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HABITAT, POPULATION, BREEDING ACTIVITIES AND THREATS TO HOUBARA BUSTARD IN NAG VALLEY (PAKISTAN) IN 1999–2001

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Abstract. Nag Valley is located 27^0 41' N and 65^0 14' E between Besima and Panjgur in the south-west of the District Kharan. It is a narrow valley having an area about 1500 km^2. Its altitude varies between 1100 m and 1600 m. Surveys were carried out to study the Houbara habitat and population density. A total of 118 plant species belonging to 61 families were recorded. Vegetation was very specific according to soil type. The most dominant species on the basis of importance value were *Zygophyllum eurypterum, Rhazya stricta, Pennisetum divisum, Convolvulus spinosus, Otostegia aucheri, Astragalus stocksii, Cymbopogon jwarancusa, Haloxylon ammodenderon, Haloxylon griffithi, Fagonia indica* and *Peganum harmala.* Two new species *Douepia tortuosa* and *Cynomorium songaricum* were recorded from Nag area. The density of wintering Houbara was 0.141 ± 0.024 ind./km^2 in 1999, which gradually decreased to 0.116 ± 0.023 in 2000 and 0.103 ± 0.023 ind./km^{2}in 2001. The decline was 17.92 % in 2000 and 10.92 % in 2001. The density of breeding Houbara in Nag Valley was 0.041 ± 0.021 ind./km^2 in 1999, which decreased to 0.038 ± 0.019 in 2000 and 0.034 ± 0.020 ind./km^2 in 2001. The decline was 8.06 % in 2000 and 10.53 % in 2001. There were 20–30 pairs of Houbara during breeding season in Nag. Excessive hunting, overgrazing, poaching, deforestation and shrinkage of habitat are the main threats to breeding population.

Key words: Houbara Bustard, *Chlamydotis undulata,* Pakistan, ecology, conservation.

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Местообитания, население, гнездование и угрозы джеку в долине Наг (Пакистан). - М.С. Надим, А.А. Миан, Г. Рашид, М. Асиф. - Беркут. 13 (2). 2004. - Долина Наг расположена на юго-западе округа Харан в провинции Белуджистан. Ее площадь около 1500 км^2. Исследования проводились с целью изучения местообитаний и населения джека. Было зарегистрировано 118 растений из 61 семейства. Растительность сильно менялась в зависимости от типа почвы. Плотность населения зимующих джеков составляла 0.141 ± 0.024 ос./км^2 в 1999 г., в 2000 г. снизилась на 17.92 %, а в 2001 г. – на 10.92 %. Плотность населения гнездящихся джеков составила 0.041 ± 0.021 ос./км^2 в 1999 г., в последующие годы снизилась на 8.06 % и 10.53 %. Численность джека в долине Наг в гнездовой сезон составляет 20–30 пар. Основными угрозами для вида являются: чрезмерная охота, перевыпас, вытаптывание, сведение лесов и уменьшение площади местообитаний.

INTRODUCTION

The Houbara Bustard (*Chlamydotis undulata macqueenii*) is a desert-adapted species that utilizes "open or shrubby, level or undulating more or less arid plains uninhabited by man" (Cramp, Simmons, 1983). Houbara typically occurs in the areas that receives 140 mm to 230 mm annual rainfall and have a temperature range of 4–34 ^{0}C but they may tolerate short periods of lower and higher temperatures (Collins, 1984; Mian, 1988). The species seems to prefer sandy soil with a sparse vegetation of low shrubs (Mendelssohn, 1980). Houbara has wide ecological amplitude and occurs in 25 different vegetative communities totaling 93 plant species but similar in having a regular shrub layer and low vegetation cover (Mian, 1988).

Balochistan is the largest province of Pakistan and always considered as the breeding ground of Houbara Bustard. Kharan and Chagai districts used to comprise the best breeding habitats of Houbara Bustard. There is no recent record of Houbara breeding in Chagai but Houbara is still breeds in Nag Valley (Nadeem et. al., 1997). Nag Valley is a sub-tehsil of Besima (district Kharan) located 27^0 41' N and 65^0 14' E between Besima and Panjgur in the south-west of the district Kharan. Its altitude varies between 1100 m and 1600 m. It is a narrow valley having an area about 1500 km^2.

The climate of the area is generally arid with a maximum precipitation of about 200 mm per annum. Virk (1995) recorded the mean minimum temperature 15 ^{0}C and mean maximum 32 ^{0}C in the month of April. There were good rains in 1997 resulting in green vegetation but after that no rain was received since 2001, due to which vegetation was in poor conditions.

The present study was undertaken to highlight the habitat conditions, vegetation composition and wintering and breeding Population of Houbara in Nag Valley.

MATERIAL AND METHODS

Vegetation sampling

Vegetation of the area was sampled by quadrat laid along a transect. Each transect was separated from the previous one by 10 km, traveled by 4 x 4 Toyota double cabin. Five quadrats (10 x 10 m) were taken perpendicular to both sides of the transect line, with a 10 m distance between two consecutive quadrats. Density, frequency and percent coverage of all the species were recorded and their importance value was calculated in accordance with Hussain (1983).

Plant species were identified at Botany Department, Punjab University Lahore and National Herbarium Islamabad and have been preserved for herbarium record.

Population estimates

The surveys were conducted every year in late September for wintering population and March to May (1999–2000) for breeding population. Population estimates for Houbara were made by Simple Strip method. Transects of 10 km length and 500 m wide (250 m on both sides) were studied, by driving 4 x 4 vehicle at a low speed (20 km/h) along transect. Transects were taken randomly at different prime habitats with use of one vehicle. Survey time was from sunrise to 10^{30} am and from 3^{00} pm to sunset. The distance of birds flushed was noted in approximation and indirect clues such as footprints, droppings and feathers were noted on both sides of transects. Fresh footprints and droppings were considered while estimating population. The data were analyzed following standard statistics (Tanner 1978; Maan et al., 1999; Nadeem et al., 2004).

Density, D = ng/2W (L).

Total population estimates, P = D x A.

Where: n = number of Houbara groups observed; g = mean group size; 2W = width of transect on both side of transect; L = total length of all transects; A = total area of habitat.

Climate

Temperature of Nag Valley was recorded at Houbara Research, Rehabilitation and Breeding Center (HRRBC), Nag Valley (Kharan).

Soil analysis

Twenty samples of soil were collected in order to determine the status of soil fertility. This study was carried out to correlate the significance of soil fertility with distribution of plants. Soil analyses were carried out by Soil Survey Department, Quetta (Balochistan).

RESULTS

Vegetation sampling

A total of 118 plant species belonging to 61 families were recorded (Table 1). Vegetation was very specific according to soil type. The most dominant species on the basis of importance value, were *Zygophyllum eurypterum* and *Rhazya stricta,* which grow in gravel sand, sandy clay and sandy streambeds. *Pennisetum divisum* and *Convolvulus spinosus* were also wide spread species found in sandy clay and sandy streambeds. The other common species of Nag were *Otostegia aucheri, Astragalus stocksii, Cymbopogon jwarancusa, Haloxylon ammodenderon, Haloxylon griffithi, Fagonia indica* and *Peganum harmala.* Two new species *Douepia tortuosa* and *Cynomorium songaricum* were recorded from Nag area.

The leading family was Chenopodiaceae with eight species, followed by Compositae, Boraginaceae and Tamaricaceae. A maximum

Table 1

Details of plant species in Nag Valley (1999–2001) Информация о видах растений в долине Наг (1999–2001)

Family	Species	1999				2000				2001				Habitat
		R.D.	**R.F.**	**R.C.**	**I.V.**	**R.D.**	**R.F.**	**R.C.**	**I.V.**	**R.D.**	**R.F.**	**R.C.**	**I.V.**	Types
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Adoxaceae	*Aegopordon berardioides*	0.72	1.20	0.52	2.44	0.54	1.01	0.18	1.73	–	–	–	–	SC
Alismataceae	*Allium sp.*	1.00	0.81	0.47	2.28	0.65	0.46	0.71	1.82	0.46	0.91	0.17	1.54	SD & SC
	Althea ludwigii	0.46	1.44	0.06	1.96	0.91	0.41	0.08	1.40	–	–	–	–	SC
Amaryllidaceae	*Amberboa turanica*	4.62	3.92	2.32	10.86	3.02	2.71	2.72	8.45	2.94	2.11	1.23	6.28	SC & GS
Anacardiaceae	*Andrachne tclephioides*	0.71	2.81	1.41	4.93	0.91	3.62	0.33	4.86	–	–	–	–	SC
Apocyanaceae	*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	GS,SC&SSB
Araucariaceae	*Argyrolobiun roseum*	0.52	1.52	3.14	5.18	0.86	0.42	1.03	2.31	0.82	0.93	0.54	2.29	GS
Asclepiadaceae	*Pergularia daemia*	0.51	0.89	0.21	1.61	0.37	0.25	0.11	0.73	–	–	–	–	RS
	Pergularia tomentosa	2.63	1.43	1.63	5.69	–	–	–	–	–	–	–	–	RS
	Glossonema varians	1.03	0.86	1.00	2.89	1.10	0.79	0.46	2.35	–	–	–	–	SD
Aspleniaceae	*Atriplex dimorphostegium*	0.56	0.42	0.16	1.14	0.43	0.21	0.13	0.77	0.26	0.12	0.10	0.48	SD & GS
	Asthenatherum forsskalii	1.30	1.02	0.94	3.26	–	–	–	–	–	–	–	–	SC
Balanophoraceae	*Cynomorium songaricum*	0.84	0.70	0.63	2.17	0.36	0.26	0.31	0.93	–	–	–	–	SSB
Basellaceae	*Bassia eriophora*	2.33	1.47	1.8	5.60	2.67	1.17	0.56	4.40	1.31	1.40	0.50	3.21	SD & GS
Boraginaceae	*Gastrocotyle hispida*	3.82	2.13	2.42	8.37	3.71	2.61	2.61	7.93	1.31	1.31	1.81	3.43	SD & GS
	Bromus tectorum	1.62	1.92	1.32	4.86	1.02	1.71	0.72	3.45	–	–	–	–	SC
	Heliotropium cabulicum	0.71	1.81	1.41	3.93	0.81	1.43	0.82	3.06	0.91	1.62	0.33	2.86	GS & SC
	Heliotropium strigosum	1.23	1.52	7.13	9.88	3.73	2.72	1.00	7.45	0.82	0.93	0.54	2.29	SC, GS&SD
	Heliotrpium cfaii	0.52	1.52	3.14	5.18	0.86	0.42	1.03	2.31	–	–	–	–	SC
Capparidaceae	*Capparis spinosa*	1.02	1.71	0.72	3.45	–	–	–	–	–	–	–	–	SC
Caprifollaceae	*Cardaria chalepense*	2.63	1.43	0.63	4.69	1.61	0.51	0.52	2.64	–	–	–	–	SC
Cascutaceae	*Cutandia memphitica*	2.72	1.13	2.34	6.19	1.12	1.24	1.93	4.29	0.91	0.11	0.31	1.33	GS
Chenopodiaceae	*Chrozophora tinctoria*	1.73	0.51	1.65	3.89	1.34	1.31	0.82	3.47	0.50	0.84	0.63	1.97	GS
	Chrysopogon aucheri	0.71	0.83	0.44	1.98	0.30	0.21	0.68	1.19	–	–	–	–	SC
	Kochia stellaris	1.42	2.91	0.72	5.05	0.92	1.13	0.71	2.76	1.10	0.60	0.30	2.00	SSB
	Chesneya parviflora	3.30	2.91	3.78	9.99	2.11	1.86	2.02	5.99	1.12	3.21	0.96	5.29	SC
	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	GS & SC

Continuation of the Table 1

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	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	GS & SC
	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	SD & SSB
	Salsola arbuscula	1.63	1.22	1.73	4.58	1.71	1.11	0.31	3.13	–	–	–	–	SC&SSB
Cistaceae	*Colchicum robustum*	2.43	4.72	3.83	10.98	3.31	4.30	1.77	9.38	2.21	3.63	2.02	7.86	SC&GS
Compositae	*Artemesia maritime*	3.22	2.83	3.62	9.67	3.01	2.57	2.81	8.39	0.23	3.22	2.84	6.29	SD
	Artemisia sieberii	1.00	1.71	1.48	4.19	1.21	1.11	0.81	3.13	–	–	–	–	SD
	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	SD & SC
	Echinops griffithi	0.31	0.33	0.20	0.84	0.10	0.21	0.18	0.49	–	–	–	–	SC
	Gymnarrhena micrantha	1.40	1.94	0.94	4.28	1.61	0.01	1.91	3.53	0.31	0.73	0.92	1.96	GS
	Cousinia prolifera	2.81	1.43	1.63	5.87	1.81	1.43	1.63	4.87	1.30	1.14	0.31	2.75	SC
Convolovulaceae	*Convolvulus spinosus*	3.01	2.83	1.43	7.37	1.80	3.31	0.77	5.88	1.34	2.63	0.81	4.78	SC & SSB
Cruciferae	*Douepia tortuosa*	1.00	1.20	0.65	2.85	0.49	0.55	0.36	1.4	–	–	–	–	SSB
	Malcolmia sp.	3.21	1.93	2.02	7.16	2.50	1.44	1.74	5.68	–	–	–	–	SD
Cucurbitaceae	*Citrullus colocynthis*	2.22	1.21	2.72	6.15	1.74	1.32	1.31	4.37	–	–	–	–	SD & SC
Datiscaceae	*Desmostachya bipinnata*	0.41	1.32	0.66	2.39	1.14	0.72	0.33	2.19	–	–	–	–	SC
	Dianthus crinitis	0.21	0.54	0.27	1.02	0.14	0.28	0.19	0.61	–	–	–	–	GS
Ebenaceae	*Ebenus stellata*	1.32	1.62	1.92	4.86	0.41	1.03	2.14	3.58	1.23	0.65	1.01	2.89	SD&GS
Elatinaceae	*Enneapogon persicus*	1.70	1.73	0.85	4.28	0.92	0.23	0.92	2.07	–	–	–	–	GS
	Eremophrum bonapartis	0.23	0.71	0.52	1.46	0.30	0.22	0.15	0.67	–	–	–	–	SC
	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	SSB
Equisetaceae	*Eremostachys loasifolia*	1.63	0.92	0.91	3.46	1.12	1.41	1.21	3.74	0.63	0.41	0.22	1.26	SC & GS
Euphorbiaceae	*Euphorbia caeladenia*	0.41	0.68	0.13	1.22	0.30	0.32	0.27	0.89	–	–	–	–	SC & GS
	Phyllanthus rotundifolis	1.49	1.41	1.53	4.43	1.89	1.31	0.89	4.09	0.40	0.33	0.15	0.88	SSB
Flacourtiaceae	*Fortuynia bungei*	2.30	2.00	1.41	5.71	1.65	1.00	1.43	4.08	0.47	0.38	1.19	2.04	SD&SSB
Fumariaceae	*Gaillonia macrantha*	1.44	1.33	1.38	4.15	1.36	0.90	0.72	2.98	1.10	0.82	0.73	2.65	SC
Graminae	*Pennisetum dichotomum*	3.20	2.39	2.86	8.45	2.10	2.91	1.78	6.79	1.74	1.06	1.48	4.28	SC & SSB
	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	SC & SSB
	Danthoniopsis stocksii	2.99	2.22	1.43	6.64	2.53	1.86	1.60	5.99	2.67	1.00	1.09	4.76	SC
Hydrocharitaceae	*Hyoscyamus insanus*	1.36	2.03	1.74	5.13	1.35	1.36	1.59	4.30	1.28	1.00	0.73	3.01	GS
Iridaceae	*Isatis emarginata*	2.13	1.63	1.23	4.99	1.56	1.00	1.02	3.58	1.56	0.72	0.90	3.18	SC
Juncaceae	*Koelpinia linearis*	1.89	1.11	1.06	4.06	–	–	–	–	–	–	–	–	GS

Continuation of the Table 1

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Labiatae	*Lappula barbata*	1.02	1.11	0.92	3.05	–	–	–	–	–	–	–	–	GS
	Lappula spinocarpos	1.68	1.45	0.73	3.86	1.00	1.90	0.71	3.61	–	–	–	–	SC
	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	SD & SC
Loranthaceae	*Lotus makranicus*	2.39	2.10	1.78	6.27	–	–	–	–	–	–	–	–	SC
Martyniaceae	*Mattiastrum bungei*	3.21	3.20	2.29	8.70	3.21	2.20	1.29	6.70	1.45	0.90	0.59	2.94	GS
Najadaceae	*Nannorrhops ritchieana*	1.89	1.16	0.76	3.81	1.77	2.33	0.66	4.16	1.23	0.96	0.56	2.75	SSB
	Nerium odorum	2.39	4.65	2.35	9.39	3.10	0.85	0.61	4.56	–	–	–	–	SSB
	Nonnea edgeworthii	1.20	0.76	0.36	2.32	0.69	1.00	0.72	2.41	0.79	0.81	0.53	2.13	GS
Nymphaeaceae	*Ochradenus aucheri*	2.38	1.93	1.63	5.94	1.07	1.64	1.54	4.25	1.48	1.23	0.63	3.34	GS
Oleaceae	*Oligochaeta ramose*	3.54	2.64	1.35	7.53	2.62	2.57	1.45	6.64	1.34	1.72	1.25	4.31	GS
Onagraceae	*Onobrychis tavemierifolia*	1.77	1.22	1.49	4.48	1.31	.94	1.02	3.27	1.07	0.72	0.59	2.38	SD
Orbanchaceae	*Orobanche cemua*	2.55	1.65	1.37	5.57	1.00	.85	0.84	2.69	1.42	0.89	0.41	2.72	SSB
Papilonaceae	*Alhagi maurorum*	2.81	2.00	1.87	6.68	1.20	1.91	1.26	4.37	1.29	1.98	0.62	3.89	SC
	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	SC & GS
	Astrogalus sericostochys	3.21	3.20	2.17	8.58	2.71	2.10	1.03	5.84	–	–	–	–	SC
	Astrogalus tribulus	1.85	1.43	0.99	4.27	–	–	–	–	–	–	–	–	SC
	Sophora griffithii	0.84	2.86	2.11	5.81	1.77	2.33	0.10	4.20	1.20	1.03	0.85	3.08	SSB
	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	SSB
Pedalaiceae	*Periploca aphylla*	3.26	2.14	1.75	7.15	1.01	1.43	0.66	3.10	–	–	–	–	SSB
	Peganum harmala	5.56	4.98	3.82	18.36	1.30	3.71	2.88	7.89	2.67	1.57	1.86	6.10	SC
Plantaginaceae	*Plantago ovata*	2.70	2.30	0.66	5.66	1.53	1.64	0.72	3.89	1.13	0.79	0.16	2.08	GS
Plumbaginaceae	*Poa annua*	1.30	0.89	0.58	2.77	0.63	2.00	0.08	2.71	0.56	0.23	0.19	0.98	SD
Poaceae	*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	SC & SSB
	Cynodon dactylon	0.85	0.59	0.48	1.92	0.43	0.79	0.51	1.73	–	–	–	–	SC & SSB
	Panicum antidotale	1.00	0.87	0.67	2.54	0.96	1.10	0.46	2.52	–	–	–	–	SSB
	Stipagrostis ciliate	0.40	0.31	0.23	0.94	–	–	–	–	–	–	–	–	RS
Polygonaceae	*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	SD & RS
	Calligonum crinitum	1.00	0.69	0.84	2.53	0.72	0.12	0.25	1.09	0.52	0.35	0.11	0.98	SD
	Polygonum afghanicum	1.31	1.21	1.06	3.58	1.19	1.41	0.55	3.15	0.77	0.71	0.55	2.03	SD &RS
Proteaceae	*Psammogeton biternatum*	5.72	2.62	1.13	9.47	3.36	2.62	1.00	6.98	1.13	1.00	1.22	3.35	SC
	Psammogeton stocksii	1.47	4.76	0.49	6.72	1.01	0.83	0.42	2.26	0.21	0.43	0.21	0.85	SC

End of the Table 1

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Pteridophyta	*Pterophyrum alivieri*	4.62	3.57	3.45	11.64	1.76	4.42	0.90	7.08	0.36	1.23	0.87	2.46	SD
	Pteropyrum aucheri	4.87	3.34	1.64	9.85	2.87	1.34	1.14	5.35	2.17	1.34	1.84	5.35	SD
	Pulicaria crispa	3.32	2.41	1.21	6.94	1.82	1.21	1.01	4.04	0.91	1.00	0.41	2.32	SD & SC
Punicaceae	*Pycnocycla aucheri*	1.11	4.52	0.53	6.16	0.40	0.16	0.11	0.67	–	–	–	–	GS
Ranunculaceae	*Resedia pruinosa*	2.34	1.88	2.55	6.77	1.79	1.09	1.16	4.04	1.52	0.68	0.36	2.56	SD & SC
Rubiaceae	*Rumex vesicarius*	0.89	0.66	0.91	2.46	–	–	–	–	–	–	–	–	SC
Salvadoraceae	*Salvia aegyptiaca*	1.94	1.09	1.24	4.27	1.42	1.29	0.73	3.44	–	–	–	–	GS
	Salvia santolinifolia	1.29	1.20	0.94	3.43	–	–	–	–	–	–	–	–	GS
Sapotaceae	*Savignya parviflora*	2.80	1.27	1.88	5.95	1.41	1.00	0.75	3.16	1.01	1.22	0.63	2.86	GS
Saxifragaceae	*Scabiosa candollei*	3.06	2.95	1.09	7.10	2.05	1.29	1.06	4.40	1.30	1.74	1.04	4.08	SC
Schizaeaceae	*Scorzonera tortuissima*	2.90	4.51	0.48	7.89	2.10	2.87	1.99	6.96	1.33	1.44	1.17	3.94	SC & SSB
	Scorzonera papposa	6.43	5.36	2.12	13.91	3.23	2.16	1.02	6.41	1.38	1.82	0.26	3.46	GS
Scrophulariaceae	*Seddera latifolia*	0.98	1.00	0.39	2.37	0.20	0.10	0.03	0.33	–	–	–	–	SC
	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	SC
Solanaceae	*Lycium ruthenicum*	1.34	1.26	1.10	3.70	1.35	1.51	0.99	3.85	0.79	0.56	0.43	1.78	SSB
Sparganiaceae	*Sphaerocoma aucheri*	2.11	1.99	1.08	5.18	–	–	–	–	–	–	–	–	SC
Sterculiaceae	*Stipa capillata*	1.44	1.65	0.73	3.82	1.01	0.86	0.77	2.64	0.24	0.62	0.11	0.97	SD
	Stipa pennata	1.53	2.05	1.14	4.72	–	–	–	–	–	–	–	–	SD
Tamaricaceae	*Tamarix aphylla*	1.23	1.41	1.56	4.20	–	–	–	–	–	–	–	–	SSB
	Tamarix dioica	1.31	1.23	1.00	3.54	0.98	0.83	0.52	2.33	0.56	0.41	0.37	1.34	SSB
	Tamarix mascatensis	2.34	5.62	1.21	9.17	1.54	5.92	0.31	7.77	0.92	3.57	0.29	4.78	SSB
	Tavernieria glabra	4.23	3.81	3.28	11.32	3.33	2.68	2.75	8.76	1.77	1.43	1.06	4.26	GS
	Tavernieria spartea	3.61	6.21	8.32	18.14	1.31	5.31	10.82	17.44	4.63	7.72	1.43	13.78	SC
Verbenaceae	*Phyla nodiflora*	1.31	4.82	1.30	7.43	0.33	4.41	3.72	8.46	0.61	4.52	1.63	6.76	RS
	Vincetoxicum stocksii	2.41	3.32	1.04	6.77	1.81	3.32	1.46	6.59	2.11	2.52	1.66	6.29	SC
Zygophyllaceae	*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	GS & SC
	Fagonia ovalifolia	4.36	3.69	3.65	11.70	3.23	2.22	2.13	7.58	1.55	1.68	1.31	4.54	GS & SC
	Tribulus longipetalus	4.86	8.83	5.56	19.25	3.43	5.95	8.10	17.48	2.22	7.31	7.20	16.73	SC
	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	GS,SC&SSB

R.D. – Relative density, R.F. – Relative frequency, R.C. – Relative cover, I.V. – Importance value; SD – Compact sandy, GS – Gravel sand, SSB – Sandy streambed, SC – Sandy clay often used as cultivation, RS – Rocky slope/surface.

Photo 1. Houbara concealed in *Astragalus stocksii.*

of 33 species were found in sandy clay soil, followed by 20 species in gravel sand, 16 in sandy streambeds and 11 on compact sandy habitat. Only four species were confined to rocky slops. Dominant species on sand clay were *Tavernieria spartea, Withania coagulans, Alhagi maurorum* and *Echinopsis griffithi*, while in sandy habitat *Calligonum crinitum* and *Haloxylon salicornicum* were common. In sandy streambeds *Sophora mollis, Nannorrhops ritchieana, Nerium odorum* and *Tamarix* were leading species while on gravel sand beside the *Zygophyllum eurypterum* and *Fagonia indica, Colchicum robustum, Euphorbia caeladenia* and *Plantago ovata* were dominant.

Importance value of plant species (1999–2001) showed that almost all species in Nag Valley were decreasing due to overexploitation and drought. Many species, which observed in 1999, did not found in 2001 (Table 1). It appeared that food plants of Houbara were gradually decreasing like other species. The importance value of *Fagonia indica*, which is the most preferred food of Houbara, was 18.69, 14.37 and 12.85 in 1999, 2000 and 2001 respectively. Although it was decreasing gradually, but is still in good numbers in the habitat. Importance value of *Salsola arbuscula* in three years was 4.58, 3.13 and 0.00 indicating a constant decrease. *Artemisia maritima* is another food plant of Houbara but its numbers were also decreasing and the importance value was 9.67, 8.39 and 6.29 in 1999, 2000 and 2001. *Haloxylon salicornicum* is also preferred by Houbara and had importance values 6.68, 4.37 and 3.89 showing a gradual decrease. Similarly food plants *Tribulus longipetalus, Alhagi maurorum, Artemisia sieberii, Heliotropium strigosum* and *Heliotropium cabulicum* were also decreasing.

Houbara shelter plants (Photo 1) (*Zygophyllum eurypterum, Rhazya stricta, Cymbopogon jwarancusa,* and *Astragalus stocksii*) were also rapidly decreasing, being the only source of fuel wood for the people of Nag Valley. The importance value of *Zygophyllum eurypterum* (1999–2001) was 45.19, 33.29 and 32.33 indicating a gradual decline. Importance value of *Rhazya stricta* was 20.93, 19.13 and 16.39 showing a constant decrease. *Cymbopogon jwarancusa* had importance values 16.52, 12.19 and 9.09 indicating a progressive decline. Similarly the numbers of *Astragalus stocksii* was also decreasing, and the importance value was 17.03, 12.13 and 9.16.

Photo 2. Houbara in Nag Valley (May 2000).

Climate

Rainfall and temperature is the governing factors in the desert. The rainfall is usually erratic and irregular. The rains are mostly received during winter and very rarely in early spring. Rainfall seems to exhibit a cyclic fluctuation with 2–3 years of drought followed by more generous rain. The rainfall greatly influenced the vegetation density.

For these three years (1999–2001) rainfall has been below than normal due to which most of the plant species had dried, the effect was more severe on some seasonal herbs that grow only after the rainy season. Consequently there were few insects but the density of lizards and other reptile does not seem to have suffered from this drought. Windstorms (speed 10–20 mph) are constant feature of Nag Valley and they lower the temperature. In summer the heat is moderate (Table 2). The moderate temperature and cool nights, even in July/August support the breeding population of Houbara.

Soil Analyses

The soil composition was different according to soil texture. The results (Table 3, 4) of soil in breeding habitat of Houbara in Nag Valley depict that 27 % of the soil were classified as loam, 12 % as silt loam and 61 % as loamy sand. The soil has a wide range in texture and fertility levels. Soils are alkaline in reaction, impregnated with salts and highly calcareous in nature. The soil has been found low in organic matter, phosphorus and nitrogen, and low to medium in potassium. A balanced use of chemical fertilizer is essen-

Table 2

Temperature (°C) record of Nag Valley at HRRBC Nag Valley 1999–2001 Температурный режим (°C) в долине Наг в 1999–2001 гг.

Month	1999				2000				2001			
	Ave Min	Ave.Max.	Lowest	Highest	Ave Min	Ave Max.	Lowest	Highest	Ave Min	Ave Max.	Lowest	Highest
January	5.22	15.92	1	16	5.83	16.64	1	16	6.11	16.89	1	15
February	6.10	18.21	2	18	6.37	18.72	3	17	6.57	17.81	2	16
March	12.15	24.81	7	30	8.82	23.64	2	28	10.91	25.23	6	29
April	16.16	29.96	11	34	17.00	35.16	9	35	17.12	33.74	12	35
May	20.29	33.58	15	37	23.16	38.96	18	38	22.86	38.47	18	37
June	23.60	37.83	17	41	24.00	39.83	19	42	23.96	38.61	20	40
July	27.20	38.31	20	42	25.41	40.41	19	42	26.31	41.11	20	41
August	24.35	37.67	20	39	24.94	38.39	20	40	23.66	39.32	21	40
September	21.40	34.36	16	38	22.27	35.71	17	37	23.52	36.32	17	39
October	13.14	28.70	10	30	13.67	29.11	10	29	12.65	29.55	11	31
November	8.90	24.66	5	27	9.11	24.97	6	26	8.22	23.80	7	26
December	4.90	17.25	1	20	4.82	16.87	1	19	5.21	17.35	2	20

Table 3

Detail of soil analysis of samples collected from Nag Valley
Результаты анализа почвенных образцов из долины Наг

Sample No. Up–Down	T.S.S., %	pH	Clay, %	Silt, %	Sand, %	Texture
01 54–99	0.038	7.8	27	13	60	Sand/Loam
02 55–99	0.048	7.9	25	15	60	
03 56–99	0.080	7.6	24	17	59	Loamy sand
04 57–99	0.051	7.8	22	13	65	
05 58–99	0.11	8.0	21	12	67	Loamy sand
06 59–99	0.10	7.9	17	13	70	
07 60–99	0.063	8.1	23	9	68	Sand/Clay/Loam
08 61–99	0.071	8.2	17	11	78	
09 62–99	0.091	8.3	19	14	67	Sandy Loam
10 63–99	0.042	8.1	21	13	66	
11 64–99	0.053	7.8	17	13	70	Sand/Clay/Loam
12 65–99	0.091	8.0	23	9	68	
13 66–99	0.073	8.1	19	9	72	Sand Loam
14 67–99	0.10	8.2	11	11	78	
15 68–99	0.012	8.2	9	15	76	Loamy sand
16 69–99	0.016	8.3	11	12	77	
17 70–99	0.019	8.4	12	26	62	Loamy sand
18 71–99	0.16	8.2	13	21	66	
19 72–99	0.17	8.1	9	20	71	Sandy Loam
20 73-99	0.032	8.3	11	18	71	

tial for economical beneficial return, due to classification of the soil.

The soil has sufficient nutrients to support a variety of plant species in Houbara habitat. But it depends on rainfall, which is erratic. During low rainfalls even drinking water gets scarce and both plant and animal communities suffer adversely.

Population

The density of wintering Houbara (Table 5) in Nag Valley was 0.141 ± 0.024 ind./km^2 in 1999, which gradually decreased to 0.116 ± 0.023 in 2000 and 0.103 ± 0.023 ind./km^2 in 2001. The reason was, population still arriving in late September and secondly the vegetation was dry than Punjab due to low rainfall. The decline was 17.92 % in 2000 and 10.92 % in 2001. If we compare the population of 2001 to 1999, then the decline was 26.89 % in two years, which is alarming.

Table 4

Composition of soil in Nag Valley
Состав почвы в долине Наг

Sample No. Up-Down	$CaCo_3$	Organic matter, %	N, %	P_2O_5, %	K_2O, %	Na, %
01 54-99	28	0.70	0.078	11	13	–
02 55-99	29	0.42				
03 56-99	30	0.36	0.021	10	10	–
04 57-99	27	1.07				
05 58-99	24	0.57	0.016	12	12	–
06 59-99	26	0.54				
07 60-99	27	0.63	0.057	15	11	–
08 61-99	25	0.80				
09 62-99	20	0.26	0.031	08	09	–
10 63-99	22	0.95				
11 64-99	18	0.51	0.029	09	11	–
12 65-99	20	0.51				
13 66-99	23	0.80	0.031	07	17	–
14 67-99	21	0.75				
15 68-99	19	0.57	0.031	07	16	–
16 69-99	18	0.54				
17 70-99	19	0.63	0.030	11	09	–
18 71-99	21	0.80				
19 72-99	22	0.62	0.060	09	13	–
20 73-99	20	0.60				

The density of breeding Houbara (Photo 2) in Nag Valley was 0.041 ± 0.021 ind./km^2 in 1999, which decreased to 0.038 ± 0.019 in 2000 and 0.034 ± 0.020 ind./km^2 in 2001 (Table 5). The decline was 8.06 % in 2000 and 10.53 % in 2001. The population of 1999 to 2001, if compared, then the decline was 17.74 % in two years. It was estimated that there were 20–30 pairs of Houbara during breeding season in Nag Valley. Density figures assessed were somewhat low from minimum sustainability. The bird showed no significant preference for a particular

habitat with unique set of ecological condition. Population was uniformly distributed in the gravel sand, sandy clay, sandy desert and sandy streambed. However, fluctuations were found with the availability of food plants.

Photo 3. Eggs of Houbara Bustard. 21.04.1998.

Breeding activities

In 1986–1988, National Wildlife Research Center Taif collected eggs from Nag Valley during egg collection expedition, in order to raise the breeding stock for Taif breeding center. At that time there was a good breeding population of Houbara but this exercise left adverse affects and even now people collect the eggs/chicks and tried to sale. It causes a serious decline of breeding population and now limited population breed there. An abandoned nest of Houbara was found in Mazardan area of Nag Valley in April 1998 (Photo 3) with two eggs and pieces of broken shell. Both the eggs were fertile but due to uncertain reasons, embryos died in early stages of development. The presence of broken shell and size of the nest lead to the fact that one or two eggs did hatched. The nest was on the fringes of a wheat field, located N 27° 60.896 and E 65° 21.352 and the altitude was 1567 ± 51 m a. s. l.

Another old nest (Photo 4) of Houbara with some pieces of shell debris was found on 21.04. 1999. The nest was located next to a small tuft of *Haloxylon* near an uncultivated field, adjoining other three wheat fields. The location of the nest was N 27° 15.464 and E 65° 03.337 and the altitude was 1343 ± 36 m. The nest was a shallow scrape measuring 12 x 14 cm, the size indicating that two or three eggs might have been hatched. The footprints of female and two chicks were also observed in the area but chicks were not seen. The aeronautical distance of this place from Nag Village was 7.94 km. No nest was seen in the year 2000 and 2001.

Table 5

Houbara wintering and breeding population in Nag Valley (1999–2001)
Зимующая и гнездовая популяции джека в долине Наг (1999–2001)

Year	Total area of habitat, km²	Transects, n	Surveyed area, km²	Birds recorded	Density, ind./km²	Estimated population
Wintering population						
1999	1,500	34	170	24	0.141 ± 0.024	212
2000	1,500	36	180	21	0.116 ± 0.023	174
2001	1,500	33	165	17	0.103 ± 0.023	155
Breeding population						
1999	1,500	58	290	12	0.041 ± 0.021	62
2000	1,500	68	340	13	0.038 ± 0.019	57
2001	1,500	58	290	10	0.034 ± 0.020	51

Photo 4. Nest of Houbara with eggshell debris. 21.04.1999.

There are several factors responsible for low breeding success of Houbara in Nag Valley. The presence or absence of rain during breeding season could be a very important factor on the growth of chicks or on their death. Nesting may only take place if conditions are favourable i. e. sufficient vegetation and food become available after winter rainfall but in Nag Valley sever drought conditions were observed from couple of years. Lack of food may limit the breeding success. Disturbance and grazing pressure are the critical factors for failure of breeding. The nest is frequently abandoned when the female is disturbed, exposing the eggs to temperature and predators. Breeding success may also be density-dependent as there is very low density of Houbara in Nag Valley; the chances of finding mate are reduced. This may be particularly important for Houbara where the male must attract a female to a specific display site but at low densities it is very difficult.

Nag Valley is not only the breeding ground of Houbara Bustard, but it also supports a number of breeding species. The eggs of Stone Curlew (*Burhinus oedicnemus*), Indian Courser (*Cursorius coromandelicus*) and Indian Sandgrouse (*Pterocles exustus*) were seen in the area. Chicks of Stone Curlew, Hoopoe Lark (*Alaemon alaudipes*) and See See Partridge (*Ammoperdix griseogularis*) (Photo 5) were also recorded. A number of reptiles and other animals like Cape Hare and foxes are also breed in the locality. This area is also a migratory route of Common Cranes (*Grus grus*) and Dalmatian Pelicans (*Pelecanus crispus*). Pelican used Nag area as stopover during their migration toward the coast of Gawadar (Arabian Sea). Two groups of 25–30 birds (Photo 6) in each, of Dalmatian Pelican were observed transiting near Nag Village on 7.04.1998. Groups of 15–20 and about 10 pelicans were again seen at the same locality on same date in 1999 and 2000 respectively.

Photo 5. Chick of See See Partridge.

Threats to the breeding population

Although the Houbara appears well protected legally, but in many areas the protection is only theoretical. The fact that there is a law protecting the Houbara does not stop it from being hunted unless the law is enforced. In most areas it is difficult to implement the law for basic practical reasons; the habitat of Houbara is extremely vast, the birds are generally at low densities. There are very few agencies responsible (rangers, game watchers etc.) to enforce the law and they are not well equipped.

The people of Nag are generally found of hunting. They also invite hunters from adjoining areas of Panjgur and Besima. They mainly hunt for meat and fun. Because of number of specific conditions, which make it, difficult to control the keeping and use of firearms by the local population and also owing to the low level of nature conservation education, the local landlords and bureaucracy are also involved in hunting. Arabs did not hunt here since 1997, to support the breeding population but local hunt there throughout the year and do not care for breeding season. Beside the Houbara, they hunt the Indian Courser, Sandgrouses, See See Partridges and Cape Hare (*Lepus capensis*). The numbers of these species are also rapidly decreasing.

Photo 6. Dalmatian Pelicans in Nag Valley.

Poaching on Houbara breeding grounds is still widespread and causes appreciable losses. Egg collection expeditions by Saudi team from National Wildlife Research Center Taif 1986–1988 left adverse effects. They purchased eggs from locals at the rate of Rs. 1,000 to Rs. 3,000 per egg/chick. This is an attractive amount for poor inhabitants. The practice of collecting and selling eggs/chicks still continues, causes a serious decline to breeding population.

Increasing human population has led to an increasing demand on land for agriculture, in prime breeding habitat of Houbara. Modern machinery (tractors) has made it easier for people to expand their agricultural activities. Consequently, wild lands are being brought under plough continuously depriving the birds from natural habitats which are essential for their breeding success. Although the cultivated field sometimes contribute a rich source of food for the bustards during droughtness but further reduction in the remaining natural habitat would endanger the existence of the population by eliminating the essential breeding sites.

Natural predators of Houbara and its chicks in the Nag Valley are foxes, cats, monitor lizards and birds of prey. Monitor lizards often destroy the nest of Houbara. Moreover domestic dogs of nomads living in the breeding area also damage the Houbara eggs/chicks.

Overgrazing unlike hunting, indirectly affects Houbara depleting natural food resources. The result is initially less drastic but the end result is the same. As the population increases, their needs also increase. Consequently, livestock size (50–200 in every house) increases, as it is the only source of income. This is also increasing the disturbance in the breeding habitat. Overgrazing not only takes away the shelter but also deprived the birds from vegetable food as well as insects and other arthropods that constitute an important part of their diet. Moreover, the uprooting of shrubs (Photo 7) as fuel wood led to accelerating the deforestation in the area. Shrubs are also used for making their huts and pens for livestock. They used mainly *Zygophyllum eurypterum, Rhazya stricta* and *Haloxylon salicornicum* as fuel wood, which is also a favourite shelter for houbara. The removal of shrubs takes away shelter and nesting cover of the breeding birds and their chicks.

The area of Nag Valley was declared as a Wildlife Sanctuary in September 1995 to support the breeding population but it is only on papers. Hunting, poaching, grazing and deforestation are still continued. Poaching of chicks/eggs and trapping of live birds should be

Photo 7. Uprooting of *Zygophyllum* for fuel wood.

checked strictly. It would seem urgent to slow down the removal of bushes, which are a shelter and food source for the Houbara Bustard and are necessary for their security in reproduction. There should be a permanent ban on hunting and development of new agricultural fields should be discouraged.

Above all, the local population should be educated in Conservation Ethics. This can be done through awareness campaigns and involving the people in conservation activities through Participatory Rural Approach. Effective protection could be achieved by involving local communities in the conservation projects. This would be feasible only if they are made responsible for the protection of wildlife species especially the birds, and involved in income generating projects such as birds' breeding and farming. Income sharing and income generating activities of the local populace would win their favour and the cause of conservation would get a boost.

DISCUSSION

Nag Valley is an admixture of alluvial plains spread over an area of 1500 km^2. There are mild undulating sandy areas with frequent tracks of bare ground covered with black and dark-brown stones which provide an ideal background for camouflage of breeding Houbara and other birds. A total of 118 plant species were recorded belonging to 61 families. Two new species *Douepia tortuosa* and *Cynomorium songaricum* were recorded. The vegetation was different in different soil. Only two species *Zygophyllum eurypterum* and *Rhazya strictica* were common in three types of habitat i. e. gravel sand, sandy clay and sandy streambeds, while *Heliotropium strigosum* was also grows in gravel sand, sandy clay and sandy soils. Ten species were common in two habitats gravel sand and sandy clay, seven species were found in sandy clay soil and sandy streambeds, and four species confined only to gravel sand and sandy habitat. Similarly two species were common in sandy soil and sandy streambeds, two were found only in sandy soil and rocky surface while all other species were specific to a single habitat. No data is available for comparison.

In Nag Valley the densities were 0.141, 0.116 and 0.103 birds per km^2 for 1999, 2000 and 2001 respectively. The wintering population was 212 birds in 1999 in breeding habitat of 1500 km^2. The population dropped to 174 Houbara in 2000 and 155 Houbara in 2001. Only few previous studies were available for comparison, Mian (1997a) reported the densities during December 1986–1987 as 0.15, 0.30, 0.24, and 0.18 for east, center, west and south Kharan respectively. In present study low densities were recorded because population estimates were made in early season (last week of September) and population still arriving.

The density of breeding Houbara in Nag Valley was 0.041 ± 0.021 ind./km^2 in 1999, which decreased to 0.038 ± 0.019 in 2000 and 0.034 ± 0.020 ind./km^2 in 2001. Population was 62 birds in 1999, which dropped to 57 in 2000 and 51 in 2001. The decline was 8.06 % in 2000 and 10.53 % in 2001. It was estimated that there were 20–30 pairs of Houbara during breeding season in Nag Valley. Mian (1988) reported 40–60 breeding pairs in western Balochistan.

Ruthless hunting, poaching of eggs/chicks, habitat shrinkage, overgrazing, and fuel wood collection are the main factors for the decline of Houbara, especially the breeding population. Although Houbara is well adapted to living in an agro-pastoral system yet the increasing in agricultural activities affects the breeding population of Houbara Bustard. Expansion of agricultural fields reduces the extent of breeding areas and increased human activities make the bird more vulnerable to hunting and trapping. Lavee (1986) reported intensive cultivation is a threat to the population of Houbara in the northern Negev. Removal of shrubs by fuel wood collection and overgrazing takes away shelter and nesting cover of the breeding birds and their chicks. Lavee (1985) found that heavily grazed area in Israel were reduced the plant cover, so that deprived the birds from vegetable food as well as insects. Collins (1984) also described a similar situation on the Canary Islands. The loss and alternation of the Houbara habitat has played a significant role in its decline, e. g. there has been substantial change in the Russian habitat (Ponomareva, 1985) and Israel. Only 1,000 km^2 out of possible 3,000 km^2 is now considered suitable for Houbara (Mendelssohn, 1980). The areas now suitable for Houbara as a habitat have declined in quality and quantity and have fragmented across the range. *Zygophyllum eurypterum* and *Haloxylon* are main shrubs of the breeding habitat in Nag valley which provide shelter to the Houbara but both species were under severe pressure of cutting for fuel wood and making thatches as tree cover is absent in the valley.

Management strategies involving the local populace are required immediately to boost the breeding population. Scientific studies with the cooperation of international scientists would be helpful in this regard. Strict rules of wildlife sanctuary should be applied and law enforcement agencies should actively be participated to improve the situation. It would seem urgent to bane hunting and poaching completely. Awareness to local populace is necessary about sustainable use of wildlife resources.

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