

Autumn migration of the Ringed Plover *Charadrius hiaticula* in North-east Iberia

J. FIGUEROLA & J. MARTÍ

The post-nuptial migration of the Ringed Plover *Charadrius hiaticula* is very well studied in most of Europe, but the information relative to the Mediterranean region is very scarce. From 27 July to 12 October 1992 and 27 July to 24 September 1993, a total of 61 censuses were carried out at the Salines de la Trinitat, (40°.37'N 00°.35'E), a salt-pan in the Ebro Delta Natural Park. In 1993, 29 censuses were also carried out at the Estany del Cortalet, (42°.15'N 03°.40'E), in the Aiguamolls de l'Empordà Natural Park, a small wetland area, 350 km north of the Ebro Delta. The main autumn passage occurred between early August and late September, with two periods of maximum passage at the Ebro Delta (21-30 August and 10-24 September), and only one at the Aiguamolls de l'Empordà (5-9 September). The apparently limited use of the Aiguamolls in the first period of autumn migration could be related to the absence of suitable areas for the species in this zone. A significantly higher number of birds migrated through the Ebro Delta in 1993 than in 1992, a year of very poor breeding success for Arctic waders.

Key words: Ringed Plover, *Charadrius hiaticula*, waders, autumn migration, phenology, Mediterranean, north-east Spain.

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INTRODUCTION

Ringed Plover *Charadrius hiaticula* migration phenology has been studied along the Atlantic coast of Europe. This small wader has been the focus of several detailed studies regarding its phenology and

leap-frog migration strategy (Salomonsen 1955). However, the species has received little attention in the Mediterranean.

The aim of this study was to monitor the phenology and the differences in migration pattern of this species in two different areas, using the census data ga-

thered in 1992-1993 in the Ebro Delta and in 1993 in the Aiguamolls de l'Empordà.

MATERIAL AND METHODS

The main fieldwork was carried out in the Salines de la Trinitat (40.37N 00.35N). This is the most extensive area of mudflats and the only salt-pan than is still actively exploited in the Ebro Delta. The Ebro Delta is, together with Santa Pola (Alicante), the only wintering locality regularly used by the species in North-east Iberia (Ferrer et al. 1986).

The two study periods were from 27 July to 12 October 1992 (with 39 censuses), and 27 July to 24 September 1993 (with 22 censuses). The Aiguamolls de l'Empordà (P.N.A.E.), a coastal wetland area 350 km to the north, was also surveyed 29 times from 27 July to 24 September 1993. In this second area Ringed Plovers are only present during migratory periods (Sargatal & del Hoyo 1989). The censused area was the Estany del Cortalet (42.15N 03.40E), a freshwater flooded area of 18 ha. More detailed descriptions of the two areas studied can be found in Maldonado (1977) and Sargatal & Fèlix (1989).

In both areas the different counts were grouped in five day periods, starting on 27 July (see Figs. 1 and 2). To test differences in number and phenology between years and between localities we used a mixed model two-way ANOVA, where periods were fixed, and place or year non-fixed (Tiedemann 1992). Since census data follows a Poisson distribution, data were transformed before analysis, using the square root of the two maximum censuses for each five day period (Sokal & Rohlf 1981). Previously 0.5 was added to each observation to allow for a correct transformation of 0 values (Tiedemann 1992). Once transformed, the census data

adjust correctly to a normal distribution (Kolmogorov-Smirnov test, $D_n=0.12$, $p=0.46$). In four of the 36 censuses, only one census per period was available. In these cases a dummy census, with the same result as that obtained in the real one, was added to the analysis. Due to the different duration of census periods in 1992 and 1993, statistical differences could only be tested during the period censused in the two years (27 July to 24 September).

The ages of 7 birds ringed during the autumns of the period 1990-1993, as well as those of 3 dead birds found in the Ebro Delta study area were also analysed.

RESULTS AND DISCUSSION

In the study areas the autumn migration period is mainly from early August to early October (Figs. 1 and 2), although small numbers of birds were observed away from traditional wintering areas until early November.

At the Ebro Delta (Fig. 1), two main periods of migration could be identified. The first occurred around the end of August, with a maximum of 60 and 105 individuals in 1992 and 1993 respectively, in the period 26-30 August. A second maximum occurred during late September, with 55 individuals (20-24 September 1992) and 112 individuals (10-14 September 1993). The timing of autumn migration in this area is very similar to that reported on the Lower Rhine (Andres & Reeber 1992) and in the Camargue (Cramp & Simmons 1983). Nevertheless, the first main period of migration occurs approximately one week after that reported in the Vistula Mouth in Poland (Gromadzka 1992, 1994a). On the other hand, migration occurs along the Atlantic coast of Spain nearly seven weeks later than reported for the Ebro Delta (Domin-

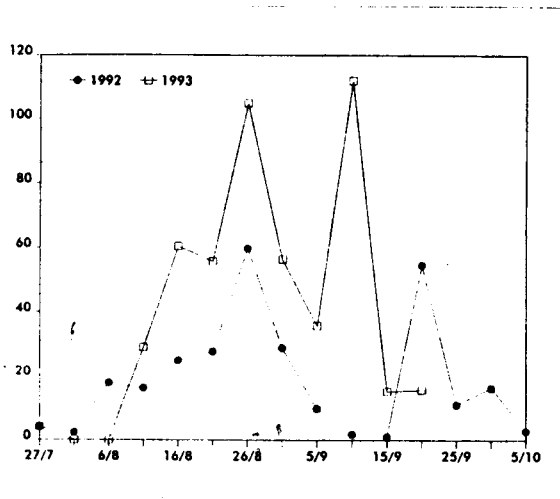


Figure 1. Maximum number of birds censused in the Ebro Delta study area for each of the five day periods. Each period is referred to by its first day.

Figura 1. Número máximo de aves censadas en el Delta del Ebro para cada periodo de cinco días. Cada periodo está indicado por su primer día.

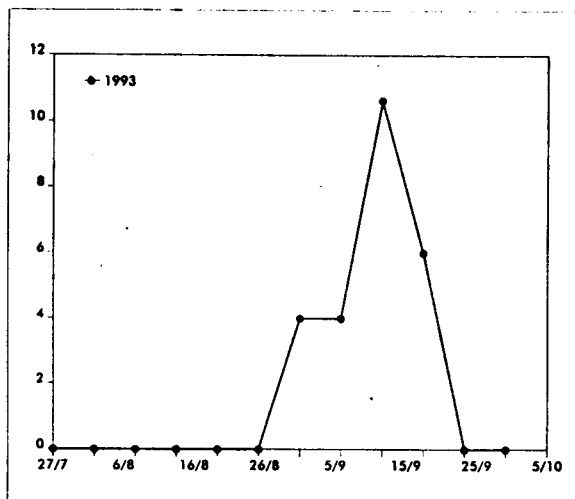


Figure 2. Maximum number of birds censused in the Aiguamolls de l'Empordà study area for each of the five day periods. Each period is referred to by its first day.

Figura 2. Número máximo de aves censadas en Aiguamolls de l'Empordà para cada periodo de cinco días. Cada periodo está indicado por su primer día.

quez & Rabuñal 1989), when very few birds were censused in the studied areas in the Mediterranean.

Migration at the Aiguamolls de l'Empordà is concentrated only in one main period (Fig. 2), with a maximum of 11 individuals during 5-9 September. However, very small numbers of birds were reported during July-November in other areas of the Natural Park (Estació Ornitològica P.N.A.E. unpublished). The migration at the Aiguamolls is very similar in timing and pattern to that found in the Lower Rhine (Andres & Reeber 1992) and in the Llobregat Delta (Gutiérrez et al. 1995), where only one main migration maximum was found. Like the Aiguamolls, these areas are only used by very small flocks of Ringed Plovers during autumn migration (nine individuals is the maximum recorded, Andres & Reeber 1992).

No differences were found in bird numbers within periods (mixed-model

ANOVA, Tables 1 and 2), suggesting that the differences between various counts of the same period do not exceed the differences between periods. The absence of significant differences within periods did not confirm the occurrence of systematic counting errors, nor could any effect of grouping the data into five day periods be detected.

Censuses showed statistical differences in number and in migration pattern (Tables 1 and 2). Autumn passage at the Ebro Delta involved a significantly higher number of individuals in 1993 than in 1992 (Table 1). These differences could not be due to habitat transformation, nor to differences in water levels, since these are regulated artificially with regular variations. Possibly this variation in numbers was the result of the high variability of annual breeding success in most waders species (Underhill et al. 1993), although weather effects on migration and other

Parameter	F	d.f.	p
period	1.866	11	>0.1 n.s.
year	15.167	1	=0.0007*
interaction	7.637	11	<0.0001*

Table 1. Effects of period and year on the numbers counted in each five day period in the Ebro Delta. An asterisk (*) indicates a significant difference.

Tabla 1. Efectos del periodo y año sobre los totales censados en cada periodo de cinco días en el Delta del Ebro. El asterisco indica la existencia de diferencias significativas.

causes could not be discounted. The year 1992 has been signalled by several authors as a very bad breeding season for Arctic waders (Underhill et al. 1993), and juvenile presence of most wader species was very low in this year compared with that reported in other years at the Ebro Delta (Figuerola et al. 1993). A higher proportion of young birds was also reported at the Vistula Mouth in 1993 than in 1992 (Gromadzka 1994a,b).

Higher numbers of Ringed Plovers were also reported at the Ebro Delta than at the Aiguamolls de l'Empordà (Table 2), with very small numbers present at the latter.

Establishing the age composition of each of the two Ebro Delta migration periods is very difficult since the number of Ringed Plovers trapped in the study area was very small. However, ringing studies carried out in Poland show that adult migration occurs earlier than that of juveniles (Gromadzka 1992). This suggests that the first maximum could be formed mainly of adult birds and the second one mainly of young birds. Age composition of the ringed sample shows a prevalence of adult birds in the Ebro Delta (5 of 7 aged birds).

Parameter	F	d.f.	p
period	1.937	11	>0.1 n.s.
place	156.579	1	=0.0001*
interaction	7.644	11	<0.0001*

Table 2. Effects of period and study area on the numbers censused in each five day period in 1993. An asterisk (*) indicates a significant difference.

Tabla 2. Efectos del periodo y área de estudio sobre los totales censados en cada periodo de cinco días en 1993. El asterisco indica la existencia de diferencias significativas.

A significant difference was found in migratory pattern between the two studied years at the Ebro Delta (ANOVA, period and year interaction, Table 1), with nearly twice as many birds censused in 1993, and 10 days of difference in the occurrence of the second maximum (Fig. 1). In 1993 the highest number of birds was censused in the second period (in contrast to 1992), suggesting a higher presence of young birds in this year. Differences between years in Ringed Plover migration pattern were also reported by Tiedemann (1992) in Iceland. Differences were also significant when comparing 1993 census data for the two study areas (period and place interaction, Table 2), produced by the different characteristics of the migration of Ringed Plovers at these two sites.

The Aiguamolls de l'Empordà presents very few, rather small, areas suitable for Ringed Plovers in autumn. The presence of these areas is very variable and unpredictable between years, since it depends on very variable environmental conditions. The unpredictable and less suitable areas are less used by adult birds as Rosner (1990) has shown in Dunlins *Calidris alpina*, very few birds being present at the Aiguamolls

at the start of migration, when a first maximum of migration occurs at the Ebro Delta. This habitat unpredictability may account for the differences found in this study between the autumn migration at the Ebro Delta and Aiguamolls de l'Empordà. •

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RESUMEN

La migración postnupcial del Chorlitejo Grande *Charadrius hiaticula* en el Nord-este de Iberia

*La migración postnupcial del Chorlitejo Grande *Charadrius hiaticula* ha sido estudiada en dos zonas del litoral catalán.*

Del 25 de julio al 12 de octubre en 1992 y del 25 de julio al 21 de septiembre en 1993, se llevaron a cabo un total de 61 censos en "Les Salines de la Trinitat",

(40.37N 00.35E), en el Parque Natural Delta de l'Ebre. En 1993, 29 censos se realizaron también en "L'Estany del Cortalet", (42.15N 03.40E), en el Parque Natural Aiguamolls de l'Empordà. Los resultados de los censos se agruparon en periodos de 5 días a partir del 27 de julio; los dos censos más elevados de cada periodo fueron analizados mediante un modelo mixto de ANOVA de dos factores.

El periodo de máxima migración se extiende desde principios de agosto hasta finales de septiembre, detectándose variaciones anuales en cuanto a la ocurrencia de los momentos de máximo paso. La migración postnupcial de 1992 fue menos abundante que la de 1993, reflejando posiblemente un mayor éxito reproductor en este último año.

El esquema migratorio de esta especie en el Delta del Ebro y en los Aiguamolls de l'Empordà presenta diferentes características. En el Delta del Ebro se aprecian dos máximos migratorios, uno a finales de agosto y un segundo a mediados de septiembre. El Chorlitejo Grande es escaso durante la migración postnupcial en los Aiguamolls de l'Empordà. En esta zona solo se detectó un máximo de migración, a mediados de septiembre, durante el último periodo de la migración de adultos y en el momento principal de la migración de los jóvenes. Este tipo de esquema migratorio ha sido registrado en otras áreas, caracterizadas por la escasez e impredecibilidad de zonas adecuadas para esta especie durante la migración postnupcial.

RESUM

La migració postnupcial del Corriol Gros *Charadrius hiaticula* al nord-est de la península Ibèrica

*La migració postnupcial del Corriol Gros *Charadrius hiaticula* ha estat estudiada a dues zones del litoral català.*

Del 25 de juliol al 12 d'octubre al 1992 i del 25 de juliol al 21 de setembre al 1993, es portaren a terme un total de 61 censos a les "Salines de la Trinitat", (40° 37'N 00° 35'E), al Parc Natural Delta de l'Ebre. Al 1993, també es realitzaren 29 censos a "L'Estany del Cortalet", (42° 15'N 03° 40'E), al Parc Natural Aiguamolls de l'Empordà. Els resultats dels censos es van agrupar en períodes de 5 dies (el primer període s'inicià el dia 27 de juliol); els dos censos més elevats de cada període van ser analitzats mitjançant un model mixt d'ANOVA bifactorial.

El període de màxima migració s'estén des de principi d'agost fins a final de setembre, amb variacions anuals pel que fa als períodes de màxim pas. La migració postnupcial de 1992 va ser menys nombrosa que la de 1993, reflectint possiblement un major èxit reproductor en aquest darrer any.

L'esquema migratori d'aquesta espècie al Delta de l'Ebre i als Aiguamolls de l'Empordà presenta diferents característiques. Al Delta de l'Ebre s'aprecien dos màxims migratoris, un a finals d'agost i un segon a mitjan de setembre. El Corriol Gros és escàs durant la migració postnupcial als Aiguamolls de l'Empordà. En aquesta zona només es detectà un màxim de migració, a mitjan de setembre, durant l'últim període de la migració dels adults i en el moment principal de la migració dels joves. Aquest tipus d'esquema migratori ha estat registrat en altres àrees, caracteritzades per la carència i impredictibilitat de zones adequades per a aquesta espècie durant la migració postnupcial.

REFERENCES

ANDRES, C. & REEBER, S. 1992. Phénologie du stationnement des limicoles à Gamsheim (Bas-Rhin) de 1978 à 1989. *Ciconia* 16(2): 57-102

CRAMP, S. & SIMMONS, K. E. L. 1983. *The Birds of the Western Palearctic*. Vol. III. Oxford: Oxford University Press.

DOMINGUEZ, J. & RABUÑAL, J. L. 1989. Migrating waders on the Atlantic coast of Galicia (NW Spain). *Misc. Zool.* 13: 141-151

FERRER, X., MARTINEZ-VILALTA, A. & J. MUNTANER 1986. *Història Natural dels Països Catalans*. Vol 12: Ocells. Barcelona: Enciclopèdia Catalana.

FIGUEROLA, J., COPETE, L. M. & GUSTAMANTE, L. 1993. *Biologia dels limícol·ls al Delta de l'Ebre: Migració i muda postgeneratives*. MS Report for the Diputació de Tarragona.

GROMADZKA, J. 1992. *Wader ringing at Vistula Mouth (Gulf of Gdansk, Poland): Autumn 1991*. Report of Ornithological Station, Institute of Ecology, Polish Academy of Sciences, Gdansk, Poland.

GROMADZKA, J. 1994a. *Wader ringing at Vistula Mouth (Gulf of Gdansk, Poland): Autumn 1993*. Report of Ornithological Station, Institute of Ecology, Polish Academy of Sciences, Gdansk, Poland.

GROMADZKA, J. 1994b. *Wader ringing at Vistula Mouth (Gulf of Gdansk, Poland): Autumn 1992*. Report of Ornithological Station, Institute of Ecology, Polish Academy of Sciences, Gdansk, Poland.

GUTIERREZ, R., ESTEBAN, P. & SANTAEUFEMIA, F. X. (1995). *Els ocells del Delta del Llobregat*. Barcelona: Lynx Edicions.

MALDONADO, A. 1977. Introducció geològica al Delta del Ebro. *Treb. Inst. Cat. Hist. Nat.* 8: 7-45.

ROSNER, H. -U. 1990. Sind Zugmuster und Rastplatzansiedlung des Alpenstrandläufers (*Calidris alpina alpina*) abhängig vom Alter?, *J.Orn.* 131(2): 121-139

SALOMONSEN, F. 1955. The evolutionary significance of bird migration. *Dan. Biol. Medded.* 22(6): 1-61

SARGATAL, J. & FELIX, J. (eds.) 1989. *Els Aiguamolls de l'Empordà. Aspectes ecològics, històrics i socials. Quaderns dels Indiketes 3.* Figueres: Ed. ART-3.

SARGATAL, J. & DEL HOYO, J. 1989. *Els ocells del Parc Natural dels Aiguamolls de l'Empordà.* Barcelona: Lynx Edicions.

SOKAL, R. R. & ROHLF, F. J. 1981. *Biometry.* 2nd ed. New York: W. H. Freeman.

TIEDEMANN, R. 1992. Analysis of variance as a statistical method for analysing bird migration patterns. *Wader Study Group Bull.* 65: 43-45

UNDERHILL, L.G., PRYS-JONES, R.P., SYROECHKOVSKI E.E. Jr., GROEN, N.M., KARPOV, V., LAPPO, H.G., VAN ROOMEN, M.W.J., RYBKIN, A., SCHEKKERMAN, H., SPIEKMAN, H. & SUMMERS, R. W. 1993. Breeding of waders (Charadrii) and Brent Geese *Branta bernicla bernicla* at Pronchishcheva Lake, northeastern Taimyr, Russia, in a peak and a decreasing lemming year. *Ibis* 135: 277-292