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GROWTH AND DEVELOPMENT OF GREAT SPOTTED CUCKOOS AND THEIR MAGPIE HOST[1]

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Abstract. The increase in body weight, and of tarsal, culmen, wing and tail lengths in nestlings of the Great Spotted Cuckoo (*Clamator glandarius*) and of its host, the Magpie (*Pica pica*), was studied in the "Hoya de Guadix" (southern Spain). The effect of parasitism on the growth of host nestlings was also analyzed. Great Spotted Cuckoo nestlings grew faster than Magpie nestlings in unparasitized and in parasitized nests. There is some evidence that the size of the host species did not influence the growth rate of parasite nestlings. When more than one parasite chick was raised in the same nest, competition for food was strong and the younger nestling starved. Magpie chicks had a larger weight asymptote and reached 90% of the asymptotic value earlier in unparasitized nests than in parasitized ones.

Key words: Great Spotted Cuckoo; Clamator glandarius; *Magpie;* Pica pica; *parasitism; nestling growth.*

INTRODUCTION

Parasites are generally said to affect the fitness of their hosts adversely. Two major kinds of brood parasites are know; those ejecting all other offspring from the host nest (e.g., European Cuckoo, *Cuculus canorus*) and those growing up together with the offspring of the host (e.g., Great Spotted Cuckoo, *Clamator glandarius*). While it is obviously detrimental for hosts to be parasitized by a cuckoo ejecting their nestmates, the negative effects of being parasitized by a non-ejecting cuckoo have less often been documented. Adaptation among cuckoos to such a situation could be a rapid development, fast growth and superior competitive ability (Payne 1977, Marvil and Cruz 1989).

The Great Spotted Cuckoo is an obligate brood parasite whose palearctic populations are migratory, wintering in Africa south of the Sahara and breeding mainly in the Iberian Peninsula, being numerous in the southern half (Cramp 1985). It is considered a specialist brood parasite mainly parasitizing the Magpie (*Pica pica*) in Europe (Cramp 1985, Soler 1990).

Great Spotted Cuckoo parasitism has a negative effect on Magpie reproduction; the breeding success of the host in parasitized nests is very low, only 19.2% of the nests fledged any host chicks (Soler 1990). The nestling Great Spotted Cuckoo does not reject the host's eggs or young as does the European Cuckoo and therefore, parasite young must compete with host chicks for parental care. It is a general assumption that parasites negatively affect the fitness of their hosts by affecting either the quantity or the quality of their offspring. The main objective of this study was to test whether Great Spotted Cuckoo nestlings depressed the growth rate of Magpie host nestlings reared in parasitized nests.

Very little information exists on the development of Great Spotted Cuckoo parasites, and the growth rate of host nestlings has only rarely been compared with growth rate of nestlings reared in unparasitized nests (Valverde 1971, Mundy and Cook 1977).

STUDY AREA AND METHODS

The study was carried out in the "Hoya de Guadix" (southern Spain), a cereal-producing plain at 900–1,100 m altitude (for details, see Soler 1989, 1990), an area in which the Great Spotted Cuckoo parasitism is very recent (Soler and Møller 1990, Soler 1990).

The growth of Great Spotted Cuckoo and Magpie nestlings was studied in 17 nests ($n = 26$ nestlings). Although 25 Magpie eggs hatched, many chicks starved early during the nestling period. The growth rate of Magpie nestlings was also determined in 10 unparasitized nests ($n = 41$ nestlings). During the last days of the nestling period it is very difficult to measure Great Spotted Cuckoo chicks since they frequently escape

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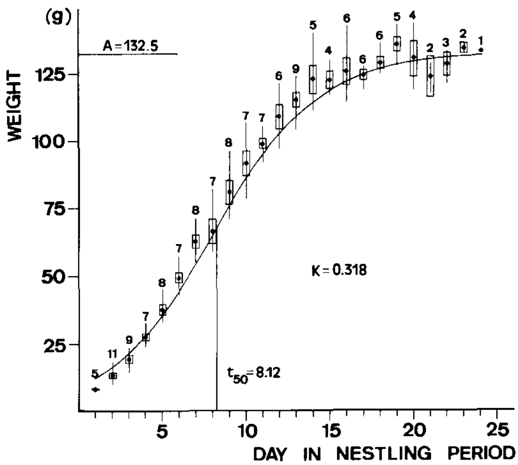

FIGURE 1. Mean daily weights for nestlings Great Spotted Cuckoos. The bars indicate the standard error and the vertical lines range. Numbers are sample size. Growth curve determined by the logistic model (Ricklefs 1967). Nestling growth characteristics (A, K, t_{50}) are also given. Hatching day is day 1.

from the nest. For that reason, there are very few data available from the late nestling period. Each nest was visited at the same time of the day.

The young were marked at birth with different colored woolen threads tied loosely to the tarsus, changing them at every visit. When nestlings were 9–11 days old, they were ringed with metal rings. The nests were visited every two or three days, and some even daily. We measured tarsus, culmen, wing, tail, 6th primary remex and central rectrix lengths, and body weight. We also recorded the daily changes in the morphology variation. Weights were taken, using 30 g, 100 g and 300 g Pesola spring balances depending upon the nestlings' age. The lengths were measured with a thin ruler with a stop at zero (accuracy 0.1 cm), in the case of the wing, tail and feathers, or with a calliper (accuracy 0.01 cm) for the rest. All the measurements were taken according to Svensson's (1970) method.

Weight data for all nestlings were fitted to a logistic equation of the form:

$$W = A/1 + e^{-K(t-t_{50})}$$

in which W is the weight of the bird in grams at age t, A is the approximate asymptote of the growth curve, K is the growth rate constant, e is the base of natural logarithms, and t_{50} is the age (days) at the inflection point of the growth curve, which occurs at one half the asymptotic weight on a logistic curve (Ricklefs 1967, 1968).

To analyze the influence of parasite chicks on the growth rate of the Magpie nestlings, we considered all hatchlings, including the runts whose weight usually was maintained for some days until they died. Runts occurred in unparasitized Magpie nests as a consequence of hatching asynchrony and brood reduction, but they were more frequent in parasitized nests probably due to parasitism. One of the main effects of parasitism is to reduce the survival probabilities of some chicks, so it is improper to analyze only the growth of the survivors.

RESULTS AND DISCUSSION

WEIGHT

The nestling period of Great Spotted Cuckoo chicks was 20.3 days (SE = 0.34, range = 17–27 days, n = 29 nestlings).

At hatching (during the first 24 hours) the average weight was 7.8 g and nestlings gained weight quickly, completing half of their growth between days 8 and 9 (t_{50} = 8.12). This quick growth continued until day 14, after which the weight of nestlings leveled off (Fig. 1). At fledging (days 23 and 24), the average weight was 133.7 g which represented 79.1% of the adult male weight and 99.8% of the adult female weight (according to data from Valverde 1971).

Great Spotted Cuckoo nestlings grew faster (K = 0.32) than Magpie nestlings in unparasitized nests (K = 0.24) (ANCOVA, $F = 60.43$; $P < 0.001$) and also faster than Magpie nestlings in parasitized nests (K = 0.27) (ANCOVA, $F = 17.85$; $P < 0.001$). A similar result has been obtained in the Brown-headed Cowbird (*Molothrus ater*), its chicks grew faster than Solitary Vireo (*Vireo solitarius*) chicks (Marvil and Cruz 1989).

In the Shiny Cowbird (*Molothrus bonariensis*), Wiley (1986) found that the growth rate increased significantly with host body size. In our study area the Carrion Crow (*Corvus corone*), being approximately twice the size of the Magpie, is also parasitized by Great Spotted Cuckoos. We observed the growth in only two parasite nestlings reared by Carrion Crows and very few measurements were taken, but the values were very similar to those of nestlings reared by Magpies. In the study by Mundy and Cook (1977), it is clear that nestlings of Great Spotted Cuckoos reared by Magpies (data from Valverde 1971) were of similar size or even bigger than those reared by Pied Crows, in spite of the Pied Crows's larger size. It appears that in the Great Spotted

Cuckoo, which parasitizes hosts larger than itself, the size of the host does not influence the growth rate of cuckoo nestlings.

When more than one parasite chick exists in the same nest, the younger may starve because of competition with the older conspecific (Soler 1990). The growth rate of three parasite chicks that hatched on alternate days is shown in Figure 2 (data not included in Fig. 1). It is interesting to point out some aspects: 1) The only Magpie chick that hatched, died on the next day. 2) The last hatched parasite chick starved to death on the fourth day without having grown. 3) The second parasite chick lived for 13 days, but it was a runt and died on its 14th day. 4) The first parasite chick to hatch had a nestling period longer than usual and it left the nest with a weight less than normal (see Fig. 1). In spite of this, it is not rare to find more than one parasite chick surviving per nest (Soler 1990); so it is possible that in this nest there are some problems with food availability or with the ability of the individual or pair to rear their offspring.

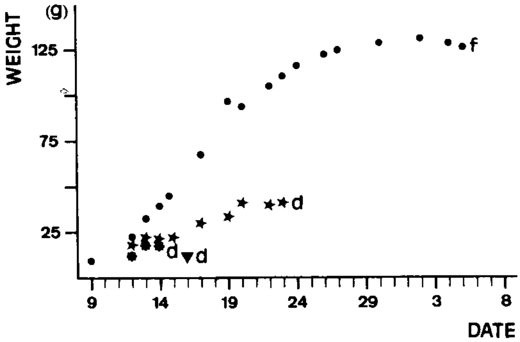

FIGURE 2. Weight increase in three parasitic chicks (dot, star and asterisk) and one host chick (triangle). Only one cuckoo fledged (f) and the other three nestlings died (d). Dates are from May 9th & onwards. All weights were obtained in the evening, between 19:30 and 20:30 hours.

GENERAL GROWTH PATTERN

The values for the various body measurements per day are illustrated in Fig. 3. The development of Great Spotted Cuckoo chicks has been described in two different papers (Valverde 1971, Mundy and Cook 1977) but data do not exist about the growth rate of the different parameters, only about the primary feather and tail lengths in one nestling (Valverde 1971).

Dorsal skin darkens between days 3 and 6. Quills develop on day 4 or 5. The feathers of the tail break the vanes between days 8 and 9, and they appear in the majority of the quills between days 12 and 13, being well feathered by day 15 or 16. See also Valverde (1971) and Mundy and Cook (1977). Wings and tail grow quickly, mainly after the feathers emerge (Fig. 3). At fledging, wing length was 54% and 56% of that of the adult male and female length, respectively (data from Cramp 1985). The tail remains less developed at fledging, representing only 37% of the adult male length and 40% of the adult female length (data from Cramp 1985).

At hatching, the bill is pale pink and begins to darken about day 5. The culmen length grows slowly (Fig. 3), and at fledging (between day 19 and the end of the nestling period), it represents 80% of the adult male length and 81% of the adult female length (data from Cramp 1985). According to Valverde (1971), the hatching tooth is kept at least until day 16; we have found that in the majority of chicks it remained throughout the nestling period, and even after fledging (83%, $n = 12$). In most birds this tooth is usually lost a few days after hatching (O'Connor 1985). However, in some corvids as in the Jackdaw (Soler and Soler 1990) and Magpie (pers. obs.), it is conserved during the entire nestling period.

At hatching, the lower mandible is longer than the upper mandible. Between days 11 and 12, they reach the same length and after 13 days the latter is longer than the former. After hatching, the buccal cavity darkens, becoming red with more conspicuous papillae, but from day 7 or 8, both lose color intensity and become less conspicuous. The eyes begin to open on the fourth day and on the ninth they are completely open in practically all the nestlings.

At hatching, tarsi are pink, but begin to darken about day 4. This is the measured parameter that changed most quickly, mainly until day 16. From then on, it grows slowly (Fig. 3). Fledglings leave the nest with tarsal length very similar to that of adults (92% of the male and 97% of the female) (Cramp 1985).

EFFECT OF PARASITISM ON THE GROWTH RATE OF HOST CHICKS

Magpie chicks had a larger asymptote in unparasitized than in parasitized nests (Fig. 4), and reached 90% of the asymptotic value ($t_{90} = 18.59$) earlier than nestlings from parasitized nests ($t_{90} = 20.02$). Considering only data after nestlings reaching 90% of the asymptote, Magpie fledglings weighed more in unparasitized ($\bar{x} = 167.4 \pm 1.8$, $n = 50$) than in parasitized nests ($\bar{x} =$

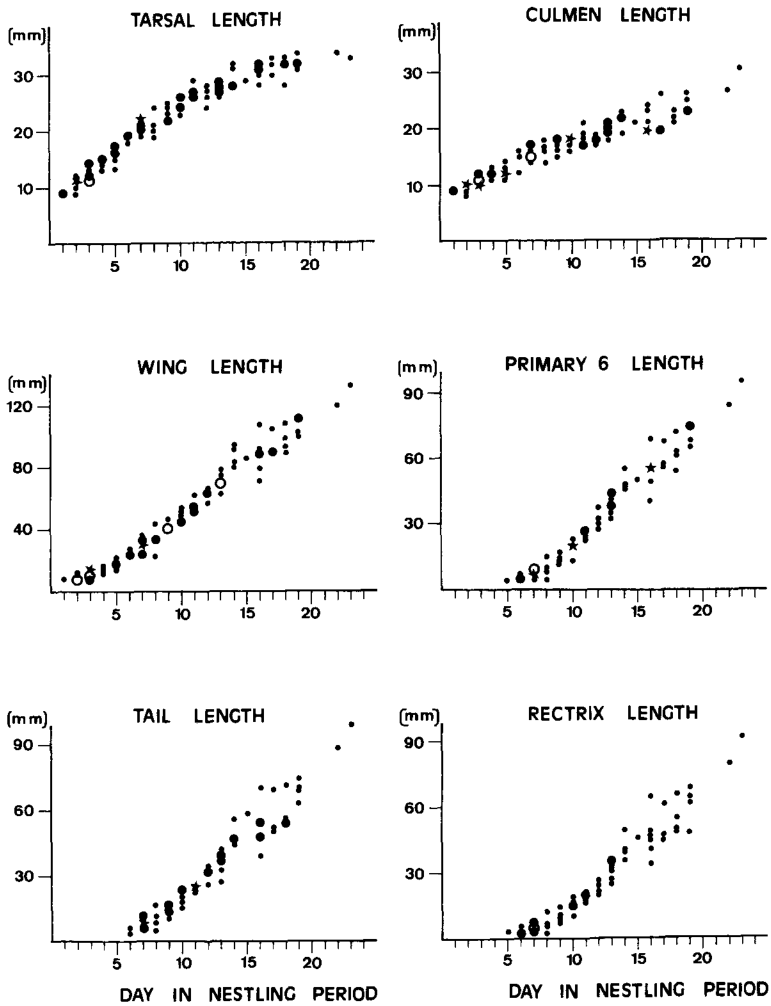

FIGURE 3. Mean size for body measurements of Great Spotted Cuckoo nestlings as a function of age. Point = one individual, closed circle = two individuals, star = three individuals, open circle = four individuals.

149.7 ± 3.8, $n = 26$, $t = 4.3$, $P < 0.001$). This supposes an important handicap in future survival because it has been demonstrated that heavier Magpie chicks have a higher probability of survival (Eden 1985).

The growth rate of Magpie nestlings in unparasitized nests is slower than that cited by Ricklefs (1968, $K = 0.332$) probably because runts were not excluded from the analysis in our study (see methods).

The effect of the parasite chicks on the growth rate of host chicks remains unclear. The development of Vireo nestlings is slower in nests parasitized by Brown-headed Cowbirds than in unparasitized nests (Marvil and Cruz 1989). However, in Yellow Warbler (*Dendroica petechia*) and Red-winged Blackbird (*Agelaius phoeniceus*), growth rates do not differ significantly with or without cowbirds (Weatherhead 1989). In our study the growth rate constant is significantly smaller for nestlings raised in unparasitized ($K = 0.24$) than in parasitized nests ($K = 0.27$, ANCOVA, $F = 10.03$, $P < 0.01$). This unexpected result is due to the presence of numerous Magpie runts during the first seven days of the nestling period, which slows down the overall growth rate (see Fig. 4b). Given that Ricklefs method transforms curves to straight lines, using the conversion factor of the logistic equation, the difference in growth rate can be

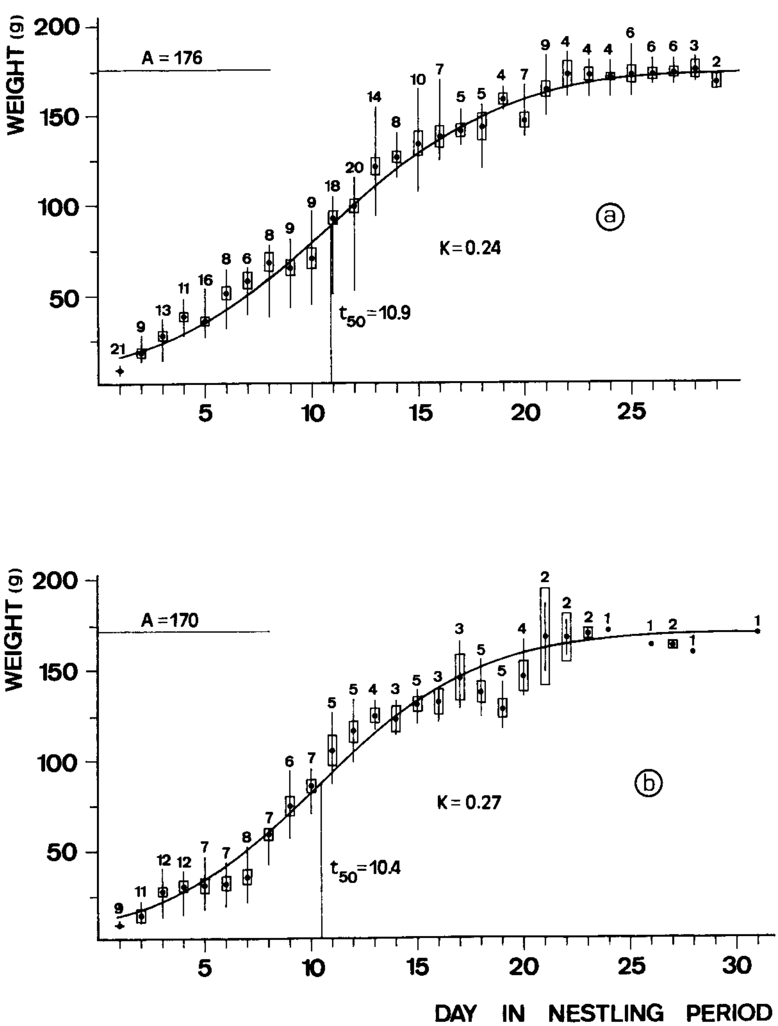

FIGURE 4. Mean daily weights for Magpie nestlings in unparasitized (a) and in parasitized nests (b). Data presentation as in Fig. 1.

explained by the disappearance of runts after the first seven days leading to an increased growth rate during the following days. This idea can be tested by comparing the growth rate in three different stages. During the first seven days, Magpie nestlings in unparasitized nests grew considerably faster than those in parasitized ones (ANCOVA, $F = 23.16$, df $= 31$, $P < 0.001$), whereas during the other two stages there were not significant differences (between 7–20 days; ANCOVA, $F = 0.04$, df $= 98$, $P > 0.2$; between 20–24 days; ANCOVA, $F = 0.82$, df $= 31$, $P > 0.2$).

Therefore, we can conclude that K values are larger for nestlings from parasitized than from unparasitized nests because of the effect of the numerous runts on the average body weight which increases very little in the first seven days.

In conclusion, Great Spotted Cuckoo parasitism causes host nestlings, to grow slowly and to fledge at a lower weight. These factors may have a negative effect on the future survival prospects of the young (Perrins 1965, Nur 1984, Ricklefs 1984).

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