

Breeding biology of the Short-toed Snake Eagle *Circaetus gallicus*

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Abstract

The Short-toed Snake Eagle *Circaetus gallicus* is a resident diurnal raptor that is widely distributed across India. We monitored the activities and behaviour of a breeding pair of Short-toed Snake Eagles for three continuous breeding seasons from 2013 to 2015. Information on the feeding habits and diet of the species, along with observations on hatchling growth, behaviour, and parental care are presented. Its incubation period lasted from 44 to 46 days. The Short-toed Snake Eagle feeds its hatchlings with 22 species of vertebrates, including, 69.63% of reptiles (16 species) and 14.28 of mammals (4 species), 3.57% of amphibian (1 species) and 0.59% of birds (1 species), excluding 11.90% of regurgitated food. The pair shares parental duties of incubation, feeding the chicks, hunting, and care of the young.

Introduction

The Short-toed Snake Eagle (henceforth STSE) *Circaetus gallicus* is a medium-sized eagle (Accipitridae). The genus *Circaetus* has six species of which five are restricted to Africa, with just this species being widely distributed outside Africa, breeding in southern Europe, north-western Africa (Clark *et al.* 2005) and Asia (Cramp & Simmons 1980), including India (Ali & Ripley 1983; Inskipp & Inskipp 1991; Naoroji 2006). Though it is fairly common, and a widespread local resident (Naoroji 2006), it has potentially declined in Gujarat (Khacher 1996). Our observations suggest that the species is uncommon in the Saurashtra Peninsula.

Generally, STSE prefers relatively open habitats, with agricultural fields, for foraging. It nests mostly on trees (Inskipp & Inskipp 1991; Vlachos & Papageorgiou 1994; Naoroji 2006), and cliffs (Shirihai 1996). STSE has one breeding clutch each year and lays a single egg. Chicks reach maturity after four years (Darawshi 2011). No obvious sexual dimorphism exists, except in the comparative body sizes of the sexes: males being only slightly smaller than females (Naoroji 2006).

There is plenty of published literature on STSE populations from other parts of the globe, especially about its habitat (Bakaloudis *et al.* 1998), nest's features and ecology (Bakaloudis *et al.* 2000, 2005; Joubers 2002), and breeding behaviour (Petretti 1988; Vlachos & Papageorgiou 1994; Bakaloudis *et al.* 2000; Joubers 2002). However, very little information is available on the Indian population, except general notes on its breeding biology (Dharmkumarshinji 1955; Ali & Ripley 1963; Grimmett *et al.* 1998; Naoroji 2006).

A number of methods have been used to study its diet, a few studies based largely on the analysis of stomach contents (Thiollay 1968), but most depending on the interpretation of pellet contents and prey remains. Some studies have also been carried out, using indirect observations, to assess the diet of its young (Boudoint *et al.* 1953; Betsy 1971; Choussy 1973; Ivanovsky 1992), but none include a comparative analysis

between the prey consumed by nestlings and adults, except a study by Bakaloudis & Vlachos (2011).

We studied the feeding habits of breeding STSE, contribution of prey items in the diet, prey delivery rate of adults, and prey consumed by nestlings, over three continuous breeding seasons of probably the same nesting pair.

Study area

The study area comprised mixed open scrub, and agricultural lands, three kilometers away from human habitation, namely, Kharva (22.63°N, 71.68°E), and Nana Kerala (22.67°N, 71.73°E) villages, Wadhvan Taluk, Surendranagar District, Gujarat. The study site had only a few tall trees (10–15 m) of 'khijado' *Prosopis cineraria*, within a two-kilometer radius. The entire area is predominantly an agricultural landscape with small, scattered, pockets of thorny scrub, dominated by *khijado*, 'gando baval' *P. juliflora*, 'bordi' *Zizyphus* sp., 'gorad' *Acacia senegal*, 'desi baval' *A. nilotica*, 'ingoriya' *Balanites aegyptiaca*, 'piludi' *Salvadora persica*, 'kerdo' *Capparis decidua*, and *Euphorbia* clusters. The agricultural fields are used only during one season, i.e., the monsoon, when cotton *Gossypium*, millet *Pennisetum*, and jowar *Sorghum* is cultivated. During winter and summer, the fields remain vacant and dry, devoid of any anthropogenic activities, due to the harsh hot climate. This landscape is situated in the semi-arid Gujarat-Rajuwad zone, considered as the Saurashtra Plateau by Rodgers & Panwar (1988).

Methodology

Between February 2013 and June 2015 we studied three nests of STSE. These were visually monitored from sunrise to sunset using binoculars (8x40). We also monitored the species itself, to gather information on parental care, and to evaluate the prey (food): identifying its numbers, and variety brought to the nest by the STSE.



145. The Short-toed Snake Eagle nest is monitored with help of automatic motion / time lapse camera, which is fixed two meters from the nest on a tree branch.

Automatic cameras: The nests were also monitored using the automatic motion/time lapse (three minutes) cameras using Bushnell 119405 and Cudde back digital1200, for six weeks each, in 2013 and 2014. Our reason for using cameras after incubation, especially during hatching, was to minimise disturbance to the birds. The cameras were fixed on a nearby branch, above nest level, at a distance of one to two meters, ensuring that the breeding pair was minimally disturbed [145].

In 2015, we continued monitoring the nest for 12 weeks, documenting the breeding cycle from the hatching of the egg till the fledgling left the nest. All images captured on camera were scrutinised to identify the prey brought to the nest by the parents, by referring to published literature (Smith 1935, 1943; Whitaker & Captain 2004). The behaviour of the parent and the chick was noted, along with other relevant information. The behaviour of the chick, on the basis of our direct observation, and also from the image/video records was also analysed. The hatchling's hourly activity (behaviour) was given numerical values of 1 to 6, wherein a value from 1 to 5 was ranked as a low level of activity, and above 5 as high, or intensive activity.

During the study we were especially cautious not to disturb the nesting birds. Therefore, measurements of egg size/weight, and hatchling size/ weight were not taken.

Observations & results

Nest site selection and nesting activities: Usually, in this area, STSE construct stick nests on khijada trees, choosing a different tree each year, within a radius of 1.5 km from the location of the previous year's nest tree (*pers. observ.*, DM). Nest dimensions, and other relevant information such as nest height from the ground, tree trunk girth, tree height, etc., are summarised in Table 1. Nests were placed either on the north-eastern, or on the

Table 1. Morphometrics of the Short-toed Snake Eagle's nests on khijado *P. cineraria* trees

Year of nesting	2013	2014	2015
Height of tree (m)	12.5	10.6	12.0
Girth of tree-trunk (cm)	201	164	210
Height of nest above ground (m)	8.56	7.40	8.5
Diameter of branch supporting the nest (cm)	40	45	53
Diameter of nest's outer circumference (Average cm)	38	42	48
Height of nest (cm)	22	25	24
Depth of nest cup (cm)	9	10	9
Nest orientation in relation to nest-tree-trunk	North-east	East	North-east

Table 2. Short-toed Snake Eagle: Summarised data of date of nest construction, egg laying, incubation period, and hatching dates.

Year	2013	2014	2015
Start of nest building	First week of February	First week of March	Third week of January
Egg-laying	26 February	19 March	05 February
Hatching	10 April	03 May	21 March
Incubation period (days)	44	46	46
Chick left the nest on	27 June	19 July	20 June
Hatchlings used the nest for (days)	85	91	120

eastern side in the canopy of the tree.

During 2013, and 2015, nest construction activities were observed in the second, and first weeks of February, and January, respectively. But in 2014, it began in the first week of March. The pair was actively involved in its construction, which took them 10–15 days, (Table 2). Both birds were observed collecting nesting material from the ground, as well as by breaking twigs from off trees.

Nesting material consisted of dry sticks, branches and twines of seven species of plants, including khijado, gando baval, gorad, desi baval, ingoriya, and cotton. The nesting material was available in the surroundings of the nesting tree. The birds also added some fresh, green leafy twigs and straws of piludi and khijado to the nest [146, 147].



146. The Short-toed Snake Eagle repairs its nest continuously in the breeding season: a female with dry twigs;



147. The Short-toed Snake Eagle repairs its nest continuously in the breeding season: female with green leaves.

Egg, egg-laying, and incubation: The female laid a single, large, unmarked white egg that was less oval than round. In all three seasons, eggs were laid in the afternoon. We did not measure the weight and size of the egg, but estimated the latter to be 8x9 cm (visual comparison with branch, which was later measured). The summarised data of the breeding cycle is given in Table 2.

The offering of food, during the span of breeding season, by the male (28.5%–33.3%), or by the female (66.6–71.4%), to its mate, especially when one was incubating, was noted to be seven (in 2013) to nine times (in 2015). Either of the pair usually brought prey, including common garden lizard *Calotes versicolor*, common sand boa *Gongylophis conicus*, and common Indian monitor *Varanus bengalensis* to the nest for its companion

[148a-d]. The parents never left the egg unattended in the nest, except for those few seconds or minutes during the changing of incubation duty. Both the parents continued incubating the egg round the clock, with female spending more time at night (69%; 31 nights) than the male (31%; 14 nights), while male usually incubating during the afternoon. Mostly at night, one parent always remained at the nest for incubation duty, while the other parent stayed within a radius of 40 m, on a nearby tree. During the change of duties, each parent rotated the egg slightly, changing its position with either its beak, or feet, after covering the egg for incubation.

The average incubation period was 44–46 days. In 2014, we kept a close watch over the nest during the last days of incubation, to observe and record the parents' behaviour, and the process of hatching. A small crack/hole was seen on the egg on the forty-fifth day. The chick emerged entirely from the egg the next day, i.e., on the forty-sixth day. The hatching process took almost over 24 hours [149a-d]. During this hatching process, the parent did not cover up the egg entirely (by incubating bird crouching over the egg).

Fledgling growth and colours: The changes in plumage colour and growth of the chick, right from the day of hatching to the fifteenth week, were noted (Table 3; [150a-l]). By the end of the tenth week the chick had developed fully, and its size and colour were similar to an adult.

Behaviour of the fledgling: We observed the ontogenic, neonatal, and various other developmental stages of the chick in all the three seasons. Behaviour like: raising and wobbling head, food-begging, wing-flapping, jumping, hopping, prey-tearing, etc., were documented during the study. The gradual development of the chick, over time, from the first week to the fifteenth, was also documented (Fig. 6).

Food spectrum: 20 species of prey was brought to the nest as food; these belonging to four classes of vertebrates. Ten families of vertebrates were brought by STSE for feeding the chicks, excluding unidentified lizards, snakes, rodents, and regurgitated foods. The most diversified, and dominant, prey category in the diet of the chick was 13 reptilian species, including ten species of snakes (two venomous species), and three species of lizards. A lesser variety of food items (nine species) were recorded in 2013, while a greater diversity (18 species) was recorded in 2015 (Table 4). Details with numbers and percentage of year 2015 (only) are given in Table 5.

For this information, we used images from the cameras and also relied on direct observation. We noticed that snakes were often brought intact, instead of being decapitated, even if they were venomous species like a cobra or a viper. Both parents



148a-d. Ritualised behaviour between the female and male Short-toed Snake Eagle—the female often brought nesting material, and food for the male, during the incubation periods: (a) female offering nesting material, (b) female offering *C. versicolor* (c), male accepting food, and (d) incubating male feeding on a *C. versicolor*.



149a-d. A small crack/hole was seen in the egg on the 45th evening of incubation, and the chick hatched on the 46th evening—a process that took almost over 24 hours.

Table 3. Observations of the Short-toed Snake Eagle chick from day one to the end of the twelfth week

Age	Growth and plumage	Body colours	Behaviour
1 day	Absolutely white in colour; looked like a small lump of cotton.	Blackish eye and a grey-black beak, white feet, and pink claws.	Hardly raised its head.
1st week	Body was covered with down.		Raised the head and begged for food.
2nd week	Grown about half the size of tarsi of parents.		Neck wobbling while begging food, making it difficult to collect food from the parent's beak.
3rd week	Body colour was still mostly white with few black-brown specks of emerging pin-feathers; a number of pins on the wings, nape, and dorsal regions.	Eyes colour changed from grey-black to a very light orange.	Begging food from the parents with low-pitched screams.
4th week	Good number of black-brown feathers developed on wings, back, and head. Grown up to the knees of the parents.		Unstable head movement disappears.
5th week	The throat, breast, and belly still downy white. Chick grown sizably, almost reaching the tibia feathers of the parent.	Eyes colour light yellowish; claws appeared dark black.	
6th week	Pin-feathers remain on the throat and breast. Rest of the body covered with feathers. Grown almost 70–80% of the size in comparison to the parents.		Chick is capable of ingesting food entirely.
7th week	Completely feathered. Now only slightly smaller than its parents.	Eye colour completely changed to yellowish-orange.	Flapping wings, apart from jumping, and hopping.
8–9th weeks	It is difficult to distinguish from parents.		Jumping.
10–11th weeks			Hopping.
12th week			Now tearing at food.

often offered regurgitated food to the chick, making it very difficult to identify the prey.

Feeding frequency: Usually, both parents brought food for the chick. Occasionally, both arrived simultaneously, but they fed the chick separately. Usually one parent would keep busy in assisting or feeding the chicks in case of a larger prey item, while the other one would actively forage or at times, perch on a nearby tree. Both the parents actively participated in getting food for the

chick. In 2015, the first meal brought by the parent was between 0730 to 1030 hours, and the last time food was delivered was recorded between 1630 to 1820 hrs. An average of two prey deliveries ($n=168$) were recorded in a day. The highest food delivery frequency was observed between 1000–1400 hrs (Fig. 7).

Usually, it is difficult to recognise the sex of an adult if it is seen by itself. But in this case, both birds were often sighted at



Pics: Dewratsinh Mori

150a–l. The growth and development of a Short-toed Snake Eagle chick, from five weeks to ten weeks of age; (g) chick growth at five week; (h) chick at six weeks; (i) seven weeks old chick; (j) eight weeks old chick; (k) nine weeks old chick; and (l) ten weeks old chick.

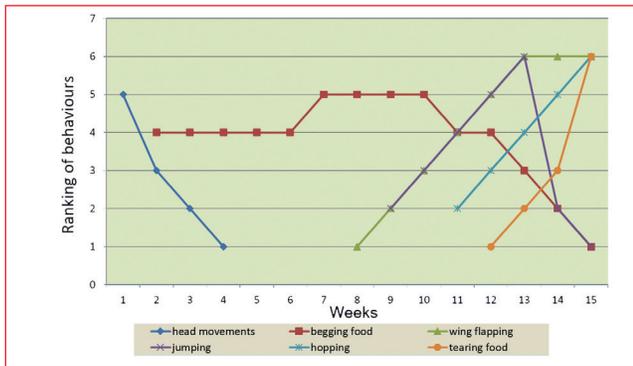


Fig. 6. The pictograph showing various ontogeny behaviours development in chick of Short-toed Snake Eagle from one week to fifteen weeks of developments.

the nest together, or soon after one another, enabling us to tell them apart on the basis of their sizes: so in this specific pair we noticed the female had unmarked feathers on its tibia whereas the male had distinctively marked feathers. Usually, the female brought larger prey. The male would assist her in tearing, cutting, and feeding the chick. We observed that the male performed a greater part of duties like food tearing, cutting, and feeding the chick (90%), when compared to the female (10%).

Parental care: We observed parental care behaviour from day one till the end of week 15, when the chick fledged. Both parents actively assisted in tearing the prey into tiny pieces, so that the hatchling could swallow it easily. Whenever they brought a larger prey item, considerable amount of time was spent in cutting it up; especially when the prey comprised common Indian monitor, large snakes—red sand boa *Eryx johnii*, common trinket snake *Coelognathus helena*, Indian rat snake *Ptyas mucosa*, and spectacled cobra *Naja naja*—or Indian hare *Lepus nigricollis*. Both parents attended the nest and chick, and both participated equally in overall parental care, but various activities of bringing the food, feeding the chick, sanitation of the nest, and other actions were performing unequally.

During the first four weeks, the parents never left the chick unattended in the nest. Especially in the afternoon, the male always remained on the nest, shading the chick with spread out wings, from the direct sunlight. Whenever any large bird of prey appeared in the sky, the parent would immediately shield the chick by half- or fully expanded its wings. Protecting the chick from sunlight was mainly performed by the male (95.23%), rather than the female (4.77%). From the fifth week onwards the parents also brought water in their beaks along with food, to offer to the chick but when the chick swallowed up the entire prey, parent would immediately fetch more water for the chick. However, after the ninth week, such heat protection behaviour mostly stopped.

Usually the male cleaned the nest, removing remains of foods. Also, at times the male would assist to carefully pullout prey from the female's beak, whenever she brought a large prey, such as a snake, or a common Indian monitor lizard to the nest.

Bird fauna in the nesting area: During the study, we noted 50 species of birds belonging to 23 families, within a radius of one kilometer of the nest tree. The noteworthy bird species included five diurnal raptors, namely, Black-winged Kite *Elanus caeruleus*, Eurasian Sparrow-hawk *Accipiter nisus*, Shikra *A. badius*, Oriental Honey Buzzard *Pernis ptilorhynchus*, and Common Kestrel *Falco tinnunculus*, along with two species of nocturnal birds: Indian

Table 4. List of prey brought to the nest for the Short-toed Snake Eagle chicks.

Family	Species	2013	2014	2015
Amphibian – anuran				
Bufonidae	1 Common Indian toad <i>Duttaphrynus melanostictus</i>	Y	Y	Y
Reptiles – lizards				
Agamidae	2 Hardwicke's bloodsucker <i>C. minor</i>	Y	-	Y
	3 Common garden lizard <i>C. versicolor</i>	Y	Y	Y
Varanidae	4 Common Indian monitor <i>V. bengalensis</i> [5 adult+6 subadult+14 juvenile+hatchling]	Y	Y	Y
	5 Unidentified Lizards	Y	Y	Y
Reptiles – snakes				
Boidae	6 Red sand boa <i>Eryx johnii</i>	Y	Y	Y
	7 Common sand boa <i>Gongylophis conicus</i>	Y	-	-
Colubridae	8 Common trinket snake <i>Coelognathus helena</i>	-	-	Y
	9 Indian rat snake <i>Ptyas mucosa</i>	-	-	Y
	10 Banded racer <i>Argyrogena fasciolata</i>	-	-	Y
	11 Checkered keelback <i>Xenochrophis piscator</i>	-	-	Y
	12 Leith's sand snake <i>Psammophis leithii</i>	-	-	Y
	13 Gujarat snake <i>Wallaceophis gujaratensis</i>	Y	Y	Y
	14 Unidentified snakes	Y	Y	Y
Elapidae	15 Spectacled cobra <i>Naja naja</i>	-	Y	Y
Viperidae	16 Saw-scaled viper <i>Echis carinatus</i>	-	Y	Y
Birds				
Leiothrichidae	17 Jungle Babbler <i>Turdoides striata</i>	-	-	Y
Mammals				
Muridae	18 House rat <i>Rattus rattus</i>	Y	Y	Y
	19 Gerbil <i>Gerbillus</i> sp.	-	Y	Y
	20 Bandicoots <i>Bandicota bengalensis</i>	-	-	Y
Leporidae	21 Indian hare <i>Lepus nigricollis</i> (Sub Adult)	Y	Y	Y
	22 Unidentified rodents – mammals	Y	Y	-
	23 Digested regurgitated food (DRF)			Y

Eagle-Owl *Bubo bengalensis*, and Spotted Owlet *Athene brama*. All these birds are predators and could compete for food, though no direct interactions were observed amongst them or with the breeding STSE pair.

Some smaller birds visited the nest tree. But no interaction was observed between them and STSE. A pair of Eurasian Collared Dove *Streptopelia decaocto* constructed a nest exactly below the STSE's nest in 2013, and bred successfully. A pair of House Crows *Corvus splendens* often mobbed the nesting eagles [151] in mornings.

Discussion

In this study, we observed the nesting preparation, beginning in the second week of January 2015. But in 2014 it commenced in the first week of March, perhaps due to the impact of temperature variation in the area. Bakaloudis *et al.* (2005) noted a similar change in breeding time due to temperature changes, in north-eastern Greece. Our study corroborates Dharmkumarshinji's (1955) observations in the Saurashtra region, where STSE commenced nest construction in mid-January, stretching till March. This ended with the chick leaving the nest in mid-June.

Table 5: Numbers and percentage of prey species brought to the nest for chicks by the Short-toed Snake Eagles in 2015.

Family	Species	No.	%	Type	Total	%
Amphibian – anuran				Toad	=6	3.57
Bufo	1 Common Indian toad <i>D. melanostictus</i>	6	3.57			
Reptiles – lizards				Lizard	=77	45.83
Agamidae	2 Hardwicke's bloodsucker <i>C. minor</i>	2	1.19			
	3 Common garden lizard <i>C. versicolor</i>	44	26.19			
Varanidae	4 Common Indian monitor <i>V. bengalensis</i> (5 adult + 6 subadult + 14 juvenile + 2 hatchlings)	27	16.07			
	5 Unidentified lizards	4	2.38			
Reptiles – snakes				Snake	=40	23.80
Boidae	6 Red sand boa <i>E. johnii</i>	3	1.78			
Colubridae	7 Common trinket snake <i>C. helena</i>	1	0.59			
	8 Indian rat snake <i>P. mucosa</i>	6	3.57			
	9 Banded racer <i>A. fasciolata</i>	7	4.16			
	10 Checkered keelback water Snake <i>X. piscator</i>	2	1.19			
	11 Leith's sand snake <i>P. leithii</i>	7	4.16			
	12 Gujarat snake <i>W. gujaratensis</i>	3	1.78			
	13 Unidentified snakes	7	4.16			
Elapidae	14 Spectacled cobra <i>N. naja</i>	3	1.78			
Viperidae	15 Saw-scaled viper <i>E. carinatus</i>	1	0.59			
Birds				Bird	=1	0.59
Leiotherichidae	16 Jungle Babbler <i>T. striata</i>	1	0.59			
Mammals				Mammal	=24	14.28
Muridae	17 House Rat <i>R. rattus</i>	14	8.33			
	18 Gerbil <i>Gerbillus</i> sp.	06	3.57			
	19 Bandicoot <i>B. bengalensis</i>	01	0.59			
Leporidae	20 Indian hare <i>L. nigricollis</i> (Sub Adult)	03	1.78			
	21 Digested regurgitated food (DRF)	20	11.90	DRF	=20	11.90
Total		168			157	

The annual selection of a new khijado tree for nesting, and the construction of a new nest in it by STSE corroborate an earlier study of Vlachos & Papageorgiou (1994), and is a strategy of STSE. Khijado has protuberant thorns on its branches, and it stands tallest in the surrounding landscape. It is traditionally protected, and never felled, as many local communities worship it. It is also the only tall tree within a wide arid expanse.

The birds use dry sticks and twigs, with sparse use of some green leafy twigs, as nesting material. Petretti (1988), and Bakaluudis *et al.* (2000) clarified upon the use of fresh green nesting materials by other raptor species including, for the purposes of nest sanitation and the maintenance of optimum humidity levels. The most widely accepted reason for raptors bringing green vegetation to their nests is that they advertise territory occupancy (Newton 1979). STSE construct a nest in dry open landscapes using dry sticks; doing the same here may result in high visibility of nest, (especially from the sky). Hence the birds perhaps use fresh green twigs in the nest to camouflage the nest.

Studies by Newton (1979), and Bakaluudis *et al.* (2000) support our observations that STSE continue to bring nesting materials, and repair the nest, during the entire breeding season. Newton (1979), and Bakaluudis *et al.* (2000) further explain that the continual addition of nesting material increases the size of the nest to accommodate the increasing size and activity of the nestlings, particularly when they begin to exercise their wings. Perhaps this is more important for STSE because they build small nests in comparison to their body size. We too noted, like Newton (1979), and Bakaluudis *et al.* (2000) that after the seventh week, the STSE chick started wing-flapping, and wing-pumping, and stayed within the same nest for a further seven weeks. With the chick growing bigger and heavier, the nest required additional strengthening, and augmentation towards the later weeks, which the adults carry out. However, Joubert (2002) interpreted this behaviour of STSE as more of a ritual than proper nest building. In the present study, it was noted that during the incubation period one of the birds brought both, nest material, and food for the opposite partner too. These behaviours, of bringing nesting material, or food may have been some kind of ritual between the nesting pair.

Our observation of the incubation period (44–46 days) is similar to 45–47-days in Europe (Cramp & Simmons 1980), and a little less than the earlier records of 47, and 48 days by Vlachos & Papageorgiou (1994), and Naoraji (2006) respectively.

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151. Interactions between House Crows and female Short-toed Snake Eagle of the breeding pair: such behaviour was often observed during the breeding season.





Pics: Dewratsinh Mori

152a–d. A photographic sequence of large prey that the female STSE failed to regurgitate: (a) the bird brings a large (c. 60–70 cm) common Indian monitor to the nest at 10:04 hrs, (b) she is unable to regurgitate it, (c) after great effort, only 40–45 cm of the tail portion comes out, (d) the desperate female at 02:28 hrs.

The growth and behaviour of the fledgling presented here, has not been hitherto reported. It was the female that primarily incubated, and brought food for the chick, whereas the male extensively fed, and protected the chick. The sharing of breeding-related responsibilities could be a temporary understanding between the sexes, and may not be a general behaviour trait. Naoroji (2006) noted that when a male is younger then he serves a greater role in parental care than a more experienced female that has the better ability to hunt.

Over 22 species of vertebrates, including one species each of an amphibian and a bird, 16 species of reptiles and four species of mammals were brought to the nest by the pair. The data shows a higher number of lizards (77; comprising three species), followed by snakes (40; nine species), mammals (24; four species), and then amphibians and birds (one of each), excluding the unidentifiable lizards, snakes, and rodents. This study reconfirms that STSE are expert predators of snakes, reiterating studies of their dietary analysis (Boudoint *et al.* 1953; Thiollay 1968; Betsy 1971;

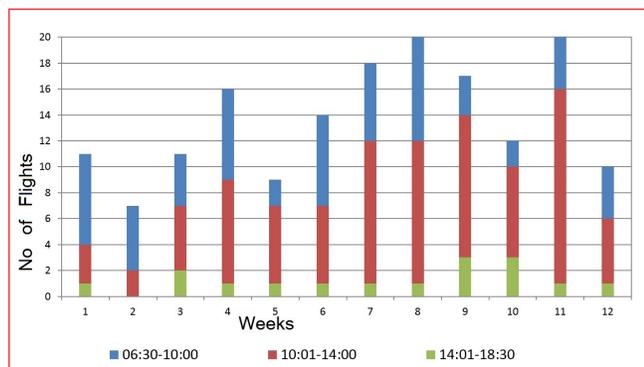


Fig. 7. The pictograph of flight frequency of Short-toed Snake Eagle for food brought at various times of the day.

Cramp & Simmons 1980; Amores & Franco 1981; Jaksic & Delibes 1987; Petretti 1988; Vlachos & Papageorgiou 1994; Bakaloudis *et al.* 1998, 2005; Gil & Pleguezuelos 2001; Moreno-Rueda & Pizarro 2007; Bakaloudis & Vlachos 2011). According to Dharmkumarshinji (1955) STSEs occasionally hunt birds, and a comparable observation was noted as 0.59% of its diet, in comparison to other groups of vertebrates, comprised birds.

The STSE is capable killing, and transporting, 1–1.2 m long snakes (Dharmakumarsinhji 1955; Betsy 1971; Bakaloudis & Vlachos 2011), including large venomous cobras, and over 30–40 cm long adult common Indian monitor (Naoroji 2006). This large-sized prey had been entirely swallowed by STSE when they were brought to the nest. However, in one instance in 2013, a female STSE brought a large common Indian monitor (c. 60–70 cm) to the nest at about 10:04 hrs. She was unable to pull the lizard out and after a long struggle she could only

manage to pull 40–45 cm of its tail [152a–d]. She continued her efforts to pull it out till 14:28 hrs but being unable to do so, she flew away from the nest with the prey. Ingesting an entire common Indian monitor, face first, and then egesting it through the esophagus, without causing any internal injury, requires some special ability.

During the study, we noted some outstanding hunting skills by STSE. In 2015, the parent birds brought 77 lizards of various sizes, including 44 common Indian monitor, and 14 juvenile and hatchling common monitor lizards (these are numbers of lizards predated only between the months of March and June). Higher numbers of common garden lizards were predated due to the coinciding of their breeding season with the emerging of common monitored lizard hatchlings. Most common garden lizard males are usually busy with courtship during this time (Daniel 2002). Generally, adult males perch on a vantage point and advertise their presence by displaying their flamboyant red-coloured anterior body, with continuous head movements (Smith 1935). Perhaps, such attention-seeking situation also helps STSE to locate these lizards and hunt them down.

Conclusion

For three continuous breeding seasons from 2013 to 2015, STSE started nesting activity beginning in January–March. The bird selected nesting site in a remote undisturbed area of dry scrub along with agricultural fields. The female laid a single round white egg during February–March, incubating it for 44–46 days (average six weeks) in June–July. After hatching, the development of chick took almost fifteen weeks to grow from a pink-coloured, downy feathered chick, into one that resembled an adult. The nestling left the nest after 85–120 days (September–October) after hatching in June–July. Both parents were actively and equally engaged in various breeding activities like nest construction, incubation, and feeding the chick. The eagles fed the hatchling about twenty kinds of vertebrates, including reptiles, mammals, amphibians, and birds. The highest numbers of prey-food items were noted to be reptiles, followed by mammals, amphibians, and birds.

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