



Analysis of Avian Diversity at Chintamoni Kar Bird Sanctuary: An Urban Forest Perspective

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.56557/UPJOZ/2023/v44i123528

Editor(s):

(1) Dr. Angelo Mark P. Walag, University of Science and Technology of Southern Philippines, Philippines.

Reviewers:

(1) Jayanta Kumar Mallick, India.

(2) Eneider Ernesto Pérez Mena, Spain.

Original Research Article

Received: 11/04/2023

Accepted: 13/06/2023

Published: 20/06/2023

ABSTRACT

Chintamoni Kar Bird Sanctuary (CKBS) is an urban forest located on the southern fringes of Kolkata. The objective of our study was to document and analyze the diversity of the avian population in CKBS. The line transect method was used and avian diversity, species richness and evenness were analyzed using Shannon Diversity Index, Shannon Equitability Index, relative diversity and relative abundance. Our study recorded 37 bird species belonging to 9 orders and 23 families with most species being recorded from Order Passeriformes followed by Piciformes and Ciconiiformes. The species were well distributed across a number of avian families. Birds rare in metropolises like the Oriental white eye (*Zosterops palpebrosus*) were also recorded here. Analysis of relative abundances showed that many species comparatively rare in cities like the common tailor bird (*Orthotomus sutorius*) and white throated fantail (*Rhipidura albicollis*) showed an abundance similar to more commonly seen species. Values of 2.844 and 0.788 were obtained for Shannon Diversity Index and Shannon Equitability Index indicating high species diversity and

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evenness. However, high species diversity is not due to assemblage of migratory birds in winter. Species diversity and evenness are highest during the summer months (Shannon Diversity Index = 2.862; Shannon Equitability Index = 0.812) which could be due to dense forest cover, a large number of fruit bearing trees and many water bodies in the sanctuary which provide a favourable habitat for birds in hot weather. Our study indicates that a number of birds appear to be thriving as a stable avian community at CKBS and this urban forest acts as a haven for bird species otherwise rare in Kolkata, further emphasizing the need for taking necessary conservation measures for protection for this urban forest under the strained environmental conditions prevalent in urban metropolises.

Keywords: Chintamoni Kar Bird Sanctuary; urban forest; birds; relative abundance; species evenness; species diversity.

1. INTRODUCTION

It is estimated that there are around 18,000 bird species distributed along the varied landscape of this planet [1]. Bird species and communities are important as indicators of the prevailing ecological conditions in various ecosystems, including the forest ecosystem. For preservation and management of the natural environment, monitoring of ecosystems and communities in the natural environment is necessary [2]. As it is not practical to monitor all species residing in an ecosystem or community, distribution and abundance of birds are often studied as indicators of biodiversity and of ecosystem health. The avian diversity and distribution provide information about the overall health of a forest [3-5]. Urbanization and associated stresses caused by anthropogenic activities generally leads to a loss of biodiversity and can negatively affect species behaviour and distribution either directly or indirectly through alterations of habitats [6,7]. Cities are often a heterogeneous mixture of different habitats and urban forest habitats provide refuge for a number of bird species.

The Chintamoni Kar Bird Sanctuary is situated at Narendrapur on the southern fringes of the metropolis of Kolkata. Formerly known as "Kayaler Bagan", this urban forest was originally notified as a sanctuary in 1982 and later renamed as Chintamoni Kar Bird Sanctuary (CKBS) after the noted sculptor Chintamoni Kar in 2005 [8]. This urban forest originally covered around 27 acres but the area had been reduced to 17 acres by 2005 [8]. Since a relatively small amount of time (less than 2 decades) has passed since the area was notified as CKBS (in 2005), the sanctuary provides a unique opportunity to study bird diversity and distribution. However, though this sanctuary is frequently visited by bird watchers and wildlife photographers, studies on the diversity of avian fauna remain quite limited.

Despite its small size, the sanctuary has large floral and faunal diversity. A large variety of epiphytes, ferns and orchids are found in the sanctuary which is home to a number of species of butterflies and birds. As it was formerly a fruit orchard, the sanctuary has a large number of fruit bearing trees which can provide food resources for a number of birds. A bamboo plantation is also present [8-11]. Variation in weather conditions in different seasons of the year could also affect avian distribution and diversity. The sanctuary is mainly made up of evergreen trees many of which are 12-15 m tall with dense and widespread canopies. The diverse trees can accommodate a considerable number of bird species. Its location in the city, however, makes it isolated from any other nearby forests which may affect the distribution of faunal species. Our objective was to document and analyze the avian diversity in this urban forest environment.

2. METHODOLOGY

2.1 Study Area

Chintamoni Kar Bird Sanctuary (Latitude: 22° 25' 45" N, Longitude: 88° 24' 4" E) is situated at Narendrapur on the southern fringes of the metropolis of Kolkata, West Bengal, India and is spread over 17 acres of land (Fig. 1a). Formerly a fruit orchard, the sanctuary has a large number of fruit bearing trees including mango (*Mangifera indica*), rose apple (*Syzygium jambos*), aash phol (*Dimocarpus longan*), jackfruit (*Artocarpus heterophyllus*), coconut (*Cocos nucifera*), tamarind (*Tamarindus indica*) and guava (*Psidium guajava*) [8]. The undergrowth is very dense with many epiphytes and ferns. A number of artificial water holes provide fresh water to its inhabitants throughout the year. The climate is tropical with temperatures ranging around 28-38°C in summer and high rainfall experienced

during the monsoon season (mid-June to mid-September).

2.2 Line Transect Method

The survey of bird species was carried out by the Line Transect Method. This method involves the observers moving along a fixed path (transect line) and recording the occurrence of animals observed on both sides of the path traversed. Accordingly, Line Transects were performed along the central path in the map (Fig. 1b) and birds seen within 50 meters on both sides of the road were identified and individuals of each species counted. The data was accordingly recorded along with time and date of visit. A total of 18 surveys were performed at various times of the day (between 8:00 AM - 3:00 PM) and in various seasons (summer, autumn and winter) over the period 2018-2019. Of these, 13 surveys were conducted in the summer months (May-June) and 5 surveys were conducted in autumn and winter months (October-January).

2.3 Recording and Documentation of Data

For identification of the various species of birds, "The Book of Indian Birds" (author: Salim Ali) and "Birds of Indian Subcontinent" (authors: Grimmett, Inskipp & Inskipp) were used as reference [13,14]. Details of each survey, mentioning date and time of survey, were recorded in data sheets. For bird identification, observation and photographic documentation, optical equipment such as Olympus 7X21PCIII field binocular, Nikon d5600 and Nikon d7500 digital SLR cameras along with Nikkor 200-500 and Tamron 150-600 G2 telephoto lens were used.

2.4 Analysis of Data

The collected data was analyzed using the following statistical parameters.

1) Relative abundance of each species was calculated using the formula:

Relative abundance of species X = (Total no. of individuals of species X / Total no. of individuals of all species) x 100

2) Relative diversity (RD_i) of each family was calculated using the formula: [15]

$RD_i = (\text{No. of species in the family} / \text{Total no. of species}) \times 100$

3) Diversity of bird species were calculated using the Shannon Diversity Index. Shannon Diversity Index (also known as Shannon-Wiener Index) was formulated by Shannon and Wiener in 1949, is one of the diversity indices most used in ecological studies for quantifying species diversity. It is quantified as:

$$H = - \sum P_i \ln (P_i)$$

where H= Shannon's diversity index, P_i = Relative abundance of species and $\ln(P_i)$ = Natural logarithm of relative abundance [15-17].

4) Shannon Equitability Index (Shannon H_{max}) provides information about species evenness, i.e., how rare or common species are in a community. It is quantified as:

$$E = H / H_{max}$$

where E = equitability (range 0-1), H= Shannon's diversity index and H_{max} = maximum species diversity = $\ln S$ where S = number of species recorded [15-17].

3. RESULTS

3.1 Species Observed

The list of bird species recorded in the sanctuary during the surveys are given in Table 1. A total of 37 species belonging to 9 avian orders and 23 avian families were observed. The maximum number of species were recorded from Order Passeriformes (16 species from 11 families) followed by Order Piciformes (7 species from 2 families) and Order Ciconiiformes (4 species from 2 families). The family with highest relative diversity (Fig. 2) was Picidae (4 species, $RD_i = 10.811$), followed by Corvidae, Muscicapidae and Megalaimidae (3 species each, $RD_i = 8.108$). The observed avian diversity was spread across a number of families. Photographs of some of the species observed are as given in Fig. 3.

3.2 Relative Abundance of Avian Species

The relative abundances of the observed species are represented in Fig. 4. The ten most common species ranked in order of relative abundance were jungle babbler (*Turdoides striatus*) (23.579); red vented bulbul (*Pycnonotus cafer*) (14.316), red whiskered bulbul (*Pycnonotus jocosus*) (9.895), common tailor bird (*Orthotomus*

sutorius) (5.263), black headed oriole (*Oriolus xanthornus*) (4.211), white throated fantail (*Rhipidura albicollis*) (4.211), Asian koel (*Eudynamys scolopaceus*) (3.789), rufous treepie

(*Dendrocitta vagabunda*) (3.789), brown hawk owl (*Ninox scutulata*) (3.368) and lesser flameback woodpecker (*Dinopium benghalense*) (2.737).

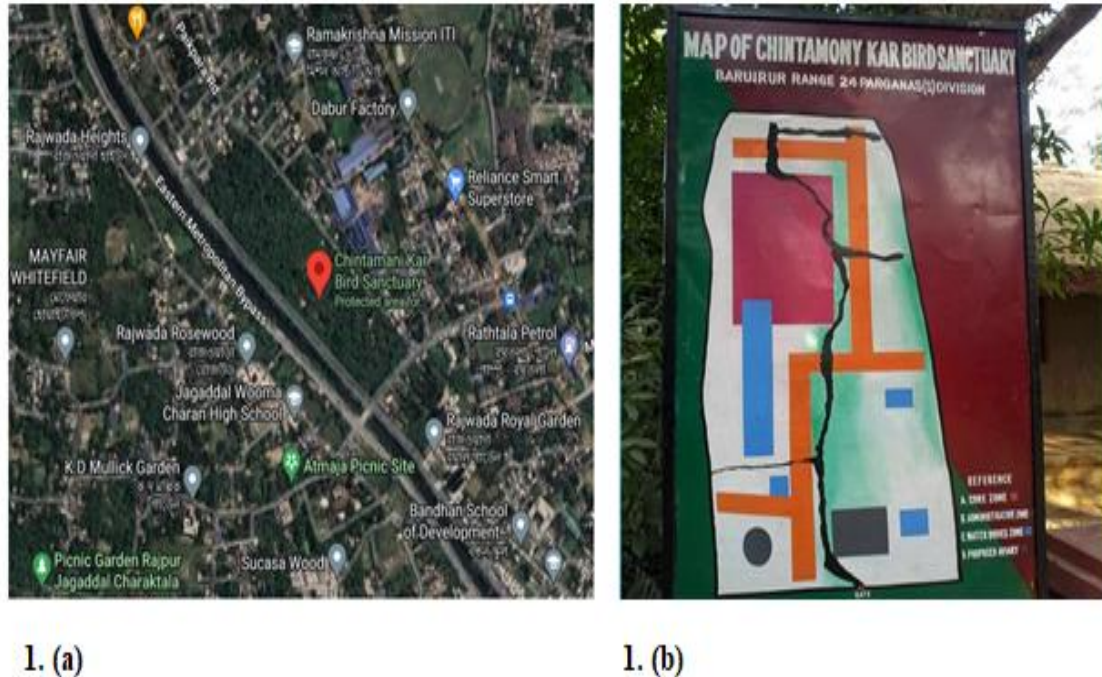


Fig. 1. Chintamani Kar Bird Sanctuary. (a) Location of the sanctuary [12] (b) Map of CKBS (Photograph taken by the authors)

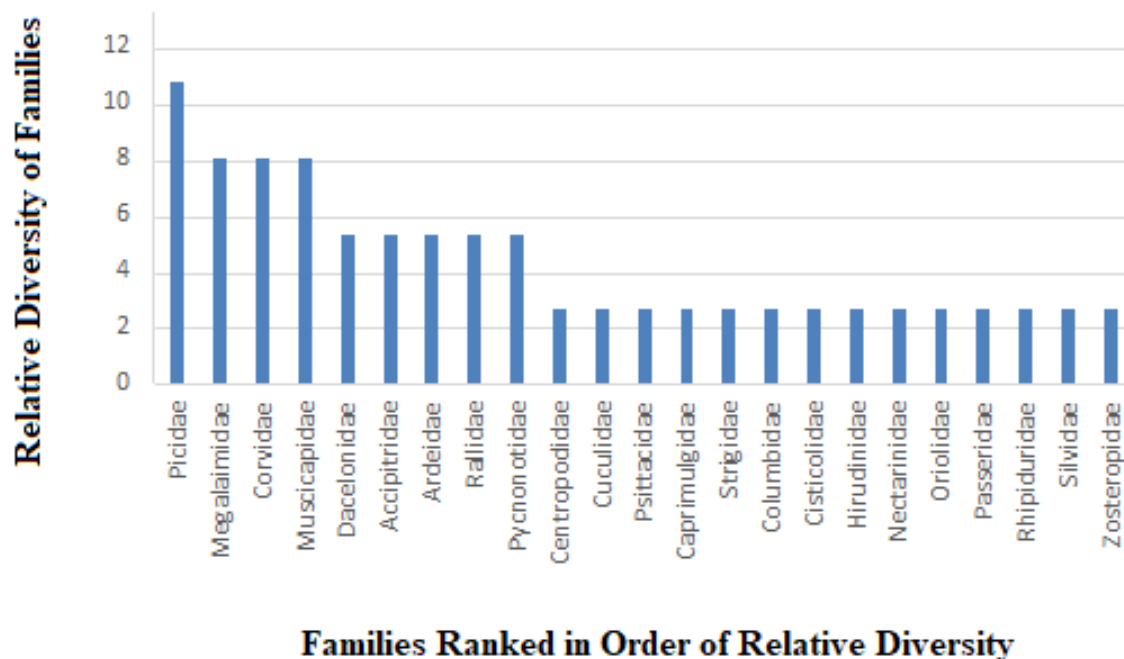


Fig. 2. Relative diversity of avian families observed in CKBS

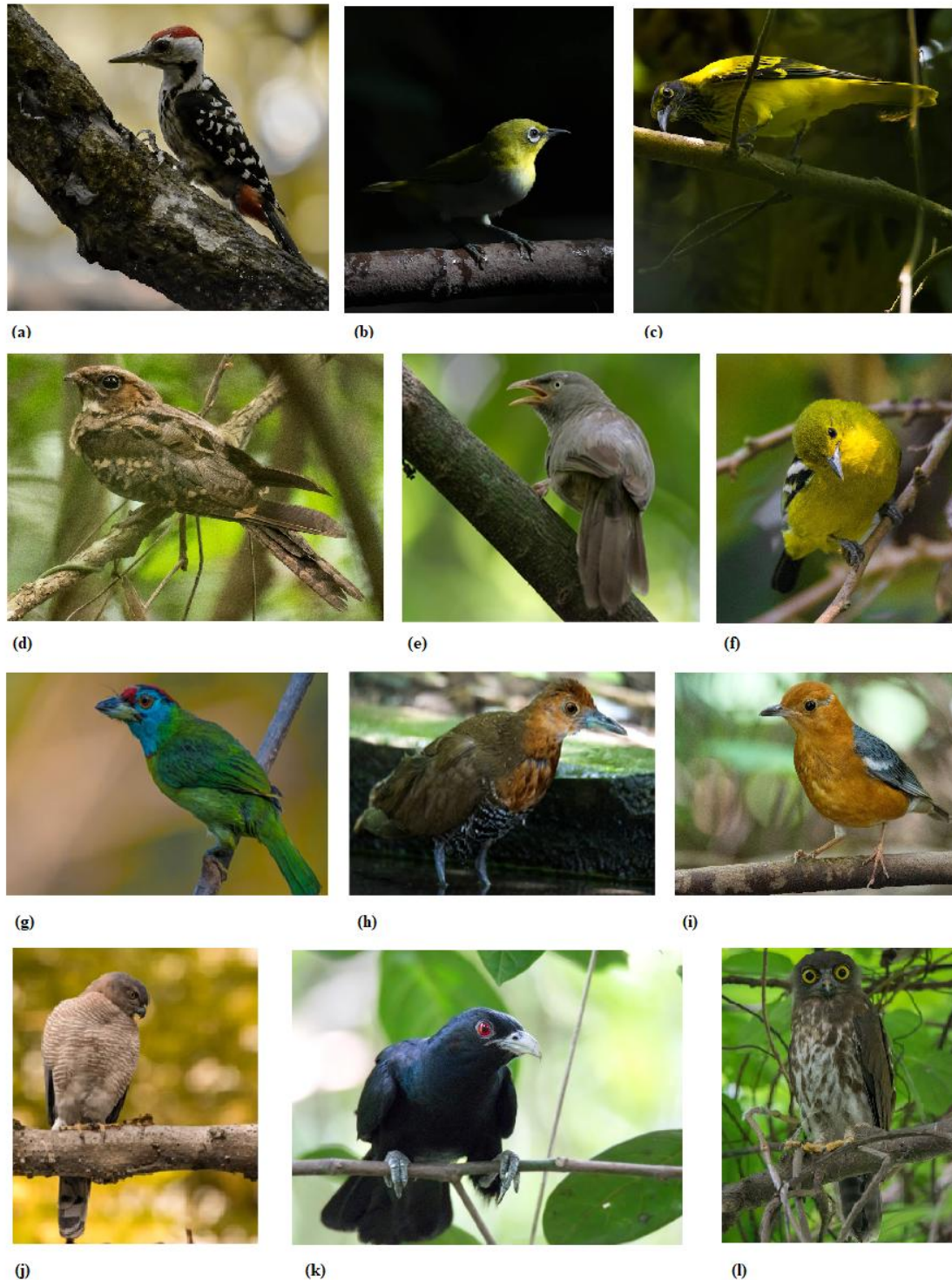


Fig. 3. Birds observed in CKBS during surveys (a) Fulvous breasted woodpecker (*Dendrocopos macei*) (b) Oriental white eye (*Zosterops palpebrosus*) (c) Black headed oriole (*Oriolus xanthornus*) (d) Long tailed nightjar (*Caprimulgus climacurus*) (e) Jungle babbler (*Turdoides striatus*) (f) Common iora (*Aegithina tiphia*) (g) Blue throated barbet (*Megalaima asiatica*) (h) Slaty legged crane (*Rallina eurizonoides*) (i) Orange headed thrush (*Zosterops citrina*) (j) Shikra (*Accipiter badius*) (k) Asian koel (*Eudynamis scolopacea*) (l) Brown hawk owl (*Ninox scutulata*)

(Photographs taken by the authors)

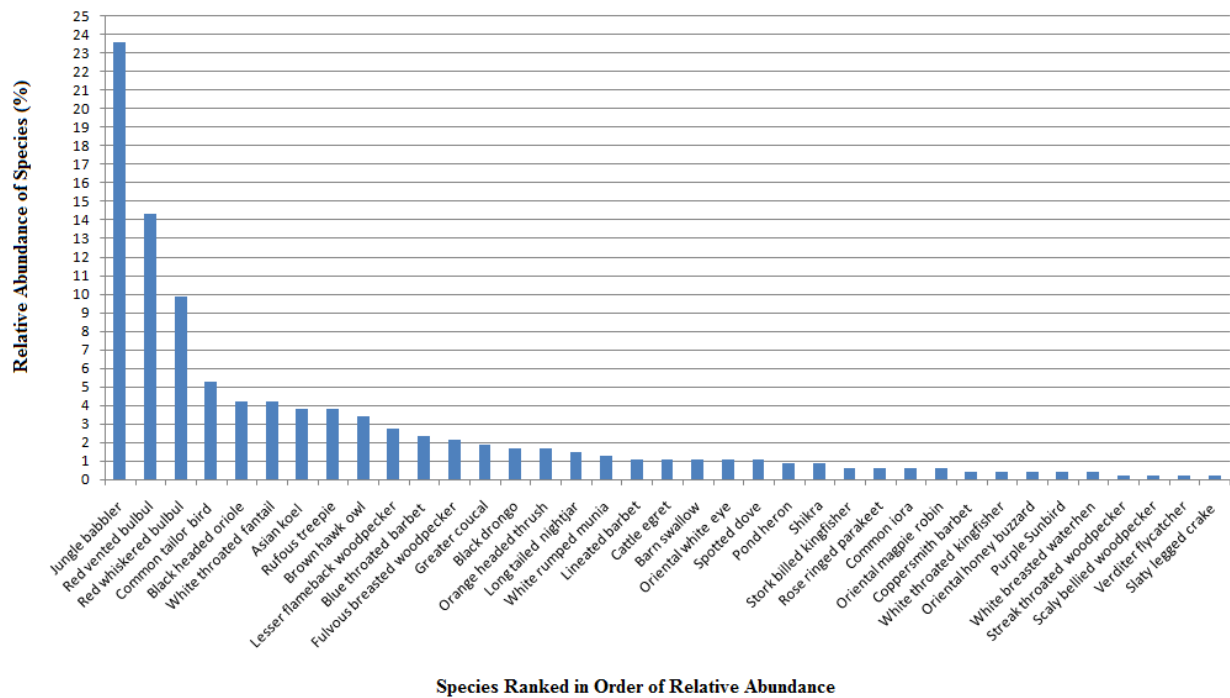


Fig. 4. Relative Abundance of avian species observed in CKBS

Table 1. List of avian species recorded in CKBS

Order	Family	Common name	Scientific name
Piciformes	Megalauidae	Blue throated barbet	<i>Megalaima asiatica</i>
		Lineated barbet	<i>Megalaima lineata</i>
		Coppersmith barbet	<i>Psilopogon haemacephala</i>
	Picidae	Fulvous breasted woodpecker	<i>Dendrocopos macei</i>
		Lesser flameback woodpecker	<i>Dinopium benghalense</i>
		Streak throated woodpecker	<i>Picus xanthopygaeus</i>
		Scaly bellied woodpecker	<i>Picus squamatus</i>
		Stork billed kingfisher	<i>Halcyon capensis</i>
Coraciiformes	Dacelonidae	White throated kingfisher	<i>Halcyon smyrnensis</i>
		Greater coucal	<i>Centropus sinensis</i>
Cuculiformes	Centropodidae	Asian koel	<i>Eudynamis scolopaceus</i>
Psittaciformes	Cuculidae	Rose ringed parakeet	<i>Psittacula krameri</i>
Strigiformes	Caprimulgidae	Long tailed nightjar	<i>Caprimulgus climacurus</i>
	Strigidae	Brown hawk owl	<i>Ninox scutulata</i>
Columbiformes	Columbidae	Spotted dove	<i>Streptopelia chinensis</i>
Ciconiiformes	Accipitridae	Shikra	<i>Accipiter badius</i>
		Oriental honey buzzard	<i>Pernis ptilorhynchus</i>
	Ardeidae	Pond heron	<i>Ardeola grayii</i>
		Cattle egret	<i>Bubulcus ibis</i>
Gruiformes	Rallidae	Slaty legged crane	<i>Rallina eurizonoides</i>
		White breasted waterhen	<i>Amaurornis phoenicurus</i>
Passeriformes	Cisticolidae	Common tailor bird	<i>Orthotomus sutorius</i>
	Corvidae	Common iora	<i>Aegithina tiphia</i>
		Rufous treepie	<i>Dendrocitta vagabunda</i>
		Black drongo	<i>Dicrurus macrocercus</i>

Order	Family	Common name	Scientific name
	Hirudinidae	Barn swallow	<i>Hirundo rustica</i>
	Muscicapidae	Oriental magpie robin	<i>Copsychus saularis</i>
		Orange headed thrush	<i>Zoothera citrina</i>
		Verditer flycatcher	<i>Eumyias thalassinus</i>
	Nectarinidae	Purple Sunbird	<i>Nectarinia asiatica</i>
	Oriolidae	Black headed oriole	<i>Oriolus xanthornus</i>
	Passeridae	White rumped munia	<i>Lonchura striata</i>
	Pycnonotidae	Red vented bulbul	<i>Pycnonotus cafer</i>
		Red whiskered bulbul	<i>Pycnonotus jocosus</i>
	Rhipiduridae	White throated fantail	<i>Rhipidura albicollis</i>
	Silvidae	Jungle babbler	<i>Turdoides striatus</i>
	Zosteropidae	Oriental white eye	<i>Zosterops palpebrosus</i>

3.3 Calculation of Diversity and Evenness of Distribution of Avian Species

Shannon Diversity Index was used to determine diversity of bird species and a value of 2.844 was obtained for the entire study period. Taking the observations during the summer months (May-June) and during autumn and winter (October-January) separately, the value of Shannon Diversity Index was found to be 2.862 during summer and 2.347 during autumn and winter.

Species evenness was determined by Shannon Equitability Index and a value of 0.788 was obtained for the entire study period. Taking the observations during the summer months (May-June) separately, the values of Shannon Equitability Index were found to be 0.812 during summer and 0.771 during autumn and winter.

4. DISCUSSION

Over the past few decades, global biodiversity has been significantly and adversely affected by anthropogenic activities. Urbanization and commodity driven deforestation are among the principal causes for loss of tree cover [18]. In 2021, 10.21% of the total geographical area in Indian mega cities were under forest cover [19]. This makes it more imperative and essential to conserve the existing forested areas in various regions of India including megacities.

Our current study seeks to record and analyse the avian diversity in an urban forest, CKBS, situated on the southern fringes of Kolkata. Our study recorded a total of 37 species belonging to 9 avian orders and 23 avian families, with most species observed from Order Passeriformes followed by Piciformes and Ciconiiformes (16, 7 and 4 species respectively) and from the families Picidae, Corvidae, Muscicapidae and Megalaimidae ($RD_i \geq 8.108$).

Calculation of relative diversity of avian families indicated that the observed species are well distributed across a number of avian families with no single family showing very high dominance. The relative abundance plot indicated that a variety of species are present in appreciable numbers with 12 species showing a relative abundance value above 2.0. Interestingly, many species which are comparatively rare in the urban environment like the common tailor bird (*Orthotomus sutorius*) and the white throated fantail (*Rhipidura albicollis*) showed a relative abundance equivalent to more common species like the black headed oriole (*Oriolus xanthornus*), Asian koel (*Eudynamis scolopacea*) and the rufous treepie (*Dendrocitta vagabunda*). Species otherwise rarely seen in Kolkata, like the Oriental white eye (*Zosterops palpebrosus*) and the white rumped munia (*Lonchura striata*), were also observed here. Thus, CKBS appears to host bird species which are otherwise quite rare in the south Kolkata landscape, emphasizing the need for protection for such an urban forest environment.

Calculation of Shannon Diversity Index gave a value of 2.844 for the entire study period indicating the presence of an avian community with high species diversity. In several bird communities in and around Kolkata, the diversity is usually increased due to wintering assemblages and migratory bird species arriving during winter. However, in CKBS, although species diversity is high throughout the year, Shannon Diversity Index had higher values (2.862) during summer in comparison to autumn and winter (2.347). Our study thus indicates that the observed high species diversity at CKBS is not due to the arrival of migratory birds during winter. The higher species diversity during the summer months could be due to a number of factors including dense forest cover, a large

number of fruit bearing trees and many water bodies in the sanctuary (both artificial and natural) which provide favourable conditions and resources for birds to thrive in the hot, comparatively arid summers. When species evenness was determined using Shannon Equitability Index, a value of 0.788 was obtained for the entire study period and 0.812 during the summer months, indicating high species evenness even during the summer months. Thus, the avian community in CKBS is composed of a large number of species, many of which are represented by a good number of individuals.

In communities, factors which affect species richness, diversity and evenness can include the size of the habitat, the harshness of conditions in the habitat, the isolation of the habitat and the primary productivity. In CKBS, although the size of the habitat is quite small and the community is isolated from nearby forest patches, the presence of a diverse array of flora including many fruit bearing plants, appear to create a number of niches and habitat patches, thus allowing a large number of avian species to be accommodated. Also, as birds are capable of flight, they can cross the intervening urban environment and reach CKBS, reducing the degree of isolation of the avian community. The dense and varied plant cover ensures that primary productivity is quite high, allowing a number of species to thrive here. High species diversity, evenness and richness indicates a stable avian community, low anthropogenic activity and comparatively low pollution levels in the sanctuary, further emphasizing the need to protect CKBS and its surrounding environment.

5. CONCLUSION

Our study indicates that Chintamani Kar Bird Sanctuary (CKBS), an urban forest in Kolkata, has high avian species diversity, richness and evenness. Interestingly, the observed diversity in CKBS is not due to winter migrants, with the diversity being highest during the summer months. The reasons for this could be the dense forest canopy, presence of many fruit bearing trees and abundant water bodies in CKBS providing conditions favourable for birds in hot weather. An appreciable number of bird species appear to be thriving as a stable avian community at CKBS and this urban forest acts as a haven for many birds otherwise rarely seen in the Kolkata landscape. Our study further emphasizes the need for taking necessary conservation measures for protection for this

urban forest and the birds residing in the same, particularly under the strained environmental conditions currently prevalent in urban metropolises.

ACKNOWLEDGEMENTS

We are thankful to Mr. Pranoy Raha, Forest Range Officer, Chintamani Kar Bird Sanctuary for his help and support.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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