SPECIES DIVERSITY OF BIRDS IN UNIVERSITY CAMPUS: A CASE STUDY

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Abstract: University campuses play a significant role in conservation of avifaunal diversity, particularly in India, but these educational biodiversity key spots were mostly neglected for study. Hence, an attempt was made in the present study that aimed to record the diversity of birds in Bharathiar University campus located in Tamil Nadu, India. Point counts bird survey method was adopted to determine the diversity of birds. A total of 38 birds belonging to 23 families were recorded from 144 point count samples. Mean species richness per sample was 14±0.47 species (±S.E.), and Shannon diversity index (*H′*) was 2.0±0.04. This study provides baseline data for monitoring the avifauna in the university campus, and reflects the importance of university campus in conservation of bird species.

Keywords: Birds, Point counts, Shannon diversity, IVI, University campus, India

Global climate is changing and it is expected huge number of extreme climatic events such as prolonged droughts and floods (Bennett et al. 2014) to occur, particularly on transformed regions dominated by human activities (Opdam & Wascher 2004). Such human interrupted ecosystems will experience shift in the distribution of precipitation (McAlpine et al. 2009), that may affect the capacity of the biota to bounce back after the prolonged stressed period. Although, birds are one of the successful organisms for understanding climate-change effects, observational data are still scarce to understand the mechanisms that impact on the population as well as on the composition of bird community (Knudsen et al. 2011).

Next to climate change, urbanization in the recent decades have caused irreversible damage to many ecosystems, impacting natural habitats and reducing biodiversity, and by 2060 two-thirds of human will occupy cities (Paton et al. 2012). Almost 50% of the human population lives in urban lands that occupy relatively a little part of total terrestrial area, but they impact greatly on biologically productive area (Rayner et al. 2015), and they are growing very fast across the globe (Ferenc et al. 2014). Such lands have negative ecological consequences on wildlife habitat that include, reduction, fragmentation of natural habitats, besides other disturbances such as anthropogenic light and noise pollution (Marzluff et al. 2008) and change in the biotic composition (McKinney 2006). Changes in landscape pattern by humans have affected many once-pristine natural ecosystems (Tscharntke et al. 2012).

Spatial separation of habitat patches across the landscape (for foraging, nesting, etc.) help in understanding how landscape structure influence species and communities in human-dominated areas (Leibold et al. 2004). Species that fails to respond quickly to the changing environmental conditions would lead to reduction in population or species extinction (Thomas et al. 2004; Knudsen et al. 2011). Survival and successful reproduction of a species depends on the timing of life-history events of the species with fluctuating environment (Roff 2002). Survival of an organism requires all necessary resources in a habitat which is mostly unique in nature for each species (Lindenmayer & Fischer 2006). Birds are a taxonomic group that is significantly affected by urbanization (Stagoll et al. 2010). Out of the 8600 bird species recorded worldwide, 1226 species according to IUCN Red List are considered as endangered species and 7 % of these species found in India (Roy et al. 2012). Shrinking of natural habitats would pose great threat to bird community. In the last decade, interest on studying the urban biodiversity has increased notably.

The combined effect of climate change and urbanization leading to habitat loss is one of the most dangerous conditions for conservation of bird diversity. Under this situation, remnants of wild vegetation and plantations in university campus provide a hope for bird conservation. In India, there are 744 universities with varying land size, and most of them have at least a few patches of natural vegetation and plantations. However, documentation of birds in such areas was not given importance as like the forests and other reserve areas. Bharathiar University (BU) is one such with c.1000 acres of land area, lies at tropical climatic zone. An attempt was made in the present study that aimed to achieve the following main objectives: 1) To determine diversity, frequency, abundance and importance value index of birds in BU, 2) To classify the birds into different dominant/rare category, 3) To determine percent of similarity among the bird species, and 4) To compare the diversity of birds of present study area with that of other regions. Further, a few conservation measures were suggested in this paper for sustainability of bird diversity in university campus.

MATERIALS AND METHODS

Study Area

The present study was carried out in BU campus located in Tamil Nadu, India (Fig. 1). It covers c.1000 acres and lies between 11°01'52"N to 11°02'50"N latitudes and 76°52'10"E to 76°52'13"E longitudes at tropical climatic zone. Terrain of the campus is almost plain, and the elevation gradually varies from 512 to 482 m asl. The campus is predominantly with non-calcareous sandy loam red soil, with low organic carbon. It has a few remnants of wild vegetation and plantation forests of about 25 years old. Some of the common faunal community includes wild boars, hares, snakes, mongooses. Indian pythons do visit the campus rarely to prey on dogs. Elephants from the Western Ghats forest visit the campus during dry seasons in quench of thirst.

The available climate data for the study area (for the period 2002-2011) revealed that the average annual rainfall was 645 mm, and the rainfall was maximum (54 % of the total rainfall) during October-November (Fig. 2). Mean monthly temperature for the same period was 27 °C (Fig. 3). The mean minimum and mean maximum temperatures were 22°C and 32°C, respectively.

METHODS

Diversity of bird species in BU campus was determined through point counts bird survey method (Bibby et al. 1992; Horak et al. 2013). In this method, observer stops at a series of survey points separated by equal distances. In the present study, birds were surveyed at every 100 m distance of the 500 m line transect, and at each survey point ten minutes was spent for counting birds by sighting visually or through binocular (Jiguet et al. 2012) within a radius of 50 m and also birds were photographed. A total of 144 such samples were done in 97 non-rainy days during February 2014 to July 2014. Samples were carried out soon after sunrise in the morning (06:00-08:00 hours) or before sunset in the evening (16:00-18:00 hours). The field guide, Ali (2012), was referred for identification of birds in the field, assigning binomial name, family and order for each species.

Species richness was calculated as the total number of bird species recorded from the 144 point counts samples. Abundance and frequency were calculated for all the bird species recorded in this study. Abundance was determined as the total number of bird counts, and frequency was determined as the total number of occurrence of birds in each sample (n=144).

Diversity of birds in the university campus was determined using Shannon diversity index (H') following Magurran (2004), $H' = - \sum p_i \times \ln p_i$, where, p_i is the proportion of the total number of individuals of species 'i'. Expected species richness, Chao 2, a non-parametric estimator of species richness which uses occurrence data from multiple samples in aggregate to estimate the species diversity of the whole, was determined using Biodiversity Pro (version 2). The observed species richness was compared with expected species richness using species-sample curve, as number of samples on x-axis against cumulative number of species on y-axis.

Important value index (IVI), a measure of relative prominence of various species was calculated for all the species to find key species in the university campus, IVI = rF + rA, where, rF is relative frequency of the species; rA is relative abundance of the species.

Based on abundance all the birds recorded were classified into four dominant/rare categories, viz., predominant (birds with >1000 counts), dominant (500-1000 counts), rare (100-500 counts) and very rare (<100 counts).

Bray-Curtis cluster analysis was performed to find the similarity (%) among different bird species recorded from the university campus using Biodiversity Pro software, based on total occurrence of birds in the 144 point counts samples.

Analysis of variance (ANOVA) was performed (using SPSS software) to test the significance of variation in frequency and abundance among different species classified into four dominant/rare categories.

RESULTS

A total of 38 bird species belonging to 23 families were recorded from 16703 bird sightings in 144 point counts bird survey samples (Table 1). The density of birds recorded per sample was 116±4.74 birds (± S.E.), and it ranged from just one to 313 birds per sample. The mean species richness (number of bird species) per sample was 14±0.47 species, and species richness ranged from one to 27 species per sample. Shannon diversity index calculated per sample was 2.0±0.04, and the index varied from less than 0.1 to 2.8 per sample. The observed and expected (Chao 2) species richness for the present study had almost similar trend (Fig. 4). The frequency (n=144) of bird occurrence was maximum for Indian peafowl with 97, followed by common myna (96), Indian tree pie (95), Asian koel (94) and crimson sun bird, house crow and jungle crow had 93 each (Table 2). Total abundance was greater for house crow (3237), followed by Indian peafowl (2512), common myna (2191), common babbler (1947) and cattle egret (851) (Table 2). House crow scored maximum IVI value 24.02, followed by Indian peafowl (19.87), common myna (17.90), common babbler (16.24) and cattle egret (9.03) (Table 2). The results of Bray-Curtis cluster analysis (Fig. 5), revealed that common myna and common babbler had high similarity index, followed by black drango and Asian koel. While, house sparrow had least similarity value and separated from all other species (Fig. 5), followed by ashy drango and rose ringed parakeet which had very low similarity value with other species.

Among the four dominant/rare categories, the predominant category alone contributed maximum (59%) to total abundance but had just 11 % of total species richness (Fig. 6). In contrast, the very rare category with almost ten times lesser than the contribution of predominant category in total abundance, shared 45% of the total species richness. Birds such as house crow, Indian peafowl, common myna and common babbler with high abundance fell under the predominant category *(Table 2)*. One way ANOVA revealed that there existed a significant variation in frequency ($F_{(3,37)}$ = 52.579, p<0.001) and abundance ($F_{(3,37)}$ = 207.186, p<0.001) among different species classified into four dominant/rare categories.

DISCUSSION

Birds are used for assessing ecosystem quality (Ridley et al. 1984). To have effective conservation measures for bird species it is necessary to study the population size of the bird. It is well known that population studies were used to check the long time changes in natural and manmade ecosystems (Wiens 2001). The study area, Bharathiar University campus with a few patchy remnants of wild vegetation, plantation, garden, avenue plants and lawn, structurally provides a complex landscape that support high diversity of bird species. Empirical and theoretical evidence have proved local species richness is highly influenced by the landscape and regional species pools (Lawton 1999; Gaston 2000), and structurally complex landscapes support more species than simple landscapes.

When compared, the species richness of present study (38 species) falls within the range reported earlier (Table 3). It is equal to the number reported for agricultural landscape of Czech Republic (Horak et al. 2013); almost twelve times lesser than the value reported for Amazonian rainforest of French Guiana (Thiollay 1994) but about three times higher than the value reported for continuous forest region of Hawaii Island (Flaspohler et al. 2010). Shannon diversity index recorded for the present study (2.0) is lesser than the evergreen forests of Silent Valley (3.3) and moist deciduous forests of Mukkali (3.45) (Jayson & Mathew 2000), both located around 60 km away from the present study area.

It is important to study the diversity of avifauna in the university campus to help to monitor and conserve the biological diversity of the region where buildings are being increased in numbers replacing the green vegetation and agricultural lands that support avifauna. In the present study, the maximum species (38 species) was achieved at the 50th point count sample (one-third of the total sample size) indicating the sampling adequacy. When compared, the observed species richness and the expected (Chao2) species richness were almost similar in terms of cumulative species richness (Figure 4). The total abundance was recorded greater for house crow as expected, and it was followed by Indian peafowl, common myna, common babbler and cattle egret (Table 2). While, the frequency of bird occurrence was maximum observed for Indian peafowl

(67%) indicating that the national bird occupies all nook and corners of the campus, and it was surprising to observe such a big bird scored the high against the most abundant house crow. In fact the latter scored less than common myna, Indian tree pie, Asian koel and crimson sun bird. However, house crow scored maximum IVI value 24.02, followed by Indian peafowl (19.87), common myna (17.90), common babbler (16.24) and cattle egret (9.03) (Table 2).

Categorizing birds into dominant/rare category help to understand the structure of bird population. In the present study, although there are 38 species, about 45% of them belong to very rare category (<100 bird counts). This explains the critical condition that may lead to local extinction of those species in near future if conservation steps are not taken promptly. Further, one way ANOVA revealed that there existed a significant variation in frequency ($p<0.001$) as well as abundance ($p<0.001$) of birds among the four dominant/rare categories.

It is necessary to address the impacts of human activities that have accelerated extinctions and continue to threaten bird populations. Understanding the population size is important for taking proper conservation measure for any species. Population studies were traditionally used to monitor long term changes in bird population, to assess habitat quality, and to know the responses of birds to both natural and manmade environmental changes (Wiens 2001).

To maintain a viable population, conservation measures are needed (Muller et al. 2005; Broyer 2009). There are several factors that influence changes in bird populations such as availability of food, location of nesting sites, availability of nesting materials, introduced diseases, predators, and competitors (Margules et al. 2000; Ramesh & McGowan 2009), however, habitat loss is considered atop among the others. At this stage, educational institutions like BU with natural and plantation forests serve as a good habitat for the bird community.

CONCLUSION

Bharathiar University campus supports a rich diversity of birds. The present study provides baseline data for monitoring the diversity of bird species in the campus. This study creates awareness on documenting birds in other university campus of the nation. Future research on the behavior and feeding ecology of birds in the campus will help to understand the birds more accurately and thereby pave the way for their better conservation measures. Birds play ecologically significant role in plant pollination and seed dispersal, and their conservation is highly necessary for the proper functioning of the ecological system. Although, there are natural and plantation forests in the BU campus as habitat for birds of this region, conservation measures are of immense need for their future survival. We suggest a few conservation measures for protecting the diversity of birds in the university campus: (1) Planting fruit trees such as jamun, guava, fig, etc. inside the campus will increase the habitat size for birds, (2) Keeping water pots all over the university campus to drive the thirsts of birds during drought season, (4) Awareness program for conservation of bird species among the campus aspirants, (5) Initiating biomonitoring program is necessary for monitoring and conservation of the birds of BU campus.

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Table 1. List of birds recorded from the study area with scientific name, family and order

Common name	Scientific name	Family	Order
Ashy drango	*Dicrurus leucophaeus*	Dicruridae	Passeriformes
Asian koel	*Eudynamys scolopaceus*	Cuculidae	Cuculiformes
Asian palm swift	*Cypsiurus balasiensis*	Apodidae	Passeriformes
Asian paradise fly catcher	*Terpsiphone paradisi*	Monarchidae	Passeriformes
Black drango	*Dicrurus macrocerus*	Dicruridae	Passeriformes
Black kite	*Milvus migrans*	Accipitridae	Falconiformes
Black shoulder woodpecker	*Chrysocolaptes festivus*	Picidae	Piciformes
Blue rock pigeon	*Columba livia*	Columbidae	Columbiformes
Blue tailed bee-eater	*Merops orientalis*	Meropidae	Coraciiformes
Cattle egret	*Bubulcus ibis*	Ardeidae	Ciconiiformes
Common babbler	*Turdoides caudatus*	Leiothrichidae	passeriformes
Common myna	*Acridotheres tristis*	Sturnidae	Passeriformes
Crimson sun bird	*Aethopyga siparaja*	Nectariniidae	Passeriformes
Crimson throated barbet	*Megalaima rubricapilla*	Megalaimidae	Piciformes
Emerald dove	*Chalcophaps indica*	Columbidae	Columbiformes
Forest wagtail	*Dendronanthus indicus*	Motacillidae	Passeriformes
Goldenbacked woodpecker	*Dinopium javanense*	Picidae	Piciformes
Great black woodpecker	*Dryocopus javanense*	Picidae	Piciformes
Grey wagtail	*Motacilla cinerea*	Motacillidae	Passeriformes
House crow	*Corvuss plendens*	Corvidae	Passeriformes
House sparrow	*Passer domesticus*	Passeridae	Passeriformes
Indian peafowl	*Pavo cristatus*	Phasianidae	Galliformes
Indian tree pie	*Dentrocitta vagabunda*	Corvidae	Passeriformes

Jungle crow	*Corvus macrohynchos*	Passeridae	Passeriformes
Jungle owlet	*Glaucidium radiatu*	Strigidae	Strigiformes
Lesser coucal	*Centropus bengalensis*	Cuculidae	Cuculiformes
Little spider hunter	*Archnothera longisrotra*	Nectariniidae	Passeriformes
Loten's sun bird	*Nectarinia lotenia*	Nectariniidae	Passeriformes
Nilgiri wood pigeon	*Columba elphinstonii*	Columbidae	Columbiformes
Purple rumped sun bird	*Nectarinia zeylonica*	Nectariniidae	Passeriformes
Red vented bulbul	*Pycnonotus cafer*	Pycnonotidae	Passeriformes
Red whiskered bulbul	*Pycnonotus jocosus*	Pycnonotidae	Passeriformes
Rose ringed parakeet	*Psittacula krameri*	Psittaculidae	Psittaciformes
Scarlet minivet	*Pericrocotus roseus*	Campephagidae	Passeriformes
Small button quail	*Turnix sylvatica*	Turnicidae	Turndiformues
Small sun bird	*Nectarinia minima*	Nectariniidae	Passeriformes
White breasted kingfisher	*Halcyon smyrnensis*	Alcedinidae	Corasseriformes
Yellow throated sparrow	*Petronia xanthocollis*	Passeridae	Passeriformes

Table 2. Frequency, abundance and IVI value of the 38 bird species recorded, along with dominant/rare category (VR- very rare, R-rare, D-dominant, PD-predominant)

Species	Category	Frequency (n=144)	Abundance			IVI
			Total	Mean	±SD	
Ashy drango	VR	13	29	1.93	1.62	0.82
Asian koel	R	94	426	4.53	2.07	7.24
Asian palm swift	R	34	170	5.00	2.37	2.71
Asian paradise fly catcher	VR	10	18	1.80	1.23	0.61
Black drango	R	91	353	3.88	2.09	6.65
Black kite	VR	15	17	1.13	0.35	0.85
Black shoulder wood pecker	VR	21	28	1.33	0.66	1.21
Blue rock pigeon	D	77	641	8.32	4.19	7.68
Blue tailed bee eater	R	66	186	2.82	1.33	4.40
Cattle egret	D	79	851	10.77	10.40	9.03

Common babbler	PD	92	1947	21.16	7.47	16.24
Common myna	PD	96	2191	22.82	7.15	17.90
Crimson sun bird	R	93	387	4.16	2.08	6.95
Crimson throated barbet	R	76	235	3.09	2.12	5.20
Emerald dove	VR	10	11	1.10	0.32	0.56
Forest wagtail	VR	22	24	1.09	0.29	1.24
Goldenbacked woodpecker	VR	13	14	1.08	0.28	0.73
Great black woodpecker	VR	12	14	1.17	0.39	0.68
Grey wagtail	VR	30	32	1.07	0.25	1.69
House crow	PD	93	3237	34.81	8.84	24.02
House sparrow	VR	10	61	6.10	9.49	0.86
Indian peafowl	PD	97	2512	25.90	7.50	19.87
Indian tree pie	R	95	398	4.19	3.24	7.12
Jungle crow	D	93	684	7.35	4.51	8.73
Jungle owlet	R	60	165	2.75	1.82	3.98
Lesser coucal	R	90	219	2.43	1.57	5.80
Little spider hunter	R	50	133	2.66	1.10	3.29
Loten’s sun bird	R	63	238	3.78	1.44	4.57
Nilgiri wood pigeon	VR	25	26	1.04	0.20	1.40
Purple rumped sun bird	R	63	243	3.86	3.05	4.60
Red vented bulbul	VR	24	36	1.50	2.04	1.41
Red whiskered bulbul	VR	18	19	1.06	0.24	1.01
Rose ringed parakeet	VR	12	26	2.17	0.94	0.75
Scarlet minivet	VR	26	51	1.96	0.82	1.60
Small button quail	D	79	635	8.04	4.40	7.74
Small sun bird	R	83	328	3.95	3.58	6.10
White breasted kingfisher	VR	64	86	1.34	1.42	3.71
Yellow throated sparrow	VR	17	32	1.88	1.32	1.04

Table 3. Comparison of diversity of bird species of BU campus with other regions

Location	SR	MD	Reference
Bharathiar University Campus, India	38	PC	Present study
Continuous forest region, Hawaii Island.	10	PC	Flaspohler et al. 2010
Natural, semi-natural and crop Vegetation area, central Spain.	19	PC	Rey-Benayas et al. 2010.
Steppe and semiarid environments, Fuerteventura Island, Spain.	20	TT	Carrascal et al. 2012.
Urban Road Strip Corridors, Pachuca, Mexico	26	LT	Carbo-Ramirez & Zuria 2011
Sal forest, Corbett National Park, India	27	PC	Kidwai et al. 2013
Mesic Highveld Grassland Bio Region, South Africa.	27	LT	Little et al. 2013
Urban Gardens, Pachuca, Mexico	28	PC	Carbo-Ramirez & Zuria 2011
Natural grass land and grazed pastures, western Italian Alps	29	PC	Caprio et al. 2011
Andean forest, Columbia.	29	PC	Aubad et al. 2010
Urban Parks, Pachuca, Mexico	32	PC	Carbo-Ramirez & Zuria 2011
Agricultural landscape, Czech Republic	38	PC	Horak et al. 2013
Mar de Plata City, Argentina	39	T	Leveau & Leveau 2012
Farmland, Sweden	40	PC	Wretenberg et al. 2010
Anekere wetland, Karnataka, India	44	PC, DC	Bhat et al. 2009
Mixed species forest, Corbett National Park, India	47	PC	Kidwai et al. 2013
Agricultural landscape, Lower Silesia, Poland	50	TM	Wuczynski et al. 2011
Farmland, Sweden.	52	PC	Hiron et al. 2013.
Dekinda Forest Reserve, Balana, Sri Lanka	56	PT	Wijesundara & Wijesundara 2014
Hemiboreal forests, Estonia	62	BC	Rosenvald et al. 2011
Scrub forest, Sariska Tiger Reserve, India	63	T	Shahabuddin & Kumar 2007
Buxa Tiger Reserve, North Bengal, India	68	PC	Roy et al. 2012
Mangroves, Kundapura, India	70	LT	Kumar & Kumara 2014

Assam University Campus, Silchar, India	73	TW	Chakdar et al. 2016
Rasik Beel Wetland, North Bengal, India	75	PC	Roy et al. 2012
Gorumara National Park, North Bengal, India	87	PC	Roy et al. 2012
Parks, Iberian Peninsula	91	FR	Paton et al. 2012
Thane Creek, Maharashtra, India	95	PC	Chaudhari-Pachpande & Pejaver 2016
Agricultural Wetlands, Uttar Pradesh, India	99	BC	Sundar & Kittur 2013
Silent Valley, Kerala, India	137	LT	Jayson & Mathew 2000
Wet Tropics bioregion, north-East Australia.	141	LT	Catterall et al. 2012
Chandoli National Park, Western Ghats, India	151	PC	Ramchandra, 2013
Farmland, forest, suburban and Cities, France	160	PC	Jiguet et al. 2012
Palni hills, Western Ghats, India	196	RT, RS, TW, MN	Ramesh et al. 2012
Human-modified landscapes, Sri Lanka & India	206	T	Goodale et al. 2014
Forest regions of the state of Parana and Santa Catarina, Brazil	273	PC	Anjos et al. 2011
Buxa Tiger Reserve, West Bengal, India	284	LT	Sivakumar et al. 2006
Urban parks, USA	360	GBT	Oliver et al. 2011
Rainforest, French Guiana, Amazonia	441	ES	Thiollay 1994

SR-species richness, MD-method, PC-point count, LT-line transect, MN-mist netting, T-transect, DC-direct count, TM-territory mapping, PT-point transect, BC-bird count, FR-fixed routes, RT-road transect, RS-road survey, TW-trial walk, GBT-group bird trip, IBS-individual bird sighting, ES-extensive survey

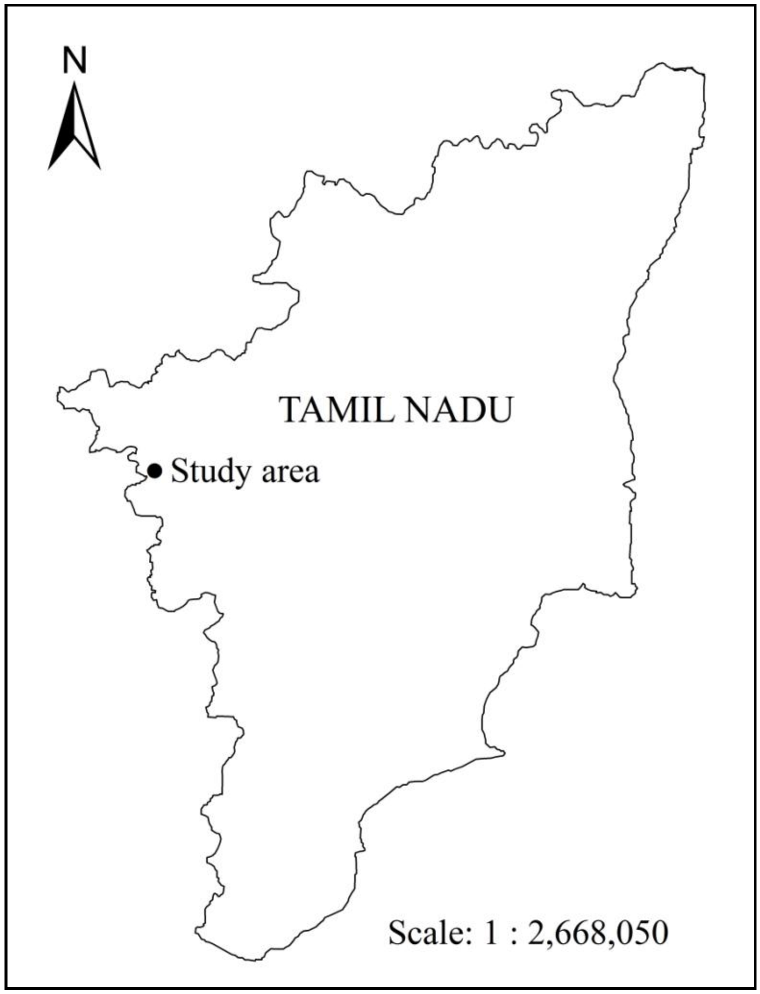

Figure 1. Map showing location of the study area in Tamil Nadu, India

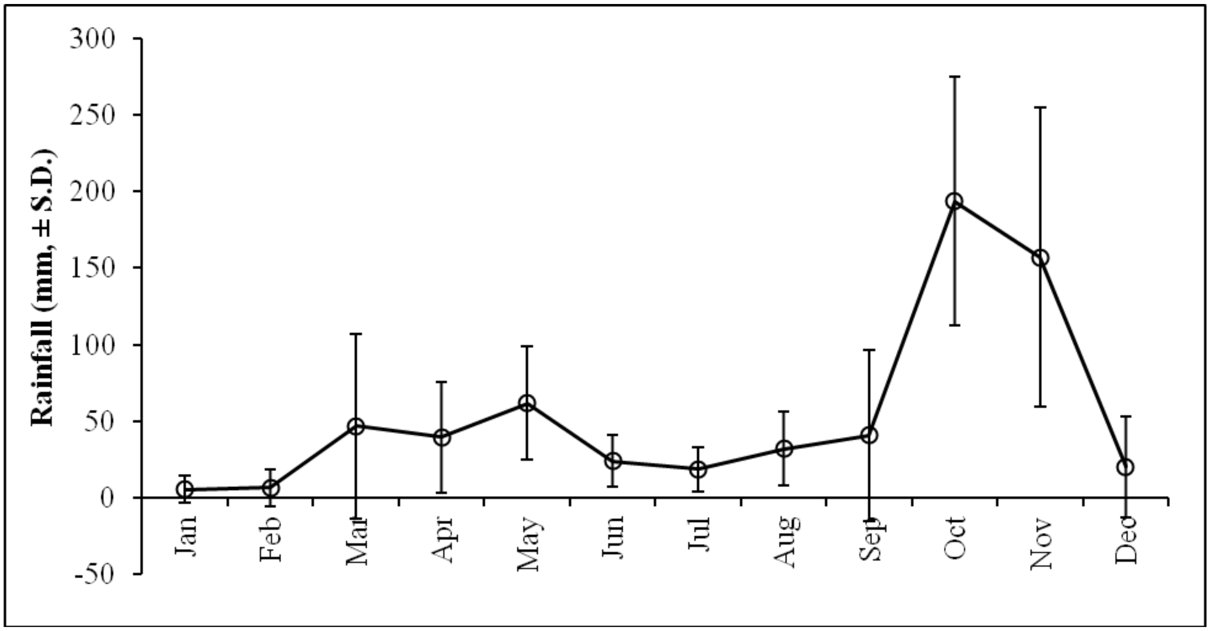

Figure 2. Mean monthly rainfall pattern for the study area

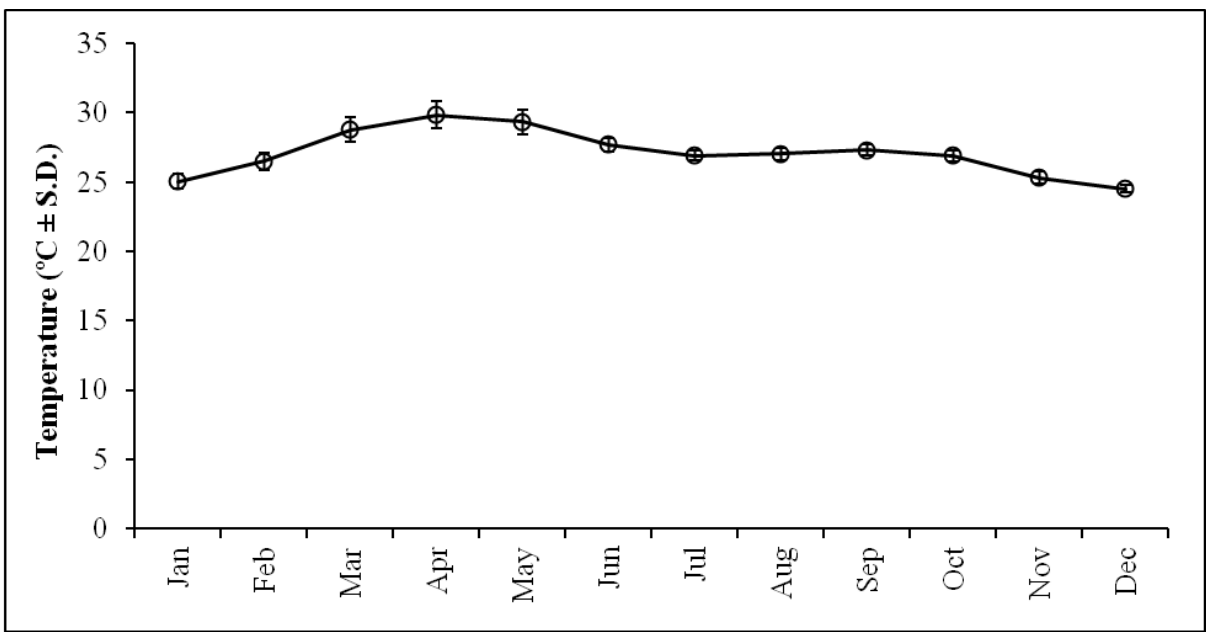

Figure 3. Mean monthly temperature pattern for the study area

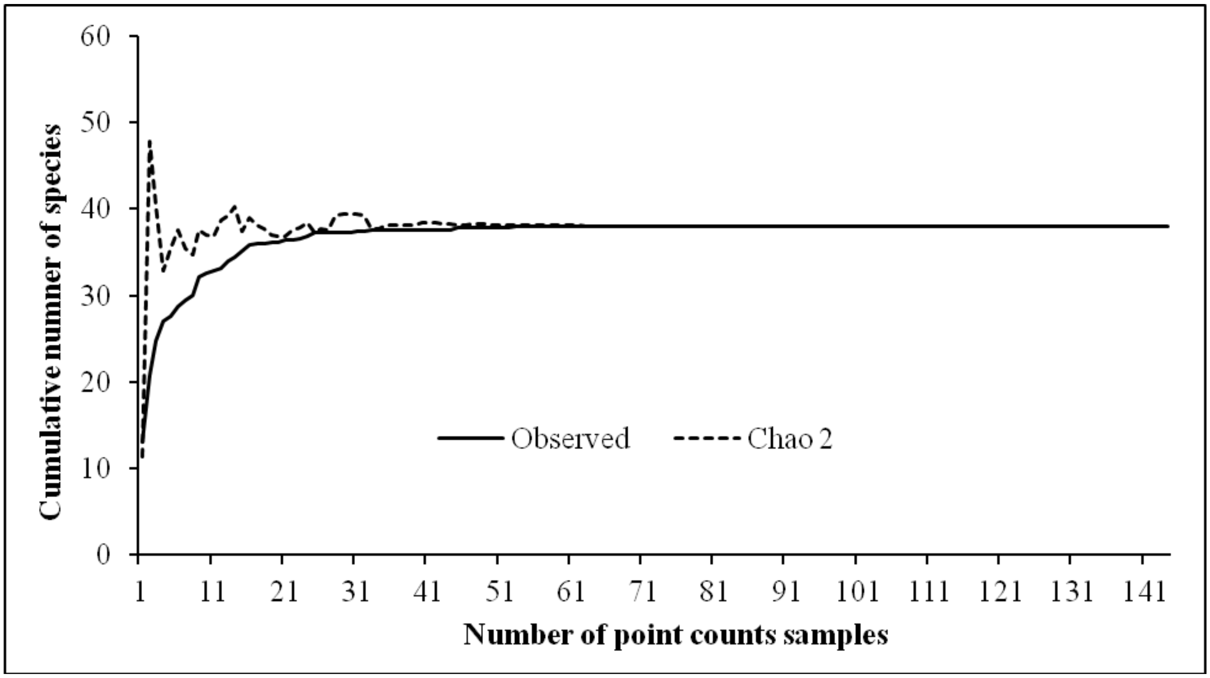

Figure 4. Comparison of observed and expected species richness (Chao 2)

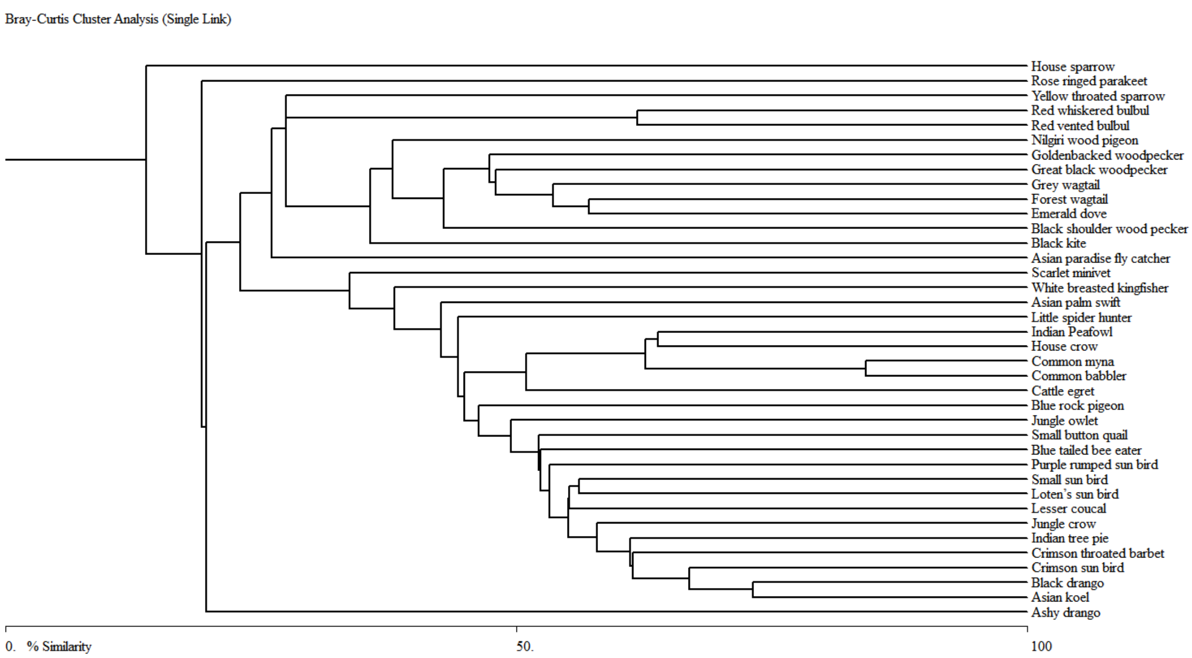

Figure 5. Bray-Curtis cluster analysis showing the similarity (%) among the birds

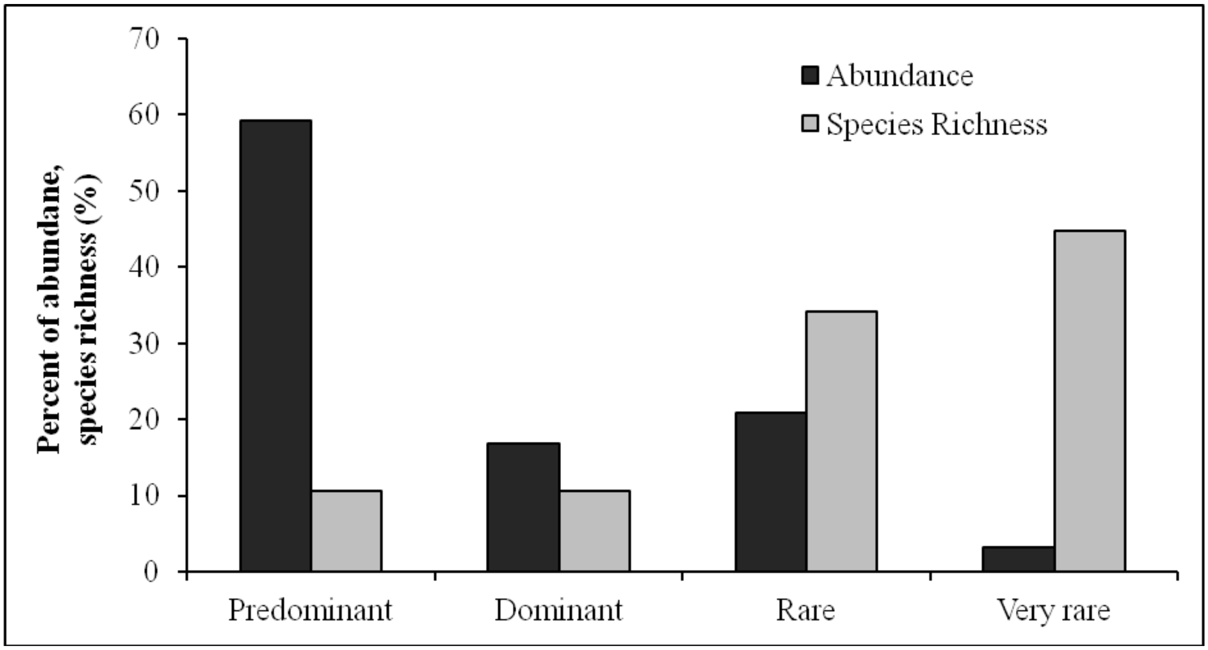

Figure 6. Percent of abundance and species richness of birds by four dominant/rare categories