Intern. Stud. Sparrows 2024, 46: 20-34

DOI: 10.59443/ISSpar-2024-0002

Venu Divin, Ramesh Roshnath*

Centre for Wildlife Studies, Kerala Veterinary and Animal Sciences University,
Wayanad, Kerala, PIN – 673576, India.
* Corresponding author: roshnath.r@gmail.com

ROOSTING BEHAVIOUR OF HOUSE SPARROWS, *PASSER DOMESTICUS* AT KERALA VETERINARY & ANIMAL SCIENCES UNIVERSITY CAMPUS IN WAYANAD, KERALA, INDIA

ABSTRACT

Due to their common urban status and suspected decline, house sparrows are garnering attention worldwide. Ecological studies, particularly those about roosting behaviour, are scarce compared to the abundance of population studies on this species. We studied the flock of sparrows that roost at the Kerala Veterinary and Animal Sciences University campus in Wayanad, Kerala, India, with a focus on the environmental factors that affect roosting behaviour. House Sparrows were found to roost in three different flocks on campus. While seasonal variations were noted within the sites, overall abundance did not differ between the sites. Sparrows were found to choose different species of roosting trees and when disturbed, they have been observed to change their roosting locations. It was found that house sparrows gathered at 4:02 PM, pre-roosting at 4:48 PM, and roosting at 5:56 PM. The chirping ceased at 6:08 PM. Environmental variables are known to affect roosting behaviour in sparrows. While light intensity, temperature, and sunset time all had an impact on pre-roosting and roosting behaviour, the assemblage was influenced by the latter. Changes in environmental variables may have an impact on their roosting pattern, which could then have an impact on their fitness in future.
Key words: House Sparrow, roosting, population, environmental variables

INTRODUCTION

All birds do roosting, which is a period of inactivity comparable to sleep in humans, even though the benefits and motivation is different. Except for nocturnal birds, which roost in the morning, most birds go to sleep during the night (Gadgil and Ali 1975). Roosting can be temporary or permanent, solitary or communal (Kuroda 1961, Counsilman 1974, Gobes and Bolhuis 2008, Johnson 2010, Moleón et al. 2011, Jayson 2018, Shipley et al. 2019, Minor et al. 2020, Perez et al. 2022). The main benefits of communal roosting behaviour are the enhancement of individual foraging success (Ward and Zahavi 1973), facilitation to get partners (Beauchamp 1999), predation dilution effect (Eiserer 1984) and help to maintain body temperature or thermoregulation (Burns et

al. 2013). The transmission of diseases, parasites and increased detection by predators are costs associated with communal roosting (Moore et al. 1988, Kulkarni and Heeb 2007, Buehler and Piersma 2008). Therefore, roosting is an important behavioural aspect of a bird's life.

Different environmental factors such as day length, light intensity, temperature, weather conditions and the roosting substrate influence roosting behaviours (Davis and Lussenhop 1970, Swingland 1976, Everding and Jones 2006, Janicke and Chakarov 2007, Ientile 2014). Examining roost activity and species abundance might help to understand the current state of various bird species in a particular area thus; avian communal roosts can be focal points for scientific research and conservation (Dwyer et al. 2018, Manzoor et al. 2021).

House Sparrows (*Passer domesticus*) are sedentary species and movement is restricted towards small areas ranging from one to two kilometres (Anderson 2006). House 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). They are commensals to humans, and this behaviour evolved ten thousand years ago with the spread of agriculture (Saetre et al. 2012, Ravinet et al. 2018). They are known to perish without human presence (Summers-Smith 1959, Ravinet et al. 2018).

Human colonisation and the introduction of House Sparrows to various continents by humans have made them an abundant bird species (Anderson 2006). But, they are experiencing population declines due to a variety of factors which vary depending on the region and circumstances, including increased urbanisation, structural changes to buildings, the removal of gardens and other vegetation from human habitats, the modernization of agricultural systems, and increased use of pesticides (De Laet and Summers-Smith 2007, Tobolka 2007, Roshnath et al. 2018, Angelier and Brischoux 2019). This made the scientific community focus on this species and prompted scientific studies worldwide (Patel and Dodia 2021).

So far, studies on House 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, Bijith and Roshnath 2022). The lack of preferred roosting trees and associated vegetative areas in human-inhabited areas are known to contribute to their population declines (Cannon et al. 2005, Singh et al. 2013, Roshnath et al. 2018). This means roosting sites are important for sparrow conservation (Patel and Dodia 2021). Understanding life history traits including the roosting behaviour of a species will aid in their conservation efforts (Gadgil and Ali 1975). Therefore, the present study on the roosting ecology of House Sparrows was conducted with the following objectives:

1. To identify the roosts and estimate roosting flocks 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.

MATERIALS AND METHODS

Study area

Kerala Veterinary and Animal Sciences University campus (11°32′30″N 76°01′13″E) is located at Pookode, Wayanad district of Kerala state, India. The campus has 40 hector area with mixed vegetation including riparian habitats, evergreen forest patches, coffee plantations, grasslands and rocky habitats and forms a part of the Western Ghats. The man-made structures include administrative and academic buildings, hostels, farm buildings, canteen *etc.*, facilitate nesting and foraging spaces for House Sparrows. Including House Sparrows more than 200 bird species have been reported from the campus as per eBird data source.

Sampling methods

House Sparrows were counted using the point count method (Sutherland 2006) and the total number was estimated from 2022 April to 2023 March at the campus, where all of the roosting sites were surveyed twice a month, from 15:30 to 19:30 hours.

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 individuals of House Sparrow in the gathering place which is mostly near the roosting tree and with time more individuals join the flocks (Singh et al. 2013). Opportunities for foraging and sand-bath 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. After pre-roosting, all the birds were found to move to the roosting tree together at the same time. During the starting of the **roosting stage,** House Sparrows make a chirping call (different from normal calls) which lasts until sunset (Patel and Dodia 2021). The start and end times of each stage and chirping were recorded using a stopwatch. 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 was studied. All the analyses were done in R software (version 4.3.1) using the packages "dplyr", "ggpubr", "tidyr", "cowplot", "mgcv" and "chron".

RESULTS

House Sparrows roost as three separate flocks on the campus which are at the average 1078 ± 348 m away from each other (Fig. 1). The hospital complex had the highest

abundance (13.31 ± 5.49), followed by the cattle shed (11.19 ± 5.93) and headquarters (10.74 ± 4.76; Fig. 2). Although total abundance did not differ between sites ($p = 0.13$), seasonal variations were observed ($p = 0.01$; Fig. 3) within the sites. The roosting substrate varied between the sites (Table 1) and was observed to change in response to human disturbance.

The roost at the hospital complex was a Golden Dewdrop Tree (*Duranta erecta*), but when disturbed they moved to a Jackfruit Tree (*Artocarpus heterophyllus*) nearby. At headquarters, they roost on a Weeping Fig (*Ficus benjamina*) and the birds were seen to relocate their roost to a bamboo thicket that was 128 metres away when disturbed during garden maintenance, arts festivals, etc. A bamboo thicket was the roosting substrate at the cattle shed during the early study period which got shifted to a Passion Fruit vine (*Passiflora edulis*) grown in the employer's quarters, as the earlier site was disturbed and lit up for some construction works. Thus, sparrows respond to human disturbance by shifting their roost sites.

House Sparrows were found to assemble at 4:02 PM (mean) followed by pre-roosting at 4:48 PM and roosting at 5:56 PM. Chirping stopped by 6:08 PM (average 12 min after mean roosting time). The mean duration of the assembling activities was 55 ± 22 minutes; the pre-roosting activities were 58 ± 21 minutes and the chirp duration of 12 ± 13 minutes. A diagrammatic representation of each activity is given in Fig. 4.

Generally, (considering data from all seasons), except for the roosting time which was affected by weather (p-value < 0.05) and the time of the last chirp which was affected by light intensity ($p < 0.001$) none of the other variables showed any significant relationships (Table 2). But when monsoon data (no or less sparrow activities) was removed, the analysis revealed that the assemblage was affected by time of sunset ($p < 0.001$), pre-roosting was affected by light intensity ($p < 0.001$), temperature ($p < 0.05$) and time of sunset ($p < 0.01$) and roosting was affected by time of sunset ($p < 0.001$), light intensity ($p < 0.001$) and temperature ($p < 0.05$). Environmental variables had varying effects during various seasons (Table.3; supplementary results). During the cloudy and rainy days, pre-roosting and roosting happened earlier while pre-roosting ($t = -3.19$) and roosting ($t = -6.29$) time got delayed with increasing light intensity (-ve t-value). Temperature was found to be positively correlated with the duration of assemblage ($R = 0.28$), pre-roosting ($R = 0.07$) and chirp duration ($R = 0.15$; Fig. 5). The number of individuals and duration of chirping were not related ($R = 0.13$; Fig. 6).

DISCUSSIONS

House Sparrows are indicators of a healthy urban environment and sustainable development (Modak 2015). House Sparrows are distributed all over Kerala (Nameer and Praveen 2021) and are reported to be declining (Dandapat et al. 2010, Raju 2015, Bijith and Roshnath 2022). To conserve them, it is important to know about their life history

traits and the habitat relationship. Especially, it is very essential to understand their roosting behaviour as a life history trait that is less studied of this species.

All roosting populations observed on the campus were small in size. Competition for resources and nesting sites could be the factor limiting the roosting population size. House Sparrows preferred to nest in rural areas even though more nesting cavities were present in urban areas due to the presence of food (Dhanya and Azeez 2010, Angelier and Brischoux 2019). High population abundance was also reported in agricultural fields compared to urban areas (Khera et al. 2010). While some studies reported increased preference towards towns due to increased food availability (Mannasaheb et al. 2019). So it seems that not the location is most important but the availability of food that affects the distribution of the House Sparrow more (Bijith & Roshnath 2022). House Sparrows at headquarters (includes the main administrative and academic buildings, canteen, and garden) mostly rely on food waste from the canteen, nearby men's hostel mess and spillovers from poultry feed of pet birds. They are also found to forage in the university garden looking for live prey such as insects and worms. While at the hospital complex, (which includes a hospital, staff housing, and hostels for students) sparrows are found to be fed by people living at staff quarters and they are found forage food in surrounding weeded vegetation for as live prey. The main sources of food for the sparrow population at cattle sheds (which comprise farm buildings, employee housing, and pasture areas) are cattle feeds, grains from hay, and live prey in cattle dung. Comparative high food availability and less abundance of other competitive granivorous birds such as munias and doves at headquarters might be the reason why the population was found to be high.

After becoming independent, young House Sparrows depart for new locations and create new roosting sites (North 1973). Although we didn't collect data on population demographics, monthly change in the abundance of House Sparrows at each location may be caused by such mobility of juveniles. In South India, House Sparrows have been seen breeding all year round (Chamberlain et al. 2007). Likewise, young individuals were seen throughout the study period, and active nests were seen every month except for June and July when the monsoon season was at its peak.

Roost site selection is an important factor when it comes to the survival and fitness of birds (Yuan et al. 2018, Rao and Babu 2021, Sureshmarimuthu et al. 2023) especially colonial roosting sparrows (Anderson 2006). Sparrows are known to select roosting sites based on the availability of short trees, food availability and less disturbance (North 1968, Bijith and Roshnath 2022). They also use buildings or nest boxes for roosting (Tobółka 2011, Patel and Dodia 2021).

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. At first, a few birds gather near the roosting tree and with time more birds, join the flock (Singh et al. 2013). We observed birds assemble at multiple sites near the roosting tree and all were found to engage mostly in foraging. The presence of multiple gathering sites associated with each

roosting location could be a method of resource partitioning concerning availability (Elgar 1987, Bernat-Ponce et al. 2018). Assembling was affected by the time of sunset (Patel and Dodia 2021) as we observed sparrows assembling late with delayed sunset and vice versa.

After assemblage, they move to the less active stage called pre-roosting (by 4:48 PM mean) during which they perch near the roosting tree and engage in preening. Occasionally they are found to do sand bathing. Sparrows started pre-roosting activities 2 hours before sunset (Anderson 2006) and we observed the same (1hr 34min before sunset) on the campus. After the pre-roosting stage, all the non-breeding sparrows move to their regular roosts while nesting pairs roost at their respective nests (Patel and Dodia 2021).

Roosting behaviour is a function of light intensity and the time of sunset (Davis and Lussenhop 1970, Swingland 1976, Peh 2002). We found that light intensity, temperature, weather and time of sunset had a direct effect on the pre-roosting and roosting time of House Sparrows when monsoon data were removed from the analysis. These results support the observations from the previous studies (Singh et al. 2013, Patel and Dodia 2021). In rainy weather, sparrows restrict all activities and are active only in the break period of rain. Pre-roosting and roosting behaviours were delayed by increased light intensity, but they were quickened or early during cloudy weather. Thus, the environment variables such as the intensity and duration of light play a significant role in roosting behaviour. For small birds and birds in northern areas, thermoregulation has an influence on the evolution of communal roosting (Beauchamp 1999) and sparrows are known to stay closer and huddle when temperature decreases (Burns et al. 2013). But, the present study did not evaluate the positioning of sparrows in the roost. Hence, behavioural changes related to the change in temperature could not be observed. However, it was observed that the duration of assembling, pre-roosting and chirping have a positive correlation with ambient temperature i.e., the duration of these activities increases with the increasing temperature.

CONCLUSION

Our roosting flocks are small, and they fluctuate between seasons. The House Sparrow's roosting stages are directly influenced by the intensity and duration light, temperature, and the weather. The influence of different environmental variables reflects that climate change can affect their roosting pattern and other life-history traits including breeding and survivability of chicks (Dybala et al. 2013, Jesus and Jimenez 2022).

ACKNOWLEDGEMENT

We thank Dr. Deorge Chandy and Dr. Biju S. for their unwavering assistance during the research. We also acknowledge the invaluable advice Dr. Ashis Jha provided on

the statistical portion of the work. We appreciate Dr. Jenny De Laet of the University of Ghent in Belgium for her insightful feedback that helped improve the manuscript's current state. VD expresses gratitude to his peers for helping him with his fieldwork.

Author's contribution: Divin V. – Conceptualization (equal), Data curation (equal), Formal analysis (lead), Investigation (lead), Methodology (equal), project administration (equal), writing original draft (equal). Roshnath Ramesh – Conceptualization (equal), Data curation (equal), Formal analysis (supporting), Investigation (supporting), Methodology (equal), project administration (equal), Supervision (lead), writing – review & editing (equal).

Funding: None

Conflic

REFERENCES

Anandan G., Kumaresan M., Thomas A., Benickson C., Devi R., Geethu M., Augustine J., Kavipriya J., Mithun Raj M., Shiva R. 2014 – The house sparrow is homeless: A small attempt to conservation – J. Biodivers. Endanger. Species 2: 124.

Anderson T.R. 2006 – Biology of the Ubiquitous House Sparrow: From Genes to Populations – Oxford University Press.

Angelier F., Brischoux F. 2019 – Are house sparrow populations limited by the lack of cavities in urbanized landscapes? An experimental test – Journal of Avian Biology 50(3): 1-6.

Balaji S. 2014 – Artificial nest box for house sparrow: An apt method to save the dwindling species in an urban environment – International Journal of Biodiversity and Conservation 6(3): 194-198.

Baskaran S., Rajesh P., Pavaraj M., Bakavathiappan G. 2010 – Occurrence of House Sparrow *Passer domesticus indicus* L. in Sivakasi, Virudhunagar District, Tamil Nadu, India – Indian Journal Of Natural Sciences 1(3): 155-158.

Beauchamp G. 1999 – The evolution of communal roosting in birds: Origin and secondary losses – Behavioral Ecology 10(6): 675-687. https://doi.org/10.1093/beheco/10.6.675.

Bernat-Ponce E., Gil-Delgado J.A., Guijarro D. 2018 – Factors affecting the abundance of House Sparrows *Passer domesticus* in urban areas of southeast of Spain – Bird Study 65(3): 404-416. https://doi.org/10.1080/00063657.2018.1518403.

Bijith P., Roshnath R. 2022 – Factors affecting House Sparrow *Passer domesticus* distribution in the Kannur district of Kerala, India – Intern. Stud. Sparrows 44: 4-13. https://doi.org/10.2478/isspar-2023-0001.

Buehler D.M., Piersma T. 2008 – Travelling on a budget: Predictions and ecological evidence for bottlenecks in the annual cycle of long-distance migrants – Philosophical Transactions of the Royal Society B: Biological Sciences 363(1490): 247-266.

Burns D.J., Ben-Hamo M., Bauchinger U., Pinshow B. 2013 – Huddling house sparrows remain euthermic at night, and conserve body mass – Journal of Avian Biology 44(2): 198-202.

Cannon A.R., Chamberlain D.E., Toms M.P., Hatchwell B.J., Gaston K.J. 2005 – Trends in the use of private gardens by wild birds in Great Britain 1995-2002 – Journal of Applied Ecology 42(4): 659-671. https://doi.org/10.1111/j.1365-2664.2005.01050.x.

Chamberlain D.E., Toms M.P., Cleary-McHarg R., Banks A.N. 2007 – House sparrow (*Passer domesticus*) habitat use in urbanized landscapes. Journal of Ornithology 148(4): 453-462. https://doi.org/10.1007/s10336-007-0165-x.

Counsilman J.J. 1974 – Waking and Roosting Behaviour of the Indian Myna. Emu – Austral. Ornithology 74(3): 135-148. https://doi.org/10.1071/MU974135.
Dandapat A., Banerjee D., Chakraborty D. 2010 – The case of the disappearing house sparrow (*Passer domesticus indicus*) – Veterinary World 3(2): 97-100.
Davis G.J., Lussenhop J.F. 1970 – Roosting of starlings (*Sturnus vulgaris*): A function of light and time. Animal Behaviour 18: 362-365. https://doi.org/10.1016/S0003-3472(70)80049-5.
De Jesus A.D., Jimenez A.G. 2022 – Effects of acute temperature increases on House sparrow (*Passer domesticus*) pectoralis muscle myonuclear domain – Journal of Experimental Zoology Part A: Ecological and Integrative Physiology 337(2): 150-158. https://doi.org/10.1002/jez.2544.
De Laet J., Summers-Smith J.D. 2007 – The status of the urban house sparrow *Passer domesticus* in north-western Europe: A review – Journal of Ornithology 148 (2): 275-278.
Deepalakshmi S., Salomi A. 2019 – Impact of urbanization on House sparrow (*Passer domesticus*) diversity from Erode and Namakkal districts, Tamilnadu, India. International Journal of Advanced Research in Biological Sciences 11: 22-27.
DeVries P.J., Schull J., Greig N. 1987 – Synchronous nocturnal activity and gregarious roosting in the neotropical skipper butterfly *Celaenorrhinus fritzgaertneri* (Lepidoptera: Hesperiidae) – Zoological Journal of the Linnean Society 89(1): 89-103.
Dhanya R., Azeez P.A. 2010 – The house sparrow *Passer domesticus* population of arakku township, Andhra Pradesh, India. Indian Birds 5(6): 180-181.
Dwyer J.F., Fraser J.D., Morrison J.L. 2018 – Evolution of communal roosting: A social refuge–territory prospecting hypothesis – Journal of Raptor Research 52(4): 407-419.
Dybala K.E., Eadie J.M., Gardali T., Seavy N.E., Herzog M.P. 2013 – Projecting demographic responses to climate change: Adult and juvenile survival respond differently to direct and indirect effects of weather in a passerine population – Global Change Biology 19(9): 2688-2697.
Ehrlich P., Dobkin D.S., Wheye D. 1988 – Birder's handbook. Simon and Schuster.
Eiserer L.A. 1984 – Communal Roosting in Birds – Bird Behavior 5 (2-3): 61-80.
Elgar M.A. 1987 – Food intake rate and resource availability: Flocking decisions in house sparrows – Animal Behaviour 35(4): 1168-1176. https://doi.org/10.1016/S0003-3472(87)80173-2.
Forshaw J.M. 2010 – Parrots of the World (Vol. 70) – Princeton University Press.
Gadgil M., & Ali S. 1975 – Communal roosting habits of Indian birds. Journal of the Bombay Natural History Society, 72(3): 716-727.
Ghosh S., Kim K.-H., Bhattacharya R. 2010 – A survey on house sparrow population decline at Bandel, West Bengal, India – Journal of the Korean Earth Science Society 31(5): 448-453.
Gobes S.M.H., Bolhuis J.J. 2008 – Bird Brains Key to the Functions of Sleep – Science 322(5909): 1789-1789. https://doi.org/10.1126/science.322.5909.1789a.
Perez G., Zhao W., Cheng Z., Belotti M.C.T.D., Deng Y., Simon V.F., Tielens E., Kelly J.F., Horton K.G., Maji S. Sheldon D. 2022 – Using spatio-temporal information in weather radar data to detect and track communal bird roosts – bioRxiv, 2022.10.28.513761. https://doi.org/10.1101/2022.10.28.513761.
Ientile R. 2014 – Year-round used large communal roosts of Black-billed Magpie *Pica pica* in an urban habitat. Avocetta 38: 59-65.
Janicke T., Chakarov N. 2007 – Effect of weather conditions on the communal roosting behaviour of common ravens *Corvus corax* with unlimited food resources – Journal of Ethology, 25: 71-78.
Jayson E.A. 2018 – Factors affecting roosting ecology of birds in Kerala – Research Report 541: 72. KFRI (Kerala Forest Research Institute, Peechi).
Jhajhria A. 2020 – A review on the need for conserving the house sparrow in India – Journal of Entomology and Zoology Studies 8(2): 1157-1159.

Johnson J.B. 2010 – Roosting ecology of bats in a disturbed landscape – Graduate Theses, Dissertations, and Problem Reports. https://doi.org/10.33915/etd.3114.
Johnston R.F., Selander R.K. 1964 – House sparrows: Rapid evolution of races in North America – Science 144(3618): 548-550.
Kanaujia A., Kumar A., Kushwaha S., Kumar A. 2014 – Spatial Distribution and Habitat Preference of the House Sparrow (*Passer domesticus*) in Urban semi-urban and Rural landscape of Lucknow and its neighboring areas, Uttar Pradesh, India – Proceeding of International Conference by Department of Zoology University of Lucknow on Biodiversity and Environment: 182-188.
Khera N., Das A., Srivasatava S., Jain S. 2010 – Habitat-wise distribution of the House Sparrow (*Passer domesticus*) in Delhi, India – Urban Ecosystems 13(1): 147-154. https://doi.org/10.1007/s11252-009-0109-8.
Kulkarni S., Heeb P. 2007 – Social and sexual behaviours aid transmission of bacteria in birds. Behavioural Processes 74(1): 88-92.
Kuroda N. 1961 – The roosting behaviour system in the Grey Starling – Journal of the Yamashina Institute for Ornithology 3(2): 123-125. https://doi.org/10.3312/jyio1952.3.123.
Lewis S.E. 1995 – Roost fidelity of bats: A review – Journal of Mammalogy, 76(2): 481-496.
Merke F.R., Mosbech A. 2008 – Diurnal and nocturnal feeding strategies in Common Eiders – Waterbirds 31(4): 580-586.
Minor K., Bjerre-Nielsen A., Jonasdottir S.S., Lehmann S., Obradovich N. 2020 – Ambient heat and human sleep – arXiv Preprint arXiv:2011.07161.
Modak B.K. 2017 – Impact of urbanization on House sparrow distribution: A case study from Greater Kolkata, India – Proceedings of the Zool. Society, 70(1): 21-27.
Moleón M., Bautista J., Madero A. 2011 – Communal Roosting in Young Bonelli's Eagles (*Aquila fasciata*) – Journal of Raptor Research 45(4): 353-356. https://doi.org/10.3356/JRR-11-30.1.
Moore J., Simberloff D., Freehling M. 1988 – Relationships between bobwhite quail social-group size and intestinal helminth parasitism – The American Naturalist 131(1): 22-32.
Murgui E. 2009 – Seasonal patterns of habitat selection of the House Sparrow *Passer domesticus* in the urban landscape of Valencia (Spain) – Journal of Ornithology 150(1): 85-94. https://doi.org/10.1007/s10336-008-0320-z.
Nameer P., Praveen J. 2021 – An Atlas Of Birds Of Kerala 2021 – http://archive.org/details/an-atlas-of-birds-of-kerala-2021.
Narayana B.L., Rao V.V., Venkateswara Reddy V. 2019 – Composition of birds in agricultural landscapes of Peddagattu and Sherpally Area: A proposed uranium mining sites in Nalgonda, Telangana, India. Proceedings of the Zool. Society 72(4): 380-400.
North C.A. 1968 – A study of house sparrow populations and their movements in the vicinity of Stillwater, Oklahoma – Oklahoma State University.
North C.A. 1973 – Movement Patterns of the House Sparrow in Oklahoma – Ornithological Monographs 14: 79-91. https://doi.org/10.2307/40168059.
Page G., Whitacre D.F. 1975 – Raptor predation on wintering shorebirds – The Condor 77(1): 73-83.
Patel F.P., Dodia P.P. 2021 – Roosting patterns of House Sparrow *Passer domesticus* Linn., 1758 (Aves: Passeridae) in Bhavnagar, Gujarat, India – Journal of Threatened Taxa 13(14), Article 14. https://doi.org/10.11609/jott.6631.13.14.20209-20217.
Paul M. 2015 – A review of house sparrow population decline in India – Asia Pacific Journal of Research 1(29): 38-40.
Pearson D.L., Anderson J.J. 1985 – Perching heights and nocturnal communal roosts of some tiger beetles (Coleoptera: Cicindelidae) in southeastern Peru – Biotropica: 126-129.

Peh K.S.-H. 2002 – Roosting behaviour of house crow (*Corvus splendens*) in relation to enviromental variables – Raffles Bulletin of Zoology, 50(1): 257-262.
Post W. 1982 – Why do grey kingbirds roost communally? – Bird Behavior 4(1): 46-49.
Rajashekar S., Venkatesha M.G. 2008 – Occurrence of house sparrow, *Passer domesticus* indicus in and around Bangalore. Current Science 94(4): 446-449.
Raju S. 2015 – Population trend of the common birds in a residential area of Thiruvananthapuram City, Kerala – Indian Birds 10(2): 40-45.
Rao G.B., Babu S. 2021 – Roost-site selection and population assessment of gulls wintering along India's west coast reveals the importance of conserving coastal habitats – Ornithological Science 20(2): 161-174.
Ravinet M., Elgvin T.O., Trier C., Aliabadian M., Gavrilov A., Sætre G.-P. 2018 – Signatures of human-commensalism in the house sparrow genome. Proceedings of the Royal Society B 285(1884): 2018-1246.
Roshnath R., Arjun C.P., Ashli J., Sethu D., Gokul P. 2018 – Status survey and conservation of the House Sparrow *Passer domesticus* (Aves: Passeriformes: Passeridae) through public participation in Kannur, Kerala, India – Journal of Threatened Taxa 10(8), Article 8. https://doi.org/10.11609/jott.3528.10.8.12098-12102.
Saetre G.-P., Riyahi S., Aliabadian M., Hermansen J.S., Hogner S., Olsson U., Gonzalez Rojas M.F., Sæther S.A., Trier C.N., Elgvin T.O. 2012 – Single origin of human commensalism in the house sparrow. Journal of Evolutionary Biology 25(4): 788-796. https://doi.org/10.1111/j.1420-9101.2012.02470.x.
Salcedo C. 2010 – Environmental elements involved in communal roosting in *Heliconius butterflies* (Lepidoptera: Nymphalidae) – Environmental Entomology, 39(3): 907-911.
Sharma P., Binner M. 2020 – The Decline of Population of House Sparrow in India – International Journal of Agricultural Science 05: 1-4.
Shipley A.A., Sheriff M.J., Pauli J.N., Zuckerberg B. 2019 – Snow roosting reduces temperature-associated stress in a wintering bird – Oecologia 190(2): 309-321. https://doi.org/10.1007/s00442-019-04389-x.
Singh R., Kour D.N., Ahmad F., Sahi D.N. 2013 – Roosting behaviour of house sparrow (*Passer domesticus* Linnaeus, 1758) in some urban and rural areas of Jammu Division – J & K. Munis Entomol. Zool 8(2): 803-811.
Soini P. 1987 – Ecology of the saddle-back tamarin *Saguinus fuscicollis illigeri* on the Rio Pacaya, northeastern Peru – Folia Primatologica 49(1): 11-32.
Summers-Smith D. 1954 – Colonial behaviour in the House Sparrow – British Birds 47(8): 249.
Summers-Smith D. 1959 – The House Sparrow *Passer domesticus*: Population Problems – Ibis, 101(3-4): 449-455. https://doi.org/10.1111/j.1474-919X.1959.tb02403.x.
Sureshmarimuthu S., Babu S., Honnavalli N.K., Rajeshkumar N. 2023 – Where do the Tropical Owls Roost: Multiscale Habitat Variables Explain Roost Site Selection by Two Sympatric Otus Species in the Andaman Archipelago, India – Acta Ornithologica 57(2): 181-196.
Sutherland W. J. 2006 – Ecological census techniques: A handbook – Cambridge University Press.
Swingland I.R. 1976 – The influence of light intensity on the roosting times of the rook (*Corvus frugilegus*) – Animal Behaviour 24(1): 154-158. https://doi.org/10.1016/S0003-3472(76)80109-1.
Tobółka M. 2007 – Sparrow Hawks *Accipiter nisus* attacks Sparrows *Passer* sp. Roosting in White Stork nests: Intern. Stud. Sparrows, 32: 39-41.
Tobółka M. 2011 – Roosting of tree sparrow (*Passer montanus*) and house sparrow (*Passer domesticus*) in white stork (*Ciconia ciconia*) nests during winter – Turkish Journal of Zoology 35(6): 879-882. https://doi.org/10.3906/zoo-1003-106.

Ward P. 1965 – Feeding ecology of the black-faced dioch *Quelea quelea* in Nigeria – Ibis 107(2): 173-214.
Ward P., Zahavi A. 1973 – The Importance of Certain Assemblages of Birds as "Information-Centres" for Food-Finding – Ibis 115(4): 517-534. https://doi.org/10.1111/j.1474-919X.1973.tb01990.x.
Yasin M., Khan H.A., Majeed W., Mushtaq S., Hedfi A., Maalik S., Ben Ali M., Mustafa S., Kanwal S., Tahreem S. 2022 – Investigation of roost composition of passerine birds in different environmental conditions – Brazilian Journal of Biology 82, e263354. https://doi.org/10.1590/1519-6984.263354
Yuan B., Yan Y., Cheng Z., Jiang A. 2018 – Roosting habitat selection of Hume's Pheasant (*Syrmaticus humiae*) in a fragmented forest patch, northwestern Guangxi, southwestern China – Global Ecology and Conservation 16, e00457.

SUPPLEMENTARY RESULTS

During Pre-monsoon; Pre-roosting is affected by weather (p-value < 0.001), and Light intensity (p-value < 0.001), roosting is affected by weather (p-value < 0.001), and Light intensity (p-value < 0.01) and time of last chirp is affected by weather (p-value < 0.01) and light-intensity (p-value < 0.001). Assembling was not affected by any variable like weather, temperature, and light-intensity and sunset.

During Monsoon none of the activities were affected by observed variables.

During Post-monsoon; assembling is affected by time of sunset (p-value < 0.01), pre-roosting is affected by weather (p-value < 0.01), roosting is affected by weather (p-value < 0.001), light-intensity (p-value < 0.001) and time of sunset (p-value < 0.05) and time of last chirp is affected by weather (p-value < 0.01), light-intensity (p-value < 0.001) and time of sunset (p-value < 0.05).
by time of sunset (p < 0.001), light intensity (p < 0.001) and temperature (p < 0.05).

Table 1. List of roosting trees species used by House Sparrows

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

Table 2. Range of environmental variables (Mean ± SD) across different roosting activities (*p < 0.05)

Data	Activity	Temperature (°C)	Light intensity (lux)	Time of Sunset (PM)
Full season	Assembling	26.9 ± 2.6	22062 ± 13588	06:33 ± 0:17
	Pre-roosting	25.5 ± 2.3	8386 ± 4763	06:33 ± 0:17
	Roosting	23.4 ± 1.9	1872 ± 1190	06:33 ± 0:17
Excluding Monsoon	Assembling	27.9 ± 2.3	26565 ± 10715	06:24 ± 0:15*
	Pre-roosting	26 ± 2.2*	9157 ± 4840*	06:24 ± 0:15*
	Roosting	24.1 ± 2.1*	1905 ± 1335*	06:24 ± 0:15*

Table 3. Season wise range of environmental variables (Mean ± SD) across different roosting activities (*p < 0.05, **p < 0.005)

Variables		Temperature (°C)	Light intensity (lux)	Time of Sunset (PM)
Season	Activity			
Pre-Monsoon	Assembling	29.4 ± 1.9	26222 ± 9760	06:37 ± 0:03
	Pre-roosting	27.3 ± 2.1	8899 ± 5495**	06:37 ± 0:03
	Roosting	25.5 ± 1.8	16089 ± 1100*	06:37 ± 0:03
Monsoon	Assembling	25.6 ± 2.6	15976 ± 14785	06:45 ± 0:12
	Pre-roosting	24.5 ± 2.4	7343 ± 4512	06:45 ± 0:12
	Roosting	22.6 ± 1.3	1826 ± 976	06:45 ± 0:12
Post-Monsoon	Assembling	26.4 ± 1.6	26968 ± 11950	06:09 ± 0:10*
	Pre-roosting	24.8 ± 1.3	9461 ± 4039	06:09 ± 0:10
	Roosting	22.5 ± 1.1	2253 ± 1518**	06:09 ± 0:10*

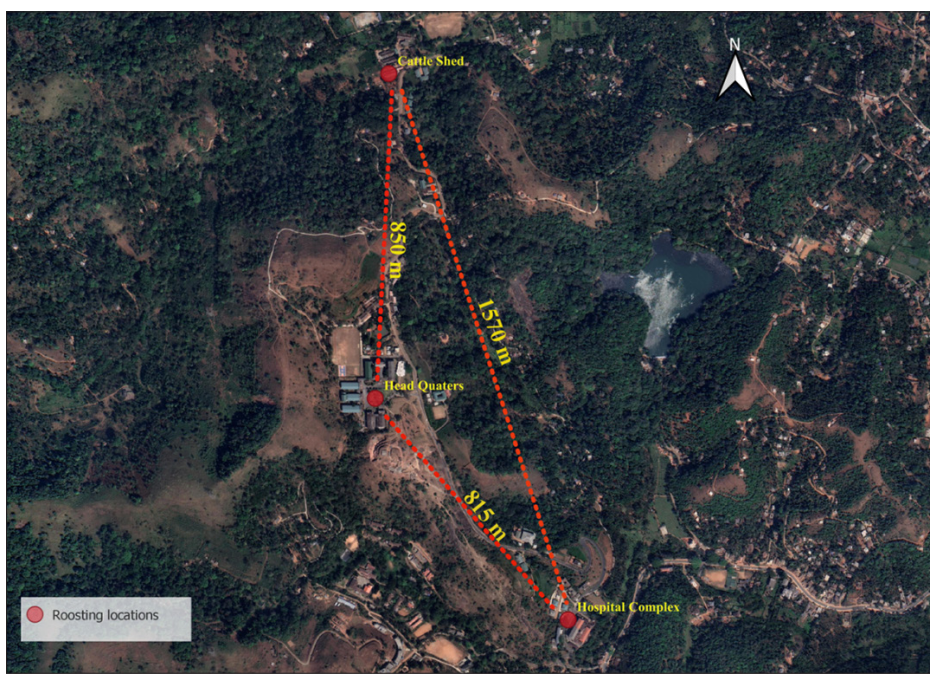

Fig. 1. Study site showing the roosting locations (Map data ©2024 Google, Imagery ©2024 Terra-Metrics)

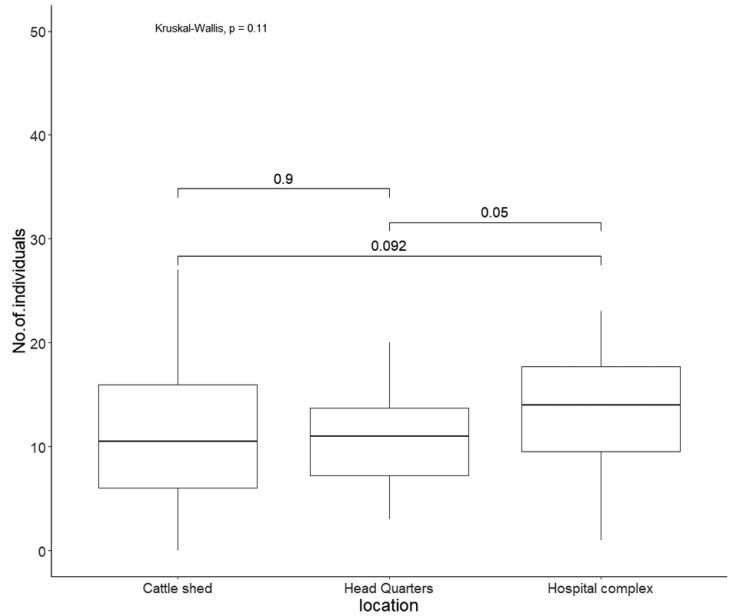

Fig. 2. Box plot showing the roosting House Sparrow population at three different locations

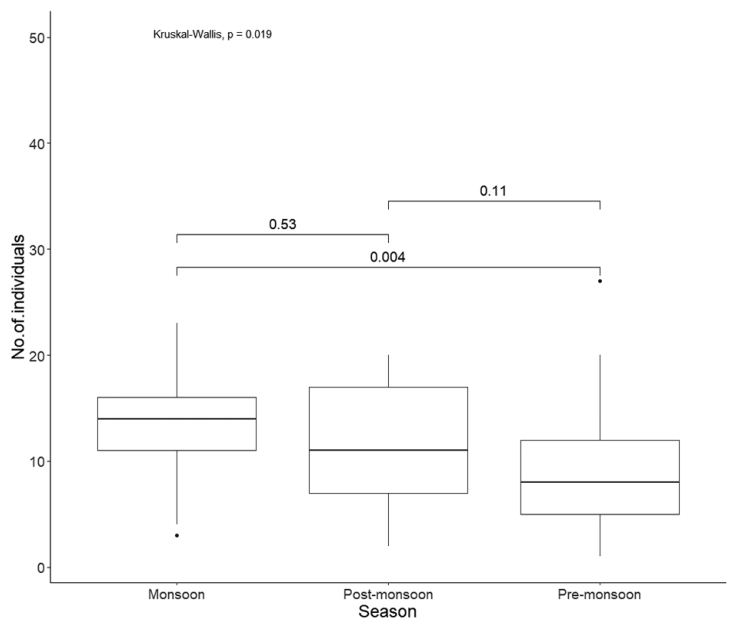

Fig. 2. Box plot showing the roosting House Sparrow population at three different locations

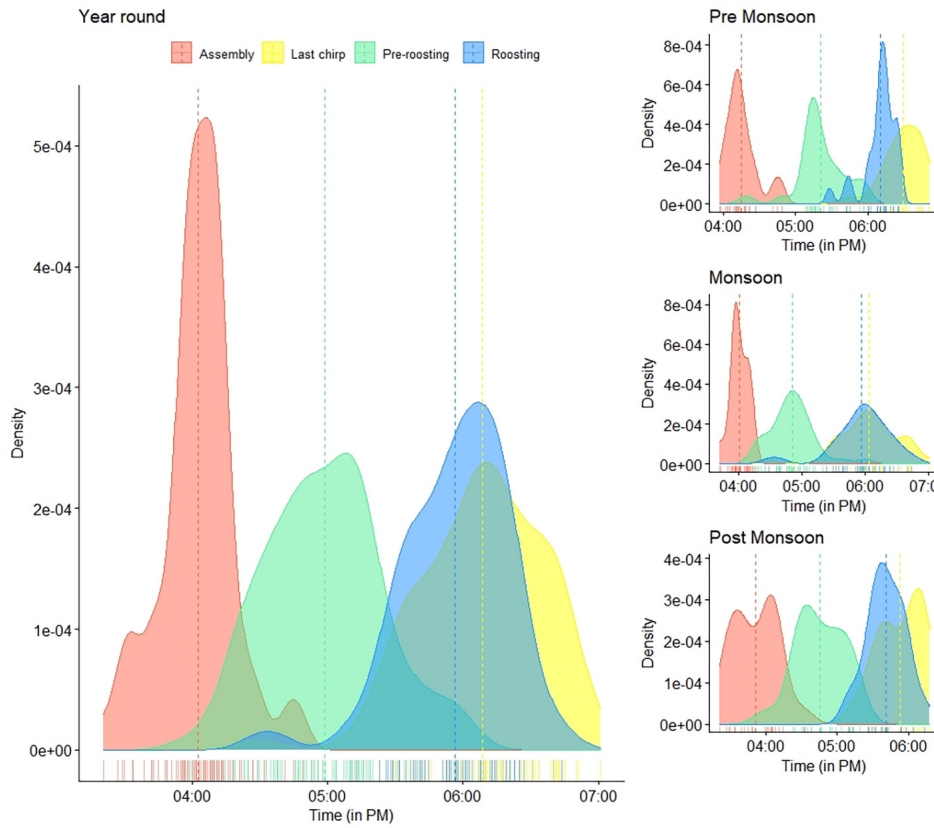

Fig. 4. Roosting pattern of House Sparrow

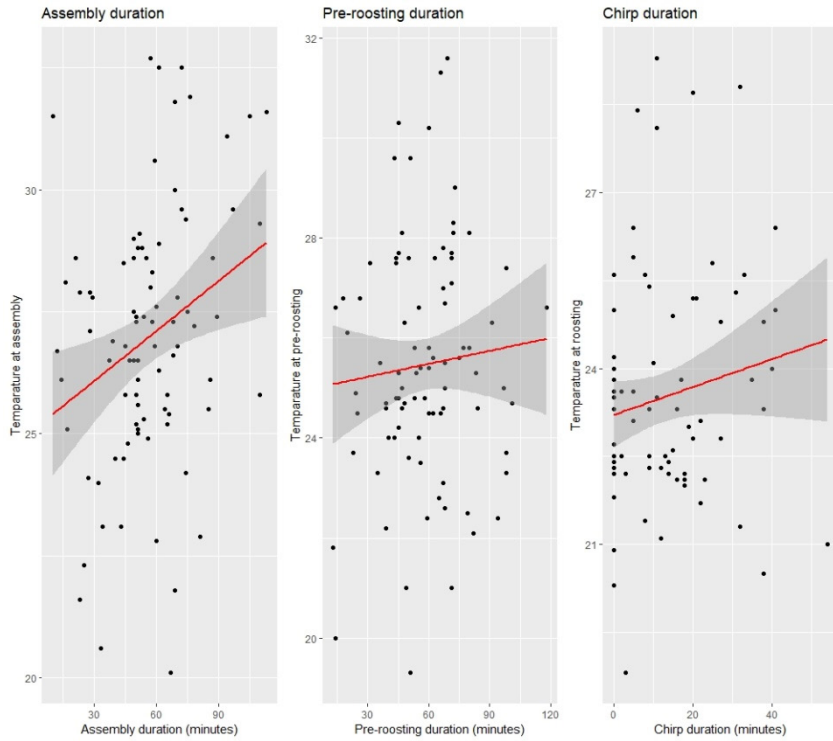

Fig. 5. Correlation of temperature and duration of activities

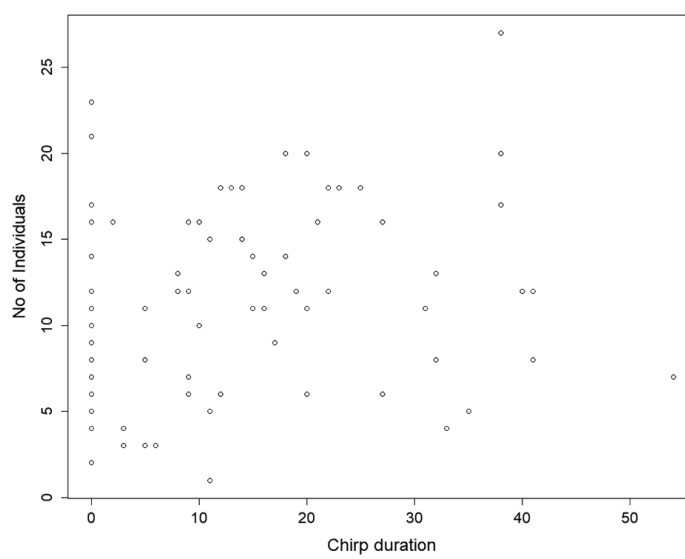

Fig. 6. Correlation between duration of chirp and number of individuals in the roost (year round data)