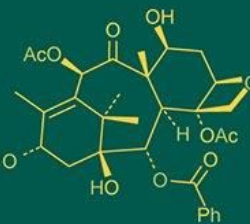
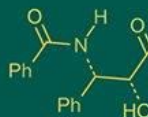
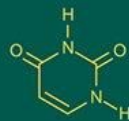
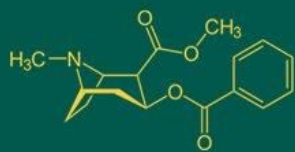


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Spatio-temporal assemblages of commensal bird species in urban landscapes of Ludhiana city

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Abstract

Commensal bird species i.e. Rock Pigeon, Common Myna and House Crow were studied in relation to their spatial and temporal assemblages at four locations i.e. location 1 (Rajguru Nagar), location 2 (Agar Nagar), location 3 (Phase-3, Dugri) and location 4 (Punjab Agricultural University) comprising of 12-point sites at each location in urban landscape of Ludhiana city, Punjab. Structural features consisted of maximum build area at location 2 followed by location 1, 3 and 4 whereas vegetation area was highest at location 4 followed by location 3, 1 and 2. Rock Pigeon was most spatially distributed species at all locations followed by Common Myna and House Crow at location 1 and 3; House Crow and Common Myna at location 2 and 4. Rock Pigeon was maximum at point 8 (location 1) due to presence of well-planned housing structure and wide roads, Common Myna was maximum at point 32 (location 3) and House Crow was maximum at point 33 (location 3) due to presence of vegetation and modernized housing structures. Temporal variation in three urban commensal bird species was also recorded across four locations which revealed that Rock Pigeon, House Crow and Common Myna showed distinct monthly fluctuations in abundance, with peaks and declines varying by location site. The spatial and temporal distribution of Rock Pigeon, Common Myna and House Crow in Ludhiana observed due to variation in built-up and vegetation areas that collectively shape commensal bird assemblages in urban environments.

Keywords: Avifauna, commensal species, spatial distribution, temporal distribution

Introduction

Avian species constitute the most diverse evolutionary group and they have a unique place in the ecosystem. There are many roles of birds in an ecosystem and they act as pollinators, pests and scavengers etc (Mariyappan *et al.*, 2023) [1]. Urbanized areas provide food resources to birds both directly and indirectly. Directly, they provide food resources as feeders and indirectly in the form of garbage, waste treatment and transfer. In man-made habitats, granivores species are the more successful than insectivore because seeds are more easily available in human occupied areas as compared to other food resources (Patankar *et al.*, 2021) [2].

The function of urban ecosystem can be interpreted by estimating the spatial relation of bird diversity and vegetation fertility, transforming urban planning policies. Many bird species get benefit from urbanization as their natural environmental areas get protected or new conditions are formed whereas some get threatened (Reis *et al.*, 2012) [3]. The spatial pattern of vegetation-related resources in urban landscape is determined by human activity (Alberti, 2015) [4]. The temporal stabilization of habitat and food resources and exclusion of migrant species encouraged by urbanization cause a seasonal homogenization of bird composition (Leveau *et al.*, 2015) [5]. Most ornithology studies conducted along urban-rural gradients have shown that the diversity and structure of avian communities are negatively affected by urbanization. The increase in urbanization affects bird species richness and urban habitats were dominated by urban generalist species; thus, creating biotic homogenization.

Species living in urban areas differ from those existing in their natural habitats and with the expansion of residential areas, there is fragmentation of bigger ecosystems (McKinney, 2002) [6], substitution by exotic ornamental species of pre-existing native species and purging of natural vegetation (Aronson *et al.*, 2015) [7]. A study conducted on urban landscape showed negative effect of population elevation like pollution, climatic variations, desertification, habitat destruction and fragmentation and invasion of exotic species (Aravind *et al.*, 2010) [8].

Commensal birds are species such as Blue Rock Pigeon, *Columba livia*; Common Myna, *Acridotheres tristis* and House Crow, *Corvus splendens* that reside near human activities either permanently or temporarily and taking advantage from food and shelter resources. These bird species are commonly found in urban landscapes at global level (Ranjana and Acharya, 2019, Tan *et al.*, 2020, Lim *et al.*, 2023) [9-11].

The objective of the study was to determine spatial and temporal assemblage of three most abundant commensal bird species i.e. Blue Rock Pigeon, Common Myna and House Crow in urbanized landscapes of Ludhiana city so that efforts should be done to create sustainable environments for both humans and these commensal bird species in urban ecosystems.

Material and Methods

Study area: Ludhiana city in Punjab (30.9010°N, 75.8573°E) is a large industrial city with an area of 310 sq. km and has an average elevation of 244 meters (789 ft). Ludhiana features a humid subtropical climate with roughly 890 millimetres of precipitation annually. Ludhiana has average annual temperature of about 24.3°C. The abundance of three commensal bird species i.e. Rock Pigeon, Common Myna and House Crow was recorded from April 2019 to March 2020 at four locations of approximately 1 km area and each location divided into 12 points located equidistantly. The description of selected locations is as follows:

Location 1: Rajguru Nagar was a varied housing structure. Vegetation consisted of native as well as introduced tree and shrub species. It was an unplanned urban area with narrow streets. Mostly houses were two or three storeys. There was one Gurudwara and two parks at this location. Points 1-12 were taken at this location.

Location 2: Agar Nagar was a highly urbanized residential area including high human disturbances. There were few small shops run by people from within their houses. This location had two public parks and one school. There was a temple at the entrance of the location. Points 13-24 were taken at this location.

Location 3: Phase-3, Dugri Estate had modern housing structures with mature trees and newly planted saplings. This was a well-planned urban area with wide roads. The houses were mostly two or three storeys. There was one school and a small market at this location. Points 14-36 were taken at this location.

Location 4: Punjab Agricultural University Campus (PAU) had residential houses lacking structural diversity and characterized by diversity of tree types both as rows along lanes and fruit trees in their backyards. The houses were mostly two storeys. Points 37-48 were taken at this location.

Structural features of locations

The data on structural features of the studied locations i.e. area covered under vegetation, build up, parks, fallow land and road cover was taken from Punjab Remote Sensing Centre Ludhiana.

Point count method: Point count method was followed for noting spatial activities of different bird species and data was taken on monthly intervals to ascertain temporal trends in

their activities and abundance (Bibby *et al.*, 1992) [12]. Sampling was carried out by taking 12 equidistant points in 1 Km transect to monitor and record bird activity systematically and thoroughly; thereby a total of 48 points were visited for 4 selected transects on monthly intervals. Time duration of 10 minutes per point per observation was taken to observe the bird species namely Blue Rock Pigeon, Common Myna and House Crow.

Bird traits were recorded and compared with the morphological features mentioned in the standard field guides, namely The Book of Indian Birds (Ali, 2002) [13] for proper identification.

Relative abundance

Relative abundance was calculated using the formula:

$$ni/N \times 100$$

Where ni is referred to as the number of species of i th species and N is the total number of species recorded in the study area.

Data analysis was done on abundance values recorded per point per bird species per month in the studied area, out of pooled data of individual species the graph were plotted to understand spatial and temporal patterns of studied three bird species. Bird observations taken were also analysed in relation to structural habitat types of each transect to understand their utilization and abundance of studied commensal bird species.

Results and Discussion

Structural Features of different locations

Location 1 was having maximum area under built up (46.01%) followed by road cover (27.75%), vegetation cover (15.06%), park area (6.43%) and fallow land (4.74%) (Table 1). Location 2 had maximum area under built up (68.59%) followed by road cover (18.48%), park cover (5.68%), vegetation (5.12%) and fallow land (5.68%). The maximum area at location 3 was cover by built up (38.68%) followed by road cover (32.56%), vegetation (19.42%), park cover (7.13%) and fallow land (2.21%). At location 4, maximum area was under vegetation (61.92%) followed by built up (21.20%), road cover (8.96%), fallow land (5.88%) and park (2.05%). The spatial description of the structural features of the studied locations showed that road cover was maximum at location 3 (32.56%), built up was maximum at location 2 (68.59%), vegetation cover came out to be maximum at location 4 (61.92%), fallow land was found covering maximum area at location 4 (5.88%), parks covered most area at location 3 (7.13%). These types of structural features of a landscape in urban cities with houses having patches of native vegetation play a beneficial role for native birds (Humphrey *et al.*, 2023) [14].

Spatial distribution of commensal birds

The spatial distribution of three commensal bird species recorded at different points in four locations (Fig 1). At location 1, maximum spatial distribution of Common Myna was observed at point 1 and minimum at point 11, that of House Crow was maximum at point 12 and minimum at point 5 and that of Rock Pigeon was maximum at point 8 and minimum at point 3,4 and 5. At location 2, Common Myna showed the maximum distribution at point 24 and minimum at point 22, House Crow showed maximum distribution at

point 13 and 19 and minimum at point 21 and Rock Pigeon showed the maximum distribution at point 20 and minimum at point 16 and 18. At location 3, the results of spatial distribution of Common Myna showed the maximum distribution at point 33 and minimum at point 26, that of House Crow was maximum at point 33 and minimum at point 26 and Rock Pigeon showed maximum distribution at point 29 and 31 and minimum at point 32. At location 4, Common Myna showed maximum distribution at point 42 and 43 and minimum at point 46, House Crow showed maximum distribution at point 42 and minimum at point 44, 45 and 47 and Rock Pigeon showed the maximum distribution at point 46 and minimum at point 40 and 41. It was observed that Rock Pigeon was most spatially distributed species at all locations followed by Common Myna and House Crow at location 1 and 3; House Crow and Common Myna at location 2 and 4. Rock Pigeon was maximum at point 8 (location 1) and this point had well-planned housing structure and wide roads. Rock Pigeons successfully adapted to urban environments and utilized rooftops and balconies in multi-storeyed buildings as their nesting and roosting sites. Moreover, wide roads in urban areas facilitated efficient foraging that ensured a constant supply of anthropogenic food resources (Sol *et al.*, 2014) ^[15]. Common Myna was maximum at point 32 (location 3) and House Crow was maximum at point 33 (location 3) and these points had vegetation and modernized housing structures which offered an optimal balance by providing foraging and breeding opportunities in the form of food waste, nesting sites on buildings and insects, fruits, shelter in vegetation (Grünwald and Reif, 2025) ^[16]. The corvids such as house crow in present study demonstrated high levels of adaptability to urban environments because of their flexibility in resource use and behavioral plasticity that enabled them to exploit novel resources for nesting and feeding (Benmazouz *et al.*, 2021) ^[17]. The three commensal bird species were influenced by factors related to spatial scaling and were found exploiting wider resources as well as thriving well in urbanized landscape. Granivores species such as Rock Pigeon are benefitted from anthropogenic food which ultimately supports their higher abundance as corroborated by Lim and Sodhi (2004) ^[18]. The abundance of Common Myna was high at location 3 due to the fact that these species can feed on fruits, insects as well as anthropogenic food and getting benefitted from proximity to humans pertaining to their commensal behaviour (Khera *et al.*, 2009) ^[19].

Temporal distribution of commensal birds

Temporal variation among the studied locations showed that Rock Pigeon being the most abundant commensal species

was found to have maximum value in May (57.89%) at location 1, January (42.50%) at location 2, January (62.04%) at location 3 and January (28.57%) at location 4 (Fig.2). This finding is in accordance with that of Ali *et al.* (2013) ^[20] which also observed higher population density of the pigeon in Islamabad during winter season due to availability of suitable roosting sites, nesting sites, feeding sites and water points. The minimum variation in distribution of Rock Pigeon was recorded during October (21.95%) at location 1, August (17.53%) location 2, both August and September (0%) at location 3 as well as location 4. Common Myna was having maximum value in April (21.62%) at location 1, February (22.35%) at location 2, April (15.94%) at location 3 and February (15.25%) at location 4 whereas it was recorded minimum during February (5.13%) at location 1 (Fig.3), December (3.60%) at location 2, November (0.13%) at location 3 and January (0%) at location 4. Common mynas are considered to opportunistic omnivores whose diet shifts seasonally, relying heavily on insects during the breeding season to meet higher protein demands (Griffioen and Clarke, 2002) ^[21]. Thus availability of insects required as food and for breeding of common myna might be one of the factor for its monthly variation at different locations. The House Crow had maximum value recorded during April (13.51%) at location, September (31.71%) at location 2, April (14.49%) at location 3 and January (8.57%) at location 4 whereas its minimum values were recorded during August (3.33%) at location 1, March (0.84%) at location 2, December as well as January (0.08%) at location 3 and November (0.02%) at location 4 (Fig.4). The temporal variation in House Crow observed was due to seasonal movement and changes in its foraging behaviour in urban environments as reported by Ryall (2003) ^[22].

There are many factors in environment that affect the spatial and temporal distribution of these commensal bird species. The built-up infrastructure influenced the spatial distribution of birds in urban landscapes (Suarez-Castro *et al.*, 2024) ^[23]. The climatic factors caused temporal fluctuations in bird assemblages and abiotic factors such as low temperature and high precipitation caused decrease in bird abundance (Santillan *et al.*, 2018) ^[24]. Moreover, the birds are distributed according to type of habitat available for them for their shelter, presence of suitable food materials such as grains, insects etc, and proper nesting sites. Sahni and Kler (2023) ^[25] reported that bird species i.e. Rock Pigeon, Common Myna, Eurasian Collared-Dove, House Crow, House Sparrow, Red-vented Bulbul and Rose-ringed Parakeet owing to their habitat flexibility were able to exploit the ample feeding and nesting resources offered by urban landscapes.

Table 1: Structural features of four locations in Ludhiana city

Location	Road	Vegetation	Built up	Fallow land	Park
1	27.75	15.06	46.01	4.74	6.43
2	18.48	5.12	68.59	2.14	5.68
3	32.56	19.42	38.68	2.21	7.13
4	8.96	61.92	21.20	5.88	2.05

Conclusions: The present study suggests that in an urbanized landscape, the spatial and temporal distribution of commensal

bird communities are governed by surrounding structural features and environmental factors in an ecosystem.

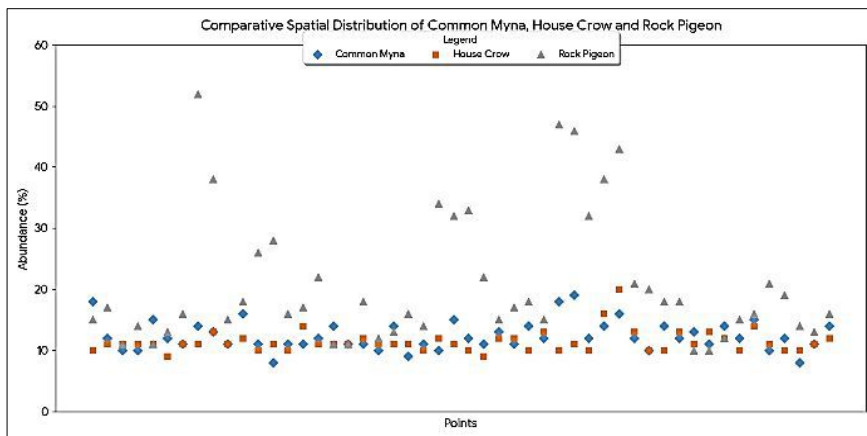


Fig 1: Comparative spatial distribution of Common Myna, House Crow and Rock Pigeon at all the studied locations

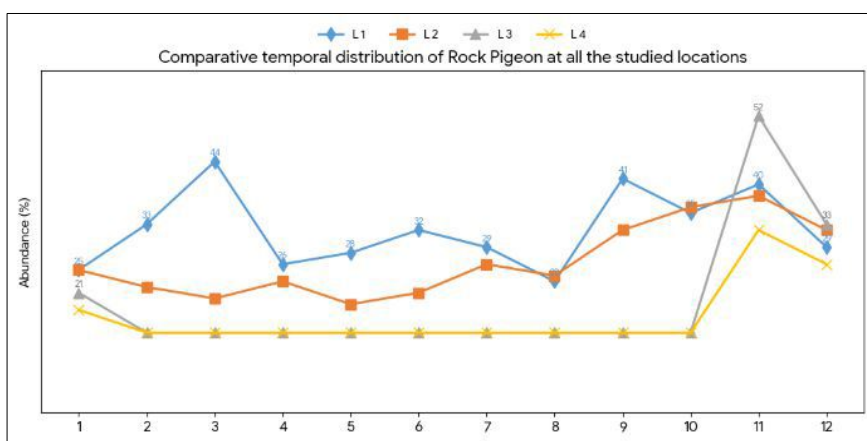


Fig 2: Comparative temporal distribution of Rock Pigeon at all the studied locations

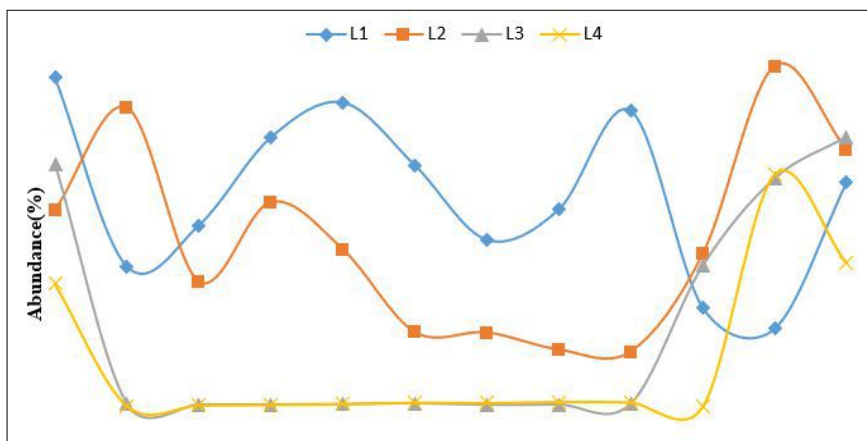


Fig 3: Comparative temporal distribution of Common Myna at all the studied locations

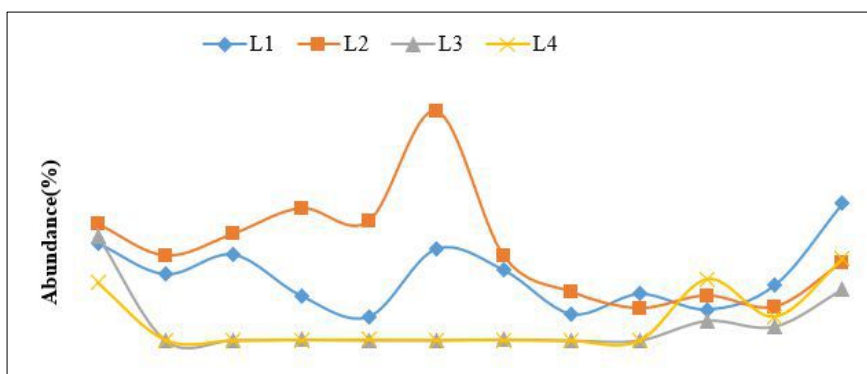


Fig 4: Comparative temporal distribution of House Crow at all the studied locations

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Conflict of Interest

No conflict of interest

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