Marine environment data inventory for the Bay of Biscay, Celtic Sea and west of Ireland, March - July 1977.

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Fisheries Laboratory Lowestoft 1985

Fisheries Research Data Report No 6

Data Rep., MAFF Direct. Fish. Res.,
Lowestoft, (6), 44 pp.

MINISTRY OF AGRICULTURE, FISHERIES AND FOOD
DIRECTORATE OF FISHERIES RESEARCH
FISHERIES RESEARCH DATA REPORT

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LOWESTOFT
1985

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1. INTRODUCTION

During the spring and early summer of 1977 the Fisheries Laboratory, Lowestoft undertook a plankton survey of the Bay of Biscay, Celtic Sea and Porcupine Bank west of Ireland. A series of five survey cruises was made in this area, by the MAFF research vessel CIROLANA, between March and July. The principal objective of this survey was to collect plankton samples from the Western mackerel spawning grounds (Johnson, 1977) and to estimate the Western mackerel spawning stock size from the number of eggs spawned (Lockwood et al., 1981).

In the course of the survey sea-surface temperature measurements were collected to convert egg abundance estimates to production estimates. With relatively little increase in costs, and no increase in ship's time, it was also possible to measure a number of other environmental and phytoplanktonic parameters. The main biological results from this survey have been published (Lockwood et al., 1981; Walker and Pipe, 1977; Coombs and Mitchell, 1981; Coombs et al., 1981) but the additional environmental data have not been published hitherto.

The survey area is one which is relatively unknown when compared with the North Sea, but in recent years it has increased in importance in terms of fisheries (Bridger, 1978; Lockwood, 1978; Lockwood and Shepherd, 1984; Pawson, 1979; Eaton, 1983) and oil and mineral resources (Sibthorpe and Unwin, 1977). For the use of those who have an interest in the area, the environmental and phytoplanktonic data collected during the MAFF plankton survey are presented here, without interpretation, in charts and tables, together with a brief explanation of how each parameter was measured.

The limits to the survey area (Figure 1) were drawn to encompass the major part of the Western mackerel spawning grounds. The eastern boundaries were set by the coasts of France, England and Ireland, plus lines drawn from Brittany to Cornwall and from Cornwall to Kinsale. The western limit was drawn 30-100 km west of the 200 m isobath, from 43°30'N in the south to 55°N in the north.

This area was divided into numbered rectangles 0.5° latitude by 0.5° longitude, at the centres of which were the sampling positions, e.g., the latitude and longitude of position 69 is 48°15'N 10°15'W. The tables of data identify station position by the rectangle reference numbers shown in Figure 1.

The extent to which this area was covered on each research cruise is shown in Figure 2. Figures 3-14 illustrate the distributions of each parameter monitored.

2. SAMPLING

2.1 The continuous environmental monitoring system

Temperature, turbidity, oxygen, pH and *in vivo* chlorophyll 'a' concentrations were all measured continuously by an environmental monitoring system. Clean sea water was drawn from 4.5 m below the sea surface by a stainless-steel pump and fed through stainless-steel and ABS plastic piping to a rectangular, transparent, perspex box. Water entered the box through one end at the bottom and left at the opposite top end. En route it passed an array of sensor heads measuring the parameters listed above. The value for each parameter was recorded on a multi-channel pen-chart recorder.

2.2 The physical environment

Temperature (Figures 3 and 4, Tables 1-5)

Sea-surface temperatures (Figure 3) were monitored continuously by two separate systems and at station positions by a third. The continuous records were taken by a ship's hull-mounted thermograph, measuring 5 m below the sea surface, and by a YSI Components precision thermistor fitted in the environmental monitoring system. The latter was calibrated over the ranges 2-12°C and 10-20°C.

The third system used a thermistor mounted on the plankton sampler which provided a temperature-depth profile at each plankton station (Harding *et al.*, 1971). Sampling was limited to a maximum depth of 100 m. The 100 m isotherms are shown in Figure 4. The positions of the surface isotherms were plotted from the continuous records but the 100 m isotherms were drawn by linear interpolation between observations made at each plankton station.

In Figures 3 and 4, the April and May temperatures and salinities in the Bay of Biscay are from observations made by the French fisheries research vessel LA PELAGIA, which was participating in the plankton programme.

Salinity (Figure 5, Tables 1-5)

At each plankton station 500 ml of surface sea water was collected from the environmental monitoring system overflow and returned to the laboratory for analysis with an Auto-Lab inductively-coupled salinometer (Model 601, Mk VIII). The isohalines were drawn by linear interpolation between observations.

Turbidity (Figure 6, Tables 1-5)

Turbidity, recorded as percentage light transmission, was measured with a tungsten filament light source shining through a lens fitted to one side of the environmental monitoring chamber onto a receiver on the opposite side of the monitoring chamber. In the receiver the light passed through a collimator and Vλ filter onto a type BPX 80 photo diode. The instrument measured turbidity as a percentage of light transmission, when 100% transmission occurs through the monitoring chamber when it is filled with distilled water.

Oxygen (Figure 7, Tables 1-5)

Oxygen concentrations were measured with an Electronics Instruments Ltd (EIL) oxygen electrode (Model 1510) modified to work from the mains supply and to give a chart record as well as the direct analogue display.

pH (Figure 8, Tables 1-5)

pH was measured with an EIL pH electrode (Model 30c), similarly modified to operate in the same manner as the oxygen electrode.

Of all the parameters measured and instruments used, pH gave the least consistent results. The instrument calibration was checked against a buffered standard at least once a day but, due to either inexperience of shipboard operators or instability within the instrument, the measurements were unreliable and only two pH distributions were drawn with any confidence.

2.3 The biological environment

Phytoplankton concentrations

Chlorophyll 'a' was measured (μg/l) as an index of phytoplankton abundance. Measurements were made of the fluorescence of living cells present in the sea water passing through a fluorometer measuring cell, and also by measuring fluorescence following the acetone extraction of chlorophyll from the filter paper through which sea water had been filtered. Both methods, which are summarized below, have been described in detail by Lincoln (1976).

Fluorescence was measured with a Turner Fluorometer (Model III) fitted with a red-sensitive photomultiplier to extend the range of the instrument from 650 to 750 nm and to increase by ten-fold the sensitivity to chlorophyll 'a'. Light from a blue, fluorescent lamp (F 4T5) passed through a blue filter (Corning CS5-60) onto the sample. Light emitted by the sample was passed through a secondary red filter (Corning CS2-64) onto the photomultiplier. This technique minimizes interference from accessory pigments.

In vivo chlorophyll 'a' concentrations (Figure 9, Tables 6-10)

Water from the environmental monitoring chamber passed through a continuous flow cuvette fitted in the fluorometer and in vivo chlorophyll 'a' fluorescence was measured continuously. The results were recorded with the physical parameters which were also monitored continuously.

Total chlorophyll 'a' concentration (Figure 10, Tables 6-10)

A sample of 250 ml sea water was collected from the fluorometer outflow and drawn through a Sartorius cellulose nitrate membrane filter (0.45 μm pore size) by a vacuum pump. The filter membrane was then dissolved in 90% acetone in a clean graduated centrifuge tube. The tubes were spun at 3 000 rpm for 20 min, then 5 ml of the clear liquid was drawn off into a clean fluorometer cuvette which was placed in the fluorometer and a reading taken. The sample was then acidified with 2N hydrochloric acid to convert the chlorophyll to phaeophorbides, another plant pigment which is a product of chlorophyll decay. A second fluorometer reading was then taken.

The concentration of chlorophyll 'a' was calculated from the equation:

$$\text{chlorophyll 'a' } (\mu g/l) = k(b-a),$$

where k = calibration constant for the fluorometer,
b = the fluorometer reading before acidification,
a = the fluorometer reading following acidification.

Total phaeopigment concentration (Figure 11, Tables 6-10)

Phaeopigments are a product of chlorophyll decay and may be estimated from the same fluorometer readings taken for the chlorophyll 'a' concentrations:

$$\text{phaeopigment } (\mu g/l) = k(2a-b).$$

Acidification factors

The acidification factor is the ratio of the measurements a and b described above:

$$\text{acidification factor} = b/a.$$

Lorenzen (1967) defined an acidification factor of 1.35 as the level at which the concentration of chlorophyll 'a' is equal to the concentration of

phaeopigments. An acidification factor of less than 1.35 indicates more phaeopigment than chlorophyll, and may indicate a decline in phytoplankton abundance, possibly due to grazing. The significance of these acidification factors is discussed by Yentsch and Menzel (1963), Holm-Hansen (1965) and Lincoln (1975).

Some acidification factors of less than 1.35 derived from the total chlorophyll and total phaeopigment measurements were calculated (Tables 7 and 8) but were not sufficiently numerous for distribution charts to be drawn.

Nanoplankton chlorophyll 'a' concentrations (Figure 12, Tables 6-10)

Indices of nanoplankton abundance were obtained by filtering 250+ ml of sea water through a 10 μm filter to remove the large phytoplankters, and then filtering 250 ml of the filtrate through the Sartorius membrane filter. The filter membrane was then treated in exactly the same way as in the estimation of total chlorophyll 'a' concentrations.

Nanoplankton phaeopigment concentrations (Figure 13, Tables 6-10)

These concentrations were measured following the same procedure with the nanoplankton samples as was used with the total phytoplankton samples. Distributions were not drawn for June or July because recorded levels were too low.

Nanoplankton acidification factors (Figure 14, Tables 6-10)

The nanoplankton acidification factors were estimated in the same way as for total phytoplankton. Definite areas of declining phytoplankton abundance with acidification factors less than 1.35 were identified and distributions were drawn for April, May, June and July.

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Table 1 Environmental data: CIROLANA 3, 15-28 March 1977

Station no.	Date (Mar '77)	Surface temp. (°C)	100 m temp. (°C)	Salinity (°/oo)	Turbidity (% light transmission)	pH	O_2 (% saturation)
4	20	13.05	12.4	34.25	92	8.45	92
5	"	13.10	12.1	35.02	92	8.59	92
6	19	12.50	12.0	35.17	92	8.55	94
7	"	13.99	12.0	35.17	92	8.45	93
9	20	12.60	*	34.85	90	8.40	104
10	"	12.50	12.3	35.13	88	8.55	106
11	"	12.18	11.9	35.06	92	8.50	102
12	19	12.20	11.9	35.10	92	8.50	98
13	"	12.60	12.0	35.17	95	8.60	98
14	"	12.90	12.0	35.19	93	8.65	96
15	18	11.80	11.9	35.45	94	8.65	100
16	"	11.59	11.7	35.15	95	8.50	100
17	19	11.90	11.8	35.19	95	8.60	102
21	20	11.80	*	34.77	82	8.35	96
22	"	11.75	*	32.69	80	8.34	102
23	"	11.40	*	33.02	90	8.40	95
24	"	11.60	11.7	35.02	89	8.35	92
25	21	11.75	11.7	35.14	89	8.35	100
26	"	11.75	11.7	35.15	89	8.50	100
27	"	11.60	11.7	35.15	92	8.30	90
28	18	11.75	11.9	35.45	96	8.60	100
30	"	10.90	-	35.42	96	8.60	98
31	"	10.85	-	35.42	95	8.60	100
33	21	11.60	11.5	35.66	90	8.37	95
38	"	11.40	*	33.26	86	8.50	100
39	"	10.90	11.3	31.97	87	8.45	100
40	"	10.50	*	33.61	90	8.39	98
41	22	10.50	11.1	35.29	90	8.36	96
42	18	11.60	-	35.44	94	8.60	100
43	22	11.20	11.3	35.65	92	8.40	95
44	"	11.30	11.3	35.57	93	8.40	94
45	"	10.50	11.2	35.52	94	8.30	92
50	"	11.00	11.0	35.58	94	8.64	96
51	"	11.25	11.1	35.56	95	8.65	89
52	"	11.40	11.2	35.59	95	8.70	95
53	"	10.50	10.9	35.59	92	8.35	92
57	15	10.35	-	35.35	87	8.35	91
60	24	10.60	10.8	33.79	92	8.70	104
61	23	10.90	*	35.58	97	8.55	97
62	"	11.40	10.5	35.51	94	8.50	96
63	"	11.70	10.6	35.53	96	8.50	98
64	"	11.80	10.6	35.52	96	8.60	98
65	"	11.00	10.9	35.56	95	8.60	92
66	"	11.00	10.9	35.58	94	8.60	90
67	"	10.40	10.8	35.57	94	8.50	92
83	24	10.50	10.5	35.54	93	8.40	92
86	"	10.40	10.4	35.35	93	8.40	90
87	"	10.40	10.1	35.33	94	8.55	92
88	"	10.50	10.0	35.32	94	8.55	92
89	"	10.60	10.2	35.37	94	8.55	93
90	"	10.50	10.1	35.37	94	8.55	92

Table 1 continued

Station no.	Date (Mar '77)	Surface temp. (°C)	100 m temp. (°C)	Salinity (°/oo)	Turbidity (% light transmission)	pH	O_2 (% saturation)
91	24	10.40	10.2	35.39	94	8.55	96
92	25	10.20	10.0	35.46	93	8.40	95
93	"	10.10	10.0	35.33	93	8.42	96
94	"	10.30	-	35.35	94	8.40	96
95	"	10.15	*	35.31	93	8.40	96
96	"	10.70	*	35.47	93	8.40	97
97	"	10.80	-	35.52	94	8.52	96
99	26	10.80	10.5	35.54	93	8.40	96
102	28	10.00	8.6	35.37	84	8.35	93
103	"	10.20	8.4	35.28	85	8.35	88
104	"	9.60	8.5	35.30	82	8.22	94
105	"	9.70	8.5	35.30	83	8.20	94
106	"	10.00	8.6	35.33	83	8.30	95
107	"	9.50	8.6	35.31	83	8.35	92
108	"	10.00	8.7	35.32	83	8.32	90
109	"	9.50	8.6	35.31	84	8.33	90
118	26	9.70	9.4	35.24	85	8.36	92
119	"	9.70	9.3	35.25	84	8.39	92
120	"	9.80	9.1	-	86	8.40	94
121	"	9.90	9.2	35.46	87	8.53	92
122	"	10.40	9.8	35.46	87	8.55	96
123	"	10.80	10.2	35.57	93	8.40	91
124	"	10.80	10.4	35.52	93	8.40	97
128	27	10.00	9.9	35.35	85	8.40	92
134	"	9.70	9.1	35.19	85	8.50	90
140	"	9.50	8.9	35.14	84	8.55	90
141	"	9.30	*	35.16	84	8.32	90
142	"	9.20	8.8	35.16	84	8.31	92
143	"	9.40	8.9	35.09	83	8.42	90
144	"	9.50	9.2	35.16	86	8.42	90

* Depth less than 100 m.
- No reading taken.

Table 2 Environmental data: CIROLANA 4, 8-16 April 1977

Station no.	Date (Apr '77)	Surface temp. (°C)	100 m temp. (°C)	Salinity (°/oo)	Turbidity (% light transmission)	O_2 (% saturation)
71	9	11.00	10.9	35.59	95	104
72	"	11.10	11.0	35.52	94	104
73	"	10.50	10.8	35.51	95	104
74	"	10.60	10.5	35.46	93	104
75	"	10.90	10.8	35.56	91	102
76	"	10.60	10.6	35.48	93	-
77	"	10.40	10.3	35.40	93	104
78	"	10.50	10.5	35.39	94	104
79	"	10.50	10.4	35.40	94	104
80	8	10.40	10.4	35.38	94	102
81	"	10.60	10.5	35.40	94	100
82	"	10.50	10.3	-	94	98
83	"	10.80	10.6	35.13	89	98
84	"	10.90	10.6	35.49	88	88
98	9	10.80	10.7	35.49	94	104
99	10	10.90	10.9	35.94	95	102
100	"	10.70	10.9	35.48	94	102
101	"	10.25	11.1	35.41	94	104
102	"	9.85	10.8	35.32	94	107
103	"	9.80	9.6	35.29	93	104
104	"	9.99	9.7	35.28	93	104
105	"	10.10	9.7	35.30	92	104
106	"	10.15	9.7	35.30	92	102
107	"	9.95	9.7	35.28	92	104
108	"	10.00	9.9	35.34	93	102
109	"	10.00	9.9	35.32	93	106
110	11	10.28	10.2	35.34	93	104
111	"	10.00	*	35.29	94	104
114	"	9.80	*	35.31	93	104
126	12	10.80	10.6	35.45	94	98
127	"	10.70	10.6	35.48	94	99
128	"	10.40	10.2	35.44	91	102
129	"	9.69	9.5	35.24	93	101
130	"	9.49	9.2	35.16	92	98
131	11	9.55	9.3	35.23	92	98
132	"	9.70	9.4	35.25	93	99
133	"	9.65	10.3	35.20	93	99
134	"	9.60	10.3	35.21	93	99
135	"	9.40	10.1	35.19	92	100
136	"	9.40	*	35.14	93	98
146	12	10.65	10.3	35.46	96	99
148	13	10.75	10.5	35.45	-	100
149	"	10.65	10.3	35.45	94	96
150	"	9.78	10.3	35.04	92	100
152	"	9.68	9.0	34.82	88	107
162	14	10.20	10.1	35.40	94	104
163	"	10.00	9.8	35.39	93	106
164	"	10.22	10.0	35.45	93	104
165	"	10.30	10.2	35.46	93	104
166	"	10.30	10.2	35.43	93	100
167	"	9.99	9.4	35.32	93	98
168	13	9.12	10.2	35.15	*	97

Table 2 continued

Station no.	Date (Apr '77)	Surface temp. (°C)	100 m temp. (°C)	Salinity (°/oo)	Turbidity (% light transmission)	O_2 (% saturation)
169	13	9.40	9.9	34.94	88	107
180	14	10.00	9.8	35.47	94	104
184	"	10.25	10.1	35.40	94	102
185	"	10.30	10.2	35.40	94	102
186	15	10.00	10.0	35.40	94	104
187	"	10.00	9.8	35.38	94	104
188	"	10.00	9.8	35.39	98	104
189	"	9.85	9.7	35.38	93	104
190	"	9.85	9.8	35.39	93	104
191	"	9.15	9.5	34.98	*	114
192	"	8.95	*	34.78	93	103
193	"	8.82	*	34.73	91	112
203	16	10.41	10.2	35.38	94	104
204	"	10.30	9.9	35.38	95	102
205	"	10.39	10.3	35.41	94	103
206	"	10.20	10.0	35.27	93	102
207	"	10.20	10.0	35.39	94	101
208	"	9.90	9.9	35.36	94	102
209	"	9.80	9.6	35.35	93	102
210	15	9.80	9.7	35.35	93	102
211	"	9.80	9.7	35.34	93	102
212	"	8.83	9.2	35.12	91	104

* Depth less than 100 m.
- No reading taken.

Table 3 Environmental data: CIROLANA 5, 10-19 May 1977

Station no.	Date (May '77)	Surface temp. (°C)	100 m temp. (°C)	Salinity (°/oo)	Turbidity (% light transmission)	pH	O_2 (% saturation)
60	18	11.75	10.8	35.35	89	8.40	100
61	"	11.30	10.6	35.43	90	8.35	99
62	"	11.70	10.5	35.44	88	8.40	101
63	"	11.70	10.4	35.42	90	8.30	102
64	"	11.80	10.5	35.45	90	8.25	98
65	"	11.70	10.5	35.49	92	8.40	99
66	"	11.70	10.8	35.51	92	8.40	98
67	"	12.20	10.9	35.53	92	8.40	98
68	17	12.00	10.8	35.42	92	8.30	97
74	"	12.10	10.6	35.44	89	8.50	102
83	19	11.70	10.6	35.27	93	8.25	90
86	"	11.60	10.6	35.13	89	8.40	95
87	"	11.50	10.1	35.29	86	8.40	102
88	"	11.40	10.0	35.29	90	8.40	102
89	"	11.90	9.9	35.31	91	8.40	103
90	"	12.05	9.9	35.39	90	8.40	102
91	"	12.00	10.1	35.39	90	8.25	102
92	"	12.10	10.1	35.29	92	8.25	98
93	"	12.20	10.1	35.27	91	8.35	98
94	17	11.80	9.7	35.29	92	8.40	100
95	"	11.70	9.8	35.33	89	8.40	99
96	"	11.50	10.3	35.35	88	8.25	90
97	"	11.50	10.6	35.46	93	8.24	90
99	"	11.50	10.2	35.45	92	8.40	101
114	15	11.00	*	35.23	92	8.35	102
115	"	10.80	*	35.19	89	8.35	103
116	"	10.70	9.3	35.16	77	8.35	101
117	16	10.80	9.6	35.19	93	8.25	100
118	"	10.90	9.3	35.19	92	8.25	100
119	"	10.90	9.3	35.19	92	8.35	99
120	"	11.10	9.3	35.17	92	8.34	98
121	"	11.10	9.3	35.15	92	8.35	101
122	"	11.20	10.0	35.20	91	8.38	101
123	"	11.40	10.2	35.43	92	8.30	92
124	"	11.40	10.4	35.46	92	8.26	100
136	15	10.70	9.1	35.05	88	8.35	100
138	"	11.20	*	34.90	93	8.25	90
139	"	11.00	*	34.97	93	8.20	100
140	"	11.10	8.9	34.97	93	8.35	92
141	"	10.90	9.0	35.01	92	8.39	97
142	"	10.80	9.4	35.06	92	8.40	99
143	14	10.70	9.4	35.05	91	8.42	100
144	"	10.40	9.9	35.06	93	8.30	95
145	"	11.50	9.9	35.28	90	8.25	101
146	"	11.40	10.3	35.43	93	8.35	97
147	"	11.78	10.5	35.48	93	8.35	97
148	"	11.30	10.4	35.42	92	8.35	99
149	"	10.90	10.1	35.27	91	8.15	103
152	"	10.70	8.8	35.01	91	8.15	101
153	13	11.00	9.5	35.12	89	8.15	100
154	"	11.30	10.2	35.42	89	8.18	102
155	"	12.40	10.3	35.45	93	8.10	103

Table 3 continued

Station no.	Date (May '77)	Surface temp. (°C)	100 m temp. (°C)	Salinity (°/oo)	Turbidity (% light transmission)	pH	O_2 (% saturation)
156	13	12.40	10.2	35.46	92	8.10	104
157	"	11.80	10.1	35.45	92	8.20	103
158	"	11.10	9.9	35.39	88	8.15	103
159	"	10.80	10.0	35.39	87	8.10	99
161	"	10.50	10.3	35.35	91	8.10	98
174	11	10.80	9.4	34.88	91	8.10	90
175	"	10.35	9.6	35.01	90	8.04	100
176	"	10.50	9.6	35.38	90	8.00	104
177	"	10.80	9.8	35.38	88	8.10	102
178	12	10.75	9.7	35.38	88	8.09	101
179	"	10.70	9.7	35.36	88	8.03	103
180	"	10.60	9.9	35.37	86	8.10	102
181	"	10.45	9.6	35.39	91	8.08	99
192	"	10.30	-	34.76	91	8.00	98
194	"	10.35	-	35.25	89	8.02	103
195	"	10.60	-	35.36	89	8.02	102
196	"	10.50	-	35.35	88	8.05	106
197	10	10.70	-	35.37	88	8.08	101
198	"	10.80	-	35.37	88	8.10	102
199	"	10.90	-	35.37	86	8.10	103
200	"	10.90	-	35.39	87	8.10	101
201	"	11.00	-	35.39	88	8.10	103
202	"	10.95	-	35.60	90	8.10	-

* Depth less than 100 m.
- No reading taken.

Table 4 Environmental data: CIROLANA 6, 2-11 June 1977

Station no.	Date (Jun '77)	Surface temp. (°C)	100 m temp. (°C)	Salinity (°/oo)	Turbidity (% light transmission)	O_2 (% saturation)
39	2	14.70	*	34.31	92	99
40	3	14.10	11.4	34.44	92	98
41	"	14.00	11.4	34.47	91	98
42	"	13.50	11.5	35.14	88	98
43	"	12.90	12.0	35.49	88	94
44	"	13.20	11.3	35.63	85	97
45	"	13.40	*	35.65	90	98
46	"	13.60	*	35.62	90	99
47	"	13.20	11.3	35.58	90	100
48	"	13.30	11.2	35.45	90	100
50	"	12.70	11.3	35.56	88	100
59	5	13.05	12.0	35.01	89	96
60	"	13.20	11.4	35.21	88	100
61	"	12.90	11.1	35.39	90	96
62	"	12.10	11.1	35.48	88	100
63	"	12.50	10.9	35.43	90	99
64	4	13.20	10.9	-	90	100
65	"	13.10	11.5	-	89	100
66	"	13.60	11.4	35.56	87	105
67	"	13.90	*	35.61	88	104
68	"	13.60	11.3	35.59	88	104
69	"	13.45	11.3	35.57	87	104
70	"	13.50	11.7	35.56	89	101
84	5	12.00	11.8	35.19	90	88
85	"	11.81	11.6	35.09	90	87
86	"	12.00	11.2	35.24	87	100
87	"	12.40	*	35.30	89	104
88	6	12.90	10.5	35.29	91	98
89	"	12.90	10.2	35.32	91	102
90	"	13.20	10.3	35.33	89	96
91	"	13.20	10.2	35.35	89	102
92	"	13.00	9.9	35.46	89	99
93	"	13.26	10.1	35.28	90	100
94	7	13.05	10.1	35.31	88	102
95	"	13.30	10.2	35.38	88	104
96	"	13.40	10.6	35.37	93	97
97	"	12.60	11.0	-	92	99
98	"	13.60	11.1	35.51	91	104
99	"	13.40	*	35.53	94	102
114	9	12.98	*	35.32	95	100
115	"	13.19	10.4	35.33	95	99
116	"	13.43	9.5	35.26	96	97
117	"	13.56	10.1	35.25	96	98
118	8	13.80	9.6	35.25	96	96
119	"	13.90	9.5	35.24	95	99
120	"	14.00	-	35.23	97	98
121	"	14.55	-	35.19	97	99
123	"	13.41	*	35.30	95	95
124	"	13.25	10.8	35.46	94	100
125	"	13.30	10.8	35.49	93	103
137	9	13.40	-	35.29	98	99
138	"	13.75	*	34.91	91	97

Table 4 continued

Station no.	Date (Jun '77)	Surface temp. (°C)	100 m temp. (°C)	Salinity (°/oo)	Turbidity (% light transmission)	O_2 (% saturation)
139	9	13.80	*	34.88	91	97
140	"	13.75	*	34.97	91	96
141	"	13.44	10.2	34.97	89	97
142	"	13.43	9.5	34.87	89	97
143	10	12.92	-	35.02	89	96
144	"	12.25	10.1	35.08	89	96
145	"	12.70	10.2	35.13	90	96
146	"	13.20	10.5	35.27	90	99
147	"	13.08	10.9	35.51	90	101
149	"	12.62	10.2	35.15	89	100
153	"	12.59	9.3	35.01	89	99
154	11	12.79	10.5	35.38	88	99
155	"	12.39	10.8	35.48	89	99
156	"	12.70	10.5	35.46	88	100
157	"	12.50	10.7	35.48	81	100
177	"	12.10	10.3	35.42	87	102

* Depth less than 100 m.
- No reading taken.

Table 5 Environmental data: CIROLANA 8, 15-25 July 1977

Station no.	Date (Jul '77)	Surface temp. (°C)	100 m temp. (°C)	Salinity (°/oo)	Turbidity (% light transmission)	O_2 (% saturation)
8	23	> 20.0	11.6	34.19	96	103
10	"	> 20.0	*	33.76	97	105
12	"	> 20.0	11.8	33.68	92	103
17	22	> 20.0	11.6	34.98	94	110
18	"	> 20.0	11.6	34.37	96	108
21	23	> 20.0	*	32.10	96	107
23	"	> 20.0	*	33.36	94	106
24	"	> 20.0	11.8	33.49	90	106
25	"	> 20.0	11.7	34.25	87	106
27	22	19.50	11.4	34.64	93	105
30	"	17.30	11.4	34.92	94	106
31	"	18.40	11.4	34.70	92	103
32	"	18.90	11.5	34.29	92	103
34	23	19.80	11.6	33.49	94	102
38	"	17.40	*	33.63	93	98
39	24	19.10	11.5	33.53	94	100
40	"	19.30	11.4	33.40	95	98
41	"	18.80	11.4	34.28	91	98
43	22	16.20	11.6	35.12	91	109
44	"	16.60	11.9	35.12	93	109
45	21	17.40	11.6	35.24	94	102
51	"	17.30	12.0	35.32	96	103
52	"	16.70	11.6	35.30	94	102
53	"	16.40	12.1	35.25	94	103
57	24	17.40	11.5	34.64	92	98
59	"	16.60	11.8	34.71	92	98
62	21	16.90	11.3	35.10	97	102
63	"	16.80	11.2	35.17	97	103
64	"	16.60	11.4	35.22	95	102
65	"	16.40	11.4	35.24	96	106
66	"	16.40	11.9	35.21	94	106
82	20	17.30	10.9	35.07	96	103
84	24	16.00	11.2	34.92	92	99
85	"	15.90	11.0	34.98	93	100
88	20	16.90	10.3	35.01	96	102
89	"	17.20	10.1	35.03	96	102
90	"	17.20	10.2	35.00	95	101
91	"	17.10	10.1	35.01	94	102
92	"	17.00	10.0	35.07	94	102
93	"	16.80	9.9	35.06	96	101
94	"	16.70	10.2	35.09	96	103
95	"	16.60	10.2	35.12	96	102
96	"	16.40	10.4	35.21	95	103
100	19	16.20	11.1	35.31	96	107
112	25	15.70	*	34.75	94	98
115	19	16.60	*	34.99	94	103
116	"	16.50	9.5	34.94	94	103
117	"	16.60	*	34.84	95	103
118	"	16.70	9.8	34.88	95	106
119	"	16.60	9.5	34.86	95	107
120	"	16.70	9.6	34.89	95	107
121	"	16.70	9.7	34.93	96	106

Table 5 continued

Station no.	Date (Jul '77)	Surface temp. (°C)	100 m temp. (°C)	Salinity (°/oo)	Turbidity (% light transmission)	O_2 (% saturation)
122	19	16.50	10.3	34.94	96	102
123	"	16.50	10.4	35.12	96	103
137	18	16.70	*	34.98	93	108
G+	"	16.20	*	34.72	93	113
138	"	15.90	*	34.65	93	104
139	"	16.70	*	34.62	92	103
140	"	16.40	*	34.60	93	102
141	"	16.50	9.2	34.61	90	104
142	"	16.20	9.4	34.58	85	108
143	"	16.10	9.7	34.60	97	106
144	"	16.10	10.0	34.79	87	106
145	"	16.00	10.3	34.86	86	105
146	17	16.00	10.6	34.98	85	107
148	"	16.10	10.7	35.18	85	106
153	"	15.80	9.6	34.68	90	105
169	"	16.00	9.5	34.60	93	107
175	"	15.20	9.8	34.61	90	105
176	"	15.00	10.1	34.89	91	102
177	"	14.70	10.3	35.18	90	102
178	"	14.70	10.2	35.16	90	102
179	"	14.50	9.9	35.15	90	102
180	"	14.70	9.9	35.12	90	103
181	16	14.60	10.1	35.11	88	103
183	"	14.60	10.4	35.09	75	105
194	15	14.60	9.9	34.60	94	103
195	16	14.40	10.0	34.98	93	104
196	"	14.10	10.0	35.05	92	104
197	"	14.10	10.3	35.05	92	103
198	"	14.10	10.2	35.10	91	103
199	"	14.00	*	35.12	92	103
200	"	14.00	10.2	35.14	92	103
201	"	14.40	10.8	35.14	91	104

*Depth less than 100 m.
+See Figure 1.

Table 6 Chlorophyll 'a' and phaeopigments: CIROLANA 3, 13-28 March 1977

Station no.	Date (Mar 1977)	In vivo fluorescence	Total phytoplankton			Nanoplankton		
			Chlorophyll 'a'+	Phaeopigment+	Acidification factor T	Chlorophyll 'a'+	Phaeopigment+	Acidification factor N
4	20	12.4	2.08	1.31	1.61	0.55	0.46	1.54
5	"	10.8	1.83	0.52	1.78	0.42	0.21	1.67
6	19	14.0	1.39	0.46	1.75	0.42	0.34	1.56
7	"	-	2.38	0.30	1.89	0.86	0.32	1.73
9	20	-	1.25	1.43	1.47	0.54	0.39	1.58
10	"	14.0	6.07	0.95	1.86	1.13	0.42	1.73
11	"	11.6	2.74	1.31	1.68	0.92	0.57	1.62
12	19	-	2.20	0.42	1.84	0.54	0.36	1.60
13	"	10.0	1.90	0.60	1.76	0.29	0.23	1.56
14	"	9.6	-	-	-	-	-	-
15	18	8.4	1.13	0.61	1.65	0.28	0.17	1.62
16	"	-	0.99	0.69	1.59	0.27	0.23	1.54
17	19	14.0	2.20	0.54	1.80	0.29	0.29	1.50
21	20	5.6	0.71	0.31	1.69	0.34	0.29	1.53
22	"	9.9	1.16	0.50	1.70	0.63	0.32	1.67
23	"	-	0.69	0.29	1.70	0.48	0.23	1.67
24	"	-	0.65	0.27	1.70	0.59	0.22	1.73
25	21	-	1.45	0.48	1.75	0.44	0.25	1.64
26	"	16.4	2.44	0.95	1.72	0.84	0.38	1.70
27	"	4.8	0.65	0.46	1.58	0.22	0.26	1.46
28	18	6.0	0.49	0.36	1.58	0.23	0.16	1.59
30	"	24.8	1.07	0.46	1.70	0.34	0.22	1.61
31	"	30.4	2.26	1.37	1.62	0.42	0.54	1.44
33	21	-	1.39	0.67	1.67	0.55	0.32	1.63
38	"	-	1.90	0.77	1.71	1.84	0.60	1.76
39	"	12.0	1.47	0.63	1.70	1.20	0.44	1.73
40	"	9.6	0.80	0.32	1.72	0.68	0.14	1.82
41	22	10.8	1.18	0.55	1.68	0.76	0.42	1.64
42	18	6.0	0.59	0.71	1.45	0.23	0.32	1.42
43	22	-	0.31	0.17	1.64	0.13	0.18	1.42
44	"	-	0.37	0.28	1.57	0.18	0.16	1.52
45	"	6.9	-	-	-	-	-	-
50	"	4.8	0.39	0.27	1.60	0.17	0.17	1.50
51	"	-	0.32	0.17	1.66	0.15	0.11	1.58
52	"	4.8	0.42	0.23	1.65	0.16	0.09	1.63
53	"	3.7	0.26	0.17	1.66	0.26	0.12	1.69
57	18	24.8	0.61	0.48	1.56	0.50	0.32	1.61
60	24	-	1.96	0.12	1.70	0.13	0.07	1.65
61	23	6.0	0.32	0.26	1.55	0.32	0.18	1.64
62	"	5.3	0.34	0.14	1.70	0.29	0.14	1.67
63	"	3.1	0.31	0.20	1.61	0.25	0.13	1.66
64	"	2.9	0.20	0.11	1.64	0.19	0.10	1.67
65	"	3.7	0.24	0.17	1.58	0.19	0.13	1.59
66	"	3.5	0.21	0.14	1.60	0.14	0.12	1.55
67	"	4.0	0.26	0.22	1.54	0.17	0.17	1.50
83	24	5.6	0.40	0.27	1.59	0.36	0.26	1.58
86	"	5.2	0.43	0.27	1.61	0.37	0.23	1.61
87	"	4.0	0.20	0.13	1.61	0.14	0.11	1.57
88	"	3.5	0.26	0.21	1.55	0.20	0.17	1.55
89	"	3.9	0.37	0.26	1.59	0.30	0.23	1.56
90	"	4.4	0.37	0.28	1.57	0.30	0.26	1.54

Table 6 continued

Station no.	Date (Mar 1977)	In vivo fluorescence	Total phytoplankton			Nanoplankton		
			Chlorophyll 'a'+	Phaeopigment+	Acidification factor T	Chlorophyll 'a'+	Phaeopigment+	Acidification factor N
91	24	5.7	0.50	0.25	1.67	0.35	0.26	1.58
92	25	5.3	0.90	0.61	1.60	0.44	0.29	1.60
93	"	6.5	1.07	0.65	1.62	0.34	0.25	1.57
94	"	5.9	0.57	0.38	1.60	0.29	0.23	1.56
95	"	6.3	0.71	0.27	1.72	0.32	0.25	1.56
96	"	6.9	-	-	-	0.63	0.27	1.70
97	"	5.7	0.39	0.24	1.62	0.31	0.17	1.64
99	"	3.9	0.21	0.14	1.60	0.16	0.12	1.58
102	28	-	0.65	0.21	1.76	0.36	0.20	1.65
103	"	4.5	0.36	0.18	1.67	0.19	0.11	1.63
104	"	7.7	0.94	0.29	1.76	0.42	0.19	1.69
105	"	5.3	0.55	0.20	1.73	0.26	0.12	1.69
106	"	4.9	0.32	0.20	1.62	0.23	0.19	1.55
107	"	-	0.26	0.21	1.55	0.21	0.18	1.54
108	"	4.9	0.23	0.21	1.52	0.15	0.20	1.43
109	"	6.1	0.27	0.27	1.50	0.23	0.21	1.52
112	13	5.1	0.42	0.28	1.60	0.29	0.14	1.67
118	26	6.0	0.48	0.19	1.72	0.32	0.14	1.69
119	"	7.6	0.64	0.21	1.75	0.37	0.17	1.69
120	"	8.5	1.18	0.23	1.73	0.55	0.23	1.70
121	"	9.1	1.34	0.34	1.80	0.42	0.22	1.66
122	"	-	0.56	0.22	1.72	0.36	0.18	1.67
123	"	4.8	0.32	0.20	1.61	0.11	0.16	1.65
124	"	4.5	0.20	0.14	1.60	0.19	0.13	1.59
128	27	7.2	0.60	0.20	1.75	0.41	0.21	1.66
134	26	6.1	0.45	0.20	1.69	0.34	0.14	1.70
140	27	7.1	0.40	0.22	1.64	0.38	0.19	1.67
141	"	6.7	0.43	0.20	1.68	0.34	0.20	1.62
142	"	6.1	0.56	0.21	1.73	0.42	0.19	1.69
143	"	6.9	0.76	0.25	1.75	0.46	0.19	1.71
144	"	7.2	0.63	0.21	1.75	0.47	0.22	1.68

* The units are fluorometer units, x 3 scale, Turner Fluorometer Model III.
+ Values derived from acetone extraction data and expressed in µg/l.
- No reading taken.

Table 7 Chlorophyll 'a' and phaeopigments: CIROLANA 4, 8-16 April 1977

Station no.	Date (Apr 1977)	In vivo fluorescence	Total phytoplankton			Nanoplankton		
			Chlorophyll 'a'+	Phaeopigment+	Acidification factor T	Chlorophyll 'a'+	Phaeopigment+	Acidification factor N
71	9	4.7	-	-	-	-	-	-
72	"	5.2	0.36	0.22	1.61	0.31	0.18	1.64
73	"	3.6	0.24	0.21	1.53	0.09	0.31	1.23
74	"	4.5	0.20	0.58	1.25	0.08	0.52	1.14
75	"	3.9	0.26	0.39	1.40	0.11	0.29	1.27
76	"	5.1	0.31	0.69	1.31	0.25	0.37	1.40
77	"	5.1	0.18	0.53	1.25	0.14	0.35	1.29
78	"	5.9	0.35	0.32	1.52	0.24	0.32	1.43
79	8	6.4	0.20	0.67	1.23	0.33	0.34	1.58
80	"	6.9	0.38	0.25	1.60	0.33	0.28	1.52
81	"	4.8	0.18	0.37	1.32	0.16	0.28	1.36
82	"	4.4	0.13	0.52	1.20	0.10	0.34	1.23
83	"	5.1	0.46	0.46	1.50	-	-	-
84	"	6.2	0.44	0.61	1.42	0.42	0.43	1.50
98	9	4.6	0.19	0.16	1.55	0.16	0.16	1.51
99	10	4.5	0.21	0.24	1.48	0.18	0.17	1.52
100	"	3.9	0.13	0.20	1.41	0.13	0.16	1.45
101	"	6.5	0.36	0.36	1.50	0.32	0.31	1.50
102	"	5.9	0.61	0.57	1.52	0.26	0.30	1.46
103	"	6.0	0.38	0.46	1.46	0.33	0.25	1.57
104	"	4.3	0.52	0.44	1.54	0.27	0.31	1.47
105	"	4.5	0.68	0.31	1.69	0.28	0.17	1.62
106	"	5.0	0.54	0.31	1.64	0.23	0.28	1.45
107	"	6.8	0.60	0.37	1.62	0.82	0.25	1.54
108	"	5.6	0.13	0.63	1.18	0.21	0.28	1.42
109	"	5.5	0.14	0.56	1.20	0.20	0.24	1.45
110	11	5.3	0.13	0.47	1.22	0.08	0.53	1.13
111	"	4.8	0.28	0.29	1.50	0.13	0.37	1.25
114	"	5.6	0.47	0.41	1.53	0.18	0.54	1.25
126	12	4.9	0.05	0.81	1.06	0.13	0.64	1.06
127	"	5.1	0.14	0.58	1.19	0.10	0.55	1.19
128	"	6.4	0.24	1.60	1.30	0.18	0.48	1.30
129	"	6.6	0.34	1.04	1.24	0.18	0.42	1.24
130	"	6.4	0.58	0.48	1.54	0.17	0.25	1.54
131	11	8.0	1.02	0.66	1.61	0.46	0.41	1.61
132	"	12.0	1.68	1.07	1.62	0.61	0.42	1.62
133	"	6.5	0.50	0.46	1.52	0.32	0.31	1.52
134	"	6.8	0.21	1.39	1.13	0.16	0.74	1.13
135	"	5.3	0.20	0.72	1.20	0.06	0.87	1.20
136	"	4.9	-	-	-	-	-	-
146	12	6.5	0.23	0.85	1.21	0.24	0.54	1.31
148	13	4.9	0.08	0.66	1.11	0.12	0.46	1.21
149	"	4.5	0.20	0.54	1.27	0.16	0.52	1.23
150	"	10.9	1.62	2.57	1.37	0.64	1.11	1.37
152	"	23.6	6.09	3.40	1.64	1.55	1.45	1.52
162	14	6.2	0.36	0.32	1.52	0.30	0.29	1.51
163	"	6.4	0.60	0.41	1.60	0.42	0.38	1.53
164	"	5.9	0.35	0.29	1.55	0.32	0.29	1.52
165	"	6.1	0.16	0.66	1.20	0.14	0.67	1.18
166	"	6.5	0.11	0.78	1.12	0.19	0.50	1.27
167	"	7.6	0.19	1.04	1.15	0.32	0.68	1.32

Table 7 continued

Station no.	Date (Apr 1977)	In vivo fluorescence	Total phytoplankton			Nanoplankton		
			Chlorophyll 'a'+	Phaeopigment+	Acidification factor T	Chlorophyll 'a'+	Phaeopigment+	Acidification factor N
168	13	8.6	0.10	1.84	1.05	0.26	1.44	1.15
169	"	25.6	2.24	6.84	1.25	0.37	4.60	1.07
180	14	7.3	0.42	0.36	1.57	0.41	0.30	1.57
184	"	6.6	0.13	0.16	1.46	0.12	0.14	1.45
185	"	5.7	0.20	0.18	1.53	0.16	0.16	1.51
186	15	7.0	0.21	0.26	1.44	0.14	0.23	1.38
187	"	7.1	0.26	0.27	1.50	0.18	0.25	1.42
188	"	6.6	0.23	0.30	1.43	0.21	0.29	1.42
189	"	6.0	-	-	-	-	-	-
190	"	5.3	0.24	0.44	1.47	0.14	0.30	1.32
191	"	7.5	4.52	2.70	1.63	1.24	1.36	1.48
192	"	6.8	-	-	-	-	-	-
193	"	10.5	0.70	0.58	1.55	0.39	0.48	1.45
203	16	4.5	0.15	0.21	1.41	0.09	0.32	1.21
204	"	4.8	0.15	0.35	1.30	0.15	0.30	1.34
205	"	5.1	0.16	0.32	1.34	0.14	0.27	1.34
206	"	6.2	0.25	0.28	1.47	0.21	0.18	1.54
207	"	6.7	0.28	0.23	1.55	0.18	0.20	1.46
208	"	7.3	0.34	0.36	1.48	-	-	-
209	"	5.5	0.26	0.24	1.52	0.17	0.33	1.34
210	15	7.5	0.36	0.31	1.53	0.29	0.19	1.60
211	"	6.5	0.29	0.42	1.41	-	-	-
212	"	13.1	-	-	-	0.21	0.40	1.34

* The units are fluorometer units, x 3 scale, Turner Fluorometer Model III.
+ Values derived from acetone extraction data and expressed in µg/l.
- No reading taken.

Table 8 Chlorophyll 'a' and phaeopigments: CIROLANA 5, 10-19 May 1977

Station no.	Date (May 1977)	In vivo fluorescence	Total phytoplankton			Nanoplankton		
			Chlorophyll 'a'+	Phaeopigment+	Acidification factor T	Chlorophyll 'a'+	Phaeopigment+	Acidification factor N
60	18	37.2	2.80	1.18	1.70	1.62	0.02	1.99
61	"	33.0	1.49	0.36	1.81	0.73	0.42	1.63
62	"	40.0	4.37	1.49	1.75	0.87	0.97	1.47
63	"	29.8	1.82	1.21	1.57	0.68	1.04	1.39
64	"	21.8	0.23	0.28	1.46	0.39	0.35	1.53
65	"	20.5	0.72	0.64	1.53	0.22	0.42	1.34
66	"	23.5	1.15	0.86	1.57	0.47	0.62	1.43
67	"	29.2	0.60	0.18	1.76	0.18	0.11	1.62
68	17	26.2	-	-	-	0.53	0.17	1.76
74	"	21.0	1.18	0.41	1.74	1.07	0.39	1.73
83	19	23.0	1.31	1.03	1.14	0.82	0.49	1.68
86	"	31.5	1.71	0.76	1.78	0.39	0.24	1.70
87	"	45.5	2.12	1.81	1.54	1.02	0.77	1.57
88	"	29.5	1.31	1.03	1.56	0.81	0.51	1.62
89	"	25.8	2.07	0.40	1.69	0.39	0.24	1.61
90	"	28.8	-	-	-	-	-	-
91	"	28.0	0.93	0.21	1.82	0.84	0.21	1.80
92	"	24.8	0.69	0.22	1.76	0.46	0.12	1.79
93	"	32.0	0.46	0.10	1.84	0.38	0.12	1.76
94	17	15.2	0.72	0.29	1.71	0.53	0.31	1.64
95	"	14.2	0.60	0.34	1.64	0.70	0.22	1.75
96	"	15.4	0.66	0.46	1.60	1.02	0.61	1.62
97	"	10.4	0.15	0.24	1.39	0.24	0.17	1.58
99	"	17.4	0.62	0.32	1.66	0.21	0.18	1.54
114	15	10.6	0.93	0.37	1.72	0.28	0.14	1.67
115	"	16.8	1.12	0.48	1.70	0.72	0.22	1.76
116	"	20.2	1.77	0.61	1.74	1.39	0.30	1.82
117	16	14.2	1.10	0.32	1.78	0.73	0.00	2.03
118	"	15.0	1.13	0.38	1.75	0.63	0.35	1.64
119	"	10.4	0.44	0.25	1.64	0.26	0.16	1.62
120	"	11.2	0.63	0.36	1.64	0.24	0.58	1.29
121	"	11.1	0.59	0.27	1.68	0.38	0.21	1.64
122	"	12.7	0.86	0.35	1.71	0.65	0.19	1.77
123	"	10.2	0.41	0.48	1.78	0.32	0.17	1.65
124	"	12.8	0.44	0.28	1.61	0.25	0.03	1.89
136	15	23.2	2.23	0.81	1.73	1.71	0.76	1.69
138	"	9.2	0.31	0.21	1.60	0.22	0.25	1.46
139	"	9.4	0.30	0.20	1.60	0.26	0.16	1.62
140	"	9.3	0.32	0.17	1.65	0.30	0.15	1.71
141	"	11.0	0.63	0.57	1.52	0.24	0.36	1.39
142	"	13.2	1.20	0.69	1.64	0.18	0.18	1.50
143	"	18.5	2.50	1.19	1.68	0.25	0.23	1.53
144	14	15.0	1.84	1.01	1.65	0.20	0.22	1.48
145	"	30.0	2.26	1.81	1.56	0.54	0.77	1.42
146	"	10.5	0.66	0.41	1.62	0.37	0.26	1.59
147	"	10.6	0.41	0.20	1.67	0.24	0.14	1.63
148	"	17.4	1.15	0.96	1.54	0.71	0.57	1.56
149	"	17.6	1.44	0.70	1.67	0.42	0.21	1.67
152	"	10.1	0.43	0.20	1.69	0.23	0.08	1.73
153	13	25.0	1.61	0.26	1.86	0.92	0.25	1.79
154	"	27.0	2.19	0.37	1.86	1.02	0.25	1.80

Table 8 continued

Station no.	Date (May 1977)	In vivo fluorescence	Total phytoplankton			Nanoplankton		
			Chlorophyll 'a'+	Phaeopigment+	Acidification factor T	Chlorophyll 'a'+	Phaeopigment+	Acidification factor N
155	13	14.0	0.82	0.63	1.56	0.38	0.15	1.71
156	"	8.4	1.15	1.77	1.67	0.36	0.25	1.59
157	"	8.6	0.77	0.37	1.68	0.24	0.14	1.63
158	"	19.0	2.89	3.28	1.62	0.55	0.75	1.42
159	"	36.5	1.82	0.56	1.36	0.42	0.93	1.29
161	"	16.0	1.09	1.13	1.49	0.25	0.25	1.51
174	11	16.0	0.92	0.55	1.63	0.84	0.47	1.64
175	"	9.4	0.97	0.58	1.63	0.79	0.35	1.69
176	"	21.0	2.59	2.01	1.56	1.00	0.52	1.66
177	"	27.0	2.64	1.44	1.65	1.07	0.93	1.54
178	12	23.5	2.43	0.95	1.72	0.83	0.62	1.57
179	"	42.8	2.52	1.56	1.62	1.13	0.12	1.90
180	"	38.5	5.08	1.38	1.79	0.82	1.34	1.38
181	"	18.4	-	-	-	-	-	-
192	11	10.0	0.74	0.55	1.57	0.54	0.45	1.54
194	"	20.0	2.58	1.71	1.60	1.13	1.07	1.51
195	"	43.0	2.11	1.07	1.50	0.32	0.61	1.40
196	"	39.0	2.34	1.52	1.61	0.49	0.71	1.41
197	10	46.5	2.28	2.65	1.46	0.49	0.66	1.43
198	"	47.0	2.52	1.52	1.62	0.56	0.48	1.54
199	"	47.0	2.57	1.45	1.64	0.52	0.55	1.49
200	"	41.0	2.14	1.45	1.60	0.68	0.84	1.45
201	"	58.5	2.65	1.42	1.65	0.65	0.54	1.55
202	"	65.0	1.71	0.64	1.73	0.55	0.39	1.59

* The units are fluorometer units, x 3 scale, Turner Fluorometer Model III.
+ Values derived from acetone extraction data and expressed in µg/l.
- No reading taken.

Table 9 Chlorophyll 'a' and phaeopigments: CIROLANA 6, 2-11 June 1977

Station no.	Date (June 1977)	In vivo fluorescence	Total phytoplankton			Nanoplankton		
			Chlorophyll 'a'+	Phaeopigment+	Acidification factor T	Chlorophyll 'a'+	Phaeopigment+	Acidification factor N
39	2	29.8	-	-	-	-	-	-
40	3	31.0	-	-	-	-	-	-
41	"	32.8	-	-	-	-	-	-
42	"	35.6	-	-	-	-	-	-
43	"	34.8	-	-	-	-	-	-
44	"	37.0	-	-	-	-	-	-
45	"	35.6	-	-	-	-	-	-
46	"	36.7	-	-	-	-	-	-
47	"	34.0	-	-	-	-	-	-
48	"	34.5	-	-	-	-	-	-
50	"	48.5	-	-	-	-	-	-
59	5	24.2	-	-	-	-	-	-
60	"	18.0	-	-	-	-	-	-
61	"	25.0	-	-	-	-	-	-
62	"	26.5	-	-	-	-	-	-
63	"	24.0	-	-	-	-	-	-
64	4	24.2	-	-	-	-	-	-
65	"	28.9	-	-	-	-	-	-
66	"	38.0	-	-	-	-	-	-
67	"	30.0	-	-	-	-	-	-
68	"	33.0	-	-	-	-	-	-
69	"	34.5	-	-	-	-	-	-
70	"	41.0	-	-	-	-	-	-
84	5	15.4	-	-	-	-	-	-
85	"	24.4	-	-	-	-	-	-
86	"	38.6	-	-	-	-	-	-
87	"	27.2	-	-	-	-	-	-
88	6	19.4	-	-	-	-	-	-
89	"	18.3	-	-	-	-	-	-
90	"	19.5	-	-	-	-	-	-
91	"	17.6	-	-	-	-	-	-
92	"	18.9	-	-	-	-	-	-
93	"	17.4	-	-	-	-	-	-
94	7	17.6	-	-	-	-	-	-
95	"	17.7	-	-	-	-	-	-
96	"	19.2	-	-	-	-	-	-
97	"	21.0	-	-	-	-	-	-
98	"	31.7	-	-	-	-	-	-
99	"	26.0	-	-	-	-	-	-
114	9	29.8	0.48	0.20	1.71	0.42	0.16	1.72
115	"	29.1	0.34	0.14	1.71	0.33	0.14	1.71
116	"	25.2	0.17	0.07	1.70	0.19	0.06	1.77
117	"	27.3	0.26	0.10	1.72	0.14	0.05	1.72
118	8	27.8	0.26	0.08	1.75	0.16	0.06	1.73
119	"	25.6	0.20	0.08	1.72	0.14	0.05	1.75
120	"	23.0	0.17	0.06	1.74	0.14	0.06	1.71
121	"	20.8	0.13	0.08	1.60	0.09	0.05	1.60
123	"	22.7	0.37	0.29	1.56	0.32	0.26	1.56
124	"	26.9	0.84	0.34	1.71	0.42	0.29	1.59
125	"	21.3	-	-	-	-	-	-

Table 9 continued

Station no.	Date (June 1977)	In vivo fluorescence	Total phytoplankton			Nanoplankton		
			Chlorophyll 'a'+	Phaeopigment+	Acidification factor T	Chlorophyll 'a'+	Phaeopigment+	Acidification factor N
137	9	31.0	0.20	0.10	1.67	0.20	0.10	1.67
138	"	28.8	0.09	0.04	1.70	0.06	0.03	1.65
139	"	28.5	0.05	0.02	1.68	0.07	0.03	1.68
140	"	27.7	0.11	0.07	1.62	0.10	0.05	1.67
141	"	26.3	0.12	0.06	1.67	0.11	0.06	1.64
142	"	27.4	0.15	0.08	1.65	0.13	0.07	1.64
143	10	31.2	0.36	0.22	1.62	0.36	0.22	1.62
144	"	37.4	0.20	0.13	1.62	0.26	0.17	1.60
145	"	36.9	0.11	0.06	1.66	0.11	0.06	1.67
146	"	38.2	0.18	0.08	1.69	0.17	0.05	1.80
147	"	41.4	0.44	0.17	1.72	0.36	0.12	1.75
149	"	39.6	0.31	0.12	1.72	0.27	0.11	1.71
153	11	30.9	-	-	-	0.13	0.06	1.70
154	"	32.8	0.66	0.14	1.82	0.60	0.20	1.75
155	"	34.4	0.42	0.18	1.70	0.39	0.18	1.69
156	"	38.1	0.60	0.17	1.78	0.41	0.10	1.80
157	"	45.0	0.50	0.16	1.76	0.40	0.12	1.77
177	"	47.1	0.94	0.32	1.75	0.99	0.23	1.81

* The units are fluorometer units, x 3 scale, Turner Fluorometer Model III.
+ Values derived from acetone extraction data and expressed in μg/l.
- No reading taken.

Table 10 Chlorophyll 'a' and phaeopigments: CIROLANA 8, 15-25 July 1977

Station no.	Date (July 1977)	In vivo fluorescence	Total phytoplankton			Nanoplankton		
			Chlorophyll 'a'+	Phaeopigment+	Acidification factor T	Chlorophyll 'a'+	Phaeopigment+	Acidification factor N
8	23	6.0	0.13	0.08	1.61	0.14	0.07	1.68
10	"	5.7	0.11	0.11	1.50	0.14	0.06	1.69
12	"	6.1	0.14	0.09	1.62	0.13	0.04	1.68
17	22	5.6	0.10	0.05	1.68	0.11	0.05	1.68
18	"	2.0	0.09	0.06	1.60	0.09	0.05	1.65
21	23	6.0	0.14	0.11	1.71	0.11	0.06	1.67
23	"	6.5	0.16	0.08	1.67	0.16	0.07	1.68
24	"	7.2	0.19	0.14	1.58	0.15	0.14	1.53
25	"	6.3	0.11	0.08	1.59	0.10	0.07	1.57
27	22	5.2	0.11	0.07	1.59	0.10	0.09	1.55
30	"	8.0	0.26	0.15	1.62	0.26	0.17	1.60
31	"	6.4	0.15	0.15	1.50	0.17	0.15	1.53
32	"	5.3	0.13	0.09	1.61	0.14	0.08	1.64
34	23	6.7	0.06	0.04	1.61	0.05	0.04	1.53
38	24	10.4	0.76	0.34	1.69	0.42	0.39	1.53
39	"	6.7	0.18	0.07	1.73	0.24	0.07	1.76
40	"	2.0	0.23	0.07	1.75	0.24	0.06	1.80
41	"	7.1	0.24	0.12	1.67	0.20	0.14	1.60
43	22	10.0	0.65	0.31	1.68	0.53	0.26	1.67
44	"	8.0	0.26	0.17	1.60	0.26	0.14	1.65
45	"	6.3	0.10	0.12	1.50	0.14	0.12	1.53
51	21	5.3	0.11	0.07	1.62	0.11	0.07	1.61
52	"	8.8	0.37	0.17	1.69	0.27	0.20	1.57
53	"	10.4	0.41	0.26	1.62	0.32	0.27	1.54
57	24	7.7	0.36	0.19	1.66	0.27	0.17	1.62
59	"	8.8	0.37	0.14	1.65	0.29	0.17	1.63
62	21	5.2	0.18	0.09	1.67	0.17	0.07	1.71
63	"	5.1	0.17	0.09	1.67	0.15	0.08	1.65
64	"	6.5	0.27	0.12	1.70	0.22	0.12	1.65
65	"	6.3	0.31	0.14	1.69	0.26	0.15	1.62
66	"	7.6	0.39	0.14	1.74	0.27	0.20	1.57
82	20	4.7	0.14	0.15	1.47	0.15	0.12	1.56
84	24	10.0	0.67	0.34	1.67	0.37	0.19	1.67
85	"	9.6	0.36	0.17	1.68	0.32	0.15	1.68
88	20	5.6	0.24	0.15	1.61	0.14	0.17	1.55
89	"	5.1	0.20	0.12	1.63	0.19	0.14	1.58
90	"	5.3	0.32	0.15	1.68	0.32	0.17	1.66
91	"	4.4	0.20	0.14	1.60	0.19	0.12	1.61
92	"	5.3	0.29	0.15	1.65	0.29	0.15	1.65
93	"	5.5	0.26	0.17	1.52	0.24	0.22	1.50
94	"	5.3	0.15	0.12	1.56	0.14	0.14	1.50
95	"	4.8	0.10	0.10	1.50	0.08	0.14	1.38
96	"	5.3	0.15	0.14	1.53	0.14	0.14	1.50
100	19	5.3	0.08	0.15	1.36	0.08	0.14	1.38
112	25	10.0	0.41	0.24	1.63	0.34	0.24	1.59
115	19	6.5	0.34	0.19	1.65	0.34	0.19	1.65
116	"	6.3	0.27	0.15	1.64	0.26	0.19	1.58
117	"	5.7	0.27	0.15	1.64	0.29	0.14	1.68
118	"	6.0	0.29	0.17	1.63	0.27	0.20	1.57
119	"	4.9	0.26	0.17	1.60	0.26	0.15	1.62
120	"	4.8	0.27	0.15	1.64	0.26	0.15	1.62

Table 10 continued

Station no.	Date (July 1977)	In vivo fluorescence	Total phytoplankton			Nanoplankton		
			Chlorophyll 'a'+	Phaeopigment+	Acidification factor T	Chlorophyll 'a'+	Phaeopigment+	Acidification factor N
121	19	4.3	0.15	0.10	1.60	0.12	0.14	1.47
122	"	4.3	0.15	0.19	1.45	0.10	0.14	1.43
123	"	5.2	0.15	0.12	1.56	0.12	0.19	1.39
137	18	7.1	0.32	0.17	1.66	0.37	0.14	1.73
138	"	5.2	0.42	0.20	1.66	0.34	0.19	1.65
139	"	4.4	0.27	0.15	1.64	0.24	0.15	1.61
140	"	4.7	0.24	0.20	1.54	0.26	0.15	1.62
141	"	4.9	0.31	0.14	1.69	0.29	0.17	1.63
142	"	5.6	0.37	0.14	1.65	0.36	0.17	1.68
143	"	5.9	0.41	0.15	1.73	0.31	0.37	1.60
144	"	5.3	0.26	0.10	1.71	0.26	0.10	1.71
145	"	5.3	0.22	0.15	1.59	0.26	0.12	1.68
146	17	5.7	0.31	0.14	1.69	0.26	0.14	1.65
148	"	5.3	0.19	0.09	1.69	0.18	0.08	1.69
153	"	4.7	0.19	0.09	1.69	0.16	0.09	1.53
169	"	4.1	0.19	0.08	1.71	0.18	0.07	1.73
175	"	5.2	0.20	0.10	1.67	0.20	0.10	1.67
176	"	7.2	0.26	0.14	1.65	0.26	0.15	1.62
177	"	9.6	0.20	0.48	1.30	0.32	0.17	1.66
178	"	8.4	0.26	0.14	1.65	0.27	0.15	1.64
179	"	10.0	0.22	0.15	1.59	0.24	0.14	1.64
180	16	8.4	0.27	0.17	1.62	0.29	0.15	1.65
181	"	11.6	0.70	0.03	1.95	0.54	0.19	1.74
183	"	12.0	0.71	0.29	1.71	0.63	0.29	1.68
194	15	4.7	0.17	0.07	1.71	0.12	0.14	1.47
195	16	7.2	0.26	0.12	1.68	0.22	0.14	1.62
196	"	10.4	0.36	0.15	1.70	0.32	0.17	1.66
197	"	8.4	-	-	-	-	-	-
198	"	9.6	0.34	0.19	1.64	0.34	0.14	1.71
199	"	8.4	0.31	0.19	1.62	0.24	0.15	1.61
200	16	7.2	0.22	0.03	1.88	0.19	0.06	1.75
201	"	6.8	0.41	0.19	1.69	0.36	0.17	1.68
G	18	8.4	0.68	0.20	1.77	0.63	0.26	1.71

* The units are fluorometer units, x 3 scale, Turner Fluorometer Model III.
+ Values derived from acetone extraction data and expressed in µg/l.
- No reading taken.

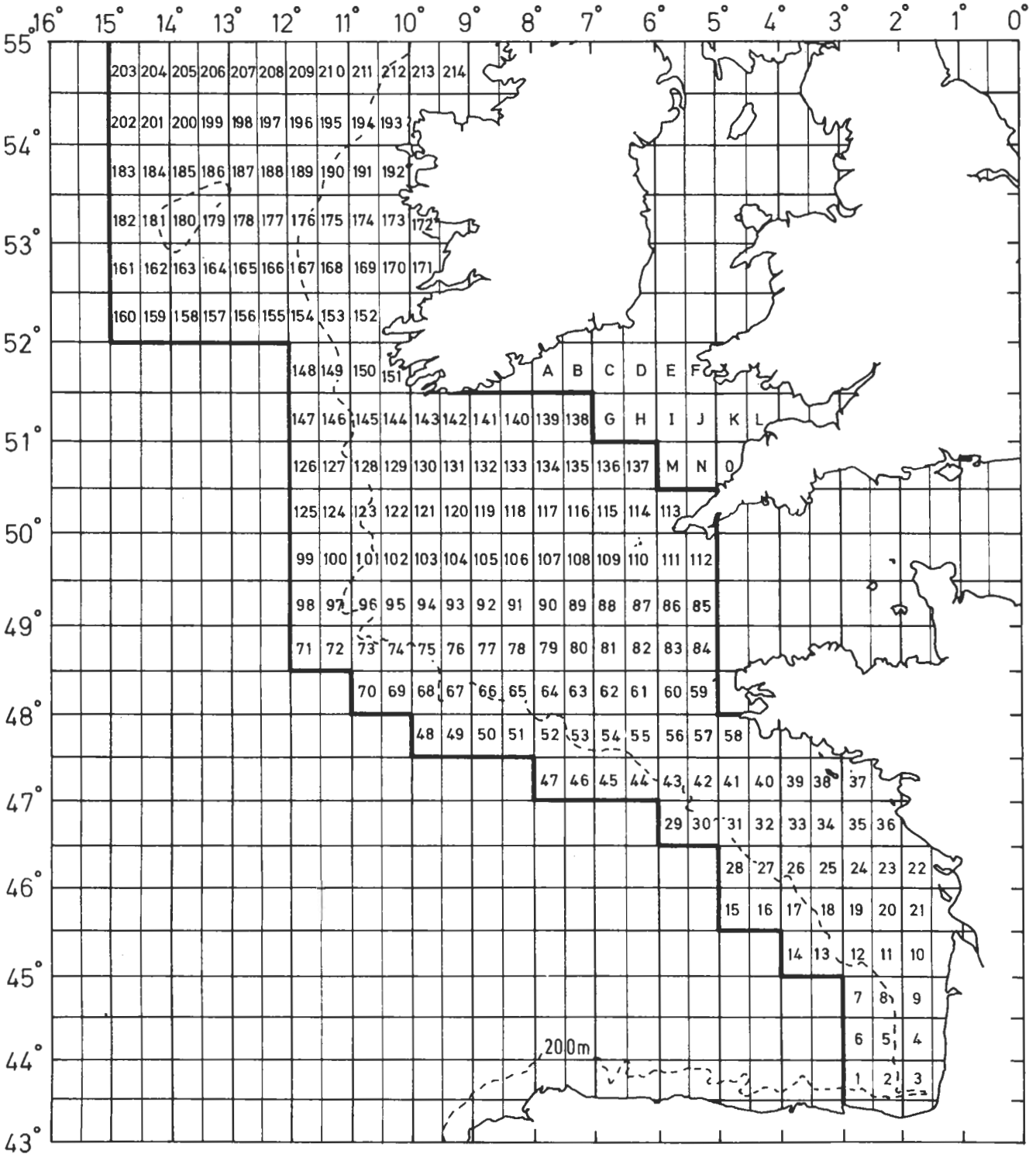
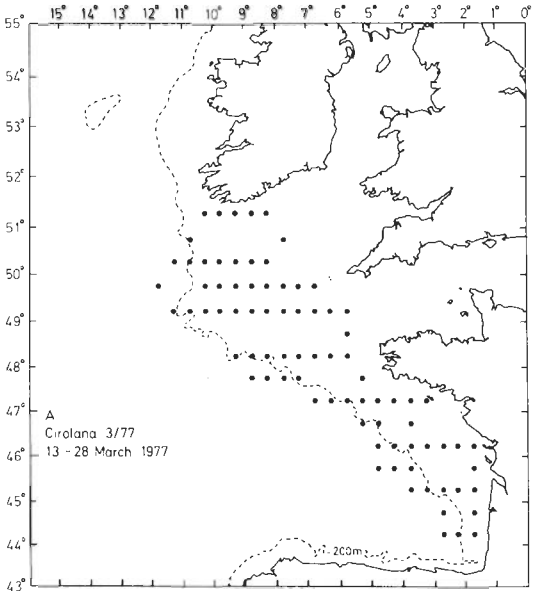
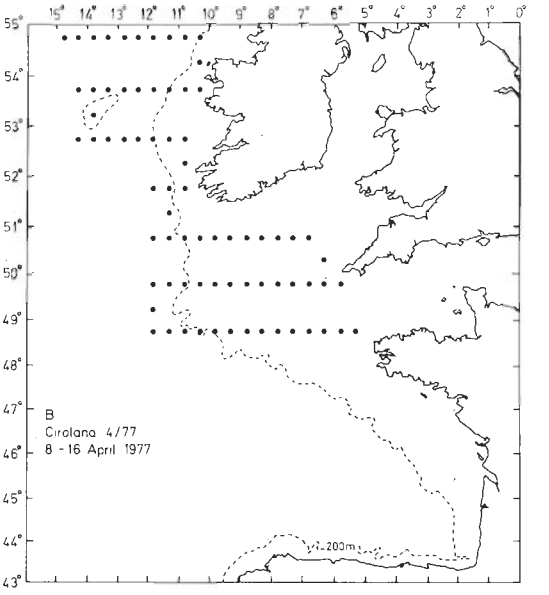
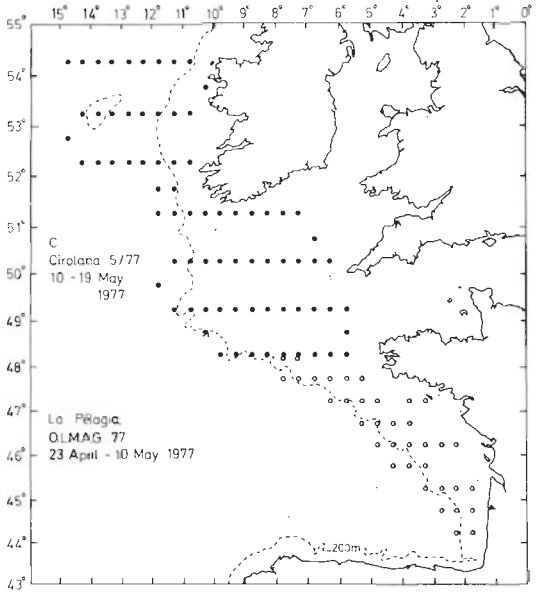
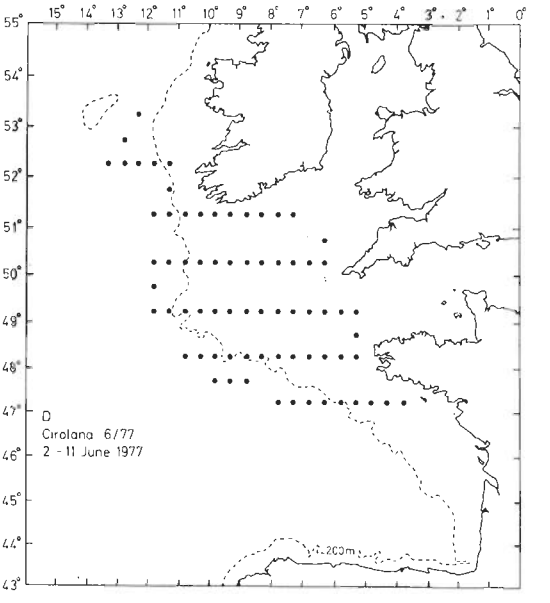


Figure 1 The plankton survey grid. Each sampling station was at the centre of a numbered rectangle and is assigned that number in the tables.









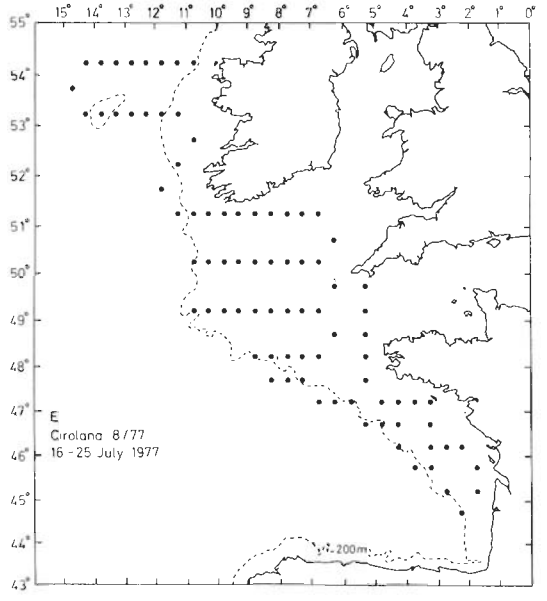
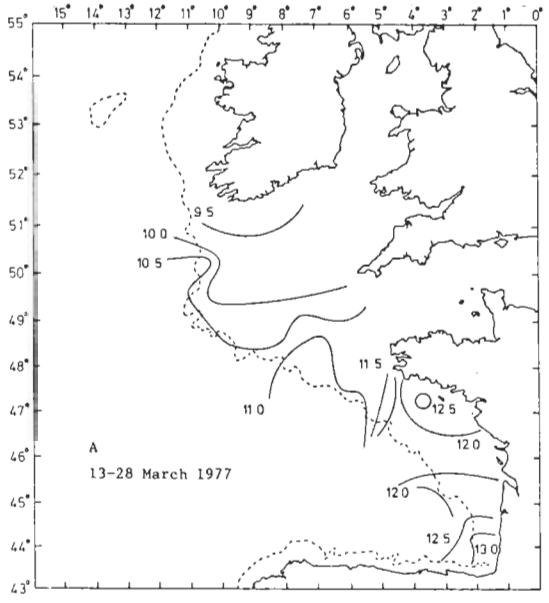
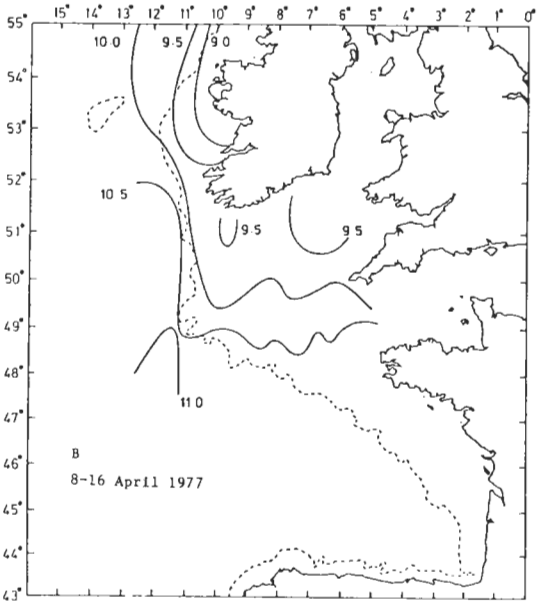
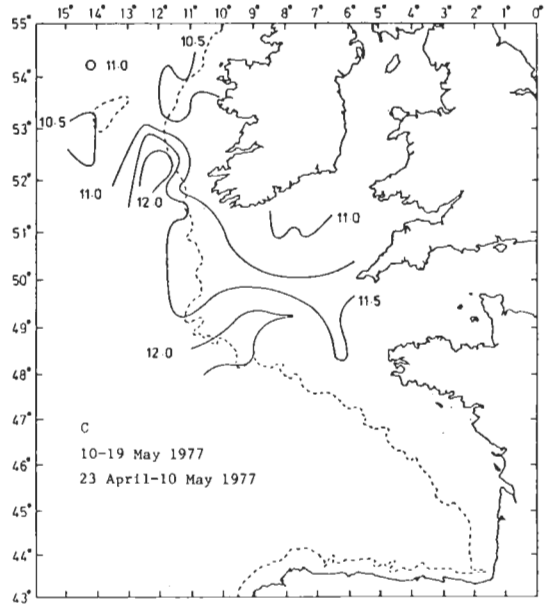
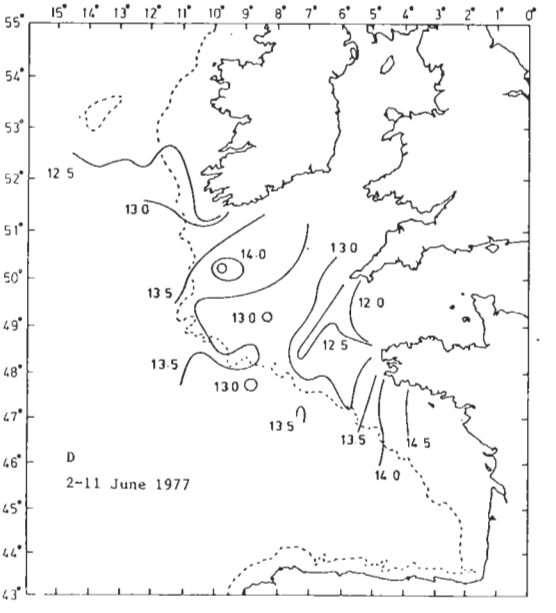


Figure 2 Distribution of sampling stations in each of the five months March-July. Closed circles (March-July inclusive) CIROLANA; open circles (May only) LA PELAGIA.









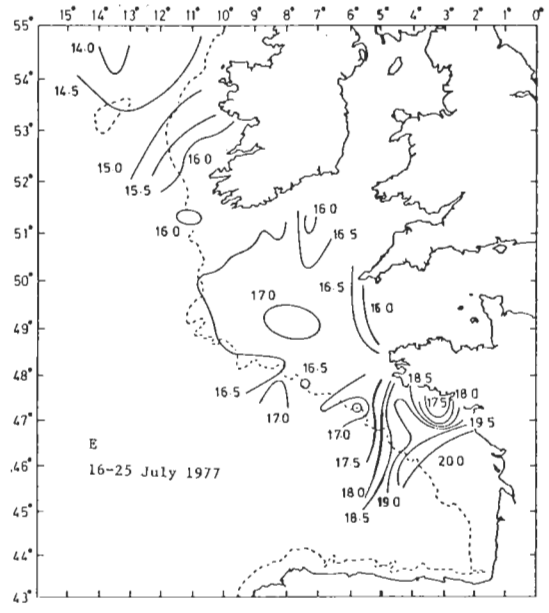
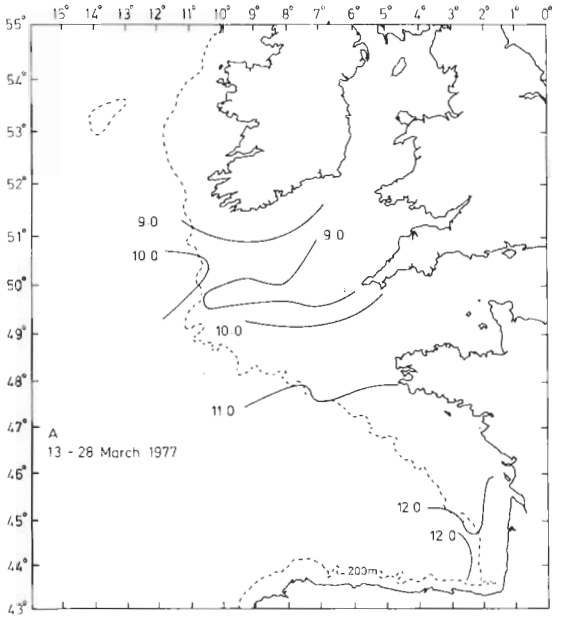
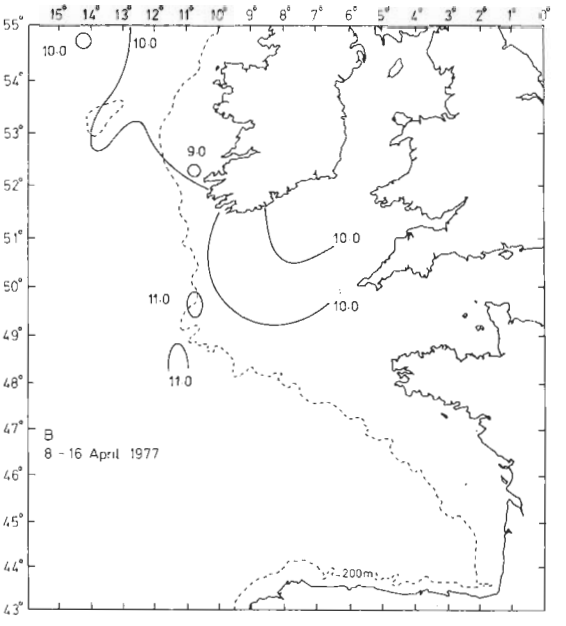
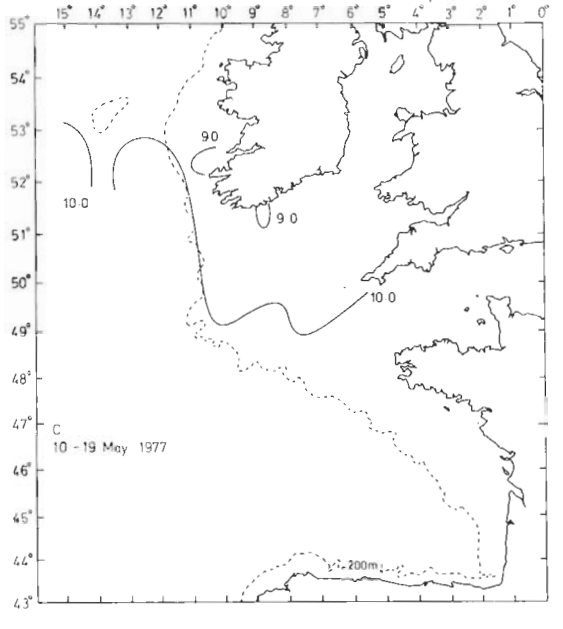
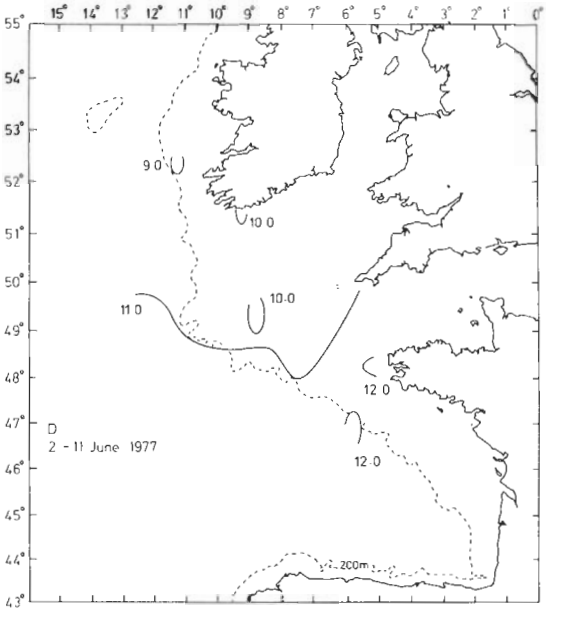


Figure 3 Sea surface temperature, °C.









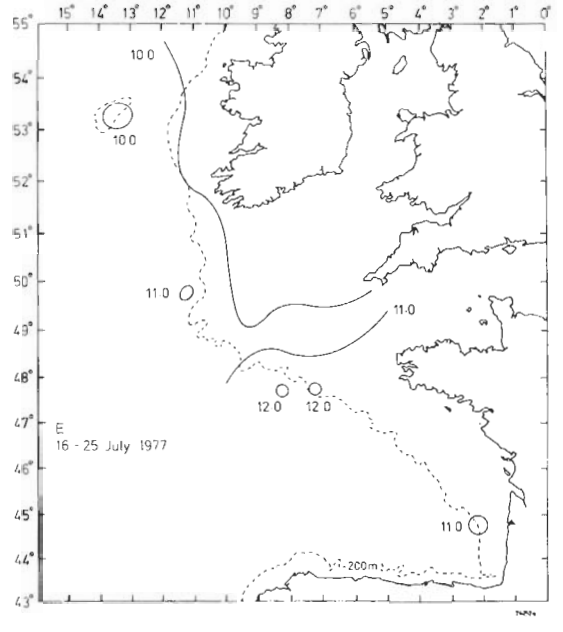
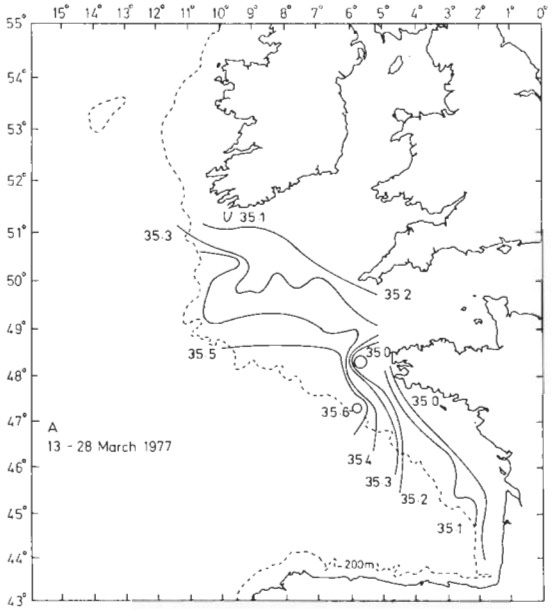
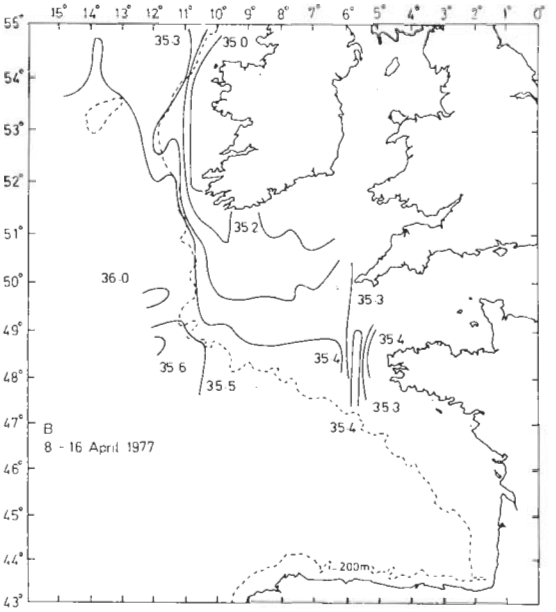
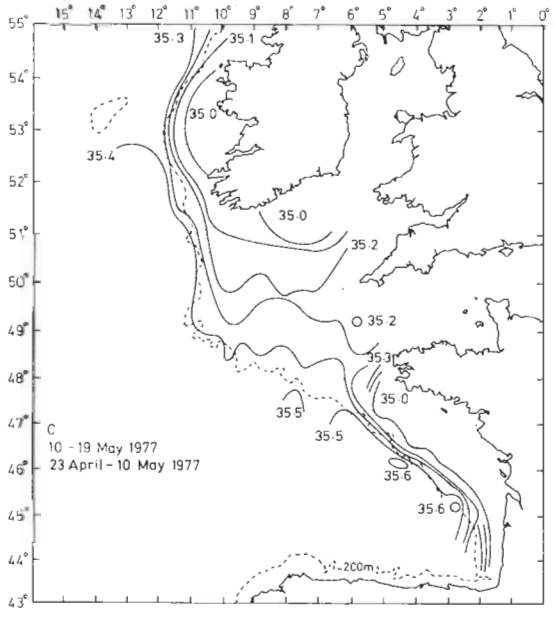
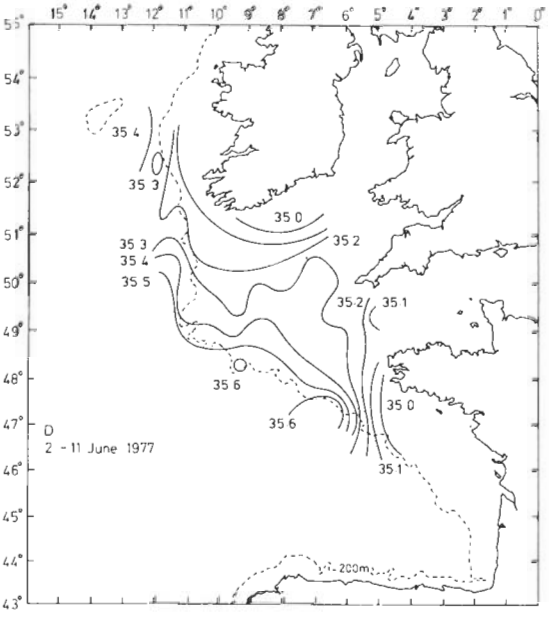


Figure 4 Sea temperature, °C, at 100 m depth.









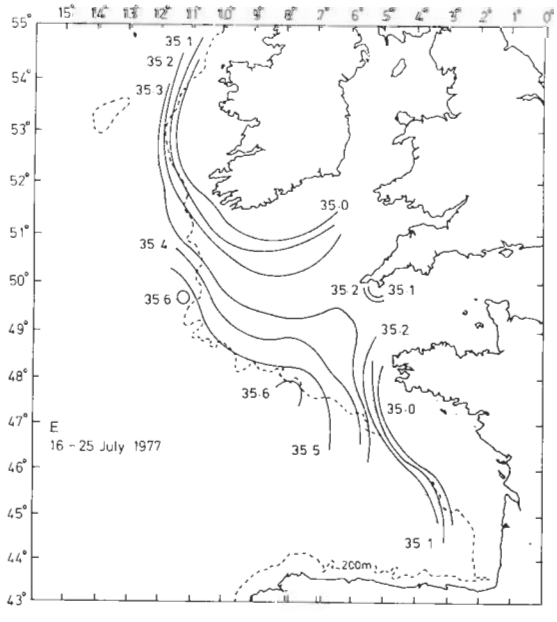
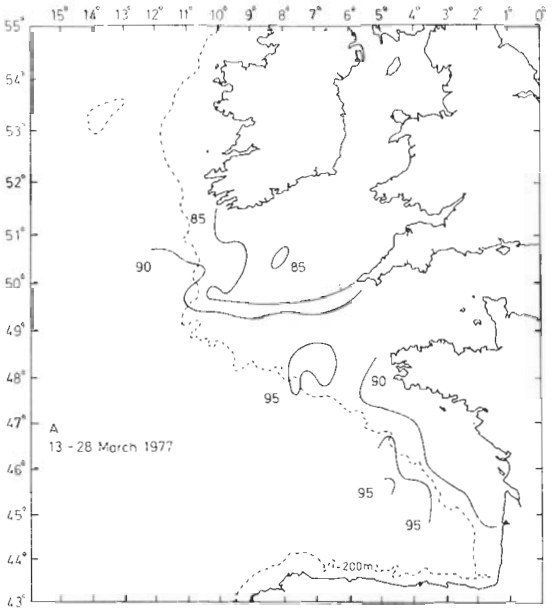
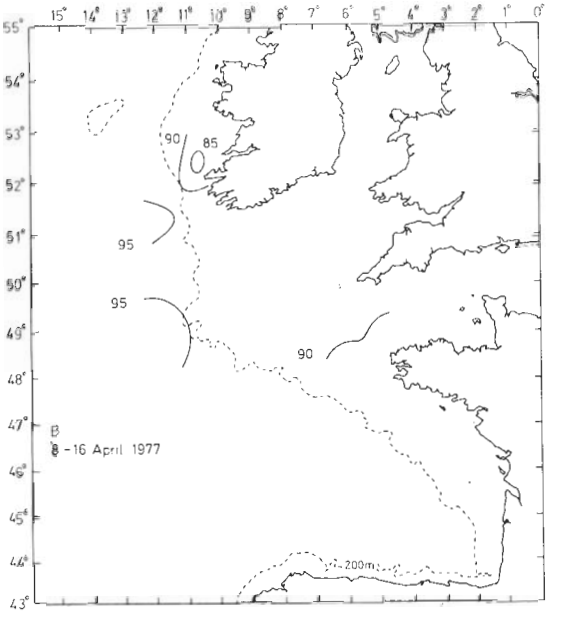
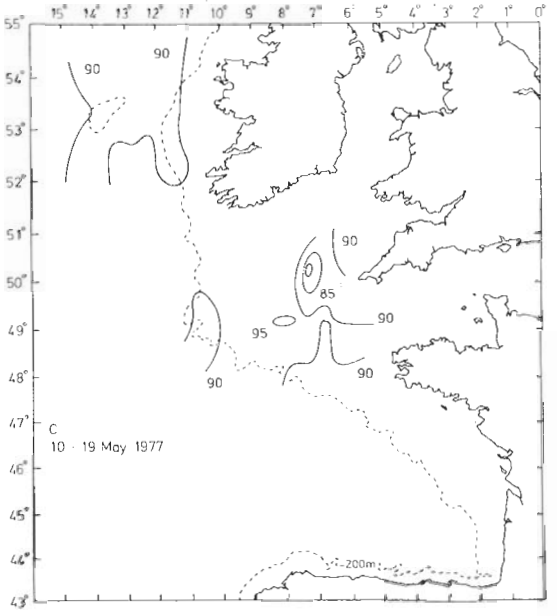
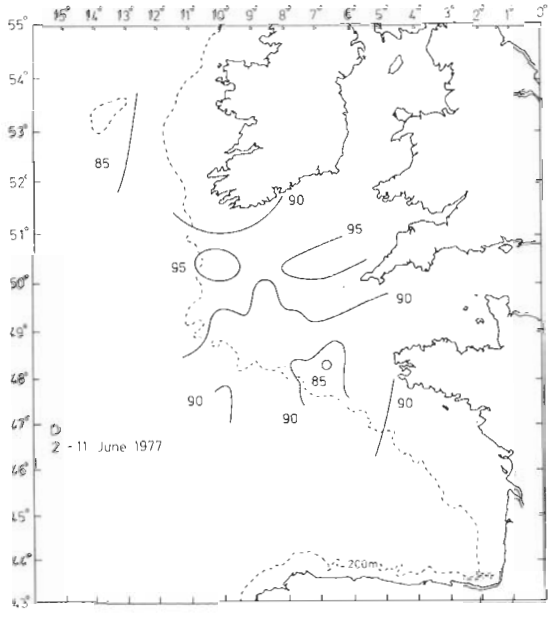


Figure 5 Surface salinity, °/oo.









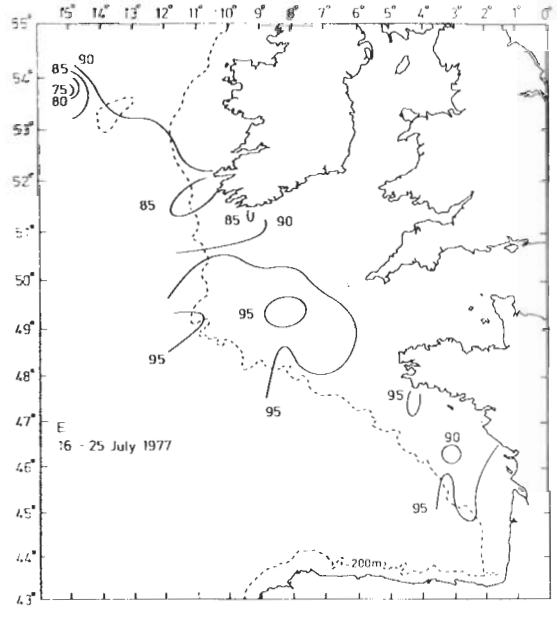
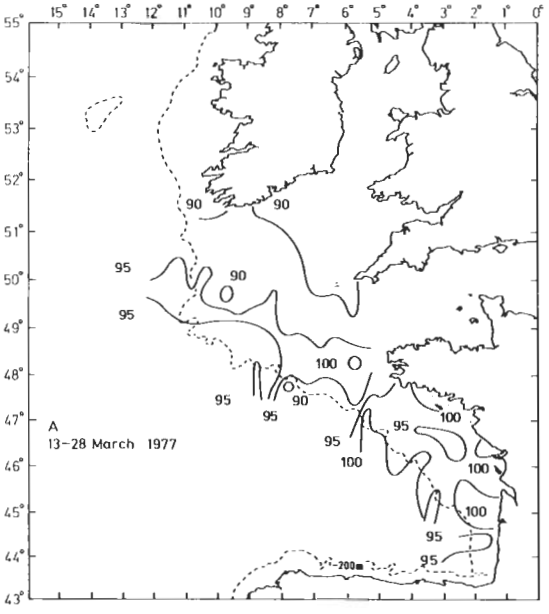
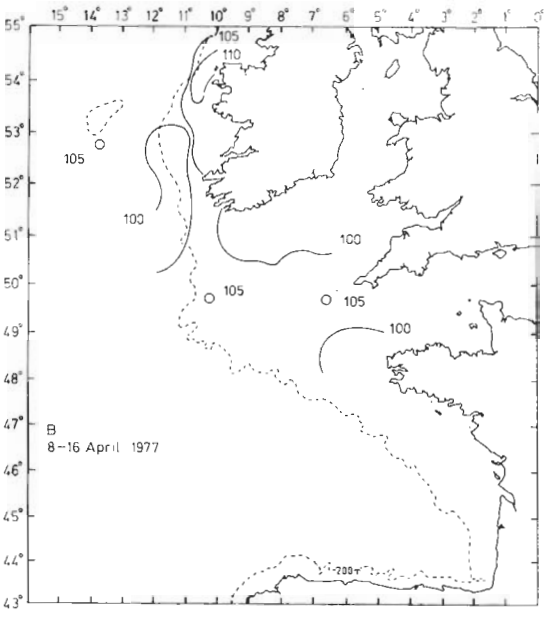
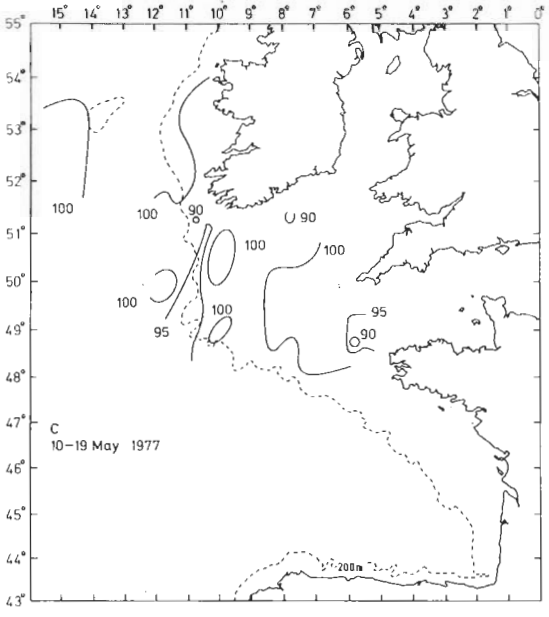
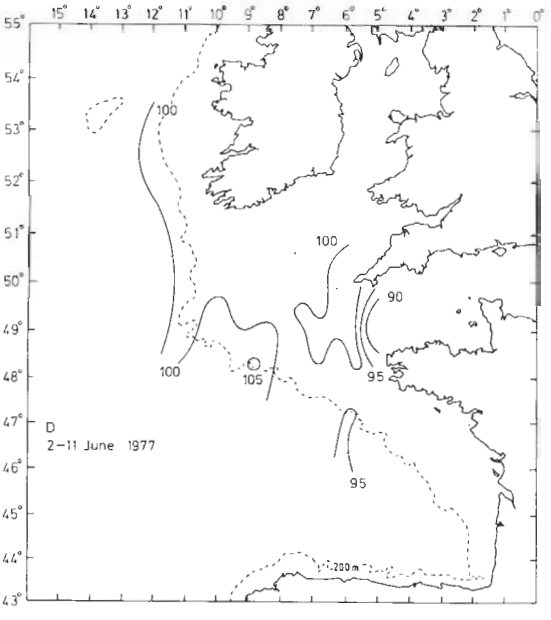


Figure 6 Percentage light transmission at the sea surface.









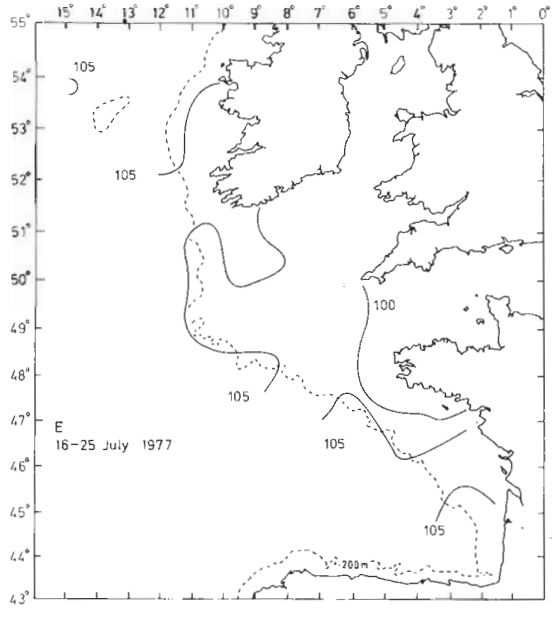
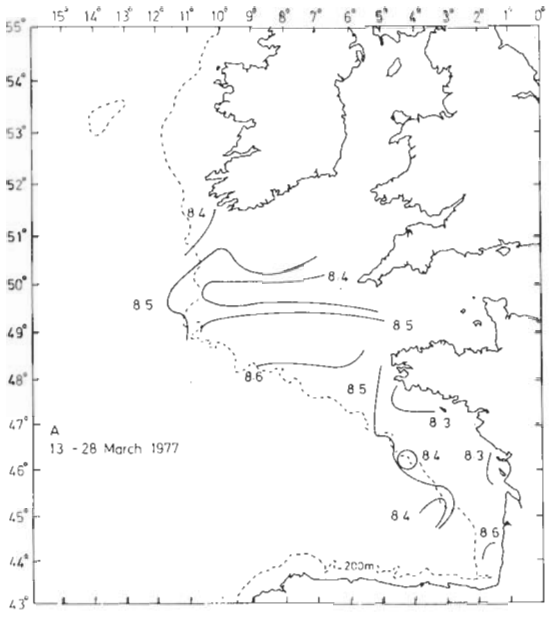


Figure 7 Oxygen concentration, % saturation, at the sea surface.



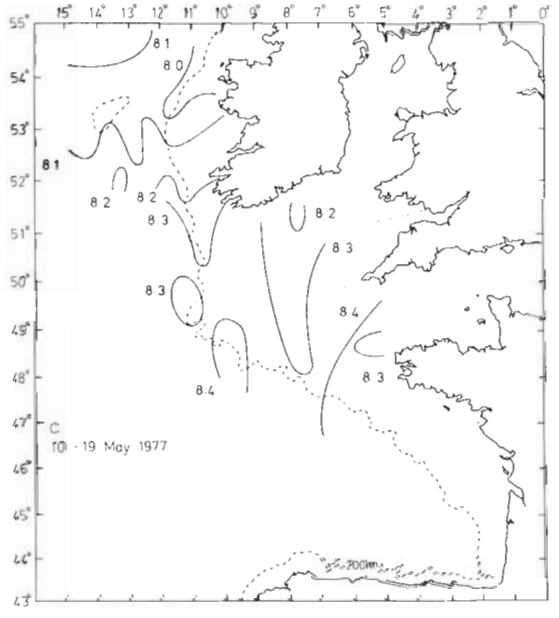
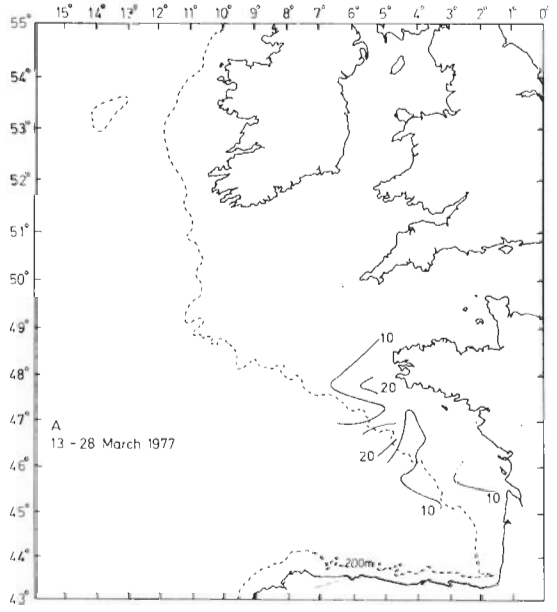
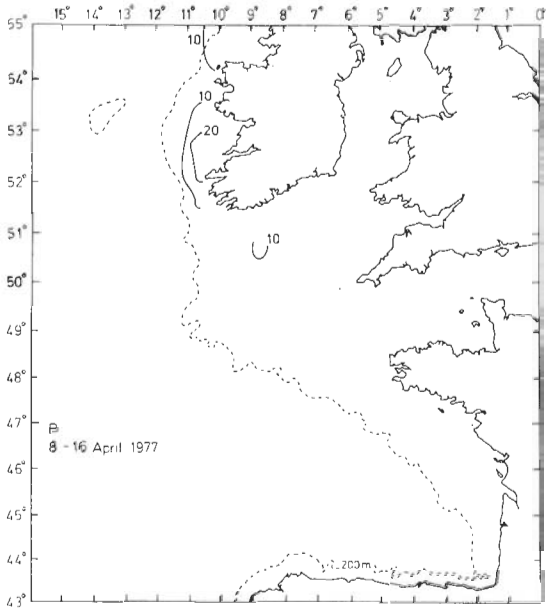
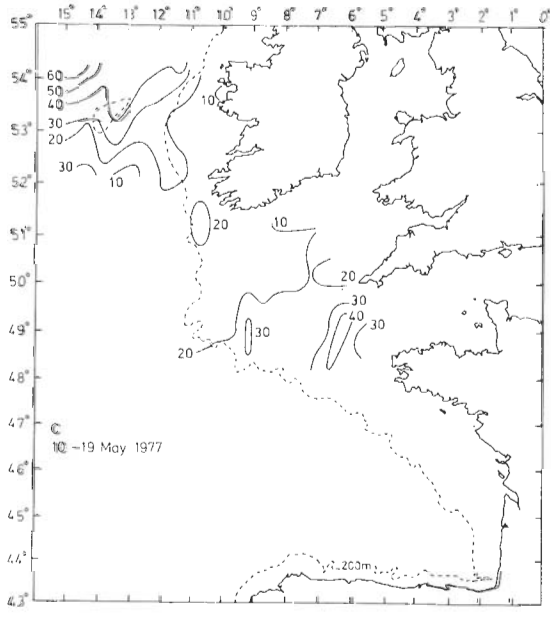
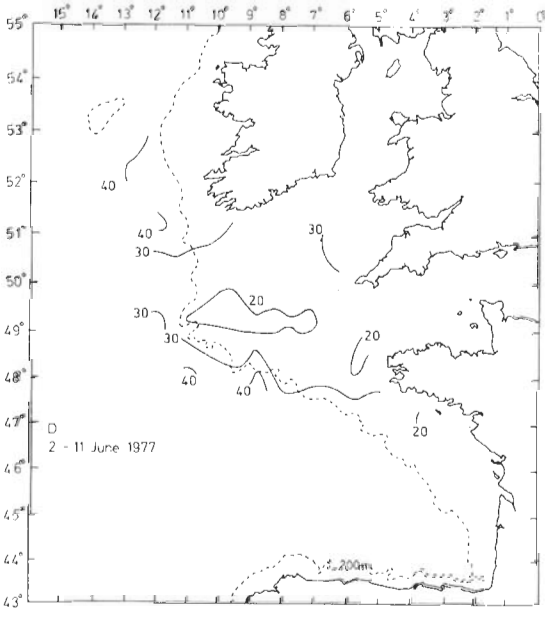


Figure 8 Surface pH. (Results for April, June and July were unreliable.)









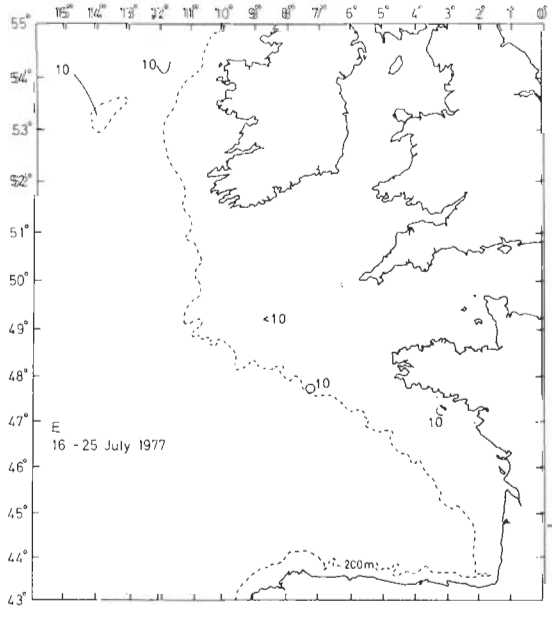
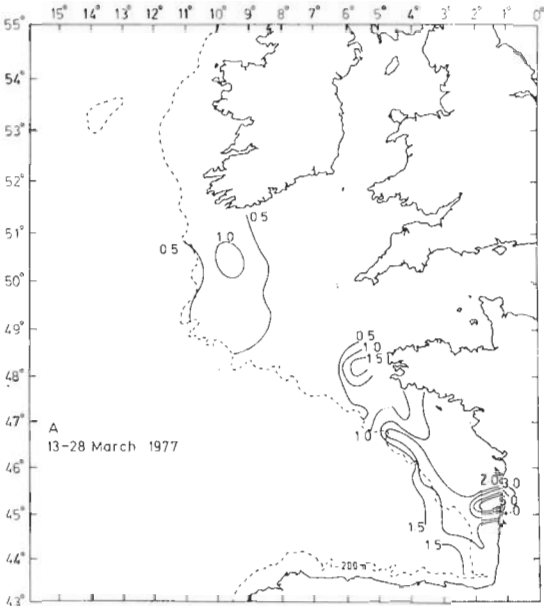
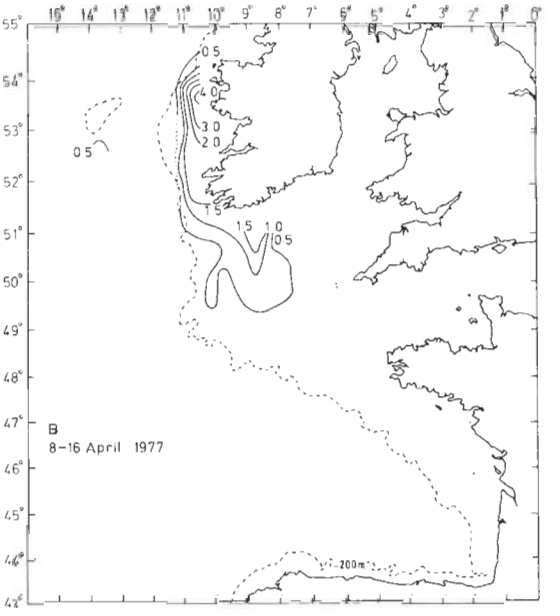
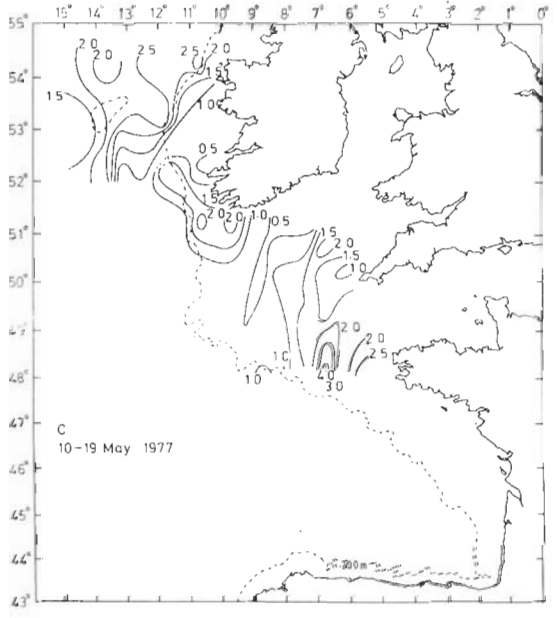
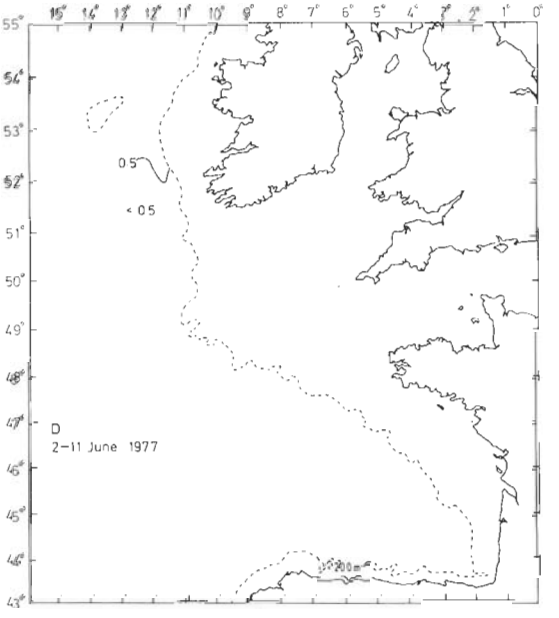


Figure 9 In vivo chlorophyll 'a', µg/l.









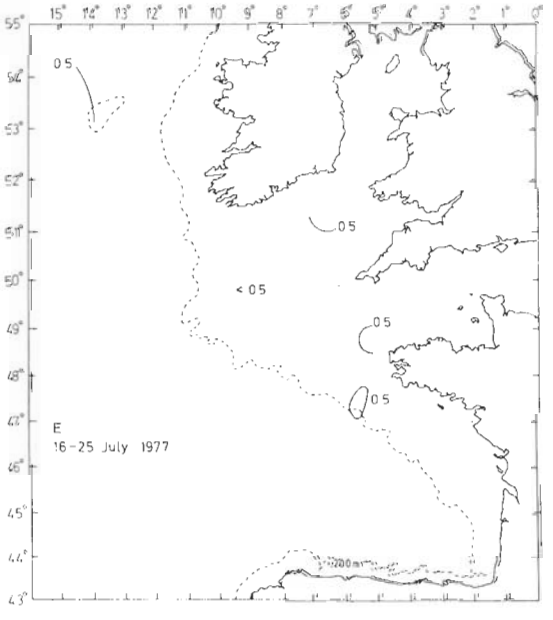
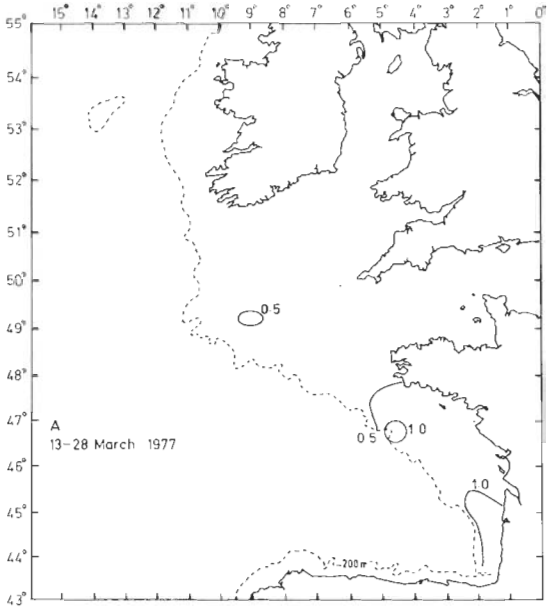
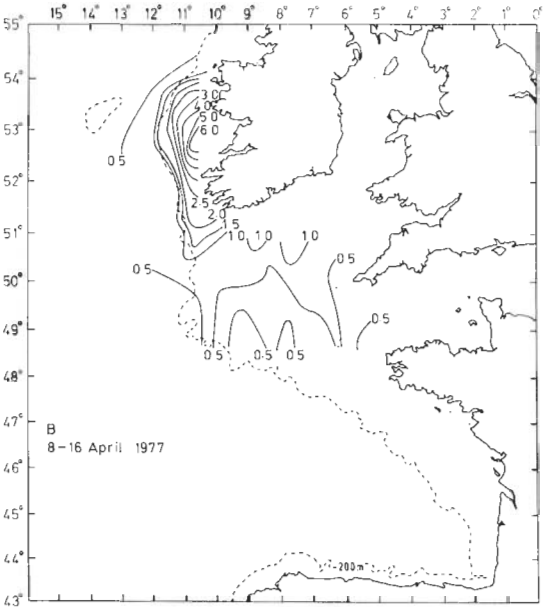


Figure 10 Total chlorophyll 'a', µg/l, by acetone extraction.





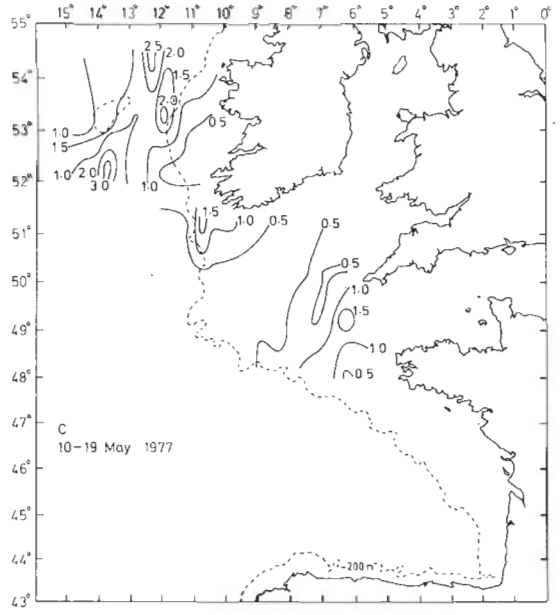
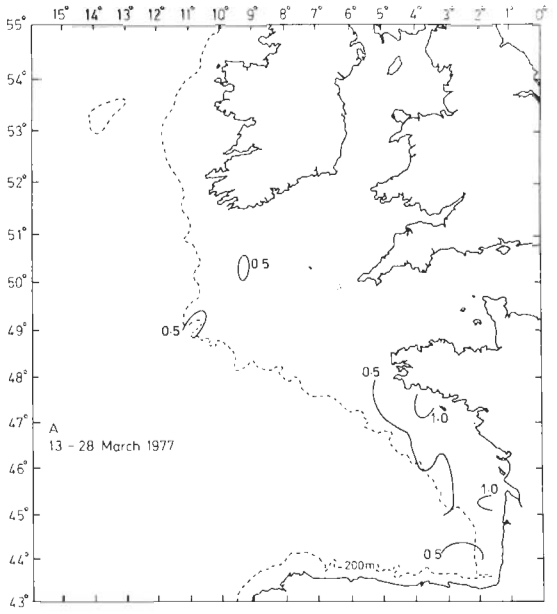
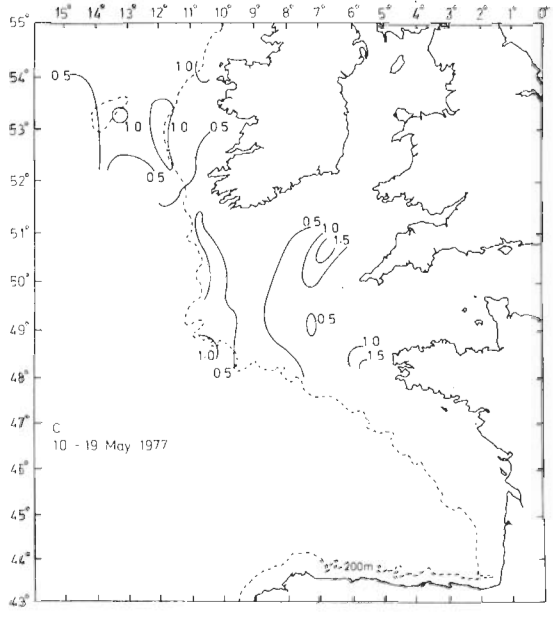
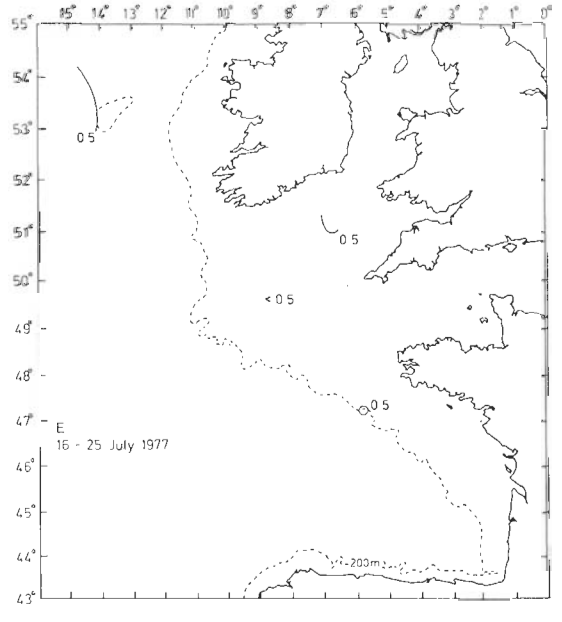
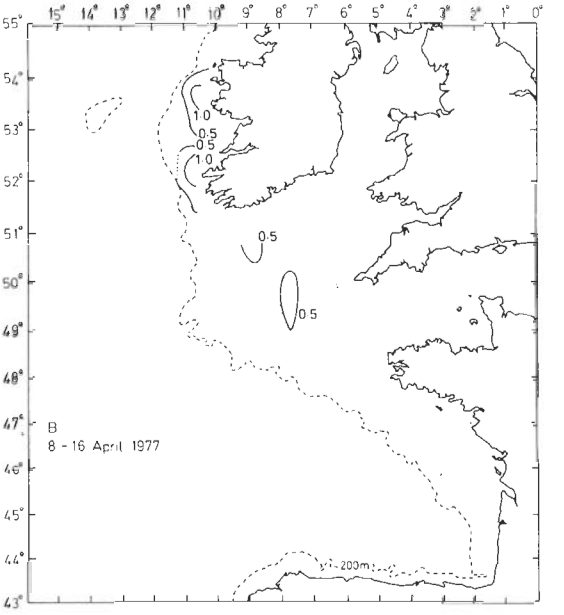


Figure 11 Total phaeopigments, µg/l. (Very low levels were recorded in June and July.)









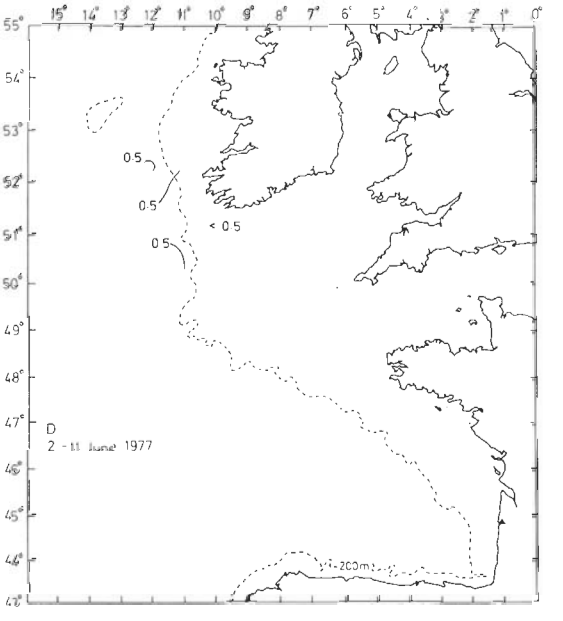
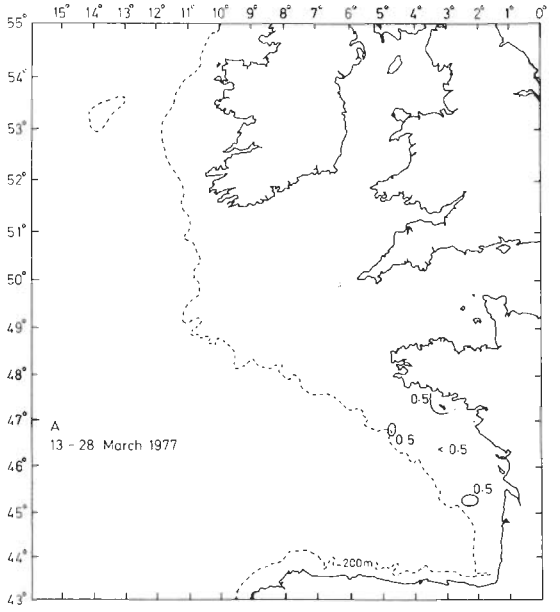
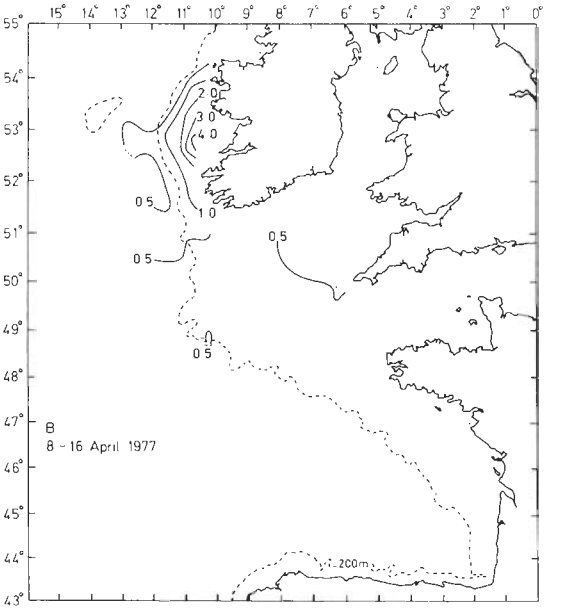


Figure 12 Nanoplankton chlorophyll 'a', µg/l.





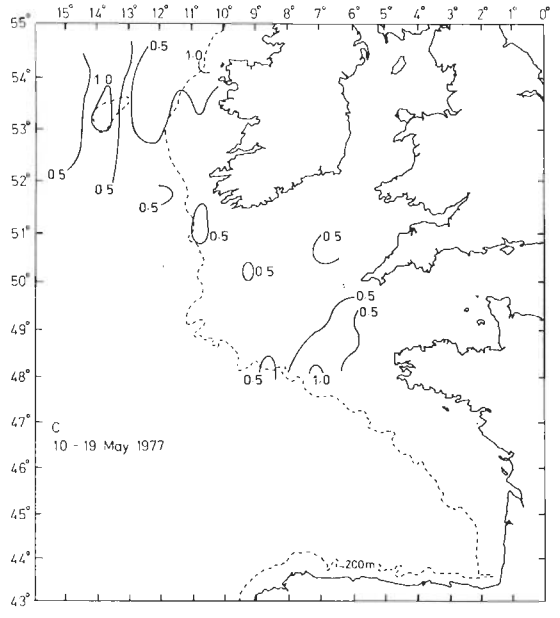
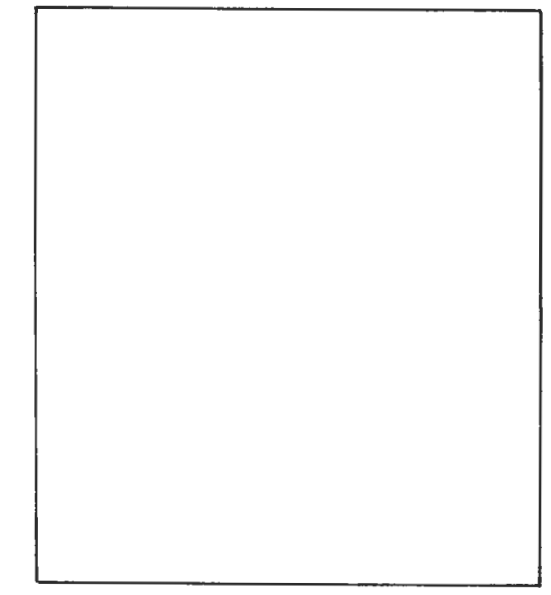
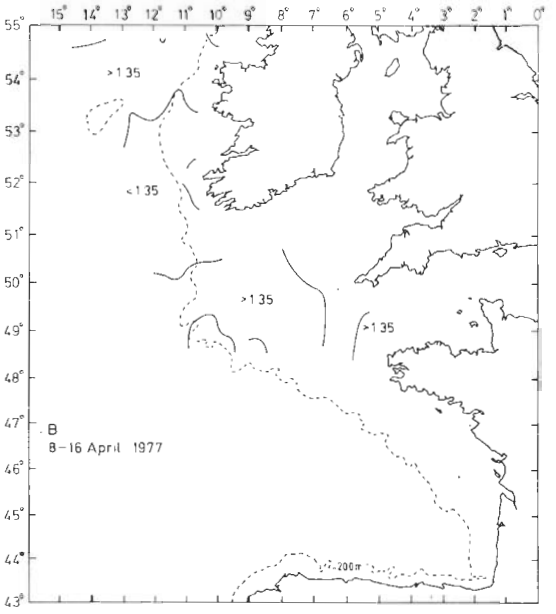
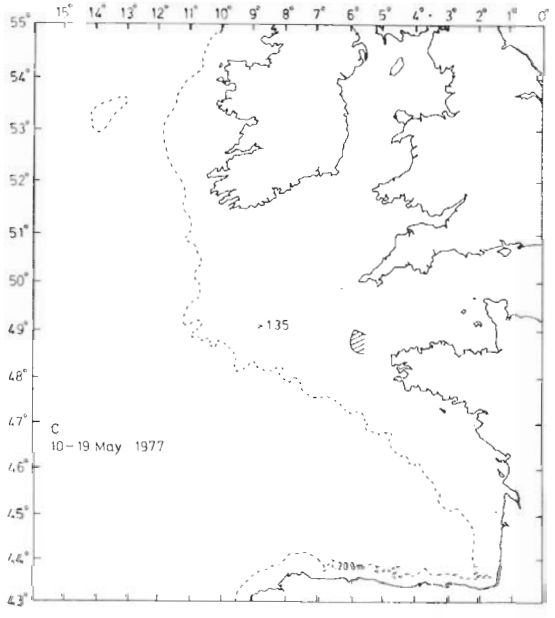
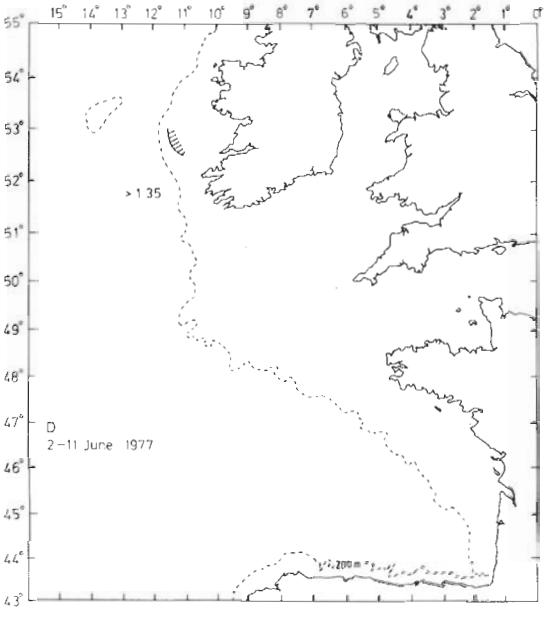


Figure 13 Nanoplankton phaeopigments, µg/l. (Very low levels were recorded in June and July.)









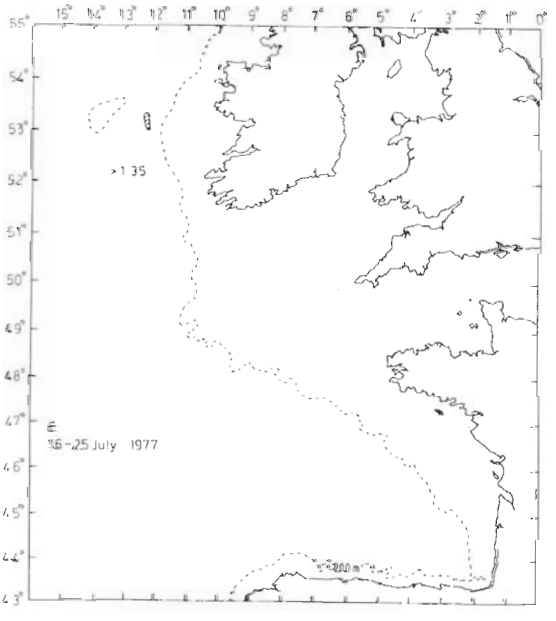


Figure 14 Nanoplankton acidification factor. (All values in March were in excess of 1.35.)

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Marine environment data inventory for the Bay of Biscay, Celtic Sea and west of Ireland, March - July 1977.

ISSN 0264-5130