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PHOSPHORUS AND SILICON IN SEA WATER OFF PLYMOUTH DURING 1955

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(Text-figs. 1–4)

Analyses of sea water collected during 1955 at the International Hydrographic Station E1 (lat. 50° N., long. 4° 22′ W.) are here presented in the same form as in previous reports (Armstrong, 1954, 1955). The methods of collection and analysis were substantially unchanged.

Temperature and salinity

The minimum surface temperature recorded was 7·7° C on 15 March, the maximum 18·53° C on 13 July. A quite surprising fall in surface temperature took place between 13 July and 11 August, during a spell of unusually warm weather. Temperatures and salinities on these dates are shown in Table 1. During July and August air temperatures recorded at Mount Batten meteorological station, Plymouth, were as follows:

July	Mean max. 22·0° C	Mean min. 13·1° C	Mean 17·6° C
Aug.	Mean max. 22·4° C	Mean min. 14·7° C	Mean 18·6° C

Winds were mainly light north-east and east.

The vertical distribution of temperature at E1 is shown in Fig. 1. At the beginning of the year temperatures were, as is usual, uniform from top to bottom of the water column, some surface warming becoming just apparent in April. By 9 May there was a slight temperature gradient in the column, but no marked thermocline; one was, however, well established at about 30 m on 13 June, and persisted, with some fluctuation in depth, until September. By 18 October the water column was again isothermal.

The highest salinities were recorded on 15 March (mean 35·27‰). During summer the values were low (34·89‰ on 11 August), rising in the autumn, though November (35·04‰) was significantly lower than October (35·17‰) or December (35·13‰). The change in salinity below 25 m between 13 July and 11 August, shown in Table 1, is probably significant of a change in water mass.

Phosphate

The winter maximum was notably high, the integral mean values of 0·59 and 0·58 μg atom P/l. for February and March being the highest recorded since 1929. In an attempt to determine the extent and, if possible, the source

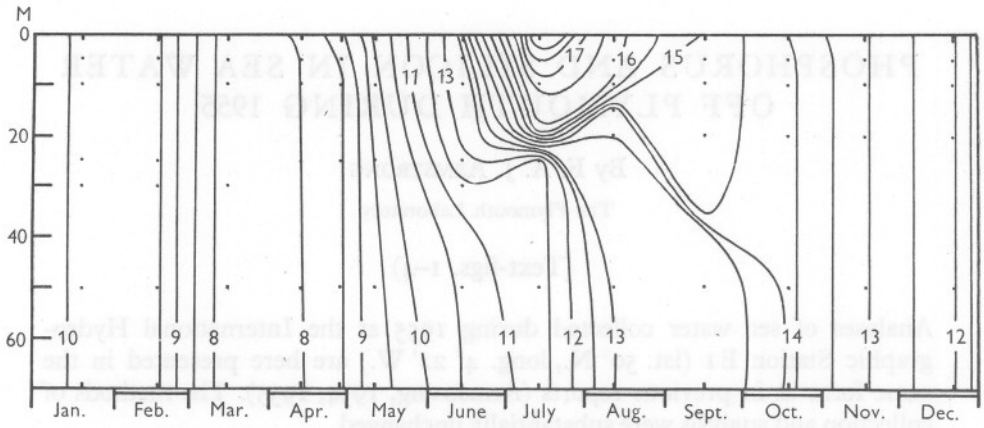

Fig. 1. Vertical temperature distribution at International Hydrographic Station E1, 1955. Contour lines at 0·5° C intervals.

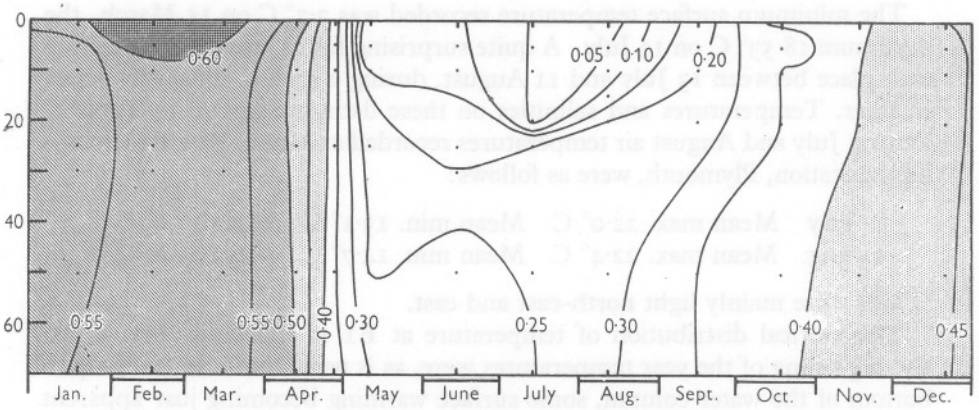

Fig. 2. Vertical distribution of phosphate at International Hydrographic Station E1, 1955. Contour lines at 0·05 μg atom P/l. intervals.

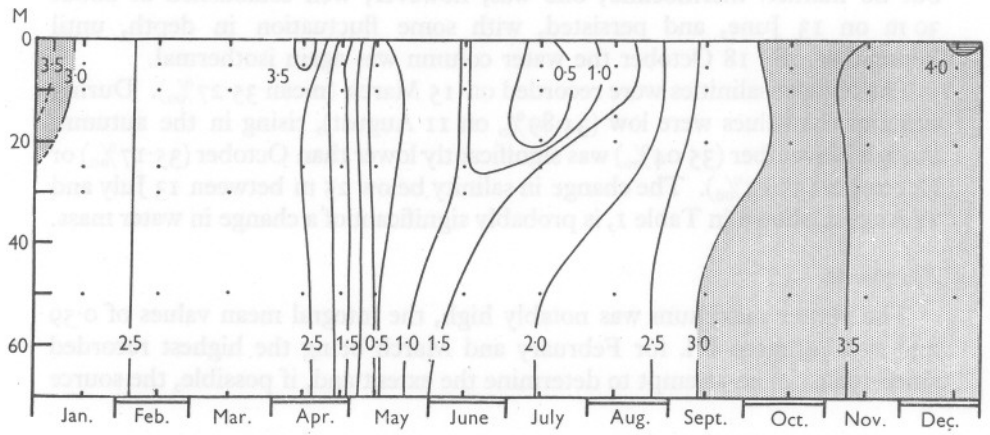

Fig. 3. Vertical distribution of silicate at International Hydrographic Station E1, 1955. Contour lines at 0·5 μg atom Si/l. intervals

TABLE 1. TEMPERATURES AND SALINITIES AT INTERNATIONAL HYDROGRAPHIC STATION E1, 13 JULY AND 13 AUGUST 1955

	Temperature (° C)		Salinity (‰)	
Depth (m)	13 July	11 Aug.	13 July	11 Aug.
0	18·53	16·20	34·97	34·98
5	17·55	16·15	34·92	34·91
10	16·77	16·04	34·93	34·90
15	—	13·75	—	34·90
20	15·27	13·49	34·93	34·91
25	11·36	—	34·93	—
50	11·30	13·07	34·96	34·85
72	11·22	13·07	34·93	34·89

TABLE 2. INTEGRAL MEAN CONCENTRATIONS IN WATER COLUMN AT STATION E1

Date	Phosphate-P (μg atom P/l.)	'Total-P' (μg atom P/l.)	Silicate (μg atom Si/l.)
18. i. 55	0·54	0·61	2·12
16. ii. 55	0·59	0·70	2·82
15. iii. 55	0·58	0·71	2·65
12. iv. 55	0·49	0·62	2·72
27. iv. 55	0·36	—	1·77
9. v. 55	0·22	0·49	0·39
13. vi. 55	0·22	0·31	1·33
13. vii. 55	0·17	0·35	1·40
11. viii. 55	0·19	0·39	1·87
15. ix. 55	0·25	0·44	2·94
18. x. 55	0·32	0·47	3·11
17. xi. 55	0·36	0·54	3·68
21. xii. 55	0·38	0·54	3·26

TABLE 3. POSITIONS OF STATIONS AND PHOSPHATE CONCENTRATIONS AT 10 m DEPTH, WESTERN APPROACHES, 14–21 MARCH 1955

Date	Station no.	N. Lat.	W. Long	Phosphate at 10 m (μg atom P/l.)
14. iii. 55	1 (E2)	49° 27′	4° 42′	0·58
	2 (E3)	48° 34′	5° 13′	0·15
15. iii. 55	3	47° 46′	6° 05′	0·58
	4	47° 20′	6° 28′	0·56
16. iii. 55	5	46° 30′	8° 00′	0·56
17. iii. 55	6	47° 14′	7° 55′	0·55
	7	47° 50′	7° 40′	0·63
18. iii. 55	8	48° 18′	7° 30′	0·60
	9	49° 00′	9° 00′	0·60
	10	49° 47′	10° 15′	0·63
19. iii. 55	11	50° 35′	11° 28′	0·72
	12	50° 34′	11° 10′	0·76
	12A	50° 32′	10° 56′	0·72
	12B	50° 32′	10° 50′	0·75
	13	50° 19′	10° 20′	0·64
20. iii. 55	14	50° 07′	8° 43′	0·63
	15	49° 50′	8° 00′	0·64
	16	49° 50′	7° 15′	0·56
	17	49° 50′	6° 00′	0·54
21. iii. 55	18	49° 53′	5° 12′	0·58

of this phosphate-rich water, Dr L. H. N. Cooper in R.V. *Sarsia* made a survey of the area at the mouth of the English Channel, working twenty stations as shown in Fig. 4 between 14 and 21 March 1955. Table 3 gives the positions of the stations and phosphate concentrations found at 10 m, and areas characterized by differing phosphate concentrations are indicated by shading in the figure.

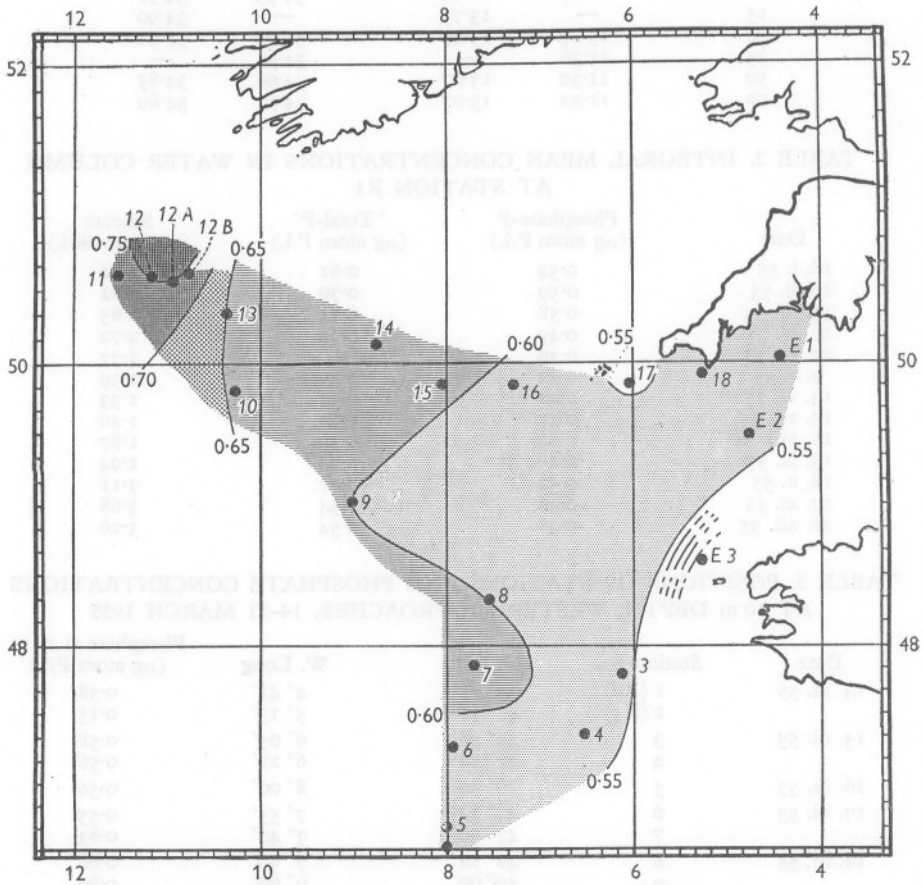

Fig. 4. Distribution of phosphate at 10 m depth in part of Western Approaches, 14–21 March 1955. Contour lines at 0·05 μg atom P/l. intervals.

Although notably high phosphate concentrations were found in surface waters over the continental slope southwest of Ireland there is no evidence that water from there has ever entered the English Channel, and no satisfactory source for the high phosphate water was found within the area surveyed. Low values of around 0·05 μg atom P/l. were found in the upper 10 m layer in July and August.

The vertical distribution of phosphate is shown in Fig. 2, and it will be seen that the water column was almost homogeneous until 9 May, by which date plant growth had removed a considerable amount of phosphate from the upper 25 m. Low concentrations of phosphate in the upper layers persisted until the breakdown of the thermocline.

Silicate

The vertical distribution of silicate is shown in Fig. 3 It is seen that the water column was homogeneous up to and including 9 May. On that date there was little variation in silicate concentration with depth, in contrast to the marked layering of phosphate. Silicate was low throughout the water column. During the summer, silicate was less in the layer above the thermocline than in the deeper water, but no very low concentrations were recorded, the smallest being around 0·2 μg atom Si/l. in the upper 20 m on 13 July.

Silicate at these depths had increased to about 1·5 μg atom Si/l. on 11 August, although the intervening period had been notable for bright warm weather (as recorded above) such as would be expected to favour growth of diatoms and consumption of silicate. It has already been observed that in the deeper water at least, a significant change in salinity occurred between these dates.

By 18 October silicate concentration was uniform throughout the water column, and was higher than at the beginning of the year. Mean values for December are lower than for November, which is unexpected.

Integral mean concentrations

The computed figures are given in Table 2. The decreases in the spring representing consumption of nutrients by the phytoplankton were: phosphate 0·42 μg atom P/l., 'total phosphorus' 0·40 μg atom P/l., silicate 2·43 μg atom Si/l.

SUMMARY

Temperatures and salinity, phosphate, total phosphorus and silicate analyses of water from the International Hydrographic Station E1 during 1955 are discussed. The seasonal variation is shown, and it appears that consumption of nutrients by plants in the spring was: phosphate 0·42 μg atom P/l., 'total phosphorus' 0·40 μg atom P/l., silicate 2·43 μg atom Si/l., these being means for the whole water column. Some irregularities are pointed out; they are probably attributable to changes in the water mass.

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