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Sex- and age-related differences in the biometrics of a wintering population of Yellowhammers *Emberiza citrinella*

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The biometrics of a population of Yellowhammers wintering in NE Spain are detailed. Males had significantly longer mean wing-length and tail-length than females, and they were also significantly heavier. First winter birds had smaller mean wing-length and bill-depth than adults. Discriminant analysis using wing-length and body mass permitted the correct sexing of 90% of the individuals, whereas ageing analysis only gave correct discrimination for 65%. Biometrics are a useful additional sexing criterion, but they should not be used alone to age birds.

Key words: Yellowhammer, *Emberiza citrinella*, sexing and ageing discrimination, biometrics, NE Spain.

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INTRODUCTION

The Yellowhammer *Emberiza citrinella* is a sexually dimorphic passerine showing great variability both in size (Bibby 1978) and in the colour of non-breeding plumages (Thompson 1987). This leads to great morphological overlapping between age and sex classes which results in difficulties when attempting to sex and age this species (e.g. Norman 1992).

Several studies have tried to clarify the relationship between plumage coloration and biometrics (Vansteenwegen & Pozner 1990, Norman 1991). However, the reliability of different biometrical variables for sex and age discrimination has not yet been quantified.

In this paper the biometrical data of a migratory population of Yellowhammers wintering in NE Spain are described. Discriminant analysis is then used to obtain discriminant functions which allow for additional sexing and ageing criteria of the species.

MATERIAL AND METHODS

The study area comprises the surroundings of the village La Palma d'Ebre (Tarragona) 41°.17'N 00°.40'E. This area is in a typical Mediterranean zone at an altitude of 300 m. a.s.l. The natural vegetation is composed mostly of Mediterranean bushes along with small stands of Aleppo Pine *Pinus ha-*

	$\overline{X}$	*SD*	*n*	*Range*
WING				
First-winter female	84.19	2.02	192	79.00–89.50
First-winter male	88.79	1.93	158	83.00–93.00
Adult female	85.17	1.81	155	80.50–89.50
Adult male	90.36	2.31	130	84.00–95.00
BILL TO SKULL				
First-winter female	14.38	1.04	47	13.00–16.60
First year male	14.24	1.00	37	12.70–16.70
Adult female	14.74	1.07	29	12.20–16.70
Adult male	15.11	1.22	16	13.50–17.20
CULMEN				
First-winter female	11.76	0.64	122	10.50–13.00
First-winter male	11.76	0.62	115	10.10–13.25
Adult female	11.83	0.66	111	10.00–13.25
Adult male	11.89	0.60	94	10.20–13.25
D.BILL				
First-winter female	5.62	0.34	122	5.00–6.60
First-winter male	5.56	0.33	113	5.00–6.40
Adult female	5.60	0.27	110	5.00–6.50
Adult male	5.63	0.32	93	5.10–6.80
TARSUS				
First-winter female	20.09	0.97	36	18.40–22.00
First-winter male	20.38	0.74	33	19.00–22.00
Adult female	20.10	0.78	28	18.50–22.00
Adult male	20.16	0.49	12	19.50–21-20
TAIL				
First-winter female	72.40	2.25	178	67.00–78.00
First-winter male	76.33	2.34	146	70.50–82.00
Adult female	72.98	2.21	141	66.00–78.00
Adult male	77.41	2.67	127	69.00–84.00
BODY MASS				
First-winter female	28.37	2.09	191	20.50–36.90
First-winter male	29.95	1.76	157	26.00–35.00
Adult female	29.20	1.79	154	25.00–37.30
Adult male	30.38	1.70	130	26.00–36.50

Table 1. Biometrics of Yellowhammers wintering in NE Spain.

Taula 1. Biometria de les verderoles hivernants al NE d'Espanya.

	SEX	AGE	AGE x SEX
WING	205.28***	19.52***	1.00 NS
BILL TO SKULL	0.01	8.0*	1.61 NS
CULMEN	0.08	0.1	0.66 NS
BILL DEPTH	0.63	10.41**	4.91 NS
TARSUS	1.72	0.19	0.46 NS
TAIL	78.62***	3.94	0.22 NS
BODY MASS	30.84***	4.92	0.51 NS

Table 2. Two-way ANOVA for different Yellowhammer biometrics according to age and sex. F values and associated probability are provided. For lenght of wing, bill and culmen, and bill depth, df= 1, 125; for lenght of tarsus and tail and body mass, df= 1, 105. *** $p<0.001$, ** $p<0.01$, * $p<0.05$.

*Taula 2. ANOVA bifactorial de diferents variables biomètriques segons edat i sexe. Es donen els valors de F i la probabilitat associada. Per ala, bec, culmen i alçada del bec, df= 1, 125; per tars, cua i massa corporal, df= 1, 105. *** $p<0.001$, ** $p<0.01$, * $p<0.05$.*

lepensis. Cultivation includes groves of olives and almonds with scattered vineyards.

In this area the Yellowhammer is exclusively a wintering species arriving in late October and leaving from late February to early April. From November to March between 1986 and 1992, 742 birds at seven different roosts were mist-netted and ringed. All the birds were weighed to the nearest 0.2 g. using a Pesola spring balance, and the wing-length (maximum chord) was measured to the nearest 0.5 mm. using a stopped ruler. Length of tail (to the nearest 0.5 mm.), bill (to skull), culmen (bill to feathering) and tarsus, and bill depth, were measured following Svensson (1992).

Each bird was aged and sexed according to Svensson (1992). In addition, the contrast between moulted and unmoulted tertials and primary coverts was used to improve age discrimination. About 16% (n= 117) of the birds were not aged, and 25 birds could not be sexed, and were therefore omitted from the analysis.

The significance of different measurements to discriminate sex and age was analysed through discriminant analysis (Norusis, 1986; SPSSPC +). In order to avoid the possible *masking effect* of age and sex, four discriminant analyses were carried out considering combinations in age and sex separately . In a first analysis all the variables were used. However, since improvement in sex and age classification was just 1-2% higher than when using only wing length and weight, and since these two measurements are the standard ones in ringing studies, it was decided to present only the results of the analysis with these two parameters.

RESULTS

Table 1 summarizes biometrics by sex and age. Male Yellowhammers had significantly longer mean wing-length and mean tail-length than females and also had higher body mass (Table 2). Adults showed longer mean wing-length and bill-depth than first-winter birds (Table 2). The different variables were highly intercorrelated (8 out 21 correlations between the seven biometrical variables were correlated at $p<0.05$.

Sexual discriminant analysis, using wing-length and body mass, resulted in 90% of the individuals being correctly classified,

Class Used	N	Discriminant Function	Group centroids	% Cases classified
AGE DISCRIMINATION				
Female	345	D= 0.38WING + 0.259BODY MASS – 40.149	– 0.34/+0.41	63%
Male	287	D= 0.47WING – 42.439	– 0.27/+0.34	66%
SEX DISCRIMINATION				
First-winter	348	D= 0.492WING + 0.044BODY MASS–43.752	–1.06/+1.29	90%
Adult	284	D= 0.503WING + 0.0562BODY MASS–42.398	–1.16/+1.38	90%

Table 3. Discriminant analysis statistics on age and sex discrimination. Analysis was carried out separately on first-winter birds and adults (sex discrimination) and on males and females (age discrimination) (See text for details).

Taula 3. Resultats de l'anàlisi discriminant sobre edat i sexe. L'anàlisi es va realitzar de forma separada entre juvenils i adults (discriminació del sexe) i sobre mascles i femelles (discriminació de l'edat).

either within the adult or the yearling age classes (Tables 3 and 4).

Discriminating analysis of age resulted in 63% of the females correctly classified (using wing-length and body mass) and 66% of the males (using only wing-length) (Tables 3 and 4).

The mean wing-lengths of Yellowhammers from England were compared with those of the birds from Spain (Table 5). In all sex and age classes those wintering in Iberia tended to be larger but differences were not significant (t-Student test, in all cases $p>0.20$). Lack of significance may be due to small sample sizes, and the use of a comparison between a single British observation with the mean of the Spanish sample.

DISCUSSION

The Yellowhammer follows the tendency found among some passerines of a marked sexual dimorphism, with males being larger than females (Amadon 1959). The resulting discriminant function using wing-length and weight allowed the correct sexing of 90%

	Wilks' Lambda			
	SEX DISCRIMINATION		AGE DISCRIMINATION	
	First-winter	ADULT	FEMALE	MALE
WING-LENGTH	0.42	0.30	0.94	0.88
BODY MASS	0.42	0.38	0.92	—

Table 4. Wilks' Lambda values obtained in the different discriminant analyses (see Table 3). All the values were significant at $p<0.001$.

Taula 4. Valors de Wilks Lambda obtinguts en les diferents anàlisis discriminants (vegeu Taula 3). Tots els valors significants per a p<0.001.

	Oxford UK (1)	Cleveland UK (2)	Catalonia Spain (3)
First-winter female	81.8 (n=48)	82.4 (n=69)	84.19 (n=192)
First-winter male	87.3 (n=37)	87.3 (n=28)	88.79 (n=158)
Adult female	83.8 (n=6)	84.6 (n=32)	85.17 (n=155)
Adult male	89.8 (n=23)	89.4 (n=46)	90.36 (n=130)

Table 5. Comparison in mean wing-length of birds from England, UK (1) Evans 1969 and (2) Norman 1991; (3) present study. All measurements from the period November-March.

Taula 5. Comparació en la mitjana de l'ala (corda màxima) entre ocells d'Anglaterra (1) Evans 1969; (2) Norman 1991; (3) present estudi. Totes les mesures corresponen al període novembre-març.

of the sample. However, when sexing birds by means of biometrics, it should be remembered that there is a wide range of variability in wing-length, leading to a great overlap between sexes (e.g. over 50% in a British population studied by Bibby, 1978). Cases of extremely small males (e.g. wing-lengths of 81 mm.) have also been reported (Vansteenwegen & Pozner 1990).

Results also showed a certain amount of dimorphism in age in the Yellowhammer with first-winter birds having shorter wings, as it is the case in most passerine species (Alatalo et al. 1984). This age dimorphism is consistent with previous studies of the same species by Norman (1991), who stated that the final adult wing-length is achieved during the first complete moult. Ageing by measurements alone proved to be inappropiate given the results of the discriminant analysis, but they could be combined with an accurate knowledge of the extent of postjuvenile moult of tail feathers (Norman 1992), tertials and wing coverts (pers. obs.).

Several problems can arise when sexing Yellowhammers by coloration. Svensson (1992) commented that some birds are difficult to sex. In spite of the usual dichromatism between the sexes, the presence of individuals showing either intermediate or abnormal coloration has been reported (Bereszynski 1973, Horváth 1974, Vansteenwegen & Pozner 1990) and the existence of such birds may hinder definite sexing. In the present study over 4 % of the birds remained unsexed, although probably there were some individuals classified incorrectly because of this overlap in colour and biometrics. Therefore, the use of biometrics seems to be a useful supportive additional character to take into account, even in spite of its limitations.

The biometrics of the population studied coincide with previous studies of other populations (Evans 1969, Norman 1991). The overall wing-length range given by Svensson (1992) does not differ from the results shown in this paper. However, some females had maximum wing-lengths of 89,5 mm (88 mm in Svensson 1992) whilst for males some were below 83 mm from this study (82 mm in Svensson 1992). A comparison of the mean wing-length with those of different British populations resulted in a tendency for larger values for birds wintering in Spain, which may be due to the comparison of a wholly migratory population with another, mostly sedentary one (Prys-Jones 1977). •

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RESUM

Diferencies biomètriques relacionades amb l'edat i el sexe en una població hivernant de Verderola Emberiza citrinella.

La verderola Emberiza citrinella *és una espècie que presenta dimorfisme sexual. La gran variabilitat entre mascles i femelles i l'alt grau de solapament biomètric entre sexes fan que hi hagi alguns problemes tant en el sexat com la datació de l'espècie (Thompson 1987, Vansteenwegen & Pozner 1990, Norman 1991). L'objectiu d'aquest treball és descriure la biometria d'una població hivernant tenint en compte, especialment, les diferències en relació al sexe i l'edat i valorar la importància de la biometria com a criteri adicional de sexat i datat.*

L'estudi es va realitzar al terme municipal de La Palma d'Ebre (Tarragona) en una zona de caire mediterràni a 300 m. s.n.m. Des de novembre a març del periode 1986-1992 es vàren anellar 742 verderoles trampejant 7 dormiders diferents.

Les mesures biomètriques que es van prendre foren pes, ala (corda màxima), cua, bec, culmen, alçada del bec i tars. Els ocells es van datar i sexar segons els caracters descrits per Svensson (1992) i a partir d'observacions personals. Un total de 117 ocells (16%) no es van poder datar amb exactitud, i 25 exemplars no es van sexar; aquests ocells no es van utilitzar alhora d'estudiar la biometria.

Els mascles de verderola van donar valors mitjans significativament més grans que les femelles a l'ala i cua i també vàren pesar més. Els valors mitjans de l'ala i alçada del bec va ser menor en els joves que en els adults.

De cara a conèixer la diferent significació de l'ala i pes per discriminar sexes i edats es van realitzar quatre anàlisis discriminants (Norusis 1986) considerant separadament grups d'edat i sexe. L'anàlisi va donar quatre funcions discriminants que separaren el 90% dels mascles i femelles mentre que només classificaven el 63-66% dels grups d'edats.

Les mesures biomètriques de l'ala i el pes resulten útils com a criteris adicionals per a la determinació d'edats i sexes però, com a norma, no s'han d'utilitzar separadament. De cara a la datació, es pot combinar la biometria amb una revisió acurada de la muda parcial postjuvenil com les rectrius (Norman 1992), terciàries i cobertores alars (pers. obs.).

Les verderoles hivernants a l'àrea d'estudi presentaven uns valors mitjans de l'ala més grans que els descrits per a ocells britànics probablement pel fet de comparar poblacions sedentàries amb migrants.

REFERENCES

ALATALO, R.V., GUSTAFSSON, L. & LUNDBERG, A. 1984. Why do young passerine birds have shorter wings than older birds?. *Ibis* 126: 410-415.

AMADON, D. 1959. The significance of sexual differences in size among birds. *Proc. Amer. Phil. Soc.* 103: 531-536.

BERESZYNSKI, A. 1973. (Non-typical colouration of Yellowhammer). *Not. Orn.* 3-4: 76-77.

BIBBY, C. 1978. Sexual dimorphism in some passerines. *Wicken Fen Group Report* 10: 38-43.

EVANS, P.R. 1969. Winter fat deposition and overnight survival of Yellow Buntings (*Emberiza citrinella*). *J. Anim. Ecol.* 38: 415-423.

HORVÁTH, L. 1974. (Cirl Bunting-like features in the Yellow Hammer, *Emberiza citrinella*). *Vertebr. Hung.* 15: 39-43.

NORMAN, W. 1991. Wing-length and plumage colouration in relation to age and sex in Yellowhammers. *South Cleveland Ring. Group Annual Report* 13: 20-24.

NORMAN, S.C. 1992. Ageing Yellowhammers throughout the year. *Ringing & Migration* 13: 117-119.

NORUSIS, M. J. 1986. *SpSS/PC+ Advanced Statistics*. Chicago, Illinois: SPSS Inc. 204 p.

THOMPSON, B. 1987. Sex and the Yellowhammer ringer. *Ringers' Bulletin* 7: 27.

PRYS-JONES, R.P. 1977. *Aspects of Reed Bunting ecology, with comparisons with the Yellowhammer*. D. Phil. thesis, University of Oxford.

SVENSSON, L. 1992. *Identification Guide to European Passerines*. Stockholm: Svensson.

VANSTEENWEGEN, C. & POZNER, D. 1990. Determination du sexe chez le Bruant jaune. Controle des criteres en vigueur sur des individus de collection. *Bulletin de Liaison* 21: 34-36.