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Residues of Organochlorine Insecticides in Fishes in Lake Nubia

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The construction of the High Dam across the Nile in 1961, 10 km south of Aswan in Egypt, was the start of the formation of one of the biggest man-made lakes. The filling of this lake, which serves as a reservoir for the Nile waters, commenced in May 1964 and is expected to finish in 1980 when the maximum water storage capacity of the High Dam is attained. The length of the submerged area is at present 480 km,of which 300 km are within the Egyptian territory and is known as Lake Nasser, whilst the 180 km stretch which lies in the northern most part of the Sudan is known as Lake Nubia. The whole lake has an average width and depth of 13 km and 25 metres respectively. The total volume of water in the lake is 157 km^3 and its surface area is 6000 km^2. An early description of the basic features of the geopography and fish fauna of the Sudanese sector of the lake,and a discussion of its fisheries potential is available (GEORGE 1971). Since then the importance of this lake for fish production for both the Sudan and Egypt has greatly increased. At present the total annual catch in both countries is estimated at 15,000 tons and is expected to reach as much as 60,000 tons. Consequently there is much concern over the environmental quality of this lake particularly in relation to its fish productivity. The presence of foreign chemicals, including pesticides, in aquatic ecosystems could damage fish productivity in numerous ways (KOEMAN and STRIK 1975). In this respect the most likely source of chemical contamination lies in the cotton growing region along the Blue and White Niles in Central Sudan. In this area, the annual pesticide usage amounts to nearly 2500 tons, of mostly organochlorine compounds such as DDT, toxaphene and endosulfan (EL ZORGANI et al 1976). This investigation was undertaken as a preliminary attempt to test for the presence of residues of persistent pesticides in the fish fauna of Lake Nubia.

Materials and Methods

Twenty-nine fish specimens belonging to seven different species were collected at Wadi Halfa site on L. Nubia during December 1975 (TABLE 1). From each fish a sample of muscle and liver

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tissues were removed and kept in 4% formalin for at least two days before being despatched to Wad Medani. On arrival to the laboratory, samples were stored at - 10o until processing.

TABLE 1

Fishes from Lake Nubia Sampled for Residue Analysis

Type		No.of Specimens:		Weight range(Kg)
Barbus bynni (Forsk.)	:	5	:	2.0 - 7.0
Hydrocynus forskalii (Cuv.)	:	3	:	1.8 - 2.1
Labeo niloticus (Forsk.)	:	5	:	0.9 - 7.5
Labeo coubie (Rupp.)	:	5	:	3.6 - 5.2
Lates niloticus (Linn.)	:	5	:	1.2 - 5.5
Tilapia galilaea (Linn.)	:	2	:	1.0 - 1.2
Tilapia nilotica (Linn.)	:	4	:	1.5 - 3.5

Samples of tissues (10 g or less) were extracted following the method described for organochlorine residues in animal tissues (DE FAUBERT MAUNDER et al 1964). The extracts were analysed by gas-liquid chromatography using a Perkin-Elmer F 11 instrument equipped with a ^{63}Ni electron-capture detector and a glass column (1m x 3 mm i.d.) packed with 1% silicone OV-25 on Chromosorb G-AW-DMCS treated 100/120 mesh. Temperatures of the oven, injection block and detector were 190°, 220° and 210° respectively. Nitrogen at (70 ml/min.) was the carrier gas used. For identification of residues, sample chromatograms were compared with those of authentic pesticides and peak heights were used for their quantitative determination.

Sub-samples of some of the extracts were also analysed by GLC at the Institute of Analytical Chemistry, University of Stockholm. In this case two column types, one containing QF-1/SF-96 (5 and 3%) and the other containing pure SF-96 (4%) as the stationary phase, were used. There was good agreement between the results of analysis from the Swedish laboratory and our laboratory.

Results and Discussion

Residues are expressed as ug/kg wet tissue. Out of 58 samples of tissues analysed, only 10 were found to contain detectable levels of residues (TABLE 2). p,p'- DDE was found in all of the ten samples, while p,p'-DDT was found only in 3 muscle samples. The highest level of total residue (184 ug/kg) was found in a muscle sample of a specimen of *Hydrocynus forskalii*.

TABLE 2

Residues of Organochlorine Insecticides in Some Fishes from Lake Nubia

Type	Residue Content (ppb) ug/kg		
	p,p'-DDE	p,p'-DDT	Total as p,p-DDT[a]
Barbus bynni (Forsk.)			
1- Muscle	1.0	5.0	6.0
2- Muscle	107.0		119.0
3- Liver	39.0		43.0
Hydrocynus forskalii (Cuv.)			
1- Muscle	3.0	5.0	8.0
2- Muscle	153.0	14.0	184.0
Labeo coubie (Rupp.)			
1- Muscle	21.0		23.0
Labeo niloticus (Forsk.)			
1- Liver	4.0		4.0
2- Liver	2.0		2.0
3- Liver	12.0		13.0
Lates niloticus (Linn.)			
1- Muscle	6.0		7.0

[a]DDE content was multiplied by 1.11

In an earlier study on Nile fishes from the Gezira canals, specimens of this species were also found to contain the highest residue levels from amongst five types of fishes examined (EL ZORGANI 1976). Based on these findings, the suggested suitability of this fish as an indicator species for chemical monitoring of organochlorine pesticides in some African lakes and rivers (KOEMAN and PENNINGS 1970), could also be extended to the Nile basin.

In all the specimens in which DDE and/or DDT were found in the muscle tissue, none was detectable in the liver. This is contrary to the established trend in birds, where livers always contain residues at higher concentrations than the muscles, and are hence considered of value as indicator organs for monitoring bird exposure to organochlorines (EL ZORGANI 1976, WALKER and MILLS 1965). The weak tendency of fishes to store organochlorine pesticides in their livers has previously been demonstrated during a study of DDT absorption and distribution in the brown trout Salmo trutta (HOLDEN 1962). However, in the case of 4 specimens of labeo niloticus, residues were detectable only in the livers. This is more likely due to the high fat content of these liver samples.

The results of this sampling of L. Nubia fishes shows that residues of organochlorine pesticides are present, though at very low concentrations, in the majority of common species. These residues have apparently originated from the areas of intensive pesticide application in the Gezira and along the White Nile in Central Sudan. The natural processes of weathering are likely to result in the transfer of pesticide residues to the main course of the Nile, especially during the rainy season, and hence their transport downstream. Organochlorine pesticides in water will be taken up very rapidly by living organisms (SODERGREN 1968) or are either completely adsorbed by particulate matter (KEITH and HUNT 1966). Lake Nubia is the site of deposition for most of the Nile-borne silt and other suspended matter. Under these circumstances, and in view of the continuous use of persistent organochlorines in agriculture in Central Sudan, it is expected that an appreciable build-up of residues with time will take place in this lake. Increased contamination with residues is certain to adversely affect the fish population (HOLDEN 1965) and hence endanger the plans for the development of a fisheries industry in this vital area. In order to keep the situation under control, it is essential that a system for the continuous monitoring of residues in the key environmental components in the whole lake should be established.

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