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## Communication

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# Diversity and temporal variation of the bird community in paddy fields of Kadhiramangalam, Tamil Nadu, India

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**Abstract:** Paddy, a major food crop of India, provides a variety of habitats in a short period of time and supports diverse organisms. Paddy fields also harbour many birds with varying species composition across the different cultivation phases of paddy. This study, conducted in the paddy fields of Kadhiramangalam, Tamil Nadu, India, recorded the bird community composition there during the various cultivation phases of paddy. The bird community data was analysed and a total of 87 bird species were recorded from the study area belonging to 41 families and 13 orders. The growth phase (PS 3) is the most diverse phase. The bird composition showed a significant variation across the paddy cultivation phases with overall average dissimilarity of 71.41%. The patterns shown by graphs of bird species composition across the paddy cultivation phases is based on guild, habitat usage and order overlap and elucidates that the change in bird community composition temporally can be attributed to the niche variability across the paddy cultivation phases. The major species contributing to these changes observed are Black-headed Munia, Baya Weaver, Common Sandpiper, Barn Swallow, Common Myna, and Black Drongo in this region.

**Keywords:** Agro-ecosystems, aves, habitat usage, paddy cultivation phases, rice fields.

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## INTRODUCTION

Birds are known to play a dual role as pests and as bio-controllers of pests in various agro-ecosystems (Borad et al. 2000). But, for decades the focus on birds in agro-ecosystems has been to study their foraging effects on crop yield and their control (Beri et al. 1968; Jotwani et al. 1969; Chahal et al. 1973; Jain & Prakash 1974; Bhatnagar 1976; Dhindsa & Toor 1980; Dhindsa et al. 1984; Parashaya et al. 1986; Subramanya 1987; Saini & Toor 1991). A few studies exist on the beneficial role of birds in agro-ecosystems (Chakravarthy 1988; Parashaya et al. 1994; Asokan & Ali 2010). The attitude on wildlife conservation became inclusive of large man-managed ecosystems (Bambaradeniya et al. 2004; Edirisinghe & Bambaradeniya 2006). Since then, the biodiversity associated with paddy fields is being considered in the light of conservation (Bambaradeniya et al. 1998; Edirisinghe & Bambaradeniya 2008; Elphick et al. 2010). Many studies on the bird use of paddy fields with focus on wetland species have been undertaken in the last two decades worldwide (Elphick et al. 2010; Sicemore & Maine 2012; Nam et al. 2015; Marco-Mendez et al. 2015).

India, being an agrarian economy, produces 21.2% of world's paddy in an area of 3.85 million hectares (Agristat 2016), making it the second largest producer of rice in the world. This large area under paddy cultivation throughout India is known to support 351 bird species (Gopisundar & Subramanya 2010). The bird species using the paddy fields are seen to vary regionally. Paddy fields are dynamic habitats and go through different habitats in a single crop cycle. This temporal variation in biodiversity during a paddy crop cycle is successive (Bambaradeniya et al. 2004). The habitat variations also lead to changes in resource availability for birds. This will have an impact on the bird community composition. As such, the bimodality in the activity pattern of birds in paddy fields during a day is known (Sridhara et al. 1983). In studying the ecological importance of birds in paddy field ecosystems, the understanding of this temporal variability in bird community would be useful. This paper aims to discern the patterns of temporal variation of bird community composition in paddy fields and explores the probable causes for the patterns observed.

### Study Area

This study was conducted in Kadhiramangalam Village, Thiruvidaimarudur Taluk, Thanjavur District, Tamil Nadu (11.4'42.63"–11.4'58.24" $^{0}$N & 79.31'18.729"–79.31'59.247" $^{0}$E). Tamil Nadu is one of the top five rice producing states in India with 2.04 million hectares (4.7% of India's paddy cultivar land) under paddy cultivation, producing 7.65% of India's rice (Agristat 2016). In Kadhiramangalam, the whole of the low lying plains are intensive agricultural areas with the major crop being paddy interspersed with very small patches of sugarcane and timber wood. The main source of water for these paddy fields is from bore wells although it is a part of the fertile Cauvery delta. Farmers used to harvest three crops in the past. In recent years, they harvest only a single crop due to unavailability of water. The fields are flooded before land preparation and later irrigated as required. Chemical fertilizers and urea are used in 80% of the fields. Pesticides are used at the farmer's discretion.

## METHODS

### Field Methodology

To understand the bird species composition, strip-transect method (Sutherland 2000) was used. Two study sites (A and B) (Images 1–4), that were more than 2-km apart, were selected in the study area. A transect of 1-km was marked in each study site. Bird data was collected for two cropping seasons of paddy cultivated from August 2016 to January 2017 and September 2017 to March 2018 from both sites. Data collected included the bird species, numbers encountered and the field variables such as field conditions (wetland, wet and dry land) and also the paddy cultivation phases.

The data has been compartmentalised into seven phases of paddy cultivation to quantify the variations in bird composition over time (Bambaradeniya et al. 1998; Paliwal & Bhandarkar 2014). The seven paddy cultivation phases identified are

1. Land preparation and sapling phase (paddy stage - PS 1*) – Tilling and levelling are done and seed dispersed for saplings. Inundated wetlands. Around 15 days.
2. Transplantation phase (PS 2) – This stage includes transplantation and crop growth up to one foot in height. Inundated wetlands. Around 20 days.
3. Growth phase (PS 3) – From one ft grown crop till complete growth before flowering. Inundated wetlands. Around 30 days.
4. Flowering phase (PS 4) – Panicle formation and flowering. Wet fields. Pockets of wetlands. Around 10

* Following cultivation phases of paddy will be denoted as PS 1, 2, 3, 4, 5, 6 and 7 respectively.


**Image 1. Study area. Source: Google Earth.**

days.

5. Milking phase (PS 5) – During the milking period. Wet/ dry fields. Around 15 days.

6. Maturing phase (PS 6) – The panicles get mature. Wet/ dry fields. Around 15 days.

7. Drying and harvesting phase (PS 7) – The crop starts drying. Later harvested. Dry/wet fields. Pockets of wetlands.

### Analytical Methodology

Data compiled, tabulated and subjected to basic descriptive statistics for studying the community characteristics. Pair-wise ANOSIM (Analysis of similarity) (Clarke & Green 1988) with Bray-Curtis index was used to test the significance and understand the extent of variation in the bird species composition between the paddy cultivation phases. To explore the species-wise contribution to dissimilarity, SIMPER (Similarity percentage) was used. Richness and diversity indices (Magurran 1988; Morris et al. 2014) were used to understand the temporal variation in the diversity. All these analyses were performed with PAST 3.1 (Hammer et al. 2001). The patterns in temporal variations in bird species composition, feeding guild composition and habitat usage were analysed by constructing relative abundance graphs using MS Excel 2007.

## RESULTS

### a) Bird Community Composition and Diversity

Eighty-seven bird species belonging to 13 orders and 41 families were recorded from the study area (Figs. 1a & b). Overall data shows that the passerines were the most abundant birds both in terms of species and population abundance. All species are in the Least Concern category of the IUCN Red List except Black-headed Ibis *Threskiornis melanocephalus* and Red-necked Falcon *Falco chicquera* that are in the Near Threatened category. The basic descriptive statistics of the data compiled are summarized in Tables 1 & 2. The maximum variance and standard deviation is observed in PS 5.

The change in relative abundance of the birds as per their taxonomic order (Fig. 2a), broad feeding guild (Fig. 3a) and habitat dependency (Fig. 4a) shows significant patterns.

As the growth of paddy proceeds, a steady decline in the number of birds of Charadriiformes, Pelecaniformes and Coraciiformes was observed. Similarly an increase and steep decline of the birds of Accipitriformes and Falconiformes was also observed with time. A steep

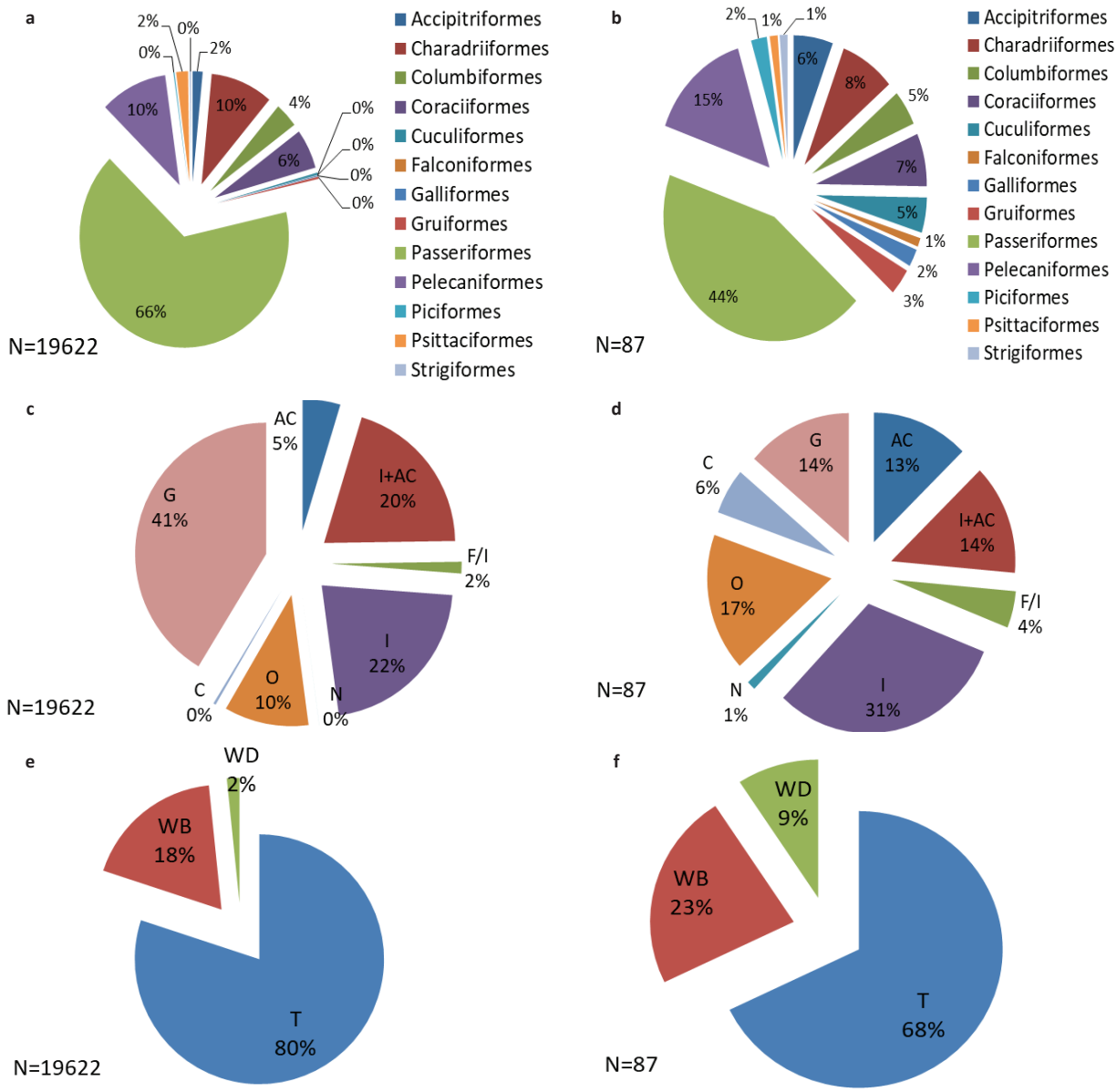


**Figure 1. a, c & e—bird community composition in paddy fields based on order, guild and habitat dependency respectively | b, d & f—bird species composition in paddy fields based on order, guild and habitat dependency, respectively. Guild: AC—Aquatic Carnivore | C—Carnivore | F—Frugivore | G—Granivore | I—Insectivore | N—Nectarivore | O—Omnivore. Habitat Dependency: WB—Waterbird | WD—Wetland Dependent | T—Terrestrial.**

**Table 1. Bird community in paddy fields summary. Descriptive statistics based on species richness.**

| Paddy growth phases | Species richness | No. of transects | Total encounters | Mean | Standard deviation | Co-efficient of variance in %age | Minimum species/ transect | Maximum species/ transect |
|---|---|---|---|---|---|---|---|---|
| PS 1 | 53 | 14 | 2106 | 19.71 | ±3.47 | 17.61 | 12 | 27 |
| PS 2 | 55 | 16 | 2536 | 21.13 | ±2.7 | 12.8 | 15 | 27 |
| PS 3 | 60 | 15 | 2097 | 21.86 | ±4.03 | 18.44 | 16 | 31 |
| PS 4 | 65 | 15 | 3591 | 25.33 | ±3.59 | 14.21 | 19 | 32 |
| PS 5 | 58 | 10 | 4296 | 24.8 | ±4.75 | 19.18 | 18 | 33 |
| PS 6 | 62 | 14 | 3871 | 25 | ±3.78 | 15.14 | 20 | 32 |
| PS 7 | 54 | 10 | 1125 | 21 | ±6.43 | 30.61 | 9 | 31 |


Image 2. Congregation of wetland birds during PS 1.


Image 3. Birds during PS 3.


Image 4. Black-headed Munias and Baya Weaver during PS 5.

increase in Passeriformes and Psittaciformes after PS 4 was seen. Strigiformes increased after PS 3. Galliformes and Gruiformes remained steady across the stages (Fig. 2a).

Diversity and Species Richness indices (Table 3) show that PS 3 (growth phase) is the most diverse with 60 species although PS 4 (flowering phase) has highest species richness and PS 2 (transplanted paddy phase) seems to be the most even. These indices also show that PS 5 (milking phase) is the least diverse with low evenness and high dominance.

The R value of ANOSIM (at 95% confidence) shows that there is a significant difference in the bird species composition between the seven phases of paddy cultivation cycle (Table 4). The average dissimilarity among the seven phases was 71.41% (SIMPER). The R values between two consecutive stages were significant except PS 5 and PS 6 ranging from 0.16 to 0.21. Between two non-consecutive stages the values ranged from 0.21 to 0.71.

Ninety percent of this change is accounted for by 29 species of the total 87 bird species recorded (Appendix 1). The major contributors to this change are, *Lonchura malacca* (19.67%) followed by *Ploceus philippinus* (11.16%), *Actitis hypoleucos* (8.06%), *Hirundo rustica* (6.554%), *Acridotheres tristis* (3.86%), and *Dicrurus macrocercus* (3.499%) (Figs. 5 a & b) contributing to over 50% of the variations seen.

**b) Feeding guilds and the temporal variation**

The birds were categorised into eight broad feeding guilds based on their feeding preferences in Ali & Ripley (1978) (Figs. 1c & d), viz. insectivores, granivores, carnivores, nectarivores, omnivores, aquatic carnivores (species that feed on aquatic vertebrates and invertebrates), frugivores + insectivores, and aquatic carnivores + insectivores. Considering species richness as the factor, insectivorous guild dominates (32%) as in any terrestrial habitat. Dominance of the gregarious granivorous birds is evident in the abundance pattern showing 41% of total encounters of the granivores.

The relative abundance of these guilds (based on encounter rate) across the paddy growth phases showed a four times increase in granivores from PS 3 to PS 4 (Fig. 3a). More than 50% of the omnivores declined from PS 3 to PS 4. Carnivores also declined from PS 2 onwards. The frugivores are negligible in paddy field ecosystem. The insectivores and aquatic carnivores+insectivores were observed to increase in PS 3, decrease in PS 4 and PS 5 (40% decrease) and again increase in PS 6, probably an artefact of this miscellaneous classification.

**c) Wetland birds in paddy fields**

Bird community of paddy fields were analysed as per their known habitat association. The 87 bird

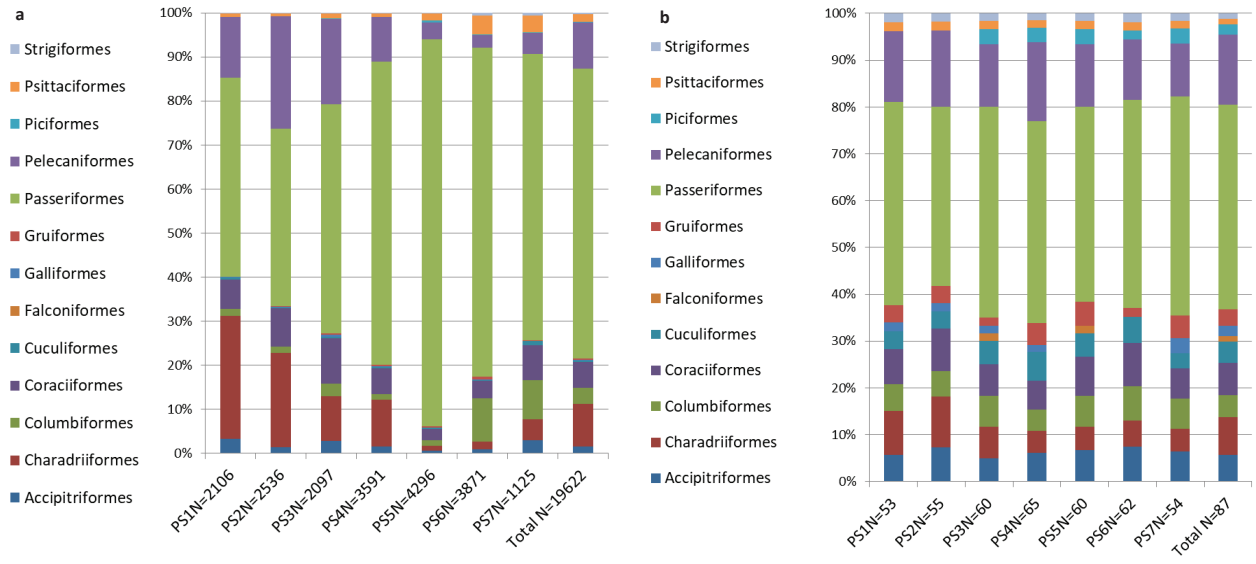


**Figure 2. Temporal variation in taxonomic composition of bird community of paddy fields based on order and; a—relative abundance, and b—species richness.**

**Table 2. Bird community in paddy fields summary. Descriptive statistics based on total encounters.**

| Paddy growth phases | Species richness | No. of transects | Total encounters | Mean | Standard deviation | Co-efficient of variance in %age | Minimum encounters/ transect | Maximum encounters/ transect |
|---|---|---|---|---|---|---|---|---|
| PS 1 | 53 | 14 | 2106 | 150.42 | ±68.14 | 45.2 | 71 | 304 |
| PS 2 | 55 | 16 | 2536 | 158.5 | ±48.44 | 30.5 | 97 | 264 |
| PS 3 | 60 | 15 | 2097 | 139.8 | ±54.33 | 38.86 | 88 | 246 |
| PS 4 | 65 | 15 | 3591 | 239.4 | ±149.79 | 62.56 | 111 | 659 |
| PS 5 | 58 | 10 | 4296 | 429.6 | ±308.37 | 71.78 | 105 | 1065 |
| PS 6 | 62 | 14 | 3871 | 276.5 | ±179.91 | 65.06 | 75 | 784 |
| PS 7 | 54 | 10 | 1125 | 112.5 | ±63.07 | 56.62 | 32 | 216 |

species recorded from the study area were classified into three categories, viz., Waterbirds (wetland birds), wetland-dependent birds, and terrestrial birds; and their response to the changes in paddy stages was analysed. Of these, 28 bird species (relative abundance - 20%) are wetland associated, belonging to seven orders and 13 families. Twenty of these 28 bird species are true water-birds belonging to three orders, viz., Charadriiformes – 6 species (5 families), Gruiiformes – 2 species (1 family), Pelecaniformes – 12 species (4 families). Eight species are wetland dependent belonging to 6 orders, viz., Charadriiformes – 1 species (1 family), Pelecaniformes – 1 species (1 family), Coraciiformes – 3 species (1 family), Accipitriformes – 1 species (1 family), Gruiformes- 1 species (1 family). The rest are terrestrial (Figs. 1 e & f). The relative abundance of these birds across paddy stages shows more than 80% decrease in water-birds and wetland dependent species from PS 2 to PS 6 with a 50% drop between PS 3 and PS 4 (Fig. 4).

Twenty-two species are migrants (25.2%) of which 12 species (54.5%) are wetland dependent. Nineteen species are partial migrants (21.8%) of which 10 species (52.6%) are wetland dependent.

## DISCUSSION

According to Subramanya (1987), the bird community in paddy fields are bimodal across paddy cultivation phases with peaks during the tilling/levelling phase and growth phase of paddy. This pattern was observed by considering only the species richness in each of the stages. Along with the species richness the number of birds in each of the species (population abundance) is also a significant factor to explore and understand the bird life of paddy fields. Since availability of prey

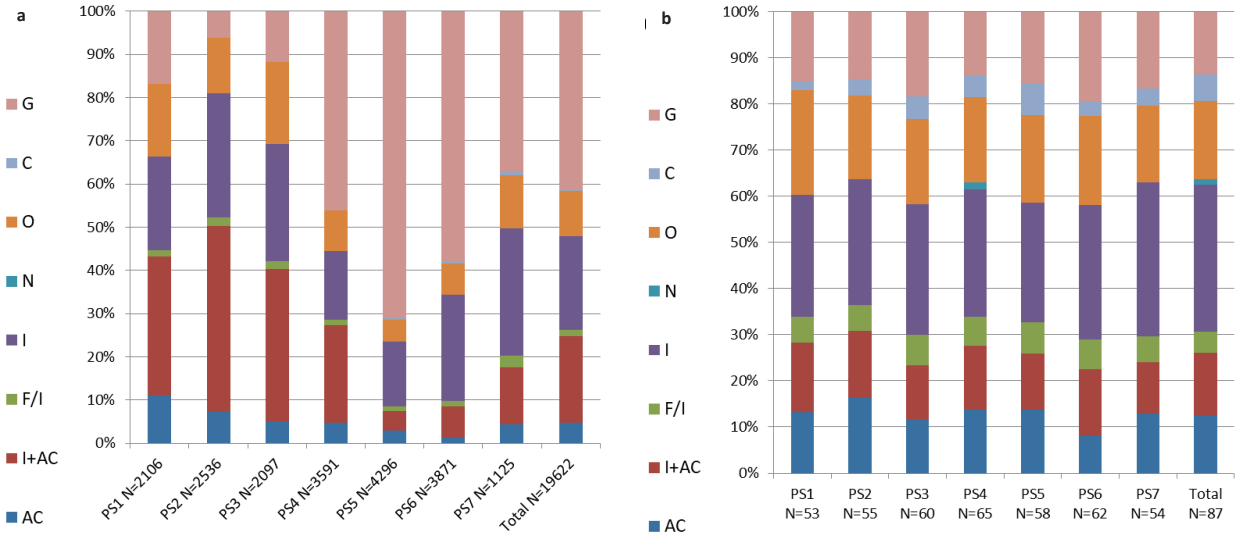


**Figure 3. Temporal variations in bird feeding Guild Composition of paddy fields based on a) relative abundance, and b) species richness. AC—Aquatic Carnivore | I—Insectivore| F/I—Frugivore and insectivore | O—Omnivore | C—Carnivore | N—Nectarivore | G—Granivore.**

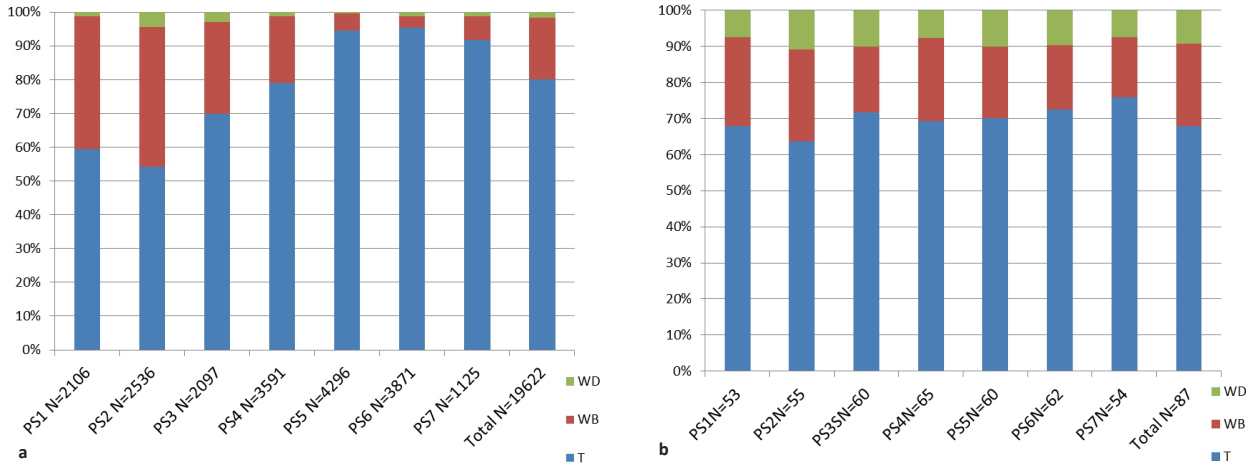


**Figure 4. Temporal variations in bird community composition in paddy fields based on habitat dependency and a) relative abundance, and b) species richness: WD—Wetland dependent birds | WB—Waterbirds | T—Terrestrial birds.**

**Table 3. Richness and diversity indices of birds across paddy growth stages. The highest values of the indices are in bold and the least underlined. * is the most diverse.**

| | PS 1 | PS 2 | PS 3 | PS 4 | PS 5 | PS 6 | PS 7 | Total |
|---|---|---|---|---|---|---|---|---|
| Taxa_S | 53 | 55 | 60* | **65** | 58 | 62 | 54 | 87 |
| Individuals | 2106 | 2536 | 2097 | 3591 | 4296 | 3871 | 1125 | 19622 |
| Dominance_D | 0.0915 | 0.0720 | 0.0606* | 0.1294 | 0.2419 | 0.1943 | **0.0601** | 0.0884 |
| Simpson_1-D | 0.9085 | 0.9279 | 0.9393 | 0.8706 | 0.7581 | 0.8057 | **0.9399** | 0.9116 |
| Shannon_H | 2.885 | 3.039 | 3.181 | 2.7 | 2.065 | 2.514 | **3.234** | 3.073 |
| Evenness_e^H/S | 0.3379 | 0.3796 | 0.4011* | 0.2289 | 0.136 | 0.1992 | **0.4702** | 0.2483 |
| Menhinick | 1.155 | 1.092 | 1.31 | 1.085 | 0.8849 | 0.9965 | **1.61** | 0.6211 |
| Equitability_J | 0.7267 | 0.7583 | 0.7768 | 0.6468 | 0.5086 | 0.609 | **0.8108** | 0.688 |
| Berger-Parker | 0.2023 | 0.1447 | **0.1283** | 0.2927 | 0.3638 | 0.4141 | 0.1653 | 0.2283 |

**Table 4. R values of one-way ANOSIM (Bray-Curtis) between pairs of paddy growth stages. Permutation N = 9999, R= 0.3357, p= 0.0001. p value is less than 0.05 between all pairs in bold.**

| | PS1 | PS2 | PS3 | PS4 | PS5 | PS 6 |
|---|---|---|---|---|---|---|
| PS2 | **0.1787** | | | | | |
| PS3 | **0.2151** | **0.1635** | | | | |
| PS4 | **0.2768** | **0.3761** | **0.2106** | | | |
| PS5 | **0.5038** | **0.6299** | **0.5546** | **0.1823** | | |
| PS6 | **0.4555** | **0.6366** | **0.445** | 0.0877 | 0.1128 | |
| PS 7 | **0.3778** | **0.7102** | **0.5028** | **0.2252** | **0.3781** | **0.1641** |

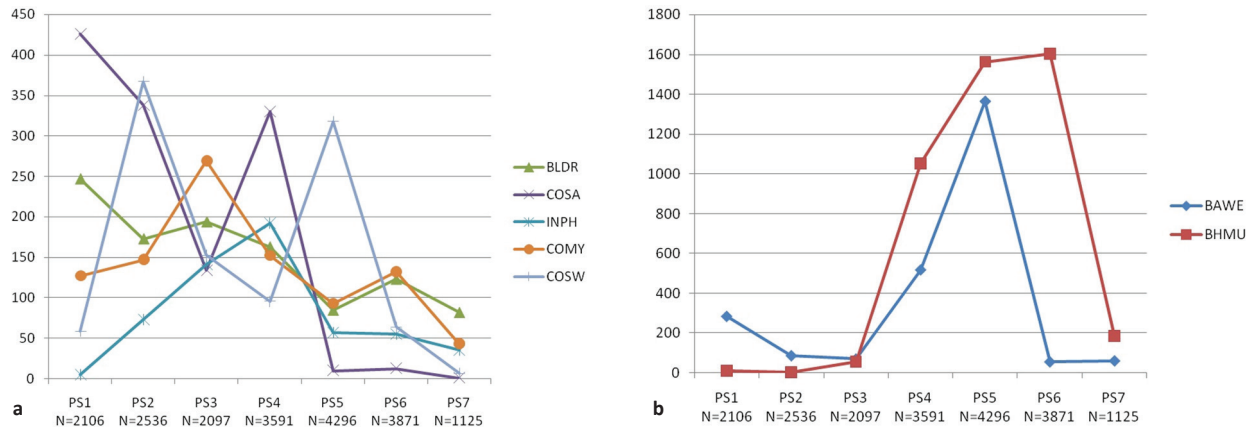


**Figure 5. Variation of top contributors to change across paddy cultivation phases. A: COSA- Common Sandpiper | COSW—Barn Swallow | COMY—Common Myna | BLDR—Black Drongo | INPH—Indian Pond Heron. b: BAWE—Baya Weaver | BHMU—Black-headed Munia.**

is known to affect bird abundance in paddy fields (Bambaradeniya et al. 1998), it is the feeding guilds and the opportunity provided by the changing ecosystem as a substratum for feeding in the paddy fields that determine the life of birds in this ecosystem. Hence, for the better understanding of temporal variation and its significance, the abundance of each species is important along with the species richness in the paddy fields.

The number of passerines increased across the cultivation phases from PS 1 till PS 5 and reduced in PS 6 and PS 7. Simultaneously, birds belonging to Charadriiformes, Pelecaniformes and Coraciiformes decreased from PS 1 through PS 5 and recovered slightly from PS 6 to PS 7. Columbiiformes showed a fourfold increase from PS 5 to PS 6 and Psittaciformes also showed a threefold increase from PS 5 to PS 7 (Fig. 2a). These results coincide with the trends observed in the guild composition variations where aquatic carnivores and insectivores + aquatic carnivores decreased through PS 2 to PS 5 with peak in PS 2. The same trends can be visualised in the wetland and wetland dependent species from PS 1 through PS 7 (Fig. 4a). The granivores showed a drastic increase from PS 3 with a peak in PS 5 and decreased in PS 6 and 7. The insectivores maintained a minimal of 15% across all the stages although the number increases which denotes their rise in abundance also across PS 1 and PS 7 (Fig. 3a).

Thus, the current study shows that there is a linear (table 3) significant change in bird community composition temporally in paddy fields along with the changes in paddy phases. This change is gradual. The richness (Table 2) did not show significant variation between the seven paddy cultivation phases considered here. So, during a cropping cycle of paddy a variety of niches are available that are also dynamic in nature. Hence, the temporal variation in bird community is due to niche variability across the different paddy cultivation phases.

The differences in bird community observed between two consecutive phases among PS 1–PS 2 and PS 3–PS 4 with R values at 0.178– 0.21 (Table 3) indicate the changes of available niches in the same area during that time frame. This may be because of the sudden change in habitat; (a) in case of PS 1 and PS 2, the presence

of transplanted paddy in an open wetland kind of ecosystem, (b) in the case of PS 3 and PS 4, the changes in crop density and start of panicles and drying of lands, opens avenues for new available niches. Simultaneously the process displaces a few niches already present. Increase in granivores till PS 5 and decrease only 50% till PS 7 seems to coincide with the increase in Columbidae and Psittaculidae that are seen to flock to feed on fallen grains after harvest.

The best examples of the dependency on the availability and accessibility of niches can be seen in PS 5 (milking phase) and PS 3 (growth phase). The high dominance Index value in the milking phase of paddy can be attributed to the increase in relative abundance of Passeriformes especially granivores and decrease of aquatic carnivores + insectivores (Figs. 2a & 3a). The low evenness may also be because of drastic increase in two species—*Lonchura malacca* and *Ploceus philippinus*. The steep decline in omnivores may be due to loss of open wetland conditions (Nam et al. 2015) and the crop density hinders the activities of raptors like *Milvus migrans* and *Haliastur indus*. Insectivores and mixed feeders maintain 20% of the overall abundance across the stages although there is an increase in total encounters. This shows there is an increase in the abundance of insectivores and aquatic carnivores + insectivores along the paddy stages which follow the arthropod abundance in rice fields (Bambaradeniya 1998) and changes with the habitat variations (Fig. 3a).

It can be concluded that there is a significant change in the paddy field bird composition temporarily with peak diversity during the plant growth phase (PS 3) of paddy cultivation phases. This change in bird community composition can be attributed to the dynamic habitat variability happening during paddy cultivation. Twenty-nine bird species contribute to 90% of the bird community changes seen in Kadhiramangalam region. The major contributing species are Black-headed Munia, Baya Weaver, Common Sandpiper, Barn Swallow, Common Myna, and Black Drongo in this region. All these except Black Drongos are colonial/ flocking birds. Hence, their presence or absence gives the major contributions. The temporal variability in the microhabitats of the paddy fields provide varied substratum in support of various bird species of different feeding guilds. This makes paddy fields a good candidate to be considered as a 'keystone habitat' for bird communities.

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**Appendix 1. Checklist of birds in Paddy fields of Kadhiramangalam (Praveen et al. 2016).**

| | Scientific name | Common name | Move-ment | Feeding guild | Habitat | IUCN status | % age contribution to overall dissimilarity (SIMPER) | Relative abundance (%) |
|---|---|---|---|---|---|---|---|---|
| I | **Order Galliformes** | | | | | | | |
| | **Family Phasianidae** | | | | | | | |
| 1 | *Francolinus pondicerianus* | Grey Francolin | R | G | T | LC | 0.1729 | 0.112 |
| 2 | *Pavo cristatus* | Indian Peafowl | R | O | T | LC | 0.04625 | 0.02 |
| II | **Order Columbiformes** | | | | | | | |
| | **Family Columbidae** | | | | | | | |
| 3 | *Columba livia* | Rock Pigeon | R | G | T | LC (dec) | 2.88 | 2.461 |
| 4 | *Streptopelia decaocto* | Eurasian Collared Dove | R | G | T | LC (inc) | 0.127 | 0.076 |
| 5 | *Streptopelia senegalensis* | Laughing Dove | PM | G | T | LC | 0.1919 | 0.097 |
| 6 | *Streptopelia chinensis* | Spotted Dove | R | G | T | LC (inc) | 0.9167 | 0.993 |
| III | **Order Cuculiformes** | | | | | | | |
| | **Family Cuculidae** | | | | | | | |
| 7 | *Eudynamys scolopaceus* | Asian Koel | PM | O | T | LC | 0.2126 | 0.178 |
| 8 | *Hierococcyx varius* | Common Hawk Cuckoo | PM | I | T | LC | 0.09703 | 0.046 |
| 9 | *Centropus sinensis* | Greater Coucal | R | C | T | LC | 0.0452 | 0.046 |
| 10 | *Clamator jacobinus* | Pied Cuckoo | M | I | T | LC | 0.1241 | 0.071 |
| IV | **Order Gruiformes** | | | | | | | |
| | **Family Rallidae** | | | | | | | |
| 11 | *Gallinula chloropus* | Common Moorhen | M | O | WB | LC | 0.05449 | 0.035 |
| 12 | *Zapornia fusca* | Ruddy-breasted Crake | PM | O | WD | LC (dec) | 0.06516 | 0.046 |
| 13 | *Amaurornis phoenicurus* | White-breasted Waterhen | R | O | WB | LC | 0.2928 | 0.245 |
| V | **Order Pelecaniformes** | | | | | | | |
| | **Family Ciconiidae** | | | | | | | |
| 14 | *Anastomus oscitans* | Asian Openbill | PM | AC | WB | LC | 1.895 | 1.844 |
| | **Family Ardeidae** | | | | | | | |
| 15 | *Ixobrychus flavicollis* | Black Bittern | PM | I+AC | WB | LC (dec) | 0.05399 | 0.04 |
| 16 | *Bubulcus ibis* | Cattle Egret | PM | I | WD | LC (inc) | 0.5555 | 0.377 |
| 17 | *Ixobrychus cinnamomeus* | Cinnamon Bittern | PM | I+AC | WB | LC | 0.03129 | 0.015 |

| | Scientific name | Common name | Move-ment | Feeding guild | Habitat | IUCN status | % age contribution to overall dissimilarity (SIMPER) | Relative abundance (%) |
|---|---|---|---|---|---|---|---|---|
| 18 | *Ardea intermedia* | Intermediate Egret | PM | I+AC | WB | LC (dec) | 2.691 | 1.926 |
| 19 | *Ardeola grayii* | Indian Pond Heron | R | I+AC | WB | LC | 3.057 | 2.84 |
| 20 | *Ixobrychus minutus* | Little Bittern | PM | I+AC | WB | LC (dec) | 0.02426 | 0.02 |
| 21 | *Egretta garzetta* | Little Egret | PM | I+AC | WB | LC (inc) | 2.249 | 1.849 |
| 22 | *Ardea purpurea* | Purple Heron | M | AC | WB | LC | 0.07015 | 0.056 |
| | **Family Threskiornithidae** | | | | | | | |
| 23 | *Platalea leucorodia* | Eurasian Spoonbill | M | AC | WB | LC | 0.008825 | 0.005 |
| 24 | *Plegadis falcinellus* | Glossy Ibis | M | AC | WB | LC (dec) | 0.1489 | 0.122 |
| 25 | *Threskiornis melanocephalus* | Black-headed Ibis | PM | AC | WB | NT (dec) | 1.437 | 1.019 |
| | **Family Phalocrocaracidae** | | | | | | | |
| 26 | *Microcarbo niger* | Little Cormorant | PM | AC | WB | LC | 0.4764 | 0.28 |
| **VI** | **Order Charadriiformes** | | | | | | | |
| | **Family Recurvirostridae** | | | | | | | |
| 27 | *Himantopus himantopus* | Black- winged Stilt | M | O | WB | LC (inc) | 1.522 | 0.958 |
| | **Family Charadriidae** | | | | | | | |
| 28 | *Charadrius dubius* | Little Ringed Plover | M | I+AC | WB | LC | 0.3769 | 0.28 |
| 29 | *Vanellus indicus* | Red-wattled Lapwing | R | I+AC | WD | LC | 1.591 | 1.554 |
| | **Family Rostratulidae** | | | | | | | |
| 30 | *Rostratula benghalensis* | Greater Painted Snipe | M | AC | WB | LC (dec) | 0.01222 | 0.01 |
| | **Family Scolopacidae** | | | | | | | |
| 31 | *Actitis hypoleucos* | Common Sandpiper | M | I+AC | WB | LC (dec) | 8.067 | 6.38 |
| 32 | *Gallinago gallinago* | Common Snipe | M | AC | WB | LC (dec) | 0.6628 | 0.464 |
| | **Family Laridae** | | | | | | | |
| 33 | *Chlidonias hybrida* | Whiskered Tern | M | I+AC | WB | LC | 0.02225 | 0.01 |
| **VII** | **Order Accipitriformes** | | | | | | | |
| | **Family Accipitridae** | | | | | | | |
| 34 | *Milvus migrans* | Black Kite | R | O | T | LC | 0.7647 | 0.724 |
| 35 | *Haliastur indus* | Brahminy Kite | R | AC | WD | LC (dec) | 0.6436 | 0.591 |
| 36 | *Elanus caeruleus* | Black-winged Kite | R | I | T | LC | 0.2424 | 0.204 |
| 37 | *Accipiter badius* | Shikra | R | C | T | LC | 0.0268 | 0.025 |
| 38 | *Butastur teesa* | White- eyed Buzzard | R | C | T | LC | 0.009357 | 0.005 |
| **VIII** | **Order Strigiformes** | | | | | | | |
| | **Family Strigidae** | | | | | | | |
| 39 | *Athenebrama* | Spotted Owlet | R | C | T | LC | 0.251 | 0.224 |
| **IX** | **Order Piciformes** | | | | | | | |
| | **Family Picidae** | | | | | | | |
| 40 | *Dinopium benghalense* | Lesser Golden-backed Woodpecker | R | I | T | LC | 0.09068 | 0.061 |
| | **Family Ramphastidae** | | | | | | | |
| 41 | *Psilopogon haemacephalus* | Coppersmith Barbet | R | F/I | T | LC (inc) | 0.2115 | 0.102 |
| **X** | **Order Coraciiformes** | | | | | | | |
| | **Family Meropidae** | | | | | | | |
| 42 | *Merops philippinus* | Blue-tailed Bee -eater | PM | I | T | LC | 0.039 | 0.015 |
| 43 | *Merops orientalis* | Green Bee-eater | PM | I | T | LC (inc) | 0.2097 | 0.158 |

| | Scientific name | Common name | Move-ment | Feeding guild | Habitat | IUCN status | % age contribution to overall dissimilarity (SIMPER) | Relative abundance (%) |
|---|---|---|---|---|---|---|---|---|
| | **Family Coraciidae** | | | | | | | |
| 44 | *Coracias benghalensis* | Indian Roller | PM | I | T | LC (inc) | 0.2962 | 0.183 |
| | **Family Alcedinidae** | | | | | | | |
| 45 | *Ceryle rudis* | Pied Kingfisher | R | AC | WD | LC | 0.2425 | 0.183 |
| 46 | *Alcedo atthis* | Common Kingfisher | PM | AC | WD | LC | 0.1167 | 0.076 |
| 47 | *Halcyon smyrnensis* | White-throated Kingfisher | R | I+AC | WD | LC | 2.207 | 5.172 |
| **XI** | **Order Falconiformes** | | | | | | | |
| | **Family Falconidae** | | | | | | | |
| 48 | *Falco chicquera* | Red-necked Falcon | R | C | T | NT (dec) | 0.02114 | 0.01 |
| **XII** | **Order Psittaciformes** | | | | | | | |
| | **Family Psittaculidae** | | | | | | | |
| 49 | *Psittacula krameri* | Rose-ringed Parakeet | R | G | T | LC (inc) | 1.93 | 1.824 |
| **XIII** | **Order Passeriformes** | | | | | | | |
| | **Family Oriolidae** | | | | | | | |
| 50 | *Oriolus oriolus* | Eurasian Golden Oriole | M | F/I | T | LC (inc) | 0.161 | 0.132 |
| | **Family Artamidae** | | | | | | | |
| 51 | *Artamus fuscus* | Ashy Woodswallow | R | I | T | LC | 0.4899 | 0.326 |
| | **Family Dicruridae** | | | | | | | |
| 52 | *Dicrurus macrocercus* | Black Drongo | R | I | T | LC | 3.499 | 5.407 |
| | **Family Laniidae** | | | | | | | |
| 53 | *Lanius cristatus* | Brown Shrike | M | I | T | LC (dec) | 0.07865 | 0.051 |
| | **Family Corvidae** | | | | | | | |
| 54 | *Corvus splendens* | House Crow | R | O | T | LC | 0.2367 | 0.158 |
| 55 | *Dendrocitta vagabunda* | RufousTreepie | R | O | T | LC | 0.375 | 0.362 |
| 56 | *Corvus macrorhynchos* | Large-billed Crow | R | O | T | LC | 0.6461 | 0.189 |
| | **Family Monarchidae** | | | | | | | |
| 57 | *Terpsiphone paradisi* | Asian Paradise Flycatcher | M | I | T | LC | 0.01098 | 0.005 |
| | **Family Nectariniidae** | | | | | | | |
| 58 | *Leptocoma zeylonica* | Purple-rumped Sunbird | R | N | T | LC | 0.01199 | 0.01 |
| | **Family Ploceidae** | | | | | | | |
| 59 | *Ploceus philippinus* | Baya Weaver | R | G | T | LC | 11.16 | 12.491 |
| | **Family Estrildidae** | | | | | | | |
| 60 | *Lonchura malacca* | Black-headed Munia | R | G | T | LC | 19.67 | 22.826 |
| 61 | *Euodice malabarica* | Indian Silverbill | R | O | T | LC | 0.09012 | 0.066 |
| 62 | *Amandava amandava* | Red Munia | R | G | T | LC | 0.1149 | 0.076 |
| 63 | *Lochura punctulata* | Scaly-breasted Munia | R | G | T | LC | 0.1346 | 0.107 |
| 64 | *Lonchura striata* | White-rumpedMunia | R | G | T | LC | 0.2203 | 0.153 |
| | **Family Passeridae** | | | | | | | |
| 65 | *Gymnoris xanthocollis* | Yellow-throated Sparrow | PM | O | T | LC | 0.2035 | 0.138 |
| | **Family Motacillidae** | | | | | | | |
| 66 | *Motacilla cinerea* | Grey Wagtail | M | I+AC | WD | LC | 0.01241 | 0.01 |
| 67 | *Anthus rufulus* | Paddyfield Pipit | R | I | T | LC | 0.6765 | 0.464 |
| 68 | *Motacilla maderaspatensis* | White-browed Wagtail | R | I | T | LC | 0.2047 | 0.132 |

| | Scientific name | Common name | Move-ment | Feeding guild | Habitat | IUCN status | % age contribution to overall dissimilarity (SIMPER) | Relative abundance (%) |
|---|---|---|---|---|---|---|---|---|
| | **Family Alaudidae** | | | | | | | |
| 69 | *Mirafra affinis* | Jerdon'sBushlark | R | O | T | LC | 0.5862 | 0.418 |
| | **Family Cisticolidae** | | | | | | | |
| 70 | *Prinia socialis* | Ashy Prinia | R | I | T | LC | 1.079 | 0.902 |
| 71 | *Orthotomus sutorius* | Common Tailorbird | R | I | T | LC | 0.01861 | 0.01 |
| 72 | *Prinia hodgsonii* | Grey-breasted Prinia | R | I | T | LC | 0.02298 | 0.01 |
| 73 | *Prinia inornata* | Plain Prinia | R | I | T | LC | 1.592 | 1.391 |
| 74 | *Cisticola juncidis* | Zitting Cisticola | R | I | T | LC | 2.917 | 2.899 |
| | **Family Acrocephalidae** | | | | | | | |
| 75 | *Acrocephalus dumetorum* | Blyth's reed Warbler | M | I | T | LC (inc) | 0.6365 | 0.499 |
| 76 | *Iduna rama* | Syke's Warbler | M | I | T | C | 0.008166 | 0.01 |
| 77 | *Acrocephalus agricola* | Paddyfield Warbler | M | I | T | LC (dec) | 1.595 | 1.386 |
| | **Family Hirundinidae** | | | | | | | |
| 78 | *Hirundo rustica* | Barn Swallow | M | I | T | LC (dec) | 6.554 | 5.422 |
| 79 | *Cecropis daurica* | Red-rumped Swallow | M | I | T | LC | 2.49 | 1.62 |
| | **Family Pycnonotidae** | | | | | | | |
| 80 | *Pycnonotus cafer* | Red-vented Bulbul | R | F/I | T | LC (inc) | 0.8179 | 0.958 |
| | **Family Leiothrichidae** | | | | | | | |
| 81 | *Turdoides affinis* | Yellow-billed Babbler | R | O | T | LC | 1.961 | 1.804 |
| | **Family Sturnidae** | | | | | | | |
| 82 | *Sturnia pagodarum* | Brahminy Starling | R | F/I | T | LC | 0.3347 | 0.245 |
| 83 | *Acridotheres tristis* | Common Myna | R | O | T | LC (inc) | 3.858 | 4.907 |
| | **Family Muscicapidae** | | | | | | | |
| 84 | *Luscinia svecica* | Bluethroat | M | I | T | LC | 0.01241 | 0.01 |
| 85 | *Saxicola maurus* | Siberian Stonechat | M | I | T | LC | 0.002521 | 0.005 |
| 86 | *Copsychus saularis* | Oriental Magpie Robin | R | I | T | LC | 0.009394 | 0.005 |
| 87 | *Saxicola caprata* | Pied Bushchat | PM | O | T | LC | 0.01659 | 0.01 |

Movement: M— Migrant | PM— Partial Migrant | R— Resident. Habitat: WB—Waterbird | WD—Wetland dependent bird | T— Terrestrial bird. Guild: AC—Aquatic Carnivore | I—Insectivore | F—Frugivore | G—Granivore | C—Carnivore | N—Nectarivore | O—Omnivore. IUCN Status: LC— Least Concern | (dec)—decrease in population | (inc)—increase in population; NT—Near Threatened.

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