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CHEMISTRY OF SEA WATER WEST OF ALEXANDRIA.

H. I. EMARA *, M.F. ISKANDER ** AND F.N. ASSAD*

* Institute of Oceanography and Fisheries, Alexandria, Egypt.

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

ABSTRACT

Water samples collected from the area west of Alexandria during the period from January to November 1977, showed that the area of Alamein was higher in oxygen concentration by 0.41 ml/l (8% saturation) than El-Mex region which is more affected by industrial wastes. The concentration of the plant nutrients was very low. However, the inshore water was slightly higher than the offshore water. The low N:P ratio (4:1) indicates a faster assimilation of nitrate than for phosphate, while the very high rati Si:P (170:1) indicates a slackening of phytoplankton growth and regeneration of silicon. High concentrations of organic matter up to 4.20 mg O_2/L were recorded in February due to the effect of Ummum drain. The amount of oxygen present after complete oxidation of organic matter varied from 56 to 80 % throughout the year.

INTRODUCTION

The investigated sections west of Alexandria extend about 105 km along the coast, between latitude 28 58' E-29 50'E and 30 50' N-31 09'N. It covers an area of about 1050 km^2.

The eastern part of the investigated sections is affected by brackish water from El-Ummum drain and Lake Maryut. The discharging water varied between 168 and 240 million cubic meters/month. The investigated sections are also affected by oil pollution from ARAB Petroleum Pipelines Company, Western Egyptian Petroleun Company and Alexandria Company for Petroleum. In addition, the area is subjected to industrial wastes resulting from chlorine and chemical factories. This investigation was udnertaken due to changes of physical, chemical and biological conditions of south eastern Mediterranean sea after the construction of Aswan High Dam 1966 leading to a decrease of nutrient salts and organic matter input to the coastal area, in addition to marine pollution.

MATERIALS AND METHODS

Sea water samples were collected during the period from January to November of 1977 on board the R/V Faras El-Bahr from two sections namely El-Mex and El-Alamein west of Alexandria (Fig.1). The samples were collected with reversing Nansen bottles at the standard depths 0, 10, 20, 30, 50, 75 and 100 meters and were analyzed to determine dissolved oxygen, dissolved inorganic phosphate, silicate nitrite,nitrate and oxidizable organic matter.

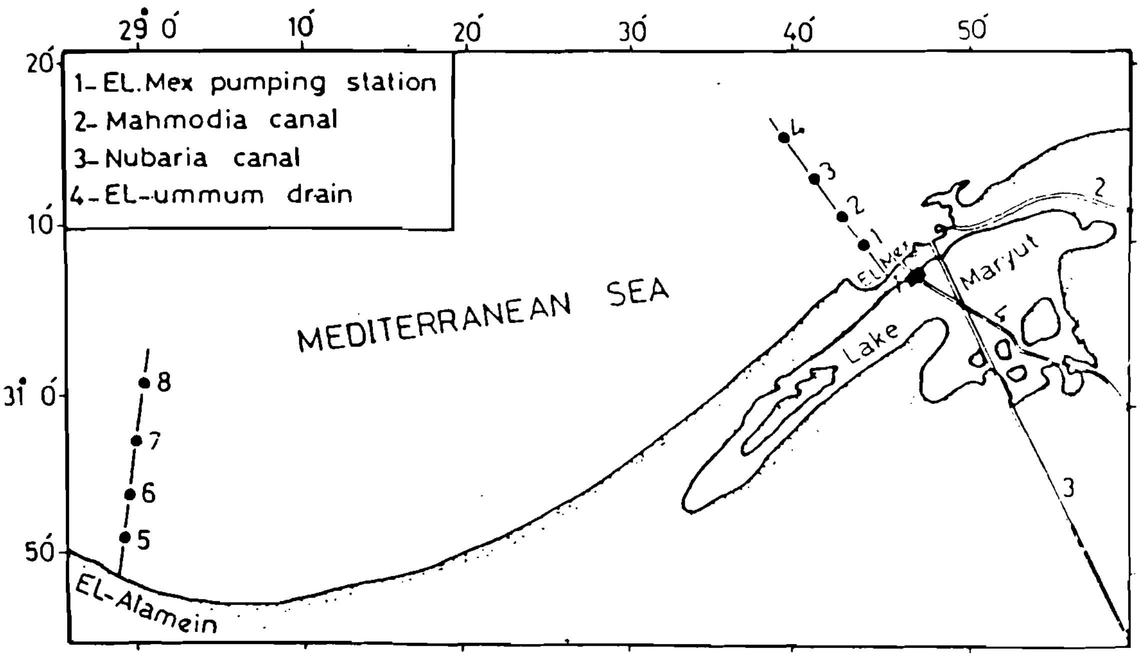

Fig. 1. Area of investigation and location of sampling stations.

Oxygen

Oxygen was determined by the classic winkler method, using all precautions mentioned by Strickland & Parsons, 1968. The oxygen percentage saturation was calculated on the basis of the International Oceanographic Tables, published jointly by the National Institute of Oceanography of Great Britain and UNESCO (volume 2).

Inorganic phoshpate

The sea water sample is allowed to react with a composite reagent containing molybdic acid, ascorbic acid, and trivalent anthimony. The resulting complex heteropoly acid is reduced in situ to give a blue solution the extinction of which is measured at 8859 A°.

Silicate

The sea water sample is allowed to react with molybdate under conditions which result in the formation of the silicomolybdate, phosphomolybdate and arsenomolybdate complexes. A reducing solution, containing metal and oxalic acid, is added which reduces the silicomolybdate complex to give a biue reduction compound and simultaneously decomposes any phosphomolybdate or arsenomolybdate. The extinction of the resulting solutions is measured at 8100 A°.

Nitrate and Nitrite

The nitrate in sea water is reduced almost quantitatively to nitrite when a sample is run through a column containing amalgamated cadmium filings. The nitrite thus produced is determined by diazotizing with sulphanilamide and coupling with N-(1-napthyl)-ethylenediamine to form a highly coloured azo dye the extinction of which is measured at 5430 A°. A correction may be made for any nitrite initialy present in the sample.

The chemical analysis of phosphate, silicate, nitrite and nitrate were performed as described by Strickland & Parsons, 1968.

Oxidizable organic matter

The oxidizable organic matter is determined by the method of Ellis et al, 1946. The sea water is boiled with alkaline potassium permangante. After cooling dilute sulphuric acid is added followed by few solid potassium iodide. The liberated iodine is then titrated against standard thiosulaphate solution using starch as indicator. The statistical treatment of result was made according to Hoel, 1971.

RESULTS AND DISCUSSION

Dissolved Oxygen

The distribution of dissolved oxygen, and its percent saturation of the area west of Alexandria (Section El-Mex, El-Alamein), are illustrated in Figs. 2-5.

The average seasonal concentration of dissolved oxygen and its percent saturation (Table 1) at both sections, showed that the section of Alamein was higher in concentration by 0.41 ml/L (8% saturation) than El-Mex section which is more affected by the industrial wastes.

The calculated horizontal oxygen gradients from the inshore to the offshore stations at El-Mex and El-Alamein sections were found to be - 1.22×10^{-4} ml. $O_2 . l^{-1} m^{-1}$ and 1.51×10^{-4}ml. $O_2 . l^{-1} m^{-1}$ respectively. Oxygen supersaturation up to 121% was observed at depths 50-100 meters at the Alamein section (Fig. 5.C) during summer season. In the upper layers of the sea, where there is sufficient light, photosynthesis by phytoplankton may predominate and lead to the removal of CO_2 and the liberation of Oxygen. Supersaturation was also due to Atlantic current entering the Mediterranean through the strait of Gibralter (Emara et al., 1973). The presence of the later was confirmed by the presence of low salinity layer

TABLE 1

AVERAGE CONCENTRATION OF OXYGEN (ml/l) AND PERCENT SATURATION AT EL-MEX EL-ALAMEIN SECTIONS IN DIFFERENT SEASONS.

SECTION		Winter	Spring	Summer	Autumn	Average
El-Mex						
	Dissolved	3.88	3.79	4.42	4.59	4.17
	% sat.	71	73	95	95	83.5
El-Alamein						
	Dissolved	4.18	5.13	4.52	4.57	4.58
	% sat.	76	95	97	98	91.5

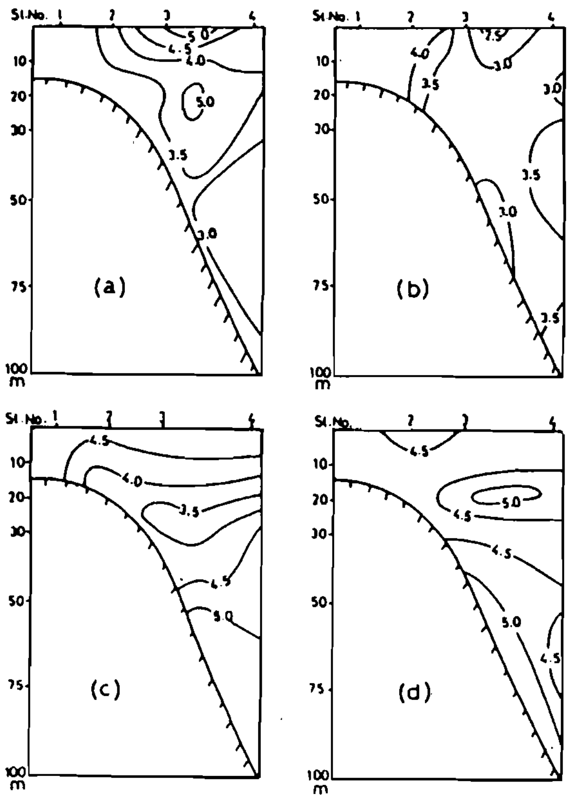

Fig. 2. Vertical distribution of dissolved oxygen(ml/L) at El-Mex section during: (a) Winter (b) Spring (c) Summer (d) Autumn.

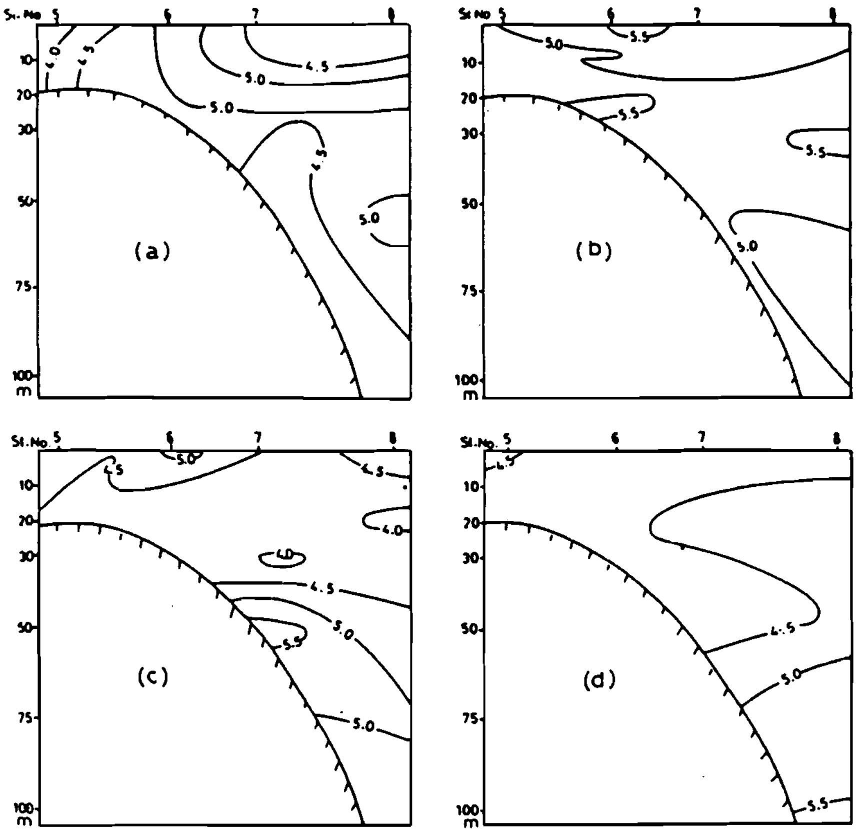

Fig. 4. Vertical distribution of dissolved oxygen (ml/L) at El-Alamein section during:
(a)Winter (b)Spring (c)Summer (d)Autumn.

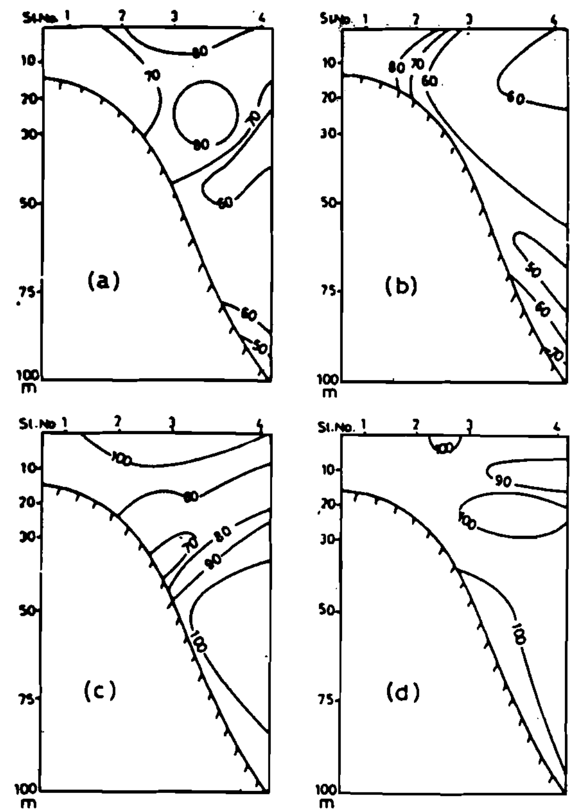

Fig. 3. Vertical distribution of oxygen percentage saturation (%) at El-Mex section during:
(a)Winter (b)Spring (c)Summer (d)Autumn.

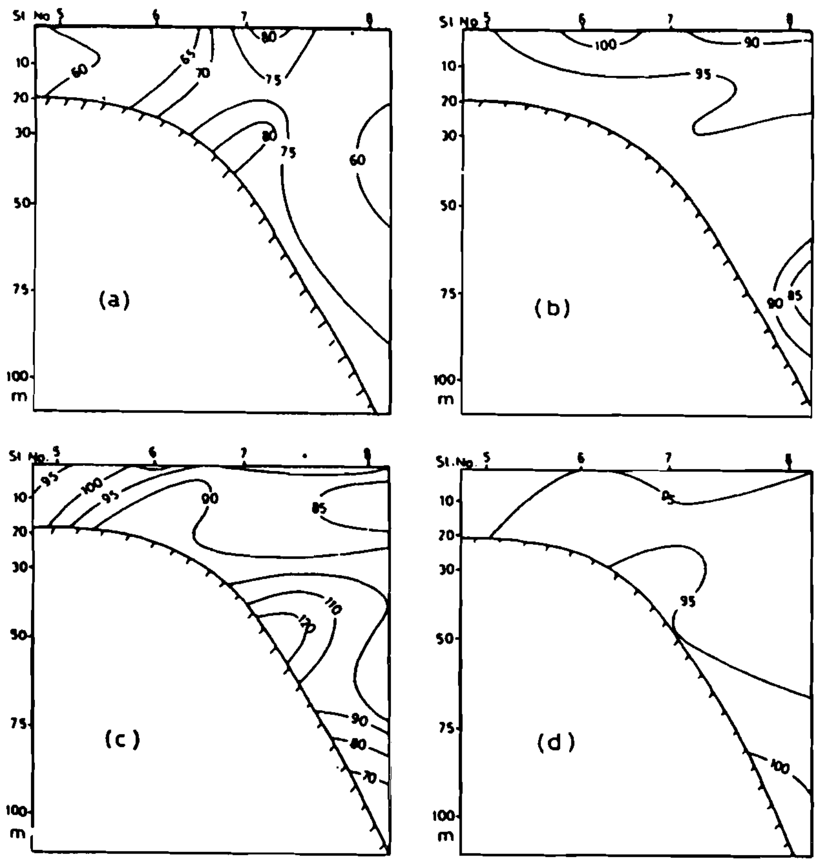

Fig. 5. Vertical distribution of oxygen percentage saturation at El-Alamein during: (a)Winter (b)Spring (c)Summer (d)Autumn.

(38.08 - 38.21%°) at these depths. On the other hand undersaturation of oxygen (50-90%) was observed during winter and spring months. This may be attributed to oxygen consumption due to insitu decomposition of organic matter as well as industrial wastes that are more pronounced at El-Mex region (Figs. 3a,b) than at Alamein.

Nutrient salts

The vertical distribution of inorganic phosphate, silicate and nitrate in different seasons are given in Figs. 6-10. Exception for silicate, the concentration of plant nutrients at the surface and at 100 meter depth were very low.

The concentration of silicate showed complete depletion at both sections, during winter monthes, the highest concentration was recorded in October

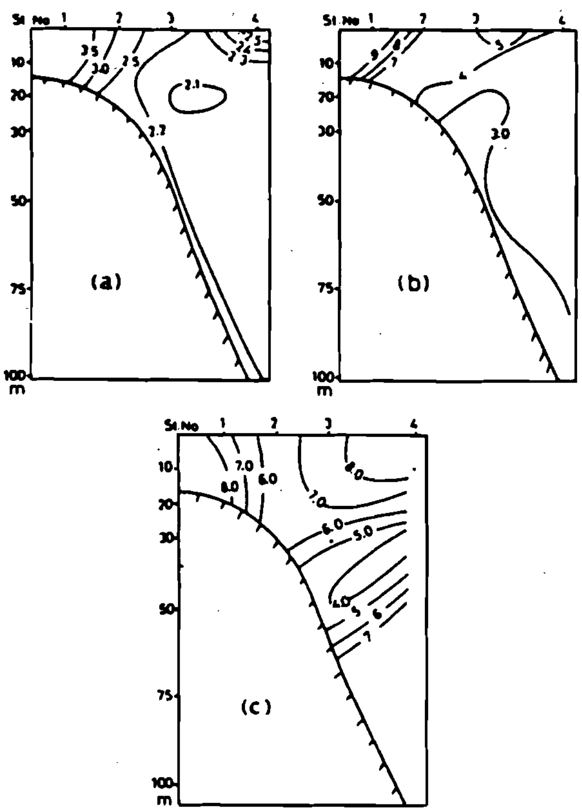

Fig. 7. Vertical distribution of silicate (µg atl) at El-Mex during:
(a)Spring (b)Summer (c)Autumn.

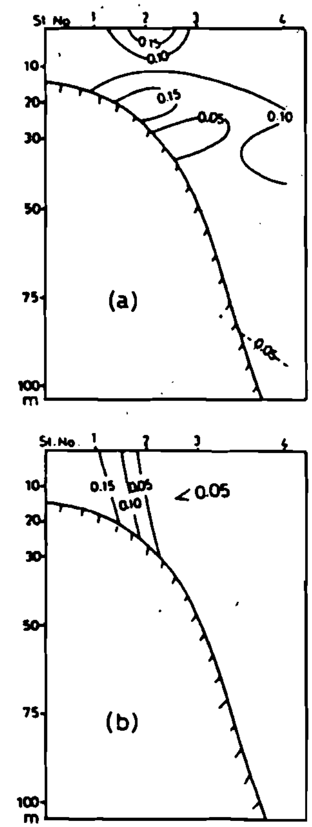

Fig. 6. Vertical distribution of phosphate (µg at/l) at El-Mex during:
(a)Spring (b)Summer.

(Fig. 8) at Alamein section (7.6 ug-at Si / l) and in June (Fig. 7) at El-Mex (9.5 ug-at Si / l).

The inshore water showed slightly higher concentration of nutrients with the exception of silicate (Table II) than the offshore water during autumn season and that can be attributed to the effect of land drainage. This is also confirmed by the strong negative correlation between salinity and silicate (r = 0.80 - 0.86) during spring and autumn seasons where silicate increases with decreasing salinity.

The fresh water discharge from El-Ummum drain showed good positive correlation (r = 0.78) with nitrate ion. Like silicate, salinity also showed very strong negative correlation with inorganic phosphate indicating that with decreasing salinity under the effect of land drainage and discharge water from El-Ummum drain, the concentration of plant nutrient increases. The correlation between phosphate, silicate and nitrate was generally strong (r = 0.63 - 0.92) with positive sign.

Harvey (1926) pointed out that phytoplankton simultaneously utilize phosphate and nitrate and they should vary in the same way and the N:P ratio should remain constant in water and organisms (on an atom basis it has a value of 15:1) although exceptions do exist, especially in restricted and/or surface waters. In the North Atlantic, Richards (1958) found at intermediate depth, the ratio Si:N:P = 16:16:1.

In the area of El-Mex and El-Alamein the ratio N:P by atom (Table III) do not show any agreement with the ratio of Harvey or Richards. The low ratio of N:P (4:1) which was recorded in all seasons indicates a faster assimilation of nitrate than for phosphate. On the other hand, the very high ratio Si:P (except winter season) indicates a slackening of phytoplankton and regeneration of Silicon. In Alexandria water, El-Rayis (1973) obtained nearly similar results for N:P , however, for the ratio Si:P his recorded values were generally high (17-55 : 1) but still lower than the present observations.

The available data revealed that the rate of depletion of phosphate ions from autumn till winter which was 6.044 x 10^{-8} ug. l^{-1}.sec.$^{-1}$, while its rate of regeneration from spring till summer was calculated to be 1.787 x 10^{-7} ug.l^{-1}. sec.$^{-1}$. Thus, the rate of depletion of phosphate was 0.34 the rate of its regeneration in this area.

Oxidizable Organic Matter

The distribution of dissolved organic matter (Figs. 11,12) showed that it varied in the whole area from a minimum of 0.30 mg O_2/l in April to a maximum of 4.20 mg O_2/l in February.

The inshore waters were richer in organic matter than the offshore waters during winter and autumn seasons (Table 4). In addition, the deeper or bottom

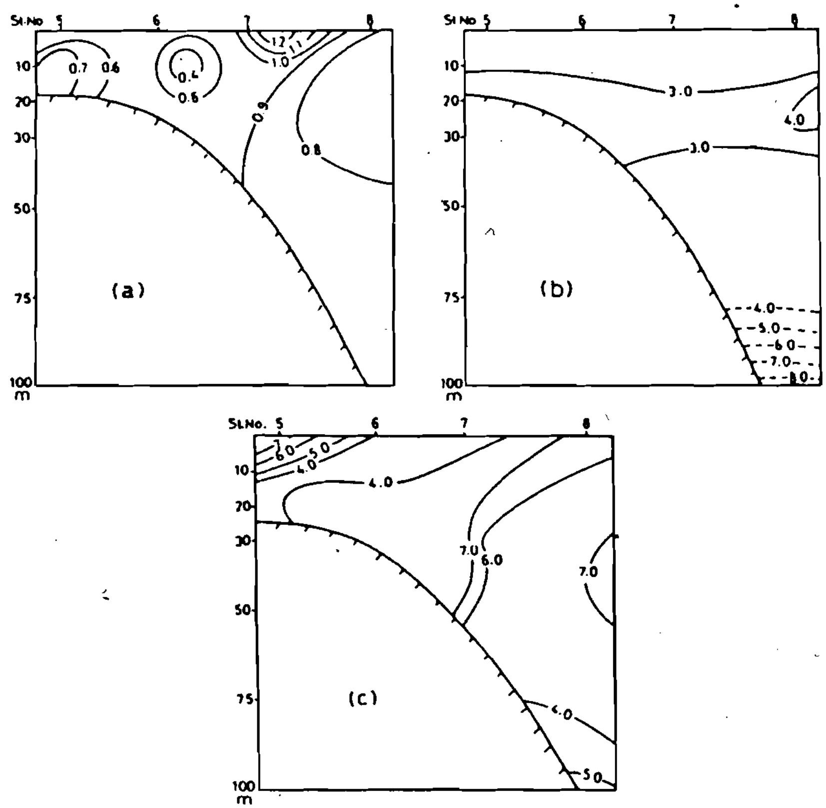

Fig. 8. Vertical distribution of silicate (μg ar/l) at El-Alamein during:
(a)Spring (b)Summer (c)Autumn

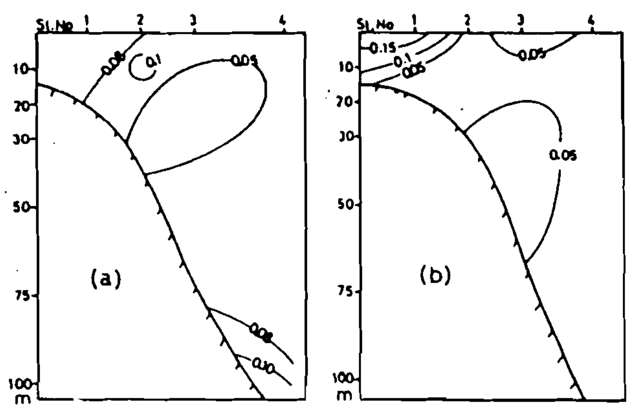

Fig. 9. Vertical distribution of nitrate
(μg at/l) at El-Mex during:
(a)Winter (b)Spring.

TABLE 2

SEASONAL AVERAGE CONCENTRATIONS OF NUTRIENT SALTS (ug-at/l) AT INSHORE AND OFFSHORE STATIONS OF EL-MEX AND EL-ALAMEIN.

Nutrient Salts		SEASON Winter	Spring	Summer	Autumn
PO_4^{---}	Inshore	0.02	0.05	0.16	0.50
	Offshore	0.02	0.04	0.02	0.02
NO_2^-	Inshore	0.01	0.04	0.05	0.01
	Offshore	0.01	0.03	0.03	0.00
NO_3^-	Inshore	0.06	0.13	0.05	0.05
	Offshore	0.04	0.04	0.01	0.04
SiO_3^{---}	Inshore	0.00	4.26	7.4	7.4
	Offshore	0.00	3.79	3.3	8.51

TABLE 3

SILICON: NITROGEN: PHOSPHORUS RATIOS IN THE AREA WEST OF ALEXANDRIA DURING 1977.

Season	Silicon	Nitrogen	Phosphorus
Winter	0.0	3	1
Spring	81.4	3	1
Summer	133	4	1
Autumn	170	2	1

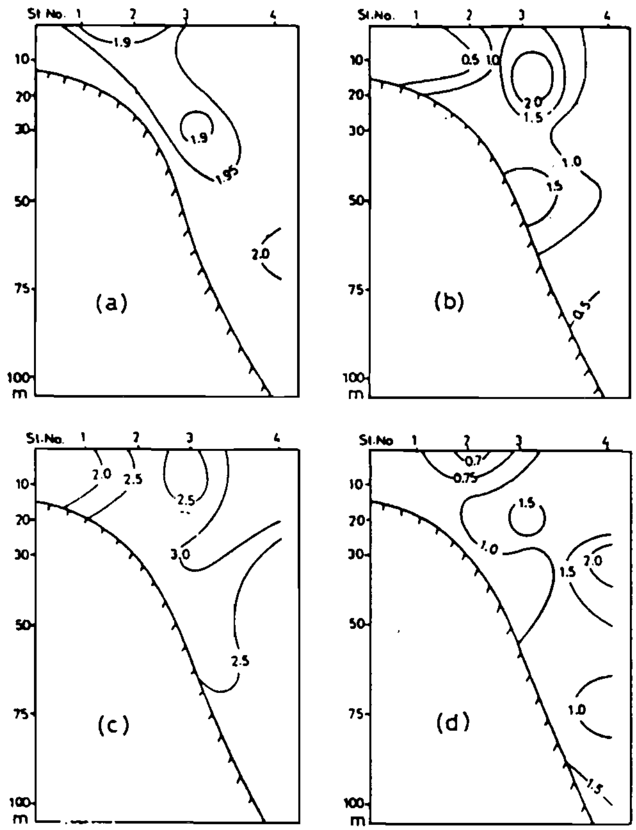

Fig. 11. Vertical distribution of oxidizable organic matter ($mg\ O_2\ /l$) at El-Mex during: (a)Winter (b)Spring (c)Summer (d)Autumn.

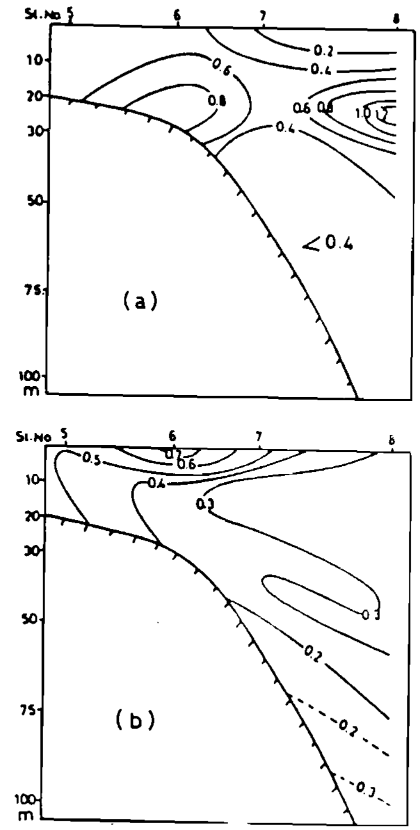

Fig. 10. Vertical distribution of nitrate (µg at/l) at El-Alamein during: (a)Spring (b)Summer.

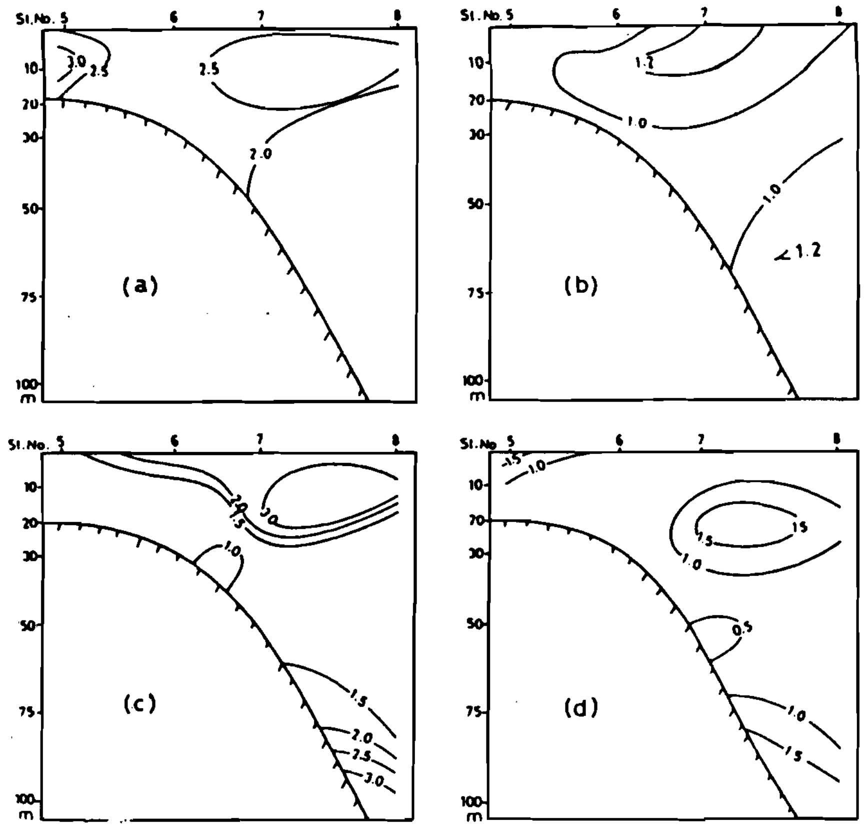

Fig. 12. Vertical distribution of oxidizable organic matter ($mg\ O_2/l$) at El-Alamein during:
(a)Winter (b)Spring (c)Summer (d)Autumn.

water was higher in organic content by 1.28 times than the surface water (except during winter season). This can be attributed to mixing with the bottom sediments which contain higher level of organic matter.

In the Egyptian Mediterranean water, Emara (1973) found surface values up to 1.13mg O_2/l during summer season, which is nearly 1/4 the values in the present investigation.

The higher concentration of organic matter is mainly due to water discharging from Ummum drain as well as chemical pollution of organic origin.

Oxidizable organic matter showed strong negative correlation with temperature (r = - 0.75) and nitrate ions (r = - 0.87) during spring and summer

TABLE 4
AVERAGE CONCENTRATION OF OXIDIZABLE ORGANIC MATTER AS (mgO_2/l) AT THE INSHORE AND OFFSHORE WATER AND AT SURFACE AND 100 m DEPTH

	SEASON			
Type of water	Winter	Spring	Summer	Autumn
Inshore water	1.96	1.44	1.56	1.20
Offshore water	1.66	1.55	2.00	0.96
Surface water	1.98	1.46	2.01	0.89
100 meter	1.76	1.87	2.76	1.73

TABLE 5
AMOUNT OF O_2 NECESSARY FOR OXIDATION OF ORGANIC MATTER TOGETHER WITH THE AMOUNT PRESENT AFTER COMPLETE OXIDATION.

Season	Organic matter mg O_2/l	Dissolved Oxygen mg/l	Oxygen necessary for complete oxidation mg/l	% of O_2 present after oxidation
Winter	2.05	5.75	2.55	55.6
Spring	1.34	6.38	1.67	73.8
Summer	2.21	6.33	2.75	56.6
Autumn	1.05	6.54	1.31	80.0

seasons respectively. If organic material is formulated as $(CH_2O)_{106}(NH_3)_{16}$ H_3PO_4, then the normal oxidation of organic material in sea water by oxygen can be represented by the equation (Richards 1965)

$$(CH_2O)_{106}\ (NH_3)_{16}\ H_3PO_4 + 138\ O_2$$

$$106\ CO_2 + 122\ H_2O + 16\ HNO_3 + H_3PO_4.$$

Thus the complete oxidation of organic matter associated with one atom of phosphorus requires 276 atoms of oxygen. This equation enables one to calculate the amount of oxygen necessary for complete oxidation of organic material in the investigated area (Table 5).

In view of the previous assumtion, the amount of oxygen calculated after complete oxidation of organic matter in the area west of Alexandria varies from 56 to 80% throughout the year indicating that the water is well aireated even after oxidation of all organic matter present.

CONCLUSION

Supersaturation of oxygen at subsurface levels was mainly due to photosynthesis and to Atlantic current entering the Mediterranean through the strait of Gibralter.

Undersaturation was more pronounced at El-Mex section due to industrial pollution.

The concentrations of nutrient salts showed low concentration, however, the inshore water showed slightly higher concentration than the offshore water due to discharge of fresh water from El-Ummum Drain.

The concentration of oxidizable organic matter is higher in the coastal area than the offshore area, in addition, the deeper or bottom water is rich in organic content than the surface water.

The area west of Alexandria is well aireated even after complete oxidation of organic matter.

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