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Original Article

Feeding ecology of house crows in a high-altitude Himalayan urban landscape

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ABSTRACT

House crows, known for their adaptability, thrive in urban settings by exploiting anthropogenic food sources. We explored the feeding dynamics of house crows (*Corvus splendens*) in the unique high-altitude urban environment of Srinagar, Jammu and Kashmir. Our research, conducted from July 2023 to February 2024, involved comprehensive field observations across diverse urban and semi-natural landscapes, examining the crows' dietary patterns, feeding behaviors, and group dynamics. Results indicate that house crows predominantly forage in small to medium-sized groups, with larger groups observed less frequently. These smaller groups often engage in opportunistic feeding behaviors, and prefer kitchen waste and slaughterhouse remains, which are abundant and energy-rich. Interestingly, smaller groups also showed dietary diversity by including dead animals, insects, and rats, which highlights their adaptability. Statistical analyses revealed that scavenging is the predominant feeding behavior, facilitated by the urban environment's abundant waste. However, behaviors like predation and kleptoparasitism were also noted, although less frequently. Moreover, our findings suggest that while urbanization profoundly influences crow feeding behavior, crows exhibit considerable flexibility in their feeding strategies across different urbanization levels. The analysis did not find a significant correlation between urbanization and specific feeding behaviors, which indicates an adaptive response to urban environmental conditions.

Introduction

Urbanization is one of the most significant factors influencing biodiversity, particularly for species adapting to human-modified landscapes (Blair 2004; McDonald et al. 2013; Seress and Liker 2015). Among these species, the house crow (*Corvus splendens*) stands out due to its high adaptability, opportunistic feeding behaviors, and widespread presence in urban environments (Goodwin 1986). House crows have successfully exploited urban settings, thriving on anthropogenic food sources such as kitchen waste, slaughterhouse remains, and discarded grains (Kumar and Ojha 2023). Due to this adaptability, they are an ideal model for studying how urbanization affects avian feeding dynamics.

House crows are omnivorous scavengers, which exhibits highly opportunistic feeding behaviors that enable them to exploit a wide range of food sources. Their feeding behavior is also influenced by the availability of human-provided food, competition, and environmental factors (Marzluff et al. 2012). Studies in urban India suggest that house crows play a critical role in waste management, consuming significant amounts of organic waste, thus reducing potential health hazards (Majhi and Das 2022). Similarly, in urban habitats, such as the city of Prayagraj in India, house crows have been observed to significantly feed in unhygienic places, preferring food items from miscellaneous sources like human refuse and carcasses over natural plant and animal sources during the daytime (Kumar and Ojha 2023). This behavior indicates their adaptability and resourcefulness in urban settings, where traditional food sources may be scarce or less accessible.

Srinagar, the summer capital of Jammu and Kashmir, presents a unique setting for investigating the feeding ecology of house crows. The city's diverse landscape, which includes urban zones, wetlands, lakes, and agricultural fields, provides a range of habitats

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for these birds (Yousuf and Shah 2014; Yousuf et al. 2023). The fluctuating climatic conditions, with temperatures ranging from 37°C in summer to -14°C in winter, further add complexity to the crows' feeding strategies. The presence of historical Mughal gardens and urban spaces increases the interaction between crows and human settlements, which offers a natural laboratory to understand how urbanization and environmental changes shape crow behavior. Despite extensive research on house crows in different urban areas, limited studies have focused on their feeding ecology in high-altitude urban settings like Srinagar. The unique geography and climatic conditions of the region make it an interesting site to explore how urbanization influences feeding patterns in this adaptable species. Srinagar's varied ecosystems and biodiversity, ranging from wetlands and lakes to landfills and highly urbanized spaces, provide an excellent opportunity to examine the role of habitat diversity in shaping crow feeding behavior (Rahul et al. 2014). It is be essential to understand the different environmental factors, including altitude, urbanization, and litter abundance, and how they affect crow feeding patterns, which can offer insights into how avian species adapt to urban landscapes. High-altitude cities like Srinagar face different environmental challenges compared to other regions. These include lower oxygen levels, long and cold winters, and big seasonal changes in the types and amount of food available. Such conditions can affect how birds use their energy, search for food, and adjust their diets. Studying how crows feed in these areas helps us understand how flexible and adaptable birds can be when living in tough and quickly changing mountain cities.

The feeding patterns of house crows are influenced by the time of day, with a marked preference for feeding in the morning. During this time, they rely more on plant and animal sources, which may be more abundant or accessible in the early hours (Kumar and Ojha 2023). This temporal variation in feeding behavior highlights the crow's ability to adjust its foraging strategies based on the availability of resources, a crucial adaptation for survival in fluctuating urban environments. Despite the abundance of various plant species in urban areas, house crows show a significant preference for the products of specific plants, such as *Ficus religiosa*, *Azadirachta indica*, *Ficus racemosa, Ziziphus, Ficus indica*, and *Artocarpus lacucha* (Kumar and Ojha 2023). This selective feeding behavior suggests that house crows may have developed preferences for certain plant species that offer nutritional benefits or are more readily available in their habitat. House crows often feed in groups, although solitary feeding is not uncommon. Congregational feeding is particularly evident when house crows utilize carcasses, often in collaboration with feral dogs, to access food that would otherwise be difficult to obtain alone (Kumar and Ojha 2023). This social aspect of feeding behavior indicates a level of cooperation and social structure within crow populations, which may enhance their ability to exploit challenging food sources in urban environments.

In urban settings, house crows engage in both interspecific and intraspecific competition for food resources. Interspecific competitive events are more common, with house crows displaying aggressive behavior toward other bird species such as *Acridotheres tristis, Acridotheres ginginianus, Gracupica contra, Passer domesticus, Bubulcus ibis, Egretta garzetta, Columbia livia*, and *Milvus migrans* (Kumar and Ojha 2023). These interactions show the competitive nature of urban ecosystems, where multiple species vie for limited resources, and the house crow's aggressive strategies to secure its share. House crows use a variety of feeding methods, including searching, stealing, specific food offerings, and retrieving food from cached sites (Kumar and Ojha 2023). These strategies reflect the crow's adaptability and intelligence, allowing it to maximize food intake in diverse and often unpredictable urban environments. As an invasive species, house crows can significantly alter local ecosystems, affecting native biodiversity and ecological balance. The study aims to study the house crow feeding dynamics in high-altitude Himalayan urban landscapes and provide information into the broader ecological impacts of urbanization on avian species.

Material and methods

Study area

Our research was conducted in Srinagar, the summer capital of the Jammu and Kashmir State of India, situated at the heart of the Kashmir Valley. This area lies between 34° 05' 24'' north latitude and 74° 47' 24'' east longitude, at an altitude of 1730 meters above sea level. Srinagar is renowned worldwide for its natural beauty, characterized by a range of diverse ecological zones including steep hills, urban landscapes, paddy fields, and the iconic Dal and Nageen lakes (Figure 1). The temperature in Srinagar varies significantly throughout the year, ranging from a high of 37°C in June-July to a low of -14°C in December-January, influencing the diverse habitats and the behavior of avifauna. The city is also famous for its Mughal gardens like Nishat Bagh, Shalimar Bagh, Cheshmashahi, and Harwan. These gardens are not only tourist attractions but also serve as important habitats for various bird species, contributing to the city's ecological diversity. Additionally, the hills of Shankaracharya and Hari Parbat, located on the eastern and western sides of Dal Lake, respectively, add to the richness of the habitat available for study.

Field work

Field observations were conducted at five distinct sites within Srinagar, each characterized by a unique combination of ecosystems. Dargah has an aquatic lake, urban, and crop field ecosystems, which offer a diverse range of feeding opportunities for the crows. Soura is characterized by urban environments, wetlands, and landfills, which provides a mix of natural and anthropogenic feeding grounds. Khanyar is predominantly urban with some areas of social forestry, which adds a semi-natural element to the otherwise built environment. Sonwar has landfill, riverine, urban, and montane ecosystems, which presents varied feeding and behavioral observation points. Hyderpora consists of urban settings, wetlands, and landfills, that mirror the complex interaction between natural habitats and urban development.

Our fieldwork was conducted from July 2023 to February 2024, thus covering both the summer and winter seasons to note seasonal variations in crow behavior. We visited each site monthly and conducted observations during three standardized daily intervals: morning (07:00–10:00), noon (12:00–14:00), and evening (16:00–18:00). This helped capture daily variation in feeding activity under different light and human disturbance conditions. Each observation session lasted between 30 to 40 minutes, strategically brief to reduce the disturbance to the birds and maintain the naturalness of the observed behaviors.

Data collection

For our research, we utilized several primary tools to assist in data collection and observation. The Global Positioning System (GPS) devices were crucial for accurately determining the location and altitude of observation points, helping link specific behaviors to geographical characteristics. Binoculars were essential for observing crows at a distance, minimizing human disturbance

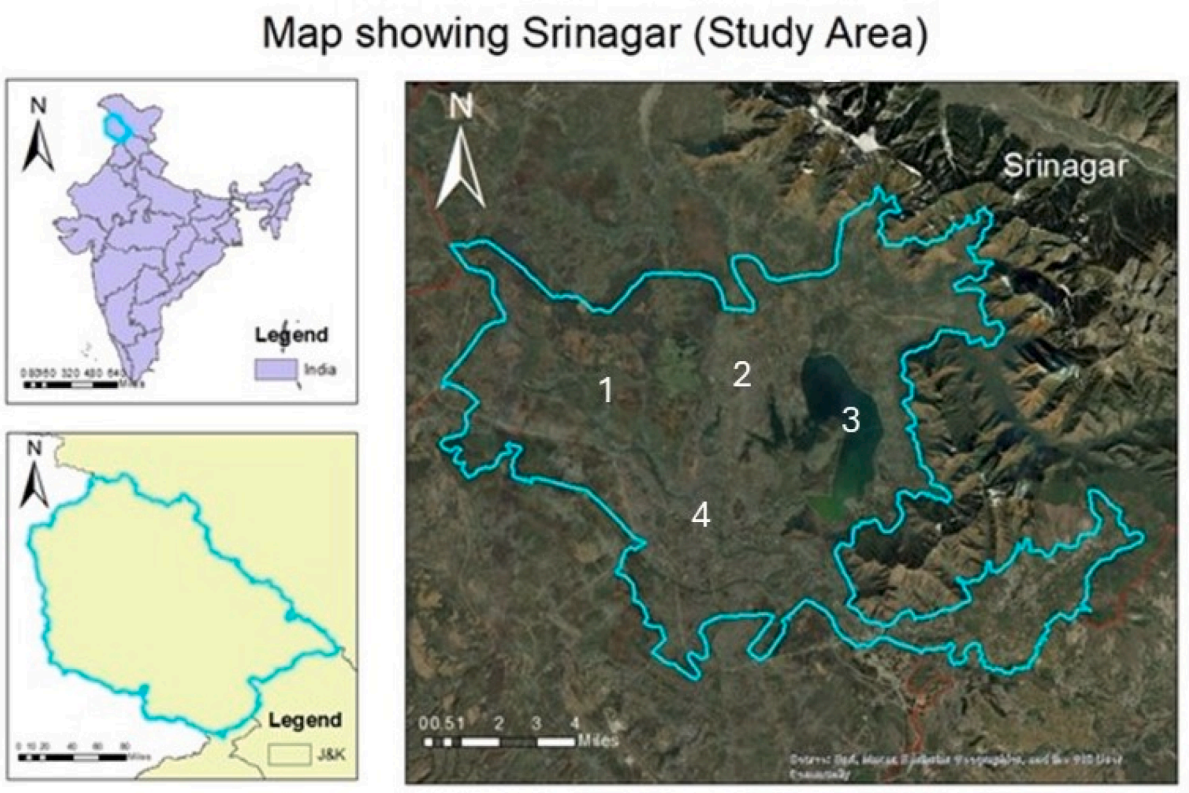

Figure 1. Map showing the location of Srinagar city with different habitat types such as (1) crop field, (2) urban, (3) lake and (4) landfill.

while allowing detailed observation of natural behaviors. A Canon EOS 1500D camera with an 300 mm lens was used to capture high-quality images and videos of crows during feeding, providing valuable visual data that supported behavioral analyses.

Data collection was carefully carried out, focusing on several key aspects. We recorded how long the crows fed and the specific behaviors they exhibited during feeding, such as scavenging or predation. Detailed notes were made regarding the various food items crows consumed, which were later classified and analyzed. The influence of surrounding factors like litter presence and the level of urbanization was carefully documented to understand how these elements affect crow feeding habits. We also noted the availability of different food items at each site to link these observations to the specific characteristics of each habitat to draw correlations between available resources and crow behaviors. We grouped the feeding behavior of house crows into six main types based on what they ate and how they obtained their food. *Scavenging:* eating human-related waste like kitchen scraps or meat remains from slaughterhouses. *Predation:* hunting and eating live animals such as insects or small rats. *Kleptoparasitism*: stealing food from other animals. *Granivory*: referred to eating grains or seeds. *Opportunistic feeding:* consuming any available food that didn't fit into the other categories. *Aquatic feeding:* searching for food near or in water, like picking up insects or scraps from the water's surface. To understand how urbanization affected their behavior, we used an urbanization index adapted from Patterson et al. (2023). This index was built by observing features like the number of buildings, roads, shops, and the amount of visible waste in an area using satellite images and on-site checks. Each location was scored from 0 (least urban) to 5 (most urban) to compare crow feeding patterns across different urban settings.

Statistical analysis

All the analysis for this study was done in R Studio and ArcMap 10.8 as our primary tools. We started by applying basic descriptive statistics to get a clear view of how crows typically gather during feeding times. To go deeper into the relationships between crow group sizes and their food preferences, we employed the chi-square test of independence. This choice was ideal for our categorical data as it enabled us to check if different types of food were preferred by various group sizes. We compared the actual feeding habits of the crows with what we might expect by chance, and this test helped us identify significant dietary patterns among the birds.

We also explored how environmental factors such as litter abundance and levels of urbanization impact crow feeding behaviors. For this analysis, regression techniques were important as they allowed us to mix continuous and categorical variables and understand which factors were good predictors of specific feeding behaviors. Further, we used multinomial logistic regression to examine the effects of litter on various feeding behaviors. This method was really helpful for guessing how likely different behaviors were, based on the environment, and it was key to understanding out how crows handle city life challenges.

Additionally, we looked at the relationship between altitude and feeding duration using correlation analysis. We also utilized analysis of variance (ANOVA) to compare feeding durations across different types of food and times of the day. This analysis was key in determining whether the type of food or the time of day influenced how long crows fed, with results showing significant variations.

Results

Our results revealed that the activity counts were predominantly characterized by a unimodal distribution, peaking at approximately 5 individuals per observation. The data revealed that smaller group sizes were more frequently observed, with the highest occurrence noted for groups comprising 4 to 6 crows. As the number of crows per observation increased, a marked decrease in frequency was observed. Large gatherings, exceeding 15 crows, were notably rare (Figure 2). This might suggest that house crows in this region typically forage or engage in social activities in smaller groups, possibly to optimize feeding opportunities or due to the spatial configuration of available resources.

As far as the food type is concerned, we saw a diverse selection of food categories consumed by varying numbers of crows. We looked at how house crows in different group sizes fed on various types of food. Small groups of 2 to 4 crows ate many different things like grains, fruits, insects, dead animals, and sometimes even from water sources. But as the group size increased, the variety of food they ate became smaller. Medium-sized groups of 5 to 6 crows still ate a mix of foods but started focusing more on high-energy items like slaughter waste and kitchen waste. The largest groups, with 8 to 20 crows, were mostly seen eating only slaughter waste and kitchen waste, and rarely ate natural foods. This shows that bigger groups prefer easy-to-access, rich food that can feed many crows at once (Figure 3).

The house crows were found to adapt a range of foraging strategies. Scavenging was observed to be the most variable behavior among the crows, with a wide spread in the number of observations, indicating that this behavior was common but varied significantly in frequency among the population (Figure 4A). Predatory and opportunistic behaviors also showed considerable variability, which reflects the adaptive feeding strategies employed by crows in different contexts. In contrast, granivory and kleptoparasitism displayed less variability and lower frequencies, suggesting these behaviors were less common or more consistent among observed individuals. Aquatic feeding and aquatic behaviors were the least observed, with very few instances recorded, showing their minimal role in the overall feeding repertoire of the house crows in this urban area.

The analysis of feeding behavior across different food sources among house crows in Srinagar revealed a pronounced preference for anthropogenic sources over natural sources. Predation and scavenging were the most frequently observed behaviors associated with anthropogenic sources. Scavenging, in particular, was predominant, reflecting the crows' strong reliance on human-provided resources (Figure 4B). This behavior was recorded significantly more often when compared to predation, which was the next most common behavior linked to anthropogenic sources. In contrast, behaviors such as granivory and kleptoparasitism showed a more balanced occurrence between anthropogenic and natural sources, though still slightly leaning toward anthropogenic. Aquatic behaviors and aquatic feeding were minimally observed, indicating these are less significant in the crows' overall feeding strategy.

We studied the impact of litter abundance on the feeding practices of house crows, which indicated that varying levels of litter had differential effects on crow feeding behaviors. Predation and scavenging behaviors were most pronounced in areas with high litter abundance, which suggests that increased litter correlates with more opportunities for these feeding strategies (Figure 4C). This could be due to the attraction of other animals to litter sites, which in turn provides predation opportunities, or more directly through the accessibility of food waste.

Opportunistic feeding displayed a consistent presence across all litter levels, which reflects the crows' ability to adapt to diverse environmental conditions by exploiting whatever food sources are available. Granivory and kleptoparasitism were observed relatively consistently across different litter conditions, indicating that these

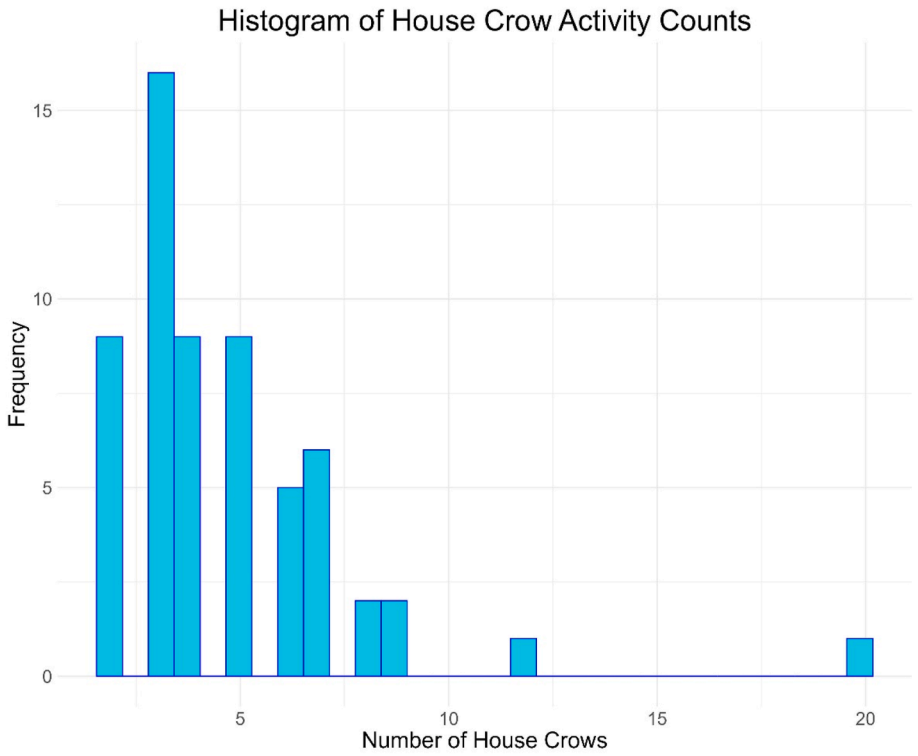

Figure 2. Histogram displaying the distribution of house crow activity counts.

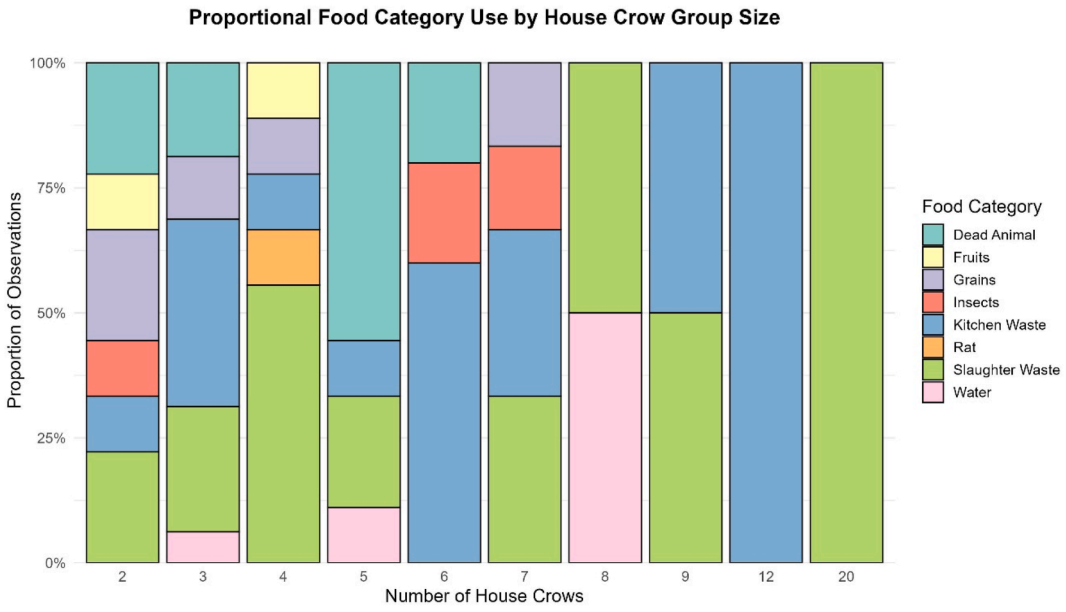

Figure 3. Proportional representation of food categories consumed by house crows across different group sizes.

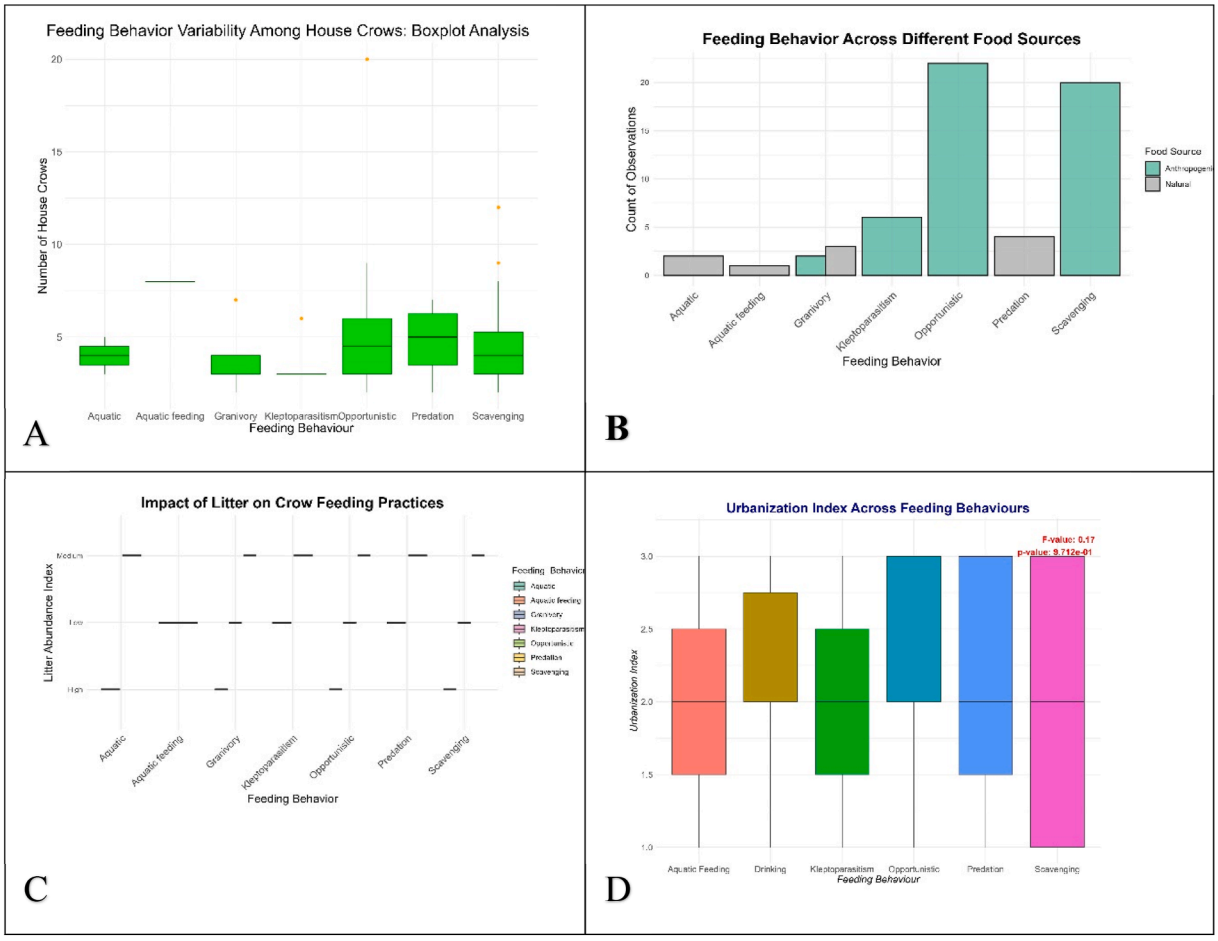

Figure 4. Different plots A, showing variability in house crow feeding behaviors, highlighting group sizes and behavior outliers; B, Comparing house crow feeding behaviors across anthropogenic and natural food sources; C, depicting the influence of litter abundance on various crow feeding practices; D, showing the urbanization index's impact on different feeding behaviors, with included statistical significance.

behaviors are less influenced by the immediate availability of litter and more by other factors, perhaps including the distribution of grain and the behaviors of other species which crows may steal food. Aquatic and aquatic feeding behaviors were least affected by the litter abundance, occurring infrequently across all levels of litter presence.

The analysis of the urbanization index relative to feeding behaviors of house crows in Srinagar revealed varied influences of urbanization on different feeding strategies. The results reveal that scavenging behavior was most prevalent in areas with the highest urbanization index, suggesting a strong correlation between increased urban development and reliance on scavenging (Figure 4D). This may be attributed to the greater availability of waste in highly urbanized areas, which provides substantial feeding opportunities for the crows.

In contrast, behaviors such as kleptoparasitism and opportunistic feeding were observed across a broad range of urbanization levels, with no clear trend indicating a preference for more or less urbanized areas. This indicates that these behaviors are versatile and adaptable across different levels of urban development. Predation and aquatic feeding displayed intermediate levels of association with urbanization. Despite the variability across different behaviors, the overall F value of 0.17 and a p value of 0.971 suggest that there is no statistically significant difference in the urbanization index across the observed feeding behaviors, indicating that while urbanization may influence specific feeding behaviors, the effect is not statistically robust across the behaviors studied. This could imply that house crows have a high degree of behavioral flexibility, allowing them to exploit available resources in a variety of urban settings. The changes in feeding duration of house crows throughout the day in Srinagar demonstrated that feeding durations varied significantly across different times of the day. The longest feeding durations were observed during the evening, as indicated by the wider spread and higher median value in the boxplot (Figure 5A). This suggests that house crows were more actively feeding during the evening hours.

Morning and afternoon times showed moderate feeding durations, with morning times displaying slightly higher variability in duration than the afternoon. This could imply that morning feeding behaviors are influenced by factors that do not affect the afternoon as much. Interestingly, the feeding duration at noon was notably shorter, with a much lower median and less variability. This could indicate that midday conditions, possibly including higher temperatures or human activity, might deter prolonged feeding during this time.

The analysis of the relationship between altitude and feeding duration among house crows in Srinagar displayed a slight negative correlation. The scatter plot shows that as the altitude increased, the duration of feeding generally decreased, as represented by the downward trend line. The correlation coefficient of -0.18 supports this observation but indicates a weak relationship between these two variables (Figure 5B). The p value of 0.1562 suggested that the correlation observed is not statistically significant, implying that other factors may be influencing feeding durations more than altitude alone. This could mean that altitude has a minimal direct impact on feeding duration, or that the variation in feeding time at different altitudes is influenced by a complex set of environmental or biological factors not captured solely by altitude.

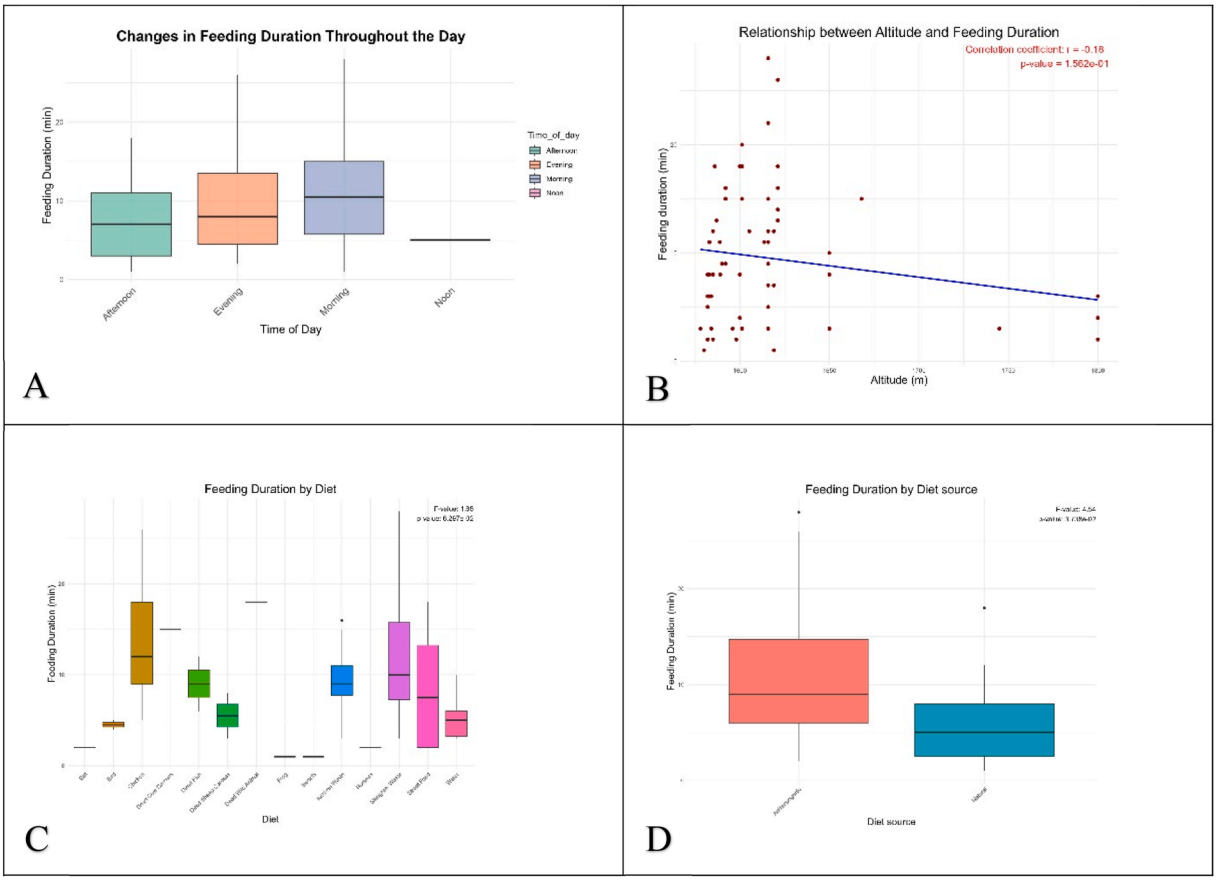

Figure 5. Plots showing A, house crow feeding duration by time of day; B, the negative correlation between altitude and feeding duration; C, the feeding duration of house crows by different diet types; D, feeding duration between anthropogenic and natural diet sources, with statistical annotations.

We studied how different types of diet influenced the feeding duration of house crows in Srinagar. The boxplot analysis demonstrated a significant variation in feeding duration based on the type of food consumed. Crows spent the longest time feeding on chicken slaughter waste, as indicated by the wide range and high median duration in the yellow box. This suggests that chicken was either particularly appealing or required more time to consume. Conversely, feeding durations on bird and chicken were much shorter, represented by the small green boxes, indicating quicker consumption or lesser interest compared to other food types. Feeding on kitchen waste and slaughter waste, shown in pink and purple, also involved longer durations, which could suggest these food sources were plentiful or involved complex feeding behaviors like scavenging amongst waste, which takes more time. The *F* value of 1.85 and a *p* value of 0.0297 indicate that the differences in feeding durations across various diets were statistically significant (Figure 5C). This suggests that the type of food significantly affects how long house crows feed, likely influenced by factors such as the nutritional value, availability, and the effort required to access the food.

We also analyzed the feeding durations based on whether they consumed anthropogenic (human-made) or natural food sources in Srinagar. The red box, representing anthropogenic sources, showed longer feeding durations compared to the teal box for natural sources. This indicates that house crows spent more time feeding on human-provided food. The median feeding duration for anthropogenic sources was higher, and the overall range was broader, suggesting a greater variability in how long crows engaged with these food types. In contrast, feeding durations for natural sources were shorter and less variable. The F-value of 4.54 and a *p* value of 0.0338 show that the differences in feeding durations between anthropogenic and natural diet sources were statistically significant (Figure 5D). This suggests that the nature of the food source significantly impacts feeding behavior, with crows spending more time on human-made food sources, possibly due to their higher availability or nutritional content.

We tried to understand how altitude, habitat type, and litter abundance influenced the feeding duration of house crows in Srinagar. The results showed that feeding duration varied across different habitats and changed with altitude, although these trends were not uniform across all habitat types. Feeding durations tended to decrease as altitude increased, indicated by the general downward trend across most habitat types. However, the strength of this relationship varied by habitat. For example, in residential areas and public parks (represented by blue and pink lines), feeding durations remained more consistent across different altitudes compared to more natural settings like forests and lakes (shown by the yellow and cyan lines) (Figure 6).

Additionally, the spread of data points within each habitat type suggested variability in feeding duration that could be attributed to factors other than just altitude, such as litter abundance and specific environmental conditions within each habitat. We investigated the influence of litter abundance and urbanization on the feeding behavior of house crows through a multinomial logistic regression analysis. The results showed how the probability of different feeding behaviors changed with feeding duration under varying levels of litter abundance.

For crows feeding in areas with low and medium litter abundance, the predicted probability of observing specific feeding behaviors remained relatively stable and low across all feeding durations, illustrated by the green and orange lines respectively. However, in highly littered environments, the predicted probability of certain behaviors increased significantly with longer feeding durations, as depicted by the steep upward curve of the blue line (Figure 7). This analysis indicates that as feeding duration increased in highly urbanized and littered areas, house crows were more likely to exhibit feeding behaviors that take advantage of the abundant waste, suggesting an adaptation to maximize resource use in more polluted environments. The other lines remaining flat suggest that in cleaner areas, the duration of feeding does not significantly change the likelihood of different behaviors, implying a consistent feeding pattern irrespective of duration.

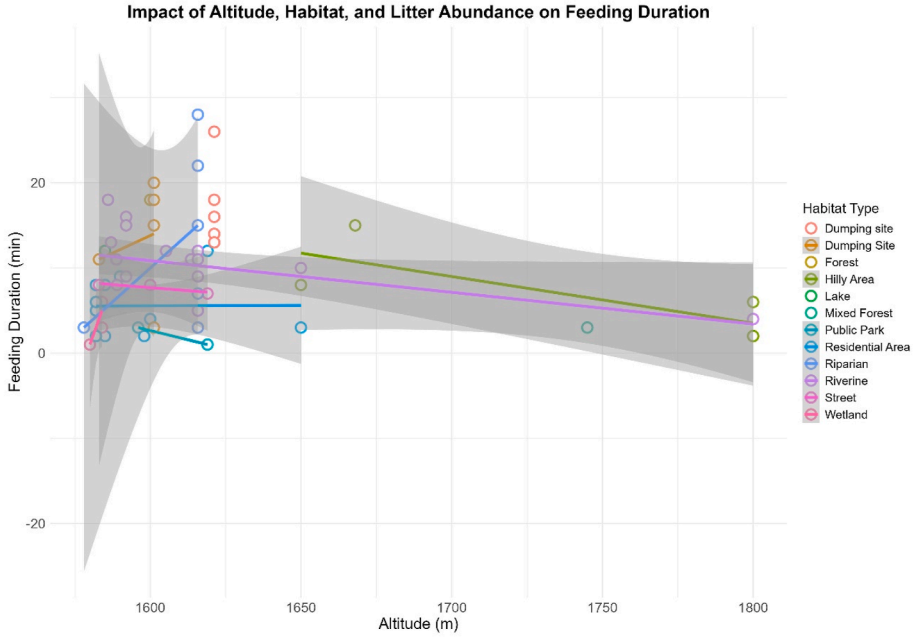

Figure 6. Scatter plot with regression lines showing relationship between feeding duration of house crows and altitude across different habitat types in Srinagar. Colored lines represent fitted linear trends for each habitat, showing how feeding time changes with elevation. Shaded areas indicate confidence intervals. Overall, a weak negative trend is observed in most habitats, suggesting that feeding duration generally decreases with increasing altitude, although this pattern varies by habitat type.

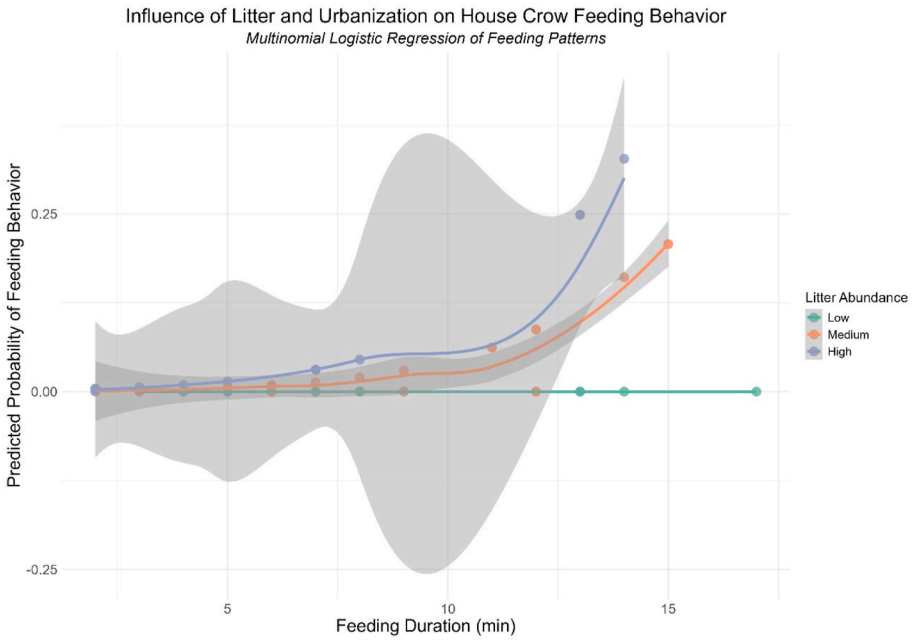

Figure 7. Multinomial logistic regression analysis depicting the influence of litter abundance and urbanization on house crow feeding behavior.

Discussion

Our study on the feeding ecology of house crows in Srinagar provided valuable information into how urbanization, food availability, and environmental factors shape the foraging behaviors of this highly adaptable species. House crows are known for their opportunistic feeding habits, and our findings confirm that their diet and behaviors are strongly influenced by anthropogenic food sources. One of the key findings of our study was that house crows in Srinagar generally forage in small to medium-sized groups, with larger gatherings being relatively rare. This pattern is similar to observations made in other urban settings, where crows typically form groups of 3–6 individuals to optimize feeding efficiency while minimizing competition (Kumar and Ojha 2023). The unimodal distribution of crow group sizes in our study suggests that smaller groups have better access to food, as competition is lower, and food resources are more manageable. The presence of these larger groups may indicate an adaptation to exploit food resources that require cooperation or communal scavenging.

House crows have been observed to prioritize energy-rich foods, such as processed human leftovers, over natural food sources like insects and small vertebrates (Majhi and Das 2022). This dietary preference is an important survival strategy, as it allows crows to maximize their energy intake with minimal effort in highly urbanized environments. The diversity in the crows' diet, particularly among smaller groups, is noteworthy. As we found that groups of 2–4 crows were more likely to consume dead animals, insects, and small rodents. This suggests that when fewer individuals are present, crows may engage in opportunistic feeding behaviors, taking advantage of available prey that requires less competition. Larger groups, on the other hand, exhibited a strong preference for slaughterhouse waste and communal feeding sites. This behavior could be explained by the higher food availability in such locations, where multiple crows can feed simultaneously.

We found that scavenging was the most frequently observed foraging strategy among house crows, followed by predation and opportunistic feeding. This dominance of scavenging behavior by birds has been found in some previous studies as well, where urban crows have been shown to rely heavily on human-generated food waste (Chace and Walsh 2006). The high frequency of scavenging behavior in our study indicates that house crows in Srinagar are highly dependent on anthropogenic resources, which are more abundant and easily accessible than natural food sources. Interestingly, our study also found that behaviors such as granivory and kleptoparasitism were less common, suggesting that house crows in Srinagar may not rely as much on these strategies as populations in other urban regions. Kleptoparasitism, or food theft from other birds, has been reported more frequently in highly competitive environments where food is scarce (Morand-Ferron et al. 2007). However, in Srinagar, where food waste is readily available, crows may not need to engage in aggressive food-stealing behaviors as frequently.

We found a strong correlation between urbanization levels and scavenging behavior. House crows were observed scavenging most frequently in areas with high urbanization indices, particularly in heavily polluted environments such as landfills and markets. Urbanization increases food availability for scavengers, leading to a higher reliance on anthropogenic waste (Patterson et al. 2023). The strong presence of crows in areas with high litter abundance further supports this trend, as increased waste levels provide more feeding opportunities. Interestingly, our statistical analysis showed no significant difference in feeding behaviors across different urbanization levels. This suggests that while urbanization may influence the availability of food, house crows exhibit a high degree of behavioral flexibility, allowing them to adapt to various environmental conditions.

When compared to studies from low-altitude urban areas like Prayagraj and Kolkata (Kumar and Ojha 2023; Majhi and Das 2022), house crows in Srinagar were found to depend more on scavenging and showed fewer cases of stealing food from other animals (kleptoparasitism). This difference may be due to the colder weather, limited food during some seasons, and uneven food availability in high-altitude places. These findings suggest that elevation and location can play an important role in shaping how birds find and use food in cities.

We examined the effects of various environmental factors on feeding duration. We found that crows spent the longest time feeding during the evening, with shorter feeding durations recorded at noon. This pattern could be explained by the influence of temperature and human activity. High temperatures at midday may discourage prolonged feeding, while increased human presence may create disturbances that cause crows to feed more quickly in less time (Ward and Low 1997). The influence of altitude on feeding duration was weak, suggesting that altitude alone does not play a significant role in shaping crow feeding behavior in Srinagar. However, habitat type did appear to affect feeding duration, with crows in residential areas and public parks exhibiting more stable feeding durations than those in forests or lake areas. This may be due to the predictability of food availability in human-inhabited areas, where food waste is regularly disposed of, compared to natural environments where food resources are more sporadic (Biswas et al. 2024)

Finally, we found that crows spent more time feeding on anthropogenic food sources compared to natural food. The statistically significant difference in feeding durations between these two categories suggests that human-provided food not only dominates their diet but also influences how long they engage in feeding activities. This indicates that urban birds prioritize energy-dense, easily accessible food sources (Biswas et al. 2024). We found the strong influence of urbanization on the feeding ecology of house crows in Srinagar. The preference for kitchen waste, the dominance of scavenging behavior, and the correlation between urbanization levels and feeding strategies all point to the adaptability of house crows in urban environments. While house crows exhibit significant dietary flexibility, their heavy reliance on anthropogenic food sources raises important ecological concerns, particularly regarding waste management and competition with native bird species.

Future research should explore the long-term impacts of urbanization on crow populations and their interactions with other urban wildlife. Additionally, studying how seasonal changes further influence crow feeding behavior could provide deeper details into their ecological adaptability. It would be very essential for urban planning and wildlife conservation efforts in rapidly growing cities.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

CRediT authorship contribution statement

Shahnawaz Ahmad Khatana: Writing – review & editing, Validation, Resources, Data curation. **Mohd Arif:** Writing – review & editing, Visualization, Validation, Supervision, Resources, Project administration, Methodology, Investigation, Conceptualization. **Parvaiz Yousuf:** Writing – review & editing, Writing – original draft, Validation, Supervision, Software, Methodology, Investigation, Formal analysis, Conceptualization.

Ethical statement

All the observations were made at a distance without affecting the natural behavior of this species. No birds were harmed directly or indirectly while conducting this study.

Data availability

The data can be obtained from the corresponding authors upon reasonable request.

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