Pakistan J. Zool., vol. 54(6), pp 2519-2525, 2022 DOI: https://dx.doi.org/10.17582/journal.pjz/20210818110804

Oriental Skylark (*Alauda gulgula*) Nestling Morphometry and Feeding Habits in Bajaur Khyber-Pakhtunkhwa Pakistan

Rahmat Ullah Khan[1]*, Asif Sadam[2], Karim Gabol[1], Waheed Ali Panhwar[3], Sajid Mahmood[4], Mustafa Kamal[5], Hamid Ullah[6], Syed Abidullah[7], Muhammad Tufail[8], Bashir Ahmad[4], Gul Bacha Khan[4] and Habib Ul Hassan[1]

[1]*Department of Zoology, University of Karachi, Karachi-75270, Pakistan*
[2]*College of Life Sciences, Hainan Normal University, Haikou-571158, China*
[3]*Department of Zoology, Shah Abdul Latif University, Khairpur, Sindh, Pakistan*
[4]*Department of Zoology, Hazara University, Mansehra, Pakistan-21300*
[5]*Department of Zoology, Abdul Wali Khan University, Mardan-23200, Pakistan*
[6]*Department of Zoology, Bahawalnager Campus of the Islamia University, Bahawalapur*
[7]*Department of Botany, Abdul Wali Khan University, Mardan-23200, Pakistan*
[8]*Institute of Biomedical Sciences, Shanxi University, Taiyuan, China*

Article Information
Received 18 August 2021
Revised 15 September 2021
Accepted 07 October 2021
Available online 07 January 2022 (early access)
Published 08 August 2022

Authors' Contribution
This manuscript is extracted from the PhD research work of RUK, supervised by KG. WAP and SM analyzed the diet. AS, MK, HU, SA, MT, BA, GBK and HUH helped in writing and formatted the manuscript.

Key words
Arthropods, Bajaur, Chicks, Diet, Hatchlings, Nestlings, Morphometry, Skylark

ABSTRACT

The present investigation was aimed to improve the contemporary information about morphometry and diet of Oriental skylark *Alauda gulgula* nestling from hatching to 8th day very carefully during the breeding season (April, May, June, and July) 2019, in district Bajaur. A total of 70 nestlings of 22 nests were studied systematically. The eggs were hatched out both from the middle point and blunt end. All the eggs were hatched asynchronously with closed eyes and a naked body. They opened their eyes on average after 3.27±0.4 days of hatching. Their wing and tail feathers grew on an average of 3.8±0.3 day of age. On the 8th day, their average morphometry (cm) was: body length 6.7±0.1, wingspan 4.8±0.1, tail feathers 0.8±0.7, beak 0.7±0.3, chest 2±0.1, legs 2.02±0.5, middle claw 0.2±0.04, hind claw 0.4±0.04, and average body weight (g) 20.7±0.7. From hatching till the 3rd day of age, they were fed totally with larvae of arthropods, most1y Lepidoptera and Coleoptera (40%), Hymenoptera (12%) and Diptera (8%). However, adults and grains were not fed. Nestlings (4th day age) were fed by adults (32%), larvae (69%), and grains (2%). While the chicks were fed mostly by adults (72%), with larvae (23%) and grains of seed (5%). Significant differences were present in the growth of all traits, morphometry, diet, and food collection sites. However, no difference in feeding was noted. The main loss of nestlings was by mammalian predators and grazing and cutting of local crops. Awareness about the protection strategy of skylark from egg laying till fledging is required among locals and farmers.

INTRODUCTION

Oriental skylark (*Alauda gulgula*) is a longitudinal migratory bird of Afghanistan, Pakistan, especially of district Bajaur. Oriental skylark makes its nests on ground in grasses and agricultural lands (Gabol and Khan, 2021). It was primarily studied in Lao in the year 1997 (Duckworth *et al*., 2002). Oriental skylark is a house sparrow-sized bird (Donsker, 2014) widespread around Asia, including Northern Pakistan, Europe, and Africa. They makes their nests on the ground (Cramp *et al*., 1992; GM, 2002; Toochin and Meredith, 2018). Oriental skylark is the only passerine bird that mostly inhabits agricultural farmlands (GM, 2002; Praus and Weidinger, 2010). Oriental skylark has eleven to thirteen subspecies (Gill and Donsker, 2013; Little, 2017).

Oriental skylark mostly forage on the ground. The adults are generally vegetarian and granivorous; hatchlings and chicks mostly forage on larvae and soft-bodied insects (Donald *et al*., 2002). Both parents are equally involved in the care and feeding by the variety of local insects to the hatchlings (Gabol and Khan, 2021). In Pothwar Plateau, Pakistan, during winter season, they mostly feed on both wheat and mustard grains (Siriwardena *et al*., 1998; Piha *et al*., 2003). Hatchling and chicks of skylark are affected mainly by cutting of grasses and crops (Wilson *et al*., 1997). Suitable habitats and grass covered areas have a

* Corresponding author: rahmatullahkhanpk@gmail.com
0030-9923/2022/0006-2519 $ 9.00/0

rich density of arthropods as sources for feeding adults and nestlings (Gabol and Khan, 2021; Wakeham *et al*., 1998).

The skylark varies from generally other threatening agricultural passerines in nesting and foraging, mostly on the land in open fields. Therefore, any decreases in invertebrate presence triggered by more insecticide usage or changes in crop management are more likely to be reflected in the body condition and growth rate of skylark nestlings than in those of most other agricultural- areas passerines. There is proof that some vegetation and arthropod groups, some of which are important food sources for birds (Bell, 1990; Wilson and Browne, 1993; Wilson *et al*., 1999), have declined in numbers since the introduction of modern pesticides (Donald and Morris, 2005).

The current study was conducted to fill the gap in information. We recorded the important data about the hatchability, morphometry, and diet of growing hatchling, nestling, and chicks of Oriental skylark in Bajaur valley. This study will enhance and develop an effective strategy for the physiology and conservation of skylarks.

MATERIALS AND METHODS

Study area

The present research was conducted both in agricultural and grass lands of district Bajaur (34^{0}42-46.921 N and 071^{0}27-34.289 E) Khyber Pakhtunkhwa, Pakistan during April- July 2020. The total area of Bajaur is 1290 km^2 (Fig. 1) (Abidullah *et al*., 2019, 2021; Gabol and Khan, 2021; Khan and Gabol, 2021; Khan *et al*., 2021).

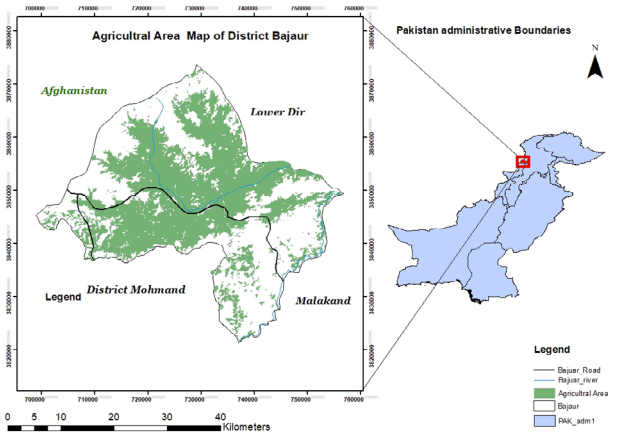

Fig. 1. Map of study area showed agricultural and grassy areas.

Morphometry

All the morphometric dimentions of 70 nestlings belonging to 22 nests were recorded till 8th days of age. All the targeted nests were observed daily both in the morning (7:00-10:00 Am) and in the afternoon (2:00-5:00 Pm) while hatchability, body mass, body growth, morphometry, and feeding activities were recorded by using digital balance (0.1-3000g), Vernier Caliper/measuring tap, camouflaged monitoring camera, and spotting scope until the chicks were 8 days old. As soon as a nest with chicks was located, it was observed intensively (from a distance of 60 m) three times a day for one hour to record food collection sites and the number of feeding per crop type per day. The food load carried in the beak was assessed on a subjective scale where one was the smallest and four was the biggest. However, the parents input in the feeding of the young was not documented.

Diet analysis

To identify feeding materials age-wise, the broods were categorized into three groups (i) hatchlings, (ii) nestlings, and (iii) chicks using both direct and indirect methods. For direct identification of diet spotting scope (40×70mm) was used three times a day. While for indirect diet identification, fecal material was collected from 1-8 days old nestlings in a collecting tube. However, to reduce the effect of diurnal variation in the diet, the material was collected three time a day after one hourly observations were recorded. The nestlings usually defecated when handled, and most of the droppings were obtained by holding a tube immediately beneath the cloaca. Chicks were not individually marked, so all droppings from a particular nest and sampling occasion were pooled and preserved in 95% ethyl alcohol. They were analyzed under a binocular microscope at x 25-40 magnification and identified by experts, by adopting the method described by Sotherton et at. (1987). Several randomly selected droppings were also examined using specially made slide preparations at x 100 magnification to look for insects and aphids. The number of each prey item was determined by counting number of characteristic parts, dividing by the number of parts per individual, and rounding off. The data from all chicks in a given nest were pooled daily, and the diet was estimated as the proportion by the number of each prey category. Droppings were collected from 70 nestlings belonging to 22 nests up to the age of 8 days.

RESULTS

The current study was based on successful hatching, diet, and morphometric measurements of Oriental skylark nestlings. All the eggs were hatched on the same day within a few hours. Their hatching mainly was recorded during the initial hours of the day, however some hatching was also recorded during the evening. Of 70 eggs, 54 were

hatched by breaking the rounded end of the eggshell, and 16 eggs were hatched on breaking the middle point (Table I). The shells were thrown out of the nests. The female covered on the nestlings continuously for the first two days and routinely during the cold and rainy days in order to provide warmth to the nestlings. The data were recorded up to the 8th day of hatching.

Table I. Oriental skylark (*Alauda gulgula*) nestling hatchability and growing activity per day.

		Facts			
Nest no.	**Hatching side of eggs**	**Eye opening day**	**Wing and tail feather felt (day)**	**Attempt to jump (day)**	**Flying attempt (day)**
N1	RE	3rd	4th	7th	16th
N2	RE	3rd	4th	7th	16th
N3	RE	3rd	4th	8th	14th
N4	RE	4th	4th	8th	17th
N5	MP	3rd	4th	8th	15th
N6	MP	4th	3rd	8th	15th
N7	MP	3rd	3rd	8th	16th
N8	MP	3rd	4th	8th	14th
N9	MP	3rd	4th	9th	17th
N10	MP	4th	4th	7th	15th
N11	RE	3rd	4th	8th	17th
N12	RE	4th	4th	8th	15th
N13	RE	3rd	4th	8th	15th
N14	MP	4th	3rd	8th	16th
N15	MP	3rd	3rd	8th	15th
N16	MP	3rd	4th	8th	16th
N17	MP	3rd	4th	8th	14th
N18	MP	4th	4th	8th	17th
N19	MP	3rd	4th	8th	15th
N20	MP	3rd	4th	8th	17th
N21	MP	3rd	4th	9th	15th
N22	MP	3rd	4th	7th	15th
Average		3.27±0.4	3.8±0.3	7.90±0.5	15.54±0.9

RE, round end; MP, middle point

The nestlings lived in their nests for about seventh to eleven days, but we recorded the data for 8 days. Nestlings from age 1-4 days produces siv, siv, siv like voices. The weight of first-day nestling ranged from 3 to 3.9 g, that increased consecutively, and on the 8th day of hatching, its weight ranged between 20 to 22.7 g and an average of 20.7±0.7 g (Fig. 2, Table II).

The nestlings opened their eyes on the third or fourth day when they could stand on their legs. Wing and tail feathers growth was also felt on the fourth day of their life. The first try to jump out from their nests was noted on the 6th to 8th days of life, while during this stage, they were also trying to hide and camouflage (Table I).

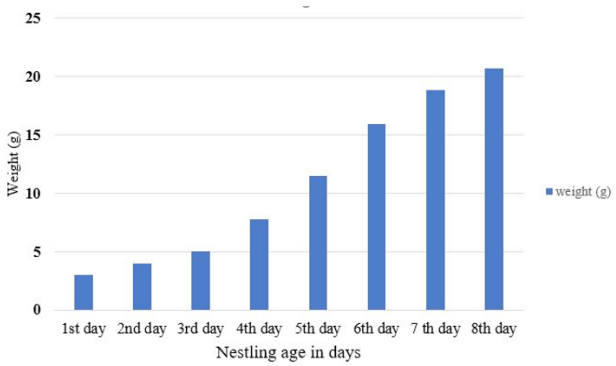

Fig. 2. Oriental skylark Nestlings weight gainday.

The average morphometric measurement of 21 chicks on the 8th days of age was recorded. The body weight ranged from 19.9-22.1g with an average of (20.9±0.7) g. Body length ranged from 6.5 to 6.9cm with an average of 6.7±0.1cm, similarly wing span ranged from 4.6-5 (4.7±0.1) cm, tail ranged from 0.7-0.9 (0.8±0.7) cm, beak ranged from 0.7-0.8 (0.7±0.04) cm, chest ranged from1.8-2.2 (1.9±0.1) cm, leg length ranged from1.9-2.1 (2.0±0.5) cm, middle claw ranged from 0.2-0.3 (0.2±0.04) cm and hind claw ranged from 0.4-0.5 (0.4±0.04) cm (Table II).

As a result, the nestlings opened their eyes on 3-4 days of age. Similarly, on 3-4 days of age, wings and tail feathers had also appeared. The chicks were able to jump and move inside the nests at 7-9 days. However, the growth rate of a nestling started to increase after 4th day of hatching (Table I).

Nestlings diet

Both the parents cooperatively fed the nestlings. They searched and captured 50 to 600m distance from the nest in all directions. Holding the prey in beaks parents would reach the nestlings and feed them. In total, 318 droppings from all 7 nests from 1-8 days were collected. From day 1-4 was considered hatchlings, and their food was larvae of Lepidoptera 45%, Coleoptera 45%, Hymenoptera 12%, and Diptera 8%. Although at the age of 5 and 6 days considered nestling and the main components of their food include larvae and adults of Lepidoptera, Coleoptera, Hymenoptera, Diptera, and 2% seeds. Similarly, 7-8 days broods were considered as chicks, and the main components of their diets was adult arthropods followed by larvae and about 5% seeds (Table III).

Table II. Average morphometric measurements on 8th days Oriental skylark nestlings in district Bajaur.

					(cm), (g)				
Nest No.	**Body length**	**Wing span**	**Tail**	**Beak**	**Chest**	**Leg length**	**Middle claw**	**Hind claw**	**Weight (g)**
N1	6.9	5	0.9	0.7	2.2	2.1	0.2	0.4	22.1
N2	6.5	4.7	0.8	0.8	1.8	1.9	0.2	0.5	20.9
N3	6.8	4.6	0.8	0.8	2	2	0.3	0.4	20
N4	6.7	4.9	0.8	0.8	1.9	2	0.2	0.4	21
N5	6.9	5	0.9	0.8	2.1	2	0.2	0.4	21
N6	6.8	4.8	0.7	0.7	2	2.1	0.3	0.5	20
N7	6.6	4.8	0.8	0.8	2	2	0.3	0.5	22
N8	6.8	4.7	0.7	0.7	1.9	2.1	0.2	0.4	20.8
N9	6.8	4.7	0.9	0.8	2	2	0.2	0.4	19.9
N10	6.9	4.6	0.8	0.8	1.8	1.9	0.3	0.5	20.9
N11	6.5	4.9	0.8	0.8	2.2	2	0.2	0.4	20
N12	6.8	5	0.8	0.8	1.8	2	0.2	0.4	21
N13	6.7	4.8	0.9	0.7	2	2	0.3	0.5	21
N14	6.9	4.8	0.7	0.8	1.9	2.1	0.3	0.5	20
N15	6.8	4.7	0.8	0.8	2.1	2	0.3	0.4	22
N16	6.6	4.6	0.7	0.8	2	2.1	0.2	0.4	20.8
N17	6.8	4.9	0.9	0.7	2	2	0.2	0.4	19.9
N18	6.9	5	0.7	0.8	1.9	2.1	0.3	0.5	21
N19	6.5	4.8	0.8	0.7	2	2	0.2	0.4	20
N20	6.8	4.8	0.7	0.8	1.9	2.1	0.2	0.4	22
N21	6.7	4.7	0.9	0.8	2.1	2.1	0.3	0.5	20.8
N22	6.9	4.7	0.8	0.8	2	2	0.2	0.4	20
Mean±Std	6.75±0.1	4.79±0.1	0.8±0.7	0.77±0.04	1.9±0.1	2.02±0.06	0.2±0.04	0.4±0.04	20.7±0.7

Table III. Dietary materials feder (%) to the hatchlings, nestlings, and chicks during growing stages.

Stage	**Dietary materials**	**Lep**	**Col**	**Hym**	**Dip**	**Seeds**	**Total (%)**
Hatchling	Arthropod adults	-	-	-	`-	-	0
	Larvae	40	40	12	8	-	100
	Grains	-	-	-	-	-	0
Nestling	Arthropod adults	11	9	6	6	-	32
	Larvae	22	25	12	10	-	69
	Grains	-	-	-	-	2	2
Chick	Arthropod adults	18	28	14	12	-	72
	Larvae	7	5	4	7	-	23
	Grains	-	-	-	-	5	5

Lep, Lepidoptera; Col, Coleoptera; Hym, Hymenoptera; Dip, Diptera.

Feeding activity

The food was actively searched and brought from a distance of 50-600 m. In all cases and all five crop types, both parents took part in feeding the young. Feeding frequency varied from 10 to 28 per crop type per day (3 h). Almost 60% arthropods were collected from wheat (*Triticum aestivum*) fields, and 40% from barely (*Hordeum vulgare*), mustard (*Brassica campestris*), nusk (*Lens ervoides*) and grasslands (Fig. 3).

Load size

The parents collect more dietary materials from wheat fields, followed by grasslands. It was possible to identify items in the beak accurately only when parent birds passed sufficiently close to the observer. Load size reflected a combination of the number and size of items being carried. The heaviest loads were typically giant caterpillar-like larvae of ground beetles, spiders, and dragon flies (adults and larvae). Smaller loads were typically that of small larvae, small beetles, and hemipterans. There were no significant differences in load size for any particular nestling age, either between nests in the same crop or between nests in different crop types. Hence, data were pooled according to nestling age and crop type. There was no significant interaction between nestling age and crop type (Fig. 3).

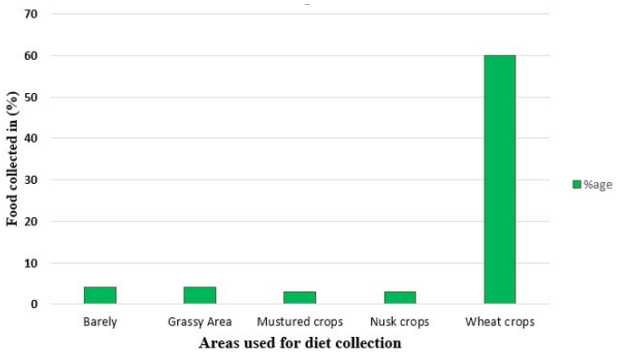

Fig. 3. Collection of feeding materials by Oriental skylark from various crops fields.

Diet composition

The dietary materials of hatchling, nestling, and chicks mainly consist of Lepidoptera, Coleoptera, Hymenoptera, Diptera, and grains of local seeds, as shown in Table III.

Ecological factors affecting fledging of chicks

All the eggs of each nest hatched on the same day within few a hours respectively. However, chicks of some nests fledged and left the nests within 7-9 days. As a result available dietary materials and suitable environmental conditions supports in earlier fledging stage i.e., seven days. We noted that the chicks of early May fledge earlier as local crops and vegetation have not yet been harvested, that harbour variety of arthropods for their diet. When crops are harvested, and grasslands grazed insect fauna also decreases. Farmers and other local interference in fields disturbs the activity of parents that also affects the quality of life of skylark and hatching and fledging time is delayed.

DISCUSSION

The current study is based on successful hatching, diet, and morphometric measurements of Oriental skylark nestlings in Bajaur. All the eggs were hatched on the same day within a few hours. Their hatching mainly was recorded during the initial hours of the day, however some hatching was recorded during the evening as well. In West Bulgaria, Shurulinkov (2005) published about the hatching of skylark; according to him, all skylark eggs are commonly hatched within few hours during morning hours but some times in the afternoon and probably during night.

Most of the eggs were hatched by breaking the rounded end of the eggshell, and a few hatched by breaking the middle point. The shells were thrown out of the nest. Shurulinkov (2005) also reportedresults similar to ours. According to him, hatching begins from the blunt poles, and in some cases middle point of the shell breaks, and the shells are removed by parents. The female with nestlings continuously covers the nestling for the first two days and routinely especially during the cold and rainy days in order to provide warmth to the nestlings. The skylarks female remained in the nest up to 8th day of hatching. Verstijnen *et al*. (2021) reported similar results in Europe.

The nestlings lived in their nests until they were able to move and fledge. Nestlings produced siv, siv, siv and chicks siver, siver siv like voices. The weight of the first-day nestling ranged from 3 to 3.9 g, which increased consecutively, and on the 8th day of hatching, its weight ranged from 20 to 22.7 g and an average of 20.7±0.7 g. Verstijnen *et al*. (2021) and Shurulinkov (2005) recorded that the nestlings stayed in their nest for about 8-10 days. The nestlings changed their morphology by gaining body weight and producing adult like voices.

The nestlings opened their eyes on the third or fourth day, when they could stand on their legs. Wing and tail feather growth also appeared on the fourth day of their life. The first try to jump out from their nests was noted on the 6th to 8th days of life, while during this stage, they were also trying to hide and camouflage. Li *et al*. (2015) and Verstijnen *et al*. (2021) reported that the weight rapidly increased in the first week. In the mid-first week, some tail, wing, and contour feathers were grown. While after a week, they could catch feeding materials.

The average morphometric measurements of 70 chicks of 8 days age were noted. The body weight ranged from 19.9-22.1 with an average of (20.9±0.7) g. Similar results were also reported by Li *et al*. (2015). Nestlings of skylark attempted to fly on 8th to 11th days of hatching with body mass 22-27 g.

Similarly, the chicks attained adults like body length, wing span, tail, beak, chest, legs length, middle claws and hind claw. Mainjargal *et al*. (2013) studied nesting behavior, diet, and morphometry of the nestling of Eurasian skylark and other three different species of lark comprehensively. They reported that the body length of skylark nestlings increased significantly with age. He also reported morphometric measurements of four morphological characters viz., wingspan, body mass, bill, and tarsus, that were compatible to our results.

At the age of 3-4 days the nestling opened their eyes and feathers started growing on their naked body. However the chicks were able to jump and run a little inside the nests by 7-9 days. Southwood and Cross (2002) reported that at the end of the first week, the nestlings opened their closed eyes and their feathers started to grow. He also reported that more dietary proteins helped in good plumage and quick fledging from nests.

Parents searched and brought food to the nestlings from 50-600 m in their beaks. Donald and Morris (2005) also reported similar results. From 1-8 days of nestlings, a total of 318 faecal drops from all 22 nests were analyzed. The food of nestlings aged 1-4 days (hatchlings), consisted of only larvae of Lepidoptera 45%, Coleoptera 45%, Hymenoptera 12%, and Diptera 8% without any adults or plant materials. The nestlings of 5-6 days of age were fed on both larvae and adults of Lepidoptera, Coleoptera, Hymenoptera, Diptera, and 2% seeds. Similarly, 7-8 days nestling (chicks) consumed adult arthropods followed by larvae and about 5% seeds. Green (1978) and Holland *et al.* (2006) reported that the diet of nestlings consisted of both larvae and adults of arthropods (Coleoptera 84%), seeds, and sand particles. Poulsen *et al*. (1998) recorded that only invertebrates were the diet of nestlings. Elmegaard *et al.* (1999) recorded that the diet of chicks was aphids. Geiger *et al*. (2014) recorded Diptera and Orthoptera as the diet of nestling. Similar results were reported by Weibel (1999) Mainjargal *et al*. (2013) reported that the major food category consumed by nestlings included Coleoptera and Orthoptera.

The present study recorded that skylark covered their nestling during the unfavorable conditions. Cramp *et al.* (1992) explored that in West Europe, skylark covered their nestlings up to fledging stage to keep them warm during the cold, rainy season and harsh environmental conditions. The earlier fledging and body growth of chicks depends upon dietary materials and suitable habitat. This conditions remained feasilble untill early May. After this local crops were harvested and variety of insects and safety were compromised. Farmer and other local disturbances in the fields a; so hampers the activity of parents that affects the feeding of nestlings and their fledging is delayed. Schläpfer (1988) and Poulsen *et al*. (1998) reported that chick deaths were caused by starvation. However, if good diet was made available to nestlings, it proved helpful in earlier fledging of nestlings. When the nestlings left the nest, they lived for about one week within 50-80 m^2 of their nest, while still dependent on their parents.

ACKNOWLEDGMENTS

The authors gratefully acknowledge the University of Karachi, Pakistan, for providing an opportunity to complete this doctoral degree work.

Statement of conflict of interest

The authors have declared no conflict of interest.

REFERENCES

Abidullah, S., Rauf, A., Khan, S. W., Bibi, A., and Fazal, S., 2019. Traditional uses of medicinal plants in their conservation in Charmang Village, Bajaur, KP, Pakistan. *Int. J. Bioorg. Chem.,* **4**: 70. https://doi.org/10.11648/j.ijbc.20190401.20

Abidullah, S., Rauf, A., Zaman, W., Ullah, F., Ayaz, A., Batool, F., and Saqib, S., 2021. Consumption of wild food plants among tribal communities of Pakistan-Afghan border, near Bajaur, Pakistan. *Acta Ecol. Sin*., https://doi.org/10.1016/j.chnaes.2021.08.002

Bell, G.P., 1990. Birds and mammals on an insect diet: A primer on diet composition analysis in relation to ecological energetics. *Stud. Avian Biol.,* **13**: 416–426.

Cramp, S., Simmons, K., Ferguson-Lees, I., Gillmor, R., Hollom, P., Hudson, R., and Voous, K., 1992. *Handbook of the birds of Europe, the Middle East and North Africa*. Oxford University Press.

Donald, P., Evans, A., Muirhead, L., Buckingham, D., Kirby, W., and Schmitt, S.E.I., 2002. Survival rates, causes of failure and productivity of Skylark *Alauda arvensis* nests on lowland farmland. *Ibis,* **144**: 652-664. https://doi.org/10.1046/j.1474-919X.2002.00101.x

Donald, P.F., and Morris, T.J., 2005. Saving the skylark. *Br. Birds,* **98**: 570-578.

Donsker, F.G.D., 2014. *IOC World bird list*. Version 4.2.

Duckworth, J., Davidson, P., Evans, T., Round, P., and Timmins, R., 2002. Bird records from Laos, principally the upper Lao/Thai Mekong and Xiangkhouang Province, in 1998-2000. *Forktail*, **18**: 11-44.

Elmegaard, N., Andersen, P., Odderskaer, P., and Prang, A., 1999. *Food supply and breeding activity of Skylarks in fields with different pesticide treatment.* Paper presented at the Proc. 22 Int. Ornithol. Congr., Durban.

Gabol, K., and Khan, R. U., 2021. Breeding biology and nidology of Oriental skylark (*Alauda gulgula*) in district Bajaur, Khyber Pakhtunkhwa, Pakistan. *Pure appl. Biol*., **10**: 1326-1337. https://doi.org/10.19045/bspab.2021-100137

Geiger, F., Hegemann, A., Gleichman, M., Flinks, H., de Snoo, G.R., Prinz, S., and Berendse, F., 2014. Habitat use and diet of skylarks (*Alauda arvensis*) wintering in an intensive agricultural landscape of the Netherlands. *J. Ornithol.,* **155**: 507-518. https://doi.org/10.1007/s10336-013-1033-5

Gill, F., and Donsker, D., 2013. IOC world bird list (version 3.3). *Int. Ornithol. Union,* http://dx.doi.org/10.14344/IOC.ML.3.3 Available online at http://www.worldbirdnames.org/

GM, Z., 2002. *A checklist on the classification and*

distribution of the birds of the world: Science Press, Beijing.(in Chinese).

Green, R., 1978. Factors affecting the diet of farmland skylarks, *Alauda arvensis*. *J. Anim. Ecol.*, **47**: 913-928. https://doi.org/10.2307/3678

Holland, J., Hutchison, M., Smith, B., and Aebischer, N., 2006. A review of invertebrates and seed-bearing plants as food for farmland birds in Europe. *Ann. appl. Biol.,* **148**: 49-71. https://doi.org/10.1111/j.1744-7348.2006.00039.x

Khan, R.U., and Gabol, K., 2021. Breeding biology of chakoor partridge (*Alectoris chukar*) in Bajaur, Khyber-Pakhtunkhwa, Pakistan: Critically affected by eggs collection and predation. *Pure appl. Biol.,* **10**: 913-921. https://doi.org/10.19045/bspab.2021.100094

Khan, R.U., Sadam, A., and Mahmood, S., 2021. Population ecology of chakor partridge (*Alectoris chukar*) in District Bajaur, Khyber Pakhtunkhwa, Pakistan. *Pakistan J. Zool.,* **52**: 1197-1200. https://doi.org/10.17582/journal.pjz/20190806070800

Li, S., Peng, W., and Guo, C., 2015. Factors affecting nest success of the oriental skylark on the tibetan plateau. *Ornithl. Sci.,* **14**: 47-52. https://doi.org/10.2326/osj.14.47

Little, R.M., 2017. Roberts bird guide. *Ostrich,* **88**: 99-100.

Mainjargal, G., Buuveibaatar, B., and Boldbaatar, S., 2013. Morphology, diet composition, distribution and nesting biology of four Lark species in Mongolia. *Mongol. J. biol. Sci.,* **11**: 3-11. https://doi.org/10.22353/mjbs.2013.11.01

Piha, M., Pakkala, T., and Tiainen, J., 2003. Habitat preferences of the skylark *Alauda arvensis* in southern Finland. *Ornis Fenn.,* **80**: 97-110.

Poulsen, J.G., Sotherton, N.W., and Aebischer, N.J., 1998. Comparative nesting and feeding ecology of skylarks *Alauda arvensis* on arable farmland in southern England with special reference to set-aside. *J. appl. Ecol.,* **35**: 131-147. https://doi.org/10.1046/j.1365-2664.1998.00289.x

Praus, L., and Weidinger, K., 2010. Predators and nest success of skylarks *Alauda arvensis* in large arable fields in the Czech Republic. *Bird Study,* **57**: 525-530. https://doi.org/10.1080/00063657.2010.506208

Schläpfer, A., 1988. *Populationsökologie der Feldlerche "Alauda arvensis" in der intensiv genutzten Agrarlandschaft* (in German). Verlag nicht ermittelbar.

Shurulinkov, P., 2005. On the breeding biology of Skylark, *Alauda arvensis cantarella* (Aves: Passeriformes) in West Bulgaria. *Acta Zool. Bulg.,* **57**: 207-216.

Siriwardena, G.M., Baillie, S.R., Buckland, S.T., Fewster, R.M., Marchant, J.H., and Wilson, J.D., 1998. Trends in the abundance of farmland birds: A quantitative comparison of smoothed common birds census indices. *J. appl. Ecol.,* **35**: 24-43. https://doi.org/10.1046/j.1365-2664.1998.00275.x

Sotherton, N.W., Moreby, S.J. and Langley, M.G., 1987. The effects of the foliar fungicide pyrazophos on beneficial arthropods in barley fields. Ann. appl. Biol., **111**: 75-87.

Southwood, T.R.E., and Cross, D.J., 2002. Food requirements of grey partridge *Perdix perdix* chicks. *Wildl. Biol.,* **8**: 175-183. https://doi.org/10.2981/wlb.2002.031

Toochin, R., and Meredith, M., 2018. Status and occurrence of Eurasian skylark (*Alauda arvensis*) in British Columbia. *IBIS*. https://ibis.geog.ubc.ca/biodiversity/efauna/documents/EUSK-article-RT-MM.pdf

Verstijnen, Y.J., Maliaka, V., Catsadorakis, G., Lürling, M., and Smolders, A.J., 2021. Colonial nesting waterbirds as vectors of nutrients to Lake Lesser Prespa (Greece). *Inland Waters*, **11**: 1-17. https://doi.org/10.1080/20442041.2020.1869491

Wakeham-Dawson, A., Szoszkiewicz, K., Stern, K., and Aebischer, N.J., 1998. Breeding skylarks Alauda arvensis on environmentally sensitive area arable reversion grass in southern England: Survey-based and experimental determination of density. *J. appl. Ecol.,* **35**: 635-648. https://doi.org/10.1046/j.1365-2664.1998.355336.x

Weibel, U.M., 1999. *Effects of wildflower strips in an intensively used arable area on skylarks (*Alauda arvensis*)*. ETH Zurich.

Wilson, J.D., and Browne, S.J., 1993. *Habitat selection and breeding success of skylarks* Alauda arvensis *on organic and conventional farmland.* BTO Research Report No. 129

Wilson, J.D., Evans, J., Browne, S.J., and King, J.R., 1997. Territory distribution and breeding success of skylarks *Alauda arvensis* on organic and intensive farmland in southern England. *J. appl. Ecol.*, pp. 1462-1478. https://doi.org/10.2307/2405262

Wilson, J.D., Morris, A.J., Arroyo, B.E., Clark, S.C., and Bradbury, R.B., 1999. A review of the abundance and diversity of invertebrate and plant foods of granivorous birds in northern Europe in relation to agricultural change. *Agric. Ecosyst. Environ.,* **75**: 13-30. https://doi.org/10.1016/S0167-8809(99)00064-X