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PHENOLOGICAL PARAMETERS OF A BLUETHROAT *LUSCINIA SVECICA AZURICOLLIS* POPULATION BREEDING AT HIGH ALTITUDE IN SPAIN

PARÁMETROS FENOLÓGICOS DE UNA POBLACIÓN DE PECHIAZUL *LUSCINIA SVECICA AZURICOLLIS* NIDIFICANTE A GRAN ALTITUD EN ESPAÑA

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SUMMARY.—Bluethroats *Luscinia svecica azuricollis* breeding in Spain belong to a poorly known endemic subspecies that is restricted to a relatively small distribution range. We aimed to present information on some basic life-history parameters from a population breeding at high altitude in central Spain. In particular, we wanted to answer the following questions: (1) When do these birds reach their breeding area, and when do they depart? (2) When do chicks appear in the population? (3) Do adult birds reach their breeding area with extra fuel? Do they depart from their breeding areas with fuel? (4) Do they moult within their breeding area? To answer these questions we used ringing data of birds captured during 2011 at La Covatilla, Salamanca province. Adults were caught mostly from May to July (no captures in August, 2.4% of adults in September). First-year bluethroats, however, appeared in June and remained in the zone up to September. Moulting adults (66% of 12 birds in total) were caught only in July. Moulting first-year birds were caught from July to September. The percentage of moulting first-year birds in relation to all captures in August and September was comparatively low (10% in both months) relative to July (40%), indicating that most birds underwent their post-juvenile moult shortly after fledging. Body condition (residual body mass) did not differ between age classes and months. We detected no evidence suggesting fuel accumulation before the autumn migration. Thus, if the population needs to gain fuel for this migration, this must happen elsewhere.

Key words: Central System, endemism, fuel load, moult, population structure.

RESUMEN.—Los pechiazules *Luscinia svecica azuricollis* nidificantes en España pertenecen a una subespecie endémica escasamente conocida. En esta nota tratamos de contribuir a conocer algunos parámetros de su historia natural en un área de cría localizada a gran altitud en el centro de España. En particular, se abordaron las siguientes cuestiones: (1) ¿Cuándo llegan los individuos nidificantes al área de cría y cuándo la abandonan? (2) ¿Cuándo se incorporan los primeros pollos a la población? (3) ¿Llegan los adultos con reservas extras a la zona de cría? ¿Parten de la zona de cría con reservas?

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(4) ¿Tiene lugar la muda en el área de cría? El estudio se realizó en La Covatilla (provincia de Salamanca) durante 2011. Se capturaron aves adultas sobre todo entre mayo y julio (en agosto no se capturó ninguno y en septiembre solo un 2,4% de todos los que se capturaron en todo el periodo de estudio). Las aves de primer año se capturaron desde junio hasta septiembre. Se capturaron adultos mudando solo en julio (66% de 12 aves), mientras que las aves de primer año se capturaron ejemplares en muda activa desde julio hasta septiembre. El porcentaje de individuos de primer año en muda activa en agosto o septiembre fue más bajo (10%) que en julio (40%), sugiriendo que la mayoría de los individuos de primer año mudan tras abandonar el nido. La condición corporal no varió entre clases de edad ni durante el periodo de estudio. No se registró ganancia de reservas al final de la época de estudio, por lo que, si existe ganancia de reservas previa a la migración posnupcial, esta ha de llevarse a cabo en otras zonas.

Palabras clave: endemismo, estructura de la población, muda, reservas corporales, Sistema Central.

Knowledge of basic aspects of species' biology is a fundamental requirement in more complex studies (e.g. evolutionary or applied ecological studies), as well as for implementing conservation or management measures. Phenological studies focus on processes that show cyclical (e.g. annual) variations. Classic research on this topic for breeding birds analyses such parameters as timing of breeding or permanence within breeding quarters (Tøttrup *et al*., 2012; Solonen, 2014); laying, hatching and fledging dates (D'Amico *et al*., 2003; Bogdanova *et al*., 2007); timing of moult in the breeding quarters (Jenni and Winkler, 1994; Alonso and Arizaga, 2011) and seasonal variation in body condition (Polo and Bautista, 2006; Alonso and Arizaga, 2011).

The bluethroat *Luscinia svecica* breeds widely across Palearctic Eurasia, with an outpost presence in Alaska (Cramp, 1988; Collar, 2005) (no longer breeds in Canada apparently and only had a marginal presence there; http://www.hbw.com/species/bluethroat-luscinia-svecica). The Iberian population is likely to be a distinct subspecies, *L. s. azuricollis* (Johnsen *et al*., 2006), which breeds at high altitude in mountain ranges of northwestern and central Iberia, normally at 1,200-2,000 m, although some nest well below 1,000 m. The breeding sites are abandoned in winter and until the bluethroats return in spring, from wintering areas that are likely to be in tropical Africa (Arizaga *et al*., 2006b). The bluethroat in Europe is a species of concern (Annex I of Birds' Directive). Improving our knowledge of the basic phenological parameters of populations at their breeding areas is important from the standpoint of conserving this Iberian endemic subspecies (Arizaga *et al*., 2011).

The fundamental phenological parameters of bluethroats at their breeding sites in Spain are poorly known (Arizaga *et al*., 2011). A montane songbird in Spain (Gómez-Manzaneque, 2003; but see García *et al*., 2008) would be expected to show phenological parameters associated with breeding at high altitude, such as (1) late arrival at breeding sites and early departure after breeding, (2) a relatively late laying date, with a correspondingly late appearance of first-year birds within the population, and (3) a rapid post-breeding/juvenile moult. First-year bluethroats perform a partial moult prior to the autumn migration period, whereas adults undergo a complete moult on their breeding areas (Jenni and Winkler, 1994; but see Ellegren and Staav, 1990). This pattern has not hitherto been investigated for bluethroats breeding in Iberia.

We aimed to determine some fundamental phenological parameters for a bluethroat population breeding at high altitude in Spain.

In particular, we wanted to answer to the following questions: (1) when do these birds reach their breeding area, and when do they depart? (2) When do chicks appear in the population? (3) Do adult birds reach their breeding area with extra fuel? Do they depart from their breeding areas with fuel? (4) Do they moult in their breeding area?

Data were obtained near La Covatilla (40º 21' N, 05º 41' W, 1,962 m.a.s.l), in the Sierra de Béjar, west of the Sierra de Gredos in central-western Spain. This is one of the chief breeding areas for the bluethroat in Iberia (Gómez-Manzaneque, 2003). The density of bluethroats in Sierra de Béjar was estimated to be 3 birds/10 ha (Peris, 1983), one of the highest in Iberia (Arizaga *et al*., 2011). The vegetation in this area comprises broom (*Genista*, spp.), distributed in more or less dense patches among which there are small flooded zones with peat bogs, streams and meadows. The area is grazed by cattle in summer.

Sampling was carried out during the 2011 breeding season, from early April until no birds were seen in the area. Sampling consisted of visual checking for the presence of the species, capture and ringing. Capture was carried out once we saw that the species was present and contined for one month after the last captures. Overall, the area was visited at fortnightly intervals from April to October. Bluethroats were captured with spring traps baited with mealworms *Tenebrio* spp., as well as in mist nets situated close to water points, soil depressions, etc. Birds were attracted to the traps with tape lures of the male territorial song). Once captured, each bird was ringed, sexed and aged (Svensson, 1996). Birds were aged either as first-years or adults, based on their wing feathers. We also recorded wing length (to 0.5 mm), tarsus length (to 0.1 mm) and body mass (to 0.1 g). We also checked whether each bird was moulting or not. All captures were assigned to *L. s. azuricollis* since the other subspecies that also occur in Iberia, *L. s. namnetum* and *L. s. cyanecula* (Arizaga *et al*., 2006a) only occupy lowland wetlands and only occur during migration periods or in winter; up to April in spring and from mid-August in autumn (Tellería *et al*., 1999).

Statistical procedures were used to test whether (1) the proportion of moulting birds varied between months (using the χ^2 test), and (2) body condition varied between age classes and across the season (months were used as the time unit for these analyses). Body condition was estimated by regressing body mass on wing length. This regression fitted the data better than a regression of body mass on tarsus length (wing length: $r^2 = 0.12$, $F = 27.74$, $P < 0.001$; tarsus length: $r^2 = 0.06$, $F = 13.99$, $P < 0.001$; $n = 216$). Residual body mass on wing length (i.e. residual values from a linear regression of body mass on wing length) fitted the normal distribution (K-S test: $Z = 0.975$, $P = 0.297$; $n = 216$). Thus, we conducted an ANOVA on residual body mass with age and month as fixed factors; the interactions were not considered in the model due to the small sample sizes and the fact that not all age-classes were captured during all months (fig. 1).

Bluethroats were only recorded during May-September. However, no adults were caught in August, and in September only 2.4% of all captures ($n = 42$) were adults (fig. 1). First-year bluethroats appeared in the population in June and were captured until September. By October, all birds had left the area.

Moulting adults (66% of 12 birds in total) were only caught in July. Moulting first-year birds, however, were caught from July to September. The percentage of moulting first-year birds in relation to all captures in August and September was comparatively low (10% in both months) in relation to July (40%), these differences being statistically significant ($\chi^2 = 19.10$, $P < 0.001$, df = 2), indicating that most birds underwent their post-juvenile moult shortly after fledging.

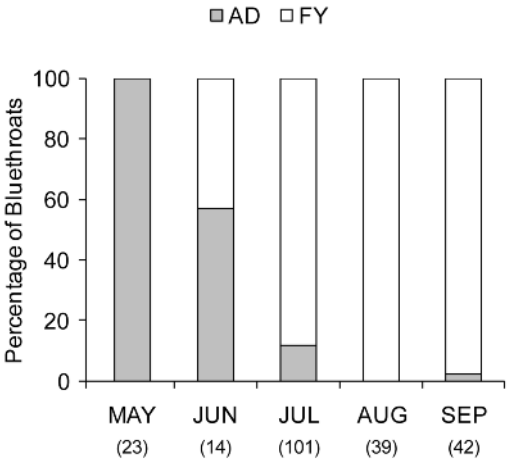

FIG. 1.—Proportions (%) of adult and first-year birds (AD and FY, respectively) among bluethroats captured at La Covatilla in 2011. Sample sizes are shown below each month. Each bird has been considered once per month.
[Porcentaje de adultos y primeros años (AD y FY, respectivamente) en la población de La Covatilla, en 2011. El tamaño muestral se indica bajo cada mes. Cada individuo se consideró una vez por mes.]

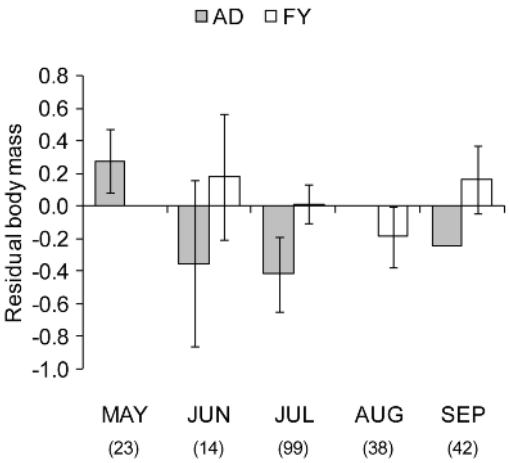

FIG. 2.—Seasonal variation (mean ± SE) of residual body mass of adult and first-year bluethroats (AD and FY, respectively) captured at La Covatilla in 2011. Sample sizes are shown below each month.
[Variación estacional (media ± SE) de los residuos de la masa corporal de adultos y primeros años (AD y FY, respectivamente) de pechiazul en la población de La Covatilla, en 2011. El tamaño muestral se indica bajo cada mes.]

Body condition (residual body mass) did not differ between age classes and months (ANOVA: Age, $F_1 = 2.422$, $P = 0.121$; Mon., $F_4 = 1.412$, $P = 0.231$; $n = 216$; fig. 2).

In accordance with the late parental arrival, first-year birds (fledglings) first appeared within the population in June. However, given that adults became established in May, it is evident that they were able to breed immediately after arrival. Although we did not find significant seasonal differences in residual body mass, it can be seen that adults tended to be more fuel-loaded in May (fig. 2). Having extra fuel loads when arriving at their breeding sites may enhance breeding success (Eichhorn *et al.*, 2010). If this is confirmed for the bluethroat, from a conservation standpoint it would be important to know where such energy stores are acquired.

It is interesting that adults became very scarce from August onwards. Capture-biases are unlikely, as adults were caught in reasonably large numbers until June and first-year birds were also caught until September using the same methodology. We cannot exclude that using tape lures may create some bias (Herremans, 1989; Figuerola and Gustamante, 1995; Brotons, 2000) and, for instance, may be less efficient in capturing adults late in the season, but we also used mist nets (without tape lures), where both adult and first-year bluethroats were captured. Alternatively, hardly any adults are caught once they start to moult. This is a common bias in some passerines (J. Arizaga, pers. obs.) but in this case we should notice that eight of 12 adults caught in July were moulting. Accordingly, it is more likely that

the lack of adults from August onwards was due to most of them having already left the area. Moult migration is performed by several passerine species (e.g. Borras *et al*., 2004), and by the bluethroat in particular (Ellegren and Staav, 1990). This rapid departure may be driven by the need of adults to find other alternative sites richer in food (or some other specific requirement) either to moult or to gain the energy stores needed for autumn migration (Newton, 2008). First-year bluethroats remained in the area until September, indicating that at least some birds of this age leave their natal sites later than the adults.

Both adults and first-year birds moulted soon after breeding, i.e. well before the autumn migration (Svensson, 1996). The main moulting period in July matches the dates reported in northern Europe (Cramp, 1988) and is even earlier than in some southern wetlands such as on the French Atlantic coast (R. Musseau, pers. com.). Our observations do not exclude the possibility that some individuals leave the breeding zone to moult elsewhere. In northern Europe, bluethroats have been observed to leave their breeding sites immediately after breeding and start their moult at the first stopover sites along their migration route (Ellegren and Staav, 1990). We detected no evidence supporting fuel accumulation for the autumn migration, supporting previous findings indicating that bluethroats are not able to gain fat until the post-breeding moult is finished (Lindström *et al*., 1994). Indeed, moulting and migration are highly energy-demanding processes with little or no temporal overlap within the annual cycle (Jenni and Winkler, 1994; Berthold, 2001). Thus, if the study population needs to gain fuel for this migration, this too must happen elsewhere, such as at lowland wetlands (Arizaga *et al*., 2010; Correia and Neto, 2013).

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