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Egg size variability between clutches of Choughs (*Pyrrhocorax pyrrhocorax*)

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Abstract - The main sources of egg-size variability at interclutch level (clutch size and female) have been analyzed for 57 pairs of Choughs breeding at the Ebro Valley (Monegros) area in 1992. Egg-size variability is not affected by clutch size variation (4,5 and 6 eggs), whereas it is influenced by female characteristics. These results are discussed in relation to the findings in other birds, particularly Corvidae, and a final hypothesis, taking into account the existence of sexual dimorphism and courtship feeding behaviour in these birds, is emitted to explain them.

Introduction

The Chough (*Pyrrhocorax pyrrhocorax*) is a widely distributed bird, ranging from European Atlantic coasts to the Himalayas (Coombs 1978). Although accurate data on changes in breeding pair densities are only available from the British Isles (Rolfe 1966, Bullock et al. 1983, Warnes 1983, Bignal and Curtis 1988). there is general agreement about its population decline in Europe during the last two centuries (Guillou 1981, Owen 1988). At present, reduced populations are scattered throughout its range and, because of this, the Chough has been included among the species of wild birds requiring maximum protection (Easterbee and Bignal 1988). Therefore, data on their breeding biology and ecology are relevant to ensure suitable conservation policies. Data on breeding parameters of Choughs are very scarce, mainly due to low breeding densities and the difficulties in reaching their nesting sites, though some studies are available for the British Isles (Bignal et al. 1987).

In the Iberian Peninsula, there are still some areas with large populations of Choughs (Soler 1988; Blanco et al. 1991) and, in some cases, with easily accessible nests (Tella and Torre 1993), but their breeding biology still remains poorly known.

Among reproductive parameters, egg size has been recognized as a relevant factor in determining hatchling size (Rofstad and Sandvik 1987) and chick growth and survival in quite different bird groups (Parsons 1970; Schifferli 1973; Ricklefs et al. 1978; Slagsvold *et al.* 1984). So, even though it has not yet been investigated in Choughs, we assume that egg-size differences have potential relevancy to analyze breeding success variability among pairs also in this species. Furthermore, it will be of great interest for conservation strategies, to know whether such potentially influential reproductive parameters depend mainly on pair or territory characteristics.

Material and Methods

Data were collected during the breeding season of 1992 from Choughs nesting in abandoned buildings from the Ebro Valley (Northeast Spain), where there is a large population of such birds (Tella and Torre 1993).

Fiftyseven pairs of Choughs were monitored during this study. Nest visits were distributed during the breeding season to determine clutch size and breeding success (number of hatched eggs, number of fledged chicks). All nests containing eggs were visited at least twice since egg laying had started. There was an interval of 10 days between such visits and when final clutch size was recorded. No more than 15 min. was spent in each visit, and possible undesirable effects were monitored by recording the time elapsed before the female returned to the nest. This was generally short (range 7-34 min.).

In a total of 2910 egg-days of exposure the loss of only one egg was recorded, so it was assumed that

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egg loss was very low during this season; and that clutch sizes reported would closely correspond to the eggs actually laid.

All the eggs were marked with a felt-tip pen and their length and breadth were measured with a digital caliper (± 0.1 mm). Since Chough eggs have a typical ellipsoid shape, their external volume was estimated using Hoyt's (1979) volume constant Kv.= 0.509 to egg length x breadth^2. Since our methodological approach did not allow the obtention of freshly laid eggs, egg weight was not measured because of its variation along the incubation period (Rahn and Ar 1974).

To test for egg size differences among females (i.e. breeding pairs) and clutch sizes, a hierarchical analysis of variance on egg size parameters, with clutch size as a fixed effect and including breeding pairs as nested random effect, was undertaken using those clutch sizes with sufficient sample size, namely 9 clutches of four, 28 of five and 17 of six eggs (n=54). Normality of distributions was assessed through inspection of normal plots and departures from homoscedasticity using Box-M test.

Results

In Table 1 descriptive statistics corresponding to a case egg (n=291) approach are given. These 291 eggs were distributed in five different clutch sizes (2 of three eggs, 9 of four, 28 of five, 17 of six and 1 of seven eggs). The modal clutch size was five eggs and the mean clutch size 5.10 (s.d. 0.82). In Table 2 we give statistics corresponding to the case-nest approach (n=54).

Results obtained from the nested analysis of variance performed on these clutches indicate that, while a relevant nest effect was detected for egg size variability (Vol.: $F_{51,224} = 18.03$, $p < 0.001$), no significant egg-size effect was found linked to clutch size (Vol.:$F_{2,51} = 0.32$, $p= 0.731$). Nest differences in egg-size estimated through volume were the result of significant nest differences arising both from egg length ($F_{51,224} = 16.01$, $p < 0.001$) and breadth ($F_{51,224} = 10.56$, $p< 0.001$). Neither egg length nor breadth showed clutch-size related significant effects.

Discussion

Interclutch variability in egg size is an outcome of various interactions between parental quality and ecological conditions (Birkhead 1991), but there is general agreement that female phenotype might explain a large amount of this interclutch variability (see Jover *et al.* 1993 and references therein).

There is evidence that clutch size and egg size are inversely related when comparisons are performed at the across species level (Blackburn 1991); at within species level, however, the existence of such a trade-off between these variables is not so clear.

Some authors have found positive relationships between clutch size and egg size (Coulson 1963, Ojanen *et al.* 1978) while in other cases the relationship found was the opposite (Myrberget 1977, Ojanen *et al.* 1978) or did not appear at all (Pikula 1971, Bryant 1975, Ojanen *et al.* 1978). Especially relevant is the case reported by Järvinen and Väisänen (1983) working with three different populations of Pied Flycatchers (*Ficedula hypoleuca*) in Finland, where they found all three trends, attributing differences to female quality and habitat conditions. Potti (1993), working with Pied Flycatchers has found that egg size tends to increase from clutches of four- to five-eggs and to diminish from those of five- to six- and seven-eggs, suggesting the existence of a trade-off between clutch-size and egg-size, but only detectable under stringent ecological conditions (Lindén and Möller 1989). In any case, at within species level it is clear that female condition and other ecological and life history constraints might produce significant deviations from this pattern (Blackburn 1991, Potti 1993).

Working with Magpies in Sweden, Högsted (1980, 1981) attributes the variation in clutch size observed in his studies, mainly to differences in food supply (i.e. territory quality). However, these results do not agree with those reported by Goodburn (1991) for Magpies in England, who found that female quality is the main factor explaining both clutch and egg size variation. Discrepancies between such studies are attributed by Goodburn (1991) to a greater degree of variability in territory quality, enhanced by the

Table 1 - Measures in mm and volume in ml for n=291 Chough eggs from the Ebro Valley in 1992.

	Mean	Std.dev	Min	Max
Lenght	40.71	1.66	35.98	45.37
Breadth	27.77	0.69	25.62	29.66
Volume	15.99	1.11	12.49	19.46

Table 2 - Measures (mm) and volume (ml) of Chough eggs grouped by nest and accounting for the Global values and the three main clutch sizes (4,5 and 6) at the Ebro Valley area in 1992. A total of 54 clutches are included (9 of four eggs, 28 of five and 17 of six).

	C-S	Mean	Std.dev	Min	Max
Lenght					
	G	40.71	1.45	37.03	44.81
	4	40.36	1.12	38.45	41.73
	5	40.91	1.24	38.57	43.14
	6	40.57	1.90	37.03	44.81
Breadth					
	G	27.74	0.58	26.29	28.90
	4	27.63	0.57	26.99	28.35
	5	27.74	0.65	26.29	28.90
	6	27.80	0.49	27.15	28.85
Volume					
	G	15.96	0.97	13.78	18.98
	4	15.69	0.80	14.91	17.09
	5	16.03	0.87	13.78	17.90
	6	15.98	1.21	14.09	18.98

existence of more frequent territory vacancies, in Högsted's studies.

This would suggest that female effects on clutch size could be overcome only when differences among territories are large enough. If this is so, our results might indicate that, in our study area and in this breeding season, Choughs occupy rather similar quality territories and, then, differences in clutch size stated should come, mainly, from differences in the breeding pair quality.

Since, as occurs in Magpies, in Choughs the larger male parent (Tella and Torre 1993) provides food for the female during the laying and incubation periods and for both the female and their brood during the early stages of brooding period (Easterbee and Bignal 1988), differences in the breeding parameters, other than those which are primarily linked to female phenotype, as occurs with egg size (Van Noordwijk *et al.* 1981; Birkhead 1991; Jover *et al.* 1993) or shape (Bignal, pers.com.), could be better explained by male characteristics and their interaction with the female ones. This would suggest that the different cluth sizes reported are due to differential abilities of males to provision their females, chiefly during the rapid follicular growth period of egg formation (Walsberg 1983).

Further long term studies including repeatibility among pairs and territories are needed to evaluate properly their influency in egg-size and the relationship of this trait to lifetime breeding success of Choughs.

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Riassunto - Per 57 coppie di Gracchi corallini nidificanti nella valle dell'Ebro (Spagna) nel 1992, è stata analizzata la variabilità dimensionale delle uova deposte, ponendola in relazione alla dimensione della covata. Le dimensioni delle uova non sono risultate essere significativamente influenzate dal numero di uova deposte per coppia (4-5-6 uova). Le caratteristiche della femmina sono probabilmente il fattore che maggiormente influenza la variabilita nella dimensione delle uova in questi corvidi.

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