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Effect of Some Water Pollutants on the Biology of the Nile Bolti, *Oreochromis niloticus*

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Abstract: Samples of water and *Oreochromis niloticus* fish were collected from El-Mahmoudya channel near Alexandria for contaminants determination. The data show that El Mahmoudya channel water includes relatively high levels of Fe, Cu and chlordane and much higher levels of Zn and lindane. Most of the dissolved, metals and organic contaminants or their metabolites were monitored in the fish and then eggs. The above pollutants were found to affect spawning behaviour and duration. The average number of eggs per spawn were higher in the control groups than the contaminated ones. The residue levels monitored in the eggs affected the fry survival of the Nile fish.

Key words: *Oreochromis niloticus* priding, environmental, water pollution

INTRODUCTION

Environmental contamination is an inevitable consequence of the human activities and natural phenomena as well. Current evidence points out that our environment has long been considered a dump or disposal medium of limitless capacity which could absorb, utilize or detoxify partially any amount of any material committed to it[1].

In aquatic the environment short-term or chronic exposure to pollutants resulting from spills may lead to impairment of species ability to survive even though individual specimens do survive. Survival of the species has far greater ecological significance than survival of one or even many individuals. Often the so-called "fish kills" may have great public impact but a "fish kill", per se may not eliminate a species from an area[2,3].

Environmental monitoring and surveillance programs which commonly use fish as the principal indicator, have reported elevated levels of contaminants in biota from many major water bodies and in some cases note that fish have attained concentrations that are of concern when viewed from a human health perspective[4,5]. The toxicological effects of these contaminants on the fish population are largely unknown.

One aspect of the biology of species inhabiting perturbed environments that has received little attention is the relationship between contaminant levels in spawning fish and that passed to their reproductive products. Some studies have reported reduced survival rates of adults and larvae containing levels of contaminants[6-9]. These studies have demonstrated the effects of contaminants on reproductive success, but were limited to observations on the effect of these contaminants in spawning behaviour in one species and did not identify the biological factors that influence the transfer of heavy metal residues from fish to gametes.

The present study was conducted to determine the effect of some water pollutants on the spawning behaviour, number of egg production per spawn of the Nile Bolti, *Oreochronis niloticus* which is the most abundant species in the fresh water bodies of Egypt and examine the transfer of these contaminants between females and their eggs.

MATERIALS AND METHODS

During the first day of experiment samples for contaminants determination were collected from the depth of 50-100 cm of El-Mahmoudya channel, near Alexandria by vacuum suction through polythene tubing into a 10 L. Buchner flask. This channel is the main fresh important water resource for drinking and fishing (Fig. 1) The work was done through the period from March-May (2002). The 10 L water sample was immediately filtered, using 0.45 μm membrane filter which had been previously washed with metal free water and dried to constant weight at 60°C. The filtered material was washed with 5 ml distilled water and stored in a deep freezer. The filtrate was immediately passed through chelating resin columns for the separation

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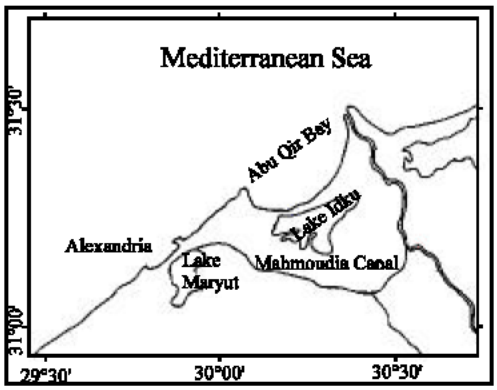

Fig. 1: Location map of the study site

of heavy metals such as Cu, Pb, Cd, Ni, Z n and Fe by atomic absorption spectrophotometry[10]. Analysis for organic contaminants such as DDT, chlordane, lindane and Endrin took place by gas chromatography. Substances whose average concentration were less than 10 μg kg^{-1} or not detectable in 50% of the samples tested were not reported.

Other samples of water were obtained directly from the same position of channel at the same depth. Water samples were distributed in ten glass tanks, each of 50 L. The bottom of tanks was covered by sand layer of 15 cm obtained from the same channel.

Each tank was stocked in the last week of March (2002) with a pair of adult *Oreochronis niloticus* (one male and one gravid female). The length of these fishes ranged between 20 and 26 cm. The females were checked continuously for eggs by gentle pressing on their sides. The specimens were fed on a commercial fish food as dry pellets with 35% protein. The fish appetite was retained by this diet fed at a rate of 3% of their body weight, gave the best growth rate according to the study of Hassanean[11].

Another 3 tanks with the previous specifications were used as a control for the experiment, but their water content and fish pairs were obtained from Maryut fresh water fish farm, west of Alexandria. The control and contaminated tanks were kept in the laboratory under normal natural light and temperature(12D; 12L; 25°C±1.5).

Feeding of fish was stopped, when the branchiostegal membrane was expanded after the prespawning activities of males. The fish refused to take food and the males were removed from the female tanks. The eggs were left in the buccal cavity of females until hatching. After the mothers released the fry, they were collected by a scoop net out of the tank, counted and frozen until analysis. The spawning behaviour was observed and recorded for each spawn during the period from end of April to the beginning of September. The periods between spawn times were also recorded . At the end of spawning periods, all female fish were killed and frozen until analysis.

The concentrations of heavy metals in mothers and fry were determined in gravid fish, eggs and fish without eggs by atomic absorption using cold vapour technique. A 0.2 g sample was placed in each test tube containing a mixture of sulfuric and nitric acids and heated to 90°C overnight. The samples were then heated to 220°C (fuming) to facilitate oxidation. After cooling, 1.5 ml of a 6% potassium permanganate solution was added to complete the oxidation. A 30% hydrogen peroxide solution was added dropwise after 2 h to remove brown precipitate. The samples were then completed to 60 ml. A portion of each sample was then transferred into a reaction tube of the spectrophotometer for heavy metal determination.

Analysis for organic contaminants: A 10 g fish or fry sample was thoroughly mixed with 25 ml anhydrous sodium sulfate (Na_2SO_4) in a jar and allowed to stand for 30-40 min. The mixture was transferred to 25x595 mm Teflon stoppered chromatographic column with a glass wool plug which contained 5cm Na_2SO_4 and 75 ml methylene chloride (CH_2Cl_2). The jar was rinsed with 15 ml CH_2Cl_2 which was also added to the column. After standing for 30 min, the CH_2Cl_2 was allowed to drip 6-8 ml min^{-1} into 300 ml round bottomed flask. When the CH_2Cl_2 was drained to 2.5 cm of the sample tap, successive volumes of 100 and 55 ml CH_2Cl_2 were added and allowed to drip into the flask. To separate the residue fractions, Florisil was added to a 6x390 mm Teflon stopped chromatographic column. The separation of different organic contaminants took place by gas chromatograph.

Changes in contaminant levels could be entirely explained on the basis of differences in concentrations observed between fish and eggs alone. Contaminant levels were examined on basis of the micrograms of each substance present in the eggs and post-spawning fish.

Inter and intra-specific relationships among weight and contaminants parameters were examined for statistical significance using the regression equation $Y=a+bx$, $Y=ae^{bx}$ and $\log y=\log a+b\log x$. The equation of best-fit, determined by the correlation coefficient, was reported for each data set.

RESULTS

The range and mean concentrations of some dissolved trace metals and organic contaminants (ug l^{-1}) in the study site are listed in Table 1. The data show that

Table 1: Contaminant levels (ug l^{-1}) in gravid fish, eggs and egg less fish

	Pollutants									
Contaminant levels	Fe	Zn	Ni	Cd	Pb	Cu	DDT	Chlordane	Lindane	Endrin
Channel water Mean	3.77	9.18	0.88	1.49	2.14	1.53	1.90	2.28	8.13	1.11
(µg L^{-1}) Max.	9.18	13.08	2.11	4.15	11.08	5.12	5.92	4.40	13.70	3.04
Min.	1.02	3.11	0.33	0.46	0.46	0.66	0.62	1.47	0.14	0.20
Gravid Fish Mean	12.12	24.12	0.00	4.66	8.16	4.15	5.17	8.22	20.15	0.00
(µg L^{-1}) Max.	20.37	40.05	0.00	9.12	19.22	8.07	11.04	18.07	36.22	0.00
Min.	2.15	7.12	0.00	2.33	3.12	1.18	1.15	2.19	6.14	0.00
Eggs	4.16	5.12	0.00	1.17	2.22	1.64	2.37	1.08	2.22	0.00
Mean (µg L^{-1}) Max.	6.77	8.20	0.00	2.43	5.37	2.90	3.12	4.20	5.12	0.00
Min.	0.69	3.12	0.00	1.12	2.12	0.22	0.17	0.99	0.16	0.00
Egg less Fish	7.46	20.32	0.00	2.42	5.12	2.37	3.36	7.02	16.20	0.00
Mean (µg L^{-1}) Max.	14.96	35.18	0.00	6.33	14.06	6.15	8.16	14.26	31.14	0.00
Min.	2.04	3.12	0.00	0.17	1.18	0.36	0.92	1.15	5.22	0.00

the Mahoudya channel is characterized by relatively high levels of Fe, Cu and chlordan and a mush higher level of Zn and Lindane.

Most of dissolved metals and organic contaminants or their metabolites were monitored in fish and eggs (Table 1). Concentrations of Zn, Fe, lindane and chlordane were proportionally higher than those of other contaminants. There was a great difference in residue levels between fish and eggs among the different contaminants that were directly proportional with the concentration of these substances in water. Concentrations of most contaminants in gravid fish in all studied samples were about 20-45% higher than what was found in their eggs. Ni and Endrin were not detectable among the studied flesh or deposited in their eggs. The level of contaminants in eggs were substantially lower than in whole body. The grand mean for the percent of different contaminants in fish that were deposited in eggs for the studied species were about 23%.

Spawning behaviour and duration: During spawning, the fish males pressed with their forehead in a circular movement against the lower abdominal region of the females. This activity resulted in the deposition of a batch of great number of eggs toward in the bottom of the cage. As the eggs were deposited, the male passed over them spraying his milt. After the spawning was completed, the female immediately picked up the fertilized eggs in its mouth. Most of spawning periods took place in the afternoon.

Throughout the 10 contaminated fiberglass tanks and the 3 control ones, the female fish were put under observation during spawning until hatching and the fry were set free. The incubation period of eggs took about 10-12 days. After 4-6 days, the males began prespawning activities until the females deposited other batches of eggs and soon.

Figure 2 showed that the fishes of the control tanks gave five broods in 130 days during the period from

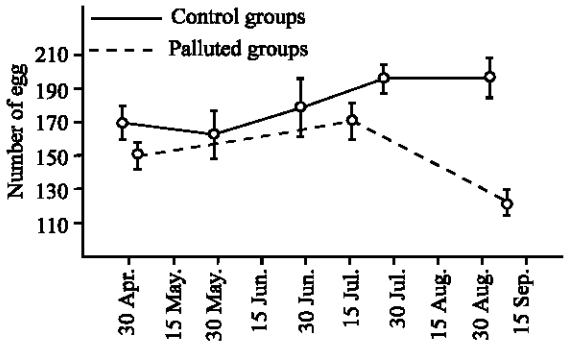

Fig. 2: Total number of eggs produced in the fiberglass tanks by similar sized brood of *Oreochromis niloticus* during the period from 28 April to 8 September (2002). Ranges are represented by the vertical lines

the end of April to the beginning of September. The contaminated groups gave three broods only in the same period approximately, but the first brood began some days latter. The duration between periods of spawning was increased from 30-36 to 55-75 days in the control and contaminated groups, respectively. The average number of eggs per spawn was decreased from 162-195 in the control groups to 120-170 in the contaminated ones.

DISCUSSION

The present results indicated that different ratio of most pollutants were concentrated in the fishes as well as their eggs. However, when assessing the potential risk of aquatic pollutants to fish under natural conditions, two opposing factors have to be taken into consideration. Firstly, toxicity test data relate to exposure of fish to constant concentrations of pollutants, as where these concentrations may decline in water. Secondly, the fishes tested may be in a relatively resistant stage in their life cycle[3,12-16].

The toxicological effects contaminants may have on eggs at the concentrations observed are difficult to assess, because of the limited information available on the effect of individual substances and their possible synergistic response. For fresh water organisms, it has been shown that hardness and pH alter the toxicity of most contaminants[17].

The data suggest that the residue levels monitored in this study could have detrimental effects on egg and fry of *Oreochronis niloticus* and possible effects on the spawning.

On the other hand spawning could have significant effects on the kinetics of aquatic contaminants in fish. This may be due to changes in weight and residue levels which are attributed to egg deposition and to differences in residue concentrations between fish and eggs.

Studies which have examined the distribution of different contaminants in fish reported that concentrations can vary among tissues and organs species[8] which can change seasonally [18,19].

First spawning of the control groups occurred at the last week of April till the end of September. The average number of eggs per spawn ranged from 162-195 each 35 days. This is in agreement with Yashow[20], Siraj *et al.*[21] and Guerrero[22].

From the present results, it is evident that the number of eggs produced per spawn was decreased from 162-195 in the control groups to 120-170 in the contaminated ones. Johansson[6] reported 46-100% mortality in fertilized eggs and fry of *Salmo solar* whose PCB levels ranged from 0.6 to 1.9 mg kg^{-1}. Hogan and Brauhn[7] reported that rainbow trout eggs which contained 0.33 mg kg^{-1} Aroclor incurred 10-28% mortalities and 60-70% of the fry were deformed after 30 days posthatch[16].

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