

DISTRIBUTION OF OXYGEN AND NUTRIENT SALTS IN THE QATARI WATERS

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ABSTRACT

The horizontal and vertical distribution of oxygen and the nutrient salts concentrations as well as the atomic ratios of the elements P: N: Si in the Qatari waters during 1984 were discussed. The mean concentration of dissolved oxygen was higher in February than that of July or December. The vertical distribution of oxygen showed more or less uniform values in February which were asserted by its small vertical gradient. The concentrations of inorganic nitrogen species and silicates were higher in February by two fold than that of July. The atomic ratio of P: Si was close to normal values (1:15) except in February which was considerably high. The ratio P: N was very low with the exception of the coastal area of the southeastern section of the Qatari waters.

INTRODUCTION

The significance of oxygen and nutrients in the sea, especially of phosphate, silicate and inorganic nitrogen species, is well recognised in understanding the diversities exhibited in the distribution of marine population in space and time and also in characterizing the water masses and their movements in conjunction with other physical oceanographic parameters.

The marine environment of the Gulf in general and of Qatar in particular has very special geographical and meteorological conditions. In view of this fact and because of the little available information about the oxygen and nutrients in the Qatari waters; it is felt that enriching and studying such information in different periods of the year, may help in understanding the chemical properties of the Qatari waters.

MATERIAL AND METHODS

More than 770 water samples were collected at 16 sampling stations located between $24^{\circ} 30' N$ and $27^{\circ} 00' N$ (Fig. 1), during February, July and Decembers of the year, 1984 using R/V Mukhtabar Al-Bihar.

The water samples were collected at the standard depths 0, 10, 20, 30, 40 and 50 meters by Nansen bottles provided with reversing thermometers.

Dissolved oxygen, inorganic phosphate, silicate, nitrate, nitrite and ammonia were determined according to Strickland and Parsons (1968). The oxygen percentage saturation was calculated on the basis of international oceanographic tables (Anonymous, 1972).

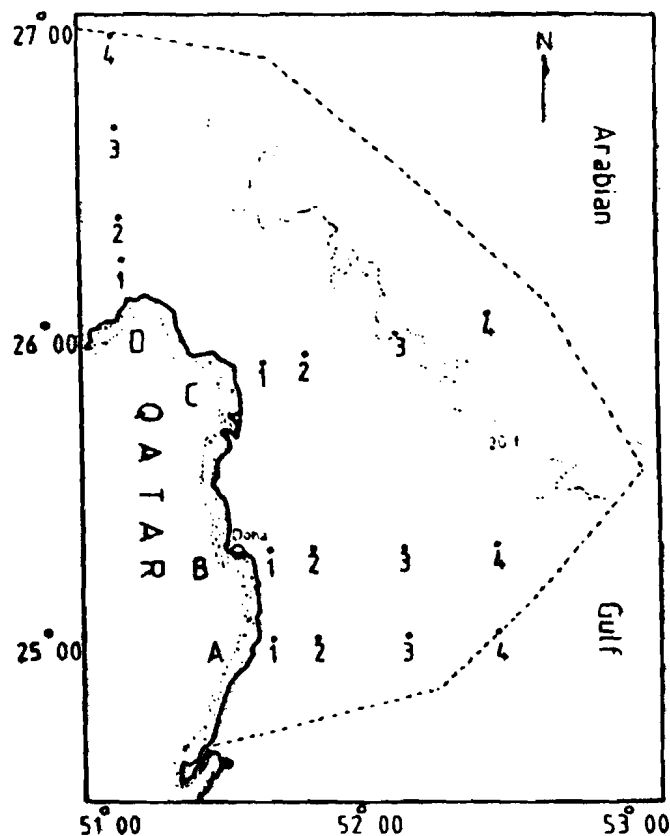


FIG. 1.
Area of investigation and locations of stations

RESULTS AND DISCUSSION

The horizontal distribution of dissolved oxygen at the surface, showed that it varied in time and place throughout 1984. Local variation with high oxygen content up to 5.56 ml/l, 106 % saturation were observed in front of Doha section during February (Fig. 2). The other areas showed values below 5 ml/l. In December, there was a tendency of oxygen to decrease from south to north, particularly in section D, where the oxygen decreased from 4.2 to 3.6 ml/l (Fig. 3). On the other hand, observations of July (Fig. 4) showed a reverse trend in distribution. Moreover, the coastal area of the southern part (section A) showed low oxygen concentration (3.52 ml/l - 87 % saturation) during the study period, that can be attributed to the consumption of oxygen by industrial wastes characterizing that section.

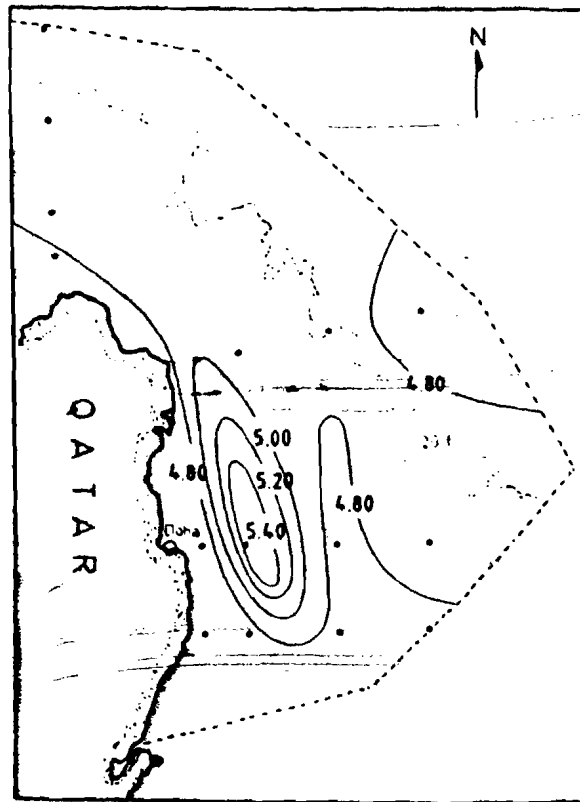


FIG. 2.
Horizontal distribution of Oxygen ml/l at the
surface, February 1984.

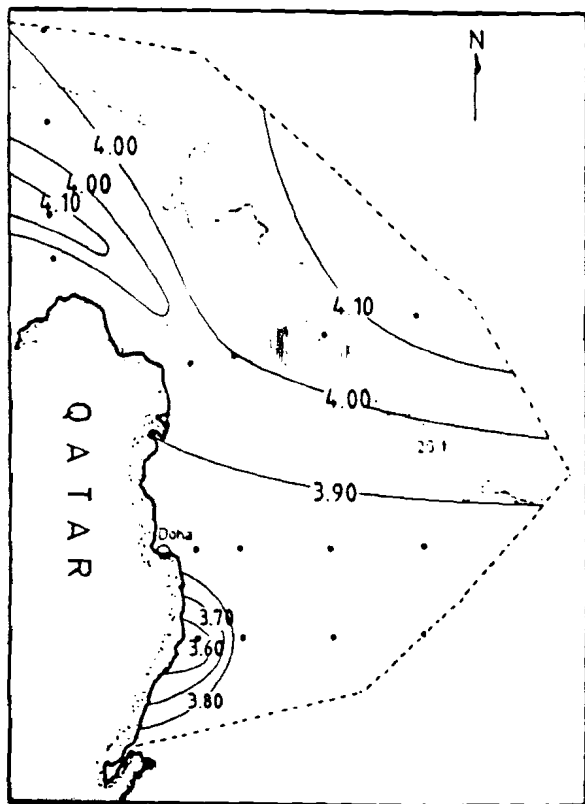


FIG. 4.
Horizontal distribution of Oxygen ml/l at
the surface, July 1984.

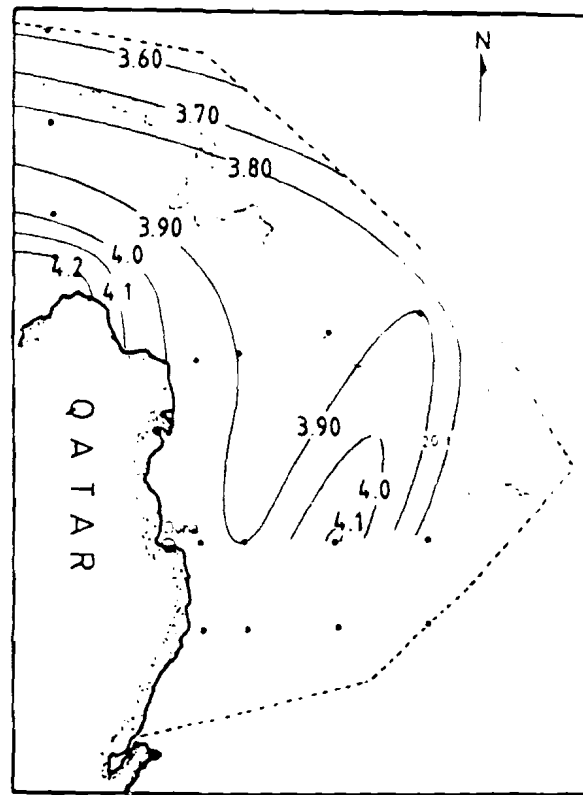


FIG. 3.
Horizontal distribution of Oxygen ml/l at the
surface, December 1984.

The vertical distribution of dissolved oxygen in February as well as in December did not show marked variations with depth. In February and under the influence of convection intermixing; the water columns showed comparatively uniform oxygen values which were asserted by their small vertical gradients (2.8×10^{-3} - 6.5×10^{-3} ml.l⁻¹.m⁻¹). On the other hand, in July (Fig. 5), the deeper stations (c and d) showed a decreased trend by increasing depth, and the calculated oxygen gradient varied from 8.0×10^{-3} to 11.6×10^{-3} ml.l⁻¹.m⁻¹, from surface to bottom. The rate of oxygen loss from February till July at the surface and near the bottom water was found to be 8.0×10^{-8} and 8.7×10^{-8} ml.l⁻¹.sec⁻¹, respectively. From July till December the oxygen gain at the surface and near the bottom was very small 5.0×10^{-9} ml.l⁻¹.sec⁻¹. Due to lack of information during the period, December - February, in which the oxygen gain is expected to be considerably high due to decrease in temperature and water agitation, the oxygen gain was not calculated. However, Emara et al. (1985), found that the rate of oxygen gain in the waters in front of Doha city throughout the water column was seven fold higher than the oxygen loss.

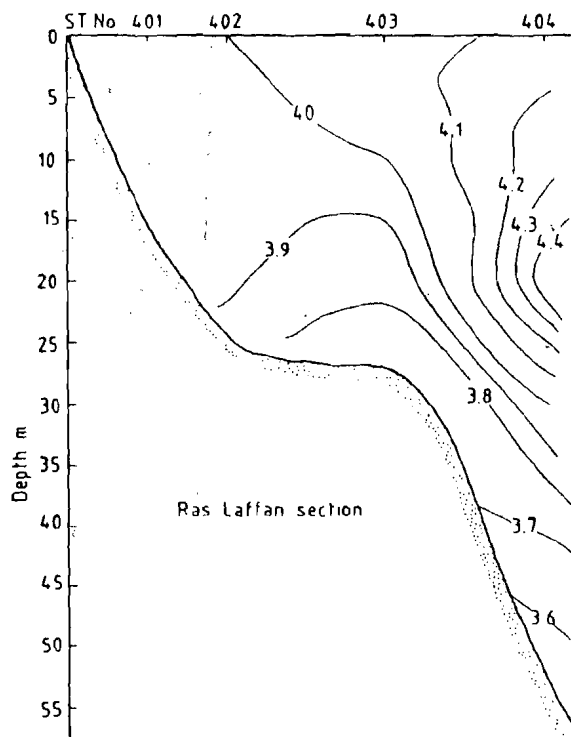


FIG. 5.
Vertical distribution of Oxygen ml/l at
section C, July 1984.

The distribution of phosphate at the surface waters in the different seasons of 1984 is presented in Figs. 6 & 7. The concentration varied from 0.01 to 1.44 ug at/l with a mean value of 0.22 ± 0.10 ug at/l. In February (Fig. 6) there was a tendency for phosphate to increase in a seaward direction with a horizontal gradient of 3.2×10^{-6} ug at $l^{-1} \cdot m^{-1}$, while in July there was no distinct trend in the distribution. In December the coastal stations of section B and C showed very high concentration of phosphate (Fig. 7) and the values decreased in a seaward direction at a rate of 1.99×10^{-5} ug at $l^{-1} \cdot m^{-1}$.

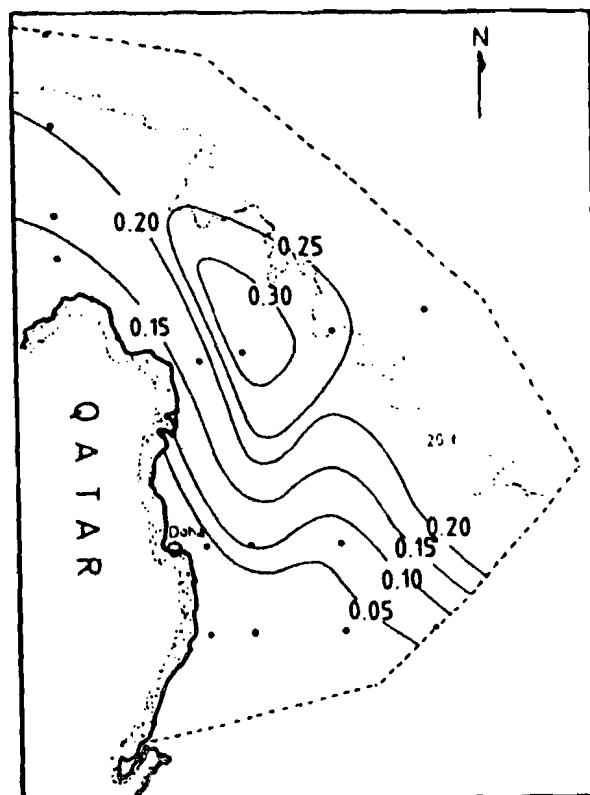


FIG. 6.
Horizontal distribution of inorganic phosphate
ug-at/l at the surface, February 1984.

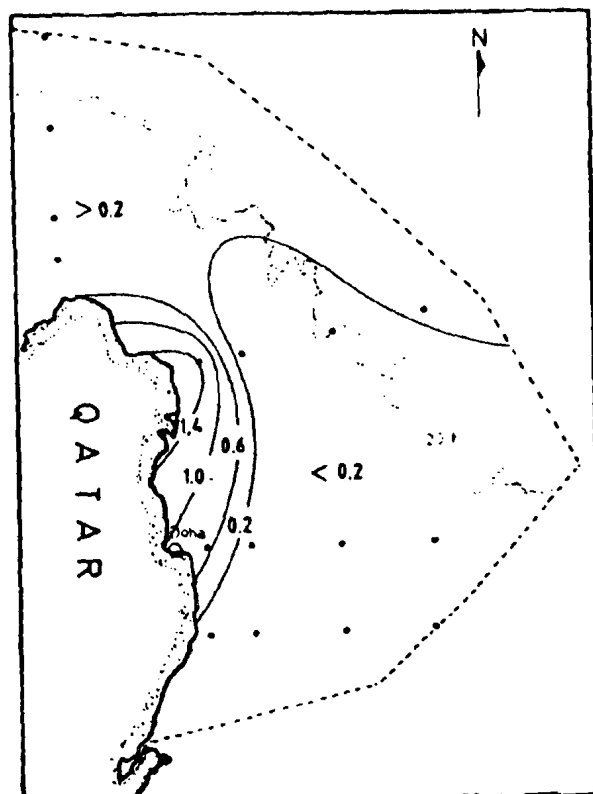


FIG. 7.
Horizontal distribution of inorganic phosphate
ug-at/l at the surface, December 1984.

The concentration of silicate fluctuated between 2.15 and 6.81 ug at/l with a higher value in February (5.91 ± 0.22 ug at/l) compared to July (2.96 ± 0.13 ug at/l) and December (3.59 ± 0.22 ug at/l). In July and December, the general trend of distribution showed a decrease in concentration away from the coast, then increased again (Figs. 8 & 9). The same trend was also observed in February (Fig. 10) but with a tendency of concentration to increase, particularly at the northern part all the way in an offshore direction at a rate of 2.8×10^{-5} ug at $l^{-1} \cdot m^{-1}$.

Riley and Chester (1971) pointed out that the regeneration of silicon commences during summer when phytoplankton growth slackens, and continues until the maximum value is attained in early winter. The present observation showed that the maximum value for silicate is attained in late winter with a rate of regeneration of 4.5×10^{-8} ug at $l^{-1} \cdot sec^{-1}$.

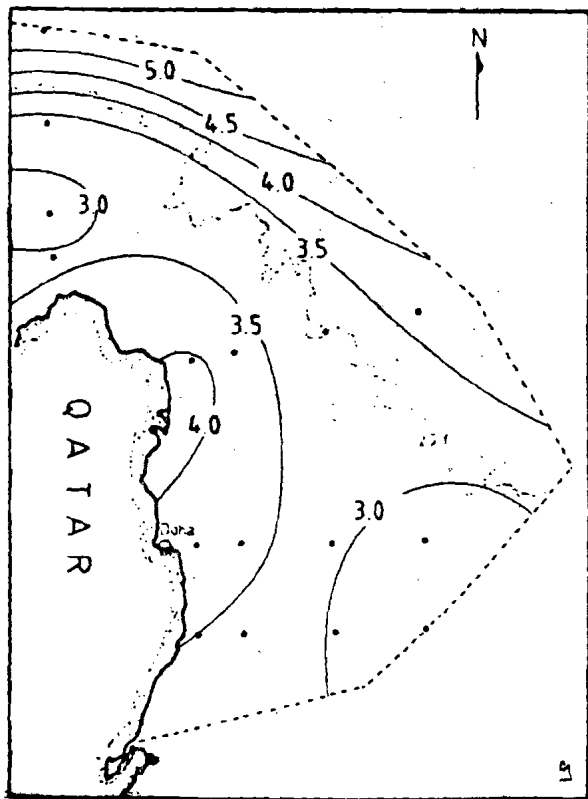


FIG. 9.
Horizontal distribution of silicate $\mu\text{g-at/l}$
at the surface, December 1984.

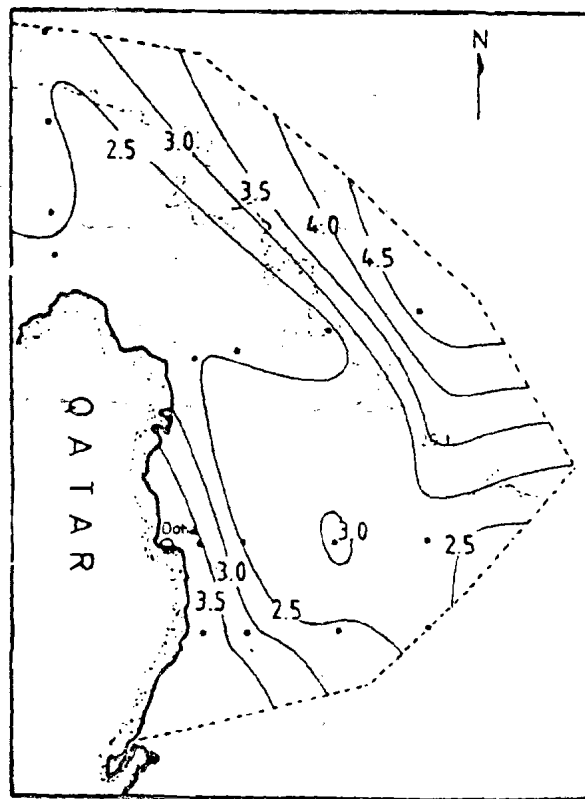


FIG. 8.
Horizontal distribution of silicate $\mu\text{g-at/l}$
at the surface, July 1984.

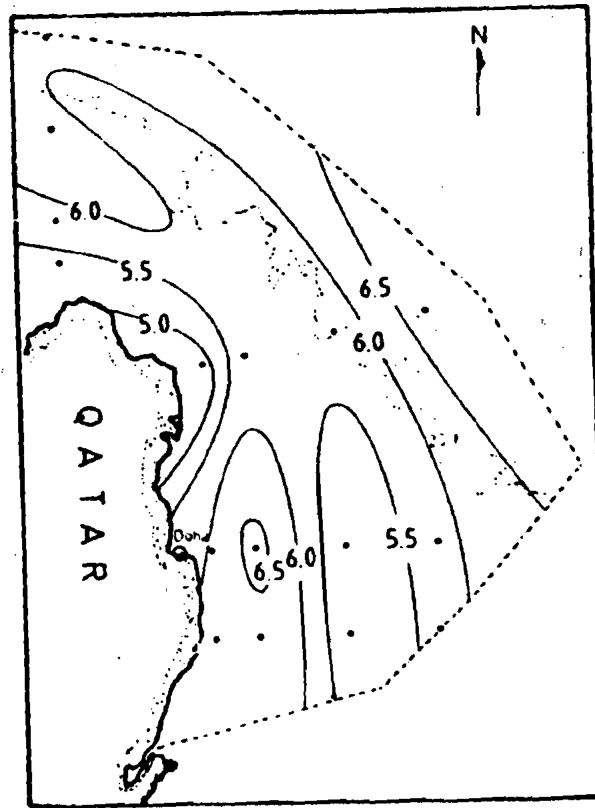


FIG. 10.
Horizontal distribution of silicate ug-at/l
at the surface, February 1984.

The concentrations of inorganic nitrogen species at the surface water showed low values (0.06-0.52 ug at/l) for nitrate, and from undetectable concentration to 0.3 ug at/l for nitrate and 0.47 ug at/l for ammonia. Like silicate; the concentration of nitrate also showed an increase in a sea ward direction (Fig. 11).

The vertical distribution of nutrient salts did not show marked variations with depth except for the deeper stations C₄ and D₄, where the level of nitrate and nitrite showed an increase 13 and 15 fold between the surface and the near bottom waters. This significant increase in nutrient salts could have come from the decomposition of easily oxidizable organic matter which was associated with low oxygen content (3.57-3.61 ml/l, 75-86 %) at this depth (Fig. 12).

Reviewing the data available on oxygen and nutrients in the Gulf, Kuronuma (1974) reported concentrations for Qatari waters similar to the present work. Jacob et al. (1982) reported higher values (4.14-6.78 ml/l) for oxygen,

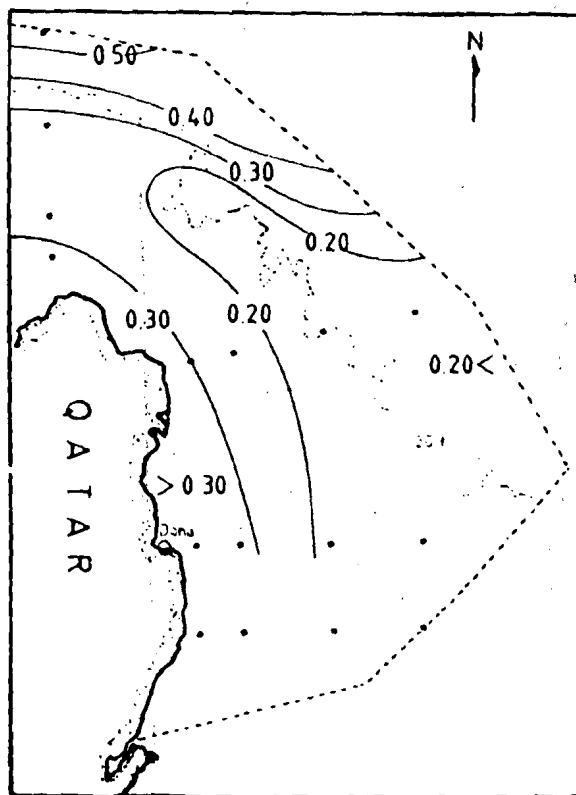


FIG. 11.
Horizontal distribution of nitrate ug-at/l
at the surface, December 1984.

(0.81-2.26 ug at/l) for phosphate, (8.21-24.28 ug at/l) for silicate, (6.5-22.1 ug at/l) for nitrate and (1-4.29 ug at/l) for nitrite in the surface waters along the southeast coast of Kuwait. Meanwhile, in the adjacent Arabian Sea waters, Sankaranarayanan and Reddy (1970) recorded phosphate concentration four fold higher than the Qatari waters.

Many authors, are of the opinion that the best N : Si : P ratio necessary for healthy diatom growth is about 15:15:1. In various parts of the Gulf, there is no available date concerning the mentioned ratio except that of Emara et al. (1985) who stated values of 2:31:1 and 6:68:1 during summer and winter respectively, in front of Doha city. The calculated atomic ratio of the elements N:Si:P in different sections of the Qatari waters during 1984 is presented in Table 1. The ratios are nearly similar in July and December, but with a higher value in February. In Qatar

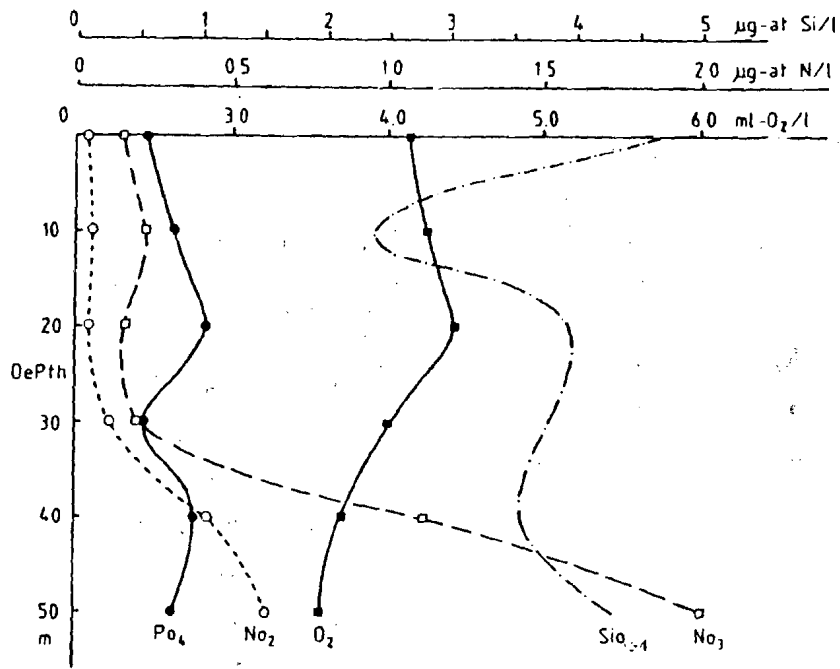


FIG. 12.
Vertical distribution of oxygen (ml/l) and
nutrient salts ($\mu\text{g at/l}$) at station C_4 in July 1984.

water, the ratio Si:P was close to normal (16:1), except that of February which was high (Fig. 13), while the ratio N:P was generally below 4 indicating that the inorganic nitrogen species is probably the limiting element, not phosphorus (Emara et al, 1985). The nitrate-phosphate relationship (Fig. 14) also showed low values, particularly in July where it reached (0.86-3.40 : 1). On the other hand, the area of Umm Saiid showed the highest ratio for N:P (15.1) probably resulting from the water discharged from the Qatar Fertilizer Company containing urea and ammonia at a rate of 175 and 245 ton/month, respectively.

CONCLUSION

In Qatar water, dissolved oxygen shows a uniform vertical distribution, asserted by its small vertical gradient, and higher concentration value in February 1.3 fold that of July and December.

The seasonal variations of the nutrient salts were not clear in this oligotrophic water, however, the concentrations of inorganic nitrogen species and silicate were higher in February by two fold than in July.

TABLE 1.
Atomic ratios P: N: Si at different parts of
the Qatari waters during 1984.

Section, and area	Month	Atomic ratio		
		P	N	Si
Section A,	February	1	15.7	194.0
Umm Saïid	July	1	3.4	29.5
Section B	February	1	5.7	63.2
Doha	July	1	1.6	21.9
	December	1	2.4	20.9
Section C	February	1	2.3	23.0
Ras Lafan	July	1	1.8	11.6
	December	1	1.4	13.1
Section D	February	1	3.2	31.1
Ras Reken	July	1	0.9	13.2
	December	1	2.8	15.1
The whole	February	1	3.8	40.7
area	July	1	1.7	16.4
	December	1	2.1	15.6

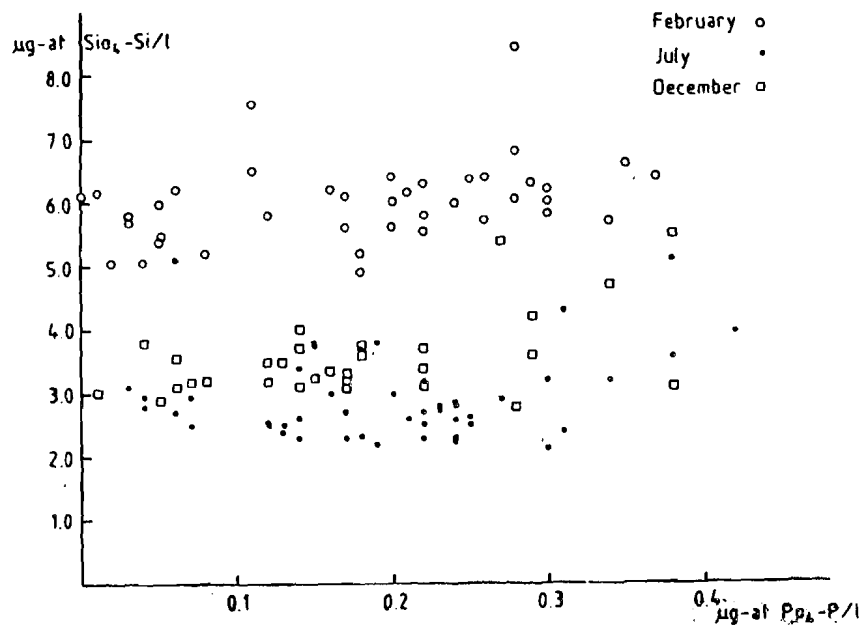


FIG. 13.
Phosphate-silicate relationship during 1984.

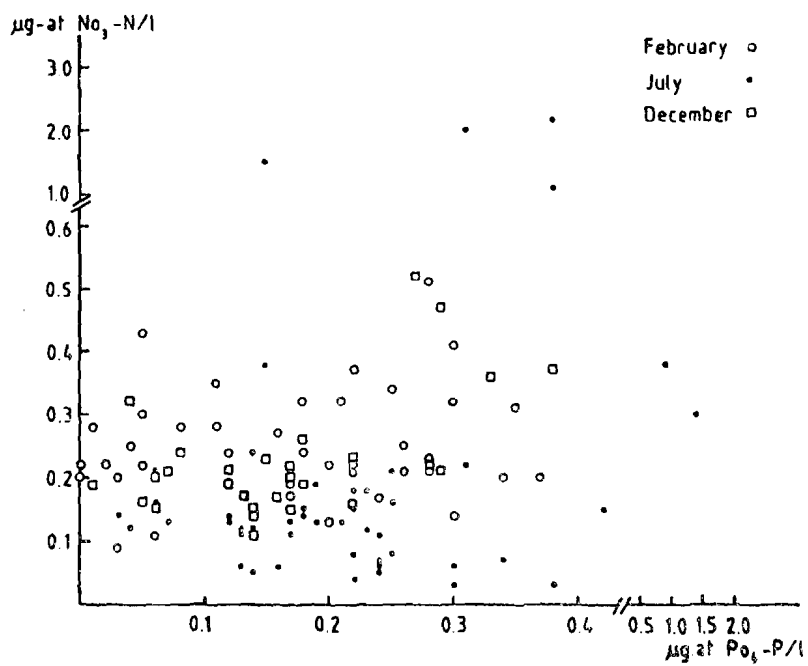


FIG. 14.
Phosphate-nitrate relationship during 1984.

Unlike that of the temperate regions, the ratio between silicon, nitrogen and phosphorus is highly variable. This variation may presumably be due to the differential and rapid rates of regeneration and consumption of nutrients accompanied by extensive mixing of water masses which seems to be a characteristic feature of tropical waters.

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**ADSORPTION OF DISSOLVED ORGANIC CARBON (DOC) ON GLASS
FIBER FILTERS DURING PARTICULATE ORGANIC CARBON (POC)
DETERMINATION**

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ABSTRACT

The amount of adsorbed dissolved organic carbon (DOC) onto glass fiber filters during samples filtration for particulate organic carbon (POC) determination was quantified. Adsorbed DOC reached >50% of POC observed on filters. DOC adsorption is a function of the quality and quantity of filtered samples.

INTRODUCTION

The methods used for determination of dissolved organic carbon depend mainly on filtering a known volume of water sample through precombusted glass fiber filter. The retention capacity of such filters is significantly high due to their formation of thick glass fiber mats possessing large surface area thus retaining finer particles than the nominal pore size of the filter.

MATERIAL AND METHODS

During determination of DOC, an attempt was made to check the optimal analytical conditions and complete recovery of this fraction during and post to filtration step. The question is: does the measured amount of POC actually represents POC or POC in addition to DOC adsorbed onto glass fiber filters? To solve this problem, an experiment was performed where different volumes of sea water samples, chosen to represent eutrophic (A) as well as oligotrophic (B) environments, were filtered. Filtration was through five precombusted (450°C for 4 hrs.) glass fiber filters (Whatmann type GF/C, 0.45 μ m) placed in a single holder. Filters containing particulate material were placed in a 10 ml pre-combusted glass ampoules containing 0.2 gram of $K_2S_2O_8$, 0.5 ml of 6% phosphoric acid and 10 ml of organic free deionized distilled water. Filter blanks were carried out in quadruplicates to which the previously mentioned

reagents were added. All ampoules were sealed with specially designed Model 524 PS purging and sealing unit. The CO₂ content of each ampoule was determined using an O. I. C. non dispersive infrared carbon analyzer (IR) Model 524 D following the wet-combustion technique of Menzel and Vaccaro (1964) modified by Fredericks and Sackett (1970).

RESULTS AND DISCUSSION

The data, expressed as ug C/filter \pm standard deviation, observed for triplicate sample determinations are recorded in Table 1. Results represent the total organic carbon on filters uncorrected for blanks (average 8.4 ± 0.7 ug C/filter). However, values for the top filter (after blank subtraction) represent the real POC (ug C/filter) for the

TABLE 1.
Values of organic carbon retained on glass fiber filters during filtration of different water types and volumes.

Location	Filter	Volume filtered (liters)	ug C/filter* \pm S.D.	Average Ad. DOC/POC‡
Eastern Harbour of Alexandria (A)**	1	0.5	52.3 \pm 3.2	34%
	2	0.5	18.1 \pm 0.4	
	3	0.5	17.6 \pm 1.6	
	4	0.5	17.6 \pm 1.9	
	5	0.5	16.8 \pm 0.5	
	1	1	92.1 \pm 6.5	25%
	2	1	28.4 \pm 2.6	
	3	1	22.2 \pm 1.2	
	4	1	21.6 \pm 2.0	
	5	1	21.3 \pm 1.8	
Agami (20 Km offshore) (B)**	1	5	22.5 \pm 4.1	53%
	2	5	12.6 \pm 1.3	
	3	5	11.9 \pm 1.9	
	4	5	11.5 \pm 1.0	
	5	5	11.7 \pm 0.9	
	1	10	38.2 \pm 4.8	39%
	2	10	15.9 \pm 1.9	
	3	10	14.4 \pm 1.8	
	4	10	14.6 \pm 2.4	
	5	10	14.7 \pm 1.7	

* Values not corrected for filter blanks (8.4 ± 0.7 ug C/filter)

** Mean chlorophyll a for eutrophic and oligotrophic waters are 9 and 0.1 mg/m, respectively.

samples; while, on the other hand, the subtraction of filter blanks from the mean values of the second to the fifth filters yields the amount of adsorbed DOC on the filters.

The mean adsorbed DOC values for the eutrophic samples were 9.2 and 15 ug C/filter for 0.5 and 1 liters while those for oligotrophic waters were 3.5 and 6.5 ug C/filter for 5 and 10 liters, respectively. The increase of adsorbed DOC fraction with increasing sample volume is opposed by a remarkable decrease in the relative contribution of adsorbed DOC to the POC observed on the top filter (Table 1). This indicates the magnitude of adsorbed DOC in oligotrophic than eutrophic waters.

However, increasing adsorbed DOC levels with increasing volume implies that adsorption sites in case of small volume samples were not fully saturated with adsorbed DOC. The increase of sample volume to 1.25 (for eutrophic) and 12 (for oligotrophic) liters showed equal or even less values for adsorbed DOC than those observed in case of one and ten liters indicating that these volumes could be considered as maximum adsorption limit volumes for such waters. Blockage or saturation of filtering sites was probably reached.

The loss of DOC through adsorption on glass fiber filters during this experiment affected the levels of DOC in the filtered samples determined by the same technique. Between 10% and 20% of DOC were lost during filtration steps. This depends mainly on the type of water and amount of sample filtered. It is therefore recommended to increase the volume of filtered samples (1.0 liter for eutrophic and 10 liters for oligotrophic waters), to eliminate as possible problems caused by DOC adsorption onto glass fiber filters thus increasing POC values and in the mean-while lowering the loss in DOC from filtered samples.

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