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Brief report

Parasitism rate by the Common Cuckoo *Cuculus canorus* increases with high density of host's breeding pairs

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1. Introduction

Local parasitism rates by the Common Cuckoo *Cuculus canorus* on a given host population may vary widely and unpredictably between years (Lack 1963, Johnsgard 1997, Davies 2000). This is apparently the case for the *gens* of the Common Cuckoo which regularly parasitizes the Rufous Bush Chat *Cercotrichas galactotes* in southern Spain, whose annual rate of parasitism varies a great deal, at least in a population that has been intensely studied (Alvarez 1994, pers. obs.).

High nest density of hosts of other cuckoo species and cowbirds has been interpreted as a defence against brood parasitism, whose intensity is consequently lowered, since high nest density may facilitate vigilance and deterrence (Rothstein 1990, Soler *et al.* 1998, Clotfelter & Yasukawa 1999, Strausberger 2001). For the Common Cuckoo, Lack (1963) suggested that hosts would be parasitized only in areas where they are numerous, and not in areas where they are scarce. However, this was not the case: host (the Reed Warbler *Acrocephalus scirpaceus* and the Redstart *Phoenicurus phoenicurus*) abundance was found to be unrelated to frequency of parasitism (Lindholm 1999, Rutila *et al.* 2002), or at low values in areas of high risk of parasitism (i.e., near trees, Øien *et al.* 1996). This was attributed to potential hosts avoiding those areas, while high nest density would provide a more effective system of alarm against cuckoos.

With respect to the Common Cuckoo–Rufus Bush Chat dyad, an early start to the breeding season by certain chat pairs has been shown to facilitate parasitism by the former (Palomino *et al.* 1998).

According to this and to the potential effects of climatic conditions on the parasite and host populations (which could affect the intensity of parasitism), and in order to understand the causes of variation of the impact of parasitism by the Common Cuckoo on Rufous Bush Chat nests I examined the relationship between annual rates of parasitism and densities of the host's breeding pairs, dates of start of reproduction and climatic parameters.

2. Study area and methods

The study area (33–50 ha at 37°9´N, 2°14´W, at 12 m a.s.l., 20 km south of Seville, Spain), with Mediterranean climate, is mostly used for intensive vineyard agriculture (Rufous Bush Chats build their nests nearly always on vine stocks, which are 1–1.5 m high), with orchards, interspersed fruit trees, greenhouses and areas of kitchen gardens and vegetable fields.

For each year of study (1992–1993 and 1995–2001), data were obtained on rate of parasitism (percentage of active Rufous Bush Chat nests parasitized by the Cuckoo), density of breeding chat pairs per hectare, date of laying of the first egg (median number of days from 1 May of each year of the five earliest laying pairs), and averages of monthly values of precipitation in mm/m^2 and temperature in °C from January to June (adult cuckoos leave the area in July). Precipitation and temperature data came from a meteorological station located 1.5 km from the study area. The Spearman rank correlation coefficient was used as a measure of the association between the rate of parasitism and the other variables.

3. Results

Of a total of 623 active chat nests the annual rate of parasitism showed high variation throughout the period of study (Table 1), although male and female cuckoos were observed in the area even in those years with no parasitism, at least at the start of the chats' breeding season.

Considering the mere passage of time, a trend was found towards a decrease in parasitism rate over the years (r_s = –0.778, P = 0.014, n = 9). The number of years passed was also significantly and negatively related to the density of breeding pairs (r_s = –0.946, P = 0.0001, n = 9), but not to the date of laying (r_s = 0.293, P = 0.444, n = 9), average temperature (r_s = 0.653, P = 0.057, n = 9) and precipitation (r_s = 0.200, P = 0.606, n = 9).

Comparisons of the rate of parasitism with the other variables yielded two significant results: a positive relationship with respect to density of breeding pairs (r_s = 0.903, P = 0.001, n = 9) and a negative one with average temperature (r_s = –0.803, P = 0.009, n = 9) (Table 1 and Fig. 1). Parasitism frequency was not affected at a significant level by either the date of first laying (r_s = –0.114, P = 0.771, n = 9) nor by total precipitation (r_s = –0.552, P = 0.123, n = 9).

Given that average temperature is significantly and negatively correlated with density of host breeding pairs (r_s = –0.828, P = 0.006, n = 9) (and not total precipitation: r_s = –0.393, P = 0.295, n = 9), the influence of average temperature on the association between rate of parasitism and density of breeding host pairs is important. To solve this problem the Kendall partial rank-order correlation (Siegel & Castellan 1988) was used, resulting in a highly significant correlation between rate of parasitism (x) and density of breeding pairs (y) when average temperature (z) was held constant ($T_{xy,z}$ = 0.669, P < 0.01, two-tailed), as well as a low correlation of rate of parasitism with average temperature when density of the host breeding pairs was controlled ($T_{xz,y}$ = –0.257, n.s.). This result demonstrates that the relation between parasitism rate and density of the host beeding pairs is independent of the influence of average temperature.

Table 1. Yearly values of the variables used.

Year	Active host nests (n)	Parasitism rate (%)	Host density (pairs/ha)	Date of laying of 1st egg (Mdn from 1 May)	Average precipitation (mm/m^2)	Average temperature (°C)
1992	29	27.59	2.03	24	26.84	15.62
1993	44	27.27	1.37	34	38.18	14.92
1995	86	11.63	1.18	15	21.87	16.30
1996	89	8.99	0.84	21	85.28	16.37
1997	62	8.06	0.58	25	44.65	16.87
1998	62	0	0.58	37	40.70	16.37
1999	73	20.55	0.82	37	10.32	16.15
2000	93	2.15	0.58	23	29.57	16.53
2001	85	0	0.52	31	51.13	16.50
Total	623					
Average		11.80	0.94	27	38.73	16.18

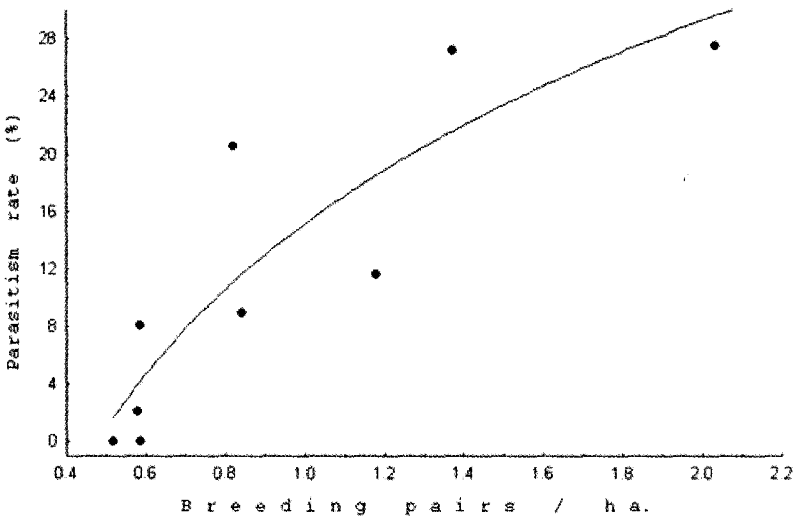

Fig. 1. Rate of parasitism of active Rufous Bush Chat nests by the Common Cuckoo versus density of breeding host pairs.

4. Discussion

These findings suggest that cuckoos could gain an advantage from having a high density of the host's breeding pairs in their home ranges, since they would have not only a great number of potential hosts available, but they would also be able to observe closely several prospective hosts from high vantage points (Alvarez 1993, Øien *et al.* 1996, Moskát & Honza 2000, Clarke *et al.* 2001). This latter observation gives them the opportunity to lay each egg at the optimal moment (i.e., when host birds are away from their nest during the periods of laying or early incubation of each pair).

Although nests of early arriving chat males (which pair with early laying females) are apparently more easily parasitized by the cuckoos in the studied population (Palomino *et al.* 1998), the effect, as shown in my results, is apparently not sufficiently strong for the date of the start of reproduction to affect the annual rate of parasitism.

Soler *et al.* (1998) observed a reverse relationship as reported here between nest density and rate of parasitism for the Great Spotted Cuckoo *Clamator glandarius* and its host the Magpie *Pica pica*, which they interpret as a result of the latter nesting at high densities in resource-rich habitats as a defensive response to brood parasitism. This behaviour by the Great Spotted Cuckoo should be regarded as part of its strategy of brood parasitism, which does not include egg or chick eviction (Alvarez & Arias de Reyna 1974, Johnsgard 1997), as does that of the Common Cuckoo, and which has to rely on entirely different tactics.

The fact that breeding Rufous Bush Chat pairs in the vicinity of another whose nest is being approached by a Cuckoo do not join the attack (and the pair involved does so only when the Cuckoo is approaching or near its nest) (Alvarez 1994) diminishes the importance of high-pair density as a defence against parasitism, and what probably finally prevails is the interest of cuckoos for as many breeding pairs as possible within their home range.

Although we could expect high parasitism rate to produce multiple parasitism (more than one egg laid in some nests, apparently by different Common Cuckoo females, which has been reported to occur from England to Hungary, Wyllie 1981), no case of multiple parasitism was observed in my study area. Nevertheless, multiple parasitism can be overlooked, since a second laying female Cuckoo may remove the egg laid by the first one (Wyllie 1981).

The relationship between average temperature and parasitism rate appears to be indirect, that is, high temperature producing low nest density (through an effect on food resources?), and this in turn affects the frequency of parasitism. Besides, since average temperature in the study area increases gradually from a minimum of 10.5 °C in January to maxima of 26.2 °C and 26.5 °C in July and August, respectively, and adult cuckoos leave the area and are not seen at all by the middle of July, we cannot ignore the possibility that they leave when the temperature is high. The overall impression, considering that the Guadalquivir valley, where the study area is located, is the hottest region of the Iberian peninsula (Lautensach 1967), is that, although indirectly, temperature may greatly affect the Cuckoo and/or the Rufus Bush Chat, as well as the relationship between the two species.

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Selostus: **Isäntälajin tiheys vaikuttaa käen loisinnan kohteeksi joutuvien pesien määrään**

Käen loisimien isäntälajien pesien määrä voi paikallisella tasolla vaihdella huomattavastikin eri vuosina. On esitetty, että käki voisi loisia isäntälajiaan vain sellaisilla alueilla, joilla isäntälaji esiintyy runsaana. Väittämä ei ole saanut tukea kaikista tehdyistä tutkimuksista. Artikkelin kirjoittaja tutki, kuinka käen loisinta vaikutti ruostepyrstön pesintään Espanjassa vuosina 1992–1993 ja 1995–2001. Kirjoittaja vertaili käen loisinta-asteen, isäntälajin tiheyden ja pesinnän aloitusajankohdan sekä säätilan välisiä suhteita. Tutkimuksessa mukana olleista ruostepyrstön pesistä loisinnan kohteeksi joutui 11.8%. Loisinta-aste vaihteli vuosien välillä 0%–28 %. Isäntälajin tiheyden kasvaessa kasvoi myös käen loisinta-aste. Lämpötilan alenemisen myötä loisinta-aste laski. Toisaalta alhaiset lämpötilat vaikuttivat negatiivisesti myös ruostepyrstöjen määrään. Yksityiskohtaisemmat analyysit osoittivat, ettei lämpötilalla ollut suoraa vaikutusta ruostepyrstön tiheyden ja loisinta-asteen väliseen suhteeseen. Ruostepyrstön muninnan aloituspäivämäärällä tai sademäärällä ei havaittu olevan vaikutusta loisinta-asteeseen. Tulokset viittaavat siihen, että käki hyötyisi isäntälajin suuresta tiheydestä.

References

Alvarez, F. 1993: Proximity of trees facilitates parasitism by Common Cuckoo Cuculus canorus on Rufous Bush Warblers Cercotrichas galactotes. — Ibis 135: 331.

Alvarez, F. 1994: A gens of Cuckoo Cuculus canorus parasitizing Rufous Bush Chat Cercotrichas galactotes. — J. Avian Biol. 25: 239–243.

Alvarez, F. & Arias de Reyna, L. 1974: Mecanismos de parasitación por Clamator glandarius y defensa por Pica pica. — Doñana, Acta Vert. 1: 43–65.

Clarke, A. L., Øien, I. J., Honza, M. Moksnes, A. & Røskaft, E. 2001: Factors affecting Reed Warbler risk of brood parasitism by the Common Cuckoo. — Auk 118: 534–538.

Clotfelter, E. D. & Yasukawa, K. 1999: The effect of aggregated nesting on Red-winged Blackbird nest success and brood parasitism by Brown-headed Cowbirds. — Condor 101: 729–736.

Davies, N. B. 2000: Cuckoos, cowbirds and other cheats. — Poyser, London. 310 pp.

Johnsgard, P. A. 1997: The avian brood parasites. — Oxford Univ. Press, Oxford. 409 pp.

Lack, D. 1963: Cuckoo hosts in England. — Bird Study 10: 185–201.

Lautensach, H. 1967: Geografía de España y Portugal. — Vicens Vives, Barcelona. 814 pp.

Lindholm, A. K. 1999: Brood parasitism by the cuckoo on patchy reed warbler populations in Britain. — J. Anim. Ecol. 68: 293–309.

Moskát, C. & Honza, M. 2000: Effect of nest and nest site characteristics on the risk of cuckoo Cuculus canorus parasitism in the great reed warbler Acrocephalus arundinaceus. - Ecography 23: 335–341.

Øien, I. J., Honza, M., Moksnes, A. & Røskaft, E. 1996: The risk of parasitism in relation to the distance from reed warbler nests to cuckoo perches. — J. Anim. Ecol. 65: 147–153.

Palomino, J. J., Martín-Vivaldi, M. & Soler, M. 1998: Early arrival is not advantageous for Rufous Bush-Robins parasitized by Common Cuckoos. — Auk 115: 235–239.

Rothstein, S. I. 1990: A model system for coevolution: avian brood parasitism. — Annu. Rev. Ecol. Syst. 21: 481–508.

Rutila, J., Latja, R. & Koskela, K. 2002: The common cuckoo Cuculus canorus and its cavity nesting host, the redstart Phoenicurus phoenicurus: a peculiar cuckoo-host system? — J. Avian Biol. 33: 414–419.

Siegel, S. & Castellan, N. J. 1988: Nonparametric statistics for the behavioral sciences. — McGraw-Hill, New York. 399 pp.

Soler, M., Soler, J. J., Martínez, J. G., Pérez-Contreras, T. & Møller, A. P. 1998: Micro-evolutionary change and population dynamics of a brood parasite and its primary host: the intermittent arms race hypothesis. — Oecologia 117: 381–390.

Strausberger, M. M. 2001: The relationship of habitat and spatial distribution of nests with Brown-headed Cowbird parasitism of Red-winged Blackbirds. — Wilson Bull. 113: 129–133.

Wyllie, I. 1981: The cuckoo. — Batsford, London. 176 pp.