*Punjab Univ. J. Zool., Vol. 13, pp. 65-78, 1998*

# ON BIOLOGY OF HOUBARA BUSTARD (*CHLAMYDOTIS UNDULATA MACQUEENII*) IN BALOCHISTAN, PAKISTAN: BREEDING

AFSAR MIAN*

*Institute of Pure and Applied Biology, Bahauddin Zakariya University, Multan-60800, Pakistan*

**Abstract:** Spotting of 7 nests and 10 broods in Balochistan (Pakistan) suggests a regular breeding of 50-100 hens over some 9,000 $km^2$. Breeding potentials are high for Rakshan (Bisemah and Nag), medium for northern Chagai and Kharan, and low for south-western and central Kharan. Average clutch ($2.0\pm0.2$) and brood ($1.9\pm0.2$) size suggests normal breeding potentials. Egg laying starts from late February and lasts till late April, while chicks appear between late February and mid May. Egg laying is restricted to stony deserts located in mild hilly undulates at >600 m above sea level. Shrub (6-11%) and herbal (5-19%) cover is low and all the species are green and sprouting. *Zygophyllum* sp., *Anabasis* sp., *Astragalus hyrcanus-ziziphus* sp. and *Cocculus* sp. communities have been identified. *Lepus capensis, Vulpus* sp., *Gazella bennetti, Felis* sp., *Canis lupus, C. aureus* (mammals), *Alaemon alaudipes, Pterocles* sp., *Cursorius cursor, Burhinus oedienemus, Ammoperdix griseogularis, Ammomanes deserti, Alauda arvensis, Galerida cristata* and a number of raptors (birds) are widely distributed. Insects (beetles, ants, grasshoppers) and reptiles (lizards, snakes) are common. Grazing stress and human disturbance are high. Male starts displaying at its own, selecting a raised surface. Nest represents a scrap on the ground and is placed on the ridge away from shrubs. Only hens incubate the eggs and protect chicks. Hens frequently leave nest on spotting approaching predator.

**Key words:** Grounds, potential, chronology, ecology, behaviour.

## INTRODUCTION

Despite, speculations on presence of breeding of the Asian race of Houbara (*Chlamydotis undulata macqueenii*) in southern coastal Balochistan (Pakistan), *i.e.*, Makran (Ali and Ripley, 1983, original version appearing in 1969; Siddiqi, 1972) and collection of an egg from Maslakh (20 km in north-west of Quetta; Anonymous, 1972), it was not regarded as a regular activity for the area. Persistent reports of hunters and prominants from central highland Balochistan during our tour (Mian and Surahio, 1983) and responses to a questionnaire forced us to suggest that some 50-100 Houbara do lay eggs in these tracts (Mian, 1983, 1984). This was supported by subsequent collection of an egg from Yakmuch (western Chagai; Karim and Hasan, 1983) and a report suggesting that Dubai Wildlife Centre received 3 eggs from this area (Kermani, 1983; IG Forests, Pakistan; personal communication). The presence of regular breeding was later adequately confirmed by sighting of eggs, chicks and adults (Mian, 1985). This paper attempts at presenting some more supportive data

*Present Address: Department of Biological Sciences, University of Arid Agriculture, Rawalpindi, Pakistan.

0079-8045/98/0001-0065 $ 03.00/0 

on breeding of Houbara from different tracts of Balochistan, with some preliminary information on its breeding biology.

## MATERIALS AND METHODS

Possible breeding grounds of Houbara in Balochistan (Yakmuch, Nokchah, Padag, Pul Chutao, Inam Bostan, Dak Plain, Jalwar, Sarwan, Urmagai, Bisemah, Rakshan, Patao, Maslakh) were visited between end March and mid April during 1984 and 1985 under the guidance of pre-contacted guides. Breeding was ascertained through direct observations on adult birds, eggs and chicks (aided by binoculars 8x40) and indirectly through spotting fresh foot tracks, faecal materials and/or feathers. All the guides were strictly instructed not to collect eggs or chicks. They were only required to communicate sighting of eggs or chicks to be confirmed by the author

A tour of potential breeding tracts (Chagai, Kharan, Bisemah, Rakshan) was conducted during March-May 1986, through field guides to collect some preliminary ecological data. Vegetative communities were established and named on visual dominance of the species (Braun-Blanquet, 1932). Physical habitat type, general topography, associated plant species, general shrub cover and phenology were recorded directly, while altitudes were adopted from Champion *et al.* (1965). Sighting records on general fauna were maintained and relative abundance of dominant species was judged through frequency of their encounter. Record on number of grazing livestock, distribution of cultivations and human settlements, and level of human activity was also maintained for different tracts.

Nests were located with the help of local guides. Number of eggs, general location and presence of markers around the nest was recorded. Activity of adult bird was judged through foot prints present around the nest. A search was maintained to record male display and courtship during different tours of Houbara wintering tracts.

## RESULTS

### *Breeding tracts and potentials*

Information available till date (Table 1; Fig. 1; partly reported in Main, 1985) suggests that regular egg laying was present in Inam Bostan plains (north-eastern Chagai), Gonnakoh (north-west Chagai), Dalloh (north-western Kharan), Bedi (north central Kharan), Bisemah (north-eastern Khuzdar), Rakshan and Nag (north Punjgur). There were some indications of breeding in Kissan (south-eastern Kharan), Maslakh (Pishin), Qamar-uddin Karaz (Zhob) and south-eastern coastal tracts of Gwadar, but these could not be adequately confirmed. Chicks and adults have been spotted over a wider-range. These were present in Padag, Pul Chutao, Nokchah (north central Chagai), Gurrak Rakh (north Kharan) and Ranawar (north west Kharan), apart from all the tracts where the eggs were spotted.

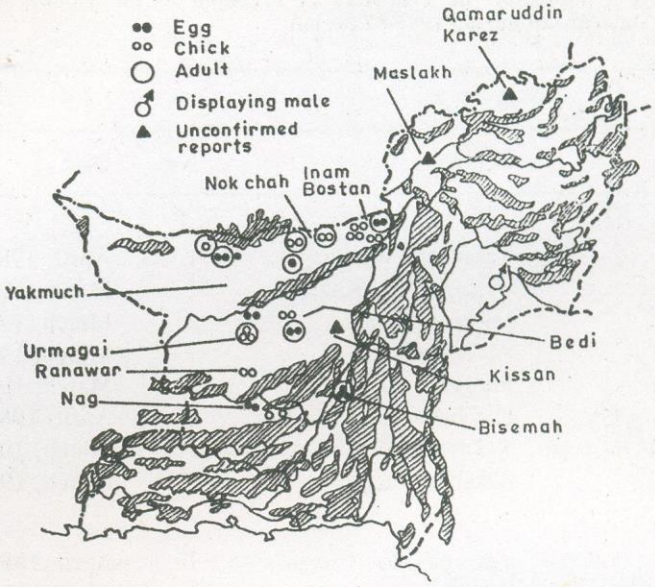


Fig. 1: Line sketch of Balochistan, indicating approximate areas, from where positive indications of breeding of Houbara have been collected during 1983-85 period.

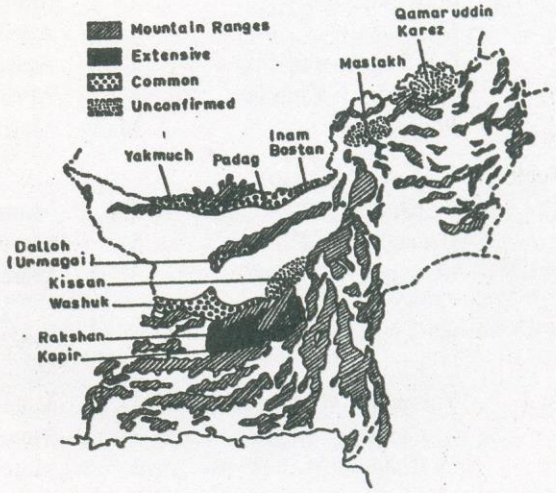


Fig. 2: Tentative distribution of the breeding population of Houbara in Balochistan.

**Table 1:** **A synopsis of the evidences of breeding of the Houbara collected from Balochistan during 1983-87 period.**

| | Area | | |
|---|---|---|---|
| Specific | General | No. | Date |
| **Eggs** | | | |
| Gonnakoh | Yakmuch, W. Chagai | 1 | April, 1983** |
| Dalloh | Urmagai, W. Kharan | 2 | March, 1983# |
| Bedi | Jawar, C. Kharan | 2* | March, 1983# |
| Bisemah | W. Khuzdar | 3* | March, 1985 |
| Rakshan | Punjgur | 2* | March, 1985 |
| Inam Bostan | E. Chagai | 2* | April, 1986 |
| Gonnakoh | Yakmuch, W. Chagai | 2* | March, 1986 |
| Nag | Rakshan, Punjgur | 2 | March, 1986 |
| **Chicks** | | | |
| Gonnakoh | Yakmuch, W. Chagai | 1* | April, 1983# |
| Padag | C. Chagai | 2 | April, 1983# |
| Dalloh | Urmagai, W. Kharan | 3* | March, 1983# |
| Jalwar | C. Kharan | 2 | April, 1983# |
| Padag | C. Chagai | 1* | March, 1984# |
| Nokchah | C. Chagai | 2* | March, 1984# |
| Gurrak Rakh | C. Kharan | 2 | March, 1984# |
| Inam Bostan | E. Chagai | 2 | April, 1984# |
| Inam Bostan | E. Chagai | 2 | April, 1985 |
| Ranawar | Washuk, S. Kharan | 2 | April, 1985 |
| Nag | Punjgur | Many | March-May, 1986,1987 |
| **Adult breeding flock** | | | |
| Jalwar | C. Kharan | 2@ | March, 1984# |
| Dalloh | Urmagai, W. Kharan | 5 | March, 1984# |
| Dalloh | Urmagai, W. Kharan | 3? | March, 1984# |
| Urmagai (western valleys) | W. Kharan | 1 | March, 1984# |
| Gurrak Rukh | C. Kharan | 1? | March, 1984# |
| Gonnakoh | Yakmuch, W. Chagai | 4? | March, 1984# |
| Pul Chatao | C. Chagai | 2 | March, 1984# |
| Nokchah | C. Chagai | 2 | March, 1984# |

* eggs/chicks associated with hen. ** as reported by Karim and Hasan, 1983. # Mian, 1985. @ sufficient indications of 6 foraging birds. ? not confirmed. $ persisted throughout summers.

Data on 7 clutches, available from the area, suggest that majority (5) had 2 eggs, while 3 and 1 (incomplete clutch ?) eggs were present in one clutch each. The average clutch size is calculated to be $2.0 \pm 0.2$ (mean $\pm$ standard error of mean) eggs/hen. The information available on 10 broods, with 10-30 days old chicks, suggest an average brood size of $1.9 \pm 0.2$, majority (7) having 2 chicks (3 chicks in 1, and 1 chick in 2 broods).

The eggs were recorded between early March and late April. The chicks were recorded between late March and end May or early June.

## *Ecological studies*

### *Physical habitat*

Table 2 presents a synopsis of the ecological characters of different potential breeding grounds of Houbara. The table suggests that the breeding was present in the areas located at 600-1,000 m above sea level.

Most of the tracts shared a common character of being stony deserts. The soil was sandy showing different degrees of stabilisation. A layer of loose stones formed a cover, varying from an almost complete cover of grey stones, in relatively stabilised tracts, to very scattered stones, in more sandy tracts. Egg laying was more frequent in stabilised tracts, while some egg laying was recorded in depressions, present between sand dunes, having stabilised silty soil with very widely dispersed stones. No egg laying was recorded in sand dunes. Chicks and adults were, however, present in sandy tracts.

All the valleys, having confirmed egg laying, were open, having very mild to mild hilly undulates, with slops gradually ascending towards one of the nearby mountain or hill. Water courses were dispersed between undulates.

## *Phytohabitat*

Four vegetative communities were distributed in Houbara breeding tracts in Balochistan (Table 2). In Chagai and parts of Kharan, *Anabasis* sp. community was recognised. Dominant species was associated with *Calligonum comosum, Pennisetum dichotomum* and *Rhazya stricta* in different combinations. A few other species also gave scattered appearance. In southern tracts (eastern Kharan, Washuk and Rakshan), breeding was associated with *Zygophyllum* spp. community. Dominant species was generally associated with a number of species. The most close associates included *P. dichotomum* and *R. stricta*, though *Artemisia maritima* and *Withania coagulans* were also widely distributed in different stands. *Astragalus hyrcanus-Ziziphus* sp. community was present in Dalloh valley (Urmagai), which was composed of many species sharing the general vegetative cover, including *P. dichtomum* and *R. strict*. In Bisemah, *Coccuhus* sp. community was identified, where the dominant species was associated with 4 (*P. dichtomum, R. stricta, Alhagi camelorum, Peganum harmela*) species, each sharing a low general vegetative cover.

**Table 2: A synopsis of the ecological data on different breeding tracts of the Houbara in Balochistan.**

| Area | Physical Features | | | Vegetative Features | | |
|---|---|---|---|---|---|---|
| | Altitude (m) | Habitat Type | Topography | Community | Shrub Cover (%) | Potentials* |
| Rakshan | 1,000 | Stony deserts | Mild Hilly undulates | *Zygophyllum* sp. | 9.78 | A1 |
| West Chagai | 900 | " | " | *Anabasis* sp. | 5.65-9.29 | A2 |
| East Chagai | 700 | " | Middle undulates | " | 8.55 | A3 |
| Washuk | 700 | " | Flat plains, mild undulates | *Zygophyllum* sp. | 16.22 | B1 |
| North Kharan | 600 | " | Hilly valleys, mild undulates | *Astragalus hyrcanus-Ziziphus* sp. | 9.77 | B2 |
| Bisemah Centre | 1,000 | " | Hilly undulates | *Cocculus* sp. | 2.09 | B3 |
| Kharan East | 700 | Sandy depressions | Hard flat plains with sandy undulates around | *Anabasis* sp. | 11.29 | C1 |
| Kharan Centre | 700 | Stony deserts | Hilly undulates | *Zygophyllum* sp. | 9.44 | C2 |
| Chagai | 800 | " | " | " | 6.55 | C2 |

Breeding potentials: A high, B confirmed, C weak positive evidences; 1 high, 2 medium, 3 low.

Apart from the perennials, which provide the major part of the shrub or community cover, there was a rich growth of spring ephemerals which provide a good herbal cover (5-19%) during breeding season. All the shrubs were green bearing profusely sprouting foliage. Zygophyllum and Cocculus were on flowering or fruiting stage. The average shrub cover ranges between 2 and 16% though for the major parts it remains between 6 and 11%. The shrub cover was mainly present in depressions and water courses, while the undulates/ridges had very scattered and isolated distribution of bushes/shrubs, yielding a very low cover. The herbal cover was, however, higher on the ridges than in depressions. The shrub or herb cover did not follow a regular pattern with increasiing breeding potentials of the species.

*Fauna*

Mammal fauna was dominated by cape hare (*Lepus capensis*) and fox (*Vulpes* sp.), which were still present as good populations. Indian gazelle (*Gazella bennetti*) and cats (*Felis* sp.) gave rare appearance. There were indications of presence of wolf (*Canis lupus*) and jackal (*C. aureus*) but were very rare. Some desert rodents were also present as small populations.

Dominant species of birds included hoopoe lark (*Alaemon alaudipes*), sandgrouses (*Pterocles* sp.), cream coloured courser (*Cursorius cursor*), stone curlew (*Burhinus oedicnemus*), seesee partridge (*Ammoperdix griseogularis*) and larks (*Ammomanes deserti*, *Alauda arvensis*, *Galerida cristata*). All these species breed in the valleys and were widely distributed as scattered individuals, but as significant populations. Amongst raptors, eagles, vultures, kestrels and owls have been frequently recorded, hovering over the breeding tracts.

Lizards (including monitor ?) were frequently observed, while indirect evidences suggested the presence of snakes.

Amongst insects, beetles (family Tenebrionidae), large black ants (Formicidae) and grasshoppers (*order Orthoptera*) were frequent, while butterflies gave a rare appearance.

The majority of the nests examined under present study were located in the areas having high to very high population of the grazing livestock. There was a fairly high level of human activity associated with grazing and fallow land cultivation in all the tracts having significant egg laying. The nomadic camps were also scattered in all the valleys.

*Behaviour*

A male was observed performing courtship display for four consecutive days in Sibi during early February. The bird selected an embankment (about 1 m high) erected around the cultivated wheat field and displayed regularly in the morning and the evening. No female was seen near, though a flock of birds used to regularly visit the area for night foraging. Male used to go for a brief casual grazing in the cultivation at intervals.

A nest was observed in deeper parts of Bisemah valley. It represented slight depression on bare ground, produced by scraping away of the stones. It was placed on a ridge at a distance of 3-4 m from and in the centre of a triangular disposition of three small bushes of *Alhagi camelorum*. Nest indicated a successful hatch of both the eggs. Foot prints of the adult bird (female ?) indicated its frequent movement from/to the nest. All the other nests examined shared this general description with minor variation in number, position, size and species composition of the shrubs. A general impression created on seeing the location of the nests consistently suggested that one of the bushes around the nest was taller than the others. One of the guides reported that the incubating hen left the nest, when he was still at a considerable distance. All the presently collected reports suggested that the young chicks were either alone or associated with the hen

only. The chicks have never been seen with the male and/or with a male-female pair of adults.

## DISCUSSION

### *Potential Areas*

The presently collected information suggest that Houbara regularly breeds in highland valleys of Rakshan (extending from Bisemah to some 30 km west of Nag), northern Chagai (a belt of different widths extending from Inam Bostan to Gonnakoh), north-western Kharan (Urmagai and associated valleys). The breeding potentials are very high for Rakshan and high for Chagai and Kharan. Breeding could be confirmed for south-western (Washuk) and central Kharan. Sporadic breeding may occur in south-eastern Kharan (Kissan valley), northern highlands (Maslakh and Qamar uddin Karaz) and coastal tracts (Fig. 2). None of the previous reports has indicated the presence of breeding in major parts of the presently reported tracts (Ali and Ripley, 1983; Siddiqi, 1972; Anonymous, 1972). The areas exploited for chick rearing are more widely distributed and include the associated tracts, especially those falling along the spring migratory routes of the species/race.

### *Breeding Potentials*

The present results suggest that majority of the females in the area lay 2 eggs, though some may lay 3 or 1, with an average clutch size of $2.0 \pm 0.2$ eggs/hen. This partly goes against Anonymous (1986) suggesting that the majority of the hens lay 3 eggs in the area. The average clutch size is close to that recorded for Central Asia (2.4: Alekseev, 1980) and slightly lower than that for Israel (2.8: Lavee, 1988). This suggests that this population is not remarkably different in its breeding potentials from the populations in the other established breeding grounds.

A larger brood size ($1.9 \pm 0.2$ chicks/brood) can thought be an artefact attributable to the loss of entire brood or clutch (Lavee, 1988), yet it goes in conformity with the general observations of Anonymous (1986), suggesting that the females in the areas successfully hatch the major part of the clutch and chicks have a better survival rate.

### *Breeding Chronology*

Sighting of eggs in early March and chicks towards end March suggests that nesting starts during mid February and egg laying towards end February. Fledging of chicks starts towards mid March. The presently available evidences suggest that egg laying extend up to April and chicks can appear till mid May. This breeding schedule seems partly supported by the previous reports suggesting presence of mature eggs in ovary of a female is hot during February from Sindh (Roberts, 1985) and records on breeding chronology from the Gulf States (eggs collected in March: Dickson, 1949; Platt, 1985). Breeding appears to initiate earlier in Balochistan than that suggested for breeding grounds of the Central Asia, where the species lays eggs in early to mid April

(Ponomareva, 1979) extending up to late April (Alekseev, 1980) and chicks appearing in May. Such an adjustment can be partly explained on the expected difference in temperature and associated biotic conditions.

### *Status of breeding population*

Number of eggs and chicks recorded in different breeding tracts, suggest that an estimated population of some 50-100 hens regularly lay eggs in the areas under Balochistan. This confirms our early report (Mian, 1984). These estimates also stand supported by the estimates of P. Paillat (Leader, Pakistan Egg Collection Team, National Wildlife Research Centre, Taif, Saudi Arabia, 1987; personal communication) suggesting that some 60 hens laid eggs in Rakshan valley during 1987. Houbara breeds over some 9,000 $km^2$ (northern Chagai=4,000; Rakshan valley = 3,750; Kharan = 1,250) of Balochistan giving an estimated population density of a breeding hen/90-180 $km^2$ (around 0.01 hen/$km^2$). The available estimates on population of some most favourable breeding tracts of Houbara in Central Asia, suggest a density of about 1 hen/25 $km^2$ (Ponomareva, 1979, some 10,000 breeding hens distributed over 250,000 $km^2$ of ideal breeding grounds in Kyzylkum). This suggests that the areas under Balochistan do constitute significant breeding tracts of this bustard species holding reasonable density of the breeding population.

### *Breeding ecology*

The present results allow us to develop following generalizations on possible control of ecological factors on breeding activities of Houbara:

#### *Altitude*

Egg laying occurs at altitudes above 600 m. Higher altitude ensures favourable temperature for the brooding adults and eggs. A temperature range of 17-20°C has been reported during spring (the breeding period of Houbara) for Canary Islands (Collar and Goriup, 1983; Collins, 1984). It appears that this race is adapted to breed at lower temperatures as compared with other two races of Houbara (Cramp and Simmons, 1980) or other species of bustards distributed in Indo-Pakistan subcontinent (Great Indian bustard: Ali and Rahmani, 1982; Manakadan, 1985). A comparatively mild temperature in coastal tracts (Gwadar) may also be within tolerable limits of this race.

#### *Physical habitat*

The egg laying is restricted to the stony deserts. Topographically these are slop plains having mild undulations. Grey stones of varying sizes are scattered over loose sandy or relatively stabilised soil. Though egg laying has been recorded in bare silty plains having few scattered stones, yet it is probably not a regular breeding habitat of the race/species. The conditions of physical habitat, suggested under present study, agree in the general description of the breeding grounds provided by Ponomareva (1979) and Alekseev (1980).

*Vegetative cover*

Present results suggest an absolute shrub cover of 6-11% plus a significant growth of the spring ephemerals, for the major parts of the tracts under breeding population. This indicates that the egg laying occurs in the tracts having adequate vegetative cover to afford protection and food to the incubating hen and newly hatched birds. Quantitative estimates on vegetative cover are not available from other parts of Houbara breeding range. However, reported distribution of egg laying in the areas with sufficient shrub cover and a good growth of ephemerals, and absence of nests in completely bare tracts, may provide some indirect support to our present findings (Ponomareva, 1979; Alekseev, 1980). These findings also get some support from Haddane (1985) suggesting that drought (and consequent limitation of vegetation) limits the egg laying potentials of this species in Morocco.

Presence of nest on the ridges, representing almost bare tracts with very scattered small shrubs (major part of the vegetation in depressions), may suggest that vegetative cover is not required for camouflaging of the brooding female. The species appears to depend upon its own camouflaging armoury. Such a position of the nest possibly saves the species from predation of eggs by the animals, which mainly concentrate in patches having higher vegetative cover.

*Vegetative communities*

The major part of the breeding occurs in *Anabasis* sp. and *Zygophyllum* sp. communities, though some scattered nests have been observed in *Astragalus hyrcanus-Ziziphus* sp. and *Cocculus* sp. communities. Dominant species in different communities are though associated with different other plant species, yet *Pennisetum dichotomum* and *Rhazya stricta* are present in all the stands. It is difficult to suggest a specific significance of these species in the breeding biology of Houbara and can only be regarded as a chance association.

*Grazing stress*

The presence of breeding in the areas under very high to high livestock grazing stress and in association with fallow land cultivations suggests that Houbara in the area has adopted to breed in fairly disturbed tracts. The breeding tracts, being located in the hilly valleys and at higher altitudes, having moderate temperature and higher availability of surface water, also attract nomads along with their livestock. These findings go against the previous reports suggesting that nesting occurs in very desolated areas and that grazing causes disturbance to the nesting Houbara (Ponomareva, 1979; Alekseev, 1980) or Great indian Bustard (Ali and Rahmani, 1982). Present observations are in conformity with similar reports from Israel (Lavee, 1985, 1988), where Houbara has adapted to breed in tracts having high disturbances from grazing livestock and associated human activity.

*Fauna*

The fauna is Palearctic in character as may be expected under the geographical location of such tracts. Houbara shares almost same set of animal species in its breeding grounds of the Central Asia (Ponomareva, 1979, 1985; Alekseev, 1980).

Our results suggest a considerable similarity between faunal associates of the wintering and nesting Houbara. Mammals are largely residents and hence a pronounced seasonal variation in their distribution is not expected. Major part of the avifauna is winter visitor. However, under favourable temperatures the dominant bird species persist in the area to lay eggs. A number of species of raptors also breed in the associated hills/mountains (Ticehurst, 1926-27) and hence there is a significant increase in their populations in these areas. The limited available data on the relative abundance suggest an increase in the population of all the insects and a higher activity of reptiles under suitable temperatures. The general insect population and reptile activity increase under optimal temperatures (Ali and Rahmani, 1982; Manakadan, 1985). Higher population of insects can increase the availability of food, while those of raptors and reptile can increase adult, chick and/or egg predation.

*Breeding behaviour*

*Courtship display*

Displaying males selects a prominent place, where other birds (females) are most likely to visit. The period of display coincides with the optimal foraging activity. This goes in conformity with many previous reports on Houbara and other birds. Such a behaviour increases the chances of finding the mate. However, absence of females near the displaying males suggests that the pair bond is weak, confirming the reports of Collins (1984) and Gal (1980). This also suggests that males start displaying at their own and are not conditioned to the presence of female/females.

*Nest*

The nesting site is very ingeniously selected. Laying eggs on bare ground, away from the shrubs and having growth of ephemerals, in the stones, having camouflaging background and avoiding depressions or dried water courses are all adaptive characters. This saves the adults, eggs and/or chicks from detection by predators as also suits the alert nature of adult Houbara, allowing an early detection of predator. The shrubs, water courses and depression prove vulnerable points for detection of the nest by carnivores and reptiles. The ephemerals around nests provide food within easy access of the incubating female and reduce the chances of leaving the eggs unattended.

Significance of a prominent bush near the nest can not be anticipated with the present level of information. However, it may work as a marker to guide the females to the nest. Such markers have special value in desert steppes, which are remarkably similar looking.

*Incubation/progeny rearing*

Present results support the previous suggestion that only females incubate the eggs (Lavee, 1985) and protect/rear the chicks (Collins, 1984). The females frequently leave the nest at suitable part of the day for foraging and/or when staying on the nest is considered unsafe for the hen or the nest.

**Acknowledgements**

The study was partially financed by a support from WWF-Pakistan and conducted in active collaboration with Balochistan Forest Department. A number of field guides deserve full credit for their whole hearted field support, which made this research as success.

## REFERENCES

ALEKSEEV, A.F., 1980. The Houbara Bustard in the northwestern Kyzylkum (U.S.S.R.). *Zool. Zhurn.*, **59**(8): 1263-1266.

ALI, S. AND RAHMANI, A.R., 1982. Study of ecology of certain endangered species of wildlife and their habitats: The Great Indian Bustard. Annual Rep. 1, 1981-82 Bombay Nat. His Soc., Bombay, pp. 154.

ALI, S. AND RIPLEY, R.D., 1983. *Handbook of the birds of India and Pakistan*. Oxf. Univ. Press, Dehli, pp. 737.

ANONYMOUS, 1972. Houbara in Baluchistan. *Outdoorman* (Karachi), **2**(6): 15.

ANONYMOUS, 1986. Houbaras: Activity Report, May 1986. *National Wildlife Research Centre, Taif, Saudi Arabia*, pp. 3-22. (unpublished working document).

BRAUN-BLANQUET, J., 1932. *Plant sociology: the study of plant communities*. (eds. G.D. Fuller and H.C. Cornard). McGraw-Hill Book Co., Inc., New York.

CHAMPION, H.G., SETH, S.K. AND KHATTAK, G.M., 1965. *Forest types of Pakistan*. Pakistan Forest Inst., Peshawar, pp. 238.

COLLAR, N.J. AND GORIUP, P.D., 1983. The ICBP Fuerteventura Houbara Expedition: introduction. *Bustard Studies*, No.1, pp.1-8.

COLLINS, D.R., 1984. *A study of the Canarian Houbara Bustard Chlamydotis undulata fuertaventurae, with special reference to its behaviour and ecology*. Unpublished M. Phil. Thesis, Univ. London, pp. 175.

GRAMP, S. AND SIMMONS, K.E.L. (eds), 1980. *The Birds of the western Palearctic*, Vol. II. Oxf. Univ. Press, London, pp. 636-655.

GAL, B., 1980. *Houbara survey in 1979*. Rep. Nature Conservation Res. Inst., Tel Aviv Univ., Tel Aviv, Israel.

HADDANE, B., 1985. The Houbara Bustard in Morocco: a brief review. *Bustard Studies*, No.3, pp.109-112.

KARIM, S.I. AND HASAN, A., 1983. Houbara Bustard in Pakistan. *WWF-Pakistan Newsletter*, **2**(4): 3-6.

LAVEE, D., 1985. The influence of grazing and intensive cultivation on the population size of the Houbara Bustard in the northern Negev, Israel. *Bustard Studies*, **3**: 103-107.

LAVEE, D., 1988. Why is the Houbara *Chlamydotis undulata macqueenii* still endangered species in Israel? *Biol. Conserv.*, **45**(1): 47-54.

MANAKADAN, R., 1985. *The ecology of the Great Indian Bustard, Choriotis nigriceps* (Vigors), *habitat*. M.Sc. Thesis, Univ. Bombay, pp.129.

MIAN, A., 1983. Houbara demands conservation in Pakistan. *WWF-Pakistan Newsletter*, **2**(4): 1-3.

MIAN, A., 1984. A contribution to biology of Houbara: 1982-83 wintering population. *J. Bombay Nat. Hist. Soc.*, **81**: 537-545.

MIAN, A., 1985. A contribution to the biology of Houbara: some evidences of breeding in Baluchistan. *Proc. Pakistan Congr. Zool.*, **5**: 261-269.

MIAN, A. AND SURAHIO, M.I., 1983. Biology of Houbara Bustard (*Chlamydotis undulata macqueenii*) with reference to Baluchistan. *J. Bombay Nat. Hist. Soc.*, **80**: 111-118.

PONOMAREVA, T., 1979. The Houbara Bustard: present status and conservation perspectives. *Okhota i okhotnich'e khozyaistvo*, 11, pp.26-27. (in Russian, English translation by M.G. Wilson, ICBP, Bustard Studies, No.3, pp.93-96).

ROBERTS, T.J., 1985. The Houbara Bustard in Pakistan in relation to conservation. *Bustard Studies*, **3**: 35-38.

SIDDIQI, M.S.U., 1972. Identifying the bustards. *Outdoorman (Karachi)*, **2**(7-8): 29-32.

TICEHURST, C.B., 1926-27. The birds of British Baluchistan. *J. Bombay Nat. Hist. Soc.* (in three parts). **XXXI**: 687-711, 862-881; **XXXII**: 63-97.

*(Received: October 13, 1997)*