Nota Curta / *Short Note*

Head coloration, fuel load and flight muscle in wintering male Reed Buntings *Emberiza schoeniclus*

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Feather coloration often works as a signalling trait indicating social status. Our aim was to analyze the seasonal patterns of head coloration in the Reed Bunting *Emberiza schoeniclus* throughout the winter and explore whether coloration was associated with social rank. We hypothesized that, if males with more black on their head are dominant and adults are dominant over first-year birds, then (1) adult males should have more black than first-year birds and (2) males with more black should have better body condition than males with less black. Data were collected from a population of Reed Buntings wintering at a lagoon in northern Iberia (Badina de Escudera, Ebro valley). For each bird, we measured head coloration (amount of black, scaled from 1, <1/3, to 3, >2/3), fat and muscle scores. The proportion of males with more black on their heads increased over time and was higher in adults than in first-year birds early in the season. However, this was not the case from mid-winter onwards, indicating that the proportion of individuals with more black on their heads was not age-dependent by the end of the winter. Fat and muscle scores did not vary between birds with different head coloration, even when controlling for age and time. This result suggests a null or undetectable relationship between head coloration and body condition.

Key words: Reed Bunting, *Emberiza schoeniclus*, dominance, social status, status signalling, Badina de Escudera.

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Feather coloration often acts as a signalling trait indicating social status (Rowher 1975, Savalli 1995, Bókony *et al.* 2006). In particular, larger or more intensely coloured patches are usually associated with dominance (Parsons & Baptista 1980, Senar *et al.* 1993). Alternatively, coloration can simply act as a signal associated with individual identification (Shields 1977), play a role in sexual behaviour (Veiga 1993, Griggio & Hoi 2010) or be associated with parasite resistance (González *et al.* 1999).

The Reed Bunting *Emberiza schoeniclus* is an Eurasian songbird with manifest sexual dimorphism in coloration (Cramp & Perrins 1994). After their complete moult in late-summer, both sexes have similar head plumage. Males abrade the pale, buff tips of their head feathers during winter (Svensson 1996), thereby acquiring their typical black head in late winter/early spring; breeding females, on the other hand, have a duller streaked-brownish head. Here we test the hypothesis that head coloration in male reed buntings acts as a signal indicating social status (Rohwer & Rohwer 1978, Parsons & Baptista 1980). A prediction of this hypothesis is that dominant males should have a higher proportion of black on their head than subordinates. If, in addition, adults are dominant over first-year birds as occurs in several bird species (Moore *et al.* 2003, Senar 2006; but see Senar *et al.* 1993), we would expect adults to have more black than first-year birds (e.g. Veiga 1993).

Because of their higher social rank, males with more black on their head could have an advantage when foraging and have priority access to food. Consequently, dominant birds often have lower fuel reserves than subordinates, which tend to accumulate more fuel as they suffer from restricted food access (Ekman & Lilliendahl 1993, Witter & Swaddle 1995). In other cases, however, dominant birds have been seen to accumulate more fuel than subordinates (Piper & Wiley 1990, Senar *et al.* 2000), which is often argued to be due to the fact that dominant birds can expel subordinates from favourite feeding sites and hence obtain more or better food. We hypothesize that in periods of high energy demand such as winter or when preparing for spring migration, dominant birds should have larger fuel loads. This is because birds accumulating more fuel are expected to increase their survival prospects during the winter (Polo & Carrascal 1997, Gosler 2002); as well, once spring migration starts they are expected to migrate more quickly (Newton 2008) and/or arrive in their breeding areas with more fuel, factors that are often associated with better breeding performance (Sandberg & Moore 1996). Thus, if head coloration in Reed Buntings is linked with social status, we predict that males with more black on their heads should have greater fuel loads than males with less black, especially before spring migration.

Our aim was to analyse the seasonal patterns of head coloration in reed buntings throughout the winter and explore whether coloration was associated with social rank. We hypothesized that, if males with more black on their head are dominant and adults are dominant over first-year birds, then (1) adult males should have more black than first-year birds and (2) males with more black should be in better body condition than males with less black.

Material and Methods

Reed buntings were captured with mist nets at a constant effort site at Badina de Escudera, a lagoon of approximately 50 ha in northern Iberia (Villafranca; 42°16'N 01°42'W). The reed beds *Phragmites australis* surrounding the lagoon are used by Reed Buntings as a roosting site during the winter (Arizaga *et al.* 2009). Mist nets were placed in the reed bed at fixed points from two hours before to one hour after dusk, four times a month between Oct-Mar, beginning in Oct 2002 and finishing in Mar 2004.

Once captured, birds were ringed and their sex and ages determined (Svensson 1996). Reed buntings were classified as either first-year birds (EURING code 3/5; birds with retained juvenile feathers in their wings and tails) or adults (EURING code 4/6; older birds captured after having performed at least one complete moult). In addition, fat (on a scale from 0–8; Kaiser 1993) and muscle scores (on a scale from 0–3; Pinilla 2000) were recorded. We scored head coloration (black patch extension) from 1–3 (1: <1/3 black; 2: 1/3-2/3 black; 3: >2/3 black).

Data analysis

Given that the study was focused on males, data corresponding to females, to birds of unknown age and sex and to birds for which data were incomplete was ignored. Fat and muscle scores had a slightly positive skewed distribution and did not fit the normal distribution (Kolmogorov test: $P < 0.001$), although they were symmetrically distributed and had a relatively low standard deviation (SD/mean < 15%). However, they showed high heteroscedasticity (Levene test, $P < 0.05$) and we only used four categories for muscle scores. Thus, we used Generalized Linear Models with fat and muscle scores as dependent ordinal variables, and head coloration, period and age as independent

Table 1. AICc scores for models used to test the effect of head coloration, period and age on fat and muscle scores. Abbreviations: H, head coloration; P, period; A, age. The term "×" refers to full models with interactions between factors. The model with the lowest AICc value is in bold.
Puntuacions AICc dels models que es van emprar per comprovar l'efecte de la coloració del cap, el període i l'edat sobre el greix i múscul. Abreviacions: H, coloració del cap; P, període; A, edat; el terme "×" indica l'existència d'interacció entre factors. En negreta s'assenyalen els models amb les puntuacions més baixes.

Models	Fat	Muscle
H×P×A	421.122	193.696
H, P, A	400.903	175.386
H	408.882	200.407
P	397.806	171.362
A	407.458	198.736

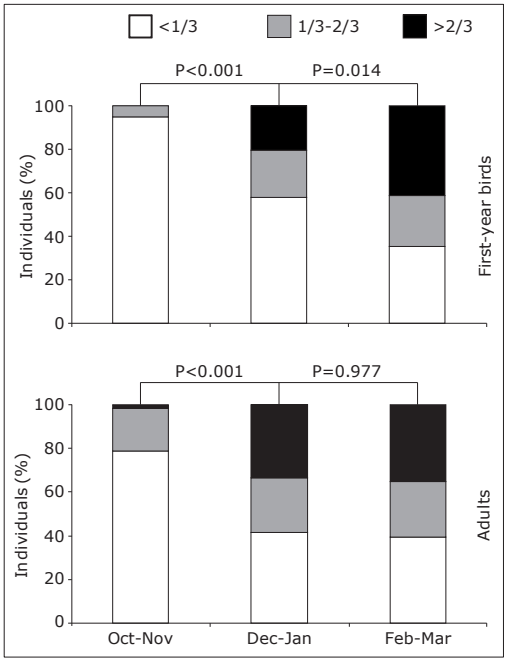

Figure 1. Seasonal variation in the proportion of black on the heads of wintering male Reed buntings. *P*-values come from pair-wise chi-square tests. Sample sizes: adults (Oct-Nov: *n* = 66, Dec-Jan: *n* = 75, Feb-Mar: *n* = 71); first-year birds (Oct-Nov: *n* = 60, Dec-Jan: *n* = 97, Feb-Mar: *n* = 51).
Variació estacional de la proporció de negre al cap dels mascles de repicatalons a l'hivern. Els valors P indiquen l'existència de diferències significatives entre períodes segons comparacions dos a dos mitjançant un test de chi-quadrat. Mida de la mostra: adults (Oct-Nov: n = 66, Dec-Gen: n = 75, Feb-Mar: n = 71), joves (Oct-Nov: n = 60, Dec-Gen: n = 97, Feb-Mar: n = 51).

control factors. Due to constraints imposed by the sample size, the sampling year was not included as an additional factor and sampling months were lumped into two-month periods (Oct-Nov, Dec-Jan, Feb-Mar). Given that full models with interactions could have reduced the statistical power of our relatively small sample size, we tried to simplify the models using an Akaike approach corrected for small sample sizes (AICc) to obtain simpler models whose fit to the data would be better than more complex models. Models were ranked by AICc and the model with the lowest AICc was the best final model. Models with a difference in AICc < 2 from the first model did not differ statistically (Burnham & Anderson 1998). SPSS 15.0 software was used for statistical analysis and means are given as ± SE.

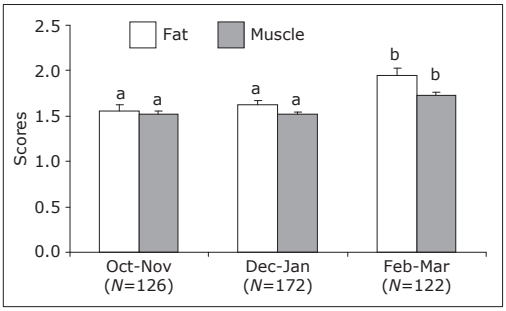

Figure 2. Seasonal variation (mean ± SE) of fat and muscle scores of male Reed buntings at Badina de Escudera. Within each variable, the same letter groups together means without significant differences (after an *a posteriori* test). Sample size in brackets.
Variació estacional (mitjana ± SE) del greix i múscul de mascles de repicatalons en Badina de Escudera. Per a cada variable, la mateixa lletra agrupa les mitjanes entre les quals no hi havia diferències significatives (després d'un test a posteriori). Mida de la mostra, en parèntesis.

Results

The proportion of reed buntings with more black on their head increased over time ($\chi_2^2 = 74.469$, $P < 0.001$; see Fig. 1 for sample sizes). The extent of black coloration increased progressively throughout the season in first-year birds, but only increased in adults from Oct-Nov to Dec-Jan, stabilizing thereafter (Fig. 1). Moreover, in Oct-Nov adults had more black on their heads than first-year birds (Oct-Nov: $\chi_2^2 = 7.210$, $P = 0.011$; Dec-Jan: $\chi_2^2 = 5.109$, $P = 0.078$; Feb-Mar: $\chi_2^2 = 0.455$, $P = 0.800$).

The generalized linear models that best fitted the data only considered the effect of period on fat and muscle scores (Table 1). Thus, fat and muscle scores did not vary between birds with different head coloration, even when controlling for age and time. Fat and muscle scores increased during winter (ca. 25%), reaching their highest values in Feb-Mar (Fat: Wald's statistics = 12.016, $df = 2$; $P = 0.002$; Muscle: Wald's statistics = 30.033, $df = 2$; $P < 0.001$; Fig. 2).

Discussion

The proportion of males with more black on their head increased during winter. Early in the season the proportion of birds with more black was higher in adults than in first-year birds. However, this

difference disappeared from December onwards, indicating that the black extension was age-dependent only during late autumn (Oct-Nov). In late winter (Feb-Mar), 30-40% of males still had less than one third of their heads black, suggesting that some males reach their breeding areas still with a high proportion of pale-tipped feathers tips (e.g. Møller & Erritzøe 1992, Veiga 1996).

Fat and flight-muscle scores did not vary between birds with different amount of black on their heads. One hypothesis explaining this result is that if males with more black were dominant over paler birds (Parsons & Baptista 1980), such dominance would not determine fuel load and flight muscle scores or, in other words, would have a negligible effect on fuel load. This could happen under a scenario of high food availability or if subordinates are able to develop compensatory foraging behaviours (Carpenter *et al.* 1993). Alternatively, it is also possible that the amount of black on the birds' heads was not related with male social status. Thus, head coloration patterns may act just as a signal associated with individual identification (Shields 1977, Whitefield 1987), be associated with sexual selection (Veiga 1993, Griggio & Hoi 2010) or have no signalling function at all.

Fat and flight-muscle scores were highest in Feb-Mar (i.e. just before the spring migration period). This fuel accumulation (mainly as fat) and the hypertrophy of the flight muscle indicate that reed buntings in late winter were preparing for migration. If competition to obtain food occurs in this period, however, our results suggest that individuals with different amounts of black on their heads and of different ages perform equally well.

This work highlights the fact that head coloration is unrelated to body condition in wintering reed buntings and does not vary between age classes at the end of the winter. However, this does not mean that such coloration has no signalling importance during the winter. Experimental approaches controlling for several environmental factors such as food availability or focusing on other proxies of body condition are still necessary.

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Resum

Coloració del cap, càrrega de combustible i múscul pectoral dels mascles de Repicatalons *Emberiza schoeniclus* a l'hivern

La coloració de les plomes amb freqüència actua com a senyal associat a l'estatus social. L'objectiu del nostre estudi és analitzar els patrons de variació de la coloració del cap en mascles de repicatalons a l'hivern i explorar si la coloració s'associa a l'estatus social. Plantegem la hipòtesi que si els mascles amb els caps més negres són dominants i si al seu torn els adults dominen als joves, (1) els mascles adults han de tenir més negre al cap que els joves; i (2) els mascles amb més negre han d'estar en millor condició corporal que els que tenen menys negre. Per a això, es van utilitzar repicatalons capturats en una llacuna de la vall de l'Ebre (Badina d'Escudera). A cada exemplar, se li va mesurar la coloració del cap (quantitat de negre, en una escala de l'1, <1 / 3, al 3,> 2 / 3), el nivell de greix i múscul. La proporció de mascles amb més negre va ser major al final del període d'estudi que al començament. Aquesta proporció va ser més alta en adults durant el començament de l'hivern, fet que indica que la proporció d'individus amb més negre va ser independent de l'edat al final de l'hivern. El nivell de greix i múscul no va variar entre individus amb diferents graus de coloració del cap una vegada controlats els efectes del període i edat. Això fa pensar en un efecte nul o indetectable de la coloració del cap en la condició corporal.

Resúmen

Coloración de la cabeza, carga de combustible y músculo pectoral de los machos de Escribano Palustre *Emberiza schoeniclus* en invierno

La coloración de las plumas con frecuencia actúa como señal asociada al status social. El objetivo de nuestro estudio es analizar los patrones de variación de la coloración de la cabeza en machos de Escribano Palustre en invierno y explorar si la coloración se asocia al status social. Planteamos la hipótesis de que si los machos con cabezas más negras son dominantes y si, a su vez, los adultos dominan a los jóvenes, (1) los machos adultos tienen que tener más negro en la cabeza que los jóvenes; y (2) los machos con más negro deben estar en mejor condición corporal que

los que tienen menos negro. Para ello se utilizaron escribanos invernantes capturados en una laguna del Valle del Ebro (Badina de Escudera). En cada ejemplar, se midió la coloración de la cabeza (cantidad de negro, en una escala del 1, <1/3, al 3, >2/3), el nivel de grasa y músculo. La proporción de machos con más negro fue mayor al final del periodo de estudio que al comienzo. Esta proporción fue más alta en adultos durante el comienzo del invierno, lo que indica que la proporción de individuos con más negro fue independiente de la edad al final del invierno. El nivel de grasa y músculo no varió entre individuos con diferentes grados de coloración de la cabeza una vez controlados los efectos del periodo y edad. Esto hace pensar en un efecto nulo o indetectable de la coloración de la cabeza en la condición corporal.

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