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STUDIES ON THE PHYSICO-CHEMICAL CHARACTERISTICS OF MEX BAY AND NEW DEKHAILA HARBOUR WATERS OF ALEXANDRIA, EGYPT

BY

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ABSTRACT

A comprehensive environmental study was carried out in four successive seasonal cruises for evaluating the effect of contamination with different kinds of sewage, agricultural and industrial wastes on the water quality of Mex Bay and new Dekhaila Harbour of Alexandria for their management and protection. In the present investigation, water temperatures were directly affected by solar radiation and seasonal changes in air temperatures. Salinity of Mex Bay and Dekhaila waters was mostly influenced by the amounts of sewage waters discharged through Umum Drain and the rate of exchange with the adjoining open sea water. The variability of pH values in the surface water of Mex Bay was explained to 55% by DO followed by organic matter (PV) contents. However, in Dekhaila Harbour, DO in the surface and total alkalinity in the bottom waters were the only variables fitted in the stepwise regression model that affected pH values. The mean values of total alkalinity showed higher levels in the surface water of the two study regions during the whole period of investigation, except in August for Dekhaila Harbour. The important role of photosynthetic activity in increasing the alkalinity values in summer and decreasing them in winter was observed and statistically confirmed. The mean values of specific alkalinity in the two water bodies were noticeably high compared with the accepted values for the oceanic water. DO and its related parameters (BOD and PV) have been used, as basic water quality criteria for assessing sewage pollution. The most important *factors controlling DO concentrations were discussed and evaluated. The relatively low BOD values in Mex Bay compared with those in Dekhaila Harbour suggest that the prevailed conditions affecting the biological oxidations of organic matter were more suitable in Dekhaila than in Mex waters such as DO content and microorganisms abundance. The mean annual BOD/PV ratios calculated for Mex and Dekhaila waters indicated that most of the sewage wastes reaching the two regions had a biodegradable character.*

INTRODUCTION

Mex Bay extends for about 15 km between El Agamy head land in the west and the Western Harbour in the east, with a mean depth of 10 m. It receives a heavy load of waste waters from Umum Drain and Lake Maruit (144-284 x $10^6 m^3$/month), in addition to untreated industrial wastes from Chloro Alkali plant, tanneries and Alexandria Petroleum company. Dekhaila Harbour is a semi enclosed protected basin, constructed newly adjacent to the western part of Mex Bay. It is economically one of the most important harbours in Egypt. It is also subjected to major types of pollution especially those dumped from the ships traffic to and from the harbour which continuously affect its water quality. The main objective of the present study is to evaluate the effect of contamination with different wastes on the water quality of Mex Bay and Dekhaila Harbour for the purpose of their management and protection. Comparsion between the levels of pollution in both neighbouring marine environments was another objective, as Mex Bay is under stress for a longer time than the newly constructed Dekhaila Harbour. Several investigations were carried out on El Mex Bay (Aboul Dahab, 1985; Emara ***et al.***, 1990; Said ***et al.***, 1991; Fahmy ***et al.***, 1995 and others). However the present work introduces the first data base for the water quality of Dekhaila Harbour of Alexandria.

MATERIAL AND METHODS

Water samples were collected seasonally from eleven stations in Mex Bay and four stations in Dekhaila Harbour from October 1993 to August 1994. The stations were selected to represent different sites in the two regions (Fig. 1). Water samples were collected using Niskin's bottle, from the surface (0.5 m), middle and near bottom water layers, depending on the total depth of each

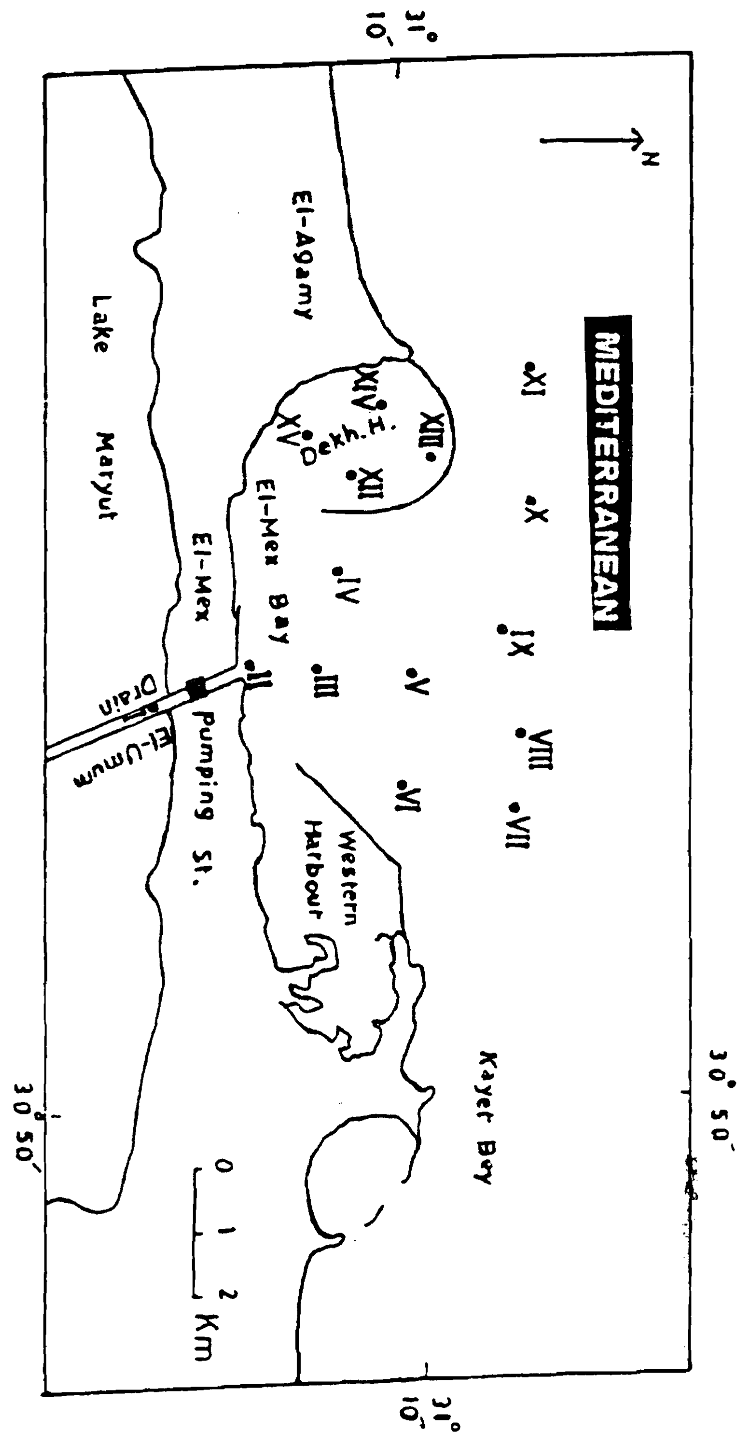

Fig. (1): Map showing the locations of El Mex and El Dekhaila Harbour and the position of stations.

station. Water temperature was measured, using a reversing thermometer attached to the Niskin's bottle and corrected by calibration curves. Salinity was determined from the electrical conductivity ratio using a Beckman induction salinometer (Model RS-7C). Measurements of pH were carried out by a digital pH-meter (Orient Research model 201). Determinations of the rest of parameters were according to Riley and Skirrow (1961) for total alkalinity, Grasshoff (1979) for dissolved oxygen, APHA (1985) for Biological oxygen demand, and FAO (1975) for oxidizable organic matter.

RESULTS AND DISCUSSION

The seasonal average and annual mean values of different water characteristics in the surface, middle and bottom layers in Mex Bay and Dekhaila Harbour are given in Tables 1 and 2, their regional average values are presented graphically in Figs 2 and 3, respectively.

Water temperature

The vertical distribution of water temperature illustrates that the surface temperature of the two regions are generally higher than those of the bottom throughout the year, except in January in which the reverse order occurred. Waste water (6-11.8 X 10^6 m^3/day according to Saïd *et al.*,1991) which is a land characteristics (with higher temperature in summer and lower in winter) when flowing to the Mex Bay over the marine waters and showing the vertical variations in water temperature. The sequence of seasons showed that the seasonal average temperature values were as usual in the region, maximum in August and minimum in January. This indicates that seasonal temperature variations are directly affected by waste water temperatures, solar radiation and seasonal changes in air temperatures.

Salinity (S‰)

In the present investigation, salinity was used as indicator to reflect changes resulting from mixing of fresh and seawaters. salinity of Mex Bay and Dekhaila Harbour was mostly affected by the amount of the discharged sewage waters and the rate of exchange with the adjoining open sea. Surface salinity distribution in Mex Bay indicated that discharged wastes from Umum Drain are dispersed (driven) in the northwest domain, which is in agreement with Aboul Dahab results (1985). Salinity distribution in the two regions showed a

Table (1): Seasonal average and annual mean values of different water characteristics in the Mex Bay during October 1993 - August 1994.

Parameters	Depth	Oct. 1993	Jan. 1994	May 1994	Aug. 1994	Annual Means
Temp.	S	27.30	16.75	27.18	29.60	—
C°	M	—	16.98	26.25	—	—
	B	25.96	17.30	25.80	28.70	—
	W.C	26.63	17.01	26.41	29.15	—
S‰	S	20.46	23.35	13.83	18.25	18.97
	M	26.90	42.45	39.61	27.33	34.07
	B	33.35	41.76	36.39	36.39	36.97
	W.C	26.90	35.85	29.94	27.32	30.00
pH	S	8.53	8.31	8.31	8.74	8.47
	M	--	8.42	8.32	—	8.37
	B	8.65	8.36	8.33	8.59	8.48
	W.C	8.59	8.36	8.32	8.66	8.44
T. alk	S	6.53	3.67	5.86	4.30	5.09
$ml.eq.l^{-1}$	M	6.16	3.29	3.99	3.62	4.27
	B	5.78	3.49	4.10	2.93	4.08
	W.C	6.16	3.48	4.65	3.62	4.48
Sp. alk	S	0.577	0.284	0.765	0.426	0.513
	M	0.414	0.140	0.182	0.239	0.244
	B	0.313	0.151	0.204	0.145	0.203
	W.C	0.435	0.192	0.384	0.270	0.320
DO	S	5.11	5.15	5.58	6.17	5.50
$ml.l^{-1}$	M	5.99	7.05	4.74	5.10	5.72
	B	6.87	8.47	5.47	4.02	6.21
	W.C	5.99	6.89	5.26	5.10	5.81
BOD	S	4.10	2.38	—	5.64	4.04
$ml.l^{-1}$	M	3.32	1.60	—	4.42	3.11
	B	2.54	1.32	—	3.20	2.35
	W.C	3.32	1.77	—	4.42	3.17
DOM	S	5.75	3.96	6.95	10.06	6.68
$mgO_2.l^{-1}$	M	5.10	3.18	5.63	7.88	5.45
	B	4.43	3.94	5.59	5.70	4.92
	W.C	5.09	3.69	6.06	7.88	5.68

S= surface M= middle B= bottom W.C.=

Table (2): Seasonal average and annual mean values of different water characteristics in the new Dekhaila Harbour during October 1993 - August 1994.

Parameters	Depth	Oct. 1993	Jan. 1994	May 1994	Aug. 1994	Annual Means
Temp.	S	27.50	16.20	27.50	29.80	—
C°	M	—	16.60	26.25	—	—
	B	25.50	16.95	25.50	28.50	—
	W.C	26.50	16.58	26.42	29.15	—
S‰	S	30.36	35.99	13.43	25.44	26.31
	M	34.60	38.33	39.21	30.52	35.79
	B	38.84	41.68	38.78	36.20	38.88
	W.C	34.60	38.83	30.47	30.72	33.66
pH	S	9.06	8.33	8.47	8.64	8.63
	M	8.94	8.39	8.21	8.61	8.54
	B	8.82	8.45	8.34	8.57	8.55
	W.C	8.94	8.39	8.34	8.61	8.57
T. alk	S	5.64	3.56	5.66	3.84	4.68
$ml.eq.l^{-1}$	M	5.39	3.33	3.90	3.88	4.13
	B	5.14	3.10	3.76	3.92	3.98
	W.C	5.39	3.33	4.44	3.88	4.26
Sp. alk	S	0.336	0.179	0.761	0.273	0.387
	M	0.281	0.155	0.180	0.227	0.211
	B	0.239	0.134	0.175	0.196	0.185
	W.C	0.285	0.156	0.372	0.232	0.261
DO	S	9.24	6.29	4.28	10.07	7.47
$ml.l^{-1}$	M	8.03	7.57	4.00	7.92	6.88
	B	6.82	8.84	3.72	5.77	6.29
	W.C	8.03	7.57	4.00	7.92	6.88
BOD	S	7.59	2.30	—	9.58	6.49
$ml.l^{-1}$	M	5.19	1.88	—	6.54	4.54
	B	2.79	1.47	—	3.51	2.59
	W.C	5.19	1.88	—	6.54	4.54
DOM	S	6.00	3.63	7.05	10.07	6.69
$mgO_2.l^{-1}$	M	5.10	3.30	6.53	8.70	5.91
	B	4.20	2.98	4.40	7.40	4.75
	W.C	5.10	3.30	5.99	8.72	5.78

S= surface M= middle B= bottom W.C.=

continuous vertical increase. It is mainly open sea water below the Mex Bay which is a mixture of different origins (sewage, agricultural, industrial and open sea mixture). So, the discharged wastes and their distribution into the study areas are mostly responsible for the decrease in surface water salinity. The effect of water disposal was more pronounced on Mex Bay compared to that of Dekhaila Harbour as indicated from the annual mean salinity values of 30.00 and 33.66‰, calculated for the two regions, respectively (Tables 1 and 2). Relationship between salinity and water temperature was found to be significantly negative in the surface and bottom waters of Dekhaila Harbour ($r = -0.607$ and -0.850, respectively), this association was insignificant in Mex Bay, reflecting the dominant role of the amount of discharged water on salinity distribution in Mex Bay of wide salinity variations and on Dekhaila Harbour of narrow salinity variations (Fig. 2).

Hydrogen ion concentration (pH)

pH value plays an important role in many life processes in the sea. It may also reflect the redox potential, productivity and pollution levels of the aquatic environments. In the present study, the absolute vertical pH values exhibited a considerable range of fluctuations reaching 1.60 for the surface and 1.25 for the bottom waters of Mex Bay and 0.90 for the surface and 0.77 for the bottom waters of Dekhaila Harbour. This suggests that the effect of different effluents are more significant in the surface water of Mex Bay. Moreover, the pH values in Dekhaila Harbour showed, relatively high levels in the surface compared with those recorded in the subsurface waters as obtained from their seasonal and regional average values (Table 2 and Fig. 2). This may explain the increasing rate of photosynthetic activity in the surface and decomposition of the descending planktonic remains and the relatively high organic load in the bottom water and surface sediments (Saad, 1976). This evidence can be supported by the positive correlations found in the surface water between pH values with DO content in Mex Bay ($r = 0.46$, $p = 0.001$) and with DO and water temperature in Dekhaila Harbour ($r = 0.58$ and 0.57 respectively), since the two parameters are used as good indicators for the producution level. The highly significant positive association obtained between pH and total alkalinity in the bottom water of the harbour ($r = 0.76$, $p = 0.001$) implies the important role of the quantity and kinds of compounds in the bottom water that collectively shift pH to the alkaline side (Aboul Kassim, 1987). Stepwise regression analysis was attempted, using pH as dependent and the other physicochemical parameters as

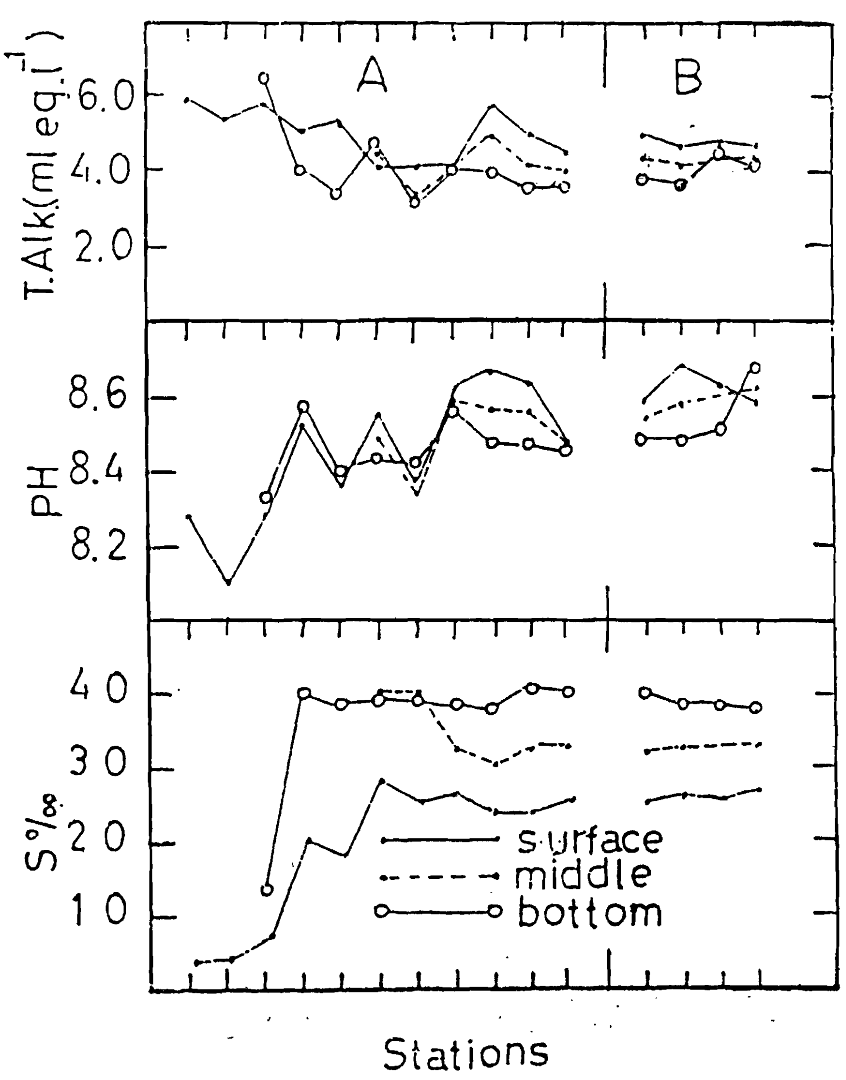

Fig. (2): Regional variations of S‰, pH and T. alk. average values at different water levels of the Mex Bay (A) and Dekhaila Harbour (B) during Oct. 1993-Aug. 1994.

independent variables at all stations of the two regions. It shows that, the variability of pH values in the surface water of Mex Bay can be explained to 55% by dissolved oxygen followed by dissolved organic matter contents as the following:

$$pH = 7.871 + 0.067\ DO + 0.052\ OM$$
$$(r^2 = 0.55,\ n = 44,\ P < 0.001)$$

However, in Dekhaila Harbour, DO content in the surface and total alkalinity in the bottom waters are the only variables entered in the regression model that affected pH.

$$pH = 8.920 + 0.049\ DO \quad \text{................ surface water}$$
$$(r^2 = 0.50,\ n = 16,\ P < 0.01)$$
$$pH = 7.893 + 0.184\ \text{Total alkalinity} \quad \text{........ bottom water}$$
$$(r^2 = 0.75,\ n = 16,\ p < 0.001)$$

Total alkalinity

Total alkalinity is simply expressed as the sum of equivalents of HCO_3^-, CO_3^{2-} and $B(OH)_4^-$ ions (Grasshoff, 1975). The surface distribution of total alkalinity during the period of study showed a general decrease towards the northern and north-western parts of Mex Bay. On the other hand, the pattern of distribution in the middle and bottom water layers followed to a great extent that of the surface especially at the stations located further away from the direct effect of the Umum Drain in Mex Bay and at most stations of Dekhaila Harbour. The absolute values fluctuated between 2.00 and 8.23 meq/l in the surface water of stations XI in August and I in October respectively, in Mex Bay and from 2.63 to 5.68 meq/l in the middle and surface waters of station XV in January and October respectively in Dekhaila Harbour. The seasonal alkalinity average values showed relatively higher levels in the surface water of the two regions compared to their bottom water during the whole period of investigation except in August for Dekhaila Harbour in which the surface value was slightly less than the bottom one (Table 2). Alkalinity enhancement in the surface water might caused partially from the large amounts of fresh water discharged into Mex Bay (Grasshoff, 1975). This evidence can be supported from the inverse correlations obtained between total alkalinity and S‰ in the surface water of Mex and Dekhaila regions ($r = -0.354$ and -0.525, respectively). Significant positive correlations found between total alkalinity and water temperature in the surface of the Bay ($r = 0.414$, $p < 0.01$) and surface and bottom layers of the harbour ($r = 0.444$ and 0.461, respectively, $p < 0.01$) reflect the important role of temperature in increasing photosynthetic activity in summer and decreasing them in winter and consequently causing the increase and decrease in total alkalinity values respectively (Aboul Kassim, 1987). Regression analysis indicated that 58% of total alkalinity variability in the bottom water of Dekhaila Harbour could be accounted for by pH variations as follows:

$$\text{T. alkalinity} = -20.899 + 2.909\ \text{pH} \ ....\text{bottom water}$$
$$(r^2 = 0.576, n = 16, p < 0.001)$$

Based on the above discussion it is concluded that, variations in total alkalinity are mostly controlled by physical and chemical processes taking place in the two regions. The annual mean values of total alkalinity for the whole water column recorded slight increase in Mex Bay than Dekhaila Harbour waters (Table 1 and 2).

The annual mean values of specific alkalinity (Total alkalinity/chlorinity) calculated for the whole water column of Mex and Dekhaila regions (0.320 and 0.261, respectively) were noticeably high when compared with 0.126 as an accepted value for the oceanic water (Morcos, 1970). Such variations appear to be associated with differences in calcium content of the waters (Koczy, 1956) or it might be the result of changes in other properties, such as DO, carbon content, silicate, ... (Grasshoff, 1975).

Dissolved oxygen (DO)

Dissolved oxygen is considered as one parameter for the identification of different water masses. Its distribution reflects to a great extent the local processes of production and consumption. In Mex Bay, the absolute surface, middle and bottom DO values fluctuated between the minima of 1.67 $ml.l^{-1}$ at station II in August, 3.23 and 0.10 $ml.l^{-1}$ at station X in May and August, respectively and the maxima of 10.60 $ml.l^{-1}$ at station IX in August, 7.47 and 10.08 $ml.l^{-1}$ at stations VII and VIII respectively in January. However, in Dekhaila Harbour, an interesting feature was observed when the minima in the surface, middle and bottom DO values were found at station XV in May, although the maximum values were 10.70 $ml.l^{-1}$ in the surface of station XIV in October, 6.97 and 9.96 $ml.l^{-1}$ in the middle and bottom of station XV in January and October respectively. The regional distribution of DO average values (Fig. 3) showed remarkably high oxygen content in the northern part of Mex Bay and Dekhaila Harbour, at which the stations are located further away from the direct

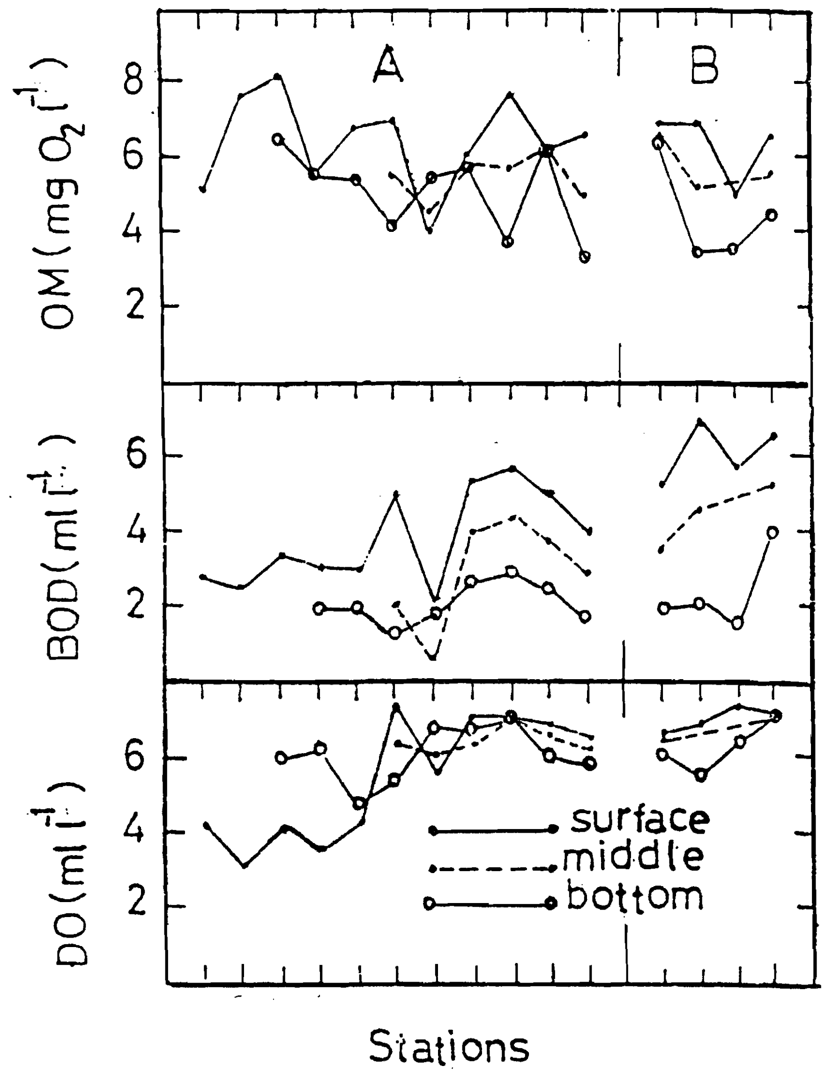

Fig. (3): Regional variations of DO, BOD and DOM average values at different water levels of Mex Bay (A) and Dekhaila Harbour (B) during Oct. 1993-Aug. 1994.

effect of sewage discharges. Based on the seasonal average values (Tables 1 and 2) the surface DO content in Mex Bay was lower in October and January and higher in May and August than that of the bottom water. However, in Dekhaila Harbour, the surface DO values were higher than those of the bottom during all seasons except in January. In the two regions, the most important factors controlling the DO budget were the quantity and quality of the discharged sewage wastes, the exchange of water with the open Mediterranean waters and the high rate of photosynthetic activity of phytoplankton production that producing large amount of O_2. These conditions were clearly demonstrated in Mex Bay in the surface water of station II in August and in the middle of station VII in May, when the lowest DO content was accompanied with the highest dissolved organic matter in the first and the contrary in the second case. Also, in the middle of station XI in May, when the lowest DO content was accompanied with the lowest S‰. Moreover, in Dekhaila Harbour the middle water of station XIV in January sustained the highest DO and S‰ accompanied with the lowest organic matter. DO content in Mex Bay showed positive correlations with S‰ in the surface and bottom waters ($r= 0.534$ and 0.477, respectively). The effect of organic matter on decreasing the concentration of DO was significant in the bottom water ($r= -0.411$, $p\leq 0.001$) and insignificant in the surface water reflecting the influence of some other inorganic constituents such as NH_4 and NO_2 ($r= -0.743$ and -0.535, respectively) on DO values in the surface water of Mex Bay. The effect of temperature on DO concentrations was indicated by the inverse correlation found between the two variables in the bottom water of Mex Bay ($r= -0.466$, $p\leq 0.001$). High positive associations found between DO and pH in the surface water of Mex and Dekhaila regions ($r= 0.468$ and 0.578, respectively) justified the important role of photosynthetic activity, through the elevation of pH values, by supplying the surface water of the two regions with DO. These assumptions are confirmed by the following stepwise regression equations:

$DO = 3.68 + 0.042\ S‰ - 0.059\ NH_4$ .... Mex surface water

($r^2= 0.776$, $n= 44$, $p< 0.001$)

$DO= 12.26 - 0.238\ Temperature - 2.096\ NO_2$ .... Mex bottom water

($r^2= 0.45$, $n= 44$, $p< 0.001$)

$DO = 7.64 - 7.87\ NO_2$ .... Dekhaila bottom water

($r^2= 0.44$, $n=16$, $p< 0.001$)

Biological oxygen demand (BOD)

Because oxygen demanding wastes rapidly deplete DO of the water, so it is important to estimate the amount of these pollutants in given water bodies. During the period of study, the BOD values in Mex waters fluctuated between 0.36 and 10.09 $ml.l^{-1}$ at the bottom of station V in January and at surface of station IX in August respectively with an annual value of 3.17 ± 2.14 $ml.l^{-1}$. However in Dekhaila Harbour, these absolute values ranged from 0.83 to 10.04 $ml.l^{-1}$ at the bottom of station XII in January and at the surface of station XIII in August, respectively, giving an annual value of 4.54 ± 3.2 $ml.l^{-1}$. On the whole, the BOD values decreased with depth at most stations of the two regions. This can be confirmed from the regional average BOD values (Fig. 3). Variations of the BOD seasonal averages in the whole water column of Mex and Dekhaila regions showed minima (1.77 and 1.88 $ml.l^{-1}$) in January and maxima (4.42 and 6.54ml.l-^{1}) in August, respectively. Significant positive correlations were found between BOD values with water temperature in the surface ($r = 0.507$ and 0.829) and bottom waters ($r = 0.375$ and 0.619) of Mex and Dekhaila, respectively and with DO in the surface of the two regions ($r = 0.697$ and 0.739, respectively).These indicate that the rate of organic matter decomposition by microorganisms is directly proportional to water temperature and dissolved oxygen content. This can be confirmed by stepwise regression analysis performed between different parameters in each of the two water bodies and justified that 68% and 94% of BOD variability in the surface water of Mex and Dekhaila areas, respectively can be explained by water temperature followed by DO as the following:

BOD =-4.483 + 0.205 Temp. + 0.634 DO ..... Mex surface water

($r^2 = 0.68$, $n = 44$, $p \leq 0.001$)

BOD =-6.318 + 0.267 Temp. + 0.531 DO + 0.276 DOM

..... Dekhaila surface water

($r^2 = 0.935$, $n = 16$, $p \leq 0.001$)

ECPH (1975) pointed out that 1 ppm BOD is a characteristic of nearly pure water. Water is considered fairly pure with a BOD of 3 ppm and of doubtful purity when the BOD values reach 5 ppm. A comparison between these levels with those of the present study showed that the annual BOD average values for the whole water column amounting to 3.17 ± 2.19 $ml.l^{-1}$ (equivalent to 4.53 ± 3.13 ppm) for Mex Bay and 4.54 ± 3.17 $ml.l^{-1}$ (equivalent to 6.49 ± 4.53 ppm) for Dekhaila Harbour are comparatively high. It is interesting to mention that the relatively lower BOD value in Mex Bay than that in Dekhaila Harbour irrespective of the discharge of large amount of untreated sewage in Mex region suggests that the prevailing conditions responsible for the biological oxidation of organic matter was more suitable in Dekhaila than in Mex waters such as DO content and the abundance of microorganisms.

Oxidizable organic matter content (Permanganate value)

Measurement of the oxygen equivalent to the amount of material oxidized by a strong oxidizing agent, such as potassium permanganate ($KMnO_4$), gives a convenient characterization of the water quality. This test is usually called PV test (Aboul Kassim, 1987). In the present study, the concentrations of the chemically oxidizable organic matter in the water of Mex Bay and Dekhaila Harbour were investigated and showed spatial and temporal variations. Vertically, the pattern of organic matter distribution in the two water bodies showed a decrease with depth at most stations. This can be confimrmed from the seasonal and annual mean values calculated for the different water levles (Tables 1 and 2). The organic supply introduced into the area and the slow rate of self purification processes resulted in the elevation of the organic matter content to 1.3 and 1.4 times in the surface than the bottom waters of Mex Bay and Dekhaila Harbour, respectively. It is also, indicated from the regional average distribution that, the PV values were higher at the stations located in the vicinity of Umum Drain and decreased far away (Fig. 3). The inverse correlations found between PV values and S‰ in the surface and bottom waters of the two regions are in support to this evidence. The concentrations of organic matter at different levels in the two regions were noticeably high in the warm season and low in the cold season. The role of temperature, as a dominant factor accelerating the rate of organic matter oxidation was indicated from the direct strong associations between the PV values and water temperatures in the surface and bottom waters of the two study areas. The annual mean values of the oxidizable organic matter in the two regions were approximately similar, amounting to 5.68 and 5.76 $mgO_2.l^{-1}$ for Mex and Dekhaila waters, respectively.

The reasonable way for determing the type of waste water discharge, and for knowing if it is or not biodegradable is by calculating the BOD/PV ratio. A BOD/PV ratio of 1:1 is characteristic of well purified water. The biodegradable compounds have a ratio of $\leq$ 2:1, while that of 2:1-4:1 is specific for crude domestic sewage. Carbohydrates and proteins enriched wastes (food processing

Table (3): The mean of different environment characteristics in Mex Bay and Dekhaila Harbour in the Dekhaila Harbour during October 1993 - August 1994.

Area of study		S‰	pH	T.alk. meq.l^{-1}	sp.alk	DO ml.l^{-1}	BOD ml.l^{-1}	DOM mg.l^{-1}	References
Mex Bay	S	18.97	8.47	5.09	0.513	5.50	4.04	6.48	present study
	B	36.97	8.48	4.08	0.203	6.21	2.35	4.92	
Dekhaila H.	S	26.31	8.63	4.68	0.387	7.47	6.49	6.69	present study
	B	38.88	8.55	3.98	0.185	6.29	2.59	4.75	
Mex Bay	S	36.36	---	---	---	2.40	---	---	Aboul Dahab 1985
	B	38.14	---	---	---	3.20	---	---	
Mex Bay		6-35.2	7.84-7.96	---	---	1.82-2.87	---	2.60-5.12	Said, *et al.*, 1991
Western H.		36.97	8.13	---	---	3.32	---	---	Hemeda, 1982
Eastern H.	S	33.17	8.20	2.43	0.122	5.09	3.86	3.15	Aboul Kassim 1987
	B	37.92	8.08	2.30	0.112	3.42	1.76	1.34	
in front of El Boughaz	S	36.05	7.87	---	---	4.52	12.40	---	Mahmoud 1985
	B	38.66	8.03	---	---	5.86	8.42	---	

wastes) have ratios equal or greater than those for sewage (ECPH, 1975). In the present study, the BOD/PV ratios calculated from their annual mean values of the whole water column in Mex and Dekhaila waters amounted to 0.80:1 and 1.13:1, respectively. This may indicate that most of the sewage wastes reaching the investigated two areas had a biodegradable character.

The mean values of the most environmental characteristics recorded during the present study are relatively higher than those recorded for other Egyptian coastal waters (Table 3). This implies the intensive effect of contamination with different kinds of effluents discharged into the investigated areas. The present study on Mex Bay when compared with the previous one (Table 3) showed higher DO values depending on the water quality discharged into this area.

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