Impact of Agricultural Pesticides on the Population Status and Breeding Success of Select species of Fish-eating Birds in Tamil Nadu

Final Report

Submitted to Ministry of Environment and Forest
Govt. of India.

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Co-Investigator : C. Sivasubramaniyan
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Sálim Ali Centre for Ornithology and Natural History
(Centre aided by Ministry of Environment & Forests, Govt. of India)
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2. Abstract of the project

Fish-eating birds such as egrets, herons and storks are largely associated with agricultural ecosystems. In Tamil Nadu although there are breeding colonies within protected areas, their major feeding habitats are smaller ponds and lakes located within agricultural

ecosystems. While it may be a general presumption that the population of these fish-eating birds is on the decline, there is very little information available on the population status and breeding success of these birds. Further it is possible that environmental contaminants mainly from agricultural activities have been insidiously playing a role in the overall population decline of these birds. However, information available are inadequate. The present project included three major components. The first component was to conduct a survey and locate the heronries in Tamil Nadu and the second one was to monitor the population and breeding ecology of colonial water birds, and the third one was to document residue levels of OC in select components and assess the impacts. Number of study sites and species was decided based on the survey output and significance rating. Although ecological factors are responsible for the population decline or breeding success, the present study documented the possible ill effects of chemicals of agricultural origin on select species of fish-eating birds.

Survey was conducted to identify the heronries in the state. Local people were enquired to get details on the nesting locations and breeding history of colonial nesting birds. Direct count method was followed to estimate the number of species and individuals. Breeding ecology of select colonial nesting birds were studied using focal animal sampling technique. Agricultural practices, land-use pattern, threats and disturbances were also recorded. Samples, namely fishes, dead birds and eggs were collected as per standard operating protocols. To document pesticide residues, Soxhlet extraction method was followed with suitable solvents and cleaned up for estimating organochlorine residues using Gas Chromatograph equipped with electron capture detector.

Field surveys in 41 heronries in 14 districts were conducted between March and September 2007. The distribution showed that not all the districts in Tamil Nadu have ideal breeding locations for the colonial nesting birds. Number of heronries located in Tirunelveli (8), Kanyakumari (7) and Ramanathapuram (6) were relatively more. The remaining districts had between one and three sites. With respect to species distribution, Little Egret, Little Cormorant and Indian Pond Heron were found in nearly twenty heronries in Tamil Nadu. Black Ibis and Wooly-necked Stork were found only in two locations. Heronries, namely Vedanthangal Bird Sanctuary, Vettangudi Bird Sanctuary and Koonthankulam Bird Sanctuary were selected for further studies.

During the period of study (October 2007 - March 2010), 18 species of fish-eating birds were observed in Vedanthangal Bird Sanctuary. Total population was the maximum (30,551) during March 2010 and minimum (118) during September 2009. Of which Cattle Egret, Glossy Ibis, Painted Stork, Spot-billed Pelican, Indian Cormorant and Little Cormorant were the predominant species. White-throated Kingfisher and Pied Kingfisher were only a few in numbers. Out of the18 species found in the sanctuary, 12 species were observed breeding. However, we monitored eight species, namely Spot-billed Pelican, Asian Openbill, Black-headed Ibis, Painted Stork, Grey Heron, Little Cormorant, Little Egret and Eurasian Spoonbill. On the whole, the total number of nests recorded was the maximum (3,185) during 2009-10 and minimum (2,819) during 2007-08. Among the species the maximum number of nests was of Spot-billed Pelican (887) followed by Painted Stork (576) and Asian Openbill (570). Nests of Darter and White-throated Kingfisher were only a few.

Between October 2007 and March 2010, 21 species of fish-eating birds were observed in Koonthankulam Bird Sanctuary. Total population was the maximum (28,190) during March 2010 and minimum (52) during October 2009. Of all the species, Cattle Egret, Glossy Ibis, Painted Stork, Spot-billed Pelican, Indian Cormorant and Black-headed Ibis were the predominant species. White-throated Kingfisher and Pied Kingfisher were only a few. Out of 21 species found in this sanctuary, 11 were observed breeding. However, we monitored six species, namely Spot-billed Pelican, Black-headed Ibis, Painted Stork, Little Egret, Intermediate Egret and Indian Cormorant. The maximum number of nests (3,650) was recorded during 2009 - 10 and minimum (2,169) during 2007-08. Among the breeding birds, Painted Stork (1,861) was the predominant species followed by Spot-billed Pelican (877).

The population and number of species in Vettangudi Bird Sanctuary were relatively lower than in Vedanthangal and Koonthankulam. Population was the maximum (3989) during December 2008 and minimum (17) during March 2010. Among the species, Cattle Egret, Little Egret, Asian Openbill and Black-headed Ibis were more in number and White-throated Kingfisher was less. Species, namely Asian Openbill, Black-headed Ibis, Little Cormorant, Black-crowned Night Heron, Intermediate Egret, Little Egret and Darter nested in the sanctuary. We monitored species, namely Asian Openbill, Black-headed Ibis, Little Cormorant and Intermediate Egret. Among all the species, Asian Openbill (326) was the most predominant. During 2009, seven species of birds settled into begin nesting in December, but due to inadequate water and disturbance by Greater Spotted Eagle, all of them deserted the Sanctuary soon. Density was calculated to examine the variation in population of colonial nesting birds among the study sites, species, and families. Differences in the density of colonial nesting birds among the study sites, species, families, and between seasons were significant ($P<0.05$).

In Vedanthangal Bird Sanctuary, most of the nests were found on *Acacia nilotica* and *Barringtonia acutangula.* Among the species, Asian Openbill, Painted Stork, Black-headed Ibis, Grey Heron, Eurasian Spoonbill and Little Egret predominantly used *Barringtonia acutangula*. Indian Cormorant, Spot-billed Pelican and Darter mostly preferred *Acacia nilotica.* In Koonthankulam Bird Sanctuary, Painted Stork, Little Egret, Intermediate Egret and Indian Pond Heron preferred *Prosophis juliflora*, while Indian Cormorant, Spot-billed Pelican and Darter used *Acacia nilotica*. Many of the birds breeding in Vettangudi Bird Sanctuary preferred *Acacia nilotica.* Nest-site characteristics, such as tree diameter at breast height, canopy level, tree and nest height, nest distance from water spread area and human settlement were also gathered and discussed.

Data on breeding success of select species of colonial nesting birds were gathered in Vedanthangal, Koonthankulam and Vettangudi Bird Sanctuaries. Totally 1583 nests belonging to five families, namely *Ardeidae, Pelecanidae, Ciconiidae, Phalacrocoracidae* and *Threskiornithidae* were focused. In Vedanthangal, Black-headed Ibis and Spot-billed Pelican showed the highest breeding success during 2007-08, while the same species had the least success during 2009-10. In Koonthankulam, Spot-billed Pelican and Painted Stork had the highest success rate, while Intermediate Egret had the least. Among the four species of birds studied in Vettangudi Bird Sanctuary, Little Cormorant was the most successful breeder.

Towards assessing pesticide contamination, three hundred individuals comprising nine species of fishes covering two seasons, namely breeding (October to March) and non-breeding season (April to September) of birds were collected from the study sites. Among the organochlorines analyzed, HCH was most frequently detected followed by Heptachlor epoxide, Endosulfan and DDT. Σ OCPs in fishes showed variation, but was not significant (P>0.05). Among the isomers, β-HCH contributed more than 50% to the Σ HCH. Among DDT metabolites, p,p' DDT had high percentage of occurrence. Among the cyclodiene insecticide residues, Endosulfan was detected in more than 60% of the fishes. Variations in organochlorine residue levels among the locations and between seasons were not significant (P>0.05).

Totally 76 individuals belonging to 14 species of birds found dead during the study period were analyzed for pesticide residues in various tissues. Among various organochlorine pesticide residues analyzed, levels of HCH were the maximum. Σ HCH ranged between BDL in muscle of Spot-billed Pelican and 981 ppb in muscle of Indian Cormorant. Heptachlor epoxide, Σ Endosulfan and Σ DDT ranged from BDL to 963 ppb, BDL to 637 ppb and BDL to 208. 6 ppb respectively. Comparatively, low levels of Dieldrin ranging between BDL and 109.3 ppb in the tissues were recorded. Concentration of Σ DDT, Dieldrin and heptachlor epoxide significantly (P<0.05) varied among the locations while Σ HCH, Σ Endosulfan and Dieldrin significantly (P<0.05) varied among the species. On the whole, levels of organochlorine residues detected were higher in the tissues of wading birds such as Cattle Egret, Little Egret and Grey Heron than in swimming birds, namely Little Cormorant and Indian Cormorant. Higher accumulation of p,p' DDT, β- HCH and Σ Endosulfan in the tissues indicate continued exposure to these chemicals. The residue levels of DDT, HCH, Dieldrin, Heptachlor epoxide and Endosulfan in all the birds studied, did not indicate any poisoning. However, HCH the most predominantly detected contaminant in all the birds can be expected to create harm, if the birds are continuously exposed. Similarly, DDT and its metabolites are also capable of creating certain abnormalities, especially reproductive failures, if exposure continues.

Totally 97 eggs of 12 species of birds were analyzed for organochlorine pesticide residues. Among the species studied, Painted Stork, Spot-billed Pelican and Black-headed Ibis were near threatened. Egg measurement and eggshell parameters including shell index of all the species of birds were calculated. Thickness showed negative correlation with organochlorine residues. Among various organochlorine pesticide residues analyzed, isomers of HCH were the maximum followed by Σ DDT, Heptachlor epoxide and Σ endosulfan. Among the isomers, γ-HCH contributed more than 50% to the Σ HCH. Among the metabolites, p,p' DDE had higher accumulation in all species studied. Similarly, the cyclodiene insecticides, Σ endosulfan contributed more than 50%. Concentration of Σ DDT, HCH, heptachlor epoxide and endosulfan in the eggs significantly (P<0.05) varied among the species. Levels of Σ organochlorine residues detected were the highest in the eggs of Little Cormorant followed by Intermediate Egret and Grey Heron, while eggs of Eurasian Spoonbill had the lowest. The levels of OC residues detected in the eggs of birds currently studied are well below the threshold levels (4 - 8 μg/g wet wt) associated with impaired reproduction. However, DDE concentration in eggs of Painted Stork (228.06 ng/g) and Black-headed Ibis (72.74 ng/g) may be associated with effects on survival rate of young ones of these species if continuously exposed to such pesticides.

Although all the sanctuaries have official boundary, physical demarcation is missing. There are no proper earthen or cemented dykes in Vedanthangal and Koonthankulam Bird Sanctuaries to control the movement of water from the Sanctuaries. During monsoon, runoff not only floods the cultivable areas nearby and the Sanctuaries, but also brings in residues of pesticides and fertilizers from the agricultural lands. Hence, earthen bunds need to be built to avoid agricultural runoff entering the Sanctuary and help hold sufficient amount of water for breeding birds. It is recommended to plant more new saplings to augment nesting tree availability. Construction of artificial nesting sites as a stopgap measure might also help the birds to an extent. Firewood collection, illegal fishing by local people and cattle grazing are the other issues in all the study sites. Development of community based conservation programme might help solve these issues. As legislation on the use of pesticides alone is unlikely to help conserve birds and the environment, it is recommended to advocate eco-friendly cultivation methods, and eventually organic farming.