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FISH LIVER AS INDICATOR OF AQUATIC ENVIRONMENTAL POLLUTION.

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ABSTRACT

Laboratory experiments have shown high accumulation of pollutants, e.g. heavy metals and insecticides in the liver of **Tilapia zillii** Gerv., living in fresh or saline water. Meanwhile, the field applications demonstrated a change and increase in the liver conditions when the fish lives in polluted water. This could allow the hepatosomatic index to be considered as an indicator of aquatic environmental pollution with heavy metals and insectisides.

INTRODUCTION

One of the important functions of the liver is to clean the blood, coming from the intestine, of any poisons or pollutants. Potshukov (1954) showed that fishes are less sensitive to poisons absorped by the intestine than mammals. He explained that the fish has a liver with tissues less affected with poisons. Imura (1972) proved that the liver of tuna converts mercury into methyl mercury which is less poisonous. Bjerk (1973) reported that the highest DDT content of Cod living in water polluted with DDt occured in the liver. Harvey et al (1974 b) suggested that for the chlorinated hydrocarbons, the lipid fractions of gilled organisms are in some sort of chemical equilibrium with the sea water and that the pollutants enter the blood through permeable body surface, such as the gills. The chlorinated hydrocarbons would then be partitioned between blood lipids, and presumably by circulation, with other body lipids and the sea water directly through permeable body membranes. Berman and Ulzin (1968) and Saleh (1969) had mentioned that the fish liver is the main reservoir for microelements and lipids necessary for the vitality of the fish.

The present study is a trial to prove that liver condition could be used as an indicator of aquatic environmental pollution with heavy metals and insecticides.

MATERIALS AND METHODS

This study consists of two parts

a- Laboratory experiments were carried out by using labelled calcium ^{45}Ca as chloride, labelled iron ^{55}Fe as chloride, labelled mercury ^{203}Hg

as chloride and labelled ^{14}C DDT dissolved in acetone. For each isotope, two aquaria were used; one for saline water (30‰), and the other for fresh water (tap water). Each aquarium contained 50 liters water and 20 euryhaline **Tilapia zillii** Gerv of similar size (17 gm in weight) captured from Lake Qarun where the water salinity is about 30‰. They were left in the aquaria for ten days for acclimatization and an equal amount of the radioactive element was added. Each 10 days, four fishes were taken from each aquarium. The fish length and weight was recorded. Its liver was removed, weighed and its activity was measured by Gigar counter as impulses/minute. One gram of the fish flesh was cut and its activity was also measured.

Each 5 days, the radioactive element content in water aquaria was measured as impulses/minute in ml water. The water aquaria were slowly aerated by compressed air and its temperature was 25 ± 3°C (no artificial heaters were used). The fish was not fed during the experiments.

The accumulation factor (AF) for any elements in an organ was calculated by a simple ratio

AF = Impulses.minute. gm tissue/Impulses.minute.l ml water

The value of AF is a good indicator for the interaction between the fish and its environment (Goldberg,1976).

b- Field work:

Various sized **Tilapia zillii** were collected from the polluted water drain El-Qalaa, Lake Mariut and another sample from the comparatively clean area of the same lake, namely Bab El-Abid.

The gutted weight of every fish was recorded. Its liver was removed and weighed. The hepato-somatic index was calculated by the equation (Jangaard, 1967):

H.S.I. = Wt. of liver in gm. x 100 /Gutted wt. of fish in gm

RESULTS AND DISCUSSION

The discussion includes; first, the results obtained from the experimental work. Secondly, the results of the field work are presented and discussed to demonstrate the difference between the hepatosomatic index obtained for a fish living in polluted environment and that living in relatively clean environment.

The laboratory experiments showed that the accumulation factor of ^{45}Ca in the liver and the flesh of **Tilapia zillii** was nearly the same. This indicates that the fish liver does not play an important role in the storage of calcium which is considered as one of the macroelements of hydrosphere. However, it was noticed that Tilapia zillii living in fresh-water contained more ^{45}Ca than that living in saline water. Consequently, ^{45}Ca content in the fresh

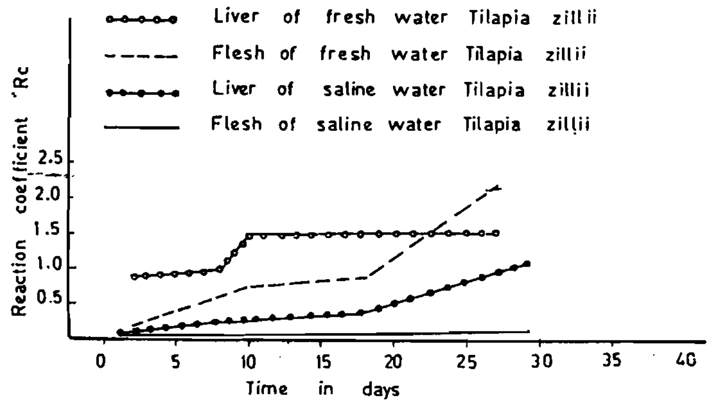

Fig. 1. Variation of Ca^{45} in the liver and flesh of T. zillii living in fresh and saline water.

water aquarium decreased by about 20% (from 426 to 339 impulses/minute/ml water) and by only 8% in the saline water (from 439 to 401 impulses/minute/ml water), table 1 and figure 1.

The accumulation factor ^{55}Fe in the liver of **Tilapia zillii** living in fresh or saline water was ten times greater than that in the fish flesh which was about one. This means that the fish liver is the main reservoir for iron (microelements). It was also observed that **Tilapia zillii** living in fresh water contained more ^{55}Fe than that living in saline water, table 2 and figure 2.

Mercury may be a good representative of inorganic pollutants thrown in the aquatic environment. The accumulation factor of ^{203}Hg in the liver of **Tilapia zillii** living in fresh or saline water was hundred times greater than that in the fish flesh. However, the accumulation factor of ^{203}Hg in the fish flesh was considerably high. It was also noticed that the fish living in fresh water contained more ^{203}Hg than that living in saline water, table 3 and figure 3.

DDT is one of the famous insecticides used in agriculture. The accumulation factor of ^{14}C DDT in the liver of **Tilapia zillii** living in fresh or saline water was considerably higher than that in the fish flesh which itself had a high value. It was recorded that **Tilapia zillii** living in saline water contained more ^{14}C DDT than living in fresh water, table 4 and fig. 4.

From the above results; it can be concluded that the fish liver is not a reservoir for calcium (macroelements). On the contrary, there is high and progressive increase in its accumulation factor of heavy metals and insecticides.

Table 1

Variation in ^{45}Ca content "impulses / minute / gram" in liver and flesh of **Tilapia zillii** obtained from fresh water and saline water aquaria, accumulation factor AF is also shown.

Time (days)	Fresh Water Fish					Saline Water Fish				
	Impulses / min. / 1 ml water	Liver		Flesh		Impulses / min. / 1 ml water	Liver		Flesh	
		Impulses min. / g.	AF	Impulses min. / g.	AF		Impulses min. / g.	AF	Impulses min. / g.	AF
	426					439				
2	415	340	0.82	100	0.32	431	032	0.07	09	0.[illegible]2
10	390	480	1.23	250	0.64	413	110	0.27	21	0.[illegible]5
20	370	560	1.51	290	0.78	408	137	0.34	41	0.[illegible]0
30	355	565	1.59	330	0.93	404	149	0.37	15	0.[illegible]0
40	339	800	2.57	678	2.00	401	160	0.40	57	0.[illegible]4

Table 2

Variation in ^{55}Fe content "impulses / minute / gram" in liver and flesh of **Tilapia zillii** obtained from fresh water and saline water aquaria, accumulation factor AF is also shown.

Time (days)	Fresh Water Fish					Saline Water Fish				
	Impulses min. / 1 ml. water	Liver		Flesh		Impulses min./ 1 ml. water	Liver		Flesh	
		Impulses min./g.	AF	Impulses min./ g.	AF		Impulses min./g.	AF	Impulses min./g/.	AF
-	14	-	-	-	-	18	-	-	-	-
02	12	0145	012.083	08.0	0.660	17	040	02.353	0.3	0.036
12	10	0358	035.800	10.0	1.000	15	063	04.200	0.6	0.400
22	07	0425	060.714	11.5	1.642	13	110	08.461	0.7	0.580
32	06	0650	108.300	13.0	2.160	12	145	12.080	0.9	0.750
42	06	1122	178.000	06.0	1.000	12	209	17.410	4.5	0.380

Table 3

Variation in ^{203}Hg content "impulses / minute / gram" in liver and flesh of **Tilapia zillii** obtained from fresh water and saline water aquaria, accumulation factor AF is also shown.

Time (days)	Fresh Water Fishes					Saline Water Fishes				
	Impulses min. /1 ml water	Liver		Flesh		Impulses min. /1 ml. water	Liver		Flesh	
		Impulses min./g.	AF	Impulses min./g.	AF		Impulses min./g.	AF	Impulses min./g.	AF
At the beginning	78	-	-	-	-	77	-	-	-	-
Hours	57	2900	0050.877	043	00.75	74	1135	015.34	050	00.675
01	-	-	-	-	-	60	1150	019.16	063	01.050
10	08	4950	0618.750	140	17.50	21	1440	068.60	110	05.200
20	06	5670	0943.000	140	23.60	14	5730	032.40	110	07.900
30	02	6740	3370.000	145	72.50	06	-	-	-	-
40	02	8410	4205.000	145	72.50	06	5540	923.00	110	18.300

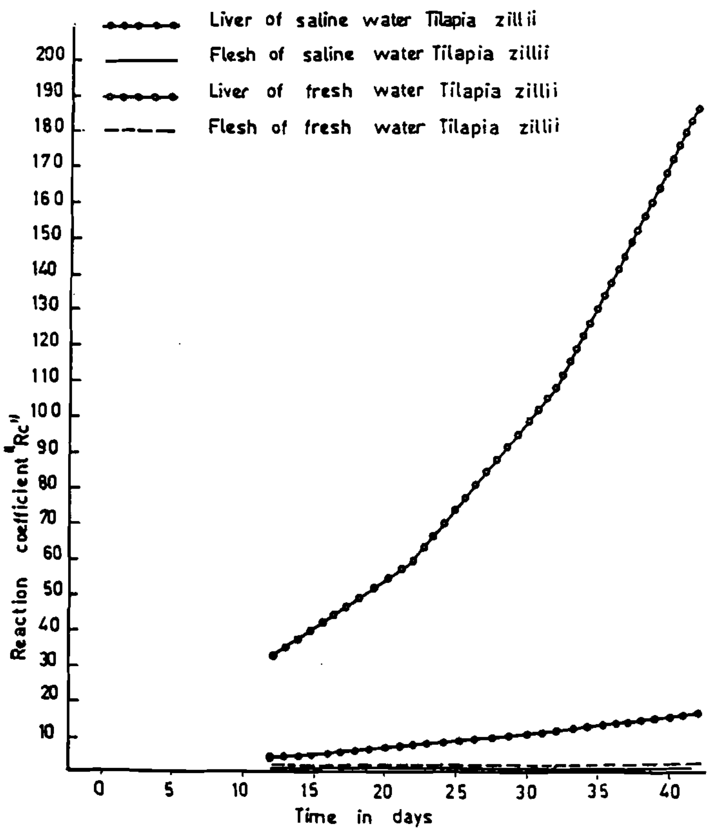

Fig. 2. Variation of ^{55}Fe in liver and flesh of **T. zillii** living in fresh and saline wáter.

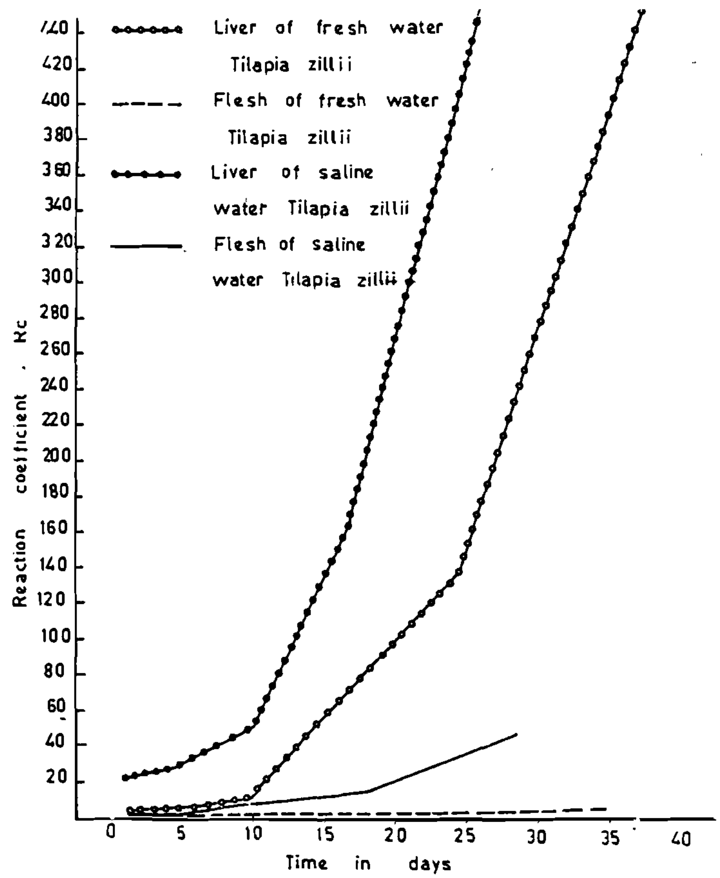

Fig. 3. Variation of ^{14}C DDT in liver and flesh of **T. zillii** living in fresh and saline water

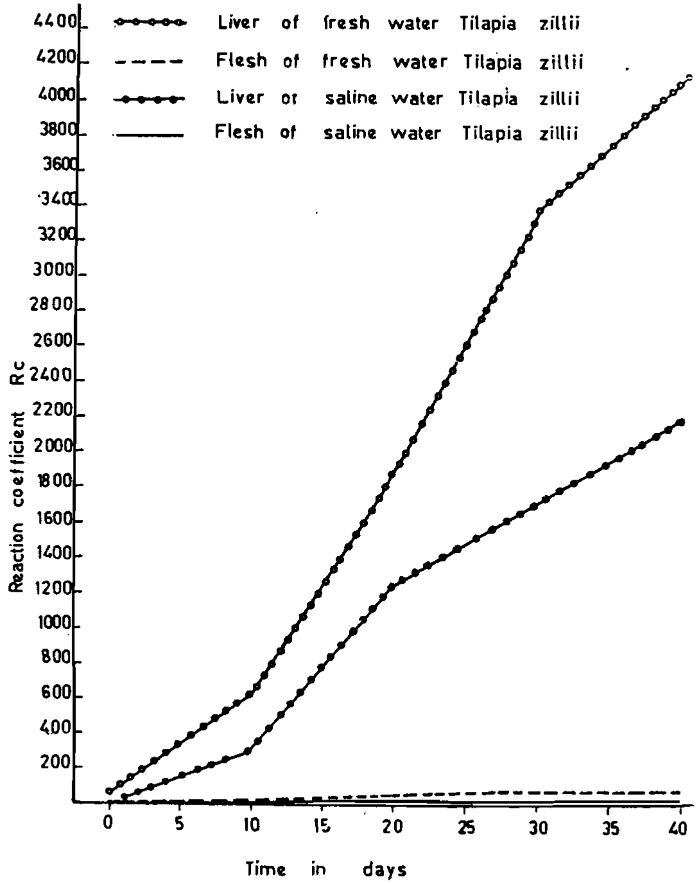

Fig. 4. Variation of ^{203}Hg in liver and flesh of T. zillii living in fresh and saline water.

It was noticed also that **Tilapia zillii** surviving in fresh water contained more ^{45}Ca, ^{55}Fe and ^{203}Hg than that living in saline water. **Tilapia zillii** inhabiting saline water uptook more ^{14}C DDT than that living in fresh water. These results probably mean that the euryhaline fish uptakes more heavy metals when it inhabits fresh water. On the other hand, its content of insecticides is more when it lives in saline water. Such phenomena could be explained by the fact that the euryhaline fish absorbs more elements and ions when it inhabits fresh water to avoid hypotonism. It eliminates elements and ion from the swallowed water when it lives in saline water to avoid hypertonism (Black, 1957).

Field study:

El-Qalaa drain (Lake Mariut) is highly polluted canal with industrial and agricultural wastes. As a result, only a limited population of fishes remain living in this polluted water. A random sample of **Tilapia zillii** was caught

Table 4
Variation in DDT C^{14} content "impulses /minute / gram" in liver and flesh of **Tilapia zillii** obtained from fresh water and saline water aquaria, accumulation factor AF is also shown.

	Fresh Water Fishes					Saline Water Fishes				
Time (days)	Impulses min./1ml water	Liver		Flesh		Impulses min./ 1 ml water	Liver		Flesh	
		Impulses min./g.	AF	Impulses min./g.	AF		Impulses min./g.	AF	Impulses min./g.	AF
00	11.0	-	-	-	-	5.0	-	-	-	-
01	10.5	0030	002.86	06	0.57	4.2	112	026.60	07	01.66
05	10.4	0035	003.36	06	0.58	3.5	123	035.20	09	02.57
10	10.3	0082	007.96	09	0.87	3.0	182	060.60	29	09.60
17	10.0	0183	018.30	11	1.10	2.5	591	236.40	35	14.00
27	09.5	1210	127.37	18	1.89	2.0	928	464.00	88	44.00
35	08.5	3625	426.35	39	4.59	There were no fishes remained alife.				

from this drain (in Winter season). Another similar sample was caught from a comparatively clean water (Bab El-Abid Lake Mariut). The hepatosomatic index of the collected fishes of different sizes was determined for both areas.

The average value of H.S.I. for **Tilapia zillii** living in polluted water and that living in the comparatively clean water, are given in Table 5.

Table 5
Average H.S.I. for **Tilapia zillii** caught from Bab El-Abid (comparatively clean water) and from El-Qalaa drain (polluted water).

Area	Average value of H.S.I.
Bab El-Abid	2.3 ± 0.14
Qalaa drain	3.5 ± 0.21

The field results showed an increase in the weight of the liver of **Tilapia zillii** living in the polluted water. This increase is explained as due to the accumulation of pollutants in the liver of the polluted fish. This explanation is well supported by the previously mentioned in the experimental studies, i.e. the H.S.I. of **Tilapia zilli** living in polluted water is significantly higher than that living in the comparatively clean water, table 5. The influence of spawning and similar factors on H.S.I. must be avoided as far as possible in such comparison.

CONCLUDING REMARK

The pollution of the aquatic environment causes an increase in the hepatosomatic index. This probably means that the H.S.I. could be used as a quick indicator for the level of pollution in the aquatic environment. As a matter of fact, the amount of pollutants in the fish liver is directly proportional to the degree of pollution in the aquatic environment by heavy metals and pesticides. Accordingly, the hepatosomatic index may be considered as valid indicator for this type of pollution.

On the other hand, the plankton or oxygen indicators are suitable merely for aquatic environmental pollution with human wastes or organic wastes respectively.

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