

Observations on Nest-sites, Eggs and Nestling Growth Patterns of the Small Bee-eater *Merops orientalis* L. in India

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Abstract: Nest-sites, eggs and nestling growth patterns of Small Bee-eater *Merops orientalis* was studied in the Cauvery Delta regions of the Tamil Nadu, India between 2005 and 2006. They excavated a long tunnel ranged from 79 to 125 cm with ended of widened egg chamber. Mean diameter and circumference of the entrance hole opening was 8.94 ± 1.03 cm and 26.9 ± 3.55 cm respectively. They excavated a tunnel from 52.1 cm bottom and 158.7 cm top of the sandy river banks. Clutch size varied from 2-6 and clutches of three were very common. Maximum and minimum length and width of eggs were 23.0 x 20.0 mm and 18.0 x 14.0 mm respectively. Weight of the eggs varied between 2.0 and 5.0 g. The newly hatched nestlings were 3.16 g in weight and reached maximum of 23.16 g on day 24. A reduction weight was noticed in the last few days and reached 20.75 g during fledging. The other body parts attained maximum maturity from hatching to fledging.

Key words: Small Bee-eater • Nest-sites • Eggs • Nestling growth

INTRODUCTION

Bee-eaters (Aves: Meropidae) are a clade of 26 species with considerable diversity in social and breeding behaviors. The Small Bee-eater *Merops orientalis* is the most variable species in the family in regard to plumage color and can be subdivided into 6-8 geographically variable races [1]. They are common in open cultivated fields, nest on face of perpendicular banks of ravines, sandy river banks and sandy bunds and gently sloping bare ground, around cultivated tracks [2]. Small Bee-eaters are aerial insectivores arrive on breeding grounds in March and can be seen foraging frequently in agricultural fields. Over 95% of their prey items come from the insect orders Coleoptera, Hymenoptera, Odonata, Lepidoptera, Hemiptera and Orthoptera [3, 4]. Little information previously was available on the breeding aspects of this species [2, 5, 6]. In this paper we addressed the nest-sites, eggs and nestling growth patterns of the Small Bee-eater in Tamil Nadu, India.

MATERIAL AND METHODS

Study area: The study was conducted in Cauvery river banks and the adjacent areas of Mannampandal (18°18' N,

79° 50' E) in Nagapattinam District, Tamil Nadu, India between 2005 and 2006. Agriculture is the major economics of this area, contributes a higher share of rice production in the state. The sugarcane, groundnut, green gram, black gram, cotton, etc are other major crops cultivated in this area. The river Cauvery and its tributaries are major perennial water sources used for irrigation. Woody vegetation is sparse in the form of groves and roadside trees. The predominant tree species found in the study area *Cocos nucifera*, *Borassus flabellifer*, *Madhuca indica*, *Mangifera indica*, *Enterolobium saman*, *Tamarindus indicus*, *Ficus benghalensis*, *Ficus religiosa*, *Thespesia populnea*, *Acacia arabica*, *Odina woder* and *Azadirachta indica*. Important shrub species are *Prosopis juliflora*, *Jatropha glandulifera* and *Adhathoda vesica*. Plantations of *Casuarina equisetifolia*, *Tectona grandis* and *Bamboosa arundinacea* are also found in the study area. Based on the north-east monsoon the study area is divided into four seasons. Summer ranges from April to June (with mean maximum temperature of 38°C) and north-east monsoon started between October and December. The cold season starts in November and may last until January.

Nest-sites: During the breeding season, the study area was thoroughly searched to detect nests. The tunnel depth, diameter and circumference of the entrance opening, distance of the hole to the bank bottom and distance of the hole to the bank top of each nest was measured by using a standard measuring tape and centimeter scale [5]. Distance to nearest agricultural lands, groves, human habitations, perch site and electric line were measured in meters by a marked rope.

Eggs: The freshly laid eggs were numbered with a felt-tipped pen, measured with Vernier calipers and weighed to the nearest 0.5g with a spring balance, care was taken to avoid excessive disturbance, which might have attracted predators. Shape index of eggs was computed using the formula, $Si=B*100/L$, where Si = shape index, B =breadth and L = length of the egg in centimeters [7].

Nestling Growth Patterns: Growth changes in the Small Bee-eater nestlings were measured from hatching to fledging and method employed for measuring nestlings followed by Pettingil [8]. All the nests were visited every 3 days, taking both photographs of the young and morphometric measurements of the body parts. Disturbances were minimized by handling the nestlings very carefully during the measurements. All the nestlings were allotted individual identification marks. Totally eight measurements were made 1) *body weight*, using a spring balance of 1g accuracy; 2) *body length*, from the tip of the bill to the tip of the longest rectrix; 3) *bill length*, from the tip of the upper mandible to the base of the culmen; 4) *bill width*, distance between the upper and lower mandible; 5) *wing length*, as the straight length from the bend of the wing to the tip of the longest primary; 6) *wing span*, the distance from tip to tip of the longest primaries of

the outstretched wings; 7) *tarsus length*, measurement from the base of the tarsometatarsus to the base of the middle toe and 8) *tail length*, the distance from the tip of the longest rectrix to the base of the middle rectrices.

RESULTS

Nest-sites: The nesting season of the Small Bee-eater was initiated in March and ended with June. Breeding is quite synchronous among Small Bee-eater nests. Excavation of nest cavities was in its final stages or complete by mid-March. Totally 34 nests of the Small Bee-eater were recorded during the study period. Of these 15 nests were active and 19 were inactive. The inactive or old nests were identified with typical hole pattern and the undigested insect remains found in the nest hole and egg chamber. Nest burrows were located in the along the side of river banks (95%) and sandy grounds (5%). Nests consisted tunnels that measured 8.9 ± 1.03 cm in diameter (range 7.2-11.2cm) and 26.9 ± 3.55 cm in circumference (range 18-36cm). The entrance tunnels were angled and it was impossible to see into the nesting cavity from outside the entrance. The posterior end of the tunnel was wide and formed the nesting chamber. Length of the nest tunnels varied from 79 to 125cm with a mean length of 104.9 ± 13.48 cm (Table 1). The Small Bee-eater excavated the nests 207.5 ± 15.2 cm from bottom and 96.6 ± 3.2 cm from top of the river banks. Distance to agricultural lands (13.2 ± 2.87 m), perching site (0.5 ± 0.33 m) and electric line (13.6 ± 2.17 m) were closer to the nest-sites (Table 1).

Eggs: The eggs of the Small Bee-eater are spherical and small in size. In total 56 eggs were examined during the study belonged to 15 clutches. Longer and thinner eggs had lower shape index while shorter and thicker ones had higher index. No correlation could be found between

Table 1: Physical characteristics of Small Bee-eater nest holes and habitat around the nests (n = 34)

Variables	Mean±SD	Min.	Max.
Nest hole diameter (cm)	8.9±1.03	7.2	11.2
Nest hole circumference (cm)	26.9±3.55	18.0	36.0
Tunnel depth (cm)	104.9±13.48	79.0	125.0
Distance of the hole to the bank bottom (cm)	52.1±2.69	38.5	127.0
Distance of the hole to the bank top (cm)	158.7±4.11	82.3	196.1
Distance to nearest agricultural lands (m)	13.2±2.87	8.5	24.0
Distance to nearest groves (m)	21.8±4.30	11.0	35.0
Distance to nearest perch-site* (m)	0.5±0.33	0.5	1.0
Distance to nearest electric line (m)	13.6±2.17	4.0	16.5
Distance to nearest human habitation (m)	455.3±7.21	250.0	550.0

*included small trees, shrubs and sticks

Table 2: Morphometric development and gain in body weight in young Small Bee-eater from hatching to fledging. Values are mean±SD.

Age in days	No. of chicks	Body weight (g)	Body length (cm)	Bill length (cm)	Wing length (cm)	Tail length (cm)
0	43	3.16±0.28	3.73±0.21	0.11±0.03	1.39±0.11	0.14±0.05
3	43	4.44±0.44	4.67±0.15	0.19±0.04	2.47±0.13	0.31±0.06
6	37	7.35±0.37	5.85±0.14	0.48±0.04	2.92±0.07	0.45±0.06
9	37	11.88±0.48	8.57±0.43	0.77±0.10	3.90±0.18	0.75±0.06
12	29	15.46±0.95	10.73±0.26	1.43±0.07	5.70±0.18	1.21±0.12
15	32	19.88±1.24	12.63±0.13	1.88±0.09	7.07±0.21	1.95±0.08
18	25	22.60±2.31	13.38±0.14	2.05±0.07	8.20±0.21	2.64±0.12
24	25	23.16±2.10	14.40±0.24	2.37±0.08	8.77±0.13	3.11±0.07
21	23	20.70±2.30	15.36±0.30	2.40±0.08	9.54±0.20	3.73±0.16
27	16	20.75±0.57	15.93±0.04	2.52±0.01	10.57±0.05	4.17±0.04

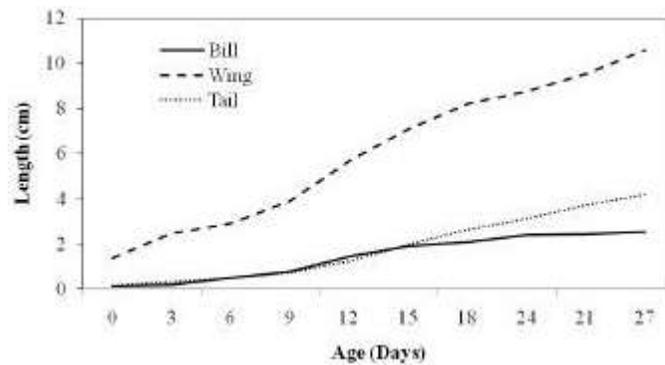


Fig. 1: Development of bill, wing and tail in young Small Bee-eater

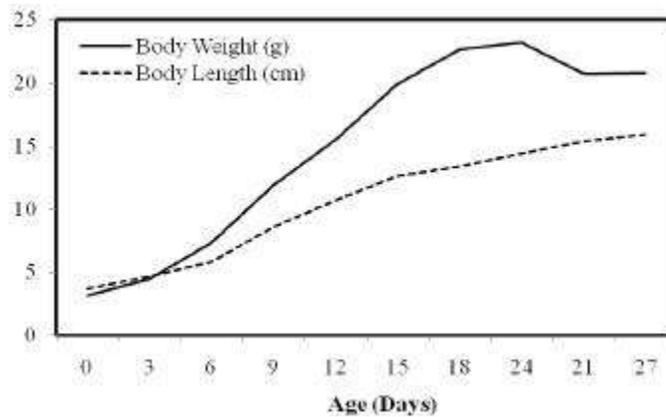


Fig. 2: Development of body and weight gain in young Small Bee-eater

weight and shape index ($r = -0.067$, no significant, $df = 56$). The eggs are white in colour with no markings or spots. The highest weight eggs examined during the study was 5g and lowest 2g and the average 3.3±0.65g. The minimum length of the egg was 20mm and minimum width 14mm. The maximum egg length was 23mm and width 18mm. The mean length was 21±0.09mm and the width 14±0.11mm. Clutches of three and four were most common and had a percentage frequency of 46.6 and 40.0 respectively. Clutches of five and six were very rare.

Nestling growth patterns: In Small Bee-eater, hatching was asynchronous. Nestlings grew from 3.16±0.28g at hatching to peak weight of 23.16±2.10g at day 24, then slowly declined and reached to the weight of 20.75±0.57g on day 27. The body length of nestlings reached from 3.73±0.21cm at hatching to 15.93±0.04cm by the end of day 27. The bill length was 0.11±0.03cm at hatching and it reached to 2.52±0.01cm on day 27. At the time of hatching, the length of wing was 1.39±0.11cm and it gradually increased and attained maximum length of 10.57±0.05cm

on day 27. The tail length showed a considerable amount of growth during the nestling period. The growth was 0.14 ± 0.05 cm at hatching and it increased to 4.17 ± 0.04 cm during day 32 (Table 2; Fig. 1 and 2).

DISCUSSION

Nest-sites: In the present study 95% of the nests were recorded in the sandy river banks. Some earlier studies have also been reported that bee-eater preferred sandy river banks for nest construction [2, 5, 6, 9-12]. Sandy soil preference for nesting were also reported that some other soil excavating nest species *viz.*, White-breasted Kingfisher *Halcyon smyrnensis*, Eurasian Kingfisher *Alcedo atthis*, Sand Martin *Riparia riparia* [13-15]. The reason for preferences of sandy soils has lower soil pressure, density and moisture than more clay-rich soils. Sandy soils probably provided for faster and easier excavation of nest cavities. With high porosity, nest tunnels constructed with sandy soils would also have better ventilation, which was important to diffuse gases to maintain a tolerate level of O_2 and CO_2 in the nest cavities [16]. Heneberg [14] stated that soil particle size could also affect the structure of nest tunnels, but in the present study we are not analyzed the soil particle size.

Small Bee-eater excavated a tunnel from 79 to 125 cm with a mean depth of 104.9 cm. Nest entrance had a mean diameter of 8.9 ± 1.03 cm while the circumference of the nest was 26.9 ± 3.55 cm. These measurements are more or less similar to those reported by Ali and Ripley [17], Fry and Fry [18] and Asokan [5]. It builds a tunnel from 52.1 cm above the ground and 158.7 cm from top of the river banks. Cornwell [19] reported that the Belted Kingfisher constructed nest at least five feet above the ground and 12 to 18 inches from the top of the embankment, near the bottom of the organic soil layer. The agricultural lands, perch site and electric line were closer to the nests-sites. The agricultural lands provided variety of protein rich insect prey items to the parents as well as nestlings. The nearest small trees, shrubs, sticks and electric line served as a perching site overlooking the nest and searching the insect preys. In this study, we found that Small Bee-eater avoided placing nest cavities in areas with dense vegetation. Many bee-eater species have also been nesting on river banks without much vegetation [12, 16, 20-21]. Predation is a constant threat to successful reproduction in this species and reduced vegetation at the nesting sites probably facilitates detection of predators and increases the effectiveness of mobbing behaviour.

Eggs: Small Bee-eater was found to lay small eggs with mean length and width of 21.0 ± 0.09 mm and 14.0 ± 0.11 mm and weighed 3.3 ± 0.65 g. reported that egg measurements for Small Bee-eater *i.e.*, mean length, width and weight were 21.0 mm, 18.0 mm and 2.62 g. Egg measurements in the present study are in full agreement with those of the previous report [5]. The clutch size varied from 4 to 7 [17] and 2 to 5 per clutches [5] were reported. In the present study, clutch size of Small Bee-eater varied from 3 to 6 and the majority (46.6%) was three. Several factors might contribute to clutch size variability *viz.*, condition of the breeding female, availability of resources necessary to produce eggs, presence of helpers at the nest, time of laying in the season and anticipated future availability of food for feeding nestlings [5, 22-24] recorded that insect availability and rainfall over the 3 month period before laying accounted for 16% of variations in clutch size of White-fronted Bee-eater *Merops bullockoides*.

Nestling growth patterns: The weight of chicks on the first day was 3.16 g which increased to 23.16 g at 24 day of age. However, there was a drop in the mean weight of nestlings at last few days and reached 20.75 g at the time of fledging. Many observers have noted a decrease in rate-of-gain in weight as feathers were being produced or as temperature control was being established. Banks [26] reported that the decrease in actual and relative gain in weight of the final three days of nestling life in the White-crowned Sparrow *Zonotrichia leucophrys* was probably due to a shift in the energy budget, as more food was utilized in production of feathers and heat. Welty [27] stated that many nestlings loose body weight few days before leaving the nest. This loss was supposed to be due to the utilization of fat deposits and skeletal muscles for the energy to leave the nest. This body weight reduction is helped to the advantage for moving out the nest. Krebs and Avery [28, Lessels and Ovenden [29], Emlen *et al.*, [30] recorded significant weight loss before fledging in the nestlings of *Merops* species. This loss of weight is also found in some aerial insectivores [31-32] and other bird species [33-39].

Development of the different structure of the nestlings was not uniform throughout the nestling period. The body length, bill length, wing length, wing span, tail length and tarsus length attained the maximum maturity at the time of fledging stage. The Small Bee-eater used above body parts immediately after fledging for successful survival. These kinds of growth allometry in the adaptive parts had been observed in several avian species [39-44].

Variability in nestling growth rates can be due to many ecological factors. Ecological factors that influence nestling growth of Small Bee-eaters are generally related to limitations in food availability, weather, habitat differences and quality, parasites, competition between nest mates and parental abilities.

ACKNOWLEDGEMENTS

We thank the Ministry of Environment and Forests (MoEF), Government of India for the financial assistance (Project No. 14/14/2001/ERS/RE) to undertake field investigations. We wish to express our sincere thanks to the Head of the Department and other Staff members of Zoology and Wildlife Biology and the Principal and the Management of A.V.C. College (Autonomous), Mannampandal, India for having rendered facilities and encouragement.

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