



A report on population ecology of *Pseudibis papillosa* and *Ciconia episcopus* in Muzaffarnagar, India: Threskiornithidae and Ciconiidae: Aves

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Abstract

Population ecology of Red-naped ibis or Indian black ibis, *Pseudibis papillosa* (Temminck, C J 1824) and Asian Woolly-necked stork or White-necked stork, *Ciconia episcopus* (Boddaert, P 1783) in Muzaffarnagar, India was studied and the collected data revealed that the Red-naped ibis species population was seen throughout the year with good number, while the population of Woolly-necked stork species population was seen with less number at specific certain area, selected for each observation. A survey based population counting data of Red-naped ibis at selected twelve regions from January 2020 to December 2023 revealed that in the year 2020, the mean count value, variance and SD were calculated as 49.08, 59.09 and 7.68 respectively. The calculated values for same were 50.91, 39.24 and 6.26 in year 2021 and 53.75, 69.85 and 8.35 in year 2022. These values were found as mean- 54.25, variance-64.52 and SD-8.03 in the year 2023. The population count of Woolly-necked stork at five places with specific area on Ganga canal road and in Bhopa region from Jan 2020 to Dec 2023. The observed data of population count of Woolly-necked stork were analysed and mean count value-14.83, variance-1.47 and SD-1.21 were calculated in year 2020. The same values were calculated as mean count- 13.91, variance-3.40 and SD-1.84 in the year 2021. The same values were calculated as, mean- 12.08, variance-6.07 and SD-2.46 on the basis of taken observations in the year 2022. The values for the year 2023 were assessed as mean-14.08, variance-3.57 and SD-1.89.

Keywords: Red-Naped ibis, Threskiornithidae, Ciconiidae, ecology, pesticide, stork

Introduction

Bird population in a region indicates about the environmental conditions and health status of ecosystem of that area. Availability of habitat, food, shelter, environmental conditions and adaptability decide the health and size of a bird species population in an area. Population ecology of any bird species examines how and why the population change over time in a region. In the current scenario we are noticing fast pace of urbanization, industrialization, highways development, deforestation and other man-made developmental activities which are encroaching the habitats of bird species, resulting in to shrinkage of size of habitats. The current population research study is dealing with the two bird species, the Red-naped ibis or Indian black ibis, *Pseudibis papillosa* (Threskiornithidae), is a large black bird with long legs and a long downcurved bill with a white patch on the shoulders and the top of the featherless head with a patch of bright red warty skin, developed in adult birds and the Woolly-necked stork, *Ciconia episcopus*, a species of large wading bird in the stork family Ciconiidae in Muzaffarnagar and neighbouring districts of Indian plains. The human developmental plans and activities including use of insecticides in agriculture sector can affect the life and behaviour of these bird species. As per the IUCN report, the red-naped ibis species falls in least concern, (LC) and woolly necked stork in near threatened, (NT). The human developmental process can be responsible for the habitat loss of these bird species and they might be forced to face the environmental constrains, as use of pesticides in agriculture areas for the protection of crops from insect-pests, altering their normal life and behaviour. For ecological wellbeing, the population study of these birds is very important to investigate the environmental impacts on the size of population.

Climate change is now a well known and conspicuous event in the present time due to some direct and indirect anthropogenic activities as regular vast emission of carbon di-oxide along with other green house gases, regular deforestation and shrinkage of forest area, unplanned urbanization and other human activities are posing a serious threat to animal diversity by affecting the habitats, distribution, food, foraging and reproductive success. Birds also have a special role in conservation as they not only help to identify areas most worth saving, but also have the capacity to make conservation.^[1] Birds can live in different habitats depending upon the living conditions, different species live in different geographical zones. Birds exhibit the most diverse range of ecological functions among vertebrates and they symbolize an indicator group with regard to the effect of habitat change in ecosystem.^[2] Avian biodiversity studies are crucial in determining the urbanization on birds community and also in many other factors of biodiversity conservation.^[3] Bird population is a sensitive indicator of pollution in both terrestrial and aquatic ecosystem.^[4] The 1^o C rise in mean global temperature is causing serious and often and unexpected impacts on species affecting their abundance, genetic composition, behaviour and survival. Species declines threaten the services that that nature provides to people which include functioning as carbon sink and increasing our resilience. Mean global temperature has risen 1^oC since pre-industrial time as a result of human activities, in addition to increasing global temperature, the impacts of climate change include extreme weather events such as drought, hurricanes and rising sea levels due to melting the glaciers. NASA, 2017 report says that the global mean temperature over the time since 1880 increased 1^oC. Global temperature rise induced climate change event, heavy use of insecticides in agriculture sector, urbanization and other haphazard

developmental activities and their impacts are in focus in relation to the population ecology of taken birds in Muzaffarnagar and adjacent region, located in Indian plains. Species are already being impacted by anthropogenic climate change and its rapid onset is limiting the ability of many species to adapt to their environments. Climate change is currently affecting 19% of species listed as threatened in IUCN red list of threatened species, increasing the likelihood of their extinction. Rising temperatures have led to the ecological, behavioural, physiological and genetic changes in species. [5, 6]

The present survey based research study is designed to estimate the population ecology of Red-naped Ibis or Indian black ibis, *Pseudibis papillosa* and woolly-necked stork or White-necked stork, *Ciconia episcopus* in Muzaffarnagar and adjacent region of Indian plains.

Muzaffarnagar district is situated in northern plains of India, 272 meters above sea level in Doab region of Indo-Gangetic Plain and lies between Ganga and Yamuna rivers in Saharanpur division in northern part of Uttar Pradesh at longitude 77.6 and latitude 29.4. It is situated midway on Delhi-Haridwar/Dehradun national highway. Muzaffarnagar has a monsoon influenced humid subtropical climate, characterised by much hot summers and cooler winters. Summers from early April to late June and are extremely hot. The monsoon arrives in late June and continues till middle of September. Temperatures drop slightly, with plenty of cloud cover but with high humidity. The average annual temperature remains 24.2°C. Highest precipitation falls in the month of July, with an average 261.4 mm.

Agricultural activities and production of different crops as sugar cane, wheat, rice, maize, jowar (sorghum) and bajara (pearl millet) are the general customs of this region. In some parts there is the existence of gardens of mango, guava and other fruit trees. The heightened trees of Eucalyptus, Poplar and other wild trees are also available in the open region and on road sides. These birds prefer such trees to build the nests. They also prefer heightened electrical transmission line pylons for nest building.

Materials and Methods

The proposed survey based study was carried out in Muzaffarnagar, India from January 2020 to December 2023 on monthly basis. The certain specific area, near the natural habitats at twelve places for Red-naped ibises were selected for observation. Similarly five places were selected for Woolly necked storks, at two months gap from January 2022 to November 2023. The birds were identified by using *Avibase* – The World Bird Database. The sample study areas were urban, sub-urban and rural areas as per the method, Soni, K.C. *et al.* (2009). The counting of birds was carried out either at the time when the birds were feeding or roosting in the specific periphery of nesting. The population of Red-naped ibis and Woolly-necked stork was assessed by adopting counting at feeding and roosting site. The average number of adult birds at one roosting and feeding site remain remained more or less constant for a period of at least two weeks of the month. Each observation for counting was carried out during first two weeks of each month. It was assumed, no radical overlap of bird individuals among the different roosts and feeding sites in the selected study area. Observation for count was carried out from 8 hrs to 17 hrs in a day. The aspects of plan of carried out study included the population ecology, population parameters and

dynamics of taken birds. The nesting and roosting sites were identified and counting of birds was done. The collected data analysed and results related to population count were assessed. Twelve and five counting sites with specific region were selected for Red-naped ibises and Woolly-necked storks respectively. An area with the dimensions as 20x20 Km for Red-naped ibises, and 10x10 Km for Woolly necked stork were selected for observation. The main roads, agricultural farm link roads and muddy ways were used for counting purpose. Ecology and behaviour of birds during study time period was also studied.

Results and Discussion

Population ecology of Red-naped ibis or Indian black ibis, *Pseudibis papillosa* and Woolly-necked stork, *Ciconia episcopus* in muzaffarnagar, india was studied and the collected data revealed that the Red-naped ibis species population was seen throughout the year with good number, while the population of Woolly-necked stork species population was seen with less number at specific certain area, selected for each observation. A survey based population counting data of Red-naped ibis at selected twelve regions from January 2020 to December 2023 revealed that in the year 2020, the mean count value, variance and SD were calculated as 49.08, 59.09 and 7.68 respectively. The calculated values for same were 50.91, 39.24 and 6.26 in year 2021 and 53.75, 69.85 and 8.35 in year 2022. These values were found as mean- 54.25, variance-64.52 and SD-8.03 in the year 2023. The population count of Woolly-necked stork at five places with specific area on Ganga canal road and in Bhopa region from Jan 2020 to Dec 2023, with monthly observations. The Woolly-necked storks nests were seen on high tension electric pylons and a sporadic presence was seen, but in less count in study region. (Fig. 4-8)

The observed data of population count of Woolly-necked stork were analysed and mean count value-14.83, variance-1.47 and SD-1.21 were calculated in year 2020. The same values were calculated as mean count- 13.91, variance-3.40 and SD-1.84 in the year 2021. The same values were calculated as, mean- 12.08, variance-6.07 and SD-2.46 on the basis of taken observations in the year 2022. The values for the year 2023 were assessed as mean-14.08, variance-3.57 and SD-1.89.

The highest count of ibises was observed in the months of November, December and January of each study year. (Fig. 1, 2 and 3)

During the time of lockdown, as imposed due to Covid- 19, the previous count was considered.

General behaviour of Red-naped or Indian black ibis was also observed, and it was found that, the birds exhibit a flight in a circular path on a sunny day. The birds make a loud sound during roosting. In second half of the February month, the ibis was seen carrying twig to Eucalyptus tree for nest building. *Eucalyptus lanceolatus* tree was seen as preferred site for nest building. Behaviour of copulation in Red-naped ibises was seen in the month of June at heightened mobile phone pylons/tower on a sunny day at 09 hrs approx. They make loud sound during this course of behaviour. They were seen for a longer time period at one site during roosting. They have the general tendency to fly in group and maintain an afraid behaviour to humans. The ibis make a repeated sound in response to another ibis's sound.

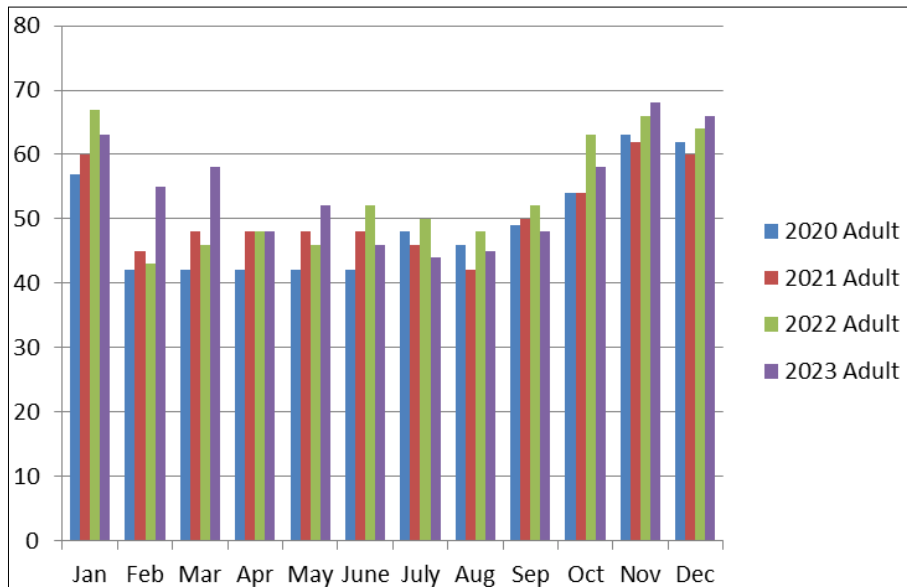


Fig 1: Population count of *Pseudibis papillosa* from Jan 2020 to Dec 2023.

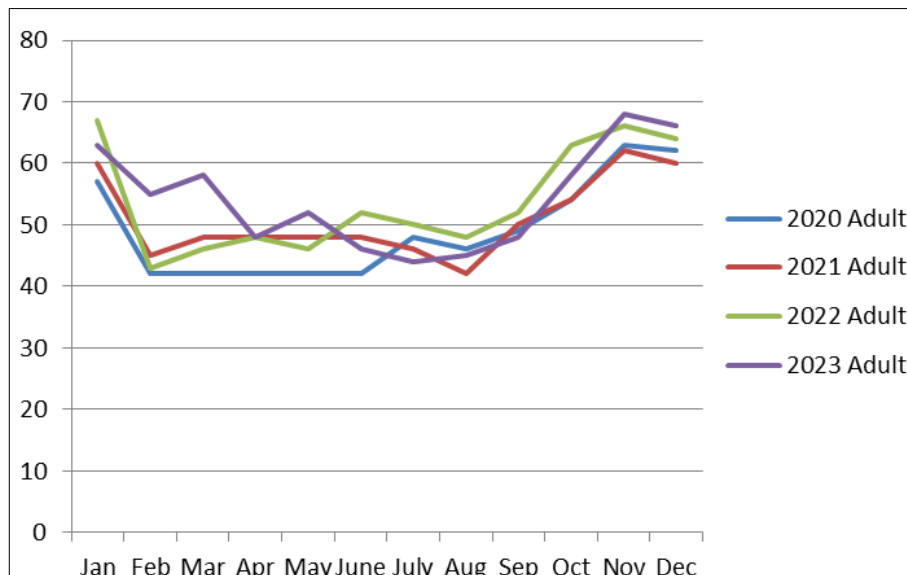


Fig 2: Population fluctuation of *Pseudibis papillosa*, monthwise from Jan 2020 to Dec 2023.

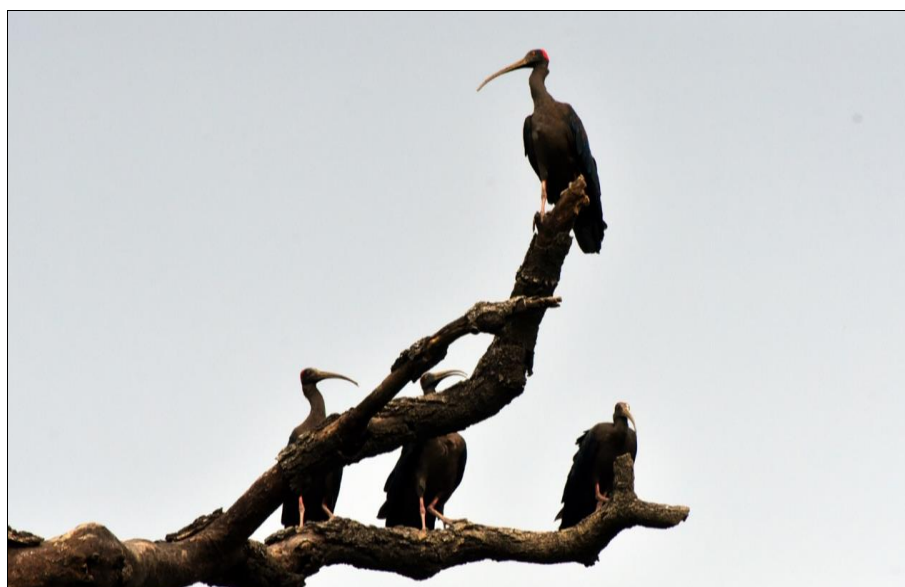


Fig 3: Photo of *Pseudibis papillosa*, the Indian black Ibis, taken through DSLR camera in Muzaffarnagar, Uttar Pradesh, India. (copyright photo)

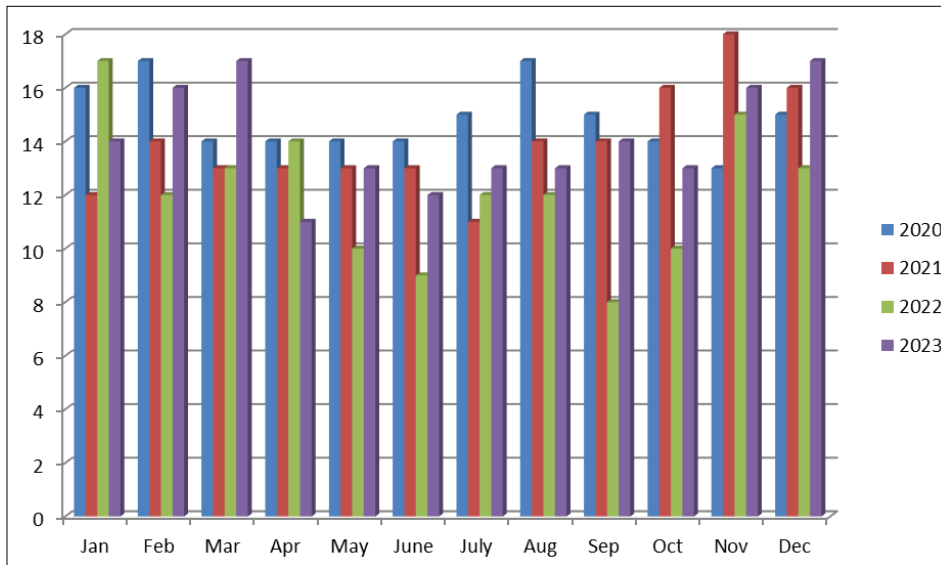


Fig 4: population count of *Ciconia episcopus*, monthwise from Jan 2020 to Dec 2023.

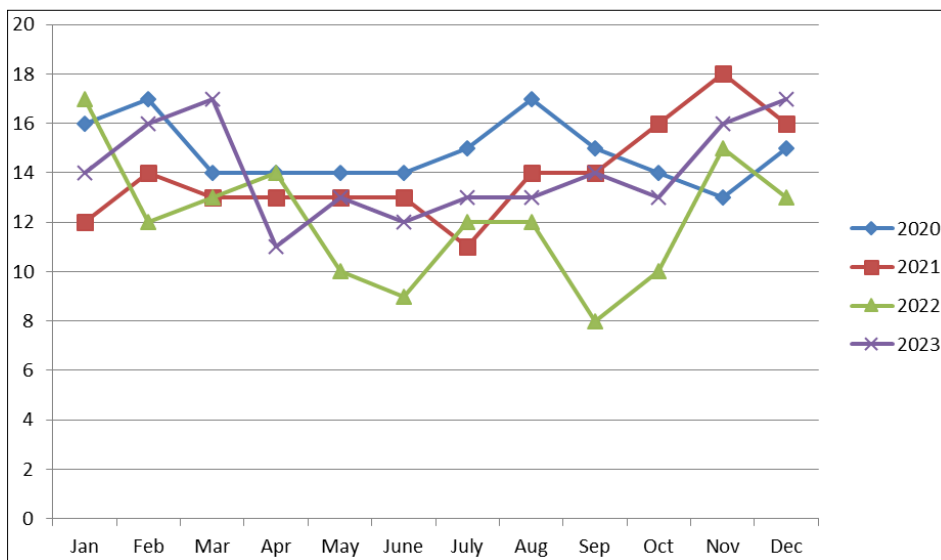


Fig 5: Population fluctuation of *Ciconia episcopus*, monthwise, from Jan 2020 to Dec 2023.

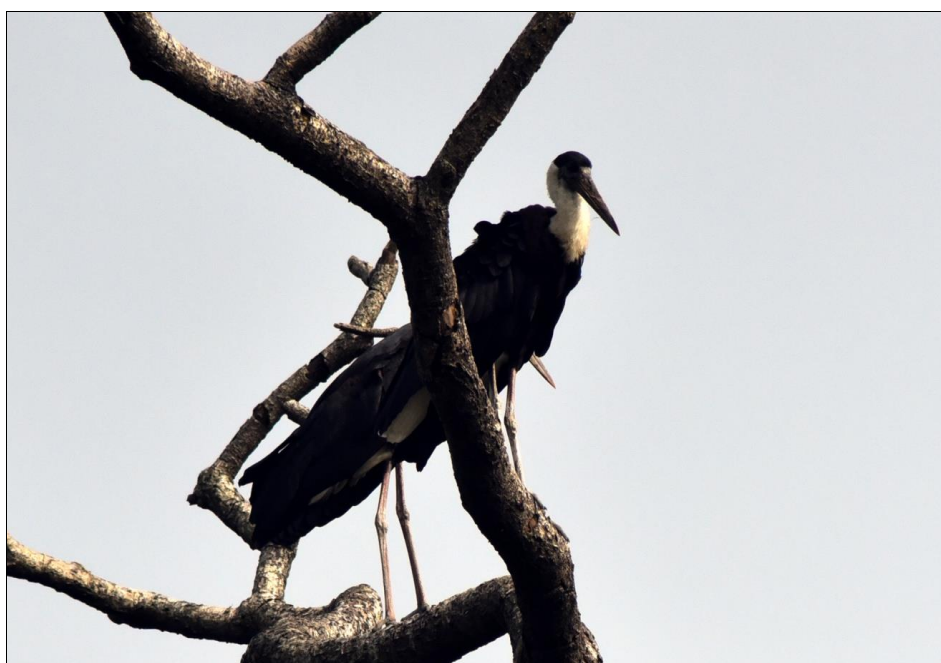


Fig 6



Fig 7



Fig 8

Fig 6, 7 and 8: Photos of *Ciconia episcopus*, the Woolly necked stork taken through DSLR camera in Muzaffarnagar, Uttar Pradesh, India. (Copyright photos)

Nesting ecology, inter specific interactions and nesting association of Indian black Ibis, *Pseudibis papillosa* inhabiting in arid zone of Rajasthan was studied.^[7] In some Ibises reduced reproductive success was recorded due to poor nest site selection.^[8] Nest site selection is closely related to individual fitness since it influences the probability of successfully raising offspring.^[9] The poor nest site selection leads to nest predation and hence affect the natural selection of bird species.^[10] Factors like inclement weather and proximity to feeding places may also influence

bird species of small body size. Larger species are better to tolerate weather oscillations and can make long distance trips in search of food.^[11] Breeding habitat is of prime importance for the fitness of individuals.^{[12][9]} In a given species, nest site quality varies in space and time at different scales due to different environmental factors affecting reproductive success.^[13] The distribution of individuals among patches of varying qualities should correspond to an ideal free or an ideal despotic distribution depending on the type of territory competition existing among individuals.^[14]

Nest site selection of colonial Ibises nesting in mixed species heronries was studied.^[15] The nesting requirements of black ibis are poorly known except the brief accounts.^[16] Interspecific interactions between two species could be expected that black ibis often use deserted nests of kites and vultures.^[16] Protective nesting associations with birds of prey have been described as a mechanism for defending nests against predators.^{[11][17]} The widespread occurrence of a protective nesting association in some groups of birds, few descriptions are available in the literature for Ciconiformes species.^{[11][12]} Nesting associations in ibises reduced nest predation and breeding success was high when nesting occurred nearer aggressive raptors.^[18] Level of organochlorine pesticides residues in blood was analysed in various species of birds from India, and DDT was found as 19 ng/ml in Black Ibis, *Pseudibis papillosa*.^[19] Histological observations were carried out on the kidneys of Indian black ibis, *Pseudibis papillosa*.^[20] Pesticides injure birds directly and indirectly, by a combination of different kinds of effects. There is evidence that birds are continuing to be harmed by pesticide use. In the farmland of Britain, population of ten different bird species declined by ten million breeding individuals between 1979 and 1999, a phenomenon thought to have resulted from loss of plants and invertebrate species on which the birds feed (Mineau, 2004^[21]). Carson (2009)^[22] reported that throughout Europe, 116 species of birds are now threatened due to pesticides. Reduction in bird populations have been found to be associated with times and areas in which pesticides are used. Dichlorodiphenyldichloroethylene (DDE)-induced egg shell thinning has specially affected whole bird populations (Duffard *et al.*, 1981) ^[23]. The content of calcium, bicarbonate, chloride, sodium and potassium are also reduced in the eggshell gland lumen in ducks exhibiting eggshell thinning Shenthikumar *et al.*, 2000) ^[24]. Worldwide, hundreds of incidents of organophosphate, OP and carbamates, CM induced bird poisoning are reported. Both OP and CM inhibit the enzyme acetylcholinesterase and in acute poisoning 50-70% inhibition occurs. Sub lethal effects of these pesticides are endocrine disruption, alterations in feeding behaviour and compromised immune system which affect avian reproduction. Critical bird habitat is affected by pesticide use. Pesticides cause the local extinction, behavioural changes, loss of safe habitat and population decline in several birds. A toxic regime must be established within the Protected Areas (WHO, 1989^[25]; ATSDR/US, 1994^[26]; Carson, 2009^[22]; Brian, 2014) ^[27]. The “bad actors” that is responsible for much of the avian mortality witnessed around the globe tend to be the same familiar products such as carbofuran, monocrotophos, diazinon, parathion and fenthion (Mineau, 1999) ^[28]. OP and CM pesticides are applied in a wide variety of habitats including agricultural lands, forests, rangelands, wetlands, residential areas and commercial sites (Mineau, 2004^[21]; Yadav, 2010^[29]). Chemical pesticides cause serious sub lethal effects during the reproductive stages of birds. Sub lethal exposure may contribute to other causes of mortality such as trauma. The preying birds like peregrine falcon, whooping Crain and bald eagle are subjected to secondary poisoning when they consumed prey (Tsfahunegny, W. *et al.*, 2016).^[30] Seasonal variation in the population of Indian black ibis, *Pseudibis papillosa* inhabiting in the arid zone of Rajasthan, India was determined with an average 40.08⁺- 3.62 and 35.33⁺- 4.61 in 2003, 42.5⁺- 4.81 and 43.16⁺- 8.69

in 2004, 42.16⁺- 4.23 and 38.33⁺- 4.47 in 2005 and 36.25⁺- 3.81 and 34.91⁺- 4.42 in 2006 ibises were recorded in rural and urban areas respectively.^[31] Many factors could influence applicability of census method, such as habitat type, weather conditions, time of census, effect of observer and behaviour of species.^[32] Many Indian bird species roost communally.^[33] Since the Ibis is fairly large size bird, it is easy to count individuals at roosting sites when the species aggregates as per its communal roosting habit.^[34] Aggregations of ibises are larger and more stable at the roosts than on feeding grounds. Referring to this method, it is more reliable to carry out a census at roost sites than on the foraging ground, though the ibis is a flocking feeder.^[35] Birds which feed together usually roost together.^[36] Birds select their roost site locations nearest to the feeding sites.^[37] For flock feeding ibis, direct count obtained at roosts might give a most reliable census result.^{[38]to[43]}

Species that are unable to respond positively to climate change may be most vulnerable due to lack of phenotypic and genotypic adaptability. Species with poor dispersal ability may be unable to move with change in their climate and space, especially when compounded by habitat fragmentation. Rapid changes in environment are likely to favour generalist/adaptable species and be detrimental to highly specialized adapted to a fine ecological niche. The small population size will make species more vulnerable to rapid stochastic changes, if the climate becomes more variable, as predicted. Populations can be severely reduced by extreme climatic events, and an increase in their frequency may affect the viability of populations in the long term. Climate change may affect the viability of the habitats that birds use, changing the timing and abundance of their food supplies and other sources. Large scale changes in agriculture, including crop types and pesticide usages (in response to changing pest population), will be a particularly important factor for many bird species that live in human-modified habitats. Although there is a substantial body of evidences for changes in phenology of birds, particularly of the timing of migration and nesting, the consequences of these responses for a species' population dynamics is still an area requiring in depth research.^[44]

The insecticides and pesticides which are being used in agriculture sector can harm the life including bird species. There are 234 pesticides registered in India. Out of these 4 are WHO class Ia pesticides, 15 are WHO Ib pesticides and 76 are WHO class II pesticides, together constituting 40% of the registered pesticides in India. In terms of consumption too, the greatest volumes are of these poisons. The data regarding the pesticide in different states of India, show the broad picture of their extensive use in agriculture sector as the top pesticide consumer is Uttar Pradesh, 39938 metric tonnes technical grade material during 2005-06 to 2009-10 as per the official data of Directorate of Plant Protection, Quarantine and Storage, Govt. of India, followed by Punjab 29235, Haryana 21908, Maharastra 16480, Rajasthan 15239, Gujarat 13430, Tamilnadu 12851 metric tonnes in this time period. All India total consumption was 210,600 metric tonnes in this time period. In India the most consumed pesticides were sulphure (fungicide) 16424, Endosulfan (insecticide) 15537, Mancozeb (fungicide) 11067, Phorate (insecticide) 10763, Methyl parathion (insecticide) 08408, Monocrotophos (insecticide) 8208, Cypermethrin (insecticide) 7309, Isproturon (herbicide) 7163, Carbendazim (fungicide) 6767, Butachlor (herbicide)

6750, Quinalphos (insecticide) 6329, Copper oxychloride 6055 and Dichlorvos insecticide 5833 metric tonnes quantities during 2005-06 to 2009-10.

As per the Indian situation, regarding carcinogenic pesticides, there are 24 pesticides registered and used, classified as potential carcinogens by the US EPA which are Acephate (C), Alachlor (B₂), Atrazine (C), Benomyl(C), Bifenthrin (C), Captan (B₂), Chlorothalonil (B₂), Cypermethrin (C), Dichlorvos (C), Diclofop-methyl (C), Dicofol (C), Mancozeb (B₂), Methomyl (C), Metolachlor (C), Oxadiazinon (C), Oxyflourfen (C), Permethrin (C), Phosphamidon (C), Propiconazole (C), Propoxur (B₂), Thiodicarb (C), Thiophanate methyl (C), Triadimefon (C), and Trifluralin (C). Here B indicates probable human carcinogen (B₂ indicating sufficient evidence of carcinogenicity from animal studies and C indicates possible human carcinogen (limited evidence of carcinogenicity in animals, in the absence of human data Cox, Caroline (1992).^[45] In India 76% of pesticides used is insecticides, against 44% globally (Mathur,1999).^[46] The main use of pesticides in India is for cotton crops (45%), followed by paddy and wheat (Mathur, SC. (1999).^[46] Insecticides are extensively being used in sugar crop fields as these are – Bifenthrin for termite control, Carbofuran for top borer control, Chlorantraniliprole for termite and early shoot and top borer, chlorpyrifos for black bug, early shoot and stalk borer, and pyrrilla, Clothianidin for termites, Fipronil for early shoot and root borer, Imidacloprid for termites, Monocrotophos for shoot borer, mealy bug, pyrrilla, scale insects, stalk borer, Phorate for top borer and white grub, Thiamethoxam for termites and early shoot borer. In the view of pesticide use in agriculture sector in India, a further extensive study regarding to environmental and health impacts in birds and humans, is needed to be completed.

Declaration: Author has no conflict of interest.

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