Avocetta N° 20: 158-161 (1996)

Reproductive parameters and nestling growth in Hoopoe *Upupa epops* in an area of Central Italy

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Available data on the breeding biology of the Hoopoe *Upupa epops* are rather scanty and specific studies are episodic (e.g. Kubik 1960) the main information being reviewed in Glutz von Blotzheim (1980), Cramp (1985), Fry *et al.* (1988). The aim of this contribution is to provide data on the reproductive parameters and the nestling growth of Hoopoes nesting in artificial nest-boxes.

The study area is located inside the WWF oasis of Macchiagrande (41° 52' N, 12° 17' E), a mediterranean scrub surrounded by grassland along the coast of the Central Thyrrenian sea (about 240 ha). Overall nine nest-boxes were used. Six of them were installed during the winter 1990, while other three boxes were added during the winter of 1995. The nest boxes (25 cm x 25 cm x 35 cm, hole diameter=6 cm) were placed between 3-5 m above the ground, attached to trees, with random exposure, spaced at least 100 m each other. Data were collected during five years (1990-95). The inspection of the nest-boxes was carried out weekly for the whole breeding season; in 1992 and 1993 it lasted only until mid June.

As regards the reproductive parameters, we assumed that females lay one egg per day (Bussmann 1950, but see Fry *et al.*. 1988) and that the onset of incubation occurred after the first egg was laid (Cramp 1985; pers. obs.). For each clutch we considered: hatching success = (hatched eggs/laid eggs) x 100; fledging success = (fledged young/hatched eggs) x 100; breeding success = (fledged young/laid eggs) x 100.

The eggs were measured with a gauge (±0.1 mm). In 1994 the chicks from four nest-boxes were weighed with an electronic balance (±0.1 g) every two to four days from the date in which their hatching was detected. Individual recognition of the nestlings was assured by coloured ring, by differences in size (see results) and by marking of claws with nail varnish. In the spring of 1995 several females were captured on the nest in order to check the nest site fidelity.

The percentage of occupation in the study years was fairly high, however in the first year none of the nest-boxes were used and in the second year only two clutches were laid (Figure 1).

During the study period the earliest laying date was

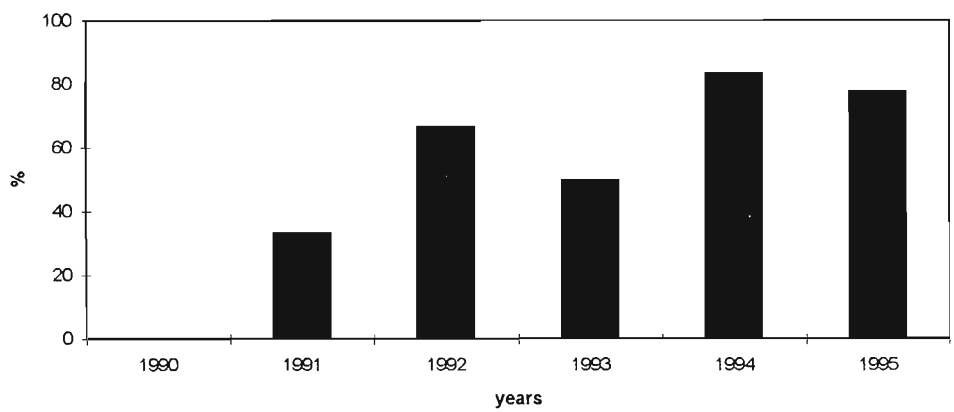

Fig. 1. Nest-box utilization (%) in the study years.

Accepted 19 December 1996

April 10 and the earliest fledging date was May 18. However, in 1995 no eggs were found before April 26 and the fledging date of the chicks ranged between June 3 and August 3.
The dates of laying grouped into periods of ten days show two peaks (Figure 2). It must be noted that in one of the five nests of 1994 and in two of seven nests of 1995, a clutch was laid after the first brood fledged; the dates of the beginning of these possible second broods ranged between June 3 and July 4. Therefore the second peak could be due to the laying of the second clutches.

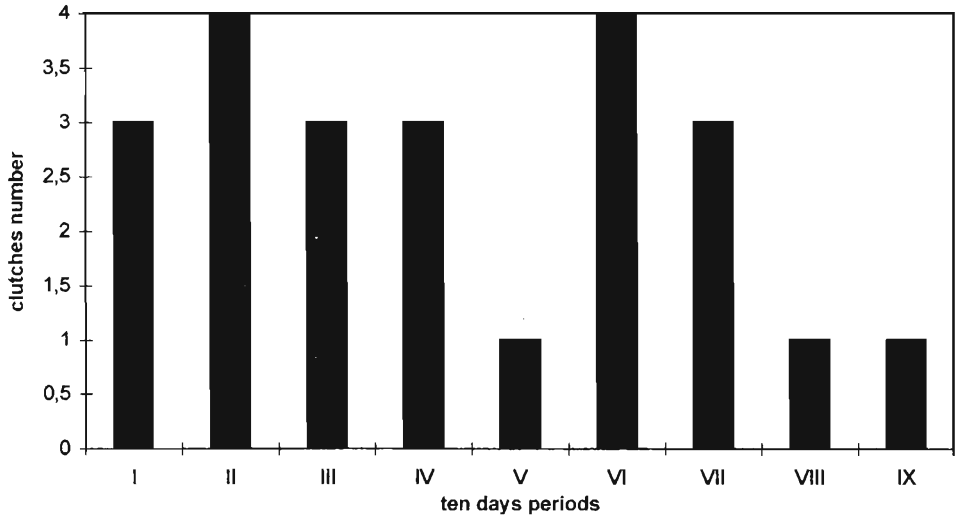

Fig. 2. Number of clutches laid each ten days (first period=April 10-20).

No significant differences in clutch size laid in different months were observed (Mann-Whitney test). However, the average clutch size in April was 7.7 (s.d.=1.0; n=6), in May 7.0 (s.d.=1.0; n=3), in June 7.2 (s.d.=1.3; n=8). Moreover, in the three nests with a second brood, the size of the apparent first clutch was on the average higher ($\bar{x}$=7.7; s.d.=0.6) than the second ($\bar{x}$=6.3; s.d.=1.5).
It is likely that predation was not the only factor affecting hatching and fledging success (Table 1), because if we do not consider the preyed clutches, the hatching success rise to 81.8%, while fledging remains unaffected.

Tab. 1. Reproductive parameters of Hoopoe after pooling the study years (n=number of clutches; except for nestling period and egg size where n= number of nestlings or eggs).

	Clutch size	Incubation period	Nestling period	Hatching success	Fledging success	Breeding success	Length of eggs	Width of Eggs
mean	7.3	16.6	25.4	65.5	79.4	52.0	25.4	17,4
s.d.	1.1	0.9	1.6	36.3	22.4	33.2	0.9	0,6
n	18	5	22	20	16	20	67	68

In all clutches the asynchronous hatching of eggs led to nestlings of clearly different size in the first days after hatching (Figure 3-4). All the chicks that starved were the last hatched of their clutches. In a nest the death of three chicks occurred in the period in which a halt in growth was observed for the two chicks successfully fledged (Figure 3).
The mean mass of three chicks measured in the hatching day was 2.9 g (s.d. = 0.2). Overall the mass of the chicks rapidly increased up to a maximum (ranging between 69 and 84 g) and showed a reduction the days before fledging (60-73 g). This trend was observed in 19 of 21 successfully fledged chicks. However, in several instances the mass of the last hatched chick increased very gradually or even diminished, reaching the fledging value only in the last days of nestling period when some of its siblings had already fledged or were losing weight (Figure 4).
In 1995 one of the three females examined on the nest was found to have been ringed as a chick the previous year.

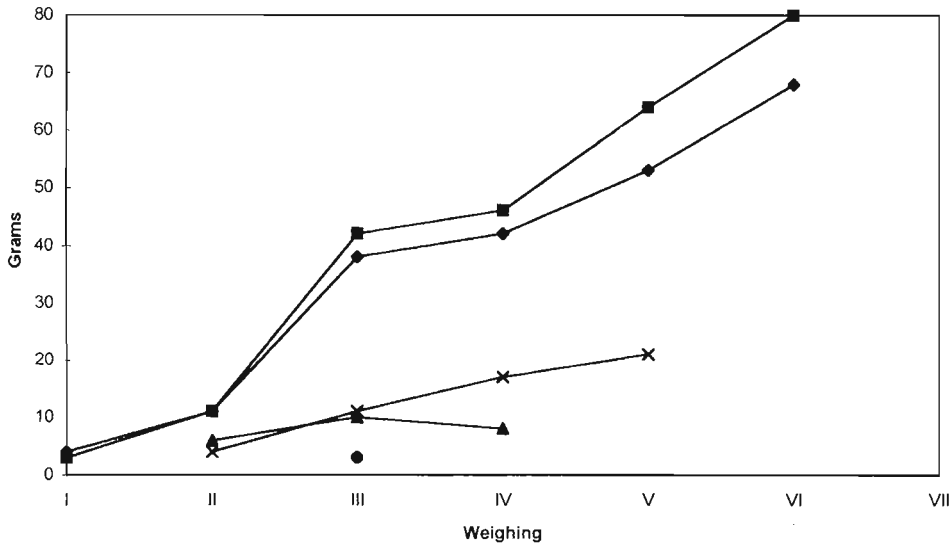

Fig. 3. Mass increase in a nest where three out of five chicks died.

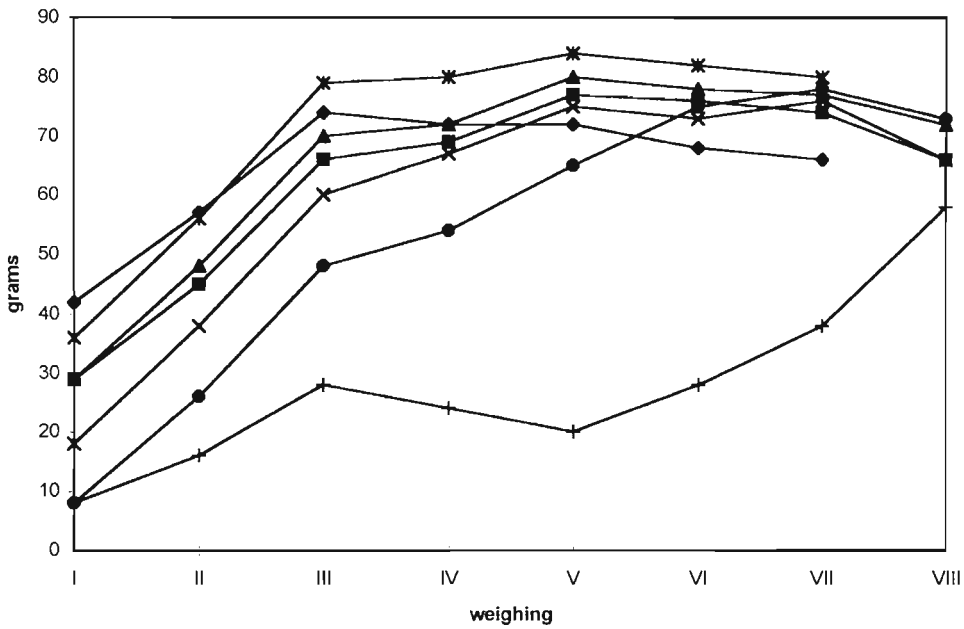

Fig. 4. Mass increase of seven Hoopoe chicks from a brood in which all chicks fledged successfully.

Only at the end of the spring of 1991 females of Hoopoe had turned their attention to the nests boxes. However, in the following years the nest-boxes showed a high percentage of occupation which would encourage the undertaking of analogous experiments by using artificial nests for Hoopoe in other areas.

Our data (Table 1) are similar to those reported by other authors (Kubik 1960, Glutz von Blotzheim 1980, Cramp 1985, Fry *et al.* 1988) and the growth curve for the chicks showes the sygmoidal form typical of many altricial birds species (Ricklefs 1968). The number of second brood was apparently high, as reported for southern population of Hoopoe (Cramp 1985).

The anomalous weight increase of some of the chicks and the observation that the death of the chicks occurred only for the last hatched, apparently during periods of scarce availability of food and not caused

by predation, seem consistent with the "brood-reduction" hypothesis (Lack 1968, but see Magrath 1990).

Acknowledgements - We thank C. Carere for the revision of the manuscript and F. Oddono for the help during the field work.

Riassunto - Vengono riportati alcuni dati, raccolti nelle stagioni riproduttive 1990-95 nell'oasi WWF di Macchiagrande (Roma), sui principali parametri riproduttivi, sulle dimensioni delle uova e sull'incremento ponderale dei pulcini di Upupa. I risultati sembrerebbero in accordo con le poche informazioni disponibili in Europa sulla specie. L'uso di nidi-artificiali sembra un buon mezzo per studiare la biologia riproduttiva dell'Upupa.

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