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Sex and age related biometrical patterns in Pyrenean Citril Finches (*Serinus citrinella*)

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Abstract: BORRAS A., J. CABRERA, T. CABRERA & J. C. SENAR (1998): Sex and age related biometrical patterns in Pyrenean Citril Finches (*Serinus citrinella* P.). Vogelwarte 39: 196–202.

Sex and age variation in external biometric measurements is described for the eastern Pyrenean Citril Finch population (n = 376 birds from 16 localities). Citril Finch overall biometry could be summarized by five Principal Components (PCA), which explain 60% of total variation. The PC1 was related to overall feather size of the birds (wing, third primary and tail lengths). Adult males were the larger birds and yearling females the smaller ones. PC2 was related to the shape of the bill (mainly width and depth), but no sex or age differences appeared in relation to this component. The three next overall principal components (PC3–5) were related to wing shape, based on PCA on the relative lengths of the primary feathers (P2–P8) corrected for body size and allometry. These three components varied according to sex and age in a complex way. Pyrenean Citril finches showed larger wing lengths than central European populations, which suggests that although a clinal variation in size from north to south should be expected, other factors as habitat quality or diet may also be of great importance in determining the size of Citril Finches.

Key words: Citril Finch (*Serinus citrinella*), biometry, Pyrenees, sex, age.

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1. Introduction

The Citril finch (*Serinus citrinella citrinella* P.) typically inhabits the boreal mountain zones of western temperate Europe (CRAMP & PERRINS 1994). Its distribution is discontinuous, with four main nucleous: the Alps, in Central Europe, and the Pyrenees, the Cantabrics and the Central and Iberian System Mountains in Spain. The biometry of the species is only known for the most eastern population (eastern Alps, [BRANDL & BEZZEL 1989] and Swiss Jura [MÄRKI & BIBER 1975]), and only a few data from the Pyrenees are available based on Museum skins (CRAMP & PERRINS 1994).

The Alps and Pyrenean populations seem to differ in feeding ecology, with the Pyrenean population highly relying on pine seeds (BEZZEL & BRANDL 1988, BORRAS & SENAR 1991, CRAMP & PERRINS 1994). They also differ in some population parameters, with the Pyrenean population showing higher densities than that in the Alps (BEZZEL & BRANDL 1988, CRAMP & PERRINS 1994, BORRAS & JUNYENT 1993). As a consequence, some biometric differences between these populations could appear. The aim of this paper is to provide a detailed biometric description of the species from the eastern Pyrenees and to compare it with other populations.

2. Material and Methods

Citril Finches used in this study were trapped from January to June 1996 at the Oriental Pyrenees and adjacent valleys, and at plains of central Catalonia (NE Spain). Total number of localities sampled was 16, from 9 different counties (Montmajor, Fonollosa [Barcelona province], Lles [Girona], Castellar de la Ribera, Clariana, Guixers, Naves, Odén, Tuixent-La Vansa [Lleida]). A total of 376 birds were captured with mist nets. Sex and age were determined according to SVENSSON (1992) and JENNI & WINKLER (1994). We measured mass (to the nearest 0.1 g), wing (maximum chord), tail, tarsus, bill depth and width following SVENSSON (1992). Bill length was measured from the distal corner of the nostril to the tip, first and third primary lengths (R1 and R3 respectively) were measured following JENNI & WINKLER (1989), and distance between the tips of the first eight primaries (excluding P1, measured ascendantly) and the tip of the wing (to the nearest 0.25 mm), following SVENSSON (1992) and CHANDLER & MULVILHILL (1988). The distance from the tip of each primary to the tip of the wing was transformed to primary lengths (i.e.: distance from carpal joint to primary tip on the folded wing) by substracting each primary length from wing-length (following EVERED 1990). We worked out this transformation, instead of directly obtaining primary lengths, because we were interested in the flying outline, and previous prospective analyses had showed a low correlation between direct and transformed feather-length measurements (and wing-shape indexes). Transformed feather-lengths were then corrected for body size and allometry using the equations in SENAR et al. (1994), and a principal components analysis (PCA) was used to obtain the primary sources of variation in feather lengths, and therefore wing shape (SENAR et al. 1994).

We used MANOVA to test for overall differences in biometry between sexes and ages, and ANOVAS to specifically test for these differences within each variable. Principal components analysis (PCA) was used to summarise Citril Finch variation in biometry. We used the SPSSPC+ statistical package for all analyses (NORUSIS 1986).

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3. Results

Male and adult Citril Finches showed a longer wing, third primary and tail. Body mass also tended to be higher for male and adult birds, and first primary was longer for yearling birds. No differences between sexes and ages appeared in beak and tarsus measurements (Tables 1 and 2). The interaction between age and sex was only significant for wing and the third primary lengths, so that adults showed longer wings and third primaries than yearlings, the difference being especially important in the males (Table 2).

Mean length (±SE) of the distance from each primary to the wing-tip was P2: 1.26 ± 0.04, P3: 0.09 ± 0.01, P4: 0.15 ± 0.01, P5: 1.79 ± 0.05, P6: 8.26 ± 0.06, P7: 13.27 ± 0.06, P8: 16.28 ± 0.06 (N = 376). Three principal components defined wing shape variation in the Citril Finch accounting for 77% of the total variation in standardized primary lengths (Table 3). PC1 represented an axis of increasing proximal primary lengths (P 5 – P 8), and could therefore be interpreted as an index of wing pointedness. PC2 was an axis representing increasing distal (P 2 – P 3) primary lengths. PC2 was also related, to a lower degree, to increasing proximal primary lengths (P 6 – P 8) and inversely related to P 4 – P 5 primary lengths. PC2 could therefore be interpreted as an index on concavity of the wing shape. PC3 was an inverse relationship between distal (P 2 – P 5) and proximal (P 6 – P 8) primary lengths. These three axes represented the principal dimensions of wing shape in Citril finches and so they were used to quantify wing-shape variation. Wing shape PC1 varied according to sex and age (Table 4). However, the almost significant two-way interaction suggests that the age difference was only significant for females (i.e. adult females had less pointed wings than yearling ones) (Planned comparisons; yearling vs. adult females: $F_{1,372} = 7.29$, $p = 0.007$, yearling vs. adult

Table 1: Mean ± standard error for Citril Finch biometric measures. Data are provided separately for each age and sex, and for the whole population.
Tab. 1: Mittelwerte ± und Standardfehler biometrischer Daten getrennt nach Alter und Geschlecht.

	Yearling Female	Adult Female	Yearling Male	Adult Male	Population Mean
Body mass	12.88 ± .14	12.93 ± .13	12.27 ± .05	12.53 ± .05	12.58 ± .05
Wing length	76.39 ± .19	77.91 ± .23	78.29 ± .12	80.59 ± .17	78.47 ± .11
Tail length	52.76 ± .26	53.64 ± .21	53.89 ± .14	55.50 ± .25	54.05 ± .12
Bill length	8.83 ± .06	8.81 ± .05	9.01 ± .04	8.96 ± .04	8.92 ± .02
Bill width	5.84 ± .02	5.87 ± .03	5.88 ± .02	5.86 ± .02	5.87 ± .01
Bill depth	5.81 ± .03	5.75 ± .02	5.82 ± .02	5.81 ± .02	5.80 ± .01
Tarsus	14.68 ± .04	14.70 ± .05	14.70 ± .04	14.74 ± .04	14.71 ± .02
R3 length	58.92 ± .15	59.66 ± .20	60.35 ± .11	62.15 ± .16	60.43 ± .10
R1 length	7.20 ± .07	7.44 ± .08	7.28 ± .04	7.35 ± .06	7.31 ± .03
N	76	64	134	102	376

Table 2: Two-way ANOVA values for differences between ages and sexes in Citril Finch biometrical measures. In all the cases d.f. = 1,372. Overall MANOVA Wilks' Lambda values for age = 0.75, p<0.001, for sex = 0.57, p<0.001, for the interaction age x sex = 0.94, p = 0.01; d.f. = 9,364.

Tab. 2: Zweifaktorielle Varianzanalyse zur Prüfung von Unterschieden biometrischer Daten des Zitronengirlitzes nach Alter und Geschlecht. In allen Fällen: Freiheitsgrade = 1, 372. MANOVA Wilks' Lambda-Werte für Alter = 0,75, p<0,001, für Geschlecht = 0,57, p<0,001, für die Interaktion Alter x Geschlecht = 0,94, p = 0,01; d.f. = 9,364. .

	Age		Sex		Age x Sex	
	F	p	F	p	F	p
Body mass	2.96	0.09	31.24	<0.001	1.43	0.23
Wing length	116.10	<0.001	166.94	<0.001	4.73	0.03
Tail length	31.44	<0.001	45.19	<0.001	2.65	0.10
Bill length	0.42	0.52	11.77	0.001	0.04	0.83
Bill width	0.00	0.95	0.46	0.50	0.56	0.45
Bill depth	0.00	0.95	0.46	0.50	0.56	0.45
Tarsus	0.33	0.57	0.47	0.50	0.03	0.85
R3 length	66.17	<0.001	155.82	<0.001	11.51	0.00
R1 length	6.35	0.01	0.03	0.87	1.81	0.18

Table 3: Principal components analysis (PCA) of wing shape in Citril Finches (n = 376 birds), based on the relative lengths of the primary feathers (P2–P8) corrected for body size and allometry as described in text.

Tab. 3: Hauptkomponentenanalyse (PCA) der Flügelform des Zitronengirlitzes (n = 376 Vögel) basierend auf der relativen Länge der Handschwingen (P2–P8) korrigiert nach Körpergröße und Flügelmaßen, wie im Text beschrieben.

	PC1	PC2	PC3
P2	–0.12	0.53	0.19
P3	–0.08	0.56	0.29
P4	0.19	–0.15	0.63
P5	0.23	–0.04	0.51
P6	0.28	0.12	–0.01
P7	0.28	0.17	–0.33
P8	0.25	0.25	–0.37
Eigenvalues	3.03	1.37	0.98
% variance	43%	20%	14%

males: $F_{1,372} = 0.21$, p = 0.65) (Fig., Table 4). Wing shape PC2 also varied according to sex and age, but the two-way interaction stressed that although yearlings always had larger wing shape PC2 scores than adults, independently of sex (i.e. a more concave wing shape), adult females had smaller wing shape PC2 scores (i.e. less concave wing) than adult males (Planned comparisons; yearling male vs. yearling female: $F_{1,372} = 1.13$, p = 0.29; adult male vs. adult female: $F_{1,372} = 23.13$, p<0.001; yearling male vs. adult male: $F_{1,372} = 27.31$, p<0.001) (Fig., Table 4). Finally, males showed larger wing shape PC3 scores than females, and adults than yearlings (Fig., Table 4).

Citril Finch overall biometry could be summarized by five Principal Components. The PC1 was related to overall feather size of the birds (see Rising & Somers 1989), and the lengths of wing, third primary and tail highly influenced that component (Table 5). According to this component adult males were the larger birds, followed by yearling males, adult females and with the smaller

Table 4: Two-way ANOVA values for differences between ages and sexes in Citril Finch wing shape PC scores (see Table 3). In all the cases d.f. = 1,372. Overall MANOVA Wilks' Lambda values for age = 0.79, p<0.001, for sex = 0.90, p<0.001, for the interaction age x sex = 0.97, p = 0.01; d.f. = 3,370.

Abb.: Zweifaktorielle Varianzanalyse zur Prüfung von Unterschieden nach Alter und Geschlecht in den Hauptkomponenten der Flügelform des Zitronengirlitzes (siehe Tabelle 3). In alle Fällen: Freiheitsgrade = 1,372. MANOVA Wilks' Lambda-Werte für Alter = 0,79, p<0,001, Geschlecht = 0,90, p<0,001, Interaktion Alter x Geschlecht = 0,97, p = 0,01; d.f. = 3,370.

	Age		Sex		Age x Sex	
	F	p	F	p	F	p
PC1	5.83	0.02	11.38	<0.001	3.44	0.06
PC2	85.79	<0.001	18.36	<0.001	8.19	0.01
PC3	2.91	0.09	8.30	0.01	0.02	0.89

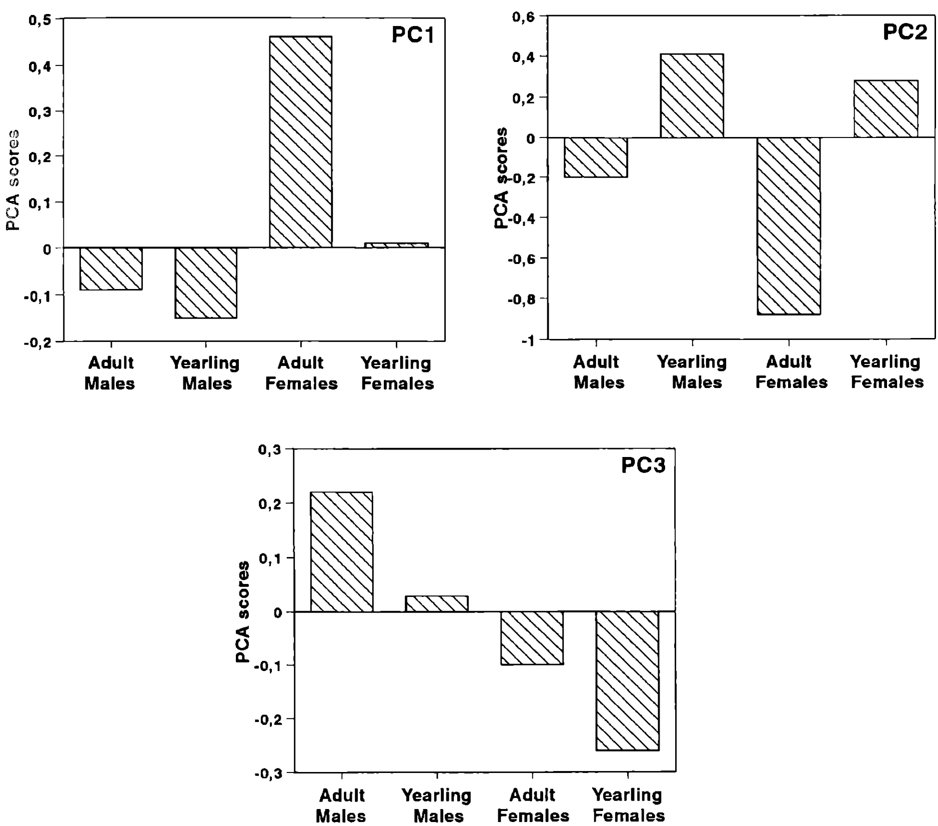

Fig.: Factor scores by sex and age on the three first wing shape principal components (PC1–PC3; see text). Wing shape is based on principal components analysis on the relative lengths of the primary feathers (P2–P8) corrected for body size and allometry.

Abb.: Mittelwerte getrennt nach Geschlecht und Alter für die drei ersten Hauptkomponenten der Flügelform (PC1–PC3: siehe Text). Die Flügelform basiert auf einer Hauptkomponentenanalyse der relativen Handschwingenlängen (P2–P8), korrigiert nach der Körpergröße und den Flügelmaßen.

Table 5: Principal components analysis (PCA) of body size and shape in Citril Finches (n = 376 birds). Wing shape PC scores (see tables 4 and 5) are also included.

Tab. 5: Hauptkomponentenanalyse (PCA) der Körpergröße des Zitronengirlitzes (n = 376 Vögel). Eingeschlossen sind dabei auch die Hauptkomponenten-Werte der Flügelform (siehe Tabelle 3 und 4).

	PC1	PC2	PC3	PC4	PC5
Body mass	–0,02	0,54	–0,21	0,46	–0,11
Wing length	–0,90	–0,17	0,04	0,10	–0,05
Tail length	–0,70	–0,01	0,12	0,13	0,13
Bill length	–0,26	0,36	–0,39	–0,38	0,08
Bill width	–0,03	0,61	0,18	–0,06	–0,22
Bill depth	–0,08	0,67	–0,25	–0,11	–0,26
Tarsus	–0,07	0,42	0,31	0,16	0,27
R3 length	–0,89	–0,07	0,14	–0,04	–0,08
R1 length	–0,39	-0,08	-0,58	0,10	-0,11
Wing shape PC1	0,16	-0,36	-0,25	0,30	-0,64
Wing shape PC2	-0,07	-0,08	0,03	**-0,75**	-0,26
Wing shape PC3	-0,05	0,10	0,62	0,03	-0,52
Eigenvalues	2,36	1,61	1,20	1,09	0,99
% variance	20%	13%	10%	9%	8%

Table 6: Two-way ANOVA values for differences between ages and sexes in Citril Finch overall biometric PCA scores. In all the cases d.f. = 1,372.. Overall MANOVA Wilks' Lambda values for age = 0.64 , p<0.001, for sex = 0.59, p<0.001, for the interaction age x sex = 0.96, p = 0.02; d.f. = 5,368.

Tab. 6: Zweifaktorielle Varianzanalyse zur Prüfung von Alters- und Geschlechts-Unterschieden in den Hauptkomponenten-Werten der Körpergröße des Zitronengirlitzes. In allen Fällen: Freiheitsgrade = 1,3 72. MANOVA Wilks' Lambda-Werte für Alter = 0,64, p<0,001, Geschlecht = 0,59, p<0,001, Interaktion Alter x Geschlecht = 0,96, p = 0,02, d.f. = 5,368 .

	Age F	p	Sex F	p	Age x Sex F	p
PC1	82.05	<0.001	168.04	<0.001	7.18	0.01
PC2	1.50	0.22	0.55	0.46	0.34	0.56
PC3	0.78	0.38	18.85	<0.001	1.65	0.20
PC4	109.45	<0.001	46.25	<0.001	3.60	0.06
PC5	0.35	0.55	0.01	0.75	0.08	0.77

size, the yearling females (Table 6). The second overall principal component (PC2) was related to the shape of the bill (mainly width and depth) (Table 5). No sex or age differences appeared in relation to overall PC2 (Table 6). The three next overall principal components (PC3–5) were related to wing shape, as already explained in the previous section (Tables 5 and 6). These five components together explain 60% of the total variation in Citril Finch biometry (Table 5).

4. Discussion

Size variation in Pyrenean Citril Finches, according to sex and age, was similar to that found in many other Passerine species: adult males are the larger class and juvenile females the smaller one (e.g. CRAMP & PERRINS 1994, SVENSSON 1992). The pattern is similar to that found in Central Eu-

Table 7: Wingh length variation between different Citril Finch populations.We provide means ± SD.
Tab. 7: Variation in der Flügellänge zwischen verschiedenen Populationen des Zitronengirlitzes. Angegeben sind Mittelwerte ± Standardabweichungen .

	Eastern Pyrenees	Eastern Alps	Swiss Jura
Adult males	80.59 ± 1.74	79.00 ± 1.50	79.03 ± 1.85
Yearling males	78.30 ± 1.45	77.60 ± 1.51	
Adult females	77.91 ± 1.87	77.08 ± 1.51	76.62 ± 1.91
Yearling females	76.39 ± 1.68	75.87 ± 1.37	
Sample size	376	843	138
Source	this study	BRANDL & BEZZEL 1989	MÄRKI & BIBER 1975

ropean Citril Finch populations (BRANDL & BEZZEL 1989). The variables influencing overall size (according to PCA [RISING & SOMERS 1989]), however, may vary across species. Tail or tarsus length may be of great importance in some species (e.g. JOHNSTON & SELANDER 1973, BJÖRKLUND 1991, FREEMAN & JACKSON 1990), but not in others (e.g. PAYNE 1987, SCHLUTER & SMITH 1986, FREEMAN & JACKSON 1990). The pattern shown by the Citril Finch clearly gives more importance to wing and tail lengths, which could be related to the highly stereotyped courtship flights displayed by the males (CRAMP & PERRINS 1994).

Patterns of wing shape variation are similar to that of the Siskin (*Carduelis spinus*), for which the same methodological approach has been used (SENAR et al. 1994), which suggests that wing shape components found may be quite general, at least for Cardueline finches.

Comparison of wing length between Pyrenean and Alpine populations (Table 7) shows that although Swiss and German populations do not differ (t-test, adult males $t = 0.15$, ns; adult females $t = 1.81$, ns, see Table 7 for sample sizes), Pyrenean and German populations do show significant differences, with Pyrenean populations being larger for any sex/age class (t-test, adult males $t = 8.68$, $p<0.05$, yearling males $t = 4.26$, $p<0.05$, adult females $t = 3.34$, $p<0.05$, yearling females $t = 2.62$, $p<0.05$) (Table 7). This larger size could be due to measurement error between different researchers. However the larger wing length tendency for southern populations suggests that although a clinal variation in size from north to south is typically expected (e.g. JAMES 1970, JOHNSTON & SELANDER 1973), other factors as habitat quality or diet may also be of great importance (RAND 1961, PEHRSSON 1987). This stresses the need for a detailed comparison of the biometrics between different Citril Finch populations, using additional measures.

5. Zusammenfassung

In der vorliegenden Arbeit wird die Variation biometrischer Daten in Beziehung zu Geschlecht und Alter von einer Population des Zitronengirlitz (*Serinus citrinella*) im Osten der Pyrenäen beschrieben (n = 376 Vögel von 16 Standorten). Die Daten konnten in fünf Hauptkomponenten zusammengefaßt werden, die 60% der gesamten Variation erklären. Hauptkomponente 1 hängt mit der Länge der Federn zusammen (Flügellänge, Länge der 3. Handschwinge, Schwanzlänge). Adulte ♂ waren am größten, einjährige ♀ am kleinsten. Die Hauptkomponente 2 ist mit der Schnabelbiometrie verknüpft (hauptsächlich Breite und Höhe), aber es gibt bei dieser Komponente keinen Geschlechts- oder Altersunterschied. Die folgenden drei Hauptkomponenten (PC 3–PC 5) betreffen die Flügelform, was über die relative Länge der Handschwingen (P 2 – P 8) korrigiert nach Körpergröße und Allometrie (Flügelmaße) analysiert wurde. Diese drei Komponenten variierten je nach Geschlecht und Alter auf komplexe Art und Weise. Die Zitronengirlitze der Pyrenäen hatten längere Flügel als die Zitronengirlitze aus Mitteleuropa, das heißt, obwohl man eine Variation Nord-Süd in der Gesamtgröße erwartet, ergab sich, daß auch andere Faktoren, wie die Qualität des Habitates oder die Ernährung von Bedeutung sind, wenn man die Größe der Zitronenzeisige erklären will.

6. References

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