

Research Article

Behavioral Pattern of Endemic Sri Lanka Grey Hornbill (*Ocyceros gingalensis*) within the Breeding and Nonbreeding Seasons

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The hornbills are among the most extraordinary looking birds in the world. Out of two species of hornbill, the *Ocyceros gingalensis* is the only endemic grey hornbill in Sri Lanka. This study was conducted in Mihintale Sanctuary which is comprised of secondary dry mixed evergreen forest patches and semiurbanized area from 2013 to 2015. Ad libitum focal animal sampling was used to construct an ethogram for the behavior of Sri Lanka grey hornbill (SLGh). The study recorded 35 behavioral events in 11 acts under 4 types of their activities. Courtship and mating activities were recorded within the study period. Food items were changed throughout the parental care period. Within this period chicks were offered sufficient food comprised of fruits and flesh. These revealed that the nesting of the SLGh in suburb areas is not good sign since it potentially indicates the loss of adequate breeding conditions in the forest. Conservation of SLGh depends on protection of trees and tree cavities as an important ecological niche.

1. Introduction

There are 55 different species of hornbills which were found throughout Asia and Africa but there is no similar genus which could find both of these continents [1]. 31 species of hornbills already present within Asian continent and among them two species present in Sri Lanka. Due to large body size [2, 3] and monogamous behavior hornbills can be designated as keystone or flagship species in some countries [1]. Also they are considered to be one of the most important seed dispersal birds [3, 4] in the ecological habitats and play an important role in forest dynamics because they disperse seeds of many forest trees, especially the large seeded ones [5–7], and many serve as “mobile links” [8] in the food-web organization for rain forests [9].

Sri Lanka grey hornbill (*Ocyceros gingalensis*) is the only endemic hornbill species found in Sri Lanka. According to IUCN categories they are considered as the least concern species which can be categorized into family Bucerotidae, the old world birds. The family Bucerotidae was introduced (as Buceronia) by the French polymath Constantine Samuel

Rafinesque in 1815 [10]. These birds are common in the forested areas of the low country dry zone as well as wet zone [11]. Normal size of the Sri Lankan grey hornbill is more or less similar to black crows with prominent large bill which can be used to separate both sexes of them. Males are always bigger than the females, though the extent to which this is true varies according to species [12]. Bill of the female is grayish or dull black in color with a creamy yellow patch on the upper mandible while male birds have yellow color beak with a black color patch on the upper mandible. Without these prominent characters there are no other variations between them for first sight identification. Commonly the forest areas of low country dry and wet zones Sri Lanka grey hornbills could be observed. They usually form 5–6 individuals in flocks in nonbreeding season [13] in tall forests where hanging creepers and lianas offer easy perches. It often inhabits strands of tall trees close to river beds in the more remote areas of the low country [14]. In terms of breeding biology, both species require tree cavities, and these are not common among human habitations, due to the absence of mature old trees. Thus the general records of breeding have all come from

TABLE 1

Type of behavior	Behavioral act	Behavioral event
Self-maintenance behavior	Cleaning	Preening, bill cleaning, wing stretching, puffing plumage, sand bathing, scratching
	Foraging	Picking fruits, darting, pouncing, killing and feeding, searching, holding
	Shelter seeking	Standing posture, sitting posture, roosting, perching
	Elimination	Defecation
	Defense	Attacking, pecking on glass windows, long aggressive calls
Reproductive behavior	Pair bonding	Touching beaks, feeding each other
	Courtship and mating	Intercourse
	Nest selection	Nest searching, carving the entrance, covering up the entrance, incubating eggs, nest guarding, regurgitating, feeding the female and the brood, nest cleaning
Territorial behavior	Territorial display	Charging each other, aggressive calls, showing off
Other behaviors	Collision with glass window	Looking at glass window, colliding with it in a high speed

forests or semiforested surroundings. Detailed scientific, systematic breeding biological studies of this species still remain largely undocumented in Sri Lanka [15]. Also the information base to determine their distribution and status remains somewhat inadequate. Though the Sri Lankan grey hornbill distributed both wet and dry zones in the country, no prior studies have been carried out on their behavioral ecology. Thus the current study has been conducted aiming at studying breeding and other behavioral patterns of grey hornbill in dry zone.

2. Methodology

2.1. Study Area. The study was conducted within Mihintale Sanctuary in Mihintale Divisional Secretariat, Anuradhapura District, North Central Province Sri Lanka, at about 8°21'04.63"N and 80°30'11.24"E. Preliminary survey has been conducted for positioning nest cavities and locating fruiting trees within 4.0 km² area which consisted of both urbanized and forests areas. Biodiversity of this area is very high with endemic floral and faunal species. The area is legally protected by forest department, wild life department, and archeological department together.

The behavioral study was conducted within 2013 to 2015 to cover up both breeding and nonbreeding behavior of the Sri Lanka grey hornbill. Mist nests were laid at selected places to capture the birds and 9 birds were ringed by using colored plastic rings prior to the study to allow individual identification in the field. Nine ringed birds were used to focal sampling method [16]. Scan sampling method was used for the observation of 4 hornbill flocks within 0600–1800 hours in two-hour categories with 10-minute intervals at selected places where these hornbills were actually foraging. All the activities performed by the selected birds in the flocks were recorded in stem and leaf note for the further analysis and the focus did not assigned any meaning or motivation to them [17].

Previously nest locations were found at the beginning of the breeding season. To locate the nest cavities the fecal patches under the nest cavities were used or it was done by following male bird when it is carrying food for the female

and the chicks during breeding period. To study the breeding behavior three successful nest cavities were selected and time budgeting was conducted for focal nest during each of the two breeding cycles.

Number of frequencies that the male bird visits the nest, amount of food that it carries to the nest, and the types of food it carries to the nest were recorded at each nest location. The observations were made using Bushnell 10 × 50 binoculars from the ground, from a standpoint which offered a good view of the nest as well as the surrounding area.

3. Results and Discussion

Basically life cycle of Sri Lankan grey hornbill within the year was divided into three different phases. Those are prebreeding, breeding, and postbreeding phases. From the beginning of the year they started the courtship behavior which is included in prebreeding phase. The courtship starts at beginning of January. The hornbill family is characterized by an incubation period closely correlated with body size and by an unusually long nestling stage [1]. Nest sanitation observed during the present study was similar to the reports made by [9] for Great Hornbill and Narcondam Hornbill *Aceros narcondami*, respectively.

3.1. Ethogram. The following ethogram was conducted for the Sri Lanka grey hornbill including different behavioral events in—and acts under—major types of behavior (self-maintenance behavior, locomotion behavior, reproduction behavior, and territorial display) (Table 1).

3.2. Self-Maintenance. Six foraging events are documented basically. These include piking which is the event where the bird uses the elongated beak to pick the ripped fruits from the trees (Figure 1). Pouncing could be observed when hornbill captured the small insects. Quickly grasp the animal while flying and then perch to kill the prey for eating. Sometimes it shares the prey but most of the time in breeding season the female bird got greater chance to have the prey alone herself.



FIGURE 1: Fruit picking by male at the edge of a branch.

Elimination. Sri Lanka grey hornbill defecates with an upward tail jerk while perching on a tree and specially within the breeding season female bird and the juveniles defecates out of the nesting cavity for keeping the cavity clean.

Shelter Seeking and Resting. Standing posture (Figure 2) can be described as standing on both legs in the same position for observing around and sometimes on land (Figure 3) as well as on a tree branch. While they are resting in the middle of the day time, sitting and resting (Figure 4) could be observed.

Perching. This can be considered the primary resting behavior of the hornbills as the most other birds. When perching on warm weather, Sri Lanka grey hornbill often seeks silent shade. SLGh normally selected fruiting trees or shady trees for perching. Purpose of perching on trees is the resting or foraging. Neem (*Azadirachta indica*), Palu (*Manilkara hexandra*), and Pihimbiya (*Filicium decipiens*) trees were used by them specially for foraging purposes. It was also observed that cleaning beak was also associated with the perching. Perching in pairs supports the pair bonding behavior too.

Preening. After a feeding session completed bill cleaning (Figure 5) is taking place. It rubs the beak against the tree branch in closing or opened bill. Preening (Figures 6(a), 6(b), and 6(c)) is also characteristic way of cleaning feathers. Closed beak was used for the preening tail feathers by bending whole body to backward. The outer surface of the wing is preened by bending the neck sideward without any movement of the wing [18].

Allopreening (see [19]). A bird preening another bird's wing was recorded in Sri Lanka grey hornbill behavior during courtship period.

Wing Stretching. The bird stretches out feather in forewings and tail alternatively while resting on a tree branch [20]. Puffing plumage or showing plumage also can be observed at the end of the preening session.

Bathing is uncommon activity for the Sri Lanka grey hornbills; there is only one record about sand bathing on the ground. Sun bathing or water bathing was not observed during study period.

Vocal Communication. Information passed among the animals basically by signaling each other [21]. Vocalization is one major way of signaling by using several sounds. The calls of hornbills are loud and vary distinctly between different species [22], Kaa, Kaa, Kaaa calls and also sometimes Kak,

Kak, Kak,, Kak calls uttered [11]. Mumbling calls are also significant during resting posture. Also the alarm calls are defined as those calls which function to alert others to the presence of potential danger, such as presence of predators [20, 23].

Locomotion. No more terrestrial locomotion patterns were recorded. Mostly arial locomotion was observed. Hornbills are not flying frequently, they usually fly long distances, and heights of the flight could be 5–10 m above the ground. They also performed short flights from one tree to the adjacent one. Gliding behavior was recorded when it is flying from height to the lower height mostly also for the long distance traveling.

3.3. Reproductive Behavior. During courtship, the female's major behavior was preening the flumes while that of male was perching. Courtship feeding and grappling of bills with clapping wings observed in the present study are similar to observations of Kannan & James (1997) for Great Hornbill. Interesting behavior was that male keeps offering the female fruits and pieces of bark and mud pellets. The male always carries a fruit in its bill which is ready to be delivered to the female. Even when the female does not accept anything being offered, the male keeps offering the food (Figure 7) to the silent female. When the male and female are in pairs, they treat each other by passing fruits and pieces of barks, bill grappling, touching bills (Figure 8), and even pulling each other's tail [24]. These behaviors were observed during courtship.

Before mating the female spends most of her time (Figure 9) preening her body feathers and basking in sunlight. Mating (Figures 10(a) and 10(b)) was taking place at the end of February. The female becomes less and less active and stays in the nest tree or follows the male to nearby trees when the male is foraging. The female shows inactive behavior (Figure 12). The male also offers her pieces of dry bark, which she tosses, juggles with her bill, and then breaks it into pieces. Mating happens in very short period and produces were their own calls during this period.

Under normal circumstances, a male hornbill induces a female bird to enter a cavity during the breeding season [25]. The nesting season lasted for three months, from March to June, as Indian grey hornbill [26]. The hornbills started to prepare themselves for breeding in early January, when such prenesting behavior as nest-cavity searching [27], mating, and courtship feeding were recorded. Both male and female hornbills were noticed peeping into tree cavities, one after the other, and this was often noted and continued until the female enters into the nest cavity. It has been suggested that the darkness of the cavity triggers a hormone involved in molting.

In the study area, females entered their cavity in the beginning of March and some late nests were also recorded in April. As soon as the female entered the cavity she started cleaning the nest and observed her throwing out all the waste materials left in by the previous user. Later, excreta of the chicks were tossed out by female with her beak through the nest slit and the female ejecting her own excreta through the cavity entrance was observed. The female started sealing the cavity entrance with her bill using mud, cattle dung, and dry tree bark delivered by the male and her own fecal matter.

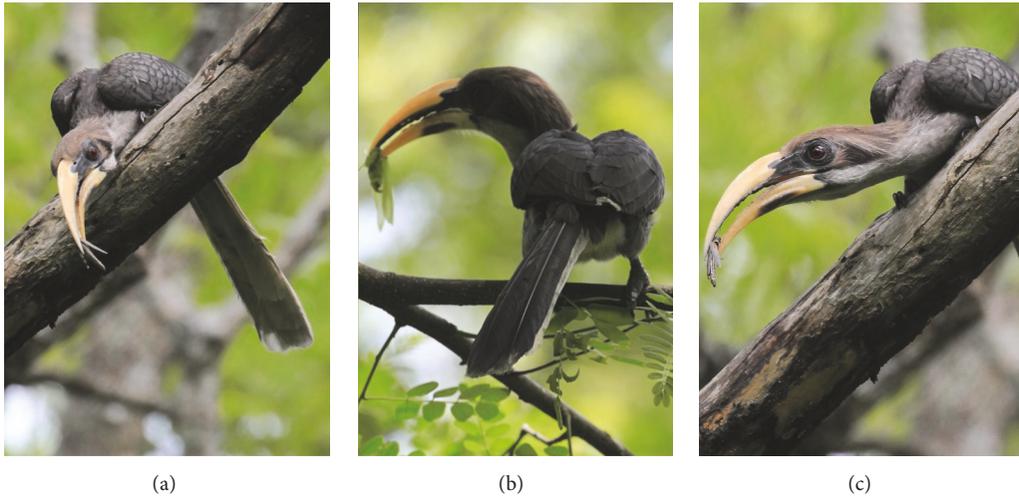


FIGURE 2: Searching around before entering the cavity with food for the juveniles.



FIGURE 3: Ground perching.



FIGURE 5: Different ways of preening feathers.



FIGURE 4: Resting on a tree branch.

Throughout the nesting period the task of the male is to keep feeding (Figure 11) the chick and the female inside the cavity.

For the observed 7 nests of grey hornbill, the nesting period averaged approximately 104 ± 6 days. Begging calls of the nestlings were heard on an average of 40 ± 7 days after the female entered the cavity. Clutch size could not be recorded. The female emerged on average 76 ± 5 days after sealing in and the nestlings fledged an average of 13 days after the female emerged. Two fledglings from one nest and the one from another nest were recorded. The newly fledged chicks were smaller in size than the adults, with fresh plumage and undeveloped casques. Food supplied by male is comprised of 90% of plant foods in morning hours and 69% animal food in the evening (Figure 13). Food items were changed throughout the parental care period. Within this period chicks were offered sufficient food like fruits of *Manilkara hexandra*, *Azadirachta indica*, *Ficus* sp., and *Loxococcus* species, rice,

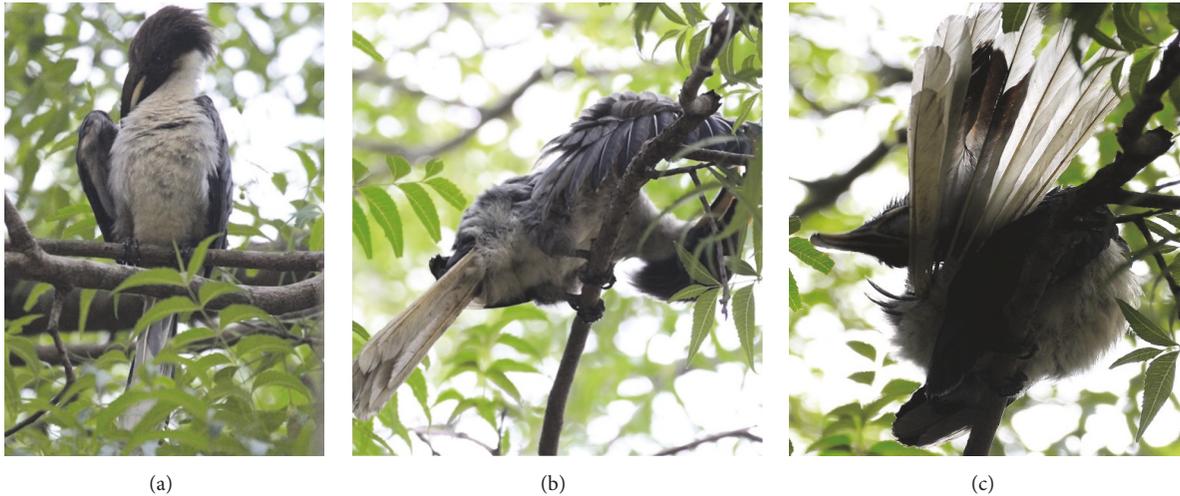


FIGURE 6: The closed beak was used for the preening tail feathers by bending the whole body to backward.



FIGURE 7: Fruit holding with a long curved beak.



FIGURE 8: Beak touching by both before mating.

and flesh foods such as *Calotes versicolor*, some insects, and worms. While considering the types of feeds, comparatively higher amount of plant materials was used to feed during morning hours than the evening and gradually it shows greater variation to higher amount of animal parts during afternoon section (Figure 14). Other than these pieces of information, nest site locations, nest site characteristics, and important remarks were kept.

When the chicks were grown enough, female bird was broken out from the cavity and then both adults left to forage [21]. When the chicks come out where the postbreeding period started, parental care was considerable feature which was observed from them due to the way of taking care of their juveniles. The adults fed the chicks for more than a week, but later they started to feed themselves and flew long distances following their parents.

3.4. Territorial Behavior. Its territory is the entire area defended by a bird at a given time of its life. Territory is the

area which is regularly used by an animal such as a bird by defending actively the others but living space is the same except active defending [28]. Most of the time Sri Lanka grey hornbill shows the territorial behavior by making the aggressive calls to other birds who came across its territory.

Defense. With large body size of the hornbills, small or medium sized birds are not attacking these birds during the study period. And also there is only one recording of defense of Sri Lanka grey hornbill with the Malabar pied hornbills at the same nesting tree with the loudly Kaaaak Kaaaak Kaaa... calls. The surrounding threats were slowly scanned by the male bird before reaching the nest which guarantees the security of the juveniles.

4. Conclusions and Remarks

The SLGh is not very active bird while considering most preferable behaviors. But it has great variety of behaviors; most of them are unique behaviors. The birds are very



FIGURE 9: Food offering by male to the female.

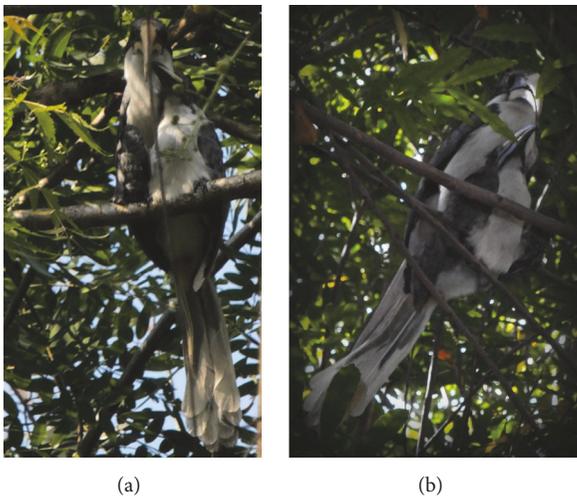


FIGURE 10: Matting.



FIGURE 11: Nest feeding.

alert, always searching around its habitat, also bit aggressive. Poaching or killing SLGh was not recorded within the study period and also nest site predation was not recorded. But

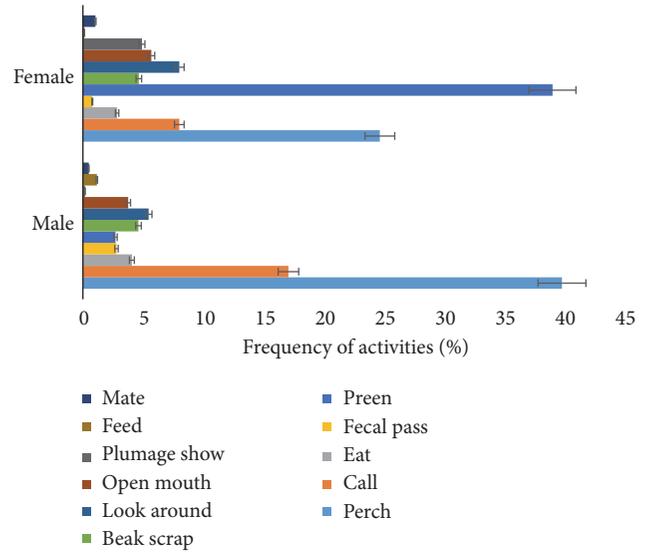


FIGURE 12: The frequency of activities of both male and female per day within the period of 0600–1800 hours.

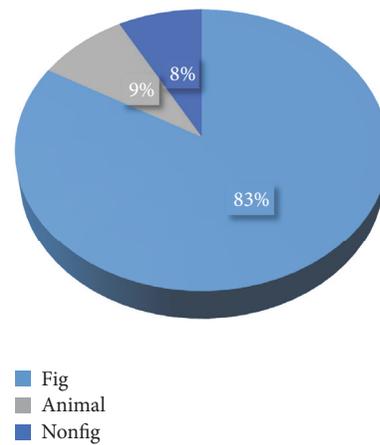


FIGURE 13: Average amount of three types of food items fed within the day time of 0600–1800 hours.

removing favorable trees for SLGh with deforestation looks only major problem which can affect the life cycle of SLGh with food and nesting cavities. The SLGh acts as a mobile linker as well as seed disperser of the habitat. Thus the conservation of hornbills assumes greater importance in preserving the entire ecosystem in especially dry zone forests.

Disclosure

The abstract “Behavioral Study of Sri Lanka Grey Hornbill (*Ocyrceros gingalensis*) in Semiurbanized Area Mihintale” of this abstract was presented in World Biodiversity Congress, Colombo, Sri Lanka, 2014.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

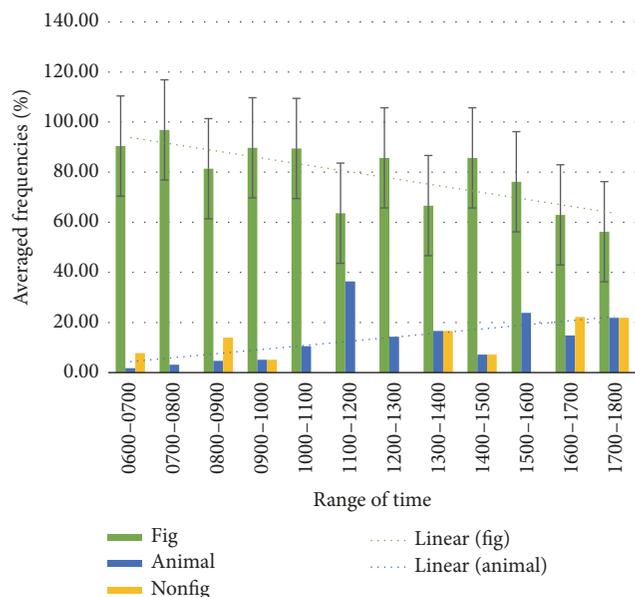


FIGURE 14: Averaged amounts of food items fed during 0600–1800 hours in one-hour categories.

Authors' Contributions

Iresha Wijerathne is responsible for conducting the experiment and manuscript writing. Sriyani Wickramasinghe is responsible for experimental design, manuscript correction, and supervision.

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