Bull. Inst. Oceanogr. & Fish. ARE, 8 (1) 1982 : 81– 86.

STUDY ON ENTRANCE AND ACCUMULATION OF POLLUTANTS THROUGH THE DIFFERENT ORGANS AND TISSUES OF TILAPIA ZILLII GERV. LIVING IN FRESH AND SALINE WATER.

H.H. SALEH
Institute of Oceanography and Fisheries, Alexandria, Egypt.

ABSTRACT

Laboratory experiments showed that the entrance and accumulation of pollutants in the fish flesh is very high compared with the non-toxic elements. However, the maximum content of pollutants is in the internal organs,e.g. kidney, gills and liver. The intrance and accumulation of inorganic pollutants, e.g. Hg is higher when the euryhaline fish inhabits polluted fresh water, while its content of DDT (organic pollutants) is more when it survives in polluted saline water.

INTRODUCTION

Straganov[1] mentioned that from 48 elements well investigated in sea water, the water organisms use and control about half of these elements. Some elements are used only in very low concentrations. Others e.g. Hg (pollutants) are completely not needed by water organisms. Portmann[2] proved that there is a direct proportionality between the pollutants concentration in water environment and their content in aquatic organisms. Scott and Armstrong[3] mentioned that there also appeared to be more variable positive relation between mercury concentration and fish condition "fatness". Show[4] repoeted that there is a direct correlation between the fatness of an organ or tissue and its content of DDT.

This study is a trial to estimate the main difference in entrance and accumulation of toxic and non toxic elements through the body of **Tilapia** zillii Gerv living in fresh or saline water.

MATERIAL and METHODS

Laboratory experiments were carried out by using labelled calcium (^{45}Ca Cl_2), labelled iron (^{55}Fe Cl_3), labelled mercury (^{203}Hg Cl_2), and labelled carbon DDT (^{14}C DDT dissolved in acetone). Two aquaria were used for every isotope, one for saline water 30 ‰ and the other for fresh water. Each aquarium contained fifty liters water and fifteen euryhaline **Tilapia** zillii of similar size captured-from Lake Qarun where the water salinity is about 30 ‰. After fish were acclimatized in water aquaria, an equal amount of the radioactive elements was added. The experiment continued

for about 40 days. At the end of the experiment, the length and weight of every fish was recorded. Its liver, kidney, gills, gonads, caudal fin (as representative of the skin), empty intestine and intestinal content were removed, weighed and their activities were measured as impulses/minute. One gram of the fish flesh was cut and its activity was measured also. The concentration of the radioactive element in water aquaria was measured at beginning and end of the experiment as impulses/minute/ml water.

The weight of fish flesh was considered as half of the total fish weight, and the area of covering skin is equal to 7.5 area of caudal fin, Iarjabak[5].

The aquaria were slowly aerated, and the water temperature was 28 $\pm$ 3°C (no artificial heaters were used). The fishes were not fed during the experiments.

RESULTS AND DISCUSSION

The percentages of ^{45}Ca or ^{55}Fe (non toxic elements) accumulated in different organs and tissues of **Tilapia zillii** living in fresh water was nearly similar to that living in saline water. The maximum percentages of ^{45}Ca or ^{55}Fe accumulation was in the covering skin or intestinal content respectively, i.e. more than 75% of ^{45}Ca content in **Tilapia zillii** living in fresh or saline water was accumulated in its covering skin, and about 50% of ^{55}Fe content was in its intestinal content. The fish flesh contained about 10% of ^{45}Ca and 2.5% of ^{55}Fe content in the fish. The internal organs, e.g. gills, liver and kidney contained low percentages of ^{45}Ca or ^{55}Fe. However, the liver contained considerable amount of ^{55}Fe, fig. 1.

The percentages of ^{203}Hg content or ^{14}C DDT content (inorganic and organic pollutants, respectively) in different organs and tissues of **Tilapia zillii** living in fresh water was nearly similar to that living in saline water. The percentage of the accumulated ^{203}Hg or ^{14}C DDT in fish flesh was considerably high. Thus, about 25% of ^{203}Hg or ^{14}C DDT content in **T. zillii** living in fresh or saline water was accumulated in its flesh. The flesh content of ^{203}Hg or ^{14}C DDT was nearly equal to that accumulated in the covering skin. The percentages of ^{203}Hg or ^{14}C DDT contents in the internal organs, e.g. gills, kidney and liver was comparatively high, fig. 1, table 1.

The percentage of ^{45}Ca , ^{14}C DDT and to some extent ^{55}Fe contents in the gills and skin of **T. zillii** living in fresh water were higher than that living in saline water and the opposite occurred in the case of ^{203}Hg, fig. 1, table 1. Karzenkin[6] proved that the main routes for entrance for elements and compounds present in aquatic environment into the fish are the gills and skin mainly caudal fin. As a result of gill and skin activity,

1. Covering skin
2. Fish flesh
3. Gonads
4. Empty intestine
5. Intestinal content
6. Gills
7. Kidney
8. Liver

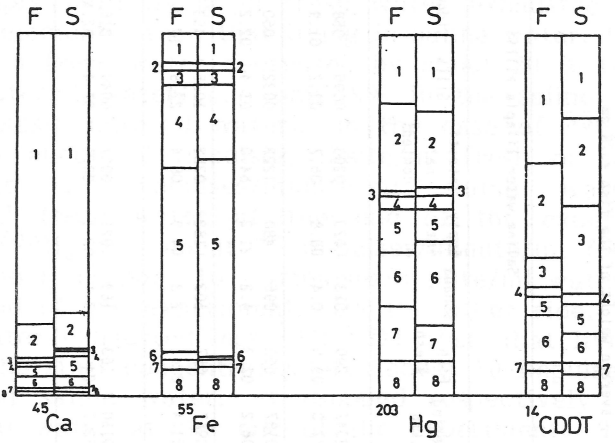

Fig. 1. Distribution of ^{45}Ca, ^{55}Fe, ^{203}Hg and ^{14}C DDT in different organs and tissues of **T. zillii** living in fresh or saline water(30‰).

The amount of ^{45}Ca, ^{203}Hg, and ^{55}Fe contents in **T. zillii** living in fresh water were higher than that living in saline water; while the ^{14}C DDT content in **T. zillii** living in fresh water was lower than that living in saline water, table 1.

The high content of ^{45}Ca or ^{55}Fe in the gills and covering skin of **Tilapia zillii** living in fresh water was accompanied by high content of these elements in its body. On the other hand, the high content of ^{203}Hg or ^{14}C DDT in the gills and covering skin was met with low content of these toxic substances in the body of **Tilapia zillii**, table 1, i.e. the high content of ^{45}Ca or ^{55}Fe (non toxic elements) in gills and skin may reflect high absorption rate of ^{45}Ca or ^{55}Fe, while the accumulation of ^{203}Hg or ^{14}C DDT in the gills and covering skin probably means resistance of these organs for entrance of ^{203}Hg or ^{14}C DDT (pollutants) into the fish body.

Such results may indicate that the fish selects and absorbs the non toxic elements by its gills and skin. Love[7] postulated that the fish is not completely dependent for its nourishment on food taken by mouth. Few substances, mostly inorganic, are absorbed directly from the surrounding water presumably by the way of the gills. On the other hand, the pollutants are characteristic by their adsorption and permeability through the living tissues (Goldberg[8]). The comparatively low content of ^{203}Hg in **Tilapia**

Table 1

Average content (impulses / minute) and percentages of ^{45}Ca ^{55}Fe, ^{203}Hg and ^{14}C DDT in different organs and tissues of **Tilapia zillii** living in fresh and saline water 30%° , average weight of the fish = 28 gm.

Isotope Used		Fresh Water **Tilapia zillii**									Saline water **Tilapia zillii**							
		Covering skin	Fish flesh	Gonads	Empty intestine	Intestinal content	Gills	Kidney	Liver	Total	Covering skin	Fish flesh	Gonads	Empty int.	Intestinal content	Gills	Kidney	Liver	Total
^{45}Ca	Content	27844	3345	167	235	1199	1506	110	094	34500	2347	290	013	023	0203	0096	058	014	3044
	%	80.7	09.7	0.5	00.7	03.5	04.3	00.3	0.3	100	77.0	09.5	0.4	00.8	06.7	03.2	01.9	0.5	100
^{55}Fe	Content	00198	0063	120	570	1335	0045	060	147	02538	0187	052	095	480	1223	0032	050	145	2264
	%	07.8	02.5	4.7	22.5	52.5	01.8	02.4	5.8	100	08.2	02.3	4.2	21.2	54.0	01.4	02.2	6.4	100
^{203}Hg	Content	01058	1367	092	221	0653	0830	832	545	05598	0967	057	103	182	0382	1035	453	448	4527
	&%	18.9	24.4	1.6	04.0	11.6	14.9	14.9	9.7	100	21.4	21.1	2.3	04.0	08.4	22.8	10.0	9.9	100
^{14}C DDT																			
	Content	00071	0048	016	007	0011	0026	004	014	00197	0150	163	163	021	0057	0049	016	042	0661
	%	36.0	24.4	8.1	03.6	05.6	13.2	02.9	7.1	100	22.7	24 7	3.1	03.1	08.6	07.4	02.4	6.4	100

living in saline water is due to resistance of its gills and skin for entrance (to some extent) of ^{203}Hg, while **Tilapia zillii** living in fresh water resisted to certian extent the entrance of ^{14}C DDT and so its body content of ^{14}C DDT comparatively low, table 1.

In general, **Tilapia zillii** living in fresh water exhausted more ^{45}Ca, ^{55}Fe and ^{203}Hg (elements) than that living in saline water, table 1. The content of ^{45}Ca in fresh water decreased by about 20 % (from 426 to 339 impulses/minute/ml water) and only 8% in the saline water (from 439 to 401 impulses/minute/ml water). In the case of ^{55}Fe, the start concentration was about 16 impulses/minute/ml fresh or saline water. It decreased to 11 impulses/minute/ml saline water and 9 impulses/minute/ml fresh water at the end of the experiment. The concentration of ^{203}Hg was about 77 impulses/minute/ml for both fresh or saline water and it dropped to 2 impulses/minute/ml water in the two aquaria by the end of the experiment. On the other side, **Tilapia zillii** living in fresh water exhausted less ^{14}C DDT than that living in saline water, table 1. The start concentration was about 10 impulses/minute/ml in both fresh and saline water. It dropped respectively to 7 and 4 impulsus/minute/ml water at the end of the experiment. The fishes in the saline water aquarium were unhealthy and their mortality were high, while these inhabiting fresh water appeared still healthy.

The previous phenomena may be cleared by the fact that the fish living in fresh water absorbs more elements and ions to avoid hypotonism, while that living in saline water swallows much sea water and eliminates elements and ions to avoid hypertonism (Black[9]).

ACKNOWLEDGEMENT

The Auther is deeply indepted to Prof. A. Samaan and Miss O.W. Sedrak.

REFERENCES

1- Skraganov ,N.S. 1962. **Fish Ecology and physiology** (in Russian), Moscow State University. Moscow, p. 496.

2- Portmann, J.E. 1972. The levels of certain metals in fish from coastal waters around England and Wales. **J. Aquaculture**, 1: 91-96.

3- Scott, D.P. and F.A.J. Armstrong 1972. Mercury concentration in relation to size in several species of fresh water fishes from Monitoba and North western Ontario, **J. Fish. Res., Bd of Canada** 29: 1685-1690.

4- Show, S.B. 1972. DDT residue in eight Calitornia marine fishes. **J. Calif. Fish. and Game**, 58: 22-26.

5- Darjombak, A.A.1973. **Lectures in Physiology of fishes** (in Russian), VNIRO

institute, Moscow, p. 117.
6-Karzenkin, G.S. 1962. **The use of isotopes in fish researches** (in Russian), VNIRO Institute, Moscow, p. 90.
7-Love, R.M. 1970. **The chemical biology of fishes.** Academic Press, London, p. 547.
8-Goldberg, E.D. 1976. **The heath of the Oceans.** The Unesco/Press. Paris, p. 172.
9-Black, V.S. 1957. Excretion and Osmoregulation, From **Physiology of Fishes** . Edited by M.E. Brown, Academic Press. London, vol. I. Chap. IV.