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CHEMICAL CONDITIONS IN BARDAWIL LAGOON IV - NUTRIENT SALTS

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ABSTRACT

Water samples were collected from the Bardawil lagoon during the period from August 1985 to November 1986 for studying the distribution of nutrients. Nitrite showed a depletion nearly the year-round. Silicate was present only during summer, Ammonia showed a slight decrease towards the bottom, while nitrate showed a reverse pattern. The low N:P ratio (3:1) or (6 & 4 :1) indicates a faster assimilation of nitrate than of phosphate. The high ratio Si: P (35 : 1) and (23 :1) for both surface and bottom waters respectively indicates a stackening of diatom and regenration of silicate.

INTRODUCTION

The ecosystem of Sabkhet El-Bardawil has been described elsewhere (Yitzhak, 1971; Siliem, 1989 a & b). Mediterranean Sea water inflows through Bughase I at the western arm. Bughase II was dugout during the period of this study at the eastern arm (Fig. 1). No streams flow into the Lagoon.

MATERIAL AND METHODS

Twelve stations covering the whole Lagoon were selected (Fig. 1). Water samples were collected at the surface and at the layer overlying the Lagoon's bottom by means of a standard water sampler (Ruttner sampler). Samples were analysed for ammonia, nitrite, nitrate, phosphate and silicate. These nutrients were determined according to Anon. (1965).

RESULTS AND DISCUSSION

The concentration of ammonia in the investigated area showed considerable variations and rapid changes (Fig. 2). The seasonal average values of ammonia in the Lagoon water ranged from 19.08 41.48 ug/l at surface to 16.64 - 37.76 ug/l at the subsurface layer. While the annual variations were 24.71 ug/l and 22.5 ug/l at the surface and near the bottom respectively. The ammonia content decreased downward. In addition, ammonia increased during summer (high temperature) and decreased in the other seasons (low temperature).

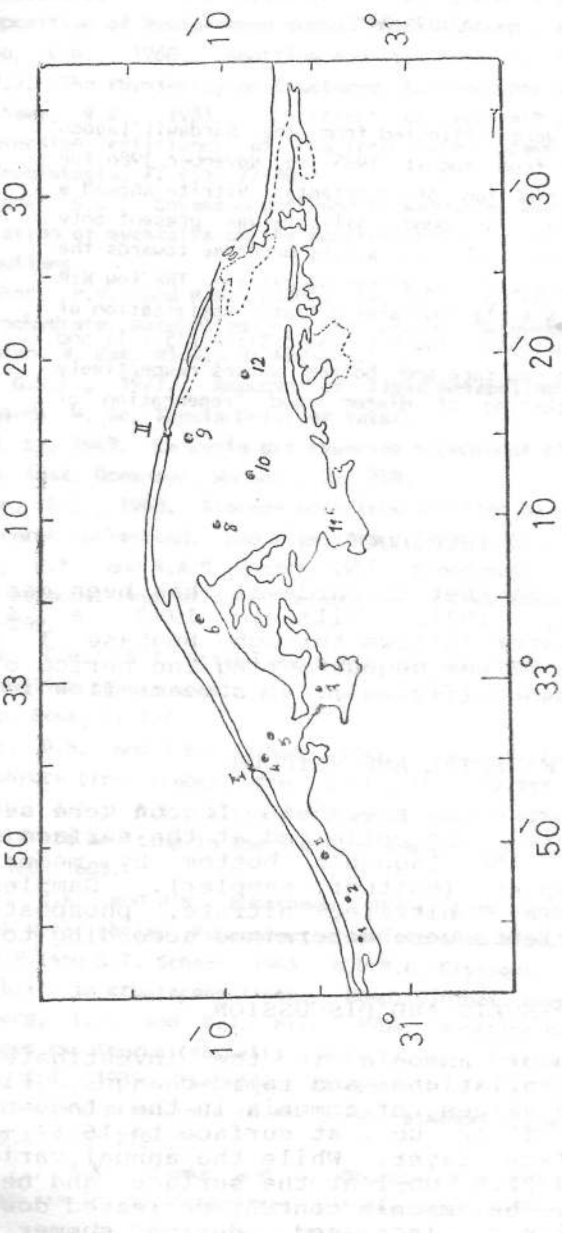

FIG. 1
Location of stations in Bardawil Lagoon

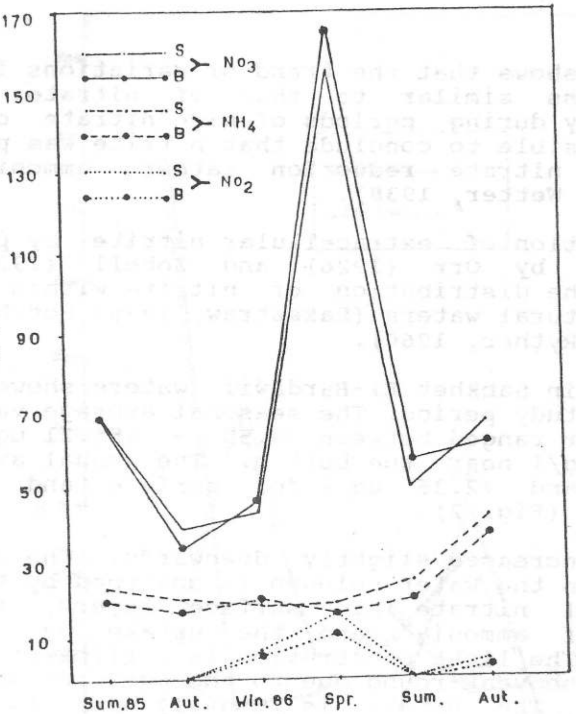

FIG. 2
Ammonia, Nitrite and Nitrate variations during the years, 1985 and 1986

Sverdrup et al. (1942) found that ammonia in sea water shows a wide range in value from 4.9 to 49.03 ug/l. The values obtained for the Bardawil Lagoon were slightly lower than these values and more or less than the values given by Grasshoff (1976). He, stated that, the amount of NH_4 and NO_2 rarely exceed 70 ug/l in oxygenated, unpolluted waters and the toxic one to the fish is NH_3 and not NH_4 ion.

Nitrite in the Bardawil Lagoon showed a complete depletion during the period of investigation. Some exceptions were recorded; in winter at stations 1-5, spring at stations 2-4 and 6-7 for surface layer only and during autumn. Grasshoff (1976) confirmed that nitrite may be excreted by phytoplankton especially during periods of luxury feeding, i.e. if a surplus of nitrate and phosphate stimulates a heavy bloom of plankton (Fig. 2).

Figure 2 shows that the trend of variations in nitrite is more or less similar to that of nitrate. Nitrite was detected only during periods of high nitrate content which makes it possible to conclude that nitrite was produced as a result of nitrate reduction rather ammonia oxidation (Einsele and Wetter, 1938).

The excretion of extracellular nitrite by phytoplankton as observed by Orr (1926) and Zobell (1935) may also influence the distribution of nitrite within the surface layers of natural waters (Rakestraw, 1936; Hutchinson, 1957; Vaccaro and Ryther, 1960).

Nitrate in Sabkhet El-Bardawil waters showed variations during the study period. The seasonal average values for the surface water ranged between 39.58 - 155.21 ug/l and 35.4 - 164.58 ug/l near the bottom. The annual average values were 70.73 and 72.36 ug/l for surface and bottom layers respectively (Fig. 2).

Nitrate increases slightly downwards. The concentration of nitrate in the water coloumn is governed by the advective transport of nitrate into surface layers, the microbial oxidation of ammonia and the uptake by the primary producers. The light penetration is sufficient to reach the bottom all the year-round due to the general shallowness of the Lagoon. The uptake is usually must faster than the processes transporting nitrate into the surface layers. Therefore, the nitrate concentration in surface water is low. This was indicated also by Grasshoff (1976) and stated that the concentration of nitrate in most surface waters is close zero.

The relatively high values of nitrate recorded in winter 1986 may be due to the decomposition of dead algae (Zobell, 1946; Zafar, 1964; Siliem, 1974). Fig. 2 shows a nitrate maximum concentration in spring and autumn 1986 and minimum concentration in summer. A similar trend was observed in Lake Manzalah (El-Wakeel and Wahby, 1970); Lake Maryut (Wahby, 1961, & Samaan, 1966 and for Lake Quarun (Naguib, 1958), also in the sea (Vaccaro, 1965).

In the clean waters, nitrate concentration varies from 4.1 to 602 ug/l (Sverdrup et al., 1955). The values obtained for the Lagoon is clearly less than those values recorded for the Oceans.

In Bardawil Lagoon the surface average phosphate ranged between 9.69 ug/l in early autumn 1986 to 425.98 ug/l in late autumn 1985. The bottom seasonal average concentration is higher, especially over the bottom which ranges between 3.55 ug/l in October. 1986 to 462.13 ug/l in November. 1985. While the regional average values were 152.11 and 158.70 ug/l for surface and bottom water layers respectively (Fig. 3).

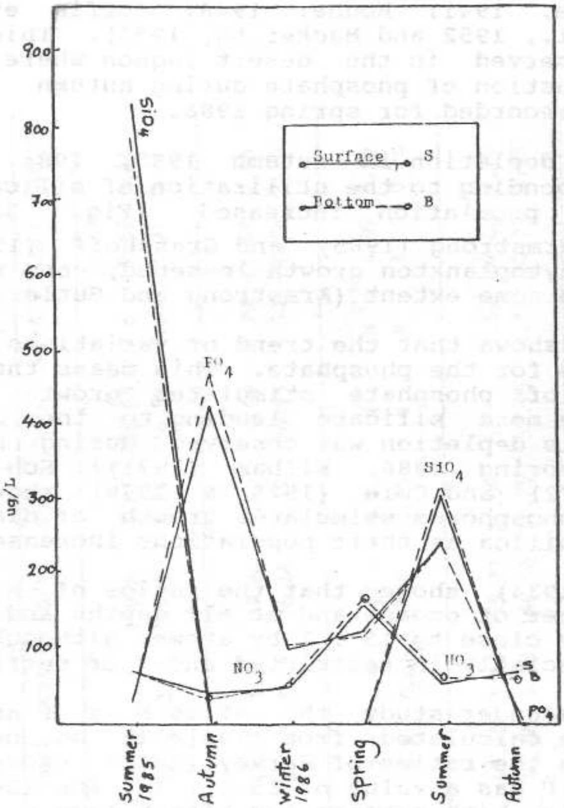

FIG. 3
Phosphate Nitrate and Silicate Variations during 1985 and 1986

The phosphorus content of seawater has been estimated to be about 61.96 ug/l, but in euphotic zone, the level was usually much lower (Grasshoff, 1976). The values obtained for the Bardawil Lagoon being higher than that obtained by Grasshoff due to the arid climate. Hutchinson (1957) listed Good Enough Lake, British Columbia, with 208 g/m^3 which is 10,000 times the mean from dilute lakes in humid regions.

In lakes, phosphorus is affected by both utilization by phytoplankton and the interchange between mud and the overlying water. Phosphate concentration may limit the rate of photosynthesis (Goldman, 1961). Phytoplankton not only utilize this trace of phosphorus for their growth and reproduction but also they store phosphorus in their tissues in big quanteties if phosphorus in water allow it (Ruttner, 1968; Einsele, 1941; Rodhe, 1948; Coffin et al., 1949; McCarter et al., 1952 and Mackereth, 1953). This phenomenon is clearly observed in the desert lagoon where there is a complete exhaustion of phosphate during autumn 1986 and the lower values recorded for spring 1986.

A marked depletion in autumn 1985, 1986, winter and spring corresponding to the utilization of silicates as the phytoplankton population increased (Fig. 3). This is confirmed by Armstrong (1965) and Grasshoff (1976). During the summer phytoplankton growth lessened, and silicate was regenerated to some extent (Armstrong and Butler, 1960).

Figure. 3 shows that the trend of variations of silicate is the reverse for the phosphate. This means that, the high concentration of phosphate stimulates growth of diatoms, which utilize more silicate leading to the depletion of silicate. This depletion was observed during autumn 1985, winter and spring 1986. Kilham (1971); Sch elske and Steormer (1972) and Cole (1975 & 1979) showed that the addition of phosphorus stimulates growth of diatoms; which utilize more silica as their populations increase.

Redfield (1934) showed that the ratios of N : P in the sea, in a number of oceans and at all depths and in plankton were generally close to 15 : 1 by atoms; although exceptions do exist, especially in restricted and / or surface water.

In the area under study the ratios N : P and NO_3 : PO_4 (Table 2 were calculated from Table 1) do not show any agreement with the ratios of Harvey (1926) except in autumn 1986 where N:P has a value of 15.5 : 1. The low ratio of N : P (3:1), for both surface and bottom layers, recorded in spring and the ratio of N : P (6 & 4:1) for both surface and bottom respectively recorded in summer 1985, indicate a faster assimilation of nitrate than for phosphate. The very lower ratios recorded were in agreement with the observations of Ketchum et al., 1958 who found the ratio in English coastal surface waters varied from zero in summer to values of 5:1 and 10:1 in winter. On the contenental shelf they were from 1.2:1 to 7:1 (Armstrong, 1965). On the other hand, the high ratio Si:P (35:1) and (23:1), for both surface and subsurface respectively, indicate a stackening of diatoms and regeneration of silicon. El-Rayis (1973) obtained the ratio of Si:P of high value (17-55 : 1) in Alexandria water which nearly closes to the ratio obtained for the lagoon waters.

SUMMARY

The concentrations of nutrient salts showed regional and seasonal variations. Ammonia values are slightly less than sea water values, and increased downwards. Nitrite showed with some exceptions a complete depletion and its trend is correlated to nitrate variations. Nitrate increases slightly downwards and is governed by advective transport of nitrate into surface layers, the microbial oxidation of ammonia and the uptake by the primary producers.

Table 1

Seasonal average concentrations of nutrient salts (ug/ l & ug at/l) in Bardawil Lagoon.

		1985 Summer		Autumn		Winter		1986 Spring		Summer		Autumn	
		ug/l	ugat/l	ug/l	ugat/l	ug/l	ugat/l	ug/l	ugat/l	ug/l	ugat/l	ug/l	ugat/l
PO_4^{3+}	S	5.95	0.84	425.98	13.75	95.98	3.1	119.8	3.87	235.58	7.6	9.69	0.31
	B	37.95	1.22	462.13	14.92	97.54	3.15	114.8	3.71	114.8	7.63	3.55	0.11
NH_3^{+}	S	22.73	1.62	20.5	1.46	17.08	1.36	19.64	1.40	24.99	1.79	41.48	2.96
	B	21.02	1.50	18.08	1.29	20.67	1.48	16.64	1.19	20.95	1.50	37.76	2.70
NO_2^{-}	S	N	N	N	N	7.0	0.5	15.75	1.12	N	N	4.09	0.29
	B	N	N	N	N	6.4	0.45	11.9	0.85	N	N	3.65	0.26
NO_3^{-}	S	68.75	4.91	39.58	2.83	43.75	3.13	155.21	11.09	50	3.57	67.08	4.79
	B	67.05	4.79	35.42	2.53	46.88	3.35	164.58	11.75	57.95	4.14	62.29	4.45
SiO_4^{3-}	S	831.21	29.62	N	N	N	N	N	N	300.05	10.7	N	N
	B	776.99	27.69	N	N	N	N	N	N	310.18	11.05	N	N

S = Surface B = Bottom

Table 2
Silicon: Nitrogen: Phosphorus Ratios (by atoms and by ug/l) in the Bardawil Lagoon

	Silicon				Nitrogen				Phosphorus			
	S		B		S		B		S		B	
	ug/l	ugat/l	ug/l	ugat/l	ug/l	ugat/l	ug/l	ugat/l	ug/l	ugat/l	ug/l	ugat/l
Summer 1985	32	3	20.5	23	2.65	6	1.77	4	1	1	1	1
Autumn	N	N	N	N	0.09	0.21	0.08	0.17	1	1	1	1
Winter 1986	N	N	N	N	0.46	1.0	0.48	1.1	1	1	1	1
Spring	N	N	N	N	1.3	3	1.4	3	1	1	1	1
Summer	1.27	1.4	1.31	1.5	0.21	0.5	0.25	0.5	1	1	1	1
Autumn	N	N	N	N	6.9	15.5	17.5	40	1	1	1	1

S = Surface B = Bottom

Phosphate concentration in Bardawil Lagoon is higher than that recorded for sea water due to the arid climate. In additions, phosphate showed a complete exhaustion during autumn and the lower values were recorded in spring.

A marked depletion of silicate was observed in autumn, winter and spring corresponding to its utillization of silicate. The trend of silicate variation is the reverse of that for phosphate.

The low N:P ration indicates a faster assimilation of nitrate than phosphate, while the high Si:P ratio indicates a lessening of diatoms and regeneration of silicates.

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