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***Research Article** (Open Access)*

DOES THE SELECTION OF NESTING SITES AND MATERIALS BY URBAN BIRDS ACT AS A PREDATOR DETERRENT? A COMPARATIVE ANALYSIS OF THE HOUSE CROW (*CORVUS SPLENDENS*), RED-VENTED BULBUL (*PYCNONOTUS CAFER*) AND ROCK PIGEON (*COLUMBA LIVIA*) IN URBAN CHENNAI

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ABSTRACT
The study investigates whether the selection of nesting sites and materials by three urban-dwelling bird species in Chennai - the House Crow (*Corvus splendens*), Red-vented Bulbul (*Pycnonotus cafer*) and Rock Pigeon (*Columba livia*) serves as an adaptive strategy to deter predators. This research compares the nest architecture, material selection, and placement of these species to evaluate differences in their nesting behaviors in an urban environment. The nests of the House Crow are larger, loosely constructed, and frequently contain prickly twigs that may act as a defense mechanism against predators like snakes, but the nests of the Red-vented Bulbul are smaller, more securely woven, made primarily of coconut fibers, and more hidden within hibiscus plants. Instead of using complex materials for protection, the Rock Pigeon builds simpler nests on man-made buildings, instead of height and inaccessibility. The findings highlight the role of urban environments in shaping the nesting behaviors of these three species, with implications for understanding avian adaptation to urbanization. This study contributes to the broader understanding of avian nesting behaviors in urban ecosystems and offers insights into the evolutionary pressures driving material selection and site preference.

Keywords: *Urban Avian Nesting, Predator Deterrence, Species-Specific Adaptations*

INTRODUCTION
Urbanization and rapid environmental change have led to significant alterations in the nesting behaviors of avian species. Birds such as the house crow (*Corvus splendens*), red-vented bulbul (*Pycnonotus cafer*), and rock pigeon (*Columba livia*) have demonstrated remarkable adaptability to anthropogenic habitats, making them key subjects for ecological and behavioral studies in urban settings (Benmazouz *et al*., 2021). These species are highly successful in urban landscapes due to their flexible nesting behaviors, dietary generalism, and tolerance to human disturbances (Marjakangas *et al*., 2021).
The house crow, a highly opportunistic species, typically nests in tall trees or human-made structures such as telecommunications towers, utilizing various materials, including synthetic ones, as an adaptive response to urban waste (Abin *et al*., 2024). On the other hand, the red-vented bulbul, known for its territorial behavior, often selects shrubs and medium-height trees in suburban and semi-urban areas for nesting, balancing exposure and cover from predators (Tariq *et al*., 2024). Pigeons, one of the most

widespread avian species in urban areas, build nests in sheltered areas such as building ledges and lofts, benefiting from human structures for protection against harsh environmental conditions (Cull *et al*., 2024). Given the growing concerns over urban expansion, it is critical to study the nesting ecology of these bird species to understand their adaptive mechanisms in response to habitat alterations and increasing human interference. This study aims to investigate the nesting behaviors, material usage, and site selection of *Corvus splendens*, *Pycnonotus cafer*, and *Columba livia* across different urban landscapes, with a particular focus on the strategy of predator deterrence demonstrated by them. The findings of this research can contribute to urban wildlife management by providing insights into how these species adapt themselves to avoid predators and how city planning can mitigate potential human-wildlife conflicts (Cull *et al*., 2024; Lequitte-Charransol *et al*., 2024).

MATERIALS AND METHODS

Study Locations and Species

The study was carried out in two primary locations in Chennai, Tamil Nadu, India.
Location 1: Pammadukulam Village, Redhills, Chennai: Two bird species, *C. splendens* and *P. cafer*, were studied. The crow's nest was found in a *Musa acuminata* (Mango tree), while the bulbul nested in a *Hibiscus rosa-sinensis* (Hibiscus plant).
Location 2: Ethiraj College for Women, Egmore, Chennai: A nest of *C. livia* was observed inside the campus laboratory, located on a high shelf in the corner of the room.

Observation Period and Schedule

Observations were made daily during the peak activity hours for each species. Nests were monitored visually (*direct visual observation*), and some behavior was captured to document nest architecture and predator interactions.

Nest Morphology

The observed species exhibited distinctive structural adaptations that align with their ecological niches and urban surroundings. The *C. splendens* nest, notable for its larger dimensions and loosely arranged materials, reflects an opportunistic and unstructured assembly suited to more open environments. It incorporates both organic elements like twigs and leaves and anthropogenic materials, such as plastic wires and metal scraps, suggesting a behavioral adaptation to urban landscapes rich in human waste (krishnappa *et al*., 2024). This combination offers moderate stability, compensating for its exposure to predators. In contrast, the *P. cafer* nest was compact and well-concealed, structured to provide maximal protection in dense foliage. The tightly woven composition speaks to a sophisticated use of natural fibers, enhancing both the physical resilience of the nest and its ability to evade detection by predators (Johnson *et al*., 2017). Lastly, *C. livia*, often exploiting human-made structures, constructed a minimalist nest, relying on height and the architectural features of buildings rather than complex nest construction for protection, demonstrating its capacity to adjust to urban nesting opportunities (Ibáñez-Álamo *et al*., 2015).

Nest Composition

The material choice further emphasizes the birds' adaptive responses to their environment. The *C. splendens* nest displayed a heterogeneous mix of synthetic and natural materials, with significant use of plastic components. The presence of such non-biodegradable materials illustrates the species' ability to exploit urban waste while also introducing potential ecological risks, such as entanglement and decreased structural integrity (Jagiello *et al*., 2023). The *P. cafer* nest, on the other hand, exhibited a preference for organic materials, particularly coconut fibers and fine twigs, likely chosen for their availability and ability to create a well-insulated and sturdy nest (Ali and Ripley, 1987). This aligns with the species' natural

nesting habits, emphasizing concealment and security over the incorporation of external materials. The *C. livia* nest was rudimentary, reflecting the pigeon's reliance on the urban environment for protection, with construction materials limited to debris such as small twigs and feathers, underscoring the pigeon's adaptability to simplified nesting strategies within anthropogenic spaces (Pandian, 2020).

RESULTS AND DISCUSSION

The study sites presented distinct environmental factors and anthropogenic influences, providing contrasting settings for nesting behaviors, predator deterrents, and interaction with human activities. Three species were observed, each exhibiting distinct nest-building behaviors and predator deterrence mechanisms. The ubiquitous urban and rural House Crow is known for building large, open nests from various materials, including natural and synthetic items. Red-vented Bulbul, *P. cafer* favours concealed areas in dense foliage, relying on natural cover to deter predators. The urban synanthrope Rock Pigeon builds its nest in man-made structures to protect itself from predators. The inclusion of species with varying levels of reliance on anthropogenic structures allowed for a broad analysis of urban adaptation strategies.

Observation Period and Schedule

All observations adhered to ethical guidelines established for non-invasive wildlife research (Animal Behaviour Guidelines, 2021). Nests were monitored from a distance of at least 2 meters to avoid disturbing the birds or influencing their behavior. Observations were made using direct visual methods, occasionally supplemented with a smartphone camera. No physical handling of nests, eggs, or chicks occurred, and no flash photography was used during observation to prevent distress. Nest dimensions were measured only after confirming that the birds were no longer actively using the nests, ensuring minimal disturbance. The study was conducted for 3 months (June-August). The behavior of *C. splendens and P. cafer* was observed from early morning to late evening (5.00 am to 6.30 pm) and of C. *livia during college hours (7.30 am to 5.00 pm).* The climatic conditions at the two study sites were recorded during the observation period. The temperature was recorded at 91.66±1.16°F, with 60.15±1.58% humidity and wind speeds of 9.34±0.04 mph at location 1 and the temperature was 92.67±0.58°F, with 56.23±1.16% humidity and wind speeds of 9.14±0.11. mph at location 2 (Figure 1 & 2).

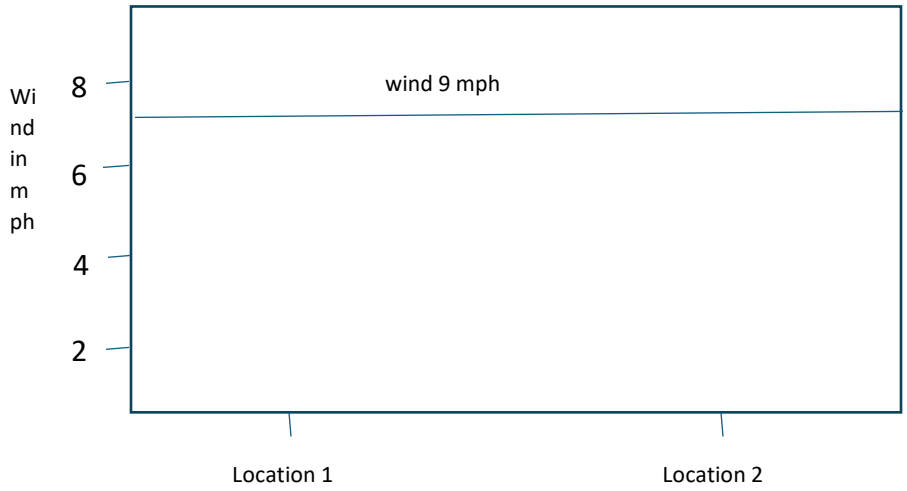

Figure 1: The parameter of wind in location 1 and location 2

These environmental variables represent typical monsoonal conditions in Chennai during the observation period, with relatively high temperatures and humidity. The temperature, humidity, and wind conditions

in urban environments significantly impact the reproductive success and nesting behavior of birds. For species like the House Crow and Red-Vented Bulbul, external climatic conditions such as high humidity and fluctuating temperatures can affect nest stability and egg incubation (Mainwaring, 2015). Pigeons. The crow and bulbul's nests were exposed to fluctuating external conditions, whereas the pigeon's nest was protected from outdoor elements within the college laboratory (Ranjan and Ansari, 2019).

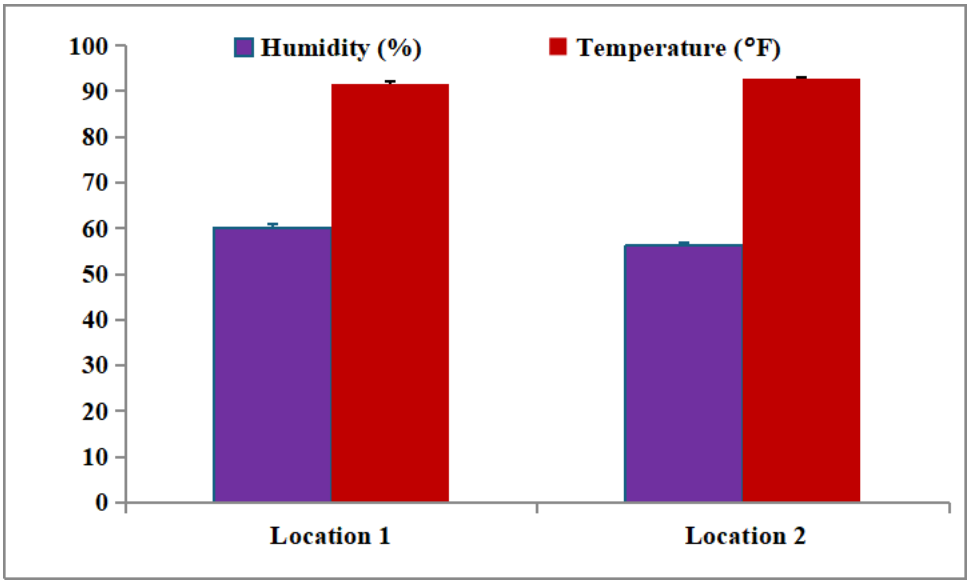

Figure 2: The parameter of humidity (%) and Temperature (°F) in location 1 and location 2

Nest Construction and Dimensions

The nests' measurements were taken with a measuring tape and shown in Table 1. The nest of House Crow, positioned at a height of 10.2 feet in a mango tree, measured 48 cm in diameter and 11 cm deep. The Red-vented Bulbul's nest was built inside a hibiscus plant at an elevation of 3.9 feet. The nest measured 11 cm in diameter and 4 cm in depth. The pigeon's nest inside the college laboratory was 8.6 feet above the ground, with a diameter of 23 cm and a depth of 6 cm. The House Crow aced predation from snakes, which are prevalent in the area. According to Barker and Wolfson (2021), the use of spiny materials and synthetic detritus in nest construction may act as mechanical deterrents for these predators. The Red-vented Bulbul, predation pressure from crows was high in the area. The bulbul's reliance on dense foliage for nest concealment (degree of concealment) is consistent with its natural defense against predators (Johnson *et al*., 2017). The Rock Pigeon, had no immediate predators due to the protective indoor environment. Its nesting choice within the classroom reflects a reliance on human-made structures as protection from predation (Figure 3).

Nesting Behavior and Materials

The House Crow, in addition to natural materials like twigs, the crow incorporated plastic wires, iron scraps, and parts of plastic carry bags into its nest. The Red-vented Bulbul, cconstructed its nest primarily using twigs, leaves, and fibers from nearby vegetation, relying heavily on the dense hibiscus plant for concealment. The Rock Pigeon built a simple, shallow nest using minimal materials such as twigs. The urban heat island effect and fluctuating humidity levels in cities could have a significant impact on bird reproductive success and nesting behavior. Recent research has highlighted that increased temperatures in

urban areas not only affect adult birds but also lead to higher rates of chick mortality, dehydration, and nest abandonment (Bourne *et al*., 2020).

Table 1: Structural dimensions of House Crow, Red-vented Bulbul and Rock Pigeon nests.

Variables	House Crow	Red-vented Bulbul	Pigeon
Nest diameter parallel to long axis (cm)	48.1	11.0	23.3
Nest diameter perpendicular to long axis (cm)	46.4	10.3	21.5
Nest height (cm)	11.2	4.3	6.3
Mean outer wall thickness (cm)	2.5	1.2	1.5
Maximum cup depth (cm)	11.3	4.1	6.2
Total nest mass (g)	220.0	48.0	129.0
Structural wall mass (g)	148.0	26.0	57.0
Cup lining mass (g)	59.0	13.0	30.0
Cup volume (cm^3)	19903	380	2492

Figure 3 a. House Crow nest located 10.2 feet above the ground in a mango tree; b. Red-Vented Bulbul nest, 3.9 feet above ground in a hibiscus plant; c. Rock Pigeon nest positioned 8.6 feet high on a laboratory shelf.

The variation in nest dimensions and materials aligns with previous research, indicating that individual and environmental factors influence nest construction (Ali and Ripley, 1987). The House crow's nest included synthetic materials such as plastic wires, parts of plastic carry bags, and metal objects, including iron wires. These materials reflect the increasing influence of urban waste on avian nesting behavior. This suggests an opportunistic approach to urban nesting and highlights the significant impact of urban waste on avian behavior (Noreen and Sultan, 2021). The use of synthetic materials by the House Crow suggests an adaptive response to the availability of urban waste, an observation supported by the studies of Jadhav and Patange, (2018). In bulbuls, the method of choosing well-covered nesting sites is a key predator deterrence strategy (Watling, 1983). The pigeon's choice of a high, indoor shelf reflects an opportunistic nesting strategy in response to human presence, seeking shelter from external predators (Prior *et al*., 2002).

Interaction with Human Activity

In the House Crow, there was moderate human activity due to ongoing building near the nest site. However, the crows appeared to tolerate these interactions without disturbance. In Red-vented Bulbul, Minimal human interaction was observed. Occasional monitoring and feeding by the observer occurred, but human activity near the nest was otherwise absent. In the Rock Pigeon, high human activity was recorded, as the pigeon nested inside an actively used classroom. A 2015 study has shown that birds' proximity to humans also alters their stress levels, influencing factors like reproductive timing and nest defense strategies (Tarjuelo *et al*., 2015). Additionally, the construction and noise from human activities can indirectly contribute to an increase in predator presence, further complicating the nesting environment. Beyond nesting behavior, urban birds play a key role in urban ecosystems, from controlling insect populations to being a food source for larger predators. Birds like the House Crow play a crucial role in waste management by scavenging, which indirectly helps control insect and rodent populations in urban areas (Sorace, 2002). Understanding these interactions can provide further insights into how cities benefit from these birds, despite their sometimes perceived nuisance value.

Noise pollution and nesting success

In urban environments, noise pollution is an often-overlooked factor that can significantly affect avian behavior and reproductive success. Birds rely heavily on vocal communication for mate selection, territory defense, and parent-offspring interactions. However, in cities, anthropogenic noise from traffic, construction, and human activities can mask these critical vocalizations, disrupting normal behaviors. This phenomenon has been observed across several species, and evidence suggests that elevated noise levels force birds to either alter their vocal frequencies or increase their call intensity, leading to potential increases in energy expenditure (Chamberlain *et al*., 1971). For the House Crow, an opportunistic and adaptable species, noise pollution may pose less of a challenge compared to other species. The crow's behavioral flexibility allows it to thrive in urban areas where noise levels are high. However, prolonged exposure to elevated noise may still result in subtle disruptions to social interactions, stress, or reproductive inefficiencies. While crows are less reliant on vocal communication compared to songbirds, the impact of urban noise on stress levels and long-term reproductive success cannot be entirely discounted. Studies have suggested that even highly adaptive species like crows may experience physiological stress responses to chronic noise (Broad *et al*., 2024). The study by Takeda *et al*. (2022) highlights that chronic exposure to urban noise disrupts their acoustic signals, which can lead to mating delays and a reduction in overall reproductive fitness (Pharr, 2021). In contrast, the Red-Vented Bulbul, which depends heavily on vocal communication for mating and parental care, is likely to be more directly affected by noise pollution. The presence of continuous urban noise can interfere with the ability of parent bulbuls to effectively communicate with their chicks, potentially leading to lower feeding efficiency and reduced survival rates (Sanchez, 2022). Additionally, noise pollution can hinder mate selection, as females may struggle to assess male calls accurately, which could lead to delayed reproduction or

suboptimal mate choices (Engel *et al*., 2024). Given the bulbul's reliance on vocal signals, noise pollution represents a significant environmental stressor in urban settings. Rock Pigeons, while also present in urban environments, appear less affected by noise pollution due to their reliance on visual cues rather than vocal communication. Nesting primarily in man-made structures, which often provide insulation from external noise, pigeons may experience fewer negative effects from urban noise compared to species that depend on acoustic signals. However, while pigeons may be less vulnerable to noise disruptions, urban noise pollution still contributes to overall environmental stress, potentially affecting their behavior indirectly through increased urban activity and other stressors (Amjad *et al*., 2023). The Rock Pigeon may not be directly affected by noise due to their reliance on visual cues, but the increase in artificial lighting disrupts their circadian rhythms, influencing nesting and breeding times (Lea *et al*., 2024).

Degree of Nest Concealment and Novel Observations

The House Crow, by incorporating synthetic materials into its nest, the crow demonstrated an opportunistic use of urban waste. This behavior has been documented in other urban bird species, but its impact on reproductive success remains unclear (Król and Hernik, 2020). The bulbul's choice of a concealed nest site in the hibiscus plant highlights its reliance on vegetative cover for predator deterrence. Studies have suggested that the degree of concealment plays a critical role in the reproductive success of bulbuls, although this has not been extensively studied in urban environments (Ullah *et al*., 2021). The Rock Pigeon, the indoor nesting strategy of the pigeon highlights an interesting adaptation to human structures. While pigeons are known for their tolerance of urban environments, the long-term effects of nesting in heavily trafficked human spaces have yet to be fully explored. The pigeon's apparent tolerance for human presence aligns with previous studies on urban pigeon behavior (Bodden, 2023).

Conclusion

This study emphasizes the intricate nesting and avian behaviour of urban-adapted birds, highlighting their remarkable resilience to environmental and anthropogenic pressures. The distinctive adaptations of the House Crow (*C. splendens*), Red-vented Bulbul (*P. cafer*) and Rock Pigeon (*C. livia*) are reflective of their ecological roles and survival strategies in urban ecosystems.

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