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NESTING AND DIET OF THE BARN OWL (*TYTO ALBA*) IN PAKISTAN

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ABSTRACT.—We investigated nesting of Barn Owls (*Tyto alba*) in central Punjab, Pakistan, from 1999–2002. We also documented diet of Barn Owls in southern Punjab and southeastern Baluchistan, Pakistan. Of 40 nests found in central Punjab, 33 were located in tree hollows, four in buildings, and three in nest boxes. Egg-laying was observed primarily between the second week of August and October ($N = 23$), with a smaller number of nests started May–July ($N = 5$). Fledging of the autumn nests was completed by early January, and all breeding efforts observed in May–July were unsuccessful. During the August–January breeding period, clutch size averaged 5.83 eggs ($SE = 0.47$; range = 1–12; $N = 23$) and brood size 4.15 nestlings ($SE = 0.28$; range = 2–7; $N = 20$). Shrews (59%), birds (19%), rats and mice (13%), and insects (7%) were the main prey in southern Punjab, whereas rats and mice (93%), shrews (4%), and amphibians and reptiles (3%) were the main prey in southeastern Baluchistan.

KEY WORDS: *Barn Owl*; *Tyto alba*; brood size; clutch size; diet; nest cavities; reproductive success.

NIDIFICACIÓN Y DIETA DE *TYTO ALBA* EN PAKISTÁN

RESUMEN.—Investigamos el comportamiento de percha y la nidificación de *Tyto alba* en el centro de Punjab, Pakistán, entre 1999 y 2002. También documentamos la dieta de esta especie en el sur de Punjab y el sureste de Baluchistan, Pakistán. De 40 nidos encontrados en el centro de Punjab, 33 se ubicaron en cavidades en árboles, cuatro en edificios y tres en cajas de nidificación. La puesta de huevos se observó predominantemente entre la segunda semana de agosto y octubre ($N = 23$), y un número menor de nidos fueron iniciados entre mayo y julio ($N = 5$). Todos los pichones de los nidos del otoño ya habían salido de los nidos a principios de enero, y ninguno de los esfuerzos reproductivos observados entre mayo y julio tuvo éxito. Durante el período reproductivo de agosto a enero, el tamaño promedio de las nidadas fue de 5.83 huevos ($EE = \pm 0.47$; rango = 1–12; $N = 23$), y el de las parvadas de 4.15 pichones ($EE = \pm 0.28$; rango = 2–7; $N = 20$). Las musarañas (59%), aves (19%), ratas y ratones (13%) e insectos (7%) fueron las presas principales en el sur de Punjab, mientras que las ratas y ratones (93%), musarañas (4%) y anfibios y reptiles (3%) fueron las presas principales en el sureste de Baluchistan.

[Traducción del equipo editorial]

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The Barn Owl (*Tyto alba stertens*) is considered a scarce species in Pakistan. It is sparsely and erratically distributed in the vicinity of older and larger towns of the Indus plains, where it nests and roosts in human-made structures, and feeds on small mammals (Roberts 1991a). The primary limiting factors on the population of Barn Owls in Pakistan include the paucity of nesting sites, and human persecution (many people there view this species as a bad omen; Mahmood-ul-Hassan 2006). In spite of this, the Barn Owl is still fairly well distributed in canal-irrigated portions of the Indus plains, where it nests and roosts mainly in tree trunks, and feeds on small mammals inhabiting croplands, patches of sandy scrublands, and human settlements (Mahmood-ul-Hassan 2006).

Extensive studies have been made on the nesting and feeding habits of the Barn Owl in many parts of the world (Roulin 2002, Altwegg et al. 2003, Harambos et al. 2005) but little is known of the ecology of this species in South Asia and particularly Pakistan. In this country, Mason and Lefroy (1912), Whistler (1949), Ali and Ripley (1969) and Roberts (1991a) were the primary sources of information on the distribution, diet, and breeding habits of the Barn Owl until Mahmood-ul-Hassan et al. (2000) provided more quantitative data on the diet of the population of central Punjab.

The flexible breeding and dietary habits of the Barn Owl (Cottam and Nelson 1937, Marti 1994, Taylor 1994, Walk et al. 1999) probably helped this raptor to exploit the ecological changes that occurred nearly one hundred years ago with the development of a large-scale irrigation system in the Indus plains of Punjab. This caused a progressive replacement of the original tropical thorn forest by canal-irrigated tree-fringed croplands, forest plantations, and urban and rural settlements.

Here, we describe the nesting habits of the Barn Owl in central Punjab. We also examine the diet composition of Barn Owls for southern Punjab and southeastern Baluchistan.

METHODS

Study Area. The study area in central Punjab is a part of the Indus Plain and includes the districts of Hafizabad, Sheikhupura, Faisalabad, Jhang, Toba Tek Singh and Okara (Fig. 1). Southern Punjab (Bahawalnagar district), is somewhat drier and hotter than central Punjab as it lies at the periphery of the Cholistan desert. All these districts have canal irrigation and generally appear as a vast savanna of croplands and scattered trees. Climate is hot and dry. The temperature in summer may occasionally rise to 50°C, although during winter nights it may fall below 0°C (Taber

et al. 1967). The average annual rainfall ranges from 28 cm to 35 cm and is usually concentrated during the monsoon months of June–July.

Southeastern Baluchistan is characterized by humid winds during the monsoon season, and is hot, dry and frost-free for the rest of the year. Its natural vegetation includes dry temperate semi-evergreen scrub forest and the region shows Mediterranean affinities in terms of both flora and fauna (Roberts 1991a). Canal-irrigated agriculture is present in some portions of this area.

Nesting Habits. To locate nest sites that Barn Owls used, the authors and two field assistants made systematic searches of potential cavities covering an area of four acres per hr. Searches were conducted between June 1999 and May 2002 in the central Punjab districts of Hafizabad (32°04'N, 73°41'E), Sheikhupura (31°42'N, 73°30'E), Faisalabad (31°25'N, 73°07'E), Toba Tek Singh (30°57'N, 72°28'E), Jhang (31°16'N, 72°19'E) and Okara (30°48'N, 73°27'E). The presence of excreta on the outside of a cavity and the smell of rotting prey, particularly during the breeding season, alerted us to possibly occupied sites.

We considered that cavities containing fresh prey or pellets and/or having Barn Owls present nearby were occupied by Barn Owls. The onset of nesting was ascertained by the presence of eggs or young in the nest cavities, and nests containing one or more eggs or nestlings were defined as active nests. After an active nest was located, the nest cavity was checked at least once per mo to record clutch and brood size.

Mean brood size for nests that contained chicks was determined at a stage when the facial disk was already evident in the youngest nestling. A nest was considered successful when at least one nestling survived to fledging age. Hatching success was computed by dividing the number of nestlings by the number of eggs laid, and fledging success was obtained by dividing the number of fledglings by the number of eggs hatched. Laying dates were back-calculated assuming a 2-d interval between the laying of successive eggs (Durant et al. 2000) and an incubation period of 30 d (Taylor 1994).

Diet. A total of 252 pellets were collected from September 2000 to August 2001 from two roosting cavities located in southern Punjab (Bahawalnagar district; 29°59'N, 71°42'E). Another 252 pellets were collected from a single cavity in southeastern Baluchistan, near the town of Usta Muhammad Khan (28°11'N, 68°03'E).

RESULTS

Nesting Cavities. We found a total of 40 nests/roosts occupied by Barn Owls, each of which was located >3 km from all the others. Twenty-two of these were located in the Faisalabad district, eight in Jhang district, three each in Toba Tek Singh and Sheikhupura districts, and four in Hafizabad district. Of these 40 nests, 33 were in tree hollows, four in buildings, and three in wooden nest boxes erected by the authors. Of the 33 tree nests, 70% were cavities in the main trunk and 30% in the limbs. Sixty-four percent of the tree nests had one opening, 21% had two, 12% had three and 3% had four.

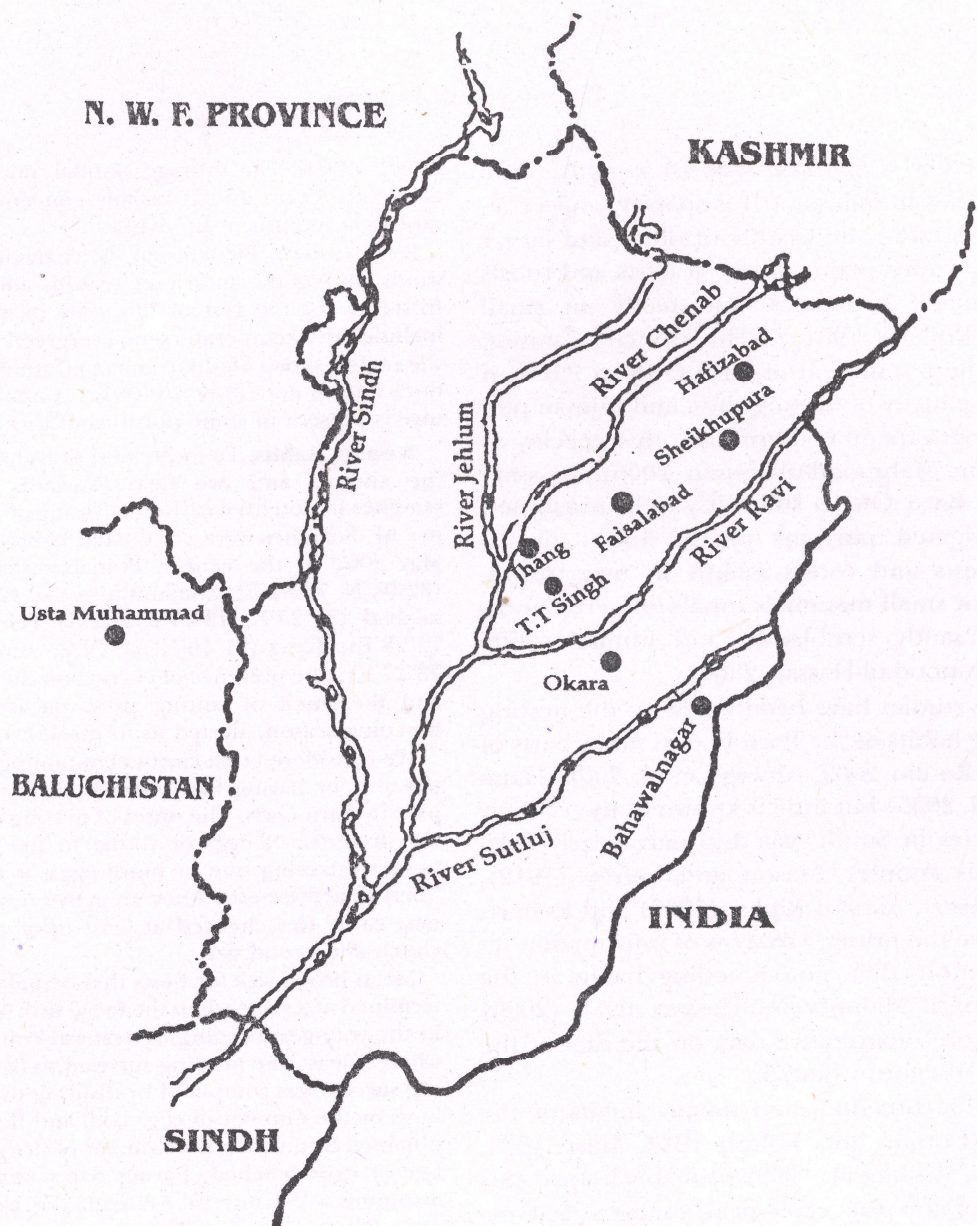


Figure 1. Location of Hafizabad, Sheikhpura, Faisalabad, Jhang, T.T. Singh, Okara (central Punjab), Bahawalnagar (southern Punjab) and Usta Muhammad Khan Town of Jafferbad district (southeastern Baluchistan) where we collected data on the breeding and dietary habits of the Barn Owl.

The diameter at breast height (dbh) of the trunks of the nest trees averaged 1.1 m (SE = 0.1; range = 0.6–2.5). The height of the nests above ground averaged 4.1 m (SE = 0.3; range = 1.0–10.5). Depth of the tree hollows varied from 0.25–1.50 m. The diameter of the floor of the hollows averaged 65 cm. Hollows that were not circular in shape, averaged 35 cm long and 23 cm wide. Of the nests in buildings, three were in the minarets of village mosques and one on a cornice inside the dome of a shrine.

Reproduction. Five of the occupied tree cavities showed early signs of nesting by Barn Owls (e.g., fresh pellets, decapitated prey, owls present), but were subsequently found to be occupied by other species such as the jungle cat (*Felis chaus*; $N = 1$), snake ($N = 1$), monitor lizard (*Varanus monitor*; $N = 1$), and wasps ($N = 2$). Seven additional occupied sites never contained evidence of eggs or chicks, and were perhaps being used only as roosting sites. Twenty-eight nests were active.

Table 1. Barn Owl occupied nests¹ recorded in different months of the year from June 1999 through May 2002 in central Punjab, Pakistan.

MONTH	NUMBER OF NESTS			ALL YEARS		
	1999–2000	2000–2001	2001–2002	NUMBER	MEAN	PERCENT
August–January (main) breeding period						
Sept.	3	4	3	10	3.33	30.3
Oct.	3	3	5	11	3.67	33.3
Nov.	2	1	1	4	1.33	12.1
Dec.	1	1	1	3	1.00	9.1
Subtotal	9	9	10	28	7.63	84.8
May–July breeding period						
May	—	1	2	3	1.00	9.1
June	—	1	1	2	0.67	6.1
Subtotal	—	2	3	5	1.67	15.2
TOTAL	9	11	13	33	11.00	100

¹ Includes 28 nests that later became active and 5 nests that were subsequently usurped by other species.

We recorded clutch size, brood size, breeding phenology, and reproductive success at the 28 active nests, which were located in 14 regions of central Punjab (five in Faisalabad district, four in Jhang district, two each in Sheikhpura and Hafizabad districts and one in Toba Tek Singh district). Breeding activity was recorded at these sites between June 1999 and May 2002.

Breeding phenology. Of 28 active nests of Barn Owl that we found, 23 were recorded in September–December and five in May–July (Table 1). It was inferred by backdating that egg-laying in our population started between 7 and 9 August. However, the laying period spanned from mid-August to October. Fledging was usually completed by early January. For active nests in May–July, egg-laying began on 27 April and ended on 8 May.

Number of broods per season. Most females produced one brood per year, but in five instances, two broods were recorded in the same nest in the same year. As none of the breeding adults were marked, it was not possible to ascertain whether these were replacement broods, second broods, or whether one of the breeding pair had been replaced. Female Barn Owls have been reported to desert their offspring in order to maximize their reproductive success (Roulin 2002).

Clutch size, brood size, and reproductive success. We recorded a total of 28 clutches and 22 broods. The mean clutch and brood sizes were 5.83 ± 0.47 (SE) and 4.15 ± 0.28 (SE) during August to January (Table 2). Such figures were lower for the five clutches recorded outside the main breeding

period (Table 2). Of these, only two reached the hatching-stage but none of these hatchlings survived. Similarly, mean hatching and fledging success were higher during August–January than during May–July (Table 3).

Diet Composition. On an annual basis, shrews (59%) were the primary prey in southern Punjab with birds (19%), rats and mice (13%) and insects (7%) as complementary prey (Table 4). However, diet composition varied seasonally and 48% of the spring diet of southern Punjab was composed of birds and insects (Table 5). Finally, rats and mice were the most common prey item (93%) of the annual diet in southeastern Baluchistan (Table 4).

DISCUSSION

Nesting Habits. Breeding of the Barn Owls of central Punjab occurs primarily from August to January, with a few pairs breeding from May to July. In peninsular Malaysia nesting occurs year round (Lenton 1984). Even in temperate zones, where generally the owl begins nesting in early spring, nesting sometimes occurs in the winter season (Stewart 1952, Walk et al. 1999).

At the onset of laying, which extended from the first week of August through October, rodents formed an important component of the diet of the Barn Owl population of central Punjab (Mahmood-ul-Hassan et al. 2000). After September, the raptor ate more shrews, and continued to do so till early January when almost all young had fledged (Mahmood-ul-Hassan et al. 2000). Young Barn Owls usually remained in the care of their parents for

Table 2. Clutch and brood sizes of a Barn Owl population of central Punjab, Pakistan (N = sample size; r = range).

YEAR	CLUTCH SIZE		BROOD SIZE	
	MEAN (r) \pm SE	N	MEAN (r) \pm SE	N
August-January (main) breeding period				
1999-2000	5.13 (1-8) \pm 0.743	8	4.33 (3-6) \pm 0.422	6
2000-2001	7.00 (5-12) \pm 0.900	7	4.43 (4-6) \pm 0.297	7
2001-2002	5.50 (2-9) \pm 0.732	8	3.71 (2-7) \pm 0.680	7
Combined	5.83 (1-12) \pm 0.465	23	4.15 (2-7) \pm 0.284	20
May-July breeding period				
1999-2000	—	—	—	—
2000-2001	2.50 (2-3) \pm 0.500	2	2.0 (1-3) \pm 1.00	2
2001-2002	2.67 (1-6) \pm 1.667	3	—	—
Combined	2.60 (1-6) \pm 0.927	5	2.0 (1-3) \pm 1.00	2

more than two months after fledging (Ottieni et al. 1972). Thus, when the young owls of central Punjab were ready to hunt for themselves, they enjoyed relatively favorable food conditions during March-September, when most small mammals maintain high rates of reproduction (Beg and Ajmal 1977, Beg and Rana 1978, Beg et al. 1981, 1983, 1986).

The mean productivity of our population was comparable to the estimates reported for other regions of the world. Clutch size in other studies ranged from 2.9 in Surinam to 7.2 in Utah, U.S.A. (Haverschmidt 1962, Ottieni et al. 1972, Lenton

1984, Baudvin 1986, Wilson et al. 1986, Marti 1992, 1997, Walk et al. 1999), brood size from 3.8-5.5 (Lenton 1984, Pikula et al. 1984, Baudvin 1986, Wilson et al. 1986, Marti 1997, Walk et al. 1999).

Diet in Punjab and Southeastern Baluchistan.

From May through August, rodents were the most common prey in the diet in central Punjab. After August, the proportion of shrews started to increase, reaching a peak in December, after which the proportion of rodents increased again. By May, rodents outnumbered shrews and by August the reversal process was completed. Thus, the house shrew (*S.*

Table 3. Hatching and fledging success in a Barn Owl population of central Punjab.

YEAR	NO. NESTS LOCATED	NO. AC-TIVE NESTS	NO. SUC-CESSFUL NESTS	% SUC-CESSFUL NESTS	NO. EGGS Laid	NO. EGGS Hatched	NO. FLEDG-LINGS	% HATCH-ING SUC-CESS ¹	% FLEDG-ING SUC-CESS ²	NO. FLEDGLINGS/SUCCESSFUL NEST
August-January breeding period										
1999-2000	9	6	6	100	41	26	24	63.4	92.3	4.00
2000-2001	9	8	7	87	49	31	30	63.3	96.7	4.29
2001-2002	10	9	6	66.7	44	26	22	59.1	84.6	3.14
Total	28	23	20	86.9	134	83	69	61.9	83.1	3.80
May-July breeding period										
1999-2000	—	—	—	—	—	—	—	—	—	—
2000-2001	2	2	—	—	5	4	—	80.0	—	—
2001-2002	3	3	—	—	8	—	—	—	—	—
Total	5	5	—	—	13	4	—	30.8	—	—

¹ % Hatching success = (No. eggs hatched/No. eggs laid) \times 100.

² % Fledging success = (No. fledglings/No. eggs hatched) \times 100.

Table 4. Prey composition in the annual samples of Barn Owl pellets collected in southern Punjab, southeastern Baluchistan and central Punjab (*N* = number of prey items).

PREY ITEMS	% FREQUENCY (<i>N</i>)		
	SOUTHERN PUNJAB	SOUTHEASTERN BALUCHISTAN	CENTRAL PUNJAB ¹
Shrews	59.0(240)	4.0(23)	65.0(1569)
<i>Suncus murinus</i>	59.0(240)	4.0(23)	64.9(1567)
<i>S. etruscus</i>	—	—	0.1(2)
Squirrel	—	—	0.2(5)
<i>Funambulus pennanti</i>	—	—	0.2(5)
Rats and mice	13.2(54)	92.8(530)	27.4(660)
<i>Rattus rattus</i>	1.2(5)	0.9(5)	3.7(91)
<i>R. meltda</i>	1.7(7)	53.6(306)	5.9(140)
<i>Mus musculus</i>	3.4(14)	11.5(66)	1.9(48)
<i>M. booduga</i>	2.0(8)	17.3(99)	1.8(45)
<i>Bandicota bengalensis</i>	1.2(5)	1.9(11)	7.0(166)
<i>Nesokia indica</i>	1.5(6)	4.4(25)	1.4(34)
<i>Tatera indica</i>	0.2(1)	3.2(18)	1.8(43)
<i>Golunda ellioti</i>	—	—	0.4(10)
Unknown rats	2.0(8)	—	3.4(83)
Bats	1.2(5)	0.4(2)	2.0(49)
Birds	18.9(77)	—	5.1(122)
Amphibians and reptiles	0.2(1)	2.8(16)	0.3(6)
Insects	7.4(30)	—	0.1(2)
Total no. prey items	407	571	2413
No. pellets	252	252	1691

¹ Data taken from Mahmood-ul-Hassan et al. 2000.Table 5. Seasonal changes in the diet of Barn Owls in southern Punjab during September 2000 through August 2001 (*N* = number of prey items).

PREY ITEMS	% FREQUENCY (<i>N</i>)			
	WINTER	SPRING	SUMMER	FALL
Shrews	70.4(100)	47.9(35)	54.4(68)	53.9(37)
<i>Suncus murinus</i>	70.4(100)	47.9(35)	54.4(68)	53.9(37)
Rats and mice	17.6(25)	5.4(4)	20.6(14)	16.0(11)
<i>Rattus rattus</i>	2.1(3)	—	1.6(2)	—
<i>R. meltda</i>	1.4(2)	2.8(2)	1.6(2)	1.5(1)
<i>Mus musculus</i>	3.5(5)	—	4.0(5)	7.2(4)
<i>M. booduga</i>	3.5(5)	—	1.6(2)	1.5(1)
<i>Bandicota bengalensis</i>	0.7(1)	1.3(1)	1.6(2)	1.5(1)
<i>Nesokia indica</i>	3.5(5)	1.3(1)	—	—
<i>Tatera indica</i>	—	—	—	1.5(1)
Unknown rats	2.8(4)	—	0.8(1)	4.3(3)
Bats	—	—	4.0(5)	2.9(2)
Birds	12.0(17)	42.3(30)	11.2(14)	23.1(16)
Amphibians and reptiles	—	—	0.8(1)	—
Insects	—	5.6(4)	18.4(23)	4.3(3)
Total no. prey items	142	73	125	69
No. pellets	92	46	73	41

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Appendix. Mean weight (g) of the young and adults of the main mammalian prey of barn owls. Data were obtained through snap-trapping in central Punjab (n = sample size).

Species	Mean body weight (n)		
	Young	Adult	Weighted average ^a
<i>S. murinus</i>	37(30)	49(40)	44(70)
<i>R. rattus</i>	69(105)	118(46)	84(151)
<i>R. meltdada</i>	41(40)	59(52)	51(92)
<i>M. musculus</i>	9(78)	15(106)	12(184)
<i>M. booduga</i>	8(35)	10(21)	9(56)
<i>B. bengalensis</i>	68(19)	168(27)	127(44)
<i>N. indica</i>	72(82)	129(82)	101(164)
<i>T. indica</i>	56(42)	131(54)	98(96)

^a [(Body mass of young × No. of young snap-trapped) + (Body mass of adult × No. adults snap-trapped)] / (No. of young snap-trapped + No. of adults snap-trapped). Data taken from Mahmood-ul-Hassan 2004.