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HEAVY METALS CONCENTRATION LEVELS IN SOME FISH SPECIES OF LAKE MARIUT AND THE NOZHA HYDRODROME, EGYPT DURING 1974 AND 1995

BY

L.M. SHAKWEER*, AND M.M. ABBAS

* National Inst. Ocean. and Fisheries, Anfoushy, Alexandria - Egypt.

Key Words: Heavy metals, lake fishes, Egypt.

ABSTRACT

Results of comparing the concentration levels of Cu, Zn, Mn in the muscle tissues of the common fish species inhabiting lake Mariut and the Nozha Hydrodrome in Alexandria Egypt, during 1974 and 1995 under similar conditions (using the same reagents and apparatus in the analysis) showed that the levels showed lower values in the samples collected during 1995 than those collected during 1974 from lake Mariut. Higher concentrations of these metals were recorded at the Nozha Hydrodrome during 1995. The levels of such metals are less than the international allowable levels. On the other hand Pb showed increased levels in both sites in 1995 than in 1974 and its levels are higher than the permissible ones.

The samples of ***Oreochromis aureus, Sarotherodon galilaeus*** *and* ***Bagrus bayad*** *collected from the Nozha Hydrodrome during the years 1974 and 1995 showed that the concentration values of Cu increased from 3.83 to 13.83, 3.65 to 10.89 and from 3.71 to 5.52mg/Kg, the values of Zn in the samples showed an increase from 11.93 to 48.79, 9.83 to 29.48 and from 10.74 to 22.72 mg/Kg and the values of Mn in the samples increased from 1.40 to 3.34, 1.58 to 3.01 and from 1.78 to 3.40 mg/Kg for the mentioned species respectively. For Lake Mariut the percentage increase in the relative concentrations of Pb during 1974 and 1995 were 80.4%, 66.9%, 293.0% for* ***O. aureus, S. galilaeus and Tilapia zillii*** *respectively.*

For the Nozha Hydrodrome samples the percentages were 382.3%, 335.9% and 260.8% for ***O. aureus, S. galilaeus*** *and* ***B. bayad*** *respectively.*

INTRODUCTION

Lake Mariut, lying to the south of Alexandria occupies a small portion of a large ancient lake found in the past time. The area of this lake decreased gradually as a result of land reclamation to reach about 17,000 feddans during the last few years. In 1939, the Nozha Hydrodrome was separated artificially from lake Mariut by an embankment, which is 9.0 Km in length. This Hydrodrome covers an area of about 1200 feddans.

In fact, there are several factories close to the northern side of lake Mariut. The industrial and sewage wastes of these factories as well as the domestic sewage of a part of the southern part of Alexandria are dumped directly without treatment into the northern side of the lake. In addition, Qala Drain, transports to it large amounts of industrial wastes and sewage into the south eastern side of this lake. Such untreated industrial and sewage wastes increased the levels of heavy metals concentrations in the water and sediments of lake Mariut (Saad ***et al.*** 1981). Consequently, these metals are accumulated with considerable concentration in the biota of the lake.

The Nozha Hydrodrome receives its water from the Nile (Mahmoudia Canal) through a short feeding canal which is connected with the inlet of such Hydrodrome. The inlet is opened occasionally to compensate for the water lost by evaporation, and to keep the level of the Hydrodrome constant. The average water depth of this Hydrodrome -with the exception of the deep depression which surrounds the whole area - is about 3.6 m. (Wahby ***et al.*** 1993). The Hydrodrome has been used for about 40 years as a fish farm for both the fresh water fish species (Nile fishes) and some of the marine fish species specially grey mullet.

Therefore lake Mariut and the Nozha Hydrodrome has been considered as fishing grounds providing the fish markets of Alexandria with considerable amounts of the fish available in such markets.

During the last twenty years, the human activities in the areas adjacent to lake Mariut and the Nozha Hydrodrome have been obviously developed. Consequently the rates of waste water discharge in lake Mariut increased to drastic levels. Various organic and non-organic chemical compounds are annually dumped into the lake. Nozha Hydrodrome is affected by pollution of the Nile water from Mahmoudia canal. As a result of the continuous discharge of waste water into the lake during such period of time it is believed that the rate of heavy metals accumulation increased steadily in this area from one year to the next.

In his study on the accumulation of heavy metals in the tissues of ***Tilapia zillii*** caught from contaminated and clean areas, Ghazaly (1992) pointed out that, fish accumulate trace elements from their environment, and can act as indicators for the levels of these elements in the environment, therefore they can be considered as excellent organisms for the study of some long-term changes in heavy metals concentrations in their ecosystems.

Aim of the present investigation :

It is aimed in the present investigation to compare between the concentrations of some heavy metals in the muscle tissues of the common fish species which were surviving in lake Mariut and the Nozha Hydrodrome since twenty years with those surviving in these areas at the present time. This enables us to collect the necessary and basic informations that help in detecting the trends of fish contamination by heavy metals in these fishing grounds during the last period of time. Such informations may be considered as an index in expecting the levels and trends of pollution by heavy metals that may exist at these areas during the following years .

MATERIAL AND METHODS :

a - sampling of fish :

Fish samples of different species were collected - by the first author - from lake Mariut and the Nozha Hydrodrome in 1974. Samples of the flesh of such fish species were kept in the dry condition. These samples have been used as a part of the present analysis . Fish sampling was repeated from the same

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fishing areas during 1995 for getting the other part of samples used in the present work.

These fish samples were collected from the commercial catch taken from different localities of lake Mariut and the Nozha Hydrodrome. The sampled fish were kept in iced polyethylene bags while transporting it to the laboratory. Measurement of fish length was carried out to the nearest mm and the weight was determined to the nearest gm before sampling the organs of fish.

The number of fish sampled, length and weight of fish are given in Table (1). Preparation of samples was done according to FAO Tech Paper No. 158 (Bernhard 1976).

B - Determination of heavy metals concentrations in fish samples :

Samples were taken from the fish flesh for the determination of heavy metals concentrations. A part of each sample was dried at 60 °C to a constant weight, then kept in the dry condition in a dissicator. The other parts of the fish flesh were kept in plastic bags in a deep freezer for digestion and determination of heavy metals concentrations in the wet condition. The liver and gonads of each of the fish samples were kept iced before digestion. The digestion of either the dry or wet samples was carried out by the use of A.R. HNO_3 60% concentration at 60 °C.

Determination of heavy metals concentrations was carried by the use of Atomic Absorption Spectrophotometer (Perkin Elmer model 2380). Analysis of the flesh samples of fish collected in 1974 and 1995 was carried out simultaneously at one time for heavy metals concentrations under similar conditions applying similar techniques and using the same apparatus. This helps in avoiding any expected variations that occasionally result from the use of different chemicals, techniques and apparatus. The personal error that may occur during such type of analysis if carried out under different conditions by various technicians can be also avoided in the present work. Therefore it may be convenient to compare between the data concerning the concentrations of heavy metals in the fish samples collected during 1974 and 1995, which have been obtained under comparable conditions .

Table (1) : Size (cm) and weight (gm) of fish sampled from the Nozha Hydrodrome and lake Mariut.

Location	Year	Species	No.	Min. L. (cm)	Max. L. (cm)	Av. L. (cm)	Min Wt. (gm)	Max. Wt. (gm)	Av. Wt. (gm)
Lake Mariut	1974	*Sarotherodon galilaeus*	18	9.8	20.0	13.98	14	138	55.5
		Tilapia zillii	26	8.3	15.0	12.52	15	65	42.2
		Oreochromis aureus	24	8.2	13.5	11.89	10	43	28.0
	1995	*Sarotherodon galilaeus*	32	10.2	18.7	14.2	15	135	53.6
		Tilapia zillii	16	10.5	13.5	11.75	20	55	32.5
		Oreochromis aureus	26	13.2	17.7	14.56	35	95	55.5
Nozha Hyd.	1974	*Sarotherodon galilaeus*	15	10.1	19.7	13.25	15	135	57.5
		Bagrus bayad	18	35.0	67.0	60.25	250	2250	1612.5
		Oreochromis aureus	14	20.0	33.0	26.50	154	650	326
	1995	*Sarotherodon galilaeus*	12	9.6	19.5	15.4	15	130	52.1
		Bagrus bayad	14	29.2	33.6	31.97	120	185	156.4
		Oreochromis aureus	17	18.3	21.7	19.87	90	170	128.2

C - Determination of heavy metals concentration in lake Mariut water :

Water samples were collected seasonally from four stations in lake Mariut (as shown in Fig. 1), during 1995. Surface and bottom water samples were filtered through a 0.45 μm Millipore filter membrane. Metals in the filtered lake water were preconcentrated using APDC-MIBK extraction procedure and back extraction into an acidic aqueous solution. The final acidic extracts were analyzed using Atomic Absorption Spectrophotometer. A detailed description of the method is given by Boniforti *et. al.* (1984) and Florence and Batley (1976).

Environmental characters of the areas investigated :

It is a matter of fact that the concentrations of heavy metals in the various organs of fish can be influenced by the ambient environmental conditions. Wren and McCrimmon (1983) pointed out that, differences in heavy metals burdens of fish may be explained by description of water quality, specially dystrophy, acidity and hardness. Thus factors influencing these variables in water may also affect heavy metals availability and uptake in fish. Therefore it is believed that it is necessary to point out in the present study to the environmental conditions that prevailed at the Nozha Hydrodrome and lake Mariut during 1974 and 1995.

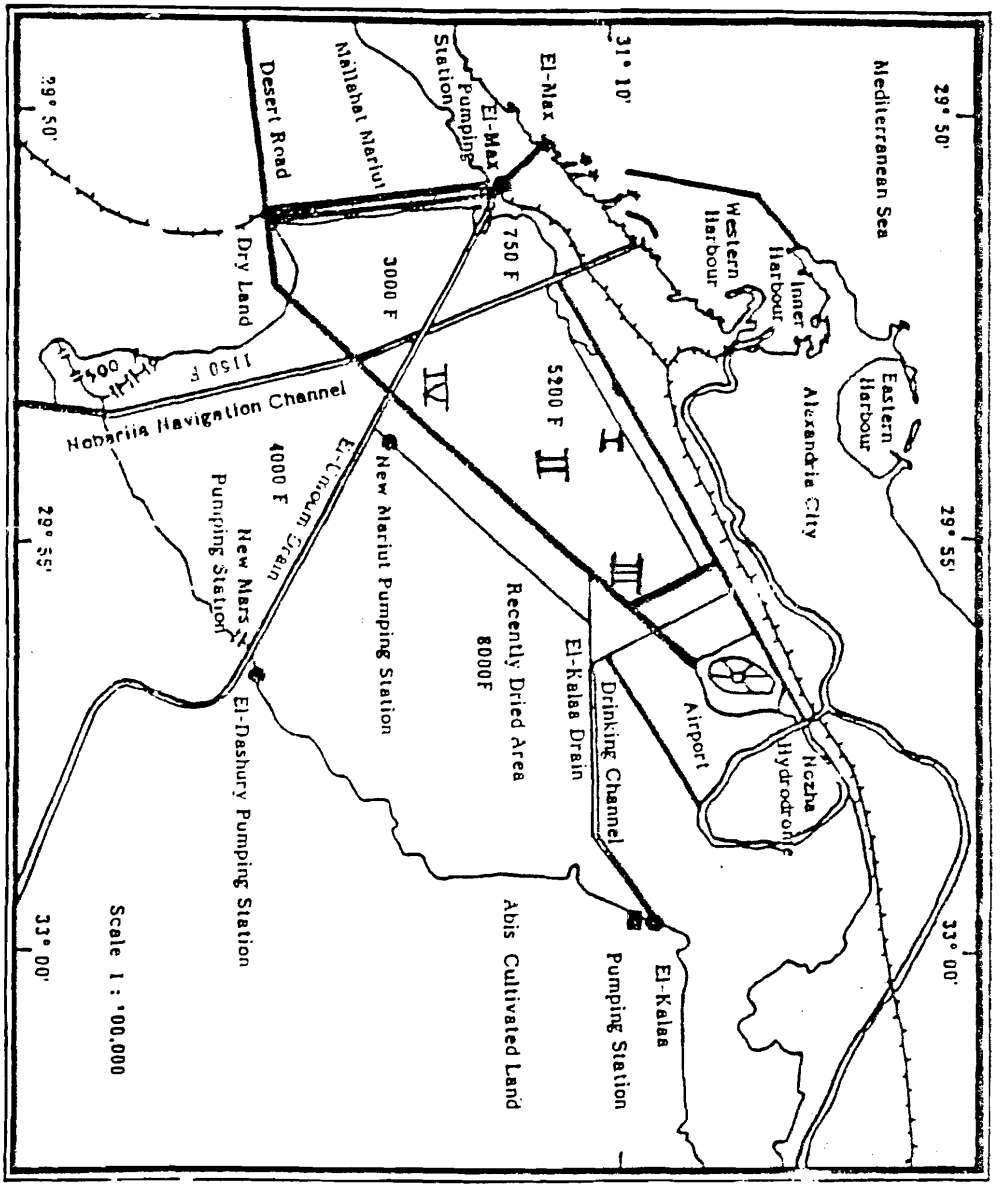

Fig. (1) : Location map of Fishing Areas from Lake Mariut and Nozha Hydrodrome

A - Environmental characteristics of lake Mariut water during the period 1970 - 1980 :

Ahdy (1982), in her study on the distribution of some heavy metals in lake Mariut, indicated that the hydrographical conditions and chemical composition of the lake water during period from October 1978 to Sept. 1979 were as follows :

The water temperature ranged between 14.6 °C in February and 32.8 °C in August.

The dissolved oxygen ranged between 2.0 and 5.1 mg/L.
Total phosphate 68.9 µg at / L.
Nitrate 35.0 µg at / L.
Silicate 198.0 µg at / L.
Dissolved Zn 10.6 µg / L.
Dissolved Cu 4.0 µg / L.
Dissolved Mn 27.1 µg / L.

During the period from May 1975 to March 1977 a detailed study was carried out on lake Mariut. This study concerned mainly with the hydrographical, hydrobiological and fisheries aspects of the lake with special reference to the problem of marine pollution in such marine environment at that time. The data and conclusions of this study can be summarized, according to El-Sharkawy 1978, in the following points :

1. The dissolved oxygen in the lake water fluctuated in a wide range from 0.14 to 11.0 mg/L depending upon the location, time of the day and time of the year. It was difficult to show specific pattern for the fluctuations off dissolved oxygen in the whole lake.
2. The biological oxygen demand ranged between 39.0 mg/L. and 175.0 mg/L. With an average value of 70.2 mg /L in the whole area of the lake. The higher values were found in the highly polluted areas of the lake while the lower values were found in the less polluted areas.
3. The concentrations of sulphides had an average value of 4.5 mg/L.
4. The weight of solid matter ranged from 2625 mg/L. And 3618 mg/L. With an average of 2980 mg/L.

5. The concentrations of dissolved chlorides ranged from 1037 mg/L to 1629 mg/L with an average of 1206 m/L.
6. The average water temperature ranged from 14.0°C in February and 29.0 °C in August.
7. The Secchi depth ranged from 12 to 120 cm.
8. The average concentration of the nitrates was 0.32 mg/L.
9. The concentrations of silicates ranged between 1.5 to 25.0 mg/L.
10. The concentrations of PO_4^{--} ranged from 0.0 to 14.8 mg/L.

Saleh ***et. al.*** (1983), in their study which concerned with the effect of water pollution in lake Mariut on mortality and survival rates of ***Tilapia zillii*** indicated that the concentrations of some heavy metals in the lake water ranged between 0.11 to 1.30 mg/l, from 0.123 to o.605 mg/l and from 0.012 to 0.046 mg/l for Cu, Zn and Mn respectively.

However the above mentioned authors believed that lake Mariut was being subjected during the period from 1970 to 1980 to the discharge of high rates of heavy metals and other sorts of marine pollution.

Those authors pointed out also that the hydrographical conditions, water chemistry and the living organisms in lake Mariut had been inversely affected as a result of discharging the industrial, agricultural and domestic wastes into the lake . Referring to their conclusions, they recommended that this problem has to be seriously considered by the Egyptian authorities for prohibiting further marine pollution of the lake which can be expected to exist in the following years.

B - Environmental characteristics of lake Mariut water during 1995-1996 :

The environmental characteristics of lake Mariut during 1995 - 1996 have been studied by Essa and Faltas (1997). The physical and chemical parameters of lake Mariut can be summarized according to those authors as following :

1. Water temperature ranged from 13.9 °C to 30.5 °C having an annual average of 23.75 °C.
2. Water salinity was low with an average of 2.49 mg/L. In the main basin of the lake. The other basins had relatively higher salinities ranging between 6.2 and 7.88 mg/L.
3. Low values of dissolved oxygen were recorded in the main basin (3.36 mg/L) while the other basins were highly oxygenated (6.07 - 7.20 mg/L) .

4. The main basin of the lake had the highest values of nutrient contents (nitrates and nitrites = 0.40 mg/L, ammonia = 7.80 mg/L, and phosphate = 2.14 mg/L) reflecting higher fertility in that zone due to the large amount of nutrients discharged into this basin by the drainage waters. Other basins were characterized by relatively lower nutrients .
5. The highest average value of total alkalinity was recorded in the main basin (319.28 mg/L) lower values were recorded in the other basins (206.67 mg/L to 186.67 mg/L).
6. The pH was comparatively low in the main basin (7.79). The highest recorded value was 8.41 in the north west basin.

Heavy metals concentrations in lake Mariut water during 1995 :

The average concentrations of some heavy metals (Zn, Cu, Mn, Fe, Cd and Pb) in the surface water of lake Mariut during 1995 were carried out through the present study. These concentrations are given in Table (2). It is obvious from such data that the concentrations of these metals varies from one part to another in the main basin of the lake. This reflects the impact of different factors affecting the lake. Cd has the lowest concentrations, but it is presently posing the greatest potential hazards.

It can also be indicated that the average concentrations of Cu and Mn in the lake water have decreased from 4.0 µg/L in 1975 to 2.56 µg/L during 1995 for Cu and from 27.1 µg/L to 5.15 µg/L for Mn. On the other hand the average concentration of Zn increased from 10.6 µg/L in 1975 to 15.10 in 1995 (Ahdy, 1982 and the present paper) .

C - Hydrographical conditions and chemistry of the Nozha Hydrodrome water during the period from 1970 to 1980 :

Analysis of the Nozha Hydrodrome water was carried out by Ahdy (1982). She collected her samples during the period from October 1978 to Sept. 1979. According to her investigation, the hydrographical conditions and chemistry of the Nozha Hydrodrome water were as follows :

Water temperature ranged between 15.0 °C in February and 33.0 °C in August.

Table (2) : Concentrations of Zn, Cu, Mn, Fe, Cd and Pb (µg/L) in the water of lake Mariut during 1995.

Season	*Area*	*Concentration of metal µg/L*					
		Zn	*Cu*	*Mn*	*Fe*	*Cd*	*Pb*
Summer	Station I	---	5.51	2.75	26.76	0.82	1.54
	II	15.27	4.65	25.12	39.35	1.89	1.41
	III	25.41	4.28	17.42	14.16	1.31	1.59
	IV	24.51	3.67	2.02	22.56	1.15	0.58
Autumn	Station I	18.68	2.95	2.41	13.89	0.34	1.69
	II	11.04	1.25	1.51	13.33	0.75	0.52
	III	17.97	0.68	1.11	3.89	1.32	0.52
	IV	16.86	1.81	1.41	12.22	1.61	1.72
Winter	Station I	16.93	2.65	2.61	13.42	1.25	1.59
	II	6.31	0.84	0.71	4.16	0.29	0.43
	III	4.94	1.21	2.61	5.09	0.29	0.58
	IV	8.22	1.21	2.11	4.63	0.59	0.94
Average		15.10	2.56	5.15	14.46	0.97	1.09

Dissolved oxygen was 8.8 ml/L.
Silicate 254 µg at/L.
Nitrate 12 µg at/L.
Total phosphate 4.5 µg at/L.
Dissolved Zn 8.1 µg /L.
Dissolved Cu 4.2 µg /L.
Dissolved Mn 3.3 µg /L.

El-Rayis and Saad (1984), indicated that the concentrations of heavy metals in Rosetta branch of the Nile River (which provides the Nozha Hydrodrome with water) were 8.2, 1.3, 0.5 µg /L for Zn, Cu and Mn respectively. The samples which were used in their study were collected during June 1978.

Wahby ***et. al.*** (1993) pointed out that the following average figures which may be considered as an indicator for some of the hydrographical conditions and chemistry of the Nozha Hydrodrome water during the season of 1982 :

- Temperature ranged from 15.6 °C in December to 28.8 °C in August.
- pH fluctuated between 8.0 and 8.9 .
- Dissolved oxygen ranged between 4.04 and 5.75 ml/L.
- Phosphate-P ranged from 5.86 to 26.15 µg at/L.
- Nitrate-N ranged from 1.56 to 18.00 µg at/L.

The date given by the last author may indicate that the dissolved oxygen in the water of the Hydrodrome was relatively low for the survival of fish in such area.

D - Hydrographical conditions and chemistry of the Nozha Hydrodrome water during 1995 - 1996 :

Analysis of the Nozha Hydrodrome water has been carried out by the governmental authorities who supervise fish farming in such area during 1995 - 1996. According to such analysis the hydrographical conditions in this area were found as follows :

- Temperature ranged between 15.0 °C and 31 °C.
- pH ranged from 8.13 to 8.60
- Dissolved oxygen fluctuated from 5.90 to 7.8 ml/L.
- Sechi depth ranged from 40 to 60 cm.
- Alkalinity ranged between 250 to 330 mg/L.
- Total nitrogen ranged from 0.022 to 350 ppm.
- Total phosphorous ranged from 0.062 to 0.093 ppm.
-
- As for the concentrations of trace metals in the river Nile water-from which the Hydrodrome receives its water - El-Shayeb (1996) indicated that:
- Dissolved Zn ranged from 0.05 to 0.1 mg/L.
- Dissolved Cu ranged from 0.03 to 0.2 mg/L.
- Dissolved Mn ranged from 0.02 to 1.92 mg/L.

It has been pointed out also by El-Sayed ***et. al.*** (1996) that the concentrations of such metals in the river Nile water during 1995 were as follows :

- Dissolved Zn ranged from 0.510 to 0.650 mg/L.
- Dissolved Cu ranged from 0.033 to 0.086 mg/L.
- Dissolved Pb ranged from 0.440 to 0.930 mg/L.

It can therefore be indicated from the recent studies which concerned with the problem of water pollution in lake Mariut and the Nozha Hydrodrome that the water of such areas are still subjected to the discharge of higher rates of domestic and industrial wastes. This leads us to expect that the marine organisms surviving in such areas are suffering from the drastic effects of marine pollution on the condition and health of these organisms.

RESULTS AND DISCUSSION

Concentrations of Cu, Zn, Mn and Pb in the muscle tissues of fish :

The concentrations of the four heavy metals Cu, Zn, Mn and Pb in the muscle tissues of fish collected from lake Mariut (***Oreochromis aureus*** , ***Sarotherodon galilaeus*** and ***Tilapia zillii***) and those of the Nozha Hydrodrome (***Oreochromis aureus*** , ***Sarotherodon galilaeus*** and ***Bagrus bayad***) during 1974 and 1995 are given in Tables (3) and (4). It can be pointed out from the results given in these Tables that :

1. The concentrations of the three heavy metals Cu, Zn, and Mn in the muscle tissues of fish collected from lake Mariut during 1995 were in most of the cases lower than the concentrations of these metals in the flesh of fish collected during 1974.

2. The concentrations of Pb in the flesh of the three fish species collected from lake Mariut during 1995 were obviously higher than the concentrations of such element in the flesh of fish collected during 1974 .

3. It is obvious that the concentrations of the four metals Cu, Zn, Mn and Pb in the flesh of fish collected from the Nozha Hydrodrome during 1995 were significantly higher than their concentrations in the flesh of the same fish species collected during 1974.

4. The decreased concentrations of the two heavy metals (Cu and Mn) in the muscles tissue of fish surviving at lake Mariut during the recent years in comparison with their concentrations in the flesh of the same species that were surviving in the same area since twenty years can be attributed to the lower concentrations of these metals in the lake water during 1995 than their concentrations in 1974. The concentrations of these metals in the lake

water as given by Ahdy (1982), were 4.0 µg/L. for Cu and 27.1 µg/L. for Mn. The present study indicated that their concentrations were 2.56 µg/L and 5.15 µg/L respectively (Table 2).

The analysis of the Nozha Hydrodrome water on the other hand in 1978 indicated that the concentrations of Zn, Cu, and Mn were 8.1 µg/L, 4.2 µg/L and 3.3 µg/L respectively (Ahdy 1982).

Recent analysis of Nile water, from which the Nozha Hydrodrome receives its water indicated that the concentrations of the metals ranged between 0.03 to 0.1 mg/L for Zn, between 0.03 to 0.2 mg/L for Cu and between 0.02 to 1.92 mg/L for Mn (El-Shayeb, 1996).

It can be believed therefore that the increased concentrations of Cu, Zn and Mn in the Nozha Hydrodrome and river Nile waters during the last few years in comparison with their concentrations in such water since twenty years may have played a major role in increasing the concentrations of such elements in the muscle tissues of fish surviving in the Hydrodrome during the recent years.

However, it has been pointed out by various authors to the idea that the concentrations of heavy metals in the marine environment can be correlated to their concentrations in the bodies of animals surviving in such environment.

Halstead (1972) pointed out that, when the chemical pollutants are dumped into the marine environment, they enter a dynamic system. They are not only diluted and dispersed by storms, winds, and currents, but become intimately involved in the complexities of the biological food web of the sea. These pollutants may be reconcentrated by the aquatic biota.

Usal and Tuncer (1984) stated that, the marine organisms accumulate the chemicals as well as the heavy metals in large quantities in their bodies as compared to their surroundings in the sea water. This results in an increase in the heavy metal levels of these organisms as well as in the fish through feeding adsorption and absorption.

Table (3) : Average concentrations of Cu, Zn, Mn and Pb (mg/Kg) in the flesh of fish collected from lake Mariut (in the dray condition).

Species	*Cu*		*Zn*		*Mn*		*Pb*	
	1974	*1995*	*1974*	*1995*	*1974*	*1995*	*1974*	*1995*
S. galilaeus	5.42	4.81	39.93	20.75	5.66	1.79	17.46	29.14
O. aureus	7.13	5.34	56.38	32.81	6.71	2.34	7.56	13.64
T. zillii	5.64	6.10	46.21	21.33	3.91	4.36	12.48	41.56

Table (4) : Average concentrations of Cu, Zn, Mn and Pb (mg/Kg) in the flesh of fish collected from Nozha Hydrodrome (in the dry condition).

Species	*Cu*		*Zn*		*Mn*		*Pb*	
	1974	*1995*	*1974*	*1995*	*1974*	*1995*	*1974*	*1995*
O. aureus	3.83	13.83	11.93	48.79	1.40	3.34	7.4	35.69
B. bayad	3.71	5.52	10.74	22.72	1.78	3.40	11.34	40.92
S. galilaeus	3.65	10.89	9.83	29.48	1.58	3.01	8.79	38.32

These statements favor to good extent the data given in the present study which indicated that the variations in the concentrations of Cu, Zn, Mn and Pb in the flesh of fish collected from lake Mariut and the Nozha Hydrodrome during the recent years and twenty years back can be fairly correlated to the concentrations of such metals in these fishing areas during such periods of time.

Concentrations of Zn, Cu, Mn, and Pb in the internal organs of fish :

Tables (5) and (6) give the concentrations of Zn, Cu, Mn and Pb in the flesh (in fresh condition), liver, and gonads of ***Oreochromis aureus*** , ***Sarotherodon galilaeus*** and ***Tilapia zillii*** from lake Mariut and ***Oreochromis aureus***, Sarotherodon galilaeus and ***Bagrus bayad*** from the Nozha Hydrodrome during 1995. It can be concluded from the data given in these Tables that :

Table (5) : Average concentrations of Cu, Zn, Mn and Pb (mg/Kg) in the flesh, gonads and liver of fish collected from lake Mariut (in the fresh wet conditions).

Species	*Cu*			*Zn*			*Mn*			*Pb*		
	Fl.	*Gon.*	*Liv.*	*Fl.*	*Gon.*	*Liv.*	*Fl.*	*Gon.*	*Liv.*	*Fl.*	*Gon.*	*Liv.*
S. galilaeus	1.18	5.50	45.56	5.09	29.99	21.30	0.49	3.35	1.93	7.14	35.29	13.12
O. aureus	1.39	14.80	25.50	8.54	39.70	15.20	0.61	3.26	2.12	3.55	47.10	5.74
T. zillii	1.37	10.25	39.02	4.79	25.20	14.30	0.98	5.97	3.63	9.33	50.52	16.14

Table (6) : Average concentrations of Cu, Zn, Mn and Pb (mg/Kg) in the flesh, gonads and liver of fish collected from the Nozha Hydrodrome (in the fresh wet conditions).

Species	*Cu*			*Zn*			*Mn*			*Pb*		
	Flesh	*gonad*	*liver*	*Flesh*	*gonad*	*liver*	*Flesh*	*gonad*	*liver*	*Flesh*	*gonad*	*liver*
O. aureus	3.6	3.30	64.55	12.70	51.2	37.07	0.87	1.65	1.33	9.29	16.59	17.42
B. bayad	1.38	-	6.76	5.68	-	14.12	0.85	-	0.45	10.23	-	7.64
S. galilaeus	2.67	3.38	30.71	7.23	28.92	21.89	0.74	1.42	1.13	9.40	16.90	18.50

1. the concentrations of Cu are very high in the liver of fish if compared by its concentrations in the flesh or gonads of fish sampled in the present paper.

Buckley ***et. al.*** (1982) indicated that, in fish, the liver is the major storage organ for copper . It has been also mentioned by Salanki ***et. al.*** (1982) that, in fishes, the liver is the selective organs for storage of copper. Accumulation of Cu in the liver can be the result of detoxicating mechanisms and may originate from this metal in the food.

It can be concluded therefore, that the liver concentrates copper in high levels. This explains the high rates of copper accumulation in such organ as found in the present paper.

2. The highest concentrations of Zn have been recorded in the gonads of fish in comparison with its concentrations in the flesh or liver of the three species investigated.

In this concern, Windom ***et. al.*** (1973), in their studies on zinc concentrations in 35 fish species from the north Atlantic, found that the reproductive organs of these fish species accumulated elevated levels of zinc in comparison with the other organs of fish.

Mawson and Fischer (1953) indicated that high zinc concentrations are associated with the reproductive organs in the vertebrates.

These conclusions agree to a good extent with the data presented in the present paper which show high rates of Zn accumulation in the gonads of fish.

3. The concentrations of Cu, Zn, Mn and Pb in the flesh of fish collected from the Nozha Hydrodrome are higher than their concentrations in the flesh of fish collected from lake Mariut in the cases of ***Oreochromis aureus***, ***Sarotherodon galilaeus*** .

4. The National Health and Medical Research Council, recommended that the standard concentrations of Cu and Pb for human consumption (Marks ***et. al.*** 1980) are :

   30.0 mg/Kg for Cu and 2.0 mg/Kg for Pb

   As for the allowable concentrations of Zn in the fish flesh, Western Australian Food and Drug Regulation listed a level of 40 mg/Kg for human consumption (Marks ***et. al.*** 1980).

   Comparing the concentrations of heavy metals in the fish flesh as shown in Tables 5 and 6 with such permissible concentrations it can be indicated that concentrations of Cu, Zn and Mn in the muscle tissues of fish collected from either lake Mariut or the Nozha Hydrodrome during 1995 are still below the allowable levels. On the other hand Pb concentrations in the fish flesh are higher than the permissible ones.

CONCLUSIONS

It can be concluded from the present investigation that :

1- The concentrations of Cu, Zn and Mn in the muscle tissues of fish collected from lake Mariut during 1995 were lower than their concentrations during 1974.

The concentrations of these metals increased in the flesh of fish sampled from the Nozha Hydrodrome during 1995 in comparison with their concentrations in fish sampled from the same area during 1974.The ratios between the concentrations of these metals during 1974 and there concentrations during 1995 in the Nozha Hydrodrome were as follows :

For Cu these ratios were :

3.61: 1 in case of ***Oreochromis aureus*** .

1.49: 1 in case of ***Bagrus bayad.***

And 2.98 : 1 in case of Sarotherodon galilaeus .

For Zn the ratios were:

4.09 :1, 2.12 :1 and 3.0 : 1 for the three species respectively .

For Mn the ratios were:

2.39 :1 for ***Oreochromis aureus***, 1.91 : 1 for Bagrus bayad and 1.90 : 1 for ***S. galilaeus .***

2- The concentrations of Pb in the muscle tissues of fish collected from either lake Mariut or the Nozha Hydrodrome increased during 1995 than that of 1974 .

The ratios between the concentrations of this element in 1995 to it concentrations in 1974 were 1.67 : 1, 1.80 : 1 and 3.33 : 1 for three fish species sampled from lake Mariut .

In case of the other three species sampled from the Nozha Hydrodrome these ratios were 4.82 :1, 3.61 : 1 and 4.63 :1 .

This leads us to conclude that the concentrations of Pb in the flesh of fish during 1995 increased to 4.26 times on the average of its concentrations during 1974 in the Nozha Hydrodrome . In case of lake Mariut this element increased in 1995 by 2.27 times its concentrations in this area during 1974

3- The observed variations in the concentrations of heavy metals in the flesh of fish collected during 1974 and 1995 from the two areas of investigation can be fairly correlated with the concentration of these metals in the water of these areas.

4- The concentrations of Cu were comparatively high in the liver of fish sampled from either lake Mariut or the Nozha Hydrodrome if compared with its concentrations in the other organs of the fish body.
On the other hand Zn showed higher concentrations in the gonads of fish than its concentrations in the muscle tissues or liver.

5- Higher concentrations of Cu, Zn, Mn and Pb were found in the flesh of ***O. aureus*** and ***S. galilaeus*** collected from the Nozha Hydrodrome than those found in the same fish species collected from lake Mariut.

6- The concentrations of Cu, Zn and Mn in the flesh fish collected from the two areas investigated are lower than the international permissible concentrations. On the other hand the concentrations of Pb in the muscle tissues of fish sampled from those areas exceeded the allowable concentrations .

REFERENCES

Ahdy, H. (1982) : Distribution of heavy metals in lake Mariut and Nozha Hydrodrome and their accumulation in fish. M.Sc. Thesis. Submitted to Fac. Sci., Alex. University .

Bernhard, M. (1976) : Manual of methods in aquatic environment research. Part III. Sampling and analysis of biological material. FAO fish techn. Pap. No. 158. PP. 124 .

Boniforti, R., R. Ferraroll, P. Frigllori, D. Heltal and G. Quelrazza (1984) : Intercomparison of five methods for determination of heavy metals in sea water. Anal. Chim. Acta, 162. 151 - 155.

Buckley, J.T., M. Roch, C.A. Rendell and A. T. Matheson (1982) : Chronic exposure of coho salmon to sublethal concentrations of copper. 1. Effect on growth, on accumulation and distribution of copper and on copper tolerance. Comp. Biochem. Physiol. 72 C : 15 - 19.

El-Rayis, A.O. and N. A. H. Saad (1984).: Concentration of Cu, Cd, Zn, Fe and Mn in the Nile river water and its contribution to the Mediterranean. VII Journees Etud. Pollutions, Lucerne, C.I.E.S.M. (1984).

El-Sayed, A.S. and H.A. Abdel Salam, (1996) : Air pollution reduction in Urban areas by solving traffic congestions. International Conference on Environmental Protection is a Must. 21 - 23 May, 1996, Alexandria, Egypt 928 - 45.

El-Shayeb, M. M. (1996) : Evaluation of the Nile Raw water : Proceedings of the 6th International Conference on Environmental Protection is a must. 21 - 23 May, 1996, Alexandria, Egypt 122 - 27.

Essa, M. A. And S. N. Faltas (1997): Impact pollution problems on some fishery aspects of Tilapias in lake Mariut basin, Egypt. Proceedings of the 7th International Conference on Environmental Protection is a must. 20 - 22 May, 1997, Alexandria, Egypt 419 - 41.

Florence, T. M., and G.E. Batley (1976) : Removal of heavy metals from sea water by a chelating resin. Talanta, 23, 179 - 86.

Ghazaly, K.S. (1992) : A comparative study of trace elements accumulation in tissues of the Teleost ***Tilapia zillii*** from contaminated and clean areas. Bull. Nat. Inst. Ocean. And fish., A.R.E. 18 : 37-41 .

Halstead, B.W. (1972) : Toxicity of marine organisms caused by pollutants. Marine pollution and sea life. Fishing news books Ltd. London. 584-94.

Marks, P.J., D. Plaskett, I.C. Potter and J.S. Bradly (1980) : Relationship between concentration of heavy metals in muscle tissues and body weight of fish from the Swan - Avon estuary, Western Australia. Aust. J. Mar. Fresh water Res., 31 : 783 - 93 .

Mawson, C. A. And H. I. Fischer (1953) : Zinc and carbonic anhydrase in human semen. Biochem. J., Vol. 55 : 696 - 700 .

Saad, M.A.H., A.A. Ezzat, O. A. El-Rayis and H. Hafez (1981) : Occurence and distribution of chemical pollutants in lake Mariut, Egypt. II. Heavy metals. Water, Air and Soil pollution 16 : 401-7.

Salanki, J., K. V. Balogh and E. Berta (1982) : Heavy metals in animals of lake Balaton. Water Research Vol. 16. 1147-52 .

Saleh, H., A. Hamza and B. El-Baghdadi (1983) : Effect of water pollution in lake Mariut on mortality and survival rates of ***Tilapia zillii*** (Gerv.). Bull. Of High Inst. Of Pub. Health. Vol. 8 No. 5 : 60 - 76 .

Usal, H. And S. Tuncer (1984) : A comparative study on the heavy metals concentrations in some fish species and in the sediments from Izmir Bay. VII es Journees Etud. Pollutions . Lucerne. C. I.E. S. M. 275 - 84 .

Wahby S.D., M. Shridah, M. Ebeid and W. Abu El-Naga (1993) : Fertilizing a small lake - Nozha Hydrodrome, Egypt. Arch. Hydrobiol. 4 : 589 - 604 .

Windom H., R. Strikney, R. Smith, D. White and F. Taylor (1973) : Arsenic, cadmium, copper, mercury and zinc in some species of North Atlantic finfish. J. Fish. Res. Bd. Can. 30 : 275 - 79.

Wren, C.D. and H.R. Mc Crimmon, 1983. Mercury levels in the Sun fish, ***Lepomis gibbosus***, relative to pH and other environmental variables of Precambrian Shield Lakes. Can. J. Fish. Aquat. Sci., 40: 1737-44.