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Annual Reproductive Success of the Hoopoe Lark *Alaemon alaudipes* in Nag Valley (1999-2001), Kharan, Pakistan

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Abstract.-The different breeding parameters were studied in the two nearby populations of Hoopoe Lark in Nag Valleys. Fifty one active nests were located with mean clutch size of 2.41 eggs per nest. The nest and egg success of the Kereichi population was estimated as 0.71 and 0.32 while it was 0.50 and 0.39 respectively for the population of Lope Valley. The annual reproductive success of the female of both populations were determined to be same, however, the mean clutch size, nest success, egg success and fledgling success were different in both populations.

Keywords: Nag Valley, hoopoe lark, nest success, egg success, fledgling, annual reproductive success.

INTRODUCTION

Hoopoe lark (*Alaemon alaudipes*) is a passerine and cursorial bird; it can run very fast with the help of long legs and always reluctant to fly even when disturbed. It encountered mostly as single individual rarely in pairs (Roberts, 1992). It occurs from the Cape Verde Islands through North Africa, east of Arabia, south of the Atlas Mountains, Iraq, Southern Iran, Syria, Afghanistan, Pakistan and Northwest India (Ali and Ripley, 1987; Cramp, 1988; Birdlife International, 2004). It is widely distributed in the desert areas of Balochistan (Chagai, Kharan), Sind (Sibi, Tharparkar) and Punjab (Cholistan) provinces as well as Mekran coastal areas of Pakistan (Ali and Ripley, 1987; Roberts, 1992).

It is a bird of deserts and semi-desert areas, usually associated with barren clay flats and low sand dunes. It avoids the agricultural lands and foothill regions (Roberts, 1992). It nests on the ground with two eggs being laid and incubated by both sexes (Birdlife International, 2004). Ali and Ripley (1987) described the nest as large untidy looking structure of sticks with deepest cup in center having depth of 40mm, usually placed in a bush upto 60cm; it laid 2-3 eggs incubated by female only. Roberts (1992) described the status of Hoopoe Lark as SCARCE within the Pakistan; however Birdlife International (2004) listed it as a Least Concern.

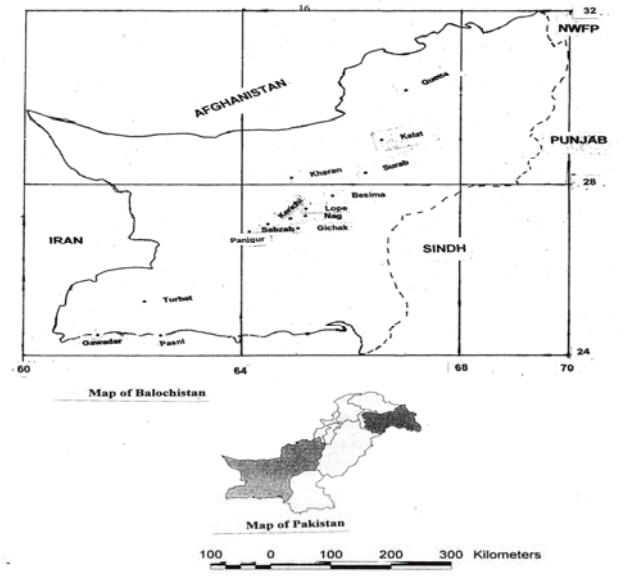

Fig. 1. Map of Balochistan showing Nag Valley.

MATERIALS AND METHODS

Study area

Nag Valley is located 27° 41 N and 65° 14 E between Besima, and Panjgur in the south west of the Kharan District (Fig. 1). The Valley comprises an area of 1500 km^2 with varying altitude of 1100–

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1600m above the sea level. The annual rainfall is about 200mm and the climate is generally arid. During the period of 1999-2001 the mean minimum and maximum temperatures were recorded as 15°C and 29°C respectively; In winter the temperature often dropped below zero while in summer it may rises up to 42°C (Nadeem *et al.*, 2004). The rainfall is erratic with periods of 2-3 years of drought; good rains were received during 1997, resulting in green vegetation and after that there was a drought period since 2001, resulting in poor vegetation (Nadeem *et al*., 2004). The Valley has two subdivisions; the comparatively smaller Lope valley and larger Kereichi area; the Loope is relatively plain area dominated by *Haloxylon ammodenderon, Haloxylon griffithi, Pennisetum divisum, Convolvulus spinosus, Otostegia aucheri, Astrogalus stocksii, Cymbopogon jwarancusa, Echinops echinatus, Fagonia indica, Zygophyllum eurypterum, Rhazya stricta, Calliigonium comosum,* and *Whithania coagulans.* Cultivated fields of wheat and fodder are present in patches. The Kereichi area appeared to be 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.* The smaller patches between the slopes have maximum vegetation cover and such type of boarder patches used for cultivation.

Nest recording and monitoring

Maximum nests were spotted by observing the parents with Binoculars (10x50) from a suitable distant vantage point; the help of local shepherds/Nomads were also taken in locating the nests and few nests encountered accidentally. The nests were checked regarding timing and success of breeding at interval of one week; care was taken to record the data without disturbing the pairs; GPS position of the nests were recorded and they relocated with the help of GPS and other existing landmarks. The eggs were measured with dial caliper and weight measured with spring balance during the first nest check. When the nest was found to be empty on first check, it was carefully searched for small fragments of shell, the presence of which indicates that hatching has occurred. It was assumed to determine the first-egg laying date that the first egg was laid 27 days before the observed hatching date (Green *et al*., 2000).

The nest success and egg success was calculated according to Nice (1957), Ricklefs (1969) and Skutch (1985), as follows:

$$\text{Nest success} = \frac{\text{No. of clutches that produce young}}{\text{Total number of clutches}}$$

$$\text{Egg success} = \frac{\text{No. of young that leave the nest}}{\text{Total number of eggs}}$$

The annual reproductive success (ARS) of the Hoopoe Lark (counted as the number of broods successfully reared per female) was calculated by following Murray (2000). The comparison of ARS was made between the population of the Lope Valley and Kereichi area.

RESULTS

In the study period (1999-2001) 70 nests of the Hoopoe Lark were located of which 51 were active with 123 eggs. Nineteen nests were destroyed at initial stages before the egg laying. Maximum nests were found to be built in *Convolvulus spinosus* (Fig. 2) while few were also recorded in *Haloxylon griffithi* and *Astrogalus stocksii*. Laying dates varies from late February to mid May but maximum laying occurs in mid April (Fig. 3). Incubation period varies between 17-20 days and the chicks were fledged in 20±3 days.

Fig. 2. Newly hatched chicks of Hoopoe Lark; cup shaped nest in *Convolvulus spinosus.*

Table I.- Reproductive success of Hoopoe Lark in the 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	29	23	56	2.43	49	87.50	23	46.94
2000	22	16	38	2.38	29	76.32	12	41.38
2001	19	12	29	2.42	21	72.41	08	38.10
Total	70	51	123	2.41	99	80.49	43	43.43

Table II.- Reproductive success of two populations of the Nag Valley during 1999-2001. Both the populations are single brooded and often lay replacement clutch in case of loss. In this Table *e.g.* 17 females laid a first clutch of which 08 were successful. From the 09 failed females 03 laid the replacement clutch, out of which 2 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					
17	08	38	2.24	14	1.75
03	02	08	2.67	04	2.0
Total 20	10	46	2.30	18	1.8
Kereichi area population					
24	17	59	2.46	17	1.0
07	05	18	2.57	08	1.60
Total 31	22	77	2.48	25	1.14

Table III.- Comparison of reproductive success indices of the two populations given in Table I.

Population	Mean clutch size	Nest success	Egg success	No. of fledglings per successful nest	ARS(b)	ARS(k)
Lope Valley	2.30	0.50	0.39	1.80	0.5147	0.93
Kereichi Area	2.48	0.71	0.32	1.14	0.8334	0.95

Table IV.- Rainfall (mm) recorded at Panjgur nearest meteorological station from Nag Valley.

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1991	35.3	29.9	14.1	0	0	0	0	0	0	0	Trace	Trace	79.3
1992	48.5	8.6	13.7	19.2	0.6	0	0	21	0	18.6	0	7	137.2
1993	11.5	Trace	0.8	14.3	0	0	1.2	0	0	0	0	0	27.8
1994	2.5	13.3	0	16.9	0	0	42.5	14	1.4	3.5	0	7.6	101.7
1995	3.4	16.3	6.7	15.3	0	0	23.5	0	0	0	0	47.2	112.4
1996	36.5	6.8	26.1	0	0	10.1	3.8	0	0	0	0	0	83.3
1997	39.3	0	67.3	66.8	7.6	13.3	12.4	12.4	0.4	41.9	37.5	5.4	304.3
1998	14.7	1.8	38.2	0	0	0	1.8	0	25	0	0	0	81.5
1999	0	**32.1**	**26.4**	**0**	0	0	0	0	5	0	0	0	**63.5**
2000	3.5	**0**	**0**	**0**	14	2.1	0	0	0	0	0	1.9	**21.5**
2001	0	**7.2**	**3**	**0**	0	2	21.6	0	0	0	0	0	**33.8**

The rainfall of laying months and study years bolded; Source: Department of Meteorology, Islamabad.

Table V.- Temperature (°C) recorded at Panjgur nearest meteorological station from Nag Valley.

Months	1992		1993		1994		1995		1996		1997		1998		1999		2000		2001	
	Ave. Min.	Ave. Max.	Ave. Min.	Ave. Max.	Ave. Min.	Ave. Max.	Ave. Min.	Ave. Max.	Ave. Min.	Ave. Max.	Ave. Min.	Ave. Max.	Ave. Min.	Ave. Max.	Ave. Min.	Ave. Max.	Ave. Min.	Ave. Max.	Ave. Min.	Ave. Max.
January	4.1	16	5.9	17.5	4.7	18.3	5.1	18.7	4.2	15.1	4.2	18.1	3.9	17.8	4.3	18.1	3.4	19.7	2.2	18.8
February	5.9	19.2	8.7	23.5	6.5	19.9	7.3	20.3	8.2	21	6.7	22.2	4.8	19.7	**7.8**	**21**	**5.4**	**20.4**	**5.6**	**21.6**
March	9.7	22.9	10.8	24.4	13.4	27.8	10.2	23	13	25.3	11.9	22.7	12.3	25.2	**10.9**	**25.3**	**9.8**	**26.5**	**11.1**	**26.3**
April	15.9	28.7	16	31.4	15.3	30.2	15.7	30.5	16.7	31.8	14.2	29	17.3	33.7	**17.9**	**33.5**	**18.8**	**35.1**	**17.3**	**33.3**
May	21.7	35.1	22.5	37.7	21	37.3	21.1	35.9	20.5	35.3	19.3	34.1	22.6	37.1	22.3	36.8	24.4	40.3	24.3	40.1
June	25.9	40.8	24.2	39.5	25.2	40.8	25.3	39.7	23.6	39	22.4	38.1	22	38.2	24.8	40.3	24.1	39.1	25.9	39.8
July	25.5	39.6	26.1	39.5	25.1	37	25.5	38.7	24.9	39.3	24.5	39.5	23.7	40	25.5	39.6	25.3	39.4	26.2	39
August	23.2	36.2	23.1	38.2	24.1	37.5	24.4	38.3	22.6	38.8	21.8	37.9	25.1	39.8	23.5	39.5	24.2	38.6	23.6	38.1
September	18.8	33.5	20.3	36.1	18.7	32.5	19.9	35.2	19.3	36.5	18.6	36.2	21.1	36.5	20.9	36.3	21.2	37.4	20.6	36.6
October	14.8	29.5	13.3	28.9	15.8	30.3	16.8	31.4	13.1	30.4	14.6	30.1	15.4	29.2	14.5	31.9	15.6	32.2	15.3	32.5
November	10.1	26.5	10.5	27.2	12	27.5	8.9	25.4	6.9	23.3	9.7	22.4	9.3	25.7	10.6	26.8	10.1	24.7	10.2	26.9
December	8	21.8	5.6	22	5.3	19.5	7.5	17.4	3.6	20.6	5.4	17.4	6.9	24.5	4	20	6.5	21.6	8.9	24
Ave. of year	15.3	29.1	15.6	30.5	15.6	29.9	15.6	29.5	14.7	29.7	14.4	29	15.4	30.6	**15.6**	**30.8**	**15.7**	**31.3**	**15.9**	**31.4**

The temperature of laying months and study years bolded. Source: Department of Meteorology, Islamabad.

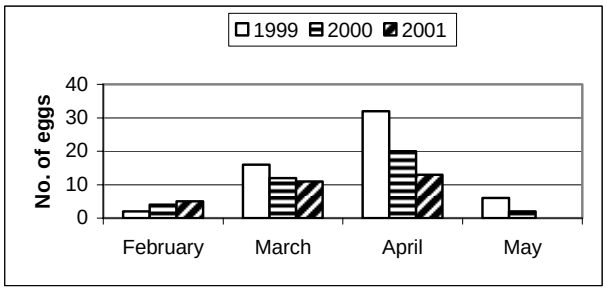

Fig.3. Egg-laying of Hoopoe Lark in different months in Nag Valley.

Measurements of 110 eggs revealed the average length of 22.8±0.33 mm (range: 17.36-26.44mm) and average width of 14.59±0.24mm (range: 10.25-19.45 mm). The mean clutch size was 2.43 eggs per nest in 1999, followed by 2.38 and 2.42 for the year 2000 and 2001, respectively. The hatching success was 87.5% in 1999 and 72.41% during 2001. The fledging percentage was 46.94 in 1999 and 38.10 in 2001 (Table I).

In Lope Valley 17 females laid a total of 46 eggs in 20 nests and mean clutch size was recorded 2.30 eggs per nest. The nest and egg success of the females of Lope population was 0.50 and 0.39 respectively (Table III). The number of fledgling produced per successful clutch is 1.8.

The 24 females of the Kereichi population laid 77 eggs in 31 nests with a mean clutch size of 2.48 eggs per nest. The nest and egg success of the females of Kereichi area was 0.71 and 0.32. The number of fledgling produced per successful clutch is 1.14.

The $ARS_{(b)}$ counted as number of brood recorded for the Lope population was 0.5147 which was 0.8334 for the population of Kereichi. The $ARS_{(k)}$ counted as mean number of youngs reared for the females of Lope Valley was 0.93 and for the population of Kereichi 0.95. The $ARS_{(b)}$ is the number of broods reared divided by the number of females and $ARS_{(k)}$ is the number of young reared divided by the number of females.

DISCUSSION

In the Nag Valley breeding area of Hoopoe Lark, 70 nests were recorded with mean clutch size of 2.41 during 1999-2001. Comparable data is not available for this species; however Ali and Riply

Table VI.- Importance Value Index IVI (RD+RF+RC) of some important plant species of study area (RD=Relative density, RF=Relative frequency, RC=Relative cover).

Species	1999				2000				2001			
	RD	RF	RC	IVI	RD	RF	RC	IVI	RD	RF	RC	IVI
Rhazya strictica	9.81	8.91	2.21	20.93	9.00	3.62	6.51	19.13	1.23	9.51	5.65	16.39
Haloxylon ammodenderon	4.20	2.92	1.87	8.99	3.42	2.81	1.06	7.29	1.30	2.63	2.72	6.65
Haloxylon griffithii	**2.55**	**2.94**	**2.90**	**8.39**	**0.64**	**4.53**	**1.61**	**6.78**	**0.91**	**2.81**	**1.76**	**5.48**
Haloxylon salicornicum	0.68	0.73	0.32	1.73	0.31	0.28	0.22	0.81	0.21	0.26	0.16	0.63
Echinops echinatus	0.31	0.92	0.66	1.89	0.65	0.41	0.33	1.39	0.21	0.64	0.14	0.99
Convolvulus spinosus	**3.01**	**2.83**	**1.43**	**7.37**	**1.8**	**3.31**	**.77**	**5.88**	**1.34**	**2.63**	**0.81**	**4.78**
Ephedra intermedia	3.33	2.43	1.22	6.98	2.91	1.22	1.92	6.05	1.40	0.87	1.22	3.49
Otostegia aucheri	6.71	5.08	2.31	14.10	4.93	4.35	3.16	12.44	4.31	4.16	2.01	10.48
Nerium odorum	2.39	4.65	2.35	9.39	3.10	0.85	0.61	4.56	--	--	--	--
Astrogalus stocksii	**6.56**	**6.62**	**3.85**	**17.03**	**4.81**	**5.22**	**2.10**	**12.13**	**3.08**	**3.57**	**2.51**	**9.16**
Pennisetum divisum	9.46	10.61	2.73	22.80	9.41	7.43	3.02	19.86	5.23	7.28	6.08	18.59
Panicum antidotale	1.00	0.87	0.67	2.54	0.96	1.10	0.46	2.52	--	--	--	--
Cymbopogon jwarancusa	5.13	6.43	4.96	16.52	4.79	3.89	3.51	12.19	3.23	3.30	2.56	9.09
Calligonum comosum	0.63	4.00	1.69	6.32	1.56	2.18	0.86	4.60	1.07	1.12	0.87	3.06
Withania coagulans	3.11	2.78	1.89	7.78	2.04	1.46	1.01	4.51	1.02	0.87	0.73	2.62
Fagonia indica	7.12	6.68	4.89	18.69	9.71	4.32	0.34	14.37	2.91	9.20	0.74	12.85
Sophora mollis	1.13	1.86	1.03	4.02	1.11	1.11	1.03	3.25	1.70	0.80	0.71	3.21
Zygophullum eurypterum	15.72	13.13	16.34	45.19	11.12	7.24	14.93	33.29	12.91	7.11	12.31	32.33

The plants used for nesting by Hoopoe Lark are in bold letters. Source: Nadeem *et al*. (2004).

(1987) reported the clutch size of 2-3 eggs. Roberts (1992) described the nest building mainly in March-April, however newly clutches can be observed at the end of May and early June. The maximum egg laying was occurred in March but it fluctuated slightly with the variations of Temperature. Ali and Riply (1987) described the breeding season of Hoopoe Lark March to July which possibly extended sometimes up to September. In present study the maximum laying was recorded in April followed by March and few eggs were also observed in late February and early May. The egg number was 56, 38, and 29 for the year 1999, 2000 and 2001 respectively. The laying success, mean clutch size and hatching success in different years (Table I) perhaps influenced by the variation of rainfall and temperature (Tables IV, V). There were comparatively good rains in the breeding season of 1999 while few showers were received in the year 2000-2001. The vegetation cover was comparatively better in the 1999 under the influence of good rains of the year 1997 (Table IV) however it was poor in 2001 (Table VI). The Importance Value Index of key plant species including the plants used for nesting was declined gradually (Table VI). We found all the nests on the medium sized bushes with more than 60 cm in length from the ground in accordance with Ali and Riply (1987); however, Birdlife International (2004) reported that Hoopoe Lark nests on the ground with two eggs.

The hatching success was recorded 80.49% in present study, comparable data is not available. The nest and egg success for the Lope population was 0.50 and 0.39 respectively. No comparable data is available regarding these parameters for Hoopoe Lark. The nest and egg success of Kereichi population was 0.71 and 0.32 respectively. The nest success indicates that the Kereichi population is more successful however egg success of the Lope population is better. Fifty percent of clutches of population Lope produced youngs while Seventy one percent clutches of the population of Kereichi produced youngs. The mean clutch size (sometimes used as indicator of reproductive success) however was greater of Lope population than the Kereichi population. The annual reproductive success in term of number of broods reared ($ARS_{(b)}$) is smaller in Lope population however the $ARS_{(k)}$ in the both populations is almost same. Therefore both the populations are seems identical however they achieved the mean number of young reared per female in different ways. Thence, reproductive success of the females, if measured on the basis of usual measures (clutch size, egg success, nest

success), the results could be misleading as in present study the performance of the females of Kereichi seems to be better on these measures, however the mean annual reproductive success $ARS_{(b)}$ and $ARS_{(k)}$ of both populations is same and remain unaffected by their differences in the clutch size, mortality rate of eggs/nestlings. Murray (2000) also concluded the same results. Perhaps the replacement clutches compensated the mortality of clutches/nestlings and thus the reproductive success remains the same.

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Table V.- Temperature (°C) recorded at Panjgur nearest meteorological station from Nag Valley.

Months	1992		1993		1994		1995		1996		1997		1998		1999		2000		2001	
	Ave. Min.	Ave. Max.	Ave. Min.	Ave. Max.	Ave. Min.	Ave. Max.	Ave. Min.	Ave. Max.	Ave. Min.	Ave. Max.	Ave. Min.	Ave. Max.	Ave. Min.	Ave. Max.	Ave. Min.	Ave. Max.	Ave. Min.	Ave. Max.	Ave. Min.	Ave. Max.
January	4.1	16	5.9	17.5	4.7	18.3	5.1	18.7	4.2	15.1	4.2	18.1	3.9	17.8	4.3	18.1	3.4	19.7	2.2	18.8
February	5.9	19.2	8.7	23.5	6.5	19.9	7.3	20.3	8.2	21	6.7	22.2	4.8	19.7	**7.8**	**21**	**5.4**	**20.4**	**5.6**	**21.6**
March	9.7	22.9	10.8	24.4	13.4	27.8	10.2	23	13	25.3	11.9	22.7	12.3	25.2	**10.9**	**25.3**	**9.8**	**26.5**	**11.1**	**26.3**
April	15.9	28.7	16	31.4	15.3	30.2	15.7	30.5	16.7	31.8	14.2	29	17.3	33.7	**17.9**	**33.5**	**18.8**	**35.1**	**17.3**	**33.3**
May	21.7	35.1	22.5	37.7	21	37.3	21.1	35.9	20.5	35.3	19.3	34.1	22.6	37.1	22.3	36.8	24.4	40.3	24.3	40.1
June	25.9	40.8	24.2	39.5	25.2	40.8	25.3	39.7	23.6	39	22.4	38.1	22	38.2	24.8	40.3	24.1	39.1	25.9	39.8
July	25.5	39.6	26.1	39.5	25.1	37	25.5	38.7	24.9	39.3	24.5	39.5	23.7	40	25.5	39.6	25.3	39.4	26.2	39
August	23.2	36.2	23.1	38.2	24.1	37.5	24.4	38.3	22.6	38.8	21.8	37.9	25.1	39.8	23.5	39.5	24.2	38.6	23.6	38.1
September	18.8	33.5	20.3	36.1	18.7	32.5	19.9	35.2	19.3	36.5	18.6	36.2	21.1	36.5	20.9	36.3	21.2	37.4	20.6	36.6
October	14.8	29.5	13.3	28.9	15.8	30.3	16.8	31.4	13.1	30.4	14.6	30.1	15.4	29.2	14.5	31.9	15.6	32.2	15.3	32.5
November	10.1	26.5	10.5	27.2	12	27.5	8.9	25.4	6.9	23.3	9.7	22.4	9.3	25.7	10.6	26.8	10.1	24.7	10.2	26.9
December	8	21.8	5.6	22	5.3	19.5	7.5	17.4	3.6	20.6	5.4	17.4	6.9	24.5	4	20	6.5	21.6	8.9	24
Ave. of year	15.3	29.1	15.6	30.5	15.6	29.9	15.6	29.5	14.7	29.7	14.4	29	15.4	30.6	**15.6**	**30.8**	**15.7**	**31.3**	**15.9**	**31.4**

The temperature of laying months and study years bolded. Source: Department of Meteorology, Islamabad.