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Organochlorine Residues in the Waters of Keoladeo National Park, Bharatpur, Rajasthan

S. Muralidharan*

Bombay Natural History Society, "Hornbill House," S B Singh Road, Bombay - 400 023, India

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Pesticides, especially organochlorines, due to their slow decomposition rate and long half-life, remain in the environment for a protracted period of time and exert deleterious effects on non-target organisms. Wetlands suffer the maximum as the agricultural run off finally finds its way into aquatic systems. Although many studies relating to pesticide contamination in various biological and non-biological components are available in many north American and European countries, in India there are only very few (Agarwal et. al 1986; Bakre et. al 1990; Kulshrestha et. al 1990; Nayak et.al 995). In the present study residue levels of a few organochlorine pesticides, namely BHC and its isomers, DDT and its metabolites, and aldrin were measured during 1989 and 1990 in the waters of Keoladeo National Park, Bharatpur, India and the total annual input into the wetland system was calculated.

MATERIALS AND METHODS

Keoladeo National Park, situated between 27° 7.6' to 27° 12.2' N and 77° 29.5' to 77° 33.9' E is two kilometres southeast of Bharatpur city, 50 km west of Agra and 180 km north of Delhi. The area of the Park is about 29 sq km and, of which approximately 8.5 sq.km is the wetland. A unique feature of the wetland ecosystem of Keoladeo National Park is its origin from a natural depression, which was an evanescent rain-fed wetland. The construction of Ajanbund, a temporary reservoir, in the confluence of two major rivers, namely Banganga and Gambhir (Fig. 1), by the erstwhile rulers of Bharatpur, about a kilometre from

Present address: Division of Ecotoxicology, Sálim Ali Centre for Ornithology and Natural History, Anaikatti, Coimbatore - 641 108, India

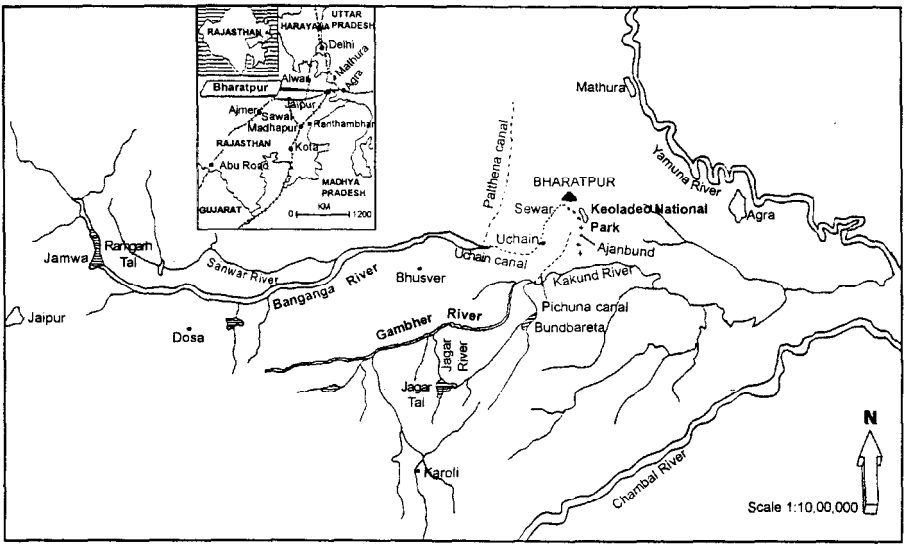

Fig. 1. Banganga and Gambhir river system

the border of the Park, some 250 years ago, to supply water regularly to the area marks the beginning of human involvement in the conversion of this natural depression into a permanent waterfowl reserve (Vijayan 1991). It is one of the Ramsar Convention and IUCN's World Heritage sites, and known the world over for its large concentration of migratory waterfowl, colonial fish-eating birds and the rare Siberian Crane.

Ajanbund, during monsoon gets water from its catchment areas, and in turn supplies to the Park through a canal. It becomes a cultivable land once water is supplied to the Park and also to the villages located close by for irrigation. As pesticides are being indiscriminately used in the catchment areas of the river systems and also in Ajanbund, the chances of the Park getting residues are all the more strong. Samples of water (2 lit), in an integrated fashion, were collected during the water supply to the Park, between July and September, at the entry point of the canal into the Park, in glass bottles which were cleaned thoroughly and rinsed with hexane. Number of samples collected was 78 and 102 during 1989 and 1990 respectively. It is to be noted that water is supplied to the Park from Ajanbund only once in a year. The duration of supply however, will vary depending on the quantum of water available at Ajanbund and need of the Park. Samples collected

were pooled and stored in refrigerator till extraction. Organochlorines were extracted into hexane by liquid-liquid partition APHA (1980). Samples were extracted three times with 75-80 mL of hexane and cleaned up through column packed with Florosil. Processed samples were stored in freezer till analysis at -20 to -25°c. Residues were estimated with gas chromatograph under the following conditions;

Detector	:	Electron capture		
Column	:	Glass, packed with 1.5% OV 17 + 1.95% OV 210		
Gas	:	Nitrogen; flow rate - 30 mL/min		
Temperature	:	Column	:	200°c
		Injector	:	220°c
		Detector	:	240°c

Recoveries from the fortified samples ranged between 85 and 94% and the results were not corrected for per cent recovery.

Based on the quantum of water released into the Park and the residues per liter of water, the total quantity of pesticide entered the Park was reckoned.

RESULTS AND DISCUSSION

Total BHC residue level ranged between 0.004 and 0.58 ppb in 1989 and 0.05 and 3.43 ppb in 1990. Of all the isomers of BHC, alpha BHC had the highest (92%) frequency of occurrence in the samples analysed followed by delta (67%), gamma (58%) and beta BHC (8%). Alpha BHC measured the maximum during 1989 (0.78 ppb) and 1990 (0.86 ppb) while beta BHC measured the minimum during 1989 and 1990, 0.02 and 0.01 ppb respectively (Fig. 2).

The average maximum concentration of total DDT was 0.5 ppb and the minimum 0.001 ppb in 1989, whereas these values were 3.86 ppb and below detection limit in 1990. Of the six metabolites of DDT, p,p' DDD, o,p' DDD and p,p' DDT measured below detectable levels (Fig.3). O,p' DDE measured the maximum concentration (0.74 ppb) and p,p' DDE the minimum (0.14 ppb) during 1989. O,p' DDT had

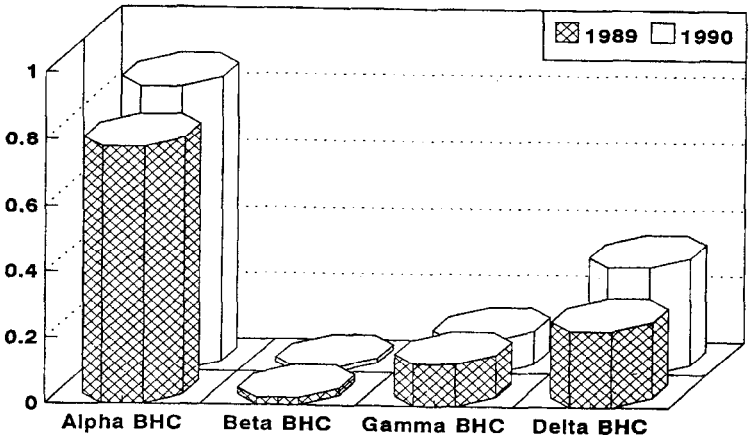

Fig. 2. Residues of BHC in the waters of Keoladeo National Park, Bharatpur

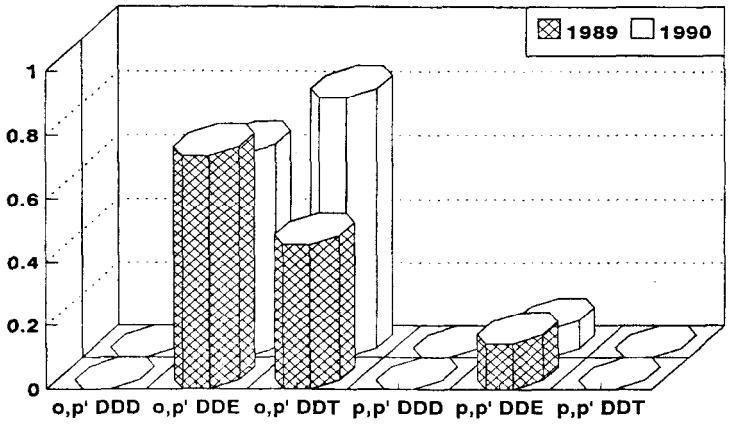

Fig. 3. Residues of DDT in the waters of Keoladeo National Park, Bharatpur

the highest residue (0.73 ppb) while p,p' DDE the lowest (0.08 ppb) during 1990. Of the three metabolites of DDT detected, o,p' DDE and o,p' DDT had 42% of frequency of occurrence while p,p' DDE had 25%. Residues of aldrin were 3.52 and 6.01 ppb during 1989 and 1990 respectively. The average frequency of occurrence was 58 and 50% during 1989 and 1990 respectively.

The concentration of total BHC as well as DDT was more in 1990 than in 1989. Similarly in 1990, the residues of aldrin were the maximum while its metabolite, dieldrin was below detection limit in all the samples. The differences in concentration between years could be

related with the usage of pesticides in the catchment areas and also the rainfall. However, the concentration need not be always linearly proportionate to the rainfall. When the levels of contamination recorded in the present investigation were compared with those available from neighbouring areas, they are lower than the levels reported by Agarwal et.al (1986) in river Jamuna, Delhi, Bakre et.al (1990) in Mahala water reservoir, Jaipur, Kulshrestha et. al (1990) in three rivers, namely Khan near Indore, Kashipra near Ujjain and Chambal near Kota, and Nayak et.al (1995) in river Ganga. Hence, the levels detected in the present study need not be alarming. However, considering the problems the Park had or has been facing due to pesticide contamination, the levels reported in this paper assume significance. It may be noted that the Park had witnessed mortality of several Sarus Crane due to aldrin poisoning between 1987 and 1990 (Muralidharan 1993) and residues of dieldrin, a metabolite of aldrin, BHC, DDT, endosulfan and heptachlor were detected in the eggs of select colonial waterbirds breeding in this Park (Muralidharan et.al 1992). Although there is no source of in house contamination, as the Park draws water form Ajanbund and also as the birds do go out to the adjoining agricultural fields for feeding, the Park and its birds are prone to pesticide contamination. Moreover, the present investigation shows explicitly that the Park harbours pesticide residues every year along with the water supply.

It is to be noted that usage of DDT and dieldrin has been banned for agriculture in India. However, DDT is being used for malaria control while dieldrin for locust control in the desert regions with the special permission from the authorities concerned. It is a welcoming news that the Indian Government banned the use of aldrin from 1st January 1994. However, unless the environmental residue levels are monitored continuously, the illegal usage cannot be found out and prevented. Further the environmental residue levels also have to be monitored as the chemicals and their metabolites are expected to remain in the system for many more years.

Estimation of total pesticide input to the Park became possible as we knew the quantity of water that entered the Park each year and also there were no water outlets from the Park. Depending on the rainfall

in the catchment areas of the rivers Banganga and Gambhir, the Park gets its share of water every year. The local irrigation department does regulate the water supply to the Park as well as to the farmers. Of the three pesticides, the input of aldrin to the Park was the maximum (Table 1). It is to be noted that aldrin gets converted into dieldrin in the environment and is much more toxic than the parent compound.

Table 1. Organochlorine input to Keoladeo National Park during 1989-90

Year	Quantum of water (cubic meter)	Quantum of residues (Kg)		
		BHC	DDT	Aldrin
1989	5.515×10^6	5.82	7.35	19.43
1990	12.680×10^6	15.28	19.63	33.17

Pesticide input to the Park was more during 1989 than 1990. The water supplied to the Park during 1990 was more than double than that of 1989 (Table 1). It is obvious that due to more rams in the catchment areas, there was more run off from the agricultural fields and thus higher pesticide input to the Park during 1990. However, the residue input need not be linearly proportional to the quantum of water supply. Water loss from the Park is only through evaporation and percolation, and there is no outlet from the Park except in years of flood. As wetland ecosystems reduce in size or as the volume and/or toxicity of pollutants increase(s), the ability of the wetland to accommodate and eliminate the contaminants gets impaired. When this point is reached, the wetland can become a source of toxicity rather than a sink (Fitzpatrick and Bhowmik 1990). Hence, unless the silt laden with pesticides are removed manually or mechanically, the pesticides that entered the Park will remain inside. However, natural decomposition of chemicals will reduce the impact on the system to some extent. Considering the scarcity of water in this part of the country, it is not possible to let out the water from the Park so as to reduce the accumulation of pesticides in the wetland. Hence, advocating farmers to resort to eco-friendly means of plant protection is the only alternative available to conserve this wetland.

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