

The origin of Lapwings *Vanellus vanellus* and Golden Plovers *Pluvialis apricaria* wintering in Portugal

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Lapwing (*Vanellus vanellus*) and Golden Plover (*Pluvialis apricaria*) ring recoveries in Portugal were compared in order to search for trends in their origin, to analyse the relationship between cold weather and the wintering population, and to discuss the age pattern of the birds. Most Lapwings wintering in Portugal come from the British Isles, the Netherlands, Southern Scandinavian Peninsula and Denmark, and Germany. Golden Plovers come from all breeding range, a vast region extending from Iceland to Siberia. Colder temperatures in mid-Winter in Northwest Europe bring more birds of both species to Portugal. After the late 1960s and during 1970s, a systematic decrease occurred in the Recovery Index of Lapwing and Golden Plover coming from several countries in North-western Europe. In the 1980s this trend persisted for birds coming from Scandinavian countries and was inverted for more southern countries. Changes in winter weather could be the most important factor determining these patterns. When winters are mild the birds may be able to remain longer in northern and eastern areas that have previously been unsuitable. Around 50% of the Lapwings recovered in Portugal are first-winter birds. We estimate that only 32% of the first-winters return in their second winter. The age distribution of the ringed Lapwings recovered in Portugal might be related with several factors, such as lack of site fidelity, nomadic and migratory behaviours and hunting pressure.



1. Introduction

Lapwing (*Vanellus vanellus*) and Golden Plover (*Pluvialis apricaria*) are two of the most widespread wintering wader species in Western Europe. This region receives in the winter 2.8–4.0 million Lapwings and 1.6–2.0 million Golden Plovers (Wetlands International 2002). According to several studies (Imboden 1974, Asensio 1992,

Trolliet 2000), the Iberian Peninsula receives Lapwings from three different itineraries: a western one, with birds coming from Britain and north-western France; a central one, with birds arriving from a vast region – spanning from north-eastern France and the Benelux to Scandinavian Peninsula and Baltic countries and, finally an eastern one, with birds coming from Russia and central Europe. According to Fernández and Asensio (1992),

around 45% of these are first winter birds. The Golden Plovers wintering in the Iberian Peninsula come from two itineraries (Byrkjedal & Thompson 1998); one more Atlantic, with British and Icelandic birds, and another more continental, including birds from Siberia and Scandinavian countries, after stopovers in the Baltic and the Benelux. For both species, it is generally accepted that climatic factors such as cold spells are responsible for variation in number of birds wintering in North-western Europe. If frost conditions persist for more than three days, mass movements ensue, usually in a south or south-westerly direction, or towards the coast (Jukema & Hulscher 1988, Kirby & Lack 1993). The number of days with snow cover and temperatures below zero displace large contingents of these species from this region and push them to southern latitudes (Elkins 1983, Balança 1984, Jukema & Hulscher 1988, Kirby & Lack 1993, Byrkjedal & Thompson 1998, Trollet 2000, Jukema *et al.* 2001).

Most of these patterns are based on Central and North European studies. Even in Asensio's approach (Asensio 1992) the data from Portugal came only from the Northern half of the country. The present paper deals with Lapwing and Golden Plover ring recoveries from the entire mainland Portugal. We examine these records with the following aims: 1) to assess whether the above described migration patterns for Iberia are also detected in Portugal; 2) to search for trends in the origin of the birds wintering in Portugal; 3) to analyse the relationship between cold weather in northern Europe and the wintering populations of both species in Portugal and discuss the role of climate change in flyway patterns; and 4) to discuss the age pattern of these species wintering in Portugal according to their origin and migratory behaviour.

2. Material and methods

2.1. Study species

Lapwing (*Vanellus vanellus*) breeds all over temperate Europe and Asia, from Iberia and the British Islands in the West to China in the East (del Hoyo *et al.* 1996, Trollet 2000). In the winter the Eastern and North-eastern European populations are fully migratory, migrating South or Southwest (Im-

boden 1974, Trollet 2000). Otherwise, the North-western European populations are mainly resident or dispersive, migrating south only in cold winters. Golden Plover (*Pluvialis apricaria*) is an Arctic and sub-Arctic breeder, with populations ranging from Iceland in the West to the Taymyr Peninsula in Siberia in the East (Byrkjedal & Thompson 1998). All Golden Plover's populations migrate south or southwest in the winter.

2.2. Ringing and ring recovery data

A total of 322 Lapwings and 153 Golden Plovers ringed abroad and recovered in continental Portugal were analysed. The bulk of the data was from the Portuguese ringing scheme with other sources backing that up. Data was extracted from the *Central Nacional de Anilhagem* (Portugal), from early and recent reports and from recent non-edited data bank. Additional data come from Denmark (unpublished data from the Copenhagen Bird Ringing Centre), from Iceland (Guomundsson 1997) and from Britain (Toms & Clark 1998). A total of 281 Lapwing and 143 Golden Plover ring recoveries came from the Portuguese and Danish schemes, both with known recovery date. The remaining 41 Lapwing and 10 Golden Plover rings came from Toms & Clark (1998) and Guomundsson (1997), respectively, with recovery date unavailable.

The oldest recoveries of both species included in this study are dated from the period of 1910–1954 and the most recent ones from February 1998 (Lapwing) and February 2000 (Golden Plover). The number of ring recoveries varied between years, with an average maximum of 21 Lapwing rings in the triennium of 1962–1964 and a minimum of zero recoveries in some years, mainly after 1990 (Table 1). Golden Plover ring recoveries varied between zero and 20 rings per year since 1956 (Table 1). It's notorious that after 1990 the number of Lapwing recoveries decreased dramatically when compared with the period 1956–1989 (Table 1). This is related with the fact that almost all Lapwing and Golden Plover rings recovered in Portugal come from shooting. Precisely, 90.5% and 4.2% of the Lapwing recoveries belong to birds shot and to birds found dead, respectively. The corresponding values for Golden Plover are 91.4% and 7%, respectively. From 1990 onwards

Table 1. Lapwing and Golden Plover ring recoveries per year in Portugal (only data with known recovering date). M – Missing data

| Year | Lapwing | Golden Plover | Year | Lapwing | Golden Plover |
|---------|---------|---------------|------|---------|---------------|
| 1910–54 | 21 | 1 | 1979 | 4 | 3 |
| 1955 | M | M | 1980 | 12 | 3 |
| 1956 | 13 | 3 | 1981 | 12 | 5 |
| 1957 | 4 | 0 | 1982 | 4 | 2 |
| 1958 | 4 | 0 | 1983 | 1 | 3 |
| 1959 | 3 | 2 | 1984 | 1 | 4 |
| 1960 | 4 | 0 | 1985 | 4 | 3 |
| 1961 | 2 | 0 | 1986 | 4 | 3 |
| 1962–64 | 63 | 9 | 1987 | 15 | 20 |
| 1965 | 8 | 2 | 1988 | 5 | 8 |
| 1966 | 3 | 0 | 1989 | 3 | 3 |
| 1967 | 15 | 1 | 1990 | 1 | 4 |
| 1968 | 13 | 1 | 1991 | 1 | 5 |
| 1969 | 1 | 1 | 1992 | 1 | 6 |
| 1970 | 13 | 1 | 1993 | 0 | 8 |
| 1971 | 19 | 3 | 1994 | 0 | 1 |
| 1972 | 2 | 2 | 1995 | 0 | 8 |
| 1973 | 11 | 0 | 1996 | 0 | 8 |
| 1974 | 1 | 0 | 1997 | 1 | 6 |
| 1975 | 1 | 0 | 1998 | 1 | 3 |
| 1976 | 3 | 1 | 1999 | 0 | 0 |
| 1977 | 0 | 0 | 2000 | 0 | 1 |
| 1978 | 0 | 0 | SUM | 281 | 143 |

Lapwing shooting was banned and consequently recent ring recoveries are scarce. However, it is still allowed to shoot Golden Plovers.

Before the 1990 Lapwing shooting ban, another main change occurred in the Portuguese hunting law. In 1974, after the democratic revolution, hunting was considered a basic civil right and was made accessible for every citizen. Because of this political change the number of hunting permits increased by 80% during the following 10 years, from about 140,000 before 1974 to about 255,000 in the 1980s (DGSFA 1964, IF 1993). This is an important factor to take in consideration when discussing ring recovery data based on shot birds.

The ringing totals for both species were obtained from published data (Asensio 1992, Cantos & Manzanque 1997, Petersen & Guomundsson 1998) and directly from ringing stations (*Vogelwarte Radolfzell*, Hiddensee Bird Ringing Centre, *Vogelwarte Helgoland*, the Copenhagen Bird Ringing Centre, the *Matsalu Looduskaitse*, Ringing Centre of the Finnish Museum of Natural History, the Dutch Ringing Centre, the British

Trust for Ornithology and the Swiss Ornithological Institute).

The full recovery data include the ring number, the date and the age of the bird at the time of ringing, ringing and recovery localities (with geographic coordinates), the date and the method of recovery. Only 53% of Lapwing recoveries and 84% of Golden Plover recoveries were complete. Consequently only parts of the total records available were used in some of the analysis presented in this document.

2.3. Ring recovery index

In order to obtain a standard measurement of the recovery data by country, a RI (Recovery Index) based on Asensio (1992), was used:

$$\text{eq. 1. } RI = \left(\frac{r}{a} \right) \times 10000$$

where *a* is the total number of individuals of a bird species ringed by A country (or group of countries) at a defined date interval, and *r* is the total number

of recoveries in Portugal of this species from the same country and date interval. The factor 10,000 is used only to avoid having numbers with many decimal places. RI is a cumulative multi-year index. This means that at a certain moment we will include all birds ringed and recovered from the beginning of ringing activity. We will compute at the same time birds ringed and recovered in a large set of years. This means the time lag between ringing and recovery can vary between less than 12 months and several years according to period considered and the life span of the species. In the present study we will compute RI for periods ranging from 10 to 80 years.

When computing average RI to compare between countries and relate it to the breeding area of each species, data corresponding to birds ringed as pulli was used whenever available. The discrimination between pulli and full-grown individuals in the ringing totals was only available for some countries. These data were only available after the 1960s, except for Britain and Ireland.

To study trends in the RI of Lapwings coming from Finland, Denmark, Germany, the Netherlands and British Isles and of Golden Plovers coming from Iceland and the Netherlands we used a data set based on all birds ringed (pulli and full-grown individuals). We choose to do this in order to guarantee large enough sample size and an analysis covering back to the early 1960s in all countries.

2.4. Climatic and bird census data

The relationship between weather and the abundances of both species wintering in Portugal was based on comparisons of climatic data with bird counts. Climatic data came from the United Kingdom Meteorological Office, the *Koninklijk Nederlands Meteorologisch Instituut* – Netherlands, and the *Instituto de Meteorologia* – Portugal. Bird counts data came from the Mid-Winter Waterbird Census from: Britain (British Trust for Ornithology, Wildfowl & Wetlands Trust, Royal Society for Protection of Birds and Joint Nature Conservation Committee), the Dutch–German–Danish Wadden Sea (Melfotte *et al.* 1994, Rösner *et al.* 1994, Poot *et al.* 1996), the Netherlands (Voslamber *et al.* 1999, 2000) and Portugal (ICN-

CEMPA, Portuguese Bird Migration Study and Protection Group).

2.5. Age distribution based on ring recoveries

Since a ringed bird has the same probability of migrating to Portugal as a non-ringed one, we expected the age distribution should be similar between ringed and non-ringed birds. We used the sample of birds ringed abroad – in their first year of life – and recovered in Portugal to estimate the age structure of Lapwing and Golden Plover populations wintering in this country. This is a sample based in the moment of ring recovery, which in most of the cases is based in the moment of shooting or the shooting season (October to February). To estimate the distribution of birds by age classes we calculate the percentage of rings recovered by each age class (% y) and to estimate the Return Rate (RR) we divided the number of rings recovered within the age class y by the number of rings recovered within the age class $y - 1$:

$$\text{eq. 2.} \quad \%y = \left(\frac{n_y}{\sum n} \right) \times 100$$

$$\text{eq. 3.} \quad \text{RR} = \frac{n_y}{n_{y-1}}$$

where n_y is the number of rings recovered within age class y , $\sum n$ is the total number of rings recovered regardless of their age class and n_{y-1} is number of rings recovered within age class $y - 1$.

3. Results

3.1 The origin of birds

More than 50% of all Lapwings recovered in continental Portugal come in similar percentages from two origins: the British Isles and the Netherlands (Fig. 1a). Other countries (ringing schemes) with more than 5% of records are, from highest to lowest: Germany and Austria, Denmark, Sweden, Belgium and Luxemburg and Finland. Birds ringed as pulli come from a wide region ranging from Britain and Ireland, Southern Scandinavian Peninsula, the Baltic inlets, Central Europe, Benelux and Central France (Fig. 1b).

Comparing the recoveries with the number of

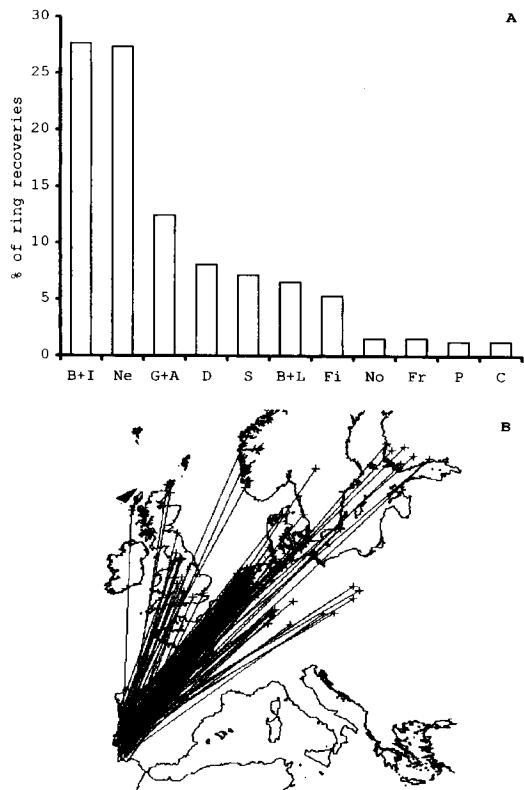


Fig. 1. Origin of Lapwings ringed abroad and recovered in Portugal. A – Distribution by country of ringing of all recovered birds from 1910 to 1998 (n = 322 rings). B+I – Britain and Ireland, Ne – Netherlands, G+A – Germany and Austria, D – Denmark, S – Sweden, B+L – Belgium and Luxemburg, Fi – Finland, No – Norway, Fr – France, P – Poland, C – former Czechoslovakia. B – Origin of birds ringed as pulli from 1910 to 1998 (n = 137 rings).

ringed birds (pulli and full-grown) along the twentieth century, the highest Recovery Index (RI) values were found for Scandinavian and Baltic countries, particularly for Denmark, Sweden, Poland and Finland. These countries are followed by the Netherlands, Britain and Ireland and Germany and Austria (Table 2). Some countries with large numbers of ringed birds, such as Russia, or with a relative geographic proximity to Portugal, such as Italy and Switzerland, had no recoveries here. Comparing RIs based only on birds ringed as pulli, the pattern was similar although there were fewer countries in this analysis. Denmark has the highest RI, followed by Netherlands, Finland, Germany and Austria and Britain and Ireland (Table 2).

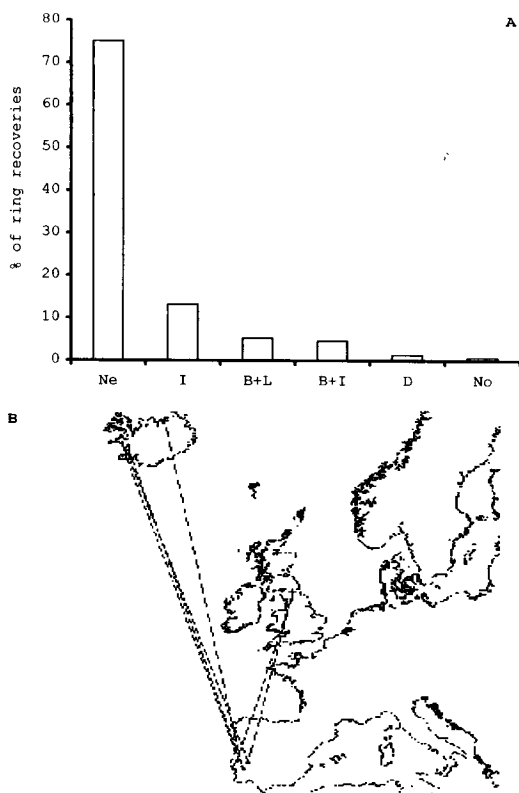


Fig. 2. Origin of Golden Plovers ringed abroad and recovered in Portugal. A – Distribution of recoveries from 1954 to 2000 by country of ringing (n = 153 rings). Ne – Netherlands, I – Iceland, B+I – Britain and Ireland, B+L – Belgium and Luxemburg, D – Denmark, No – Norway. B – Origin of birds ringed as pulli from 1954 to 2000 (n = 6 rings).

Nearly 75% of the all Golden Plovers recovered in Portugal came from the Netherlands (Fig. 2a). Icelandic birds amount to 10% and Belgian and British birds to about 5%. Birds ringed as pulli arrive only from Iceland and the British Isles (Fig. 2b). Danish birds show the highest RI (Table 3), followed by Icelandic, Dutch and British birds. Regarding only birds ringed as pulli, Iceland and Britain (with Ireland) show similar RIs (Table 3).

3.2. Trends in the ring recovery index

From 1954 to 1990 distinctive changes occurred with the RI in Portugal of Lapwings coming from several ringing schemes. The number of recoveries in the 1950s and mid-1960s was lower than that

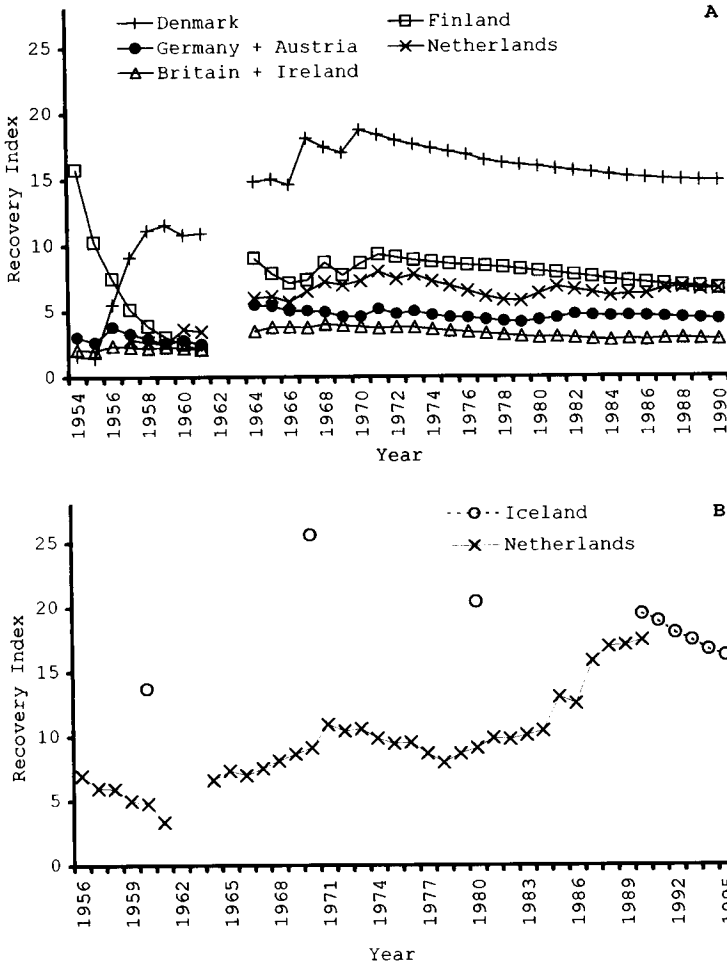


Fig. 3. Trends in the ring recovery index (RI) in Portugal (RI computed with all birds ringed as pulli and full-grown). A – Lapwing, B – Golden Plover.

in ensuing decades in all countries, with exception of Finland (Fig. 3a). After 1960 most RIs increased (Table 4). The highest RIs were recorded from the mid-1960s to the early 1970s (Fig. 3a). After that peak the RI values decreased in average during about two decades until 1990. In the 1970s this drop was steeper and highly significant in all countries (Table 4). In contrast, in the 1980s the trend was negative and highly significant only for birds coming from Finland and Denmark, becoming less significant or reverted to a positive trend for birds from the other ringing schemes (Table 4).

After a steep and significant increase during the 1960s, the Dutch RI of Golden Plovers decreased significantly in the 1970s (Table 4, Fig. 3b) and then increased again in the 1980s steeply and significantly (Table 4). In contrast, the Icelandic RI fell down at least after the early 1970s until

1995 (Fig. 3b). We couldn't calculate the yearly variation of Icelandic RI because until 1990 we only had ringing totals per decade.

3.3. Trends in ringing totals

The number of birds ringed (ringing totals) showed a great deal of variation in the past Century. In Denmark and Finland there was a strong decrease in Lapwing ringing totals after 1960 and after 1970, respectively (Fig. 4a). The latest Lapwing rings from these two countries recovered in Portugal are from 1970 and 1971, respectively. In Germany and Austria the decrease in Lapwing ringing totals occurred only after 1980. On the contrary, in the Netherlands and in Britain and Ireland there was a strong increase in the number of

Table 2. Portuguese recovery index (RI) of Lapwings ringed in Europe.

| | Total ringed | | | |
|-----------------------|--------------|------------------|-----------------|-------|
| | Period | No. birds ringed | Rings recovered | RI |
| Denmark | 1931–89 | 19,153 | 26 | 13.57 |
| Sweden | 1911–83 | 17,853 | 21 | 11.76 |
| Poland | 1931–83 | 2,109 | 2 | 9.48 |
| Finland | 1913–89 | 25,073 | 17 | 6.78 |
| Netherlands | 1910–90 | 133,176 | 88 | 6.61 |
| Britain and Ireland | 1909–89 | 168,495 | 89 | 5.28 |
| Germany and Austria | 1909–89 | 91,286 | 40 | 4.38 |
| Belgium and Luxemburg | 1960–69 | 12,912 | 5 | 3.87 |
| France | 1943–83 | 11,453 | 4 | 3.49 |
| Norway | 1914–82 | 18,540 | 5 | 2.70 |
| Former Czechoslovakia | 1934–77 | 13,396 | 2 | 1.49 |
| Russia | 1925–83 | 12,154 | 0 | 0.00 |
| Switzerland | 1926–89 | 3,844 | 0 | 0.00 |
| Estonia | 1922–79 | 2,378 | 0 | 0.00 |
| Italy | 1929–83 | 1,841 | 0 | 0.00 |
| Hungary | 1974–84 | 847 | 0 | 0.00 |
| Former Yugoslavia | 1910–83 | 593 | 0 | 0.00 |
| Spain | 1973–89 | 151 | 0 | 0.00 |
| Ringed as pulli | | | | |
| | Period | No. birds ringed | Rings recovered | RI |
| Denmark | 1969–89 | 3,816 | 2 | 5.24 |
| Netherlands | 1957–90 | 108,354 | 55 | 5.08 |
| Finland | 1968–89 | 12,302 | 6 | 4.88 |
| Germany and Austria | 1977–89 | 17,592 | 6 | 3.41 |
| Britain and Ireland | 1931–89 | 142,778 | 29 | 2.03 |

Table 3. Portuguese recovery index (RI) of Golden Plovers ringed in Europe.

| | Total ringed | | | |
|---------------------|--------------|------------------|-----------------|-------|
| | Period | No. birds ringed | Rings recovered | RI |
| Denmark | 1953–99 | 416 | 2 | 48.08 |
| Iceland | 1921–95 | 6411 | 20 | 31.2 |
| Netherlands | 1910–90 | 44232 | 77 | 17.41 |
| Britain and Ireland | 1910–99 | 6643 | 7 | 10.54 |
| Germany and Austria | 1909–99 | 453 | 0 | 0.00 |
| Finland | 1913–99 | 361 | 0 | 0.00 |
| Spain | 1973–96 | 24 | 0 | 0.00 |
| Ringed as pulli | | | | |
| | Period | No. birds ringed | Rings recovered | RI |
| Iceland | 1921–95 | 5397 | 4 | 7.41 |
| Britain and Ireland | 1931–99 | 2693 | 2 | 7.43 |
| Finland | 1968–99 | 141 | 0 | 0.0 |

Table 4. Regression coefficients (b) in RI trends of Lapwings and Golden Plovers coming from five ringing schemes (birds ringed as pulli and full-grown combined) in three different ten year period. T statistics: * P < 0.05, ** P < 0.01, *** P < 0.001, P > ns.

| Ringing scheme | Period | | |
|-------------------|--------------------|---------------------|---------------------|
| | 1961-70 (n = 8) | 1971-80 (n = 10) | 1981-90 (n = 10) |
| Lapwing: | | | |
| Finland | b = 0.531 | b = -0.136*** | b = -0.134*** |
| Denmark | b = 0.806*** | b = -0.274*** | b = -0.108*** |
| Germany + Austria | b = 0.141 | b = -0.103*** | b = -0.029* |
| Netherlands | b = 0.389** | b = -0.2451*** | b = 0.01 |
| Britain + Ireland | b = 0.169* | b = -0.095*** | b = -0.015 |
| Golden Plover: | | | |
| Netherlands | b = 0.576*** | b = -0.276*** | b = 1.022*** |

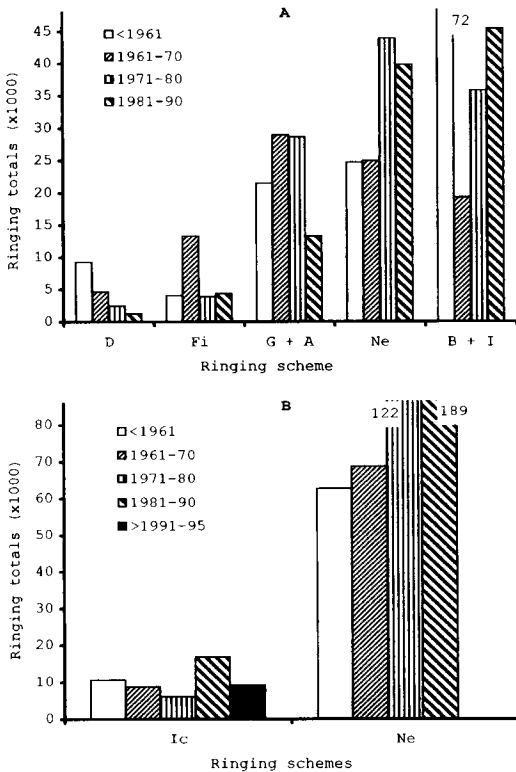


Fig. 4. Ringing totals per 10-year periods for A) = Lapwings and B) = Golden Plovers. D = Denmark, Fi = Finland, G+A = Germany and Austria, Ne = Netherlands, B+I = Britain and Ireland, and Ic = Iceland.

Lapwings ringed after 1960 (Fig. 4a). The latest rings recovered from Germany and Austria, the Netherlands, and Britain and Ireland are from

1985, 1990 and 1988, respectively. Regarding Golden Plover, we can say there was a dramatic increment in the Dutch ringing totals since 1970 and in the Icelandic ringing totals since 1980 when comparing with previous decades (Fig. 4b). The latest Golden Plover rings recovered from Iceland and the Netherlands are from 1997 and 2000, respectively.

There is a strong positive correlation between the number of Lapwings ringed in each country and the number of rings recovered in Portugal (Fig. 5a, $r_s = 0.907, P < 0.001, n = 18$). This correlation is still highly significant when we remove from the sample all countries with zero ring recoveries ($r_s = 0.904, P < 0.001, n = 11$). The same correlation is also positive and significant for Golden Plover ($r_s = 0.852, P = 0.015, n = 7$). These correlations suggest that ringing totals elsewhere in Europe affect the number of rings recovered in Portugal. On the other side, in spite of the Lapwing ringing totals being positively and significantly correlated with the RI in Portugal ($r_s = 0.687, P = 0.002, n = 18$), when we plot this data in a graph (Fig. 5b) the picture looks rather confusing. Removing from the sample all countries with RI = 0 the correlation is no longer significant ($r_s = 0.173, P = 0.612, n = 11$). The same correlation between ringing totals and RI is non-significant for Golden Plover ($r_s = 0.444, P = 0.317, n = 7$). These results suggest that ringing totals don't affect directly the RI, except when they are so low that the probability of recover a ring in Portugal is zero.

There should be an average minimum thresh-

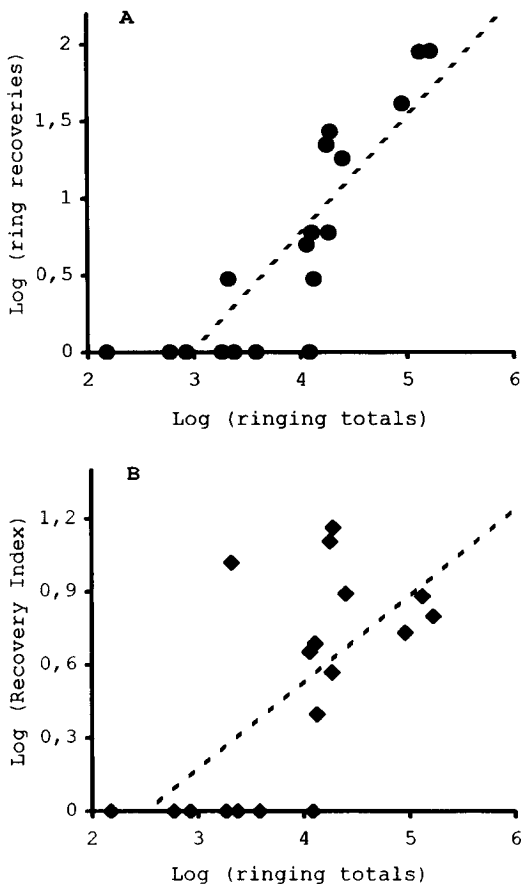


Fig. 5. Variation of Lapwing ring recoveries (A) and RI – Recovery Index – (B) with the ringing total.

old of birds ringed in any country below what there are no ring recoveries in Portugal. For instance, for Lapwings coming from Denmark this minimum threshold is 109, 520 and 1226 birds ringed per year, per 5-year, and per 10-year period, respectively (Fig. 6). A similar analysis can be made for Golden Plovers coming from the Netherlands. In this case we need more than 374, 2658 and 5780 birds ringed per year, per 5-year, and per 10-year period, respectively, to have ring recoveries in Portugal (Fig. 7).

3.4. Bird numbers vs. temperature

The abundance of Lapwings and Golden Plovers wintering in Britain is positively and significantly correlated with minimum temperatures and nega-

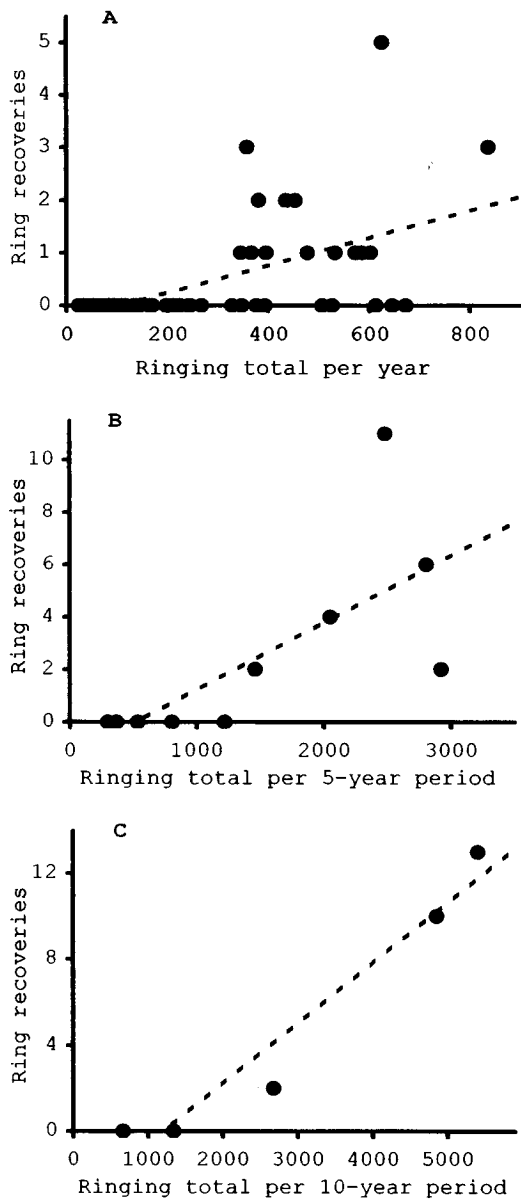


Fig. 6. Variation of Lapwing ring recoveries in Portugal with the ringing totals (pulli and full-grown combined) in Denmark by different year periods. A – per year ($y = 0.0026x - 0.2839$, $R^2 = 0.293$, $F = 19.96$, $df = 48$, $P < 0.001$), B – per 5-year period ($y = 0.0026x - 1.3522$, $R^2 = 0.516$, $F = 8.54$ $df = 8$, $P = 0.019$), C – per 10-year period ($y = 0.0028x - 3.4343$, $R^2 = 0.942$, $F = 49.12$, $df = 3$, $P = 0.006$).

tively and significantly correlated with snow cover (Table 5). Similar pattern occurs with temperature in the Netherlands, but the correlations aren't sig-

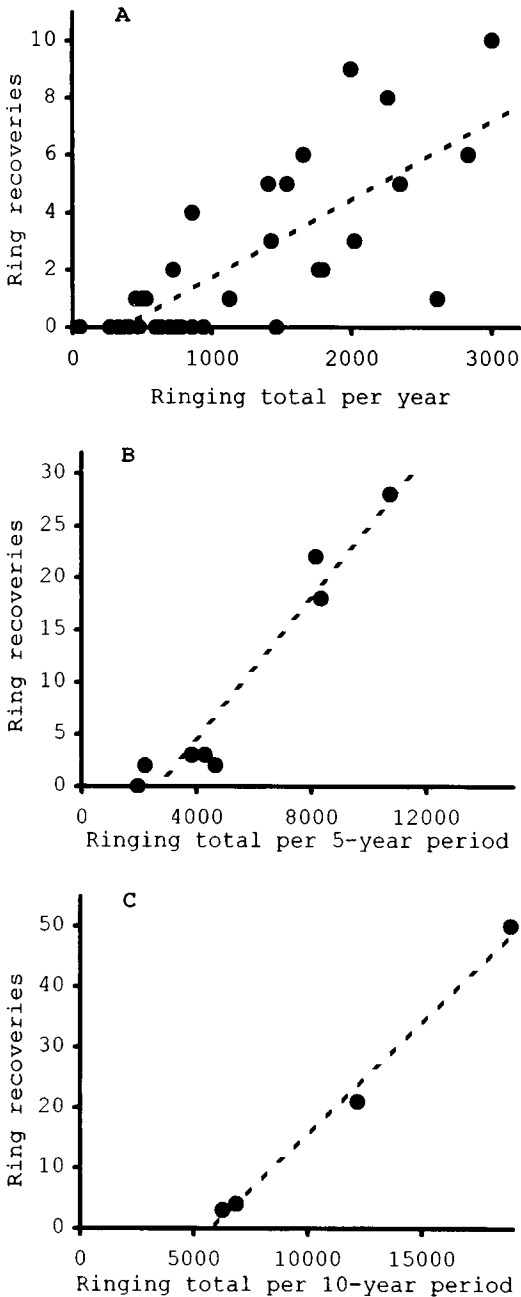


Fig. 7. Variation of Golden Plover ring recoveries in Portugal with the ringing totals (only full-grown) in the Netherlands by different year periods. A – per year ($y = 0.0027x - 1.0106$, $R^2 = 0.583$, $F = 44.79$, $df = 32$, $P < 0.001$), B – per 5-year period ($y = 0.0033x - 8.7735$, $R^2 = 0.928$, $F = 77.65$, $df = 6$, $P < 0.001$), C – per 10-year period ($y = 0.0037x - 21.686$, $R^2 = 0.992$, $F = 269.7$, $df = 2$, $P = 0.004$).

nificant (Table 5). On the other hand, in Portugal the abundance of over-wintering Lapwings and Golden Plovers and the number of ring recoveries decrease significantly with the average minimum temperatures recorded in Britain and in the Netherlands (Table 5). The number of Lapwing ring recoveries in Portugal decreases significantly with their abundance during winter in Britain and in the Netherlands (Table 5). Similarly, the number of Golden Plover ring recoveries decreases with the abundance of the species in the Wadden Sea. This means that in colder winters, when these species are less abundant in the wintering areas in north-western Europe, they are more abundant in Portugal and also their ring recovery rates are higher.

3.5. Bird age patterns

Up to 1998, half of 158 Lapwings ringed as pulli or fledglings and recovered in Portugal were spending their first-winter migration (Table 6). About 16% were second-winter birds and 10% were third-winters. The oldest bird recovered was 10-years old, spending their 11th winter in Portugal. Therefore, 82% of the Lapwings recovered in Portugal were younger than four years old (Table 6). The Golden Plover recovery pattern was quite similar, and 83% of 29 birds ringed as pulli or fledglings and recovered in Portugal were younger than four years old. But, unlike the Lapwings, the distribution of recoveries was more homogenous with respect to age: 31% were first-winter, 28% second-winter and 17% third-winter birds (Table 6). The oldest Golden Plover recovered was 9-year old (in its 10th winter). The estimated return rate (RR) of the Lapwings in the second winter (0.32) was much lower than that of Golden Plover (0.89), being similar from the third winter onwards (Table 6).

No significant differences were found in the age of recovered Lapwings before and after 1975 ($\chi^2_4 = 4.683$, $P = 0.384$), in spite of the dramatic increase in hunting permits. Neither were statistically significant differences found as regards the age of recovered Lapwings from the three groups of countries with breeding populations ($\chi^2_4 = 5.073$, $P = 0.279$). The groups considered where: the Baltic Basin and Scandinavian Peninsula (Norway, Sweden, Denmark, Poland and Finland), the

Table 5. Correlations (Pearson r) between abundance of Lapwing and Golden Plover wintering in Britain, the Netherlands and Portugal and winter temperatures in Britain and the Netherlands. Also correlations between abundance – based on number of ring recoveries and on mid-winter waterbird census (MWC) – of both species wintering in Portugal and in Britain, the Netherlands and the Dutch–German–Danish Wadden Sea. Counts \log_{10} transformed, and sample size range between 12 and 30 units (* $P < 0.05$, ** $P < 0.01$, $P > ns$).

| | Winter weather in Northwest Europe | | |
|--------------------------------|---------------------------------------|-----------------------------------|-------------------------------|
| | Average min. Temp. Netherlands | Average min. Temp. Britain | Days with Snowfall Britain |
| Lapwing: | | | |
| Britain (MWC) | | $r = 0.422^*$ | $r = -0.36^*$ |
| Netherlands (MWC) | $r = 0.495$ | | |
| Portugal (MWC) | $r = 0.286$ | $r = -0.613^*$ | $r = 0.169$ |
| Portugal (no. ring recoveries) | $r = -0.629^*$ | $r = -0.078$ | $r = -0.21$ |
| Golden Plover: | | | |
| Britain (MWC) | | $r = 0.452^*$ | $r = -0.374^*$ |
| Netherlands (MWC) | $r = 0.569$ | | |
| Portugal (MWC) | $r = -0.612^*$ | $r = -0.647^*$ | $r = -0.05$ |
| Portugal (no. ring recoveries) | $r = -0.477^*$ | $r = -0.119$ | $r = 0.078$ |
| | Abundance Mid-winter waterbird census | | |
| | Britain | Dutch–German–Danish Wadden Sea | Netherlands |
| Lapwing: | | | |
| Portugal (MWC) | $r = 0.099$ | $r = -0.191$ | $r = 0.309$ |
| Portugal (no. ring recoveries) | $r = -0.576^{**}$ | | $r = -0.646^*$ |
| Golden Plover: | | | |
| Portugal (MWC) | $r = -0.302$ | $r = -0.071$ | $r = -0.671$ |
| Portugal (no. ring recoveries) | $r = 0.072$ | $r = -0.847^*$ | $r = -0.12$ |

British Isles (Britain and Ireland) and the North-west Continental Europe (France, Belgium, the Netherlands and Germany).

4. Discussion

4.1. The origin of birds

Portugal is a wintering area for Lapwings coming mainly from North-Western Europe. A similar pattern was observed by Asensio (1992) in North-western (Atlantic) Spain and Portugal. On the contrary, in the South-eastern Spain (Mediterranean) the pattern was clearly different, with more than 50% of Lapwings coming from Central Europe (Asensio 1992). Considering this we can say that the migratory flow of Lapwings coming to Portugal begins in the Scandinavian Peninsula, Finland

and other Baltic countries. These birds reach Portugal by North, along the Atlantic Coast (Asensio 1992), after crossing Denmark, Northern Germany, Benelux and North-western France and receiving influxes from local populations and from the British and Irish populations.

Most of the Golden Plovers wintering in Portugal come from the Netherlands, and because they do not breed there (Hagemeijer & Blair 1997), all birds are ringed as full grown migrants. According to Jukema *et al.* (2001), Golden Plovers ringed in the Netherlands come from breeding places in Russia (50%), Norway (20%), Sweden (15%) and Finland (10%). Consequently, Golden Plovers wintering in Portugal come from throughout the area of distribution of the species, from Iceland to Siberia. These birds arrive to Portugal using only the two Western European itineraries described by Byrkjedal and Thompson (1998).

Table 6. Age classes (in years) of Lapwings and Golden Plovers ringed as pulli or fledglings abroad and recovered in Portugal. RR = return rate.

| Age | Lapwing | | | Golden Plover | | |
|------------------|------------|---------|------|---------------|---------|------|
| | No. birds. | % birds | RR | No. birds | % birds | RR |
| $y < 1$ | 75 | 49.7 | | 9 | 31 | |
| $1 \leq y < 2$ | 24 | 15.9 | 0.32 | 8 | 27.6 | 0.89 |
| $2 \leq y < 3$ | 15 | 9.9 | 0.63 | 5 | 17.2 | 0.63 |
| $3 \leq y < 4$ | 11 | 7.3 | 0.73 | 2 | 6.9 | 0.4 |
| $4 \leq y < 5$ | 8 | 5.3 | 0.73 | 2 | 6.9 | 1 |
| $5 \leq y < 6$ | 8 | 5.3 | 1 | 1 | 3.4 | 0.5 |
| $6 \leq y < 7$ | 2 | 1.3 | 0.25 | 0 | 0 | 0 |
| $7 \leq y < 8$ | 3 | 2 | | 0 | 0 | |
| $8 \leq y < 9$ | 2 | 1.3 | 0.67 | 1 | 3.4 | |
| $9 \leq y < 10$ | 1 | 0.7 | 0.5 | 1 | 3.4 | 1 |
| $10 \leq y < 11$ | 2 | 1.3 | | | | |
| Total | 151 | 100 | | 29 | 100 | |

4.2. Trends in ring recovery index

Basic knowledge about bird migration in Europe derives from the ringing efforts made from 1930s onwards (e.g. Bernis 1966, Snow 1966, Studer-Thiersch 1969, Imboden 1974). These early overviews on bird migration were only possible after raising the public awareness of how important it was to provide information on ring recoveries, as suggested by Peris (1991). Thus, the increase in Lapwing and Golden Plover recoveries observed in Portugal during the 1960s has probably been related with the increment of ringing activity and recovery information than to any ecological factor affecting these species. On the other hand, the observed evolution in ring recoveries from the 1970s onwards could be related to changes in the populations and/or to the habitat conditions all over the North-western European flyways (Davidson *et al.* 1999). We can't forget that the RI is not directly affected by breeding population trends, because it depends exclusively on ringing totals and on post-ringing events and factors. However, the decrease of Lapwing breeding populations can be so severe that prevents ornithologists from ringing enough birds. The strong decline and poor breeding success (Heath *et al.* 2000, Hagemeyer & Blair 1997) could have been responsible for the decrease of the Lapwing ringing totals in Finland, Denmark and Germany since the 1970s. The decreased of ringing in Denmark and Finland could explain the lack

of Lapwing recoveries from these countries since 1971. However, they certainly do not explain the other negative trends on Lapwing RIs and the negative trend on Golden Plover RI from Iceland. There should other factors affecting the RI trends.

Recovery indices in Portugal could be related with changes in recovering effort. The recovering effort in Portugal increased in late 1970s and early 1980s, following the 80% boost in the number of hunting permits after 1974. This could explain an increase in RI of Golden Plovers coming from the Netherlands in 1980s through an increase in hunting pressure. Nevertheless, it does not explain decreases in the other RIs for both species. On the contrary, the increase in hunting pressure could have masked the RI downtrends such that they would seem less steep than they actually were. Unfortunately we can not check this hypothesis because there are no records on the hunting bag for that period.

Loss or deterioration of preferred wintering habitat could have forced Lapwings and Golden Plovers to move to other countries to seek alternative wintering sites. However, farmland habitats suffered from small scale changes prior to Portuguese accession to European Economic Community (actual European Union) in 1986. This means that during most of the study period the wintering habitat of Lapwing and Golden Plover in Portugal remained rather unchanged and well-preserved. Thus, there appeared to be no reasons to associate

the decrease in recovery indices to loss of habitat quality in that period.

Climatic changes can disturb migration patterns and bird distributions worldwide (Burton 1995, McCarty 2001, Tryjanowski *et al.* 2002). In Great Britain, Golden Plovers and Lapwings are highly affected by severe weather, that prevents them accessing soil invertebrates and causes westward and southward movements (Fuller & Youngman 1979, Kirby & Lack 1993, Byrkjedal & Thompson 1998). In Portugal – as should be in Spain – more birds of both species were recorded and more rings were recovered during cold winters in northern Europe. When the weather was mild in those regions more birds were recorded there and less in Portugal. These relations are straight and fairly well documented elsewhere (Jukema & Hulscher 1988, Byrkjedal & Thompson 1998, Trolliet 2000). But in the last thirty years of the past century average temperatures higher than normal were recorded all over Europe (Burton 1995, Hulme & Jenkins 1998, World Meteorological Organization 2000, Santos *et al.* 2002). If winters have become milder, the birds may be able to remain longer in northern and eastern areas that have previously been unsuitable. Jukema and Hulscher (1997) and Kube *et al.* (1994) suggest that the observed increase of Golden Plovers in post-nuptial moult in Dutch and Danish stop-over areas could be related to an increase in autumn temperatures over the last 20 years of 20th Century. The weather patterns in Great Britain, where large flocks of Scandinavian and British Lapwings, as well as Icelandic Golden Plovers stay during mild winters (Imboden 1974, Byrkjedal & Thompson 1998, Trolliet 2000, Appleton 2002, Whittingham 2002), could affect the number of birds coming to Portugal.

Results presented by Gillings (2003a) confirm that winter weather has changed in that country, but non-linearly: winters during the 1970s were quite mild, those during the 1980s tended to be severe and those in the early 1990s were very mild. This temporal pattern of weather severity could generate changes in the RIs in Portugal. During the warm 1970s, fewer birds came to the Iberian Peninsula and consequently the ring recoveries of Lapwing and Golden Plover in Portugal decreased. Then during the 1980s, cold winters had the opposite effect, turning less steep, stabilising

or completely reversing the RIs, except for lapwings coming from Fenno-Scandinavia. Lately in the 1990s the warm weather again could have reduced steeply the number of recoveries, at least for Golden Plovers coming from Iceland. In coastal England the abundance patterns of Lapwing and Golden Plover has been reverse to the RI patterns in Portugal for the same decades (Gillings 2003a).

Our results suggest that changes in winter weather may be more important than other factors, but almost certainly there is some degree of co-influence of several factors. In any case, these data represent only part of a large-scale redistribution during non-breeding season. Lapwing and Golden Plover ring recovery trends can only be properly understood when data on wintering populations all over Europe are available. The importance of redistribution between countries cannot be determined without synchronised counts in north-west Europe and better monitoring of inland populations of Golden Plovers and Lapwings (Gillings 2003b). At the moment this information is only partially available for Portugal, the Netherlands, United Kingdom and few other countries (van der Winden *et al.* 1998, Gillings & Fuller 1999, Trolliet 2000, Leitão & Peris 2003). In addition to this, future research should investigate how plovers have reacted to changes in habitats, how they utilise them and precisely how they respond to weather.

4.3. Bird age and migratory behaviour

In Spain, 44.7% of the Lapwings recovered were first-year birds and 73.5% were younger than four years in age (Fernández & Asensio 1992). Thus, the age classes of Lapwings wintering in Portugal are similar to those reported by Fernández and Asensio (1992) for Spain, pointing out an homogeneous age structure all over the Iberian Peninsula. There seems to be also a certain degree of homogeneity in the age distribution patterns of birds coming from different regions in Northwest Europe.

The majority of Lapwing ring recoveries were first-year birds (age 0–1 year). Of these birds, around 32% are estimated to return in their second winter. In Europe the survival rate of Lapwing in the first winter should be 56–60% (Trolliet 2000). Thus, the low return rate in the second winter can

not be related only with first winter mortality. Other factors, such as lack of site fidelity, nomadic and migratory behaviour, and hunting pressure should explain it.

As many as 56.6 to 77.8% of the lapwings do not return to their natal ground after first winter (Thompson *et al.* 1994). If this lack of fidelity also holds true for the first wintering ground, this could explain in part the low number of second-year birds returning to the Portuguese wintering sites. Moreover, both young and adult lapwings are highly nomadic during winter (Balança 1984, Kirby & Lack 1993, Kirby 1997, Appleton 2002), especially due to weather constraints. It is possible that adult birds survive better over cold weather than young birds. Therefore, during adverse weather first winter birds may migrate more south to Portuguese latitudes, and for longer periods, than the adult birds. A third of the British and Irish breeding populations – mostly adults – over-winter closer to their breeding grounds (Imboden 1974, Trolliet 2000). Also differences in the time of beginning of the pre-nuptial migration associated with hunting pressure could be responsible for the differences in recoveries according to age. Adult birds wintering in southern latitudes depart to breeding grounds earlier than first-year individuals (Meltøfte 1996). Therefore, the juvenile birds have a greater chance of being shot in late January and in February by Portuguese hunters than adult birds. Considering that most of ring recoveries are based on hunting, the estimated age class distribution of birds estimates could be in a certain degree biased to first winter birds.

The proportion of Golden Plovers wintering in Portugal during their first year of life (31%) is lower than that of Lapwings. According to Guomundsson (1997), 55% of the Plovers ringed in Iceland as pulli are recovered in Northwest Europe in the same year of ringing. This fact suggests that a smaller proportion of juvenile birds winter in Portugal than in northern regions. Unlike the Lapwing, adult Golden Plovers migrate more south than first-year birds (Meltøfte 1996). Many birds reach lower latitudes as South Portugal only in their second winter, staying in Northwest Europe during their first winter. However, these patterns are based in a very small sample, and need more data to be supported.

To better understanding the dynamics of Lap-

wing and Golden Plover populations and migratory patterns we need more data. In particular, we need to cross data on population age structure deriving from ring recovery data and from winter counts for several western European countries, namely, Britain and Ireland, the Netherlands, France and Iberian Peninsula (Peach *et al.* 1999, Gillings 2003b).

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Portugalissa talvehtivien tóyhtóhyppien ja kapustarintojen alkuperä

Artikkelin kirjoittajat selvittivät rengaslöytöjen avulla Portugalissa talvehtivien tóyhtóhyppien ja kapustarintojen alkuperää, analysoivat lämpötilan ja talvipopulaatioiden välistä suhdetta sekä pohtivat lintujen ikäjakaumaan vaikuttavia tekijöitä. Tutkimusaineisto koostui 322 Portugalin ulkopuolella rengastetusta ja Portugalissa talvella kontrolloidusta tóyhtóhyppästä, ja vastaavasti 153 kapustarinnaista.

Valtaosa Portugalissa kontrolloiduista tóyhtóhyppistä oli rengastettu Brittein saarilla ja Hollannissa. Pesäpoikasina rengastetut tóyhtóhyypät tulivat Portugaliin laajalta alueelta, joka käsitti Brittein saaret, Etelä-Skandinavian, Baltian maat, Keski-Euroopan, Benelux-maat ja Keski-Ranskan. Noin 75 % Portugalissa kontrolloiduista kapustarinnoista oli rengastettu Hollannissa. Pesä-

poikasina rengastetut kapustarinnat olivat tulleet Portugaliin vain kahdelta alueelta, Islannista ja Brittein saarilta.

Luoteis-Euroopan kylmien talvien myötä molempia lajeja esiintyi Portugalissa runsaammin. 1960-luvun lopun jälkeen ja 1970-luvulla useista Luoteis-Euroopan maista saapuvien työttöhyppien ja kapustarintojen takaisinpaluu-indekseissä havaittiin systemaattista laskua. 1980-luvulla sama trendi oli vielä havaittavissa Skandinaaviasta tulevien lintujen osalta, mutta trendi oli kääntynyt toisinpäin eteläisimmistä maista tulevien lintujen kohdalla. Artikkelin kirjoittajat arvelevat, että muutokset talven sääoloissa on tärkein näitä trendejä selittävä tekijä. Leutoina talvina linnut voivat viipyä pidempään aiemmin talvehtimiseen sopimattomilla pohjoisilla ja itäisillä alueilla. Noin 50 % Portugalissa kontrolloiduista työttöhyppistä on iältään ensimmäistä kertaa talvehtivia lintuja. Tutkijat arvioivat, että vain 32 % ensimmäisen talven linnuista palaa talvehtimisalueelleen seuraavana talvena. Portugalissa talvehtivien työttöhyppien ikäjakaumaan vaikuttavat useat tekijät, kuten talvehtimispaikkaukkolisuuden puute, vaellus- ja muuttokäyttäytyminen sekä metsästyspaine.

References

- Appleton, G. 2002: Northern Lapwing (Lapwing) *Vanellus vanellus*. In: Wernham, C., Toms, M. Marchant, J. Clark, J., Siriwardena, G. & Baillie, S. (eds.): The migration atlas: movements of the birds of Britain and Ireland. — T. & A.D. Poyser. London: 290–292.
- Asensio, B. 1992: Migration of lapwing wintering in the Iberian Peninsula. — *Donāna, Acta Vertebrata*. 19: 71–84. (In Spanish with English summary).
- Balança, G. 1984: Migrations et hivernage du Vanneau huppé (*Vanellus vanellus*) et du Pluvier doré (*Pluvialis apricaria*) dans le sud de la Brie: déterminisme météorologique, sélection de l'habitat et activités. — *L'Oiseau et la Revue Française d'Ornithologie*. 54: 337–349. (In French with English summary).
- Bernis, F. 1966: Aves Migradoras Ibericas. — Sociedad Española de Ornitología. Madrid. (In Spanish).
- Burton, J.F. 1995: Birds & Climatic Changes. — Helm. London. 376 pp.
- Byrkjedal, I. & Thompson, D. 1998: Tundra Plovers – The Eurasian, Pacific and American Golden Plovers and Grey Plover. — T & AD Poyser. London. 422 pp.
- Cantos, F.J. & Manzaneque, A.G. 1997: Informe sobre la Campaña de anillamento de aves en España: Año 1996. — *Ecología*. 11: 303–422. (In Spanish).
- Davidson, N.C., Bryant, D. & Boere, G. 1999: Conservation uses of ringing data: flyway networks for waterbirds. — *Ringling & Migration* 19: S83–S94.
- DGSFA (Direcção-Geral dos Serviços Florestais e Aquícolas) 1964: A caça e a economia nacional. — DGSFA/SCPRFPN. Lisboa. 11 pp. (In Portuguese).
- Fernández, A. & Asensio, B. 1992: Análisis demográfico de la población de avefrías (*Vanellus vanellus*) invernantes en España. — *Studia Oecologica* 9: 141–147. (In Spanish with English summary).
- Elkins, N. 1983: Weather and bird behaviour. T. & A.D. Poyser, Calton.
- Fuller, R.J. & Youngman, R.E. 1979: The utilisation of farmland by Golden Plovers wintering in southern England. — *Bird Study* 26: 37–46.
- Gillings, S. 2003a: Diurnal and nocturnal ecology of Golden Plovers *Pluvialis apricaria* and Lapwings *Vanellus vanellus* wintering on arable farmland. Unpublished Doctoral Thesis. — University of East Anglia. Norwich. 216 pp.
- Gillings, S. 2003b: Plugging the gaps – winter studies of Eurasian Golden Plovers and Northern Lapwings. — *Wader Study Group Bulletin* 100: 25–29.
- Gillings, S. & Fuller, R.J. 1999: Winter Ecology of Golden Plovers and Lapwings: a review and Consideration of Extensive Survey Methods. — British Trust for Ornithology. Thetford. 56 pp.
- Guomundsson, G.A. 1997: Winter distribution of Icelandic Golden Plovers *Pluvialis apricaria*. — *Bliki* 18: 55–58. (In Icelandic with English summary).
- Hagemeijer, W.J.M. & Blair, M.J. (eds) 1997: The EBCC Atlas of European Breeding Birds: Their Abundance and Distribution. — T & AD Poyser. London. 903 pp.
- Heath, M., Borggreve, C., Peet, N., & Hagemeijer, W. 2000: European Bird Populations: estimates and trends. — *BirdLife International (BirdLife Conservation Series No. 10)*. Cambridge. 160 pp.
- del Hoyo, J., Elliott, A. & Sargatal, J. (eds.) 1996: Handbook of the Birds of the World, vol. 3. — Lynx Edicions. Barcelona. 821 pp.
- Hulme, M. & Jenkins, G. 1998: Climatic change scenarios for the United Kingdom. UKCIP Technical report No. 1. — Climatic Research Unit. Norwich.
- IF (Instituto Florestal) 1993: A mecânica da caça em Portugal: Maio de 1993. — DAAC/DSCPARS/IF. Lisboa. 20 pp. (In Portuguese).
- Imboden, C. 1974: Migration, dispersal and breeding period of the Lapwing *Vanellus vanellus* in Europe. — *Der Ornithologische Beobachter* 71: 5–134. (In German with English summary).
- Jukema, J. & Hulscher, J.B. 1988: Recovery rate of ringed Golden Plovers *Pluvialis apricaria* in relation to the severity of the winter. — *Limosa* 61: 85–90. (In Dutch with English summary).
- Jukema, J. & Hulscher, J.B. 1997: The fowler as measurer of population changes of the Golden Plover *Pluvialis apricaria*. — *Limosa* 70: 179–190. (In Dutch with English summary).

- Jukema, J., Piersma, T., Hulscher, J.B., Bunschoke, E.J., Koolhaas, A. & Veenstra, A. 2001: Goudplevieren en wilsterflappers: eeuwenoude fascinatie voor trekvogels. — Fryske Akademy, Ljouwert/KNNV Uitgeverij. Utrecht. 272 pp. (In Dutch).
- Kirby, J.S. 1997: Influence of environmental factors on the numbers and activity of wintering Lapwing and Golden Plover. — *Bird Study* 44: 97–110.
- Kirby, J.S. & Lack, P.C. 1993: Spatial dynamics of wintering Lapwings and Golden Plovers in Britain and Ireland, 1981/82 to 1983/84. — *Bird Study* 40: 38–50.
- Kube, J., Graumann, G. & Grube, B. 1994: The phenology of autumn migration of Golden Plover (*Pluvialis apricaria*) at the German Baltic coast and in inland north-eastern Germany. — *Sonderheft*. 2: 83–92. (In German with English summary).
- Leitão, D. & Peris, S. 2003: Distribution and abundance of Lapwing *Vanellus vanellus* and Golden Plover *Pluvialis apricaria* in Portugal. — *Airo* 13: 3–16. (In Portuguese with English summary).
- McCarty, J.P. 2001: Ecological Consequences of Recent Climate Changes. — *Conservation Biology* 15: 320–331.
- Meltofte, H. 1996: Are African wintering waders really forced south by competition from northerly wintering conspecifics? Benefits and constraints of northern versus southern wintering and breeding in waders. — *Ardea* 84: 31–44.
- Meltofte, H., Blew, J., Frikke, J., Rösner, H.U. & Smit, C.J. 1994: Numbers and distribution of waterbirds in the Wadden Sea. — IWRB Publication 34/Wader Study Group Bulletin 74S. Wilhelmshaven. 175 pp.
- Peach, W.J., Furness, R.W. & Brenchley, A. 1999: The use of ringing to monitor changes in the numbers and demography of birds. — *Ringling & Migration* 19: S57–S66.
- Peris, S.J. 1991: Changes in the population of European Starlings (*Sturnus vulgaris* L.) wintering in Spain during 1960–89. — *Sitta* 5: 19–26.
- Petersen, A. & Guomundsson, G.A. 1998: Seventy-five years of bird-ringing in Iceland. — *Bliki* 19: 49–56. (In Icelandic with English summary).
- Poot, M., Rasmussen, L.M., van Roomen, M., Rösner, H.U. & Südbeck, P. 1996: Migratory Waterbirds in the Wadden Sea 1993/94. — Wadden Sea Ecosystem no. 5, Common Wadden Sea Secretariat & Trilateral Monitoring and Assessment Group. Wilhelmshaven. 79 pp.
- Rösner, H.U., Roomen, M.V., Südbeck, P. & Rasmussen, L.M. 1994: Migratory Waterbirds in the Wadden Sea 1992/93. — Wadden Sea Ecosystem no. 2, Common Wadden Sea Secretariat & Trilateral Monitoring and Assessment Group. Wilhelmshaven. 72 pp.
- Santos, F.D., Forbes, K. & Moita, R. (eds) 2002: Climate change in Portugal: scenarios, impacts and adaptations measures. — Gradiva. Lisbon. 454 pp.
- Snow, D.W. 1966: The migration and dispersal of British Blackbirds. — *Bird Study* 13: 237–255.
- Studer-Thiersch, A. 1969: Das Zugverhalten schweizerischer Stare *Sturnus vulgaris* nach ringfunden. — *Der Ornithologische Beobachter* 66: 105–144. (In German).
- Thompson, P.S., Baines, D., Coulson, J.C. & Longrigg, G. 1994: Age at first breeding, philopatry and breeding site-fidelity in the lapwing *Vanellus vanellus*. — *Ibis* 136: 474–484.
- Toms, M.P. & Clark, J.A. 1998: Bird Ringing in Britain and Ireland in 1996. — *Ringling & Migration* 19: 95–168.
- Trollet, B. 2000: European Union Management Plan for the Lapwing *Vanellus vanellus*. — European Commission, DG XI. Brussels. 64 pp.
- Tryjanowski, P., Zuzniak, S. & Sparks, T. 2002: Earlier arrival of some farmland migrants in Western Poland. — *Ibis* 144: 62–68.
- Voslamber, B., van Winden, E.A.J. & van Roomen, M.W.J. 1999: Midwinterling van watervogels in Nederland, januari 1998. SOVON-monitoringrapport 1999/05, RIZA-rapport BM98.09, IKC Natuurbeheer coproductie C22. — SOVON Vogelonderzoek Nederland. Beek-Ubbergen. 76 pp. (In Dutch with English summary).
- Voslamber, B., van Winden, E.A.J. & van Roomen, M.W.J. 2000: Midwinterling van watervogels in Nederland, januari 1999. SOVON-monitoringrapport 2000/02, RIZA-rapport BM9914, Expertisecentrum LNV coproductie C-31. — SOVON Vogelonderzoek Nederland. Beek-Ubbergen. 78 pp. (In Dutch with English summary).
- Wetlands International 2002: Waterbird population estimates – third edition. — Wetlands International Global Series No. 12. Wageningen. 226 pp.
- Whittingham, M. J. 2002: European Golden Plover (Golden Plover) *Pluvialis apricaria*. In: Wernham, C., Toms, M. Marchant, J. Clark, J., Siriwardena, G. & Baillie, S. (eds.): The migration atlas: movements of the birds of Britain and Ireland. — T. & A.D. Poyser. London: 284–292.
- van der Winden, J., Gerritsen, G. & van Roomen, M. 1998: Preliminary results of a countrywide survey of staging Golden Plover, Lapwing and Curlew in the Netherlands. — *Wader Study Group Bulletin* 86: 31–32.
- World Meteorological Organization 2000: WMO Statement on the Status of the Global Climate in 2000. <http://www.wmo.ch>