Among the Cuculidae, the non-parasitic species and those that parasitize hosts of similar body size (*Clamator*, *Scythrops* and several species of *Eudynamis*, Johnsgard 1997) do not show reduction of egg size. The other cuckoos, which parasitize much smaller hosts, lay very small eggs in relation to their body size (Rahn *et al.* 1975; Wylie 1981). Egg shape in the parasitic Cuculidae varies from more rounded than the hosts’ and the non-parasitic cuckoos’ eggs in *Clamator* cuckoos, to more elongated in *Cuculus*, *Cacomantis* and *Chrysococcyx* cuckoos (Brooker & Brooker 1991).

In the Common Cuckoo egg weight is only 2.4 per cent of the weight of the adult (Lack 1968), apparently smaller than any other bird of similar size. The egg size of the different gentes correlates positively with those of their hosts (Moksnes & Røskaft 1995). No information is available on the relationship between the egg shape of the Cuckoo and its hosts at the individual level. Egg shape in the case of the Cuckoo could be affected by at least two selective forces: 1) selection for increased egg strength would favour more spherical shape, and 2) selection for incubation efficacy would favour shape optimizing heat transfer to the egg, as suggested by the results of Janiga (1996, 1997) relative to egg shape variation of feral pigeons *Columba livia* with latitude and climatic or local weather conditions.

Since more spherical eggs are more puncture-resistant (Hoy & Ottow 1964; Picman 1989), according to hypothesis 1 we would expect them in Cuckoo gentes where hosts usually practise puncture-egg-rejection. Since larger eggs would be structurally weaker, if subject to puncture-rejection they would be expected to be more rounded. Although bird eggs show tolerance to a wide temperature range (specially to unprolonged hypothermia), it appears that embryonic survival during natural incubation may be limited by heat transfer to the egg (Webb 1987). According to this and to hypothesis 2 (incubation efficacy), Cuckoo eggs in need to accommodate to the conditions of the host’s nest should adjust their shape to the requirements of heat transfer. If egg size of a giv-
Cuckoo gens would vary from smaller to larger than the accompanying host’s eggs in the clutch, we would expect larger Cuckoo eggs to show greater elongation (thus increasing heat transfer from the female through their relatively larger surface) and smaller eggs to be more rounded (i.e., with reduced heat transfer).

In the present study I tested the hypotheses of increased egg strength and incubation efficacy explaining the relationship between egg shape and size of a population of Cuckoos parasitising Rufous Bush Chats Cercotrichas galactotes. Egg measures of Cuckoo and host in southern Spain were obtained near Seville, where length and breadth (maximum diameter) of 194 Rufous Bush Chat eggs (one egg chosen at random per nest) and of 39 Cuckoo eggs were measured to the nearest 0.01 mm over a period of 9 years (1992-2000). For each egg the value of elongation (length/breadth) was obtained. All eggs were weighed to the nearest 0.01 g with a portable precision balance. The clutches containing the eggs measured were in the phases of egg-laying or early incubation. Egg volume was estimated by applying Hoyt’s (1979) technique.

Although there is considerable overlap in the egg dimensions, Cuckoo eggs showed similar values for length, higher values for breadth, and lower elongation than the host’s, and were on average larger and heavier (Table 1). Neither egg weight nor elongation were affected by the year of study (Rufous Bush Chat: $n = 194$; $F = 1.05$, $P = 0.344$; $F = 1.13$, $P = 0.397$; Cuckoo: $n = 39$; $F = 0.94$, $P = 0.451$; $F = 1.83$, $P = 0.147$; one-way ANOVA). Comparison of elongation with weight and estimated volume showed no relationship for Rufous Bush Chat eggs (with weight: $R = 0.05$, $n = 194$, $P = 0.492$; with volume: $R = 0.26$, $n = 194$, $P = 0.719$; Spearman rank correlation test), and a significant positive one for Cuckoo eggs (with weight: $R = 0.50$, $n = 39$, $P = 0.001$; with volume: $R = 0.56$, $n = 39$, $P < 0.001$) (Fig. 1). That is, for Cuckoos parasitising Rufous Bush Chats, the larger and heavier their eggs the more elongated they are.

Of the two variables contributing to Cuckoo egg shape, weight is more strongly correlated with length than with breadth (with length: $R = 0.78$; with breadth: $R = 0.65$; $n = 39$, $P < 0.005$ in both cases). Length and breadth were positively correlated in both the Cuckoo’s ($R = 0.41$, $n = 39$, $P = 0.009$) and host’s eggs ($R = 0.33$, $n = 194$, $P < 0.001$). The average estimated egg volume of southern Spanish Cuckoos (2.96 ml) falls in the lowest eighth of the range of values for West European Cuckoo gentes (2.89-3.32 ml), which would be expected according to the small body size of the Cuckoo subspecies from Iberia (Cramp & Simmons 1985), its average egg elongation (1.32) is lower than the corresponding range of values (1.34-1.42, as obtained from egg measures in Wyllie 1981).

Data on Cuckoo’s and host’s egg features affect the predictions of the propounded hypotheses in the following way: Concerning selection for puncture resistance, and taking into account that female Rufous Bush Chats (Palomino et al. 1998) reject Cuckoo eggs mainly by nest desertion, and apparently do not damage the shell of the few ejected eggs (Alvarez 1996), we should not expect larger Cuckoo eggs to be more spherical than smaller ones, as it is the case for the studied population.
In relation to selection for incubation efficacy, the positive relationship between Cuckoo egg size and elongation confirms the expectation of increased and decreased heat transfer from the female, respectively to the larger and more elongated and the smaller and more spherical Cuckoo eggs. In conclusion, Cuckoo egg shape variation in relation to egg size is probably adaptive, its significance lying in incubation, and resulting from a selecting force favouring optimisation of heat transfer from the female to the egg during incubation.

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De eieren van Koekoeken Cuculus canorus die in Zuid-Spanje hun eieren leggen in nesten van Rosse Waaierspaarden Cercotrichas galactotes worden naar verhouding langgerekt naarmate ze groter zijn. Dit is gunstig voor de warmteoverdracht tijdens het broeden, maar zou ongunstig zijn indien de waardvogel koekoekseieren zou aanpakken en vervolgens uit het nest zou verwijderen. Dat laatste doen Rosse Waaierspaarden echter niet; een eventuele reactie op de verschijning van een koekoeksei in het nest bestaat uit nestdesertie, niet uit gaatje-pikken. In de wapenwedloop tussen Koekoek en waardvogel bestaat in dit geval dus geen selectiedruk op het produceren van stevige, rondere eieren door Koekoeken die zijn gespecialiseerd op Rosse Waaierspaarden.

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