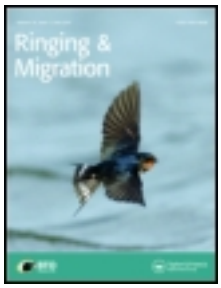

Ringing & Migration
Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/tram20

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Available online: 19 Oct 2011

To cite this article: Benjamin Guyonnet, Sebastien Gautier, Bernard Iliou & Ron W. Summers (2011): The origin and population structure of Purple Sandpipers *Calidris maritima* in northern France, Ringing & Migration, DOI:10.1080/03078698.2011.628158

To link to this article: http://dx.doi.org/10.1080/03078698.2011.628158

Ringing & Migration (2011) **iFirst**, 1–5

The origin and population structure of Purple Sandpipers *Calidris maritima* in northern France

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Biometrics of Purple Sandpipers captured in Brittany, northern France, indicated that they belonged to a long-billed population, so may have originated in Canada or Russia. There was a preponderance of males (81%). An uneven sex ratio in favour of males is proving to be the norm for winter populations of Purple Sandpiper. A high percentage of captures were of first-year birds. This was probably biased by the catching methods (mist-netting and dazzle-netting), because a lower value was obtained by observing free-living birds.

Purple Sandpipers *Calidris maritima* spend the non-breeding season on the rocky seashores of the North Atlantic. On the eastern Atlantic coast, they occur from the Kola Peninsula in northern Russia to the Iberian Peninsula (Cramp & Simmons 1983).

Within Europe, the composition of wintering populations is complex, with varying proportions of birds from different breeding populations. In Britain, birds originate from Norway, Svalbard, possibly Canada, and maybe even Russia (Nicoll *et al* 1988, Summers *et al* 2010). Likewise, in Germany (Dierschke 1995) and Sweden (Hake *et al* 1997), the origins of wintering birds have been confirmed as or suggested to be Norway, Canada, Russia and Svalbard. These studies were based on the analysis of biometrics, backed up with ring recoveries. Biometrics are useful because of the size differences between different breeding populations (Engelmoer & Roselaar 1998). Thus, different populations can be characterised according to bill and wing length. For example, Norwegian birds are characterised by short bills and wings, whilst Canadian and Russian birds have long bills and wings. The biometrics of Purple Sandpipers are further complicated by sexual size differences, as found in most waders: females are larger than males, particularly in bill length (Cramp & Simmons 1983). Thus, it is possible to determine the likely origin and sex ratio from biometrics of captured birds.

France lies at the southern part of the winter distribution of Purple Sandpipers. The population is relatively small, with approximately 2,000 birds (Dubois *et al* 2000, Deceuninck *et al* 2008), found largely in Brittany (80–90% of the wintering population; Annezo 1992). There have been no studies of this southern population. Therefore, the aim of this study was to obtain biometrics from a sample of these birds to determine their likely origin and measure the sex and age ratios.

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METHODS

Study area and catching methods

Purple Sandpipers were captured on Trielen, Brittany, one of the nine islands of the Molène Archipelago (Fig 1). This island is approximately 1 x 0.3 km in size. The study area was situated on the nature reserve of Iroise, a Natura 2000 site. Purple Sandpipers were caught with mist-nets (2008 and 2009) and by dazzle-netting (2009 to 2011). Mist-netting was possible but it was difficult to set nets in the surf on exposed rocky shores and when it was windy. Dazzle-netting was carried out with a strong light to transfix the bird in the beam until a hand-net was dropped over the bird. Table 1 summarises the dates and numbers of ringed birds. Although trapping was carried out in April, the birds were assumed to be representative of the winter population because few Purple Sandpipers occur south of Brittany (Cramp & Simmons 1983). In addition, there were 10 sightings on Trielen Island in November 2010 of birds colour-ringed in April.

Birds captured since 2009 were aged as first-year or adult. A sample of free-living birds was also aged in the field when viewed at close range. Ageing was based on the colour of the lesser and median coverts, the colour of the tertials and wear on the tips of the outer primaries (Summers 2009). They were ringed with a metal ring, and from 2009 with colour rings. Bill length was measured with dial callipers to 0.1 mm from the tip to the junction

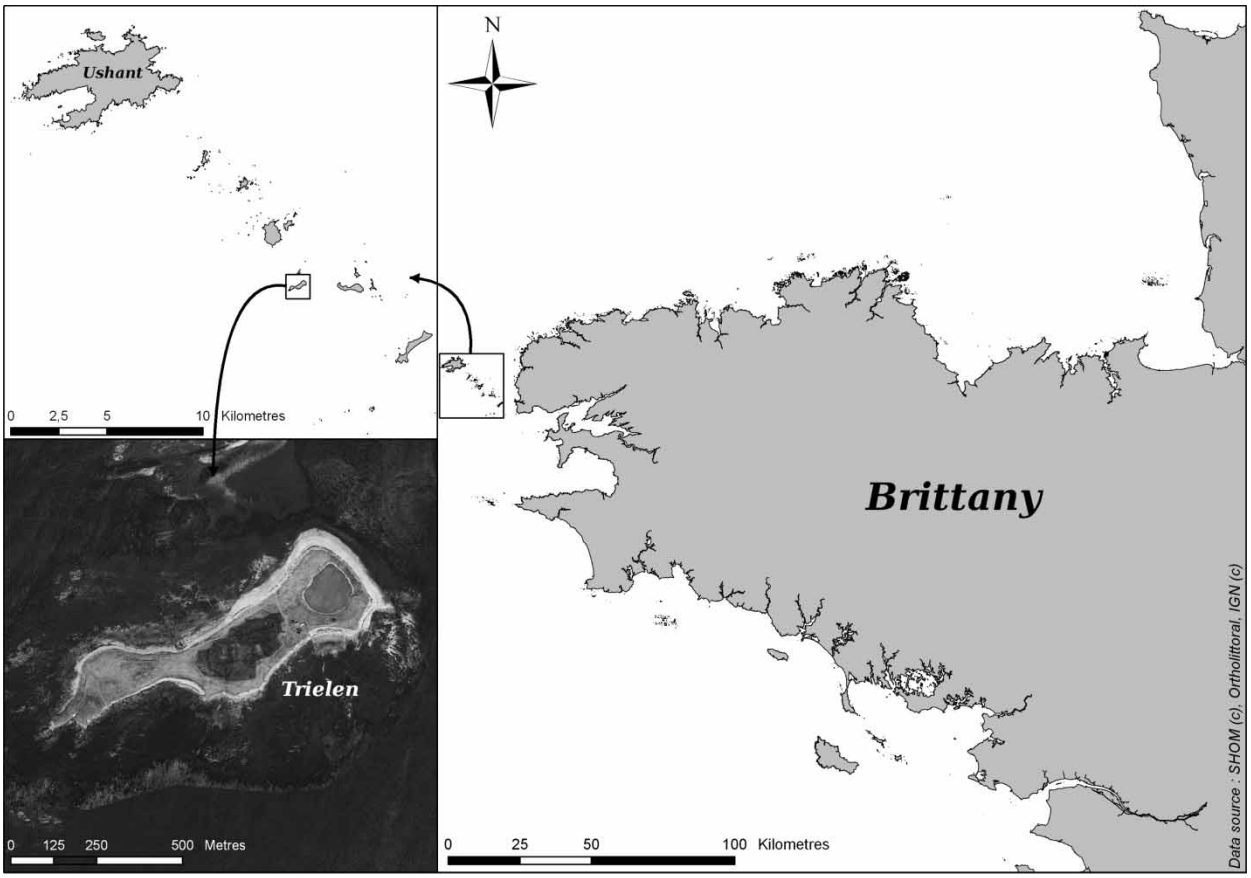

Figure 1. Location of the study area in northwest France.

Table 1. Details of catches of Purple Sandpipers in France (dates, numbers of ringed birds and methods of catching).

Date	Number of first-years	Number of adults	Total	Percent first-year	Number of birds at the high-tide roost	Method of catching
5 and 6 April 2008			6		80	Mist net
12 to 14 April 2009	3	6	9	33.3	90–110	Mist net
25 to 27 April 2009	6	3	9	66.7	95–105	Mist net and dazzle net
14 and 15 April 2010	23	12	35	65.7	140	Dazzle net
11 March 2011	7	12	19	36.8	120	Dazzle net
9 April 2011	4	8	12	33.3	184	Dazzle net
Total			90			

with the frontal feathers. Maximum wing length was measured with a stopped rule to 0.5 mm.

Biometrics and analysis

The frequency distribution of bill lengths of Purple Sandpipers tends to be bimodal, with females having longer bills. Therefore, the frequency distribution was analysed using a Harding–Cassie plot to determine the mean bill lengths of the sexes (Harding 1949, Cassie 1954). The mid-point between the means for the sexes was used to split the distribution into males and females to derive the sex ratio. The two age classes were combined because the bill lengths of first-year birds are similar to

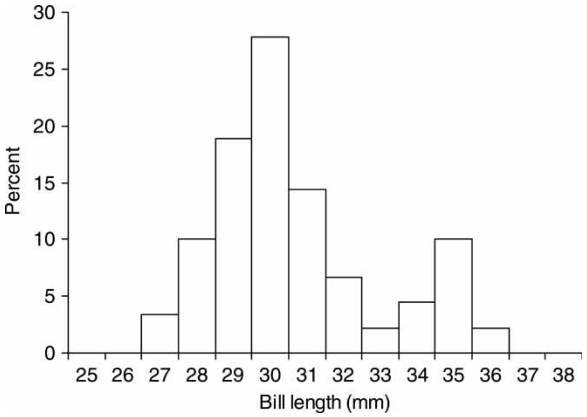

Figure 2. Frequency distribution of bill lengths of Purple Sandpipers in France (n = 90).

those of adults, and so their bills are assumed to be fully grown (Atkinson *et al* 1981, Summers *et al* 2009).

A scatter plot of bill against wing lengths was used to compare with data from different breeding populations. Given that earlier studies in Britain and southern Sweden have shown that Purple Sandpipers in this region originate from southern Norway and possibly Canada and Russia (Nicoll *et al* 1988, Hake *et al* 1997), we compared the French data with only these populations. Ellipses describing the 95% ranges (mean ± 1.96 standard deviations [sd]) for males and females were superimposed on the scatter plot.

RESULTS

For captured birds, the percentage of first-years ranged from 35.5% to 65.7% for different years (Table 1). However, direct observations of free-living birds at a high-tide roost on 14 April 2009 provided an estimate of 22% first-year birds (n = 90); the value for trapped birds in this year was 50%.

The frequency distribution of bill lengths was bimodal, with most birds around the mode for smaller bills (Fig 2). The means for the two classes were 29.8 mm (sd = 1.3) and 34.9 mm (sd = 0.7). The standard deviation for the longer bills was imprecise due to the small number of birds in this class. The mid-point between the sexes was 32.35 mm, thus splitting the distribution into 73 males (81%, 95% confidence limits 73–89%) and 17 females. The average biometrics of the males and females of the different age classes are shown in Table 2, excluding the first six birds trapped, which were not aged. This partly accounts for the small difference between the mean bill lengths in Table 2 compared to those derived from the Harding–Cassie plot, which included all birds.

Table 2. Mean bill and wing lengths (mm) of Purple Sandpipers in France. Standard deviations are in brackets.

	Sample size	Wing length	Bill length
Adult male	32	129.5 (2.9)	30.2 (1.2)
First-year male	35	129.4 (2.4)	29.4 (1.2)
All males	67	129.5 (2.6)	29.7 (1.3)
Adult female	9	134.3 (1.5)	34.4 (1.2)
First-year female	8	134.3 (1.6)	34.3 (1.1)
All females	17	134.3 (1.5)	34.4 (1.1)

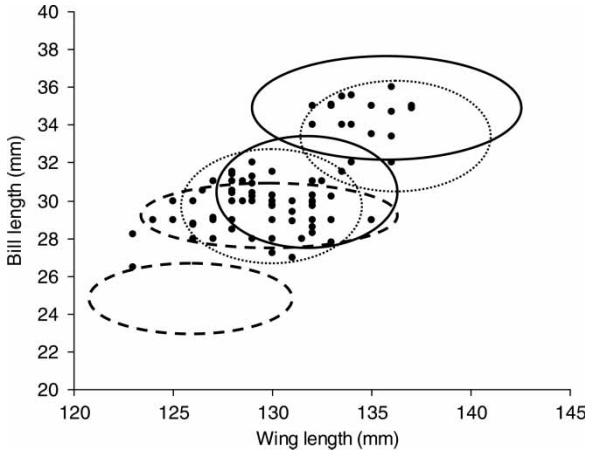

Figure 3. Scatter plot of bill length against wing length for Purple Sandpipers in France (dots). Superimposed ellipses show the 95% ranges for male (smaller) and female (larger) breeding birds from Canada (solid lines), Russia (dotted lines) and southern Norway (dashed lines). Data from breeding populations were obtained from Nicoll *et al* (1991) and Engelmoer & Roselaar (1998).

A plot of bill length against wing length showed that the data clustered into two groups, representing males (smaller) and females (larger) (Fig 3). By comparison with superimposed ellipses for data from Norwegian, Russian and Canadian breeding birds, the French birds fitted more closely with the Russian and Canadian birds.

DISCUSSION

The percentage of first-year birds amongst the mist-netted and dazzle-netted samples was high (ranging from 35.5% to 65.7% for the different years) in comparison to other studies in which birds were cannon-netted: 24% in eastern Scotland (Atkinson *et al* 1981), 21% in Troms,

Norway (Summers *et al* 1990), and 35% in Finnmark, Norway (Strann *et al* 2006). This difference was probably due to the method of catching, because the percentage of first-year birds in a free-living sample was 22%, compared to 50% in the sample captured in the same year. Presumably, it is easier to mist-net and dazzle-net first-year birds than adults (Pienkowski & Dick 1976).

The data indicate that the Purple Sandpipers that spend the winter in northern France may originate from Canada, as suspected for Purple Sandpipers that occur in northern and western Britain and Ireland (Summers *et al* 2009, Foster *et al* 2010). Therefore, France may be seen as an extension of the migratory route down western Europe. However, there is also the possibility that the French birds originate from Russia. Hake *et al* (1997) suggested that some Purple Sandpipers pass through western Sweden and the Baltic Sea to breed in Russia, having wintered in the southern North Sea. Therefore, the winter range could include northwest France.

The method of splitting the bimodal distribution according to the mid-point between the means for the two sexes has some bias. Some males above 32.35 mm will be classed as females and some females below 32.35 mm will be classed as males. However, in the determination of the sex ratio, incorrectly classified males will cancel out incorrectly classified females, until there is no more of the sex that occurs in smaller numbers. Thereafter, there will be predominance of misclassification of the dominant sex, leading to a biased though conservative sex ratio. Therefore, it is likely that the percentage of males in this sample is slightly greater than 81%.

An uneven sex ratio in favour of males is a common pattern for Purple Sandpipers for many locations through the non-breeding range: 58% in eastern Scotland (Atkinson *et al* 1981), 60% in north Norway (Summers *et al* 1990), 70% in Maine, USA (Mittelhauser *et al* 2006), 78% in Ireland (Foster *et al* 2010) and 61% in Iceland (Hallgrimsson *et al* 2011), perhaps due to differential mortality amongst males and females shortly after fledging (Hallgrimsson *et al* 2011). Greenland is the only place where more females have been found (47% males, though not significantly different from even; Summers 2007). There is no evidence that some regions have a preponderance of females. Therefore, there is growing evidence that there are more males within Purple Sandpiper populations.

ACKNOWLEDGEMENTS

We would like to thank the members of the Réserve Naturelle d'Iroise, Jean-Yves Le Gall and David Bourles for helping us in the field and Bretagne Vivante and the Centre de Recherche sur la Biologie des Populations d'Oiseaux (Muséum National d'Histoire Naturelle, Paris) for allowing the realisation of this project.

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(MS received 16 December 2010; accepted 8 August 2011)