

**On Biology of Houbara Bustard (*Chlamydotis undulata macqueenii*)
in Balochistan, Pakistan: Animal Populations Sharing Habitat**

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Abstract: Detailed survey of 53 stands created in some 75.500 km² of wintering habitat of Houbara (*Chlamydotis undulata macqueenii*) in Balochistan (Pakistan) suggests presence of 20 mammal and 41 bird species. Crude density, population level and constancy of appearance of a majority of mammals and all birds have been suggested for five broad localities (created in response to physico-biotic variations attributable to altitude and latitudes) and total tract using quadrature sampling. Seven species of rodents were snap trapped and their relative abundance judged. Majority of the species exhibited low densities, population levels and constancies. The densities and population levels of species of livestock, actually exploiting Houbara habitat, have also been suggested using quadrature sampling. Indirect evidences and encounter rates of unidentified reptiles (lacertiles and snakes) and insects (tenebrionid beetles, large black anta, grasshoppers, termites and butterfly) suggested very low populations and constancies of these groups during winters, except for beetles and ants.

Key words: Mammals, birds, reptiles, insects, livestock, density, constancy, population levels

Introduction

Distribution and abundance of animal species is decided through and amicable adjustment between basic requirement of the species (genetic potentials), availability of habitat requirements (physico-phytological conditions) and geographic location (physical/climatic barriers and geological history) of the area. Houbara tracts of Balochistan presents specific set of such factors and hence are expected to hold specific fauna, distributed to varying extent in the basic Houbara habitat. A complete absence of such studies from Houbara tracts of Balochistan and general dart (no mention of associated animals in excellent reviews on Houbara) (Ali and Ripley, 1983; Cramp and Simmons, 1980 and Roberts, 1991) of these for the other parts of its global range (Goriup, 1983 and Shirt, 1983), attracted us to collect some quantitative base line information on the distribution and abundance of animal species from Balochistan, Pakistan.

Materials and Methods

Different stands (53), established in Houbara habitat distributed in the Balochistan, were visited during early, mid and late winters between 1985-86 and 1986-87.

Balochistan (24.9-32.1° NL, 60.9-72.2° E; 347,000 km² approx) is the southwestern province of Pakistan and is traversed by a series of mountain ranges. In between these arduous ranges there are valleys, which are narrow in the northern parts and wider in southern parts. Houbara is widely distributed in all the wide valleys during winter. The altitude of these valleys gradually decreases as one moves towards southern latitudes, five broad localities, i.e., northern highlands (altitude. 1,200-1,700 m above sea level), central highlands (alt. 700-1,200 m), southern highlands (alt. 500-1,200 m), central lowlands (almost sea level) and southern lowland (< 100 m), were created presenting different physico-biotic conditions. The major part of the country is arid, rainfall decreasing as one moves southwards and westwards. The winter rains are more reliable in western and summer rains in eastern flanks.

Different categories of animals were sampled through different techniques, Mammals and birds were mainly sampled through quadrat (10 X1/2 km², 10-15 quadrats per stands) technique (Mian, 1997). The crude density figures (per km²) were calculated and used to develop estimates on population for potential tracts of each broad locality and for the total bustard tract. Rodents were snap-trapped or identified through indirect evidences and relative abundance of each species judged. The species were identified and named using Roberts (1997) for mammals, and Roberts (1991) Ali and Ripley (1983), Heinzel *et al.* (1979) and Ticehurst (1926-27) for birds. The information on relative abundance of reptiles and insects were collected through track search and physical encounter rate. Reptiles and insects could not be identified upto species level. The constancy of appearance of each species was collected by dividing the number of the stands showing the species by the total number of stands studied and expressed in percentile (Main, 2002).

A selected number of hunters, shepherds and nomads were interviewed in different areas, regarding their observations on distribution/abundance of the animals. Food track and/or fecal pellet search was also conducted by 3-4 workers walking for 30 min. through the stand area. Special emphasis was placed on big games, rara and /or nocturnal species. The records were maintained as a check to the quadrat data.

Results

Distribution

Mammals

Table 1 suggests presence of 20 species of mammals. Among rodents, Indian crested porcupine (*Hystrix indica*) was the most widely distributed, appearing in all five broad localities in association with irrigate wild vegetation or cultivation. Hotson's five-toed jerboa (*Allactaga hotsoni*) was fairly widely distributed in central highlands and presented and isolated appearance in southern highlands. Blandfod's (*Jaculus blandfordi*) and Fitz-Gibbon's pygmy (*Salpingostus michaelis*) jerboa were present in isolated localities of central highlands. Similarly, sand-coloured rat (*Millardia gleadowi*) was widely distributed in southern lowlands as fairly high populations. Cheesman's gerbil (*Gerbillus cheesmani*) was mainly present in central highlands, though it also gave an isolated appearance in southern lowlands. Small five-toed jerboa (*A. elater*) was represented in isolated localities in northern and central highlands.

Table 1: Density (Per km²±standard error of mean), constancy of appearance (C, % and estimated population (P) of different species of mammals and birds sharing wintering habitat with Houbara in different broad localities of Balochistan, Pakistan

Area (No. of stands) Species	Northern Highlands 5,500 km ² (5)			Central Highlands 33,000 km ² (25)			Southern Highlands 5,000 km ² (7)		
	Density	C	P	Density	C	P	Density	C	P
Mammalia: Rodentia									
<i>Hystrix indica</i>	?	60		?	4		?	43	
<i>Allactaga elater</i>	?	20		?	4		-	-	-
<i>Salpingotus michaelis</i>	-	-	-	?	12		-	-	-
<i>Jaculus blandfordi</i>	-	-	-	?	16		-	-	-
<i>A. hatsoni</i>	-	-	-	?	32		-	-	-
<i>Gerbillus cheesmani</i>	-	-	-	?	12		-	-	-
<i>Millardia gleadowi</i>	-	-	-	-	-	-	-	-	-
Lagomorpha									
<i>Lepus capensis</i>	0.09±0.04	80	495	0.03±0.01	60	990	0.04±0.04	56	200
Artiodactyla									
<i>Gazella subgutturosa</i>	+	80	22	+	4	7	-	-	-
<i>G. bennetti</i>	-	-	-	0.01±0.01	52	330	0.01±0.01	43	50
Carnivora									
<i>Canis lupus</i>	+	20	6	+	20	33	+	28	7
<i>C. aureus</i>	+	20	6	+	16	26	+	28	7
<i>Vulpes bengolensis</i>	0.02±0.02	60	110	+	4	7	0.03±0.02	56	150
<i>V. vulpes</i>	+	20	6	0.04±0.04	64	1,320	-	-	-
<i>Herpestes edwardsi</i>	-	-	-	+	4	7	-	-	-
<i>Hyaena hyaena</i>	-	-	-	+	8	13	-	-	-
<i>Felis libyca</i>	-	-	-	-	-	-	-	-	-
<i>F. chaus</i>	-	-	-	+	8	66	-	-	-
<i>F. margarita</i>	+	20	6	0.01±0.01	28	330	-	-	-
<i>F. caracal</i>	-	-	-	+	8	125	-	-	-
Aves: Corvidae									
<i>Corvus ruficollis</i>	+	60	17	0.11±0.06	36	3,630	+	14	4
<i>C. splendens</i>	-	-	-	-	-	-	-	-	-
<i>Pica pica</i>	+	40	11	-	-	-	-	-	-
Timallidae									
<i>Turdoides caudatus</i>	+	40	11	0.04±0.04	8	1,320	-	-	-
Turdidae									
<i>Oenanthe deserti</i>	0.01±0.01	60	55	0.11±0.06	20	3,630	0.03±0.17	43	1,500
<i>O. isabellina</i>	-	-	-	-	-	-	-	-	-
<i>O. monacha</i>	-	-	-	+	4	119	-	-	-
<i>O. finschii</i>	-	-	-	0.04±0.04	8	1,320	0.07±0.05	29	350
Silviidae									
<i>Sylvia nana</i>	-	-	-	0.03±0.02	44	990	0.11±0.07	29	550
Motacillidae									
<i>Motacilla alba</i>	-	-	-	+	8	139	0.03±0.03	14	150
Alaudidae									
<i>Alaemon alaudipes</i>	+	40	11	0.17±0.06	56	5,610	-	-	-

Table 1: continued

Area (No. of stands) Species	Northern Highlands 5,500 km ² (5)			Central Highlands 33,000 km ² (25)			Southern Highlands 5,000 km ² (7)		
	Density	C	P	Density	C	P	Density	C	P
<i>Ammomanes deserti</i>	0.12±0.11	60	660	0.08±0.03	20	2,640	0.69±0.22	56	3,393
<i>Galleria cristata</i>	0.13±0.13	80	715	0.43±0.12	60	14,190	1.25±0.39	86	6,250
<i>Alauda arvensis</i>	+	20	6	0.07±0.06	16	2,310	0.04±0.04	14	200
Meropidae									
<i>Meriopes orientalis</i>	-	-	-	-	-	-	-	-	-
Columbidae									
<i>Columba livia</i>	+	20	6	0.96±0.49	20	31,680	-	-	-
Pteroclididae									
<i>Pterocles senegallus</i>	-	-	-	-	-	-	0.11±0.11	14	550
<i>P. alchata</i>	-	-	-	0.02±0.02	8	660	0.05±0.05	43	250
<i>P. orientalis</i>	+	20	6	0.75±0.33	28	24,750	0.57±0.18	43	2,850
Glareolidae									
<i>Cursorius cursor</i>	0.16±0.10	40	880	0.16±0.14	4	5,280	0.02±0.02	14	100
Burhinidae									
<i>Burhinus oedicnemus</i>	-	-	-	0.08±0.04	4	2,640	0.04±0.04	14	200
Otididae									
<i>Otis tarda</i>	-	-	-	+	100	7	-	-	-
<i>Tetrax tetra</i>	-	-	-	+	12	7	-	-	-
<i>Chlamydotis undulata</i>	0.01±0.01	100	55	0.33±0.08	8	10,890	0.18±0.07	100	700
Phasianidae									
<i>Ammoperdix griseogularis</i>	+	20	6	0.24±0.01	16	7,920	0.61±0.49	14	3,050
<i>Alectoris chukar</i>	+	20	6	+	-	40	-	-	-
Laniidae									
<i>Lanius schach</i>	+	40	11	0.06±0.06	-	1,980	-	-	-
<i>L. vittatus</i>	-	-	-	-	-	-	-	-	-
Pycnonotidae									
<i>Pycnonotus leucogenys</i>	-	-	-	-	-	-	-	-	-
Ploceidae									
<i>Passer montanus</i>	-	-	-	-	-	-	-	-	-
Sturnidae									
<i>Sturnus roseus</i>	-	-	-	-	-	-	-	-	-
Accipitridae									
<i>Accipiter nisus</i>	-	-	-	0.03±0.02	8	990	-	-	-
<i>A. badius</i>	-	-	-	-	-	-	0.03±0.03	14	150
<i>Aquila clanga</i>	-	-	-	-	-	-	-	-	-
<i>A. rapax</i>	+	20	6	+	8	13	-	-	-
<i>Gypaetus barbatus</i>	-	-	-	+	4	7	-	-	-
<i>Milvus lineotus</i>	-	-	-	+	4	7	-	-	-
<i>Aegypius monachus</i>	-	-	-	0.08±0.08	4	2,640	-	-	-
Falconidae									
<i>Falco tinnunculus</i>	+	20	6	-	-	-	-	-	-
<i>F. subbuteo</i>	-	-	-	-	-	-	-	-	-
<i>Falco sp.</i>	-	-	-	0.01±0.01	4	330	-	-	-

Table 1: continued

Area (No. of stands)	Northern Highlands 5,500 km ² (5)			Central Highlands 33,000 km ² (25)			Southern Highlands 5,000 km ² (7)		
	Density	C	P	Density	C	P	Density	C	P
Live stock									
sheep	0.97±0.48	100	5,335	0.26±0.12	20	8,580	14.81±2.28	88	24,050
Goat	0.89±0.46	100	4,895	0.33±0.15	20	10,890	4.64±2.26	88	23,200
Camel	0.23±0.16	40	1,265	0.04±0.03	8	1,320	0.02±0.02	14	100
Cow	+	20	22	+	4	40	0.15±0.14	43	750
	Central Lowlands 3,000 km ² (7)			Southern Lowlands 29,000 km ² (3)			Overall 75,500 km ² (53)		
Species	Density	C	P	Density	C	P	Density	C	P
Mammalia: Rodentia									
<i>Hystrix indica</i>	?	100		?	15			23	
<i>Allactaga elater</i>	-	-		-	-	-		4	
<i>Salpingotus michaelis</i>	-	-		-	-	-		6	
<i>Jaculus blandfordi</i>	-	-		-	-	-		8	
<i>A. hatsoni</i>	-	-		-	-	-		15	
<i>Gerbillus cheesmani</i>	-	-		?	7			8	
<i>Millardia gleadowi</i>	-	-		?	38			9	
Lagomorpha									
<i>Lepus capensis</i>	+	67	10	0.01±0.01	23	290	0.033±0.009	55	1,985
Artiodactyla									
<i>Gazella subgutturosa</i>	-	-	-	-	-	-	+	9	29
<i>G. bennetti</i>	+	67	10	+	23	67	0.007±0.002	42	457
Carnivora									
<i>Canis lupu-s</i>	+	33	5	-	-	-	0.001	17	51
<i>C. aureus</i>	+	67	10	-	-	-	0.001	17	49
<i>Vulpes bengolensis</i>	-	-	-	0.01±0.01	15	290	0.008±0.005	19	557
<i>V. vulpes</i>	-	-	-	0.03±0.02	31	870	0.029±0.008	40	2,196
<i>Herpestes edwardsi</i>	-	-	-	+	15	22	+	6	29
<i>Hyaena hyaena</i>	-	-	-	+	23	178	0.002±0.001	9	191
<i>Felis libyca</i>	-	-	-	+	8	11	+	2	11
<i>F. chaus</i>	-	-	-	-	-	-	0.001±0.001	4	66
<i>F. margarita</i>	-	-	-	-	-	-	0.004±0.002	15	336
<i>F. caracal</i>	-	-	-	-	-	-	0.002±0.002	4	125
Aves: Corvidae									
<i>Corvus ruficallis</i>	-	-	-	+	8	11	0.053±0.029	25	3,662
<i>C. splendens</i>	+	33	5	+	8	11	+	4	16
<i>Pica pica</i>	-	-	-	-	-	-	+	4	11
Timallidae									
<i>Turdoïdes caudatus</i>	0.03±0.03	33	90	0.01±0.01	15	290	0.023±0.019	13	1,711
Turdidae									
<i>Oenanthe deserti</i>	0.55±0.48	67	1,650	0.14±0.08	31	4,060	0.157±0.051	32	10671
<i>O. isabellina</i>	1.33±1.04	100	3,900	0.08±0.06	15	2,320	0.094±0.066	9	6,310
<i>O. monacha</i>	-	-	-	-	-	-	0.002±0.002	2	119

Table 1: continued

Area (No. of stands) Species	Central Lowlands 3,000 km ² (7)			Southern Lowlands 29,000 km ² (3)			Overall 75,500 km ² (53)		
	Density	C	P	Density	C	P	Density	C	P
<i>O. finschii</i>	+	33	5	+	8	11	0.027±0.019	11	1,686
Silviidae									
<i>Sylvia nana</i>	0.37±0.29	67	1,110	0.01±0.01	8	2,900	0.0522±0.022	30	5,550
Motacillidae									
<i>Motacilla alba</i>	0.02±0.02	33	60	-	-	-	0.007±0.007	8	349
Alaudidae									
<i>Alaemon alaudipes</i>	0.16±0.07	100	480	0.01±0.01	8	290	0.089±0.025	38	6,391
<i>Ammomanes deserti</i>	1.43±1.43	33	4,290	0.09±0.04	69	2,610	0.240±0.091	43	13,593
<i>Galleria cristata</i>	11.34±5.89	100	34,020	0.06±0.06	8	1,740	1.040±0.477	55	56,915
<i>Alauda arvensis</i>	0.04±0.04	33	120	-	-	-	0.040±0.025	13	2,636
Meropidae									
<i>Meriopes orientalis</i>	0.17±0.17	33	476	+	8	67	0.010±0.001	4	543
Columbidae									
<i>Columba livia</i>	2.55±1.51	67	7,660	-	-	-	0.600±0.241	13	39,346
Pteroclididae									
<i>Pterocles senegallus</i>	1.09±0.31	67	3,270	0.02±0.01	15	580	0.081±0.055	9	4,400
<i>P. alchata</i>	-	-	-	-	-	-	0.016±0.010	9	910
<i>P. orientalis</i>	1.63±1.12	67	4,890	0.04±0.03	15	1,160	0.530±0.171	28	33,656
Glareolidae									
<i>Cursorius cursor</i>	0.40±0.25	100	1,230	0.07±0.03	31	2,030	0.130±0.062	36	9,520
Burhinidae									
<i>Burhinus oedicnemus</i>	0.05±0.05	33	150	+	8	89	0.047±0.020	19	3,079
Otididae									
<i>Otis tarda</i>	-	-	-	-	-	-	+	2	7
<i>Tetrax tetra</i>	-	-	-	-	-	-	+	2	7
<i>Chlamydotis undulata</i>	0.57±0.20	100	1,710	0.07±0.02	100	2,030	0.225±0.038	100	15,385
Phasianidae									
<i>Ammoperdix griseogularis</i>	-	-	-	+	8	11	0.195±0.097	15	10,987
<i>Alectoris chukar</i>	-	-	-	-	-	-	0.001	8	46
Laniidae									
<i>Lanius schach</i>	0.03±0.03	33	90	-	-	-	0.031±0.030	13	2,081
<i>L. vittatus</i>	-	-	-	0.01±0.01	8	290	0.003±0.003	2	290
Pycnonotidae									
<i>Pycnonotus leucogenys</i>	-	-	-	0.01±0.01	8	290	+	2	290
Ploceidae									
<i>Passer montanus</i>	-	-	-	+	8	11	0.003±0.003	2	11
Sturnidae									
<i>Sturnus roseus</i>	-	-	-	+	8	290	0.003±0.003	2	290
Accipitridae									
<i>Accipiter nisus</i>	0.07±0.04	100	210	-	-	-	0.017±0.010	9	1,2000
<i>A. badius</i>	-	-	-	-	-	-	0.004±0.004	2	150
<i>Aquila clanga</i>	0.02±0.02	33	60	0.01±0.01	16	290	0.004±0.003	6	350
<i>A. rapax</i>	+	33	5	0.02±0.02	16	580	0.006±0.005	11	604

Table 1: continued

Area (No. of stands) Species	Central Lowlands 3,000 km ² (7)			Southern Lowlands 29,000 km ² (3)			Overall 75,500 km ² (53)		
	Density	C	P	Density	C	P	Density	C	P
<i>Gypaetus barbatus</i>	-	-	-	-	-	-	+	2	7
<i>Milvus lineatus</i>	0.02±0.02	33	56	-	-	-	0.001±0.001	4	63
<i>Aegypius monachus</i>	-	-	-	-	-	-	0.038±0.038	2	2,640
Falconidae									
<i>Falco tinnunculus</i>	0.02±0.02	33	60	-	-	-	0.001±0.001	4	66
<i>F. subbutea</i>	0.02±0.02	33	60	-	-	-	0.001±0.001	2	60
<i>Falco sp.</i>	-	-	-	-	-	-	0.003±0.003	2	330
Live stock									
sheep	0.64±0.42	100	1,920	0.16±0.09	46	4,640	0.927±0.350	45	44,525
Goat	0.69±0.41	100	2,070	0.18±0.10	46	5,220	0.931±0.352	45	46,275
Camel	-	-	-	0.03±0.03	15	870	0.052±0.022	13	3,555
Cow	-	-	-	0.03±0.03	15	870	0.024±0.019	13	1,682

The cape hare (*Lepus capensis*; Lagomorpha) was fairly widely distributed (overall constancy 55%) in all the broad localities in good densities (0.01-0.09 per km²), except for central lowlands, where the density was very low. A total population of 1,985 has been estimated to be distributed with an overall density of 0.033. The major part of this population was present in central highlands (990) though a good population was present in northern highlands (495, density 0.09) and southern lowlands (290). The species was more frequent in stabilized valleys as compared with sandy tracts.

Artiodactyles were represented by two species. Goitred or Persian gazelle (*Gazella subgutturosa*) bore a wide distribution (constancy 80%) in northern highlands (northern Chagai). The species was very rare (estimated 29 heads) distributed in association with stabilized hilly valleys. The chinkara or Indian gazelle (*G. bennetti*) was widely distributed in low densities but in high constancies in all broad localities, except for northern highlands. The population of this antelope was estimated to be 457, distributed in remote parts having medium to high sand dunes with overall density of 0.007. The major part of this population (330) was present in western parts of central highlands. The species was rare (southern highlands 50; lowlands 42) to very rare (central lowlands 10) in other broad localities. The species was reported by the local farmers to be working as pest in many parts till recent past.

The carnivores were represented by 10 species. Two species of fox were relatively common. Common red fox (*Vulpes vulpes*) had a wider distribution (constancy 40%) in fairly high densities (0.03-0.04) in central highland and southern lowland deserts and in an isolated stand of northern highlands. The total population of the species is estimated at 2,196, distributed in central highlands (1,320) and southern lowlands (870). The species is being extensively persecuted for skins. A number of skins of the species were seen with local farmers in Kharan, waiting for their sale. The Indian or Bengal fox (*V. bengalensis*) exhibited a wide distribution in northern and southern highlands (constancy 56-60%), but gave a scattered appearance in central highlands and southern lowlands. The species exhibited a fairly good density in these localities (0.01-0.03). A population of 557 is estimated for different broad localities with an overall density of 0.008.

The other 8 species of carnivores were rare to very rare. Wolf (*Canis lupus*) and jackal (*C. aureus*) have appeared in isolated stands (low constancy) in all the broad localities as small populations (50) appearing in low densities (overall < 0.001). Local hunters reported large packs of wolves for some tracts till recent past. Four species of cats have been recorded. Desert cat (*Felis libyca*) appeared in a single stand (southern lowlands) and was very rare (density < 0.001). Jungle cat (*F. chaus*) and caracal or red lynx (*F. caracal*) appeared in two separate stands of central highland deserts in very low densities, caracal being better represented (125) as compared with jungle cat (66). The sand cat (*F. margarita*) had a wider distribution in the central highlands (constancy 28%, density 0.01), though it also provided a rare sighting in a single stand in northern highlands. The total population is estimated to be 336. Common Indian mongoose (*Herpestes edwardsi*) appeared as very small populations (29) in 3 isolated stands as single individuals. An estimated population of 191 was distributed over the total tract with an overall density of 0.002. The major part of this population (178) was present in southern lowlands.

Birds

The bird fauna was represented by 41 species. Out of three members of family Corvidae, brown necked raven (*Corvus ruficollis*) was widely distributed around human settlements in northern (constancy 60%) and central highlands (36%) and in an isolated stand each in southern highlands and lowlands. A population of 3,662 was estimated for the total tract with an overall density of 0.053. The population was mainly restricted to central highlands (3,630), where it yielded a high population density (0.11). Sindh house crow (*C. splendens*) was present in similar conditions in one stand each in central and southern lowlands. Magpai (*Pica pica*) was distributed in two isolated hilly valleys of northern highlands, having scattered tall shrubs or trees. The populations of both these species were very low in Houbara tract.

Common babbler (*Turdoides caudatus*) was the only representative of family Timallidae. Flocks of different sizes were spotted around Tamarix pallasii plantation in isolated stands of all the broad localities (except southern highlands) appearing in high densities in some stands (1.00; overall 0.023). A population of 1,711 is estimated for the area, a major part of which was present in the hilly valleys of northwestern Chagai (1,320) and southern Lasbella (290).

Four species of wheatears (family Turdidae) were distributed in deserts as single individual. Desert wheatear (*Oenanthe deserti*) was presenting medium to high densities (overall 0.157, range 0.01-0.55) in all the broad localities. A good population of 10,671 is estimated to be distributed in southern lowlands (4,060) and central (3,630) and southern (1,500) highlands. Finsch's wheatear or chat (*O. finschii*) appeared in scattered stands throughout the Balochistan, except for northern highlands. The species generally appeared in low densities (overall = 0.027); though high densities were recorded in two isolated stands located in central (0.90) and southern (0.47) highlands. Isabelline wheatear (*O. isabellina*) was present in high densities in all the three stands of central lowlands (average 1.33) and in two stands (0.26, 0.73) of southern lowlands. The total population is estimated at 6,310. A very small population (1129) of hooded wheatear (*O. monacha*) was spotted in a single stand of central highlands (western Chagai) in low density (0.09).

A single species, i.e., desert warbler (*Sylvia nana*), represented family Sylviidae. It appeared

in all broad localities, except for northern highlands. The species was present in high density in central lowlands (0.37) and highlands (0.11), and in a single stand of southern lowlands (stand density 0.13). In central highlands, high densities were present in some stands (0.20, 0.30, 0.30), while the other 8 stands had very low densities (< 0.01). The total population of 5,500 was mainly present in a single stand of southern lowlands (2,900).

White or pied wagtail (*Motacilla alba*; Motacillidae) appeared as low populations (349), around human settlements, in 2 isolated stands of central highlands and in one stand each of southern highlands and central lowlands.

Four species of larks (Alaudidae) have been identified, penetrating into deserts. Crested lark (*Galirida cristata*) was very common and was widely distributed (very high constancies) in all broad localities, except southern lowlands (in one stand only). The major part (34,020) of the total estimated population (56,915) was present in central lowlands (very high density of 11.34). High densities of this bird were also present in southern (1.25, population of 6,250) and central highlands (0.43, population 14,190). The densities were low in northern highlands (0.13) and southern lowlands (0.06). Desert lark (*Ammomanes deserti*) was also represented in all the broad localities but was more widely distributed in southern lowlands (constancy 69%), and northern (60%) and southern (56%) highlands. An estimated population of 13,593 was distributed with an overall density of 0.240. The density of the species was very high in southern (1.43) and central (0.69) highlands, which harboured populations of 4,290 and 3,393, respectively. Hoopoe lark (*Alaemon alaudipes*) was also spotted in all the localities, except southern highlands. The total population of 6,391 (overall density 0.089) was mainly distributed in central highlands (5,610, density = 0.17) and lowlands (480, density = 0.16). The species had small populations in northern highlands and southern highlands. Skylark (*Alda arvensis*) appeared in isolated stands throughout the bustard tracts, except southern lowland. The species appeared in the lowest densities (compared with other 3 species of larks, overall density 0.040) and as a population of 2,636. This population was mainly distributed in central highlands (2,310), where some stands held high densities (1.20, 0.50).

Family Meropidae was represented by little green bee-eater (*Meriopes orientalis*). A limited population of the species (576) appeared associated with scattered tree/tall shrubs in two isolated stands located in the eastern lowlands. The major part (476) of the estimated population (543) was present in a single stand of central lowlands.

Blue rock pigeon (*Columba livia*, Columbidae) was spotted in 8 isolated stands as large flocks, generally flying along the hilly valleys. The large flocks attributed a high density (overall 0.600) and population (39,346) to the species, though it had a limited exploitation of bustard tracts. The major part of this population was present in northern Kharan, along Raskoh Mountain (31,680) and western parts of the central lowlands (7,660) along hilly tracts.

Three species of sandgrouses (Pterocilidae) were identified from Houbara tracts having water points within easy access of the flying bird. Black-bellied (*Pterocles orientalis*) had a wider distribution (constancy 28%) as compared with spotted (*P. senegallus*, 9%) and pin-tailed (*P. alchata*, 9%) sandgrouses. *P. senegallus* was widely distributed in central lowlands (constancy 66%), where large flocks yielded a high density (1.09) and a good population (3,270). A scattered

distribution was recorded in southern highlands (density 0.11, population 550) and lowland (0.02, 580) valleys. *P. alchata* was the rarest of the three sand grouses and had a scattered appearance in central (2 stands) and southern (3 stands) highlands with an estimated population of 910 and overall density of 0.016. *P. orientalis* was distributed in all the broad localities, though it had a restricted appearance in eastern parts of the southern lowlands and northern highlands. The species usually appeared as large flocks, especially in stabilized valleys. This was the commonest of the three sandgrouses and yielded an overall population of 33,656 and overall density of 0.530. The major part of this population was present in central highlands (24,750, 0.75) and central lowlands (4,890, density 1.63). Significant populations were also present in southern highlands (2,850) and lowlands (1,160), but a very limited population was present in northern highlands.

Cream coloured courser (*Cursorius cursor*) was the sole representative of family Glareolidae and was distributed in desert in all the broad localities in good densities (overall 0.130). The major part of the total estimated population of 9,520 was present in central highlands (5,280, density 0.16). High densities of the species were also present in central lowlands (0.40) and northern highlands (0.16) and with estimated population of 1,230 and 880, respectively.

Family Burhinidae is also represented by a sole member, i.e., stone curlew (*Burhinus oediernemus*). It was present in all the broad localities (except northern highlands) in desert mostly appearing as single or in small groups of 2-3, yielding moderate densities (0.047) and population (3,079). The major part of this total population was present in central highlands 2,640. A very low density was suggested for southern lowlands. Limited population has been estimated for southern highlands (200) and central lowlands (150).

Family Otididae is represented by two other species, apart from Houbara. Great Bustard (*Otis tarda*) and little bustard (*Tetrax tetrax*) appeared as single individuals in two different stands in central highlands, suggesting very low densities and populations.

Two species of partridges (Phasianidae) were recorded in association with hilly tracts. Chukar (*Alectoris chukar*) was spotted in 4 stands distributed in hilly valleys. The species appeared as small flocks (estimated population of 46) and had only been spotted along the periphery of bustard tracts. The see partridge (*Ammoperdix griseogularis*) had a wider distribution, exhibiting a higher constancy (15%). It was sometimes present in high densities in hilly valleys of southern (0.61) and central highlands (0.24), forming medium-sized flocks (4-10). The population actually sharing Houbara habitat was estimated to be 10,987, distributed in central (7,920) and southern (3,050) highlands. A very limited population was spotted in northern highlands and no population appeared in central and southern lowlands.

Two species of shrike (Laniidae) were present in the stands having tree or tall shrubs. Rufous-backed shrike (*Lanius schach*) appeared as isolated individuals in 7 stands. The major part of the estimated population of 2,081 was present in central highlands (1,980), limited population appearing in central lowlands (90) and northern highlands (11). A population of 290 bay-backed shrikes (*L. vittatus*) appeared in a single stand in the eastern flanks of the southern lowlands.

Three families were represented by a single species, each. White eared bulbul (*Pycnonotus leucogenys*, Pycnononidae), tree sparrow (*Passer montanus*, Ploceidae) and rosy pastor (*Sturnus roseus*, Sturnidae) appeared in three different stands, in southern lowlands. The populations of

these species were very low, and were associated with human settlements.

Raptors were represented by 10 species, 7 from family Accipitridae and 3 from Falconidae. Steppe or tawny eagle (*Aquila rapax*, constancy 11%), sparrow hawk (*Accipiter nisus*, 9%), spotted eagle (*A. clanga*, 6%) and black-eared kite (*Milvus lineatus*, 4) had comparatively wider distribution. A major chunk of a comparatively good population of *Accipiter nisus* (1,200) was distributed in high densities in central (density 0.03, population 990) and southern highlands (0.07, 210). A good population (604) of *Aquila rapax* was mainly present in southern lowlands (580) with very rare appearance in southern, central and northern highlands. *Aquila clanga* (350, mainly in southern lowlands 290) and *Milvus lineatus* (63) have been represented in Houbara tract as limited populations. Shikra (*Accipiter badius*), lammergeier or bearded vulture (*Gypaetus barbatus*) and black vulture (*Aegyptius monachus*) have appeared in a single stand, each. *A. monachus* appeared as good population (2,640) hovering over an area having carcass of a camel in central highlands. The population of *A. badius* (150) was low and that of *G. barbatus* (7) very low.

Amongst falconids, kestrel (*Falco tinnunculus*, constancy 4%), hobby (*F. subbuteo*, 2%) and *Falco sp.* (2%) had very scattered appearances. The general population of all the falconids was very low (*F. tinnunculus* 66, *F. subbuteo* 60), except for *Falco sp.* (330), which appeared in good density (0.01) in central highlands.

Reptiles

Reptiles, as a group, appeared to be widely distributed, though significant populations could not be recorded in all the stands. Lacertiles (mostly agamids, monitors and lizards) were spotted in 22 and squamates (snakes) in 12 stands. The population of reptiles was generally low, as suggested by low encounter rate.

Insects

Insects were represented by 5 groups. Ground beetles (Family Tenebrionidae, *Pimela sp.*, *Adesmia sp.*, *Arthrodisia sp.*) showed a wider distribution and significant populations were recorded from 23 stands. Amongst family Formicidae (Order hymenoptera), large black ants had a wide distribution. Termites (order Isoptera) infestation was recorded in 3 stands. Grasshoppers (order Orthoptera) in a single stand in central lowlands. In general the populations of all the insects (except beetles and ants) were low, though these were more frequent during early and late winters, except for central and southern lowlands, where significant populations persisted even during mid winter.

Livestock

Four species of free grazing livestock were distributed in bustard tracts. Sheep and goat were most widely distributed in all the broad valleys with estimated population of 44,525 and 46,175, respectively, generally grazing as mixed flocks. The densities were relatively high in southern highlands (sheep= 4.81, goat= 4.64), medium in northern highlands (0.97, 0.89) and central lowlands (0.64, 0.69) and low in central highlands (0.26, 0.33) and southern lowlands (0.26,

0.18). A population of 3,555 camels was present in the total tract appearing in high densities in northern highlands. A total estimated population of 1,682 cows was distributed mainly in southern lowlands (870) and highlands (750).

Constancy

The constancy of appearance of different species was generally low. Out of a total of 61 species identified, 48 (79%: 16 mammal, 32 birds) appeared in constancy class I (< 20%: 13 = 1 mammals + 12 birds in only one stand; 8 = 3 mammals + 5 birds in two stands). Two species of mammals (Indian crested porcupine, common red fox) and 6 birds (brown necked raven, desert wheatear, desert warbler, hoopoe lark, black-bellied sandgrouse, cream coloured courser) have been placed in constancy class II (21-40%). Only 4 species (2 mammals: cape hare, chinkara; 2 birds: desert lark, crested lark) appeared in class III (41-60%). None of the species appeared in class IV (61-80%), while only Houbara was placed in class V (>80%).

Heterogeneity

The number of species appearing in different stands ranged between 1 and 21. The majority of the stands (33; 62%) had 6-11; while 9 had less than 6 and 11 more than 11 species. Generally, the number of species appearing per stand was high in eastern lowlands and lower in western flanks. Houbara appeared as sole species in some stands, located in deeper extreme deserts.

Discussion

The present sampling of the animal species appears adequate, being based upon a detailed transect sampling undertaken during different parts of the winter in morning and evening sessions (increasing chances of sampling even nocturnal) in an extensive tract. The mode of present sampling (undertaken during the day), however, has an inherent defect of under-sampling strict nocturnal species. The result of this study needs to be taken with caution as these concern the bustard tracts and for winter only, having limited bearing on the total fauna of the province.

A number of reptiles (lacertiles) and insect (especially grasshoppers) species are generally associated with steppe deserts. A low population of these species (except for tenebrionid beetles and formicid ants) can be attributed to low temperature, which directly arrests the population of insects and activity of reptiles. The studies of Ali and Rahmani (1982) and Bharat-085) have suggested low levels of populations of grasshoppers in the habitat of great Indian bustard (*Choriotis nigriceps*) between November and February in Rajasthan (India). The effect of low winter temperature is expected to be severe and extended in the major part of the bustard tracts of Balochistan, being located at higher altitudes (> 600m). A higher representation of the reptiles/insects in lowland (0-200m) also supports the present contention. More careful studies on the species composition and relative abundance of reptiles and insects is required for a better understanding of oubara biology as some of these contribute an important part to its food (Mian, 1986, 2000).

A total of 61 species of birds and mammals have been recorded. This is the first

comprehensive list of the animal species actually sharing habitat with Houbara. The previous comparable lists (Gorup, 1983; Shirt, 1983; Ali and Rahmani, 1982 and Manakadan, 1985) include all animal species seen in and/or around the bustard tract, including the species (waders and waterfowls), which do not at all share the bustard habitat, This is also the first list attempting a detailed constancy, density and population figures for such a large area.

Though, 20 species of mammals have been recorded, yet a majority of these have a limited distribution and/or low population levels. Cape hare and gazelles (chinkara and goitred, excluding one another in their distribution range) have significant distributions in Houbara habitat. Cape hare is the only herbivore with a significant population (probably slightly underestimated in present study, as per inherent handicap of sampling nocturnal). The recent trend of motorized hunting using searchlights (especially using motor bicycles) is liable of reducing its population to certain very low levels during the coming years. There are convincing reports to suggest that population of gazelles has declined in the recent years from a level where these were working as agricultural pests to a stage where these are represented by very low densities/populations. Indian crested porcupine (rodentia) and common fox (carnivora) are the two other species, having significant populations. Fox is also coming under sever hunting pressure as per increasing demand for their skins associated with extinction/rare status for large carnivores. Porcupine remains in the adjacent irrigated natural/cultivated vegetation and appears in Houbara habitat for a limited exploitation. Numerical abundance of these species in habitat of *C. u. macqueenii* has been suggested by Alekseev (1980) and Ponomareva (1979, 1985), for the summering (Central Asia) and by Taylor (1983, 1985) for the wintering grounds (Sindh, Pakistan).

Like mammals, out of 41 species of birds identified from Houbara tract, a majority has very limited distribution. The birds, like crows, wagtail, vultures, kites, rosy pastor and sparrow are associated with human settlements and seldom seen in the deeper deserts. Magpai, babblers and bee eaters are associated with thicker vegetation and/or tall plants, while see, chukar and rock pigeon remain in the hills and descend down into the associated valleys to share a limited part of Houbara habitat. Sandgrouses are though sometimes present in deeper deserts, yet are restricted to the tracts having water points within easy access of the birds. Two species of bustards (great and little) appear as stragglers (Ticehurst, 1926-27). This leaves us with very small number of the bird species (crested, desert and hoopoe lark; desert wheatear, desert warbler, black-bellied sandgrouse, cream coloured courser, stone curlew and some raptors), which happen to share significant populations with Houbara. The populations of all the other species are either low or have limited distribution in Houbara tracts. The list runs in a considerable proximity with those suggested for Canary Islands (Shirt, 1983), Central Asia (Alekseev, 1980 and Ponomareva, 1985); Israel (Mendelsohn, 1983) and Pakistan (Roberts, 1985 and Taylo, 1983, 1985). There are no record on past population levels of different bird species from the area and hence no idea can be developed on the present trends in population.

High to very high populations of four species of livestock are widely distributed in Houbara tracts. The present populations of the wild mammals are very small compared with the total grazing sheep and goats. These species of herbivores appear to grossly exceed the carrying capacity of the and land vegetation and are liable to result in habitat destruction.

Constancy of species appearance

Presence of Houbara in 100% of the stands (83% showing significant populations) and a relatively low constancy of appearance for all the other bird and mammal species can be expected under the sampling bias, i.e., favourable Houbara habitat.

The constancy of appearance is decided by an interaction between adaptive range, population levels, dispersion and body size of the species and the carrying capacity of the area. Strict carnivores/raptors, generally, have dispersed and limited populations, under a low level of food energy available at higher trophic levels, and thence yielding low constancies. The size has a direct inverse relationship over the number of the animals carried by an area, smaller species giving higher constancies. The species having limited sharing of ecological range with Houbara are also expected to have low constancies.

Heterogeneity

A low constancy of appearance of the major portion of the animal species, a comparatively larger number of the species and fewer species appearing in different stands indicate the presence of heterogeneity in animal composition. This can be expected under a wider variation existing in physico-biotic conditions of the bustard tracts of Balochistan (Mian, 1997a, 2002).

Different number of the species appearing in different stands can be expected as per different physico-biotic conditions under different areas. The tracts holding different biotopes can provide suitable habitat to a number of species, while homogeneous tracts can hold species adapted for specific conditions. The harsh desert environment, having a few very specialized plant species existing under remarkable uniform habitat conditions, is expected to hold some specifically adapted animal species. The appearance of Houbara as the only species in some parts of the deeper desert, suggest an extreme desert adaptation of this species. The species, thus, appears to survive in desert conditions, where few other animals have adaptive to survive.

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