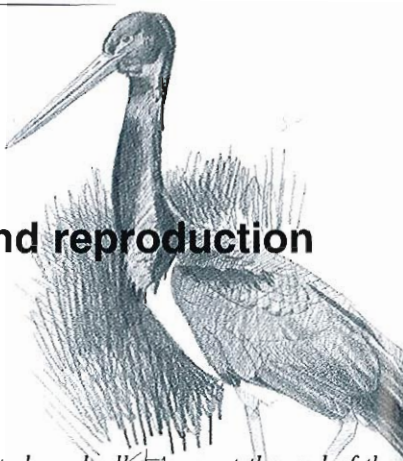
Aves, 40 (1-4) 2003 : 38 - 44

The Black Stork (*Ciconia nigra*) in Madrid region : status, population changes and reproduction



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ABSTRACT - *The population of Black Stork has augmented gradually since, at the end of the 1980s, its reproduction in the area was observed, increasing from 2 pairs in 1992, to 12 in 2000. 38.46 % out of 65 confirmed attempts of reproduction were carried out on rock, and 61.54 % on trees; we observed inter-species competition for the occupation of Black Stork nests on rock, by Griffon Vulture. The reproductive period of Black Stork in Madrid region ranges from the first week of March, when the laying of the first pairs begins, until the end of August, when the last young fly. Predominantly, it occupies woodlands as nesting areas, in supramediterranean bioclimatic layers (higher altitude, lower temperatures) as well as in mesomediterranean layers (lower altitude, milder temperatures) The pairs in the mesomediterranean zone mainly select the month of March for their laying, though they may also use the month of April, while the layings of pairs breeding in the supramediterranean layer are more concentrated in time, in April. Neither the date of the laying nor the bioclimatic zone is related to a higher breeding success, the pairs just adapt themselves to the environmental conditions to carry out their laying. During these 10 years there was a mean of 77.66 % productive pairs; 168 young were born, 3 being the most frequent number of young born to a pair. The mean productivity during this period was of 2.32 flown young / stable pair, the reproductive success being 2.53 young able to fly / breeding pair, and the fledging rate of 2.98 young / number of pairs that managed to make their young fly. These data are superior to those from other areas of the Iberian Peninsula. Because of these reproduction parameters, we come to the conclusion that the Black Stork population of the region will stay stable in the next years.*

Introduction

The Black Stork (*Ciconia nigra*) is one of 15 species of birds catalogued as being in danger of extinction in Spain, and is also catalogued as such in the Autonomous Community of Madrid.

The presence of the Black Stork in the region as a breeding species is fairly recent. In the first half of the 1980s, the species was not recorded in Madrid region (DE VIEDMA, 1983), and it was not until the end of that decade that it was mentioned for the first time (PARRA, 1988), even going unnoticed during the national survey of the Black Stork carried out in 1987 (GONZÁLEZ & MERINO, 1988). The special significance of Madrid lies in the fact that it is precisely in this territory that the species has its eastern limit of distribution in the Iberian Peninsula, so that the Iberian population may expand or contract depending on its evolution in this area. Another difference for this population with regard to other areas of the Iberian Peninsula is its location in an environment with a very high human pressure (density of population: 634 inhab./km^2; population: 5.091.336 inhabitants in 7995 km^2, in 1998); together with the extensively urbanized milieu, this renders the situation of the Black

Stork in Madrid very delicate.

In 1992, the Consejería de Medio Ambiente (Ministry of the Environment of the regional government) began to order annual surveys uninterruptedly, thus generating continuous information about Black Stork evolution in the region. In this paper we present the official data obtained during the period 1992-2001 by the Consejería de Medio Ambiente of the Comunidad de Madrid (Regional Government of Madrid).

Materials and Methods

The census of nesting pairs was based on active prospection in areas that seemed favourable for the breeding of Black Storks, based on an optimal knowledge of the area of study and of the habits of the species (FULLER & MOSHER, 1981), and was realized by a team of specialists consisting of a minimum of two people in the period between the months of March and July, in the years 1992-2001. The monitoring of breeding was realized by periodical observations of the nests from observation points hidden between 300 and 500 metres away from them, using telescopes of 20x-60x for observation. This allowed monitoring the incubation and development of the young birds as well as the period of emancipation. In the majority of cases, at least one visit per month to each nest was ensured; however, nests in vulnerable locations were subject to special monitoring, i.e. they were monitored on a daily basis or every weekend, depending on how serious the disturbances were for the affected pairs.

We have considered a pair to be stable when it can be assigned to a nest which it occupies during the breeding period; a breeding pair is a stable pair that achieved to lay eggs, independently of the success of its breeding attempt; finally, a productive pair is one that managed to make at least one of their young fly. For every year of follow-up, we have recorded the following breeding parameters:

Number of stable pairs.
Number of breeding pairs.
Percentage of breeding pairs: number of breeding pairs / stable pairs x 100.
Number of productive pairs.
Percentage of productive pairs: number of productive pairs / stable pairs x 100.
Number of young born by breeding pair.
Number of young that managed to fly.
Productivity: number of flying young / total number of stable pairs.
Reproductive success: number of flying pairs / number of breeding pairs.
Fledging rate: number of flying young / number of pairs that managed to make their young fly.
Furthermore, we recorded the nesting substratum (rock or tree).

Variation analysis have been carried out to explore the differences of the dependent variable "number of young", depending on the month and the climatic layer in which the egg laying was made. The dependent variable was transformed by the Box-Cox transformation to observe the parametricity assumptions. (SOKAL & ROHLF, 1981; STATSOFT, 1996).

Results

Nest site

The nesting population of the Black Stork occupies a broad strip of land that stretches from northeast to southwest across the Madrid region, occupying preferably woodlands between 580 and 1160 metres close to dams, rivers or streams, in two different bioclimatic layers: mesomediterranean (more temperate, occupying the flatter parts of the Madrid region) and supramediterranean (colder, occupying part of Madrid's mountain range).

Out of the 65 confirmed breeding attempts of Black Stork in the Madrid region in the period 1992-2001, 25 were realized in nests on rock (38.46%): 19 were realized on river cliffs (76% of the nestings on rock), 5 on mountainous crags (20%), and one in an abandoned quarry (4%). We have observed inter-species competition between Black Stork and Griffon Vulture (*Gyps fulvus*) for the occupation of the nests on rock. In these cases, the Black Stork had to build a replacement nest, because when it returned from the wintering sites in Africa, its nests were already occupied by Griffon Vulture, that are resident.

As for the rest of the 40 cases of reproduction, nesting took place on trees (61.54% of the confirmed laying): 1 on *Fraxinus angustifolia* (2.5%), 12 on *Pinus pinea* (30%) and 27 on *Pinus pinaster* (67.5%). Field data gathered in consecutive years indicate that Black Storks can change from rock to tree when there are problems to find adequate nesting substratums in some territories. The existence of alternative nests has also been registered, although this phenomenon is unusual for the pairs in the region of Madrid and seems to be related to disturbances close to the nest sites.

Status and nesting population changes

The evolution of the nesting population of Black Stork in Madrid region during the period 1992-2001 is shown in Table 1.

All in all, during the last ten years we have monitored 65 breeding occurrences in which the pairs managed to lay eggs; in 9 of them (13.85%) the eggs did not hatch. During these years, in Madrid there was a mean of 92.82% of breeding pairs, and of 77.66% of productive pairs with regard to the total known nesting population.

Table 1 - *Number of stable pairs, breeding pairs (%) and productive pairs (%) during the period 1992-2001. - Nombre de couples présents, de couples nicheurs et de couples productifs au cours de la période 1992-2001.*

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Number of stable pairs	2	4	4	7	6	7	9	11	12	9
Nb of breeding pairs	2	4	3	6	6	6	9	9	12	9
% of breeding pairs	100	100	75	85.7	100	85.7	100	81.8	100	100
Nb of productive pairs	2	2	3	5	5	5	7	8	9	9
% of productive pairs	100	50	75	71.4	83.3	71.4	77.8	72.7	75	100

Breeding phenology

The breeding period of the population extends over almost six months, from the first week of March, when occasional pairs begin to lay eggs, until the end of August, when the last young get independent from their parents. The normal incubation period lasts 36 - 38 days. The first hatchings of eggs take place in the beginning of April, delayed in some cases until the second week of June. There exist significant differences in the date of the laying of the eggs between the pairs breeding in the supramediterranean layer and those in the mesomediterranean zones (Yates Chi-square = 17,04194; df=1; p= 0.00004). The pairs breeding in the supramediterranean layer lay their eggs during the month of April, while egg laying of the pairs settled in the mesomediterranean layer is less concentrated in time although they lay preferably in the month of March. The beginning of the first flights of the young varies substantially from case to case, from 62 days to more than 70 days of age in other cases.

Brood size

In total, 168 young were born in the considered period of time. Brood size varies between 1 and 5, 3 being the mean (S.D. = 0.914). This is to say, the most frequent number of young / pair is 3 (39.28 %, n= 22), then 4 (30.35 %, n= 17), 2 (21.42 %, n= 12) and 1 young / pair (7.14 %, n= 4); finally, on just one occasion a pair had 5 young (1.8 %). There are no significant differences between the number of young born from pairs nesting in the mesomediterranean layer and those settled in the supramediterranean zone (F1, 47= 0.03, p= 0.87). Neither are there any significant differences with respect to the number of young / pair depending on the date of the laying (F1, 47= 0.05, p= 0.82), that is to say, the pairs laying their eggs predominantly in March don't get a larger number of young than the pairs laying in April.

Productivity, Breeding Success and Fledging Rate

The reproductive parameters Productivity (Pr.), Breeding Success (B.S.) and Fledging Rate (F.R.) in the Madrid region during the period 1992-2001, its mean and Standard Deviation are shown in Table 2.

Table 2 - *Productivity (Pr.), Breeding Success (B.S.), Fledging Rate (F.R.), Mean and Standard Deviation (S.D.) in the Black Stork population in Madrid region during the period 1992-2001. - Productivité (Pr.), succès de la reproduction (B.S.), taux d'envol (F.R.), écart-type et moyenne (S.D.) de la population madrilène de Cigogne noire au cours de la période 1992-2001.*

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	Mean	S.D.
Pr.	3	1.25	2.25	2.43	2.66	2.57	2.55	2	1.58	3	2.329	0.555
B.S.	3	1.25	3	2.83	2.66	3	2.55	2.44	1.58	3	2.531	0.641
F.R.	3	2.5	3	3,4	3.2	3.6	3.28	2.75	2.11	3	2.984	0.466

Discussion

Based on these results, we can say that the nesting population of Black Stork in the Madrid region during the last ten years has been growing gradually, following the same demographic tendency observed in other regions in Central Europe (STRAZDS *et al.*, 1996a; HORMANN, 1999). We have found that the Black Storks that occupied the supramediterranean layer of the Madrid region, associated with colder temperatures and a higher altitude, show a more delayed laying phenology (preferably in April) than the pairs settling in the mesomediterranean layer (mainly in March). These have their egg laying period less concentrated in time, spread in some cases during the first two weeks of April. However, these phenological differences have no effect on the reproductive success, that is to say the pairs that lay in March don't get a larger number of young than the pairs laying in April, nor are there any difference in the number of young between the pairs in the supramediterranean and mesomediterranean layers. The phenological differences observed between the pair nesting in the different layers are not due to reproductive advantages, but to biogeographical causes: the pairs adapt the time of the laying to the moment in which the environmental conditions are optimal (BROWN & LOMOLINO, 1998).

The size of the brood in Madrid region is similar to those found in other regions of the Iberian Peninsula (ARAUJO *et al.*, 1996). Nonetheless, comparing the data of the number of flown young per nest with the number of pairs that achieve to have young that fly, the fledging rate is still larger than the fledging rates registered in other areas of the Iberian Peninsula (Table 3), as had been observed during the first years of reproduction in Madrid (HERNÁNDEZ & FERNÁNDEZ, 1996).

One reason for this higher fledging rate, in spite of the high human pressure which the population of Black Stork in Madrid region is exposed to, are the direct conservation efforts conducted by the Consejería de Medio Ambiente of the Comunidad de Madrid, such as an active vigilance toward the most vulnerable nests to avoid disturbances, and the restriction of human activities in the nesting areas during the reproduction period, two of the problems that affect Black Storks most directly (STRAZDS *et al.*, 1996b). These satisfactory reproduction parameters let us dare to say that in the future the population of Black Stork in Madrid region will remain stable, the number of nesting pairs will even rise (there is already data of young born in Madrid that return to the region and incorporate to the breeding population), but, over all, that it may serve as a population source for colonizing other areas adjacent to Madrid region, where the nesting of Black Stork has not been observed yet.

Table 3 - *Fledging Rate of Black Stork in different areas of Iberian Peninsula. Data for Madrid (present study), for Cáceres and Badajoz (SÁNCHEZ et al., 1994), Castilla y León (SAN SEGUNDO et al., 1994) and different sites in Portugal (Monteiro, A., personal comment). Taux d'envol chez la Cigogne noire dans différentes régions de la Péninsule Ibérique. Données de Madrid (présente étude), de Cáceres et Badajoz (SÁNCHEZ et al., 1994), de Castille et Léon (SAN SEGUNDO et al., 1994) et de différents sites au Portugal (A. Monteiro, comm. pers.).*

Place	Fledging rate	Period
Madrid (Spain)	2.98	1992-2001
Cáceres (Spain)	2.55	1977, 1987 1991 & 1994
Badajoz (Spain)	2.76	1977-1994
Castilla y León (Sp)	2.7	1991-1993
Tajo (Portugal)	2.82	1995-2000
Guadiana (Portugal)	2.67	1995-2000
Duero (Portugal)	2.61	1995-2000

ACKNOWLEDGEMENTS - We thank Antonio Monteiro for his generous collaboration. We also acknowledge the translations of Andrea Ift, Axel Mahlau, Coralie Hopwood and thank Sarah Swift for improvements on the English version.

Finally, we thank Mr Luis Prada and Francisco García and the firm GesNatura s.l. for their generous support. This work is supported by Consejería de Medio Ambiente de la Comunidad de Madrid.

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La Cigogne noire (*Ciconia nigra*) dans la région de Madrid : statut, évolution de la population et reproduction

Inconnue en tant que nicheuse avant 1988 dans la région de Madrid, la Cigogne noire est, comme dans d'autres régions d'Europe, en augmentation graduelle, ce malgré le fait que, dans cette région, la pression humaine soit importante et le milieu assez urbanisé. En dépit de cette situation a priori défavorable, alors que la taille des nichées est identique à celle d'autres régions de la péninsule ibérique, le taux d'envol est supérieur. L'une des raisons de ce succès est la mise en place de mesures de conservation directes entreprises par le "Consejeria de Medio Ambiente" de la Communauté de Madrid, comme la surveillance active des nids les plus sensibles aux dérangements et la limitation des activités humaines aux environs des nids durant la période de reproduction, deux des problèmes affectant le plus la Cigogne noire. Nous présentons ici les principaux résultats des programmes de suivi durant la période 1992-2001.

Sites de nidification

La population nicheuse de Cigogne noire occupe une large bande qui s'étend du nord-est au sud-ouest à travers la région de Madrid; elle occupe préférentiellement des étendues boisées situées entre 580 et 1.160 mètres d'altitude, à proximité de barrages, rivières ou ruisseaux. Ces différents milieux appartiennent à deux régions bioclimatiques : l'une dite mésoméditerranéenne (plus tempérée, située dans les régions de plaine), l'autre dite supraméditerranéenne (plus froide, située en partie dans la chaîne de montagne madrilène).

Sur les 65 tentatives de nidification suivies durant la période 1992-2001, 25 ont été entreprises en sites rocheux : 19 sur des falaises en bord de rivière, 5 sur des rochers de montagne et une dans une carrière abandonnée. Une compétition inter-spécifique pour l'occupation de nids entre Cigogne noire et Vautour fauve (*Gyps fulvus*) a été observée. Dans de tels cas, la Cigogne noire a dû reconstruire un autre nid car, à son retour d'Afrique, le nid était déjà occupé par le Vautour, qui est un sédentaire. Pour le reste (40 cas), les pontes ont eu lieu dans des nids établis dans les arbres : 1 sur un Frêne à feuilles étroites (*Fraxinus angustifolia*), 12 sur Pin parasol (*Pinus pinea*) et 27 sur Pin maritime (*Pinus pinaster*) (67,5%). Les cigognes peuvent changer de substrat, du rocher à l'arbre, lorsqu'elles rencontrent des problèmes pour trouver des emplacements propices. L'existence de nids de substitution a été notée, bien que ce phénomène soit inhabituel pour les oiseaux de la région de Madrid, et semble liée aux dérangements à proximité des sites de nidification.

Déroulement de la nidification

La durée normale de couvaison est de 36-38 jours. Les premières éclosions ont lieu au début d'avril, les dernières étant retardées parfois jusqu'à la deuxième semaine de juin. Dans la zone supraméditerranéenne, les couples pondent leurs œufs en avril tandis qu'en zone mésoméditerranéenne, les pontes sont effectuées au mois de mars. L'envol des jeunes varie d'un nid à l'autre, à partir de 62 jusqu'à plus de 70 jours.

Taille des nichées

Au total, 168 jeunes sont nés durant la période d'étude considérée. La taille de la nichée varie entre 1 et 5 jeunes, 3 étant la moyenne. Il n'y a pas de différence significative du nombre de jeunes entre les couples nichant dans les deux zones décrites, ni du nombre de jeunes par couple en fonction de la date de ponte.

Les tableaux 1 et 2 présentent respectivement l'évolution de la population nicheuse et les paramètres de reproduction comme la productivité (Pr.), le succès de la reproduction (B.S.) et le taux d'envol (F.R.).