SPECIES COMPOSITION, ABUNDANCE AND DIVERSITY OF AVIAN FAUNA IN PAKOKKU ENVIRONS, MAGWAY REGION

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Abstract

Avifauna was investigated in four study sites of the Pakokku environs during July 2015 to June 2016. A total of 126 bird species belonging to 81 genera, 41 families and 16 orders were recorded. Of these, 35 species were water birds and 91 species were terrestrial birds. The bird species were represented with 25 migrants and 101 residents. During the study period, two endemic species, namely *Turdoides gularis* (White-throated Babbler) and *Mirafra microptera* (Burmese Bushlark) were recorded. The highest species composition was found in order Passeriformes (51.59%, 65 species), followed by Pelecaniiformes (8.73%, 11 species). Relative abundance indicated six species as very common, 10 species as common and 110 species as uncommon in Pakokku environs. In the study area, the highest species richness and diversity values were evaluated in Site I ($d = 11.643$, $D = 0.077$, $H' = 3.199$) and Site III ($d = 10.934$, $D = 0.039$, $H' = 3.646$). This situation may be related to the habitat conditions and availability of food sources. Pakokku environs may be considered rich in bird diversity due to occurrence of high number of bird species and individuals.

Keywords: Composition, Abundance, Diversity, Avian Fauna, Pakokku environs

Introduction

Birds are certainly not the only group of species affected by global change, nor even the most affected. But they are certainly among the most visible and evocative to us as a society and are thus an important window into the broader changes in ecosystems (Altwegg *et al*., 2009).

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Bird abundance and species composition vary in response to different degrees of change in vegetation structure. Considerable variation in species composition may occur along successional gradients, and many species are restricted to either initial or advanced stages (Casas *et al*., 2016).

The relative abundance of a species is often associated with the vegetation community, food resources and habitat structural complexity. Determining the avian relative abundance is highly important because this variable indicates the proportion of an existing population in a particular habitat. Microclimate and habitat structure are major factors that influence avian survival rate, reproduction success, time of breeding, species dispersal and habitat selection (Rajpar and Zakaria, 2015).

The effect of habitat heterogeneity on species diversity is a fundamental concept in community ecology often invoked to account for the absence of a species area effect. The relationship between habitat heterogeneity and bird species diversity is a well documented pattern in community ecology. Bird species richness and diversity in terrestrial landscapes is closely related to habitat structure and floristically, that bird species can occupy, resulting in greater bird diversity (Azlan *et al.*, 2015).

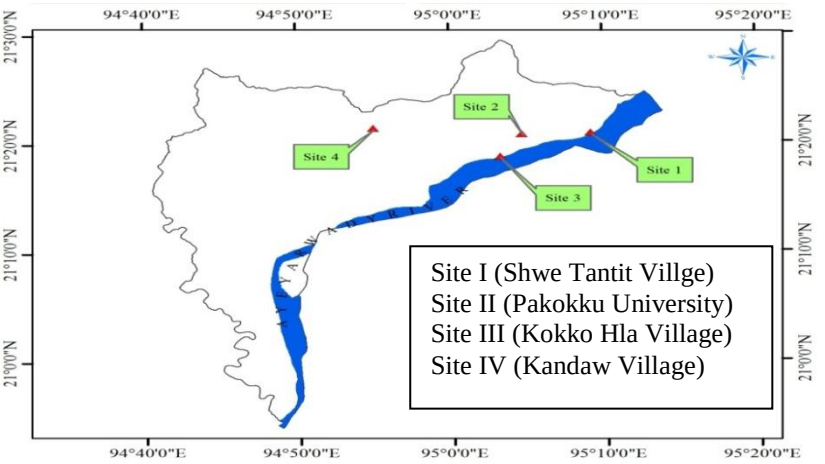
Conducting the bird diversity in Pakokku is an important need to understand the avian assemblages and distribution in different habitats for effective conservation and better management in future. Thus, it is required to assess how habitat variables affect avian distribution patterns and richness. The objectives of this study were conducted to determine the composition and abundance of bird species in different study sites and to assess the species richness, diversity and evenness of birds in Pakokku environs.

Materials and Methods

Study area

Pakokku is situated about 30 km away from the northwest of Bagan and lies at the sides of Ayeyawady River in Magway Region. Pakokku is located in the dry zone of central Myanmar. Pakokku lies between latitude 20°

20' to 21° 30' North and longitude 94° 40' to 95° 20' East. Four study sites were located in the study area as Shwe Tantit Village environs (Site I), Pakokku University (Site II), Kokko Hla Village environs (Site III) and Kandaw Village environs (Site IV) and these sites were situated at the east, north, south and west of Pakokku Township respectively (Fig. 1). The woody trees, paddy fields, bushy area, medium and tall trees, cultivated area, garden, wetland with submerged plant, flood plain, Kyi village Dam and some portions of Ayeyawady River were included in Site I. The woody trees, medium and tall trees, artificial pond, bushy area and buildings were found in Site II. The woody trees, medium and tall trees, paddy fields, flood plain, horticultural land, Kokko Hla village Dam and nearby Ayeyawady River were occurred in Site III. The less number of woody trees, medium and tall trees, bushes, artificial pond and agricultural fields were contained in Site IV.



Source: Google Earth, 2013

Figure 1. A map of Pakkoku Township showing the study sites

Study period

The present study was conducted from July 2015 to June 2016.

Study design

In terms of monitoring birds, the transect method is used. Transect surveys are used to record a variety of birds. It is a simple method that provides a uniform way of counting birds over time or across locations. An appropriate transect lines were drawn in each study site. Birds were viewed by a pair of binocular while traversing the transect routes. Birds watching were taken from 6:30 AM to 10:30 AM. In each occasion of bird watching, bird species and their individuals were recorded. Field marks such as streaks, bars, wings, eyes, tail and birds' behavior were noted down. The photos of birds were taken immediately after viewing the birds. Binoculars, camera and note book were used during the field study. Each study site was visited twice per month.

Identification and classification of species

The identification of birds was made by referring to taxonomic descriptions given by Smythies (2001), Robson (2015) and Robson (2016). Classification of birds was followed after Birdlife International (2015).

Analysis of data

The number of individuals for each species obtained during two data collections of each month was pooled and mean value was taken to represent the monthly data of each species.

The data were analyzed for the following parameters:

Relative abundance

$$\text{Relative abundance} = \frac{\text{No. of individuals of a species}}{\text{Total no. of individuals of all the species}}$$ (Bisht *et al*., 2004)

The average relative abundance was categorized as by method of Bisht *et al*. (2004).

uC = (uncommon) having relative abundance less than 0.0100

C = (common) having relative abundance of 0.0100 and above but less than 0.0500

vC = (very common) having relative abundance of 0.0500 and above.

Status

Status of the birds such as migrant or resident was worked out based on the presence or absence of bird species in each month in the study area according to King and Dickinson (1995).

M = migrant (bird migrate from cold northern to warm southern temperature regions at a definite time of each year to avoid hazard winter)

R = resident (birds that spend throughout the year in one place but some species show local movement).

Diversity

The diversity of birds was evaluated by using five methods: Margalef (1958), Simpson (1949), Shannon-Wiener (1948) and Hill (1973) (Cited by Ludwing and Reynolds, 1988) and Sorensen's Similarity Index (Odum, 1971) (Cited by Gonzalez, 1995).

Species richness

Species richness of bird species was determined by using the formula of Margalef's index (1958).

$$d = \frac{S-1}{\ln (N)}$$

Where, d = Margalef's species richness index, N = total number of individuals

S = number of species, ln = Natural Logarithm

Species diversity

Species diversity was determined by using two formulae of Simpson's index of diversity "D" (1949) and Shannon-Wiener's index "H'" (1948).

Simpson's index of diversity

$$D = \sum_{j=1}^{s} \frac{n_i (n_i-1)}{n (n-1)}$$

Where, D = Simpson's index of diversity, n_i = number of individuals in the "i" species

n = total number of individuals

Shannon-Wiener's index of diversity

$$H' = \sum_{j=1}^{S} \left[\left(\frac{n_i}{n} \right) \ln \left(\frac{n_i}{n} \right) \right]$$

Where,

H' = Shannon-Wiener's index of diversity, n = total number of individuals

n_i= number of individuals in the "i" species, S = number of species

ln = Natural Logarithm

Hill diversity number

$$N_1 = e^{H'}$$

Where,

H' = Shannon's index, N_1 = number of abundant species in the sample

$$N_2 = \frac{1}{D}$$

D = Simpson's index, N_2 = number of very abundant species in the sample

Species evenness

The measurement of bird species evenness or equitability (or relative species abundances) was assessed by using Hill's evenness index (1973).

$$E = \frac{\left(\frac{1}{D} \right)}{e^{H'}} = \frac{N_2}{N_1}$$

Where, E = Hill's evenness index, H' = Shannon's index of species diversity

D = Simpson's index of diversity, N_1 = number of abundant species in the sample

N_2 = number of very abundant species in the sample

Results

Throughout the study period from July 2015 to June 2016, a total of 126 bird species and 12791 individuals under 81 genera belonging to 41 families and 16 orders were observed from four study sites in Pakokku (Table 1). Among the bird species recorded, 91 species of terrestrial birds belonging to 55 genera, 30 families and nine orders and 35 species of water birds comprising under 26 genera, 11 families and seven orders were represented. Moreover, the bird species recorded were categorized into 25 migrants and 101 residents. Based on the relative abundance data of species from Pakokku environs, six species were recorded as very common, ten species as common and 110 species as uncommon (Table 2).

Composition of species in bird orders and study sites

Among the 16 orders concerned in this work, the order Passeriformes was represented with the largest number of 65 species (51.59% in composition), followed by the order Pelecaniformes (11 species, 8.73%), Charadriiformes (nine species, 7.14%), Gruiformes (eight species, 6.35%), Cuculiformes (six species, 4.76%), Columbiformes and Coraciiformes (five species, 3.97% each), Anseriformes and Accipitriformes (three species, 2.38% each), Suliformes, Falconiformes, Strigiformes and Piciformes (two species, 1.59% each) and Podicipediformes, Ciconiiformes and Bucerotiformes (one species, 0.79% each) (Fig. 2).

The highest number of 19 families was recorded under order Passeriformes, followed by order Charadriiformes containing four families and order Coraciiformes containing three families.

Moreover, with regard to the different sites, the highest number of 102 species was found in Site I and then followed by Site III (86 species), Site II (64 species) and Site IV (58 species) (Table 1).

Abundance and relative abundance of birds in different study sites

Site I

Total number of 102 bird species and 5851 individuals were recorded in Site I. The highest number of species was observed in February (92 species), followed by January (84 species) and December (77 species). The highest total number of individuals was found in February (1680 individuals) and followed by March (719 individuals), January (619 individuals) and December (575 individuals) (Table 1).

In this study site, six species of bird were recorded as very common, seven species as common and 89 species as uncommon. Among the species recorded, 81 species were residents and 21 species were migrants. Moreover, 67 species of terrestrial birds and 35 species of water birds were recorded (Table 2).

Site II

In Site II, total number of 64 species and 2849 individuals were observed. The highest number of species was recorded in February (55 species), followed by December (49 species) and November (48 species). With regard to the individuals, the highest was recorded in February (334 individuals), followed by November (316 individuals) and December (299 individuals) (Table 1).

In the case of relative abundance, three species were considered as very common, 11 species as common and 50 species as uncommon. Among the recorded bird species, 62 species were residents and two species were migrants. The species recorded were represented with 62 species of terrestrial birds and two species of water birds (Table 2).

Site III

A total of 86 species representing 2377 individuals were found in Site III. The highest number of 74 bird species in February was observed. This was followed by December (68 species) and January (63 species). Among the total

number of individuals, the highest number was recorded in February (434 individuals), followed by January (272 individuals) and March (268 individuals) (Table 1).

In the case of relative abundance, three species were taken as very common, 20 species as common and 63 species as uncommon. With regard to the species, 71 species were residents and 15 species were migrants. Sixty-two species of terrestrial birds and 24 species of water birds were represented in the avian fauna in this site (Table 2).

Site IV

Bird fauna was represented with 58 bird species and 1714 individuals in Site IV. The highest number of species was found in January (47 species), followed by February (43 species) and December (40 species). Among the bird individuals, the highest total number was recorded in February (191 individuals), followed by January and October (186 individuals each) and December (183 individuals) (Table 1).

In this study site, seven species were regarded as very common, 12 species as common and 39 species as uncommon. Among the recorded bird species, 56 species were residents and two species were migrants. In this study site, the bird fauna was represented with 55 species of terrestrials and three species of water birds (Table 2).

Comparison of diversity values among study sites

According to diversity indices evaluated among four study sites, the value of d was the highest (11.643) in Site I and the lowest (7.655) in Site IV. The highest values of D (0.039), H' (3.646), N_1 (38.329), N_2 (25.861) and E (0.675) were observed in Site III, whereas the lowest values of D (0.111), H' (2.931), N_1 (18.748), N_2 (8.999) and E (0.480) were recorded in Site II (Table 3).

Table 1. Total number of bird species and individuals in different months of each site during July 2015 to June 2016

Site	Species / Individuals	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Total
I	Species	40	42	52	53	52	77	84	92	61	36	32	37	102
	Individuals	314	306	254	198	465	575	619	1680	719	256	235	230	5851
II	Species	33	30	36	44	48	49	43	55	37	28	26	28	64
	Individuals	220	195	227	290	316	299	260	334	222	188	135	163	2849
III	Species	27	27	42	46	53	68	63	74	47	37	20	25	86
	Individuals	111	111	151	215	228	243	272	434	268	130	101	113	2377
IV	Species	28	30	31	32	32	40	47	43	30	24	19	22	58
	Individuals	110	114	125	186	158	183	186	191	124	115	106	116	1714
Total number of species		60	58	73	79	89	105	108	119	83	58	45	54	126
Total number of individuals		755	726	757	889	1167	1300	1337	2639	1333	689	577	622	12791

Table 2. Comparison on the status of bird species among study sites during July 2015 to June 2016

Status of species	Site I	Site II	Site III	Site IV	Combined sites (Pakokku environs)
Very common	6	3	3	7	6
Common	7	11	20	12	10
Uncommon	89	50	63	39	110
Migrant	21	2	15	2	25
Resident	81	62	71	56	101
Terrestrial bird	67	62	62	55	91
Water bird	35	2	24	3	35

Table 3. Comparison on diversity indices among four study sites of Pakokku environs durig July 2015 to June 2016

Indice \ Site	I	II	III	IV
S	102	64	86	58
N	5852	2849	2377	1714
d	11.643	7.920	10.934	7.655
D	0.077	0.111	0.039	0.077
H′	3.199	2.931	3.646	3.102
N_1	24.525	18.748	38.329	22.242
N_2	13.048	8.999	25.861	12.985
E	0.532	0.480	0.675	0.584

S=Total number of species, N=Total number of individuals

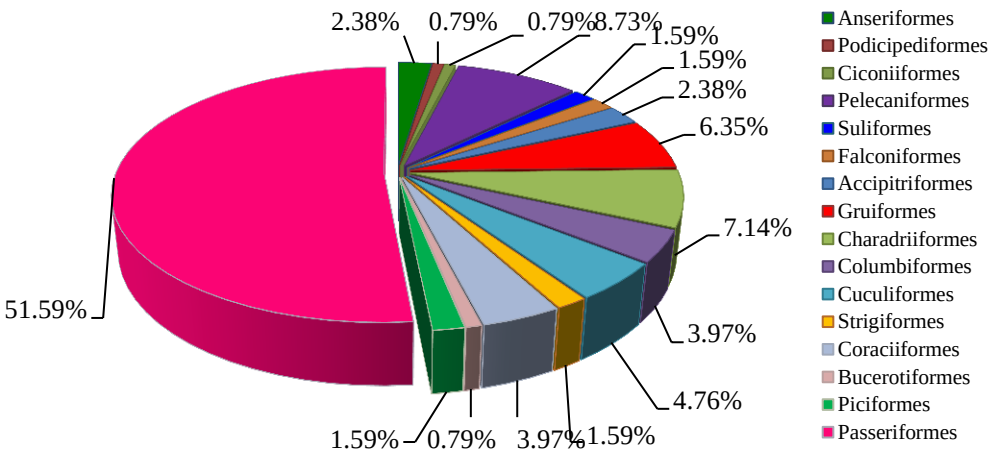


Figure 2. Percentage composition of bird species in different orders in Pakokku environs during the study period

Discussion

Throughout the study period from July 2015 to June 2016, a total of 126 bird species confined to 81 genera belonging to 41 families of 16 orders

were identified and recorded from four study sites in the environs of Pakokku. Among them, 91 species were terrestrial birds and 35 species were water birds. Moreover, 101 species of residents and 25 species of migrants were included.

Concerned with studies on the occurrence of bird species in different areas in Upper Myanmar undertaken by local researchers, Khin Hnin Thet (2013) observed 105 species of terrestrial birds and 35 species of water birds in Monywa environs; Chaw Su Shwe (2014) recorded 64 species of terrestrial birds and 14 species of water birds in Minbu environs. In this work 91 species of terrestrial birds and 35 species of water birds were recorded in Pakokku environs. Some species are same and some are different between present work and previous works. The differences may be due to environmental conditions, habitat conditions, availability of food sources and habitat sensitivity of some species.

Regarding the different orders of birds in South-East Asia, the largest order was found as Passeriformes according to Smythies (2001) and Robson (2015, 2016). In the study area, not only the highest number of bird species but also the highest species composition was found in order Passeriformes. Most of bird species recorded in the study area are terrestrial birds and included under Passeriformes.

With regard to study sites, the highest number of species was found in Site I (102 species) and the second highest number of species in Site III (86 species). The area of paddy fields was significantly more in Site I than Site III. Therefore, more number of water bird species was found in Site I than Site III. Although the number of terrestrial bird species showed less variation among the study sites, the number of water bird species were significantly more in Site I (35 species) and Site III (24 species) than Site IV (three species) and II (two species). The habitat of Site I and III possess the vast area of water body for water bird species. The flood plain area, dam and river create the wetland for water birds to swim, forage, breed and roost. Many hundreds of birds from foraging ground and paddy field come to roost together on the trees of Site I

and III. The highest total number of individuals was recorded in Site I (5851 individuals), followed by Site II (2849 individuals) and Site III (2377 individuals). The lowest number of species (58) and individuals (1714) were recorded in Site IV due to less diversified habitat and closeness to human residents.

During the study period, more number of bird species and individuals were found during December, January and February represented with winter migrants especially in Site I and III.

This study showed the high relative abundance of both water birds and terrestrial birds as well. Based on the relative abundance values, the habitats were not only preferred by land birds but are also utilized by water bird species for food, shelter and reproduction.

In the study area, the highest species richness (d) was found in Site I and second highest in Site III. However, Shannon-Wiener's diversity index (H′) and Simpson's index (D) were the highest at Site III and second highest in Site I due to aggregation of large individual number of water birds depended on the availability of the vast area of wetland. These habitats were highly productive and good foraging, nesting and roosting sites for many water birds and terrestrial birds.

But in the case of evenness index, the highest value of evenness was found in Site III and Site IV showing more even distribution of birds than the other sites. The number of individual birds recorded for each species in Site III and Site IV showed less variable whereas Site II showed the lowest value of evenness because birds were found from one individual to large flocks for each species.

Kang, *et al*. (2015) reported that local improvements to habitat structure through increased patch area, reduced human disturbance, or increased vegetation complexity could positively contribute to local species diversity.

In the present study, high diversity of birds in Pakokku environs was found to be related to the suitable and diversified habitats. Two Myanmar endemic species of *Mirafra microptera* (Burmese Bushlark) and *Turdoides gularis* (White-throated Babbler) were included in the bird fauna of Pakokku environs. Based on IUCN (2015), all species are in the status of least concern.

The habitats of Pakokku environs are well inhabited with terrestrial and water birds as well as residents and migrants. The area is considered good habitat for bird species of both terrestrial and water birds because this area has good food resources, shady trees, bushes, agricultural land and vast area of wetland.

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