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MOVEMENTS OF GREY HERONS *ARDEA CINEREA* TO AND WITHIN THE IBERIAN PENINSULA AND BALEARIC ISLANDS

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SUMMARY.—*Movements of Grey Herons* Ardea cinerea *to and within the Iberian Peninsula and Balearic Islands*. The movements of European Grey Herons are described on the basis of 585 ringing recoveries in the Iberian Peninsula, both before (1910-1975) and after (1976-1998) the legal protection of the species in Spain. The age-specific recovery rate, the time distribution of ringing recoveries and the causes of death did not vary after legal protection. Herons ringed in eastern Europe mostly moved towards the eastern side of the Iberian Peninsula. Those ringed in western Europe dispersed throughout the whole Peninsula. Grey Herons born in western Spain mostly moved within the western half of the Iberian Peninsula whereas those born in eastern Spain (Mediterranean coasts) moved all over the Peninsula. These data suggests the existence of two different metapopulations of breeding Grey Herons in Spain.

Key words: *Ardea cinerea*, Balearic Islands, Grey Heron, Iberian Peninsula, metapopulations, movements, ringing recoveries.

RESUMEN.—*Movimientos de Garzas Reales* Ardea cinerea *a y dentro de la península Ibérica y Baleares*. Se han analizado 585 recuperaciones de Garzas Reales anilladas en Europa y recuperadas en la península Ibérica, antes (1910-1975) y después (1976-1998) de la protección legal de la especie en España. La tasa de recuperación específica de la edad, la distribución temporal de recuperaciones y las causas de la muerte no variaron con la protección legal. Las garzas anilladas en países del este de Europa se dispersaron principalmente por el este de la península Ibérica, y las anilladas en países del oeste de Europa se dispersaron por toda la geografía peninsular. Las Garzas Reales nacidas en el occidente de España se desplazaron por la mitad occidental de la península Ibérica, y las nacidas en el este de España (litoral mediterráneo) lo hicieron por toda la península. Se plantea la hipótesis de la existencia de dos metapoblaciones distintas de Garzas Reales reproductoras en España.

Palabras clave: *Ardea cinerea*, Baleares, Garza Real, metapoblaciones, movimientos, península Ibérica, recuperaciones.

INTRODUCTION

The dispersal and migratory movements of the Grey Heron *Ardea cinerea* have been studied in depth in Europe (Verheyen & Le Grelle, 1952; Dorst, 1953; Rydzewski, 1957; Olsson, 1958; Marion, 1980; Draulans *et al.*, 1986; etc.), primarily on the basis of ringing recoveries of birds banded as nestlings. After abandoning the nest, Grey Herons disperse and eventually migrate towards the S-SW (Rydzewski, 1957). The mortality rate is higher for younger birds, decreases when they reach two years of age and is almost constant for birds older than three years (Mead *et al.*, 1979). Adverse environmental conditions also affect negatively survival, especially during the winter months (North, 1979).

In Spain, Bernis (1966) analysed the ringing recoveries of foreign Grey Herons. No more data have been published since then, except for monthly distributions of ringing recoveries (Díaz *et al.*, 1996). The number of recoveries has increased in the past decades and live birds are now more easily identified with the recent use of PVC rings and wing bands.

The Iberian Peninsula is a very important wintering ground for ardeids (Sarasa *et al.*, 1993). In general terms, Grey Herons winter along large interior rivers (Lekuona & Cam-

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pos, 1996) and littoral zones (Pérez-Hurtado, 1997), although many cross the Gibraltar Strait to winter in Africa (Finlayson, 1992). More specifically, however, we do not know how they are distributed throughout the Peninsula, an information that would help to improve conservation efforts.

The breeding population of Grey Herons in Spain increased rapidly after 1980 (pers. obs.), and there are now two main breeding nuclei: a) in the east, with several recent colonies along the Mediterranean coast, the most important one being La Albufera de Valencia (Prósper & Hafner, 1996); and b) in the west, with many colonies on the Duero, Tajo, Guadiana and Guadalquivir rivers, which are among the oldest and largest rivers in Spain (Aguilera & Sañudo, 1986; Campos & Fernández-Cruz, 1989; Fernández-Cruz *et al*., 1992; Parejo *et al*., 1997).

In 1975, the Grey Heron was officially protected against persecution in Spain. In this paper we publish new data on foreign Grey Heron ringing recoveries in the Iberian Peninsula before and after legal protection in order to describe how the species has benefited from this measure. We also describe Grey Heron movements within Spain.

Study area and Methods

Ringing recovery data (n = 585) of foreign Grey Herons (all ringed as nestlings) in the Iberian Peninsula (Spain and Portugal) were obtained from: 1) the Ringing Office of the Spanish Ministry of the Environment (n = 469); 2) the Bird Migration Centre of the Spanish Ornithological Society (n = 102 birds recovered in Portugal from 1911 to 1980), and 3) the Centre for the Study of Migration and Protection of Birds, Portugal (n = 14 birds recovered in Portugal from 1981 onwards). The data (n = 318) on ringing recoveries and/or observations of birds ringed as nestlings in Spain were obtained from: 1) the Ringing Office of the Spanish Ministry of the Environment (n = 53); 2) the Estación Biológica de Doñana, Spain (n = 84); 3) the Estació Ornitológica de L'Albufera, Spain (n = 102); 4) the Aranzadi Sciences Society (Spain) published by Riofrío (1998) (n = 14); and 5) data published by Fernández-Cruz & Campos (1993) (n = 65).

The following data were considered for each ring recovery:

1) Place of ringing (n = 585 recoveries). Countries of origin were grouped into a) Western Europe: France (except south-east, 185 recoveries), Germany (except south, 131), Sweden (75), Holland (53), Denmark (45), Great Britain (10), Belgium (7), Norway (6) and Finland (2); and b) Eastern Europe: Switzerland (20), Russia (15), Poland (11), Czech Republic (10), Germany (only south, 8), France (only south-east, 4), Hungary (1), Estonia (1) and Latvia (1). France and Germany were divided as in Bernis (1966).

2) Place of recovery (n = 585 recoveries). The Iberian Peninsula was divided into four zones (Fig. 1): Zone 1, Cantabrian-Atlantic coast; Zone 2, Guadalquivir marshes and surroundings; Zone 3, Mediterranean coast, including the Balearic Islands; Zone 4, central area of the Peninsula. In order to facilitate analysis, recoveries were grouped according to administrative provinces.

3) Date of recovery (n = 480). Recoveries were grouped by season: spring (April-June), summer (July-September), autumn (October-December) and winter (January-March).

4) Bird age (n = 286 recoveries). We only considered live Herons or those recently dead (less than one week). Each year of life began on April 1 (see Marion, 1980).

5) Cause of death (n = 469 recoveries). These were grouped into: a) death caused directly by humans (hunting, traps, etc.) or b) other causes (unknown, natural death, etc.).

Grey Herons born in Spain were only considered when ringed as nestlings. We did not consider older birds or unspecified ages. Bird observation refers to the observation of a live ringed bird (and also generally marked with a PVC ring to be read at a distance or a wing band). Local birds were attributed to recoveries and/or bird observations within a radius of 10 km from the original ringing site.

Results

Movements to the Iberian Peninsula and Balearic Islands

We obtained 585 recoveries of foreign Grey Herons, 572 of which were recorded in the Iberian Peninsula and 13 in the Balearic Islands.

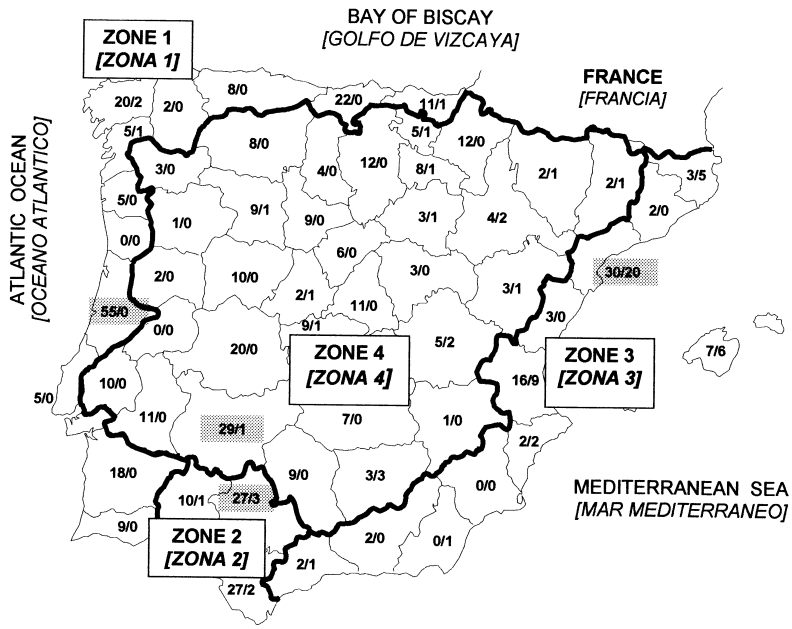

FIG. 1.—Number of recoveries of Grey Herons in the Iberian Peninsula and Balearic Islands. The numbers on the left in each province indicate the number of birds from western Europe and the numbers on the right, from eastern Europe.
[Número de recuperaciones de Garza Real en la península Ibérica y Baleares. En cada provincia los números de la izquierda son aves procedentes de países del oeste de Europa y los de la derecha son aves procedentes de países del este de Europa.]

Recoveries were distributed throughout the whole Peninsula (Fig. 1), but mostly in the Aveiro marshes on the Portuguese Atlantic coast (zone 1) and the Ebro delta on the Mediterranean coast (zone 3). The next most frequented were the marshes along the Guadalquivir and in Cádiz province (zone 2) and Badajoz province (zone 4).

Most of the Grey Herons originally ringed in Eastern Europe were recovered in the Mediterranean coast ($\chi^2_1 = 27.76$, $P < 0.01$; Table 1), and those ringed in Western Europe were evenly dispersed throughout the rest of the Iberian Peninsula ($\chi^2_1 = 1.31$, $P > 0.5$).

The time distribution of the recoveries of foreign Grey Herons was concentrated in autumn and winter (Fig. 2). This tendency did not change ($\chi^2_3 = 1.85$, $P > 0.5$) with legal protection of the species in 1975. During spring and summer, recoveries decreased (4.2% and 11.2%, respectively), probably because most European herons were in their breeding colonies.

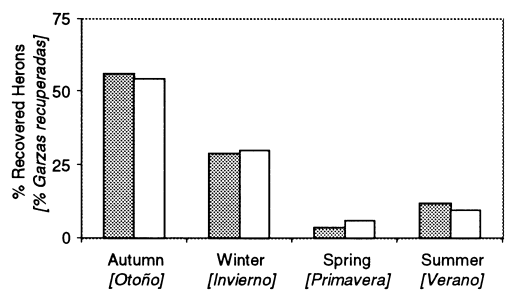

FIG. 2.—Percentage of foreign Grey Herons recovered in Spain in 1910-75 (shaded bars, $n = 346$) and 1976-98 (white bars, $n = 134$) according to season.
[Porcentaje de Garzas Reales extranjeras recuperadas en España entre 1910-75 (barras sombreadas, n = *346) y 1976-98 (barras vacías,* n = *134) según las estaciones del año.]*

TABLE 1

Number (percentage) of foreign Grey Herons recovered in the four zones utilised to divide the Iberian Peninsula, according to their origin (western and eastern Europe).
[Número (porcentaje) de Garzas Reales extranjeras recuperadas en las cuatro zonas en las que se ha dividido la península Ibérica, según su procedencia (oeste y este de Europa).]

Place of recovery *[Zona de recuperación]*	West *[Oeste]*	East *[Este]*	Total
Atlantic coast (Zone 1) *[Litoral Atlántico (Zona 1)]*	160 (98%)	4 (2%)	164
Southern marshes (Zone 2) *[Marismas del sur (Zona 2)]*	64 (91%)	6 (9%)	70
Mediterranean coast (Zone 3) *[Litoral Mediterráneo (Zona 3)]*	67 (60%)	44 (40%)	111
Center (Zone 4) *[Centro (Zona 4)]*	223 (93%)	17 (7%)	240
Total	514 (88%)	71 (12%)	585

TABLE 2

Percent age classes of foreign Grey Herons when recovered in Spain from 1910-75 and 1976-98.
[Porcentaje de Garzas Reales extranjeras según su edad cuando fueron recuperadas en España durante los períodos 1910-75 y 1976-98.]

Age *[Edad]*	1910-75	1976-98	Total
1	64.22 %	52.94 %	61.54 %
2	14.22 %	13.24 %	13.99 %
3	5.05 %	8.82 %	5.94 %
4	5.05 %	8.82 %	5.94 %
≥5	11.46 %	16.18 %	12.59 %
n	218	68	286

TABLE 3

Recoveries of Grey Herons in Spain according to the cause of death (caused directly by man or others) from 1910-75 and 1976-98.
[Recuperaciones de Garzas Reales en España según las causas de la muerte (por el hombre u otras) en los períodos 1910-75 y 1976-98).]

	Man *[Hombre]*	Others *[Otras]*	Total
1910-75	75.9 %	24.1 %	346
1976-98	78.3 %	21.7 %	129
Total	76.5 %	23.5 %	469

The majority (61.5%) of birds recovered were less than one year old (Table 2). This did not vary with legal protection ($\chi^2_4 = 4.51$, $P > 0.5$). The cause of death was normally due to human actions (Table 3), mostly shootings, and this tendency did not decrease with the legal protection either ($\chi^2_1 = 0.18$, $P > 0.5$).

Movements within the Iberian Peninsula

We obtained 84 recoveries (24 local) and 234 observations (191 local) of Grey Herons ringed as nestlings in Spain (Table 4) from: a) Villagodio, Moreruela and Allas heronries, in the Duero valley; b) Borbollón heronry, in the Tajo valley; c) Vitoria heronry, northern Spain; d) Doñana National Park and Odiel Natural Park heronries, in the Guadalquivir valley; and e) Albufera de Valencia, on the Mediterranean coast.

Herons ringed in breeding colonies in western Spain dispersed to the western half of the Peninsula (Fig. 3A). Those ringed in colonies in southern Spain did not move above the northern half of the Peninsula, and settled relati-

TABLE 4

Recoveries and observations of Grey Herons ringed as nestlings in Spain (the number of local birds appears in brackets).
[Recuperaciones y controles de Garzas Reales anilladas como pollos en España. Entre paréntesis, el número de las locales.]

Ringing area *[Zona de anillamiento]*	Recoveries *[Recuperaciones]*	Observations *[Observaciones]*	Total
Levante	16 (1)	100 (81)	116 (82)
Duero Valley *[Valle del Duero]*	9 (3)	2 (1)	11 (4)
Tajo Valley *[Valle del Tajo]*	19 (2)	65 (65)	84 (67)
Guadalquivir marshes and surroundings *[Marismas del Guadalquivir y alrededores]*	39 (18)	67 (44)	106 (62)
Ebro Valley *[Valle del Ebro]*	1	0	1
Total	84 (24)	234 (191)	318 (215)

vely near their original breeding colonies and in northern Africa (Morocco), except for one that was found in Italy (Fig. 3A).

Herons ringed in La Albufera dispersed differently than described above (Fig. 3B): some flew to western Spain and others to Africa (some all the way to Senegal) and others were recovered in central Europe (Poland).

Observations of birds with PVC rings confirmed mixing between colonies. One heron ringed as a nestling (metal ring G12482) in the Odiel Natural Park (southern Spain) was seen breeding two years later in the Doñana National Park, *ca.* 50 km SE. This suggests a genetic exchange between colonies in the same geographic zone.

DISCUSSION

The legal protection of Grey Herons in Spain did not appear to have modified either specific mortality indices per age nor the causes of death, nor the temporal distribution of recoveries. This finding contrasts with other foreign populations, where mortality of birds less than one year old decreased after legal protection (Marion, 1980), suggesting that the age structure of the winter population in Spain has remained stable at least during the past few decades.

According to the recovery data, several places in the Iberian Peninsula are particularly important wintering grounds (Fig. 1), especially coastal marshes and large interior rivers. Some of these areas are already legally protected (De Juana, 1990). Nonetheless, most deaths are due to deliberate actions by man, which suggests a need for increased public awareness. Probably the damage done by Herons on fish farms (Feunteun & Marion, 1988; Carss, 1993) is part of the cause that they were still persecuted.

We observed two different types of movements of Grey Herons born in Spain: birds from the west dispersed exclusively around the western half of the Peninsula, while eastern populations dispersed more widely. This suggests that Grey Herons born in western Spain may constitute a metapopulation (made up of two breeding nuclei in the Duero, Tajo, Guadiana and Guadalquivir valleys), as opposed to the metapopulation on the eastern Mediterranean coast, whose main breeding nuclei are in La Camargue, southern France (Kayser *et al.*, 1994), and La Albufera (Prósper & Hafner, 1996). A similar dispersal pattern has been observed in Little Egrets *Egretta garzetta* born in Spain (Bartolomé *et al.*, 1996). It would be interesting to find out whether there is an exchange of breeding birds among the nuclei of each metapopulation. This has not yet been documented, possibly because little effort has been made to ring birds in these areas.

The dispersal of birds from La Albufera (Spanish Mediterranean coast) was more similar to that in central Europe than to that of other birds in Spain. This suggests that the Spanish

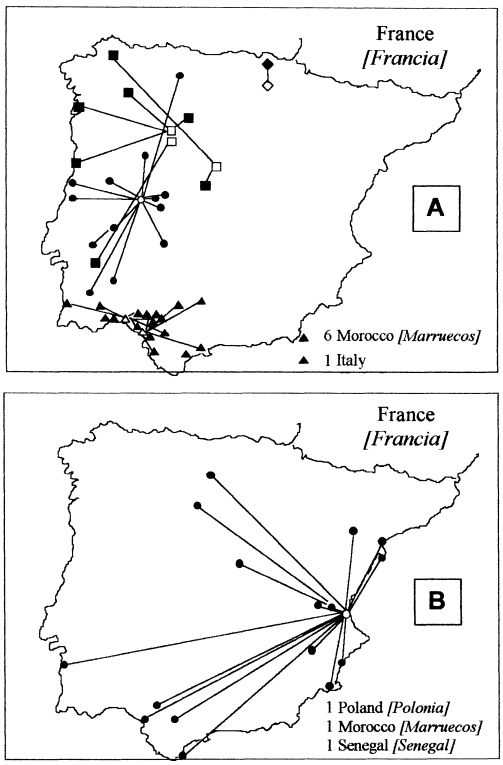

FIG. 3.—Recoveries and observations of ringed Grey Herons in Spain. *A*: western populations (Duero valley: squares; Tajo valley: circles; Guadalquivir valley: triangles; Ebro valley: diamonds). *B*: eastern population (Albufera de Valencia). Empty symbols: place of ringing. Shaded symbols: place of observation or recovery. Only the most representative observations are shown.
[Recuperaciones y controles de Garzas Reales anilladas en España. A: *población del oeste (Valle del Duero: cuadrados; Valle del Tajo: círculos; Valle del Guadalquivir: triángulos; Valle del Ebro: rombos).* B: *población del este (Albufera de Valencia). Símbolos vacíos: lugar de anillamiento. Símbolos llenos: lugar de control o recuperación. Sólo se han dibujado los controles más representativos.]*

colony, founded in 1984 (Gómez *et al*., 1987), may have been colonised by birds from these countries. The fact that one Grey Heron born there was later recovered in Poland supports this hypothesis. Nonetheless, a genetic analysis is needed for confirmation.

There was genetic exchange between the colonies in southern Spain (Odiel Natural Park and Doñana National Park), suggesting that these breeding nuclei could have had a common origin in time. The Doñana colony was founded in the 1950s (Bernis & Valverde, 1954), and the Odiel colony in the late 60s and early 70s (Aguilera & Sañudo, 1986), possibly after the movement of some breeding Herons from the former colony. Their high tendency to disperse (as opposed to other nuclei in western Spain) implies that these Herons may be better adapted to the special environmental conditions of southern Spain (a more benign climate during the winter, closer to Africa, etc.) and are possibly genetically different. A coordinated study on the DNA of Grey Heron populations could improve the understanding of these interesting dispersal patterns.

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