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Effects of Pollutants on Some Aquatic Organisms in Temsah Lake in Egypt

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Abstract: Temsah lake is considered one of the wild life features in Egypt in general and in the Suez Canal region in particular. Through field experiment, concentrations of some pesticides which are used around the area, were monitored in the tissues of some birds of prey (wild birds), some species of algae, fish and crustaceans. The results obtained revealed: (1) The presence of some Organochlorines (OC) in the tissues of many of the tested birds represented in (DDE, Heptachlore, HCH, Dicofole). (2) The presence of high residues of Organophosphorus (OP) pesticides represented in malathion and diazinon in most of the tested birds. But they were not detected with high levels in any of fish, crustaceans or algae. (3) The presence of high concentrations of (OC) compounds in the tissues of algae, crab, mullet and some birds (moorhen-cormorant and gulls). Meanwhile, none of those compounds was detected in the water samples. (4) The presence of high levels of all detected pesticides in the tissues of crab makes it the very acceptable bioindicator to mirror the pollution of the lake, then followed by algae. (5) Pollutants can be transferred through the food chain which causes biomagnification of them in the bodies of the higher organisms in the food chain. It could be concluded that implementation of the environmental management practices in Lake Temsah is still needed to protect these ecosystems from more pollutions which could affect human health and environment.

Key words: Aquatic organisms, organchlorines, organphosphorus, pollutants

INTRODUCTION

In Ismailia, as a coastal city, people basically depend on fish as a main source of animal protein; most of this fish is caught from the Suez Canal and lake Temsah. In the same time agriculture is considered one of the driving forces of Egypt's economy, thus intensive agriculture systems have been employed in order that agriculture can cope with the massive population, which led to the extensive use of pesticides resulting in various problems. Besides the final effect of these pesticides on human health by consuming polluted food (Abdel Fattah, 1992; Senthilkumar *et al*., 2001).

Lake Temsah, the main site of the study, besides being one of the well known wetlands in the Suez Canal region and a main tourist attraction, it is one of the main Sites in Egypt where vast numbers of migratory birds are passing through, specially during winter on their way from Europe to Africa. The ecosystem of the lake embraces a large variety of wildlife species specially birds. The quality of life in the lake has been drastically affected by a number of reasons. One of them is that the lake is the end point of a drain canal that discharges huge volumes of agricultural drain water and industrial wastewater, laden with a variety of organic pollutants, including pesticides and mineral oils used in crop protection (Varo *et al*., 2002).

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The present study has intended to monitor residues of some major pesticides, usually used in crop protection, in a variety of organisms in the food chain such as plankton, crustacean, fish and finally in wild birds. And to come up with a possible bioindicator to mirror prevalence of some tested pollutants in water bodies. Also to investigate the biomagnification of pollutants caused by their presence in the environment.

MATERIALS AND METHODS

A survey of pesticides in the aquatic ecosystems of Lake Temsah in Ismailia was performed in season 2005, as followed:

Study Area

The study area was Lake Temsah, which is located on the North of the Suez Canal (Fig. 1). The Lake is the end point where some municipal, agricultural and industrial wastewaters are discharged. The lake is also an important source of fish in Ismaillia.

Collecting Samples

Samples of water, plankton, crustacean and fish were collected from Lake Temsah and birds were monitored and collected from around the same lake too (Fig. 2).

Sampling of Water

Three replicates of water samples were collected from five parts of the lake, including the area where an agricultural drainage canal discharges. Two hundred and fifty milliliters volume closed funnels were lowered to 60 cm of the water depth; funnels were then opened until filled with the water. Funnels were closed under the water surface and pulled up.

Sampling of Algae

Some live algae were collected from around the lake and the close part of the canal. Samples were brought to the laboratory and identified. They were allowed to dry off sunlight for 72 h. When they were well dried, they were kept in silica gel for preservation until extraction was performed. The identified samples used in this study were *Ulva lactuca*, *Sarconema fihiformis*, *Hypnea corntua* and *Ceatophllaceae* sp.

Crustaceans Sampling

Two crustaceans' species were selected to the present study. Shrimp (*Penaeus japonicus*) and crab (*Neptuns pelagicus*). Two replicates of shrimps (1-1.5 cm) and craps (10-12 cm) length were used. Collection was made from different parts of the lake. Samples were taken to the laboratory where extraction and clean up was conducted according to the method reported by Tawfic and Ismail (1991).

Sampling of Fish

Two fish species were selected representing two different feeding habits and different niches in the water ecosystem. *Mugil capito* which is a bottom feeder detritus fish and *Oreochromis niloticus* which is omnivorus fish lives in the water column. Fish were brought from the fish market on the lake side so that they would represent the same sections of the waterway. The average of fish weight was 27±2 g. Fish were brought to the laboratory shortly after collection and kept in the deep-freezer for some few days until extraction was performed.

Fig. 1: Map of lake Temsah location

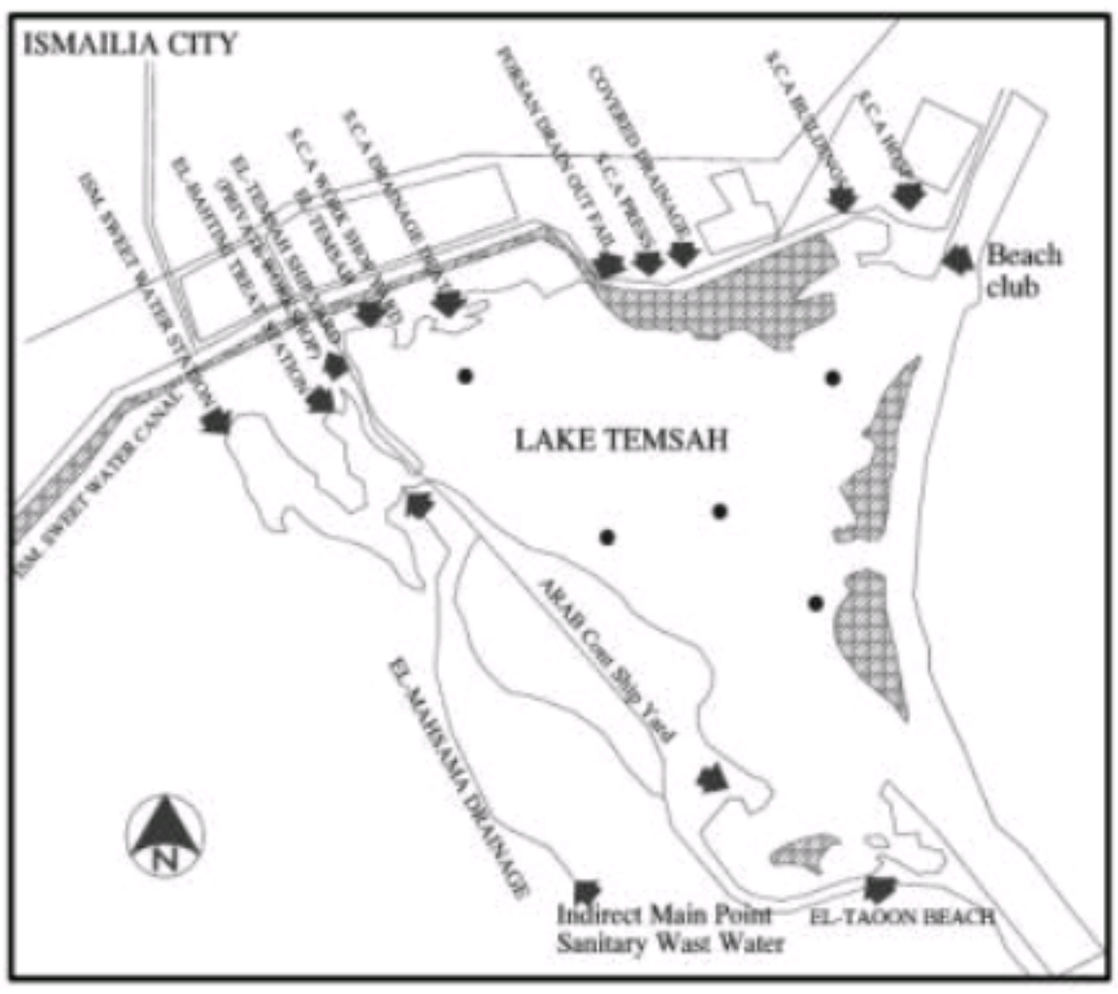

Fig. 2: Sites of collecting samples from lake Temsah

Sampling of Birds

Eight species of birds were monitored from around Lake Temsah and the areas close to it to identify most species and possibly their relative abundance. Other birds were collected from special local markets where pets are sold. On the other hand, few species were shot by a group of associates. Birds were slaughtered as soon as they were caught, samples from breast muscles and liver were taken and kept in the deep freezer (-20°C) until the extraction took place. The collected birds in this study varied between migrate and resident birds in order to enclose different spices that exist around the lake. The most important item in the collected seabirds diet is fish, some of them feed also on crustacean (Nelson, 1980). Collected resident birds were cattle egret, coot, moorhen and teal. Where the collected migrate birds were black headed gull, crane, cormorant and painted snipe.

Determination of Pesticides

Muscles samples of fish, crabs, shrimps and birds' breast and liver samples were processed to separate organochlorines and Polychlorinated Biphenyls (PCBs), as well as to separate organophosphorus pesticides (Larini *et al*., 1971). Separation of organochlorines and PCBs from Wter samples was based on the method reported by Mes *et al*. (1984) and modified by Tawfic *et al*. (2002). The gas liquid chromatography processes for organochlorines and organophosphorus were conducted in the Pesticides Analysis Center located in Dokki, Cairo, using a Hewlett - Packard, model 5890 gas liquid chromatography.

Statistic Analysis

Data were statistically analyzed to test the significant differences ($p<0.05$) using SAS (1998).

RESULTS AND DISCUSSION

Results of the gas chromatography analysis of water, algae, crustacean and fish samples collected from Lake Temsah and of birds collected from around the lake and the surrounding areas are shown in Table 1 and 2. Results revealed that no residues of DDT were detected in all tested samples included in this study indicating that no fresh DDT is being used and that old residues are becoming too small to be detected. Virtually, high residues of DDE were detected in most of the testes organisms which are possibly only DDT's metabolic products remains. None of the Organochlorines (OC) pesticides represented in DDE, Dicofol, HCH and Heptachlor were detected in the water samples. Meanwhile, relatively high concentrations of organochlorine were detected in the rest of the tested samples as following:

For Algae, Crustacean and Fish

The DDE was detected in all tested fish, crustacean and algae; the highest level was detected in crab muscles representing 1128 μg kg^{-1}, followed by mullet, shrimp and algae representing 290, 189

Table 1: Mean of residues of some pesticides (μg kg^{-1}) in some organisms from Lake Temsah (±SD)

	Pesticides						
Sample	DDE	Heptachlor	HCH	Dicofol	Diazanon	Malathion	PCBs
Water*	nd	nd	nd	nd	0.50±0.01	0.3±0.03	nd
Algae	176.0±3.40	nd	87±1.68	863±6.38	nd	nd	nd
Crab	1128±3.00	nd	66±1.06	457±6.31	nd	64.0±0.60	nd
Shrimp	189.0±9.00	nd	nd	123±2.65	0.98±0.06	34.0±1.80	nd
Mullet	290.0±11.00	39±0.70	46±0.53	790±3.30	26.0±0.69	nd	nd
Nile tilapia	21.00±3.00	nd	nd	78.0±1.59	nd	nd	nd

nd: Not detected; *Residues in water samples are detected in μg L^{-1}

Table 2: Mean of residues of some pesticides (µg kg^{-1}) in some birds (±SD)

		Pesticides						
Birds	Tissue	DDE	Heptachlor	HCH	Dicofol	Diazinon	Malathion	PCBs
C. Egret	Breast	17.21±0.28	42.90±1.56	2.0±0.37	44.5±1.9	nd	0.03±0.01	nd
	Liver	nd	nd	nd	0.60±0.05	nd	17.70±0.9	nd
Coot	Breast	56.00±2.11	1.50±0.1	nd	nd	nd	nd	nd
	Liver	4.00±0.1	nd	nd	nd	nd	49.70±0.9	nd
Moorhen	Breast	61.70±1.41	10.50±0.17	nd	36.5±2.1	7.00±0.2	34.40±0.2	nd
	Liver	nd	nd	nd	12.5±0.7	23.01±0.75	116.70±2.19	nd
Teal	Breast	nd	nd	4.0±0.02	7.32±0.22	nd	nd	nd
	Liver	nd	nd	nd	nd	36.00±0.3	nd	nd
B.H. Gull	Breast	11.60±0.2	19.43±0.25	2.3±0.2	15.00±0.1	nd	nd	1.67±0.06
	Liver	1.20±0.27	0.80±0.2	nd	0.80±0.08	97.70±3.5	256.70±1.3	nd
Cormorant	Breast	nd	nd	nd	nd	nd	nd	nd
	Liver	11.30±0.2	nd	nd	nd	14.30±0.3	148.80±2.28	nd
Crane	Breast	0.18±0.02	nd	nd	nd	nd	nd	nd
	Liver	nd	nd	nd	nd	nd	45.00±1.8	nd
P. Snipe	Breast	0.40±0.04	nd	nd	nd	nd	nd	0.74±0.02
	Liver	nd	nd	nd	nd	36.70±0.17	nd	nd

nd: Not detected

and 176.4 µg kg^{-1}, respectively. The lowest level was detected in Nile tilapia recording only 21 µg kg^{-1}. Heptachlor was not detected in any of the tested samples except for mullet occurring 39 µg kg^{-1}. The 96-h LC_{50} values of heptachlor was found to be from 5.3 to 13 µg L^{-1} in bluegill sunfish; 7.4 to 20 µg L^{-1} in rainbow trout, 6.2 µg L^{-1} in Northern pike, 23 µg L^{-1} in fathead minnow and 10 µg L^{-1} in largemouth bass (Johnson and Finley, 1980). Which makes the detected concentration in mullet was very high. The HCH was detected in algae, crab and mullet at levels of 87, 66 and 46 µg kg^{-1}, respectively. None was detected in Nile tilapia or in shrimp. Generally, HCH is highly to very highly toxic to fish and aquatic invertebrate species, its 96 h LC_{50} values range from 1.7 to 90 µg L^{-1} in trout, coho salmon, carp, fathead minnow, bluegill, largemouth bass and yellow perch (Johnson and Finely, 1980). However, HCH is able to bioconcentrate in aquatic organisms by 1400 times the ambient water concentrations, indicating significant bioaccumulation (Ulman, 1972).

The highest levels of detected dicofol were 863.2, 790 and 456.5 µg kg^{-1} in algae, mullet and crab respectively, followed by 123 and 78 µg kg^{-1} in shrimp and Nile tilapia,. These results contrast with those of Rohm and Haas (1991) which indicated that dicofol is highly toxic to algae, fish and aquatic invertebrates as the LC_{50} was 0.075 mg L^{-1} in algae, 0.12 mg L^{-1} in rainbow trout, 0.37 mg L^{-1} in sheepshead minnow, 0.06 mg L^{-1} in mysid shrimp and 0.015 mg L^{-1} in shell oysters.

For Birds

The DDE was detected in the breasts of all tested birds except for cormorant and teal. The highest residues of DDE were detected in breasts of moorhen and coot (61.7 and 56 µg kg^{-1}, respectively). Such high residue level is probably due to the feeding habits of these birds and/or due to their higher content of lipids (Table 2). In the laboratory of World Health Organization (1989), studies on bird reproduction have demonstrated the potential of DDT and DDE to cause slight effects on courtship behavior, delay in pairing and egg laying and decrease in egg weight in ring doves and Bengalese finches. LD_{50}s range from greater than 2,240 mg kg^{-1} in mallard and 841 mg kg^{-1} in Japanese quail to 1,334 mg kg^{-1} in pheasant (Hudson *et al*., 1984). In birds, exposure to DDT occurs mainly through the food web through predation on aquatic and/or terrestrial species having body burdens of DDT, such as fish, earthworms and other birds, predator species of birds are the most sensitive to these effects (World Health Organization, 1989).

Hepatochlor was detected in the breast of cattle egret, gull and moorhen, representing 42.9, 19.43 and 10.5 µg kg^{-1}, respectively. None was detected in cormorant, crane, painted snipe, or teal.

Heptachlor is moderately to highly toxic to bird species (Hudson *et al*., 1984). Heptachlor and its metabolite have been found in the fat of fish and birds and also in the liver, brain, muscle and eggs of birds (WHO, 1984). The HCH levels detected were low compared with the results of Hill and Camardese (1986). The highest level was 4 μg kg^{-1} in the breast of teal. It was also detected with lower levels in cattle egret and gull representing 2.8 and 2.3 μg kg^{-1}, respectively. While, none was detected in coot, cormorant, crane, moorhen or p. snipe.

Generally, birds of prey can contain up to 89 ppm of HCH in their fat, nevertheless, HCH is moderate and practically non toxic to birds (Ulman, 1972). The detected concentrations of HCHs in birds are considered nontoxic to bird species as they are far below the lethal concentrations or doses; LD_{50} was found to be more than 2000 mg kg^{-1} in the mallard duck, LC_{50} in 5 days in Japanese quail was 490 ppm (Hill and Camardese, 1986) and in pheasant and bobwhite quail were 561 ppm and 882 ppm, respectively (Ulman, 1972).

Dicofol was detected in the breasts of four birds; the highest levels detected were 44.5 μg kg^{-1} in cattle egret and 36.6 μg kg^{-1} in moorhen, followed by 15 μg kg^{-1} in gull and 7.32 μg kg^{-1} in teal. No residues were detected in coot, cormorant, crane or painted snip. Dicofol is slightly toxic to birds. In other birds like bobwhite quail, its 8-day dietary LC_{50} is 3010 ppm, 1418 ppm in Japanese quail and 2126 ppm in ring-necked pheasant. Eggshell thinning and reduced offspring survival were noted in the exposed birds (Rohm and Haas, 1991).

Different residues' levels of Organophosphorus (OP) compounds were detected in the samples represented in diazinon and malathion. Very low traces were detected in water sample; 0.5 and 0.3 μg L^{-1} for diazinon and malathion, respectively (Table 1). High residue levels of OP were detected in most of livers of the tested samples (Table 2), while low levels were detected in the rest of the samples (Table 1).

For Fish, Crustacean and Algae

Diazinon was detected only in mullet and shrimp occurring 26 and 0.98 μg kg^{-1}. Meanwhile, no diazinon was detected in algae, crab or Nile tilapia. Moderate levels of malathion were detected in crabs and shrimps' muscles by 64 and 34 μg kg^{-1}, respectively. None was detected in algae, mullet or Nile tilapia. Diazinon is highly toxic to fish (Buhler, 1991) while malathion has a wide range of toxicities in fish, extending from very highly toxic in the walleye (96-h LC_{50} of 0.06 mg L^{-1}) to highly toxic in brown trout (0.1 mg L^{-1}) and the cutthroat trout (0.28 mg L^{-}), to moderately toxic in fathead minnows (8.6 mg L^{-1}) and slightly toxic in goldfish (10.7 mg L^{-1}) (USPHS, 1995). Various aquatic invertebrates are extremely sensitive (Menzie, 1980). Because of its very short half-life, malathion is not expected to bioconcentrate in aquatic organisms. Which explains the very low levels detected in the tested fishes. While, shrimp is potential to show an average concentration of 869 and 959 times the ambient water concentration (Howard, 1991), which also explains the high levels detected in shrimps.

For Birds

The highest levels of Diazinon were detected in livers of gull, painted snipe and teal representing 79.6, 36.7 and 36 μg kg^{-1}, respectively. Followed by cormorant recording 14.3 μg kg^{-1}. None was detected in cattle egret, coot or crane. The highest levels of malathion were detected in livers of gull, cormorant and moorhen representing 256.7, 148.8 and 116.7 μg kg^{-1}, respectively. Followed by coot, crane and cattle egret representing 49.7, 45 and 17.7 μg kg^{-1}, respectively. Malathion was detected in the breasts of only two birds; moorhen and cattle egret representing 34.4 and 0.031 μg kg^{-1}, respectively. Non was detected in painted snipe or teal. Birds are quite vulnerable to diazinon poisoning and they are significantly more liable to diazinon than other wildlife. In general, LD_{50} values for birds range from 2.75 to 40.8 ppm (USEPA, 1995). On the other hand, malathion is moderately

toxic to birds, its reported acute LD_{50} values are: in mallards, 1485 mg/kg; in pheasants, 167 mg kg^{-1}; in blackbirds and starlings, over 100 mg kg^{-1} and in chicken 525 mg kg^{-1} (Smith, 1993). Furthermore, 90% of the dose to birds was metabolized and excreted in 24 h via urine (Menzer, 1987). However, the detected concentrations of diazinon and malathion might not be dangerous to birds.

Very low traces of PCBs, which are usually industrial waste compounds, were detected only in breasts of painted snipe and gull; 0.74 and 1.67 μg kg^{-1}, respectively (Table 2). Meanwhile, none was detected in water, algae, crab muscles, shrimp or fish muscles (Table 1). Most likely, this result is due to the absence of the industrial wastes in the lake as there are no industrial establishments in the neighborhood of the lake. However, the presence of the PCBs in p. snipe and gull is probably due to being migrate birds, thus PCBs residues in their bodies might be a result of accumulations of polluted food or waters from other areas birds have been to, other than the area on which the study was made.

Detected OC pesticides in birds were intensed in breasts. On the other side, OP pesticides were focused in the livers. This is probably referring to recent exposure of those birds to OP pesticides or to their widespread existence more than OCs; hence, they were extensively detected in livers where toxicant are supposed to be detoxified. The higher level of residues detected in mullet than detected in tilapia can possibly be because mullet is a bottom feeding fish which lives at the bottom of the lake, where residues of pesticides concentrations be higher than at the surface where tilapia lives. Besides that mullet contains higher levels of lipids in its body than tilapia does, which can also lead to the same result. The high residues detected in crab and shrimps muscles can be due to the same previous reasons.

Total residues of both OC and OP compounds detected in migrant birds; black headed gull, crane, cormorant and painted snipe were higher than those detected in resident birds; cattle egret, coot, moorhen and teal. Total residues were 660.92 and 586.66 μg kg^{-1} in migrant and resident birds, respectively. This is probably due to that they are migrate birds. Thus, the residues in their bodies might be a result of accumulations of polluted food or waters from other regions birds have been to, in addition to the residues accumulation caused in the study area as well. Virtually, results of the birds' analysis still need more researches on and further work to assure them because there are still some variations in the residues levels in birds' tissues, which can presently be explained by some or all of the following different reasons:

- The limited numbers of birds used as replicates from each spices to represent the random samples
- The differentiations of age among collected birds
- Some of the birds were resident while others were migrating birds; which refers to different physiological conditions of both groups of birds which enables each to be adapted to the different ecological condition they are adapted to and affected by
- Birds are opportunistic, thus they feed on what is available (Nelson, 1980).That causes variations of feeding resources for the same/or different species
- The variations in the feeding habitats of different species of birds; Some of the collected birds like gull, teal and crane feed mainly on fish, while others like cattle egret and moorhen feed on crustacean and mussels. However, coot feed on algae as well as on fish. And since the capability fish, crustaceans and algae to accumulate residues in their bodies differ, consciously the levels of residues in birds which feed on them differ

The tested pesticides were clearly biomagnified through the food chain of the tested organisms, as shown in Table 1 and 2. Most of detected pesticides were not detected in the water of the lake even thought they were detected in the other living organisms. No residues of OC were detected in the lake water, even though they were detected in the organisms' tissues. And very small traces of OP were detected in the water even though they were detected in higher concentrations in other samples.

The low concentrations detected in water is possibly due to:

- Lipophilicity of organochlorines compounds; hence, they are rarely detected in water
- The accumulation of pesticides in tissues of organisms where lipids are found. Pesticides are adsorbed by fish through gills, skin and food (Ulman, 1972). Heptachlor has been shown to bioconcentrate in aquatic organisms such as fish, mollusks, insects, plankton and algae by 200 to 37,000 times of its concentration in the surrounding waters (ATSDR, 1989)
- Volatilization, adsorption to sediments and/or photodegradation may be significant routes for the disappearance from the water i.e., heptachlor disperse from the aquatic environments due to volatization and adsorption (ATSDR, 1989), dicofol is expected to adsorb to sediment of the aquatic systems (Howard, 1991)
- The water-flow of the lake might be causing cleaning up of the water reducing pollutants concentrations in the water
- The presence of a variety of aquatic organisms in the water biomass which bioaccumulate portions of pesticides in their bodies can cause a reduction of their concentrations in the water. Specially in the bodies of organisms that contain lipids in their tissues
- It is possible that the pesticides detected in the organisms were not caused by recent exposures, but by previous exposures that were not used at the time of collecting samples and that explains there absence in water

Results noted by Zhou *et al*. (1999) showed that residues of organochlorines including DDTs, HCHs and PCBs detected in tilapia muscles (*Tilapia mossambica*) collected from inland water systems of Hong Kong in China were higher than those detected in the water sediment. Senthilkumar *et al*. (2001) reported a parallel detailed result show the biomagnification of OC in a food chain begins from the sediment where the lowest concentrations of OC were detected, then they were magnificated through organisms in order; green mussel <earthworm<frog<lizard<fish<bird egg<bats ending up at the highest concentrations in birds tissues. Recently, Varo *et al*. (2002) confirmed the accumulation of OP pesticides in *Aphanius iberus* when fed on pesticides contaminated artemia.

Residues of HCHs detected in mullet in the present study are higher than those reported by Caliskan and Yerli (2000) in fish samples collected from Koycegiz lagoon system in Turkey. In their study, the averages of HCHs were; 6.75 μg kg^{-1} in *C. capoeta*, 35.90 μg kg^{-1} in *O. mossambica*, 26.30 μg kg^{-1} in *L. ramada*, 5.33 μg kg^{-1} in *C. labrosus* and 5.00 μg kg^{-1} in *A. anguilla*. The only two detected pesticides in the water sample were the OP pesticides; diazinon and malathion with very low levels. Concentration of diazinon detected in the water surface of the lake was much lower than those detected in all of the tested organisms as well as malathion was. The low concentration of diazinon in water can be explained by the fact that organisms tissues bioconcentrate pesticides. Fish tissues can highly bioconcentrate diazinon so that concentrations in their tissues can be up to 200 times higher than those in the water in which the fish swim (Howard, 1991). Within a fish, concentrations are the highest in kidney (Tsuda, 1990) with a lack of interaction of any other environmental pollutants with their toxicity (Pathiratne and George, 1998).

Another suggestion depending on the acidity of water was reported by Lu (1995) suggests that the breakdown rate of pesticides is dependent on the acidity of water. So, at high acidic levels, one half the compound disappears within 12 h from the water. While in a neutral solution, the pesticide takes 6 months to degrade to one half the original concentrations. Even though Diazinon was detected with very low traces the lake water, but they are still considered dangerous since concentrations of less than one part per million in water are lethal according to USEPA (1986).

Concentrations of OP detected in the livers of birds are considered dangerous levels to birds; because birds are known to be more sensitive than mammals to OP in general including diazinon because their blood and liver contain lower levels of enzymes called (A esterases) that break down OP

(Walker and Mackness, 1987). Concentrations of OP detected in most of the tested samples were much higher than detected OP. But even thought, small traces of OP are considered to be a very dangerous matter more than OC are, since OP pesticides are highly toxic for aquatic organisms at concentrations generally lower than OC (Carvalho *et al*., 2002) and they are known to be a major global cause of health problems (Karalliedde, 1999).

Regarding the total residues of OC and OP detected in the tested organisms living in the ecosystem of the lake, crab and mullet had the highest concentration of total residues occurring 1714.5 and 1191 μg kg^{-1}. Followed by algae and shrimp occurring 1126 and 346.98 μg kg^{-1}. The lowest concentration was detected in Nile tilapia occurring only 99 μg kg^{-1}. The maximum number of pesticides detected in one organism, was the number of those detected in mullet which accumulated five pesticides in its tissues; DDE, Heptachlor, HCH, dicofol and diazinon. Followed by crab which accumulated four pesticides in its body; DDE, HCH, dicofol and malathion. On the other hand, Nile tilapia accumulated two pesticides in its body which is the less number of pesticides accumulated in the bodies of the tested organisms.

According to these observations, crab and mullet seem to be the best repetitive bioindicators of certain pollutants in the water ecosystems among all tested organisms; since they accumulate a variety of pesticides in their bodies with high concentrations, on contrast with Nile tilapia which accumulates small amounts and number of pesticides in their bodies. Senthilkumar *et al*. (2001) reported that aquatic organisms are time integrating, since they can indicate the presence of contaminates that are no longer in the water or those whose presence or use is intermittent. Since OP pesticides are lethal to fish even at low concentrations (Basha *et al*., 1984) and since they are highly toxic for aquatic organisms at concentrations generally lower than OC (Carvalho *et al*., 2002) their presence in the water and organisms is a matter for much concern. But even though, OP pesticides are also utilized in fish culture (mainly those based on dichlorvos and trichlorfon) in order to suppress some parasitary diseases such as monogeneoses and arthropodoses (Navratil *et al*., 2000).

Diazinon, one of the two OP pesticides detected in the tested samples, is the third most toxic OP after Azinophosmethyl and Parathion, respectively (Alabster, 1969). It is also described as very highly toxic to fish according to USEPA (1986); concentrations of less than one ppm in water are lethal. It is also known to be a widely used toxicant in a number of OP pesticides (Roberts and Hutson, 1998). Although the aquatic environment is not the target for the use of diazinon, studies have evidenced its presence and its metabolite diazoxon in the surface waters (Bailey *et al*., 2000). Besides, the results obtained in the present study. In addition Scholz *et al*. (2000) reported that even though diazinon is known to show many lethal effects when it is exposed to most organisms as well as to fish, still not all of its effects on fish organisms are known.

REFERENCES

Abdel Fattah, N.A., 1992. Detection of Pesticide Residues in Market Fish. M.V. Sci. University, Cairo.

Alabaster, J.S., 1969. Survival of fish in 164 herbicides, insecticides, fungicides wetting agents and miscellaneous substances. Int. Pest Control, 11: 25-35.

ATSDR, 1989. Agency for Toxic Substances and Disease Registry: Toxicological Profile for Heptachlor/Heptachlor Epoxide. ATSDR, Atlanta, GA., pp: 6-58.

Bailey, H.C., L. Deanovic, E. Reyes, T. Kimball and K. Larson *et al*., 2000. Diazinon and chlorpyrifos in urban waterways in Northern California, USA. Environ. Toxicol. Chem., 19: 82-87.

Basha, S.M., K.S. Prasada-Rao, R.P. Malla and P.M. Reddy, 1984. Effect of malathion and methyl parathione on the metabolic changes on the fish *Tilapia mossambicus*. Environ. Ecol., 6: 481-483.

Buhler, D.R., 1991. Transport, Accumulation and Disappearance of Pesticides. In: Chemistry, Biochemistry and Toxicology of Pesticides: Pesticide Education Program, Witt, J.M. (Ed). Oregon State University Extension Service, Corvallis, Chelsea, MI., pp: 6-13.

Caliskan, M. and S.V. Yerli, 2000. Organochlorine pesticide residues in aquatic organisms from Koycegiz Lagoon system, Turkey. Water Air Soil Pollut., 121: 1-9.

Carvalho, F.P., F. Gonzalez-Farias, J.P. Villeneuve, C. Cattini, M. Hernandez-Garza, L.D. Mee and S.W. Fowler, 2002. Distribution, fate and effects of pesticide residues in tropical coastal lagoons of Northwestern Mexico. Environ. Technol., 23: 1257-1270.

Hill, E.F. and M.B. Camardese, 1986. Lethal dietary toxicities of environmental contaminants to coturnix. Technical Report Number 2. U.S. Department of Interior, Fish and Wildlife Service, Washington, DC., pp: 6-55.

Howard, P.H., 1991. Handbook of Environmental Fate and Exposure Data for Organic Chemicals Pesticides. Vol. III, Lewis Publishers, Chelsea, MI., ISBN: TD 176.4.H69, pp: 6-13.

Hudson R.H., R.K. Tucker and S. Haegele, 1984. Handbook of acute toxicity of pesticides to wildlife resource publication 153. US Department of Interior, Fish and Wildlife Service. Washington, DC., pp: 6-54.

Johnson, W.W. and M.T. Finley, 1980. Handbook of acute toxicity of chemicals to fish and aquatic invertebrates. Resource Publication 137. U.S. Department of Interior, Fish and Wildlife Service, Washington, DC., 1980. pp: 5-17.

Karalliedde, L., 1999. Organophosphorus poisoning and anaesthesia. Anaesthesia, 54: 1073-1088.

Larini, L., A.B. Prado, D. De-Carvalho and H.C. Silva, 1971. Method of extraction and purification of chlorinated pesticides from biological material for toxicological purposes. Arq. Inst. Biol., 38: 115-123.

Lu, F.C., 1995. A review of the acceptable daily intakes of pesticides assessed by the World Health Organization. Regul. Toxicol. Pharmacol., 21: 351-364.

Menzer, R.E., 1987. Selection of Animal Models for Data Interpretation. In: Toxic Substances and Human Risk: Principles of Data Interpretation, Robert, G.T. and J.V. Rodricks (Eds.). Plenum Press, New York, pp: 5-80.

Menzie, C.M., 1980. Metabolism of pesticides. Update III. Special Scientific Report, Wildlife No. 232. U.S. Department of Interior, Fish and Wildlife Service, Washington, DC., pp: 5-29.

Mes, J., J. Doyle, R. Barret, D. Davis and D. Turton, 1984. Polychlorinated biphenyles and organochlorine pesticides in milk and blood of Canadian females during lactation. Arch. Environ. Contam. Toxicol., 32: 45-52.

Navratil, S., Z. Svobodova and Z. Lucky, 2000. Choroby ryb. Ediãní st ?edisko VFU, Brno, pp: 155.

Nelson, B., 1980. Seabirds: Their Biology and Ecology. Hamlyn Publishers, London, ISBN: 066-382-273, pp: 53.

Pathiratne, A. and S.G. George, 1998. Toxicity of malathion to *Nile tilapia*, *Oreochromis niloticus* and modulation by other environmental contaminants. Aquatic Toxicol., 43: 261-271.

Roberts, T.R. and D.H. Hutson, 1998. Metabolits Pathways of Agrochemicals. Part 2: Insecticides and Fungicides. Royal Society of Chemistry, Cambridge, ISBN: 085404499X, pp: 1475.

Rohm and Haas, 1991. Material Safety Data Sheet for Kelthane Technical B Miticide. Rohm and Haas Co., Philadelphia, PA., pp: 6-46.

SAS, 1998. Statistical Analysis System SAS user's Guide: Statistics, Version 6. SAS, Cary, N.C., ISBN: 3-540-65014-8.

Scholz, N.L., N.K. Truelove, B.L. French, B.A. Berejikian, T.P. Quinin, E. Casillas and T.K. Collier, 2000. Diazinon disrupts antipredatore and homing behaviours in Chinook salmon (*Oncorhynchus tshawytscha*). Can. J. Fish. Aquat. Sci., 57: 1911-1918.

Senthilkumar, K., K. Kannan, A. Subramanian and S. Tanabe, 2001. Accumulation of organochlorine pesticides and polychlorinated biphenyls in sediments, aquatic organisms, birds, bird eggs and bat collected from South India. Environ. Sci. Pollut. Res. Int., 8: 35-47.

Smith, G.J., 1993. Toxicology and Pesticide Use in Relation to Wildlife: Organophosphorus and Carbamate Compounds. 1st Edn., CRC Press, Boca Raton, FL., ISBN: 0849387213, pp: 5-7.

Tawfic, M.A. and S.M. Ismail, 1991. Residues of some organochlorine compounds in fish, crab and sediment from El Temsah lake, Suez Canal and their effect on the mitochondrial ATPase of the New Zealand white rabbit. J. Egyptian Public Health Assoc., 1: 557-575.

Tawfic, M.A., N. Loutfy and E. El Shiekh, 2002. Residue levels of DDE and PCBs in the blood serum of women in the Port Said region of Egypt. J. Hazard. Mater., A89: 41-48.

Tsuda, T., 1990. Bioconcentration and excretion of diazinon, IBP, malathion and fenitrothion by carp. Comp. Biochem. Physiol., 96: 23-26.

US EPA, Environmental Protection Agency (Office of Pesticide Programs), 1986. Pesticide fact sheet. Diazinon. No. 96. Washington, D.C. * Cited in Caroline Cox (1992).

USEPA, US Environmental Protection Agency, 1995. Integrated Risk Information System. Environmental Protection Agency, Washington, DC.

USPHS, U.S. Public Health Service, 1995. Hazardous Substance Data Bank. USPHS, Washington, DC., pp: 5-9.

Ulman, E., 1972. Lindane, Monograph of an Insecticide. Schillinger Verlag, Federal Republic of Germany, pp: 6-65.

Varo, I., R. Serrano, E. Pitarch, F. Amat, F.J. Lopez and J.C. Navarro, 2002. Bioaccumulation of chlorpyrifos through an experimental food chain: Study of protein HSP70 as biomarker of sublethal stress in fish. Arch. Environ. Contam. Toxicol., 42: 229-235.

World Health Organization, 1984. Environmental Health Criteria 38: Heptachlor. Health Organization, Geneva, Switzerland, pp: 6-59.

World Health Organization, 1989. Environmental Health Criteria 83, DDT and its Derivatives Environmental Effects. World Health Organization, Geneva, Switzerland.

Walker, C.H. and M.I. Mackness, 1987. A esterases and their role in regulating the toxicity of organophosphates. Arch. Toxicol., 60: 30-33.

Zhou, H.Y., R.Y. Cheung and M.H. Wong, 1999. Residues of organochlorines in sediments and tilapia collected from inland water systems of Hong Kong. Arch. Environ. Contam. Toxicol., 36: 424-431.