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Short communications

Differences in reproductive performance between two colonies of egrets in two areas with different human influence

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Cattle (*Bubulcus ibis*) and Little Egrets (*Egretta garzetta*) differ in their habitats preferences. Cattle Egret is strongly related to terrestrial habitats, mainly cultivated (Voisin 1991, Farinha and Leitao 1996) and may even forage into rubbish dumps (Burger and Gochfeld 1990, Gómez-Tejedor and de Lope 1993), while the Little Egret is mainly aquatic, being related to rice fields in some areas (Hafner and Fasola 1992). However, in Badajoz province the Little Egret seems not to have relation with irrigated lands or rice fields (Parejo and Sánchez 1999).

In the Middle Basin of the Guadiana river (Extremadura, southwestern Spain), Cattle Egrets have increased in numbers, while there is no trend for Little Egrets. The increase in the Cattle Egret population has been interpreted as the response of the species to the development of an ambitious irrigation plan (Plan Badajoz) that brought about the transformation of a large part of the traditional areas (Parejo and Sánchez 1999). In this sense, the Cattle Egret range expansion is attributed to widespread habitat alteration (Bock and Lepthien 1976, Myers 1979) and to the recent colonization of rubbish dumps as feeding areas (Franchimont 1986). In this context, we examine the hypothesis that habitat transformations will affect differently the reproductive success of the two species, Cattle and Little Egret. In order to do so, we compare the reproduction of these two species in two localities with different degrees of human alteration.

During the 1997 breeding season we studied two mixed colonies, one situated on the Guadiana river in Badajoz city (38°53'N-6°58'E) (henceforth: Badajoz) and the other situated on the border of an artificial pond 30.9 km away from the former colony (39°03'N-6°41'E) (henceforth: Morante). In Badajoz, the breeding population was 1,000 pairs of Cattle Egrets and 95 pairs of Little Egrets, while in Morante there were 550 pairs of Cattle Egrets and 20 pairs of Little Egrets.

The Badajoz colony is within the Badajoz city, which has 129,451 human inhabitants that produce around 50,000 tons of rubbish per year, what is equivalent to an estimated 1,449.5 tons of available garbage for birds to feed (Gómez-Tejedor 1992). This refuse is dumped on a surface of 2 ha, 14 km south of the city limits. The Morante colony is located 7 km from the nearest small village (1,638 inhabitants) that produces only 632.67 tons of rubbish per year (18.34 tons per year of available garbage) (Gómez-Tejedor 1992).

To characterise the available habitat for egrets feeding, we obtained the surface of each land use in a 10 km radius around each colony, considering this area as the most intensely used by the herons foraging from their colony (Hafner and Fasola 1992). We used an image analyser (Videoplan System) to quantify the different land use surfaces on maps (scale 1:50,000) of agricultural uses, identifying the following types of habitats: freshwater marshes, irrigation crops, intensive and extensive cultivation, pasture lands and shrublands (extensive and intensive cultivation and pasture lands may or may not have trees), dry farming with olives/vines, reforestation, and others (including cities, roads, etc.). The results are shown in Table 1 and characterise the extreme degree of transformation of the environment, the area around Badajoz heronry being a periurban zone where agriculture is intense, and the area around Morante heronry a semi-natural area where there are great surfaces of wooded with holm-oaks and no irrigated crops.

Before birds settlement, we installed in colonies wooden stakes of known height to use them as references of distance. We made large scale photographs of the study areas where nests were placed when they were been constructed. By means of this, nests could be individually identified from out of colonies and birds were left undisturbed. Thereafter, we visited the colonies once a week and observed them from the same place that we had

Table 1. Proportion of the surface of the two study areas devoted to each land use. Land uses are grouped in relation to the intensity of exploitation, being more intensive when all original trees (*Quercus ilex and Q. suber*) have been removed. When original trees remained, the percentage of the surface with this characteristic is shown in brackets.

	Intensive land uses				Extensive land uses			
Colonies	Irrigated crops	Reafforestations	Others	Dry crops (Vines/Olives)	Intensive crops	Extensive crops	Pasture lands-Shrublands	Freshwater habitat
Badajoz	31.1	6.04	6.3	3.1	25.1 (10.4)	6.9 (77.8)	18.7 (66.5)	2.55
Morante	0.1	1.6	0.89	13.21	24.9 (23.1)	18.7 (100)	40.1 (100)	0.31

taken the photographs. We only considered those nests that had hatchlings the first time that we observed chicks in them (the experience of observers and the descriptions of Cramp and Simmons (1977) permitted it). The date of laying for each nest was then estimated by subtracting the mean incubation period (Voisin 1991) of the species from these observed hatching dates, taking into account the mean interval between the laying of two eggs in both species (2 days, Voisin 1991). We followed only successful nests, i. e. where at least a chick hatched. We recorded: a) number of hatchlings per controlled nest; b) number of fledglings per controlled nest (we considered that a chick fledged when it survived until 20-25 days old. At about 30 days chicks are able to fly (Voisin 1991) and a whole brood is not necessarily being fed on the same tree); c) mortality rate as the percentage of the total number of chicks hatched per controlled nest that did not fledge, assuming that a chick died when it was not in the nest the last day that we observed their family group.

We assumed that, owing to the proximity of the two studied colonies, the weather conditions would not influence differently the studied reproductive parameters in both localities.

Because of the existence of a prolonged distribution of nesting attempts in the Badajoz colony (see below) we divided the breeding birds in relation to localities and laying dates, obtaining three groups of breeders from the two colonies. By doing this, the effect of other factors on reproduction can be made independent of the inter-population differences caused by the laying dates. Non-parametric statistical tests were used because samples did not fit to normality assumptions (Kolmogorov-Smirnov test) and could not be transformed to satisfy those requirements.

In the Badajoz colony the laying pattern of Cattle Egret was longer than in Morante colony with an early peak at the beginning of April and a late peak in the middle of June, which corresponds to birds that occupy the abandoned nests of early breeders (own obs.). The groups were determined by the results showed in Fig. 1, where there is a separation on the interval between 12 May and 31 May (the mean day of the interval is 20 May). Birds from Morante had only one laying peak that coincided with the early peak of Badajoz (Fig. 1). The median laying date in Badajoz was 14 April and on Morante 6 April. The median

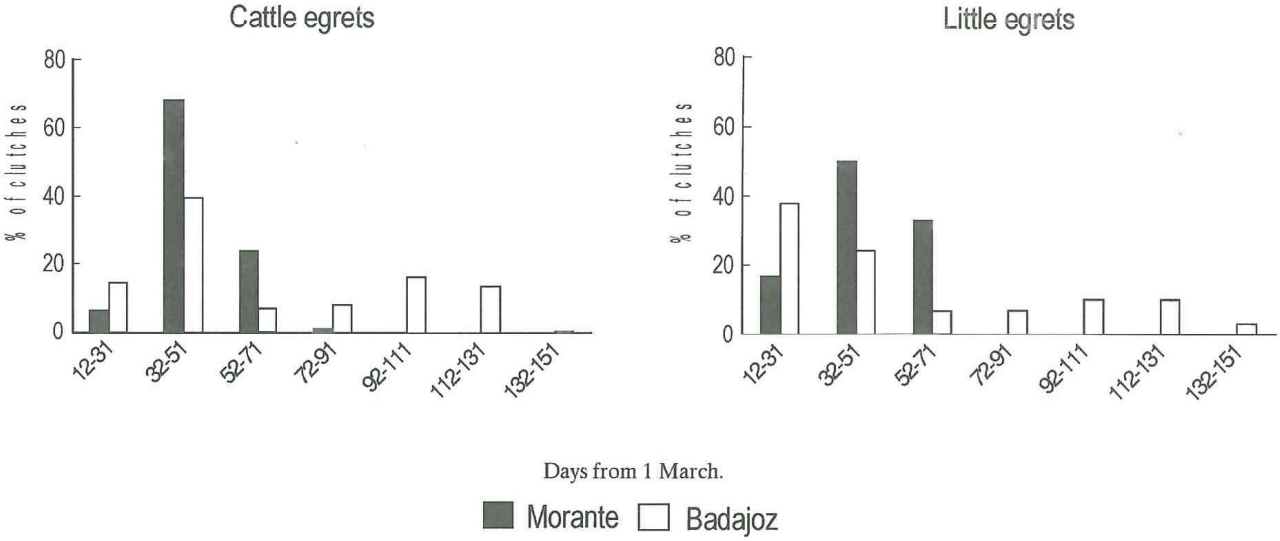

Fig. 1. Laying date distribution for Cattle and Little Egrets (grouped in 20-day periods).

laying dates varied greatly between areas (Mann-Whitney test: U=12658, n1=182, n2=113, p=0.001), although the median laying dates of the early birds in Badajoz and birds in Morante coincided (Mann-Whitney test: U=6330, n1=126, n2=113, p=0.14) (Table 2).

In Little Egret, laying followed a similar pattern, with a more prolonged distribution in Badajoz (the early peak in the second fortnight of March and the late peak between the end of June and the beginning of July) and a single peak of laying in Morante with coincided with the first of Badajoz (Fig. 1).

For this species the median laying date in Badajoz was 5 April and on Morante 3 April. The median laying dates were not different between both localities (Mann-Whitney test: U=77, n1=29, n2=6, p=0.66).

The number of hatchlings per nest of Cattle Egret differed across the three defined groups (Table 2), though there were no differences between paired groups (Scheffé test: p>0.05 in all cases) (Table 2). As regards the number of fledglings per successful nest of Cattle Egret, there were differences between the three groups of breeders (Table 2), the value being higher for early birds of Badajoz than for Morante birds (Scheffé test: p<0.01). There were no differences between late breeders of Badajoz and Morante (Scheffé test: p>0.05), or between Badajoz breeders (Scheffé test: p>0.05). In relation to the mortality rate of Cattle Egrets, this reproductive rate did not vary across groups (Table 2).

In relation to Little Egrets, there were no significant differences between the three groups either for the mean number of hatchlings per nest, for the number of fledglings per successful nest, or for the mortality rate (Table 3).

The range of breeding period is longer in Badajoz for both species, what could be related with the existence of more stable food conditions in this location. In the case of Cattle Egret, agriculture areas and manmade habitats make possible for the birds to breed during a longer period, not only during the time that insects are abundant. The explanation for Little Egret, taking into account that is a specialist predator of aquatic prey (Voisin 1991), could be related with the existence of a higher surface of freshwater, as has been shown in other areas (Farinha and Leitao 1996, Hafner and Fasola 1992). In the other hand, the loss of water protection around a colony has been shown as an important factor in the desertion of colonies, as a way to avoid predation (Perennou *et al.* 1996). This fact could explain the different extension of the breeding period in the two colonies because Morante has as a constraint that is on trees that lose their water protection in a certain time in the season, while the Badajoz colony is situated on isolated islands all year.

There were significant differences in the production of young Cattle Egrets in the two types of habitats, with a mean production of 2.0 fledglings per successful pair in the Badajoz colony, compared with only 1.7 fledglings per successful pair in the

Table 2. Mean values of laying dates and mean standard deviation of reproductive parameters in the three groups of breeders of Cattle Egrets. Dates are shown as number of days from 1 January on. Sample sizes are given in brackets. At the end of the table the values of Kruskall-Wallis tests are given.

Breeding birds	Laying date	Hatchlings/nest	Fledgings/nest	Mortality rate/nest
Early breeders in Badajoz	101.4±18.9 (126)	2.2±0.6 (77)	2.1±0.7 (77)	7.4±20.3 (77)
Late Breeders in Badajoz	170.5±11.1 (56)	2.1±0.7 (39)	1.9±0.8 (39)	9.8±21.9 (39)
Breeders in Morante	101.1±12.8 (113)	2.0±0.6 (140)	1.7±0.6 (140)	12.5±22.6 (140)
Test		H = 6.4	H = 14.9	H = 3.62
p		< 0.05	= 0.001	> 0.05

Table 3. Mean values of laying dates and mean standard deviation of reproductive parameters in the three groups of breeders of Little Egrets. Dates are shown as number of days from 1 January on. Sample sizes are given in brackets. At the end of the table the values of Kruskall-Wallis tests are given.

Breeding birds	Laying date	Hatchlings/nest	Fledglings/nest	Mortality rate/nest
Early breeders in Badajoz	99.1 ± 20.7 (22)	2.5 ± 1.3 (14)	1.9 ± 1.2 (14)	22.1 ± 38.5 (14)
Late Breeders in Badajoz	172.1 ± 11.8 (7)	2.6 ± 1.0 (7)	2.6 ± 1.0 (7)	0 (7)
Breeders in Morante	103.5 ± 19.2 (6)	2.3 ± 0.8 (7)	2.0 ± 1.0 (7)	19.0 ± 37.8 (7)
Test		H = 0.27	H = 1.9	H = 2.4
p		= 0.87	= 0.38	= 0.30

Morante colony. The most probable explanation for this is a higher availability of food for this species on the less natural habitat due to the intensive cultivation and irrigated areas, which have been previously shown to be very important for breeding population of herons (Fasola *et al.* 1981, Fasola and Ruiz 1996). During the previous months to reproduction Cattle Egrets have been reported feeding on great numbers in the rubbish dump of Badajoz city, showing that this area has great importance for the species during the non-breeding period (Gómez-Tejedor and de Lope 1993). The existence of this place with supplementary food could cause a better condition of females during the pre-laying period and so an increase in the breeding success, as has been hypothesised by other authors (see Martin 1987 and references therein). However, we can not separate the effect of habitat from the effects of other potential factors because only two colonies have been investigated.

There were no differences in the reproductive success between early and late breeders Cattle Egrets in Badajoz colony, what makes stronger the hypothesis about the good food conditions in Badajoz, because seasonal declines in breeding performance have usually been attributed to a deterioration in feeding conditions during the breeding season (Lack 1966) or to differences in quality between individuals (Arnold *et al.* 1991), and in this colony late breeders get the same reproductive benefits than the earlier ones in spite of the constraints of the depletion of food or the inexperience, youth or physical conditions.

In relation to Little Egrets there are no differences in breeding performance between localities, what allows us to say that both habitats give the same advantages to this species, though these results could be given by the small sample size for the species.

To summarise, the agricultural development seems to benefit Cattle Egrets reproduction while other factors not controlled here seem to influence Little Egrets reproduction.

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