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WATER CHARACTERISTICS OF ALEXANDRIA HOT SPOTS

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ABSTRACT

Two hot spots under the direct effect of pollutants were chosen at Abu-Qir and El-Mex bays in addition to some samples taken from the adjacent pumping stations and El-Umum drain. Physico-chemical measurements were done on the water samples collected seasonally during the year 2003-2004 at these sites to determine the levels of hydrographical parameters and biogenic elements.

Temporal as well as spatial fluctuations and statistical correlations between the analyzed variables were examined. A wide range of water temperature (17-29 °C) was measured. Salinity had a wide range for bays samples (28-36 ‰), while the drain water salinity did not exceeds 5‰. Abu-Qir water is little higher oxygenated (1.35-5.14 ml / L) than that of El- Mex bay (1.21 – 4.18 ml / L) or drain water (0.50 – 3.48 ml /L). The discharged effluents through El–Tabia pumping station are loaded with high amounts of oxidizable organic matter (up to 47 mg O_2 / L) while the level in the bays shore water did not reach 22 mg O_2 / L. The drain water showed high alkalinity up to 10 meq / L compared with lower values of the bays (< 5 meq / L). Nutrient salts in drain water showed high levels up to 28, 346, 42 and 22 µM for phosphates, silicates, ammonia and nitrites, respectively, compared with lower levels of the bays. Nitrate was found as traces in most samples; however, the water taken during Jan. 2003 from El-Tabia pumping station gave the highest level. High Chlorophyll-a level (5-7 mg /L) was obtained in the bays samples reflecting a certain eutrophication condition.

INTRODUCTION

Abu-Qir bay is a shallow semicircular basin laying 35 Km east of Alexandria (Fig. 1a). The bay receives many types of discharged effluents through El-Tabia pumping station, Boughaz El-Maadiya and Rashid Mouth of River Nile. Intensive attention was paid to investigate physico-chemical characteristics of Abu-Qir Bay [e.g; (El-Deeb 1977), (Dowidar *et al.* 1983), (Osman and Dorgham 1987), (El-Gindy 1988), (Mahmoud and Abdel- Hamied 1991), (Tayel 1992), (Nessim *et al.* 1993 and 1995), (Badr 1993), (Zaki *et al.* 1997), (Fahmy 1997), (Okbah 1999) and (Abdel-Aziz *et al.* 2001)].

The second hot spot under investigation, El-Mex bay, was chosen west to Alexandria, (Fig 1b). El-Mex bay extends for about 15 Km with a mean depth of 10 m. Several investigations were carried out to study the characteristics of the bay water such as; (Emara et al .1984 and 1992), (Dorgham *et al.* 1987), (Said *et al*. 1991), (Nessim 1994), (Fahmy *et al.* 1995), (Labib 1997) and (Abdel- Halim 2003). Both El-Mex and Abu-Qir bays receive different types and amounts of effluents; agricultural, domestic and industrial effluents. The present work aimed to study the effect of the discharged effluents

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on the chemical composition of the seawater at the selected two hot spots which are directly subjected to the pollutants.

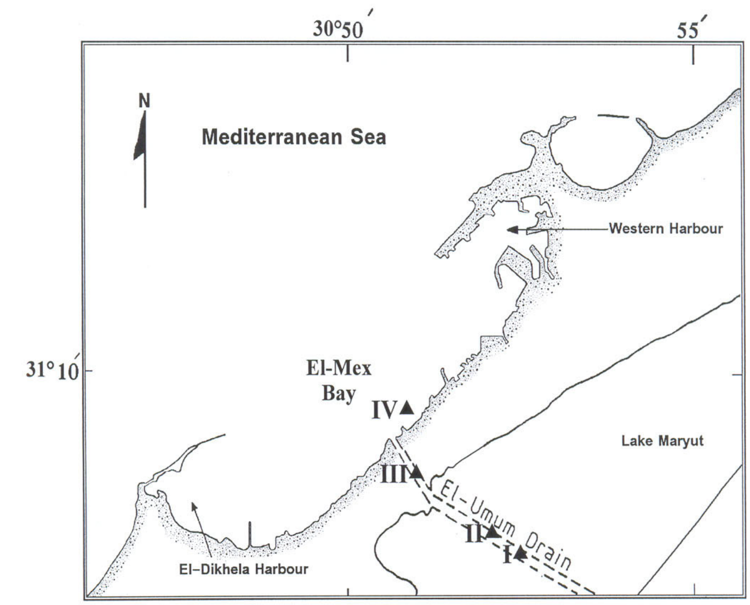

Fig. (1a): El-Mex area, sampling locations.

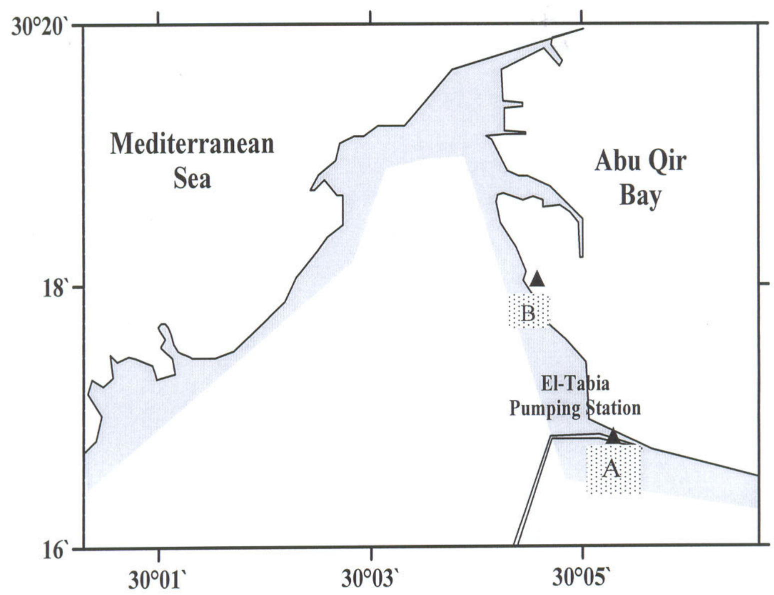

Fig.(1b): Abu-Qir area, sampling locations

MATERIAL AND METHODS

Surface water samples were collected seasonally through eight trips during the year 2003/2004 at the selected sites representing the area subjected to waste effluents (Figs.1a, 1b). Physico-chemical analysis were carried out for the collected water samples to measure the following variables (Table 1): temperature, measured by an ordinary thermometer accurate to 0.1 ºC, the pH – value, measured by a portable pH – meter, total alkalinity, determined titrimetrically using dilute HCl. Dissolved oxygen (DO) was analyzed according to the modified Winkler method, (Grasshoff 1976), oxidizable organic matter (OOM) according to Carlberg method (1972). Salinity (S‰) was calculated from the electrical conductivity of samples measured by a Beckman salinometer. Nutrients (nitrite, nitrate, ammonia, phosphate and silicate) were analyzed spectro-photometrically according to the recent oceanographically methods described by Grasshoff (1976) using a Shimadzue double beam spectro-photometer. Chlorophyll-a content was determined spectro-photometrically according to Strickland and Parsons (1972).

RESULTS AND DISCUSSION

I- Physico – Chemical Characteristics:

The surface water temperature at El-Mex hot spot varied seasonally, Fig.(2), from a minimum of 19 ºC in winter to 29 ºC in summer. The highest average surface water temperature at Abu-Qir area (26.5 ºC) was observed as expected during summer, and the lowest (17ºC) was in winter Fig. (3).

Salinity is considered as a sensitive parameter for measuring the rate of dilution of seawater caused by land-based sources discharge and subsequently it reflects the degree of contamination in aquatic environment. Water salinity at the bays sites showed wide seasonal variations, Figs. (2, 3), which directly reflect the changes in the volume and dispersion of the discharged wastewater through El-Umum drain and El-Tabia pumping station. At Abu-Qir site, the area was subjected to intensive dilution particularly during winter which reduced the salinity to reach 22.6‰. This observation agrees with those found by several authors at the same area (Abdel-Aziz *et al.* 2001). The seasonal values of salinity at El- Mex- water fluctuated between 28.3 and 32 ‰ reflecting the mixing of the bay water with fresh water. The salinity of the drain water, on the other hand, did not exceed 5‰.

The pH-value is affected greatly by the photosynthetic activity of algal organisms as well as by the amount of sewage discharge into the bays. The recorded pH- values of the surface water at Abu-Qir site (7.57 – 8.26) showed relatively little higher level if compared with that recorded at El-Mex water (7.56 – 7.93) and at drain water (7.25 – 7.93). These results are in a good agreement with those obtained by; (Nessim 1989) and (Okbah et al. 1999). The present data displays that; all the pH – values were always on the slight alkaline side and lower than that of the open sea. The decrease in the pH – value is coincided with the drop in oxygen content due to the effect of accumulating organic pollutants (Saad 1976) as well as the discharge of brackish water.

Dissolved oxygen is considered as one of the most important and useful parameters in identification of different water masses and in assessing the degree of pollution especially with organic pollutants which affects fish and other marine life through oxygen reduction or depletion. The distribution pattern of DO at El- Mex site showed a wide seasonal variation and fluctuated between 1.21 ml /L during summer and 4.18 ml /L during winter, with an annual average of 2.59 ml/L, Fig.(2). The minimum value of DO observed at El-Mex site during summer is coincided with a high amount of oxidizable organic matter, OOM, (16.64 mg O_2 / L). However, the maximum value of DO recorded during winter at the same station can be attributed to lower water temperature as well as agitation of water by strong winds (Nessim 1990). At Abu- Qir site, the minimum value of DO was recoded during winter (1.17 ml /L) and coincided with high OOM value (20.19 mg O_2 / L) while the maximum value was recorded during spring 2003 (5.14 ml /L). The annual mean of DO recorded at Abu – Qir site in the present study (2.29 ml /L) is slightly lower than that recorded by (Zaki *et al.* 1997), (2.80 ml /L). However, the present annual mean at El-Mex site (2.59 ml /L) lies within the range of previous annual mean (2.41 – 6.43 ml / L) in the last ten years at the same area (Said *et al,* 1991), (Nessim, 1994) and (Okbah *et al,* 1999). Drain water is characterized by relative lower Oxygen content (0.50-3.48 ml/L), and complete depletion of oxygen was not observed among all samples but the values were found in under saturated conditions.

Oxidizable organic matter, OOM, is far known as one of the most criteria to assess sewage pollution and organic loading (Redfield 1958). The seasonal averages of OOM ; at Abu – Qir, 3.47 – 20.91 mg O_2/L and in El-Mex water 3.40 – 16.64 mg O_2 /L, are relatively lower than those recorded in drain water [15.10 – 47.01 mg O_2/L] reflecting the influence of the drain on the chemical characteristics of the bays. The present annual means at both bays were around 8.1 mgO_2 /L, which lie within the annual mean for the last ten years recorded at the same areas (Nessim 1989) and (Zaki *et al.* 1997).

The annual mean values of total alkalinity in the surface water of Abu – Qir and El – Mex sites were 3.25 and 3.84 meq./L, respectively, which are highly matched with the values recorded for such polluted areas (Nessim & Tadros, 1988), (Nessim, 1994) and (Abdalla *et al.* 1995). On the other hand, the total alkalinity values recorded for the drainage waters, Fig. (4), were relatively higher than those reported for the bays, Figs.(2, 3), Table (1). This is also confirmed by the negative significant correlation recorded between the total alkalinity and salinity ($r = -0.729$, $p = 0.05$), Table (2).

<u>II- Nutrient Salts:</u>

The studied nutrients in the present work are; nitrites, nitrates, ammonia, phosphate and silicates, Figs. (5-9), Table (1). In principle, ammonia is the form of nitrogen preferred by algae and only when its concentration is depleted to less than 0.15 µM, nitrates and nitrites will be utilized (UNESCO, FAO, UNEP, 1988).

The nitrite values in surface water at Abu – Qir area reported during the last ten years were ranged between a minimum of 0.07µM and a maximum of 2.5 µM (Fahmy *et al.* 1997). The present data at Abu –Qir site was fluctuated between a maximum of 4.97 µM and a minimum of 0.669 µM during autumn and winter, respectively, Fig. (6). A complete depletion of nitrite was detected among all samples collected at the same area during the productive seasons; spring and summer. Riley (1977) explained the increase of nitrite during autumn as an earlier part of regeneration which fall to lower values in winter and complete depletion in spring. This phenomenon was also observed by several authors [e.g. (Nessim 1991) and (Nessim and El-Deek, 1995)]. The observed peak of nitrite during autumn is associated with a minimum value of ammonia (0.18 µM), which could be attributed to the excretion of nitrite by phytoplankton during nitrate assimilation. At El-Tabia pumping station, nitrite value was low 0.1µM in winter and is associated with high amounts of ammonia (42.02 µM) indicating the effect of wastewater discharge. Along El-Umum drain, the concentration of the nitrite ion increased gradually reaching its maximum (21.38 µM) at station III. Due to the mixing of drainage water with seawater at El-Mex site, the value of NO_2 dropped to less than 4 µM. at station IV. No significant seasonal variations in the ion concentration were observed at El-Mex site, the values ranged between 2.74 – 3.83 µM with a maximum value during summer.

Nitrate ions were nearly depleted from most samples, as a result of its consumption, except at El-Tabia pumping station where a pronounced concentration of 2.35 µM was detected during winter. This was found to be in a good agreement with (Hassan 2003).

A considerable seasonal variation in ammonia levels was observed at Abu-Qir site where the values ranged between 0.18 and 10.34µM. The highest value of ammonia, observed in winter, was coincided with lowest values of chlorophyll a, b, c, nitrite and a complete depletion of nitrate. Similar to the condition at Abu – Qir site, a very high value of ammonia was recorded in winter at El-Tabia pumping station. At El-Mex site, the value of ammonia fluctuated between 0.16 and 6.43 µM. No significant seasonal variation was observed at this site except in summer when a noticed drop in ammonia value was occurred (Riley 1977) and (Nessim 1989). At El-Umum drain, the values of ammonia fluctuated between 14.98 µM at St. I and 30.34 µM at St. III. The abundance of different nitrogen forms reflecting the increasing rate of ammonia production or increasing rate of nitrate consumption as compared to the other inorganic nitrogen species by indigenous phytoplankton (UNESCO, FAO, UNEP, 1988).

The mean concentration of phosphates in Abu-Qir waters during the last ten years was ranged between 0.3 (Tayel 1992) and 1.42 µM (Abdel Aziz et al. 2001), Fig. (8). However, at El-Mex area, the mean concentration had a higher range and fluctuated between 0.84 (Okbah et al .1999) and 3.34 µM (Said et al. 1991), Fig.(9). In the present study, the value of phosphates at Abu-Qir site had a range of 0.09 to 1.94 µM. The minimum value was observed during summer and the maximum during winter. Similar to nitrite and ammonia, phosphates had a slight seasonal variation at El-Mex site ranging between 1.02 and 2.25µM. The importance of an allochthonous source of phosphate was demonstrated by an inverse significant correlation detected between salinity, and phosphates ($r= -0.676$, $p = 0.05$), Table (2).

According to Chiaudani and Vighi (1978), when N/P ratio is higher than 6, the marine algae are considered to be P-limited and when it is lower than 4.5, they considered to be N – limited. In the present work, about 20 % of the data have N/P ratio higher than 6 while 70 % of the data have N/P ratio below than 4.5 and only 10 % are of N/P ratio nearly identical to the oceanic value. It is clear from the N/P ratio that N, in general, is the most limiting factor which agrees with the finding of Mc.Gill (1965). However, the ratio tended to increase above 6:1 during winter and autumn at St. IV and during winter and spring 2003 at St. VI and during autumn at St. III, where phosphorus becomes as limiting factor (Chiaudani and Vighi 1978).

The seasonal changes in silicate values at Abu –Qir site, were found to resemble more or less those of phosphate, a relative low value was observed during spring 2003 corresponding to the utilization of silicate as the phytoplankton population increased. As summer advanced, the level of silicate in seawater decreased to reach its minimum value in September (0.7 ± 0.16 µM). During autumn, phytoplankton growth decreased, and silicate was regenerated to some extent. Silicate maximum was observed during winter being 55.09 ± 0.3µM and followed by a marked decrease during spring 2004. The maximum observed values of phosphate and silicate during winter are coincided with minimum values of chlorophyll a, b and c (1.68, 1.53 and 4.40 mg / m^3, respectively). Contrary to other nutrient salts, the silicate values at El-Mex site showed a wide range of seasonal variations (15.4 – 50.0 µM), Fig. (7). The uptake of silicate by diatoms during winter affected its content, where the minimum recorded value was 15.4 ± 0.5 µM. The same observation was recorded by Nessim (1991) and Abu-Taleb (2004) in Alexandria coastal water. However, in warm seasons; spring and summer, the values of silicate increased. The variations of silicate concentration were mainly contributed to the supply of silicate from El-Umum drain water on one hand and its consumption by diatoms on the other hand. Thus, silicate is a good indicator of fresh water dispersion and of the potential for diatom blooms. The direct significant correlation between silicate and oxidizable organic matter [r = 0.646, p = 0.05] demonstrates allochthonous source of silicate in the surface water. The drain water showed expected great silicate amounts (155.3 – 346.4 µM), Fig.(5), if compared with the bays samples. At El-Tabia pumping station, St. V, the minimum value of silicate was reported during winter. However, at El-Umum drain, the silicate concentration increased along the drain stations to reach its maximum at St. III, Fig. (1a).

Si/P ratio is much higher than that of N/P at both bays and drain waters. The Si/P ratio was widely fluctuated between 3:1 during summer at Abu–Qir site (St.IV) and 79:1 during autumn at El- Umum drain (St.III). The relatively high Si/P ratio may be attributed to the continuous supply of wastewater effluents and drainage water through the two pumping stations.

Phytoplankton biomass has been estimated using chlorophyll-a as biomass indicator. The minimum, 1.68 mg/m^3, and maximum, 6.68 mg/m^3, Chl. a values were recorded during winter season at Abu-Qir and El-Mex sites, respectively. The two bays showed a relatively high content of Chl-a if compared with other coastal waters (Nessim, 1991). The high concentration of Chl-a content recorded in the surface water is coincided with low salinity and high values of OOM and nutrient salts, which reflects such eutrophication condition caused by drainage effluents.

Table (1): Water Characteristics of the investigated areas during the year 2003/2004

Variables	St. (I)	St. `(II)	St.(III)		St. (IV)					St. (A)	St. (B)						
			May	Oct.	Spring	Summer	Autumn 2003	Winter	Annual		Spring	Summer2003		Autumn	Winter	Spring	Annual
			2003	2003	2003	2003		2004	mean		2003	June	Sep.	2003	2004	2004	mean
WaterTemp.(°C)	--	--	--	24	27	29	21	19	24	19.9	18	26.5	26.55	22	17	23	22.2
pH	7.79	7.84	7.55	7.5	7.53	7.55	7.93	7.56	7.64	7.25	8.26	8.06	8.05	8.03	7.95	7.57	7.99
Salinity (‰)	4.06	4.21	4.32	3.5	30.4	30.9	32	28.3	30.4	1.53	33.8	33.1	35.8	30	22.6	28.6	31.2
D.O. (ml/L)	1.34	1.34	3.48	0.62	2.26	1.21	2.71	4.18	2.59	0.5	5.14	1.35	1.43	2.32	1.17	2.35	2.29
OOM (mg O_2/L)	--	--	19	15.1	7.49	16.64	5.29	3.4	8.21	47.01	5.49	3.17	10.07	5.29	20.91	3.47	8.07
Total Alk. (meq./L)	4.7	4.65	4.78	9.97	3.89	3.99	3.69	3.78	3.84	0.68	0.26	3.41	3.49	4.03	4.69	3.6	3.25
Nitrite (μM)	16.35	20.03	21.38	18.23	2.78	3.83	2.98	2.74	3.08	0.096	ND	ND	ND	4.97	0.699	ND	0.945
Nitrate (μM)	ND	ND	ND	ND	ND	ND	ND	ND	--	2.35	ND	ND	ND	ND	ND	ND	--
Ammonia (μM)	14.98	19.43	30.68	30.34	5.93	0.16	6.43	4.3	4.205	42.02	4.96	0.88	0.45	0.18	10.34	3.55	3.39
Phosphate (μM)	26.15	20.27	21.42	4.36	2.25	1.14	1.5	1.02	1.478	28.49	0.36	0.84	0.09	1.94	1.94	0.84	0.952
Silicate (μM)	260.19	241.9	252.07	346.43	50	49.2	33.81	15.4	37.103	155.33	8.033	2.37	0.7	29.54	55.09	19.74	19.246
Chl. a (mg/m^3)	--	--	--	--	--	--	--	6.64	--	--	--	--	--	4.97	1.68	2.15	--

ND = Not detected

Table (2): Correlation matrix (significant level = 0.632, p = 0.05) for the hydrographic parameters at Alexandria Hot Spots.

	Air Temp.	Water Temp.	pH	Salinity	Chlorinity	DO	OOM	Alkalinity	NO_2	NH_3	PO_4	Silicate
Air Temp.	1											
Water Temp.	0,972	1										
pH	-0,444	-0,585	1									
Salinity	0,414	0,322	0,308	1								
Chlorinity	0,423	0,326	0,332	0,997	1							
DO	-0,551	-0,575	0,503	0,337	0,314	1						
OOm	0,040	0,008	-0,262	-0,451	-0,463	-0,532	1					
Alkalinity	0,152	0,249	-0,457	-0,730	-0,722	-0,732	0,374	1				
NO_2	0,001	0,139	-0,225	-0,222	-0,247	-0,028	0,043	0,403	1			
NH_3	-0,625	-0,661	0,013	-0,525	-0,543	0,187	0,314	0,057	-0,190	1		
PO_4	-0,168	-0,074	-0,438	-0,676	-0,693	-0,256	0,284	0,581	0,566	0,498	1	
silicate	-0,094	0,004	-0,611	-0,660	-0,690	-0,344	0,646	0,533	0,528	0,479	0,848	1

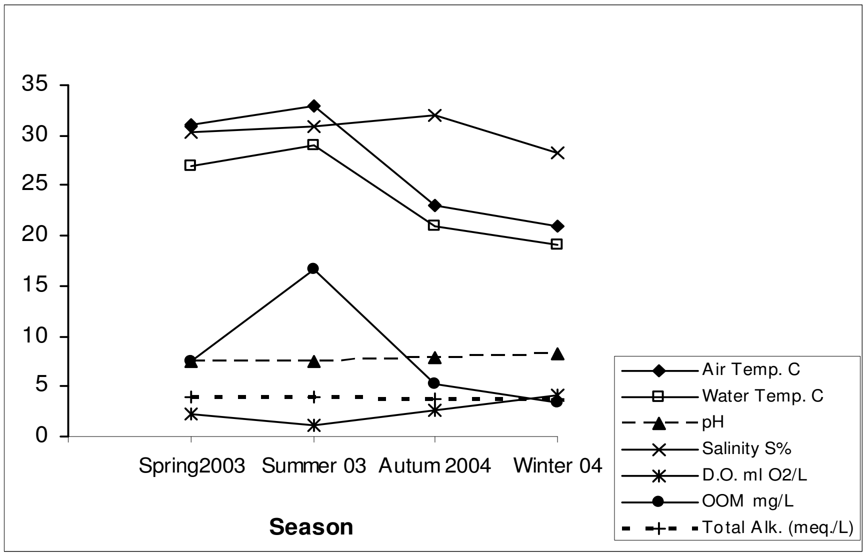

Figure 2: The hydrographic parameters for El-Mex hot spot during the year 2003/2004

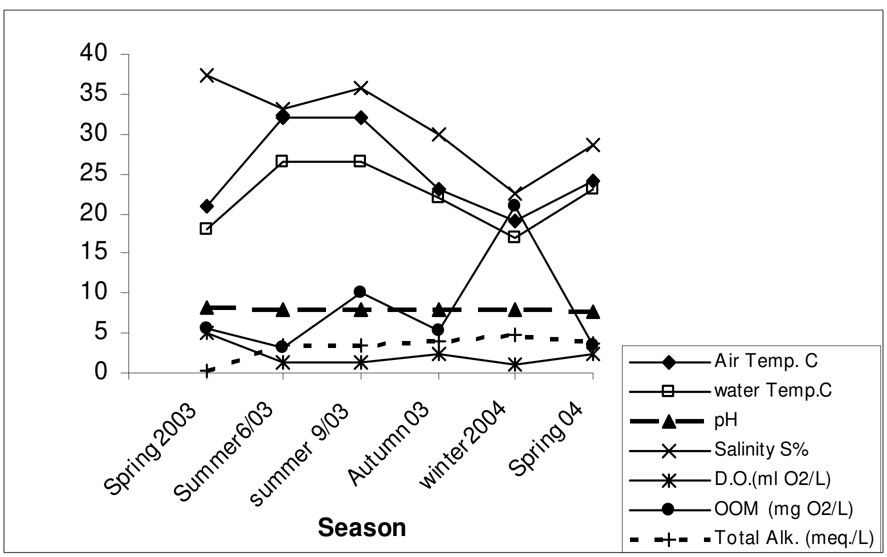

Figure 3: The hydrographic parameters at Abu-Qir hot spot during the year 2003/2004

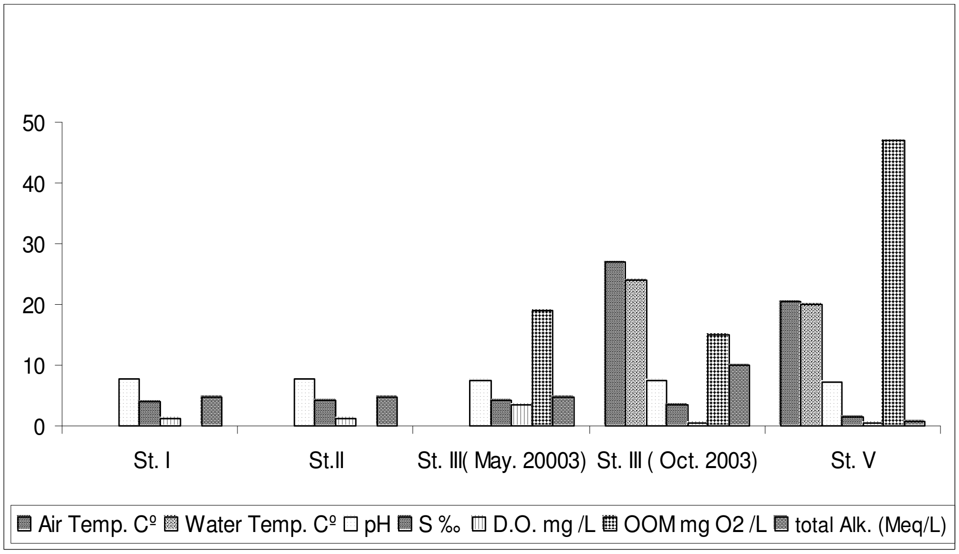

Figure (4): The hydrographical parameters for Drainage water

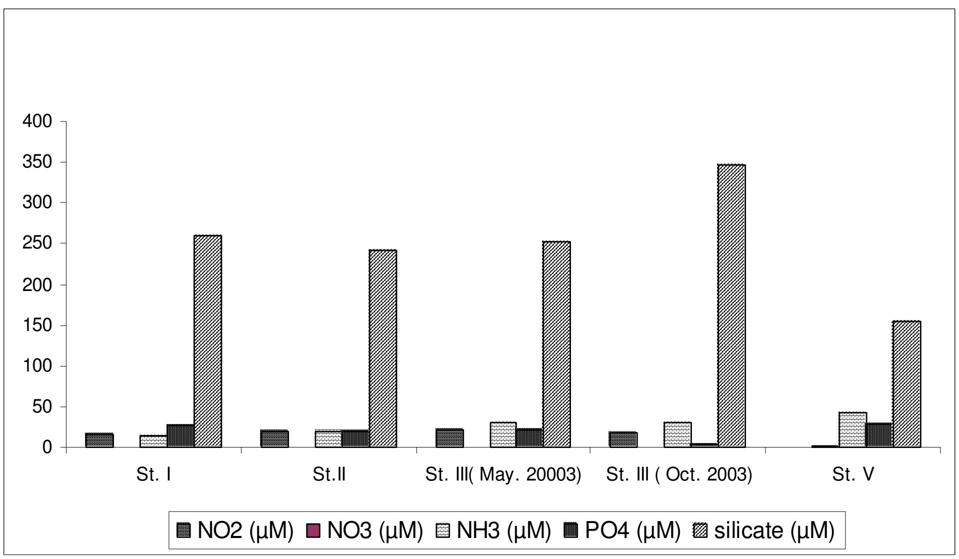

Fig (5): The Nutrient Salts for Drainage water

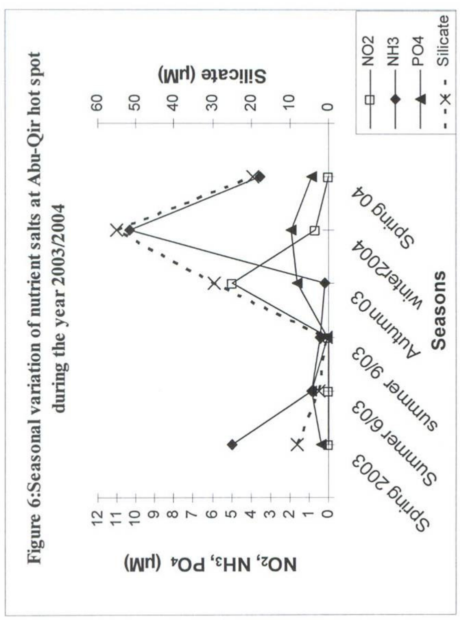

Figure 6: Seasonal variation of nutrient salts at Abu-Qir hot spot during the year 2003/2004

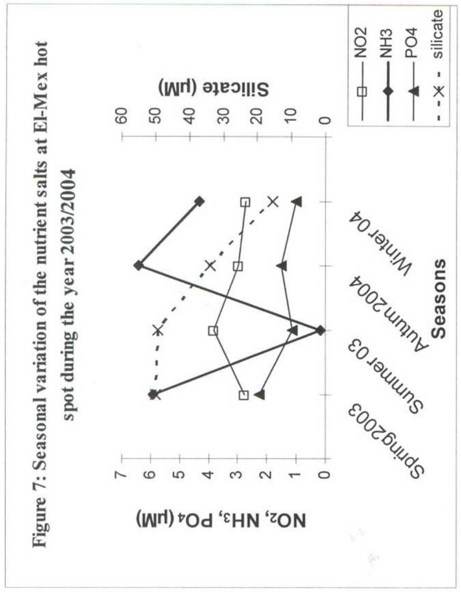

Figure 7: Seasonal variation of the nutrient salts at El-Mex hot spot during the year 2003/2004

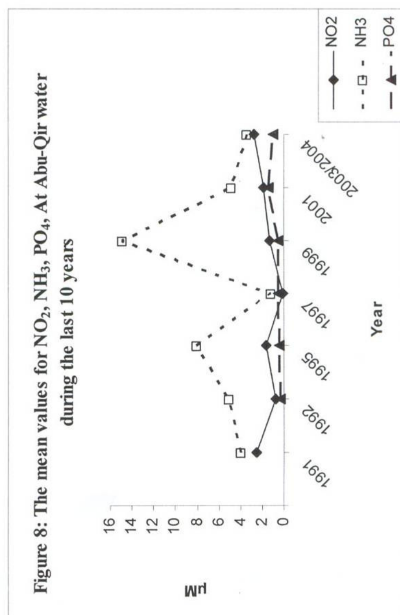

Figure 8: The mean values for NO_2, NH_3, PO_4, At Abu-Qir water during the last 10 years

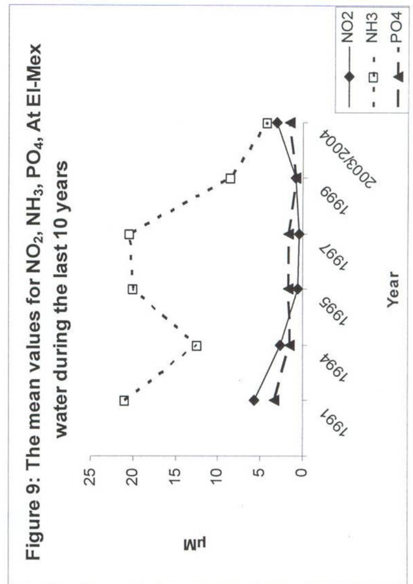

Figure 9: The mean values for NO_2, NH_3, PO_4, At El-Mex water during the last 10 years

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