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## Avian diversity in relation to indigenous trees

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**Abstract**

The present study on avian community structure in relation to indigenous trees was conducted at Punjab Agricultural University, Ludhiana (Location I) and village Machaki Mal Singh, Faridkot (Location II). Six different indigenous trees were selected i.e. Banyan (*Ficus benghalensis*), Jamun (*Syzygium cumini*) and Mulberry (*Morus alba*) Neem (*Azadirachta indica*) Pipal (*Ficus religiosa*) and Sheesham (*Dalbergia sissoo*). A total 51 species of birds were recorded belonging to 14 orders. Highest species richness (31) was recorded on Pipal tree. Cumulative count of birds on all selected trees showed numerical dominance of Common Myna (*Acridotheres tristis*), Rose-ringed Parakeet (*Psittacula krameri*) and House Crow (*Corvus splendens*). Visit of migratory birds were also recorded. The order Passeriformes was the most dominant order out of total fourteen orders of bird species observed. Among feeding habits, omnivorous birds were dominant as compared to birds having other feeding habits.

**Keywords:** Avian diversity, indigenous trees, feeding habits, community structure

**1. Introduction**

There are around 1314 species of avifauna in India <sup>[1]</sup>. About 328 species of bird fauna are found in Punjab <sup>[2]</sup>. IUCN claims that bird community faces high threat to extinction. Out of more than 9000 species of living birds, almost 150 are found to be extinct after the human arrival <sup>[3]</sup>.

Birds and trees enjoy an important relationship. Trees provide food, nesting sites and protection to birds and in return birds are also advantageous for trees as their flowers are cross pollinated, seeds are dispersed by birds. Birds also eat insects that may harm the trees <sup>[4]</sup>. The trees offer a habitat for birds and the relative abundance of birds is directly related to the presence of worthy vegetation community, food resources and habitat structural complexity <sup>[5]</sup>. Avian community structure on a particular tree species dependent upon the characteristics of the trees as well as on the various features of the habitat in vicinity <sup>[6]</sup>. Older plantations of Teak (*Tectona grandis*) always seem to support greater diversity of birds and have a more stable community structure than the younger monocultures <sup>[7-9]</sup>. Hence it is recognized that plantations of tree species which have long life span stabilizes the system by providing the habitat complexity which supports higher bird diversity. Various scientists claim that habitat structure (physiognomy) and floristics (composition) of a particular location are the key components affecting the assemblage of land birds. It was investigated that there is little or no under storey vegetation in case of Eucalyptus plantations, so these plantations lack substantial avifauna <sup>[10]</sup>.

The bird community is also affected by the amount of food a tree affords. For example *Ficus* trees are source of alternative food to most of the frugivores and many omnivorous birds. Lambert (1989) recorded about 60 bird species feeding on figs in Malaysian lowland rain forest <sup>[11]</sup>. It was also found that there is no correlation between crop size and length of the fruit season: *Ficus* crops are generally depleted in less than one week whereas *Piper* and *Cecropia* crops last three weeks or more <sup>[12]</sup>.

In the Neotropics, fruits of plants belonging to families; Melastomaceae, Moraceae and Rubiaceae are consumed by a wide diversity of "opportunistic" frugivores (e.g., tanagers, thrushes, tyrant flycatchers, and woodpeckers) whose diets include a mixture of fruit and insects. Dispersal services provided by frugivores are of high quantity but less reliable <sup>[13, 14]</sup>. Christian *et al.* reported that frugivorous and nectarivorous bird species were more prevalent in shade coffee and residential areas than in native forests <sup>[15]</sup>. The proportion of Raptors and piscivorous bird species was higher in cattle pastures and rice fields. Indigenous Polynesian island fruit birds are key pollinators and seed dispersers of native rainforest flora <sup>[16, 17]</sup>.

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The introduction of exotic tree species arises either because the native tree flora is scanty or is chiefly composed of species which are extremely slow growing and are not readily available for use. Eucalyptus, pines and poplars are extensively fast growing tree species in the world over. Approximately, 4.8 mha of *Eucalyptus* and 60,000 ha of *Populus deltoids* is estimated growing in India alone [18]. The transition from native to exotic streetscapes saw the progressive loss in population of insectivorous and nectarivorous species is observed showing a dependence of these species on structurally diverse and/or native vegetation for their basic requirements like food, shelter, nesting, roosting etc. [19]. Indigenous plantations are thought to support higher proportion of biodiversity than plantations of non-native trees. In a study from Kenya Farwig *et al.* also supported this by investigating that plantations of indigenous trees support more bird diversity than those of exotic ones [20]. Availability and diversity of fruit resources in particular landscapes affects the abundance of frugivorous birds [21], while abundance of prey resources such as arthropods in forest patches affects species richness of insectivorous birds [22].

Earlier finding have proved that structural complexity of habitat strongly influences bird communities [23, 24], especially forest interior specialists and insectivores [25, 26]. These groups of birds use large and dead or rotting trees as foraging and nesting habitats [27]. For example, reducing cover of larger trees species decreases the abundance and richness of bark-gleaning insectivores [28], while population of foliage-gleaning insectivores is reduced by the removal of tree branches and canopy cover [29]. Alexander *et al.* claims that Changes in composition, foliage density and complexity of plant species composition may adversely affect the resource availability to birds and thus influence their abundance and richness [30].

Anthropogenic habitat loss and degradation have caused a significant decline in avian diversity around the world [31]. The clearance of natural forests for agricultural purposes has seriously threatened the survival of many bird species [32]. The rapid decrease in the natural forested area has pressured avian species into utilizing shrub and open-area habitats for their survival and reproduction. Shrub habitats consist of understory woody or sapling vegetation generally measuring less than 3 m in height that exhibits specific environmental features that are rich in food resources (such as berries and insects) and offer safe shelter and nesting sites for a diversity of bird species [33].

Reducing the loss of avian habitat is a much more efficient way to enhance the bird populations in dwelling areas than attempting to restore habitat. Approximately 45 bird species in Malaysia are threatened due to habitat loss and degradation [34]. As a means of promoting the benefits of trees as habitat and food for other biodiversity, it is often stated that indigenous (native) trees should be encouraged above alien (exotic/non-native) species, because the services that they provide are already part of the local ecology, and other native species will have co-adapted with them.

The aim of this study was to determine the relationship between bird community composition, species richness, evenness, diversity and indigenous trees. Further investigations were carried out to compare the structural properties of bird communities between two selected locations.

## 2. Materials and methods

**2.1 Study area:** The study was carried out from April 2016 to March 2017 to find out the abundance of avian diversity

in relation to indigenous trees in agricultural ecosystem, the areas selected were:

**Location I:** Punjab Agricultural University, Ludhiana (75.79° E, 30.90° N, above mean sea level –189 m). Punjab Agricultural University campus comprises of agricultural fields, orchards, official complexes and residential areas.

**Location II:** Machaki Mal Singh village (74° 44' E, 30° 37' N, above mean sea level – 202 m), district Faridkot. Village area consists of residential area comprising of modern and old traditional housing structure, Anaj Mandi, ponds, canals and agrifields. Vegetation structure includes both indigenous trees and exotic trees. Most of the area is surrounded by lush green fields of Wheat (*Triticum aestivum*) and Rice (*Oryza sativa*) crop plantations.

**2.2 Method:** To study the bird abundance on six selected indigenous tree species i.e. Banyan (*Ficus benghalensis*), Jamun (*Syzygium cumini*), Mulberry (*Morus alba*), Neem (*Azadirachta indica*), Pipal (*Ficus religiosa*) and Sheesahm (*Dalbergia sissoo*) during the study, point count method was followed at selected sites and periodic surveys were carried out by adopting systematic field procedures and techniques [35]. Identification of birds were done with the help of key given by Ali [36]. Three trees of each species were selected at different sites.

**2.3 Materials:** Digital Camera (Nikon P 500), Bushnell Binocular (8X42) for observing birds and Ravi Altimeter for measuring tree height, were used.

**2.4 Statistical analysis:** The data of all observations of a month was pooled and the community characteristics were calculated to quantify the bird's community at selected locations. Relative abundance was calculated as:  $n_i/N \times 100$  where  $n_i$  is the number of birds of  $i$ th species and  $N$  is the total number of birds recorded. Species diversity was calculated by Shannon- Weiner Index;  $H = -\sum P_i \log P_i$ , Where  $P_i$  is the proportion of the  $i$ th species of birds. 'H' is referred as 'Shannon's Index'. The whole formula is known as Shannon- Wiener index of bird's species diversity [37]. Species evenness was calculated by employing the formula,  $J = H/H'_{max}$  (Where  $H$  represented the observed species diversity and  $H'_{max}$  represented the log of total number of species i.e. species richness [38]). Species evenness is also known as equitability and denoted as  $E$  (which ranges between 0-1). Kruskal-wallis test was carried out to find if there was significant difference of bird diversity among tree species. Mann-witney test was carried out to know if there was significant difference of bird diversity among individual tree species.

## 3. Results and discussion

A total 51 species of birds were recorded belonging to 14 orders. Highest species richness (31) was recorded on Pipal tree (Table 1). Cumulative count of birds on all selected trees showed numerical dominance of Common Myna (*Acridotheres tristis*), Rose-ringed Parakeet (*Psittacula krameri*) and House Crow (*Corvus splendens*). Birds belonging to order Passeriformes was the most dominant order out of the total fourteen orders of bird species observed (Table 2). Among feeding habits, omnivorous birds were in higher proportion as compared to birds having other feeding habits (Table 3).

**Banyan (*Ficus benghalensis*):** It is an evergreen tree of family Moraceae. It has a huge crown with the aerial roots extending to the ground which later on becomes trunk like and supports the crown. It has thick leathery leaves of oval shaped which are round at the tip. Fruiting generally occurs from March-May and also in September-October. Fruits are generally small in size and yellow to reddish brown in colour.

**Location I:** Total 22 species of birds were found on banyan tree at Punjab Agricultural University, Ludhiana. Species richness was maximum (16) during the fruiting period of tree, in the month of September and October. It was lowest (11) in the months June, July and January. Relative abundance of Rose-ringed Parakeet (41.74) and House Crow (36.66) was found to be maximum in the month of January and June respectively. It was lowest (0.46) of both Blue Rock Pigeon and Little Brown Dove in the month of April. Species diversity was highest in the month of September (2.18). It was lowest (1.57) in the month of December. Species Evenness was found to be highest in the month of December (0.87) and it was lowest (0.71) in the month of January. Annual abundance of House Crow (27.09) and Common Myna (18.89) were found to be maximum. Indian Cuckoo and Spotted Dove were the least abundant species recorded on this tree both showing annual abundance of 0.05.

**Location II:** Total 15 species of birds were found on Banyan tree at village Machaki Mal Singh, Faridkot. Species richness was maximum (12) in the month of October, February and March followed by 10 in the month of September. This indicated that during fruiting period trees attract more birds. Species richness was lowest (6) in the month of December. Relative abundance of Common Myna (56.81) and Rose-ringed Parakeet (46.66) was found to be maximum in the month December and June respectively. It was lowest (0.97) of Indian Treepie in the month of February. Species diversity was highest in March with value of 2.03 and lowest (1.20) in month of July. Species evenness was highest (0.83) in May. It was lowest (0.62) in month of July. Annual abundance of Common Myna (31.17) and Rose-ringed Parakeet (24.29) were found to be maximum. Juicy figs of tree are a part of diet of many bird species [39]. Asian Koel (0.52) and Blue Rock Pigeon (0.65) were the least abundant species recorded on this tree.

**Jamun (*Syzygium cumini*):** It is also called as Black Plum and belongs to family Myrtaceae. It is a medium sized evergreen tree with dense shady much branched crown. New leaves appear in February and are coppery red in colour. Flowers start appearing from March-April. Ripening of fruits takes place from June-July. Fruits are generally in purplish black in colour with juicy edible pulp.

**Location I:** Total 16 species of birds were recorded on Jamun tree at location I. Species richness was highest in the month of February and March with values 15 and 12 respectively whereas it was 5 and 6 in June-July (fruiting period) respectively. This indicates that new foliage and flowering stage of tree attracts more bird species as compared to fruiting stage [40]. Few workers also reported that jamun attracts a lot of bird diversity. Relative abundance 50.29 and 45.16 of Common Myna was highest in the month of October and September respectively. Relative abundance of House Crow was second highest 44.32 in the month of July. Species diversity was highest (2.07) in month of February. Highest

species evenness 0.83 was recorded in the month of January. Annual abundance 36.16 of Common Myna was found to be highest. Lowest annual abundance 0.07 was of Black-crowned Night-Heron followed by 0.14 of Greater Coucal.

**Location II:** Total 13 species of birds were recorded on Jamun tree at location II. Species richness 10 was highest in the month of February, March and April. During these months new foliage appears and flowering occurs which attracts more bird species then the fruiting period of Jamun. Species richness was higher at stage when new foliage appears and at flowering stage as compared to fruiting stage. Lowest species richness (4) was recorded in the months of July and August. Relative abundance was lowest (1.35) and equal of Barn Owl and Yellow legged Green-Pigeon in the month of April. Species diversity was highest 1.84 in the month of February. Species evenness was highest and equal (0.88) in all the three months July, December. Maximum annual abundance 45.65 was of Common Myna, followed by 23.12 of Jungle Babbler. Lowest annual abundance 0.05 of Yellow-footed Green-Pigeon was recorded.

**Mulberry (*Morus alba*):** Mulberry is a medium sized fruiting tree. Trees are bare in the month of January till the first week of February. New foliage starts appearing in the last week of February. Fruiting takes place in the month of March.

**Location I:** Total 30 species of birds were recorded on Mulberry tree at location I. Highest species richness (22) was recorded in both the months February and March. Lowest species richness 8 was recorded in the month of December. Highest relative abundance 40.22 and 36.84 was of Common Myna in the month of September and August respectively. Lowest relative abundance 0.51 was of Indian Roller and Red-vented Bulbul in the month of March. Highest species diversity 2.57 was recorded in the month of March. Aslan and Rejmanek stated that *Morus* sp. are favourite spot for birds for perching and eating [41]. It was lowest 1.69 in the month of December. Species evenness was recorded to be highest 0.84 in the month of November. It was lowest 0.72 in the month of August. Annual abundance of Common Myna 26.12 was recorded to be highest. Lowest annual abundance 0.06 was of Brown-headed Barbet followed by 0.17 was of Brahaminy Starling.

**Location II:** Total 23 species of birds were recorded on Mulberry tree at location II. Highest species richness 16 was recorded in the month of March. Second highest species richness 15 was recorded in the months February and April. It was lowest 8 in the month of December. Highest relative abundance 51.89 and 43.58 was of Rose-ringed Parakeet in the months January and December. Lowest relative abundance 0.56 was of Greater Coucal and Common Tailorbird in the month of March. Highest species diversity was recorded to be 2.17 in the month of May. It was lowest (1.69) in the month of December. Species evenness was highest (0.83) in the month of November. It was lowest (0.72) in the months of July and January. Annual abundance of Common Myna (24.94) was highest. Second highest annual abundance (22.52) was of Rose-ringed Parakeet. It was lowest (0.05) of Spotted Owlet.

**Neem: (*Azadirachta indica*):** Neem tree belongs to family Meliaceae. Its fruits and seeds are the source of neem oil. Neem is a fast-growing tree that can reach a height of 15–

20 meters. It is evergreen, but in severe drought it may shed most or nearly all of its leaves. Shedding of leaves takes place in the month of January. The branches are wide and spreading. The fairly dense crown is roundish. New foliage appears in month of February. The (white and fragrant) flowering occurs in the month of March and fruiting starts in the beginning of April. The fruit is a smooth (glabrous) and olive-like.

**Location I:** Total 18 species of birds were recorded at location I. Species richness was recorded to be highest in the month of March (15) which was a flowering period. Second highest species richness (14) was recorded in the month of February. Relative Abundance of Common Myna was highest 42.50 and 39.90 in the months July and October respectively. Least relative abundance (0.48) was of birds Common Golden-backed Woodpecker, Jungle Babbler, Little Brown Dove and White-breasted Kingfisher in the month of March. Highest species diversity (2.44) was recorded in the month of February. It was recorded to be lowest (1.63) in the month of December. Highest species evenness (0.84) was recorded in the month of May. Annual abundance of Common Myna (28.06) was found to highest followed by Rose-ringed Parakeet with second highest annual abundance (23.91). Common Golden-backed Woodpecker and White-breasted Kingfisher both shows the lowest (0.20) annual abundance.

**Location II:** Total 22 species of birds were found at this location. Species richness was recorded highest (19) in the month of March (new foliage stage) followed by 14 in April (fruiting Stage). It was found to be lowest (6) in the month of December. Highest relative abundance 68.00 and 62.96 of Common Myna was recorded in the month of December and November. Least relative abundance 0.52 was of Greater Coucal and Spotted Owllet in the month of April. Species diversity was found to be highest (2.45) in the month of February. Lowest species diversity (1.07) was recorded in the month of December. Species evenness was recorded to be highest (0.89) in the month of January. Species evenness was recorded lowest (0.57) in the month of November followed by 0.60 in December. Maximum annual abundance 37.31 of Common Myna was recorded. Second highest annual abundance 13.29 was of Rose-ringed Parakeet. Birds like Greater Coucal, Brown Fish-Owl, Common Golden-backed Woodpecker and Common Hoopoe shows the lowest (0.16) annual abundance.

**Pipal (*Ficus religiosa*):** Pipal belongs to family Moraceae. It is a large size tree with heart shaped leaves and spreading branches without aerial root. Figs turn dark purple on ripening and are consumed by flocks of birds. Ripening of fruits takes place in the month of March- April and also in October to November.

**Location I:** In total 31 species of birds were observed on Pipal tree during the present study. Species richness was found highest 22 in month of April. Fruiting on tree occurs during February- April and October – November which attracts more bird species during these months. Highest species diversity 2.73 was recorded in month of March. Species evenness was recorded highest in month of December that was 0.89. Highest relative abundance 31.41 and 31.37 of Rose-ringed Parakeet was observed in month of December and January respectively. Coppermith Barbet, Indian Treepie and Blue Rock Pigeon shows lowest relative abundance with

value of 0.36 in month of April. Common Myna was the first dominant bird species with 23.51 annual abundance followed by House Crow and Rose-ringed Parakeet with 19.51 and 17.97 annual abundance respectively. Other species with less annual abundance were Coppermith Barbet (0.13), Eurasian Wryneck (0.04), Common Golden-backed Woodpecker (0.13), Eurasian Golden Oriole (0.04), Indian Cuckoo (0.125), Asian Pied Starling (0.13) and White-breasted Kingfisher (0.13).

**Location II:** Total 25 species of birds were recorded on Pipal tree at village Machaki Mal Singh (Faridkot) during study period. Maximum number of species were found in the month of March (18). Species richness was lowest (5) in the month of December. Species diversity was highest in the month of April (2.28). It was lowest (1.51) in the month of August. Species evenness was highest in the month of September (0.88). Relative abundance of Rose-ringed Parakeet was highest in the month of December (50.0) and January (40.57). Relative abundance of Common Myna was second highest in the month of August (40.24) and September (38.77). Ramachandra *et al.* also reported that birds love to feed on figs and also help in seed dispersal <sup>[42]</sup>. Common Myna was the most dominant species with 29.29 annual abundance followed by 26.30 annual abundance of Rose-ringed Parakeet. Asian Pied Starling and Indian Shikra were least abundant bird species both having 0.08 annual abundance.

**Sheesham (*Dalbergia sissoo*):** It is fairly large deciduous tree with dark grey, rough and furrowed bark. It is fast growing tree adaptable and able to stand various temperatures. In the month of January- February tree is leafless and new foliage start appearing the month of March, flowering takes place in the month from March-April. Fruit ripens in the month of October and remain hanging on the trees for several months. Fruits are thin strap-shaped pods with kidney shaped light brown seeds.

**Location I:** Total 12 species of birds were recorded on Sheesham tree at location I. Species richness was maximum in the month of March (12). Species richness was almost same during all the three stages i.e. new foliage, flowering and fruiting stages. Marwaha also stated that Sheesham tree supports bird diversity <sup>[43]</sup>. Relative abundance of Common Myna (57.77) was highest in the month of September and July respectively. Least relative abundance of Little Brown Dove (0.56) was found in the month of February. Species diversity was highest in the month of March (1.93)). It was lowest 0.83 in the month of December. Species evenness was highest in month of February (0.79). It was found to be lowest 0.26 in the month of December. Annual abundance of Common Myna (39.52) was recorded to be highest. Second highest annual abundance (28.31) was of Rose-ringed Parakeet. Lowest annual abundance (0.38) was recorded of Spotted Owllet.

**Location II:** Total 10 species of birds were recorded at location II. Species richness was recorded to be highest (10) during flowering period in the month of April. It was 9 in the months of September, October, January, February and March. Lowest species richness 5 was recorded in the month of December. Highest relative abundance 64.10 and 60.68 was of Common Myna in the month of December and October respectively. Lowest relative abundance 0.60 was of both Black Drongo and Yellow-legged Green-Pigeon in the month

of April. Species diversity was recorded to be highest (1.72) in the month of February. Lowest species diversity 1.00 was found in the month of December. Species evenness was highest 0.78 in the month of February and it was lowest (0.62) in the months November and December. Annual abundance of Common Myna (42.76) was the highest. Lowest Annual abundance 0.58 was of Spotted Owlet.

Kruskal-wallis test was carried out to find if there was significant difference of bird diversity among tree species of location I and II separately. Significant difference exists only

among tree species of location 1 ( $p < 0.05$ ). This difference may be due to presence of different vegetation at different sites at location I whereas at location II same vegetation was present around all the trees. Mann-witney test was carried out to know if there was significant difference of bird diversity among individual tree species between location 1 and 2. Significant difference exists only in case of Neem tree. It may be due to difference in crown size of trees selected at both the locations. Crown size of Neem trees at location I was comparatively less than the Neem trees at location II.

**Table 1:** Avian species recorded in reference to indigenous trees

	Common Name ↓	Banyan		Jamun		Mulberry		Neem		Pipal		Sheesham	
		LI	LII	LI	LII	LI	LII	LI	LII	LI	LII	LI	LII
1	Ashy Prinia <i>Prinia socialis</i>	-	-	-	-	-	-	-	-	0.25	0.87	-	-
2	Asian Koel <i>Eudynamis scolopacea</i>	0.32	0.52	-	-	0.37	0.59	0.47	0.32	0.38	4.02	-	-
3	Asian Pied Starling <i>Sturnus contra</i>	0.59	-	-	-	1.05	-	-	-	0.13	0.08	-	-
4	Bank Myna <i>Acridotheres ginginianus</i>	0.32	-	-	-	0.31	1.13	-	-	0.50	0.16	0.87	1.02
5	Barn Owl <i>Tyto alba</i>	-	-	-	0.30	-	-	-	-	-	-	-	-
6	Bay-backed Shrike <i>Lanius vittatus</i>	-	-	-	-	0.18	-	-	-	-	-	-	-
7	Black Drongo <i>Dicrurus macrocercus</i>	2.73	2.21	2.19	3.15	1.66	2.50	5.08	5.80	1.13	2.83	2.87	3.07
8	Black Kite <i>Milvus migrans</i>	11.33	-	2.41	-	-	-	-	-	11.13	-	3.84	-
9	Black-crowned Night-Heron <i>Nycticorax nycticorax</i>	-	-	0.07	-	-	-	-	-	-	-	-	-
10	Black Redstart <i>Phoenicurus ochrurus</i>	-	-	-	-	0.31	0.15	-	-	-	-	-	-
11	Blue Rock Pigeon <i>Columba livia</i>	1.67	0.65	0.35	-	-	-	-	-	0.71	0.47	-	-
12	Brahaminy Starling <i>Sturnus pagodarum</i>	-	-	-	-	1.17	-	-	-	-	-	-	-
13	Brown-headed Barbet <i>Megalaima zeylanica</i>	-	-	-	-	0.06	-	-	-	0.33	-	-	-
14	Brown Fish- Owl <i>Ketupa zeylonensis</i>	-	-	-	-	-	-	-	0.16	-	-	-	-
15	Cattle Egret <i>Bubulcus ibis</i>	0.11	3.12	-	-	-	-	-	-	-	-	-	-
16	Common Golden-backed Woodpecker <i>Dinopium javanense</i>	-	-	0.21	0.30	-	-	0.20	0.16	0.13	0.24	-	-
17	Common Hoopoe <i>Upupa epops</i>	-	-	-	-	-	-	0.40	1.16	-	-	-	-
18	Common Myna <i>Acridotheres tristis</i>	18.89	31.17	36.16	45.65	26.15	24.94	28.06	37.31	23.51	29.29	39.52	42.76
19	Common Starling <i>Strnus vulgaris</i>	-	-	-	-	0.86	-	-	-	-	-	-	-
20	Common Tailorbird <i>Orthotomus sutorius</i>	-	-	-	-	1.29	0.66	3.21	8.06	0.42	-	-	-
21	Coppersmith Barbet <i>Psilopogon haemacephalus</i>	-	-	-	-	-	-	-	-	0.13	0.16	-	-
22	Eurasian Collared-Dove <i>Streptopelia decacto</i>	5.61	12.07	4.60	1.50	3.36	4.78	7.15	0.81	1.75	2.52	1.84	3.58
23	Eurasian Golden Oriole <i>Oriolus oriolus</i>	-	-	-	-	-	-	-	-	0.08	0.47	-	-
24	Eurasian Wryneck <i>Jynx torquilla</i>	-	-	-	-	-	-	-	-	0.04	-	-	-
25	Glossy Ibis <i>Plegadis falcinellus</i>	-	0.39	-	-	-	-	-	-	-	-	-	-
26	Greater Coucal <i>Catropus sinensis</i>	-	-	0.14	0.45	0.31	0.15	-	0.16	-	-	-	-
27	Grey Wagtail <i>Motacilla cinerea</i>	-	-	-	-	0.62	-	-	-	-	-	-	-
28	House Crow <i>Corvus splendens</i>	27.09	-	24.27	0.30	3.51	-	15.30	0.56	19.51	0.16	7.42	-
29	House Sparrow <i>Passer domesticus</i>	-	-	-	-	-	-	-	8.54	-	-	-	-
30	Indian Chat <i>Cercomela fusca</i>	-	-	-	-	-	0.74	-	0.64	-	1.42	-	-
31	Indian Cuckoo <i>Cuculus micropterus</i>	0.05	-	-	-	-	0.07	-	-	0.13	0.16	-	-
32	Indian Grey Hornbill <i>Ocyroceros birostris</i>	1.13	1.69	-	-	1.05	1.62	1.47	0.81	1.75	2.05	-	-
33	Indian Peafowl <i>Pavo cristatus</i>	0.70	-	-	-	-	-	-	-	0.33	-	-	-
34	Indian Roller <i>Coracias benghalensis</i>	-	-	-	-	0.25	0.22	-	-	-	-	-	-
35	Shikra <i>Accipiter badius</i>	-	-	-	-	-	0.07	-	-	0.13	0.08	-	-
36	Indian Treepie <i>Dendrocitta vagabunda</i>	0.92	1.95	-	-	0.74	0.81	1.07	1.13	0.58	0.71	-	-
37	Jungle Babbler <i>Turdoides striatus</i>	7.29	9.61	18.83	23.12	19.82	19.28	1.07	6.53	13.75	18.11	7.20	9.94
38	Little Brown Dove <i>Streptopelia senegalensis</i>	1.13	2.86	1.42	1.50	3.38	3.83	2.27	5.32	0.92	1.57	0.92	1.97
39	Little Cormorant <i>Phalacrocorax niger</i>	0.22	1.43	-	-	-	-	-	-	-	-	-	-
40	Oriental Magpie-Robin <i>Copsychus saularis</i>	-	-	-	-	0.25	0.22	-	-	0.25	-	-	-
41	Pied Crested Cuckoo <i>Clamator jacobinus</i>	-	-	-	-	0.12	-	-	-	-	-	-	-
42	Pied Wagtail <i>Motacilla maderaspatensis</i>	-	-	-	-	0.43	-	-	-	-	-	-	-
43	Purple Sunbird <i>Nectarinia asiatica</i>	-	-	-	-	1.05	0.09	1.40	2.18	0.79	0.39	-	-
44	Red-vented Bulbul <i>Pericrocotus cafer</i>	2.10	-	1.56	7.21	1.60	1.91	3.74	5.32	1.33	2.05	3.47	3.80
45	Rose-ringed Parakeet <i>Psittacula krameri</i>	15.27	24.29	4.39	14.86	20.12	22.52	23.91	13.30	177.97	26.30	28.32	28.44
46	Small Bee-eater <i>Merops orientalis</i>	-	-	1.84	-	1.91	2.94	2.34	-	0.96	1.65	-	-
47	Spotted Dove <i>Streptopelia chinensis</i>	0.05	-	-	-	-	-	-	-	-	-	-	-
48	Spotted Owlet <i>Athene brama</i>	1.73	-	-	-	3.26	4.05	-	0.56	0.29	-	0.38	0.58
49	White-breasted Kingfisher <i>Halcyon smyrnensis</i>	-	-	0.28	0.60	-	-	0.20	0.81	0.13	1.65	-	-
50	Yellow-legged Green-Pigeon <i>Motacilla flava</i>	1.13	5.97	0.99	1.51	4.12	5.89	2.67	1.37	1.42	4.17	3.36	4.82
51	Yellow Wagtail <i>Treron phoenicoptera</i>	-	-	-	-	0.43	-	-	-	-	-	-	-
	Species richness	22	15	16	13	-	-	18	21	31	25	12	10

**Table 2:** Order wise distribution of bird species observed on selected indigenous trees

Sr. No.	Trees →	Banyan		Jamun		Mulberry		Neem		Pipal		Sheesham	
	Orders ↓	LI	LII	LI	LII	LI	LII	LI	LII	LI	LII	LI	LII
1	Accipitriformes	-	-	-	-	-	0.07	-	-	0.13	0.08	-	-
2	Bucerotiformes	1.13	1.69	-	-	1.05	1.62	1.47	0.81	1.75	2.05	-	-
3	Ciconiformes	11.44	3.12	2.41	-	-	-	-	-	11.13	-	3.84	-
4	Columbiformes	9.59	21.55	7.36	4.51	11.13	14.50	12.09	7.50	4.80	8.73	6.12	10.37
5	Coraciiformes	-	-	2.12	0.60	2.16	3.16	2.54	0.81	1.09	3.30	-	-
6	Cuculiformes	0.37	0.52	0.14	0.45	0.80	0.81	0.47	0.48	0.13	4.18	-	-
7	Galliformes	0.70	-	-	-	-	-	-	-	0.33	-	-	-
8	Passeriformes	58.93	47.80	83.01	79.43	59.83	52.43	58.93	76.47	62.23	56.54	61.35	60.59
9	Pelicaniformes	-	0.39	0.07	-	-	-	-	-	-	-	-	-
10	Piciformes	-	-	0.21	0.30	0.06	-	0.20	-	0.63	0.40	-	-
11	Psittaciformes	15.27	24.29	4.39	14.86	-	22.52	23.91	13.3	17.97	26.30	28.32	28.44
12	Stringiformes	2.73	-	-	0.30	3.26	4.05	-	0.72	0.29	-	0.38	0.58
13	Suliformes	0.22	1.43	-	-	-	-	-	-	-	-	-	-
14	Upupiformes	-	-	-	-	-	-	0.40	1.16	-	-	-	-
Total no. of species		9	8	8	7	7	8	8	9	11	8	5	4

**Table 3:** Distribution of bird species on selected indigenous trees in reference to their feeding habit

Sr. no.	Trees →	Banyan		Jamun		Mulberry		Neem		Pipal		Sheesham	
	Feeding habits ↓	LI	LII	LI	LII	LI	LII	LI	LII	LI	LII	LI	LII
1	Carnivores	11.33	1.43	2.41	0.30	-	-	0.20	0.97	11.13	-	3.84	-
2	Frugivores	16.40	30.18	5.38	16.16	25.29	28.50	27.98	16.85	20.13	31.02	31.68	33.26
3	Granivores	7.46	15.58	23.78	4.62	7.01	8.61	9.42	6.69	3.38	4.56	2.76	5.55
4	Insectivores	6.08	7.67	7.71	13.51	11.45	13.71	12.30	17.67	5.82	10.24	4.12	4.67
5	Omnivores	58.21	45.85	60.40	65.95	56.26	48.34	50.11	58.83	61.02	55.76	57.61	56.50

#### 4. Conclusion

Total 51 species of birds were recorded belonging to 14 orders. Highest species richness (31) was recorded on Pipal tree at location I and lowest (10) was recorded on Sheesham at location II. House Crow, Common Myna, Jungle Babbler and Rose-ringed Parakeet were the most abundant birds recorded on selected indigenous tree species. Black Kite and House Crow were abundant only at location I and were rarely observed at location II. Spotted Owlet, Doves, Red-vented Bulbul were commonly observed birds at both the locations where as White-breasted Kingfisher, Asian Koel, Indian Rollers and Indian Tree pie were observed in less frequently. Presence of some migratory birds like Brown Fish-owl, Glossy Ibis, Spotted Dove and Indian Cuckoo were observed on indigenous trees during the fruiting periods which coincide with their respective migratory season. The order Passeriformes was the most dominant order out of the total fourteen orders of bird species observed. Among feeding habits, omnivorous birds were in higher proportion as compared to birds having other feeding habits. The study suggested that different bird communities utilize the indigenous trees for roosting, feeding, nesting and other activities, in different ways. In the light of these facts plantation and protection of these trees over exotic trees is the need of the hour. Therefore, further work should be carried out to support and strengthen this idea.

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