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RESEARCH ARTICLE

Roosting Behavior of Waterbirds at Ruhuna University Premises in Sri Lanka

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Abstract: Communal roosting is a habit of many waterbirds. Although it is a common behavioural pattern, only a few documentary records are available in Sri Lanka. Therefore, the present study aimed to investigate the roosting behaviour of waterbirds at Ruhuna University Premises, Sri Lanka. The study was conducted from November 2020 to February 2021 covering 20 field visits. During field visits, the abundance of waterbirds, their arrival time, intra-species, and inter-species interactions were observed. The responses of roosting waterbirds to human disturbances and occasional visitors to roosting sites were also recorded. The waterbirds roosted on a single *Sonneratia caseolaris* tree, located at the waterbody closer to the bank. Eleven species of waterbirds were identified, and the Cattle Egrets (*Bubulcus ibis*) were prominent (93%). The diversity and species abundance gradually increased during the study period. The highest species richness (11) and diversity (H- 0.8832) were recorded in February. The roosting behavior of birds has been altered by human disturbances. The waterbirds co-existed on the roosting site with inter- and intra-species associations while maintaining hierarchical levels (different height levels of the tree). Sixteen species of occasional visitors were recorded, and they left the site with the arrival of regular waterbirds.

Keywords*: waterbirds, roosting behavior, Cattle Egret, co-existence*

Introduction

Communal roosting is termed as a gathering of birds and bats of different species during the day or night-time to rest or sleep (Koli et al. 2019). Roosting birds utilize trees, creepers, and caves as their roosting sites. Some use roosting sites seasonally while others utilize them throughout the year (Jayson 2008).

A roosting site not only acts as a resting place but also reduces predator attacks increases fitness and the efficiency of foraging as well as provides thermoregulation benefits (Beauchamp 1999). Large flocks of roosting birds increase vigilance and reduce the individual risk of predation. Also, the geometry of roosting flock provides a safer roosting place for individuals in the center of the flock while members on the edges of roosting site act as the buffer zone from predation. Individuals close to each other share body heat while reducing the demands of thermoregulation. Furthermore, scientists believe that roosting birds share information, especially about feeding grounds which increases the feeding efficiency of individuals of the flock (Beauchamp 1999).

Though communal roosting behavior is not practiced by many bird groups, it is common in waterbirds (Harrison and Whitehouse 2011). Communal roosting of waterbirds is recorded in several parts of the world including India (Jayson 2008) the USA, Canada (Beauchamp 1999), the United Kingdom (Harrison and Whitehouse 2011) Sri Lanka (Wickramasinghe and Diwakara 2017). Due to habitat destruction and degradation, waterbirds tend to roost in urbanized areas. Several studies have been documented on the roosting behavior of waterbirds in cities (Toloa et al. 2017). Most of them, especially the herons, egrets, and waders, prefer to gather as mixed flocks (Harrison and Whitehouse 2011). As mixed flocks of waterbirds are a common and attractive scenery in the water bodies of Sri Lanka, detailed studies have been documented on their nesting and feeding behavior. However, only

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a few studies have been recorded on the roosting ecology of waterbirds (Wickramasinghe and Diwakara 2017). Hence, the knowledge gap may highly influence on conservation strategies of waterbirds (Koli et al 2019). In addition, no studies have been conducted on waterbirds at Ruhuna University Premises. Therefore, the present study was aimed (01) to investigate the flying routes of waterbirds at the Ruhuna University premises, (02) to identify the roosting birds and occasional visitors on selected roosting sites, (03) to determine the abundance of waterbird species within the roosting sites, (04) to study their response to human disturbances, (05) and to determine their intra- and inter-species interactions.

Materials and Methods

The study was conducted around a water body that was located close to the entrance of the University of Ruhuna, Sri Lanka (N 05.93803, E 80. 57582) (Figure 1).

The potential roosting sites near the waterbody were investigated. Identified roosting sites were selected to study the roosting ecology of waterbirds. Also, different flying routes to the roosting sites were investigated. Observation sessions were conducted randomly over four months from November 2020 to February 2021 covering 20 field visits. Field visits were conducted during weekdays from 1600-1900 h.

Figure 1: Map of the study site around the waterbody at the University of Ruhuna (https://www.google.com/maps)

During field visits, roosting birds were identified using a standard bird guide (Kotagama and Ratnavira 1994; Harrison 2011) using direct observations. Through point count their abundance was recorded using a tally counter. To minimize double counting, the counting of birds was done after they settled on the roosting tree. Also, fluctuations in the abundance of waterbirds were noted.

Avian species richness, species diversity, species evenness, and mean abundance of species in selected roosting sites were calculated using the following indices (Brown, et al., 2016).

Species richness – the number of species for the unit area (Brown et al. 2016). Species diversity was calculated using the Shannon – Weiner Diversity Index. The permanent roosting tree was considered as a unit area.

Shannon-Wiener Diversity Index (H)

$$H = -\sum_{i=1}^{R} pi \ln pi$$

where,

H- Shannon- Wiener Diversity Index
*P*i – Proportion of total abundance represented by the i^{th} species (Sarma & Das, 2015)
R- Number of observations
i – i^{th} observation

Species evenness was calculated using the below equation,

$$Evenness = \frac{H}{\ln S}$$

where,

H- Shannon-Wiener Diversity Index
S- Species abundance/number of species.

The mean abundance of a particular species (Table 3) is calculated as follows,

Mean abundance Total number of individuals of the desired species recorded during all field visits/ Total number of field visits. Similarly, monthly mean abundance (Figure 3 and 4) for a particular species is calculated as follows,

Monthly mean abundance Total number of individuals of the desired species recorded during the selected month/ Total number of field visits conducted during the selected month.

Their roosting behaviour was closely monitored using 6 × 30 binoculars and observations related to both inter- and intra-species interactions were recorded.

Table 1: Waterbirds recorded from the roosting site of the University of Ruhuna

Family	Common name and Scientific name	Maximum number observed per field visit
Ardeidae	Intermediate Egret *Ardea intermedia* Wagler, 1827	18
	Great Egret *Ardea alba* Linnaeus, 1758	17
	Grey Heron *Ardea cinerea* Linnaeus, 1758	1
	Indian Pond Heron *Ardeola grayii* (Sykes, 1832)	49
	Cattle Egret *Bubulcus ibis* Linnaeus, 1758	687
	Little Egret *Egretta garzetta* (Linnaeus, 1766)	8
Phalacrocoracidae	Little Cormorant *Microcarbo niger* (Vieillot, 1817)	12
Threskiornithidae	Black-headed Ibis *Threskiornis melanocephalus* (Latham, 1790)	98
Ciconiidae	Asian Openbill *Anastomus oscitans* (Boddaert, 1783)	14
Anhingidae	Oriental Darter *Anhinga melanogaster* (Pennant, 1769)	1
Rallidae	White-breasted Waterhen *Amaurornis phoenicurus* Pennant, 1769	2

The landing time to the roosting sites of waterbirds and their landing routes over the University premises were recorded. To identify whether there are any preferred height levels (hierarchical levels) associated with roosting birds, the roosting tree was divided into three major layers depending on the height of the tree. From ground level, up to 1 meter of the tree was categorized as "lower region", 2-3 meters of the tree as "middle region" and above 3 meters as "upper region". Occasional visitors to the roosting sites were also recorded and their interactions with the roosting birds were observed. As there were no other roosting trees located in the selected site, comparisons were done within the layers of the single roosting tree.

Results and Discussion

Roosting sites of water birds and their flying routes

Waterbirds used a single Mangrove apple tree or Kirala tree (*Sonneratia caseolaris*) as their permanent roosting site, which was located on the water body, adjacent to the land while a few Umbrella trees (*Terminalia catappa*) served as temporary roosting sites of waterbirds. Roosting birds mainly used three flying routes to reach the roosting site (Figure 2). They moved from feeding grounds located closer to the University. The waterbirds utilized the garbage dumping site, paddy fields, and the university playground as their feeding grounds before they moved to the roosting sites. Similar observations have been recorded from different countries in the world. Cattle egrets aggregated to a waste dumping site maintained by Kerala Municipal Council in India (Seedikkoya et al. 2007). They migrate to Kerala state to feed on maggots in the garbage and the study revealed that they acted as biocontrol agents of maggots. In the present study also, Cattle egrets aggregated at the dumping site to feed on decaying animals (mostly fish materials removed from fish markets closer to the dumping site) and plant materials. Similar to the observations in the present study, waterbirds in Malaysia tend to aggregate in paddy fields (Munira et al. 2014), and the study revealed that the diversity of the waterbirds varies according to the rice-growing season, growth stage of the rice plant, and farming.

Figure 2: Flying routes of roosting waterbirds to the University of Ruhuna

Roosting birds and occasional visitors

Waterbird species on the roosting sites are given in Table 1. Eleven species of waterbirds belonging to six families were recorded from the roosting sites while the majority of the birds were Cattle egrets.

Sixteen species of avian occasional visitors were recorded (Table 2). They visited the roosting tree to

gain shade. However, they left the tree within a short time, or some left the site after the arrival of roosting waterbirds.

Table 2: Occasional avian visitors recorded from roosting sites at the University of Ruhuna

Occasional visitors	Maximum number observed per field visit
Asian Koel *Eudynamys scolopaceus* (Linnaeus, 1758)	1
Blue-tailed Bee-eater (*Merops philippinus* Linnaeus, 1766)	3
Brown-headed Barbet *Psilopogon zeylanicus* (Gmelin, 1788)	1
Common Iora *Aegithina tiphia* (Linnaeus, 1758)	1
Common Kingfisher *Alcedo at this* (Linnaeus, 1758)	1
Common Tailorbird *Orthotomus sutorius* (Pennant, 1769)	2
House Crow *Corvus splendens* Vieillot, 1817	1
Indian Paradise Flycatcher *Terpsiphone paradisi* (Linnaeus, 1758)	1
Indian White-eye *Zosterops palpebrosus* (Temminck, 1824)	2
Long-billed Sunbird *Cinnyris lotenius* (Linnaeus, 1766)	2
Oriental Magpie Robin *Copsychus saularis* (Linnaeus, 1758)	2
Red-vented Bulbul *Pycnonotus cafer* (Linnaeus, 1766)	1
Rose Ringed Parakeet *Psittacula krameri* (Scopoli, 1769)	19
Spotted Dove *Spilopelia chinensis* (Scopoli, 1768)	1
Pale-billed Flowerpecker *Dicaeum agile (*Tickell, 1833)	1

Behavior noted under a novel threat

Regularly around 1720-1725 h, one or two individuals visited the Mangrove apple tree and flew over the roosting site as a circle. After two-three circular movements, they flew away in the same direction. After about 5 minutes, 2-3 individuals landed on the Mangrove apple tree following circular movements and roosted for around five minutes, and flew away. Then the first flock of cattle egrets (about 10 individuals) reached the Mangrove apple tree and flew over it and roosted temporarily on Umbrella trees adjacent to the Mangrove apple tree. After a few minutes, a second flock (about 30 individuals) reached and followed the same behavior. During that time, the first flock also flew from Umbrella trees and joined with the second flock. Both flocks flew over the Mangrove apple tree as a circle and roosted on Umbrella trees. This behavior was continued up to the arrival of the third and fourth flocks which contained a large number (more than 100 per flock) of individuals. In the end, they all landed on the Umbrella trees with noisy calls. Then 1-2 individuals directly landed on the Mangrove apple tree and all of them followed the former individuals and moved to the Mangrove apple tree to spend the night.

Conditioning to human interference

We studied their behavior continuously over a period of one week making observations at the same location. Continuous exposure to humans might have changed their behavioral patterns. Although the first one or two individuals arrived around 1730 h, most of the Cattle Egrets arrived at the roosting site closer to dusk. They avoided their arrival as notable flocks and arrived as small groups having 1-2 or 2-3 individuals. They directly roosted on to Mangrove apple tree without showing circular roaming movements above the tree. This behavior was recorded up to 1830 h and very large flocks arrived when it was very dark (1845 h).

Under removal of threat closer to them

In the subsequent week, field visits were not conducted to normalize the behavior of the birds. Few individuals of the first flock directly roosted on the Mangrove apple tree and sometimes roosted on the umbrella trees. Second, third, and fourth flocks with several individuals (60-70) roosted directly on Umbrella trees. No circular flying movements were observed. They stayed on Umbrella trees until dusk (1845-1900 h) and moved to Mangrove apple trees at once as a single flock. Daily 514.2 ± 31.7 individuals of Cattle Egrets used the Mangrove apple tree as the permanent roosting site. Occasionally aggressive behavior was recorded, competing for roosting spaces. Weak individuals (who were unable to defend their territory) and individuals with small body sizes (might be young individuals) were expelled from the Mangrove apple tree and they settled on branches of Umbrella trees closer to the Mangrove apple tree.

Similar observations were recorded in different parts of the world, and they show waterbirds tolerate human disturbance to a certain extent (Roshnath and Sinu 2017). A study from India revealed that the Black-headed Ibis can highly tolerate human disturbances and they used roosting sites with high anthropogenic effects (Koli et al., 2019).

The roosting waterbirds in the present study used temporary roosting sites before they moved to their permanent roosting sites. A similar observation was recorded in the House Crow where the birds aggregated in pre-roosting sites in small groups. When it was closer to dusk, one or two individuals directly landed on the permanent roosting site, and, later on, small groups of Crows and then large flocks moved to the roosting ground (Peh 2002). When they were in temporary roosting sites, House crows showed feeding and preening behaviors (Peh 2002)but in the present study, such behaviors were not observed instead waterbirds showed aggressive behaviors with frequent calls.

Roosting behavior of other waterbirds

Observations revealed that the presence of the observers/humans did not influence much on the roosting behavior of waterbirds except Cattle Egrets. It may be due to two reasons. Firstly, other waterbirds (except Little Cormorants) reached the permanent roosting site after the settlement of cattle egrets, confirming that the site was safe to roost. Secondly, they arrived close to dusk, and they might not see the presence of the observer. As the first comers, little cormorants roosted facing the water body and they did not recognize the observer who was present in the opposite direction.

The upper region of the roosting tree was occupied by Black-headed Ibis and Asian Openbill while the middle region was crowded by Cattle and Great Egrets. Little cormorants and Indian pond herons roosted on the lower branches of the Mangrove apple tree. Interspecific aggressive behavior was recorded among Cattle egrets, Little egrets, and Great egrets while intra-specific behavior was recorded in Black-headed ibis and Asian Openbill. Waterbirds shared their niche for co-existence while partitioning the niche for roosting (Table 3). Similar observations were recorded for feeding and nesting guilds in mixed species. This was well studied in hummingbird communities that forage on *Penstemon roseus* plant in Mexico (Lara et al. 2009)). *Selasphorus* sp. and *Calypte anna* are small hummingbirds that gain nectar from flowers that bloom in the lower part of the plant and they visit flowers earlier than the larger territorial hummingbirds, *Eugenes fulgens* and *Lampornis clemenciae*. Small species tend to forage in this way to avoid the aggression of larger species.

In contrast, the bigger species feed on flowers that bloom in the upper region of the plant and they attended late to the flowers as they feed on insects during the early hours of the day. As a result, both small and large hummingbird species co-exist in nature sharing the same flowering plant while maintaining a hierarchical feeding level (Lara, et al., 2009). Although co-existence and hierarchy are recorded with the feeding and nesting of mixed colonies, no published records are found of maintaining co-existence and hierarchy on roosting birds of mixed flocks. According to the present study, the arrival time of waterbirds varied depending on the species. Several studies revealed that the arrival time is highly correlated to environmental factors. A study in Singapore showed that the sunset time is highly correlated with the arrival time of house crows to their roosting sites (Peh 2002). Some studies revealed that in most birds, the intensity of light acts as a clue to determine the arrival time to roosting sites (Nee and Yeo 1993). Also, the temperature had a significant influence on the roosting time of Black-billed magpie and Chimney swift (Peh 2002). Therefore, further studies are necessary to investigate the variation in the arrival time of waterbirds at the Ruhuna University Premises.

Table 3: Details of other roosting water birds

Bird species	Arrival time	Mean abundance (No. ± SE)	Roosting location on the permanent roosting site (Mangrove apple tree)	Species interactions
Little Cormorant	17:00 -17:15	2.68 ± 0.47	Lower region (branches closer to water)	No aggressive behavior
Indian Pond Heron	18:10-18:40	11.83 ± 4.17	Lower region	No aggressive behavior
Great Egret	18:05- 18:40	6.44 ± 1.44	Middle region	Aggressive behavior with cattle egret for roosting space
Little Egret	18:15- 18:22	1.40 ± 0.24	Middle region	Aggressive behavior with cattle egret for roosting space
Oriental Darter	16:50- 16:10	0.23 ± 0.12	Middle region	No interactions. They flew away when the egrets arrived in large flocks
Black-Headed Ibis	17:35- 18:35	13.31 ± 4.93	Upper region	Aggressive behavior with intra-species for roosting space
Asian Openbill	17:42-18:17	3.69 ± 1.1	Upper region	Aggressive behavior with intra-species for roosting space
Purple Heron	17:33-17:40	0.10± 0.07	Middle or lower region. The lower region is most preferred.	Solitary life was preferred.
Grey Heron	17:30 -17:45	0.14 ± 0.09	Upper region	No aggressive behavior

Roosting bird abundance, diversity, and evenness during the study period

The roosting site was dominated (93%) by Cattle Egrets. Other roosting birds represented only 7% of the roosting community. A rapid increase in the mean abundance of Cattle egrets was recorded during the study period. Within four months, the abundance of Cattle egrets was more than doubled (Figure 3).

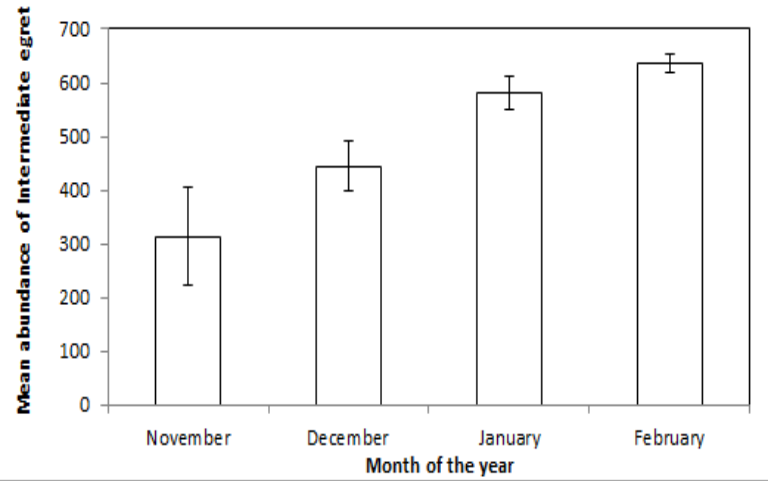

Figure 3: Monthly variation in mean abundance of Cattle Egrets during the study period.

Fluctuations in the mean abundance of little cormorants and Asian openbill were observed during the study period. In contrast, a gradual increase in the arrival of the Great Egret was recorded. During the first two months of the study, no Black-headed ibis was recorded. During January, a significant number of Black-headed Ibis utilized the roosting site, and their mean abundance was more than doubled during the subsequent month; February (Figure 4). Destruction of their previous roosting site might be the possible reason for shifting Black-headed ibis to the study site.

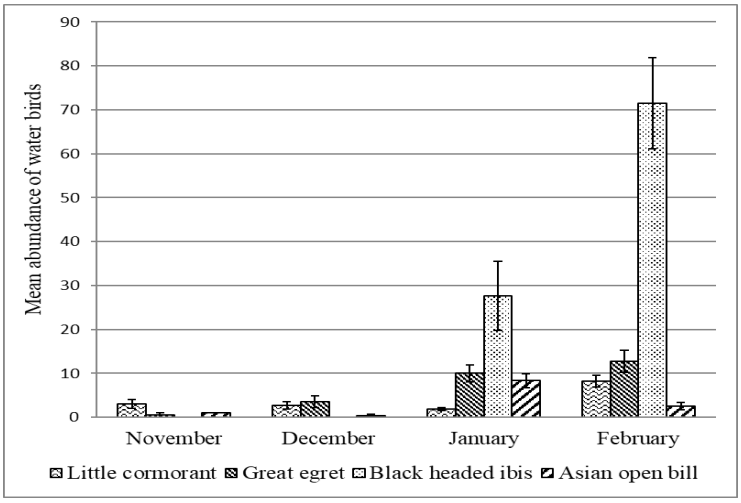

Figure 4: Monthly variation in mean abundance of waterbirds during the study period.

Table 4: Species abundance, diversity, and evenness of waterbirds at the roosting site of the Ruhuna University premises during the study period.

Month	Species abundance	Species diversity (Shannon-Weiner Index)	Species evenness (Shannon Evenness)
November	7	0.1302	0.067
December	8	0.1352	0.065
January	12	0.7047	0.285
February	12	0.8832	2.485

The highest species evenness was recorded in November as well as the lowest species diversity and abundance (Table 4). The highest species abundance was observed in January and February (Table 4) while the highest species diversity was recorded in February (Table 4).

Conclusion

The findings of the present study reveal that the roosting site at Ruhuna University premises consists of a mixed flock of waterbirds with 11 species. The majority of the waterbirds were Cattle egrets. Their abundance was gradually increasing throughout the study period. Similar observations were recorded from Black-headed Ibis and Great egret. All the species of waterbirds co-existed on the roosting tree while maintaining a hierarchy among them. Roosting birds are highly sensitive to human disturbance and accordingly, they alter their roosting behaviors. In addition to waterbirds, the roosting site acted as a resting, feeding, and shading place for sixteen species of avian occasional visitors.

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