxygen concentration and acoustic doppler current profiler results (Fig. 5). Samples of fish larvae were preserved with bulk plankton collections for the various analyses of nutritional condition.

Later in the cruise a further two lines of CTDs were worked in the same area to give additional data.

3. Particle characterisation Particle size measurements were made by Coulter Counter from surface and vertical profile samples throughout the cruise area. There was little change from the distributions observed on the *Victor Hensen* cruise in the previous week. In the inshore low salinity mixed water in the German Bight particle abundance was low and fairly evenly distributed between two groups at around 4-10 μm and 32-80 μm equivalent spherical diameter. There was little change in particle abundance or size down the water column.

Further from the coast, in stratified water, the same particle distribution was seen in water below the thermocline as observed in the coastal water (Fig. 6). In surface water a prominent mode around

64 μm in equivalent spherical diameter was associated with elevated levels of chlorophyll a. Towards the central North Sea the peak at around 64 μm declined in surface waters in parallel with lowered chlorophyll a concentration. In water below the thermocline two distinct modes at around 8-12 μm and 25-50 μm (Fig. 6) were seen in areas where there was a sub-surface peak of chlorophyll.

In mixed water off East Anglia, particle abundance was low with a single peak at around 64 μm in size.

4. Primary productivity and irradiance measurement The *in situ* light meter and ^{14}C incubation rig was deployed on 8 days during the cruise to determine the productivity of different size fractions of phytoplankton and the light available. The most abundant size fraction was phytoplankton >5μm in diameter and these cells were an order of magnitude more productive than the picoplankton (<1μm or the small nanoplankton (<5 - >1μm) fractions (Fig. 7). *In situ* light was measured successfully on 7 of the incubations, but there was a partial loss of data from the solid-state logger on one occasion. The fraction of light absorbed by phytoplankton pigments, detritus and water was determined on each occasion that the incubation rig was deployed. Fig. 8 shows the second derivative of the absorption spectrum of the particulate matter; the peaks are due to the different phytoplankton pigments which are absorbing light. The photosynthetic parameters, P_{max} and α , of the three size fractions of phytoplankton were measured each day in an artificial light gradient; the incorporation of ^{14}C label into the major biochemical constituents of the phytoplankton was also determined.

5. Zooplankton sampling Eleven hauls, a total of 411 samples (Table 1), were taken with the triple LHPR system which operated well. Clogging of the nets, especially the 200μm net, was a problem at the inshore stations where jelly fish also caused two gauze jams. Microzooplankton samples (20μm) were taken on nine of the hauls. These were washed off fresh and split in two. One half was preserved for species analysis and the other filtered into GFC papers and frozen for subsequent chlorophyll and CHN analysis. The 53μm and 200μm net samples were washed off and preserved for species analysis. At one station off the Danish coast numbers of *Amphioxus* were taken in the plankton hauls. These were preserved for biochemical analyses, for background information when assessing equivalent data for fish larvae.

Additional plankton samples were taken at intervals and preserved both for chemical analysis to gauge pollutant load as a further determinant of larval condition (DoE contract) and for subsequent Analytical Flow Cytometer analysis to estimate the proportion of viable phytoplankton cells and detritus content.

6. Larval distribution Sprat larvae were collected by oblique and stratified horizontal tows with the 20" sampler throughout the survey area. Specimens were preserved for histological and histochemical treatment, gut contents analysis, CHN determinations, growth rate (FRG), DNA/RNA ratios (FRG) and gut enzyme measurements (FRG). These parameters will be compared with the hydrographic and biological data collected concurrently and estimates of food abundance from the 53 μm

net samples.

Preliminary indications of relevant differences between the North Sea and the Irish Sea in relation to fish yield include the following:

- in all areas of the North Sea there was a higher standing stock of zooplankton and a lower content of detritus than has been observed in the Irish Sea.

-these differences were associated with stronger stratification in the North Sea, especially in relatively shallow areas (< 30 m depth) where low salinity water in the surface contributed significantly to stabilisation of the water column.

-relatively low salinity inshore water extended in surface layers a considerable distance into stratified regions towards the Central North Sea beyond the frontal zone. Intermixing of this water with relatively higher salinity Central North Sea water gave a broad area of apparently high production. The equivalent area in the eastern Irish Sea is confined to a narrow coastal strip.

7. Larval feeding experiments No significant feeding was observed in any of the samples of turbot larvae taken on board in place of sprat larvae for feeding experiments. Naturally occurring particulates were offered at ambient and at 10x concentration from areas of high and low food abundance (inshore where sprat larvae were abundant and offshore where they were scarce). No significant differences were observed in survival of larvae fed at the different regimes, all were dead 11 days after hatching. Starved larvae survived for one day less. Specimens were preserved at intervals for the various analyses of condition.

EQUIPMENT AND OPERATIONAL PROBLEMS:

1. The salinity sensor on the UNDULATOR was inoperative for the entire cruise. Although the problem may be due to a faulty electronic component, it is clear that the new sensor systems were prepared too late to allow reasonable testing prior to the cruise. The loss of salinity data severely reduced the usefulness of UNDULATOR tows which in some cases were replaced with a line of CTD stations with a consequent loss of ship time.

2. Sampling for fish larvae was hampered by lack of suitable multinet sampling equipment.

3. On the first tow with the 20" sampler system the fine mesh nose cone was lost, possibly due to incorrect securing of the attachment clips. Part way through the cruise the 53 μm fine mesh net frame attached to the 20" sampler was lost during a tow, probably due to the wing-nuts attaching it to the main sampler frame coming loose. The poor fixing was a hurried job by PML workshops which had too many other commitments to allow sufficient time to fabricate a reliable attachment system. An effective replacement was made on-board using parts from other plankton equipment.

4. Engineering work on the cooling system of the constant temperature room early in the cruise allowed the temperature to exceed 20°C. This may have contributed to the high mortalities of fish larvae experienced shortly afterwards. The problems encountered with the cooling system suggest that it was inadequately prepared in response to the request for its use.

5. Considerable time and expenditure were required by PML staff who had disembarked from the RV *Victor Hensen* cruise at Helgoland to make last minute arrangements for *Challenger* to come into port. These arrangements should have been made earlier by RVS staff who were notified of the requirements to visit Helgoland several months before.

6. Due to high mortalities during rearing insufficient sprat larvae were available from the Helgoland laboratory for use in the bioassay experiment planned on *Challenger*. As a replacement turbot larvae were provided by Golden Sea Produce fish farm for taking on board at Great Yarmouth.

High mortalities (near 100%) were experienced in some of the sub-samples, into which the larvae had been separated, during the first few days of the cruise. This may have been due to some combination of a water quality problem during routine water changing or of elevated temperatures in the constant temperature room during maintenance. Other containers of larvae in which the water was changed at different temperatures did not experience any unusual mortalities at that same time.

It was not possible to feed the larvae fresh diets of natural plankton from contrasting areas as frequently as required due to the fairly long steaming times between chosen regions and other cruise requirements to occupy fixed stations for most of the day. A further delay in providing first food to the larvae was caused by allocation of one day to sampling in conjunction with remote sensing operations. It is possible that the delay in feeding was primarily responsible for the poor survival of the larvae. The calm weather and resultant poor mixing in the larval containers may also have contributed to low levels of oxygen measured in the rearing containers and possible additional stress.

PREPARED BY: I.R. JOINT, S.H. COOMBS

DATE: 17 OCTOBER 1989

CIRCULATION: Internal

B L Bayne
R Williams
I R Joint
S H Coombs
Cruise Personnel
Notice Board
File VES 1.1

External

NERC Swindon R Paul, N R Collins, S White
IOSDL (Wormley) M Angel + Library
POL (Bidston) B McCartney (Director) + Library
(MIAS) Mrs P Edwards
RVS C W Fay (x 2)
DAFS A Hawkins (Director)
MAFF D Garrod, K Brander, J Nichols
SMBA J Matthews
Hamburg W. Nellen
Bremerhaven J. Alheit
Helgoland E. Wahl
Copenhagen P. Munk

Challenger June 1989

Triple Longhurst Hardy Plankton Recorder Haul Information

Haul No.	Date	Time (GMT)	Bottom depth	Maximum Sampler	Position	Number of Samples 20μ	53μ	200μ
NS/1	11.6.89	1225	29	26	54°00'N 06°09'E	8*	12	11
2	12.6.89	1320	29	24	54°06'N 08°00'E	3*	10	7
3	12.6.89	2440	39	36	54°08'N 07°47'E	13	13	12
4	13.6.89	1706	16	14	53°52'N 07°54'E	15	14	6*
5	15.6.89	1127	35	33	54°27'N 06°51'E	13	12	12
6	15.6.89	2212	36	34	54°27'N 06°51'E	13	13	13
7	16.6.89	1123	39	36	54°47'N 06°03'E	-	14	15
8	17.6.89	1100	46	45	55°19'N 04°55'E	17	16	17
9	20.6.89	1017	44	42	54°10'N 03°49'E	13*	20	18
10	20.6.89	2136	44	40	54°10'N 03°49'E	18	21	20
11	21.6.89	1153	42	40	52°42'N 02°51'W	-	17	5*

* Loss of some samples. Jamming due to excess clogging or jelly fish.

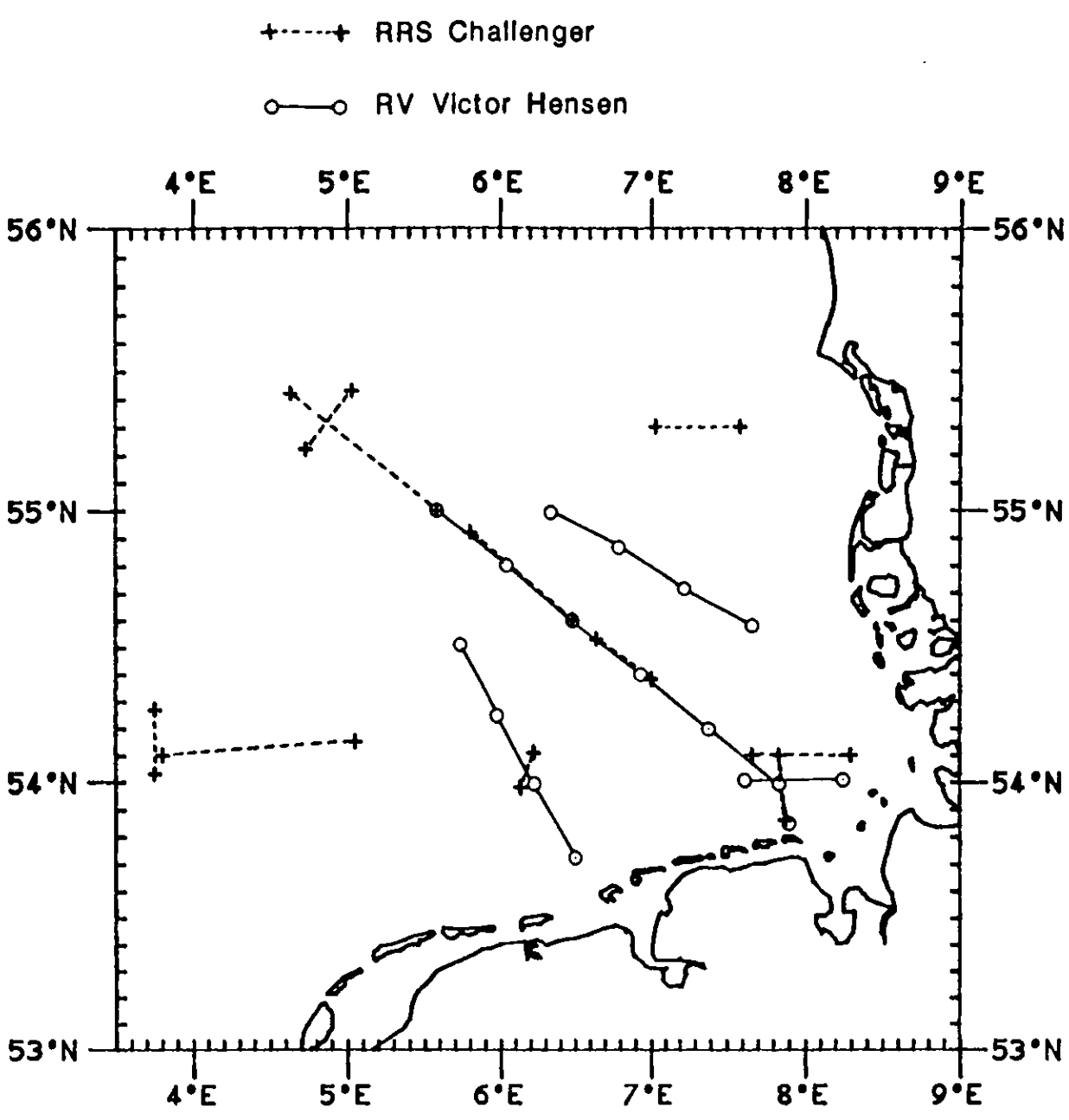

Fig 1 - UNDULATOR tows in the North Sea carried out on RV Victor Hensen, 2-9 June and RRS Challenger, 9-22 June.

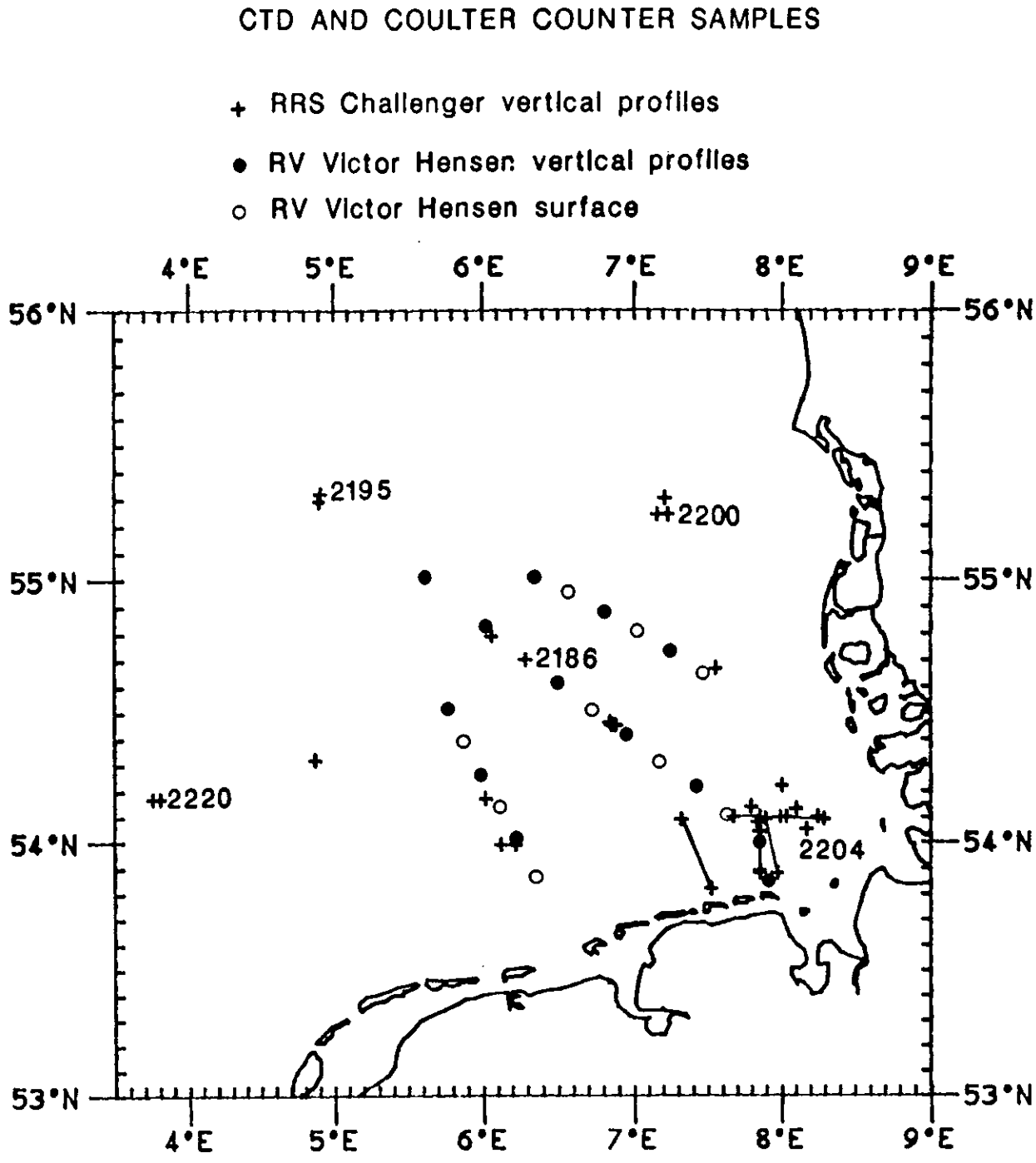

Fig 2 - Positions of water samples taken for COULTER COUNTER particle size analysis. The station numbers indicates are referred to in the text. Continuous lines indicate detailed CTD transects carried out on RRS Challenger.

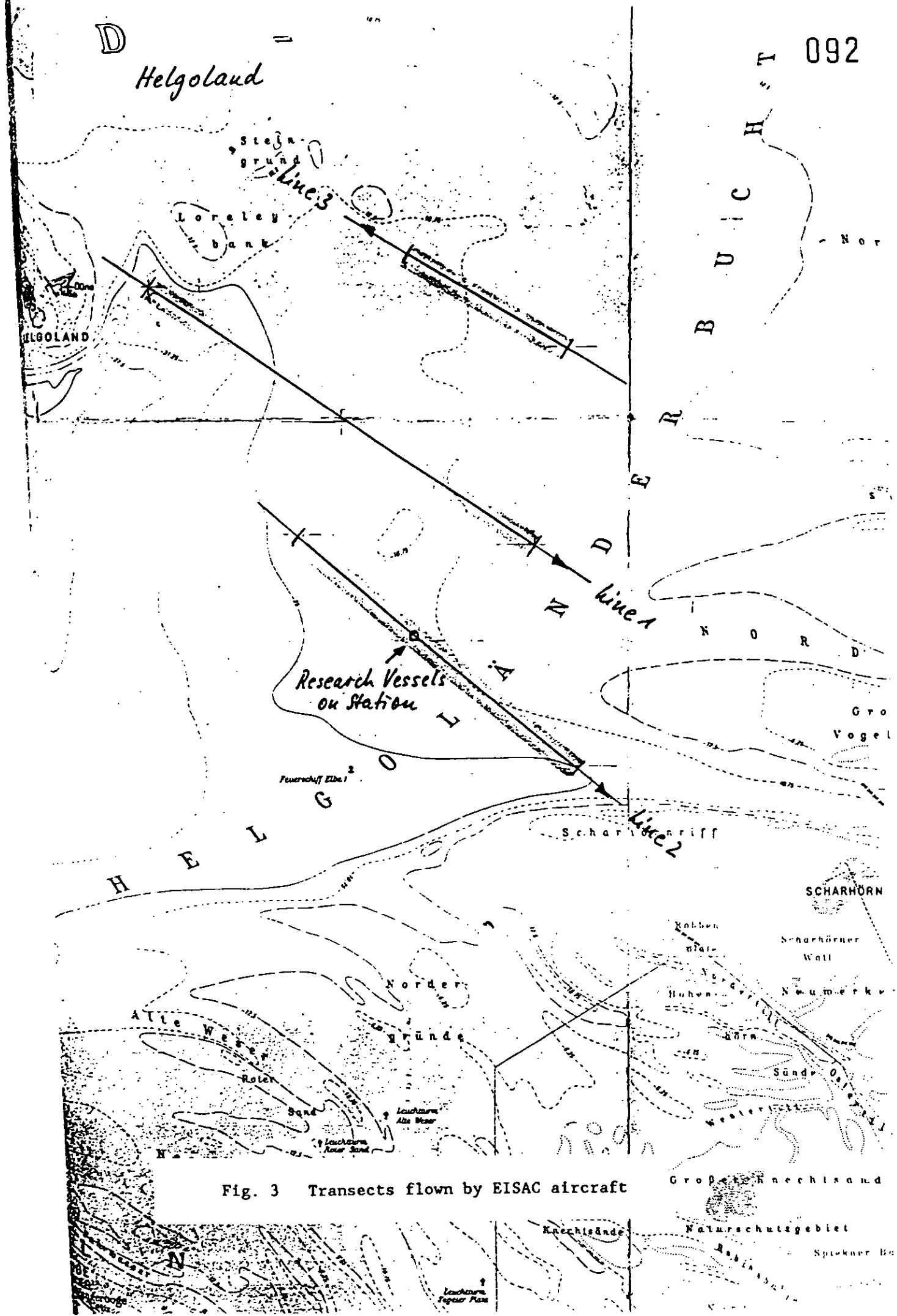

Fig. 3 Transects flown by EISAC aircraft

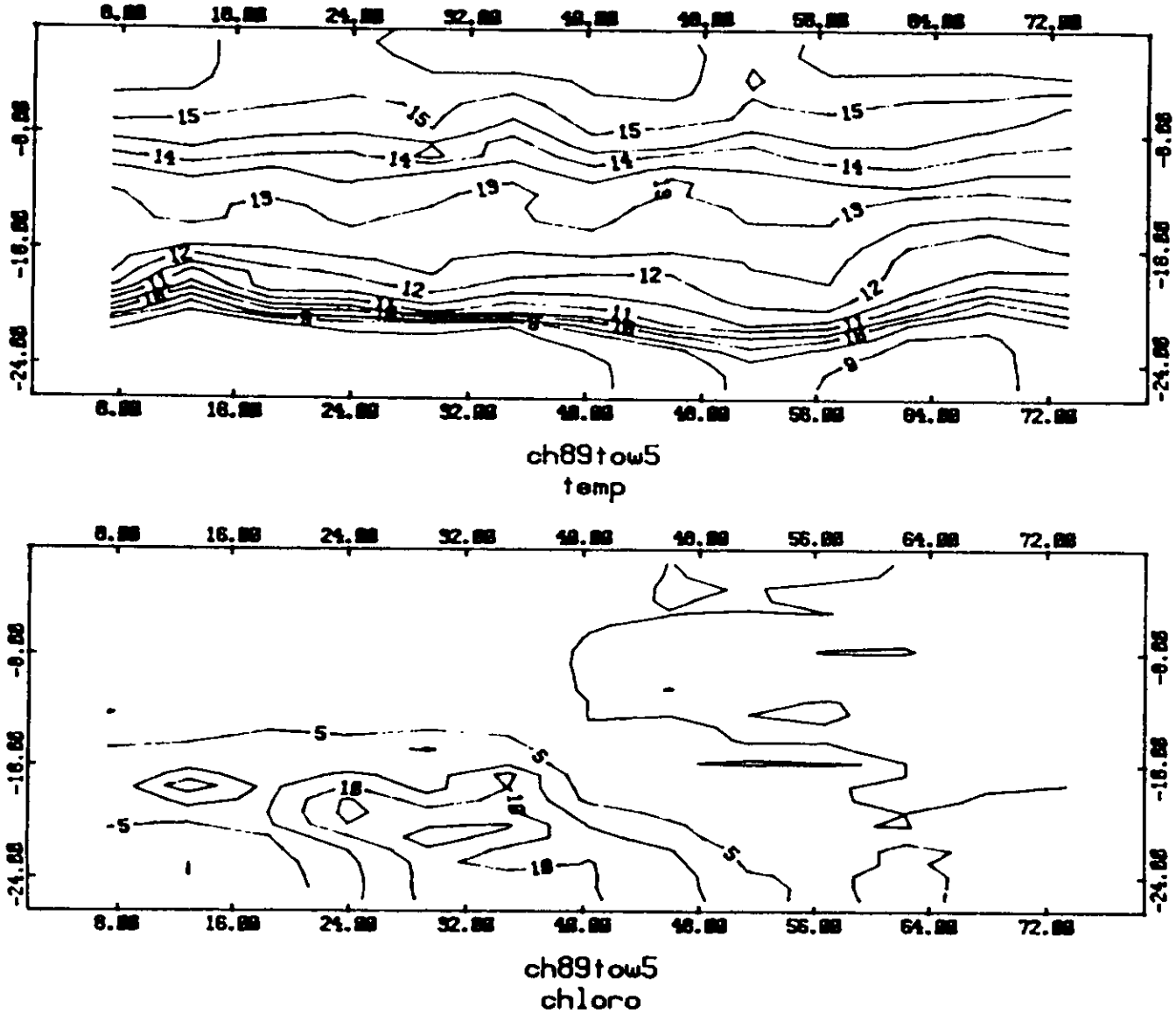

Fig 4 UNDULATOR results for temperature and chlorophyll on transects towards the central North Sea

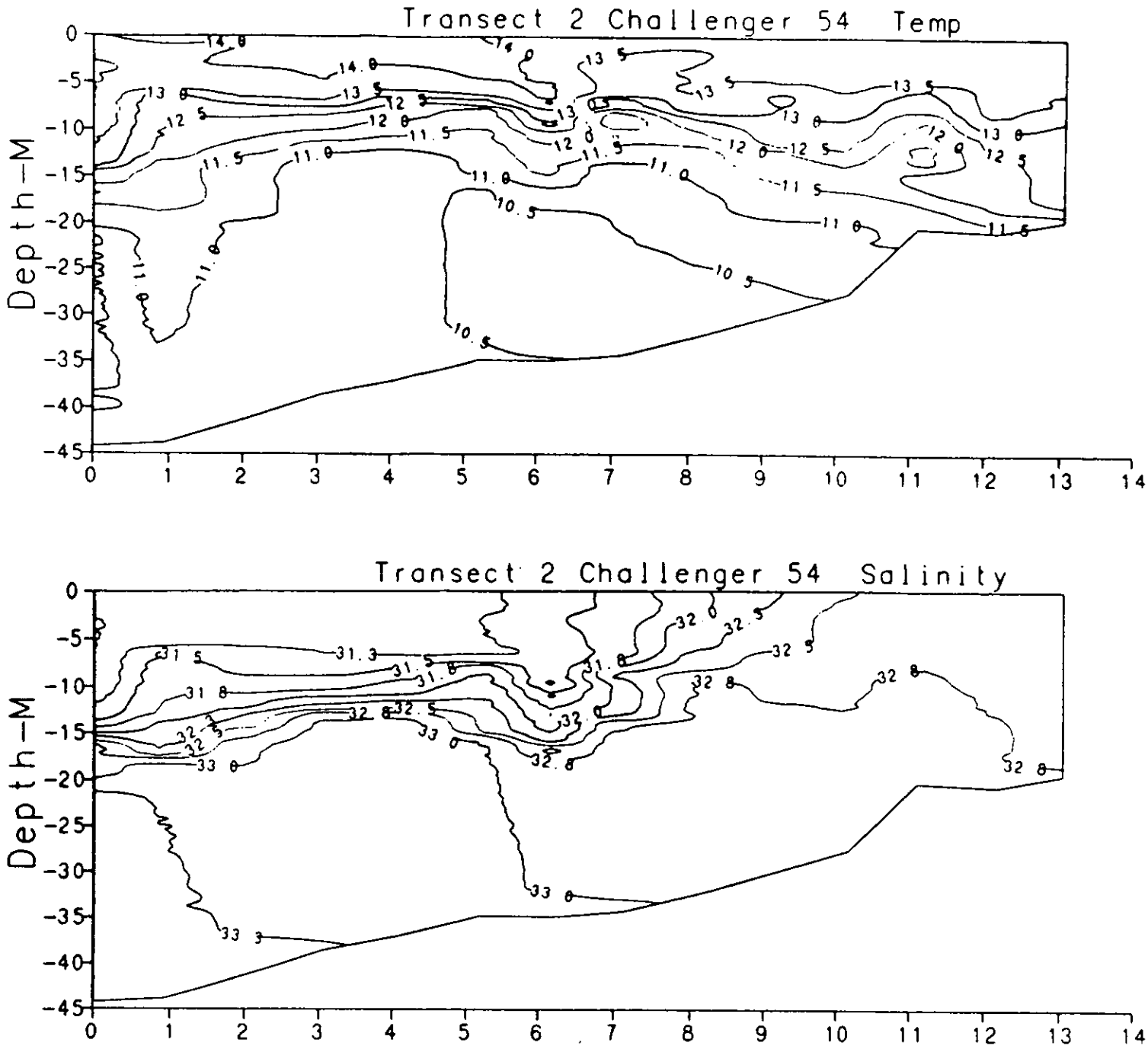

Fig 5 Temperature and salinity contour diagrams based on a line of 14 CTD stations running south from Helogoland

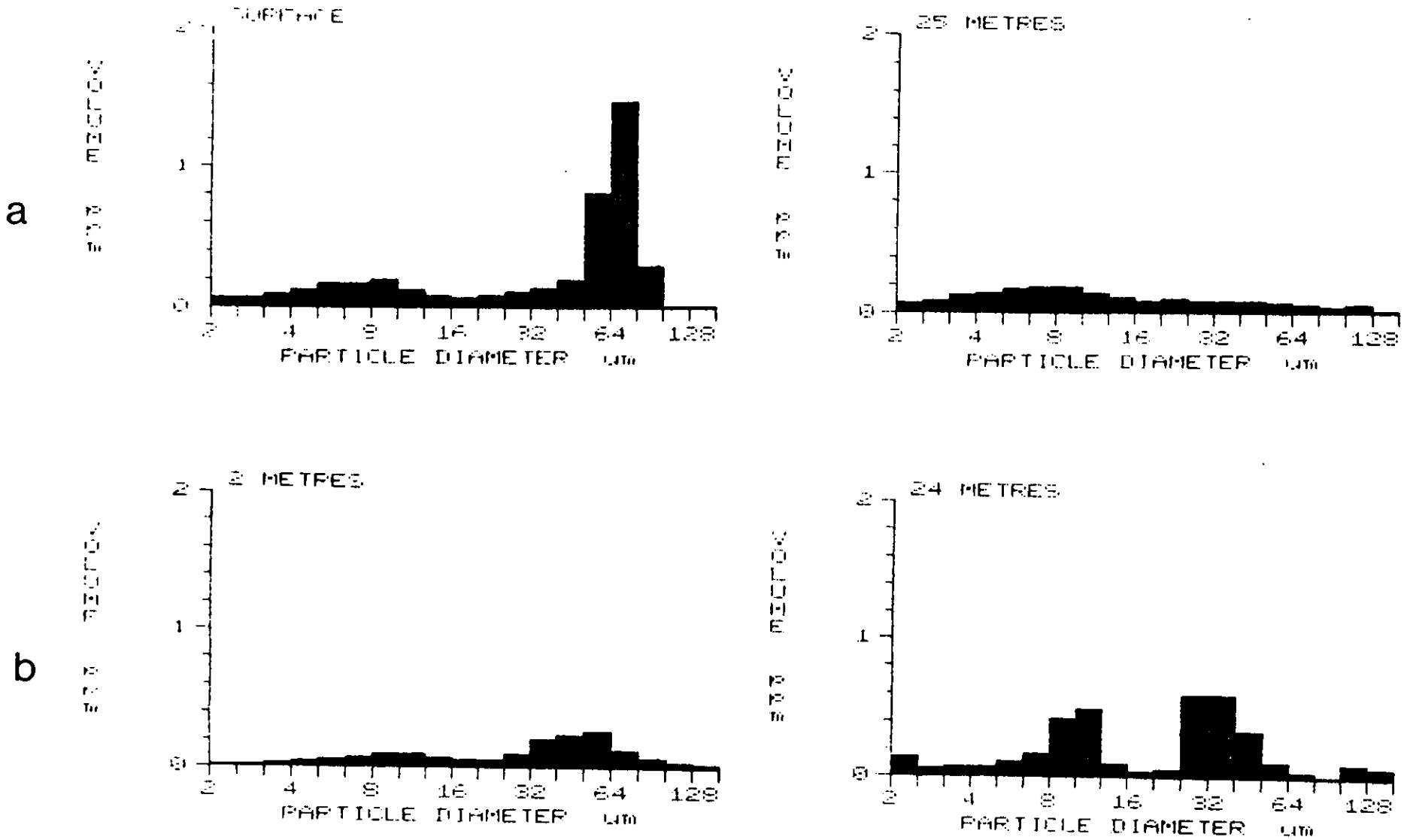

Fig 6. Particle size distribution (a) in stratified water adjacent to the frontal region of the German Bight and (b) in stratified water further towards the central North Sea

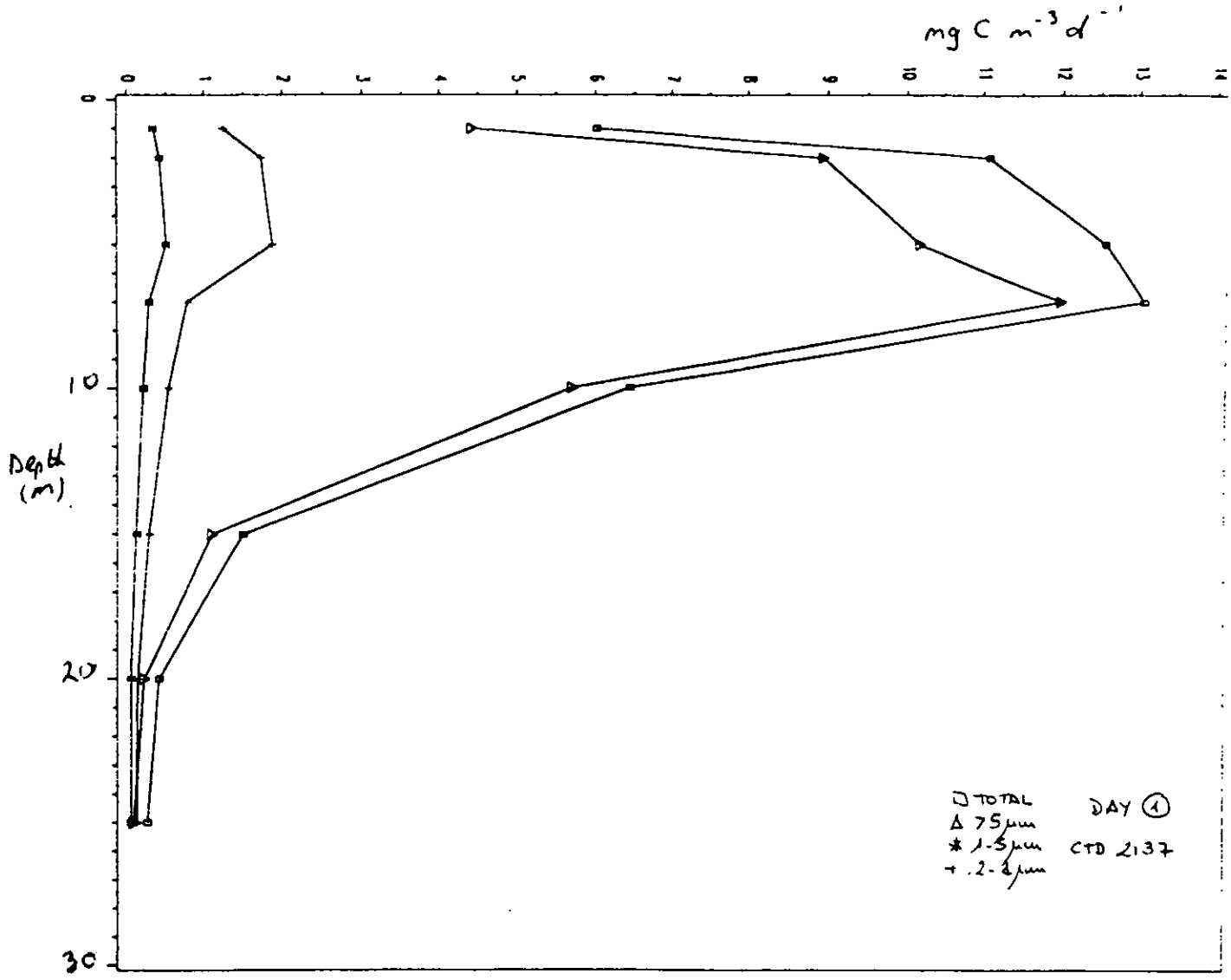

Fig. 7. Primary productivity of three size fractions of phytoplankton (>5µm, <5 ->1µm and picoplankton <1µm).

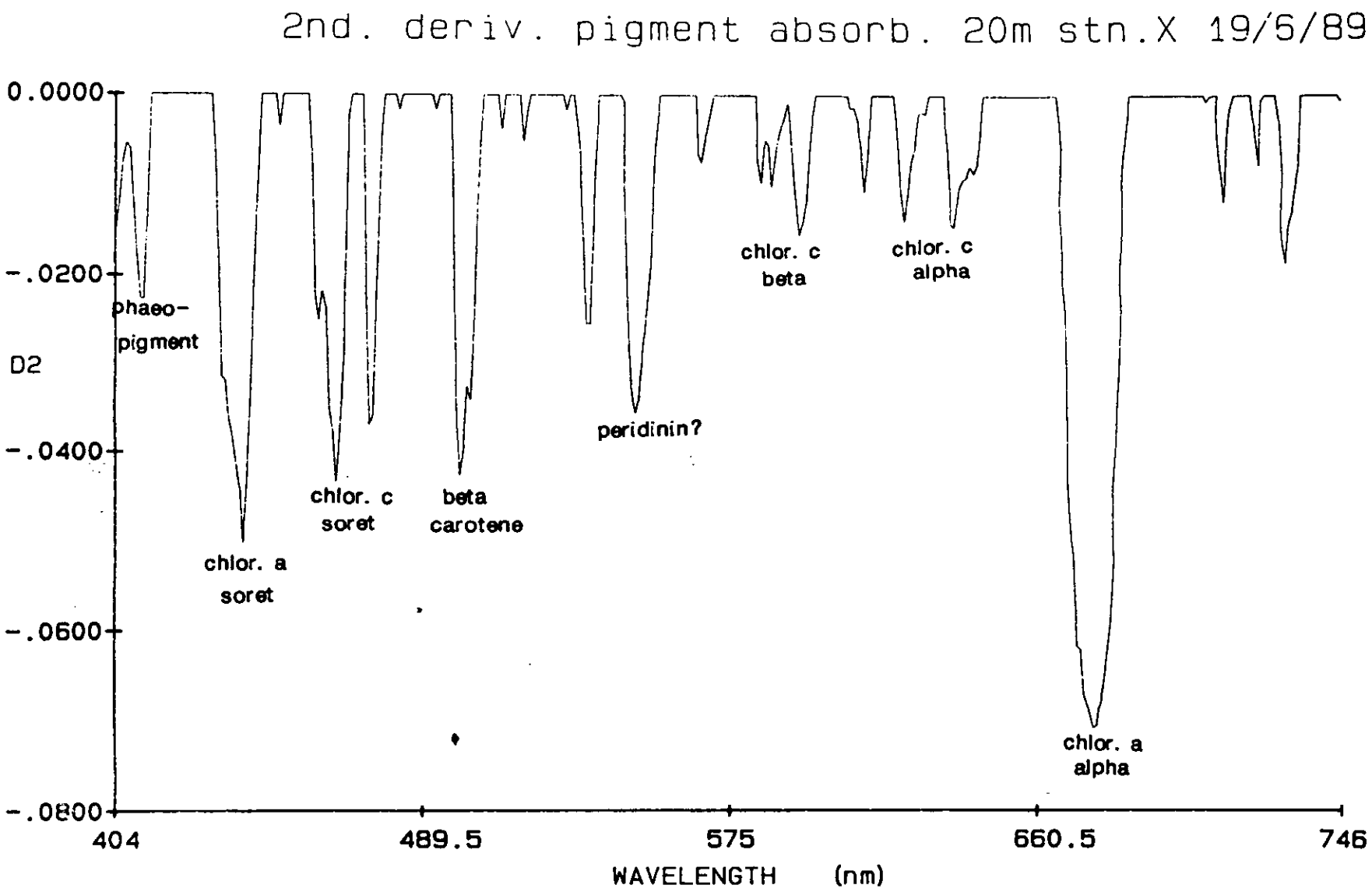

Fig. 8. Second derivative of absorption spectrum of particulate matter; each peak is due to absorption by different phytoplankton pigments.