reported for Sooty Shearwaters, so it is not yet possible to test the hypothesis that mass-related survival of fledgling Sooty Shearwaters is mediated by sex-related philopatry.

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Increased asymmetry of tarsus-length in three populations of Blackcaps *Sylvia atricapilla* as related to proximity to range boundary

The ability of individuals to thrive in a given region is considered to decrease towards the boundary of their range (Hengeveld & Haeck 1982, Brown 1984, review by Lawton 1993). The Mediterranean region is a peripheral area of the Palaearctic realm which shows pronounced droughts in summer, in contrast with more northern, mesic European sectors. Many forest passerines are scarce in Mediterranean forests and woodlands (Tellería & Santos 1993, 1994 for the Iberian Peninsula). Because most European forest passerines have a Palaearctic distribution (Blondel 1990a), such scarcity has been interpreted as a consequence of their decreased ability to thrive in this peripheral area. However, abundance may be a misleading indicator of habitat quality (Van Horne 1983). Thus, independent measures of the condition of individuals are required to confirm the unsuitability or otherwise of Mediterranean habitats for Palaearctic forest birds.

Blondel (1990b) has suggested that a critical season for bird survival in the Mediterranean region is the hot, dry summer, when high temperatures may cause nestlings to suffer hyperthermia and problems of water balance. This hypothesis may be tested by using the fluctuating asymmetry of bilateral traits as an index of the developmental stress experienced by birds. Fluctuating asymmetry is an indirect estimate of the fitness of individuals (Soulé 1967, Hoffman & Parsons 1991, Clarke 1995) that has been used to evaluate the increased stress of edge populations in other taxonomic groups (Parsons 1992). Because the growth of the tarsus is completed in passerines just before the fledging stage (Alatalo & Lundberg 1986, Potti & Merino 1994), its fluctuating asymmetry could be used as an index of environmental stress during the embryonic and early nesting periods.

Blackcaps *Sylvia atricapilla* occur throughout the western Palaearctic (Cramp 1992), inhabiting nearly all wooded habitats of the moist, northern Atlantic belt of the Iberian Peninsula (Fig. 1). In central Spain, however, they show a limited distribution, restricted to woodlands of moist mountains or river banks (Tellería & Santos 1993). Rainfall levels are, in fact, the best predictor of the distribution of Blackcaps in the Iberian Peninsula (Tellería & Santos 1993, 1994). Here, we suggest that the fluctuating asymmetry of tarsus length in breeding Blackcaps increases along the moist–xeric, latitudinal gradient of Iberian forests.

During 1995 and 1996, we studied breeding Blackcaps at three localities that cover most of the climatic gradient found in the Iberian Peninsula (Fig. 1): Alava (42°55'N, 2°29'W; altitude 620 m),

Figure 1. Location of the Blackcap study areas (black spots) in the Iberian Peninsula. Mean annual temperature isotherms for 12°C and 16°C and areas with mean annual precipitation over 600 mm (shaded) are shown. The continuous line shows the boundary between the Atlantic and Mediterranean regions.

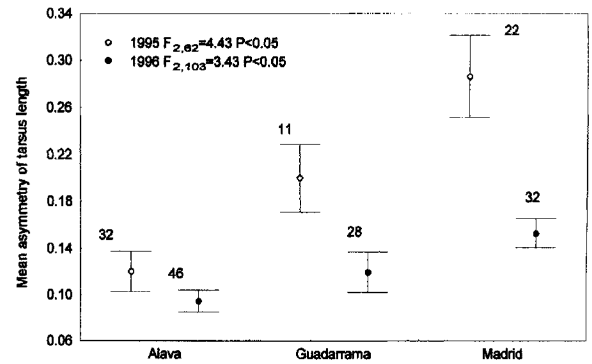

Figure 2. Mean (±s.e.) fluctuating asymmetry of Blackcap tarsus-length in the three study areas during the 1995 and 1996 springs. Numbers show sample sizes.

Sierra de Guadarrama (40°54'N, 3°53'W; altitude 1100 m) and Madrid lowlands (40°30'N, 3°40'W; altitude 600 m). After a drought for several years in the Mediterranean sector of the Iberian Peninsula, precipitation increased (total precipitation from April to July in 1995 and 1996: Alava, 143.6 mm and 118.4 mm; Guadarrama, 77.5 mm and 167.9 mm; Madrid, 31.9 mm and 93.8 mm), and mean maximum daily temperatures decreased in the 1996 spring (mean maximum daily temperatures from April to July in 1995 and 1996 [n = 122 days per year and region]: Alava, 21.9°C and 21.3°C; Guadarrama, 22.6°C and 21.6°C; Madrid, 27.5°C and 26.1°C). Maximum daily temperature in spring varied both between areas ($F_{2,726}$ = 49.2, P < 0.001) and between years ($F_{1,726}$ = 4.7, P < 0.05; but year × area interaction, $F_{2,726}$ = 0.2, n.s.). Blackcaps occupy oak woodlands in Alava (*Quercus faginea*) and Guadarrama (*Quercus pyrenaica*), whereas in Madrid they are restricted to old Black Poplar *Populus nigra* plantations and Willow *Salix* spp. thickets of river banks.

We captured Blackcaps in May–July in 1995 and 1996, using playbacks of their songs to attract them towards mist nets. This method was especially effective for territorial males (Falls 1981), although females and fledglings were also captured. Overall, we captured 93 males, 27 females and 51 fledglings in the three study areas (Alava, n = 78; Guadarrama, n = 39; Madrid, n = 54). Because Blackcaps in Iberia show high rates of fidelity to breeding areas (Cantos & Tellería 1994), we assume that most of the individuals were born at their region of capture. After capture, birds were measured, marked with standard aluminium rings (to prevent using repeated measurements of the same individual) and then released.

We measured the length of the left and right tarsus of each individual with calipers to the nearest 0.05 mm (Svensson 1992). All measurements were made by the same person (R.C.). Blackcaps were difficult to recapture (we recaptured only four individuals, of which only one was captured in another year) so that errors in measuring tarsus-length and asymmetry were estimated by comparing the measurements of the tarsi of 17 Robins *Erithacus rubecula* that were captured in the field on two occasions. Fluctuating asymmetry was estimated as the difference between the lengths of the right and left tarsi (Palmer & Strobeck 1986). Both measurements were highly repeatable in the Robins (tarsus-length: %ME = 2.33, $F_{33,34}$ = 84.6, P < 0.001; fluctuating asymmetry: %ME = 8.56, $F_{16,17}$ = 22.35, P < 0.001; where %ME is the percentage of the contribution of measurement error to total variability in the dimension; see Bailey & Byrnes 1990). The length of the tarsus did not show antisymmetry in Blackcaps, since the distribution of signed right-minus-left values did not depart significantly from normality (one-sample Kolmogorov-Smirnov test: 1995, D_{65} = 0.15, n.s.; 1996, D_{106} = 0.08, n.s.), nor did it show directional asymmetry, since the mean of signed right-minus-left values did not differ from zero (one-sample t-test: 1995, t_{65} = 1.48, n.s.; 1996, t_{106} = 1.39, n.s.; see Møller 1995). Mean tarsus-length did not correlate with tarsus-length asymmetry (1995, r_{65} = 0.145, n.s.; 1996, r_{106} = 0.01, n.s.). The mean length of the tarsus did not differ significantly between areas (Table 1).

We found no significant effects of sex (ANOVA: 1995, $F_{1,53}$ = 0.01, n.s.; 1996, $F_{1,63}$ = 0.2, n.s.) or age (ANOVA: 1995, $F_{1,63}$ = 0.2, n.s.; 1996, $F_{1,104}$ = 0.003, n.s.) on asymmetry. However, there was a significant increase in fluctuating asymmetry from Alava towards Madrid (Fig. 2). Tarsus-length asymmetry varied both between areas ($F_{2,165}$ = 9.2, P < 0.001) and between years ($F_{2,165}$ = 10.5, P < 0.01; year × areas interaction, $F_{2,165}$ = 2.1, n.s.). This interyear change affected mainly the southernmost locality (t-test for interyear variations in asymmetry: Alava, $t_{32,46}$ = 0.9, n.s.; Guadarrama, $t_{11,28}$ = 1.5, n.s.; Madrid, $t_{22,32}$ = 2.7, P < 0.01). This decrease in asymmetry of southern Blackcaps during 1996 may be related to the improvement of the environmental conditions during the 1996

Table 1. *Mean (±s.e.) tarsus-length (in mm) of Blackcaps from the three study areas*

	Right tarsus	Left tarsus
Alava (n = 78)	19.96 ± 0.075	19.92 ± 0.074
Guadarrama (n = 39)	19.97 ± 0.088	19.99 ± 0.083
Madrid (n = 54)	19.95 ± 0.097	19.91 ± 0.084
	$F_{2,168}$ = 0.05, n.s.	$F_{2,168}$ = 0.11, n.s.

spring (less dry and hot in the southern localities). However, fledglings and adults showed a similar pattern of interyear variation (three-way ANOVA: interlocalities, $F_{2,159} = 10.4$, $P < 0.01$; interyears, $F_{1,159} = 6.53$, $P < 0.05$; interages, $F_{1,159} = 0.16$, n.s.; locality–year interaction, $F_{2,159} = 3.56$, $P < 0.05$; other interactions, n.s.). Since the adults measured in 1996 were born during or before 1995, their low asymmetry cannot be a consequence of the decreased environmental stress of the 1996 spring. If fluctuating asymmetry reflects the ability of individuals to cope with environmental stress, this decrease between years in the asymmetry of adult Blackcaps could reflect the disappearance of the less fit birds (see Møller 1995 for a similar explanation on the changing patterns of asymmetry in Blackbirds *Turdus merula*). Although further data are clearly needed to interpret this interyear variation in asymmetry (e.g. was it a consequence of the hard drought of the 1995 summer? are the low interyear recapture rates a reflection of a strong mortality?), results in this paper are consistent with the proposed increase of environmental stress of nestling Blackcaps along the moist–xeric, latitudinal gradient of Iberian forests.

Although we have related fluctuating asymmetry to environmental stress during development, asymmetry could also be affected by other factors that we have not studied, for instance developmental stress caused by reduced genetic variation, hybridization or mutation (Palmer & Strobeck 1986, Leary & Allendorf 1989). However, southern Blackcaps are distributed continuously, following riparian corridors, from the forests and woodlands of the Guadarrama Mountains towards the lowland forests associated with river banks (Díaz *et al.* 1994). This distribution pattern is inconsistent with the classic scenario of small, isolated, edge populations which are likely to suffer genetic effects as a result of inbreeding or increased homozygosity (Parsons 1992).

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Medieval record of the Siberian White Crane *Grus leucogeranus* in Egypt

The discovery of a published medieval record of the Siberian White Crane *Grus leucogeranus* from the Nile Delta, together with indication of the occurrence of the species in ancient Egypt, puts a new perspective on this species which is globally threatened at this time.