World Applied Sciences Journal 9 (11): 1280-1285, 2010
ISSN 1818-4952

Nest-Site Characteristics and Breeding Biology of the Black Drongo *Dicrurus macrocercus* in Cauvery Delta, Southern India

[1]*A. Mohamed Samsoor Ali,* [2]*S. Asokan,* [3]*R. Manikannan and* [4]*G. Thomas Nithiyanandam*

[1]New No. 12, Old No. 3/10, New Street, Kollapuram - 609608, Tamil Nadu, India
[2,3,4]Department of Zoology, Wildlife Biology, A.V.C. College (Autonomous),
Mannampandal - 609305, Mayiladuthurai, Tamil Nadu, India

Abstract: Nest-site characteristics and breeding biology of the Black Drongo *Dicrurus macrocercus* was studied in Cauvery Delta of Nagapattinam District, Tamil Nadu, Southern India. This study was carried out during breeding season of Black Drongo from March to June for two consecutive years (2005 & 2006). The Black Drongo constructed neat cup shaped nests that measured 14.6cm in length, 35cm in circumference and 4.4cm in depth. The Black Drongo used four major tree species for nesting *Enterolobium saman, Acacia nilotica, Azadirachta indica* and *Tamarindus indicus*. Mean height of the nesting tree was 15.5 ± 4.48m and nests were situated at heights of about 5.5-12.5m from the ground, usually in close proximity to agricultural lands and electric lines. About 76% of Black Drongo clutches contained three eggs, while 24% had four eggs. The egg shape, color, length, width, weight and incubation period were reported. The newly hatched nestlings were 4.29g in weight and reached a maximum of 51.11g on day 15. A reduction in weight was observed during the last few days and nestlings weighed on average 39.0 g before leave out the nest. The other body parts attained their adult size before fledging. The hatching and fledging success of the Black Drongo was 79.10% and 75.47% respectively.

Key words: Black Drongo · Nest-site · Eggs · Nestling growth · Fledging success

INTRODUCTION

The Black Drongo *Dicrurus macrocercus* (Vieillot, 1817) is a small passerine bird belongs to the family Dicruridae. It is a common resident breeder in much of the tropical Southern Asia (Southwest Iran, India and Sri Lanka and Indonesia). The Black Drongo is a wholly black bird with a distinctive forked tail. It is found predominantly in the open country and perches or hunts close to the ground, where it predates on insects and/or gleans on ground level vegetation. Insect prey consists mostly of beetles, grasshoppers, bees, bugs, moths and dragonflies. The Black Drongo plays a significant role in controlling agricultural insect pests in South India [1-2]. Very few strip notes on ecological aspects of this species are available [1-11]. However, detailed breeding behavior in South India is almost lacking. This paper presents detailed information on nesting season, nest-sites, clutch size, egg morphology, incubation and nestling growth of Black Drongo, which is studied at the Cauvery Delta of Nagapattinam District, Tamil Nadu, Southern India.

MATERIALS AND METHODS

Study Area: The study was conducted in the Cauvery delta regions *viz.*, Mannampandal, Manganallur and Thiruvalanagadu (18°18' N, 79° 50' E) of Nagapattinam District, Tamil Nadu, India between 2005 and 2006. The region is generally referred to as the 'granary of South India' because of large scale agricultural operations leading to the cultivation of paddy, sugarcane, cotton, groundnut, banana, pulses and other cereals. Woody vegetation is sparse and in the form of groves and roadside trees. Predominant tree species found in the study area are *Cocos nucifera, Borassus flabellifer, Madhuca indica, Mangifera indica, Enterolobium saman, Tamarindus indicus, Ficus benghalensis, Ficus religiosa, Thespesia populnea, Phoneix psuilla, Acacia arabica, Odina wodier* and *Azadirachta indica.*

Corresponding Author: A. Mohamed Samsoor Ali, New No. 12, Old No. 3/10, New Street, Kollapuram - 609 608, Tamil Nadu, India. E-mail: amsamsoor@yahoo.co.in.

Important shrub species are *Prosopis juliflora, Jatropha glandulifera, Adhathoda vesica.* Plantations of *Casuarina equisetifolia, Tectona grandis* and *Bamboosa arundinacea* are also found in the study area. The northeast monsoon usually brings rain to the study area from October to December (65% of the total rainfall in a year) and dry seasons occur between May and July.

Nest Tree Characteristics: The total height of the nesting tree, nest location and nearest tree (potential non-nesting tree) in meters from the ground was measured using an altimeter. Diameter at Breast Height (DBH) was measured using a standard measuring tape. Distance to the nearest agricultural land, water source, grove, human habitation, road and electric line were measured in meters using a marked rope.

Eggs and Incubation: The freshly laid eggs were numbered with a felt-tipped pen, length and width was measured with Vernier calipers and weighed to the nearest 0.5 g with a spring balance and care was taken to avoid excessive disturbance, which could attract predators. The incubation period was measured from the time of the first egg laid to the time the first egg hatched.

Nestling Growth Patterns: Growth changes in the Black Drongo nestlings were measured using method described by Pettingil [12]. All the nests were visited in every 3 days, to collect the morphometric measurements of the body parts. Disturbances were minimized by handling the nestlings very carefully during the measurements. The nestlings were allocated individual identification marks. A total of 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 depth, 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.

Hatching and Fledging Success: The hatching success and fledging success of the Black Drongo were calculated by using the following formulae:

$$\text{Hatching success (\%)} = \frac{\text{No. of eggs hatched}}{\text{Total no. of eggs laid}} \times 100$$

$$\text{Fledging success (\%)} = \frac{\text{No. of nestlings fledged}}{\text{Total no. of eggs hatched}} \times 100$$

Statistical Analysis: Descriptive statistics are mean followed by standard deviation (SD). One-way Analysis of variance (ANOVA) was used to test for differences in means of variables between nesting and non-nesting trees. Significance of test was assessed at $p = 0.05$. The MINITAB 13.1 statistical package was used for all the analysis. Results of the above analysis were interpreted using standard statistical procedures [13].

RESULTS

Nesting Season: The breeding / nesting season was defined here as the period from the date of the building of the first nest to the date of the fledging of the last chick. During the period of study breeding data obtained from 21 nests and determined the breeding season to occur from March to June.

Nest Tree Characteristics: The Black Drongo constructed thin bottomed cup shape nests situated in the fork of a tree. The materials used for nest building were dry fibres, grass and twigs. Single nests were constructed in 6 to 9 days and both sexes hared the duties. The average length, circumference and depth of the nest were 14.6 ± 2.02 cm, 35.0 ± 3.72 cm and 4.4 ± 0.44 cm respectively. The weight of nest varied from 18 to 42 g with an average of 25.9 g (Table 1). Of the 21 nests, 48% were on Rain tree *Enterolobium saman,* 28% on Babool tree *Acacia nilotica,* 19% on Neem tree *Azadirachta indica* and 5% on Tamarind tree *Tamarindus indicus.* Nests were located at an average height of 8.9 ± 2.19 m (range: 5.5-12.5 m) and the average height of the nesting tree was 15.5 ± 4.4 8m (range: 8-28 m). Mean diameter at breast height (DBH) of the nesting tree was estimated to be 29.9 cm and deviated significantly from random trees (One-way ANOVA, $P<0.05$, Table 2). The nesting tree had the potential habitats such as agricultural lands (2.0 ± 1.32m) and perching site *i.e.* trees proximal to electric lines (7.8 ± 3.03) than farther away were preferred. One-way ANOVA indicated that distance to water sources, road and human habitations had significant differences ($p<0.05$) between nesting and non-nesting trees (Table 2).

Table 1: Nest characteristics of the Black Drongo (n= 21)

Variable	Min.	Max.	Mean ± SD
Total length (cm)	11.00	18.40	14.6 ± 2.02
Circumference (cm)	29.00	42.00	35.0 ± 3.72
Maximum depth (cm)	3.90	5.30	4.4 ± 0.44
Weight (g)	18.00	42.00	25.9 ± 6.74

Table 2: Nesting tree and habitat characteristic features of nesting and non-nesting trees of the Black Drongo. Values are mean ± SD

			ANOVA	
Variable	Nesting tree (n=21)	Non-nesting tree (n=21)	F	P
Height of the tree (m)	15.5 ± 4.480	17.5 ± 5.410	1.621	0.210
Nest location height (m)	8.9 ± 2.190	…	…	…
Tree DBH (cm)	29.9 ± 8.860	44.1 ± 16.60	12.025	0.001*
Distance to nearest Agricultural lands (m)	2.0 ± 1.320	4.8 ± 2.070	2.589	0.358
Distance to nearest Water sources (m)	75.2 ± 53.54	109.3 ± 49.27	4.611	0.037*
Distance to nearest Groves (m)	99.3 ± 31.32	139.8 ± 25.15	1.879	0.147
Distance to nearest Road (m)	134.6 ± 39.99	162.9 ± 30.93	6.551	0.014*
Distance to nearest Human Habitations (m)	134.4 ± 35.36	160.9 ± 27.88	7.259	0.010*
Distance to nearest Electric line (m)	7.8 ± 3.030	9.4 ± 2.820	3.020	0.089

*Statistically significant p<0.05

Table 3: Egg parameters of the Black Drongo

Egg Parameters	Min.	Max.	Mean ± SD	Number Measured (n)
Length (cm)	2.4	2.9	2.6 ± 0.14	67
Width (cm)	1.9	2.2	2.0 ± 0.07	67
Weight (g)	4.0	6.0	4.9 ± 0.82	67

Table 4: Growth patterns of different body structures of Black Drongo nestlings

Age in days	No. of chicks	Body Weight (g)	Body length (cm)	Bill length (cm)	Bill depth (cm)	Wing length (cm)	Wing span (cm)	Tarsus length (cm)	Tail length (cm)
0	33	4.29±0.31	3.57±0.30	0.18±0.08	0.11±0.03	1.18±0.10	2.48±0.11	0.29±0.09	0.12±0.05
3	31	5.92±0.32	4.52±0.27	0.55±0.09	0.20±0.05	1.83±0.18	4.78±0.62	0.91±0.09	0.28±0.06
6	26	14.85±1.32	6.04±0.38	0.74±0.11	0.20±0.04	3.15±0.20	8.06±0.32	1.14±0.11	0.42±0.07
9	19	31.74±2.26	9.97±0.39	1.19±0.15	0.36±0.07	5.78±0.14	14.81±0.62	1.41±0.08	0.55±0.06
12	23	37.48±2.63	10.87±0.19	1.56±0.07	0.59±0.05	8.13±0.34	20.37±0.42	1.91±0.10	1.03±0.11
15	19	51.11±3.75	12.60±0.33	1.86±0.13	0.89±0.08	11.39±0.36	26.83±1.38	2.41±0.07	2.82±0.43
18	18	48.67±2.97	14.28±0.47	1.87±0.11	0.92±0.06	13.42±0.44	31.54±0.49	2.47±0.11	4.59±0.21
21	16	41.38±2.22	15.71±0.24	1.93±0.09	0.91±0.06	14.46±0.27	35.04±0.81	2.53±0.11	4.73±0.22
24	12	39.00±2.13	16.19±0.18	1.99±0.03	0.93±0.08	14.98±0.17	34.98±0.62	2.57±0.09	4.81±0.19

Eggs and Incubation: The completion of nest construction and starting of egg laying appeared to be continuous without a day's gap. The color of the egg was white with red spotting of varying sizes. A complete clutch consisted of 3 to 4 eggs with a mean of 3.3 ± 0.15 eggs per clutch. Based on 67 eggs, average egg size was 26.0 ± 0.14 mm x 20.0 ± 0.07 mm (length x width) and average weight was 4.9 ± 0.82 g for 67 eggs (Table 3). During the incubation period only one of the parents remained inside the nest, while other was seen perching outside the nest. The incubation period lasted approximately 13 to 16 days.

Nestling Growth Patterns: The newly hatched chicks had unopened eyes and bodies that were naked and fleshy colored. The lining of the mouth was yellowish red with an egg-tooth. On day 3, the nestlings were able to raise their heads and produced loud food begging calls. The feather follicles and black spots under the skin appeared on day 5. The eyes opened on the eighth day and nestlings started shivering movements of their wings. When 17 to 20 days old, the nestlings resembled parents but did not have yet forked tail. The feathers were glossy black on the upper part and tinged with white in the

underparts. The nestlings flutter their wings and try to fly out the nests. Typically the nestlings left their nests on the 20th or 22nd day post hatch. Both the parents took equal part in the nestling period. The chicks were continuously fed throughout the day from morning till late evening by both parents. The soft bodied grasshoppers, beetles and lepidopteran insects were common food items and the parents transferred whole food directly to the mouth of the nestlings.

Nestlings grew from 4.29 ± 0.31 g (N = 33) at hatching to peak weight of 51.11 ± 3.75 g (N = 19) at day 15 and reached to a weight of 39.0 ± 2.13 g (N = 12) on day 24 (Table 4). The body length of nestlings was 3.57 ± .30 cm at hatching and grew to 16.19 ± 0.18 cm by the end of day 24. The bill length was 0.18 ± 0.08cm at hatching and it reached to 1.99 ± 0.03cm on day 24. The bill depth of the nestling was 0.11 ± 0.03cm at hatching and attained the size of 0.93 ± 0.08cm. At the time of hatching, the wing length was 1.18 ± 0.10cm and it gradually increased and attained maximum length of 14.98 ± 0.17cm on day 24. The tarsus length of nestlings grew from 0.29 ± 0.09cm at hatching to 2.57 ± 0.11cm by the end of day 24. The tail length showed a considerable amount of growth during the nestling period. The growth was 0.12 ± 0.05cm at hatching and it increased to 4.81 ± 0.22cm during day 24 (Table 4).

Hatching and Fledging Success: Out of 67 eggs examined, 53 hatched and hatching success was 79.10%. Rest of the eggs remained unhatched. Of the 53 hatched eggs, 40 nestlings successfully fledged resulting in 75.5% fledging success.

DISCUSSION

In the study area the Black Drongo nesting activities started during March and ended in June. In contrast, Shukkur and Joseph [3] reported that the Black Drongo breeds during April to June in Calicut University Campus, Kerala. The breeding activities of the Drongo were directly related to availability insects, because the growing nestlings needed protein rich insect diet. During March to June the insect abundance was relatively greater in our study area due to greater agricultural (paddy) operations [14]. However, availability of suitable mate, nesting materials, temperature and rainfall may also determine the nesting season of Black Drongo.

The Black Drongo constructed perfect cup nests with the collection of fibres, grasses and twigs and no other vegetative materials were used in any of the nests studied, similar to observation reported by Shukkur and Joseph [3]. Black Drongos were observed collecting the nest materials from adjoining nesting areas with plenty of fibres and grasses. The nest morphometry indicated that the mean length, circumference and depth were 14.6 ± 2.02 cm, 35.0 ± 3.72 cm and 4.4 ± 0.44 cm respectively, which is comparable with the report of Shukkur and Joseph [3].

The Black Drongo constructed the nests in the forks of *Enterolobium saman, Acacia nilotica, Azadirachta indica* and *Tamarindus indicus* which is more common in the study area and these are suitable nesting sites for many cup nesting species [15]. Shukkur and Joseph [3] recorded most of the Black Drongo nests in Jackfruit trees *Artocarpus integrifolia* at the Calicut University campus, this may be due to the availability of tree species. All the nesting trees were found to be very close to agricultural lands, probably because these areas provide grasshoppers, beetles, caterpillars and other insect prey.

The present investigation indicated that the Drongo preferred 8-28 m tall trees for nest construction at a height of 5.5-12.5 m. Shukkur and Joseph [3] stated that the Black Drongo preferred 5-30 m tall trees for nesting and the nests were located at 2.5-13m height. Santisteban *et al.* [16] showed that elevated nest height increased nest vulnerability to visually-oriented nest predators. The present investigation indicated that Black Drongo nest sites tended to be close to potential hunting areas such as agricultural lands and electric lines. Pidgeon *et al.* [17] stated that micro-habitat and vegetative composition around nesting tree are important factors in relation to nest placement and success of avian species. The micro-habitat and vegetation in the habitat not only provide nesting-site and food but also fibers, twigs, grasses for nest construction. In the present study area, underneath the electric wires, the predominant habitat was paddy and grass lands. The Black Drongo collected good quality of nesting materials and food items from these lands. Hence, the birds would have preferred the electric wires for perching and this could be the reason for having the electric line nearer the nesting trees. Similar observations were made by Ali [18] in Baya Weavers *Ploceus philippinus* and Asokan *et al.* [19] in Common Mynas *Acridotheres tristis*.

Mean clutch size observed was 3.1 ± 0.35 (range: 3-4). These values were more or less constant when compared to previous studies by Ali and Ripley [20] and Shukkur and Joseph [3]. Although clutch size of birds is often dependent on the age of the parents, with younger parents laying smaller number of eggs [21-23], diet and

territory quality [24]. The mean length and width of egg was observed to be 26.0 ± 0.14mm and 20.0 ± 0.07mm respectively, this is almost similar to the report of Shukkur and Joseph [3]. The average egg weight was recorded to be 4.9 ± 0.82g, which is quite similar to be earlier reported values [3]. The incubation period was around 13 to 16 days. The incubation started with the laying of first egg itself and second egg was laid roughly after an interval of 24 hours. Both parents took a prominent role in incubation.

The weight of chicks on the first day was 4.29g which increased to 51.11g at 15 day of age. However, there was a drop in the mean weight of nestlings at last few days and reached 39.0g at the time of fledging. Welty [25] stated that many nestlings lost 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 helps to the advantage for moving out the nest. The loss of body weight was reported in many bird species [19, 26-28]. Development of the different body parts 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 size at the time of fledging. The Black Drongo 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 [19, 29-31].

Due to their potential role as biological pest control agents, Black Drongos have been identified as agriculturally beneficial birds [2]. Breeding records of the species hence need to monitor throughout its distribution range so as to follow their population status. This preliminary or baseline data of such kind will be helpful in investigating the factors attributed to the decline in the population of Black Drongo. By enhancing such agriculturally beneficial organism in the field we can definitely look forward to minimizing the use of chemical pesticides which have toxic on the biota.

ACKNOWLEDGEMENT

We thank the Ministry of Environment and Forests (MoEF), Government of India for the financial assistance to undertake field investigations. We wish to express our sincere thanks to the HOD of Zoology and the Principal and the Management of A.V.C. College (Autonomous), Mannampandal for having rendered facilities and encouragement.

REFERENCES

1. Mathew, D.N., T.C. Narendran and V.J. Zacharias, 1978. A comparative study of the feeding habits of certain species of Indian birds affecting agriculture. J. Bombay Nat. Hist. Soc., 75: 1178-1197.
2. Asokan, S., A.M.S. Ali and R. Manikannan, 2009b. Diet of three insectivorous birds in Nagapattinam District, Tamil Nadu, India – a preliminary study. J. Threat. Taxa, 1(6): 327-330.
3. Shukkur, E.A.A. and K.J. Joseph, 1978. Breeding biology of the Black Drongo. J. Bombay Nat. Hist. Soc., 75: 1205-1211.
4. Chari, N., J.R.N. Rao, R. Ramesh and G. Sattiah, 1982. Comparative studies on flight characteristics, moment of intertia and flight behaviour of two fly-catchers, *Dicrurus adsimilis* and *Merops orientalis*. Indian J. Experi. Biol., 20: 894-896.
5. Sridharan, U. and C. Sivasubramanian, 1987. Additional records of the Black Drongo (*Dicrurus adsimilis*) feeding on birds. J. Bombay Nat. Hist. Soc., 83: 212-213.
6. Raju, A., K.S.R. Krishna and U.V. Raja, 1989. Black Drongo *Dicrurus adsimilis* nesting on electric pole. J. Bombay Nat. Hist. Soc., 86: 449-450.
7. Veena, T. and R. Lokesha, 1993. Association of Drongos with Myna flocks: Are Drongos benefited? J. Biosci., 18: 111-119.
8. Hore, B.B., P.N. Mehrotra and A. Hore, 1994. Testicular melanin pigments and the gonadal cycle in a tropical wild passerine bird, *Dicrurus adsimilis* (*Passeriformes, Dicruridae*). Funct. Devel. Morph., 4: 21-24.
9. Decandido, R., C. Nualsri and D. Allen, 2004. Migration of Black Drongo *Dicrurus macrocercus* in Southern Thailand in autumn 2003. Forktail, 20: 143-144.
10. Vincent, N., 2004. Seasonal variation in naturally occurring mobbing behaviour of drongos (*Dicruridae)* towards two avian predators. Ethol. Ecol. Evol., 16: 25-32.
11. Asokan, S. and A.M.S. Ali, 2010. Foraging behavior of selected insectivorous birds in Cauvery Delta region of Nagapattinam District, Tamil Nadu, India. J. Threat. Taxa, 2(2): 690-694.
12. Pettingill, O.S. Jr., 1985. Ornithology in Laboratory and Field. Academic Press, London.
13. Sokal, R.R. and F.J. Rohlf, 1981. Biometry. W.H. Freeman and Company, New York.

14. Asokan, S., 1998. Food and feeding habits of the Small Green Bee-eater *Merops orientalis* in Mayiladuthurai. J. Ecobiol., 10(3): 199-204.
15. Radhakrishnan, P., 2006. Studies on nest characteristics, nest-site selection and egg morphometry of selected birds in and around Mayiladuthurai, Tamil Nadu. M.Phil Thesis, Bharathidasan University, Trichy.
16. Santisteban, L., K.E. Sieving and M.L. Avery, 2002. Use of sensory cues by Fish Crows (*Corvus assifragus*), preying on artificial birds' nests. J. Avian Biol., 33: 245-252.
17. Pidgeon, A.M., V.C. Radeloff and N.E. Mathews, 2003. Landscape scale patterns of Black-throated Sparrow abundance and nest success. Ecol. Applic., 13: 530-542.
18. Ali, A.M.S., 2003. Nest characteristics, nest-site selection, nestling growth and prey delivery pattern to nestlings in the Baya Weaver *(Ploceus philippinus*). M.Sc., Thesis, AVC. College, Mannampandal, Tamil Nadu.
19. Asokan, S., A.M.S. Ali and R. Manikannan, 2009a. Nest-site selection and nestling growth patterns of the Common Myna, *Acridotheres tristis* (Linnaeus, 1766). Geobios, 36: 65-70.
20. Ali, S. and S.D. Ripley, 1983. Handbook of Birds of India and Pakistan. Oxford University Press, Bombay.
21. Coulson, J.C., 1966. The influence of the pair bond and age on the breeding biology of the Kittiwake Gull (*Rissa tridactyla*). J. Anim. Ecol., 35: 269-279.
22. Klomp, H., 1970. The determinants of clutch size in birds. Ardea, 58: 1-124.
23. Ndithia, H., M.R. Perrin and M. Waltert, 2007. Breeding biology and nest site characteristics of the Rosy-faced Lovebird (*Agapornis roseicollis*) in Namibia. Ostrich, 78(1): 13-20.
24. Hustler, K. and W. Howells, 1989. Habitat preference, breeding success and the effect of primary productivity on Tawny Eagle (*Aquila rapax*) in the tropics. Ibis, 132: 33-40.
25. Welty, C.J., 1982. The life of birds. W.B. Saunders Company, London.
26. Kumar, T.S. and J.V.R. Rao, 1984. Some observation on the weights of nestling Spotted Owlet *Athene brama brama* (T) prior to flying. Geobios, 11: 229-231.
27. Nagarajan, R., K. Thiyagesan, R. Natarajan and R. Kanakasabai, 2002. Patterns of growth in nestling Barn-owls. Condor, 104: 885-890.
28. Asokan, S., A.M.S. Ali and R. Manikannan, 2010. Breeding biology of the Small Bee-eater *Merops orientalis* (Latham, 1801) in Nagapattinam District, Tamil Nadu, India. J. Threat. Taxa, 2(4): 797-804.
29. Kumar, T.S., 1983. Bill growth in the Spotted Owlet *Athene brama brama* (T). Raptor Rese. Cent. Publi., 2: 1-4.
30. Teather, K., 1996. Patterns of growth and asymmetry in nestling Tree Swallows. J. Avian Biol., 27: 302-310.
31. Aparicio, J.M., 2001. Patterns of growth and fluctuating asymmetry: the effects of asymmetrical investment in traits with determinate growth. Behav. Ecol. Sociobiol., 49: 273-282.