

**Effect of pollutants and heavy metals
on pond heron, *Ardeola grayii***

SUMMARY OF THESIS



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SUMMARY

Birds are endothermic group of animals, belongs to Class Aves under Kingdom Animalia that include over 10,000 species worldwide, among them, 1340 (13%) bird species were observed from India. Henceforth, India shows a wide range of avifaunal diversity in term of species richness. But as per state of India's bird report 2020, of bird species assessed have decline during last few decades. There is decline in bird population in india, as more than 50%. The behavioural ecology of avian fauna deals with all the adaptive circumstances such as, flying, escaping, predation, roosting, feeding, preening, nesting, mating, breeding, parenting, territory defence, communication and migration *etc.* exhibited by the bird throughout the lifetime. For instance the foraging activity is the way of finding the foodstuff from the natural habitat. It plays a vital function in respect to the capability of animals for their survival and reproduction.

The important behaviour found in birds is the feeding behaviour. Wetland birds are generalized as well as specialized in the selection of food. Generally, the birds are herbivores, frugivorous, grainivorous, insectivorous, carnivorous, omnivorous, predators and some birds are scavengers. The habitat resources such as food, shelter and water are the fundamental requirements of an animal species for their survival and successful reproduction in a particular region.

In the present study it was observed that many factors such as; seasons structure of habitats, depth of water, height of vegetation, types of prey and their size, types of techniques used for capturing prey affects on feeding behaviour, foraging success of *A. grayii*.

This whole study was carried out in Lucknow and its associated rural area, period of study was July 2016-2019 February. This observation was done for three seasons monsoon (July-October), winter (November - February), and summer (March – June). The field visit was conducted five day in week. Study was done in five types of habitats, lake, ponds, agriculture fields, marshy area, and grassland. For observation all activities were recorded by camera and binocular, prey were counted after capturing from sweep net. Some prey which was easily seen by binocular noted in excel sheet. Data were analysed by SPSS (Ver. 21.) and Graph pad prism 5.

Ardeola grayii generally seen near edge of wetlands for feeding and resting purposes, among wetlands most preferred one was lake and pond, because other habitats were seasonally fluctuating, so availability of prey varied there, but in both lake and pond in all seasons prey was available.

A. grayii preferred water depth 10-15cm for capturing prey, less vegetation height, preferred size of prey were, for fishes 1-7cm, insects 0.5-5cm, annelids 3-7cm, amphibians 3-5cm, and mollusc 3-8cm.

Prey was abundant in lake, pond and in agriculture field, but their number varied seasonally, in monsoon seasons, most of the habitats had abundant prey but in winter and extreme summer few prey were available for *A. grayii*.

The foraging success was highest in pond (33.60 ± 29.30) followed by lake (31.87 ± 30.85), Agriculture field (12.07 ± 6.52), marshy area (11.13 ± 11.61), and grassland (9.73 ± 6.49).

In this study foraging success was more with fishes and insects in three seasons and five habitats, increasing order for success was Insects > Fishes > Amphibians > Annelids > Mollusc.

Feeding behaviour and the technique in which they utilize their feeding ground represents the fundamental ecology of that bird's species. Feeding habitat and feeding technique are, therefore, significant factors engaged in resource separation and can be used to understand feeding guilds of the birds. Indian Pond Heron, *Ardeola grayii* feeds solitary as well as in flocks. This large wading bird captures the prey by employing stand and wait strategy, very cautiously capturing the prey by walking slowly towards the prey or by standing still, waiting for the surprise attack, and occasionally hunting the prey when in flight.

Water pollution is becoming a big problem for biodiversity. The main source of water pollution is industrial waste, domestic waste. Sewage wastage directly flows in water body and acid rain which cause deposition of heavy metals in water bodies. Fresh water is a source for the development of civilizations but due to pollution there is severe threat to natural fresh water reservoir. The impairment of water quality due to introduction of pollutants is a problem faced by most industrial cities around the world. Rapid urbanization and industrialization with improper environmental planning often lead to discharge of industrial and sewage effluents into wetlands. The wetlands have a complex and fragile ecosystem, as they do not have a self-cleaning ability and therefore readily accumulate pollutants.

Heavy metals entering the water body would be adsorbed in sediments, and subsequently might migrate as a result of exchanges between water, sediment, and biota, through biological and chemical process. Heavy metals do not degrade in water but are generally not found in high concentrations, primarily due to deposition in sediments but also because of uptake by aquatic organisms. The aim of the present study was to discuss physico-chemical parameters of water in different feeding ground of *A. grayii*, heavy metals present in water, and impact on their behaviours.

A. grayii use wetlands for their life activities such as, feeding, breeding, resting, and sheltering purposes. In urban area due to day by day shrinking of water bodies, it was compelled to feed near garbage and dumping sites, if any water bodies present, *A. grayii* feed there and accumulate contamination in body. Changes in physico-chemical property of water affects not only aquatic organism living in water but also wading birds such as *A. grayii*, *B. ibis*, *G. chloropus*, *F. atra*, *A. atthis*, *H. smyrnensis*, *D. leucophaeus*. In order to analyse physico-chemical and heavy metals in wetlands, water samples were collected in twice a month in replicates in urban and rural area of lucknow from September 2016 to February 2019, in pre-cleaned polyethylene bottles. Nine physico-chemical parameters (BOD, COD, DO, pH, Total hardness, Calcium as calcium carbonate, Magnesium as calcium carbonate, Chloride, Alkalinity) of water were analysed in five feeding and nesting ground, heavy metals (Cadmium, Chromium, Lead, Mercury, Manganese, and Zinc) were also analysed. The samples used for DO and BOD examination were collected directly in dark DO bottles, some drop of manganous sulphate solution were added to fix DO. After collection stored at room temperature. In five habitats pH was ranges between 6.3 – 6.9, too much fluctuation in pH are stressful and can even be lethal to aquatic organisms, which may circulate in a food chain. Levels of pH too high (> 9) or too low (< 5) can kill aquatic life.

Biochemical Oxygen demand determines the amount of oxygen required for biological oxidation of organic matter with the help of microbial activities. In the present study the value of biochemical oxygen demand ranged between 5.06 to 29.03 mg/L.

Chemical oxygen demand determines the amount of oxygen required for chemical oxidation of most organic matter and oxidizable inorganic substances with the help of

strong chemical oxidant. High COD indicates the presence of all forms of organic matter, both biodegradable and non-biodegradable, and hence the degree of pollution in waters.

Dissolved oxygen for all five habitats was 4.3 – 7.36 mg/L, $DO > 5$ mg/L is considered favourable for growth and activity of most aquatic organisms; $DO < 3$ mg/L is stressful to most aquatic organisms, while $DO < 2$ mg/L does not support fish life.

The permissible value of alkalinity as recommended by Indian standards is 200 mg/L. Alkalinity in this study was range from 103.03 – 361.7 mg/L, the lake can be categorized as nutrient rich water body and highly productive on the basis of total alkalinity. If any water body have > 200 mg/L alkalinity is good for community production, it is also the measure of buffering capacity of water. It is important to assess the alkalinity of water bodies to determine the ability of neutralizing the acidic pollution of water from rainfall of waste water.

In the present study chloride concentration was found ranging between 22.10 to 59.8 mg/L. Site -2 was having more chloride level due to large amount of organic matter, waste of animals dumped in lake.

In this study the total hardness of water range was 137.7 to 311.36 mg/L in study area. Site 2 had highest 311.36 mg/L total hardness in water. As the content of Ca and Mg in water increases, the content of hardness also shoots up. The average value of calcium hardness for the study period was 29.6-55.4 mg/L, whereas the average value for Mg^{2+} recorded was 22.1-60.7 mg/L for the study period. Calcium and magnesium are the dominant cations in an aquatic body.

Heavy metals can have harmful effects on development, behaviour and intelligence both in animals and humans. Concentration of heavy metals in study sites were varied for five metals Cd, Cr, Pb, Hg, Mn, and Zn. the study period 2016-2017, concentration

lead was maximum in $S5 > S2 > S4$, in 2017-2018 and 2018-2019 lead was present in same concentration in both period ($S2 > S5$), mercury also present in both period in $S2$.

The presence of pollutant in feeding habitats of *A. grayii* impact on their feeding techniques used for capturing prey, and also it causes they could not get enough food for their survival, but we know that herons having good adaptation capability to any conditions, so they survived because they adapted or changed their behaviour. Scavenging, fleeing, sudden attack on their own species for food, and aggression, observed in some *A. garyii*. It showed that, they are changing their behaviour for their survival, but these things will happen to some extent, not for always, at last their population will perish, so this is alarming bell for us to do some conservation management of wetlands, so that birds or other aquatic organism survived and maintain their ecosystem, because every predator top to bottom or bottom to top affect each other.

Due to the feeding habitats of aquatic birds near to water resources such as wetlands, canals, dams, etc. so that they are much more sensitive to water qualities including heavy metals accumulation. The assesment of heavy metals in aquatic birds more feasible. As aquatic birds are constantly maintained habitation around the water resources. They are also natural drivers for several services among them monitoring of ecosystem system condition as bioindicator are well recognized. The aquatic birds are still successfully maintained their population because of food resources such as river, lake, wetlands, cropping and non-cropping fields, etc. so that identification and quantification of heavy metals are significantly important for our living system. Heavy metals have been shown to accumulate in kidney, liver, blood, feathers, eggs and

bones. In this study non-invasive methods used for assessment of heavy metals through feathers, feces, and food remnants of *A. grayii*.

Feathers provide thermal insulation and protect against mechanical injuries. Furthermore, they ensure an appropriate aerodynamic surface for flying. Feathers are made of proteins rich in sulphur-containing amino acids, which is why they accumulate heavy metals. Contaminants pass into feathers only during their formation. Among all the possible methods through which heavy metals assessments can be use, feathers, are non-destructive, least cost and easily available components for the assessment of heavy metals. Feathers are a good accumulator and indicator of heavy metals.

Feces of *A. garyii* also a good tool for investigating heavy metals in their feeding and resting habitats, Feces were collected in different areas. Birds ingested heavy metals mainly due to food and water ingestion. Naturally, aquatic birds prefer to feed at margin or inside the water bodies. So they eat many vital metals viz., sulfur and phosphorus from different feeding tactics. The ingestion of different food stubs and their size significantly differ in contamination level of heavy metals among juvenile and adults. So in this study food remnants were collected from nesting sites of *A. grayii*.

The overall study showed that, feeding sites of *A. grayii* site 2 and site 5 was more contaminated than other three sites. all five metals Cd, Cr, Pb, Mn, Zn, were present good concentration level in these two sites, Mercury (Hg) was present in food remnants of *A. grayii* in feeding site 2, in study period 2016-2017 concentration of Hg was 0.044 ± 0.07 , in 2017-2018, 0.04 ± 0.04 , and in 2018-2019, 0.15 ± 0.05 present. In sample of feces Hg was also present in site 2 and 5. So it was concluded that feces

and food remnant accumulate harmful metals such as mercury than feathers. The feeding and nesting sites 2 and 5 of *A. grayii* was more disturbed by pollutants, because, site 2 was near to hospital and densely populated area, most of the domestic and hospital wastages discharge directly in lake, so from 2016 to 2019 population of *A. grayii* and other wading birds declining, some were fly away permanently from that location, but some birds were still feeding and resting there, as a result they are accumulating contamination in their body. Site 5 was near to tannery, automobile workshop, and some local products making industry, that were discharge their wastages in lake and pond, as a result wading birds and other organism which depend on that lake, accumulating pollutants directly or indirectly in their body.

These birds preferred to stay near water bodies such as lake, river, canal, pond, marshy area, agriculture field. But we are disturbing these habitats by our selfishness nature, as a result birds either terrestrial or water birds are declining. All living organism play an important role to balance ecosystem, and these are interconnected to each other directly or indirectly. By disturbing of any one member of ecosystem, the whole system may be affected and resulted one species will be dominated. So here are some recommendations for the conservation of habitats of *Ardeola grayii* so that it will survive in its natural condition.

Lake, river, canal, and pond should be maintained, so that these birds get food and other aquatic organism such as fishes survived there.

There should be a rule for not using these water bodies for construction purposes, because in this study some lake and pond converted into buildings, as a result these birds are restricted to feed near garbage or contaminated area.

Discharged effluent from houses, workshops, factories, and hospitals should be treated properly, and it should be restricted up to a certain limit. Thrive of *Eicchornia crassipes* in lake or river should be stopped, because it decreases the level of dissolved oxygen in water. Heavy metals are serious pollutants in the aquatic environment because of their persistence and tendency to concentrate in aquatic ecosystem, by knowing their source it should not discharge in aquatic body, so that it will be stopped to accumulate in body of any living organism.