Journal of the Marine Biological Association of the United Kingdom Vol 31 No 3 1953

SEASONAL VARIATIONS IN THE PHOSPHATE AND SILICATE CONTENT OF SEA WATER

PART VI. 1948 COMPARED WITH THE 1923–25 PERIOD

By W. R. G. Atkins, F.R.I.C., F.R.S.
The Plymouth Laboratory

(Text-figs. 1–4)

The fifth paper of this series (1930) was the author's last, after which the work was handed over to L. H. N. Cooper. It was resumed by the author in 1948 to compare the early years with the post-war, since the determinations had lapsed. Measurements of the extinction coefficient of the water were also resumed, and it was desirable to obtain the chemical data at precisely the same time.

The phosphate results are, as before, expressed as P_2O_5 in mg./m.^{3}, since for crop calculations this old unit is convenient; to convert to mg. P, which is more rational, multiply by 0·437; to bring to milligram atoms multiply by 0·0141. The analyses have not been corrected for salt error, since the early results were not, and the factor for this correction has not as yet been agreed upon.

The silicate results are given as mg./m.^{3} of SiO_2, but though the standard used in Plymouth was checked for me by Dr E. J. King in Canada and agreed with his (King & Lucas, 1928), yet a different value had to be assigned to the silica factor of the picric acid solution. All values have accordingly been multiplied by 1·44.

The phosphate results for E 1, surface, from 11 February 1948 to 1 February 1949 are shown in Fig. 1 plotted against the dates. When one compares the phosphate with the corresponding values for 1923 and 1925 it is obvious that the winter concentrations are greater in the earlier years. But when considering fishery yields it is not enough to compare the winter maxima, the summer minimum must be taken into account and the difference fixes the minimum value of the plant production—minimum because some is used over again during the year. The years 1925 and 1948 were alike in having a large spring outburst, so that most of the phosphate was used up by April or May. In Fig. 2 one sees the concentration of phosphate at each depth. The maximum consumption for 1923 was reached by 10 July, and was 29·6 mg./m.^{3}. (This for calculation was rounded to 30 mg. and led to the value 1400 tons wet weight of phytoplankton per square kilometre down to 70 m.) Now taking

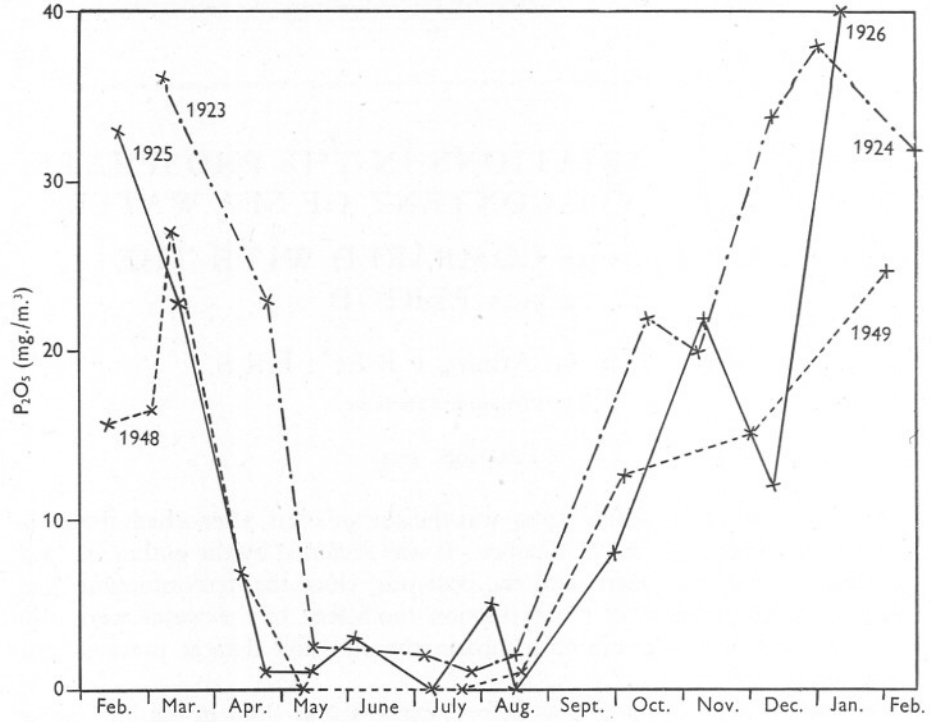

Fig. 1. Phosphate at Station E1 (50° 02′ N., 04° 22′ W.), surface. Dash and dot, 1923; full line, 1925; broken line, 1948; each year continued into the early part of the next.

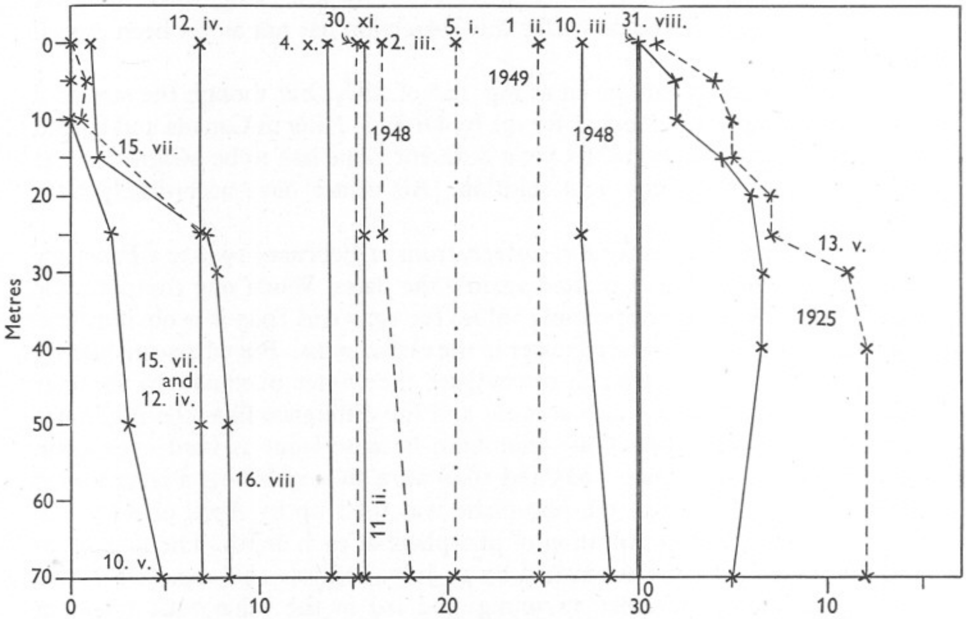

Fig. 2. Phosphate in water column at dates shown. Left-hand frame for 1948, some lines broken for clarity, and 1949, two only, dashes with dots. Right-hand frame for 1925.

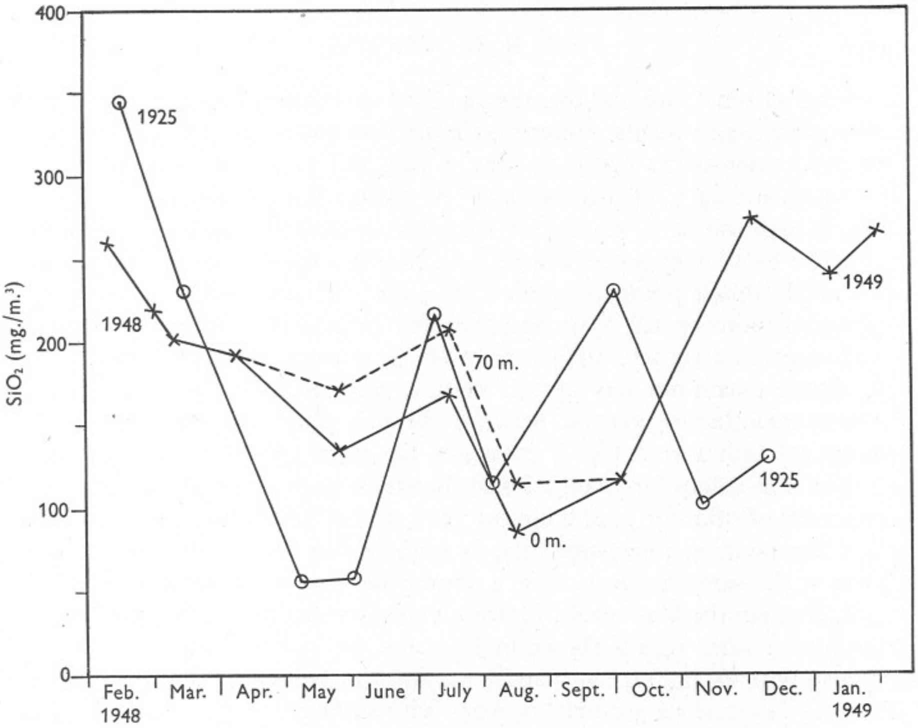

Fig. 3. Silicate at Station E 1, surface. Full line 1948 to 1949, surface and bottom in winter; broken line 70 m. when distinguishable. Full line 1925, surface.

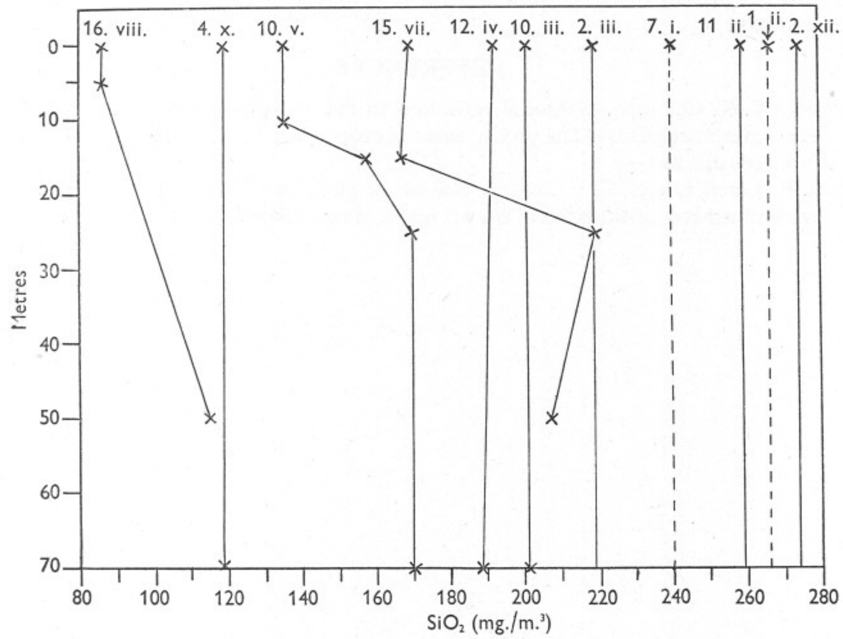

Fig. 4. Silicate in water column at dates shown, 1948, with two dates in 1949, broken line.

29·6 mg. as 100 % we find that the yield for 1925 increased a little throughout the summer, and with a winter maximum just under 92 % of that for 1923, the production by 22 April, 13 May, 8 July and 31 August was respectively 80, 80, 89 and 94 % of that for 1923. As against this the winter maximum in March 1948 was 84 % of that for 1923, but because the utilization was more complete by 10 May it also was 84 % of the 1923 value after which regeneration of phosphate preponderated. Thus 1948, with less phosphate than 1925, produced more up till May, and then fell behind. The difference between production in 1923 and 1948 is only 16 %, whereas the decrease in winter phosphate maximum was 25 %. Thus it can hardly be said that there is a strict quantitative relation between the free phosphate supplies and net phosphate utilization. Fig. 3 compares the silica cycle for 1925 and 1948, surface. The values for 70 m. are also shown for 1948, dotted line. The winter maximum of silica for 1948 is almost 75 % of that for 1925 and very curiously the corresponding phosphate ratio is slightly over 75 %—the ratio may be taken as the same for each. Fig. 4 shows the silica variation with depth for 1948. Though the May results indicate a good development of phytoplankton, enrichment with silica is shown in July, and the year's silica minimum is in August, with 86 mg./m.^{3} at 0 and 5 m. and 115 below the thermocline. But the 1925 fall in silica occurred in April with surface 58 mg., which by 3 June had become uniform down to 70 m. It should be possible to get an idea as to whether diatoms or non-siliceous algae had been mainly responsible for a plankton outburst by a comparison of the relative decreases in phosphate and silicate.

REFERENCES

ATKINS, W. R. G., 1930. Seasonal variations in the phosphate and silicate content of sea water in relation to the phytoplankton crop. Part V. *Journ. Mar. Biol. Assoc.*, Vol. 16, pp. 821–52.

KING, E. J. and LUCAS, C. C., 1928. The use of picric acid as an artificial standard in the colorimetric estimation of silica. *Journ. Amer. Chem. Soc.*, Vol. 50, pp. 2395–7.