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SHORT REPORT

Age determination of Corn Buntings *Emberiza calandra* by skull ossification after the autumn moult

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When determining the age of fully grown passerines, ringers can often rely on plumage characteristics or other subtle colour characteristics such as iris coloration (*eg* in *Sylvia* spp) or tongue-marks in some warblers (Svensson 1992). For most species, plumage differences between adults (EURING age codes 4 or greater) and birds hatched in the current calendar year (EURING code 3, referred to here as first-year birds) are applicable due to different moult strategies in these two age categories. In late summer, juveniles often undergo a partial post-juvenile moult and adults a complete post-breeding moult. Thus, the degree of abrasion and the presence of moult limits in wings (and tail) indicate the age, and there is often no need to check for other features. However, there are some passerine species where adults and juveniles both undergo a complete late-summer moult (*eg* Alaudidae, Moustached Warbler *Acrocephalus melanopogon*, Long-tailed Tit *Aegithalos caudatus*, *Sturnus* spp, *Passer* spp (Svensson 1992, Jenni & Winkler 1994)), which makes it impossible to use plumage criteria for ageing afterwards (except when an occasional juvenile flight feather is retained). Therefore we need to resort to other characteristics, such as skull ossification.

As in other vertebrates, juvenile birds immediately after fledging initially have only one layer of skull bone and as development proceeds a second layer grows below the first one. The degree of development of this second layer can often be observed as a 'line' between the double-layered (whitish with spots) and the single-layered (pinkish without spots) skull. The growth duration of this second layer of bone is often genus- or species-specific and some species complete skull ossification within two months after hatching (eg Northern Wheatear *Oenanthe oenanthe*), while other species (such as European Nuthatch *Sitta europaea*) can retain certain one-layer 'windows' even as adults (Svensson 1992, Jenni & Winkler 1994).

For some species the progress of skull ossification is well known – with practice it is straightforward to carry out and in some ringing stations it is routinely used as an ageing technique. For other species, skull ossification is poorly documented; this includes Corn Buntings *Emberiza calandra* (Glutz von Blotzheim & Bauer 1997), a species in which ageing by plumage characteristics becomes impossible after the adults and juveniles have undergone a complete moult in late summer/autumn.

To check for skull ossification state in autumn, we captured 101 Corn Buntings in November 2007 and 2008, at a small roost in northern Spain. Trapping took place in a small wetland of 0.4 ha near Olite (42°29'N 1°39'W), in the late evening of 23 November 2007 (referred to as 'late November'). In order to find possible differences in the progress of ossification, the second capture was made earlier in the year, on 7 November 2008 (referred to as 'early November'). In 2007, six mist nets of 12 m each were placed in a circle around their roost. Birds captured as they came to roost were ringed and measured, and their skulls examined to determine the extent of ossification.

To examine skull ossification, the head feathers were parted by blowing them and, if necessary, by wetting them slightly, as described by Svensson (1992). For convenience we used the ossification key from the Swiss Ornithological Institute (Vogelwarte Sempach, Switzerland), which distinguishes seven degrees of ossification (1 = least, 7 = completed ossification: Fig 1). After recording all data, the birds were immediately released.

Distribution of skull ossification state

Skull ossification was reliably determined in 95 of the 101 birds examined, but could not be determined for six individuals. Skull ossification scores showed a bimodal distribution (Fig 2): 70 of the 101 birds examined had fully ossified skulls, but most other birds had skull ossification scores of 3–5 and there was only one bird in which skull ossification was nearly complete (stage 6). This bimodal distribution with very little overlap may represent segregation into two age classes by skull ossification in November: adult birds hatched in previous years (skull

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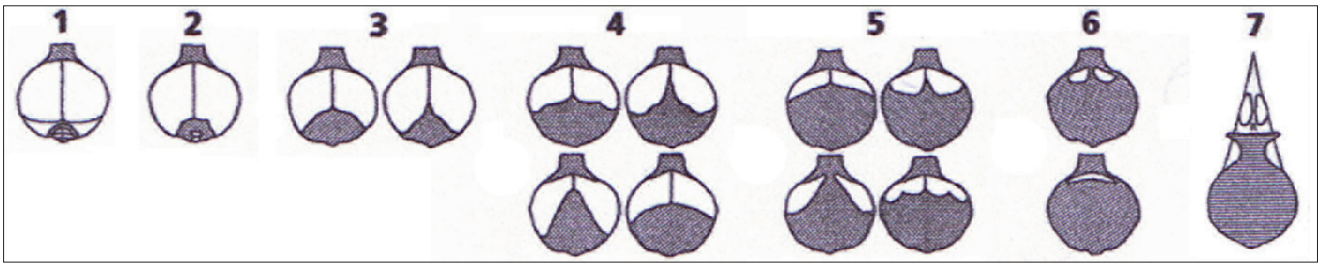

Figure 1. General pattern of skull ossification: key according to Swiss Ornithological Institute (Vogelwarte Sempach, Switzerland courtesy of Raffael Winkler), ranging from least (1) to completely (7) ossified skull.

Progress of skull ossification in November

Our results yield weak evidence for slow skull ossification within the month of November (Fig 2). The late November skull ossification distribution of 2007 corresponds with the early November skull ossification distribution of 2008 (χ^2 for fully ossified individuals *vs* incompletely ossified: non-significant, $P = 0.81$, df = 2).

This study suggests, therefore, that skull ossification may help to separate Corn Buntings into birds of the year versus adults well beyond the time they become inseparable by plumage characteristics in October. Furthermore, weak evidence suggests that skull ossification of young birds may progress slowly during November and therefore skull ossification may be an ageing method well after November.

The skull ossification distribution found (Fig 2) fits with the hypothesis that the sample of Corn Buntings examined constituted two age classes separable by skull ossification: first, birds of the current year (skull ossification 3–6) and second, older birds from previous years (7, hypothesis 1). However, it is also possible that the bimodal distribution comprises several cohorts of first-year birds with only the youngest cohort still showing incomplete skull ossification (3–6) by November, whereas older first-year birds may already show full skull ossification making them indistinguishable from adults (ossification stage 7, hypothesis 2).

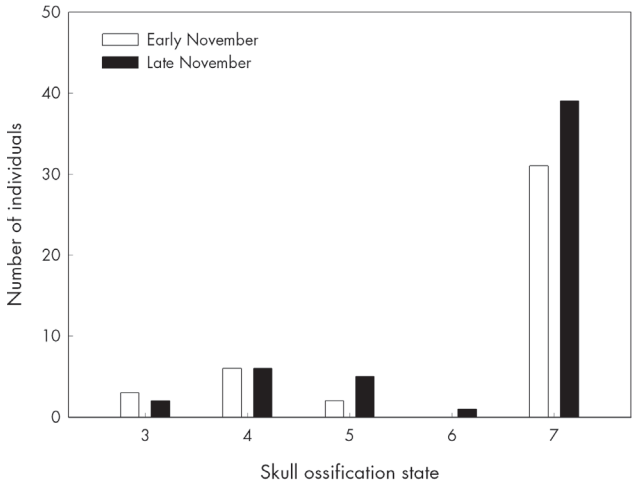

Figure 2. Bimodal distributions of skull ossification scores in November suggest that skull ossification can be a reliable method for separating juvenile (stage 3–6) and adult (7) after the post-breeding moult in November.

Based on the timing of breeding and the infrequent initiation of second broods in Corn Bunting (Hegelbach 1984, Bauer *et al* 2005), there is likely to be only a single cohort of first-year birds (hypothesis 1) in late summer rather than a mixture of cohorts. Therefore, our bimodal skull ossification distribution (Fig 2) is more likely to represent a segregation of two age classes: first-year birds and adults.

Conversely, the age distribution comprising 69% adults (full skull ossification) and only 31% juveniles (ossification 3–6) in November is surprisingly skewed towards adults, since the yearly survival rate of Corn Buntings rarely exceeds 50% (Bauer *et al* 2005). However, we view this as only weak support for the alternative hypothesis 2 because the age distribution outside the breeding season may well differ from that during the breeding season due to different dispersal behaviours of adult and first-year birds. Still, there is the possibility that some of the fully ossified individuals stem from early clutches, so that some of the birds labelled as 'adults' might be first-year birds. Nevertheless, the apparent lack of overlap in the bimodal distribution (Fig 2) suggests that skull ossification is a reliable tool to age Corn Bunting in November. The uniform skull ossification distribution found between early and late November suggests that skull ossification may be applicable for ageing Corn Buntings well after the month of November. To determine whether the method can be applied later in the autumn and into the winter, it will be necessary to follow the skull ossification of individual birds through to the next spring.

It is unknown for how long Corn Buntings show incomplete skull ossification and if they can even retain certain one-layered 'windows', as is the case for the related species Yellowhammer *Emberiza citrinella*

the present study, we did not find any birds showing such 'windows', but only 'classical' ossification limits.

The examination of skull ossification did not prove to be particularly more difficult than in other passerines. We do not support the idea that the examination of skull ossification in this species is not feasible in the field due to its thick head skin (Glutz von Blotzheim & Bauer1997) or its dense feathers (J.F. Hegelbach, pers comm) or is otherwise more difficult than in other bird species.

In conclusion, skull ossification is a viable method for ageing Corn Buntings after the moult in autumn. However, it is unknown whether the conclusions from our study will be applicable to populations in other geographical regions. Therefore, we would encourage examination of this method in other regions to test its reliability and temporal applicability.

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