Eco. Env. & Cons. 29 (August Suppl. Issue) : 2023; pp. (S65-S72)
Copyright@ EM International
ISSN 0971–765X

DOI No.: http://doi.org/10.53550/EEC.2023.v29i04s.012

Nesting Tree Selection and Temporal Variation in the Nesting of Little Egret (*Egretta garzetta*) in a Heronry Near Neendakara Harbour, Ashtamudi Wetland, Kollam, Kerala, India

Dilraj C.P.[1], S. Jisha[2] and B. Hari [3*]

Post Graduate and Research Department of Zoology, Sree Narayana College, Kollam, 691 001, Kerala, India.

(Received 14 February, 2022; Accepted 16 April, 2023)

ABSTRACT

Birds often act as a biosensor in a disturbed wetland ecosystem. Their activities such as feeding, roosting, breeding, etc. are more confined to wetland areas. The heronry is a communal nesting place of waterbirds of the orders *Ciconiiformes*, *Pelecaniformes*, *Suliformes* which comprise Egrets, Herons, Storks, Darters, Cormorants, and Ibis. The present study was focused on the number of nests of the Little Egret (*Egretta garzetta*), nesting tree species, and a number of nests on different trees near the Neendakara fishing harbor, Ashtamudi Wetland (Ramsar site No: 1204), Kollam, Kerala, during June 2018 to March 2020. Bird counting was done with the aid of binoculars, a digital camera, and a spotting scope following the direct observation method. Little Egret nests were recorded as highest in July (108) and lowest in March (34) during the 2018-19 period. During 2019-20, the highest number of nests were observed in July (93) and the lowest in March (15). Six tree species such as *Cocos nucifera*, *Tectona grandis*, *Alstonia scholaris*, *Terminalia catappa*, *Acacia nilotica* and *Casuarina equisetifolia* were utilized by the water bird for nest building. Relative abundance data revealed *Cocos nucifera* (50%) was the most utilized tree species. *Tectona grandis* (46%) harbours the highest proportion of nests. A one-way ANOVA followed by a Tukey's HSD test showed a significant difference ($P<0.05$) in the relative nest abundance per tree species. Higher number of nests and adult birds residing in the heronry was reported during the wet season (June to November) when compared to the dry season (December to May). Survival of the heronry was threatened by several factors such as natural disasters, predation, poaching, and logging prevailing in the study site. However, there were no significant differences ($P>0.05$) in the year-wise cumulative nest number.

Key words: *Heronry, Ashtamudi wetland, Neendakara fishing harbor, Egretta garzetta.*

Introduction

Avian fauna gains immense importance as bio-indicators, bio-pest controllers, scavengers, pollinators, and food resources of the ecosystem. Feeding status and availability of habitat play an important role in the distribution of the avian community (Laladhas and Oommen, 2017). Feeding scarcity associated with any shift in the natural hydrological cycles might have affected the nesting behaviour of many birds (Ramesh and Philip, 2015). The spatial and temporal clumping of the nests of waterfowls is re-

([1]Research Scholar, [2]Associate Professor, [3]Professor)

ferred to as heronries. It often acts as a good ecological model which provides information about the relationship between fitness parameters and environmental factors as well as about the climatic conditions especially the monsoon phenology (Urfi, 2011). Low predation pressure, an abundance of dense foliage trees, and adequate availability of nesting materials and feeding options are the factors that contributed to the successful establishment of good nesting (Jha, 2012). Suitable nesting sites, availability of food, anti-predator advantage, and thermoregulatory gains are major driving forces behind colonial breeding (Wittenberger and Hunt, 1985; Sashikumar *et al*., 2015). About 13% of the avian fauna in the world are colonial nesters (Lack, 1967). The colonially nesting water birds commonly belong to families such as *Anhingidae*, *Phalacrocoracidae* and *Ciconiidae* (Roshnath *et al*., 2013). Birds are expected to select the nest sites which maximize the yield of their reproductive success (Kim and Koo, 2009).

A total of 26 species of colonially nesting waterbirds have been reported from India (Subramanya, 1996). Several studies have reported the heronry status of waterbirds from different regions of India (Hilaluddin *et al*., 2003; Venkataraman, 2007; Dwevedi *et al*., 2014; Gohel *et al*., 2021; Jabaraj *et al*., 2021). Out of 26 species of colonially nesting waterbirds in India, 15 species were found to nest in Kerala (Subramanya, 2005). Later, Sashikumar *et al.* (2015) conducted a heronry survey in the entire state of Kerala. In a heronry survey conducted in 2019, a total of 6,790 nests of 11 species of birds belonging to 3 families, and among them 586 nests of Little Egrets were reported from all over Kerala (Roshnath *et al*., 2020). In this study, 153 nests of Little Egrets were reported from Kollam district. Annual heronry surveys have been carried out throughout the state of Kerala with the support of the Kerala Forest Department and various NGOs (Roshnath *et al*., 2019a; Roshnath *et al*., 2020). In Kerala, the majority of studies on heronry were reported from Kumarakom heronry, Northern Kerala heronry, and Thrissur heronry (Narayanan *et al*., 2006a; Narayanan and Vijayan, 2007; Sashikumar *et al*., 2011; Anoop *et al*., 2015; Ajitha and Jose, 2015; Roshnath *et al*., 2015; Greeshma *et al*., 2018; Greeshma and Jayson, 2020).

Nest site selection of the Herons and Egrets depends on their arrival time and body size (Kim and Koo, 2009). Little Egret, belongs to the family Ardeidae. It shows characteristic features such as morphological differences among the breeding and non-breeding adults such as the presence of intricate plumes on the upper breast, mantle, and scapulars with two thin crest feathers hanging down the back of its neck (Cramp, 1977; Grimmet *et al*., 2011). Although monospecific colonies of Little Egrets are found rarely, it is mostly shown to be shared at the nesting site with other waterfowls (Hafner *et al*., 1994).

Neendakara harbour serves as a predominant ground for the waterbirds due to its strategic location. This area is a well-known mechanized fishing center of Kerala having serious ecological and conservation problems. The major environmental threats were excessive fishing pressure, heavy depletion of the bottom fauna, juvenile fishing, bycatches, plastic pollution and oil discharges, and coastal pollution, etc. The present study aimed to study the temporal variation in the number of nests of the Little Egret (*Egretta garzetta*), the selection of trees for nesting near the Neendakara fishing harbor, Ashtamudi Wetland (Ramsar site No: 1204), Kollam, Kerala, during June 2018 to March 2020. This study signifies the importance of conservation of the heronry established in this wetland area.

Materials and Methods

Study area: Neendakara fishing harbor (8°56′15.30″N and 76°32′20.23″E) which is in the western part of Ashtamudi wetland (Ramsar Site No: 1204) Kerala, (Fig. 1). It is a major fishing harbor in Kollam district.

Sampling surveys: Heronry surveys were carried out from June 2018 to March 2020. The direct observation method (Altman, 1974) was adopted and counting was done with the aid of binoculars, a digital camera, and a spotting scope. The observations were carried out bi-weekly and the bird species were identified using a standard field guide (Grimmet *et al*., 2011). In the survey, the species of the nesting bird, the number of nests of each species, number of nesting trees were counted and recorded separately, in order to identify the newly built nests.

Seasonal analysis: Mean number of active nests and number of adult birds residing in the heronry were compared with respect to the wet season (June to November) and dry season (December to May) during the two periods of the study.

Statistical analysis: Statistical data analysis and graphical representation of data were performed

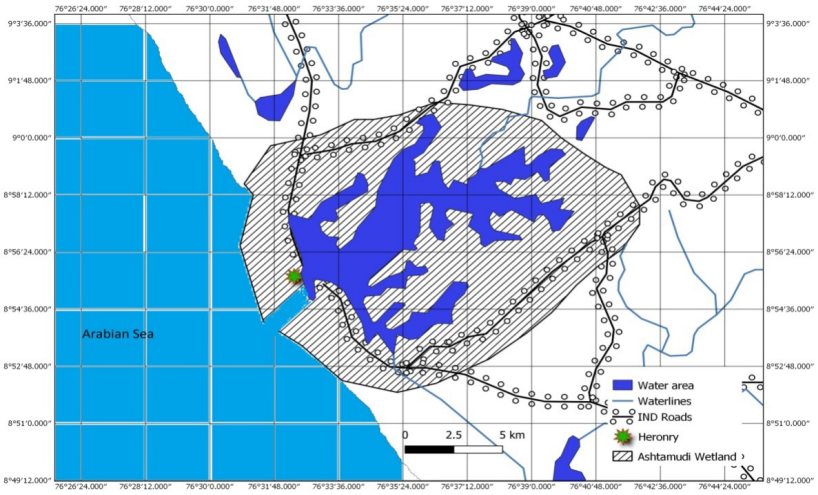

Fig. 1. Location of study site at Ashtamudi wetland, Kollam, Kerala, India.

using Microsoft Excel 2007 and R Version 4.2.1. Mean values were compared using one-way ANOVA with pair-wise comparisons made with Tukey's HSD tests.

Results

Monospecific heronry of Little Egret which belongs to the family Ardeidae and order Pelecaniformes (Fig. 2) were recorded during the study period. A total of 108 and 93 nests were observed in the 2018-19 and 2019-20 periods, respectively. This heronry comprises 38 nesting trees which belong to six species. The relative abundance of nesting tree species recorded from the study site showed that the *Cocos nucifera* was the most abundant (50%) followed by *Tectona grandis* (34%), *Acacia nilotica* (8%), *Alstonia scholaris* (3%), *Casuarina equisetifolia* (3%) and *Terminalia catappa* (3%) (Fig. 3).

Fig. 2. Little Egret heronry at Neendakara, Kollam, Kerala, India.

The relative nest abundance of Little Egret per tree showed that *Tectona grandis* harbours the highest proportion (46%) followed by *Acacia nilotica*, *Cocos nucifera*, *Terminalia catappa*, *Casuarina equisetifolia* and *Alstonia scholaris* (Fig. 4). A one-way ANOVA

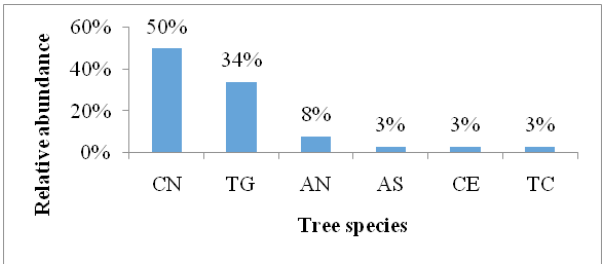

Fig. 3. Relative abundance of trees recorded from the Neendakara heronry. TG-*Tectona grandis*, AN-*Acacia nilotica*, AS-*Alstonia scholaris*, CE-*Casuarina equisetifolia*, TC-*Terminalia catappa*, CN-*Cocos nucifera*.

(F=65.5, P<0.05) followed by a Tukey's HSD test showed a significant difference in the relative nest abundance per tree species. The results revealed that *Tectona grandis*, *Acacia nilotica* and *Cocos nucifera* have significantly higher (P<0.05) nest abundance in comparison to other tree species (Fig. 5).

In the first period of the study (June 2018 to May 2019), the highest number of nests was recorded in the month of July (108). Due to adverse weather conditions such as rainfall and wind, the number of nests was reduced in August 2018 (100) and September 2018 (80). From January 2019, there was a

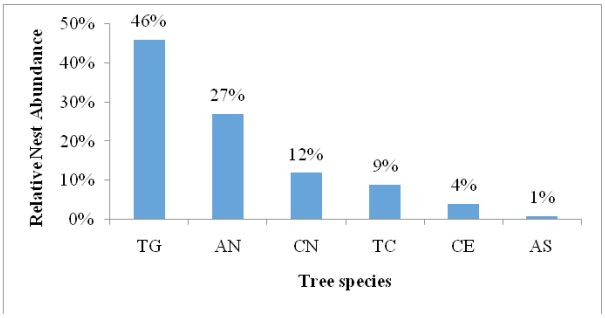

Fig. 4. Relative abundance of Little Egret nests recorded from the Neendakara heronry. TG-*Tectona grandis*, AN-*Acacia nilotica*, AS-*Alstonia scholaris*, CE-*Casuarina equisetifolia*, TC-*Terminalia catappa*, CN-*Cocos nucifera*.

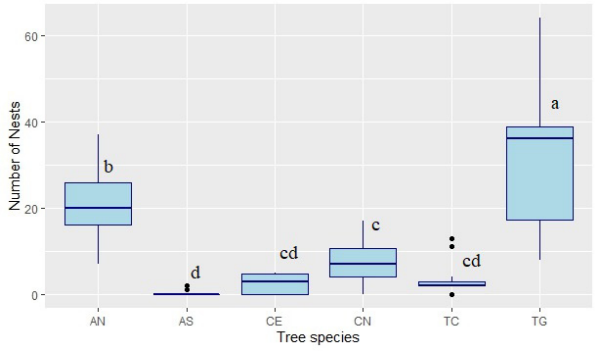

Fig. 5. Box plots representing tree-wise cumulative number of Little Egret nests. Each box plot shows the minimum, lower quartile, median, upper quartile, and maximum values. Groups not sharing lowercase letters are significantly different (P<0.05). Climatic impact on heronry TG-*Tectona grandis*, AN-*Acacia nilotica*, AS-*Alstonia scholaris*, CE-*Casuarina equisetifolia*, TC-*Terminalia catappa*, CN-*Cocos nucifera*.

decreasing trend in the number of nests and the lowest nests counts were recorded during the month of March (34). Addition of new nests were noticed in the months of April (48) and May (54) (Fig. 6). Season wise comparison reveled that, higher number of active nests per month (87) were observed during the wet season than dry season (53). Similar trend was found in the case of adult birds residing in the heronry, where 109 birds per month were reported in the wet season while it was reduced to 43 during the dry season (Fig. 7).

During the second period of the study (June 2019 to March 2020), the highest number of nests were observed in July 2019 (93) and the lowest number of nests were recorded during March 2020 (15). In the

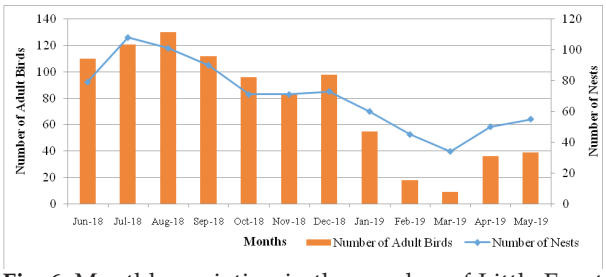

Fig. 6. Monthly variation in the number of Little Egret nest and number of adult birds recorded from the Neendakara heronries during June 2018-May 2019

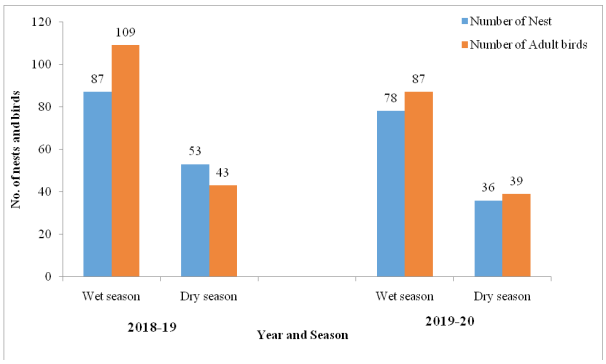

Fig. 7. Seasonal variation in the number of Little Egret nests and number of adult birds recorded during the two study periods (2018-2019 and 2019-20) from the Neendakara heronry.

month of August 2019, the number of nests (79) was found to be reduced due to unfavorable weather conditions. A decreasing trend in the number of nests was noticed from January 2020 onwards similar to the first phase of the study (Fig. 8). Higher number of nests per month (78) were reported during the wet season when compared to the dry season (36). The mean number of adult birds residing in the heronry were found to be 87 and 39 in the wet and dry season, respectively. The results of the present study indicate a reduction in the number of active

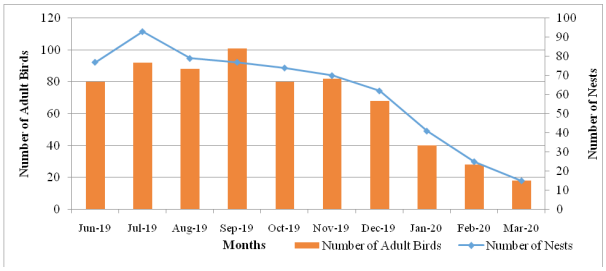

Fig. 8. Monthly variation in the number of Little Egret nests and number of adult birds recorded from the Neendakara heronry during June 2019-March 2020

nests and the number of adult birds during the dry season when compared to the wet seasons (Fig.7). One-way ANOVA (F=0.679, P>0.05) revealed that there were no significant differences in the year-wise cumulative nest numbers (Fig. 9). Even though there is a reduction in the number of nests in the second phase of the study, it is statistically not significant (P>0.05).

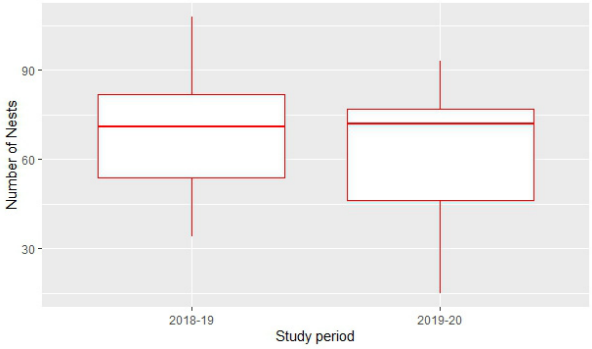

Fig. 9. Box plots representing study period wise (2018-19 and 2019-2020) cumulative number of Little Egret nests recorded from the Neendakara heronry. Each box plot shows the minimum, lower quartile, median, upper quartile, and maximum values

The abundance of adult birds was observed maximum during the month of August (121) and minimum during March (9) in the 2018-19 period. However, in the 2019-20 study period, the highest number of adult birds was observed during the month of September (101) and the lowest during the month of March (18) (Fig. 6, 8). Major threats like predation, natural calamities, tree logging were observed from the study site.

Discussion

In the present study, Little Egrets were found to use six different species of trees for building nests, at Neendakara heronry in which *Tectona grandis* and *Acacia nilotica* showed the highest nest abundance. Although the most common tree species which were utilised for nesting by Little Egrets was *Cocos nucifera*, the abundance of nesting per tree was found to be less for this species at Neendakara heronry and this may be due to poor canopy spread and no branching. There is no specific selection for nesting trees by the Little Egret, its nest distribution relies on the available vegetation (Parejo *et al*., 2001). However, features of nesting trees, such as canopy spread has a positive correlation with nest abundance (Roshnath and Sinu, 2017). Greeshma *et al*. (2018) during the heronry studies at Thrissur district recorded that Little Egret utilised *Albazia saman* for nest building. Heronry study in Northern Bankura, West Bengal showed most of the nests were harboured in *Phoenix syvelstris* (Nayak, 2021).

The present study showed that the active nest-building habit of the Little Egrets was observed during the monsoon season. According to Bennets *et al.* (2000), nesting success primarily depends on rainfall. The relationship between the nest-building habit of the waterbirds with the monsoon season was noticed in several studies (Narayanan *et al.*, 2006b). A positive correlation was clearly visible between the breeding season of Painted Stork and monsoon rainfall (Urfi, 2011). Monsoon season act as a strong driven force on the feeding behavior of the heronry birds (Frederick and Collopy, 1989). Ajitha and Jose (2015) observed the highest number of birds at Kalletumkara heronry in August and maximum number of nests in July. In the present study, the highest number of birds in heronry and active nests were observed during June to November. Greeshma and Jayson (2020) also recorded similar observations. When addressing the seasonal impact on the active nesting and nesting birds, the wet season comparatively favours the active nests and thereby the number of birds were found in a higher side during wet season when compared to the adverse dry seasons (Narayanan *et al*., 2006b; Nsor and Obodai, 2014). The presence of abundant food resources and thick vegetation secures the nest establishments during the wet season (Nsor and Obodai, 2014). An increase in stress due to unfavourable conditions during the dry season prevent adult birds from actively foraging and properly feeding the nestlings (Skwarska *et al*., 2022). Even though monsoon seasons favours the nesting habit, the extreme weather conditions during the monsoon seasons were found to affect it adversely and the destruction of nests and loss of eggs and nestlings were the direct effect of adverse weather conditions (Dabeta, 2019).

In the second phase of the present study (2019-2020) a numerical reduction in the number of nests compared to the first phase of the study (2018-2019) was recorded even though it was not statistically significant. A similar trend in the reduction of the number of nests of Egret species was reported from

the Kerala heronry survey (Roshnath *et al*., 2019a., 2020). But Bosco Marengo heronry in the Orba river reserve in Northwestern Italy showed an increasing trend in the nests of Little Egrets (Bertolino and Gola, 2008) during the study period. Least number of nests (4) were observed in Kumarakom heronry, which is the major heronry hotspot in Kerala, among the ten species of colonial waterbirds was Little Egret (Narayanan and Vijayan, 2007). Thus, it showed the importance of the monospecific heronry of Little Egrets at Neendakara where the nests were on the higher side when compared to Kumarakom heronry. Monospecific colonies of Little Egret were rare and mostly they were found in mixed colonies (Hafner *et al*., 1994; Ayas, 2007; Santoro *et al*., 2010).

Colonial nesters were often vulnerable to anthropogenic disturbances, habitat destruction, climate changes, and the availability of water and food (Narwade *et al*., 2012). In the present study, the heronry is closer to Neendakara harbour, the major fishing harbour in Kollam, where the anthropogenic pressure was observed in a higher side. Local people considered the heronry as a nuisance, mainly due to the foul smell arising from the bird droppings. To overcome this, we can adopt the method introduced by the farmers of Nelapattu bird sanctuary, where guano was used as fertilizer in combination with water during the irrigating process (Kannan, 2007).

Selection and stratification of nests, and timing of clutch initiation can affect the breeding success in heronries with mixed species (Frederick and Collopy, 1989). In the present study, monospecific colonies of Little Egrets were observed, where predation, poaching, logging of trees, and natural calamities were the factors determining the breeding success. Due to predation forces heronry birds are forced to shift their nesting habitat from wetlands to urban areas (Roshnath *et al*., 2019b). Although there was a high abundance of predatory birds mainly the Brahminy kites, Black kites and even House crows at the study site, huge accessibility to food availability in Needakara harbour prevents the heronry bird from migrating to less threatened areas. Little Egrets present in the study area, were found to be more tolerant to anthropogenic presence and pressure. Charutha *et al*., (2021) reported similar adaptability of urban heronry birds to their conspecific rural birds.

Neendakara heronry is one of the two heronry sites reported from the Kollam district (Roshnath *et al*., 2020). As it is located at the premises of Neendakara harbour, the anthropogenic influences were found to be maximum and these heronry sites are still remaining unprotected. This poses a greater challenge for its conservation. Adopting suitable heronry guards (Roshnath and Sashikumar, 2019) will reduce the nuisance produced by the nesting birds such as droppings, smell, rotting fallen food, dead chicks, feathers, etc. to some extent. As heronries are significant community units of our biosphere, the maintenance of established heronries and associated feeding areas is essential to ensure the stability of the breeding population of heronries. The role of local peoples in the conservation of heronries was reported from various parts of the country such as communal conservation of heronries adopted in Karnataka, Tamil Nadu and Andhra Pradesh (Laladhas and Oommen, 2017). Therefore, appropriate scientific conservation strategies must be implemented with the involvement of local stakeholders for the protection of these heronries and recommended for an active role in the monitoring and conservation from the part of Kerala Forests and Wildlife Department.

Recommendations for conservation

1) A detailed study and monitoring system is needed for the heronries and associated avian population.
2) Local-level awareness programme and campaigns, should be conducted for safe guarding the nests.
3) Ensure the participation of Local and State Government bodies, NGOs in implementing the measures to protect and conserve the heronries and nearby wetland habitat. Proper management of identified heronry sites require prime importance.
4) Measures such as heronry guards, and using guano as fertilisers are to be implemented to reduce the nuisance caused by the heronry.
5) Long-term study should be initiated on the impact of development activities and climatic influence on heronries.

Conclusion

Neendakara heronry, which lies very close to the Neendakara fishing harbour area and holds a mono specific colony of Little Egrets. Six tree species were utilized for nest building by Little Egrets. Although *Cocos nucifera* was the most abundant tree species in

the area, the most utilised tree species were found to be *Tectona grandis and Acacia nilotica.* This was due to the peculiar features of nesting trees, especially canopy spread. Higher number of nests and adult birds residing in the heronry was recorded during the wet season when compared to the dry season. The abundance and easy availability of food resources is one of the major reasons for the establishment of these heronries even in the midst of severe anthropogenic interferences. Persistent and scientific monitoring and at most care is needed for the conservation of these heronries.

Acknowledgement

The authors are grateful to The Principal, Sree Narayana College, Kollam for providing the facility for carrying out the study. The authors are also acknowledging the research facility provided by DST-FIST (2018-2021) and DBT Star College Programme. The First author acknowledges CSIR for granting Junior Research Fellowship for pursuing his Ph.D. Programme and University of Kerala for his Ph.D. Registration.

Conflict of interest

All the authors hereby declare there is no conflict of interest in this matter.

References

Ajitha, K.V. and Jose, B. 2015. Kalletumkara heronry, an ideal breeding site for waterbirds in Kerala, South India. *Int. J. Sci. Res.* 4(3): 923-927.

Altman, J. 1974. Observational study of behaviour: Sampling methods. *Behaviour.* 49: 227-267.

Anoop, N.R., Mathews, T.W., Vinayan, P.A., Jayakumar, S., Sujin, N.S., Sabita, C. and Anoop, R.P.N. 2015. Status and conservation of waterbirds in Panamaram heronry, Kerala and implication for management. *Asian J. Conserv. Biol.* 4(1): 76-80.

Ayas, Z. 2007. Nest site characteristics and nest densities of Ardieds (Night heron: *Nycticorax nycticorax,* Grey Heron: *Ardea cinerea,* and Little Egret: *Egretta garzetta*) in the Nallihan bird sanctuary (Sariyar Reservoir, Ankara, Turkey). *Turk. J. Zool.* 32(2): 167-174.

Bennetts, R.E., Fasola, M., Hafner, H. and Kayser, Y. 2000. Influence of environmental and density-dependent factors on reproduction of Little Egrets. *The Auk.* 117 (3): 634-639.

Bertolino, S. and Gola, L. 2008. Nest site of two heron species in Italy: A long-term study. *Waterbirds.* 31(3): 480-484.

Charutha, K., Roshnath, R. and Sinu, P.A. 2021. Urban heronry birds tolerate human presence more than its conspecific rural birds. *J. Nat. Hist.* 55 (9-10): 561-570.

Cramp, S. 1977. Studies of less familiar birds, Little Egret. *Brit. Birds.* 70: 206-214.

Dabeta, S. 2019. Impact of cyclone Fani on the breeding success of sandbar-nesting birds along the Mahanadi River in Odisha, India. *J. Threat. Taxa.* 11(14): 14895-14898.

Dwevedi, R., Singh, S.K. and Krishna, V. 2014. Heronries of Mathura district, western Uttar Pradesh, India. *Indian Birds.* 9(4): 93-95.

Frederick, P.C. and Collopy, M.W. 1989. Nesting success of five Ciconiiformes species in relation to water conditions in the Florida Everglades. *Auk.* 106: 625-634.

Gohel, T., Chaudhari, T., Dodia, P., Shukla, A. and Solanki, D. 2021. Studies on nesting colonies of heronry birds in Bhavanagar city, Gujarat, India. *Indian J. Ecol.* 48(1): 91-97.

Greeshma, P. and Jayson, E.A. 2020. Ayanikkad heronry: a new addition to the heronries of Kerala, India. *Zoo's Print.* 35(2): 31-38.

Greeshma, P., Jayson, E.A., Manoj, K. and Riju, P. 2018. Status and composition of heronries in Thrissur district, Kerala, India. *Eco. Chronicle.* 13(1): 1-6.

Grimmet, R., Inskipp, C. and Inskipp, T. 2011. *Birds of Indian subcontinent.* Oxford University Press, New Delhi, India. 86-87.

Hafner, H., Pineau, O. and Kayser, Y. 1994. Ecological determinants of annual fluctuations of breeding Little Egrets (*Egretta garzetta* L.) in the Camargue, S. France. *Rev. Ecol.* 49: 53-62.

Hilaluddin, Sha, J.N. and Shawl, T.A. 2003. Nest site selection and breeding success of Cattle Egret and Little Egret in Amroha, Uttar Pradesh, India. *Waterbirds.* 26(4): 444-448.

Jabaraj, S.F.D., Pandian, M. and Gopi, V.G. 2021. Nest site characteristics of an urban heronry at Ranipet police station, Tamil Nadu. *Indian Birds.* 17(1): 4-7.

Jha, K.K. 2012. Some breeding and ecological aspects of heronry bird at Soor Sarovar bird sanctuary Agra, Northern India. *Asian J.Conserv. Biol.* 1(1): 35-41.

Kannan, V. 2007. Nelapattu bird sanctuary: An overview. *Zoos' Print J.* 22 (9): 8-12.

Kim, J. and Koo, T. 2009. Nest site selection and reproductive success of herons in Pyeongtaek heronry, Korea. *Waterbirds.* 32(1): 116-122.

Lack, D. 1967. Interrelationships in breeding adaptations as shown by marine birds. *Proc. Int. Ornithol. Congr.* 14: 3-42.

Laladhas, K.P. and Oommen, V.O. 2017. Heronry conservation; incentives for biodiversity conservation, Project, Biodiversity Conservation. 1-6.

Narayanan, S.P., Sreekumar, B. and Vijayan, L. 2006a.

Breeding of the Oriental White Ibis *Threskiornis melanocephalus* at Kumarakom heronry Kerala, India. *Indian Birds.* 2(6): 150-151.

Narayanan, S.P., Raju, D.V., Unnikirshnan, N., Vasan, N. and Sreekumar, B. 2006b. Do Great Cormorants *Phalacrocorax carbo* displace other colonial nesting waterbirds at Kumarakom heronry (Kerala)? *Indian Birds. 2*(5): 138.

Narayanan, S.P. and Vijayan, L. 2007. Status of the colonial breeding waterbirds in Kumarakom heronry in Kerala, Southern India. *Podoces.* 2(1): 22-29.

Narwade, S.S., Gaikwad, M.C., Fartade, K.M., Fugare, R. and Rahmani, A.R. 2012. Distribution and conservation in south-west region of Deccan Maharashtra, India. *J. Care 4 Nature.* 1(1): 11-17.

Nayak, A. 2021. Nesting tree selection by scattered heronry birds of drought-prone Northern Bankura, West Bengal, India: preference of *Phoenix sylvestris* near wetland associated habitats. *Not. Sci. Biol.* 13(1): 1-16.

Nsor, C.A. and Obodai, E.A. 2014. Environmental determinants influencing seasonal variations of bird diversity and abundance in wetlands Northern Region (Ghana). *Int. J. Zoo.* 2(5): 10.

Parejo, D., Sanchez, M.J. and Aviles, M.J. 2001. Breeding biology of the Little Egret (*Egretta garzetta)* in southwestern Spain. *Ornis. Fennica.* 78: 31-38.

Ramesh, C.P. and Philip, G.H. 2015. Painted Stork heronry at Veerpurm village, Andhra Pradesh, India, a case study. *Res. J. Biological Sci.* 4(2): 84-88.

Roshnath, R., Ashokkumar, M., Unni, R., Jith, S. and Jose, A. 2013. Status of birds in heronries of Kannur district, Kerala. *Malabar Trogon*. 11: 15-20.

Roshnath, R., Athira, K. and Sinu, P.A. 2019b. Does predation pressure drive heronry birds to nest in the urban landscape? *J. Asia-Pac. Biodivers.* 12: 311-315.

Roshnath, R., Divakar, N., Chandran, K.,Valsarajan, D. and Jose, A. 2015. Heronry census, 2014 Kannur district, Kerala. *Malabar Trogon.* 12(1-3) : 9-13.

Roshnath, R. and Sashikumar, C. 2019. Conservation challenges of the heronries in Kerala. *J. Bombay. Nat. Hist. Soc.* 116: 65-67.

Roshnath, R., Sashikumar, C., Greeshma, P.C., Vishnudas, C.K. and Palot, J.M. 2019a. Heronry survey in Kerala, 2018-A summary. *Malabar Trogon.* 17(1-2-3): 40-43.

Roshnath, R. and Sinu, P.A. 2017. Nesting tree characteristics of heronry birds of urban ecosystems in peninsular India: Implications for habitat management. *Curr. Zool.* 63(6): 599-605.

Roshnath, R., Vishnudas, C.K., Siji, P.K., Dilip, G., Harikumar, M., Hari, M., Sarlin, P.J., Sivakumar, A.K. and Sashikumar, C. 2020. Kerala heronry survey 2019-A summary. *Malabar Trogon*. 18(2-3): 86-89.

Santoro, S., Manuel, M., Green, A.J. and Figuerola, J. 2010. Formation and growth of a heronry in a managed wetland in Donana, southwest Spain. *Birds Study.* 57(4): 515-524.

Sashikumar, C., Bimalnath, K.G., Praveen, E.S., Roshnath, R., Harikumar, M., Hari, M., Raju, S., Sathyan, M., Sreekumar, B., Sivakumar, A.K., Vishnudas, C.K., Nameer, P.O. and Praveen, J. 2015. Heronries of Kerala – 2014. *Malabar Trogon.* 13(2-3): 2-11.

Sashikumar, C., Vishnudas, C.K., Raju, S., Vinayan, P.A. and Shebin, V.A. 2011. Heronries of North Kerala–2011. *Malabar Trogon.* 9: 10-16.

Skwarska, J., Podstawczynska, A.,Banbura, M., Gladalski, M., Kalinski, M., Markowski, M., Wawrzyniak, J., Zielinski, J and Banbura, J. 2022. Effects of ambient temperature during the nestling stage on a stress indicator in nestling pied flycatchers *Ficedula hypoleuca. Int. J. Biomet.* 66(1): 139-148.

Subramanya, S. 1996. Distribution and conservation of Indian heronries. *J. Bombay Nat. Hist. Soc.* 93: 459-485.

Subramanya, S. 2005. Heronries of Kerala. *Malabar Trogon.* 3(1): 2-15.

Urfi, A.J. 2011. Climate change and its impacts on Indian birds: monsoon phenology and monitoring heronry birds. *Curr. Sci.* 101(9) : 1140-1142.

Venkataraman, C. 2007. Nest–site selection by colonial water birds at Vedanthangal water bird sanctuary, Tamilnadu, India. *J. Sci. Trans. Environ. Technov.* 1(2): 77-83.

Wittenberger, J. and Hunt, G. 1985. The adaptive significance of coloniality in birds. In: Farner D., King J., Parker K (eds.). Academic Press London. *Avian Biology*. 3(1): 1-78.