



(RESEARCH ARTICLE)



## Study on diel variation and effect of anthropogenic activities on birds

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### Abstract

**Background:** It has been claimed that the turndown of insect population due to strengthening agriculture may have led to a reduction in the number of farmland birds some autecological studies support this postulate. Insect abundance is significantly associated with bird density measures large scale invertebrate sampling was done using suction traps and results showed that with time as food quality and quantity changes there is a decline in farmland birds.

**Method:** The study was conducted for a period of one year, point count method was adopted to record these parameters. Relevant field guides were used to identify observed bird and insect species. Several avian species were seen preying on several insects. Such instances were listed and we also concluded about the insectivorous nature of several avian species based on sightings.

**Results:** In all the four sites collectively, order Lepidoptera of Insect fauna is dominant in all the four study sites. Several anthropogenic stresses were reported in the present study, these activities should be checked regularly and must be prohibited. During three time slots, the activity of birds was recorded and family wise bird activity were observed. Results showed that there were few species common in all the three-time slots and some disparity was recorded in their availability in the morning, noon, and evening respectively.

**Keywords:** Indore; Avifaunal Diversity; Indices; Urban; Line transect

### 1. Introduction

The relation between insect and birds fall into three categories. Firstly, when a bird builds its nest near of nests of aggressive insect, Secondly, when insect lay their eggs inside a bird's nest, and then larvae, commensal with the young ones of the birds and lastly, birds build their nests in insect nest or structure by scooping out the central part of insect's nest [1]. They can do so because they might be guided by some odor and by some unknown influences [2]. Farmland wildlife is affected by agricultural practices. This is still a topic of debate for many [3]. Due to their diversification in feeding habits, birds are dependent on fruits, nectar, insects, grains, fishes, plants parts and dead decaying remains of other organisms and this dependency has led to decline in their population in the 21st century [4]. Birds play a vital role in controlling insect population. Hunting and poaching by local population are still a threat to avian diversity. Therefore, our study is an attempt to estimate the existing insect population and its effect on bird diversity with anthropogenic activities nearby.

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## 2. Material and methods

The objective of this study was to record the diel variation in avian species, effect of insect population on bird population and to study various anthropogenic activities in our study area.

### 2.1. Study area

Nehru Park of Indore city was selected for the above study.

### 2.2. Method

Point count method.

### 2.3. Parameters

The insect fauna of each station was studied according to [3] and the data was arranged in following orders of insects. These data were compared with the diversity of birds found at station. Anthropogenic activities and its role on avifauna were studied [5]. Monitoring of all the study sites were done regularly and local anthropogenic stress was recorded. Diel variation of the various bird species was recorded [6]. Random sites were selected from the study site covering all environments (e.g. grassy area, large heighted trees with no shrubs and plain barren land) were considered for the following study. Sites was surveyed regularly throughout the year 2018. The counting of bird species took place in several intervals during the study duration. Study time was divided into three sections: The time intervals were as follows; 9 to 11 AM, 1 to 3 PM and 5 to 7 PM. According to the observed activity Diel variation was recorded in decreasing order of observed data.

## 3. Results

### 3.1. Relation between Insect and Bird Population

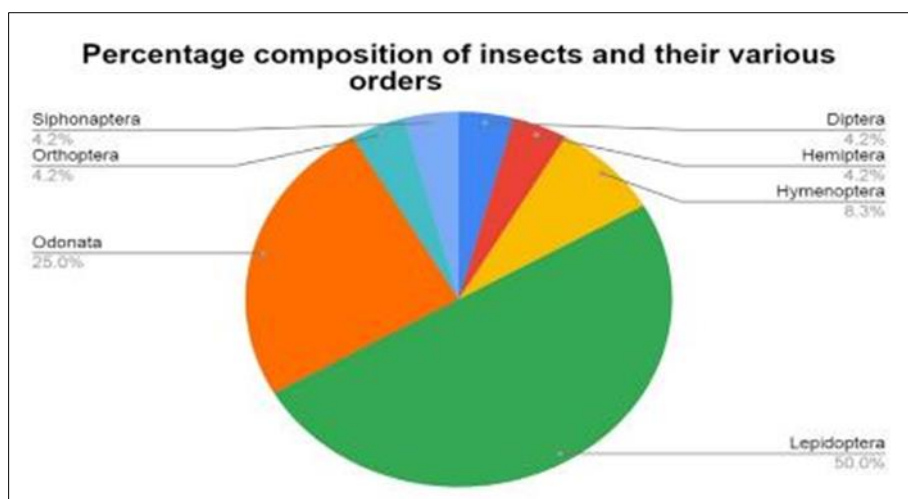
Nehru Park shows a diversity of twenty four species which are as follows; House fly (*Musca domestica*), Lantern bug (*Zanna affinis*), Honey bee (*Apis indica*), Weaver ant (*Oecophylla smaragdina*), Common bushbrown (*Mycalesis perseus*), Common emigrant (*Catopsilia pomona*), Common grass yellow (*Eurema hecabe*), Common mormon (*Papilio polytes*), Lemon pansy (*Junonia lemonias*), Danaid egg fly (*Hypolimnas misippus*), Great egg fly (*Hypolimnas bolina*), Common jezebel (*Delias eucharis*), Mottled emigrant (*Catopsilia pyranthe*), Lime butterfly (*Papilio demoleus*), Plain tiger (*Danaus chrysippus*), Small grass yellow (*Eurema brigitta*), Coral tailed cloud wing (*Tholymis tillarga*), Asiatic blood tail (*Lathrecista asiatica*), Common clubtail (*Ictinogomphus rapax*), Common hook tail (*Paragomphus lineatus*), Ditch jewel (*Brachythemis contaminata*), Parakeet Darner (*Gynacantha bayadera*), Common indian grasshopper (*Acrida exaltata*) and Flea (*Ctenocephalides orientis*). There were eight orders: Diptera, Hemiptera, Hymenoptera, Lepidoptera (dominant), Odonata, Orthoptera and Siphonaptera (Figure- 1). Therefore, this study site is rich in insect diversity which can be helpful in maintaining and attracting a good population of insectivorous avian fauna.

### 3.2. Insect and Bird association

While adopting point count method several avian species were seen praying on several insects. Such instances were listed and we also concluded about the insectivorous nature of several avian species based on sightings: Black drongo (*Dicrurus macrocercus*) was observed catching butterflies and other flying insects from the grass. We can conclude that this species is dependent on insect orders like Diptera, Lepidoptera and Hymenoptera for food. Green beef eaters (*Merops orientalis*) were also seen catching wasps and honey bees (order Hymenoptera and Diptera) in the summer season near flowering trees like *Butea monosperma* and *Ficus religiosa*.

Indian grey hornbill (*Ocyrceros birostris*) was observed twice feeding and praying differently. Firstly, they were reported near a *Butea monosperma* tree catching honey bees (order Hymenoptera) and secondly on a *Ficus religiosa* eating its bulb like fruits. Group of Jungle babblers (*Turdoides striata*) were often reported eating several insects on the ground beneath the leaves and other tree twigs. They were feeding on insects like ants, beetles and bugs of the order Hymenoptera, Coleoptera and Hemiptera. Green beef eater (*Merops orientalis*) individual population was the highest garden because of a dumping site near this park. It was seen praying on dragonflies flying near this garbage site. In our study the population of House sparrow (*Passer domesticus*) was also high and House Sparrow were observed feeding on beetles and dipteran insects on the ground. Greater coucal (*Centropus sinensis*) population were seen foraging on ground for insects of order Orthoptera, Phasmatodea and Mantodea.

In Nehru park, 34 bird species of 12 order and twenty-four species of various insects were reported and their percent composition is as follows: Diptera (4.2%), Hemiptera (4.2%), Hymenoptera (8.3%), Lepidoptera (Dominant) (50.0%), Odonata (Dragon fly) (25.0%), Orthoptera (4.2%) and Siphonaptera (4.2%). In our site, order Lepidoptera of Insect fauna is dominant, the results show a close association of bird diversity and insect population in these study sites.



**Figure 1** Various Insect orders and their percent composition at Nehru Park

### 3.3. Anthropogenic activities and its role on avian fauna

There may be several advantages of keeping a dustbin in a public place but one major disadvantage of this is that several avian species were seen feeding or searching for food in such dustbins. Generally, these dustbins are closed in the morning but in evening they are filled with waste and species like *Dendrocitta vagabunda*, *Copsychus saularis* and several squirrels were feeding on the left-over food. In Monsoon season, the grasses and short shrubs grow exponentially but, in post monsoon the authorities usually prune and remove all those overgrown parts of shrubs and grasses. In that process, species which built their nest preferring short bushes, lose their nest. Few species like *Pavo cristatus* are highly affected. Authors have noticed the broken nest of *Prinia socialis* and *Orthotomus sutorius*. These greenspaces have a large area and it cannot be fenced due to uneven land. Stray animals like cats, dogs, and cows come inside and create a menace for tourists and other avian species (Figure 2).

Dogs were seen attacking and chasing and hunting *Columba livia*, *Streptopelia senegalensis* and *Streptopelia chinensis*. The canal or any other low-level area in a given study area fills with water in monsoon and leads to growth of grasses and other weeds. This place is breeding and nesting for species like *Vanellus indicus* and *Amaurornis phoenicurus* but in post monsoon, this overgrown greenery is cleaned manually, destroying several nests and abandoning of chicks for predators. Biodegradable waste accumulated by continuous cleaning of these greenspaces lead to a pile of leaves, twigs and dead branches. To get rid of this fire in the leaves is done. Sometimes this is controllable but on odd days, fire becomes large leaving all the nearby grass, shrubs and trees burnt destroying the nesting/roosting sites of *Passer domesticus* and *Halcyon smyrnensis*.

The visitors often enter into core undisturbed areas for photography for several purposes. They are generally interrupted by the patrolling guards. But few tourists/visitors were seen chasing *Pavo cristatus* for photography. They enter untrodden roads and create chaos everywhere. Though, there are several fruit bearing trees in these greenspaces but they bear fruit in different seasons. The visitors often spread leftover food crumbs for the birds like *Turdoides striata* and *Psittacula krameri*. In addition to this guard of these green spaces (our study sites) regularly spray grains like jowar, wheat and bajra at specific locations regularly. But when these activities are not done what must be happening to the species is a matter of concern (Figure 3).

One of the major problems for sustaining bird populations is the increasing population of squirrels in these areas. These squirrels were competing for food resources and squirrels eat away the eggs of avian species due to their carnivorous nature. The green spaces have a good water supply for the whole year but sometimes due to negligence and other technical problems water supply stops and species like *Dicrurus macrocercus* and *Halcyon smyrnensis* were seen near the water fountain and others swamp with no water in it. There were people who entered one of the study sites with a poly bag and they were seen collecting crabs by displacing huge rocks near the water body. Their movement across the



shore of the water body created chaos for *Ardeola grayii* and other waders. Therefore, several anthropogenic activities were reported (Figure 2 &3).



Several species feeding on food/ grains thrown by guards and visitors.



Red wattle lapwing and its chick without a nest in the ground (earlier nest was visible).



A pair of Indian grey hornbill can be seen on the electric wires near the study area.



Rufous treepie is seen foraging on the grains sprayed by visitors.



Red Vented bulbul is seen eating the leftover food near the dustbin.



A nest of some species is found at the back of the air conditioner; it was an abandoned nest.



In post monsoon period the areas with long grasses are being removed using a lawn mower; it damages roosting and nesting sites of species like House Sparrow and Ashy Prinia.



Using lawn mower in short bushes have lead to damage of nest of Ashy Prinia.

**Figure 2** Some Images relating to anthropogenic stresses of avian fauna





**Figure 3** Some more Images relating to anthropogenic stresses of avian fauna

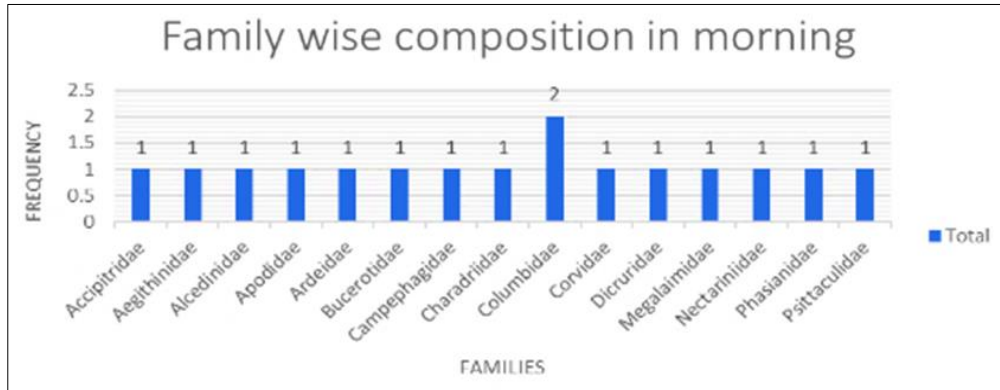
### 3.4. Diel variation of the various bird species

In the present study all sites were surveyed regularly throughout the year 2018. The counting of bird species took place in several intervals during the study duration. The time intervals were as follows; 9 to 11 AM, 1 to 3 PM and 5 to 7 PM (Time Slot 1, 2 and 3 respectively).

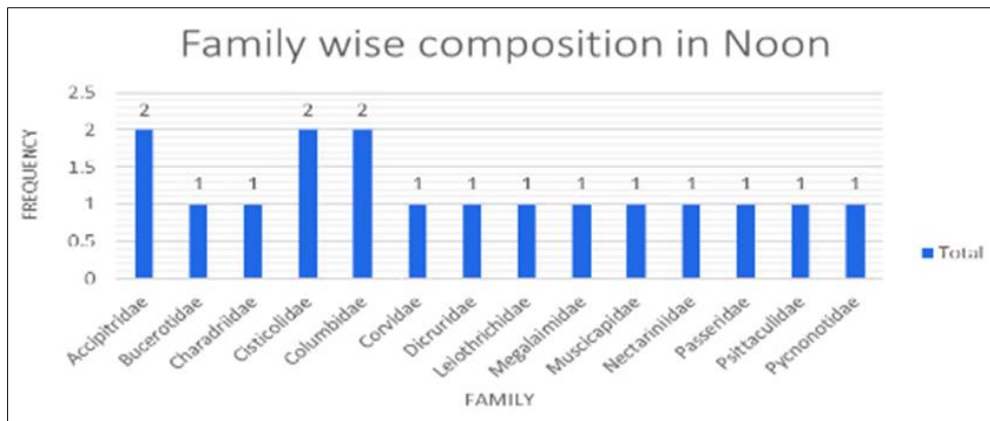
The results show that 16 species were recorded in Morning (Figure 4) and species were; *Pavo cristatus*, *Columba livia*, *Streptopelia senegalensis*, *Apus affinis*, *Ardeola grayii*, *Vanellus indicus*, *Milvus migrans*, *Ocyrceros birostris*, *Psilopogon*

*haemacephalus*, *Halcyon smyrnensis*, *Psittacula krameri*, *Pericrocotus cinnamomeus*, *Aegithina tiphia*, *Dicrurus macrocercus*, *Dendrocitta vagabunda* and *Cinnyris asiaticus*.

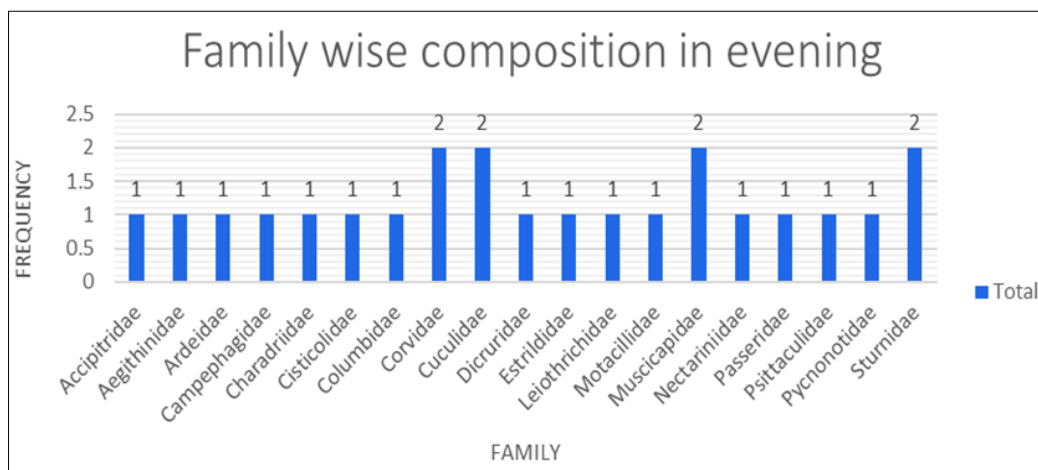
During noon (Figure 5) this number decreased to 17 which included species like *Columba livia*, *Streptopelia senegalensis*, *Vanellus indicus*, *Elanus caeruleus*, *Accipiter badius*, *Ocyrceros birostris*, *Psilopogon haemacephalus*, *Psittacula krameri*, *Dicrurus macrocercus*, *Corvus splendens*, *Cinnyris asiaticus*, *Passer domesticus*, *Prinia socialis*, *Orthotomus sutorius*, *Pycnonotus cafer*, *Turdoides striata*, and *Copsychus saularis*.



**Figure 4** Family wise species composition in Morning (Time Slot 1)



**Figure 5** Family wise species composition in Noon (Time Slot 2)



**Figure 6** Family wise species composition in Evening (Time Slot 3)

**Table 1** Family wise species composition in Morning, Noon and Evening (Time Slot 1, 2 and 3)

S. No.	Scientific Name	TS1	TS2	TS3	Order	Family
1	<i>Pavo cristatus</i>	1	0	0	Galliformes	Phasianidae
2	<i>Columba livia</i>	1	1	0	Columbiformes	Columbidae
3	<i>Streptopelia chinensis</i>	0	0	1	Columbiformes	Columbidae
4	<i>Streptopelia senegalensis</i>	1	1	0	Columbiformes	Columbidae
5	<i>Apus affinis</i>	1	0	0	Caprimulgiformes	Apodidae
6	<i>Centropus sinensis</i>	0	0	1	Cuculiformes	Cuculidae
7	<i>Eudynamys scolopaceus</i>	0	0	1	Cuculiformes	Cuculidae
8	<i>Ardeola grayii</i>	1	0	0	Pelecaniformes	Ardeidae
9	<i>Bubulcus ibis</i>	0	0	1	Pelecaniformes	Ardeidae
10	<i>Vanellus indicus</i>	1	1	1	Charadriiformes	Charadriidae
11	<i>Elanus caeruleus</i>	0	1	0	Accipitriformes	Accipitridae
12	<i>Accipiter badius</i>	0	1	0	Accipitriformes	Accipitridae
13	<i>Milvus migrans</i>	1	0	1	Accipitriformes	Accipitridae
14	<i>Ocyrceros birostris</i>	1	1	0	Bucerotiformes	Bucerotidae
15	<i>Psilopogon haemacephalus</i>	1	1	0	Piciformes	Megalaimidae
16	<i>Halcyon smyrnensis</i>	1	0	0	Coraciiformes	Alcedinidae
17	<i>Psittacula krameri</i>	1	1	1	Psittaciformes	Psittaculidae
18	<i>Pericrocotus cinnamomeus</i>	1	0	1	Passeriformes	Campephagidae
19	<i>Aegithina tiphia</i>	1	0	1	Passeriformes	Aegithinidae
20	<i>Dicrurus macrocercus</i>	1	1	1	Passeriformes	Dicruridae
21	<i>Dendrocitta vagabunda</i>	1	0	1	Passeriformes	Corvidae
22	<i>Corvus splendens</i>	0	1	1	Passeriformes	Corvidae
23	<i>Cinnyris asiaticus</i>	1	1	1	Passeriformes	Nectariniidae
24	<i>Euodice malabarica</i>	0	0	1	Passeriformes	Estrildidae
25	<i>Passer domesticus</i>	0	1	1	Passeriformes	Passeridae
26	<i>Motacilla alba</i>	0	0	1	Passeriformes	Motacillidae
27	<i>Prinia socialis</i>	0	1	0	Passeriformes	Cisticolidae
28	<i>Orthotomus sutorius</i>	0	1	1	Passeriformes	Cisticolidae
29	<i>Pycnonotus cafer</i>	0	1	1	Passeriformes	Pycnonotidae
30	<i>Turdoides striata</i>	0	1	1	Passeriformes	Leiothrichidae
31	<i>Gracupica contra</i>	0	0	1	Passeriformes	Sturnidae
32	<i>Acridotheres tristis</i>	0	0	1	Passeriformes	Sturnidae
33	<i>Saxicoloides fulicatus</i>	0	0	1	Passeriformes	Muscicapidae
34	<i>Copsychus saularis</i>	0	1	1	Passeriformes	Muscicapidae

In evening, (Figure 6) the number of bird species increased to 23 which include; *Streptopelia chinensis*, *Centropus sinensis*, *Eudynamys scolopaceus*, *Bubulcus ibis*, *Vanellus indicus*, *Milvus migrans*, *Psittacula krameri*, *Pericrocotus cinnamomeus*, *Aegithina tiphia*, *Dicrurus macrocercus*, *Dendrocitta vagabunda*, *Corvus splendens*, *Cinnyris asiaticus*, *Euodice malabarica*, *Passer domesticus*, *Motacilla alba*, *Orthotomus sutorius*, *Pycnonotus cafer*, *Turdoides striata*, *Gracupica contra*, *Acridotheres tristis*, *Saxicoloides fulicatus* and *Copsychus saularis*.

During time slot 1, the bird individuals which were counted were 273 in morning, then this number of birds decreased to 215 in noon (time slot 2) which finally increased to 409 in evening (time slot 3). Hence, there were few species common in all the three time slots and some disparity was recorded in their availability in morning, noon and in evening respectively.

Species like *Vanellus indicus*, *Psittacula krameri*, *Dicrurus macrocercus* and *Cinnyris asiaticus* were the abundant and common species in all the time zones. Their population is quite large and they are frequently recorded. Few species recorded were time specific according to their presence during a certain time example *Pavo cristatus*, *Apus affinis*, *Ardeola grayii* and *Halcyon smyrnensis* were reported only in Morning time slot, but some bird species were observed in noon time when temperature is at peak; species were *Elanus caeruleus*, *Accipiter badius* and *Prinia socialis*. Bird species which were reported only in the evening time Slots were *Streptopelia chinensis*, *Centropus sinensis*, *Eudynamys scolopaceus*, *Bubulcus ibis*, *Euodice malabarica*, *Motacilla alba*, *Gracupica contra*, *Acridotheres tristis* and *Saxicoloides fulicatus*.

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#### 4. Discussion

Our findings clearly depict that in Nehru park, 34 bird species of 12 order and twenty-four species of various insects were reported and their percent composition is as follows: Diptera (4.2%), Hemiptera (4.2%), Hymenoptera (8.3%), Lepidoptera (Dominant) (50.0%), Odonata (Dragon fly) (25.0%), Orthoptera (4.2%) and Siphonaptera (4.2%). Moreover, [21] published sixty-one species of insects from ten different orders out of which Lepidoptera was dominant with twenty-eight species and 150 bird species were reported from at Nawabganj bird sanctuary by following line transect and quadrat grid method (Table 1; Figure 1). [7] Listed ten orders of insects with sixty-one species and 157 bird species from Sandi bird sanctuary. Such a high count of insects and birds shows a very favorable environment for their interaction and in their study order Lepidoptera was dominant with twenty-eight species.

The various anthropogenic stresses were studied and authors have highlighted various points such as several avian species were seen feeding or searching for food in such dustbins. Species like *Dendrocitta vagabunda*, *Copsychus saularis* and several squirrels were feeding on the leftover food. [8] Reported 20 species at a Talab in Indore (M.P.) and reported several anthropogenic activities in the study area. Evidence of dumping of Idol was reported and the water was used extensively for various purposes other than conservation. On the other hand, they correlated these activities to the decreasing population of waterfowl (Figure 2-3).

The other issue is flooding of low-level areas in these green spaces and this place can be a breeding and nesting for species like *Vanellus indicus* and *Amaurornis phoenicurus*. Various direct and indirect threats like discharge of chemicals (pesticides and herbicides) in water bodies have led to decrease in waterfowl and native biota but anthropogenic stresses can be regulated and that would potentially increase bird watching [9].

Incidences of hunting of *Pavo cristatus* were reported by tribal people but they have majorly reported deforestation as a reason for avian species fragmentation [10]. In our study fire in the waste becomes uncontrollable leaving all the nearby grass, shrubs and trees burnt destroying the nesting/roosting sites of *Passer domesticus* and *Halcyon smyrnensis*. Sporadic fires in forest and associated areas hugely affect old and dead dried trees and in some cases it is uncontrollable. So, regular patrolling should be done to avoid such instances and it can be disastrous for the whole or cavity nesting bird population [11].

Reduction in nesting sites due to various anthropogenic stresses (human disturbances) can also lead to a case of passive coloniality [12]. On the other hand, the outside forces that lead to habitat destruction include invasion of exotic ornamental plants, excessive use of weedicides [13]. In our findings people have entered study sites for collecting crabs by displacing huge rocks near the water body. Excess tourism or entry of several people in the green spaces also leads to overcrowding and hampers the natural equilibrium [14]. They also mentioned that presence of livestock and people majorly affect threatened birds' population, so, mitigation measures must include construction of a mosaic environment with the least human disturbances.



Chicks of *Vanellus indicus* were seen caught by small kids for no reason and menace of dogs were also reported by [15]. Similarly, authors have seen stray animals like cats, dogs, and cows inside and creating a menace for tourists and other avian species. Dogs were seen attacking and chasing and hunting *Columba livia*, *Streptopelia senegalensis* and *Streptopelia chinensis*. Some activities like giving regular grains for feeding can enhance the population of *Passer domesticus* as observed by [16] but in our case these food resources are well used by squirrels and as a result their population has increased over the years and now because of their omnivorous nature eat away eggs of other bird species. In addition to this our study area has a good water supply for the whole year but due to irregularities this goal is not achievable.

[17] Reported similar environmental stresses for avian species like hunting of birds by anti-social elements for recreation, dumping of waste in the open area near study sites, entry of domestic pigs and their menace. We have reported the problem of the grasses and short shrubs pruning which leads to damaging of nests of *Pavo cristatus* and have noticed the broken nest of *Prinia socialis* and *Orthotomus sutorius*. Such tourism pressure can lead to withdrawal behaviour during breeding. Breeding patterns may change due to traffic and noise, but it can also lead to habituation [18]. The visitors often enter core undisturbed areas for photography for several purposes and were seen chasing *Pavo cristatus* for photography. The visitors often spread leftover food crumbs for the birds like *Turdoides striata* and *Psittacula krameri*. But when such care is not being taken on holidays what must be happening to the species is a matter of concern. Developments of skyscrapers and residential complexes have led to habitat fragmentation of avian species. But, on the other hand, authorities can't stop such a process but they can regulate the maintenance of remaining green spaces at utmost priority for conserving and enhancing these species' population [17]. In our study thirty-four species were reported for Diel variation study. The results showed that the family Columbidae was dominant with frequency 2 in morning which was highest among all other families, while in the noon the number increased to seventeen species and the dominant family was Accipitridae, Cisticolidae and Columbidae with a frequency of two species each. Lastly the number of bird species recorded increased to twenty-three species. The dominant families were Corvidae, Cuculidae, Sturnidae and Muscipidae with a frequency of two species. Similarly [20] reported thirty species while studying Diel variation in waterfowl at Sirpur tank. These waterfowl belonged to nine families and six different orders. Hence, our study results corroborate with the above-mentioned authors. Therefore, the above study results are an attempt to comprehend the observed Diel variation for terrestrial species.

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## 5. Conclusion

While adopting the point count method several avian species were seen preying on several insects. Such instances were listed and we also concluded about the insectivorous nature of several avian species based on sightings. The above data in results shows a close relationship between the insects' diversity and the insectivorous bird population. In all the four sites collectively, order Lepidoptera of Insect fauna is dominant in all the four study sites. The study reveals the utmost importance for maintaining such greenspaces. Several anthropogenic stresses were reported in the present study, these activities should be checked regularly and must be prohibited. During time slot 1, the bird individuals which were counted were 273 in the morning, then this number of birds decreased to 215 in the noon (time slot 2) which finally increased to 409 in the evening (time slot 3). Hence, there were few species common in all the three-time slots and some disparity was recorded in their availability in the morning, noon, and evening respectively. During the end of monsoon season, cutting and pruning is done for removal of weeds which outgrow the normal plantation which alter the habitat. In all the study sites intrusion of local people was also noted. Dead waste of fallen leaves is collected and burnt regularly which cause sporadic fire which leads to loss of habitat of avian fauna residing nearby. Due to lack of water supply, small plants get dry and this is also loss nesting site of few birds.

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## Compliance with ethical standards

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*Disclosure of conflict of interest*

There are no conflicts of interest to declare.

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