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Biometrics, ageing, sexing and moult of the Blue Chaffinch *Fringilla teydea teydea* on Tenerife (Canary Islands)

EDUARDO GARCIA-DEL-REY[1]* and ANDREW G. GOSLER[2]
[1]*Departamento de Ecologia, Facultad de Biologia, Universidad de La Laguna, 38206 La Laguna, Tenerife, Canary Islands, Spain* [2]*Edward Grey Institute of Field Ornithology, Department of Zoology, South Parks Rd, Oxford OX1 3PS, UK*

The Blue Chaffinch *Fringilla teydea* is one of a few Palearctic species for which biometric data are lacking from the field; we address this issue here. Blue Chaffinches were caught by mist net, at ten sites on Tenerife (Canary Islands), and measured. Data on biometrics and moult using standard methods are presented, and observations on mass variation in relation to time of day and body size are reported for the first time. Wing length, bill length, bill depth & tail were greater in adults and first year birds than juveniles whilst tarsus and mass were the same. The species shows a clear sexual dimorphism in size except for bill length. The duration of primary moult was estimated to be 66 days for adults. For first year birds (in their second-calendar year), the mean starting date of primary moult was 25 days earlier than adults and was completed after 109 days.

The Blue Chaffinch *Fringilla teydea* is endemic to the western Canary Islands of Gran Canaria (subspecies *polatzeki*, Hartert 1905) and Tenerife (nominate *teydea*, Webb *et al* 1842) (Cramp & Perrins 1994). It is a more robust and longer-legged species than the Chaffinch *Fringilla coelebs* (about 10% bigger) (Cramp & Perrins 1994) but, as in that species, both races are sexually dimorphic in colour; the male of the nominate race is slaty grey-blue, the female drab olive-brown, but males from Gran Canaria differ in the presence of prominent white tips to the median and greater coverts (Clement *et al* 1993), and in their smaller body size. Juveniles are similar to adult females in both subspecies (Cramp & Perrins 1994).

Virtually confined to the pine forest, which ranges from *c* 800-2,000 m (Ceballos & Ortuño 1951) on both islands (Bannerman 1963), on Tenerife this finch selects the shrub layer of *Adenocarpus* sp. when breeding and seems to forage mainly on *Myrica faya* seeds during the non-breeding season, and on pine seeds during the breeding season. (Garcia-del-Rey pers obs). However, the Gran Canaria race is red-listed as endangered because there are only about 200 individuals left in the wild (Martín *et al* 1990, Tucker & Heath 1994).

There have been few published studies of this species (Martín & Lorenzo 2001), and most of the biometric and moult data available have come from skin specimens (Cramp & Perrins 1994). Indeed, only a few wing length measurements from live birds have been published (Martin *et al* 1984), but no method of measurement was given. Neither are there published studies which consider age or sex differences in biometrics or moult data from live birds, and the ageing and sexing of the Blue Chaffinch in the hand has not been covered in the principal guides (eg Svensson 1992).

In this paper we present comprehensive Blue Chaffinch biometric and moult data from live birds, measured using standardized methods (Redfern & Clark 2001), and we suggest ageing and sexing criteria for this endemic species. We also report observations on mass variation in relation to time of day and body size.

METHODS

Study site

From 25 July 2002 to 1 October 2004, Blue Chaffinches were caught in mist nets, ringed and measured (by EGDR) at ten sites (Fig 1) in the pine forest on the island of Tenerife (Canary Islands). Nearly all of these birds (98%) were trapped when approaching drinking places during the hot summer months. All birds were examined for moult and feather wear.

Age terminology and identification

Juveniles were fledged birds that had not completed their post-fledging partial moult (post-juvenile moult).

* Correspondence author
Email: avesecot@redkbs.com

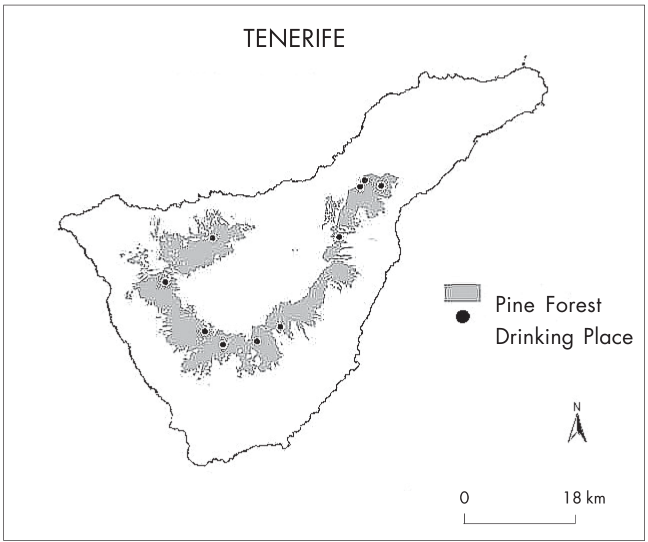

Figure 1. Distribution of drinking places in the pine forest of the island of Tenerife (Canary Islands).

Birds that had completed their post-juvenile moult but had not completed their first complete moult towards the end of their second calendar year are referred to as 'first year' birds. The term 'adults' refers to birds that had completed their first complete moult or were in their third calendar year or more. Juvenile Blue Chaffinches are similar in plumage coloration to adult females but were distinguished by the pale cream tips to the greater and median coverts and the buffish borders to the innermost greater coverts and tertials (Martin *et al* 1984, Cramp & Perrins 1994). First year males after their post-juvenile moult and before their complete moult the following year were identified by the presence of brown spots on the crown, an overall less-blue body colouration, severe wear on primary feather tips and the presence of moult limits in the median or greater coverts. First year females were also identified on the basis of moult limits within the median or greater coverts (unmoulted greater coverts have buff fringes compared to the greyish-white of adults) and severe wear of primary feather tips. Juvenile birds were not sexed.

Biometric methods

Wing length (maximum chord) was taken using a stopped rule (Redfern & Clark 2001) to 1 mm. Bill length (tip to skull), bill depth (at distal edge of nostril) and maximum tarsus length were all measured to 0.1 mm using dial callipers. Tail length was measured using an unstopped rule to the nearest 1 mm. To measure body mass, birds were weighed on a 50 g *Pesola* balance to 0.1 g; the time of weighing was also recorded. The wing shape was recorded as the distances between the tip of each primary, numbered from the outermost (distal) to the innermost (proximal) throughout this study, and the wingtip (see Svensson 1992). A transparent ruler placed between the feathers of the naturally-folded wing was used to measure the distances between the tip of each primary and the wingtip (to nearest 1 mm). The wing point (ie longest primary feather) and primary emarginations were also noted. Moult was recorded using the method described by Ginn & Melville (1983) after Newton (1966), in which each flight feather is given a score from 0 (old) to 5 (fully grown and new).

Statistical analysis

Analysis of Variance (ANOVA) was used to test for differences in measurements with respect to age (juvenile, first year and adult) and sex, followed by *post-hoc* Tukey tests (T statistic). A general measure of body size was derived as the first principal component (pc1) from a Principal Components Analysis (PCA) of the correlation matrix of wing, tail and tarsus lengths (Rising & Somers 1989, Gosler *et al* 1998). A General Linear Model (GLM) was used to test whether the mass of the birds varied with the time of the day and with body size. Kruskal-Wallis and the Mann-Whitney U test (lower bounds of critical values are reported) was used to test for differences in moult phenology and wing formula. These statistical analyses were performed with SPSS 11.0 and Minitab, and results are presented as mean ± standard error.

Moult data were analysed to estimate the starting date and its standard deviation (SD), and moult duration according to the maximum likelihood method of Underhill & Zucchini (1988), using a computer program written by Walter Zucchini. The model for type 3 data (primary moult score against date; Underhill & Zucchini 1988) was used because the data did not include birds that have completed moult. Moult score was assumed to increase linearly with time.

RESULTS

During the first weeks after fledging the bill of juvenile Blue Chaffinches is blackish overall (not slate-grey as in first year and adult birds) and the tip of the upper mandible lacks the hook on the dertrum characteristic of older birds (Svensson 1992). The ratio of adult and first year birds to juveniles caught during the summer months (n = 326) was: 13:0 in June, 140:15 in July, 68:60 in August and 15:15 in September. Thus while July was the most productive month to catch birds of breeding age, August was best for juveniles, suggesting a late fledging period for this finch. Table 1 presents a summary of the biometric data by age categories, and Tables 2 & 3 present the data by sex.

Table 1. Biometrics of Blue Chaffinches ringed on Tenerife during this study. Data are means ± standard error (SE), range and sample size (n). * Modal primary.

	All				All juveniles				All first years				All adults			
	Mean	SE	Range	n	Mean	SE	Range	n	Mean	SE	Range	n	Mean	SE	Range	n
Wing (mm)	96.6	0.3	86 -106	332	95.5	0.4	89 -101	90	94.8	0.4	86 -102	106	98.7	0.4	89 -106	136
Bill length (mm)	20.0	0.1	16.7 - 23.0	332	18.7	0.1	16.7 - 20.1	90	20.4	0.1	18.9 - 23.0	106	20.7	0.1	18.6 - 22.7	136
Bill depth (mm)	10.3	0.0	8.4 - 18.4	332	10.1	0.1	8.4 - 18.4	90	10.4	0.0	9.4 - 11.3	106	10.4	0.0	9.6 - 11.2	136
Tarsus (mm)	26.0	0.0	24.0 - 30.7	332	25.9	0.1	24.5 - 27.4	90	26.0	0.1	24.5 - 27.1	106	26.1	0.1	24.0 - 30.7	136
Mass (g)	30.7	0.1	25.0 - 37.5	332	30.4	0.2	26.3 - 35.8	90	30.7	0.2	26.5 - 36.1	106	30.8	0.2	25.0 - 37.5	136
Tail (mm)	79.2	0.3	72 - 87	201	78.3	0.5	72 - 86	42	78.5	0.4	72 - 85	70	80.3	0.4	72 - 87	89
P10-wingtip (mm)	24.6	0.2	20 - 29	135	25.7	0.2	23 - 29	42	22.9	0.3	20 - 26	21	24.4	0.2	20 - 29	72
P9-wingtip (mm)	21.1	0.2	16 - 26	135	21.8	0.2	19 - 26	42	19.7	0.3	16 - 22	21	21.1	0.2	18 - 25	72
P8-wingtip (mm)	17.7	0.2	12 - 21	135	17.9	0.3	12 - 21	42	16.3	0.3	13 - 19	21	18.0	0.2	13 - 21	72
P7-wingtip (mm)	12.3	0.2	4 - 15	135	12.3	0.3	5 - 14	42	11.2	0.3	8 - 14	21	12.7	0.2	4 - 15	72
P6-wingtip (mm)	4.1	0.1	0 - 6	135	4.5	0.1	0 - 6	42	3.7	0.3	0 - 5	21	4.0	0.1	0 - 5	72
P5-wingtip (mm)	0	0	0	135	0.0	0	0	42	0	0	0	21	0	0	0	72
P4-wingtip (mm)	0	0	0	135	0.0	0	0	42	0	0	0	21	0	0	0	72
P3-wingtip (mm)	0.2	<0.05	0 - 2	135	0.1	0.1	0 - 1	42	<0.05	<0.05	0 - 1	21	0.2	0.1	0 - 2	72
P2-wingtip (mm)	5.7	0.1	2 - 9	135	5.8	0.1	3 - 7	42	4.6	0.2	3 - 6	21	5.9	0.2	2 - 9	72
Wing-point	4*		4 - 5	133	4/5*		4 - 5	41	4*		4 - 5	22	4/5*		4 - 5	70

Table 2. Biometrics of sexed Blue Chaffinches ringed on Tenerife during this study. Data are means ± standard error, range and sample size. *Modal primary.

	First year males				First year females				Adult males				Adult females			
	Mean	SE	Range	n	Mean	SE	Range	n	Mean	SE	Range	n	Mean	SE	Range	n
Wing (mm)	97.5	0.2	93 -102	64	90.7	0.3	86 -95	42	102.8	0.2	98 -106	76	93.5	0.2	89 - 97	60
Bill length (mm)	20.4	0.1	19.0 - 23.0	64	20.4	0.1	18.9 -21.9	42	20.6	0.1	18.8 - 22.7	76	20.8	0.1	18.6 - 22.2	60
Bill depth (mm)	10.6	0.0	9.8 - 11.3	64	10.3	0.1	9.4 -11.3	42	10.5	0.0	9.7 - 11.2	76	10.3	0.0	9.6 - 11.2	60
Tarsus (mm)	26.2	0.1	24.9 - 27.1	64	25.7	0.1	24.5 -26.6	42	26.3	0.1	24.6 - 30.7	76	25.8	0.1	24.0 - 29.8	60
Mass (g)	32.0	0.2	28.0 - 36.1	64	28.8	0.2	26.5 -33.0	42	32.3	0.2	28.1 - 37.5	76	28.9	0.2	25.0 - 33.0	60
Tail (mm)	80.5	0.3	74 - 85	46	74.5	0.4	72 -79	24	83.5	0.2	80 - 87	52	75.8	0.3	72 - 82	37
P10-wingtip (mm)	24.0	0.5	22 - 26	7	22.3	0.3	20 -24	14	25.9	0.2	24 - 29	40	22.5	0.2	20 - 26	32
P9-wingtip (mm)	21.1	0.3	20 - 22	7	19.0	0.3	16 -20	14	22.4	0.2	19 - 25	40	19.6	0.2	18 - 22	32
P8-wingtip (mm)	17.6	0.4	16 - 19	7	15.6	0.3	13 -17	14	19.2	0.2	13 - 21	40	16.5	0.2	15 - 19	32
P7-wingtip (mm)	12.4	0.6	10 - 14	7	10.6	0.3	8 -13	14	13.6	0.3	4 - 15	40	11.7	0.2	10 - 14	32
P6-wingtip (mm)	4.4	0.4	2 - 5	7	3.4	0.4	0 - 5	14	4.2	0.2	0 - 5	40	3.8	0.1	3 - 5	32
P5-wingtip (mm)	0	0	0	7	0	0	0	14	0	0	0	40	0	0	0	32
P4-wingtip (mm)	0	0	0	7	0	0	0	14	0	0	0	40	0	0	0	32
P3-wingtip (mm)	0.1	0.1	0 - 1	7	0	0	0	14	0.2	0.1	0 - 1	40	0.3	0.1	0 - 2	32
P2-wingtip (mm)	5.1	0.1	5 - 6	7	4.4	0.2	3 - 6	14	6.3	0.2	2 - 9	40	5.3	0.2	3 - 7	32
Wing-point	5*		4 - 5	8	4*		4 - 5	14	4/5*		4 - 5	39	4/5*		4 - 5	31

Table 3. A summary of the biometrics for Blue Chaffinches (all first years and adults, by sexes) ringed on Tenerife during this study. Data are means ± standard error, range and sample size. *Modal primary.

	All first year & adult males				All first year & adult females			
	Mean	SE	Range	n	Mean	SE	Range	n
Wing (mm)	100.4	0.3	93 - 106	140	92.3	0.2	86 - 97	102
Bill length (mm)	20.5	0.1	18.8 - 23	140	20.6	0.1	18.6 - 22.2	102
Bill depth (mm)	10.5	<0.05	9.7 - 11.3	140	10.3	<0.05	9.4 - 11.3	102
Tarsus (mm)	26.2	0.1	24.6 - 30.7	140	25.8	0.1	24.0 - 29.8	102
Mass (g)	32.2	0.1	28.0 - 37.5	140	28.9	0.2	25.0 - 33.0	102
Tail (mm)	82.1	0.2	74 - 87	98	75.3	0.3	72 - 82	61
P10-wingtip (mm)	25.6	0.2	22 - 29	47	22.4	0.2	20 - 26	46
P9-wingtip (mm)	22.2	0.2	19 - 25	47	19.4	0.2	16 - 22	46
P8-wingtip (mm)	18.9	0.2	13 - 21	47	16.2	0.2	13 - 19	46
P7-wingtip (mm)	13.4	0.3	4 - 15	47	11.3	0.2	8 - 14	46
P6-wingtip (mm)	4.3	0.2	0 - 5	47	3.7	0.1	0 - 5	46
P5-wingtip (mm)	0	0	0	47	0	0	0	46
P4-wingtip (mm)	0	0	0	47	0	0	0	46
P3-wingtip (mm)	0.2	0.1	0 - 1	47	0.2	0.1	0 - 2	46
P2-wingtip (mm)	6.1	0.2	2 - 9	47	5.0	0.2	3 - 7	46
Wing-point	4/5*		4 - 5	47	4*		4 - 5	45

Biometrics in relation to age

There were significant differences in wing length between age categories (ANOVA $F_{2,329}$ = 28.27, $P <$ 0.001) and the mean wing length of adults was 3.2 mm longer than that of juveniles (Tukey test: T= 3.20, $P <$ 0.05) and 3.9 mm longer that that of first year birds (T= 3.87, $P <$ 0.05). There was no significant difference in mean wing lengths between juveniles and first year birds (T= 0.66, $P >$ 0.05). Bill length also differed significantly between the age classes (ANOVA $F_{2,329}$ = 227.25, $P <$ 0.001). The mean bill length of juveniles was 1.8 mm shorter than that of first year birds (T= -1.77, $P <$ 0.05) and 2.0 mm shorter than adults (T= -2.03, $P <$ 0.05). The mean bill length of first year birds was 0.3 mm shorter than that of adults (T= -0.26, $P <$ 0.05).

There were significant differences in bill depth between the different age classes (ANOVA $F_{2,329}$ = 6.81, $P <$ 0.001) and the mean bill depth of juveniles was 0.3 mm less than that of both first year birds (Tukey test: T= -0.34, $P <$ 0.05) and adults (T= -0.30, $P <$ 0.05). No difference was observed between first years and adults (T= 0.04, $P >$ 0.05). Differences in tail length were observed between the age classes (ANOVA $F_{2,198}$ = 6.46, $P <$ 0.01) and the mean adult tail length was 2.0 mm longer than that of juveniles (T= 2.05, $P <$ 0.05) and 1.9 mm longer than first year birds (T= 1.85, $P <$ 0.05). There was no difference in mean tail length between juveniles and first year birds (T= -0.20, $P >$ 0.05). However, whilst wing length, bill measurements and tail lengths were greater in adults than in juveniles, there were no significant age differences in tarsus length ($F_{2,329}$ = 1.00, $P >$ 0.05), indicating that this skeletal measure is fully-grown either before or shortly after fledging. Similarly, we found no significant differences in mass between juveniles, first years and adults ($F_{2,329}$ = 1.13, $P >$ 0.05).

Biometrics of adult and first year birds in relation to sex

The mean wing length of males was 8.0 mm longer than that of females (ANOVA $F_{1,240}$ = 483.23, $P <$ 0.001). Although the mean bill length of males did not differ significantly from that of females ($F_{1,240}$ = 0.77, $P >$ 0.05), mean bill depth was 0.2 mm greater in males than in females ($F_{1,240}$ = 20.78, $P <$ 0.001). The mean tarsus length of males was 0.5 mm longer than in females ($F_{1,240}$ = 27.57, $P <$ 0.001), and the mean tail length of males was 6.9 mm longer than in females ($F_{1,157}$ = 371.71, $P <$ 0.001). Males were also heavier, with a mean mass 3.3 g more than females ($F_{1,240}$ = 249.77, $P <$ 0.001), presumably due to the differences in body size indicated by skeletal measures such as tarsus length.

Wing formula and wing point

Comparing the relative lengths of the primaries (ie distances between the tip of each primary and the wing point) across the three age classes (Table 1), there were statistically significant differences for P10-P6, and P2 (Kruskal-Wallis tests: H>7, df= 2, $P <$ 0.001), but not for P3 (H= 1.11, df= 2, $P >$ 0.05). This comparison was not possible on P4 and P5 and due to severe feather-tip wear on first year birds and 20% of all birds caught were unmeasured (Table 1).

Within primary feathers, significant differences were found between juveniles and first year birds for P10-P6, and P2 (Mann-Whitney U-test: U≤310.5, $P < 0.05$). For all of these, juveniles had on average longer feathers than first year birds. First year birds also had shorter feathers when compared with adults, and significant differences were also found for P10-P7, and P2 (U≤434.5, $P < 0.01$) but not P6 (U=682.0, $P > 0.05$). P10 and P6 were longer in juveniles than adults by 1.3 mm and 0.5 mm, respectively (U≤1092.0, $P < 0.01$) but there were no differences between juveniles and adults with respect to the remaining primaries. Differences in primary feather length between the age categories were largely due to feather wear on first year birds.

When the sexes were compared (Table 2), statistically significant differences were found for the same flight feathers as in the age class comparison: P10-P6, P2 (Mann-Whitney U-test: U≤388.5, $P < 0.01$). There was no difference in lengths of P5, P4 or P3 (U= 640.0, $P > 0.05$) between the sexes. The wing point did not differ between age classes (Kruskal-Wallis test: H= 1.73, df= 2, $P > 0.001$) or sexes (Mann-Whitney U test: U= 974.5, $P > 0.001$). For all age categories and both sexes P6, P5, P4 and P3 were emarginated (n= 332).

Following Svensson's (1992) notation, the wing formula and the wing-point for the Blue Chaffinch on Tenerife could be represented by:

2nd P = 6/7 (= 6); Wing-point = 4-5
(n = 135) (n = 133)

ie P2 falls between P6 and P7 but occasionally equals P6 (this second part of the formula corresponds only to adult females, n = 32) (Table 1 & 2) and the wing point ranges from 4 to 5.

Mass variation with time of day and with size

As has been reported for passerines generally (Gosler *et al* 1998), wing length and tail length were very strongly correlated ($r_{199} = 0.911$, $P < 0.001$). Therefore, for analysis of mass variation in relation to time of day, Principle Components Analysis (PCA) was used to derive a single measure of body size based on a linear combination of wing length, tail length and also tarsus length. The first principle component (pc1) accounted for 73% of the variance (scatter) in wing, tail and tarsus lengths and gave a better prediction of mass (r^2=51.8%) than either wing (r^2=44.6%), tail (r^2=41.7%) or tarsus (r^2=24.6%) alone, comparable to that of a multiple regression combining wing, tail and tarsus lengths as predictors (r^2=53.0%). A General Linear Model for the effect of body size (pc1), time of day, age and sex on mass indicated that body mass was strongly correlated with body size (pc1: $F_{1,152} = 25.91$, $P < 0.001$), but also with time of day ($F_{1,152} = 6.23$, $P = 0.014$), age ($F_{1,152} = 6.27$, $P = 0.013$) and sex ($F_{1,152} = 4.17$, $P = 0.043$); the whole model accounting for 57.8% of the total variance in mass. Fig 2 shows the strong relationship between body size (pc1) and mass, in relation to sex. Blue Chaffinches averaged 1.1 g heavier in the second half of the day (from 13:00 – 21:00) than in the earlier half (06:00 – 13:00); such an increase through the day has been reported for other passerines (eg Gosler 2001).

Moult

Out of the 332 birds examined, 85 were in active moult of primary remiges. These included individuals aged as adults (14 & 5 = 19 total) and as first years (47 & 19 = 66 total). The median moult scores for first year birds were greater than those of adults, and this difference was statistically significant (Mann-Whitney: U = 178.C♂*P* < ♀.001), suggesting that first year ♂rds sta♀ed moulting earlier than adults. The start time and duration of moult was estimated for adults and first year birds separately from data for moult scores of birds in active primary feather moult using the maximum likelihood method of Underhill & Zucchini (1988). The mean start date of primary feather moult in first year birds was 13 July (SD 15.6 days) with a duration of 109 days. For adults the mean start date was 25 days later (7 August; SD 7.4 days), and the primary feather moult duration was 66 days (Fig 3). During the period of data collection, which ended on 1 October, no birds were found to have finished moult.

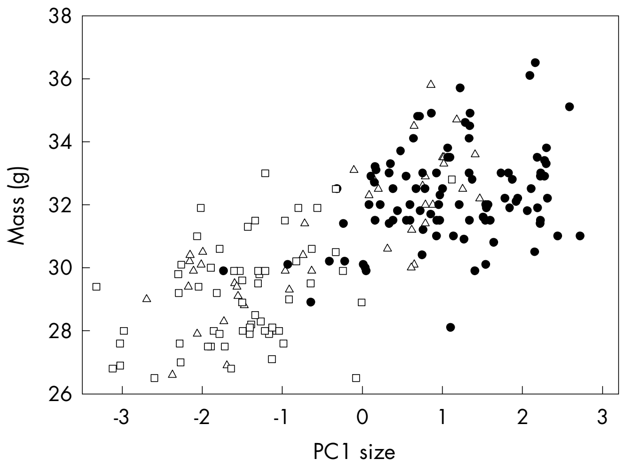

Figure 2. The relationship between body mass and size (pc1 from wing, tail and tarsus) separated by sex. Filled circles = males, open squares = females, open triangles = unsexed birds.

DISCUSSION

Ageing and sexing juvenile Blue Chaffinches

This study shows that juvenile Blue Chaffinches are on average smaller than adults in most measures of size (ie wing length, bill length, bill depth, tail length) but are similar in tarsus length and body mass. The fact that body mass correlates with body size, but does not differ among age or sex categories (although body size does differs among age and sex classes), suggests that the larger adults and males must carry less mass in other tissues, such as fat. This would be consistent with arguments presented for other species in relation to predation risk and access to resources, which tend to be, respectively, lower and greater for adults/males than for juveniles/females (eg Gosler 1996). First year birds were also larger than juveniles in all measurements except for wing length although this was probably because the primary tips tended to be more worn in first years, so that many individuals could not be measured accurately. Although the age classes differed in measurements, these cannot be used to age Blue Chaffinches reliably because the age-specific ranges overlap considerably (Table 1).

Juvenile Blue Chaffinches are easily identified in the hand by their bill size and coloration, and this has not been mentioned in previous publications (Martin *et al* 1984, Clement *et al* 1993, Cramp & Perrins 1994). The lack of a hook at the bill tip is also characteristic and reduces the bill length considerably (this study). The median coverts on the juvenile wing (before the partial post-juvenile moult) create a discontinuous wing bar, a product of the narrower whitish median coverts (with buff fringes). Therefore, to age Blue Chaffinches in Tenerife as juveniles the following criteria are suggested:

1) Innermost median coverts and tertials with buffish borders (Cramp & Perrins 1994).
2) Bill colour (blackish versus slate grey) and tip (lack of hook; this study).
3) Shape and colour of median coverts (ie discontinuous wing bar with buffish fringes, especially before partial post-juvenile moult).

During the first weeks after fledging, and just before the start of their post-juvenile moult, it is difficult to sex juvenile Blue Chaffinches (most juveniles in this study). At this stage, the only possibility is to base sexing solely on adult wing length (ie females = 89-97 mm, males = 98-106 mm; Table 2); however, difficulties arise when the wing length is close to the lower and upper bounds of males and females (97-98 mm), respectively. First year males can be sexed reliably when the wing length is above 98 mm. Once the juvenile starts its partial moult, the new feathers offer a reliable sexing criterion, as has been found in other Canary Island endemics (Illera & Atienza 2002). Any sign of blue colour (ie on lesser coverts, fringes of median and greater coverts) will suggest male. Ideally, the combination of these two different criteria (wing length and blue colour) should be used for correctly sexing partially moulting juvenile Blue Chaffinches.

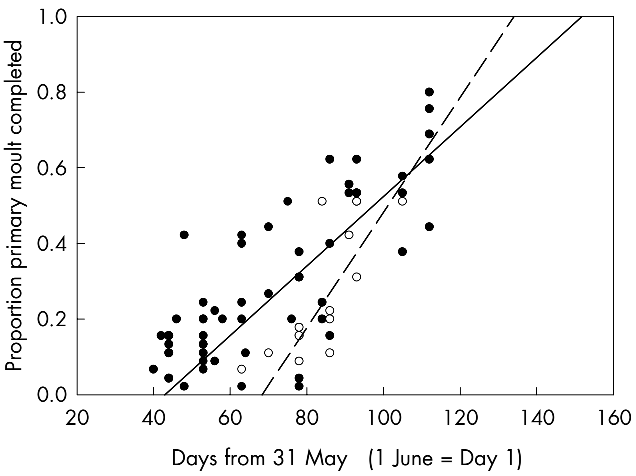

Figure 3. Underhill & Zucchini (1988) model for type 3 data (moult scores for moulting birds against date) fitted separately to first years (filled circles, solid line) and adults (open circles, dashed line). The lines were drawn using the mean starting dates and duration for first year birds (mean starting date 43 days from 31 May, duration 109 days) and adults (mean starting date 68 days from 31 May, duration 66 days). Standard deviations of the starting dates were 15.6 days for first-year birds and 7.4 days for adults.

Sexual dimorphism

The average wing lengths of male and female adult Blue Chaffinches reported here are within the range of measurements reported elsewhere for live birds (Martin *et al* 1984) and skin specimens (Cramp & Perrins 1994), but are slightly higher due to differences in methodology (minimum versus maximum chord) and the shrinkage of skins (Knox 1980). All other measurements presented here are larger as a result of the methods used to collect the data, the differences between live and dead birds, and the differences in sample sizes (see Grant 1979 for weight measurements). Therefore, adult Blue Chaffinches are sexually dimorphic in colour (Cramp & Perrins 1994) and wing length (Martin *et al* 1984; this study: females = 89-97 mm, males = 98-106 mm) but this is not so clear cut for first year birds due to the wear of the primary feathers increasing the range of overlap between males and females (females = 86-95 mm, males = 93-102 mm; Table 2).

Despite the east-west trend in bill size found for the endemic Blue Chaffinch in the Canaries (Volsoe 1955), males of the nominate race had similar bill lengths to females (but differing in all other measurements taken including bill depth). The bill of birds is generally regarded as a plastic organ, adaptable to different foods and to different methods of obtaining the food (Volsoe 1955); it is the sole food gathering structure in many species (Johnson 1966). The Blue Chaffinch has been considered as a specialist of the pine forest (Lack & Southern 1949), and uses its bill to pick up loose pine seeds from the ground, or to extract them from open cones and de-husk them (Godman 1872). At present, no rigorous diet assessment is available in the literature (Martín & Lorenzo 2001), but there is some evidence for foraging-niche differences between the sexes of Blue Chaffinches during the breeding season: both sexes tend to exploit the opened cones of *Pinus canariensis* for their seeds on the ground but females forage intensively among the needles during the breeding season (Garcia-del-Rey unpublished observations). The deeper bill of males (0.2 mm bigger) may be better for crushing foods and hard or large items in its diet. The diet of Blue Chaffinches also includes grasshoppers, adult larval Lepidoptera, beetles and plant seeds (Cramp & Perrins 1994). The narrower bill of the female suggests a more probing type of food gathering (eg among the needles, at least during the breeding season; Garcia-del-Rey unpublished observations).

Moult

Our observations agree with the moult cycle described by Cramp & Perrins (1994) for the Blue Chaffinch (ie partial post-juvenile, adult/first year complete post-breeding), and is similar to that of most European passerines (Svensson 1992). However, exceptions can also occur and one first year bird was found not to have undergone the partial post-juvenile moult. The Blue Chaffinch is a late breeder (Lack & Southern 1949) and it is difficult to explain at this stage why first year birds start moulting earlier than adults, and have a longer moult duration. This may indicate a non-breeding population of first year birds which can start their complete moult almost a month earlier than adults. More data from adults later in the breeding cycle are needed to improve estimates of moult phenology; however catching birds at drinking places during the autumn can become difficult because of the start of the autumn rains from October onwards (Marzol-Jaén 1984).

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