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Notes on the ecology of the Little Bittern *Ixobrychus minutus* at Haigam Rakh, Kashmir, India

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Little Bitterns *Ixobrychus minutus* were studied at Haigam Rakh, Kashmir, India, in 1978 and 1983. Of 16 full clutches, 14 were of four eggs with one each of three and five eggs. Indirect evidence suggests that these nests were second broods. Hatching was asynchronous. No significant difference in growth rates was found between earlier and later hatched siblings, or between young from smaller compared with larger broods, although all nestlings that died were the last hatched in their broods. A reduction in quality of incubation after the hatching of earlier young is suggested for this rather than insufficient feeding. Data on diet and adult feeding behaviour are also presented.

The present study investigated the breeding ecology of the Little Bittern *Ixobrychus minutus* at Haigam Rakh, Kashmir, India (34°15'N 74°30'E), where the species is common (Holmes and Parr 1988). The population at Haigam is of the nominate subspecies, which has a breeding range extending from Western Europe to about 80°E, so the Kashmir population is one of the most easterly. Observations of fledged juveniles in July suggest that the study nests were either second or replacement broods.

Although there have been studies on *I. m. minutus* in Europe (e.g. Groebbels 1935, Steinfatt 1935, Wackernagel 1950, Grosskopf and Graszynski 1958, Braschler *et al.* 1961), there has been little research at the eastern end of the range. Langley (1983) made a detailed study of the biology of *I. m. payesii* in South Africa.

METHODS

Study site

Haigam Rakh, *c.*50 km west of Srinagar, Vale of Kashmir (1,600 m a.s.l.) is a duck-shooting reserve of about 14 km^2 (Pandit 1982), about half of which is tall fen. The dominant plants are *Phragmites australis, Sparganium erectum, Scirpus lacustris* and *Typha angustata* (Kaul 1984). For a full description of the site see Holmes *et al.* (1983) and Kaul (1984). Studies on Little Bitterns were carried out at Haigam from 14 July to 21 August 1978 and 10 July to 20 August 1983.

Observations

Only nests found with eggs were studied in detail. There were eight study nests in both 1978 and 1983. Hides were erected 2.5 to 3 m from the study

nests. To improve nest visibility, vegetation was either cut or tied back over a 2–3 day period. The behaviour of both adults and nestlings was recorded during hide sessions varying in length from 0.5–6.0 hours.

Observations of adult feeding behaviour were made at an area of water chestnuts *Trapa natans* in 1978 and in young willow *Salix* sp. plantation at the edge of the Rakh in 1983.

Growth rates

In 1983, nestlings from all nests were weighed in the morning and evening, to an accuracy of 0.1 g using a 50 g Pesola balance or 1.0 g using a 200 g balance. Each nest was visited at approximately the same time each day. Morning weights were used to determine growth rates.

Diet

In 1983, information on diet was collected by identifying and weighing the food regurgitated on 22 occasions during weighing of nestlings and on 25 occasions by adults either during extraction from nets or ringing. Individual items were weighed where possible, but some were too light to be weighed accurately using a 50 g balance.

RESULTS

All chicks in the nests studied in 1978 hatched between 22 July and 11 August, and in 1983 between 20 July and 12 August. Only one nest, in 1978, was found early enough for the incubation period to be estimated. This had two eggs on 15 July and four on the next visit on 21 July. These eggs hatched between 1–4 August suggesting an incubation period of 17–19 days. Therefore egg-laying in the study nests probably stretched from 1–24 July.

Clutch-size and hatching success

Of 16 full clutches, 14 were of four eggs with one each of three (1978) and five (1983) (Table 1). Three clutches were preyed upon in 1983, two of four eggs and the five-egg clutch. The hatching success of eggs not predated was 88–90% (the fate of one egg in 1978 was uncertain). Overall hatching success (1978 and 1983 combined) was 70–71%. Since only one nest was found at the laying stage, it is possible that individual eggs were lost from clutches before nest discovery. However only full clutches were lost during the study, so it is considered unlikely that odd eggs were lost earlier.

Although all study nests were found before hatching, by the time the hides were in place hatching had started in several. The whole hatching period was only observed in a few nests. Eggs 1 and 2 in nests A and C in 1978 hatched within 12 hours of each other, whereas eggs 2 and 3 from nests B and C hatched with a one-day interval. In nest H 1983, two eggs hatched on 30 July,

Table 1. Nest histories of study nests in 1978 and 1983.

Year	*Nest*	*Eggs*	*Hatched*	*Surviving young*[a]
1978	A	4	4	4
	B	4	3	2
	C	4	4	3
	D	4	4	4
	E	4	3–4[b]	2
	F	3	3	3
	TOTAL	23	21-22	18
1983	G	4	3	2
	H	4	4	4
	J	4	0	0
	K	4	0	0
	L	4	4	4
	M	4	3	3
	N	4	4	4
	P	5	0	0
	TOTAL	33	18	17

a – still alive at the end of observation period
b – one egg or small young disappeared

one on 31 July and the last on 2 August. In nest G the mean hatching interval was two days. However this nest included both an unhatched egg and one that took four days to hatch; their position in the order of laying is discussed later. For the other eggs the time between the first sign of chipping and escape from the eggshell varied from 1–2 days. An adult usually removed the shell shortly after hatching; one male appeared to eat the shell.

Feeding of nestlings

On the first day after hatching nestlings had difficulty holding their heads up for more than a few seconds, although this seemed to be an important feeding stimulus for the adult, which regurgitated onto the nest. The regurgitated food was pecked at briefly by the nestling before the adult picked it up and reswallowed it. Although feeds at each nest were very brief they were also very frequent, with observed intervals of 30 seconds to 40 minutes.

The last hatched nestling at nest G 1983 was very weak and light, having taken four days to emerge from the egg. This chick was never seen to lift its head, and was not fed during five hours of observation. Before its death 36 hours later, a weight loss of 1.4 g (19%) was recorded, suggesting it rarely or never fed successfully.

By the third day nestlings could grasp the parent's beak, and from the fourth day beak-seizing became vigorous, and sometimes violent. When the parent arrived at the nest, the oldest nestling usually begged first, although feeding order was not quantified, and the first regurgitations in a feeding bout were usually transferred beak to beak. The other young in the nest would attempt to seize some regurgitated food, but since each chick begged only 2–4 times before moving away or lowering its head, and up to 11 regurgitations were recorded in a bout, there was little squabbling between siblings. In 35%

(20/55) of cases following begging, the nestling begging would miss the regurgitated food, which was then picked up by one of the other nestlings.

In nest G 1983, with only two surviving nestlings, 40% (24/60) of regurgitations were not preceded by begging, and the adult regurgitated directly onto the nest. One or both of the nestlings occasionally picked food from here, and if both parents were present they would both eat some of the regurgitate. However the regurgitating parent usually reswallowed most of the food. The regurgitate/reswallow sequence was repeated up to five times in succession. At nest H 1983 (four young) this was observed only twice, although on occasion the parent pointed its beak down as a signal to initiate begging but got no response from recently fed young. In nest A 1978 the parents fed the youngest bird without it stimulating them.

Coordination and movement around the nest improved rapidly with age, and by the fifth day after hatching the nestlings started wandering into the reeds around the nest. It became difficult or impossible to catch, and therefore weigh, nestlings above 7–11 days old.

Growth rates

The mean weight of chicks at hatching was approximately 10 g. The growth rates for nestlings in 1983 are shown in Figures 1a-e. From the weights recorded in nests G and M, the unhatched eggs appear to have been the second ones laid. After hatching, there was a 'settling period' of 2–3 days for the growth rate of each nestling, after which the growth rate appeared constant. Langley (1983) found an almost linear growth rate to about 20 days from random weighings of known-age nestlings. For the calculation of growth rate the settling period was assumed to have ended once the weight reached 20 g. The growth rate for each nestling (Table 2) was determined by least squares regression of weights against days from hatching, excluding the settling period.

To test the hypothesis that earlier hatched young grow more rapidly than later ones, the growth rates of nestlings within each nest were compared using a one-way ANOVA. No significant difference was found between the growth rates of nestlings with respect to hatching order. To test the second hypothesis that nestlings in small broods grow more rapidly than those in large broods, growth rates in nests G and M (two and three nestlings respectively) were

Table 2. Growth rates (g/day) for nestlings, 1983, calculated from morning weights.

	Hatching order			
	1	*2*	*3*	*4*
G	9.08	9.50	–	–
H	9.83	9.55	10.40	9.14
L	9.30	9.95	10.49	9.79
M	9.65	12.30	9.69	–
N	8.15	8.54	9.88	8.78

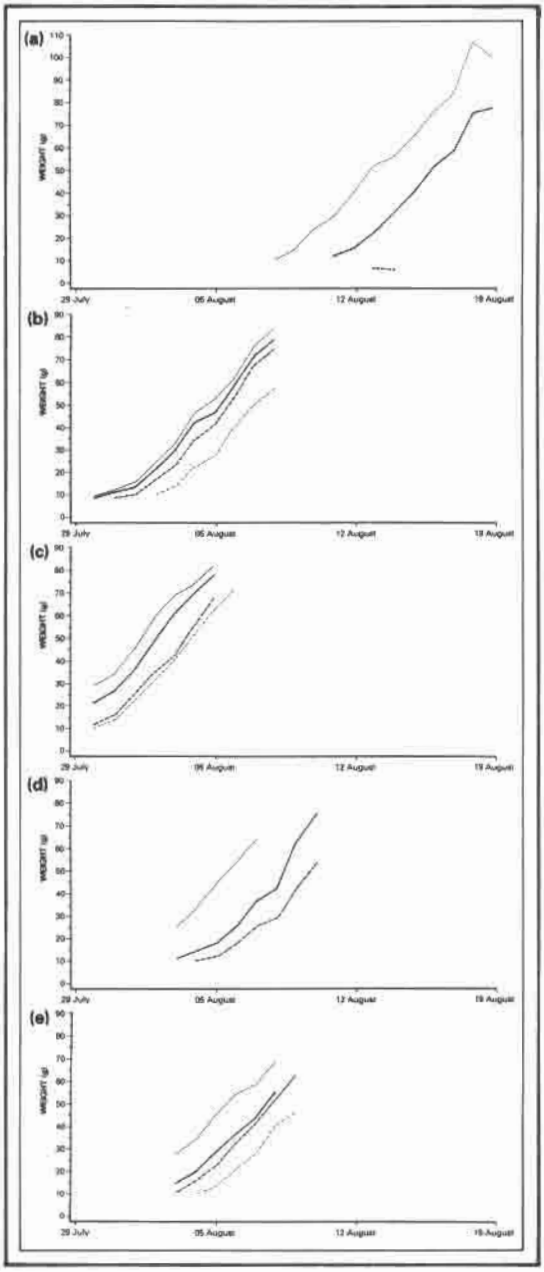

Figure 1. Growth rates for nestlings in study nests, 1983, (a) nest G, (b) nest H, (c) nest L, (d) nest M, (e) nest N. Thin unbroken line, first hatched young; thick unbroken line, second hatched young; thick broken line, third hatched young; thin broken line, fourth hatched young.

compared with nests H, L and N (four nestlings). No significant difference was found.

Between the evening and morning weighings there was either little weight gain or a weight reduction, implying that most or all feeding of nestlings occurred in daylight.

Adult feeding behaviour

In 1978, up to 20 birds were present on the water chestnut patch at one time. Typically, a feeding bird walked across the vegetation, stopping periodically. It then settled by transferring weight from one foot to the other several times, and then crouched with neck partially retracted for 10–120 seconds before striking at the surface. Whether successful or not, the bird then paused, before moving to a new position. Occasionally birds stalked prey by walking slowly across the chestnuts with neck extended horizontally, before striking at the surface. Of 123 feeding attempts recorded in a total of three hours' observations, at least 77 (62.6%) were successful. This is probably an underestimate since smaller prey may have been swallowed too quickly to be seen.

In the willow plantation in 1983, hunting birds perched on the trunk of a sapling, up to 0.5 m from the water surface, with the neck and body held horizontally or pointing slightly downwards. The bird was stationary until prey was seen, when it would strike by rapidly extending its neck, and legs if necessary. On two occasions birds plunged into the water becoming almost submerged, both times returning to the tree with a large (*c.*15 cm long) fish. In a total of 2.5 hours, 68 feeding attempts by 22 birds were observed. The observed success rate was 56% (38/60), not significantly different from 1978. Of 22 identified prey items, 17 were fish, four were frogs, and one damselfly was picked from a reed. Unlike South African *I. m. payesii* (Langley 1983), successful birds did not retreat into cover with the prey either from the willows or the water chestnuts.

Some aggression was observed between adults in the willows. These were planted about 3 m apart and on several occasions when two adults were hunting from adjacent willows, one would fly at the other, displacing it. This was repeated until the displaced bird was more than 10-15 m away. Hancock and Elliott (1978) also report that Little Bitterns are aggressive towards competitors on the feeding grounds. No aggression was noted on the water chestnuts in 1978.

Diet

Regurgitated food included fish (probably *Gambusia* and *Cyprinus* spp.), amphibians (anurans, both adults and tadpoles), insects, including Odonata adults and larvae, Coleoptera larvae (probably Dytiscidae), a cricket (Orthoptera) and a single snail and spider. The composition of adult and nestling regurgitations is shown in Table 3. There was no significant

Table 3. Adult and nestling regurgitations.

	Adult		*Nestling*	
Prey type	*n*	*% weight*	*n*	*% weight*
Fish	60	76.1	63	72.0
Amphibian	9	16.3	6	18.2
Insect	13	7.5	11	9.6
Other	1	0.1	1	0.2
Total	83	100.0	81	100.0

X^2=0.8, 2df, N.S.
Mean pellet weight: adult – 6.7 g, nestling – 2.9 g
Mean prey weight: adult – 2.0 g, nestling – 0.8 g

difference in the composition of regurgitate between adults and nestlings. This is not surprising since the food regurgitated by trapped adults was probably being taken back for the nestlings. The weight of individual prey items collected from nestling regurgitate was positively correlated with chick age (Spearman rank: df = 78, r = 2.11, $p<0.05$), indicating that chicks were fed increasingly larger prey, but there was no correlation between chick age and pellet weight.

DISCUSSION

Although egg-laying in the study nests probably started in early July, several other nests found at this time in 1978 had either well grown young, or were already empty. Fledged juveniles were seen and trapped from mid-July in both years. With an incubation period of 17–19 days and a probable fledging period of 25–30 days (Cramp and Simmons 1977, Hancock and Elliott 1978), these birds must have been from clutches completed in late May. This would suggest either that the study nests were replacement clutches, or that the Little Bittern is at least partially double-brooded in Kashmir; the high density of nests would suggest the latter. Langley (1983) found *I. m. payesii* to be double-brooded in South Africa, whereas *I. m. minutus* is single-brooded in Europe (Cramp and Simmons 1977). These similarities may be because Langley's study area was at a comparable latitude (34°S) to Haigam.

Clutch-size in this study differs from earlier Kashmir data. Wilson (1899) recorded 5–6 eggs in June, Baker (1934) 4/5–6/7 with six usual in full sets, Bates and Lowther (1952) up to seven with five "a common number" and Ali and Ripley (1983), probably compiled from the earlier works, 4–6/7. It may be that later nests (possibly second broods) have a lower clutch-size than earlier ones.

The mean weight at hatching was similar to weights recorded in Europe by Wackernagel (1950), but 25% higher than that of South African birds (Langley 1983).

The predominance of fish in the diet contrasts with data from Europe and elsewhere in Kashmir (Witherby *et al.* 1939, Cramp and Simmons 1977,

Pandit 1982) where only 25.5-42.2% of the diet was recorded as fish. The diet will obviously vary considerably with locality and time of year, with the preponderance of fish recorded in this study reflecting its abundance at Haigam in July/August. Langley (1983) found that fish made up to 72% of observed food items (n=49).

Three observations suggest that food was not limiting during the study period in 1983. First, there was an absence of intensive fighting between siblings at feeding times, in contrast to observations by Bates (1943). Second, there were frequent unsolicited regurgitations by parents, which met with no response from nestlings. Third, only one chick died, and its death was apparently unrelated to food availability. If food was not limiting in 1983, it may be asked why clutches were not larger than in 1978.

In a study of European Little Bitterns, Wackernagel (1950) recorded weights at three nests containing three, five and seven young. There is no significant difference between growth rates calculated from his results and those from the present study. Also as at Haigam, there was no significant correlation between growth rates and hatching order. However the youngest chick from the brood of seven died two days after the first weights were recorded, after a weight loss of 22%. In the present study, at least three young died in 1978, of which at least two were the youngest of the brood.

Combining Wackernagel's data with the present study, of five chicks recorded dying, at least four were the youngest in the brood, which supports the "brood reduction" hypothesis of Lack and Moreau (1965). However, it is also possible that the death of later-hatched chicks is related to a decrease in the quality of their incubation as eggs whilst the earlier-hatched chicks are being fed.

The only nest failures observed were during incubation, probably due to predation by Black Kites *Milvus migrans,* Marsh Harriers *Circus aeruginosus* or House Crows *Corvus splendens* after reed-cutters had worked close to or over the nest. After hatching the chicks are not as conspicuous as eggs, and after a few days can hide in the reeds. Since a chick would appear to be better protected than an egg, the earlier an egg hatches the better its survival chances. Thus, in species where eggs are more vulnerable to predation than chicks, asynchrony would be the expected condition (Clark and Wilson 1981).

This study comprises the results of two Oxford University expeditions to Kashmir. In 1978 most of the nest-finding and observation was carried out by Andrew Davies, assisted by P.H., Cristina Chiara, Dan Marsh and Paul Waring. Dan Marsh carried out the 1978 feeding study. We would like to thank all members of the 1983 expedition; Mir Inayatullah, formerly Chief Game Warden Jammu and Kashmir State, for permission to work at Haigam; and Ramzan Dar, Mohammed Yousuf Dar and all the staff at Haigam Rakh.

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