

ROOSTING ECOLOGY OF HOUSE SPARROW (*Passer domesticus*) IN KVASU CAMPUS, POOKODE, WAYANAD, KERALA

**DIVIN V.
(20-MSVP-06)**

DISSERTATION

Submitted in partial fulfilment of the requirement for the degree of

**MASTER OF SCIENCE
(Wildlife Studies)
2022**

**Faculty of Veterinary and Animal Sciences
Kerala Veterinary and Animal Sciences University**



**KVASU CENTRE FOR WILDLIFE STUDIES
KERALA VETERINARY AND ANIMAL SCIENCES UNIVERSITY
POOKODE, WAYANAD 673576
KERALA, INDIA**

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DECLARATION

I hereby declare that this dissertation titled “**Roosting Ecology of House Sparrow (*Passer domesticus*) in KVASU Campus, Pookode, Wayanad, Kerala**” is a bonafide record of research work done by me during my Master’s research program and that the dissertation has not previously formed the basis for the award of any degree, diploma, associateship, fellowship or other similar titles of any other University or Society.

Place: Pookode

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CERTIFICATE

Certificate that this dissertation, titled “**Roosting Ecology of House Sparrow (*Passer domesticus*) in KVASU Campus, Pookode, Wayanad, Kerala**” is a bonafide record of research work done independently by **Divin V. (20-MSVP-06)** under my guidance and supervision and that it has not previously formed the basis for the award of any degree, diploma, associateship or fellowship to him.

Place: Pookode

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CERTIFICATE

We, the undersigned members of the advisory committee of **Divin V. (20-MSVP-06)**, a candidate for the degree of Master of Science in Wildlife Studies, agree that the dissertation titled, “**Roosting Ecology of House Sparrow (*Passer domesticus*) in KVASU Campus, Pookode, Wayanad, Kerala**” may be submitted by **Divin V. (20-MSVP-06)**, in partial fulfilment of the requirement for the degree.

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Divin V.

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INTRODUCTION

1. INTRODUCTION

House Sparrows (*Passer domesticus*) are passerine birds of the genus *Passer* and the family *Passeridae*. They are small (size) sexually dimorphic granivorous birds that live in colonies (Anderson, 2006). Male birds are heavier than females and have a grey crest and black post-ocular stripes with conspicuous white dots behind the eyes, while female birds are dull brown. The main difference between male and female House Sparrows is the large, darker throat badge present in male birds (Hanson *et al.*, 2020).

House Sparrows are found primarily in urban and rural human-dominated landscapes because they find sufficient food and nesting sites there (Southern, 1945; Summers-Smith, 1959). Sparrows are found in most human-inhabited landscapes, such as private gardens, farms, agricultural fields, and markets, even in extreme climates (Summers-Smith, 1954; Johnston and Selander, 1964; North, 1973; Cannon *et al.*, 2005; Murgui, 2009; Khera *et al.*, 2010). Without human presence, local extinctions of sparrows have even been reported (Summers-Smith, 1959; Ravinet *et al.*, 2018). Thus, they are commensals of humans. Saetre *et al.* (2012) studied the evolution of commensal niche of House Sparrows with human. From the comparison of genome sequences of commensal House Sparrow population from Europe and the non-commensal Bactrianus Sparrow population (*P. d. bactrianus*) revealed that the divergence between these two groups happened ten thousand years ago. It is noted that the commensal behaviour of House Sparrows with humans, developed with the spread of agriculture (Saetre *et al.*, 2012; Ravinet *et al.*, 2018)

1.1. DISTRIBUTION

House Sparrows are one of the globally distributed bird species, native and resident in Eurasia from the British Isles, northern Scandinavia, northern Russia and northern Siberia south to northern Africa, Arabia, India and Burma. In addition, sparrows have been introduced elsewhere in the world in South

America, South Africa, Australia, and New Zealand for various purposes (Hanson *et al.*, 2020; Lowther and Cink, 2020). Later, they became a pest in introduced landscapes, leading to negative attitudes among people, especially grain farmers (Southern, 1945).

Human colonisation and the introduction of House Sparrows to various continents by humans have made them a ubiquitous bird species. Globally, they are facing a decline in their population due to various reasons such as increasing urbanisation, changes in building structure, disappearance of gardens and vegetation from human habitats (Angelier and Brischoux, 2019), modernization of agricultural systems (De Laet and Summers-Smith, 2007), increased use of pesticides (Roshnath *et al.*, 2018), and predators (Tobolka, 2007).

The recent decline made the scientific community focus on this species and prompted studies on population status and breeding biology worldwide (Patel and Dodia, 2021).

Knowing life history traits such as roosting behaviour is important for conserving a species. As a communal roosting bird, information on roosting behaviour is important (Gadgil and Ali, 1975; Patel and Dodia, 2021). Studies on the house sparrow have shown that a lack of roosting trees and the absence of gardens in human-inhabited areas contribute to population declines (Cannon *et al.*, 2005; Roshnath *et al.*, 2018).

Organisms use the roost to rest during extended periods of dormancy. In a communal roost, a group/bunch of similar or different organisms stay in the same space to rest. Communal roosts are known in organisms such as birds, bats, and primates (Ward, 1965; Soini, 1987; Ehrlich *et al.*, 1988; Lewis, 1995; Merke and Mosbech, 2008). Bees, wasps, beetles, dragonflies, butterflies, and moths are particularly prone to seeking roosting sites to protect themselves from predators (Post, 1982; Pearson and Anderson, 1985; DeVries *et al.*, 1987; Salcedo, 2010; Tobolka, 2011)

Nocturnal birds such as owls wake up as the sunset and forage at night. During day time they sleep in a safer place called roost. Most birds are diurnal means active after sunrise and go to roost at darker hours of the day (Ward and Zahavi, 1973; McCafferty *et al.*, 2001). Roosts act as a safe place during inactive times. For nocturnal animals roosting is a significant determinant of their fitness (Kerth *et al.*, 2001). For birds, roosting is getting safe location for resting somewhere during a specific period of the day. Some birds roost alone and some in groups (Mishra *et al.*, 2020).

1.2. ROOSTING FUNCTION

Birds like Black-headed Ibis (Koli *et al.*, 2019), Cattle Egret (Youcefi *et al.*, 2019), Rainbow Lorikeet (Jaggard *et al.*, 2015), Rook (Swingland, 1976), Magpie (Møller, 1985), Jungle Babbler (Gaston, 1977) and House Sparrow (Patel and Dodia, 2021) all show a communal roosting behaviour. Nocturnal birds such as owls roost in the daytime in solitude (McCafferty *et al.*, 2001). The main benefits of communal roosting behaviour are the enhancement of individual foraging success (Ward and Zahavi, 1973), reduced chance of predation (Page and Whitacre, 1975; Post, 1982; Eiserer, 1984) and help to maintain body temperature or thermoregulation (Burns *et al.*, 2013). The transmission of diseases and parasites and increased detection by predators are costs associated with communal roosting (Moore *et al.*, 1988; Kulkarni and Heeb, 2007; Buehler and Piersma, 2008). Roosting communally will facilitate opportunities to get partners, and it is energy-wise costly for territorial bird species (Beauchamp, 1999).

1.3. IMPORTANCE OF ROOST STUDY

Avian communal roosts of birds can be focal points for conservation and reveal information on evolution (Dwyer *et al.*, 2018; Manzoor *et al.*, 2021). Avian time-activity budgets are known to be influenced by numerous environmental factors (Janicke and Chakarov, 2007). The location of suitable roosting sites prior to roosting, cloud cover, and temperature significantly affects roosting behaviour

of birds (Everding and Jones, 2006). An understanding of the current situation of different birds in a given region can be gained by examining roost activity and species abundance.

In India, there are few studies on how birds roost in groups (Jayson, 2018; Patel and Dodia, 2021). Therefore, the present study is focused on understanding the factors that influence roosting behaviour of House Sparrows in KVASU Campus, Pookode.

1.4. ROOSTING BEHAVIOUR OF HOUSE SPARROW

House Sparrows use small trees with thick canopies for roosting. Their roosting time and roost leaving time show a correlation with sunset. Before roosting, some pre-roosting activities like foraging, sand bathing, water bathing, and preening can be observed. During the day, they use the roosting trees for perching, resting and hiding from predators (Patel and Dodia, 2021). House Sparrows select their roost based on the height and foliage cover of the tree and independent of species. They prefer to roost in trees with dense foliage or canopy cover with a height of up to 20 feet (North, 1968; Singh *et al.*, 2013).

Bird roosting time can vary depending on light, temperature, weather, and sunset (Davis and Lussenhop, 1970; Swingland, 1976; Ientile, 2014). So far, studies on sparrows in India have been limited to status assessments and population studies (Rajashekar and Venkatesha, 2008; Baskaran *et al.*, 2010; Ghosh *et al.*, 2010; Balaji, 2014; Paul, 2015; Roshnath *et al.*, 2018; Sharma and Binner, 2020) and few ecological works such as habitat preference (Khera *et al.*, 2010; Kanaujia *et al.*, 2014; Deepalakshmi and Salomi, 2019). There is a need to study the roosting habitat of House Sparrows. Roosting sites are important for sparrow conservation (Roshnath *et al.*, 2018; Patel and Dodia, 2021). Understanding life history traits such as roosting behaviour of a species will also help in conservation efforts of that species (Gadgil and Ali, 1975; Patel and Dodia, 2021).

Therefore, the present study on the roosting ecology of sparrows was conducted with the following objectives.

1. To identify the roosts and estimate roosting populations of House Sparrows in the Pookode Campus of Kerala Veterinary and Animal Sciences University

2. To study roosting behaviour and factors affecting such behaviour of House Sparrows

REVIEW OF LITERATURE

2. REVIEW OF LITERATURE

2.1. GLOBAL STUDIES ON HOUSE SPARROW (*Passer domesticus*)

Summers-Smith (1954) investigated the colonial behaviour of House Sparrows in North Hampshire. The author came to the conclusion that colonial life had both benefits and drawbacks for its inhabitants. Due to the size of the flock, colonies might easily attract predators to the mating place, which was a drawback of colonial behaviour. Moreover, gaining an advantage through colony behaviour would include information gathering about food sources and predator defence.

Johnston and Selander (1964) studied the House Sparrow's rapid evolution after it was introduced to North America and the Hawaiian island in the 19th century. They discovered that since the House Sparrow's introduction, there had been a noticeable adaptive divergence in size and colour. From the samples taken from various parts of North America, the study supported Gloger's eco-geographic rule, which linked colour to regional variance in temperature and humidity.

North (1973) investigated the population composition, variations in the seasonal distribution, and daily movements of the House Sparrow in Oklahoma. The author discovered that young sparrows tended to build communal roosts in trees and joined flocks made up mostly of young birds as they grew independent of their parents. From June to October, sparrows' daily movements to and from grain fields outside of the city were tracked. The larger flocks dispersed by the end of October, and no larger sparrow groups could be spotted in the grain fields. The larger sparrow flock broke and returned to its home range, and mainly consisted of adults. Most of the juveniles formed new groups and moved or established new home ranges away from the grain field.

Cannon *et al.* (2005) conducted a study on the usage of private gardens by wild birds in Britain. The study concluded that, there was a decrease in the usage of private gardens by common garden birds like House Sparrows in the study

area. This had been observed to be the result of a variety of factors including high levels of disturbance and predation, lack of nesting cover and predominantly alien plant species, and that some garden bird species were effectively subsidized in a particular habitat by artificial feeding and provision of nest boxes (Cannon, 1999; Beebee, 2001)

Chamberlain *et al.* (2007) investigated the associations of House Sparrows to their habitat by surveying 1223 randomly selected plots within urbanized landscapes of the United Kingdom. This study reported the importance of the suburban landscape for the survival of House Sparrows. Farming areas, gardens and residential areas had higher density of House Sparrow population. They observed a positive correlation between the human population and the House Sparrow population of the area. It was observed that House Sparrows occurred at higher densities when gardens were present within residential habitats. Presence of gardens was observed as a key factor for predicting the House Sparrow population. This was due to the presence of bushes in the gardens, which played a crucial role in the survival of House Sparrows in the area.

Murgui (2009) studied habitat selection and the factors influencing the distribution of the House Sparrow in the municipality of Valencia, Spain. The findings of the study suggested that urban parks and derelict land were important habitats for House Sparrow populations in the urban landscape.

2.2. GLOBAL DECLINE OF HOUSE SPARROWS (*Passer domesticus*)

Klok *et al.* (2006) evaluated the survival rate of House Sparrows in the Netherlands based on live interactions and dead recoveries of marked individuals. They found that the loss of House Sparrows in the Netherlands was caused by a lack of winter food, lack of nesting sites, lack of nesting materials, lack of food for nesting birds, and high rate of predation.

De Laet and Summers-Smith (2007) evaluated the decline of House Sparrow populations after twentieth century, in the agricultural lands of North-

Western Europe. They observed that reduced food availability due to the intensification of agriculture was the main reason for the decline of House Sparrow population.

Bell *et al.* (2010) examined the role of Eurasian Sparrowhawk (*Accipiter nisus*) in the House Sparrow population decline in Britain. They detected that predation by Eurasian Sparrowhawk may be a major reason for the decline of House Sparrows in Britain.

Angelier and Brischoux (2019) investigated decline of House Sparrow population on the basis of lack of cavities for nesting in new urban buildings of Niort, France. They found that rural nest boxes were more occupied than urban ones, suggesting that cavity availability is probably more constraining in rural areas relative to urban ones. Therefore, the study suggested that urban House Sparrow populations were probably not constrained by a lack of nesting sites in medium size cities with urban designs similar to experimental site.

2.3. STUDIES ON HOUSE SPARROWS FROM INDIA

Rajashekar and Venkatesha (2008) conducted a survey to understand the status of House Sparrows in Bengaluru. In the survey they observed that lack of nesting site could be the main reason for the decline of House Sparrows in urban habitats.

Khera *et al.* (2010) analysed the habitat-wise distribution of House Sparrows in Delhi, India. They observed that House Sparrows continued to predominate in agricultural fields. Compared to other common birds like the House Crow, Rock Pigeon, and Common Myna, their population was also lower or dropping in urban settings. A favourable correlation between plant diversity and sparrow density suggested that the sparrow's food supply might be influenced by herb cover, and the sparrow's population loss might be related to less dense vegetation in urban areas.

Baskaran *et al.* (2010) reported that the House Sparrow population was higher at residential areas of Sivakasi of Tamil Nadu. This population was associated with the food availability of the area; which meant that residential areas provided enough food like worms, insects and grains. This facility was very suitable for their breeding, due to the presence of easy and preferred food items. In few selected sites, population was less and they pointed out the causes like high traffic and removal of trees and vegetation from residential areas. Alteration of buildings reduced nesting spaces available for House Sparrows.

Ghosh *et al.* (2010) conducted a survey on House Sparrow population decline in Hoogly district of West Bengal and found that the decline was not caused by a single reason. Predation, ecological factors, competition between species, a shortage of nesting sites, sickness, a lack of food supply, and pollution were only a few of the causes of the House Sparrow population drop.

Singh *et al.* (2013) looked at the factors contributing to the House Sparrow's decline in Jammu and Kashmir, India. They argued that the decline was caused by a variety of factors rather than just one. They discovered that more concrete buildings, fewer bushes, plants, and gardens, as well as electromagnetic radiations were the main causes of the reduction. Because contemporary homes were solid concrete and lacked holes, there were fewer places for birds to nest. The study demonstrated a favourable relationship between number of nests and mud structures.

Paul (2015) reviewed that wide disappearance of House Sparrows was present in most states of India, including Kerala. The primary causes of this decline were attributed to the indiscriminate use of chemical pesticides, the decline in the population of insect prey, changes in building construction patterns, well-kept modern gardens in homes as opposed to weedy gardens that served as sparrows' feeding grounds, and electromagnetic radiation from cell phone towers.

Mannasaheb *et al.* (2019) conducted status survey in the Virajpet taluk of the Kodagu district in the central Western Ghats of India, and found that towns had a higher population density of House Sparrows than villages did. They discovered that the difference was caused by the presence of additional nesting spaces in the buildings and leftover hotel meals.

2.4. STUDIES ON HOUSE SPARROWS FROM KERALA

Roshnath *et al.* (2018) conducted a survey in Kannur district of Kerala to understand the present status and distribution of House Sparrows in Kannur district. They recorded 557 individuals from 35 different sites of Kannur district. In the survey, more number of House Sparrows was reported from small towns and rural areas.

2.5. STUDIES ON COMMUNAL ROOSTING BEHAVIOUR OF BIRDS

Seibert (1951) checked the size and composition of the heronry colony, and the relationship of roosting time with light, temperature, and tide. They found that time of sunset and sunrise was the most important factor controlling the arrival and departure of all species in the morning and in the evening. It was observed that night-roosting herons departed from the roost at a lower mean light intensity than when they returned, whereas the day roosting herons departed at a higher intensity than when they returned.

Davis and Lussenhop (1970) conducted a study on the roosting behaviour of Starlings (*Sturnus vulgaris*) and they demonstrated that the stimulus initiating their roosting behaviour was a function of light intensity and time of sunset. Their finding suggested that light intensity and sunset initiated these birds to leave from the feeding area. But, the time that Starlings arrived to roost was not correlated with light intensity. It was observed that reduced light intensity influenced Starlings to stop feeding and move to their roost.

Ward and Zahavi (1973) studied the importance of assemblage in some bird species and suggested that roosting and breeding assemblies of birds served principally as information-centres wherein knowledge of the location of food, or of good feeding sites was exchanged.

Gadgil and Ali (1975) reported a total of 59 species of birds from India exhibiting communal roosting behaviour. Even without being compelled by a lack of roosting locations, these birds had been known to form communal roosting groups that were larger than feeding or migrating flocks. The list of fifty-nine species also included the House Sparrow. 35 out of the 59 species of birds reported roosted communally year-round, while some other species only did so during the non-breeding season and migratory birds only did so during the winter.

Groot (1980) investigated information transfer in *Quelea quelea*, a socially residing Weaver Bird. Birds that are unaware of the location of food or water could learn the location of a resource they required in the presence of experienced birds. A subsequent study revealed that a flock made use of the more beneficial two food sources, of which many individuals were aware. In most cases, inexperienced birds tended to follow experienced birds, and other behavioural cues might also be involved, according to these findings of the study. The study also discussed the significance of synchronous flock behaviour.

Post (1982) investigated roosting behaviour of the Grey Kingbird (*Tyrannus dominicensis*) and observed that Grey Kingbird roosts did not function as food information exchange centres, but they did provide some predator avoidance benefits. These birds were migrants from islands with no predators. When they reached this wintering site, they were attacked by predators like domestic cats, owls and other birds of prey. Their aggregation and time of roosting and roost leaving provided safety from predation risk. They arrived at the roost only very late, after other communally roosting birds reached to the roost and left the roost before sunrise.

Weatherhead (1983) reviewed different hypotheses like information centre, thermoregulation, and predatory risk of communal roosting, and their benefit to individual bird. The study suggested that all individuals which participated in communal roosting did not have the same benefit. Dominance of the adult birds would help the juvenile bird to find the food resource and at the same time the dominant individual got the benefit of thermoregulation by perching on the centre location of the subordinate individuals.

Bishop and Groves (1991) investigated the roosting structure of Arabian Babblers (*Turdoides squamiceps*) based on the hypothesis of kin selection (sacrificing one individual's opportunity for the benefit of other relative individual) as suggested by Hamilton in 1964. Arabian Babblers used to be seen roosting, huddled together in a linear array along the branch of a tree, especially with the older male bird at the end of the array. Their observations argued against kin selection as the explanation of end roosting by older male birds and suggested that social status may be the most important determinant.

Beauchamp (1999) investigated the role of ecological factors like diet, territoriality, flocking behaviour and different hypotheses like increased foraging, reduced predation risk, and the thermoregulatory benefit to the evolution of communal roosting and its secondary habits. The author concluded that thermoregulation benefits had a key role in the emergence of communal roosting in birds because the behaviour was expected to arise more often in northern locations and in smaller species. However, the role of thermoregulation benefits was smaller in other species, because as gain often seems to be insufficient to compensate for the extra energy needed to travel to the far communal roosts.

Ginter and Desmond (2005) extensively studied the influence of roosting and foraging behaviour on home range size and movement of Savannah Sparrow (*Passerculus sandwichensis*). They found that in areas where climatic condition was harsh, sparrows roosted in areas that provided greater protection from climatic factors. The Savannah Sparrows used three different habitats (island

foredunes, interior grasslands, and lagoons) for foraging. Individuals foraging close to the coast travelled more into the inland to roost. They preferred to forage in open areas and were seen to be foraging in smaller groups or alone. They moved to the roost as larger flocks and their foraging and roosting sites showed overlaps.

2.6. ROOSTING STUDIES ON HOUSE SPARROW

Tobolka (2007) reported House Sparrows and the other *Passer* species were attacked by raptors such as Sparrow Hawks especially during sunset, the time sparrows went to roost. The author observed that raptors mostly attacked the sparrows which roosted in open areas like the White Stork's (*Ciconia ciconia*) nests. Sparrows which roosted in the bushes were safer and prone to low level of predation compared to those that roosted in White Stork's nests (White Stork makes nests in open areas like electric posts, top of the buildings *etc.*). The study concluded that sparrows looking for roosting sites in the nests were more vulnerable than sparrows spending the night in bushes.

Tobolka (2011) studied the roosting of House Sparrows and Tree Sparrows on White Stork nests in winter. The study did not find any relationship between roosting on nests by House Sparrows with weather, age on the White Stork's nest, and size of the nest. The author suggested that more studies on this topic were needed incorporating population structure, age, social hierarchy, and individual preference.

Burns *et al.* (2013) examined the benefits for the House Sparrow from huddling in the night roost. Interestingly, they found that high and stable body temperature was an advantage the House Sparrows gained from huddling. House sparrows are observed to be little fat birds, so huddling helped them keep a stable and higher body temperature with lower energy expense. The authors observed that the sparrows formed a tighter huddle as ambient temperature decreased, with frequent alteration in their position.

Singh *et al.* (2013) extensively studied four hundred and forty seven roosting House Sparrow populations in Jammu and Kashmir to understand their roosting behaviour. The study revealed that roosting time was related with light intensity, sunset time, and weather. They observed that House Sparrows chose spiny shrubs and trees less than seven feet height as their favourite roosts. It was found that sparrows were more communal roosters in urban areas due to the lack of choices of vegetation and more risk of predation compared to rural areas.

Roshnath *et al.* (2018) concluded that cutting down of roosting trees and plants were also a reason for the decline of House Sparrows. They conducted a perspective study by interviewing 140 individuals in Kannur district of Kerala, to identify the status and reason for the decline of House Sparrows in the study area. The surveyed people opined that different reasons like electromagnetic radiation, modernization of buildings, and cutting down of roosting trees contributed to the decline of the House Sparrow.

Patel and Dodia (2021) studied the roosting pattern of House Sparrows in urban, sub-urban and rural areas in Bhavnagar and concluded that roosting time and departure were correlated with solar timing. They observed that House Sparrows used more thick vegetation for roosting and pre-roosting activities.

2.7. FACTORS AFFECTING ROOSTING

Davis and Lussenhop (1970) observed that the time it took for Starlings (*Sturnus vulgaris*) to leave for the roost was directly connected to the light intensity available. They documented that arrival of the birds at the roost was not solely a function of the light-time stimulus, but was also influenced by the light intensity at the moment the birds first started flying.

Swingland (1976) described the effects of light-intensity on the roosting times of rooks (*Corvus frugilegus*) from a large roost during winter. The study showed that light intensity was related with the time of departure from the

foraging sites and it was observed that rooks had arrived at the roost during lower intensity of light after foraging during higher light intensity.

Summers *et al.* (1987) studied the structure of roosting with reference to the influence of age, sex and size of the participant, in the communal roosting of Starlings (*Sturnus vulgaris*). They concluded that the centre of the roost was the preferred location and that the observed dispersion reflected dominance. The author observed that after the arrival of the birds to roost it took twenty minutes for the noise and movement to settle inside the roosting tree. This could be the time taken for all individuals to find a resting place for that night, and it therefore appeared that competition for roosting places occurred each evening, leading to the observed differences in the sex and age structure.

Yap *et al.* (2002) identified factors affecting the selection of roost sites by invasive White-vented Mynas (*Acridotheres javanicus*) and Common Mynas (*A. tristis*) in urban Singapore. They documented canopy density as the most important factor for roost site selection by mynas.

Ientile (2014) studied the communal roosting sites of Black-billed Magpie (*Pica pica*) in an urban habitat. This study observed that Black-billed Magpie showed an active preference for areas with a favourable microclimate during the cold season for roosting year-round. They also avoided north exposed areas as well as deciduous trees. On the other hand, they selected safe areas with lesser human activity. They avoided north exposure to avoid the cold wind. They preferred the evergreen patch and avoided deciduous patch because of the thermoregulatory benefit they got from the evergreen patch.

Jaggard *et al.* (2015) investigated the roosting preferences of Rainbow Lorikeets in Sydney, Australia. They found that the lorikeets roosted in tall trees with thick trunks and medium density foliage and the trees next to their roost trees were of the same species. The birds preferred sites with high anthropogenic disturbance like road sides and close to street light possibly without close

neighbouring trees. In such areas hiding places are less for the predators also. The street lights also provided warmth at roosting time. Hand feeding and availability of food near the area also influenced the birds to choose the roost in the highly disturbed area.

2.8. CONSERVATION IMPORTANCE OF HOUSE SPARROWS

Southern (1945) reported that House Sparrows were important in some habitats like towns and that they were the best insect controllers all the year round, especially when they were with young. The economic importance of House Sparrows as the best friends of humans for the control of insects was recorded.

Roshnath *et al.* (2018) showed that public who were interviewed as part of a study showed interest towards conservation of House Sparrows because of their aesthetic value and role of maintaining a healthy ecosystem. In this perspective study, the respondents suggested provision of nest box, feeders with grain, bird bath, and planting of trees in gardens for the enhancement of House Sparrow population.

MATERIALS AND METHODS

3. MATERIALS AND METHODS

3.1. STUDY AREA

The study was carried out from 2022 April to 2022 August at the Kerala Veterinary and Animal Sciences University campus (100 acres) located at Pookode in Wayanad district of Kerala.

Wayanad district lies between north latitude 11° 26' to 12° 00' and east longitude 75° 75' to 76° 56' and is part of the Western Ghats. The land is rich in biodiversity. The altitude ranges from 700 to 2100 above mean sea level, and the most characteristic feature of the district is its low hill ridges, with sharp peaks and extensive valleys (Dileep and Nair, 2015). Wayanad has a stable House Sparrow population (Nameer and Praveen, 2021).

Kerala Veterinary and Animal Sciences University campus (11°32'30"N 76°01'13"E) is located near Lakkidi and borders the Kalpeta Forest Division. The campus has an evergreen forest patch with small shrubs, trees, and weeds. The study area is not only home for House Sparrows but also for many other forest birds. The man-made structures include administrative and academic buildings, hostels, farm buildings *etc.*, facilitating nesting spaces for House Sparrows.

From the pilot survey, three roosting populations were identified in the study area (Fig.1).

Roost 1: The Head Quarters of the university is the central location of the campus along with the main academic buildings, canteen, and garden of College of Veterinary and Animal Sciences, Pookode. A Weeping Fig (*Ficus benjamina*) in the main garden was the permanent roost for House Sparrows. During disturbances such as garden maintenance, arts fest *etc.* the birds were found to shift their roost to a bamboo located 128 m away. Such shifting of roosting sites was also reported by Patel and Dodia (2021).

Roost 2: Teaching Veterinary Clinical Complex of College of Veterinary and Animal Sciences (TVCC), Pookode, which is at the entrance of the campus harboured a roosting population. The site had hospital buildings, staff quarters, students' hostels, *etc.* A Golden Dewdrop (*Duranta erecta*) tree was the permanent roost that often got shifted to a nearby Jackfruit Tree (*Artocarpus heterophyllus*) when disturbed.

Roost 3: The cattle farm sheds of College of Veterinary and Animal Sciences, Pookode, is located at the other end of the campus. The location also had farm buildings, staff quarters *etc.* nearby. A bamboo thicket was the roosting site during the early study period which got shifted to a Passion Fruit vine (*Passiflora edulis*) grown in the employer's quarters. Details of the roosting tree are given in Table 1.

The TVCC roost was 847 m away from the head-quarters while the cattle shed roosting area was 868 m away from the head-quarters.

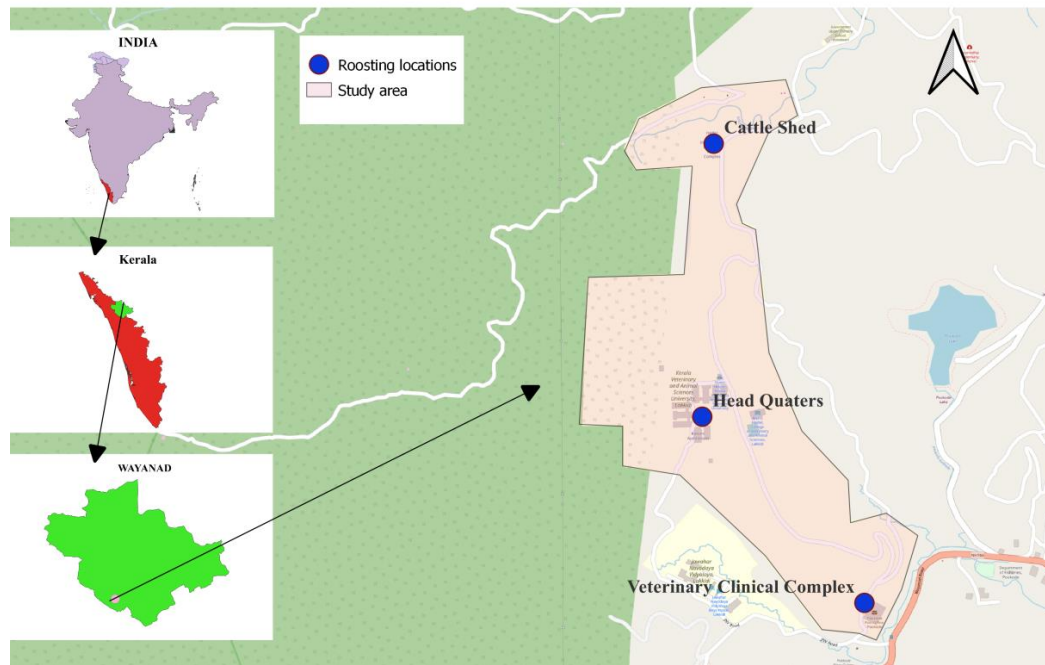


Fig.1. Map of the Study area

Table 1. Height details of the roosting trees

Tree species	Location	Height (m)	Roosting height (m)
Weeping Fig (<i>Ficus benjamina</i>)	Head Quarters	4.57	3.5
Bamboo (Bambusoideae)	Head Quarters	12.8	7.5
Golden Dewdrop Tree (<i>Duranta erecta</i>)	VCC	7.3	4
Jackfruit Tree (<i>Artocarpus heterophyllus</i>)	VCC	10.97	7
Bamboo (Bambusoideae)	Cattle Shed	7.3	5.1
<i>Aporosa cardiosperma</i>	Cattle Shed	9.1	7
Passion Fruit vine (<i>Passiflora edulis</i>)	Cattle shed	2.7	2

3.2. SAMPLING METHODS

Two sparrow roost counts were conducted in each of the three roosting sites in a month, which yielded around 6 days of observation (minimum) in a month. Sparrows were counted using the point count method (Sutherland, 2006) and the total number of sparrows was estimated.

Based on the activity, the roosting period was divided into 3 stages; assemblage, pre-roosting, and roosting. Assembly starts with the appearance of a few birds in the gathering place which is mostly near a roosting tree and with time more birds join the flocks (Singh *et al.*, 2013). Opportunities for foraging and sandbath were found at all gathering places. During assemblage, individuals spent most of their time foraging. After foraging, birds move to a less active stage involving resting, preening and sand bathing and this stage was marked as the pre-roosting stage. The start and end time of each stage was recorded. After pre-roosting, all the birds were found to move to the roosting tree together at the same time and this time was recorded as roosting time.

During roosting, sparrows chirp (different from normal calls) which lasts until sunset (Patel and Dodia, 2021). The start and end times of chirping were recorded.

Environmental factors like light intensity and ambient temperature at each stage were recorded using HTC LX-103 digital lux meter and HTC-1 digital thermometer cum hygrometer. The relationship between environmental factors and assemblage, pre-roosting, and roosting were studied. All the analyses were done in R software (version 4.1.1).

RESULTS

4. RESULTS

4.1. ROOSTING POPULATIONS AND ROOSTING LOCATIONS

4.1.1. Roosting populations

During the study period, three different populations were observed in the study area. The roosting population was seen to be varying across the sites ($p < 0.01$) (Fig. 2). Highest population was found at Roost 3 (13.73 ± 4.21) followed by Roost 2 (13.25 ± 6.21) and Roost 1 (9.27 ± 3.64). The abundance of House Sparrows in each location varied monthly (Fig. 3 and Fig. 4).

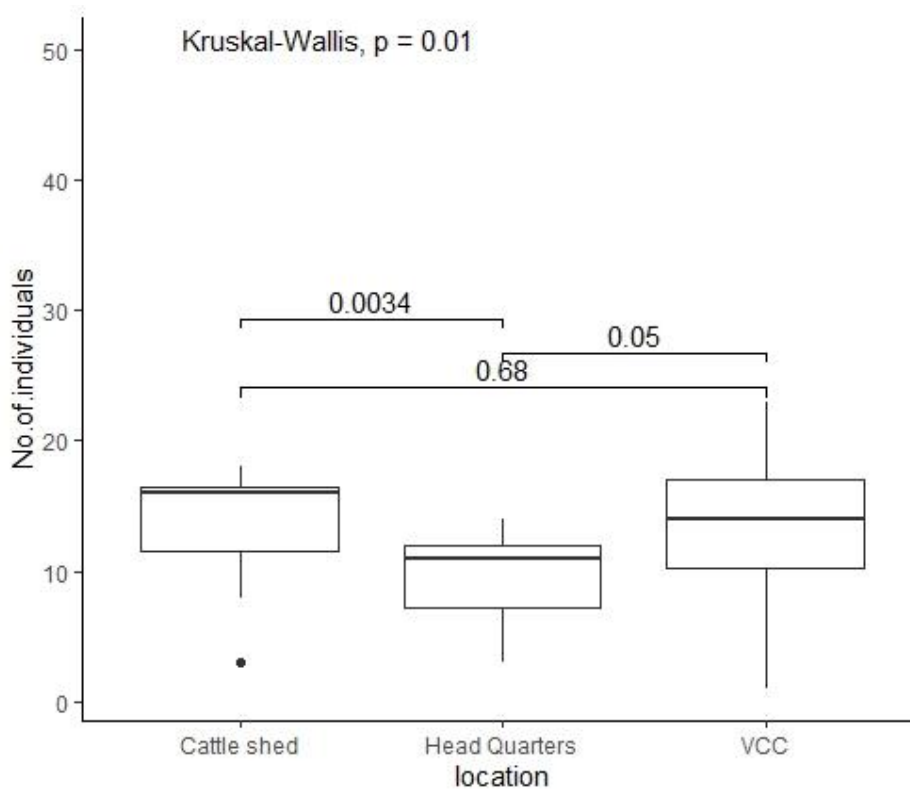


Fig. 2. Roosting House Sparrow populations at three different locations – Cattle Shed (Roost 3), VCC (Roost 2), and Head Quarters (Roost 1)

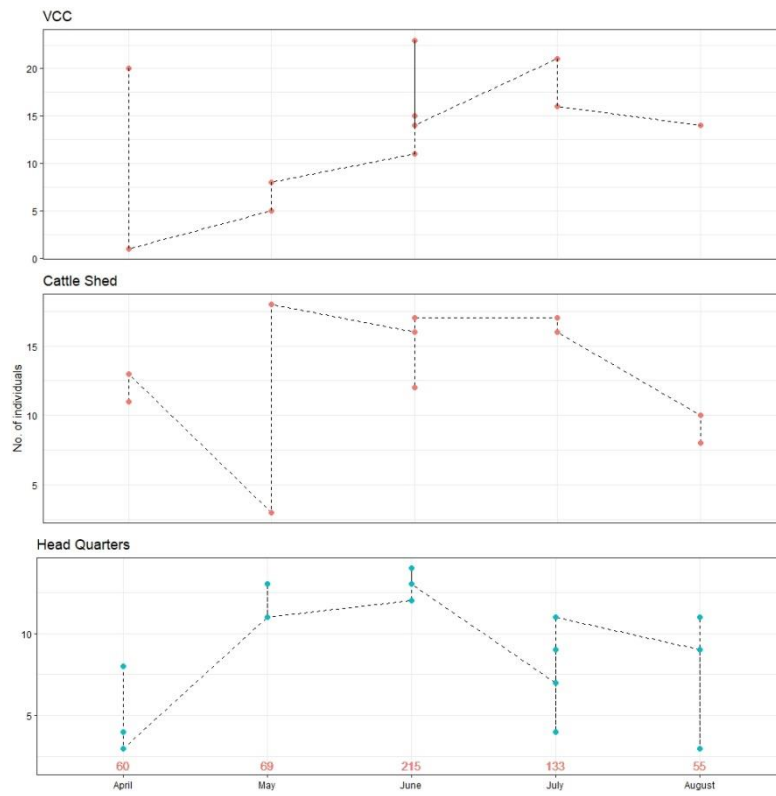


Fig.3. Abundance change of House Sparrow population across the months

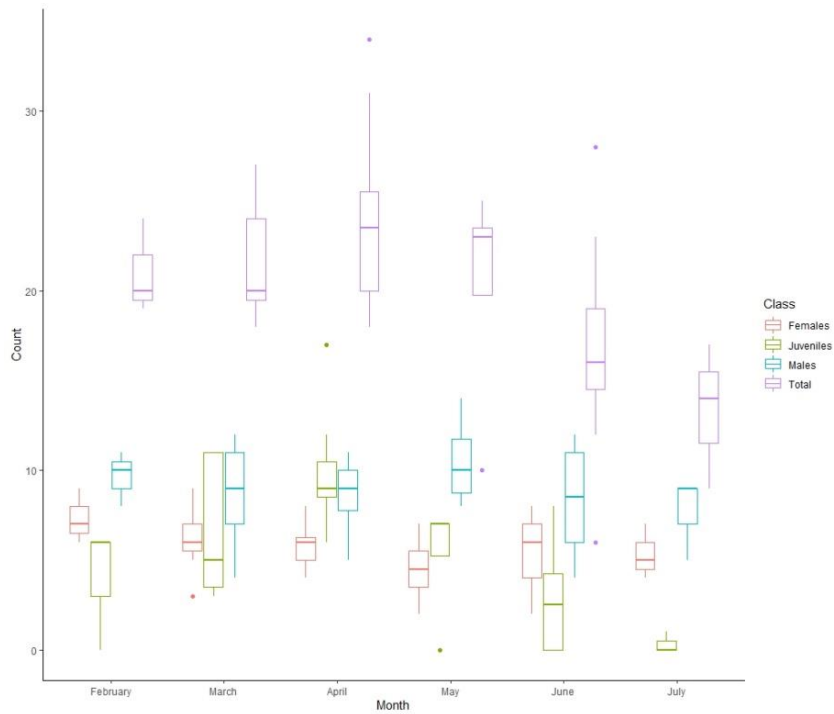


Fig.4. Population variation across the months

4.2. ROOSTING AND FACTORS AFFECTING ROOSTING OF HOUSE SPARROWS

Sparrows were found to assemble at 4:02 PM (mean) followed by pre-roosting at 4:58 PM, and roosting at 5:59 PM. A diagrammatic representation of each activity is given in Fig. 5. Early assemblage (3:42 PM), pre-roosting (4:15 PM), and roosting (4:29 PM) were observed in July.

Pre-roosting was affected by the month (p-value <0.001), temperature (p-value <0.05), and time of sunset (p-value <0.01). Other parameters like light intensity, weather, and location had no effect on pre-roosting activity. Activities such as assembly, roosting, and last chirp were not affected by month, temperature, sunset time, light intensity, weather, and location.

The mean last-chirp time was 6:10 PM. Early last chirp was observed in July (4:29 PM) and late last chirp was observed in June (7:11 PM). The duration of the last chirp and the number of individuals in the roost showed a negative correlation (-0.17; Fig. 6).

4.2.1. Other observations

During assembling, Spotted Dove (*Streptopelia chinensis*), Black Throated Munia (*Lonchura kelaarti*), Red-whiskered Bulbul (*Pycnonotus jocosus*), White-breasted Water Hen (*Amauromis phoenicurus*), and Oriental Magpie Robin (*Copsychus saularis*) seemed to be foraging with House Sparrows in all locations. Raptors like Eurasian Kestrel (*Falco tinnunculus*), Brahminy Kite (*Haliastur indus*), Crested Goshawk (*Accipiter trivirgatus*), and Shikra (*Accipiter badius*) were observed in assembling time and on a few occasions attacking by these predators was observed. In Roost 1, the permanent roost was used only by House Sparrows. In Roost 2, the permanent roost was shared with Red-whiskered Bulbul. In Roost 3, Cattle shed the first permanent roost was shared with Red-whiskered Bulbul, Black-throated Munia, Indian Pond heron (*Ardeola grayii*), Malabar Starlin (*Sturnus vulgaris*), and Spotted Dove.

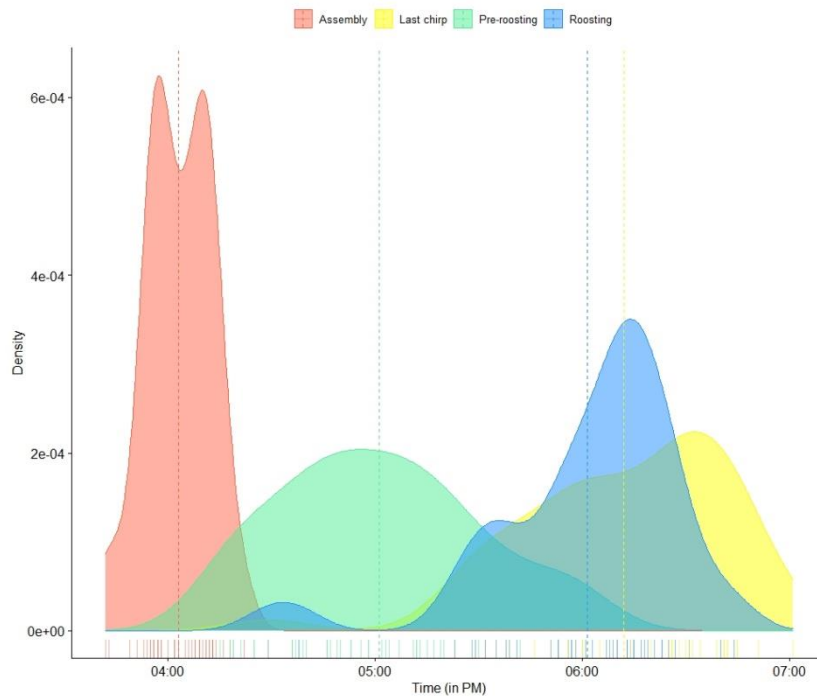


Fig.5. Roosting pattern of House Sparrows

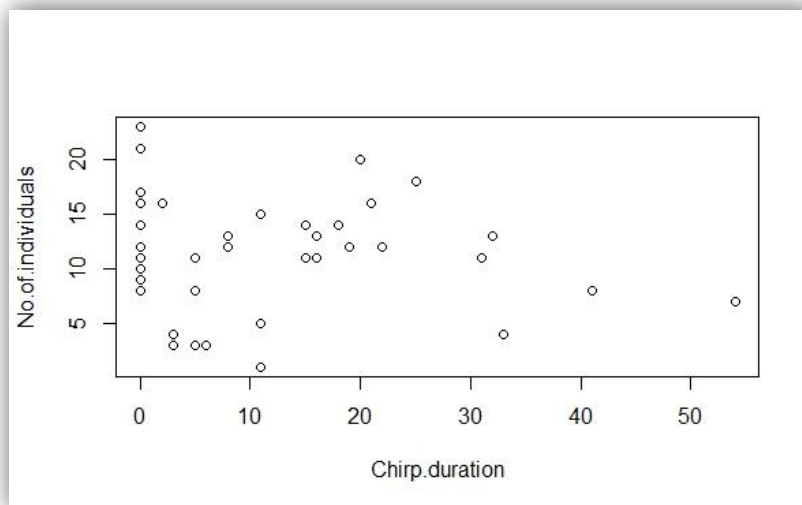


Fig.6. Correlation between duration of chirp and number of individuals in the roost



Plate 1. House Sparrows on foraging (time of assembly) (A) Garden (Roost 1) (B) Foraging with Spotted Dove (Roost 3) (C) Foraging with Black-Throated Munia (Roost 3) (D) Foraging on wasted feed from farm animals and birds (Roost 1).



Plate 2. Sand bathing activity of House Sparrows

(A) Sand bathing female House Sparrow (Roost 2) (B) Sand bathing male and female House Sparrows (Roost 1) (C) Sand bathing of House Sparrows on soil in the road (Roost 2) (D) Sand bathing House Sparrows on free soil near a parking vehicle (Roost 3) (E) Depression made on the soil by House Sparrow's sand bathing activity (Roost 2).



Plate 3. Juvenile House Sparrows on perch (Aggregation) (Roost 2)



Plate 4. Pre-roosting House Sparrows

(A) Pre-roosting House Sparrows (Roost 1), Red-whiskered Bulbul also perching with House Sparrow (B) House sparrows pre-roosting on fencing (Roost 3)

DISCUSSION

5. DISCUSSION

All roosting populations observed during the study were small in size. Competition for resources and nesting sites could be the factor limiting the roosting population size in each location. Khera *et al.* (2010) found that more House Sparrows were seen near agricultural fields and less or minimum in urbanized areas in Delhi due to the availability of more food in agricultural fields. Angelier and Brischoux (2019) observed that even in the presence of more nesting cavities in urban areas, more House Sparrows preferred to nest in rural areas due to the presence of more food resources in the latter. Mannasaheb *et al.* (2019) observed more House Sparrows in towns than in the villages of Kodagu. They correlated this finding with more food availability in towns than in villages due to the wastage of grains and food items from small hotels and shops. Dhanya and Azeez (2010) observed that House Sparrows were mostly seen near shops as they provided more food resources like grains and groceries. These observations support the inference that availability of food is a factor that affects the distribution of House Sparrows and their abundance as reported by Bijith and Roshnath (2022)

The young individuals of House Sparrows, after getting independent, move to other areas and establish new roosting sites (North, 1973). Monthly variation in the abundance of House Sparrows at each location may be due to such movement by juveniles. House Sparrow breeding has been observed throughout the year in south India (Chamberlain *et al.*, 2007). Likewise, juvenile individuals were observed throughout the study period and active nests were observed every month except during peak monsoon (June and July).

5.1.1. Light intensity

Roosting behaviour is a function of light intensity and the time of sunset and time of departure from the feeding site of Starlings was correlated with light intensity as reported by Davis and Lussenhop (1970). Patel and Dodia (2021) also

found that the time of departing to the roost is related to the time of sunset. However, it was observed that the pre-roosting stage was affected by sunset time, i.e. pre-roosting behaviours were observed an average time of 1.75 hrs. before the sunset time. Time of pre-roosting delayed with delayed sunset time and vice versa. On some occasions, early pre-roosting was observed even in during late sunset. This was due to the presence of rain on the day. Hence, we infer that weather has an effect on this activity, even though statistical conclusions show no significance. Anderson (2006) also observed the House Sparrows arrive at the roosting site before two hours. Similarly, Patel and Dodia (2021) also observed that House Sparrows arrive at roosting sites one to 1.5 hrs. before sunset time. After the arrival at the pre-roosting site, House Sparrows were observed to spend the time resting on a perch, preening or sand bathing.

House Sparrows were found to assemble by 4:02 PM (mean) when they were found to be actively foraging before entering the pre-roosting stage which was generally an hour later (4:58 PM). Pre-roosting was affected by the month, temperature, and time of sunset. The time of sunset and environmental temperature varies with the month as a climatic process. It was also observed during the study that sunset time varied with the month constantly.

5.1.2. Temperature

For smaller birds and birds in northern areas, thermoregulation has an influence on the evolution of communal roosting (Beauchamp, 1999) and sparrows stay closer and huddle when temperature decreases (Burns *et al.*, 2013). The present study did not evaluate the positioning of sparrows in the roost. Hence, an assessment of the potential effect of temperature could not be made. However, it was observed that the pre-roosting stage was affected by ambient temperature i.e. generally pre-roosting was observed during a mean temperature of 25.6°C. Pre-roosting delayed with increasing temperature. Early pre-roosting was observed at 4:15 PM with the lower temperature of 20°C in July. Late pre-roosting was observed at 6:00 PM with increased temperature of 23.7°C in June.

5.2. ROOSTING INTERACTIONS WITH OTHER SPECIES

5.2.1. Competition for food and space

Birds like the Spotted Dove, Black-throated Munia, Oriental Magpie Robin, and Grey Wagtail were observed to forage with the House Sparrows during the present study. This may have posed competition for getting enough feed at assembly time for the House Sparrows. Ghosh *et al.* (2010) observed that competition for food from similar and other bird species is a reason for the population decline of House Sparrows.

During foraging time, Blue-capped Rock Thrush was observed to peck the House Sparrow individuals, foraging at the same site for the food. The pecking was observed only during foraging activity. This behaviour may have been for gaining the dominance on the food resources as it is also an omnivorous bird that eats insects and seeds, as opined by Collar (2020).

5.2.2. Predation

Raptors like Sparrow Hawk are known to prey on roosting sparrows from White Stork's nest and when they move to roosting site (Tobolka, 2007). During the present study, Crested Goshawk, Shikra, and Common Kestrel were found to attempt preying on sparrows but were not successful. Sparrows were found to hide in nearby vegetation or inside roosting tree to escape from predators by Tobolka (2007).

Apart from thermoregulation, decreased changes of predation is a factor for roost site selection (Walsberg and King, 1980). Sparrows selected trees with dense foliage to roost to minimise visibility (Singh *et al.*, 2013; Patel and Dodia, 2021). House Sparrows spend night in the dense bushes by forming big flocks to gain benefit from thermoregulation and predation risk (Tobolka, 2007). Safety from predators was noted by Post (1982) as one of the main determinants of roost selection by birds.

Mixed species roosting helps protect from predation, thermoregulation, information gain about resources, population regulation, and migration preparation (Eiserer, 1984). Mixed species roosting was observed in two of the study sites where sparrows were found to roost along with Red-whiskered Bulbul, Black-throated Munia, Indian Pond Heron, Malabar Starling, and Spotted Dove. Similar reports of co-roosting with passerine birds were reported elsewhere (Gorska, 1975; Alonso, 1986; Rana, 1989; North, 1968; Anderson, 2006; Patel and Dodia, 2021). However, the presence of larger birds in the roosting tree may distract and force sparrows to change the roost. The presence of Alexandrine Parakeet (*Psittacula eupatria*) and Painted Stork (*Mycteria leucocephala*) in the roost have been reported to negatively affect House Sparrows (Patel and Dodia, 2021).

5.3. ANTHROPOGENIC INFLUENCE ON ROOSTING BEHAVIOUR OF HOUSE SPARROW

During the time of assembly, human disturbance has been observed as a hindrance for foraging and sand bathing activities. Disturbance made by humans to roosting trees forced the House Sparrows to change their roost on such days. Patel and Dodia (2021) have also observed House Sparrows changing their roost due to disturbances to roosting trees from human activity. Cropping of roosting trees, the active presence of humans near roosting trees at the time of roosting, and modifications like decorations with light, cutting and removal of branches forced House Sparrows to change their roost.

5.4. IMPORTANCE OF ROOST SITE CONSERVATION

Roosting communally provides opportunity to interact with other individuals, and helps them to reduce their energy expenses for information gain and getting a good mate (Patel and Dodia, 2021). Hence, it is important to protect the roosting site for the survival of House Sparrows.

House Sparrows frequently roost in gardens close to residences and towns and forage there. Gardens are becoming unsuitable for House Sparrows due to the growth of exotic trees with less foliage, cropping and pruning of garden trees, and the use of pesticides (Cannon *et al.*, 2005). Destruction of smaller trees is thought to have had an impact on the sparrow population in urban areas because sparrows are known to roost in smaller trees that are less than five metres in height (Dhanya and Azeez, 2010; Roshnath *et al.*, 2018). Therefore, protecting roost sites is crucial to maintaining the sparrow population.

SUMMARY

6. SUMMARY

Roosting is the inactive period of organisms, during which they rest in their preferred roosting site. Trees and buildings are the common structures birds' prefer for roosting. House Sparrows (*Passer domesticus*) are communal roosting birds, observed to be roosting in smaller trees at agricultural lands, gardens, and residential areas. Communal roosting behaviour helps birds to get benefit from thermoregulation, foraging efficiency, and predation mitigation.

Three roosting populations of House Sparrows were observed from the Kerala Veterinary and Animal Sciences University campus at Pookode, Wayanad. These three populations were studied for understanding the factors that affect the roosting time of House Sparrows. The selected locations were Head-quarters, Teaching Veterinary Clinic Complex (TVCC), and Cattle Shed. The roosting population throughout the study period and different factors that affected the roost time of the House Sparrows were observed at the selected locations. Temperature, light intensity, weather, and time of sunset were recorded in response to the environmental factors that affect roosting time.

The roosting activity was divided into three phases; assembling, pre-roosting, and roosting. Last chirp was observed as the end of the roosting activity. The time of assembling, pre-roosting, roosting and the last chirp were recorded through scan sampling, by observing different activities.

It was observed that the population in each location varied across months, and the highest population was observed in the Cattle Shed (Roost 3) with 13.73 mean number of individuals. In each location, sparrows used different trees for roosting like Bamboo, Weeping Fig, Jackfruit tree, Passion Fruit vine, and Golden Dewdrop tree. In each identified roosting location, facilities for nesting, foraging, and roosting were observed.

Other birds like Spotted Dove (*Streptopelia chinensis*), Black Throated Munia (*Lonchura kelaarti*), Red-whiskered Bulbul (*Pycnonotus jocosus*), White-breasted Water Hen (*Amauromis phoenicurus*), Oriental Magpie Robin (*Copsychus saularis*), Eurasian Kestrel (*Falco tinnunculus*), Brahminy Kite (*Haliastur indus*), Crested Goshawk (*Accipiter trivirgatus*), and Shikra (*Accipiter badius*) were observed in the roosting sites during the study time. These birds were associated with sparrows as competition and predation.

During assembly, sparrows mostly preferred to do foraging in the assembly sites which were observed as open sandy ground near to roosting sites. At the pre-roosting time, sparrows undertook different activities like resting on perch, preening, and sand bathing. Roosting was the final step and the sparrows moved to the roost together. The last chirp heard from the roost was recorded as the end of the roosting activity.

The present study found that temperature, month, and time of sunset influenced the pre-roosting time. Time of assembling, pre-roosting, roosting, and the last chirp were observed before sunset. It was observed that sparrows assembled at 4:02 PM (mean), pre-roosted at 4:58 PM (mean), and went for roosting at 5:59 PM (mean). The number of individuals in the roost and the duration of the chirp showed a negative correlation. Major statistical conclusions were obtained with the help of R-software.

Studying the roosting behaviour, its relatedness to the different environmental factors, and the status of roosting population gave an idea about the current status of the House Sparrow population in the selected locations. The study area was a location with a stable House Sparrow population. Since very few studies have been done on roosting behaviour of House Sparrows in India, and there are no studies from Kerala, studies like the current one are very much relevant and needed.

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ROOSTING ECOLOGY OF HOUSE SPARROW (*Passer domesticus*) IN KVASU CAMPUS, POOKODE, WAYANAD, KERALA

**DIVIN V.
(20-MSVP-06)**

**Abstract of the dissertation submitted in partial fulfilment of the
requirement for the degree of**

**MASTER OF SCIENCE
(Wildlife Studies)
2022**

**Faculty of Veterinary and Animal Sciences
Kerala Veterinary and Animal Sciences University**



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8. ABSTRACT

Communal roosting of birds can be observed all over the world. It is a common behaviour displayed by birds to gain benefits such as better thermoregulation; information on food, predators and breeding mates; and lower predation. House Sparrows (*Passer domesticus*) are communal roosting birds that live close to humans. Understanding more about roosting behaviour will help the conservation efforts of the declining House Sparrow population.

The purpose of this study was to determine the environmental factors that influence the roosting time of House Sparrows. For that purpose, three roosting House Sparrow populations were chosen and watched for five months on the campus of the Kerala Veterinary and Animal Sciences University in the Wayanad district of Kerala. The population status of the House Sparrows on the campus was another important objective of the study. To get the conclusions, the populations were directly monitored during the study period. It was observed that the roosting population at each selected location changed across the month. The temperature, time of sunset, and month influenced the pre-roosting time of House Sparrows.

KERALA VETERINARY AND ANIMAL SCIENCE UNIVERSITY
Faculty of Veterinary and Animal Sciences
PROGRAMME OF RESEARCH WORK FOR DISSERTATION FOR
MASTER OF SCIENCE DEGREE

1. Title of dissertation

Roosting Ecology of House Sparrow (*Passer domesticus*) in KVASU Campus,
Pookode, Wayanad, Kerala

2. a) Title of the department /KVASU research:

Nil

b) Project of which this forms a part:

Nil

c) Code No. if any, and order by which the departmental/KVASU research
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Nil

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5. Objectives of the study:

1. To identify the roosts and estimate roosting populations of House Sparrows in the Pookode Campus of Kerala Veterinary and Animal Sciences University

2. To study roosting behaviour and factors affecting such behaviour of House Sparrows

6. Practical /Scientific utility:

Birds are the best indicators of environmental changes and they act as a link in the food chain in a sustainable ecosystem. The House Sparrow (*Passer domesticus*) is a small (16 cm long) and compact bird with a stout and conical bill adapted for eating grains and tiny soft-bodied worms present in the ground. The House Sparrow is a symbiotic bird that has adapted well to human culture. It is a social bird and gregarious in all seasons. They often form flocks with other types of birds during feeding and it roosts communally. Currently, the House Sparrow population is in decline throughout India (Irfan and Chauhan, 2018).

House Sparrows are one of the most widespread passerine birds, common in human habitation. These populations are facing a serious decline globally. Urbanization and industrialization, leading to the loss of suitable habitats including nesting and roosting sites have contributed much to the declining House Sparrow population (Roshnath *et al.*, 2018). House Sparrow is an opportunist and can live wherever there are suitable nesting and roosting sites and enough food is available (Kanaujia *et al.*, 2014).

Pookode KVASU Campus is located in the southern part of the Wayanad district of Kerala. The campus has an evergreen patch of natural forest, green hills and human settlements, and associated facilities like farm buildings, college buildings, a canteen, and a well-connected road. 3 roosting populations of House

Sparrows were identified from 3 different locations on the campus through a pilot survey.

This study will be relevant because the current conservation efforts are ending with breeding biology studies. As a social and communally roosting bird, understanding roosting ecology of these birds has importance in conservation. Roosting facilitates the exchange of information, potential mate selection opportunities, thermoregulation *etc.* So, it is essential to understand the roosting ecology for the conservation of House Sparrows (Patel and Dodia, 2021).

7. Important publications on which the study is based:

Binkley (1977) observed that the photoperiod influenced the circadian rhythm of House Sparrows.

Kanaujia *et al.* (2014) studied the distribution and habitat preference of House Sparrow in Uttar Pradesh and observed that the House Sparrows mostly preferred to roost in bush trees and shrubs.

Irfan and Chauhan (2018) identified loss of suitable habitat including roosting trees as the major reason for decline of House Sparrows in Kupuwara city of Jammu and Kashmir.

Roshnath *et al.* (2018) studied the perspectives of people on the conservation of House Sparrows in Kannur district of Kerala. They found that reasons for decline of House Sparrow population included many factors including cutting of roosting trees.

Patel and Dodia (2021) observed roosting pattern and the duration of roosting are correlated with day length and sun set on study conducted in Bhunagar.

8. Outline of the technical programme:

Scan sampling will be used to study the roosting time and pattern of House Sparrows. Scan sampling will help to identify when each step of roosting (assembling, pre-roosting, and roosting) begins by observing the roosting House Sparrows. The House Sparrow population will be observed at the roosting hours (16 to 19 hr.) using binoculars. Assembling time, pre-roosting time, roosting time, and time of the last chirp will be noted. Data on light intensity and temperature will be recorded at the observation hours (17.30 to 19 hr.) using a lux meter and thermometer, respectively. The number of roosting individuals, breeding status, weather, and the roosting tree will be noted. Population data will be collected during roost leaving hours (7.30 to 8.30 hr.) for getting population structure.

9. Main items of observations to be made:

Time of assembling, pre-roosting, roosting, and last chirp of the roosting population

Light intensity, temperature, and calling frequency at roost during roosting hours

Number of males, females, and juveniles in each population

10. Duration of research work:

One Semester

Signature of student

Project coordination group proposed:

Nil

Place:

Date:

Signature of Guide

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Patel, F.P., and Dodia, P.P. 2021. Roosting patterns of House Sparrow *Passer domesticus* Linn., 1758 (Aves: Passeridae) in Bhavnagar, Gujarat, India. *J. Threat. Taxa.* **13** (14): 20209–20217.

Roshnath, R., Arjun, C.P., Ashli, J., Sethu, D., and Gokul, P. 2018. Status survey and conservation of the House Sparrow *Passer domesticus* (Aves: Passeriformes: Passeridae) through public participation in Kannur, Kerala, India. *J. Threat. Taxa.* **10** (8): 12098–12102.

CERTIFICATE

Certified that the research has been formulated observing the stipulations laid down under the Prevention of Cruelty to Animals Act (Amendment, 1998).

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Date:

Major Advisor

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