Oxygen, phosphate and oxidizable organic matter in the Mediterranean waters along the Egyptian coast

by

*H.I. EMARA, **Y. HALIM and **S.A. MORCOS

* *Institute of oceanography and fisheries, Kayed Bay, Alexandria (Egypt)*

** *Oceanography Department, Faculty of Science, Alexandria University.*

Oxygen, inorganic phosphate and oxidizable organic matter were studied during the four seasons of 1966 in the southern Levantine Sea on board the R/V Ichthyolog. Six sections between 29° E and 34° E, that were perpendicular to the Egyptian coast, were worked in February, April, August and Novembei 1966. Each section included about 5 stations, the deepest being 50 nautical miles offshore.

Horizontal distribution of dissolved oxygen at the surface showed periodical seasonal variation which was obviously correlated with the temperature variation. The highest values (4.91-5.96 ml/l) occured in the winter when the surface temperature was at a minimum (15.9°-18.1° C). The lowest absolute values (4.39-4.91 ml/l) occured during the summer when the surface temperature reached a maximum (26.1-28.9° C). Surface water was generally close to saturation with values ranging between 90-105 % during the entire year.

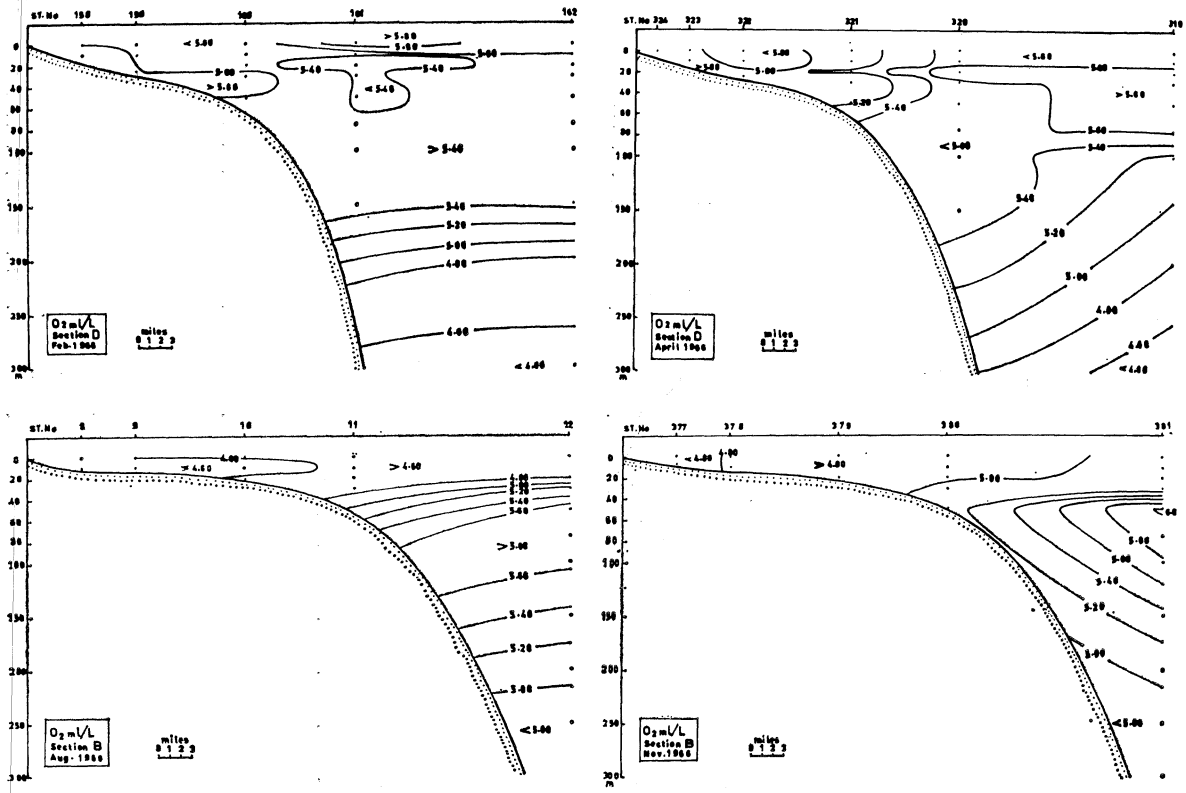

FIG. 1. — North South sections showing the vertical distribution of oxygen (ml/l) in the Egyptian waters
1-a Section D (Brullos ∿ 30° 50′ E) February 1966.
1-b Section D (Brullos ∿ 30° 50′ E) April 1966.
1-c Section B (Tina Bay ∿ 32° 40′ E) August 1966.
1-d Section B (Tina Bay ∿ 32° 40′ E) November 1966.

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The vertical distribution shows a subsurface O_2 maximum layer (Fig. 1a-1d). This layer was not observed in winter, a fact possibly due to vertical mixing; however it started to develop in April with an average value of 5.45 ml/l at 44 m. This level became deeper (an average of 79 m) with the maximal values becoming higher during the summer (average 5.79 ml/l, Fig. 1c). Further sinking is observed during the fall (average, 91 m) with values exceeding those of the summer (average, 6.01 ml/l, Fig. 1d). The most striking feature of this subsurface O_2 maximum layer is that it always coincided with the subsurface salinity minimum layer (Fig. 3c, 3d). This same observation was also very obvious during the summer of 1964 [Halim *et al.*, 1967] and in most of the near-shore stations in the summer and autumn of 1959, 1960, 1961 (N.O.D.C. Archives). [H.I. EMARA, 1969].

JACOBSEN [1912] has explained the supersaturation at subsurface levels as being caused by to the production of oxygen by plankton organisms. However, an examination of the stations of the Danish Expedition in summer 1910 allowed one to trace this layer back to the Gibraltar Strait. The subsurface O_2 maximum layer always coincided with the subsurface salinity minimum and can be attributed to the North African current of Atlantic origin which extends eastwards into the southern Levantine.

The oxygen sigma-t relationship was used to characterize waters of the southern Levantine sea along the Egyptian coast. During winter, oxygen decreased linearly with increasing density. The water was characterized by a high and narrow range of sigma-t values (28.09-29. 45) due to the small vertical gradient of temperature in the upper 300 m. The range of oxygen was also narrow (4.49-5.97 ml/l). In summer, the relationship was not linear as a result of the high stratification and the presence of a subsurface O_2 maximum layer. The vertical temperature gradient was greater, and the range of sigma-t (24.53-29.35) as well as of oxygen (4.39-6.37 ml/l) was wider during the summer. The relationship between oxygen and sigma-t gives a bell-shaped curve. In the lower range of sigma-t, oxygen increases with increa-

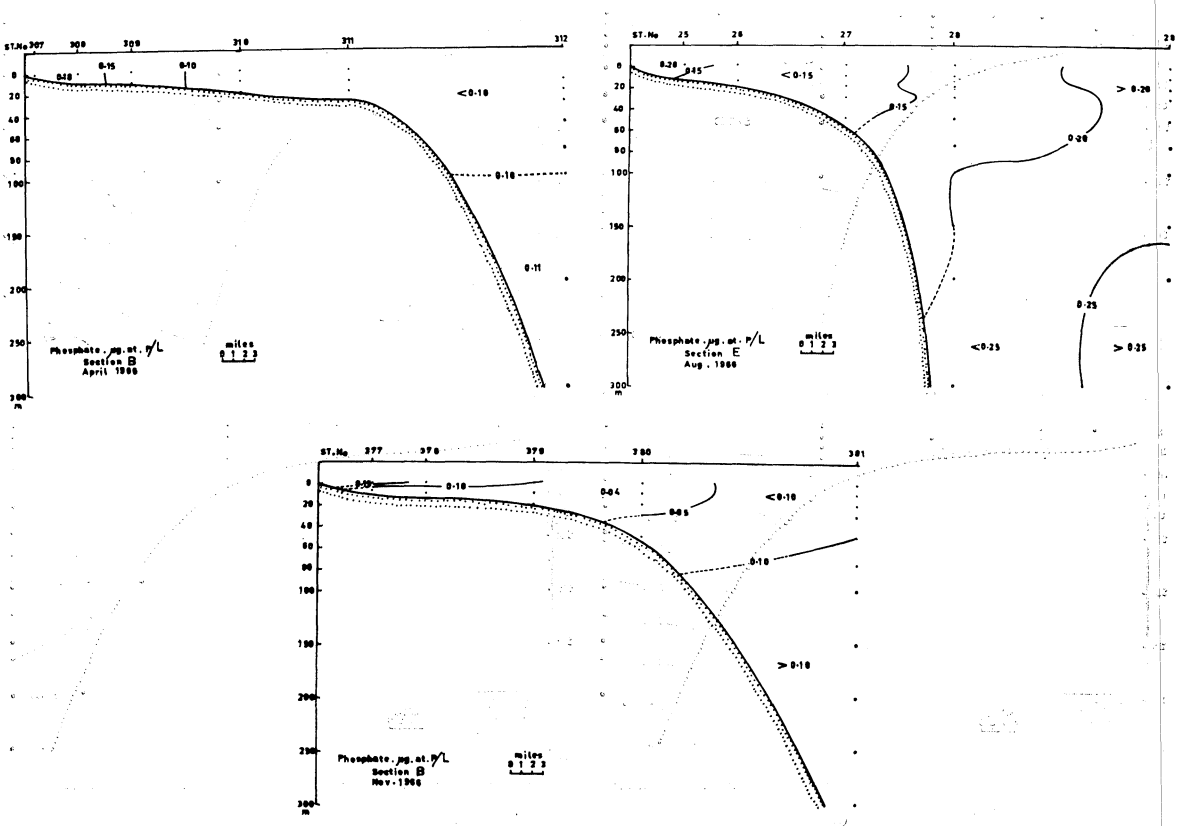

FIG. 2. — North South Sections showing the vertical distribution of Phosphate (µg.at. PO_4-P/L.) in the Egyptian waters.

2-a Section B (Tina Bay ∿ 32° 40' E) April 1966.
2-b Section E (Abu Kir ∿ 30° 10' E) August 1966.
2-c Section B (Tina Bay ∿ 32° 40' E) November 1966.

sing sigma-t. It finally reaches a maximum at the sigma-t range 27.00-28.5 which occurs in the layer of subsurface salinity minimum. This O_2 maximum is followed by a decrease of oxygen with increasing density (28.5-29.35) in the deeper portion of the water column.

As far as phosphate is concerned, the winter distribution (February) showed very low but constant values from the surface to a depth of 300 m. This distribution was attributed to vertical mixing which also resulted in homohaline and homothermal conditions. The phosphate concentration rises slightly during spring (Fig. 2a) and finally reaches a maximum for both surface and subsurface waters in summer (Fig. 2b). As the fall approaches the concentration decreases again (Fig. 2c).

It was found that the distribution of oxidizable organic matter in surface waters depends mainly on the season. The entire area was relatively poorer in winter (0.28-0.77 mg 0_2/l, Fig. 3a) and relatively richer in summer (0.33 - 1.13 mg O_2/l, Fig. 3b). On the other hand, the distribution may also depend on distance from land; coastal waters gave values as high as 0.95 mg O_2/l during the spring and 0.82 mg O_2/l during the fall. This appears to be a direct effect of land drainage because the salinity was always lower in the coastal strip. With the exception of autumn, the concentration of oxidizable organic matter in the eastern part of the study area was higher than that of the western part. Oxidizable organic matter was also comparatively higher in surface waters than in the deeper layers (200 - 300 m).

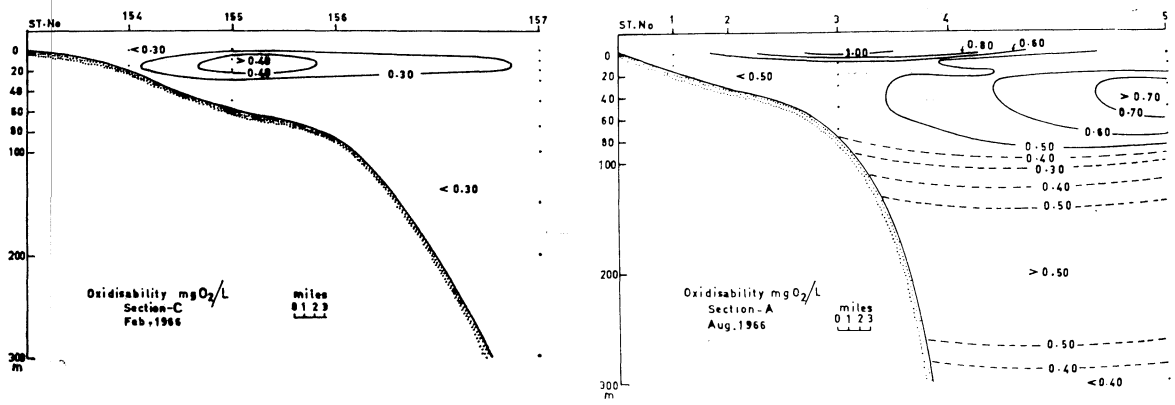

FIG. 3. — North South Sections showing the vertical distribution of oxidizable organic matter (mg. O_2/L.) in the Egyptian waters

3-a Section C (Damietta ∿ 31° 30' E) February 1966.
3-b Section A (El-Arish ∿ 33° 40' E) August 1966.

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