Ornis Fennica 88:104–109. 2011

Brief report

Differential timing of passage of populations of migratory Blackcaps (*Sylvia atricapilla*) in Spain: evidence from flight-associated morphology and recoveries

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Received 10 July 2009, accepted 22 December 2010

We examined the timing of passage of migratory Blackcaps (*Sylvia atricapilla*) at a stopover site in northern Iberia, Spain, in an area relatively close to an important wintering area for the species, in southern Iberia. With this goal, we analysed ring-recovery data and examined the seasonal, year-to-year and age variations of flight-associated morphology (wing length and wing morphology). In autumn, Blackcaps with longer and more pointed wings (supposedly long-distance migrants) were captured significantly later than birds with shorter and less pointed wings (i.e., less pronounced long-distance morphology). Moreover, in autumn Blackcaps from the Britain and Ireland were proportionally more abundant than Blackcaps from mainland Europe during early autumn than during late autumn, supporting the hypothesis that Blackcaps from the Britain and Ireland migrate earlier than those from mainland Europe. These findings suggest that Blackcaps from the Britain and Ireland might have the wing morphology characteristics for shorter-distance rather than long-distance migration. In spring, however, wing length, wing morphology and the origin (Britain and Ireland versus mainland western Europe) did not vary with trapping date. This lack of differences in spring suggests an absence of a differential timing of passage by different Blackcap populations in spring. However, we may have been unable to detect such differences due to a small sample size or the fact that spring migration takes place within a shorter period than autumn migration.

1. Introduction

In migrants with large areas of distribution, either during breeding or in winter, the timing of migration can differ among populations (e.g., Cramp 1988, 1992). Detailed analyses on this phenomenon can be useful for helping to explain causes of spatio-temporal distribution patterns among migratory populations throughout the annual cycle. Migration leaves a 'footprint' on avian morphology, because it promotes selection for adaptations for long-distance flight (Berthold 1996). Particularly, wings become longer and more pointed with increasing migration distance, which can be detected both at the inter- (Mönkkönen 1995, Calmaestra & Moreno 2001) and intra-specific level (Chandler &Mulvihill 1990, Copete *et al*. 1999, Fiedler 2005, Arizaga *et al.* 2006). Therefore, temporal variation in flight morphology during migration period at a given site may be attributable to differential passage of populations with different migration distances (Gustin *et al.* 1999, García-Peiró 2003).

The Blackcap (*Sylvia atricapilla*) is one of the most abundant passerines through the western Palaearctic, breeding from Iberia to Russia, from northern Europe to northern Africa, as well as in Macaronesia (Shirihai *et al.* 2001). Blackcap populations vary from long-distance migrants in northern Europe to strictly resident in southern Europe and the Atlantic islands (reviewed in Shirihai *et al.* 2001). A geographic cline occurs, with northern breeders having relatively longer and more pointed wings than birds breeding in more southern areas can still be found (Tellería & Carbonell 1999, Fiedler 2005). However, in some populations the migration distances can also vary at the intra-population level (Berthold 1996), so distinct morphologies could be found within a single population.

In the present work, we examined the possible existence of differential timings of passage of populations of migratory Blackcaps at a stopover site in northern Iberia, relatively close to an important wintering area for the species, in southern Iberia. With this goal, we analysed recovery data and examined the seasonal, year-to-year and age variation of flight-associated morphology.

2. Material and methods

2.1. Sampling area and ringing protocol

Field data were collected within a zone of Atlantic hedgerow at Loza (Navarra, northern Iberia, 42°50'N 01°43'W; for further details see Arizaga *et al.* 2009). Blackcaps were captured with mist nets (four linear sets, 60 m overall) during the autumn (from September to late-October) and spring migration period (from mid-March to the end of April) from September 2003 to April 2006. The mist nets were open for 4 h starting at dawn, with a mean frequency of four sampling sessions per each 10-day period.

Each Blackcap was individually ringed (or the ring was read) and its sex and age determined (Svensson 1998). Age categories used in this study were: first-year birds (i.e. birds with still some juvenile feathers in their wings and tails; EURING codes 3 and 5) and adults (older birds, caught after their complete moult; EURING codes 4 and 6). We also recorded wing length (abbreviated as 'WL'; ± 0.5 mm; method III following Svensson 1998), and the length of primary feathers P2 to P9 (± 0.5 mm; numbered from outermost to innermost primary), to assess wing morphology (abbreviated as 'WM'). To estimate WM we calculated a body size-controlled index (C_2) which is obtained from the primary feather lengths and assesses wing pointedness/roundedness (Lockwood *et al.* 1998). Positive, higher scores of the index are related to rounded wings whilst lower, negative values correspond to more pointed ones. We removed from this work those birds with unknown sex and/or age and with non-recorded measurements.

2.2. Biometric analyses

Both WL and WM had a low coefficient of variation (< 25%) and fitted the normal distribution (Kolmogorov-Smirnov test, $p > 0.05$), so the use of parametric procedures was adequate (Sokal & Rohlf 1995). To test for the effect of date on flight morphology we performed ANOVAs on WL and WM, with age, sex and year as factors and date as a covariate. Each period (autumn/spring) was considered separately. All analyses were done with SPSS 15.0. Means are given ± SE.

Table 1. The number of captures of Blackcaps at a stopover site in northern Iberia, in relation to season, year, age and sex, with their wing length and all primary feather lengths recorded.

		First-year birds		Adults	
Season	Year	Males	Females	Males	Females
Autumn	2003	210	181	82	81
	2004	227	186	82	51
	2005	278	231	66	42
Spring	2004	83	68	38	24
	2005	46	48	14	14
	2006	84	85	46	30
Total		928	799	328	242

2.3. Recovery data

Recovery data on Blackcaps ringed abroad and recaptured in Iberia, or *vice-versa*, were obtained from Euring databank. We considered here recaptures obtained in the western Pyrenees (regions ES02 and ES24 from EURING code), where the study site was carried out. Owing to sample size constraints, data were lumped into 10-day intervals (autumn: interval 1 = 1–20 September; 2 = 21–30 September, etc.; spring, interval 1 = 21–31 March, 2 = 1–10 April, etc.). Within each period, correlations between 10-day periods and (1) the mean geographic origin of recaptures, and (2) the proportion of recaptures from Britain and Ireland, were calculated.

3. Results

The data consisted of 2,297 observations, of which 1,727 were first-year and 570 were adult individuals (Table 1). In terms of biometrics in autumn, both WL and WM varied with date, age and year, with no significant interaction between these factors (Table 2). In particular, date was positively correlated with WL ($r = 0.180, p < 0.001$) and negatively correlated with WM ($r = –0.081$, $p = 0.001$), indicating that Blackcaps passing later through our site had longer and more pointed wings. Moreover, Blackcaps with a longer wing also had a more pointed wing ($r = –0.293$, $p < 0.001$), supporting the idea that both traits were related to each other in given individuals. In spring, only age had a significant effect on both WL and WM (Table 2).

The recovery data revealed that date (10-days intervals) in autumn was not correlated with the mean geographic origin (longitude: $r = 0.744$, $p = 0.149$; latitude: $r = –0.107$, $p = 0.864$, $n = 5$), but with the proportion of Blackcaps ringed in Britain and Ireland, that tended to be higher during early autumn ($r = –0.882$, $p = 0.048$, $n = 5$). In spring, however, neither the geographic origin of recaptures (longitude: $r = –0.329$, $p = 0.589$; latitude: $r = –0.395$, $p = 0.511$, $n = 5$) nor the proportion of Blackcaps ringed in Britain and Ireland were correlated with date ($r = 0.471$, $p = 0.423$, $n = 5$).

4. Discussion

Most of the explained variation in morphological traits was due to the effect of age on wing characteristics. Thus, adults had longer, more pointed wings than first-year birds. This result is in agreement with other works (Pérez-Tris & Tellería 2001) and has been linked with the idea that first-year birds may suffer from higher predation risk, which would select for the maintenance of proportionally shorter, more rounded wings that allow better manoeuvrability during the flight (Alatalo *et al.* 1984).

During the autumn migration period, long-distance migrant Blackcaps (with a longer, more pointed wing) were captured in northern Iberia significantly later than birds with a less pronounced long-distance morphology. Moreover, Blackcaps from Britain and Ireland were propor-

Table 2. ANOVA for the effect of date on wing length and wing morphology, with age, sex and year as factors in autumn (n = 1717) and in spring (n = 580).

	Autumn				Spring			
	SS	df	*F*	*p*	SS	df	*F*	*p*
Wing length								
Date	73.504	1	23.324	**<0.001**	1.041	1	0.352	0.553
Age	705.273	1	223.795	**<0.001**	224.632	1	76.002	**<0.001**
Sex	1.896	1	0.602	0.438	0.579	1	0.196	0.658
Year	20.605	2	3.269	**0.038**	17.198	2	2.909	0.055
Age×Sex	0.299	1	0.095	0.758	0.740	1	0.250	0.617
Year×Age	0.367	2	0.058	0.943	5.099	2	0.863	0.423
Year×Sex	2.298	2	0.365	0.695	1.323	2	0.224	0.799
Year×Age×Sex	4.133	2	0.656	0.519	4.718	2	0.798	0.451
Error	5370.034	1704			1675.830	567		
Wing morphology								
Date	0.098	1	5.926	**0.015**	0.047	1	3.024	0.083
Age	1.120	1	67.732	**<0.001**	0.112	1	7.177	**0.008**
Sex	0.005	1	0.314	0.575	0.002	1	0.129	0.720
Year	0.154	2	4.651	**0.010**	0.062	2	1.984	0.138
Age×Sex	0.008	1	0.495	0.482	0.024	1	1.525	0.217
Year×Age	0.030	2	0.900	0.407	0.015	2	0.481	0.619
Year×Sex	0.012	2	0.372	0.690	0.008	2	0.241	0.786
Year×Age×Sex	0.033	2	0.989	0.372	0.027	2	0.856	0.425
Error	28.173	1704			8.851	567		

tionally more abundant than Blackcaps from mainland western Europe during early autumn rather than late autumn, supporting the hypothesis that Blackcaps from Britain and Ireland migrate earlier than those from mainland Europe (e.g., Phillips 1994). Meanwhile, Fransson (1995) observed that the timing of migration in Blackcaps in southern Sweden was earlier than in southern Britain. However, as Scandinavian Blackcaps belong to a population that is differentiated from the Blackcaps of mainland west Europe (Shirihai *et al.* 2001), that arrive in Iberia (Cantos 1995), we cannot rule out the possibility that these populations would show different migration strategies, including departure times from their breeding areas.

The combination of our two findings on biometrics and recoveries also supports the idea that the Blackcaps from Britain and Ireland could have a less pronounced long-distance morphology. This is because, when compared to mainland European populations, they perform a shorter distance of migration (Pérez-Tris *et al.* 2003, Arizaga *et al.* 2006) and overwinter closer to their breeding areas (Wernham *et al.* 2002).

As a partial migrant, even a given population could exhibit high individual variation in migratory behaviour (Berthold 1996), in association with high morphological variation to suit that range of behaviours. If this hypothesis is true, our results may reflect a sequence of timing of passage of morphologically-differentiated birds, potentially from mixed populations rather than from discrete populations. Such a hypothesis, however, was not supported by our analyses on recovery data, but lent support to the population-associated differential migration hypothesis.

In spring, neither the flight-associated morphology nor the geographic origin of Blackcaps varied with the date. Hence we could not draw conclusions on the existence of differential migration at the population level. Such a result is in contrast with the rule that, generally, birds with longer migration distances pass later than others with shorter migration distances (reviewed by Newton 2008), including the Blackcap and several *Sylvia* species (Fransson 1995, Gustin *et al.* 1999). Compared to autumn, spring migration is more concentrated in time (Fransson 1995). This, together with lower sample sizes obtained during this period at Loza (Table 1), probably hampered our ability to detect different timings of migration in Blackcap populations when passing through northern Iberia should they exist (Arizaga & Barba 2009).

Acknowledgements. We are grateful to the people who assisted us during the field work, especially A. Agorreta, D. Alonso, A. Arias, I. Fernández, J. Gurbindo, G. Heras, A. Irujo, F. Jorganes, M. A. Hernández, D. Martín, A. Mendiburu, A. Murua, E. Robles, A. Vilches, A. Villarroya. The Government of Navarra funded the study and gave the ringing permits. JA was supported by a post-graduate fellowship from the Basque Government. EB was partially supported by project CGL2007-61395, Ministerio de Educación y Ciencia. M. Koivula, R. Wodarczyk and two anonymous referees provided valuable comments that helped us to improve an earlier version of this work.

Muuttoajankohdan vaihtelu mustapääkertulla yksilöiden rakennepiirteiden ja rengaslöytöjen valossa

Tutkimme muuttavien mustapääkerttujen (*Sylvia articapilla*) muuttoajankohtia Pohjois-Iberiassa, Espanjassa alueella, joka sijaitsee lähellä Etelä-Iberian tärkeää talvehtimisaluetta. Rengastusaineistoa käyttämällä selvitimme vuodenaikaista, vuosien välistä sekä ikäriippuvaa, lentämiseen liittyvää yksilöiden rakennepiirteiden vaihtelua (siiven pituus ja muoto). Syksyllä pidemmät ja terävämpikärkiset siivet omaavia yksilöitä (piirteet viittaavat pidempään muuttomatkaan) saatiin merkitsevästi myöhemmin kuin yksilöitä, joilla oli lyhyemmät ja pyöreämpikärkiset siivet (oletettavasti lyhyempi muuttomatka).

Edelleen Brittein Saarilla alun perin rengastetut yksilöt olivat mannereurooppalaisia runsaampia varhais- kuin loppusyksyllä, mikä voisi viitata edellisten aikaisempaan syysmuuton ajankohtaan. Edelleen löytömme viittaavat siihen, että Brittein Saarten yksilöillä olisi pikemmin lyhyemmän kuin pidemmän muuttomatkan siipimalli. Keväällä kuitenkaan siiven pituus, muoto tai yksilöiden alkuperä (Brittein Saaret tai Manner-Eurooppa) eivät vaihdelleet ajankohdasta riippuen, mikä voi viitata kevätmuuton samanaikaisuuteen eri populaatioilla. Toisaalta mahdolliset erot saattoivat jäädä havaitsematta pienen näytekoon tai kevätmuuton lyhyemmän keston vuoksi.

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