Research Article

Breeding biology and nidology of Oriental skylark (*Alauda gulgula*) in district Bajaur, Khyber Pakhtunkhwa, Pakistan

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Abstract

A general field survey about Oriental skylark (*Alauda gulgula*) breeding biology and nest structure (nidology) was carried out during (April, May, June, and July) 2018 and 2019, in district Bajaur. This study was conducted in order to record all the ecological factors that hurdle for the successful breeding of skylark in the study area. For this purpose, we studied 33 nests from egg laying up to the fledging stage. As a result, morphometric measurements of 112 eggs were recorded. Overall eggs were oval dusty white or grey white with black spots and mostly smooth or of somewhat rough texture. Average egg weight 3.0 g, length 2.2 cm, width 3.27 cm² and volume 3.65 cm³. Likewise explored average clutch size 3.39, incubation period 12.07 days, the number of eggs hatched 3.30 (95.19%), fledged 3.18 (97.34%), and breeding success (89.20%). After normal fledging, the floor of nests was recorded. The shape of nests was entirely round to preferential round; the average nest diameter 9.48±0.8 cm, cup diameter 7.86±0.6 cm, cup depth 6.21±0.5 cm, and nest weight 17.61±0.9 g. The main cause of breeding failure and nest loss was brutal nests and egg destruction by locals and a high rate of land as well avian predators.

Keywords: Bajaur; Breeding biology; Clutch size; Nidology; Oriental skylark

Introduction

Oriental skylark (*Alauda gulgula*) was primarily investigated in Laos during 1997 [1]. It is a small sized bird [2], having a wide dispersal range around Asia including Northern Pakistan, Europe, and Africa. They build their nests on the ground [3, 4]. It is the only passerine bird that shows a great association with agricultural farmlands [5, 6]. Skylark has eleven to thirteen subspecies [7, 8]. They mostly select dry habitats with moderate grasses and agricultural crop-lands

for nest construction. Oriental skylark constructs a cup-shaped nest in a shallow depth in the soil from threads and soft grass for breeding purposes [9, 10]. Nest construction and incubation are completed by females, but both parents feed the nestlings. The clutch is 2 to 5 eggs, eggs hatch after 12 days. Chicks start flying at the age of 8 to 11 days. They become independent of their parents at the age of 30 days. A single couple makes two to four nesting attempts in a year. The first clutch was laid in early April, and

the last broods were fed in late July. The territorial range differs mostly, but the average territories cover an area of 5000-20,000 m². Bird pairs change their territories when there is a change in vegetation and environmental conditions [11, 12]. In Western Europe, Oriental skylark population density dropped over the last 30 years due to rapid amplification in farming land [5]. Oriental skylarks were therefore considered a priority species associated with agriculture and cultivated lands for conservation and rehabilitation [12]. Among the passerines, more than 70% of nest destruction and failure was that of Oriental skylark. However, nest achievement in different crops was different [12-15].

The highest population density of Oriental skylark was observed in habitats where crops were more diverse; as crop types offer more suitable habitats for nest construction throughout the breeding period [15]. Oriental skylark does not inhabit vegetation more than 30 to 35 cm in height [15, 16].

Little data are available on the ecology of Oriental skylark in Pakistan. The population of Oriental skylark is low in Bajaur due to the loss of habitat and low productivity. So a comprehensive study was conducted about skylark nidology and breeding biology in district Bajaur, Khyber Pakhtunkhwa, Pakistan from April-July 2018 and April-July 2019 respectively.

Materials and Methods

Study area

The study was conducted on the farmland and rainfed croplands in district Bajaur (34°44.161 N, 71°31.631 E), 850-1100 m

elevation above mean sea level, covering an area of 1290 km² [17-19] (Fig. 1).

Field survey

The data were collected on the breeding biology and nidology of Oriental skylark in the study area. Potential sites were surveyed from March to July 2018 and 2019. Oriental skylarks and their nests were searched in the study area using binoculars (7x50mm) and numbered serially for data collection (Fig. 1). GPS coordinates of each nest were recorded (Table 1). Data on breeding season, egg shape, color, texture, etc. were recorded three times a week in the morning and in the evening (Tables 2 & 3, Fig. 2b, 2c, 2d, 2e, 2f). A digital camera was used to photograph the nests, eggs and nestlings. Data were recorded causing minimum disturbance to the habitat, birds, and nest predation following. Vernier caliper was used to measure eggs. A digital scale of 0.1 g to 1000 g was used to weigh eggs, and nests. The volume of eggs was determined by using the following formula No 1:

$$\text{Volume} = K_v XLW^2$$

Where “K_v” is constant =0.51, “L” and “W₂” are the length and width of skylark eggs respectively.

The breeding patterns associated with oriental skylark were determined during the breeding seasons, these patterns were clutch size, incubation period, hatching success, fledging success, and breeding success. The hatching success, fledging success, and overall breeding success were calculated according to Kour [20], by the following formulas;

$$\text{Hatching success \%} = \frac{\text{Number of egg hatched}}{\text{Total egg laid}} \times 100$$

$$\text{Fledging success \%} = \frac{\text{Number of fledging}}{\text{Number of egg hatched}} \times 100$$

$$\text{Breeding success \%} = \frac{\text{Number of fledging}}{\text{Total number of egg laid}} \times 100$$

Statistical analysis

Sample sizes varied for different parameters about breeding biology and nest characterization because we couldn't compare breeding variables for statistical significance due to the low sample size. However, analyzed as mean±standard deviation for both comparison and standard errors by MS Excel (365).

Results

Oriental skylark breeding biology and nidology were explored during the breeding season from April to July 2018 and 2019. Thirty-three nests were investigated. Some nests were explored while being constructed (9th and 16th April). The initiation of the breeding period of one skylark pair was recorded on 25th April, that which lasted up to mid-May, 2018. The remaining breeding pairs were recorded during mid-April, May and June 2018 and 2019 (Table 3 & 4).

The clutch size ranged from 2 to 4 eggs (3.39±0.9). The dimensions of eggs varied. All eggs were oval-shaped, the average weight of eggs was 3.00±0.1 g. Similarly, the average eggs length 2.20± 0.04 cm, the average width of the eggs 3.27 ± 0.16 cm² and the average volume 3.65±0.07 cm³, color grey white with black spots and smooth surface (Table 2 & Fig. 2b, 2c, 2d); the incubation period 11 to 13 (12.07±0.4) days. Hatching success was 95.19% probably due to the high predation rate. Nestlings fledged after 9 to 14 days of hatching and left the nests. A fully grown nestling on the 14th day weighed about 27.5 g (Fig. 2f). The fledging rate was 97.34% of the hatched eggs and the

overall breeding success was 89.20% (Table 3).

During the nest construction activity, both males and females equally participated in nest construction. Most activities was observed during the early morning by about 8:00 am. In the presence of any observer, the birds remained flying 50 to 100 m from the nest while singing melodious songs (Fig. 2a). A total of 112 eggs, were noted in all 33 nests. Out of 112 eggs 86 were hatched successfully while 26 eggs were destroyed due to mammalian predation and anthropogenic ignorance as shown in (Table 3).

Dimensions of each nest were recorded. All the nests were constructed on the ground in natural vegetation and in wheat and barley fields. Outline of the 81.81% nests was completely round while remaining the 18.19% were partially oblong to round. The average external diameter of all the nests was 9.48±0.8 cm, internal (Cup) diameter 7.86±0.6 cm, average cup depth 6.38±0.5 cm, and the average weight of the nesting material 17.61±0.9 g. Nesting material used to construct all the nests mainly consisted of local grasses and dry leaves of trees and local crops including *Dichanthiu annulatum* (18%), *Desmostachya bipinnata* (15%), *Heteropogon contortus* (15%), *Cynodon dactylon* (18%), *Fimbristylis squarrosa*, (10%) *Phragmites communis* (5%), local crops dry leaves (14%), plastic string (2%), contour feathers (2%) and 1% undifferentiated materials as shown in (Table 4).

Figure 1. Map of District Bajaur small dots representing sampling points

Figure 2a. A sketch of an adult Skylark b) A photo of Skylark nest with 4 oval shape white eggs with black spots c) A sketch of completely round nest consist of four eggs d) First day hatched broods e) Nestlings with developing wings and feather f) A developed Nestling of about 27.5 gm ready to left the nest

Table 1. GPS locations of all 33 nests of Skylark in district Bajaur

N. No.	Area Name	N	E	Elevation	Nesting habitat
1	Rasaky	34° 42.611	071° 24.854	940 m	Farmland
2	ShehKaly	34° 42.675	71° 25.552	874 m	Rainfed croplands
3	Dehly	34° 42.730	071° 25.762	890 m	Farmland
4	Kawser	34° 42.821	071° 25.762	914 m	Farmland
5	Khazana	34° 42.921	071° 27.346	908 m	Farmland
6	Shagy	34° 43.977	071° 24.303	972 m	Farmland
7	Patak	34° 43.660	071° 28.947	900 m	Farmland
8	Shande	34° 43.485	071° 29.895	868 m	Rainfed croplands
9	Tankhat	34° 43.369	071° 27.609	899 m	Rainfed croplands
10	Khar West	34° 43.689	071° 30.193	883 m	Farmland
11	Khar South	34° 43.016	071° 31.262	861 m	Rainfed croplands
12	Khar East	34° 44.126	071° 31.618	870 m	Farmland
13	Yousaf Abad	34° 45.214	071° 32.651	821 m	Rainfed croplands
14	BokyGhado	34° 39.545	071° 21.323	1070 m	Rainfed croplands
15	Shah Nary	34° 46.091	071° 34.289	821 m	Farmland
16	Loisum	34° 41.887	071° 23.797	962 m	Farmland
17	Sabagy	34° 41.656	071° 23.104	961 m	Rainfed croplands
18	Maskanu	34° 41.436	071° 21.493	1008 m	Rainfed croplands
19	Zoor Bander	34° 41.265	071° 20.406	1100 m	Rainfed croplands
20	Ghandow	34° 41.182	071° 20.830	1031 m	Farmland
21	TangiDery	34° 43.376	071° 21.535	1019 m	Farmland
22	Loijoher	34° 42.653	071° 22.606	989 m	Farmland
23	Samsy	34° 41.106	071° 25.502	961 m	Rainfed croplands
24	Dozakh Shah	34° 42.845	071° 24.850	940 m	Rainfed croplands
25	Inayat Kaly	34° 45.244	071° 27.198	851 m	Farmland
26	Ber Kaly	34° 46.623	071° 25.359	974 m	Farmland
27	Umary	34° 45.244	071° 27.198	851 m	Farmland
28	Kamer sir	34° 46.623	071° 25.359	974 m	Rainfed croplands
29	Samsy khor	34° 41.106	071° 25.502	961 m	Rainfed croplands
30	Umer shah	34° 41.847	071° 25.055	1100 m	Farmland
31	Redawen Shah	34° 43.974	071° 23.636	975 m	Rainfed croplands
32	Janat Shah dog	34° 43.808	071° 23.611	882 m	Farmland
33	Serkanu Shah	34° 43.774	071° 23.956	962 m	Rainfed croplands
“N. No” (Nest number), “N” (North), “E” (East).					

Table 2. Oriental skylark eggs morphometric dimensions in Bajaur, during April to July 2018 and 2019 respectively

N. No.	E. look	Egg color	Texture	E. mass (g)	E. W. (cm ²)	E. L. (cm)	E. V. (cm ³)
1	Oval	Dusty white with BS	Smooth	2.9	3.24	2.2	3.63
2	Oval	Grey white with BS	Smooth	3.2	3.61	2.3	3.80
3	Oval	Grey white with BS	Smooth	3	3.24	2.2	3.63
4	Oval	Grey white with BS	Smooth	3	3.24	2.2	3.63
5	Oval	Grey white with BS	Smooth	3	3.24	2.2	3.63
6	Oval	Grey white with BS	Smooth	2.8	2.89	2.1	3.47
7	Oval	Dusty white with BS	Small rough	2.9	3.24	2.2	3.63
8	Oval	Grey white with BS	Smooth	3	3.24	2.3	3.80
9	Oval	Grey white with BS	Small rough	3	3.24	2.2	3.63
10	Oval	Grey white with BS	Smooth	3	3.24	2.2	3.63
11	Oval	Dusty white with BS	Smooth	3.1	3.24	2.2	3.63
12	Oval	Grey white with BS	Smooth	3.2	3.24	2.3	3.63
13	Oval	Grey white with BS	Smooth	3.3	3.61	2.3	3.63
14	Oval	Grey white with BS	Smooth	3	3.24	2.2	3.63
15	Oval	Grey white with BS	Smooth	3.1	3.24	2.2	3.63
16	Oval	Grey white with BS	Smooth	3	3.24	2.1	3.63
17	Oval	Dusty white with BS	Small rough	2.9	3.24	2.2	3.63
18	Oval	Grey white with BS	Smooth	2.8	3.24	2.3	3.63
19	Oval	Grey white with BS	Small rough	2.8	3.24	2.2	3.63
20	Oval	Grey white with BS	Smooth	2.9	3.24	2.2	3.63
21	Oval	Dusty white with BS	Smooth	3.2	3.61	2.3	3.80
22	Oval	Grey white with BS	Smooth	3	3.24	2.2	3.63
23	Oval	Grey white with BS	Smooth	3	3.24	2.2	3.63
24	Oval	Grey white with BS	Smooth	3	3.24	2.2	3.63
25	Oval	Grey white with BS	Smooth	2.8	2.89	2.2	3.47
26	Oval	Grey white with BS	Smooth	2.9	3.24	2.1	3.63
27	Oval	Dusty white with BS	Small rough	3	3.24	2.2	3.63
28	Oval	Grey white with BS	Smooth	3	3.24	2.3	3.63
29	Oval	Grey white with BS	Small rough	3	3.24	2.2	3.63
30	Oval	Grey white with BS	Smooth	3.1	3.24	2.2	3.63
31	Oval	Dusty white with BS	Smooth	3.2	3.61	2.3	3.80
32	Oval	Grey white with BS	Small rough	3.2	3.61	2.3	3.80
33	Oval	Grey white with BS	Smooth	3	3.24	2.2	3.63
Mean $\pm$ standard deviation				3.0 $\pm$ 0.12	3.27 $\pm$ 0.16	2.20 $\pm$ 0.4	3.65 $\pm$ 0.07
“B.S” (Black Spots), “N. No” (Nest number), “E.W” (Egg width), “E.L” (Egg Length), “E.V” (Egg volume).							

Table 3. Breeding pattern of Oriental skylark in Bajaur, from March to July 2018 and 2019 respectively

N. No.	Clutch size	Incubation period	Eggs hatched	HS (%)	No of young fledged	FS (%)	Breeding success (%)
1	2	12	2	100%	2	100%	100
2	2	-	-	-	-	-	-
3	2	11	2	100%	2	100%	100
4	2	12	1	50%	1	50%	25
5	2	12	2	100%	2	100%	100
6	2	-	-	-	-	-	-
7	2	11	2	100%	-	-	-
8	2	12	2	100%	2	100%	100
9	2	-	-	-	-	-	-
10	2	12	2	100%	2	100%	100
11	4	12	4	100%	4	100%	100
12	4	13	4	100%	-	-	-
13	4	12	4	100%	4	100%	100
14	4	-	-	-	-	-	-
15	4	12	4	100%	4	100%	100
16	4	12	4	100%	4	100%	100
17	4	13	4	100%	4	100%	100
18	4	-	-	-	-	-	-
19	4	12	4	100%	4	100%	100
20	4	12	4	100%	4	100%	100
21	4	12	4	100%	-	-	-
22	4	12	4	100%	4	100%	100
23	4	-	-	-	-	-	-
24	4	12	4	100%	4	100%	100
25	4	12	4	100%	3	75%	75
26	4	12	4	100%	-	-	-
27	4	12	2	50%	2	50%	25
28	4	12	4	100%	4	100%	100
29	4	13	3	75%	2	50%	37.5
30	4	12	4	100%	4	100%	100
31	4	-	-	-	-	-	-
32	4	12	4	100%	4	100%	100
33	4	13	4	100%	4	100%	100
Mean $\pm$ Std	3.39 $\pm$ 0.9	12.07 $\pm$ 0.4	3.30 $\pm$ 0.9	95.19 $\pm$ 13	3.18 $\pm$ 1.0	97.34 $\pm$ 8.4	89.20 $\pm$ 24
“Std” (Standard deviation) “N.No” (Nest number), “H.S” (Hatching success), “F.S” (Fledging success).							

Table 4. Oriental skylark nests dimensions recorded in Bajaur, from March to July 2018 and 2019 respectively

N. No.	Look of nest	E. D. (cm)	I. D. (cm)	C. D. (cm)	N. W. (g)	Nest Materials	%
1	Complete .R	9	7	5.6	17	<i>Dichanthium annulatum</i>	18
2	Completely .R	8.5	7.5	5.9	16.8	<i>Desmostachya bipinnata</i>	15
3	Completely .R	8	7	6.2	16	<i>Heteropogon contortus</i>	15
4	Partial .R	8.8	7.6	6	18	<i>Cynodo ndactylon</i>	18
5	Completely .R	10	8	5.8	18	<i>Fimbristylis squarrosa</i>	10
6	Completely .R	10.5	8.3	6	19	<i>Phragmites communis</i>	5
7	Completely .R	9.5	8	5.5	17	Local crops dry leaves	14
8	Oblong .R	9.6	7.9	6	17.5	Plastic string	2
9	Partial .R	8.4	8	6	18.2	unknown	1
10	Completely .R	8.5	8	5.7	19		
11	Completely .R	8.3	8	5.5	16		
12	Completely .R	10.5	9	6.6	17.9		
13	Completely .R	10.2	9	6.9	19		
14	Completely .R	10	8.8	5.8	17		
15	Partial .R	10	8	7	16.8		
16	Oblong .R	9	7.2	6	17		
17	Complete .R	9	7	5.7	18		
18	Completely .R	9.5	7.2	6.2	17		
19	Completely .R	9.5	7.5	6.8	19		
20	Partial .R	10.5	8	5.8	17.5		
21	Completely .R	8.9	7	6	17.2		
22	Completely .R	10.5	8	7	17		
23	Completely .R	10	8	5.6	18.6		
24	Oblong .R	9.5	8	7.4	18.4		
25	Complete .R	8.8	7.5	6	16		
26	Completely .R	8.2	7.8	7	17		
27	Partial .R	10.7	8.2	5.8	18.9		
28	Complete .R	11	9	6.5	19.2		
29	Completely .R	10	9	7	17		
30	Completely .R	9	7	6	18		
31	Completely .R	8.9	7.2	6	19		
32	Completely .R	9.8	7.9	7.2	16.8		
33	Completely .R	10.5	8	6.7	16.4		
Mean±Std		9.48±0.8	7.86±0.6	6.21±0.5	17.61±0.9		100
“N. No” (nests Number), “R” (round), “E” Egg , “D” diameter, “W” Weight, “%” Percentage							

Discussion

Oriental skylark breeding biology and nidology were studied in district Bajaur. All the nests were found on dry land. Campbell *et al.* [9] also reported the Oriental skylark nests from dry habitats in grasslands. In Tibetan Plateau, the Oriental skylark selects

dry habitat for nest construction on land which has bulky grasses that are helpful in delaying avian as well as land predators [12]. We continued to investigate the breeding period from April to July both in 2018 and 2019. Delius [21] reported Oriental skylark

nesting in Britain on farmlands in early June and egg laying in early July

We observed the anthropogenic and predation impact on the nests as two nests (containing two and four eggs) out of 10 were demolished before hatching thus the hatching success is 79.41%. Wilson and Browne *et al.* [22], Mouton *et al.* [23], and Poulsen *et al.* [24] also reported the destruction of Oriental skylark and other songs birds nests by predation and agricultural activities.

The clutch size ranged from two to four eggs [25] similarly in northern latitudes clutches of two to four were recorded. Normally in the mid breeding season, the clutch size ranged from three to five [26, 27]. The 12 days incubation period was recorded (ranged 11 to 13; on an average 12.07 days). Similarly, in the early study, it was also shown that the Oriental skylark incubation period takes 12-13 days [28]. During 2011-12 a similar research was conducted in Tibetan Plateau where about 12.04 days incubation period was recorded the nesting success of oriental skylark was measured as 41.3% in Tibetan Plateau [12].

The egg profile was smooth, sometimes rough, mainly oval varying to roundish and color dusty to grey white with small black spots. Though, in an earlier investigation, it was noted that Oriental skylark eggs were grey white to greenish with a brunette spot. Another view was that the eggs were of a grey-white or greenish background covered in brown or olive spots [3, 29].

The average mass of 112 eggs was about 3.0 ± 0.12 g. The average length, width, and volume were 1.8, 2.23 ± 0.4 cm and 3.65 ± 0.07 cm³ respectively. Cramp and Brook [3], Praus and Weidinger [5] reported the Oriental skylark egg length, width and mass as about 1.7 to 8 cm, 2.3 to 2.4 cm and 3.3 g respectively.

Oriental skylark overall nest success in the study area was 89.20%. In Northern Netherlands and in Europe a slightly less nest

success in natural and arable fields was 33% [30]. In the present study nest achievement was not explored fully, suggesting that the nesting habitat is unsafe Kuiper *et al.* [31]. During the whole survey, female Oriental skylark was observed laying on eggs, similarly, Stoleson and Beissinger [32], Donald [33], Donald [34] recorded that unsafe nesting habitat decreased the population density of Oriental skylark. Marti [35] and Jose and Soler [36] reported the nesting and parental behavior of birds. Only the female incubates the eggs typically starting with the laying of the last egg [37].

We suggest that Oriental skylark is adapted to natural vegetated areas and arable fields, and selects a nest site to minimize human and livestock interruption. Skylark breeding success can be improved by protecting its habitat and by raising awareness amongst the local peoples. The study would support the conservation of Oriental skylark throughout its area of distribution.

Authors' contributions

Conceived and designed the experiments: K Gabol, Performed the experiments: RU Khan, Analyzed the data: RU Khan & K Gabol, Contributed materials/ analysis/ tools: K Gabol, Wrote the paper: RU Khan.

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