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THE VERTICAL DISTRIBUTION OF DISSOLVED OXYGEN IN THE DEEPER WATERS OF THE ARABIAN SEA IN THE NEIGHBOURHOOD OF THE LACCADIVES DURING THE SUMMER OF 1959

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INTRODUCTION

THE distribution of dissolved oxygen in the oceans has attracted the attention of oceanographers for quite some time and among the number of publications on the subject, the papers by Seiwell (1934), Miyake and Saruhashi (1956) and Richards (1957) deserve special mention. Miyake and Saruhashi have given an excellent review of the investigations on the oxygen distribution with particular reference to the occurrence of layers of oxygen minima. In presenting their observations, these authors have stated that the factors determining the vertical distribution of oxygen and the occurrence oxygen-minimum layer are ' (i) local productivity and (ii) vertical density distribution of subsurface waters.' The authors have also pointed out that oxygen deficit is closely related to increase in CO_2 and is principally the result of oxidative decomposition of the organic matter produced locally.

Studies on the water masses along the south-west coast of India have been in progress since 1957 at the Central Marine Fisheries Research Station and the parameters that have been investigated in detail so far are temperature, salinity and density. It was considered desirable to include the study of oxygen distribution, as it will help in a further elucidation of the water types and may aid in the characterization of productive and non-productive areas. Two cruises were made on board the Research Vessel *Kalava* in the month of April 1959 and a total number of 25 stations were worked in the deeper waters of the Arabian Sea. In 10 of these stations studies on oxygen distribution were made (Fig. 1). Except at one station (Stn. 434) where sampling was done down to 1,000 metres, the maximum depth of sampling was 500 metres in all the stations.

RESULTS

The results are shown graphically in Fig. 2.

The following salient features are evident on an examination of the data :

(1) The oxygen content from the surface layers down to 50 metres is more or less uniform in all the stations. Slightly lower values are seen in the first two stations which were visited in the early part of the month, as compared with the other eight stations.

(2) From 75 metres downwards there is a rapid fall in oxygen content and at 150 metres the oxygen concentration attains very low values. It may be seen

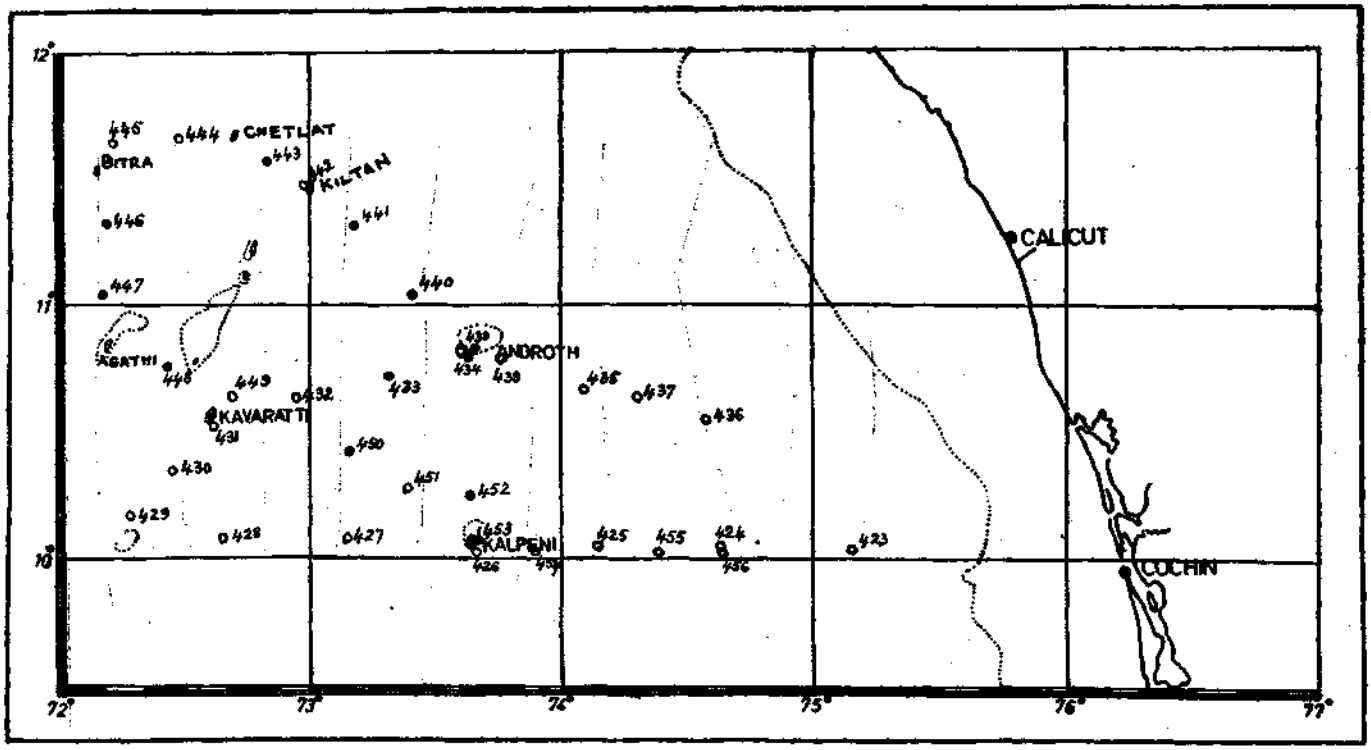

FIG. 1. Location of hydrographic stations—Oxygen sampling stations are shown as Black circles (●). Stations where oxygen samplings have not been done are shown as open circles (○).

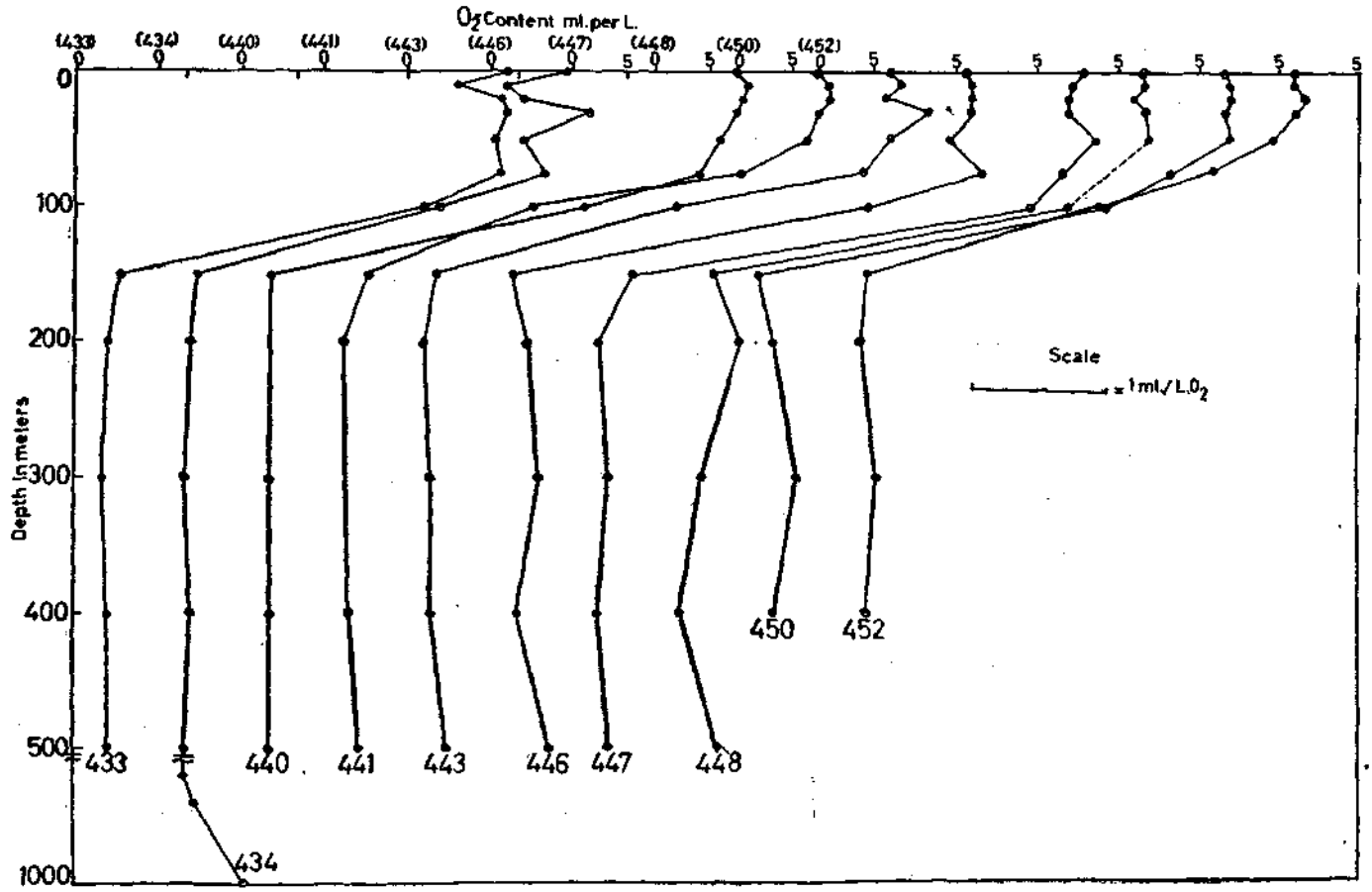

FIG. 2. Dissolved Oxygen content plotted against depth at the stations sampled. The zero value (origin) for each of the graphs from stations 434 onwards has been shifted by an equal amount to prevent overlapping of the curves. The maximum value on the scale is 5.0 ml./l.

from the temperature structure of a representative section covering the area under investigation that this layer of sharp decrease in oxygen content corresponds to the discontinuity layer (Fig. 3).

(3) The oxygen-poor layer extends from 150 metres downwards to 500 metres and the density (σt) values (Fig. 4) range between 25.0 and 27.0 with this layer.

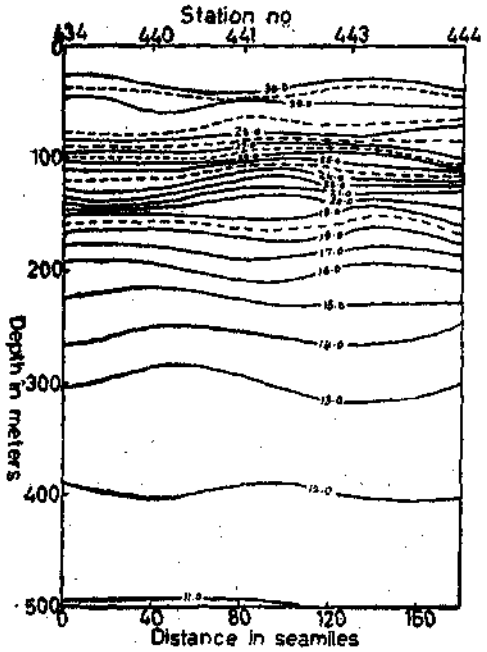

FIG. 3. Vertical temperature profiles in a representative section covering the area under investigation. Isopleth interval, 0.5°C. Discontinuity layer is seen at 100 meters.

(4) At station 434 where sampling has been done down to 1,000 metres, it is seen that oxygen values tend to increase from 700 metres and at 1,000 metres, the value is nearly double that of the minimum reached.

DISCUSSION

The vertical distribution in all the stations worked seems to be more or less in conformity with the observations recorded elsewhere (*see* Harvey, 1957). In discussing the associated biological phenomena, Harvey has quoted Seymour Sewell as stating that there is a tendency for zooplankters to congregate in the layer of oxygen-deficit and contribute materially to the process of oxygen depletion. It is not yet clear whether similar concentrations of planktonic animals occur in these waters and whether mixing processes which affect or alter the position of the oxygen-poor layer also affect the distribution of the zooplankters. Recent observations by Carruthers *et al.*, (1959) in the shelf waters off Bombay have

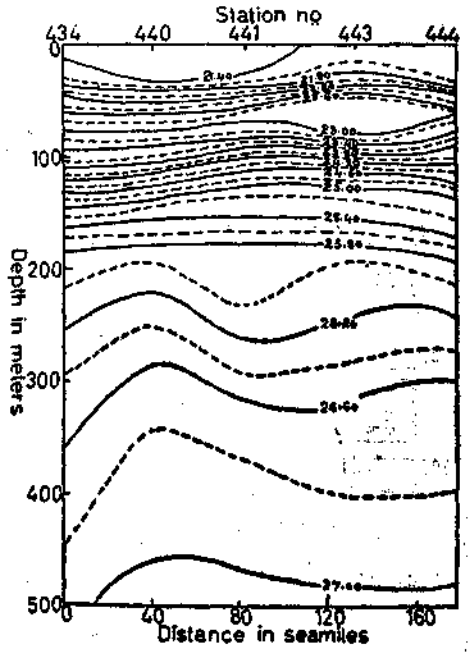

FIG. 4. Profiles of (sigma-t) in the same section as fig. 3. Isopleth interval, 0.2.

shown that in the period October-November the ' shoreward upslope of the oxygen minimum layer ' has some influence on the distribution of fish in that area. The origin of the layer of oxygen minimum is presumed by these authors to be associated with the high salinities and relatively high temperatures of these waters. An explanation based on dynamical considerations has been offered by Wüst and Dietrich (see Miyake and Saruhashi *loc. cit.*), but, according to Richards (*loc. cit.*) the explanation lies in biochemical consumption of oxygen rather than in the dynamical processes.

SUMMARY

The vertical distribution of dissolved oxygen during summer months in the deep waters of the Arabian Sea in the neighbourhood of the Laccadive Islands has been investigated and the results are presented. It has been found that the surface layer and subsurface layers down to a depth of 50 metres have a more or less uniform oxygen content. The values decrease below 50 metres and reach a minimum at or about 150 metres. The oxygen-poor layer extends down to 700 metres below which a rising trend is observed.

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References

CARRUTHERS, J. N., GOGATE, S. S., NAIDU, J. R. and LAEVASTU, T. 1959. Shorewards upslope of the layer of minimum oxygen off Bombay : Its influence on marine biology, especially fisheries. *Nature, Lond.*, **183** : 1084-1087.

HARVEY, H. W. 1957. *The Chemistry and Fertility of Sea Waters.* Cambridge Univ. Press.

MIYAKE, Y. AND SARUHASHI, K. 1956. On the vertical distribution of oxygen in the ocean *Deep-Sea Res.* **3** : 242-247.

RICHARDS, F. A. 1957. *Oxygen in oceans.* In *Treatise on Marine Ecology and Paleoecology*, **1**. *Mem. Geol. Soc. Amer.* **67** : 185-238.

SEIWELL, H. R. 1934. The Distribution of oxygen in the western Basin of the North Atlantic. *Pap. Phys. Oceanogr. Meteor.* **3** : 1-86.