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EFFECT OF SEX ON THE CONCENTRATION LEVELS OF SOME TRACE METALS IN OREOCHROMIS NILOTICUS OF LAKE EDKU AND SARDINELLA AURITA OF THE MEDITERRANEAN WATERS, EGYPT

By

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ABSTRACT

*The four trace elements Zn, Cu, Mn and Pb were determined in the flesh, gonads and liver of the males and females, of the fresh water fish species **Oreochromis niloticus** (Linn) (from Lake Edku) and the marine fish species **Sardinella aurita** (Valenciennes) (from the Mediterranean coast of Egypt) to contribute in qualifying the pollution risk from the consumption of such two common fish species in Egypt.*

*Results showed that the average concentration of Zn in the muscles of **S. aurita** was 12.15 and 19.50 mg/kg for the females and males respectively. For Cu it was 1.85 and 2.85 mg/kg. On the other hand the concentration of Zn in the muscles of **O. niloticus** was 6.01 and 6.15 mg/kg and for Cu it was 1.66 and 1.67 mg/kg for the females and males respectively. These concentrations are lower that the internationally allowable levels.*

As for Pb the concentrations were 7.04 and 6.50 mg/kg in the females and males of the former species. The concentrations of the mentioned element for the latter species were 9.01 and 8.63 mg/kg

respectively. Such concentrations are higher than the international permissible levels.

The differences between the concentrations of Mn in the flesh and gonads of the two sexes of both species are highly significant. It is also concluded that the reproductive organs of the females accumulate higher concentration of Zn than the males.

On the other hand the interelemental relationships among the concentrations of Zn, Cu, Mn and Pb in the various organs of fish showed fair positive relationships in most of the cases.

INTRODUCTION

The concentrations of heavy metals in the marine and fresh water fish species have become one of the subjects of investigation in many parts of the world. Fish of various species tend to accumulate heavy metals in the different parts of their bodies to a certain degree. this process leads to cocentration of certain metals to reach limits which may be hazardous if used for human consumption.

Some trace metals such as Zn, Cu, and Mn are essential for the marine organisms if present below certain or limited concentrations in the bodies of these organisms they act as metal factor in physiological metaloenzymes (Lehninger 1977). If these metals are accumulated with higher concentrations, they will be considered as hazardous elements for both the marine organisms and consequently for the human consumption. In this respect, Baccini and Roberts(1976) reported that, although trace amounts of heavy metals, copper and manganese are absolutely necessary to living organisms, these elements have a deleterious effect above a certain amount.

In Egypt, ***Oreochromis niloticus*** is considered as one of the most commercial and common fresh water fish species. It constitutes a considerable part in the annual fish production of the Northern Delta Lakes of Egypt.

On the other hand ***Sardinella aurita*** can be considered as one of the most important marine fish species caught from the Egyptian coast of the Mediterranean.

Due to the commercial importance of ***Oreochromis niloticus*** and ***Sardinella aurita*** for human food consumption in Egypt, it is attempted in the present study to determine the levels of Zn, Cu, Pb and Mn concentrations in the muscle tissues of these fish species. This will help in qualifying the pollution risk from the consumption of these two common species.

It has been attempted also to investigate whether it is necessary in our studies to separate between the figures representing the concentrations of the trace elements in the various organs of the females and males of the fish sampled or it is possible and convenient to combine the two concentrations in one figure without indicating the sex of fish.

Correlation coefficients between the concentrations of each element in the fish livers with those in the gonads have been calculated with the aim of investigating to what extent can we expect that higher accumulation rates of such elements in the liver may be accompanied by an increase in their concentrations in the gonads of the males and females. Similar correlations were carried out between the concentrations of these elements in the liver and muscle tissues of the fish.

On the other hand it has been attempted to find out to what extent it is possible to correlate alternatively between the mutual concentrations of each pair of these elements in the muscle tissues, liver and gonads of fish. This may help in giving a fair conclusion about the interelemental relationships between Zn, Cu, Pb and Mn, in the internal organs of both the males and females of ***Oreochromis niloticus*** and ***Sardinella aurita*** living in the Egyptian environment.

MATERIAL AND METHODS

Fish samples of ***Oreochromis niloticus*** were collected from different fishing localities of Lake Edku during the fishing season of 1994 / 1995. On the other hand, regular fish sampling was undertaken for ***Sardinella aurita*** from the commercial catch of purse seine landed at El-Anfoushi centre during the same

fishing season. The sampled fish were kept iced in clean polyethylene bags when transferred to the laboratory. Fish length of each sample was measured to the nearest mm. Total weight in gm of each fish was determined.

Samples were taken from the muscle, liver and gonads and kept in small air tight plastic bags for trace metals analysis.

Digestion of samples was carried out by the use of HNO_3 (65% conc.) at 120°C.

Determination of Cu, Zn, Pb and Mn concentrations in the fish organs were carried out using atomic absorption spectrophotometre, Perkin Elmer type, model 2380.

The number of samples, length and weight ranges of males and females of the two fish species investigated are given in table (1)

Table (1): Length and weight of speciemens examined.

Species	Sex	No of samples	Length(cm.) Min.	Max.	Av. length	Av. weight
Sardinella *aurita*	Female	21	15.5	23.6	20.60 ±2.08	71.70 ±20.42
	Male	12	15.1	24.2	21.23 ±2.40	74.70 ±21.66
Oreochromis *niloticus*	Female	16	15.0	24.5	19.77 ±2.70	140.5 ±48.49
	Male	15	16.6	26.2	19.75 ±2.46	146.1 ±55.74

RESULTS AND DISCUSSIONS:

A. 1. Zinc Concentrations:

The data for Zn concentrations in the muscle tissue liver and gonads of males and females of ***Sardinella aurita*** and ***Oreochromis niloticus*** are given in table (2).

It can be demonstrated from this table that the average concentrations of Zn were lower in the muscles than that in the gonads or liver of the fish examined.

Higher concentrations of this element were present in the liver of ***Sardinella aurita*** than that found in the gonads of either the males or females of this species. on the other hand, higher concentrations of Zn occured in the gonads of ***Oreochromis niloticus*** than that in the liver of both the males and females.

It is worth mentioning that the fish samples used in the present investigation had more or less comparable stages of maturity. Collection of these samples was carried out mainly during their spawning seasons.

The accumulation of Zn in the reproductive organs with higher concentrations than that in the liver of some fish species has been indicated in the literature by other authors.

Shakweer ***et al*** (1993) in a previous study on heavy metals content in some fishes, reported that high concentrations of Zn were detected in the reproductive organs, while moderate concentrations of this element were found in the liver of ***Oreochromis niloticus***.

Windom ***et al*** (1973) in their studies on Zn concentrations in 35 fish species from the North Atlantic found that the reproductive organs of such fish species accumulated elevated levels of Zn in comparison with the other organs including the liver of the fish.

The findings of Shakweer ***et al*** (1993) and Windom ***et al*** (1973) agree to some extent with the results given in the present paper in that the Zinc concentrations in the gonads exceed in some cases its concentration in the liver of fish.

In this respect it may be valuable to indicate that it has been demonstrated while carrying out the present investigation that the gonads of both males and females of ***Oreochromis niloticus*** attained higher concentrations of Zn at the higher stages of their maturity. The ovaries of the females contained an average concentration of 43.8mg. Zn/kg. of tissue at stages V and VI of maturity. The ovaries having IV and III stages of maturity, or below, contained only

26.9mg./kg. of this element. The testis of males of this species contained 26.1mg./kg. and 25.0mg./kg at their higher (V and VI) and lower (IV and III) stages of maturity in respective.

The conditions of gonads described in the present study were followed by applying the Hjort scale (1910) of maturity stages which is developed by Sakun and Butskaya (1968).

2. Significance of differences between Zinc concentrations in the organs of the males and females:

To test the significance of differences between the average concentrations of Zinc in the flesh, gonads and liver of the males and the corresponding concentrations in the organs in the females of each of the two species investigated, the student test (t-test) was applied in the present paper. The calculated values of "t" are given in table(2).

It can be indicated from the (t) figures given in this table that the differences between Zinc concentrations in the muscles of the males and females are not significant at high levels in cases of either ***Sardinella aurita*** or ***Oreochromis niloticus***.

The concentrations of this metal in the ovaries and liver of the females of ***Sardinella aurita*** differed significantly at high levels from the corresponding concentrations in the same organs of the males.

On the other hand the concentration of Zinc in the ovaries of ***Oreochromis niloticus*** differed significantly from its concentrations in the testis of this fish species.

Miller ***et al*** (1992), in their work on Zn accumulated in tissus of white sucker, pointed out that there was a large difference between sexes in the concentrations of Zn in gonad tissue. The concentrations of this element in the ovaries were higher than those in testis. This agrees completely with the findings given in the present investigation.

Table (2) Zn cocentrations mg/kg in the flesh, gonads and livers of *Sardinella aurita* and *Oreochromis niloticus*

Species	Sex	No.	Flesh				Gonads				Liver			
			Min.	Max.	Av.	(t)	Min.	Max.	Av.	(t)	Min.	Max.	Av.	(t)
Sardinella aurita (Medit)	Fem.	21	3.1	29.0	12.15	1.6759	26.2	118.7	44.93	3.6906	18.0	282.0	79.03	2.0862
	Male	12	7.5	49.0	19.50		11.6	72.8	21.56		13.5	72.0	38.83	
O.niloticus (Lake Edku)	Fem.	16	3.9	9.2	6.01	0.2184	21.5	56.6	37.47	2.9446	12.8	39.2	25.73	0.6272
	Male	15	3.9	10.3	6.15		11.3	58.7	25.21		17.6	55.9	23.77	

Table(3) Cu concentrations mg/kg in the flesh, gonads and livers of *Sardinella aurita* and *Oreochromis niloticus:*

Species	Sex	No.	Flesh				Gonads				Liver			
			Min.	Max.	Av.	(t)	Min.	Max.	Av.	(t)	Min.	Max.	Av.	(t)
Sardinella aurita (Medit)	Fem.	21	0.80	4.80	1.85	3.0736	1.3	5.6	3.04	0.9132	3.8	37.5	13.33	0.0552
	Male	12	1.30	3.80	2.85		1.9	6.3	3.48		2.8	22.5	13.13	
O.niloticus (Lake Edku)	Fem.	16	0.90	2.80	1.66	0.0559	2.9	9.5	4.01	1.7810	8.8	137.4	53.43	0.5598
	Male	15	0.70	4.80	1.67		3.9	9.5	5.43		10.6	159.9	46.30	

The liver of the females of ***Oreochromis niloticus*** accumulated comparable concentrations of Zn if compared by its accumulation in the livers of the males.

B. Copper concentrations:

The minimum, maximum and average concentrations of copper in the fish flesh, gonads and liver of the males and females of ***Sardinella aurita*** and ***Oreochromis niloticus*** are given in table(3).

It can be observed from this table that the liver accumulated high concentrations of this element in both the two species if compared with its concentrations in the flesh or gonads.

This agrees to a large extent with the statement of Buckley ***et al*** (1982) that "in fish, the liver is the major storage organ for copper."

It has been mentioned also by Salanki ***et al*** (1982) that "in fishes, for copper, the liver was found to be the selective storage organ".

Lauren and McDonald (1987) pointed out that the fish liver can not be treated as the sole site of internal copper accumulation. The copper binding capacity of trout liver reached the highest level after about 7 days of exposure to a solution contaning 55mg Cu /L.Further copper uptake was distributed to other internal tissues.

It can therefor be concluded from the above discussions that the liver concentrates copper in higher levels. This emphasizes the figures given in the present paper that high rates of copper accumulated in such organ if compared with either the flesh or gonads of fish as shown in table (3).

As for the differences between the rates of copper accumulation in the internal organs of the males and females of the two species under investigation, it can be detected from the data given in table (3) that in most of the cases, such differences were not significant at high levels.

With the exception of the flesh of ***Sardinella aurita*** and the gonads of ***Oreochromis niloticus***, the internal organs of the two sexes contained comparable concentrations of copper.

***C. Manganese concentrations*:**

The data concerned with the concentrations of Mn in the two species examined are given in table (4).

It can be generally observed from the present analysis that the concentrations of this element are high in the organs of the fresh water fish ***Oreochromis niloticus.***

However, Beliles (1979) pointed out that the major sources for manganese as air and water pollutant are iron and steel manufacturing and the burning of diesel fuel in the motor cars.

It can be expected therefor that fishes living in Lake Edku which situates adjacent to Edku city and borderd with various major roads, usually crowded by motor traffic, it may be expected that such fishes can be subjected to high concentrations of manganese.

The concentration of Mn from the different drains connected to the lake can not be neglected as the major source of Mn to the lake.

The concentrations of Mn in the internal organs of ***Sardinella aurita*** were relatively low. This may be due to the fact that this fish species is one of the most active pelagic fish species, which must not be vulnerable to high concentrations of Mn, as a result of their ability for the movement towards less polluted areas of the sea coast.

It may be interesting to point out to the conclusion of Saleh (1980, 1982) who showed that fish living in fresh water polluted with heavy metals accumulates more concentrations of these metals in its body than that living in brackish or saline water polluted with the same metals. This may be attributed to osmoregulation of elements and ions by fish living in different water salinities.

As for the comparison between the concentrations of Mn in the various organs of the two sexes of fish examined, it can be observed from table (4) that the flesh and gonads of the males of ***Sardinella aurita*** contained higher concentrations of this element than that in the females. The difference between

the two concentrations is significant at high levels. On the other hand the gonads of the two sexes of ***Oreochromis niloticus*** contained different concentrations of this element. It will be a sort of biasness to combine between the two concentrations in such cases in a one figure. The testis of the males contained 9.11 mg./kg. while the ovaries of the females contained only 5.83 mg/kg. Therefor it is reasonable to deal with each of the two figures separately.

D. Lead concentrations:

The distribution of lead in the marine environment has been considerably modified by human activities. It has been estimated that the rate of introduction of lead into the sea has increased 27 fold since the Pleistocene period (Tatsumoto and Peterson 1963). however by far the greatest increase has taken place in the last four decades as a result of the use of lead tetraethyl as an additive to petrol. The main source of lead pollution in the marine environment is the washing out of the atmosphere.

It is aimed in the present paper to investigate to what extent is the most common and commercial fish species ***Oreochromis niloticus*** and ***Sardinella aurita*** are contained by such toxic element. The concentrations of Pb in the internal organs of these two species are given in table (5).

It can be observed from the data given in this table that the average concentrations of Pb in the fish flesh of both ***Oreochromis niloticus*** and ***Sardinella aurita*** are considerably high if compared by the secure or allowable concentrations of this element.

It is important to point out that the risk to man that may result from the uptake of trace elements can be estimated by comparing the metal intake from an observed consumption rate of seafood with the provisionable tolerable weekly intakes (PTWI).So far the PTWI for a man of 70 kg. weight of the lead metal is 2.00 mg. kg. (Bernhard 1982).

Shakweer (1993), in her study on the contamination of marine fish species in Egypt, with lead, indicated that the flesh of all the 22 fish species examined, contained Pb with higher concentrations than the toerable levels except one species.

It can therefore be indicated that fish contamination with lead in the Egyptian water can be considered as a serious phenomena. Further water contamination by Pb in the Egyptian Mediterranean coast or the inland lakes must be seriously prohibited.

Concerning the differences between the concentrations of Pb in the organs of the males and females of the two species investigated, it can be observed from the data given in table (5) that the average concentrations of this element in the livers of the males varied from that of the females. The calculated values of (t) to test the significance of such differences were 1.1411 in case of ***Sardinella aurita*** and 1.3305 in case of ***Oreochromis niloticus.*** This emphasises that the observed differences between the two averages are not significant at high levels. Such differences may in fact be attributed to a single, high or abnormal figure in a group of concentrations, this single figure affects or leads to an increase in the calculated values of both the variance and average concentrations of such group of concentrations. It is necessary and valuable in many cases to include such odd figure in the data to indicate to what extent can the maximum level of contamination be expected among the investigated fish population.

E. Correlation between the concentrations of Zn, Cu, Mn, and Pb in the liver with their concentrations in the flesh and gonads of fish:

It is a matter of fact that the liver condition of some fish species can be observed as an indicator of an aquatic environmental pollution with heavy metals and insecticides.

Saleh (1982) found that there is a high and progressive increase in the liver accumulation factor of trace metals when the fish lives in polluted water.

Lauren and McDonald (1987) indicated that the copper binding capacity of trout liver reached the highest level after about 7 days of exposure to a solution containing 55mg Cu/L. Further copper uptake was distributed to the other internal tissues.

Table (4) Mn concentrations mg/kg in the internal organs of *Sardinella aurita* and *Oreochromis niloticus*:

Species	Sex	No.	Flesh				Gonads				Liver			
			Min.	Max.	Av.	(t)	Min.	Max.	Av.	(t)	Min.	Max.	Av.	(t)
Sardinella aurita (Medit)	Fem.	21	0.20	1.30	0.51	3.4134	0.20	1.90	0.87	1.7045	0.90	18.7	4.35	0.1578
	Male	12	0.50	1.70	0.98		1.30	2.50	1.24		1.80	5.6	4.10	
O.niloticus (Lake Edku)	Fem.	16	0.20	2.50	1.21	1.0384	0.80	18.00	5.83	1.3115	2.30	8.5	5.69	0.1347
	Male	15	0.20	2.30	0.93		2.60	16.50	9.11		1.10	15.0	5.85	

Table (5) Lead concentrations mg/kg in the internal organs of *Sardinella aurita* and *Oreochromis niloticus*:

Species	Sex	No.	Flesh				Gonads				Liver			
			Min.	Max.	Av.	(t)	Min.	Max.	Av.	(t)	Min.	Max.	Av.	(t)
Sardinella aurita (Medit)	Fem.	21	1.2	14.6	7.04	0.4770	2.1	17.9	8.10	0.2959	5.1	127.7	34.74	1.1411
	Male	12	2.3	12.8	6.50		2.1	14.9	8.63		9.6	38.3	24.83	
O.niloticus (Lake Edku)	Fem.	16	4.3	12.9	9.01	0.2856	2.9	25.7	13.59	1.6158	5.1	19.3	13.61	1.3305
	Male	15	4.8	19.3	8.63		10.3	64.3	21.09		5.5	25.7	16.25	

Stevens (1968) pointed out that the white muscle of trout makes up 66% of the whole body wet weight, this is the most likely site for extra hepatic copper accumulation.

Therefore it can be borned in mind that the extra fish concentrations of trace metals in the fish liver may lead to the distribution of these metals to the other internal organs of the body.

It is attempted in the present paper to correlate between the concentrations of Zn, Cu, Mn and Pb in the livers of the males and females of ***Oreochromis niloticus*** and ***Sardinella aurita*** and the concentrations of these elements in the flesh and gonads of these fish species .

It is usually preferred to correlate between two variables numerically, such numerical values are termed as correlation coefficient. The advantage of correlation is that it describes not only the magnitude of correlation but also its direction.

Tables (6) and (7) give the correlation coefficients (r) between the concentrations of Zn, Cu, Mn and Pb in the liver of the two fish species investigated and the corresponding concentrations of these elements in the flesh and gonads of fish in respective.

It can be indicated from table (6) that the correlation coefficient (r) had positive values in 13 cases of the 16 ones given in this table. This enables us to presume that the increase in the concentrations of these metals in the fish liver can be associated with an increase in the concentration of such elements in the reproductive organs of either the males or females of the fish examined.

From the statistical point of view, it had been indicated by Shukla and Gulshan (1971), that, if (r) is more than 0.40 but less than 0.6, there is a fair degree of correlation. If (r) is less than 0.35, there will be correlation but little association between the two series.

It appears therefore from the figures given in table (6) that in most cases, specially in that of Mn, there was a fair degree of correlation between the concentrations of the elements in the liver and gonads of fish.

As for the correlation between the concentrations of the four trace metals in the liver of the two groups examined and concentrations of these elements in the flesh, the (r) figures had positive values in 10 cases from the given 16 ones.

This indicates again that there is a general positive relationship between the two groups of concentrations. This means that the increase in certain trace metal concentration in the fish liver, can lead in most cases to an increase in the concentration of this metal in the fish flesh. The degree of correlation between the two concentrations was fair in some cases as it is shown in table (7).

F. Interemental relationships in the flesh, gonads and liver of fish.

The correlation between the concentrations of metals analyzed in the different organs of fish is described in the present investigation.

Such correlation has been previously attempted by some authors who assumed that a mutual influence between macro and microconstituents in marine organisms affects, to a large degree, the bioavailability of some metals to aquatic fauna and flora (Szefer, 1990 and Di Giullio and Scanlon, 1985). The result of such interactions may be an increase in the recovery of the trace metals from the surroundings, or competitive inhibition of their accumulation by some representatives of marine biocenosis.

To determine the metal relations, correlation coefficients have been computed for the concentrations of each pair of metals in the various organs of the males and females of ***Sardinella aurita*** and ***Oreochromis niloticus***. Such data are given in table (8).

Table(6): Correlation coefficient between Zn, Cu, Pb and Mn concentrations in the gonads and liver of fish:

Species	Sex	Correlation coefficient (r)			
		Zn	Cu	Pb	Mn
Sardinella aurita (Medit)	Fem.	+ 0.4677	+ 0. 1246	+ 0.1782	+ 0.6654
	Male	- 0.1433	+ 0.7229	+ 0.2780	+ 0.3388
O.niloticus (Lake Edku)	Fem.	+ 0.5862	+ 0.0396	- 0.2406	+0.6179
	Male	+ 0.1897	- 0.1629	+ 0.0170	+ 0.6757

Table (7): Correlation coefficient between the concentrations of trace metals in the liver and flesh of fish:

Species	Sex	Correlation coefficient (r)			
		Zn	Cu	Pb	Mn
Sardinella aurita (Medit)	Fem.	+ 0.7620	- 0.3274	+ 0.3015	+ 0.3135
	Male	- 0.0027	+ 0.6731	+ 0.5489	+ 0.6497
O.niloticus (Lake Edku)	Fem.	+ 0.8324	+ 0.1418	+ 0.4267	+ 0.0407
	Male	+ 0.0137	- 0.3506	- 0.2247	- 0.3320

Table (8) Correlation coefficients expressing the interelemental relationships in the fish organs:

Species	Sex	Element	Gonads			Liver			Flesh		
			Cu	Pb	Mn	Cu	Pb	Mn	Cu	Pb	Mn
Sardinella aurita (Medit)	Female	Zn	- 0.4617	- 0.0783	- 0.0906	+ 0.4987	+ 0.7427	+ 0.2144	+ 0.2996	- 0.1426	+ 0.5445
		Cu		+ 0.0579	+ 0.0073		+ 0.6267	+ 0.1669		- 0.0693	+ 0.3874
		Pb			+ 0.2757			+ 0.7785			- 0.1873
	Male	Zn	+ 0.8291	+ 0.7774	+ 0.7990	+ 0.5904	+ 0.3404	+ 0.7930	- 0.0518	+ 0.4842	+ 0.1581
		Cu		+ 0.4487	+ 0.7194		+ 0.6769	+ 0.9206		+ 0.2995	+ 0.6164
		Pb			+ 0.4136			+ 0.7561			- 0.2464
O.niloticus (Lake Edku)	Female	Zn	- 0.4332	- 0.4491	- 0.5436	+ 0.2099	+ 0.3601	- 0.4917	- 0.3753	+ 0.2978	+ 0.3520
		Cu		+ 0.0061	+ 0.1657		- 0.1829	- 0.0906		- 0.2011	+ 0.2868
		Pb			+ 0.0871			- 0.2205			*- 0.1678*
	Male	Zn	+ 0.4767	+ 0.2243	+ 0.0624	+ 0.2096	+ 0.0958	+ 0.0116	+ 0.6422	+ 0.3653	+ 0.6897
		Cu		- 0.2047	+ 0.4086		+ 0.2926	- 0.3409		+ 0.7512	+ 0.1272
		Pb			+ 0.5463			+ 0.3485			- 0.1425

The following points could be found from the data given in this table:

1. Positive correlations existed between the concentration of Zn and the other three elements in the testis of the males of fish examined while negative correlations were found between the concentrations of Zn and the other element in the ovaries of the females. Strong coupling correlation existed between Zn and the other elements in case of the females of ***Sardinella aurita.***

2. Positive correlations were present between the concentrations of Zn and other element in the liver of the males and females of fish analysed with the exception of one case (liver of the female of ***Oreochromis niloticus***).

3. Positive correlations existed in general between the concentrations of Zn and the other elements in the flesh of the two species studied. Two cases only of the 12 ones included in the tables attained negative associations.

4. (Cu-Pb) (Cu-Mn) were positively correlated in the gonads of both the males and females of ***Sardinella aurita*** and ***Oreochromis niloticus*** with the exception of one case (Cu-Pb) in the male of ***Oreochromis niloticus.***

5. Positive correlations existed between Cu and the other two elements (Pb,Mn) in the liver of the two sexes of the marine fish species ***Sardinella aurita***. Such correlations were negative in most of the cases belonging to the fresh water fish species ***Oreochromis niloticus.***

6. The correlations between Cu and the other two elements (Pb,Mn) in the flesh of fish were in most cases positive. In the (8) cases given only two cases had negative correlation.

7. The Pb exhibited positive correlation with Mn in the gonads of fish examined. On the other hand the two elements showed negative correlation in the fish flesh in all cases.

It could be emphasized that statistically significant interelement relationships persist between the four elements in spite of the complex influences of regional factors, taxonomic features, variation of organs and age of fish.

Summary and Conclusions:

The Egyptian coast of the Mediterranean and the Northern Delta Lakes has been subjected in the last twenty years to a drastic rate of pollution. These fishing grounds are receiving industrial, agricultural and domestic wastes with high amounts. This will become sooner or later of real danger for the fish populations living in these areas which are considered as a major source for human nutrition.

The analysis of two fish species namely ***Oreochromis niloticus*** (fresh water fish species) and ***Sardinella aurita*** (marine fish species) for trace metals which has been carried out in the present paper indicated that:

(1) Higher concentrations of Zn occurred in gonads of both sexes of Oreochromis than that occurred in their liver. The concentrations of this element in the gonads increased at higher stage of fish maturity.

(2) The differences between the concentrations of Zn in the reproductive organs of the two sexes of ***Oreochromis niloticus*** and ***Sardinella aurita*** were significant at high levels. The females accumulated higher concentrations than the males in the two species.

(3) The liver accumulated higher concentrations of Cu than that accumulated in the flesh or gonads of fish. This may indicate that, in fish, the liver is the major storage organ for the Cu.

(4) The differences between Cu concentration in the internal organs of the males and the females of fish examined were not significant at high levels.

(5) The fresh water fish species ***Oreochromis niloticus*** concentrated Mn with high rates. The marine fish species ***Sardinella aurita*** accumulated this element with low rates. This may be due to the fact that ***Sardinella aurita,*** as a pelagic fish species, was able to move away to less polluted area with Mn in the open sea water.

(6) The differences between Mn concentrations in the internal organs of the males and females of fish examined were significant at high levels in some cases.

(7) The average concentrations of Pb in the flesh examined were relatively high if compared with the tolerable levels. This means that further water contamination by Pb must be seriously prohibited and controlled by the Egyptian authorities.

(8) It was not obvious, from the statistical point of view, to get significant differences at high levels between the concentrations of Pb in the internal organs of the males and females of fish examined.

(9) It was possible to investigate that positive correlations existed between the concentrations of Zn, Cu, Mn and Pb in the liver of fish if compared with their concentrations in either the flesh or gonads in most of the cases. This may indicate that the liver was able to distribute the increased concentrations of these elements to the other internal organs of the fish.

(10) It could be investigated that there was significant interelemental relationships among the concentrations of four elements Zn, Cu, Mn and Pb in the various organs of fish. These relationships existed in spite of the complex influences of regional factors, taxonomic features, variation of organs and age of fish.

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