

## THE DISTRIBUTION OF PHOSPHATES IN THE SOUTH-WESTERN AREA IN APRIL 1938

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(Text-fig. 1)

In April 1938 the Ministry of Agriculture and Fisheries research-vessel, *George Bligh*, surveyed, in connexion with a programme of mackerel research, a large area of sea in the western English Channel, St George's Channel, and to the west of Cornwall. The opportunity was taken of estimating the distribution of the phosphate in this area by means of the "Lowestoft Photometer". This instrument has been described by Graham (1936). In preparing the samples for use in the photometer, 3 c.c. of molybdate reagent were added to about 140 c.c. of the sample to be tested, and 4-6 drops of  $\text{SnCl}_2$  solution.

In the first four charts in Fig. 1 are given the values of phosphate found at each station, at four depths, namely, at the surface, at 25, and 50 m., and at the bottom. The values are expressed as mg.  $\text{P}_2\text{O}_5$  per cu. m., and have been raised by the factor 1.3 to allow for salt error. Contours have been inserted in the charts as follows: a hatched contour to include values greater than 50, a stippled contour to include values of from 40-50, and a contour to include values of 30-40 mg. per m.<sup>3</sup>

No high degree of accuracy is claimed for these observations, for, as Graham points out, at high concentrations of phosphate the instrument is less reliable than at low concentrations; further, certain stations have been rejected because the instrument appeared to be faulty. There is, however, some internal evidence that the determinations are at least consistent, for when the itinerary of the ship brought her back into regions visited shortly before, the phosphate values were found to be in good agreement with those found previously.

The season in which the cruise was made was unfavourable for a survey of the distribution of the phosphates, for Cooper (1938) shows that, on an average, the consumption of phosphate by the phytoplankton has so far advanced, by April, that about half the year's supply has been used up. Nevertheless, in view of the scarcity of observations on the distribution of phosphates in the south-western area, it has been thought worth while to present the results obtained.

The charts show that, generally speaking, there was much more phosphate in the deeper water than at the surface. At the sea bottom, values greater than 30 mg. per cu. m. were found almost everywhere, whereas, at the surface, they

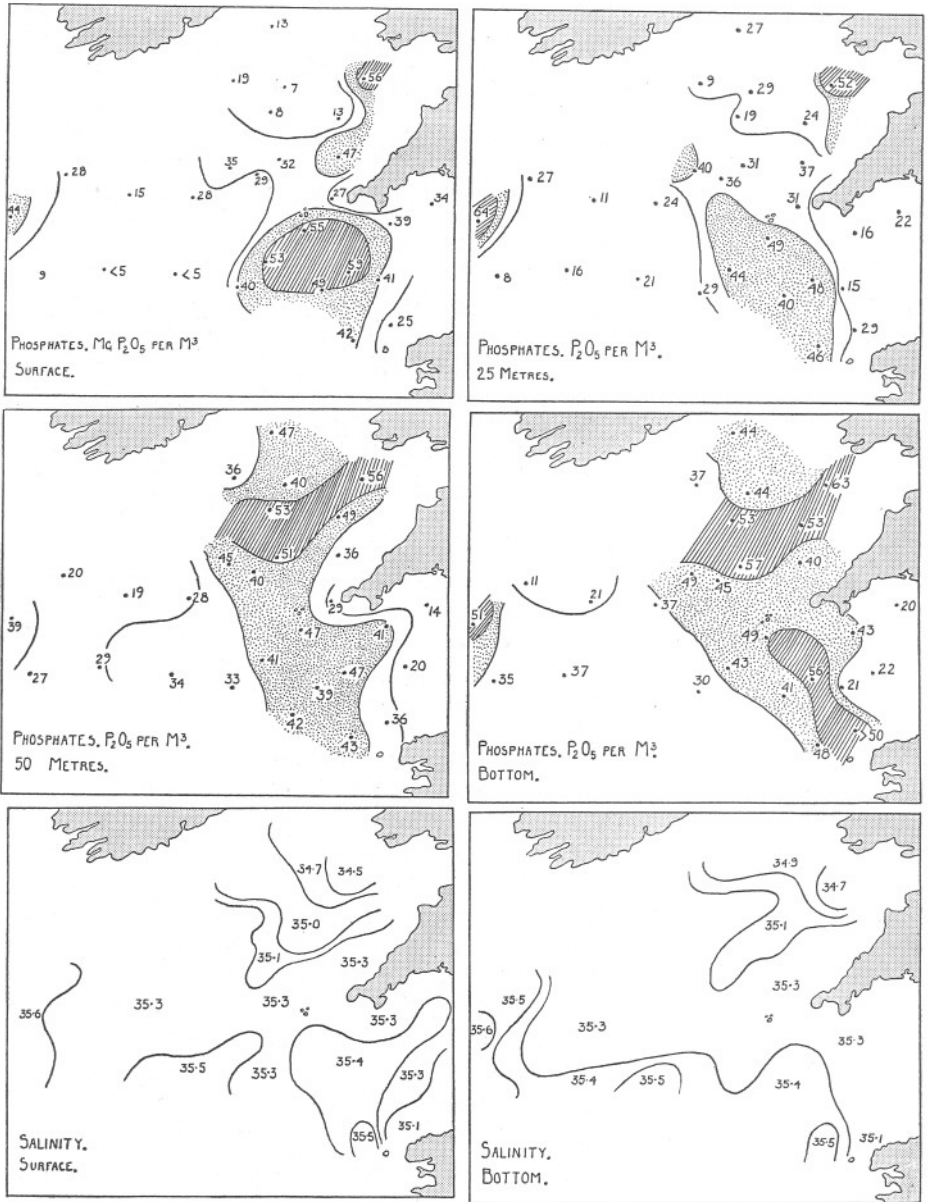


Fig. 1. Distribution of phosphate in the south-western area in April 1938, with salinities at surface and bottom.

were restricted. But at all depths there were three regions where phosphate was especially abundant, namely, off the Bristol Channel, off the English Channel, and on the edge of the Continental Shelf west of Cornwall.

Variations in the distribution of phosphate in the sea are, of course, due not only to water movements, which may carry water rich in phosphate into regions poorer in phosphate, but also to the consumption and regeneration of phosphate *in situ* by living organisms. The first factor named may perhaps be traced, in the present data, by a comparison with the salinity of the water. In Fig. 1, in addition to the four charts of phosphate distribution, are given two charts showing the salinity at the surface and at the bottom.

A tongue of water of low salinity appeared to spread westwards from the Bristol Channel, and this tongue of low salinity is closely associated with the area rich in phosphate lying off the Bristol Channel. It may be that this phosphate-rich water was derived from the extensive watershed draining into the Bristol Channel. Kalle (1937) showed that the sea in the neighbourhood of the great rivers draining into the North Sea was rich in phosphate, and Graham (1938) shows that an area rich in phosphate may be associated with the drainage from the Thames, including, of course, the output of phosphates from the London sewage.

More saline water appeared to spread from the south across and into the English Channel, and also to be present on the edge of the Continental Shelf. Probably this more oceanic water carried with it a richer supply of phosphate, derived from the upwelling of deeper water, and would in part account for the areas richer in phosphate lying at the mouth of the English Channel, and at the edge of the Continental Shelf.

As to the biological factors affecting the distribution of the phosphate, these may be seen in the scarcity of phosphate in the surface water, as compared with the deeper water. Further, stations in certain regions were markedly rich in phytoplankton. This was, in many cases, shown by the colour and smell of the water, as well as by the observed presence of the larger diatoms in the reagent tubes. Through the kindness of Mr Corbin I have had a list of the stations at which phytoplankton was plentiful in the plankton catches; and it is clear that the area comparatively poor in phosphates, which lay between the richer areas off the English Channel and at the edge of the Continental Shelf, was an area in which the phytoplankton was developing rapidly.

#### SUMMARY

The results of a survey of the distribution of phosphates in the south-western area in April 1938 show that there were three regions exceptionally rich in phosphate. These regions appeared to be associated respectively with the outflow of the Bristol Channel, with the flow of more oceanic water across the entrance of the English Channel, and with upwelling of deeper water at the edge of the Continental Shelf.

The surface water was poorer in phosphate than the deeper water, and regions poorer in phosphate were in some cases associated with a crop of phytoplankton.

## REFERENCES

- COOPER, L. H. N., 1938. Phosphate in the English Channel, 1933-8, with a comparison with earlier years, 1916 and 1923-32. *Journ. Mar. Biol. Assoc.*, Vol. XXIII, pp. 181-95.
- GRAHAM, M., 1936. The Lowestoft Photometer. *Jour. du Conseil*, Vol. XI, No. 2.
- GRAHAM, M., 1938. Phytoplankton and the Herring. Part III. Distribution of Phosphate in 1934-1936. *Min. Agric. Fish., Fish. Invest.*, Ser. II, Vol. XVI, No. 3, pp. 1-26. See also Graham and Harding, this Journal, pp. 201-6.
- KALLE, K., 1937. Nährstoff-untersuchungen als hydrographisches Hilfsmittel usw. *Ann. d. Hydr. usw.* LXV. Jahrg. HI, Berlin, 1937.