

Indexed 770

PC

CRUISE REPORT

RRS Frederick Russell Cruise 16/87

LEG 1 : 13-20 July 1987

LEG 2 : 21-31 July 1987

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Itinerary

- 13 July : Depart Plymouth
- 20-21 July : Port call, Plymouth (Personnel exchange)
- 31 July : Returned to Plymouth

The cruise tracks for Legs 1 and 2 are shown in Figs. 1 and 2.

Principal Stations occupied were :

- M : 49°24'N, 3°16'W
- DR87 : 50°06'N, 3°23'W
- E1 : 50°03'N, 4°23'W
- E5 : 49°06'N, 6°30'W
- F87 : 49°14'N, 4°31'W

### Scientific Programme

The main objectives of the cruise were as follows:

1. To study the interaction between light and nutrient limitation of primary production.
2. To carry out experiments on the time-based biochemical and photosynthetic response of the phytoplankton in the euphotic zone of the stratified region (Station E5) to pulsed increments in nutrient concentrations.
3. To determine the spatial and vertical distribution of alkaline phosphatase activity in relation to chlorophyll concentrations and phosphate availability.
4. To measure the photosynthetic activity of natural populations of *Gyrodinium aureolum* at different light levels using *in vitro* changes in dissolved oxygen and  $^{14}\text{CO}_2$  uptake rates.
5. To examine how the availability of phosphate in sediments depends upon the physical and chemical nature of the particles, and
6. To measure the concentration of amino acids present in the English Channel in the summertime.

No problems were experienced in obtaining sediment and water samples throughout the cruise and the majority of the programme was successfully carried out. A paper describing the outcome of Objective 3 is now in the press.

### Hydrography

Surface (3m) temperature, salinity, nitrate and chlorophyll *a* concentrations were monitored continuously whilst underway. On station when necessary, the water column was characterised using a CTD system with associated fluorometer; a list of these dips is given in Table 1, the data being stored on disc. Water bottle samples were used to obtain vertical profiles of chlorophyll, nitrate, ammonium, soluble reactive phosphate and, in some cases, dissolved organic phosphorus; these data are reproduced in Table 2. Table 3 contains the data obtained for mapping alkaline phosphatase activity, the relationship between the enzyme activity, chlorophyll concentration and surface temperature being illustrated in Fig. 3.

Phytoplankton

Major contributors to photosynthetic biomass at each station were: M, phytoflagellates, *Rhizosolenia alata* f. *delicatissima* and *Gyrodinium aureolum*; DR87, phytoflagellates and *Rhizosolenia stoltefothii*; E1, phytoflagellates; E5, phytoflagellates; F87, *Gyrodinium aureolum*

Comments

This was an extremely productive cruise helped, in no small measure, by the flexibility in the scientific programme made possible by the involvement of only a limited number of scientists with similar requirements and also by the enthusiastic support of the Captains and crew of the Frederick Russell. The removal from service of a ship of this size is to be regretted.

Table 1

FREDERICK RUSSELL CRUISE 16/87

CTD Profiles

Number	Date	Time	Position	Number	Date	Time	Position
1/1	14.07.87	1812	49°22'N 3°20'W	7/14	24.07.87	1401	49°02'N 6°31'W
1/2	15.07.87	0843	49°23'N 3°16'W	7/15	24.07.87	1419	49°02'N 6°31'W
1/3A	15.07.87	1824	49°23'N 3°21'W	7/16	24.07.87	1502	49°02'N 6°31'W
2/1	16.07.87	0708	48°28'N 5°28'W	7/17	24.07.87	1603	49°02'N 6°29'W
3/1	16.07.87	1345	49°11'N 4°16'W	7/18	24.07.87	1617	49°02'N 6°29'W
4/1	16.07.87	2041	50°07'N 3°31'W	7/19	24.07.87	1702	49°02'N 6°29'W
4/2	17.07.87	0842	50°07'N 3°31'W	7/20	24.07.87	1801	49°01'N 6°27'W
4/3	17.07.87	1931	50°06'N 3°30'W	7/21	24.07.87	2005	49°04'N 6°28'W
4/4	18.07.87	0815	50°07'N 3°32'W	7/22	24.07.87	2108	49°05'N 6°23'W
5/1	18.07.87	2048	50°03'N 4°23'W	7/23	24.07.87	2118	49°05'N 6°23'W
5/2	19.07.87	0817	50°03'N 4°23'W	7/24	25.07.87	0807	49°06'N 6°30'W
5/3	19.07.87	1303	50°03'N 4°22'W	7/25	25.07.87	1105	49°01'N 6°29'W
5/4	19.07.87	2005	50°03'N 4°23'W	7/26	25.07.87	1205	49°00'N 6°29'W
5/5	20.07.87	0836	50°02'N 4°22'W	8/1	26.07.87	0803	49°15'N 4°37'W
5/6	20.07.87	1255	50°00'N 4°20'W	9/1	26.07.87	0958	49°11'N 4°32'W
6/1	21.07.87	2251	49°14'N 4°31'W	9/2	26.07.87	1304	49°11'N 4°32'W
7/1	22.07.87	0804	49°06'N 6°30'W	9/3	26.07.87	2003	49°10'N 4°32'W
7/2	22.07.87	1301	49°05'N 6°31'W	9/4	27.07.87	0802	49°11'N 4°30'W
7/3	22.07.87	2011	49°06'N 6°30'W	9/5	27.07.87	1149	49°13'N 4°26'W
7/4	23.07.87	0802	49°06'N 6°30'W	9/6	27.07.87	1958	49°14'N 4°30'W
7/5	23.07.87	2003	49°06'N 6°30'W	9/7	28.07.87	0805	49°14'N 4°30'W
7/6	24.07.87	0806	49°06'N 6°30'W	9/8	28.07.87	1001	49°14'N 4°27'W
7/7	24.07.87	0842	49°05'N 6°30'W	9/9	28.07.87	1151	49°13'N 4°25'W
7/8	24.07.87	0858	49°05'N 6°30'W	9/10	28.07.87	1406	49°11'N 4°28'W
7/9	24.07.87	1008	49°03'N 6°31'W	9/11	28.07.87	1604	49°11'N 4°28'W
7/10	24.07.87	1029	49°03'N 6°31'W	9/12	28.07.87	1758	49°11'N 4°25'W
7/11	24.07.87	1040	49°02'N 6°31'W	9/13	28.07.87	1817	49°11'N 4°24'W
7/12	24.07.87	1155	49°02'N 6°31'W	9/15	28.07.87	2004	49°12'N 4°18'W
7/13	24.07.87	1338	49°02'N 6°31'W	9/16	28.07.87	2159	49°12'N 4°14'W

Number	Date	Time	Position	Number	Date	Time	Position
9/17	28.07.87	2359	49°12'N 4°12'W	9/22	29.07.87	1336	49°13'N 4°31'W
9/18	29.07.87	0534	49°15'N 4°30'W	9/23	29.07.87	1802	49°15'N 4°30'W
9/19	29.07.87	0700	49°16'N 4°14'W	9/24	30.07.87	0833	49°16'N 4°30'W
9/20	29.07.87	0902	49°16'N 4°20'W	9/25	30.07.87	1052	49°11'N 4°27'W
9/21	29.07.87	1056	49°15'N 4°16'W	10/1	30.07.87	1928	49°23'N 3°22'W

Table 2

FREDERICK RUSSELL CRUISE 16/87

Bottle Profiles

(N.D. = Not detectable)

Position: 49°22'N, 3°20'W  
 Date: 14.07.87  
 Time: 2000  
 CTD No: 1/1

Depth (m)	Temp (°C)	Chl a ( $\mu\text{g l}^{-1}$ )	$\text{NO}_3$ ( $\mu\text{M}$ )	$\text{NH}_4$ ( $\mu\text{M}$ )	$\text{PO}_4$ ( $\mu\text{M}$ )	DOP ( $\mu\text{M}$ )
5	14.1	0.86		0.28	0.11	
10	14.0	0.88		0.30	0.17	
20	14.0	0.72		0.28	0.15	
35	14.0	0.51		0.28	0.12	
50	14.0	0.28		0.36	0.33	
70	14.0	0.55		0.47	0.14	

Position: 49°24'N, 3°16'W  
 Date: 15.07.87  
 Time: 1005  
 CTD No: 1/2

Depth (m)	Temp (°C)	Chl a ( $\mu\text{g l}^{-1}$ )	$\text{NO}_3$ ( $\mu\text{M}$ )	$\text{NH}_4$ ( $\mu\text{M}$ )	$\text{PO}_4$ ( $\mu\text{M}$ )	DOP ( $\mu\text{M}$ )
5	14.0	0.41	1.29	0.31	0.15	
10	14.0	0.24	1.57	0.44	0.10	
20	14.0	0.32		0.27	0.10	
35	13.9	0.67		0.19	0.12	
50	13.8	0.66	0.93	0.36	0.15	
70	13.8	0.65		0.30	0.15	

Position: 49°23'N, 3°21'W

Date: 15.07.87

Time: 1850

CTD No: 1/3A

Depth (m)	Temp (°C)	Chl a ( $\mu\text{g l}^{-1}$ )	NO <sub>3</sub> ( $\mu\text{M}$ )	NH <sub>4</sub> ( $\mu\text{M}$ )	PO <sub>4</sub> ( $\mu\text{M}$ )	DOP ( $\mu\text{M}$ )
5	14.3	0.38	0.35		0.13	
10	14.3	0.31	0.44		0.14	
20	14.2	0.42	0.44		0.13	
35	14.2	0.32	0.47		0.13	
50	14.2	0.44	0.35		0.14	
70	14.2	0.50	0.47		0.12	

Position: 48°28'N, 5°28'W

Date: 16.07.87

Time: 0740

CTD No: 2/1

Depth (m)	Temp (°C)	Chl a ( $\mu\text{g l}^{-1}$ )	NO <sub>3</sub> ( $\mu\text{M}$ )	NH <sub>4</sub> ( $\mu\text{M}$ )	PO <sub>4</sub> ( $\mu\text{M}$ )	DOP ( $\mu\text{M}$ )
5	17.5	0.73	N.D.	0.28	0.17	
10	17.5	0.67	N.D.	0.28	0.59	
20	14.0	1.15	0.97	0.34	0.11	
35	11.5	0.51	6.39	0.31	0.18	
50	11.5	0.59	6.88	0.31	0.24	
70	11.5	0.50	6.94	0.21	0.21	

Position: 49°11'N, 4°16'W

Date: 16.07.87

Time: 1425

CTD No: 3/1

Depth (m)	Temp (°C)	Chla ( $\mu\text{g l}^{-1}$ )	NO <sub>3</sub> ( $\mu\text{M}$ )	NH <sub>4</sub> ( $\mu\text{M}$ )	PO <sub>4</sub> ( $\mu\text{M}$ )	DOP ( $\mu\text{M}$ )
5	14.0	14.50	N.D.	0.40	0.13	
10	13.7	19.00	N.D.	0.61	0.14	
20	12.6	1.22	0.50	0.51	0.15	
35	12.6	0.97	0.75	0.71	0.24	
50	12.6	0.47	0.63	0.76	0.26	
70	12.5	0.45	1.00	0.65	0.34	

Position: 50°07'N, 3°31'W

Date: 16.07.87

Time: 2130

CTD No: 4/1

Depth (m)	Temp (°C)	Chla ( $\mu\text{g l}^{-1}$ )	NO <sub>3</sub> ( $\mu\text{M}$ )	NH <sub>4</sub> ( $\mu\text{M}$ )	PO <sub>4</sub> ( $\mu\text{M}$ )	DOP ( $\mu\text{M}$ )
5	14.7	1.37	0.23		0.04	
10	14.5	1.09	0.23	0.52	0.07	
20	14.2	1.07	0.23	0.34	0.06	
35	14.2	1.49	0.23	0.34	0.13	
50	14.2	2.19	0.23	0.50	0.11	
70	14.2	1.31	0.23	0.36	0.07	



Position: 50°06'N, 3°30'W

Date: 17.07.87

Time: 2045

CTD No: 4/3

Depth (m)	Temp (°C)	Chl a ( $\mu\text{g l}^{-1}$ )	NO <sub>3</sub> ( $\mu\text{M}$ )	NH <sub>4</sub> ( $\mu\text{M}$ )	PO <sub>4</sub> ( $\mu\text{M}$ )	DOP ( $\mu\text{M}$ )
5	15.0	0.70	N. D.	0.16	0.03	
10	13.5	1.00	N. D.	0.16	0.06	
20	13.4	2.01	N. D.	0.14	0.03	
35	13.3	1.58	N. D.	0.14	0.06	
50	13.2	2.14	N. D.	0.14	0.13	
70	13.0	2.65	N. D.	0.14	0.03	

Position: 50°03'N, 4°23'W

Date: 18.07.87

Time: 2130

CTD No: 5/1

Depth (m)	Temp (°C)	Chl a ( $\mu\text{g l}^{-1}$ )	NO <sub>3</sub> ( $\mu\text{M}$ )	NH <sub>4</sub> ( $\mu\text{M}$ )	PO <sub>4</sub> ( $\mu\text{M}$ )	DOP ( $\mu\text{M}$ )
5	17.3	0.44	0.11	0.43	N. D.	
10	17.2	0.20	0.11	0.34	0.01	
20	13.4	7.76	0.11	0.33	0.01	
35	11.3	0.54	2.39	1.18	0.02	
50	11.3	0.27	2.39	1.04	0.01	
70	11.3	0.36	2.39	1.11	0.01	

Position: 50°03'N, 4°22'W  
Date: 19.07.87  
Time: 1330  
CTD No: 5/3

Depth (m)	Temp (°C)	Chl a ( $\mu\text{g l}^{-1}$ )	NO <sub>3</sub> ( $\mu\text{M}$ )	NH <sub>4</sub> ( $\mu\text{M}$ )	PO <sub>4</sub> ( $\mu\text{M}$ )	DOP ( $\mu\text{M}$ )
5	14.8	2.50	N.D.	0.10	0.03	
10	14.7	0.54	N.D.	0.07	0.03	
20	13.4	0.56	2.59	0.22	0.02	
35	13.3	0.61	2.13	0.19	0.16	
50	13.3	0.22	2.25	0.19	0.10	
70	13.3	0.32	2.25	0.19	0.16	

Position: 50°03'N, 4°23'W  
Date: 19.07.87  
Time: 2100  
CTD No: 5/4

Depth (m)	Temp (°C)	Chl a ( $\mu\text{g l}^{-1}$ )	NO <sub>3</sub> ( $\mu\text{M}$ )	NH <sub>4</sub> ( $\mu\text{M}$ )	PO <sub>4</sub> ( $\mu\text{M}$ )	DOP ( $\mu\text{M}$ )
5	16.2	2.79	0.56		N.D.	
10	16.2	2.93	0.45		0.04	
20	11.5	2.36	0.45		0.02	
35	11.4	0.13	2.84		0.14	
50	11.4	0.14	2.95		0.17	
70	11.2	0.19	2.84		0.14	

Position: 50°00'N, 4°20'W

Date: 20.07.87

Time: 1325

CTD No: 5/6

Depth (m)	Temp (°C)	Chl a ( $\mu\text{g l}^{-1}$ )	$\text{NO}_3$ ( $\mu\text{M}$ )	$\text{NH}_4$ ( $\mu\text{M}$ )	$\text{PO}_4$ ( $\mu\text{M}$ )	DOP ( $\mu\text{M}$ )
5	15.9	1.28	N.D.	0.41	0.01	
10	15.7	1.60	N.D.	0.42	0.01	
20	12.0	1.25	3.30	0.51	0.01	
35	11.2	0.54	3.75	1.00	0.03	
50	11.2	0.48	3.75	0.96	0.04	
70	11.1	0.50	4.20	0.97	0.04	

Position: 49°06'N, 6°30'W

Date: 22.07.87

Time: 0900

CTD No: 7/1

Depth (m)	Temp (°C)	Chl a ( $\mu\text{g l}^{-1}$ )	$\text{NO}_3$ ( $\mu\text{M}$ )	$\text{NH}_4$ ( $\mu\text{M}$ )	$\text{PO}_4$ ( $\mu\text{M}$ )	DOP ( $\mu\text{M}$ )
5	16.8	0.20	N.D.		0.05	0.16
20	16.8	0.32	N.D.		0.02	0.20
28	13.0	0.53	N.D.		0.11	0.13
40	9.9	0.21	4.40		0.55	0.10
60	9.9	0.07	4.30		0.58	
80	9.9	0.05	4.60		0.58	

Position: 49°06'N, 6°30'W

Date: 22.07.87

Time: 2030

CTD No: 7/3

Depth (m)	Temp (°C)	Chl a ( $\mu\text{g l}^{-1}$ )	NO <sub>3</sub> ( $\mu\text{M}$ )	NH <sub>4</sub> ( $\mu\text{M}$ )	PO <sub>4</sub> ( $\mu\text{M}$ )	DOP ( $\mu\text{M}$ )
5	17.1	0.32	N.D.	N.D.	0.06	0.13
10	16.9	0.38	N.D.	N.D.	0.04	0.13
28	11.0	1.54	N.D.	N.D.	0.04	0.15
40	9.9	0.23	6.62	N.D.	0.50	0.02
60	9.9	0.20	6.76	N.D.	0.51	0.07
80	9.9	0.23	6.47	0.11	0.58	0.10

Position: 49°11'N, 4°32'W

Date: 26.07.87

Time: 1345

CTD No: 9/2

Depth (m)	Temp (°C)	Chl a ( $\mu\text{g l}^{-1}$ )	NO <sub>3</sub> ( $\mu\text{M}$ )	NH <sub>4</sub> ( $\mu\text{M}$ )	PO <sub>4</sub> ( $\mu\text{M}$ )	DOP ( $\mu\text{M}$ )
5	16.1	10.33	N.D.	1.04		
15	15.9	14.80	N.D.	0.71		
22	13.5	7.52	N.D.	0.56		
30	12.6	5.36	N.D.	0.20		
50	12.6	4.64	N.D.	0.14		
70	12.6	3.15	N.D.	0.06		

Position: 49°10'N, 4°32'W  
Date: 26.07.87  
Time: 2035  
CTD No: 9/3

Depth (m)	Temp (°C)	Chl a ( $\mu\text{g l}^{-1}$ )	NO <sub>3</sub> ( $\mu\text{M}$ )	NH <sub>4</sub> ( $\mu\text{M}$ )	PO <sub>4</sub> ( $\mu\text{M}$ )	DOP ( $\mu\text{M}$ )
10	16.6	32.30			0.02	
20	16.2	8.80			0.02	
30	13.0	4.23			0.02	
40	12.7	3.06			0.05	
60	12.6	2.29			0.06	
80	12.6	2.52			0.07	

Position: 49°11'N, 4°30'W  
Date: 27.07.87  
Time: 1000  
CTD No: 9/4

Depth (m)	Temp (°C)	Chl a ( $\mu\text{g l}^{-1}$ )	NO <sub>3</sub> ( $\mu\text{M}$ )	NH <sub>4</sub> ( $\mu\text{M}$ )	PO <sub>4</sub> ( $\mu\text{M}$ )	DOP ( $\mu\text{M}$ )
10	16.5	9.87	0.15	0.76	0.04	
20	15.5	6.94	0.15	N. D.	0.06	
30	12.9	2.10	0.35	N. D.	0.08	
40	12.7	4.18	0.35	N. D.	0.07	
60	12.7	1.70	0.35	N. D.	0.06	
80	12.7	1.12	0.67	N. D.	0.06	

Position: 49°11'N, 4°27'W

Date: 30.07.87

Time: 1600

CTD No: 9/25

Depth (m)	Temp (°C)	Chl <sub>a</sub> ( $\mu\text{g l}^{-1}$ )	NO <sub>3</sub> ( $\mu\text{M}$ )	NH <sub>4</sub> ( $\mu\text{M}$ )	PO <sub>4</sub> ( $\mu\text{M}$ )	DOP ( $\mu\text{M}$ )
0.5	16.7	11.81	0.76		0.06	0.24
20	16.6	5.35	N.D.		0.05	0.15
30	12.8	1.97	0.11		0.09	0.13
40	12.8		0.98		0.10	0.10
50	12.8	2.75	1.20		0.06	0.09
70	12.8	2.94	0.98		0.05	0.10

Position: 49°23'N, 3°22'W

Date: 30.07.87

Time: 2000

CTD No: 10/1

Depth (m)	Temp (°C)	Chl <sub>a</sub> ( $\mu\text{g l}^{-1}$ )	NO <sub>3</sub> ( $\mu\text{M}$ )	NH <sub>4</sub> ( $\mu\text{M}$ )	PO <sub>4</sub> ( $\mu\text{M}$ )	DOP ( $\mu\text{M}$ )
5	15.5	1.28	N.D.		0.03	0.21
10	15.0	1.74	N.D.		0.05	0.17
15	14.9	3.60	N.D.		0.09	0.23
25	14.9	1.29	0.71		0.11	0.15
45	14.8	0.69	1.19		0.14	0.19
65	14.7	0.65	1.67		0.16	0.19

Table 3

FREDERICK RUSSELL CRUISE 16/87

Alkaline phosphatase activity (APA) mapping

Date	Time	Position	Chl a ( $\mu\text{g l}^{-1}$ )	PO <sub>4</sub> ( $\mu\text{M}$ )	DOP ( $\mu\text{M}$ )	APA ( $\text{nMPO}_4\text{min}^{-1}$ )
18.07.87	1530	50°06'N, 3°23'W	0.38	0.03	0.91	0.039
18.07.87	1930	50°02'N, 3°57'W	1.54	0.02	0.78	0.066
18.07.87	2100	50°03'N, 4°23'W	0.11	0.04	0.48	0.063
19.07.87	2345	49°49'N, 4°29'W	0.31	0.11	0.64	0.081
20.07.87	0300	50°03'N, 4°50'W	0.54	0.46	0.35	0.086
21.07.87	1800	49°52'N, 4°06'W		0.09		0.071
21.07.87	2230	49°14'N, 4°26'W	23.80	0.08	1.08	0.102
22.07.87	0200	49°13'N, 5°09'W	17.10	0.07	0.81	0.184
22.07.87	0400	49°09'N, 5°41'W	2.88	0.03	0.66	0.066
23.07.87	2220	48°45'N, 6°30'W	0.48	0.05	0.46	0.005
23.07.87	2400	48°25'N, 6°30'W	0.34	0.07	0.52	0.024
24.07.87	0245	48°45'N, 5°52'W	0.46	0.06	0.54	0.051
25.07.87	1430	49°20'N, 6°20'W	0.43	0.08	0.82	0.099
25.07.87	1600	49°37'N, 6°12'W	2.44	0.05	0.34	0.120
25.07.87	1712	49°50'N, 6°14'W	1.10	0.10	0.19	0.098
26.07.87	0124	49°48'N, 5°59'W	0.86	0.04	0.29	0.061
26.07.87	0304	49°38'N, 5°36'W	1.05	0.03	0.47	0.046
26.07.87	0533	49°22'N, 4°50'W	14.80	0.06	0.97	0.189
27.07.87	2300	49°30'N, 4°25'W	0.72	0.02	0.21	0.103
28.07.87	0100	49°42'N, 4°52'W	0.40	0.05	0.20	0.058
28.07.87	0250	49°30'N, 5°15'W	1.77	0.06	0.25	0.103
28.07.87	0430	49°30'N, 4°50'W	1.61	0.05	0.27	0.076
29.07.87	2100	49°05'N, 4°50'W	6.07	0.08	0.32	0.114
29.07.87	2300	49°00'N, 5°20'W	5.93	0.11	0.39	0.066
30.07.87	0030	48°55'N, 5°00'W	2.57	0.13	0.79	0.041
30.07.87	0245	48°55'N, 4°30'W	11.06	0.08	0.78	0.137
30.07.87	0405	49°00'N, 4°10'W	5.95	0.09	0.40	0.068
30.07.87	2000	49°25'N, 3°16'W	1.28	0.03	0.21	0.074

Table 4

FREDERICK RUSSELL CRUISE 16/87

Light Profiles

Date	Time	Position
15.07.87	1300	49°23'N, 3°20'W
17.07.87	1200	50°07'N, 3°29'W
19.07.87	1200	50°03'N, 4°23'W
20.07.87	1200	50°01'N, 4°22'W
22.07.87	1200	49°05'N, 6°31'W
23.07.87	1200	49°02'N, 6°32'W
24.07.87	1200	49°02'N, 6°31'W
26.07.87	1200	49°12'N, 4°31'W
28.07.87	1200	49°13'N, 4°25'W



Fig.1

RRS Frederick Russell Cruise 16/87  
Cruise track - Leg 1, 13 - 20 July

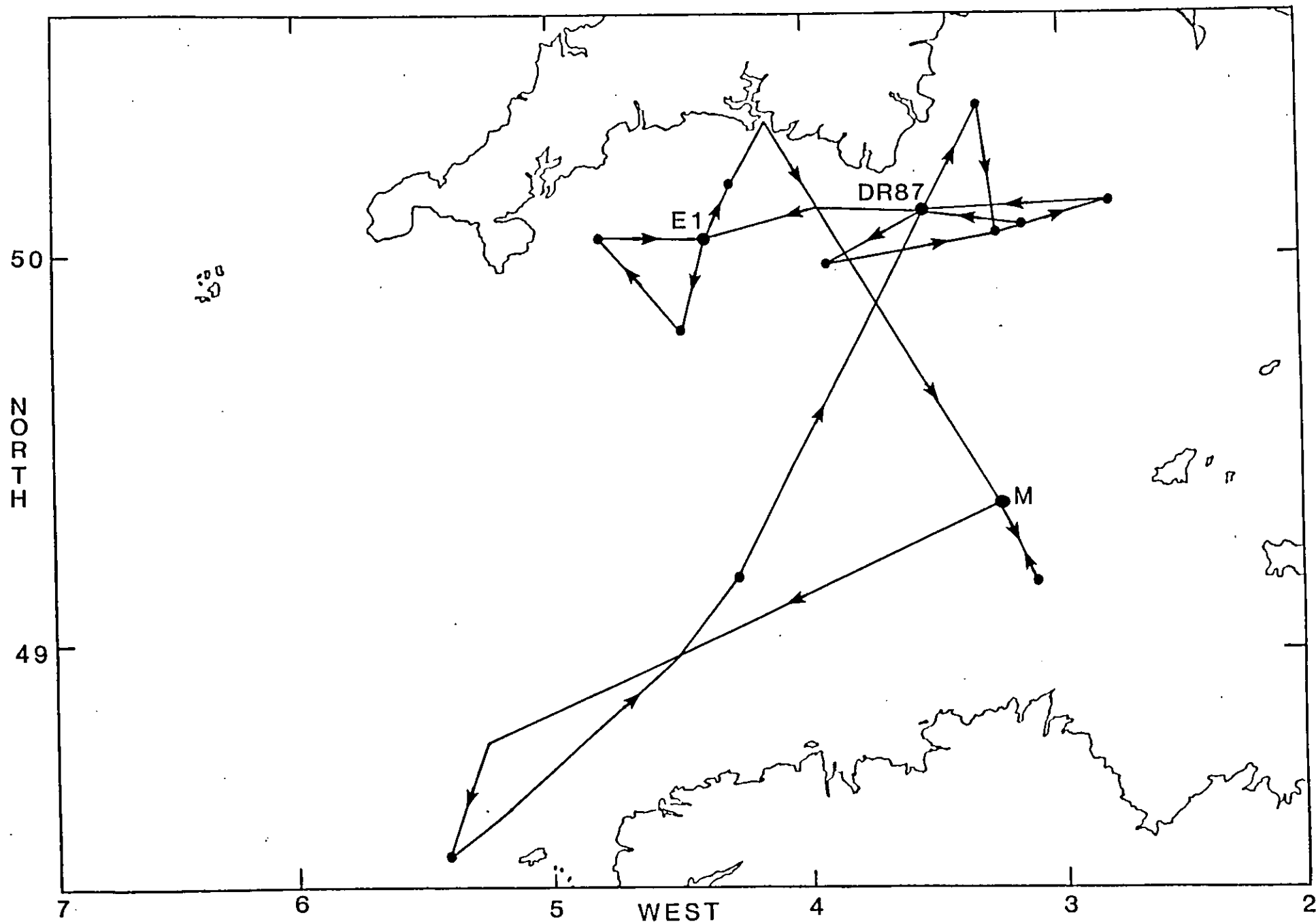




Fig.3

