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PRELIMINARY ESTIMATES OF WATER AND TRACE METALS BALANCES IN MEX BAY WEST OF ALEXANDRIA (EGYPT)

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Abstract: The Mex Bay water, about 190 X 10^6 m^3 in volume, has a residence time of about 1.2 days, while the inflowing fresh water has a residence of about 2.08 days. This short period is due to the free communication betweenthe bay and the Eastern Mediterranean waters. The rate of water exchange between bay and sea, based on salt and volume continuity in a two layers system, was found to be 161 X 10^6 m^3 day^{-1} at the upper layer towards the sea, and 155 X 10^6 m^3 day^{-1} entering the bay in the lower layer. The mass balance of metals indicates that the particulate forms of Fe, Mn, and Hg have residence times of about 8, 4.2 and 2.5 days, longer than for their dissolved forms, while an opposite behaviour is observed for Cu, with 11.9 days for the dissolved form. This evidence is interpreted as resulting from the dominant physical form of the metal.

Introduction : The highly polluted Mex bay a semielliptical open basin west of Alexandria (Fig. 1), has been intensively studied by the Aquatic Environmental Pollution Project of Alexandria University[1,2&3]. Four cruises have been carried out between Augest 1983 and Aug. 1984. In this paper, using data generated during the project, a preliminary assessment of the mass balance of fresh water and of five trace metals (Fe, Mn, Zn, Cu, and Hg) in their dissolved and particulate forms, in addition to their residence times,is attempted.

Material and method of analysis : The bay is influenced by the discharge from different effluents namely Umum drain (6X $10^6 m^3$ day^{-1} of water loaded with 5520 mg L^{-1} of particulate matter), Noubaria canal (0.9 X 10^6 m^3 day^{-1} with 11810 mg L^{-1} of particulate matter), Misr chemical industry (0.035 X 10^6 m^3 day^{-1} with 28442 mg L^{-1}) and Tanneries factories and Sloughterhouse (about 0.002 X 10^6 m^3 day^{-1} of water). The major effluent, Umum drain, is also the main source of particulate and dissolved metals into the bay. To determine the fresh water balance and its residence time, the bay was divided into 19 boxes (Fig. 1) and the volume and mean salinity for each estimated. The mean salinity determination using the salinity profile at each station was obtained by weighted mean, considering the thickness of each water layer between two measurements. The fresh water % in each box, given S the mean salinity, S_s the offshore salinity (39.2 %), and S_f fresh water salinity (4 %), is given by equation (1) :

$$m_f = \frac{S_s - S}{S_s - S_f} = 0.02841\ (39.2 - S) \qquad (1)$$

The standing stock of fresh water in the bay is the sum of fresh water volume in all boxes. The rate of water exchange between bay and sea, assuming the valid assumption of a two layers system, salt and water volume continuity is given by equations 2, 3, &4

$$Q_o = \text{outflow to the sea} = Q_R \times S_i \;/\; (S_i - S_o) \qquad (2)$$

$$Q_i = \text{inflow to the bay} = Q_R \times S_o \;/\; (S_i - S_o) \qquad (3)$$

$$t = \text{residence time} = V\,(S_i - S_o) \;/\; S_i \times Q_R \qquad (4)$$

Q_R = fresh water discharge + Rainfall - evaporation, S_i and S_o are mean salinities in the lower and upper layers of the bay and V is the bay volume.

$$t_f = \text{residence time of fresh water} = \frac{\text{Fresh water standing stock}}{\text{Fresh water discharge about } 6\times10^6\ m^3\ day^{-1}} \qquad (5)$$

The residence time of a metal is given by equation 6

t_m = Standing stock of the metal (Bay volume X mean conc.)/ rate of inflow of the metal to the system (6)

Results and discussion : The fresh water standing stock in the bay fluctuatesbetween a minimum in mid winter (3.7 X 10^6 m^3) and a maximum in mid summer (reaching 19.5 X 10^6 m^3), with a mean residence time t_f of about 2.08 days. Residence time t for the whole bay, when S_i=37.6%, S_o=36.5%, V=190.3X10^6 m^3, Q_R = 6 X 10^6 $m^3 day^{-1}$, Q_o = 161 X 10^6 m^3 day^{-1}, Q_i = 155 X 10^6 m^3 day^{-1} t = 1.2 days, which is less than that of fresh water due to entrainment effect. The mass balance of trace metals is represented by Fig. 2 and table 1. The inflow from land sources, the exchange with the sea, the exchange with the Western harbour (Fig. 1), are considered, while the unknown terms (air-sea and bottom-water fluxes) are disregarded for the time-being. The particulate forms of Fe, Mn, and Hg have longer residence times than the dissolved form. Cu has an opposite behaviour. Generally the dominant physical form of the metal has longer residence time. The total mass balance of Zn after the given approximations, show a net loss in the system; this loss might be compensated by atmospheric outfall from the adjacent cement factory. The forms with longer residence time in the bay are likely to have a more important impact on the bay.

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Table (1) Mass balances and residence times of some trace metals in Mex Bay.

Metal	Total input (kg/day) D	P	T	Standing stock (kg) D	P	T	Residence times days D	P	T
Fe	935.9	1462	2398	2399.7	11682	14082	2.56	8.0	5.9
Mn	1000.5	721.8	1722.3	1737.4	3028	4765	1.7	4.2	2.8
Zn	-382*	-65*	-447*	3063.8	1104	4167	3.7	3.8	3.7
Cu	31.9	101.8	133.6	378.7	341	719.7	11.9	3.4	5.4
Hg	3.2	2.8	6.0	1.85	7.o	8.85	0.6	2.5	1.5

(D = dissolved, P = particulate, T = total metal concentration)

* In the case of Zinc the negative total input means compensation from the atmospheric outfall from adjacent cement factory and residence time = standing stock/rate of exchange with the sea.

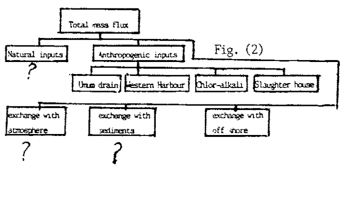

Fig. (2)

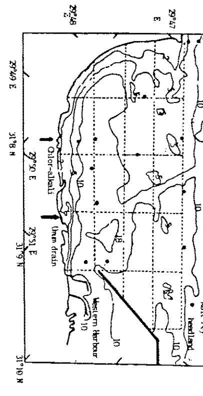

Fig. (1): A map showing Mex Bay topography (depth in meters) , positions of stations and the grid used in estimation of F.W. standing stock.

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SOME ENVIRONMENTAL FACTORS AFFECTING SURVIVAL OF FECAL PATHOGENS AND INDICATOR ORGANISMS IN SEA WATER

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ABSTRACT

This study was conducted to determine the effect of some environmental factors as temperature, slinity and light on the rate of die-off S. Typhi, S. Wein, Sh. flexneri and E. coli as examples of fecal pathogens and indicators in water. These organisms were tested in different kinds of water: Seawater, filter sterilized seawater tapwater and normal saline. These organisms were counted every two hours for 8 hours and then every day up to 7 days. It was found that there was no great difference in survival time of the tested organisms at temperature of 25-35°C, but at 40°C they died off more rapidly.
The salinity of seawater did not affect the survival time of Salmonellas. Sh. flxneri and E. coli appeared to survive longer in fresh water than seawater at temperature 30-35°C. Day light is sun light has a lethal effect on all test organisms, survival time was shorter when exposed to day light than in the dark in different types of waters, being hours up to 24 hours compared to several days in the dark. Artificial light has less effect than natural day light. It can be concluded that exposure to sunlight is the most important factor in the process of self-purification of polluted water due to sewage outfalls.

RESULTS & DISCUSSION

A. Effect of temperature:

Temperature has been one of the most frequently considered factors in affecting survival time of bacteria. Virtually most studies concluded that the rate of die-off increased as the temperature increased. This was mostly apparant with S. typhi which survived for periods varying between 6-7 days in different types of water and normal saline at temperatures up to 35°C, but died-off after 2-4 days at a temperature of 40°C. The survival of S. wein was longer at 40°C, being 3-4 days compared to 3-7 days at temperatures 25-35°C. Sh. flexneri survived only for 2-3 at 40°C, while it survived for 4-7 days at 25-35°C. E. coli survived from 1-5 days at 40°C, while it survived longer at 25-35°C being from 2-7 days. So, it is apparent from this study that there is no great difference in the survival time of the tested pathogenic organisms at temperatures 25-35°C, but they died off more rapidly at 40°C.

Table (1) shows a comparison between the die-off of the 4 tested organisms under the effect of 4 different temperatures (25-30-35-40°C) in 3 types of water & normal saline.

Org. / Time in days	Types of water															
	F.S.W.				R.S.W.				D.T.W.				N.S.			
	Temperature °C															
	25	30	35	40	25	30	35	40	25	30	35	40	25	30	35	40
S. typhi	7	7	7	2	6	6	6	2	6	6	6	4	6	6	6	3
S. wein	4	4	3	3	4	4	4	3	6	6	4	4	7	5	7	5
Sh. flexneri	2	3	3	6*	4	3	4	2	6	7	5	2	3	4	4	3
E. coli	7	5	3	1	7	4	2	3	7	7	6	5	7	4	5	5

F.S.W. = filter sterilized sea water R.S.W. = Raw sea water
D.T.W. = decholrinated tap water N.S. = Normal saline
* = time in hours

B. Effect of Salinity:

It has been stated that the most potentially toxic substances present in sea water on the basis of concentration are the inorganic salts. In this study, however, the salinity of sea water or any of its antagonistic factors did not affect the survival time of salmonellas. Many investigators studied the survival time of these organisms in sea water and reported different die-off times. This lack of uniformity could be attributed to the difference in the used techniques, tested strains and conditions of the experiments.
Regarding Sh. flexneri, it was found that it is affected some what with salinity. It survived longer in fresh water than in sea water.
Marsharipov, found that the survival of shigella was influenced by the composition of their aquous environment. E.coli appeared to survive longer in fresh water than in sea water at temperatures 30-35°C.
Numerous workers have justfied the use of E. coli as an indicator of fecal pollution. Because it survives longer in water than any of the microorganisms of public health significance. However, this study showed that E. coli and S. typhi have similar survival properties in water. The justification here lies on the fact that E. coli is easier to be detected and it is in greater number than salmonellas in polluted water.

C. Effect Of light:

Porter reported that ultraviolet and visible light have some lethel effects on bacteria and that certain bacterial cultures grow best in the dark. In this study, it is clear that these organisms survive more in the dark ranging from 4-7 days in the different waters. They survive only for few hours to one day when exposed to sun-light. Artificial light has less effect than natural light. So, it is apparant that exposure to day light is an important factor in the die-off rate of the different organisms. THis factor, hence, becomes the crucial factor in the self-purification process when disposing of sewage in the aquous environment.

Table (II) shows a comparison between the die-off of the 4 tested organisms under the effect of 3 different types of illumination in 3 types of water & normal saline,

Org. / Time in days	Types of water									
	F.S.W.		R.S.W.				D.T.W.			N.S.
	Illuminations									
	D.L.	A.L.	D.	D.L.	A.L.	D.	D.	D.L.	A.L.	D.
S. typhi	8*	1	5	1	2	6	6	1	3	6
S. wein	4*	8*	6	1	1	6	6	1	5	6
Sh. flexneri	8*	6*	5	1	3	4	7	1	4	6
E. coli	8*	1	4	8*	4	5	7	1	5	7

F.S.W. = filter sterilized sea water R.S.W. = Raw sea water
D.T.W. = decholrinated tap water N.S. = Normal saline
D.L. = day light A.L. = artificial light
D. = dark * = time in hours

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