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Avian species assemblage across a rural urban gradient in and around Shivamogga, Karnataka

S. Saadath Ali*, KL. Naik

Department of Zoology, Sahyadri Science College, Kuvempu University, Shivamogga, India

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Key words: Urbanisation, Feeding guilds, Box-plot, Synanthropic species

Abstract

Human-induced activities play a prime role in determining the avian species diversity. Urbanization directly affects the distribution of the avian species because it results in habitat fragmentation which results in the loss of avian dependent habitats. Diversity of birds and their status were examined in the different sites along the rural urban gradient. A total of 108 avian species belonging to 16 orders and 47 families were recorded in 5 study sites. Significant variation in bird species richness was observed across the rural urban gradient sites (F= 5.59, P= 0.00149, df= 5). Feeding guilds were observed in different sites. Box-plot showed the dominance of carnivorous guilds across the five study sites. Urban 1 site was dominated with omnivorous guilds and rests of the sites were dominated with Carnivorous feeding guilds. Synanthropic species was found to be declining in the population at highly urbanized area. Specialist species were completely absent in the urbanised sites and are only found to be restricted to the rural sites.

***Corresponding Author:** Saadath Ali S ✉ saadathali18@gmail.com

Introduction

Anthropogenic activities play a crucial role in determining the avian species diversity. Urbanization directly affects the distribution of the avian species because it results in habitat fragmentation which results in the loss of avian dependent habitats.

Urbanization adversely impacts avifauna by decreasing natural food availability, nesting sites, influencing body condition, breeding success, nestling survival and increasing competition, stress, increasing bioaccumulation of pollutants and rate of mortality due to collision (Seress and Liker, 2015).

Expansion of urban areas associated with mushrooming of urban sprawls and smaller suburban habitations has been shown to have serious bearing on the local species diversities increasing the local extinction rates (McKinney 2002, Marzluff, 2001) and through replacements of native species (Kowarik 1995; Blair 1996; Blair and Launer, 1997; Blair, 2001a,b). From another perspective, analyses of the status of biodiversity along urbanization gradients would also provide useful information on species response to structural changes in complex landscape mosaics both at population as well as community levels (Bolger *et al.,* 1997; Crooks *et al.,* 2004; Germaine *et al.,* 1998; Marzluff *et al.,* 1998).

Large parks and reserves in urban areas may support high species diversity because these protected areas are the habitat "fragments" of highly diverse ecosystems (Schaefer, 1994).

Urban areas of Shivamogga city has undergone a rapid change in terms of urbanization, Shivamogga city has been expanding due to anthropogenic activities.

More work on bird diversity in forest, agriculture and riverine Ecosystem has been done but little amount of work has been done in terms of studying the effects of urbanization in a metropolitan city on the distribution of birds.

The aim of the study is to analyse the avian species assemblage along urban-rural gradient in selected areas of Shivamogga. The study will enlighten the information regarding the diversity, density and evenness along the urban rural sites.

Materials and methods

Study area

The avian species assemblage across rural, urban gradient was conducted in and around Shivamogga. The study area was chosen for its variety of habitat types, which is categorized into five sites, 2 urban sites and 1 semi Urban site and 2 Rural sites were selected (Table-1).

1. Site-1 = Rural 1 (Lakkina koppa)- A Village located 15Kms from the Shivamogga. This area is bounded by dry deciduous forest with low house density.
2. Site-2 = Rural 2 (Shettihalli)- A village located 23 km from the Shivamogga. This site has good vegetation with agricultural land.
3. Site-3 = Semi Urban (Vaddina koppa)- A Rural patch within 5 km from the densely populated urban area with a few dispersed house and agricultural fields.
4. Site-4 = Urban 1- An urban area having several housing complexes, park and high human intervention area.
5. Site-5 = Urban 2- An area having Tunga river surrounded by high house lot density.

Table 1. Characteristics of the study sites selected for assessing the bird diversity.

Site no.	Site	Site Character	Site Location	House lot density
1	Rural 1(Lakkina koppa)	Least Populated	13°49'37"N 75°35'44"E	24
2	Rural 2 (Settihalli)	Moderately Populated	13°55'20"N 75°41'23"E	82
3	Semi Urban (Vaddina koppa)	Moderately Populated	13°54'22"N 75°35'42"E	95
4	Urban 1 (Gandhi Bazar)	Highly Populated	13°55'47"N 75°34'25"E	526
5	Urban 2 (Hole Stop)	Highly Populated	13°55'55"N 75°35'14"E	286

House lot densities are calculated by housing units per square km from Google Earth image (Fig. 1).

Fig. 1. Overview of Landscape and google Earth images of the study sites: a) Rural 1, b) Rural 2, c) Semi Urban, d) Urban 1 and e) Urban 2.

Methodology

The fieldwork for assessing the avian diversity in different sites was carried out at regular intervals from March 2020 to February 2022.Transects was laid down to survey birds. Five transects of 300 m long were laid randomly in each Sites. Point counts were conducted early morning between 06:30 A.M to 10:00 A.M and evening from 4:00 P.M to 6:30 P.M when bird activity was high Birds were sighted using a 10X50 wide angle Nikon action binocular and the birds were photographed using Nikon D5600 camera using three different lens (i)18-55mm (ii) 70-300 and (iii) Tamron 150-600mm telescopic lens. Calls of invisible unknown birds whose voices clearly audible were also noted down while unrecognized bird calls were recorded and later identified with the help of software's such as 'Bird Sounds' and 'Indian Birds'. Birds which were unable to be identified on spot were photographed or key identification characters were noted down and identified using field guides viz, the book of Indian birds by Dr. Salim Ali and Birds of The Indian Subcontinent by Tim Inskipp, Richard Grimmett, Carol Inskipp. Bird species were classified into various feeding guilds viz. carnivore, frugivore, omnivore, insectivore, granivore, piscivore following Ali and Ripley (1987). Diversity index and Bray Curtis cluster analysis was analysed using Past 4.03. One-way ANOVA was calculated using NCSS.

Result

In the present survey a total of 108 Avian species belonging to 16 orders and 47 families were recorded in 5 study sites. Order Passeriformes containing 24 families with 50 species dominated the study area. Checklist of recorded species with their scientific name is represented in Table 2.

Table 2. Checklist of the avifauna across the different sites. + and - indicates the presence and absence of a species respectively.

Common name	Scientific name	Rural 1	Rural 2	Semi Urban	Urban 1	Urban 2
Little Grebe	*Tachybaptus ruficollis*	+	_	_	_	_
Great Cormorant	*Phalacrocorax carbo*	+	_	_	_	+
Little cormorant	*Microcarbo niger*	+	_	_	_	+
Cattle Egret	*Bubulcus ibis*	+	+	+	_	+
Median Egret	*Ardea intermedia*	+	+	+	_	+
Little Egret	*Egretta garzetta*	+	+	+	_	+
Indian Pond Heron	*Ardeola grayii*	+	+	+	_	+
Black-Crowned Night Heron	*Nycticorax nycticorax*	_	_	_	_	+
Purple heron	*Ardea purpurea*	+	_	_	_	+
Grey heron	*Ardea cinerea*	+	_	_	_	+
Oriental White Ibis	*Threskiornis melanocephalus*	+	+	+	_	+
Black Ibis	*Pseudibis papillosa*	+	+	+	_	+
Asian Openbill Stork	*Anastomus oscitans*	+	+	+	_	+
White Necked Stork	*Ciconia episcopus*	+	_	_	_	+
Yellow footed green pigeon	*Treron phoenicoptera*	_	+	+	_	_
Rock Pigeon	*Columba livia*	_	+	+	+	+
Spotted dove	*Spilopelia chinensis*	+	+	+	_	_
Indian Peafowl	*Pavo cristatus*	_	_	+	_	_
Grey Francolin	*Francolinus pondicerianus*	_	_	+	_	_
Lesser coucal	*Centropus bengalensis*	+	+	+	_	+
Greater Coucal	*Centropus sinensis*	+	+	+	_	_
Indian cuckoo	*Cuculus micropterus*	+	_	+	_	+
Jacobin cuckoo	*Clamator jacobinus*	_	_	_	_	+
Asian koel	*Eudynamys scolopaceus*	+	+	+	_	+
White breasted waterhen	*Amaurornis phoenicurus*	+	+	+	_	+
Purple Moorhen	*Porphyrio porphyrio*	+	_	_	_	+
Indian moorhen	*Gallinula chloropus*	+	_	_	_	+
Common coot	*Fulica atra*	+	_	_	_	+
Red wattled lapwing	*Vanellus indicus*	+	+	+		+
yellow wattled lapwing	*Vanellus malabaricus*	+	_	_	_	_
common Sandpiper	*Actitis hypoleucos*	_	+	+	_	_
Indian river Tern	*Sterna aurantia*	+	_	_	_	+
Indian spotted eagle	*Clanga hastata*	+	_	_	_	
Pariah Kite/Black Kite	*Milvus migrans*	+	+	+	+	+
Black shouldered Kite	*Elanus axillaris*	+	+	_	_	_
Brahminy Kite	*Haliastur Indus*	+	+	+	+	+
Oriental Honey Buzzard	*Pernis ptilorhynchus*	+	_	_	_	_
Shikra	*Accipiter badius*	+	+	+	_	+
Spotted owlet	*Athene brama*	_	_	+	_	+
Indian Grey Hornbill	*Ocyceros birostris*	+	_	+	+	+
Common hoopoe	*Upupa epops*	+	_	_	_	_
Common flameback	*Dinopium javanense*	+	_	+	_	_
Black-rumped flameback	*Dinopium benghalense*	+	_	+	_	_
Coppersmith Barbet	*Megalaima haemacephala*	+	_	+	_	+
White Cheeked Barbet	*Megalaima viridis*	+	_	+	_	+
Blue throated Barbet	*Megalaima asiatica*	+	_	_	_	_
Green Bee eater	*Merops orientalis*	+	+	+	_	+
Blue tailed Bee eater	*Merops philippinus*	_	_	_	_	+
White-throated kingfisher	*Halcyon smyrnensis*	+	+	+	_	+
Blue-Eared Kingfisher	*Alcedo meninting*	+	_	+	_	+
Common Kingfisher	*Alcedo atthis*	+	_	+	_	+
Pied Kingfisher	*Ceryle rudis*	+	_	_	_	+
Indian Roller	*Coracias benghalensis*	+	_	+	_	_
Plum-headed Parakeet	*Psittacula cyanocephala*	+	_	_	_	_
Rose-ringed Parakeet	*Psittacula krameri*	+	+	+	_	+
Vernal Hanging parrot	*Loriculus vernalis*	_	_	+	_	_
Asian Palm swift	*Cypsiurus balasiensis*	_	_	+	_	+
House swift	*Apus nipalensis*	_	_	+	_	+
Small minivet	*Pericrocotus*	+	_	_	_	_

Common name	Scientific name	Rural 1	Rural 2	Semi Urban	Urban 1	Urban 2
	cinnamomeus					
Scarlet Minivet	*Pericrocotus speciosus*	+	_	_	_	_
Orange Minivet	*Pericrocotus flammeus*	+	_	_	_	_
Black headed Cuckooshrike	*Coracina melanoptera*	+	_	_	_	_
Eurasian Golden oriole	*Oriolus oriolus*	+	_	+	_	_
Black Naped Oriole	*Oriolus chinensis*	+	_	+	_	_
Black-hooded oriole	*Oriolus xanthornus*	+	_	+	_	_
Common Woodshrike	*Tephrodornis pondicerianus*	+	_	_	_	_
Grey Wagtail	*Motacilla cinerea*	_	+	+	_	_
White Browed Wagtail	*Motacilla maderaspatensis*	_	+	+	_	+
Tree pipit	*Anthus trivialis*	_	+	+	_	_
Red vented Bulbul	*Pycnonotus cafer*	+	+	+	+	+
Red Whiskered Bulbul	*Pycnonotus jocosus*	+	+	+	+	+
Jerdon's Chloropsis	*Chloropsis jerdoni*	+	_	+	_	_
Bay- Backed Shrike	*Lanius vittatus*	+	_	+	_	_
Rufous backed Shrike	*Lanius schach*	+	_	+	_	_
Indian Robin	*Saxicoloides fulicatus*	_	_	+	_	+
Pied Bushchat	*Saxicola caprata*	+	+	+	_	+
White-rumped Shama	*Copsychus malabaricus*	+	_	_	_	_
Oriental Magpie-Robin	*Copsychus saularis*	+	+	+	_	+
Asian Paradise Fly Catcher	*Terpsiphone paradisi*	_	_	+	_	_
Jungle Babbler	*Turdoides striata*	+	_	_	_	_
Barn Swallow	*Hirundo rustica*	_	+	+	_	+
Wire tailed Swalow	*Hirundo smithii*	_	_	+	_	_
Red-rumped swallow	*Cecropis daurica*	_	_	+	_	+
Common Tailor Bird	*Orthotomus sutorius*	_	_	+	_	_
Ashy Prinia	*Prinia socialis*	+	+	+	_	_
Common Iora	*Aegithina tiphia*	+	_	+	_	_
Black Drongo	*Dicrurus macrocercus*	+	+	+	_	_
Ashy Drongo	*Dicrurus leucophaeus*	_	_	+	_	_
Rufous Tree Pie	*Dendrocitta vagabunda*	+	_	_	_	_
House crow	*Corvus splendens*	+	+	+	+	+
Indian Jungle crow	*Corvus culminates*	+	_	_	_	_
Baya Weaver	*Ploceus philippinus*	_	+	+	_	+
Loten's Sunbird	*Cinnyris lotenius*	+	+	+	_	_
Purple Rumped Sunbird	*Leptocoma zeylonica*	+	+	+	_	_
Red Munia/Red Avadavat	*Amandava amandava*	_	+	+	_	_
Black-headed Munia	*Lonchura atricapilla*	_	_	+	_	_
White-throated Munia	*Euodice malabarica*	_	+	+	_	_
Scaly breasted Munia	*Lonchura punctulata*	_	+	+	_	_
Brahminy Starling	*Sturnia pagodarum*	+	_	_	_	_
Jungle Myna	*Acridotheres fuscus*	+	_	+	_	_
Common Myna	*Acridotheres tristis*	+	+	+	+	+
Yellow-eyed babbler	*Chrysomma sinense*	_	_	_	_	+
Blyth Reed Warbler	*Acrocephalus dumetorum*	_	_	_	_	+
Great Tit	*Parus major*	+	+	+	_	_
Black Lored Yellow Tit	*Parus xanthogenys*	+	_	_	_	_
House Sparrow	*Passer domesticus*	_	+	+	_	_
Sykess Crested Lark	*Galerida deva*	_	+	+	_	_

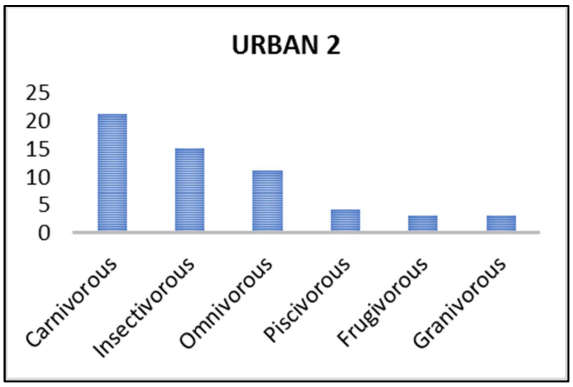
Bird richness varied significantly across the different sites along the urban rural gradient. Bird richness found to be highest in Rural 1(Margalef index =11.55) and lowest bird richness was observed in Urban 1 (Margalef index =1.384). (Table 3)

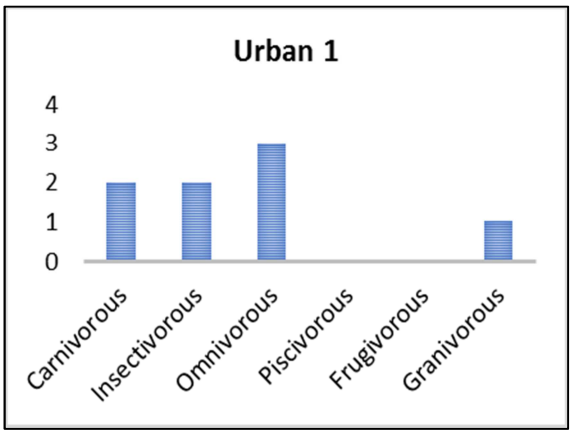
Carnivorous, Insectivorous and omnivorous birds dominated all the 5 different study sites. Insectivore, omnivore and carnivore are three major avian guilds in all habitats of this suburban area. One Way Anova tests revealed significant difference between the foraging guilds in each of the five sites (F= 5.59, P= 0.00149, df=5). Urban 1 was dominated by omnivorous birds and no frugivorous and piscivorous birds were found in this site. Urban 2 site which is an urbanized area but it also has a riverine and good

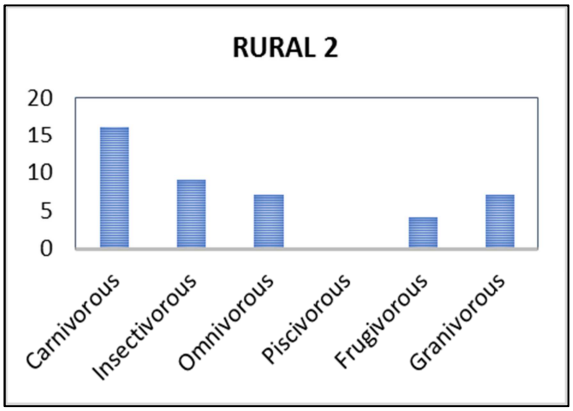
vegetation cover so all types of foraging birds were found and this site was dominated by Carnivorous birds. Compared to other sites Piscivorous birds was more dominant in Urban 2 site. Semi Urban, Rural 1 and Rural 2 were dominated by Carnivorous birds. (Fig. 2).

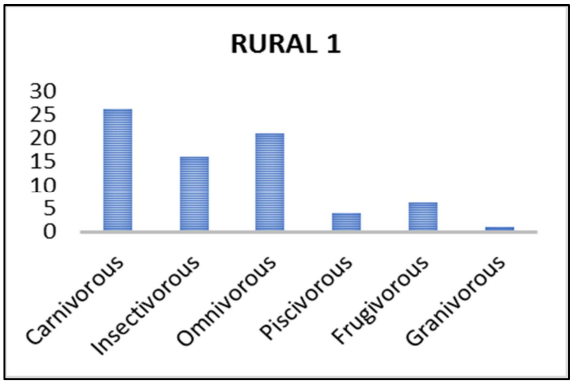
Table 3. Showing Bird community Structure of different sites of Shivamogga.

Sampling Sites	Family	Species	Shannon H	Simpson1-D	Margalef
Rural 1	35	76	4.211	0.9838	11.55
Rural 2	26	44	3.648	0.9713	7.258
Semi Urban	37	73	4.158	0.9829	10.82
Urban 1	06	8	2.018	0.8593	1.384
Urban 2	28	54	3.787	0.9734	8.121









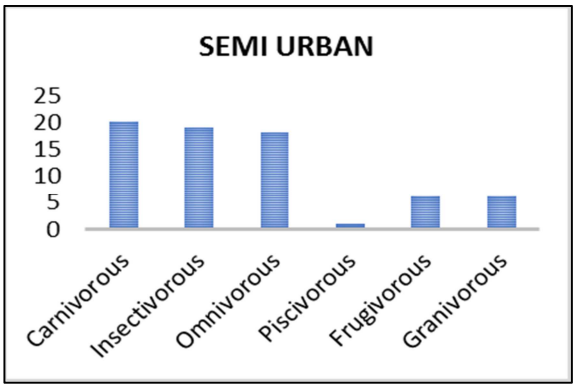


Fig. 2. Feeding guild of birds along rural-urban gradients sites in Study area.

Box-Plot shows that Carnivorous birds were dominated across the five study sites, which was followed by the omnivorous species. Piscivorous birds were found in least numbers (Fig. 3).

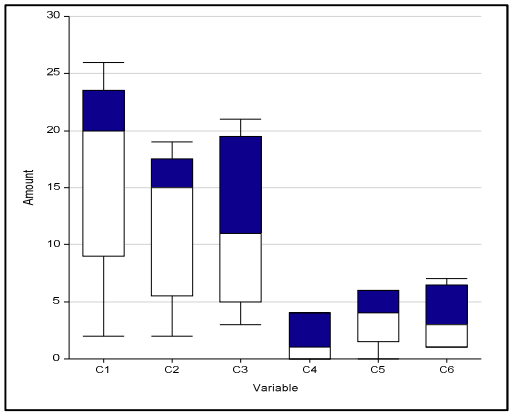


Fig. 3. Box-and-whiskers plots showing various feeding guilds observed in the study sites. Here C1, C2, C3, C4, C5 denotes Carnivorous, Insectivorous, omnivorous, Piscivorous and Granivorous respectively.

Bray Curtis similarity index revealed that Rural 2 and semi urban showed highest similarity of 0.6074 and Urban 2 and Rural 1 shows a similarity of 0.475.

Urban 1 site showed a very few similarities from rest of the sites (Fig. 4).

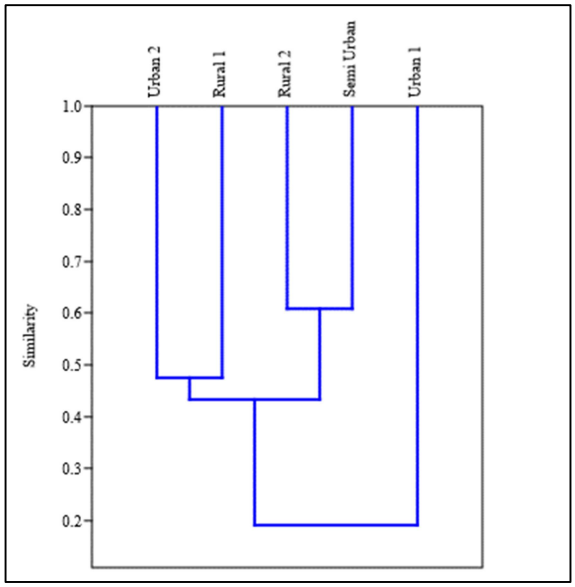


Fig.4. Bray curtis cluster analysis showing the similarity between the study sites.

Discussion

The present study reveals that a total of 108 species of avifauna belonging to 16 orders and 47 families were recorded in different sites. Bird richness was found to be higher in Rural 1 and lowest richness was observed in Urban 1, this is because of less heterogeneity in the landscape. Rural 1 comprises of a wetland, forest cover and rich vegetation cover with very low house lot density which favours the avian diversity but urban 1 is a completely urbanised area where the house lot density was higher when compared to all the other site and also supported least number of vegetation cover hence supported least number of avifauna. This depicts that avian diversity is directly proportional to the heterogeneity in the landscape and less house lot density. Feeding guilds of birds were observed in 5 different sites, Urban 1 was dominated by omnivorous species because as this is an urbanised area there will be no specific food resources such that the birds can depend on it. Dominance of omnivorous species was also observed by Beissinger and Osborne 1982, Sengupta *et al.,* 2014 and Pal *et al.,* 2019. Only in urban 1 site generalist bird species were observed while the specialist bird species were completely declined in this site. Urban 2 sites showed more piscivorous bird species compared to other sites due to the presence of riverine ecosystem in this area. Semi urban and Rural 2 showed more granivorous species this is due to the presence of agrarian ecosystem in the respective sites.

Bray Curtis similarity index was applied to all the study sites to know the similarity between the study sites. Rural 2 and semi urban site showed the highest similarity of 0.6074 this is because both the site has agrarian ecosystem and rich vegetation cover. Urban 2 and rural 1 showed a similarity of 0.475 this is because urban 2 has a riverine ecosystem and rural 1 has a wetland ecosystem due to this both the site shares maximum number of heronry and water birds. Urban 1 site is separated from rest of the site in the bray Curtis similarity index due to the dissimilarity in the habitat.

Bird communities were clearly distinct between the urban and rural sites, this shows that the bird communities segregated along the urban rural gradient. Specialist bird species were found to be increased along Urban-rural gradient. Rural site showed a greater number of specialist species. Urbanisation lead to changes in the habitat structure and resource availability and that result in the segregation of avian community (Beissinger and Osborne, 1982; Fraterrigo and Wiens 2005).

Though Uraban 1 site was completely urbanised area but urban 2 site which consist of Tunga River which harboured good number of avifaunal diversities. Semi urban site showed high avian diversity this is due to the edge effect both the specialist and generalist species were found in this semi urban site. Semi urban area supported good shrub and canopy cover which shows that more the heterogenous landscape more it supports avian diversity because it provides more space for nesting, foraging and shelter opportunities for a greater number of bird species. Many studies highlighted heterogenous landscape provide more niches to exploit and hence support high diversity (Bohning-Gaese, 1997; Fahrig *et al.,* 2011; Bonilla *et al.,* 2012; Katayama *et al.,* 2014).

Bird species composition varies significantly along urban-rural gradient sites. Some of the specialist species such as Plum headed parakeet (*Psittacula cyanocephala*), Scarlet minivet (*Pericrocotus speciosus*), Black headed cuckoo shrike (*Coracina melanoptera*), Brahminy starling (*Sturnia pagodarum*), Rufous tree pie (*Dendrocitta vagabunda*) and Black lored yellow tit (*Parus xanthogenys*) was restricted only to the Rural 1 site. High abundance of generalist species such as Rock pigeon, Black kite was observed in the urban 1 site.

Granivorous species in urban site was benefitted by public housing as these sites contain anthropogenic food which could support their higher abundance (Lim and Sodhi, 2004). Synanthropic species such as house sparrow was not found in abundance in urban 1 site which implies that its population has been declining as other urban habitats in the world.

Conclusion

Urbanised site supports low avian diversity. Avian species diversity elevated in semi urban and rural sites. Urban site was found to be dominated by omnivorous birds and it is replaced by Carnivorous guilds in the other sites. The Urban sites contain only generalist species and specialist species are restricted to the rural sites. The synanthropic species in the urban sites are also facing a threat of decline in the population due to urbanisation. Avian diversity was found to be correlated with heterogeneous landscape and very low house lot density.

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