

Research Article

Impact of Urbanization on Population Abundance of Some Passerines in the Outskirts of Faisalabad

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Introduction

Passerines, part of the Passeriformes order, are omnivores found in tropical zones except Antarctica. They have three toe arrangements and are characterized by their 7.5-117cm body length. Passerines are omnivores and pollinators, assisting in plant growth. There are approximately 313 species reported, with over 400 recorded in Pakistan. Urbanization, where natural and agronomic fields are converted into residential colonies, trading, and housing, is causing a reduction in passerine population. The growth rate of urbanization is expected to reach 70% by 2050, with increasing numbers in developing countries. Researchers have found that passerine domesticus have a brighter body mass in urbanized areas compared to rural conspecifics. Urbanization has significantly impacted the habitats and species diversity of passerine birds, a bird belonging to the order Passeriformes. This has led to habitat destruction, reduced reproductive success, increased stress levels, and competition between species. Urbanization affects the songbird population in two ways: directly by fluctuating habitats and ecosystem processes, and indirectly by disease organisms, predators, and competitors. Urbanized areas in forested North America support larger populations of bird species, while house wrens and white-eared ground sparrows forage in constructional areas. Environmental pollution, such as artificial light pollution, affects animal orientation, behavior, production, foraging communication, and migration. Urban waste, such as biomass, solid waste combustion, traffic vehicles, and heavy metal sources, also contribute to environmental pollution. Urbanization has led to a decline in the distribution and population status of avifauna worldwide, with passerine birds like the house sparrow experi-

Abstract

This study which described the urbanization effects on the two passerines (*Corvus splendens* and *Passer domesticus*) have amply provided information that the impact of urbanization appears to be taking heavy toll of wildlife in Pakistan. Unrealistic and without any plan urbanization to cater for the large influx of population as caused serious declined in the small and large mammals and also beneficial birds. It was recorded the roost exists for house sparrow in the morning were 69 ± 5.05 , the roost return 18 ± 1.83 , foraging 65 ± 4.54 , mobbing behavior was 17 ± 1.24 , bird scuffles 17 ± 1.17 and overall numerical values in the morning 257 ± 12.80 . It was evident that impact of urbanization in the Gutwala and its vicinities were far less as compared to the situations which existed several decades ago with the increase of population abundance. It is, therefore, highly significant that the conservation of wildlife remains very important and should be managed in later and spirit by equatorially managing wildlife populations and human requirements, with least impacts recorded on the wildlife sustainability.

encing a decline. This is due to factors such as predator diversity, habitat availability, food availability, competition, and disease outbreaks. Urbanization has also affected the topsoil, affecting the migratory patterns of urban birds. The loss of natural habitat patches, isolation, and fragmentation are some of the effects of urbanization. Human activities, such as anthropogenic activities, noise, pollution, and heat islands, also contribute to these changes. Species richness decreases with increasing urbanization and changes in species composition. Urbanization also impacts ecosystems and natural habitats, with factors such as toxins, human disturbance, pollution, and noise contributing to these changes. House sparrows, once successfully urbanized, are experiencing a decline due to loss of food sources and nesting sites, pollution, and predation by domestic cats. Croci et al. (2008) studied the biotic homogenization of global avifauna related to urbanization, which functioned as a filter on species traits and biological traits shared by passerine birds. They found 18 biological traits, including morphometric, distribution, feeding, and general biology, in passerine birds. Kalel et al. (2012) studied avifaunal density and diversity in larger cities like Maharashtra and Amravati, India, and found that urban adopters preferred forest environments with sedentary, omnivorous nature. However, there was no link between species tolerance level and traits in local analysis. Bokony et al. (2012) studied the effects of urbanization on wildlife increases worldwide and the seasonal changes in adult body size of house sparrows, which declined in urban areas throughout the year. They found that the same level of heterophil: lymphocyte ratio, hematocrit, and corticosterone in urban and rural birds in non-breeding season showed

no systematic variations. Yul and Yanshu (2013) conducted a survey in China on population abundance of birds in different habitats from Nov 2004-Jul 2005, finding that urbanization was responsible for declining maximum numbers of species. Urbanization caused by human population abundance closed in between 50-2000 m cushion area along with wilderness habitat. Kang et al. (2015) discussed the conservation of urban diversity and bird communities as a conservation target due to their functions in ecosystems and food webs. Forest bird communities were affected by factors such as human disturbance, habitat connectivity, and local habitat characteristics in 44 small forest patches. Seress and Andras (2015) explained that human evolution caused changes in environmental habitats due to urbanization, impacting ecological communities under urbanization. This study focused on community-level changes and factors of urban surroundings affecting bird morphology, physiology, and behavior. Urbanization significantly impacts biodiversity, breeding success, and bird territory size. Studies in Costa Rica and India found a strong relationship between territory size and urban surfaces for passerines like White-eared ground sparrows and House wrens. In Delhi, India, anthropocentric activities led to the decline of house sparrows. Urbanization levels affected occupancy and population rates, with low density areas experiencing higher rates. However, house sparrow populations were conserved in areas with low abundance.

Materials and Methods

The study examines the impact of urbanization on passerine population abundance in Faisalabad's nearby vicinities, focusing on sub-habitats affected by residencies and industrial units.

Study Sites

A survey of about 10km was made through vehicle survey near the Gut wala forest plantation. There is undeniably fairly thick forest plantation closed to this research institution. Ironically, this institution also serves for the wildlife of Central Punjab with well-established breeding center for Crocodiles.

Nonetheless, fairly close to it, the plantation which occurred in good proportions some decades back and comprised significant roost of the passerine birds, today owing to the influx of industries and also the residential colonies to accommodate the increasing population of humans no longer exist. Several birds are almost devoid of their sustainable roost and find it difficult to mobilize their diurnal activities.

Methods

For the present study, two passerine birds viz. house crow (*Corvus splendens*), house sparrow (*Passer domesticus*) were critically studied in terms of their roosting sites, roost composition and estimating their population status. The roost composition was critically lowered as compared to that of the past. The four sub-sites were sampled with a view to count the numbers of existing numbers of house sparrow and house crow respectively. The first sub-sites which was Bhai wala, Mana wala, Dar-ul- Ehsan and Chak Jhumra respectively. Observations were successively conducted in all these four sub- habitats and were conducted for three hours each in the morning and evening hours. Per hour time interval in the morning and evening were of 20 minutes with critical observations in the morning and evening hours. Birds exist and return from their roost and all these four sub-habitats with respect to urbanized environmental was conducted.

Statistical Analysis

The obtained data was statistically analyzed using the Tukey's test, Analysis of Variance (ANOVA) with the linear regression and co-relation models [49].

Results and Discussion

The study assessed urbanization's impact on passerine population abundance in Faisalabad, covering a 10-km distance and four months, observing from February to May, with 3 hour intervals for morning and evening observation. Evidently, observations were concerned with roosts exists, returns, foraging, mobbing, scuffles and roost flights during every interval in the morning and evening hours. Table 1a represents such information on the house crow movements. In the morning hours, there were burst of activities which were logical as a total of 70 crows left their roost in the morning hours. However, the returns were very low as compare to exist. Foraging on the nearby crops was also substantial after the previous night foraging hiatus. Considering the mobbing behavior, was also somewhat elevated, while the scuffles with other birds approaching there territory were also least. Considerable roosts movements or flights were apparent. Overall, the roost activities remain fairly pronounced during the morning hours (Table 1a, Figure 1a). Situations in the evening was also not very different from that of the morning except that, number of invading birds were more marginally in the evening as compare to the morning hours (Table 1b, Figure 1a).

Table 1a: Number of designated passerines viz. house crow (*Corvus splendens*) and house sparrow (*Passer domesticus*) as recorded from sub-habitat (Bhai wala), Faisalabad in February, 2020. Weekly observations have been combined in this table for morning hours.

Time (Minutes)	House Crow Movements						Total observations
	Roost exits	Roost returns	Foraging	Mobbing	Scuffles	Roost flights	
0600-0615	15	0	5	0	0	12	32
0615-0630	11	0	12	0	0	10	33
0630-0645	12	1	10	1	2	11	37
0645-0700	7	2	11	1	1	10	32
0700-0715	7	0	5	0	1	7	20
0715-0730	0	1	5	0	0	2	8
0730-0745	11	2	2	1	0	2	18
0745-0800	4	1	2	2	2	5	16
0800-0815	0	0	0	1	1	0	2
0815-0830	0	0	1	2	1	2	6
0830-0845	1	4	2	0	2	4	13
0845-0900	2	2	2	1	1	1	9
Total	70	13	57	9	11	66	226
Mean	5.83	1.08	4.75	0.75	0.92	5.50	18.83
S.E	5.41	1.24	4.11	0.75	0.79	4.32	12.00

Table 1b: Observations in evening hours, data for February have been combined in this table.

1400-1415	15	0	12	0	0	11	38
1415-1430	15	0	11	0	2	12	40
1430-1445	12	0	5	2	1	8	28
1445-1500	14	2	2	1	0	5	24
1500-1515	8	4	1	2	0	7	22
1515-1530	7	1	4	1	2	7	22
1530-1545	7	2	3	0	3	3	18
1545-1600	0	2	2	0	1	4	9
1600-1615	0	2	1	2	2	5	12
1615-1630	1	0	2	1	0	0	4
1630-1645	2	1	0	1	0	0	4
1645-1700	3	2	0	2	1	0	8
Total	84	16	43	12	12	62	229
Mean	7.00	1.33	3.58	1.00	1.00	5.17	19.08
S.E	5.86	1.23	3.99	0.85	1.04	4.06	12.24

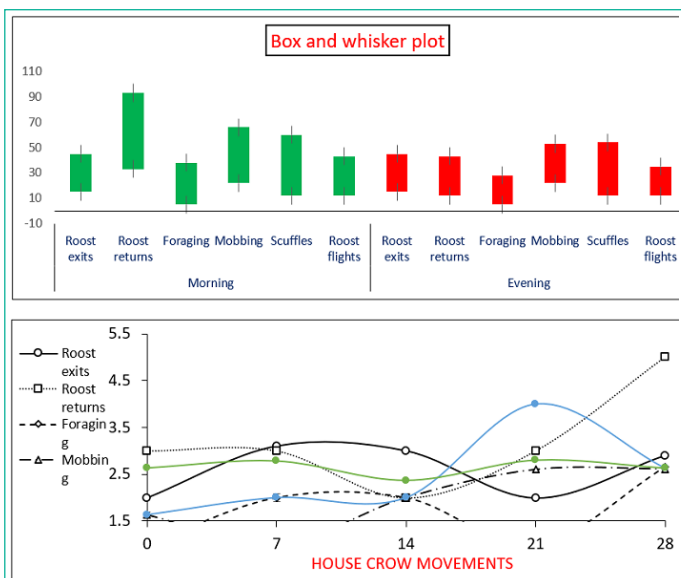


Figure 1a: Movements displayed by house crow and house sparrow as recorded in the two sub-habitats in the Faisalabad.



Figure 2a: Movements displayed by house crow and house sparrow as recorded in the two sub-habitats in the Faisalabad.

Invariably almost similar observations were recorded for the remaining observations of the house crow in the morning and evening intervals of the day. There is no doubt that is house crow is one of the important bird pests of Pakistan which also plunders significant crops and is responsible for economic losses (Table 1a, b, Figure 1-5a, b).

It is therefore, concluded that such biological rhythms of house crow and house sparrow were important to visualize per day for their assessment as voracious birds which can be troublesome to the sustainable agro-system.

Work on the present study clearly demonstrated that urbanization was the trivial factor which has curtailed maximum activities of the birds. Ironically, Faisalabad which remains one of the important agricultural hub of the Central Punjab, has been suffering due to the massive influx of migratory patterns of the villagers to the city environments for the last several decades.

Table 1c: Statistical inference determined for the different passerines viz. house crow and house sparrow in the different behavioral patterns.

	Roost exits	Roost returns	Foraging	Mobbing	Scuffles with other birds	Roost flights
Roost exits	1					
Roost returns	0.588028	1				
Foraging	0.91035	0.631082	1			
Mobbing	0.040063	-0.06754	-0.13999	1		
Scuffles with other birds	0.120776	-0.21483	-0.09644	0.25246	1	
Roost flights	0.887685	0.313907	0.881115	0.181262	0.029504	1



Figure 3a: Movements showed by passerines bird's viz. Corvus splendens and Passer domesticus as noted in the two sub-habitats in the Faisalabad.

Table 2a: Observed number of passerine birds like (Corvus splendens) and (Passer domesticus) are recorded from sub-habitat (Bhai wala), Faisalabad in February, 2020. Weekly observations have been combined in this table for morning hours.

Time (Minutes)	House Crow Movements						Total Observations
	Roost exits	Roost returns	Foraging	Mobbing	Scuffles	Roost flights	
0600-0615	17	1	6	0	0	13	37
0615-0630	10	0	11	1	2	11	35
0630-0645	11	2	12	0	3	10	38
0645-0700	6	1	10	1	1	9	28
0700-0715	7	0	6	2	2	7	24
0715-0730	0	3	5	0	1	3	12
0730-0745	10	2	3	3	0	2	20
0745-0800	5	1	2	1	1	4	14
0800-0815	0	1	1	2	3	5	12
0815-0830	1	1	0	2	0	2	6
0830-0845	0	0	2	1	1	3	7
0845-0900	1	2	1	1	1	1	7
Total	68	14	59	14	15	70	240
Mean	5.67	1.17	4.92	1.17	1.25	5.83	20.00
S.E	5.53	0.94	4.17	0.94	1.06	4.04	12.12

This study also is an attempt to provide information in the vicinities of Gutwala forest plantations which were mainly the agricultural hub in the past. Nonetheless, in the recent years urbanizations and constructions of roost have largely deprived important bird's species of their natural surroundings and therefore as either led to the bird migration and also removing their natural locations resulting in their motilities. Although, the data suggests that there remains some number of the both bird species in their natural habitats, but such proportions were not comparable to those of the past regimes owing to the rapidly occurring urbanized and industrialized environment.

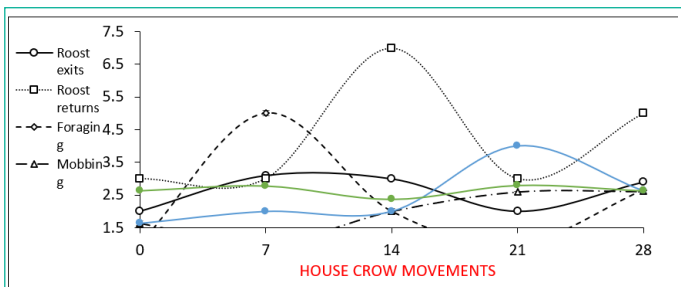


Figure 4a: Movements presented by *Corvus splendens* and *Passer domesticus* as logged in the two sub-habitats in the Faisalabad.

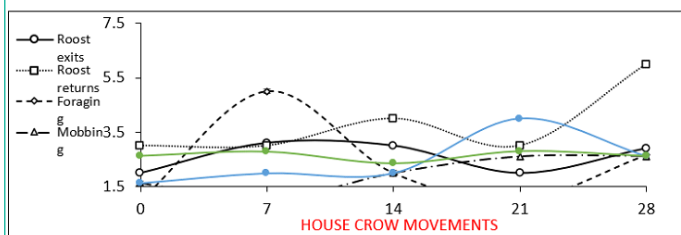


Figure 5a: Movements showed by house crow (*Corvus splendens*) and house sparrow (*Passer domesticus*) as recorded in the two sub-habitats in the Faisalabad.

Table 2b: Observations have been combined in evening hours; data for February have been shared in this table.

1400-1415	14	0	13	1	0	13	41
1415-1430	15	2	12	0	1	11	41
1430-1445	13	1	6	1	2	7	30
1445-1500	12	3	3	2	4	8	32
1500-1515	6	2	2	3	1	6	20
1515-1530	5	4	1	2	0	6	18
1530-1545	6	1	4	0	2	2	15
1545-1600	1	2	3	1	3	3	13
1600-1615	0	0	2	0	2	4	8
1615-1630	2	1	2	2	0	1	8
1630-1645	3	2	1	1	1	1	9
1645-1700	0	1	0	2	2	0	5
Total	77	19	49	15	18	62	240
Mean	6.42	1.58	4.08	1.25	1.50	5.17	20.00
S.E	5.65	1.16	4.23	0.97	1.24	4.11	12.93

Table 2c: Statistical interpretation determined for the different passerines viz. *Corvus splendens* and *Passer domesticus* in the different behavioral patterns.

	Roost exits	Roost returns	Foraging	Mobbing	Scuffles with other birds	Roost flights
Roost exits	1					
Roost returns	-0.21464	1				
Foraging	0.582189	-0.12025	1			
Mobbing	-0.27878	-0.07294	-0.34439	1		
Scuffles with other birds	-0.30034	0.377493	-0.14627	0.418258	1	
Roost flights	0.79442	-0.19528	0.806038	-0.32128	-0.01328	1

As an evinced in this study, movement patterns still indicated some bio-rhythmicity. Closely numerical numbers during the day and evening sessions suggested that both crows and sparrows in wake of the existing vegetation covers, exhibited their roost movements which accounted for their possible depredation on the nearby agricultural crops and the economic losses. The daily variations on the average of some birds might be of low proportions (approximately 8-210km) which appear to be more for several avifauna to supplement their dietary requirements. Therefore, wide array of species can be in stressful conditions which augmented their survival. In another factor which contributes to the reduced population of house crow with the other birds can be also to the least number of trees which have been serving as roost and nest for the birds.

According to some studies [55] who suggested that there were some important factors influenced in the reduction of house crow numbers in the urban habitat of the Malaysia. Of these, less trees, more residential colonies and roadside vehicles were pivotal. However, not always the numbers of trees were important to increase the house crow populations as other factors were also sequential. Undoubtedly, deteriorating ecological factors were the past various years and decades, present real challenges to the birds for their survival. Perhaps in the present environment with no urbanization number of such birds would be more as compare to the present status. As reported by [6,21]. However, flexibility of the foraging of house crow like other birds required territorial defense against the predatory birds to obtain the desirable food. The territory defense would be important [40,53] to survive on land for considerable period of time.

There are certain negative impacts of urbanization on birds like depriving them of their roosting and nesting habitats of birds like in the urban as compare to the rural surroundings. Low density populations of birds which would be of considerable Impacts in the undisturbed areas [11,16,22,41].

Conclusions

1. The study examined the impact of urbanization on the population abundance of house crow and house sparrow passerines over a four-month period. It found that roost characteristics, foraging, mobbing, and inter species conflicts affected the birds' movements. The study suggests that the abundance of passerines may have been higher without urbanization and increased traffic, suggesting that this may not have been the case in the past.

2. The avian-fauna of Punjab like the other wildlife populations seems to have been alarmingly affected due to the shifting of populations from villages to the city avenues. This situation remains fairly alarming and to jeopardized urban wildlife including the birds.

3. It was evident also in the present studies that, the Gut wala forest plantation which continue to portray the picture of wildlife conservation, has also been seriously impacted by the ongoing the ruthless urbanized population and habitats. Clearly, there is a decline in all the important bird species having experienced the serious urbanized affects.

4. In view of this, it remains potentially significant to make equal contributions from the human resources and to manage the wildlife populations. The uninterrupted human interference which transforms the wildlife has been deprived of their natural surroundings, destroys the sustainability of the ecosystem.

Table 3a: Designated number of passerines viz. house crow and house sparrow recorded from sub-habitat (Bhai wala), Faisalabad in February, 2020. Weekly observations have been shared in this table for morning hours.

Time (Minutes)	House Crow Movements						Total Observations
	Roost exits	Roost returns	Foraging	Mobbing	Scuffles	Roost flights	
0600-0615	18	1	7	0	1	14	41
0615-0630	14	1	11	2	3	11	42
0630-0645	11	0	12	1	2	10	36
0645-0700	6	3	10	0	4	9	32
0700-0715	7	0	8	1	0	7	23
0715-0730	5	4	5	0	2	6	22
0730-0745	0	1	3	2	1	8	15
0745-0800	6	2	2	2	2	4	18
0800-0815	2	1	1	3	3	1	11
0815-0830	1	0	0	0	0	0	1
0830-0845	1	1	2	0	1	3	8
0845-0900	3	2	3	1	1	0	10
Total	74	16	64	12	20	73	259
Mean	6.17	1.33	5.33	1.00	1.67	6.08	21.58
S.E	5.61	1.23	4.14	1.04	1.23	4.56	13.56

Table 3b: Observations have been verified in evening hours, data for February have been combined in this table.

1400-1415	15	1	14	0	1	13	44
1415-1430	14	0	10	1	3	11	39
1430-1445	11	2	5	3	1	10	32
1445-1500	12	1	4	1	1	7	26
1500-1515	7	3	2	1	4	6	23
1515-1530	8	2	1	2	2	7	22
1530-1545	9	0	3	1	1	5	19
1545-1600	1	1	4	1	0	2	9
1600-1615	0	1	2	0	2	4	9
1615-1630	2	0	1	2	1	1	7
1630-1645	2	1	0	1	2	0	6
1645-1700	4	1	1	1	1	1	9
Total	85	13	47	14	19	67	245
Mean	7.08	1.08	3.92	1.17	1.58	5.58	20.42
S.E	5.25	0.90	4.14	0.83	1.08	4.23	12.99

Table 3c: Statistical test determined for the different number of passerines viz. house crow and house sparrow in the different behavioral patterns.

	Roost exits	Roost returns	Foraging	Mobbing	Scuffles with other birds	Roost flights
Roost exits	1					
Roost returns	-0.81664	1				
Foraging	-0.76254	0.391925	1			
Mobbing	-0.61159	0.904534	0.371391	1		
Scuffles with other birds	-0.28977	0.636364	0.279946	0.904534	1	
Roost flights	0.869325	-0.45455	-0.95182	-0.30151	-0.09091	1

Table 4a: Number of observed passerines viz. house crow (Corvus splendens) and house sparrow (Passer domesticus) are noted from sub-habitat (Bhai wala), Faisalabad in February, 2020. Weekly observations have been collective in table for morning hours.

Time (Minutes)	House Crow Movements						Total observations
	Roost exits	Roost returns	Foraging	Mobbing	Scuffles	Roost flights	
0600-0615	16	4	9	2	1	11	43
0615-0630	14	1	11	1	1	8	36
0630-0645	11	3	9	0	0	11	34
0645-0700	10	0	10	2	1	9	32
0700-0715	7	0	6	3	2	6	24
0715-0730	8	2	4	1	3	3	21
0730-0745	3	1	2	0	1	1	8
0745-0800	0	0	3	2	2	7	14
0800-0815	2	1	0	0	4	1	8
0815-0830	1	2	0	2	2	0	7
0830-0845	2	3	1	1	4	3	14
0845-0900	3	2	2	1	1	2	11
Total	77	19	57	15	22	62	252
Mean	6.42	1.58	4.75	1.25	1.83	5.17	21.00
S.E	5.38	1.31	4.07	0.97	1.27	4.00	12.58

Table 4b: Graphical interpretation determined for the different passerine birds like house crow and house sparrow in the different behavioral arrangements.

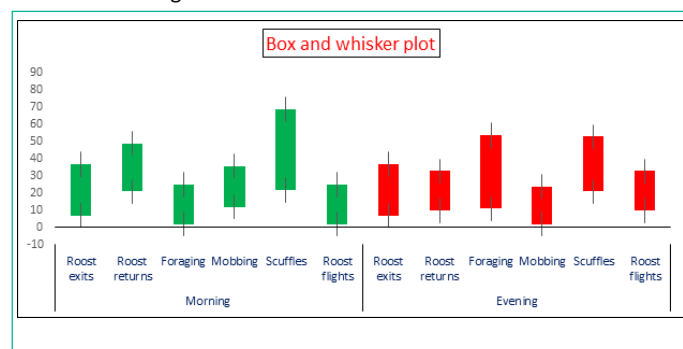


Table 5a: Number of following observed passerines viz. house crow (*Corvus splendens*) and house sparrow (*Passer domesticus*) are documented from sub-habitat (Bhai wala), Faisalabad in March, 2020. Weekly observations have been made in this table for morning hours.

TIME (MINUTES)	House Crow Movements						Total observations
	Roost exits	Roost returns	Foraging	Mobbing	Scuffles	Roost flights	
0600-0615	19	1	4	3	2	11	40
0615-0630	16	0	11	2	1	12	42
0630-0645	11	2	9	1	1	10	34
0645-0700	9	3	12	0	0	9	33
0700-0715	10	1	6	0	3	4	24
0715-0730	1	4	4	4	2	3	18
0730-0745	0	1	7	1	1	2	12
0745-0800	9	0	8	3	1	4	25
0800-0815	6	1	6	0	0	7	20
0815-0830	3	0	3	1	3	3	13
0830-0845	0	3	1	1	1	0	6
0845-0900	2	1	1	0	1	1	6
Total	86	17	72	16	16	66	273
Mean	7.17	1.42	6.00	1.33	1.33	5.50	22.75
S.E	6.28	1.31	3.59	1.37	0.98	4.12	12.46

Table 5b: Observations have been made in evening hours; data for March have been shared in this table.

1400-1415	17	1	13	1	3	12	47
1415-1430	14	2	12	2	1	11	42
1430-1445	11	1	10	1	0	10	33
1445-1500	10	4	4	0	1	7	26
1500-1515	9	3	5	4	2	8	31
1515-1530	6	2	3	2	1	6	20
1530-1545	4	1	6	0	4	4	19
1545-1600	4	1	2	1	2	5	15
1600-1615	2	0	0	2	1	0	5
1615-1630	0	2	0	0	1	2	5
1630-1645	1	3	3	0	2	1	10
1645-1700	2	1	1	1	4	3	12
Total	80	21	59	14	22	69	265
Mean	6.67	1.75	4.92	1.17	1.83	5.75	22.08
S.E	5.48	1.14	4.50	1.19	1.27	3.96	13.91

Table 5c: Statistical implication determined for the different passerine birds viz. *Corvus splendens* and *Passer domesticus* in the different behavioral movement patterns.

	Roost exits	Roost returns	Foraging	Mobbing	Scuffles with other birds	Roost flights
Roost exits	1					
Roost returns	-0.23439	1				
Foraging	0.249512	-0.10796	1			
Mobbing	-0.15377	0.603957	-0.2664	1		
Scuffles with other birds	-0.14156	0.144841	0.040656	0.703989	1	
Roost flights	0.656382	-0.41214	0.680588	-0.18611	0.19149	1

References

1. Akram N, Khan HA, Javed M. Inhibiting the house crow (*Corvus splendens*) damage on maize growth stages with reflecting ribbons in a farmland. *J Anim Plant Sci.* 2013; 23: 182-9.
2. Balaji S, Baskaran S, Pandiarajan J. Impact of urbanization on house sparrow population in Virudhunagar district, Tamil Nadu, India. *Journal of Entomology and Zoology Studies.* 2017; 5: 493-497.
3. Balmori A, Hallberg O. The urban decline of house sparrow (*Passer domesticus*): a possible link with electromagnetic radiation. *Electromagn Biol Med.* 2007; 26: 141-51.
4. Barker FK, Barrowclough GF, Groth JG. A phylogenetic hypothesis for passerine birds: taxonomic and biogeographic implications of an analysis of nuclear DNA sequence data. *Proc Biol Sci.* 2002; 269: 295-308.
5. Bhatti Z, Nazir F, Ghufuran A. A preliminary study on population of some Passeriformes at Marala Head. *J Bioresour Manag.* 2019; 4: 6-10.
6. Boggie MA, Mannan RW. Examining seasonal patterns of space use to gauge how an accipiter responds to urbanization. *Landsc Urban Plan.* 2014; 124: 34-42.
7. Bókony V, Kulcsár A, Liker A. Does urbanization select for weak competitors in house sparrows? *Oikos.* 2010; 119: 437-44.
8. Bókony V, Seress G, Nagy S, Lendvai ÁZ, Liker A. Multiple indices of body condition reveal no negative effect of urbanization in adult house sparrows. *Landsc Urban Plan.* 2012; 104: 75-84.
9. Chamberlain D, Kibuule M, Skeen R, Pomeroy D. Trends in bird species richness, abundance and biomass along a tropical urbanization gradient. *Urban Ecosyst.* 2017; 20: 629-38.
10. Chan K. Partial migration in Australian landbirds: a review. *Emu Austral Ornithol.* 2001; 101: 281-92.
11. Chopra G, Kumar A, Kumar P. The population of house sparrow (*Passer domesticus*) (Linnaeus, 1758) in different habitats of district Kurukshetra, Haryana (India). *Nat Sci.* 2012; 10: 113-22.
12. Choudhary S, Chauhan NPS, Kalsi R. Impact of urbanization on seasonal population status and occupancy of house sparrows in Delhi, India. *Curr Sci.* 2020; 119: 84-95.
13. Choudhary S, Chauhan NS, Kalsi R. Seasonal habitat selection by house sparrows across the urbanization matrix in Delhi, India. *J Wildl Biodivers.* 2019; 3: 57-65.

14. Clergeau P, Croci S, Jokimäki J, Kaisanlahti-Jokimäki MLK, Dinetti M. Avifauna homogenization by urbanization: analysis at different European latitudes. *Biol Conserv.* 2006; 127: 336-44.
15. Collier CG. The impact of urban areas on weather. *Q J R Meteorol Soc.* 2006; 132: 1-25.
16. Crick HQP, Robinson RA, Appleton GF, Clark NA, Rickard AD. The investigation into the causes of the decline of starlings and house sparrows in Great Britain. BTO Research Report No. 290. London, UK: Defra; 2002.
17. Croci S, Butet A, Clergeau P. Does urbanization filter birds on the basis of their biological traits? *Condor.* 2008; 110: 223-40.
18. Deepalakshmi S, Salomi AA. A impact of urbanization on house sparrow (*Passer domesticus*) diversity from Erode and Namakkal districts, Tamil Nadu, India. *Int J Adv Res Biol Sci.* 2019; 6: 22-7.
19. Evans KL. Individual species and urbanization. In: Gaston KJ, editor. *New York: Urban Ecol Cambridge University Press.* 2010.
20. Francis CD, Ortega CP, Cruz A. Noise pollution changes avian communities and species interactions. *Curr Biol.* 2009; 19: 1415-9.
21. Frixione MG, Casaux R, Villanueva C, Alarcón PAE. A recently established kelp gull colony in a freshwater environment supported by an inland refuse dump in Patagonia. *Emu – Austral Ornithology.* 2012; 112: 174-8.
22. Ghosh S, Ki HK, Bhattacharya R. A survey on house sparrow population decline at a decline at a Bandel, West Bengal, India. *J Korean Earth Sci Soc.* 2010; 31: 448-53.
23. Juarez R, Madrigal EC, Sandoval L. Urbanization has opposite effects on the territory size of two passerine birds. *Avian Res.* 2020; 11: 1-9.
24. Kalel M, Dudhe N, Kasambe R, Chakane S, Bhattacharya P. Impact of urbanization on avian population and its status in Maharashtra state, India. *Int J Appl Environ Sci.* 2012; 7: 59-76.
25. Kalnay E, Cai M. Impact of urbanization and land use change on climate. *Nature.* 2003; 423: 528-31.
26. Kang W, Minor ES, Park CR, Lee D. Effects of habitat structure, human disturbance and habitat connectivity on urban forest bird communities. *Urban Ecosyst.* 2015; 18: 857-70.
27. Kopij G. The effect of urbanization on population densities of forest passerine species in a Central European city. *Ornis Hung.* 2019; 27: 207-20.
28. Lee KN. An urbanizing world. In: Starke L, editor. *State of the world.* New York, London: W.W. Norton & Company; 2007: Our urban future.
29. Lim HC, Sodhi NS. Space use and habitat selection of house crows in a tropical urban environment: a radio-tracking study. *Raffles Bull Zool.* 2009; 57: 561-8.
30. Lim HC, Sodhi NS, Brook BW, Soh MCK. Undesirable aliens: factors determining the distribution of three invasive bird species in Singapore. *J Trop Ecol.* 2003; 19: 685-95.
31. Longcore TCR, Rich C. Ecological light pollution. *Front Ecol Environ.* 2004; 2: 191-8.
32. Loram A, Tratalos J, Warren PH, Gaston KJ. Urban domestic gardens (X): the extent & structure of the resource in five major cities. *Landsc Ecol.* 2007; 22: 601-15.
33. Marzluff JM, Ewing K. Restoration of fragmented landscape for the conservation of birds: a general framework and specific recommendation for urbanizing landscapes. *Restor Ecol.* 2001; 9: 280-92.
34. Marzluff JM, Shulenberger E, Endlicher W, Alberti M, Bradley G, Ryan C. *Urban ecology: an international perspective on the interaction between humans and nature.* New York: Springer. 2008.
35. McKinney ML. Effects of urbanization on species richness: a review of plants and animals. *Urban Ecosyst.* 2008; 11: 161-76.
36. Meffert PJ, Dziocck F. The influence of urbanization on diversity and trait composition of birds. *Landsc Ecol.* 2013; 28: 943-57.
37. Mills GS, Dunning JB, Bates JM. Effects of urbanization on breeding bird community structure in southwestern desert habitats. *Condor.* 1989; 91: 416-29.
38. Nakagawa S, Ockendon N, Gillespie DOS, Hatchwell BJ, Burke T. Assessing the function of house sparrows' bib size using a flexible meta-analysis method. *Behav Ecol.* 2007; 18: 831-40.
39. Poston JP, Hasselquist D, Stewart IRK, Westneat DF. Dietary amino acids influence plumage traits and immune responses in male house sparrows (*Passer domesticus*) but not as expected. *Anim Behav.* 2005; 70: 1171-81.
40. Price TD. Sexual selection on body size, territory and plumage variables in a population of Darwin's finches. *Evolution.* 1984; 38: 327-41.
41. Rajashekar S, Venkatesha MG. Occurrence of house sparrow, *Passer domesticus indicus* in and around Bangalore. *Curr Sci.* 2008; 94: 446-9.
42. Savard JL, Clergeau P, Mennechez G. Biodiversity concepts and urban ecosystems. *Landsc Urban Plan.* 2000; 48: 131-42.
43. Seress G, Liker A. Habitat urbanization and its effects on birds. *Acta Zool Acad Sci Hung.* 2015; 61: 373-408.
44. Shaw LM, Chamberlain D, Evans M. The house sparrow (*Passer domesticus*) in urban areas: reviewing a possible link between post-decline distribution and human socioeconomic status. *J Ornithol.* 2008; 149: 293-9.
45. Shochat E, Warren PS, Faeth SH, McIntyre NE, Hope D. From patterns to emerging processes in mechanistic urban ecology. *Trends Ecol Evol.* 2006; 21: 186-91.
46. Sibley CG, Monroe BL. *Distribution and taxonomy of birds of the world.* New Haven, CT: Yale University Press; 1990.
47. Silva AD, Diez-Méndez DD, Kempnaers B. Effects of experimental night lighting on the daily timing of winter foraging in common European songbirds. *J Avian Biol.* 2017; 48: 862-71.
48. Smith JDS. The decline of the house sparrow: a review. *Br Birds.* 2003; 96: 439-46.
49. Steel RGD, Torrie JH, Dicky DA. *Principles and procedures of statistics: A biometrical approach.* 3rd ed. New York: McGraw-Hill Book Co. Inc; 1997.
50. Sternbeck J, Sjödin Å, Andréasson K. Metal emissions from road traffic and the influence of resuspension-results from two tunnel studies. *Atmos Environ.* 2002; 36: 4735-44.
51. Victoria VT. To eat or not to eat: urbanization and the foraging behaviors of Michigan passerines [senior honors thesis] and Projects. 2020; 667.
52. Voogt JA, Oke TR. Thermal remote sensing of urban climates. *Remote Sens Environ.* 2003; 86: 370-84.
53. Weaving MJ, White JG, Hower K, Isaac B, Cooke R. Sex-biased space-use response to urbanization in an endemic urban adapter. *Landsc Urban Plan.* 2014; 130: 73-80.
54. Whelan CJ, Şekercioğlu ÇH, Wenny DG. Why birds matter: from economic ornithology to ecosystem services. *J Ornithol.* 2015; 156: 227-38.
55. Wilson RF, Sarim D, Rahman S. Factors influencing the distribution of the invasive house crow (*Corvus splendens*) in rural and urban landscapes. *Urban Ecosyst.* 2015; 18: 1389-400.