OnLine Journal of Biological Sciences 3 (6): 535-552, 2003
ISSN 1608-4217

On Biology of Houbara Bustard (*Chlamydotis undulata macqueenii*) in Balochistan, Pakistan: Faunal Associations

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Abstract: The data on distribution and density of animal species, sharing habitat with wintering Houbara in Balochistan (Pakistan), suggest that ***Galerida cristata*** shares the maximum association, followed by ***Lepus capensis***, ***Alaemon alaudipes***, ***Gazella bennettii***, ***Ammomanes deserti*** and ***Vulpes vulpes***. All other species have a low association with Houbara. Six major habitat types and 13 species association eco-groups have been identified on the basis "Two Way Indicator Species Analysis". Precipitation increases average density of animal population; but has no effect on species diversity. Grazing stress generally decreases Houbara density.

Key words: Association index, habitat types, species eco-groups, precipitation, grazing stress, inter-specific association

Introduction

Each animal species, having specific range of tolerance for different physico-biotic factors, is adapted to a specific range of variation in its habitat. This attributes a different degree of sharing of habitat between different animal species.

Houbara Bustard, being adapted to exploit a specific range of habitat variation, is expected to share its habitat to a specific level with different other species of animals. Animal species sharing ecosystem with this bustard species, in a specific area, are expected to show varying degree of interdependence and hence varying effects on bustard populations. Thus, varying degree of association can be expected between Houbara and other animal species, distributed along the range of its habitat. Studies on such association can help in understanding the basic position of Houbara in its ecosystem and/or the present/future possible threats to this species. The studies attempting such an association in the Houbara habitat, being limited and far from complete on a global level (Morocco = Goriup, 1983; Canary Islands = Shirt, 1983) and none existing for Pakistan and/or Balochistan, attracted our attention to undertake the present study.

Materials and Methods

Data collected during different parts of the wintering period (1986-87) on the distribution and abundance of different species of animals, including livestock in 53 stands, established in the wintering tracts of Houbara in the Balochistan (Pakistan), have been exploited for the purpose of present analysis.

Association indices of different animal species with Houbara were calculated using their presence/absence (un-weighed) and densities (weighed) in the stand areas. Mueller-Dombois and Ellenberg (1974) were followed for calculation of association indices, as per formulae:

$$IA(P) = \frac{c}{a + b + c} \times 100; \qquad IA(D) = \frac{Dc}{Da + Db + Dc} \times 100$$

where:

IA(P) = Un-weighed association index.
IA(D) = Weighed associations index.
a = Number of stands with only X species.
b = Number of stands, with only Houbara.
c = Number of common occurrence.
Da = Sum of densities of X species in all stands.
Db = Sum of densities of Houbara in all stands.
Dc = Sum of densities of two species sharing the stands.

Association indices were assigned one of the index classes (class 1 = <10; II = 11-20; III = 21-30; IV = 31-40; V = 41-50; VI = 51-60). An overall association index class was assigned to each species from the mean of weighed and un-weighed association indices.

Two way indicator species analysis was achieved followed Goriup (1983) and Hill (1973). Stands were arranged in accordance with degree of faunal similarity. Groups of stands having reasonable degree of similarity were created to represent broad habitat types of animal distribution, which were named on the general physical features of stands falling in habitat type. Species were also arranged into groups having reasonable degree of similarity in the pattern of their distribution and recognized as animal communities or species association eco-groups.

Habitat types were associated with average annual precipitation received (adopted from Champion ***et al.***, 1965). Average animal population density (per km^2) and average number of species per stand were calculated through suitable mathematical manipulations of the quadrat data. General information on topography, background soil and distribution of dominant vegetation were directly recorded in the field.

Grazing stress was judged through average density of grazing livestock (camel, sheep/goats and cattle).

Sokal and Rohlf (1969) were use for the statistical analysis.

Results

Species association

Association indices of different bird/mammal species with Houbara (Table 1) suggest a good degree of consistency between the indices derived from quantitative (weighed) and qualitative (un-weighed) data. The indices for all the species fall well below 100.

Table 1: Association index of wintering Houbara with different animal species in Balochistan. Association class I= index <10, II =10-19, III = 20-29, IV =30-39, V = 40-49, VI=50-59.

	Association Index, Class		
Species	Un-weighed	Weighed	Overall
Galerda cristata (crested lark)	54.72, VI	51.44, VI	53.08, VI
Lepus capensis (cape hare)	54.71,VI	47.37, V	51.04, VI
Alaemon alaudipes (hoopoe lark)	37.74, IV	48.57, V	43.16, V
Gazella bennettii (chinkara)	41.51,V	41.46, V	41.48, V
Ammomanes deserti (desert lark)	43.40,V	40.08, V	41.74, V
Vulpes vulpes (common red fox)	39.62,V	40.00, V	39.81, V
Cursorius cursor (cream coloured courser)	35.85, IV	34.22, IV	35.04, IV
Oenanthe deserti (desert wheatear)	32.08, IV	30.54, IV	31.31, IV
Pterocles orientalis (black-bellied sandgrouse)	28.30, III	33.88, IV	31.09, IV
Sylvia nana (desert warbler)	30.19, IV	29.20, III	29.70, IV
Corvus ruficallis (brown necked raven)	26.42, IV	22.32, III	24.37, III
Burhinus oedicnemus (stone curlew)	18.87, II	24.02, III	21.46, III
Hystrix indica (Indian crested porcupine)	22.64, III	13.24, II	17.94, II
Columba livia (blue rock pigeon)	13.21, II	20.17, III	16.69, II
Ammoperdix griseogularis (see see partridge)	15.09, II	17.45, II	16.27, II
Vulpes bengalensis (Indian fox)	18.89, II	11.50, II	15.19, II
Felis margarita (sand or dune cat)	15.09, II	14.29, II	14.69, II
Canis aureus (Asiatic jackal)	16.98, II	11.31, II	14.15, II
Canis lupus (Indian wolf)	16.98, II	9.91, I	13.45, II
Allactaga hotsoni (Hotson's five toed jerboa)	15.09, II	11.81, II	13.45, II
Alauda arvensis (skylark)	13.21, II	11.89, II	12.55, II
Lanius schach (rufous-backed shrike)	13.21, II	11.11, II	12.16, II
Turdoides caudatus (common babbler)	13.21, II	9.01, I	11.11, II
Oenanthe finschii (Finch's wheatear)	11.32, II	9.96, I	10.64, II
Aquila rapax (steppe eagle)	11.32, II	9.25, I	10.29, II
Oenanthe isabellina (Isabelline wheatear)	9.43, I	12.35, II	10.89, II
Pterocles senegallus (spotted sandgrouse)	9.43, I	11.49, II	10.46, II
Accipiter nisus (sparrowhawk)	9.43, I	9.57, I	9.50, I
Pterocles alchata (pin-tailed sandgrouse)	9.43, I	9.48,I	9.46, I
Hyaena hyaena (hyaena)	9.43, I	9.42, I	9.43, I
Millardia gleodowi (sand-coloured rat)	9.43, I	7.50, I	8.47, I
Motacilla alba (white or pied wagtail)	7.55, I	8.23, I	7.89, I
Gerbillus cheesmani (Cheesman's gerbil)	7.55, I	7.14, I	7.35, I
Herpestes edwardsi (common Indian mongoose)	5.67, I	7.62, I	6.65, I
Jaculus blanfordi (Blanford's jerboa)	7.55, I	5.73, I	6.64, I
Gazella subgutturosa (goitred gazelle)	9.43, I	1.67, I	5.55, I
Aquila clanga (spotted eagle)	5.67, I	4.72, I	5.20, I
Aegypius monachus (black vulture)	1.89, I	7.77, I	4.83, I
Alectoris chukar (chukar partridge)	7.55, I	1.74, I	4.65, I
Salpingatus michaelis (Fitz Gibbon's pygmy jerboa)	5.67, I	3.51, I	4.59, I
Felis chaus (jungle cat)	3.77, I	4.80, I	4.29, I
Merops orientalis (little green bee-eater)	3.77, I	4.31, I	4.04, I
Felis caracal (caracal or red lynx)	3.77, I	3.93, I	3.85, I
Corvus splendens (Sind house crow)	3.77, I	3.06, I	3.42, I

Table 1: Continue

Species	Association Index, Class		
	Un-weighed	Weighed	Overall
Silvis lineatus (black-eared kite)	3.77, I	2.16, I	2.97, I
Falco tinnunculus (kestrel)	3.77, I	2.16, I	2.97, I
Allactaga elater (small five toed jerboa)	3.77, I	1.30, I	2.54, I
Falco sp.	1.89, I	3.03, I	2.46, I
Accipiter badius (shikra)	1.89, I	2.59, I	2.24, I
Pycnonotus leucogenys (white -eared bulbul)	1.89, I	2.50, I	2.20, I
Pica pica (magpie)	3.77, I	0.50, I	2.14, I
Passer montanus (tree sparrow)	1.89, I	2.30, I	2.10, I
Oenanthe monacha (hooded warbler)	1.89, I	2.16, I	2.03, 1
Falco subbutea (hobby)	1.89, I	2.16, I	2.03, I
Lanius vittatus (bay-backed shrike)	1.89, I	2.15, I	2.02, I
Sturnus roseus (rosy pastor)	1.89, I	2.15, I	2.02, I
Otis tarda (great bustard)	1.89, I	1.74, I	1.82, I
Tetrax tetrox (little bustard)	1.89, I	1.11, I	1.50, I
Felis libyca (desert cat)	1.89, I	0.86, I	1.38, 1
Gypaetus barbatus (lammergeier or bearded vulture)	1.89, I	0.40, I	0.97, I

Galerida cristata and ***Lepus capensis*** are placed in association class VI and ***Alaemon alaudipes***, ***Gazella bennettii***, ***Ammomanes deserti*** and ***Vulpes vulpes*** appear in class V. Four species (***Cursorius cursor***, ***Oenanthe deserti***, ***Pterocles orientalis***, ***Sylvia nana***) are placed in class IV, while two species (***Corvus ruficollis***, ***Burhinus oedicnemus)*** in class III. Fifteen species appear in class II and 33 in class I, 23 having an association index of less than 3.

Habitat types

Two way indicator species analysis (Table 2) suggests 6 broad habitat types (columns), described as:

Highland hilly valleys

Comparatively narrow valleys and hilly undulates in northern and central highlands (altitudes 700 - 1,700m), having stabilized alluvial soils, with or without stony cover. Deep inundations appear under persistent erosion through rainwater. Water generally remains available within the reach of the animals throughout the year.

Two sub-types are recognized, on the basis of altitudinal variation:
Al: Located at altitudes above 1,000m.
A2: Falling at 700-1,000m above sea level, located in comparatively southern latitudes.

Table 2: Habitat types and animal communities (eco-groups) achieved through similarity in faunal composition of different stands studied from Houbara tract in Balochistan.
(1= present; 2=0.01-0.09 individuals/km^2; 3=0.1-0.9; 4=1.0-10.5; 5= >10)

Stand No.	1	2	3	4	5	6	9	26	27	29	10	11	12	17	21	28	30	31	32	33	34	35	36	37	41	38	39	40	51	52	53
Species Habitat type	A1					A2					B										C					D					
Pica pica	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
I *Gazella subgutturosa*	1	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Alectoris chukar	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
II *Allactaga elater*	-	-	1	-	-	1	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-
Ammoperdix griseogularis	-	-	-	1	-	-	-	4	4	4	4	-	-	-	-	-	1	-	-	-	-	-	4	-	-	-	-	-	-	-	-
Hystrix indica	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	-	1	-	1	1	1	1	-	1	-
Canis lupus	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	1	-	-	-	-	1	-	-	-	-	-
Canis aureus	-	-	1	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	-	1	-	-	1	-	1	-	-	-
III *Alaemon alaudipes*	-	-	1	-	-	3	3	3	3	-	-	2	-	3	-	2	-	-	-	-	4	-	-	-	-	3	2	3	-	-	-
Galerida cristata	3	3	1	1	-	4	1	4	-	-	1	2	-	4	-	-	3	4	4	4	-	1	3	4	-	5	4	4	3	-	-
Pterocles orientalis	-	-	1	-	-	-	-	4	4	-	-	-	-	-	4	4	3	3	-	-	-	-	4	4	-	4	4	3	-	-	3
Oenanthe deserti	2	1	1	-	-	4	-	-	-	-	-	-	-	3	-	-	-	2	-	2	-	-	3	-	-	4	-	3	3	-	3
Lepus capensis	3	3	3	1	-	1	1	1	-	1	2	-	-	-	3	-	3	1	3	1	1	1	-	-	-	1	-	1	-	-	-
Ammomanes deserti	3	3	1	-	-	3	-	-	3	-	-	-	-	-	-	-	-	3	-	2	-	-	4	3	1	-	-	4	-	1	-
Cursorius cursor	3	3	-	-	-	-	-	-	-	-	3	-	-	1	-	-	-	-	-	-	-	-	3	-	-	1	3	3	-	1	-
IV *Chlamydatis undulata*	2	1	1	1	1	3	3	3	3	3	3	2	1	3	3	2	3	3	2	3	2	2	3	2	2	3	3	3	2	2	2
Alauda arvensis	-	-	1	-	-	4	-	-	-	-	-	-	-	-	3	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-
Vulpes bengalensis	-	1	2	1	-	-	-	-	-	-	1	-	-	1	-	1	2	-	-	3	1	1	-	-	1	1	-	-	-	-	-
Columba livia	-	1	-	-	-	-	-	-	5	-	-	-	-	-	4	-	-	-	-	-	-	-	-	-	-	4	-	4	-	-	-
Corvus ruficallis	-	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	1	-	-	-	-	-	-	-	-	-	-
Lanius schach	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1	4	4	-	-	-	-	-	-	-	-	2	-	-	3	-	-
V *Vulpes vulpes*	-	-	-	-	1	1	-	3	3	-	-	-	-	-	1	4	4	-	-	-	-	-	-	-	-	2	-	3	-	-	-
Felis morgarata	-	-	1	-	-	-	1	-	-	-	-	-	-	-	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aquila rapax	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	1	-	-	3	-	-
VI *Turdoides caudatus*	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	3	2
Falco tinnuculus	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2		-	-	-	-
Sylvia nana	-	-	-	-	-	1	-	-	-	1	2	1	-	-	-	-	-	2	3	-	-	-	-	-	-	3	3	-	-	-	3
VII *Burhinus oedicnemus*	-	-	-	-	-	-	-	-	2	-	-	-	-	3	3	3	-	-	3	-	-	-	-	-	-	-	-	2	-	-	2
Gazella bennettii	-	-	-	-	-	1	2	-	-	2	1	-	-	-	2	-	1	2	-	1	-	-	-	1	1	1	1	-	-	-	-
Jaculus blanfordi	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 2: Continue

Stand No.	1	2	3	4	5	6	9	26	27	29	10	11	12	17	21	28	30	31	32	33	34	35	36	37	41	38	39	40	51	52	53
Species Habitat type	A1					A2					B										C					D					
Felis chaus	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Felis caracal	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
VIII *Allactage hatsoni*	-	-	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Milvus lineatus	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Herpestes edwardsi	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
IX Petrocles senegallus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	4	3	-	-	-	2
Pterocles alchata	-	-	-	-	-	-	-	-	-	-	3	-	-	3	-	-	-	-	-	-	-	1	1	3	-	-	-	-	-	-	-
Hyaena hyaena	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1		-	-	-	1	-	-	-	-	-	-	-	-	-	-
Oenanthe monacha	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Merops orientalis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	2
X Falca subbutea	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-
Passer nontaus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
Motacilla alba	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	2	-	-	-	-	-	-	-	2	-	-	-	-	-
Oenanthe finschii	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	2	2	-	-	-	-	-	-	-	1	-	-	-	-
Accipiter nisus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	2	2	-	2	2	3	-	-	-
Accipiter badius	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Linius vittatus	-	-	-	-	-	-	-	-		-	-	-	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3
Corvus splendens	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	-
XI *Oenanthe isalballine*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	3	3	-	3	3
Aquila clanga	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-
Sturnus roseus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3
Salpingatus michaelis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gerbillus cheesmoni	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
XII *Gypaetus barbatus*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aegypius monachus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Falco sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tetrax tetrax	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
XIII *Millardia gleadowi*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Felis libyca	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 2: Continue

Stand No.	7	8	13	14	15	16	18	19	20	22	23	24	25	42	43	44	45	46	47	48	49	50
Species Habitat types	E													F								
Pica pica	-		-	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
I *Gazella subgutturosa*	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Alectoris chukar	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
II *Allactaga elater*	-	-	-	-	-		-	-	-	-		-	-	-	-		-	-	-	-	-	-
Ammoperdix griseogularis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hystrix indica	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Canis lupus	1	-	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Canis aureus	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
III *Alaemon alaudipes*	3	4	2	-	-	-	3	3	-	2	2	-	-	-	-	-	-	-	-	-	-	-
Galerida cristata	3	1	3	4	3	-	3	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pterocles orientalis	3	-	-	-	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Oenanthe deserti	-	-	-	3	3	-	3	-	-	-	-	-	-	3	-	2	-	-	-	-	-	-
Lepus capensis	1	-	1	2	1	-	1	3	1	3	3	-	-	1	-	-	-	-	1	2	-	-
Ammomanes deserti	3	-	-	-	-	-	3	3	-	-	-	-	-	3	3	3	2	3	-	2	2	-
Cursorius cursor	4	1	3	3	-	-	-	3	-	2	1	-	-	-	3	2	3	-	-	-	-	-
IV *Chlamydatis undulata*	1	3	3	3	1	2	3	3	3	4	3	3	4	3	3	1	3	3	2	1	2	3
Alauda arvensis	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
Vulpes bengalensis	-	-	-	1	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-
Columba livia	-	-	-	3	-	-	4	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Corvus ruficallis	4	-	-	3	1	-	-	2	-	3	3	3	1	-	-	-	1	-	-	-	-	-
Lanius schach	-	-	-	2	1	-	3	3	-	2	2	1	2	-	3	2	3	-	1	-	-	-
V *Vulpes vulpes*	1	-	-	-	1	-	-	2	-	2	2	-	-	-	-	-	-	-	-	-	-	-
Felis morgarata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aquila rapax	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-
VI *Turdaides caudatus*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Falca tinnuculus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sylvia nana	1	1	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
VII *Burhinus oedicnemus*	-	-	-	-	-	-	-	3	-	3	2	-	-	-	-	-	-	-	-	-	-	-
Gazella bennettii	1	1	-	1	-	-	1	2	-	2	2	-	2	-	-	-	-	2	1	-	-	-
Jaculus blanfordi	-	-	-	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Felis chaus	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-
Felis caracal	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 2: Continue

Stand No.	7	8	13	14	15	16	18	19	20	22	23	24	25	42	43	44	45	46	47	48	49	50
Species Habitat types	E													F								
VIII *Allactage hotsoni*	-	-	-	-	1	1	1	1	1	-	-	-	1	-	-	-	-	-	-	-	-	-
Milvus lineatus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Herpestes edwardsi	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	1	-	-	-	-
IX *Petrocles senegallus*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-
Pterocles alchata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hyaena hyaena	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	2	-	-	-	-
Oenanthe monacho	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Merops orientalis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
X *Falco subbutea*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Passer nontaus	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Motacilla alba	-	-	-	-	3	-	-	1	1	-	-	-	1	-	-	-	-	-	-	-	-	-
Oenanthe finschii	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Accipiter nisus	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Accipiter badius	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Linius vittatus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Corvus splendens	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
XI *Oenanthe isalballine*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aquila clanga	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sturnus roseus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Salpingatus michaelis	-	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gerbillus cheesmoni	-	1	-	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
XII *Gypaetus barbatus*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aegypius monachus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Falco sp.	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-
Tetrax tetrax	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
XIII *Millardia gleadowi*	-	1	1	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Felis libyca	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 3: Similarity indices between faunal compositions of different habitat types of Balochistan.

	B	Al	C	A2	E	D	F
B	-	79.00	77.44	80.94	89.31	74.93	75.63
Al	79.00	-	78.94	78.38	74.93	69.65	70.00
C	77.44	78.94	-	76.72	68.73	67.04	66.93
A2	80.94	78.38	76.72	-	72.58	60.80	62.82
E	89.31	74.93	68.73	72.58	-	72.07	59.65
D	74.93	69.65	67.04	60.08	72.07	-	44.93
F	75.63	70.00	66.93	62.82	59.65	44.93	-

A1 = highland hilly valleys (>1,000 m), A2= highland hilly valleys (600-1,000 m), B= stony deserts, C= southern hilly valleys, D=lowland eastern valleys, E=highland deserts, F=lowland deserts.

Table 4: Animal density and diversity appearing under average annual rainfall gradient, received in different habitat types, identified in the wintering tracts of Houbara in Balochistan

	Al	A2	F	D	C	B	E
Average annual rainfall (mm)	267.50	190.00	155.00	153.80	147.50	119.20	118.80
Average density of animal population (per km^2)	0.57	0.86	0.64	0.98	0.74	0.63	0.59
Average number of species/stand	10.80	9.80	5.20	12.60	7.60	6.80	10.40

Al= highland hilly valleys (> 1,000 m), A2= highland hilly valleys (600-1,000 m), B= stony deserts, C= southern hilly valleys, D= lowland eastern valleys, E= highland deserts, F= lowland deserts.

Table 5: Distribution of Houbara in different livestock grazing stresses, in its wintering tracts in Balochistan

Stress Class	Number of Stands	Houbara Density (per km 2) ± S.E. *
Low	26	0.26±0.06a
Medium	10	0.15±0.07a
High	11	0.26±0.08a
Very high	5	0.13±0.05a

Grazing stress class: low = no head seen, medium = 0-1 head/km^2, high= 2-5, very high = > 5.
Mean sharing similar letters are non-significant (P<0.05)

Stony deserts

Mild undulates distributed along hills/mountains in central and southern highland valleys (altitudes: 700-1,000m), represent buffer zone between mountains and sandy deserts. Vegetation mainly in patches along depressions, where associated hills ensure availability of water.

Southern hilly valleys

Medium sized valleys located in southern latitudes at altitudes ranging from sea level to some 600m, similar to highland hilly valleys in general conditions/topography; but more arid in character.

Lowland eastern valleys

Relatively stabilized valleys at about sea level in the eastern flank of the province, having sparely distributed trees or tall shrubs. Valleys have comparatively large stretches under active cultivation; scattered in vast wild tracts.

Highland deserts

Distributed in the central highlands, having varying degree of sand dunes in different tracts, vegetation limited to the sand dunes, where a few desert-adapted species survive. These deserts present vast tracts with limited human interference, especially in extreme western flanks. Limited fallow land cultivation and sheep/goat/camel grazing.

Lowland deserts

Sandy deserts, with conditions almost similar to highland deserts, in southern coastal belt, holding a better vegetative cover provided by halophytes. More stabilized soil appears in certain tracts having scattered distribution of trees or tall shrubs.

The values of similarity indices (Table 3) suggest a fairly high association between the faunal compositions of different habitat types. B shares a high association with all other habitat types. The values of the association indices decrease gradually in A1, through C, A2 and E, so that minimum association is exhibited in D.

Species association groups

Thirteen association eco-groups of the bird/mammal species (Table 2, rows) have been identified, as:

I. A group of 3 species restricted to highland valleys (habitat type A). ***Pica pica*** is restricted to two stands of northern valleys (AI), while ***Gazella subgutturosa*** and ***Alectoris chukar*** present a wider distribution in the habitat.

II. A group of 2 species (***Allactaga elater***, ***Ammoperdix griseogularis)***, which are mainly distributed in habitat, type A; but have a scattered occurrence in B and C.

III. A group of 6 species having a wider distribution in A to E habitat types. ***Hystrix indica***, ***Canis lupus*** and *C. **aureus*** are dispersed in low populations in scattered stands, while ***Alaemon alaudipes***, ***Galerida cristata*** and ***Pterocles orientalis*** appear in higher densities and are widely distributed.

IV. An association group of 9 species having widest distribution, appearing in all habitat types (A-F). Four species (***Oenanthe deserti***, ***Lepus capensis***, ***Ammomanes deserti***, ***Cursorius cursor***) have random distribution. Other 4 species (***Alauda arvensis***, ***Vulpes bengalensis***, ***Columba livia***, ***Corvus ruficollis***) have scattered appearances. Houbara falls in all the habitat groups and is present in all the stands.

V. Three species (***Lanius schach***, ***V. vulpes***, ***Felis margarita***) constitute a group, having distribution in all the habitat types, except C.

VI. A group of 3 species (***Aquila rapax***, ***Turdoides caudatus***, ***Falco tinnunculus)*** constitute a group having restricted distribution, appearing mainly in A1 and D habitat types, though Aquila has a scattered wider appearance in C, E and F.

VII. ***Sylvia nana***, ***Burhinus oedicnemus*** and ***Gazella bennettii*** constitute a group having a wide distribution and appearing in all the habitat types, except for A1 and F. ***G. bennettii*** also appear in F in low populations.

VIII. Six species (***Jaculus blanfordi, Felis chaus, F. caracal, Allactaga hotsoni, Milivus lineatus, Herpestes edwardsi)*** constitute this group, distribution in A2 and E habitat types. ***H. edwardsi***, however, does not appear in E, but is present in scattered stands of F.

IX. A single species (***Pterocles senegallus)*** is distributed in D habitat type, with scattered appearances in certain isolated stand of C and F.

X. A comparatively heterogeneous assemblage of 10 species, appearing in different densities and patterns in B, C, E and F habitat types. Three species (***Pterocles alchata, Hyaena hyaena, Oenanthe monacha)*** appear in B, C and F; 3 (***Merops orientalis, Falco subbuteo, Passer montanus)*** mainly in D, while 4 others (***Motacilla alba, Oenanthe finschii, Accipiter nisus, A. badius)*** have scattered appearances in B, C, D and F.

XI. Five species have a very restricted appearance in D. One species (***Oenanthe isabellina)*** has a wider distribution, while 4 others (***Lanius vittatus, Corvus splendens, Aquila clanga, Sturnus roseus)*** have scattered appearance.

XII. An association of 5 species (***Salpingotus michaelis, Gerbillus cheesmani, Gypaetus barbatus, Aegypius monachus, Falco*** sp.***)*** having a scattered distributed in E only.

XIII. Two species (***Millardia gleadowi, Felis libyca)*** of mammals are restricted in their appearance to F.

Precipitation

The analysis of animal diversity and average population density in the background of the precipitation received in different habitat types (Table 4), suggests that average animal density increases gradually with increasing average precipitation, except for A and F habitat types. However, average number of animal species appearing in different habitat types, exhibit no persistent pattern with increasing rainfall gradient.

Values of correlation coefficient between precipitation and animal density (r= -0.332) and diversity (r= -0.0335) suggest a negative but not significant correlation between these parameters.

Grazing stress

Houbara density variation under different grazing stress (Table 5) suggests that different stress classes are not significantly different in holding Houbara population density, when judged by methods of maximum approximation. However, the increasing grazing stress consistently decreases the population level of Houbara, except for high stress class, where it remains appreciably higher than that demanded under generally followed pattern.

The grazing stress has a negative correlation (r = -0.5223, not significant) with average Houbara density.

Discussion

Only mammals and birds have been considered for the present analysis. This is because adequate data on species abundance/distribution is not available on reptiles and insects. However, in the wake of low populations of these groups during winter they groups have a relatively limited significance in general fauna associated with Houbara. For practical difficulties different animal groups have been considered for such analysis in previous studies (birds =

Goriup, 1983; Shirt, 1983; large mammals, birds and grasshoppers = Ali and Rahmani, 1982; Manakadan, 1985).

Species associations

Calculation of the association index, a technique basically used in phytoecological studies (Mueller-Dombois and Ellenberg, 1974), has certain inherent limitations when applied to animals. Un-weighed association index, giving no consideration to abundance, over-emphasizes the chance appearance of scattered individuals in a larger number of stands, being shared by two species. On the other hand, weighed index, calculated on relative abundance/density, over-emphasizes some chance encounter of large flocks of animals in a few stands. Though, in the present studies, the indices derived through two routes bear a considerable consistency, yet it appears advisable to find an average association index, to cater for such chance errors, liable to appear more frequently in animal analysis.

The fact that none of the species of birds or mammals bears 100% association with Houbara and only 4 share more than 40% association, suggests that Houbara is adapted to an ecological range, which has not been fully adapted by any other species. Present results provide support to the hypothesis, suggesting that Houbara has adapted to a very wide ecological range, extending into deeper desert, where few other animal species happen to survive (Mian, 2002).

Three species of larks (crested, desert, hoopoe), cream coloured courser and desert wheatear, amongst bird and cape hare, two species of gazelles (chinkara, goitred; excluding one another in their distribution ranges) and common fox, amongst mammals, share a high level of association with Houbara in its wintering tracts of Balochistan. This suggests that these species have potentials to exploit specific habitat conditions of Houbara to an appreciable level. All other species have a very low association, except for black-bellied sandgrouse, desert warbler and stone curlew. Such an association appears understandable, as these species are adapted to fight the harsh desert conditions. The other species are basically adapted to certain milder habitats, requiring direct intake of water at regular intervals. Such species remain in the associated habitats for the major part, coming to ecotone area, appearing between adjacent habitats. Thus, major part of the fauna appears to share the Houbara habitat under the edge effect.

Some of the carnivorous mammals and/or raptorial birds can potentially share a higher association with Houbara, than that suggested through association indices. They have a wider ecological range, probably sharing total Houbara habitat. These animals are placed at higher trophic level and require larger tracts, generally appear in low populations and constancies, especially under recent declines. Suggested low association of these species with Houbara can, therefore, be regarded as an artifact, appearing in the data, attributable to their low population levels.

Habitat types

Different habitat types created through grouping of the stands having similarity in the species composition have certain valid basis. Groups of species adapted to a similar range of habitat conditions, are expected in stands having same general conditions. Remarkable variation

existing in the altitudes, temperature, rainfall, soil, availability of water, size and orientation of mountain ranges and physico-biotic barriers to animals dispersal suggest presence of different habitat types in the basic range of distribution of the wintering Houbara in the Balochistan. There is considerable similarity between the physical habitat divisions, anticipated under the phytoecological studies (Mian, 1997) and habitat types suggested through animal distribution.

A relatively higher similarity indices between different habitat types may be an artifact introduced into the analysis through a very few species sharing a wider range of distribution and the major part of the fauna appearing in sporadic stands. This can also be expected under migratory nature of the majority of the fauna, which is expected to show wide movements in response to temperature gradient. Some local movements between habitats are also expected in the populations of resident mammals/birds. The effect of such movements becomes more pronounced in the tracts, like the Balochistan, where different habitat types run side by side.

The distribution of fauna in a habitat type can be explained on the set of available physico-biotic factors. The patterns of the animal distribution, suggested by the general physico-biotic factors and association indices, run considerably parallel to one another. The Balochistan, being located along the southeastern boundary of the Palearctic region, has the basic Palearctic character of the fauna, as has been suggested by high association indices between majority of the habitat types. The proximity of the lowland eastern valleys with the Oriental region and the river Indus proving as weak barrier, suggest a greater influence of the Oriental fauna in this habitat type. Such a difference in the faunal composition is reflected through comparatively low association indices of this habitat type (D) with others. The southern lowland sandy deserts (F) also present a remarkable different set of physical conditions, attributable to low altitudes and proximity to seacoast, to suggest a different set of fauna. Increasing degree of similarity in temperature and geographical location of highland valleys attribute a higher similarity in the faunal composition, as has been suggested by higher association indices. Altitudinal variations associated with the temperature gradient separate the northern (A1) and southern (A2) highland hilly valleys from southern (C) hilly valleys. The presence of harsh conditions of temperature and low precipitation separates the highland sandy deserts (E) to constitute a separate habitat type. Higher association indices appearing for northern (A1) and southern (A2) highland hilly valleys and highland deserts (E) are expected on their sharing of similar geographical areas and/or altitudes. Highland stony deserts (B) represents as ecotone, sharing the biotopes with highland hilly valleys, sandy deserts and lowland hilly valleys and hence are expected to share a higher association indices with other types.

Species eco-groups

The distribution of an animal species is decided by its habitat requirements, ecological amplitude and dispersal potentials, as also physico-ecological barriers present in the area. The eco-groups created, under the present study, suggest a different degree of sharing of ecological range of Houbara by different groups of animals. The species, having a limited distribution in certain selected habitat type, are expected to have a limited sharing of the habitat with the principal species, i.e., the Asian race of Houbara. Thus, the species included in the eco-groups III, IV, V and VII have a much wider sharing of Houbara habitat and hence can wok as potential

competitors or effective predators. Species grouping achieved under present study is in good degree of proximity with the one achieved by Goriup (1983), in general pattern of distribution of different species in different habitat groups.

Precipitation

The results suggest that, for the major part of the bustard tract, increasing precipitation directly on increases animal population density. The precipitation, in an area, is a direct character of the vegetative biomass (Walter, 1954) and it has a more pronounced effect in a desert tract. Increasing vegetative cover and/or biomass has a direct bearing on the total carrying capacity of the area for different categories of heterotrophs, depending directly or indirectly on vegetative life. The appearance of a low density of animal population in the northern valleys than that desired under the precipitation gradient, can be attributed to the presence of a harsh low winter temperature in these valleys, located at comparatively higher altitudes. There are sufficient evidences to suggest the presence of a rich animal life in these tracts during summer and spring, when the temperature is favourable (Ticehurst, 1926-27).

The significant values of coefficient of linear correlation between precipitation and animal abundance or diversity suggests a relatively minor control of precipitation levels over deciding these parameters, especially in Houbara wintering tracts in Balochistan. It is true that the rainfall increases the vegetative cover and biomass (Walter, 1954) and thence an increased carrying capacity. It can also provide a wider diversity in microhabitat conditions to support diversity of animal life. However, both animal abundance and diversity are significantly influenced by other equally potent factors, like, temperature, varied biotopes, vegetative types, geographic location and degree of human disturbance. An interaction between all such factors finally decides abundance and diversity of animal life. The negative correlation suggested in the present analysis appears to be an artifact collectively introduced by a low animal life, under low winter temperatures in the northern valleys (A1, A2) and a higher animal diversity appearing in lowland valley (D) and highland sandy deserts (E), under the edge effect, appearing due to varied biotopes available in/around the habitat types, alongwith a low density in southern latitudes (F).

Grazing stress

Man and his maintained livestock also constitute a group of animals having an almost 100% association with Houbara. Our results suggesting a negative effect of the increasing grazing stress on the population levels of Houbara go in conformity with previous general observations (Roberts and Savage, 1971; Alekseev, 1980; Surahio, 1981). The present report, however, is the first to provide some quantitative data to support this general feeling. Grazing stress has a direct effect on Houbara density through snatching away the food and shelter, the two important basic requirements of this species (Mian, 2002). The associated human activities also disturb this human shy species.

Different species of livestock can potentially have different effects on the Houbara and/or its habitat. Cattle cause direct disturbance. As it is not very widely maintained in Houbara tract (Mian, 1983), therefore, its potential effects are minimum. Sheep/goats have a direct catastrophic effect on Houbara habitat, especially when their numbers increase beyond bearable

limits (Coblentz, 1978; Robins, 1983), though they cause a limited disturbance to Houbara. Camel causes the minimum damage to desert vegetation, through browsing shrub vegetation, leaving the sprouting shoots and herbs till the stage these are in a position to tolerate browsing stress (Stiles, 1978; Robins, 1983). A slow movement in camels causes minimum disturbance to Houbara and its flat and cushioned feet cause minimum effect on the vegetation. Camel has been frequently associated with the Houbara in various reports (Mian and Surahio, 1983; Mian, 1984; Ali and Ripley, 1983), which can now probably be explained on the basis of availability of better habitat conditions.

The recent trend of development of permanent human settlements and adopting to a sedentary mode of life by human populace, replacing the traditional nomadic pattern, is liable to increase the effects of grazing stress through habitat destruction. This appears to be the potential future threat for the fauna and flora of the region, causing loss of habitat of wild animals, including that of Houbara.

Interspecific association

Different species of animals, present in the wintering tracts of Houbara in Balochistan, can be associated with it in one of the following ways.

Predators

Carnivorous mammals and raptorial birds can potentially act as predators to Houbara. Amongst mammals, fox have the widest distribution, followed by cats, hyaena, mongoose, wolf and jackal. The populations of the carnivores are under a general stress and now appear as small isolated populations. The Asiatic Cheetah (***Acinonyx jubatus)*** is believed to be already extinct and leopard (***Panthera pardus)*** is rarely sighted, attaining an endangered status (Roberts, 1997). The wolf, jackal and hyaena have a very scattered appearance in bustard tracts. Though, such carnivores have been claimed to cause some damage to Houbara in its breeding ground, by damaging/consuming eggs and/or chicks (Alekseev, 1980; Ponomareva, 1979); yet these are not expected to cause a significant damage to the adult birds, present in the wintering ground, where it is believed to be very vigil (Mian and Surahio, 1983; Mian, 1984; 1988) and capable of taking to its wings. The chances of these species to work as potent predators have further decreased under their limited populations in the area.

Raptors have potentials to work as potent predators for adult Houbara in its wintering grounds in Balochistan; yet these appear to have a limited effect. The species of raptorial birds, recorded from the area, are too small to launch and effective attack on the adult Houbara. Larger raptors are though expected to be present (Ticehurst, 1926-27; also reflected by the activities of falcon trappers); yet their populations are very low. Under these conditions, it appears that in natural ecosystem, raptors are not likely to cause a significant predation pressure.

Snakes and lizards can also potentially cause damage to Houbara, especially to the eggs/chicks. As per limited activity of the reptiles during winters, snake biting having no proven claims and limited potentials of prevalent lizards to act as predators (smaller in size), these have a limited chance of causing a significant predation pressure on the wintering Houbara.

In the absence of any previous report, suggesting mammals, birds or reptiles working as potent predators and under the logic developed under present report, it appears that man and/or falcons, used by him, are the only effective predators to adult Houbara in its wintering grounds of Balochistan. Thought, Houbara can avoid human disturbances through population adjustments and/or time budgeting, yet can not probably accommodate a massive assault coming through the present level of falconry activities (Mian, 1986, 1997-a).

Habitat competitor

Amongst herbivore mammals, two species of gazelles, cape hare and some rodents are widely distributed. These species are capable of working as potential habitat competitors to Houbara. Very low population of gazelles (Mian, 2002) is not capable of causing a danger to Houbara habitat. Cape hare is though widely distributed in appreciable populations (Mian, 2002), yet there is no indication that it is causing an unsustainable damage to vegetative habitat and hence has a limited value as habitat competitor. In the wake of an expected further decline in its population, under the persistent motorized hunting, its potentials of working as habitat competitor are further becoming slim. None of the rodents, recorded to be effectively sharing the habitat, can work as very effective habitat competitor to Houbara.

The present discussion suggests that none of the species of wild animals is expected to work as effective habitat competitor to Houbara, under natural ecosystem. In fact some of these animal species might be working as dispersal and/or pollinating agents, thus, helping in the habitat development. Human species and/or his maintained livestock appear to be the only effective habitat competitor to Houbara, causing over exploitation of the habitat through excessive woodcutting and grazing stress. The stress is expected to increase in future years under increasing human population, development of communication links, permanent settlements and modern means of transportation (Mian, 1986). The effects of such a stress can be detrimental for general vegetation in the unfavourable years of drought. Fortunately, the natural process of elimination of the livestock during the years of extreme drought lowers the grazing pressure, when the vegetation is more prone to damage.

Food competitor

The Houbara being omnivore (Mian, 1986-a, 2000; Fox, 1988) depends upon fleshy leaves/fruits/flowers and insects. None of the animals listed appears to have a feeding habit, exactly matching this bustard species (Mian, 2000). Thus, there is no effective food competitor to Houbara in the area.

Food species

Ground beetles and ants are prevalent in the wintering grounds and are consumed by the Houbara as food (Mian, 1986, 2000; Fox 1988). The populations of these species increase during late winter. The populations of reptiles and other insects are generally low in the major parts of its wintering tracts and hence are not liable to contribute a significant proportion in Houbara diet.

Acknowledgment

The study was carried out through a partial financial support from WF-Pakistan and under an active collaboration with Balochistan Forest Department. Thanks are due to a large number of field guides, who provided their help and support in the conduct of the study in difficult desert terrain.

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