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BIRDS AS BIO-INDICATORS OF RADIOACTIVE NUCLIDES IN PAKISTAN

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Abstract: Pakistan is situated in South Asia and its Indus valley is the major wintering and residing ground for millions of waterfowl. The present study was aimed to analyze the presence of accidental (Chernobyl) and experimental air borne radioactivity through migratory and indigenous birds as they are the bio-indicators of environmental pollution. The study revealed that a higher concentration of radioactivity was traced in migratory birds coming from Northern Hemisphere, compared with local birds collected from vicinity of Dera Ghazi Khan (Pakistan). The food contents analyzed in bird's stomach showed that they utilized marshy as well as terrestrial vegetation. It is concluded that the ecosystems of Northern Hemisphere and Pakistan have been contaminated with radionuclides in the first, second and third trophic levels in our various ecosystem.

Key words: Birds as bio-indicators, radioactivity, Chernobyl environmental pollution.

INTRODUCTION

Radioactive contamination is increasing day by day due to peaceful uses of atomic energy, testing of nuclear weapons and accidental release from the nuclear power plants. The accidents which occur in the nuclear power plants are mainly responsible for sudden increase in the concentration of radionuclides in the environment. On such major accident happened on April 26, 1986 at Chernobyl Nuclear Power Plant in the former USSR. It was resulted in air borne release of mega-curie quantities of fission products which are now a part of the environment not only in the former Soviet Union but spread far beyond its boundaries (Hall, 1986).

The composition of fission products released from the accidents in nuclear reactor at Windscale in U.K. showed that in addition to the noble gases, the prominent nuclides were the volatile fission products such as iodine (I), tellurium (Te), cesium (Cs) and also smaller amounts of ruthenium (Ru), strontium (Sr), cerium (Ce) and barium (Ba), (Loutit *et al.*, 1960). In accidents, I is the dominant contaminant (British Medical Research Council, 1960). During vegetation most of the air borne radioactivity come in contact with the leaves and enter the food chain (Smith and Epstein, 1964). The above mentioned mode of entry is the main source of contamination by Ce whereas Sr is only

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absorbed by the leaf surface (Yamagata, 1963).

It is evident that the contamination of the ecosystem is continously increasing due to radioactive fallout. The accident at Chernobyl was of great magnitude than any other. There are continuous reports that both the aquatic and terrestrial ecosystems have been contaminated in the Northern Hemisphere.

According to some recent studies done in Norway radio-cesium from Chernobyl reactor has been detected in Eurasian woodcock and earthworms (Atle *et al.*, 1994). Pearce (1995) has also reported radiocesium in migratory birds in Northern Ireland, released during Chernobyl accident. Millions of migratory waterfowl breed in the Northern Hemisphere in which the majority of these breed in Russia and feed on various types of food available there. It is suspected that these birds might take up radioactivity through food. A large number of migratory waterfowl of Russia origin winter in the Indus valley of Pakistan. So far, it is not known whether these migratory birds contain radioactivity, if any, what is its impact on food chain through wetland and terrestrial ecosystem. Thus the study was undertaken to analyze the radioactivity in migratory and local waterfowl.

MATERIALS AND METHODS

Aquatic migratory birds were collected from vicinity of Dera Ghazi Khan district (D.G. Khan), Ghamagar lake and Bhila Hithar of Kasur district and Kandhkot of Jacobabad district. Starling and black winged Stilt as local wildfowl were also collected from D.G. Khan area. Specimens were kept at zero degree centigrade, continued to be enclosed in polythene bags.

Stomach contents of the birds were dried (Roberts and Dorothy, 1966) and weighed. Different stomach contents, seeds, leaf fragments, salt, snail shells and pebbles were separated from each other. Percentage ratio of each component to the total dry weight of stomach contents was calculated. Different leaf fragments and kinds of seeds were identified (Martin, 1961 and Core, 1959).

Radioactivity was detected in the migratory birds by means of solid state nuclear track detector (NTD), Trade Mark Cr-39. The NTD were placed in feathers, beaks, muscles and bones of the specimens. The contact was maintained by wrapping the cellophane tape around the sample and detector. Samples with detectors were kept in the freezer at 0°C for 15 days. The etching was done by placing exposed detectors of various sizes such as 2-5 cm in the etchant solution for 10 hours at 70°C. Number of alpha tracks formed on NTD were counted per square centimeter of the NTD surface, under the microscope. The exposed NTD-Cr, 39 were subjected to microphotography.

RESULTS AND DISCUSSION

Sturnum muscles of pochard (*Aythya ferina*) and coot (*Fulica atra*) showed 75 and

70 tracks of alpha particles per centimeter square of NTD, respectively. Mallard (*Anas platyrhynchos*) and gadwall (*Anas strepera*) showed 53 and 51 tracks of alpha particles per centimeter square of NTD, respectively. Teal (*Anas crecea*) and black winged stilt (*Himantopus himantopus*) showed 15 and 12 tracks of alpha particles per centimeter square of NTD, respectively. Pintail (*Anas acuta*) and shoveler (*Anas clypeata*) showed 32 and 30 tracks of alpha particles per centimeter square of NTD, respectively. Starling (*Sturnus vulgaris*) showed 16 tracks of alpha particles on one centimeter square of NTD (Fig.1).

These results revealed that pochard and coot showed maximum radioactivity in their body while teal and black-winged stilt showed minimum concentration of radioactive nuclides. At this stage a question arises as to why there is a variation in the number of tracks of alpha particles in various birds? The first reason is that the breeding and feeding areas of birds indicating elevated redioactivity were coming from the adjacent areas of the Chernohyl while other birds were residing away from high radioactivity zones. The second reason seems to be the food of pochard and coot which might consist of plants having high concentration of radionuclides. Their stomach contained seeds of *Melilotus alba* and *Trignoella* spp. and *Oryza sativa* (rice). There were also leaves and salts (Table 1) in composition with other food materials. It appears that pochard and coot had a similar feeding ground and had already picked up radionuclides from the parent ecosystems.

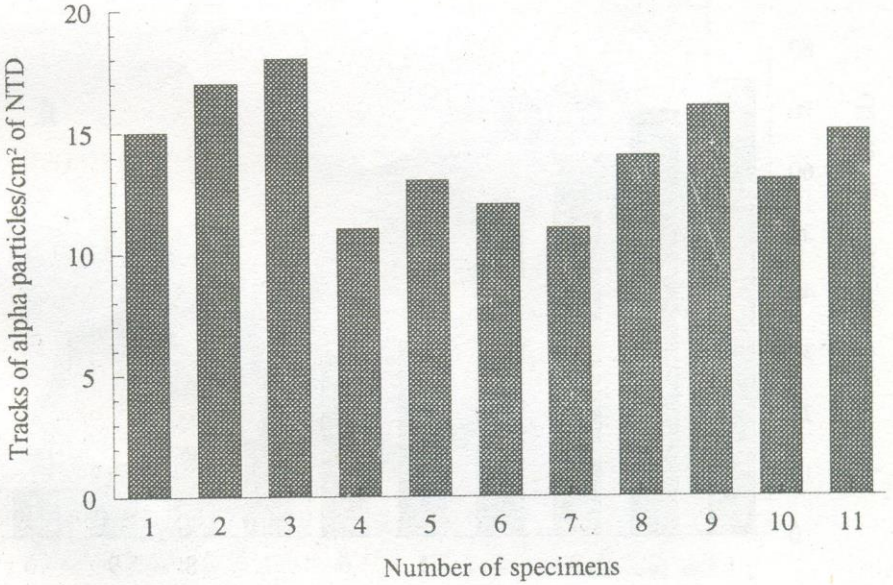

Fig. 1: Histogram showing radioactivity in different specimens of teal, *Anas crecca*.

Mallard and gadwall also showed the highest level of radioactivity with 53 and 51 tracks of alpha particles per centimeter square of NTD, respectively. These were collected from Dera Ghazi Khan district. Their stomach contents included 56.78% seeds and 12.92% leaves of *Melilotus alba* with 18.92% salts and 11.37% pebbles (Table 1). They might have obtained radionuclides from the parent ecosystem through contaminated food chain. Pintail and shoveler showed the third highest level of radioactivity with 32 and 30 tracks of alpha particles per centimeter square of NTD, respectively. The stomach contents of pintail included seeds (81.99%) with 78% rice (*Oryza sativa*). It appears that pintail has a feeding ground in semiaquatic areas like paddy fields. It might have fed on the similar type of vegetation in its breeding grounds and acquired radionuclides. Relative distribution of fall out activity in component parts of cereal crops *i.e.*, distribution of radioactivity in different parts of paddy by Sr crops are exposed to and collect as much fall out contamination as other vegetation. De-husked grain skinned food fruit is the least contaminated part of the plant and milling of rice was found to eliminate the more contaminated part of the grain (Ali, 1979). The same is true for shovelers which were collected from Dera Ghazi Khan and Kasur districts. They might have also received radionuclides from the contaminated vegetation of their breeding grounds. Teal showed minimum radioactivity with a range of 12-18 tracks of alpha particles per centimeter square of NTD (Fig.2). Their stomach contents showed seeds and leaf fragments of *Echinochloa* spp., *Amarants* spp., *Medicago denticulatum* and *Trigonella* spp. with insects, smashed shells of snails and salts. This analysis showed that, these birds might have obtained radionuclides by feeding on contaminated vegetation from their breeding sites.

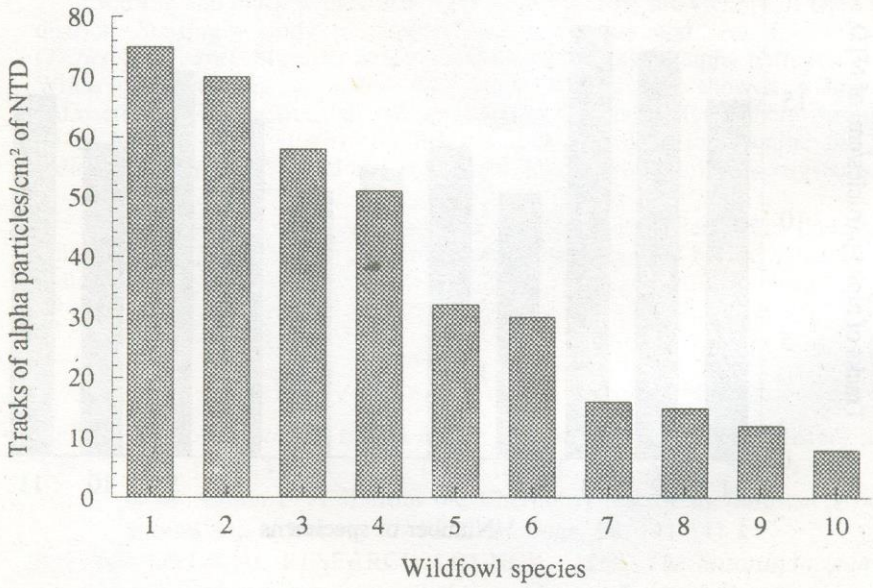

Fig. 2: Histogram showing radioactivity in different species of wildfowl. 1, pochard; 2, coot; 3, mallard; 4, gadwall; 5, pintail; 6, shoveler; 7, starling; 8, teal; 9, black winged stilt; 10, control.

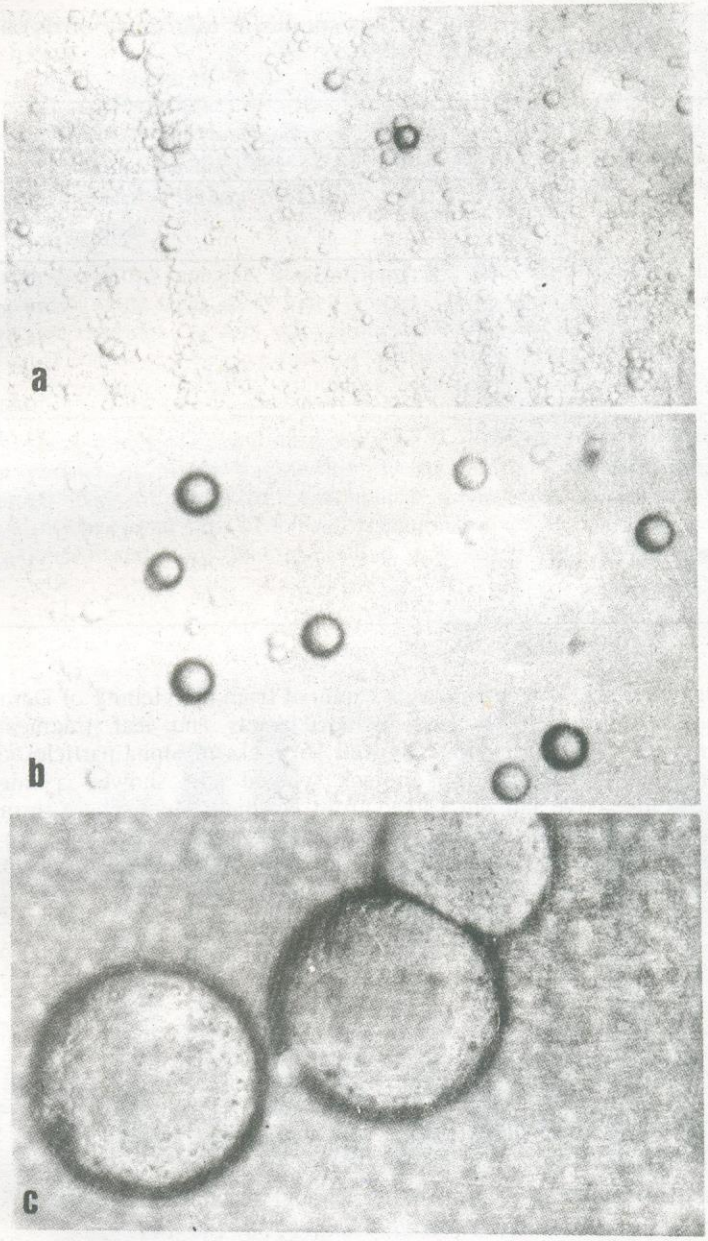

Fig. 3: Microphotograph of nuclear track detector (NTD) showing tracks of alpha particles; a, unexposed (100X); b, exposed (100X); c, exposed (400X).

Table 1: Stomach contents in various species of migratory birds collected from different localities.

Species	Area of collection	Food analysis						
		Weight (gm)		Food contents (%)				
		Wet	Dry	Seeds	Leaves	Snail shells	Salts	Pebbles
Pochard	Kandh Kot	3.90	1.29	65.00	15.50	-	19.50	-
Coot	D.G. Khan	11.80	5.52	1.16	18.88	-	79.96	-
Mallard	D.G. Khan	3.80	1.32	56.78	12.92	-	18.92	11.38
Gadwall	Kandh Kot	11.00	7.58	-	100	-	-	-
Pintail	Kasur	7.56	5.55	81.99	-	-	10.81	7.20
Shoveler	Kasur	4.01	2.75	7.27	-	-	74.54	18.19
Starling	D.G. Khan	2.52	0.46	43.48	56.52	-	-	-
Teal	D.G. Khan	2.98	1.36	44.52	-	-	55.48	-
	Kasur	1.19	0.57	40.35	-	59.65	-	-
	Jacobabad	2.36	1.01	19.80	56.44	-	23.76	-
B.W Stilt	D.G. Khan	1.31	0.30	23.34	36.66	-	-	40.00

Starling and black winged stilt were captured from the vicinity of Dera Ghazi Khan district. Starling's stomach contents included seeds and leaf fragments of wheat (*Triticum vulgare*). Sturnum muscles showed 16 tracks of alpha particles/cm^2 of NTD. While other resident waterfowl like black winged stilt showed a fair amount of radioactivity. Radioactive fall out spread from Northern Hemisphere through Pakistan up to Kuwait (Hull, 1986). Further research is needed to examine the quantity of radionuclides in the 1st, 2nd and 3rd trophic levels in our various ecosystems.

It is evident that the wetland and terrestrial ecosystems and their resources in Pakistan have also received contamination of radionuclides by the spread of Chernobyl radioactive fall out (Fig.3).

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