

An assessment of spatial distribution patterns and diversity of bird community structure in Nilgiris, Western Ghats, India

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Abstract

The present article deals with the spatial distribution pattern of birds in the Nilgiri Hills. The study was conducted in South and North forest division of Nilgiri. The survey was mainly focused at 16 locations. Line transect method was followed and survey was conducted in two different seasons namely summer and winter, collected data were analysed for species richness, diversity, abundance and relative abundance. A total of 6421 birds belonged to 139 species were recorded, which includes 37 families. Among them 11 species were endemic, 9 were migrants, 26 were local migrants, two rare and 91 residents. Coonoor had the highest species diversity and the lowest in Doddabetta. The habitat survey showed that there were more species recorded in shola forest (102) and the species richness was lowest near the settlement. Bray-curtis cluster indicated maximum similarity between the shrub and grassland (54.9%) and minimum between shola and suburban (6.74%). shola had the maximum similarity with plantation (34%) while cultivation had with grassland (56.26%) and water bodies with grassland (35.1). Cluster analysis of the bird species in different habitats showed two major clusters. The composition of birds associated with the water bodies was distinctive in all four habitats. A total of ten feeding guild were identified. Among which the insectivores were dominant in all habitats.

Keywords : Nilgiri Hills, Spatial distribution, species richness, diversity, relative abundance

INTRODUCTION

The spatial distribution pattern is an important tool to help in understanding the arrangement of the system. Understanding the spatial pattern of the species is important for perception of the structure of the species assemblage (Gaston, 1996). Spatial pattern determines the local environment of each individual and thus, through competition processes its ability to utilize available food, space and other resources (Goreaud *et al.*, 1999). Specific environmental features such as nesting or roosting sites or the amount of cover can influence the use of space by individuals (Snapp, 1976; Pulliam and Mills, 1977). Space use patterns often reflect the abilities of birds to defend and locate food or other resources (Krebs, 1973), avoid predation (Kenward, 1978), and interact with other individuals (Myers *et al.*, 1979). However Caraco, (1979) pointed out that group membership may have disadvantages, such as increasing susceptibility to disease or parasites, foraging interference and increasing costs associated with intra-specific aggression. Thus, space use patterns of birds reflect a balance of selective forces acting both to draw organisms together and spread them apart. Such bird-born data have been keys for many global environmental issues (Hahn and Mader, 1997). Information on status and distribution of species, especially threatened and endemic birds, aids in prediction of disturbance levels and execution of conservation efforts at all potential sites of their occurrence (Robin and Sukumar, 2002).

The Western Ghats have one of the most complex and patchy landscapes in India. Several detailed studies

have been conducted on different aspects on birds in the Nilgiris region (Jayson *et al.*, 2000; Raman, 2001; Raman *et al.*, 2005). The Western Ghats have a diverse avifauna. There are 07 species of birds known from Western Ghats and the adjacent narrow coastline (Daniels *et al.*, 1991). Of these, 360 birds species are residents with 16 being endemic (Stattersfield *et al.*, 1998). The Nilgiri hills in the Western Ghats are known for its high endemism (Vijayan *et al.*, 1998). Very few detailed studies were undertaken but recent includes the reports of Gokula (2008) and Das (2008). However, the bird community investigations in the higher elevations of the Nilgiris are limited, and hence the present article deals with the spatial distribution pattern of birds in the Nilgiri Hills, and assessment of the status of the birds, especially the endemics in various localities.

MATERIALS AND METHODS

Study area

The present study was conducted in Nilgiri South and North Forest Divisions. The survey was mainly focused at 16 locations in Nilgiri district which included Avalanche, Upper Bhavani, Thaishola, Emerald, Parson's Valley, Coonoor, Ooty, Cairn hill, Thalaikundha, Kalhatty, Pykara, Doddabetta, Kotagiri, Kodanad, Naduvattam, and Gudalur, covering different habitats and altitudes. The field work was carried out during December 2007 to May 2008. Birds were recorded following Line transect method (Bibby *et al.*, 1993). These areas were sampled in two seasons, winter (Dec - Feb) and summer (Mar - May). The survey was carried out for six months and for all the 16 areas. Every month all the 16 areas were covered by one line transect each area.

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These sampling locations were situated in different altitudes between 1200 m and 2600m. These areas mainly comprised of different habitats such as shola, scrub, grasslands, and water bodies, plantations of wattle, tea, pine, eucalyptus and agricultural land. Each month different habitat was selected for line transect.

Data analysis

Species richness and abundance

Bird community parameters such as species richness, diversity, abundance, relative abundance and evenness were calculated by Shannon – Weaver diversity index (1963). The total number of birds recorded was expressed as abundance of birds (Caredelus *et al.*, 2006; O'Des *et al.*, 2006).

Species diversity and evenness

Species diversity has two components: The species richness in the community and species evenness or equitability (Ludwig and Reynolds, 1998). The diversity was measured most directly expressed as an index that incorporates the interplay of species richness and relative abundance of species into single value for a given community (Wiens and Rottenberry, 1981).

Diversity was calculated using Shannon- Weaver index.

$H' = -\sum P_i \ln P_i$, Where H' = Diversity

P_i = Proportion of total sample belonging to the i^{th} species

\ln = Natural logarithm

Evenness, $E = H' / H'_{\text{max}}$ $H'_{\text{max}} = \ln S$

Where S is the number of species observed

Relative abundance Where,

n_i = number of Individuals of i^{th} species;

N = total number of individuals of all species

The species richness, evenness and diversity were calculated using statistical software version 2.6.5. (Henderson and Seaby, 2001).

Analysis of variance in breeding bird community (ANOVA) was performed to test significant variation with the habitat. Kruskal Wallis was used to find whether the breeding bird community had any significant variation among trophic groups, altitudes and seasons. Descriptive statistics including mean and Standard Deviation were employed whatever needed. All these statistical analyses were carried out using SPSS version 10.0, and Excel sheets. Clusters analysis was done using the Bio-diversity Pro.

RESULTS AND DISCUSSION

A total of 6421 birds belonged to 139 species representing 37 families and 16 orders were observed during this study which includes 11 endemic, 9 (6.47%) migrants,

26 (18.70%) local migrants, two rare and remaining 91 (65.46%) are resident.

Species Diversity and Equitability

Shannon-Weaver Diversity (H') and Equitability (E) of birds, for the study area were high with values 3.3 and 0.66 respectively. Species diversity was > 3 in all localities which ranged from 2.91 -3.33 in the study area. Coonoor had the highest species diversity and Doddabeta the lowest. Equitability was generally high (> 0.66) and ranged from (0.57 – 0.66), comparatively higher in Coonoor and lower in Doddabeta.

Habitat-wise distribution

The habitats surveyed include shola, plantations such as wattle, eucalyptus, blue gum, pine, tea, and coffee, grasslands, suburban (near settlements), water bodies, and cultivated lands. Shola was the habitat with the highest species richness with 102 bird species and abundance 3343 (Table 1). The shola forest held more resident (77) and 15 species of local migrant, six migrant species, namely Tickle's Leaf Warbler (*Phylloscopus affinis*), Tytler's Leaf Warbler (*Phylloscopus tytleri*), Blyth's Reed Warbler (*Acrocephalus dumetorum*), Eurasian Golden Oriole (*Oriolus kundoo*), and Grey Wagtail (*Motacilla cinere*) were recorded in this habitat. Four endemics, namely Small Sunbird (*Nectarinia minima*), Nilgiri Wood Pigeon (*Columba elphinstonii*), Black- and-orange Flycatcher (*Ficedula nigrorufa*), Nilgiri Flycatcher (*Muscicapa (eumyias) albicudata*), and Nilgiri Laughingthrush (*Garrulax cachinnans*) were observed in this habitat.

The plantations had the second highest species richness with 88 species, which included 51 species of resident birds, 11 migrants, 23 local migrants and 3 endemic species of the Western Ghats, namely Black- and-orange Flycatcher, Nilgiri Flycatcher and White-bellied Shortwing (*Brachypteryx major*). In the water bodies and nearby places, 51 species were recorded, of which included 33 species of residents were found.

In the grassland, species richness was 37 with 26 resident species including one endemic species, Nilgiri Pipit (*Anthus nilghiriensis*), six local migrants and four migrants. In the habitat of bush (shrub) six species of local migrants, 6 migrants and 17 species of residents were recorded. In the cultivated land species richness was low and 19 residents and four migrant were recorded. The species richness in the suburban (near settlement) habitat was the lowest. The distribution pattern of the species varied significantly with the habitat ($\chi^2=256$, $df=6$, $P < 0.00$) and the frequency of occurrence of the birds also showed significant variation ($\chi^2=135$, $df=6$, $P = 0.00$).

Of the species recorded, 73.3% was recorded in the Shola, 63.3% in the plantation, and 36.6% in the water bodies

Table 1: Species richness and abundance of birds in each habitat

Habitat	No. of species (%)*	Abundance
Shola	102(73.0)	3343
Plantation	79(56.6)	1402
Water bodies	51(36.6)	704
Grass land	41(29.4)	251
Cultivation	31(22.3)	326
Bush (Shrub)	29(18.7)	188
Suburban	24(17.2)	207

and around and very low percentage of species, 17.2% was recorded at the suburban habitat. Of the individuals 43.6% were recorded in Shola, in plantation 18.3% and followed by water bodies, cultivation, grassland and bush (scrub) and the lowest percentage of species and individuals were recorded in suburban habitat. Maximum number of resident species was in Shola while that of migrants were in plantation.

Relative abundance

Out of 139 species observed during the survey, seven species were dominant around the study area (Table 2); migrants were also more in shola followed by plantation and water bodies. Red-whiskered Bulbul was the most abundant (Relative abundance 2.97) bird and Grey Tit is the minimum abundant species with relative abundance of 1.09.

The number of dominant species was high in bush (14 species); Tytler’s Leaf Warbler was more abundant in this site (Relative abundance 5.33), followed by water bodies and nearby areas; 12 species were dominant such as Balck Bulbul (1.71), Pond Heron, Black- and- orange Flycatcher, Tytler’s Lseaf Warbler, Grey Tit; in cultivation 10 species were dominant such as, Black Drongo, Red-whiskered Bulbul, Jungle Myna. Similarly in the plantation, 10 species were dominant such as the Red-whiskered Bulbul (2.69), Oriental White-eye (2.13), Tytler’s Leaf Warbler, Grey- headed Canary Flycatcher and in the Shola 7 species were dominant such as Red-whiskered Bulbul (3.50), Oriental White-eye (2.76),

Black Bulbul, Nilgiri Laughingthrush and Pied Bush chat. In the grassland 7 species were dominant and Pied Bush chat was the most abundant species (2.64) habitat.

Table 2. Seven most abundant bird species in the study area

S.No	Species	Relative abundance
1.	Black Bulbul	1.58
2.	Grey Tit	1.09
3.	Jungle Myna	1.15
4.	Oriental White-eye	1.98
5.	Pied Bushchat	1.54
6.	Red-whiskered Bulbul	2.97
7.	Small Green Barbet	1.27

Similarity Matrix

Bray-Curtis cluster analysis indicated maximum similarity (Table 3) between the shrub and grassland (54.9%) and minimum between the Shola and Suburban (6.74%). There was notable similarity in the avifauna of grassland and cultivation (50.2%). Shola had the maximum similarity with plantation (34%) while cultivation had with grassland (50.26%) and water bodies with grassland (35.1%).

The Bray-Curtis cluster analysis of the bird species community in different habitats showed two major clusters (Figure 1). The composition of birds associated

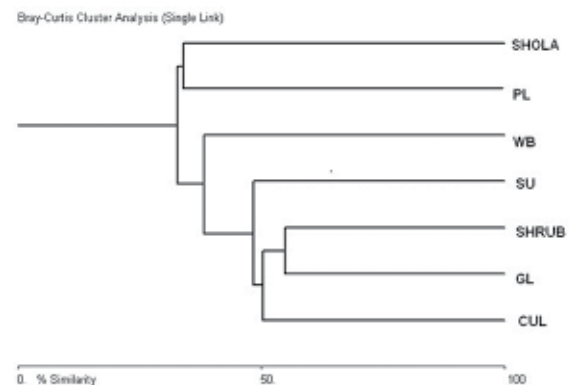


Figure 1. The Bray-Curtis Cluster diagram showing similarity of birds between the different habitats.

Table 3. Bray-Curtis cluster analysis showing the similarity of birds in different habitats

Habitats	Cultivation	Water Bodies	Plantation	Grassland	Suburban	Shrub	Shola
Cultivation	*	38.2524	21.978	50.2693	39.7749	47.8599	10.8902
Water bodies	*	*	32.748	35.0802	28.7596	30.4933	17.511
Plantation	*	*	*	18.7271	13.5404	17.4733	33.993
Grassland	*	*	*	*	48.4018	54.8926	8.4716
Suburban	*	*	*	*	*	45.0633	6.7422
Shrub	*	*	*	*	*	*	7.8608
Shola	*	*	*	*	*	*	*

with the water bodies was distinctive and all the four habitats, namely grassland, shrub, suburban and cultivation were closely associated. The second major cluster was of two habitats, namely shola and plantation, but not so closely associated.

Feeding Guilds

Birds were classified into guilds based on the food (Ali and Ripley, 1987). A total of 10 guilds were identified in the present study. The insectivorous bird species were dominant in the study area (Figure 2).

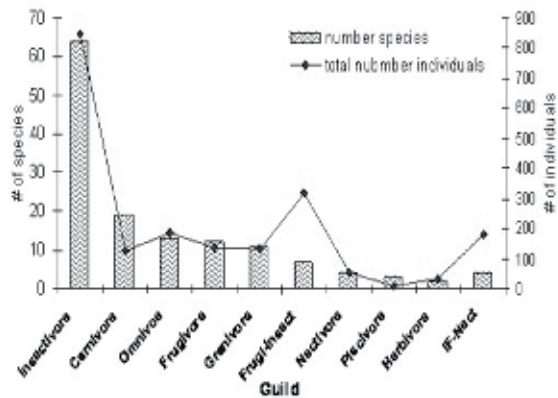


Figure 2. Guild wise species richness abundance in the study area

The species richness and abundance was more in insectivores with 64 species followed by omnivores, frugivores, granivores, and carnivores. Abundance was very low in piscivores. Based on these guilds the bird species of all guilds were more abundant in the shola habitat except herbivores and, then in the plantation and cultivation. All of these groups were less in suburban areas. The insectivores represented the predominant trophic group in all habitats followed by frugivore except in water bodies and grasslands, while the frugivore – insectivore ratio was good in all habitats except in cultivation, grass and suburban areas. The granivores were detected more or less in the same level in grassland, suburban and cultivation while the lowest number of granivores was found in bush.

DISCUSSION

Total number of 139 species observed in the study area which represents 40% of the 351 bird species reported to occur in the Nilgiri District (Ali and Ripley, 1987) and 60% of the 210 bird species reported in Nilgiris by Davison (1883), and Gokula and Vijayan (1996) have reported 266 bird species ie.76% occurring in the Mudumalai Wildlife Sanctuary, low elevation and mid-elevation forests of the Nilgiri District and 145 species ie. 41% were recorded in Upper Nilgiris by Zarri et al., (2005). It is well established that the structure of plant communities has a great influence on the distribution

of bird species. Microhabitat variations or habitat diversity is one of the major reasons for increased species as found by Gokula and Vijayan (1996). Karr, (1976) found increased species richness with high rainfall in tropical forests. The fewer number of species observed in the primary data of this study is because of the short duration of the study and fewer localities surveyed; it could also be due to impoverish of the avifauna as a result of disturbances (Vijayan and Gokula, 2006). The present study recorded 69% of bird species as resident and 15% migrants which were less when compared with the secondary data. Both these results showed comparatively less resident species than in the Mudumalai Wildlife Sanctuary (81%) found by Gokula and Vijayan., (1996). This may be because of the short duration of the present study and some resident species are shy and difficult to be observed in the dense shola forests.

The similarity matrix indicated the relationship between the bird communities in different habitats (vegetation types); a low similarity value was found between the shola forest and suburban areas and it was maximum between the shrub and grassland while that of water bodies stood separately. This suggests that the distribution pattern and habitat utilization of birds were different in different habitats. In the present study, the plantations had the second highest species richness. Khan (1978) reported that 118 bird species could adapt to the plantations in the Nilgiris. The teak plantations probably support more birds than other plantations because of foliage layers and the presence of leaf and wood feeding insects (Vijayan *et al.*, 1998) as in *Albizia* plantations in Malaysia (Mitra and Sheldon, 1993). Bushes and scrub habitats had the smaller number of species in the present study and species richness was lower in suburban areas; these had been affected by human activity resulting in the loss of suitable habitat. The forest near settlement or urbanized area recorded loss of wildlife habitats (Hostetler and Knowles-Yanez, 2003) due to decrease in vegetation and subsequently to a proportional loss of biodiversity (Savard *et al.*, 2000). However, Melles *et al.* (2003) reported that forests near urbanized landscapes formed resource areas for resident birds and vagrants.

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