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Breeding success of the Stone Curlew *Burhinus oedicnemus* in Nag Valley (1999–2001), Kharan, Pakistan

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Abstract: Variations in different breeding parameters in 2 adjacent populations of the Stone Curlew in Nag Valley were studied. A total of 106 active nests were spotted, with an overall mean clutch size of 1.42 eggs per nest. The nest and egg success of the Lope Valley population was 0.50 and 0.42, respectively, while the nest and egg success of the Kereichi population was 0.60 and 0.45. Poaching of eggs/chicks, habitat shrinkage, overgrazing, and fuel wood collection are thoughts to be the main factors affecting the breeding success of Stone Curlew in the area.

Key words: Nag Valley, Stone Curlew, nest, egg, fledgling, breeding success

The Stone Curlew belongs to Charadrii and is widely distributed throughout the Palearctic region (Tucker and Heath, 1994). It occurs throughout Europe, North Africa, and Southeast Asia (Cramp, 1988; Tucker and Heath, 1994). It is a summer migrant in the more temperate European and Asian parts of its range, wintering in Africa. It is nocturnal in feeding, as suggested by the large eyes, and categorized as a strict ground species (Whistler, 1949). It prefers the scrub desert and extensive sand dune desert. In Pakistan, it is reported from the mouth of Khyber Pass, the Jamrud plains, the north shore of Hab Dam, Popalzai plain near Chaman, Thano Bulla Khan in Hyderabad, Dalbadin, Sukkar, and some parts of northeastern Kohat in the North-West Frontier Province (Roberts, 1991). It is absent from the Salt Range and the cultivated plains of Sind and Punjab provinces, but sparsely occurs in the Cholistan and Thar deserts. It is also likely to be encountered in Sind in the broader arid valleys of hill ranges west of the Indus River, or on barren sandy islands in the Indus delta along the Mekran coast (Roberts, 1991).

The Stone Curlew is considered one of the rarest and most threatened breeding birds of the United Kingdom (Gibbons et al., 1996). The population of Stone Curlew has dropped 85% in the last 50 years; it is estimated that there are fewer than 200 pairs in the UK (Green, 1995). The main causes of decline are thought to be the loss of seminatural habitat due to urbanization and breeding success being reduced with changing agricultural practices; egg collection is also a serious threat, along with disturbance from recreational activities (Battern et al., 1990). The Stone Curlew is included among the UK Biodiversity Action Plan species and is also targeted in a Species Recovery Programme carried out by English Nature and the Royal Society for the Protection of Birds. Birdlife International listed it as a Species of European Conservation Concern due to its decline in most European countries (Tucker and Heath, 1994). Population estimates of Stone Curlew are not available for Pakistan; however, Roberts (1991) described its status as "Scarce".

The breeding season of Stone Curlew varies from February to August; however, most of the eggs are laid in April. In most cases, the nest is a scrape on the ground near the base of a bush or tuft of grass (Whistler, 1949). The clutch size is 2 eggs, and incubation is shared by both male and female. The chicks are fed by the parents for the initial few days, and they remain attached to the parents for 2 months after fledging (Roberts, 1991). In case of egg/chick loss, the breeding pair tends to produce a second clutch/brood (www.rspb.org.uk/flash.html). This study aimed to collect information about the breeding activities of Stone Curlew in the study area, which is a new breeding site in Pakistan.

Nag Valley is a subdivision of Besima (Kharan District) located at 27°41′N and 65°14′E, between Besima and

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Panjgur in the southwest of Kharan District. Its altitude varies between 1100 and 1600 m. It is a narrow valley having an area of about 1500 km^2. The climate of the area is generally arid, with an annual maximum precipitation of about 200 mm. The mean minimum and maximum temperatures were 15 and 29 °C respectively for 1999–2001. The temperature often drops below 0 °C in the winter season and may rise up to 42 °C during summer (Nadeem et al., 2004, 2011). Rainfall occurs in a cyclic way, often with periods of 2–3 years of drought. There were good rains in 1997 resulting in green vegetation, but after that, there was a drought period since 2001, due to which vegetation was in a poor condition (Nadeem et al., 2004). The Nag Valley can be subdivided into the relatively smaller Lope Valley and larger Kereichi area; the Lope area is relatively plain, dominated by *Haloxylon ammodenderon*, *Haloxylon griffithi*, *Pennisetum divisum*, *Convolvulus spinosus*, *Otostegia aucheri*, *Astrogalus stocksii*, *Cymbopogon jwarancusa*, *Echinops echinatus*, *Fagonia indica*, *Zygophyllum eurypterum*, *Rhazya stricta*, *Calligonum comosum*, and *Withania coagulans*. Cultivated fields of wheat and fodder are present in patches. The Kereichi area is more undulating, dominated by *Rhazya stricta*, *Zygophyllum eurypterum*, *Pennisetum divisum*, *Convolvulus spinosus*, *Astrogalus stocksii*, *Ephedra intermedia*, *Panicum antidotale*, *Sophora mollis*, *Nerium odorum*, and *Haloxylon salicornicum* (Nadeem et al., 2004, 2011). The smaller patches between the slopes have maximum vegetation cover; this type of border patch is used for the cultivation of wheat, maize, and fodder.

Most of the nests were located by observing the parents with binoculars (10 × 50) from a suitably distant vantage point, and were then checked to record data regarding timing and success of breeding at intervals of 1 week. The nests were located from a distance without disturbing the pairs. Once a nest was located, its GPS position was taken; it was located again with the help of GPS and existing landmarks. The nests were monitored on a weekly basis and the numbers of eggs and chicks were recorded. Egg breadth and length were measured with a dial caliper (0.02 precision), and weight was measured with a Pesola spring scale (±0.01 g accuracy) during the first nest check. We followed Hoyt (1979) to calculate the volume by using the equation $V = K \times L \times B^2$, where V is egg volume (cm^3), L is egg length (mm), B is egg width, and K is a constant (0.4866). Sphericity index was calculated as B/L × 100 (Hoyt, 1979; Aslan and Yavuz, 2010; Moosavi et al., 2011). When the nest was found to be empty on the first check, it was carefully searched for small fragments of shell, the presence of which indicated that hatching had occurred. To determine the first egg-laying date, it was assumed that the first egg was laid 27 days before the observed hatching date (Green et al., 2000).

The nest area was defined as the area in which a pair of Stone Curlew traditionally breeds, as recognized by Newton et al. (1978) for the Merlin *Falco columbarius*. The nest territory of the Stone Curlew was defined as an area of 200 m in radius around the nest. This was based on the area aggressively defended against intruders after egg-laying, as observed in this study. The nest success was calculated as the number of clutches that produced young divided by the total number of clutches, and egg success was calculated as the number of young that left the nest divided by the total number of eggs (Nice, 1957; Ricklefs, 1969; Skutch, 1985; Nadeem et.al., 2011). Student's t-test was applied for comparison of different years using a 5% level of significance. Though not quantified, the poaching of eggs/chicks, fuel wood collection, overgrazing, and expansion of agricultural land were directly observed in the area during the study duration.

During the study period (1999–2001), 126 nests of the Stone Curlew were located, out of which 106 were active, with 151 eggs; the remaining 20 nests had been destroyed at the initial stages before egg-laying (Table 1). Most of the nests (68%) were recorded on the bare gravel ground, from where the incubating female/male could see intruders from a long distance; some nests were also found under *Zygophyllum eurypterum* (18%) and *Salsola arbuscula* (14%). In most cases, the nest was a slight depression on the ground, probably developed by the sitting of the bird; both female and male share incubation. The laying period varied from late February to early May, but most of the egg-laying occurred in late March and early April (Figure 1). Incubation period varied between 24–27 days and

Table 1. Breeding success of Stone Curlew in Nag Valley during different years.

Year	Nests located	Active nests	No. of eggs	Mean clutch size	No. of hatched eggs	Hatching success (%)	No. of fledged	Fledging success (%)
1999	53	46	71	1.54	58	81.69	33	56.90
2000	42	34	49	1.44	39	79.59	22	56.41
2001	31	26	31	1.19	23	74.19	12	52.17
Total	126	106	151	1.42	120	79.47	67	55.83

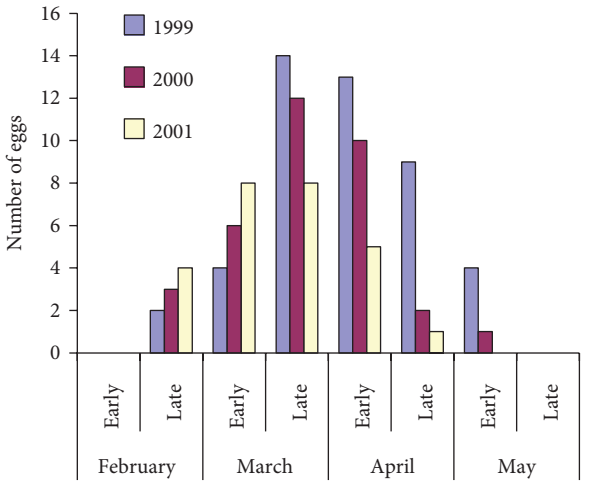

Figure 1. Laying dates of the Stone Curlew during different years in Nag Valley, Kharan Pakistan.

chicks fledged in 35 ± 2 days. The same area/nest was used again and again for many years.

Measurements of 151 eggs revealed mean egg length of 49 ± 0.34 mm (range: 45.2–54.8 mm), mean width 34 ± 0.16 mm (range: 30.5–37.2 mm), sphericity index 69.4, and volume 27.6 cm^3. The mean clutch size was 1.54 eggs per nest in 1999, followed by 1.44 and 1.19 eggs per nest for 2000 and 2001, respectively (Table 1). Hatching success was highest (81.69%) in 1999 and dropped to 79.59% in 2000 and 74.19% in 2001. Fledging success was 56.9% and 56.41% in 1999 and 2000, while it was lower (52.17%) in 2001.

In the population of Lope Valley, 23 females laid a total of 47 eggs in 32 nests (mean clutch size: 1.46). Nest success of the Lope population was 0.50, and egg success was 0.42 (Table 2). The number of fledglings produced per successful clutch was 1.25. Similarly, the 54 females of the population of the Kereichi area laid 104 eggs in 74 nests (mean clutch size: 1.40). Nest success of the Kereichi population was 0.60, and egg success was 0.45. The number of fledglings produced per successful clutch was 1.04.

In the Nag Valley, 106 nests of Stone Curlew with a mean clutch size of 1.42 were recorded during 1999–2001. Solis and Lope (1995) reported a mean clutch size of 1.81 eggs per nest of Stone Curlew over 5 years in Spain. In our study, the low clutch size perhaps reflected the low availability of food. Maximum egg-laying occurred in late March and early April depending on temperature variations. In 1999, maximum egg-laying was recorded in late March and early April owing to slightly lower temperatures, while in 2001 the peak of laying was observed in March due to slightly higher temperatures in the breeding months (Nadeem et al., 2004, 2011). Moreover, in February and March 1999, little rain was received (Nadeem et al., 2004, 2011), which perhaps extended the laying period and had a positive effect on breeding. The vegetation cover was comparatively better in 1999 under the influence of good rains during 1997; however, it was poor in 2001 (Nadeem et al., 2004, 2011). The Importance Value Index of key plant species, including the plants used for nesting, declined gradually (Nadeem et al., 2004, 2011). Bealey et al. (1999) reported maximum egg-laying in April in the United Kingdom. Green et al. (2000) reported that breeding attempts covered a period of 4 months in the United Kingdom (late March to late July), with a peak of egg-laying between 10 April and 10 July. We found all nests in the present study to be without any nest material (Figure 2), while Westwood (1983) and Solis and Lope (1995) reported that the Stone

Table 2. Breeding success of 2 populations of Nag Valley during 1999–2001. Both populations are single-brooded and often lay replacement clutches in instances of loss. In this table, for example, 23 females laid a first clutch, of which 11 were successful. From the 12 failed females, 9 laid replacement clutches, out of which 8 were successful.

No. of first-brood clutch		No. of successful brood	Total eggs	Mean clutch size	Total fledglings	Mean fledgling successful brood
Lope Valley population						
	23	11	39	1.70	13	1.18
	9	5	8	0.89	7	1.40
Total	32	16	47	1.47	20	1.25
Kereichi area population						
	54	34	83	1.54	36	1.02
	20	11	21	1.05	11	1.00
Total	74	45	104	1.41	47	1.04

Figure 2. The nest of the Stone Curlew on bare ground in Nag Valley.

Curlew uses a little nest material in the United Kingdom and Spain, which is helpful in the concealment of the laid eggs, reducing predation. Perhaps in our study the stone mixed in the sand already provides good camouflage for the eggs; hence, the species did not use any nest material in the nest.

Nest building and egg-laying were not statistically different in the years 1999 and 2000, while they were significantly lower ($P < 0.05$) in 2001 when compared with the year 1999. Hatching success and fledging success appeared to be nearly the same in all 3 years. Hatching success was recorded as 79.47%, while Solis and Lope (1995) reported lower hatching success (38.1%) from 97 nests with 176 eggs in Spain. This higher hatching success could be due to the gravel terrain, which provides excellent camouflage for the nest; the color of the eggs is perfectly matched with the surrounding stones and sand color, which perhaps reduced predation.

The nest and egg success for the Lope population was 0.50 and 0.43, respectively. No comparable data are available regarding these parameters for Stone Curlew. The nest and egg success of the Kereichi population was 0.61 and 0.45, respectively. This indicates that the females of the Kereichi population were more successful than those of the Lope population; 42.55% of the eggs of the Lope population produced fledglings, whereas 45.19% of the eggs of the Kereichi population produced fledglings. Fifty percent of clutches of the Lope population produced young that left the nests, while 60% of clutches of the population of Kereichi produced young that left the nest. The mean clutch size (sometimes used as an indicator of reproductive success), however, was greater for the Lope population than for the Kereichi population.

Poaching of eggs/chicks, habitat shrinkage, overgrazing, and fuel wood collection are the observed factors that may affect the breeding success of Stone Curlew in the area. The area of Nag Valley is also a breeding habitat of Houbara Bustard in Pakistan (Nadeem et al., 2004) and it was declared as a Wildlife Sanctuary in September 1995 to support the breeding Houbara population, but this is only on paper. Hunting, poaching, grazing, and deforestation still continue on a large scale. Poaching of eggs and chicks of Stone Curlew is a common practice in the area. People collect the eggs/chicks of Stone Curlew while searching for the eggs/chicks of Houbara Bustard and try to sell them. Poachers contacted us twice for the sale of chicks and eggs of Stone Curlew. This causes a decline in the breeding population of Stone Curlew. Although Stone Curlew is well adapted to living in an agropastoral system, the increase in agricultural activities affects breeding activity. Expansion of agricultural fields reduces the extent of breeding areas, and increased human activities make the bird more vulnerable. Removal of shrubs due to fuel wood collection and overgrazing takes away shelter and nesting cover for the breeding birds and their chicks. Lavee (1985) found that heavily grazed areas in Israel had reduced plant cover, which deprived the birds of vegetable food as well as insects. Collins (1984) also described a similar situation in the Canary Islands for the Houbara Bustard. The areas now suitable for Stone Curlew as a habitat have declined in quality and quantity and have fragmented. *Zygophyllum eurypterum*, *Rhazya stricta*, and *Haloxylon* are the main shrubs of the breeding habitat in Nag Valley, but these species were under severe pressure from the cutting of fuel wood and thatch-making, as tree cover is absent in the valley.

Management strategies with the involvement of local communities are required immediately to boost the breeding success of the Stone Curlew in the area. Strict rules of wildlife sanctuary should be applied, and law enforcement agencies should actively participate to improve the situation. It would seem urgent to ban poaching and deforestation completely. Awareness in the local populace and their involvement in conservation activities through a participatory rural approach are necessary for the sustainable use of wildlife resources.

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