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Avifauna along Ganges near Patna, Bihar, India

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Abstract

This paper presents data of the survey conducted during November 2021 to January 2022 to document the avian diversity along the 40 km stretch of the Ganges River bank from Danapur (25.638782°N, 85.038070°E) to Fatuha (25.512728°N, 85.304202°E) in Patna, Bihar, India. One hundred and thirty-four (134) species belonging to 49 families and 19 orders of birds were recorded. A new distribution record of Common Shelduck (*Tadorna tadorna*) was documented. Other notable species included Alexandrine parakeet (*Psittacula eupatria*), Painted stork (*Mycteria leucocephala*), and Pallid Harrier (*Circus macrourus*) belonging to Near threatened category and two species, the Pallas's Fish Eagle (*Haliaeetus leucoryphus*) and Steppe eagle (*Aquila nipalensis*) belonging to the Endangered category of the IUCN red list.

Keywords: Ganges, common shelduck, alexandrine parakeet, pallid harrier, pallas's fish eagle, steppe eagle

Introduction

Avifauna diversity is one of the most important ecological indicators for evaluating habitats, both qualitatively and quantitatively^[1, 2]. Birds serve as useful bio-indicators because they are ecologically versatile, live in different habitats and have different feeding habits as well^[3]. Water birds have been suggested as excellent environmental indicators as their populations are not only extremely dynamic and sensitive to change but more often reflect land use conditions^[4].

The river Ganges has drifted five to six kilometres away from Patna city in the last 30 years, due to geogenic as well as anthropogenic activities. The total length of the Ganges along the city is presently 99 kilometers. The geomorphological features in the Ganga River basin provide diverse habitats in the form of mid-channel island, inter-island channel, sand bars, floodplains and a large number of floodplain wetlands that attract local and migratory birds. The Gandak River, a major tributary of the Ganges, is also identified as an Important Bird Area (IBA) site^[5]. Movement of rivers may influence the accumulation of birds^[6].

A survey was conducted during November 2021 to January 2022 to document the avian diversity along the 40 km stretch of the Ganges River bank from Danapur (25.638782°N, 85.038070°E) to Fatuha (25.512728°N, 85.304202°E) in Patna (Fig 1). The survey area included following ghats Danapur to Fatuha:

Triveni Ghat, Naujar Ghat, Qila Ghat, Kangan Ghat, Bhadr Ghat, Gai Ghat, Loharwa Ghat, Pathri Ghat, Chaudharytola Ghat, Raushan Ghat, Masjid Ghat, Gagha Ghat, Gulbi Ghat, Rani Ghat, Law College Ghat, Baharwa Ghat, Gandhi Ghat, Krishna Ghat, Patna College Ghat, Kali Ghat, Bansi Ghat, Adalat Ghat, Anta Ghat, Collectorate Ghat, Bans Ghat, Pehelwaan Ghat, L.C.T Ghat, Kurji Ghat, Digha Ghat, Janardan Ghat, Shiv Mandir Nahar Ghat, Chai Tola Ghat and Panapur Ghat.

The study area was covered on foot and on boat along the banks of the Ganges. Bird species were observed and recorded using point count method and fixed route monitoring following^[7]. Birds in flight were also recorded. Birds were identified with the help of Ali and Ripley (1983). Fixed route monitoring method was used in boat surveys. Starting point for the boat survey was NIT Ghat at 7:30 am every Wednesday and our end point was just before Fatuha Shamshan Ghat.

The terrain along the river comprised of sand, soil and crop lands. The vegetation differed from one Ghat to another, the occupied lands were planted with more fruit bearing trees and the isolated areas were covered with different types of grasses and shrubs. The notable trees observed were *Bombax ceiba*, *Ficus religiosa*, *Ficus benghalensis*, *Ficus racemosa*, *Cocos nucifera*, *Dalbergia sissoo*, *Terminalia arjuna*, *Leucaena leucocephala*, *Saraca asoca*, *Azadirachta indica*, *Mangifera indica*, *Delonix regia* and *Cassia fistula*. Other vegetation included *Chenopodium nitrariaceum*, *Duma florulenta*, *Saccharum spontaneum*, *Pennisetum pedicellatum*, *Setaria faberi*, *Amaranthus spinosus*, *Datura stramonium* and *Lantana camara*. The stagnant portions of the river banks had plants such as *Hydrilla verticillata*, *Eichhornia crassipes*, *Nymphaeaceae (sp)*, *Pistia stratiotes*, *Azolla filiculoides*, *Salviniaceae (sp)* and *Marsilea*.

One hundred and thirty-four (134) species belonging to 49 families and 19 orders of birds were recorded. A complete taxonomic checklist of avifauna of River Ganga from Danapur to Fatuha is given in Table 1. The number of families documented was 49. Among these Anatidae and Muscipidae were the most represented families, with 10 species each, while Accipitridae was the second most represented families, with nine species each. Motacillidae was the third most represented family, with eight species. Ardeidae was represented by six species. There were five species in each of the Alaudidae, Cisticolidae and Scolopacidae families. Hirundinidae and Columbidae had four species. Corvidae, Psittaculidae, Rallidae, Phylloscopidae, Meropidae, Phalacrocoracidae and Cuculidae had three species each. Twelve families namely Megalaimidae, Recurvirostridae, Charadriidae, Lanidae, Ciconidae, Laridae, Pycnonotidae, Oriolidae, Estrilidae, Falconidae, and Alcedinidae had two species each. Phasianidae, Picidae, Bucerotidae, Upupidae, Coraciidae, Apodidae, Strigidae, Tytonidae, Glariolidae Pandionidae, Podicipedidae, Threskiornithidae, Rhipiduridae, Leiothrichidae Nectariniidae Passeridae, Dicruridae, Zosteropidae, Paridae and Campephagidae had only one species each (Fig 2). The most dominant order was Passeriformes among the other 19 orders. Among these species 46 species were winter visitors, two species were

summer visitors and the others were resident. A new distribution record of Common Shelduck (*Tadorna tadorna*) (Linnaeus, 1758) was evidenced for the first time Ganga near Bans Ghat (25.638098°N, 85.136434°E), Patna, Bihar, India (Plate 1). Three Common Shelducks was seen near Baans Ghat for two consecutive days. During the month of March this species was also recorded in the Kosi River near Nepal border, which might have migrated from Mongolia. Out of these 134 species three species Alexandrine parakeet (*Psittacula eupatria*) (Plate 2) Painted stork (*Mycteria leucocephala*) (Plate 3) and Pallid Harrier (*Circus macrourus*) belong to Near threatened category and two species, the Pallas's Fish Eagle (*Haliaeetus leucoryphus*) (Plate 4) and Steppe eagle (*Aquila nipalensis*) (Plate 5) belong to the Endangered category of the IUCN red list. A big group of Bar-headed Goose (*Anser indicus*) (Plate 6) were also seen. Most of the migratory species were seen between LCT Ghat and Baans Ghat area. We observed that the water level varied from 5-11ft in these two areas and the water was clean and clear also. Other areas were disturbed due to sand mining activities.

The present study reveals that majestic rivers like Ganges areas support a fairly rich avian diversity near a busy city like Patna, with a representation from 49 families. Field studies like ours provide the baseline data for understanding the basic ecology of individual species or bird communities and the effects of habitat modification on them. Natural habitats are undergoing rapid changes owing to multiple stressors and documentation of information on the wild fauna living in natural versus modified habitats can provide insight for management purpose. The quality of riparian corridors close to cities should be monitored periodically to assess land use changes, biodiversity, and impacts of anthropogenic disturbance and natural disasters, especially flooding; urban planners should incorporate these changes into city plans (regional, development, and master plans) as necessary [9].

This new distribution record of Common Shelduck expands the range map of this species. If these areas are monitored regularly there is a higher possibility of spotting new species or new ranges of species. Moreover, there is a need to assess the level of biodiversity and health of this river on regular basis.



Fig 1: Map of study area

Table 1: Taxonomic list of avifauna along River Ganges from Danapur to Fatuha, Patna.

| S. No. | Family | Latin name | Common name | Migratory Status | IUCN status | WPA(1972) |
|-------------------------------|-------------------|-----------------------------------|----------------------------|------------------|-------------|-----------|
| Order: Galliformes | | | | | | |
| 1 | Phasianidae | <i>Ortygornis pondicerianus</i> | Grey Francolin | R | LC | Sched.IV |
| Order: Anseriformes | | | | | | |
| 2 | Anatidae | <i>Anser indicus</i> | Bar-headed goose | WM | LC | Sched.IV |
| 3 | | <i>Tadorna tadorna</i> | Common shelduck | WM | LC | Sched.IV |
| 4 | | <i>Tadorna ferruginea</i> | Ruddy shelduck | WM | LC | Sched.IV |
| 5 | | <i>Mareca strepera</i> | Gadwall | WM | LC | Sched.IV |
| 6 | | <i>Anas crecca</i> | Common teal | WM | LC | Sched.IV |
| 7 | | <i>Spatula clypeata</i> | Northern shoveler | WM | LC | Sched.IV |
| 8 | | <i>Anas acuta</i> | Northern pintail | WM | LC | Sched.IV |
| 9 | | <i>Mareca penelope</i> | Eurasian wigeon | WM | LC | Sched.IV |
| 10 | | <i>Spatula querquedula</i> | Garganey | WM | LC | Sched.IV |
| 11 | | <i>Dendrocygna javanica</i> | Lesser whistling teal | R | LC | Sched.IV |
| Order: Suliformes | | | | | | |
| 12 | Phalacrocoracidae | <i>Phalacrocorax corba</i> | Great cormorant | R | LC | Sched.IV |
| 13 | | <i>Phalacrocorax fuscicollis</i> | Indian cormorant | R | LC | Sched.IV |
| 14 | | <i>Microcarbo niger</i> | Little cormorant | R | LC | Sched.IV |
| Order: Piciformes | | | | | | |
| 15 | Picidae | <i>Dinopium benghalense</i> | Black-rumped flameback | R | LC | Sched.IV |
| 16 | Megalaimidae | <i>Megalaima haemacephala</i> | Coppersmith barbet | R | LC | Sched.IV |
| 17 | | <i>Psilopogon zeylanicus</i> | Brown-headed barbet | R | LC | Sched.IV |
| Order: Bucerotiformes | | | | | | |
| 18 | Bucerotidae | <i>Ocyrceros birostris</i> | Indian grey hornbill | R | LC | Sched.IV |
| 19 | Upupidae | <i>Upupa epops</i> | Eurasian hoopoe | R | LC | Sched.IV |
| Order: Coraciiformes | | | | | | |
| 20 | Coraciidae | <i>Coracias benghalensis</i> | Indian roller | R | LC | Sched.IV |
| 21 | Alcedinidae | <i>Halcyon smyrnensis</i> | White-throated kingfisher | R | LC | Sched.IV |
| 22 | | <i>Ceryle rudis</i> | Pied kingfisher | R | LC | Sched.IV |
| 23 | Meropidae | <i>Merops orientalis</i> | Asian green bee-eater | R | LC | Sched.IV |
| 24 | | <i>Merops philippinus</i> | Blue-tailed bee-eater | R | LC | Sched.IV |
| 25 | | <i>Merops leschenaulti</i> | Chestnut-headed bee-eater | R | LC | Sched.IV |
| Order: Cuculiformes | | | | | | |
| 26 | Cuculidae | <i>Eudynamis scolopaceus</i> | Asian koel | R | LC | Sched.IV |
| 27 | | <i>Hierococcyx varius</i> | Common hawk-cuckoo | R | LC | Sched.IV |
| 28 | | <i>Centropus sinensis</i> | Greater coucal | R | LC | Sched.IV |
| Order: Psittaciformes | | | | | | |
| 29 | Psittaculidae | <i>Psittacula eupatria</i> | Alexandrine parakeet | R | NT | Sched.I |
| 30 | | <i>Psittacula krameri</i> | Rose-ringed parakeet | R | LC | Sched.IV |
| 31 | | <i>Psittacula cyanocephala</i> | Plum-headed parakeet | R | LC | Sched.IV |
| Order: Apodiformes | | | | | | |
| 32 | Apodidae | <i>Cypsiurus balasiensis</i> | Asian palm swift | R | LC | Sched.IV |
| Order: Strigiformes | | | | | | |
| 33 | Tytonidae | <i>Tyto alba</i> | Barn owl | R | LC | Sched.IV |
| 34 | Strigidae | <i>Athene brama</i> | Spotted owl | R | LC | Sched.IV |
| Order: Columbiformes | | | | | | |
| 35 | Columbidae | <i>Spilopelia chinensis</i> | Spotted dove | R | LC | Sched.IV |
| 36 | | <i>Streptopelia decaocto</i> | Eurasian collared dove | R | LC | Sched.IV |
| 37 | | <i>Columba livia domestica</i> | Feral pigeon | R | LC | Sched.IV |
| 38 | | <i>Treron phoenicoptera</i> | Yellow-footed green pigeon | R | LC | Sched.IV |
| Order: Gruiformes | | | | | | |
| 39 | Rallidae | <i>Amaurornis phoenicurus</i> | White-breasted waterhen | R | LC | Sched.IV |
| 40 | | <i>Gallinula chloropus</i> | Common moorhen | R | LC | Sched.IV |
| 41 | | <i>Fulica atra</i> | Common coot | R | LC | Sched.IV |
| Order: Charadriiformes | | | | | | |
| 42 | Scolopacidae | <i>Calidris minuta</i> | Little stint | WM | LC | Sched.IV |
| 43 | | <i>Calidris temmickii</i> | Temmenick's stint | WM | LC | Sched.IV |
| 44 | | <i>Tringa ochropus</i> | Green sandpiper | WM | LC | Sched.IV |
| 45 | | <i>Tringa glareola</i> | Wood sandpiper | WM | LC | Sched.IV |
| 46 | | <i>Actitis hypoleucos</i> | Common sandpiper | WM | LC | Sched.IV |
| 47 | Recurvirostridae | <i>Himantopus himantopus</i> | Black-winged stilt | WM | LC | Sched.IV |
| 48 | Charadriidae | <i>Recurvirostera avosetta</i> | Pied avocet | WM | LC | Sched.IV |
| 49 | | <i>Charadrius dubius</i> | Little ringed plover | WM | LC | Sched.IV |
| 50 | | <i>Vanellus indicus</i> | Red-wattled lapwing | R | LC | Sched.IV |
| 51 | Laridae | <i>Chroicocephalus ridibundus</i> | Black-headed gull | WM | LC | Sched.IV |
| 52 | | <i>Ichthyaeetus ichthyaeetus</i> | Palla's gull | WM | LC | Sched.IV |
| 53 | Glareolidae | <i>Glareola lactea</i> | Small pratincole | R | LC | Sched.IV |

| Order: Accipitriformes | | | | | | |
|-------------------------|-------------------|----------------------------------|---------------------------|----|----|----------|
| 54 | Accipitridae | <i>Milvus migrans</i> | Black kite | R | LC | Sched.IV |
| 55 | | <i>Elanus axillaris</i> | Black-shouldered kite | R | LC | Sched.IV |
| 56 | | <i>Circus macrourus</i> | Pallid harrier | WM | NT | Sched. I |
| 57 | | <i>Accipiter badius</i> | Shikra | R | LC | Sched.IV |
| 58 | | <i>Haliaeetus indus</i> | Brahminy kite | R | LC | Sched.IV |
| 59 | | <i>Buteo rufinus</i> | Long-legged buzzard | WM | LC | Sched.IV |
| 60 | | <i>Haliaeetus leucoryphus</i> | Pallas's fish eagle | WM | EN | Sched. I |
| 61 | | <i>Aquila nipalensis</i> | Steppe eagle | WM | EN | Sched. I |
| 62 | Pandionidae | <i>Pandion haliaetus</i> | Osprey | WM | LC | Sched.IV |
| Order: Podicipediformes | | | | | | |
| 63 | Podicipedidae | <i>Podiceps cristatus</i> | Great crested grebe | WM | LC | Sched.IV |
| Order: Pelicaniformes | | | | | | |
| 64 | Ardeidae | <i>Egretta garzetta</i> | Little egret | R | LC | Sched.IV |
| 65 | | <i>Ardea alba</i> | Great egret | R | LC | Sched.IV |
| 66 | | <i>Bubulcus ibis</i> | Cattle egret | R | LC | Sched.IV |
| 67 | | <i>Ardeola grayii</i> | Indian pond heron | R | LC | Sched.IV |
| 68 | | <i>Ardea cinerea</i> | Grey heron | R | LC | Sched.IV |
| 69 | | <i>Ardea purpurea</i> | Purple heron | R | LC | Sched.IV |
| 70 | Threskiornithidae | <i>Pseudibis papillosa</i> | Red-naped ibis | R | LC | Sched.IV |
| Order: Ciconiiformes | | | | | | |
| 71 | Ciconiidae | <i>Anastomus oscitans</i> | Asian openbill stork | R | LC | Sched.IV |
| 72 | | <i>Mycteria leucocephala</i> | Painted stork | R | NT | Sched. I |
| Order: Passeriformes | | | | | | |
| 73 | Laniidae | <i>Lanius cristatus</i> | Brown shrike | WM | LC | Sched.IV |
| 74 | | <i>Lanius vittatus</i> | Bay backed shrike | R | LC | Sched.IV |
| 75 | Corvidae | <i>Dendrocitta vagabunda</i> | Rufous treepie | R | LC | Sched.IV |
| 76 | | <i>Corvus splendens</i> | House crow | R | LC | Sched.IV |
| 77 | | <i>Corvus culminates</i> | Large-billed crow | R | LC | Sched.IV |
| 78 | Rhipiduridae | <i>Rhipidura albicollis</i> | White-throated fantail | R | LC | Sched.IV |
| 79 | Muscicapidae | <i>Copysychus saularis</i> | Oriental magpie-robin | R | LC | Sched.IV |
| 80 | | <i>Phoenicurus ochruros</i> | Black redstart | R | LC | Sched.IV |
| 81 | | <i>Luscinia svecica</i> | Bluethroat | WM | LC | Sched.IV |
| 82 | | <i>Ceromela fusca</i> | Brown rock chat | R | LC | Sched.IV |
| 83 | | <i>Saxicola carprata</i> | Pied bush chat | R | LC | Sched.IV |
| 84 | | <i>Saxicola leucurus</i> | White-tailed stonechat | R | LC | Sched.IV |
| 85 | | <i>Saxicola torquatus</i> | Eurasian stonechat | WM | LC | Sched.IV |
| 86 | | <i>Eumyias thalassinus</i> | Verditer flycatcher | R | LC | Sched.IV |
| 87 | | <i>Muscicapa dauurica</i> | Asian brown flycatcher | SM | LC | Sched.IV |
| 88 | | <i>Ficedula albicilla</i> | Taiga flycatcher | WM | LC | Sched.IV |
| 89 | Sturnidae | <i>Sturnia pagodarum</i> | Brahminy starling | R | LC | Sched.IV |
| 90 | | <i>Gracupica contra</i> | Indian pied myna | R | LC | Sched.IV |
| 91 | | <i>Acridotheres ginginianus</i> | Bank myna | R | LC | Sched.IV |
| 92 | | <i>Acridotheres tristis</i> | Common myna | R | LC | Sched.IV |
| 93 | Hirundinidae | <i>Hirundo rustica</i> | Barn swallow | WM | LC | Sched.IV |
| 94 | | <i>Cecropis daurica</i> | Red-rumped swallow | WM | LC | Sched.IV |
| 95 | | <i>Riparia diluta</i> | Pale sand martin | WM | LC | Sched.IV |
| 96 | | <i>Riparia paludicola</i> | Brown-throated martin | R | LC | Sched.IV |
| 97 | Pycnonotidae | <i>Pycnonotus jocosus</i> | Red-whiskered bulbul | R | LC | Sched.IV |
| 98 | | <i>Pycnonotus cafer</i> | Red-vented bulbul | R | LC | Sched.IV |
| 99 | Cisticolidae | <i>Prinia gracilis</i> | Graceful prinia | R | LC | Sched.IV |
| 100 | | <i>Prinia socialis</i> | Ashy prinia | R | LC | Sched.IV |
| 101 | | <i>Prinia inornata</i> | Plain prinia | R | LC | Sched.IV |
| 102 | | <i>Cisticola juncidis</i> | Zitting cisticola | R | LC | Sched.IV |
| 103 | | <i>Orthotomus sutorius</i> | Common tailorbird | R | LC | Sched.IV |
| 104 | Phylloscopidae | <i>Phylloscopos humei</i> | Hume's leaf warbler | WM | LC | Sched.IV |
| 105 | | <i>Phylloscopos collybita</i> | Common chiffchaff | WM | LC | Sched.IV |
| 106 | | <i>Phylloscopos trochiloides</i> | Greenish warbler | WM | LC | Sched.IV |
| 107 | Leiothrichidae | <i>Turdoides striata</i> | Jungle babbler | R | LC | Sched.IV |
| 108 | Nectariniidae | <i>Cinnyris asiaticus</i> | Purple sunbird | R | LC | Sched.IV |
| 109 | Alaudidae | <i>Eremopterix griseus</i> | Ashy-crowned sparrow-lark | R | LC | Sched.IV |
| 110 | | <i>Alauda gulgula</i> | Oriental skylark | R | LC | Sched.IV |
| 111 | | <i>Alaudala raytal</i> | Sand lark | R | LC | Sched.IV |
| 112 | | <i>Galerida cristata</i> | Crested lark | R | LC | Sched.IV |
| 113 | | <i>Mirafra erythroptera</i> | Indian bush lark | R | LC | Sched.IV |
| 114 | Passeridae | <i>Passer domesticus</i> | House sparrow | R | LC | Sched.IV |
| 115 | Motacillidae | <i>Motacilla maderaspatensis</i> | White-browed wagtail | R | LC | Sched.IV |
| 116 | | <i>Motacilla alba</i> | White wagtail | WM | LC | Sched.IV |

| | | | | | | |
|-----------------------------|---------------|------------------------------|---------------------------|----|----|----------|
| 117 | | <i>Motacilla flava</i> | Western yellow wagtail | WM | LC | Sched.IV |
| 118 | | <i>Motacilla cinerea</i> | Grey wagtail | WM | LC | Sched.IV |
| 119 | | <i>Motacilla citreola</i> | Citrine wagtail | WM | LC | Sched.IV |
| 120 | | <i>Anthus rufulus</i> | Paddyfield pipit | R | LC | Sched.IV |
| 121 | | <i>Anthus trivialis</i> | Tree pipit | WM | LC | Sched.IV |
| 122 | | <i>Anthus campestris</i> | Tawny pipit | WM | LC | Sched.IV |
| 123 | | <i>Anthus richardi</i> | Richard's pipit | WM | LC | Sched.IV |
| 124 | | <i>Anthus similis</i> | Long-billed pipit | WM | LC | Sched.IV |
| 125 | Oriolidae | <i>Oriolus xanthornus</i> | Black-hooded oriole | R | LC | Sched.IV |
| 126 | | <i>Oriolus kundoo</i> | Indian golden oriole | R | LC | Sched.IV |
| 127 | Estrildidae | <i>Lonchura punctulata</i> | Scaly-breasted munia | R | LC | Sched.IV |
| 128 | | <i>Lonchura malacca</i> | Tricoloured munia | R | LC | Sched.IV |
| 129 | Dicruridae | <i>Dicrurus macrocercus</i> | Black drongo | R | LC | Sched.IV |
| 130 | Zosteropidae | <i>Zosterops palpebrosus</i> | Indian white-eye | R | LC | Sched.IV |
| 131 | Paridae | <i>Parus cinereus</i> | Cinereous tit | R | LC | Sched.IV |
| 132 | Campephagidae | <i>Lalage melaschistos</i> | Black-winged cuckooshrike | WM | LC | Sched.IV |
| Order: Falconiformes | | | | | | |
| 133 | Falconidae | <i>Falco peregrinus</i> | Peregrine falcon | WM | LC | Sched.IV |
| 134 | | <i>Falco tinnunculus</i> | Common kestrel | WM | LC | Sched.IV |

Acronyms; R=Resident, WM= Winter Migrant, SM=Summer Migrant, LC= Least Concerned, NT=Near Threatened, EN=Endangered, Sched=Schedule, WPA=Wildlife Protection Act

Summary Data; Total Orders: 19, Total Families:49, Total Species:134.

Distribution Status; Resident=87, Winter Migrant=46, Summer Migrant=01

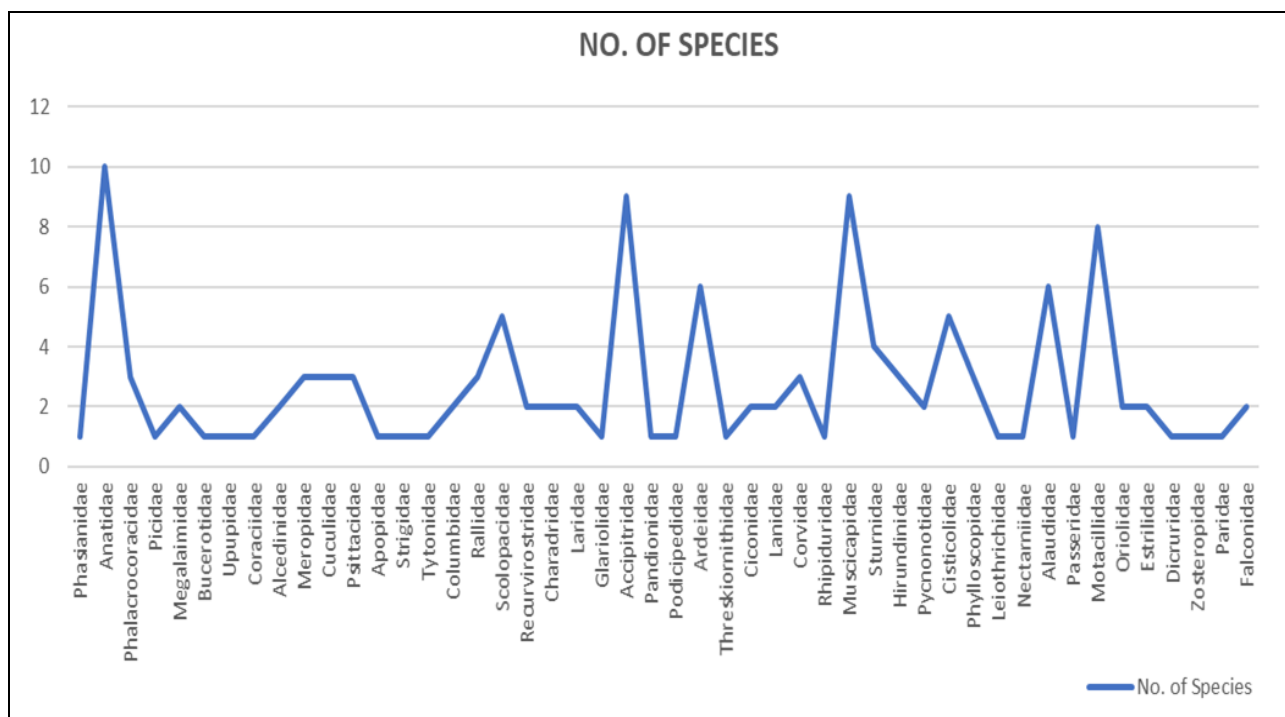


Fig 2: Line graph showing number of species seen among the recorded families

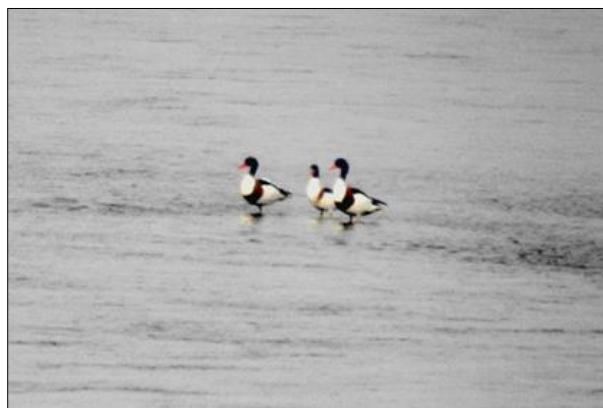


Plate 1: Common Shelduck

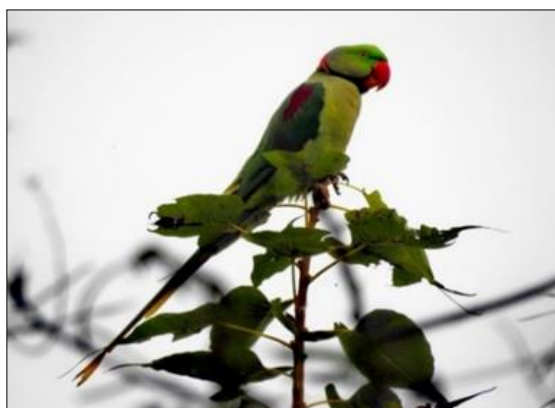


Plate 2: Alexandrine Parakeet

**Plate 3:** Painted Stork**Plate 4:** Pallas's Fish eagle**Plate 5:** Steppe eagle**Plate 6:** Bar-headed geese**Conflict of Interest**

The authors declare that they have no conflict of interest.

Author contributions

All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by Ahbar Alam, and Md Shahbaz. The first draft of the manuscript was written by Ahbar Alam and all authors commented on previous versions of the manuscript. Gopal Sharma supervised the work. Shahla Yasmin finally edited the manuscript. All authors read and approved the final manuscript.

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