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CHEMICAL CHANGES IN SEA WATER OFF PLYMOUTH DURING 1958

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(Text-figs. 1–3)

Analyses of sea water collected during 1958 at the International Hydrographic Station E 1 (lat. 50° 02′ N., long. 4° 22′ W.) are given here in the same form as in earlier reports (Armstrong, 1954, 1955, 1957, 1958; Armstrong & Butler, 1959). The methods of collection and analysis remain the same. Salinities were determined by the Government Chemist, Department of Scientific and Industrial Research. We wish again to thank Lt.-Cdr. C. A. Hoodless, D.S.C., and the crew of R.V. 'Sarsia', and Capt. W. J. Creese and the crew of R.V. 'Sula' for help at sea.

RESULTS

Temperature and salinity

The vertical distribution of temperature during the year is shown in Fig. 1. The lowest temperature measured at the surface was 8·95° C on 19 March; the highest was 16·45° C on 9 July. A weak thermocline at 15 m was established by 20 May, and it strengthened and persisted with some variation of depth down to 30 m throughout the summer. The water column had become isothermal by 22 October.

Some fluctuations of salinity occurred, as when the mean value of 35·23‰ in January dropped to 35·10 in February and returned to 35·25 in March. These changes were accompanied by the rise and fall in silicate which are shown in Table 1, and suggest a change in water mass at the station.

Phosphate

Vertical distribution is shown in Fig. 2, and integral mean concentrations in Table 1. The winter maximum found was 0·55 μg atom P/l., on 18 February. This was unusually high and in recent years was only exceeded in 1955 (0·59 in February). The lowest concentrations found were 0·07–0·09 μg atom P/l. in the top 10 m layer in June, July and August, and were about as low as are ever encountered at this station. Low values above the thermocline were recorded throughout the summer and until 1 October. By 22 October, with the autumn overturn of the water, phosphate values were uniform through the water column.

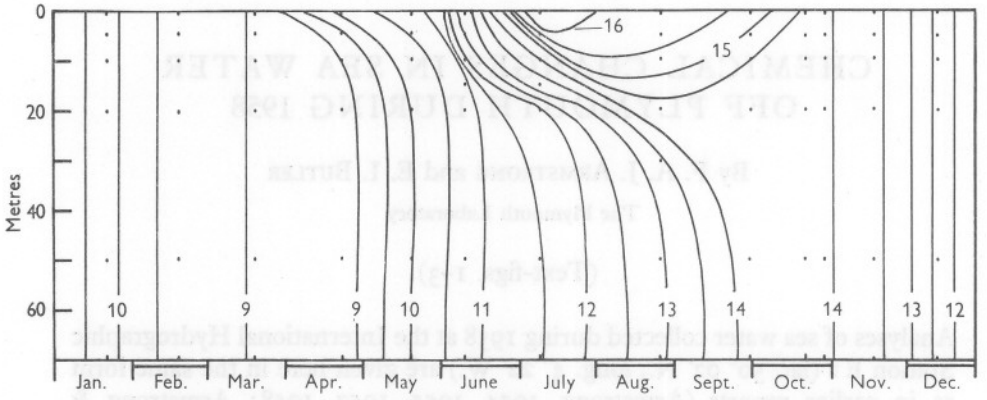

Fig. 1. Vertical temperature distribution at International Hydrographic Station E1, 1958. Contour lines at 0·5° C intervals.

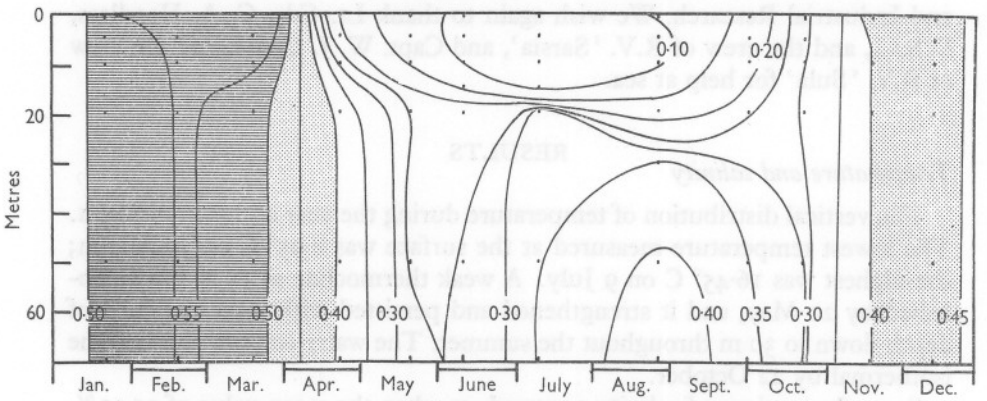

Fig. 2. Vertical distribution of phosphate at International Hydrographic Station E1, 1958. Contour lines at 0·05 μg atom P/l. intervals.

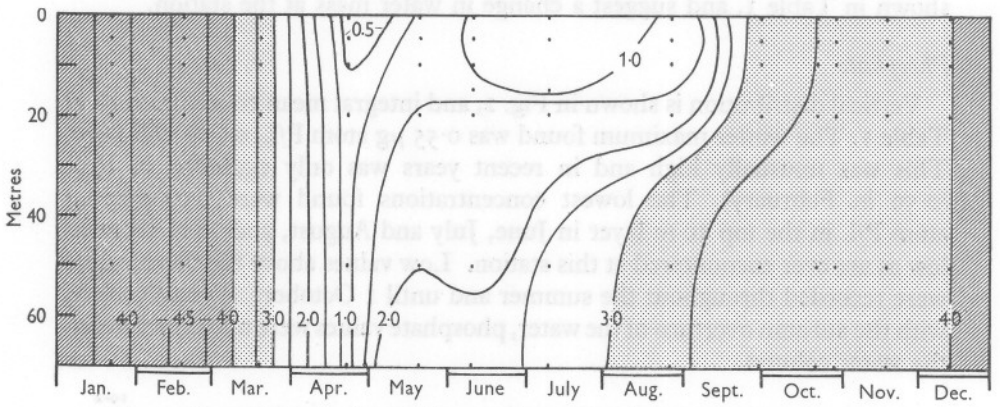

Fig. 3. Vertical distribution of silicate at International Hydrographic Station E.1, 1958. Contour lines at 0·5 μg atom Si/l. intervals.

Total phosphorus

Determinations were made in the early months of the year only, to find the winter maximum, which was 0·75 μg atom P/l. on 22 April, although sensibly similar figures were found in February and March. The value of 1·35 for the ratio of 'total' to 'inorganic' phosphorus is unusually high (Armstrong & Harvey, 1950).

Silicate

Vertical distribution is shown in Fig. 3, and integral mean concentrations in Table 1. The winter maximum value found was 4·67 μg atom Si/l. on 18 February, which was rather high. It was equalled since 1947 only in 1954 (4·70 in January) and went with the high phosphate and low salinity already mentioned.

TABLE 1. INTEGRAL MEAN CONCENTRATIONS IN WATER COLUMN AT STATION E1, 1958

Date	Phosphate (μg atom P/l.)	'Total-P' (μg atom P/l.)	Silicate (μg atom Si/l.)	Ammonia (μg atom N/l.)	Inorganic N (μg atom N/l.)
21 Jan.	0·53	0·69	3·93	—	—
18 Feb.	0·55	0·74	4·67	Less than 0·1	10·5
19 Mar.	0·54	0·73	3·64	Less than 0·1	7·6
22 Apr.	0·37	0·75	0·60	Less than 0·1	10·5
20 May	0·23	0·58	2·16	0·2	8·8
10 June	0·20	—	1·69	1·7	2·1
9 July	0·28	—	1·84	1·4	3·3
26 Aug.	0·30	—	2·61	—	—
1 Oct.	0·28	—	3·62	0·6	6·2
22 Oct.	0·30	—	3·59	—	—
18 Nov.	0·40	—	3·57	0·1	8·7
9 Dec.	0·40	—	3·95	0·2	8·9
12 Dec.	0·41	—	3·61	—	—

Low values of around 0·2 μg atom Si/l. were found in the top 10 m on 22 April, but even in the upper layers concentrations rose again in May and stayed at the 1·0 μg atom Si/l. level throughout the summer, with a temporary fall to 0·3 in July. The vertical distribution of silicate (unlike that of phosphate) had become uniform by 1 October and remained so until the end of the year.

Nitrogen

Integral mean concentrations of ammonia-N and inorganic-N (nitrate + nitrite + ammonia) are given in Table 1. The vertical distribution generally resembled that for phosphate but there are too few observations to allow a diagram to be presented. The winter maximum (of inorganic nitrogen) found was 10·5 μg atom N/l. on 18 February. The ratio N:P was then 19:1 by atoms

or 8·6:1 by weight which is similar to that for 1957. On 9 July, nitrogen compounds could not be detected in the upper layers. The methods should detect 0·1 μg atom N/l., and we infer that nitrogen was the limiting nutrient for plant growth, since an appreciable quantity of phosphorus remained available. This may be the rule at this station, in recent years at least, for although we have not the necessary nitrogen analyses, it is notable that phosphate concentrations in summer have never fallen below about 0·05 μg atom P/l., and are usually appreciably higher. We estimate that the method will detect 0·02 μg atom P/l. with certainty, and it is not difficult to reduce the phosphate content of phytoplankton culture solutions below this level, if the nitrogen supply is adequate.

Nitrogen remained low in the upper layers during the summer months, became vertically uniform by 22 October, and increased thereafter until the end of the year.

Integral mean concentrations

Some figures have been discussed. The spring decreases were: phosphate 0·35 μg atom P/l., silicate 4·07 μg atom Si/l., inorganic nitrogen 8·4 μg atom N/l. The ratio N:P consumed was 24:1 by atoms or 10·8:1 by weight.

SUMMARY

The results of analysis of sea-water samples from the International Hydrographic Station E 1 during 1958 are given in graphical form and as integral mean values for the water column of 70 m. The spring decreases of nutrients, conventionally ascribed to consumption by plants were: phosphate 0·35 μg atom P/l., silicate 4·07 μg atom Si/l., inorganic nitrogen 8·4 μg atom N/l.

At the time of winter maximum of nutrients the ratio N:P was 19:1 by atoms or 8·6:1 by weight. The ratio of these elements consumed was 24:1 by atoms or 10·8:1 by weight.

The year was notable for the high phosphorus and silicon concentrations found in February.

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