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A KEY FOR AGING AND SEXING PAINTED BUNTINGS

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Abstract.—During their first 12–17 mo of life, including their first potential breeding season, subadult male and female Painted Buntings (*Passerina ciris*) wear juvenal, first basic, supplemental and first alternate plumages that are virtually identical in color. As a result, sexing subadults by plumage color has not been possible previously. This study indicates, however, that birds with blue first alternate head plumage may be sexed as males with 90% accuracy. In addition, males have longer winglengths, on average, than females. By using plumage color and winglength together, 73% of males in first alternate plumage may be reliably sexed. In addition, about 36% of males and 27% of females in supplemental and first alternate plumage, and about 12% of males and 14% of females in juvenal and first basic plumage may be reliable sexed by winglength alone. A dichotomous aging and sexing key is presented.

CLAVE PARA DETERMINAR EL SEXO Y LA EDAD DE *PASSERINA CIRIS*

Sinopsis.—Durante los primeros 12 a 17 meses de vida (incluyendo potencialmente su primer año de reproducción), machos y hembras subadultas de *Passerina ciris,* muestran ya sea plumaje juvenil, básico primario, suplementario o primer plumaje alterno que son virtualmente idénticos en color. Como resultado, el determinar el sexo de los subadultos utilizando como criterio el plumaje ha sido imposible. En este estudio encontramos que aquellas aves con primer plumaje alterno y azul en la cabeza pueden ser clasificados como machos con un 90% de certeza. Estos individuos además tienen en promedio un mayor largo de ala que las hembras. Si se utiliza el color del plumaje alterno pueden ser identificados. Además, cerca del 36% de los machos y el 27% de las hembras en plumaje suplementario y primer alterno, y cerca del 12% de los machos y 14% de las hembras en plumaje juvenile y primer plumaje básico, pueden ser sexados por el largo del ala. Se presenta en este trabajo una clave dicotoma para identificar el sexo en estas aves.

Adult Painted Buntings (*Passerina ciris*) in definitive plumage (Humphrey and Parkes 1959) are easily sexed by differences in plumage color (Fisk 1974, Storer 1951, Thompson 1991a). During their first 12–17 mo of life, however, Painted Buntings wear juvenal, first basic, supplemental and first alternate plumages that are very similar in color between the sexes (Table 1). As a result, attempts to sex Painted Buntings in predefinitive plumages and not in reproductive condition have met with limited success (Fisk 1974, Storer 1951, Tipton and Tipton 1978). As part of two larger studies on delayed plumage maturation and species limits in Painted Buntings (Thompson 1991a,b), I collected data on plumage color, winglength and skull pneumatization of males and females in all plumages. This paper presents data regarding differences in winglength and plumage color between the sexes in predefinitive plumages, and incorporates these data into an aging and sexing key for this species.

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TABLE 1. Sequence of molts and plumages of Painted Buntings from hatching to somatic maturity.

Age at molt	Molt-resulting plumage	Date of molt	Feathers replaced during molt	Duration of plumage	Plumage coloration
	Born in natal down[1]			1–9 d	Both sexes: light drab brown
7–14 d	Postnatal-juvenal	May 15–Jul. 31	All natal plumage	Jun. 1–Aug. 31	Both sexes: uniformly drab brown
15–35 d	First prebasic-first basic	Jun. 1–Oct. 15	All body plumage except greater primary and secondary coverts	Jul. 1–Oct. 15	Both sexes: body plumage olive-green dorsally and yellow-green ventrally; remiges and rectrices, greater primary and secondary coverts brown
2–6 mo	Presupplemental-supplemental	Sep. 1–Nov. 31	All body plumage except some greater primary coverts, all rectrices, P6–P9 and S5–S9	Sep. 15–Feb. 15	Both sexes: all body plumage brighter olive-green dorsally and yellow-green ventrally. Retained juvenal inner primaries, inner greater primary coverts and outer secondaries are less green (more brown) than replaced inner secondaries and outer primaries
5–12 mo	First prealternate-first alternate	Dec. 15–May 15	Head and variable amount of other body plumage	Feb. 15–Sep. 31	Both sexes: same as supplemental plumage except males may have small patches of blue head feathers (43.4% of males, n = 341; 5.0% of females, n = 238)
12–17 mo	Adult prebasic-adult basic	Aug. 1–Oct. 15	All body and flight feathers	Sep. 1–Jan. 15	Females: same as female supplemental except all flight feathers and greater primary coverts are edged green. Males: head bright blue except chin and throat red; entire ventral surface, rump, and eyering red; back is bright green. Most flight feathers reddish
17–23 mo	Adult prealternate-adult alternate	Jan. 1–May 31	Same as first prealternate molt	Mar. 15–Sep. 30	Both sexes: same as adult basic except females may have some blue head feathers

[1] Based on Parmelee (1959, 1964); adapted from Thompson (1991a).

MATERIALS AND METHODS

Specimens.—Data for this study were collected from more than 2600 museum specimens of Painted Buntings collected in all months of the year from throughout their breeding, migratory and wintering ranges.

Aging.—Hatching-year (HY, born the current calendar year) birds and second-year (SY, born the previous calendar year) birds in supplemental or first alternate plumage (hereafter referred to as subadults) were distinguished in age from after-hatching-year (AHY, born at least one calendar year previously) or after-second-year (ASY, born at least two calendar years previously) females in definitive basic or definitive alternate plumage by the retention of juvenal (brown) greater primary coverts by subadults (Fisk 1974, Storer 1951). Similarly, HY birds in juvenal or first basic plumage were distinguished from SY birds in first alternate plumage by differences in plumage color also (see Table 1).

Sexing.—Painted Buntings in definitive plumage (hereafter referred to as adults) were reliably sexed by marked differences in plumage color (Table 1). As males and females wear essentially identical plumages until 12–17 mo of age when they begin their first definitive prebasic molt, specimens in predefinitive plumages were sexed from their specimen labels. Labels contained data regarding reproductive condition in 20% of specimens in juvenal or first basic plumage and 18% of specimens in supplemental or first alternate plumage. Although the labels of some of the remaining specimens surely indicated the wrong sex, the overall effect of such errors would tend to make my conclusions more conservative for two reasons: (1) males should be sexed incorrectly, by chance, as often as females because plumage color does not differ between sexes within subadult plumage classes. The effect of such errors would be to reduce the magnitude of differences observed between the sexes, i.e., differences in the incidence of blue body plumage and in mean winglength; (2) it is likely that subadult males were sexed incorrectly as females more often than vice-versa because Painted Buntings exhibit delayed plumage maturation (Thompson 1991a). Again, the effect of this error would be to reduce the magnitude of differences observed between the sexes in these same characters.

Winglength.—In passerines, winglength is the character most commonly used to sex individuals in species (or age-classes within species) in which males and females do not differ in plumage color (Pyle et al. 1987, Svensson 1984). Therefore, unflattend wing chord, the recommended method for determining winglength, of all specimens was measured to the nearest 0.5 mm as described by the British Trust for Ornithology (1984), and the U.S. Fish and Wildlife Service (1977). All winglength measurements are reported as means ± SE unless stated otherwise.

Plumage color.—Presence of blue and red plumage color in birds in juvenal, supplemental and first alternate plumages was recorded.

Skull pneumatization.—The extent of skull pneumatization (present,

TABLE 2. Winglength of Painted Buntings collected east of 94°W longitude in North America, and in the Bahama Islands and Cuba.

Plumage and sex class	n	Mean (mm)	SD (mm)	95% CI
Definitive males	414	69.11	1.38	66.39–71.82
Definitive females	111	64.95	1.52	61.94–67.96
Supplemental and first alternate males	138	67.19	1.42	64.38–69.99
Supplemental and first alternate females	77	64.71	1.53	61.67–67.76
Juvenal and first basic males	23	66.37	1.73	62.78–69.95
Juvenal and first basic females	19	64.87	1.93	60.83–68.90

absent or percent completed) was recorded if noted on original specimen labels.

Geographic coordinates.—Geographic coordinates of collection localities were determined from gazetteers, atlases and maps, and converted into decimal form for statistical analyses and mapping.

Statistical assumptions.—I assumed that biases in the temporal and geographic distribution of specimens were consistent among age and sex classes.

RESULTS AND DISCUSSION

Variation in winglength.—For differences in winglength between sexes or among age classes to be generally useful criteria for aging or sexing, one must be able to apply them to birds at all times of year, including spring and fall migration. Thus, I examined geographic variation in winglength of each plumage and sex class by determining the mean winglength of all specimens of each plumage and sex class, regardless of collection date, for each degree of longitude (latitude was not examined because birds migrate primarily north to south [Thompson 1991b]). These results agree well with those of Storer (1951), Fisk (1974), Tipton and Tipton (1978) and Thompson (1991b). Figure 1 illustrates that little clinal variation in winglength exists within any plumage and age class east of 93°W or west of 95°W. All plumage and sex classes, however, exhibit a dramatic increase in winglength from 93°W to 95°W, i.e., the mean winglength within each plumage and sex class in each degree of longitude west of 94°W is greater in nearly all cases than is the mean winglength in each respective age and sex class in each degree of longitude east of 94°W (Fig. 1). Therefore, I operationally divided Painted Buntings into two populations, one east of 94°W and one west of 94°W, and calculated 95% confidence intervals for the winglength of each plumage and sex class in each of these populations (Tables 2 and 3). Painted Buntings that were examined in this study and that had been collected east of 94°W longitude would be sexed correctly with 95% confidence by differences in winglength in 42% of males and 32% of females in supplemental and first alternate plumage and 9% of males and 11% of females in juvenal and first basic plumage. Similarly, Painted Buntings west of

TABLE 3. Winglength of Painted Buntings collected west of 94°W longitude in North America and north of 22°N latitude in Mexico.

Plumage and sex class	n	Mean (mm)	SD (mm)	95% CI
Definitive males	467	71.14	1.61	67.97–74.30
Definitive females	109	66.93	1.69	63.58–70.27
Supplemental and first alternate males	154	69.58	1.50	66.62–72.54
Supplemental and first alternate females	89	66.58	1.68	63.24–69.92
Juvenal and first basic males	42	67.50	1.91	63.64–71.36
Juvenal and first basic females	45	66.59	1.99	62.58–70.60

94°W longitude would be sexed correctly with 95% confidence in 30% of males and 22% of females in supplemental and first alternate plumage and 14% of males and 16% of females in juvenal and first basic plumage.

Variation in plumage color.—The sequence of molts and plumages in Painted Buntings is summarized in Table 1. The most important points regarding aging and sexing by plumage color are: (1) age can be determined for all birds, but sex can be determined only for adults and for subadults with blue first alternate head plumage (see below); (2) males and females in first alternate plumage differ in that 43.4% of males ($n = 341$) and 5.0% of females ($n = 238$) have some blue head plumage, i.e., assuming no bias in the representation of males versus females in a sample of buntings (e.g., as occurs in the differential migration of sexes in many species), 90% (43.4/48.4) of birds that exhibit some blue head plumage are males; (3) there is no difference in plumage color between males and females in juvenal, first basic or supplemental plumage.

Utility of winglength and plumage color as sexing criteria.—Of the specimens that were examined in this study, the percentage of each subadult plumage and sex class of each population that would be sexed correctly by winglength is discussed above. The only plumage and sex class that can be sexed by using winglength and plumage color is males in first alternate plumage. If these two criteria were used together, rather than independently of one another, to sex male specimens examined in this study that were in first alternate plumage, a total of 75% of males in the eastern population and 72% of males in the western population would have been sexed correctly, i.e., 32% of males in the eastern population and 24% of males in the western population could be identified as males by the presence of blue body plumage that could not be identified as males by winglength.

Rate of skull pneumatization.—As Painted Buntings may fledge young as early as early June (Parmelee 1959, Sutton 1967) and as late as early September, skull pneumatization may begin as early as early August or as late as early October (Fig. 2). Regression of date on percent of skull pneumatization completed in individual specimens (see Pimm 1976 for statistical methodology) indicates that, on average, skull pneumatization takes approximately 46 d, beginning in mid-September and ending in

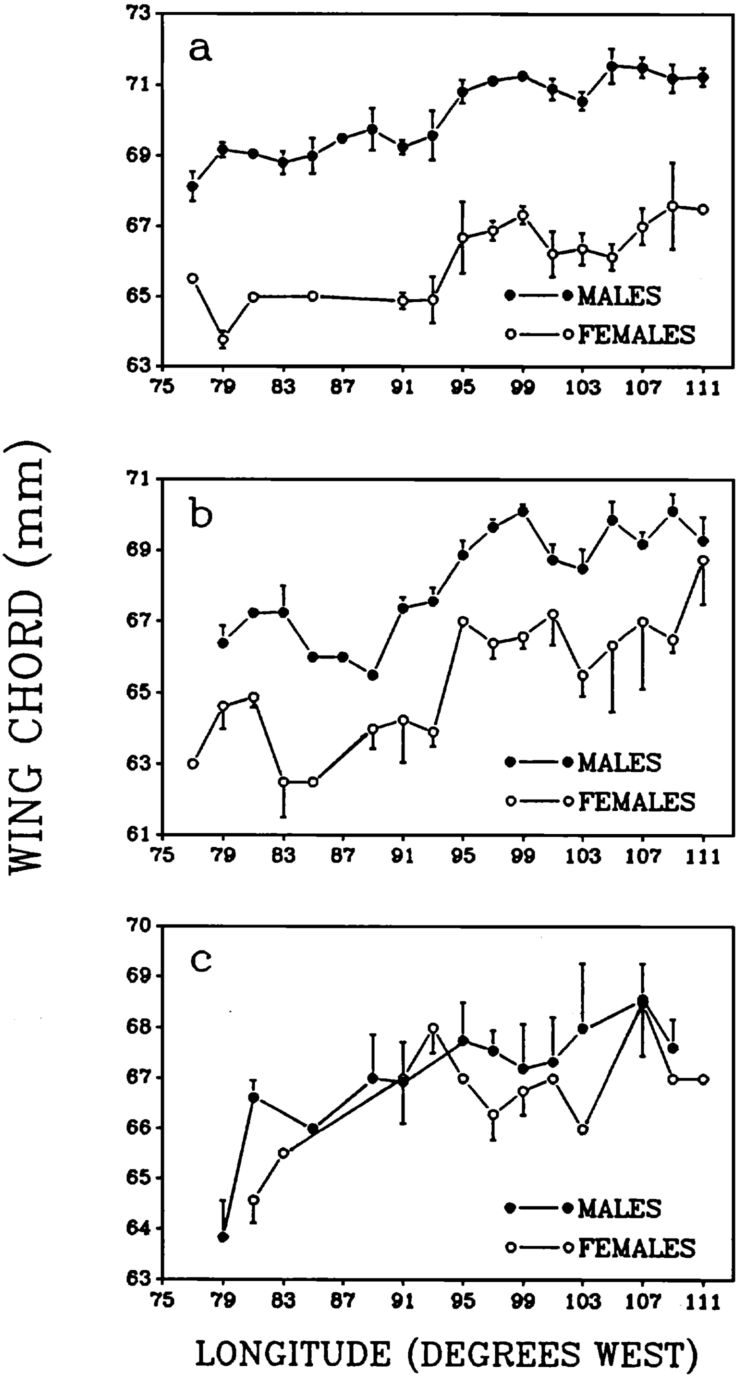
WING CHORD (mm)
a
b
c
●—● MALES
○—○ FEMALES
73
71
69
67
65
63
61
70
68
66
64
75
79
83
87
91
95
99
103
107
111
LONGITUDE (DEGREES WEST)

TABLE 4. Percentage of Painted Buntings with completely pneumatized skulls by age class and month. Sample size in parentheses.

Month	HY	SY	AHY/ASY
Jan.	—	50 (4)	60 (5)
Feb.	—	100 (1)	100 (1)
Mar.	—	100 (8)	100 (5)
Apr.	—	90.9 (11)	100 (16)
May	—	100 (12)	100 (19)
Jun.	0 (5)	85.7 (7)	100 (8)
Jul.	0 (5)	100 (1)	100 (3)
Aug.	0 (7)	100 (1)	100 (2)
Sep.	0 (23)	100 (1)	100 (7)
Oct.	0 (18)	—	100 (2)
Nov.	18.2 (11)	—	100 (9)
Dec.	58.3 (12)	—	100 (8)

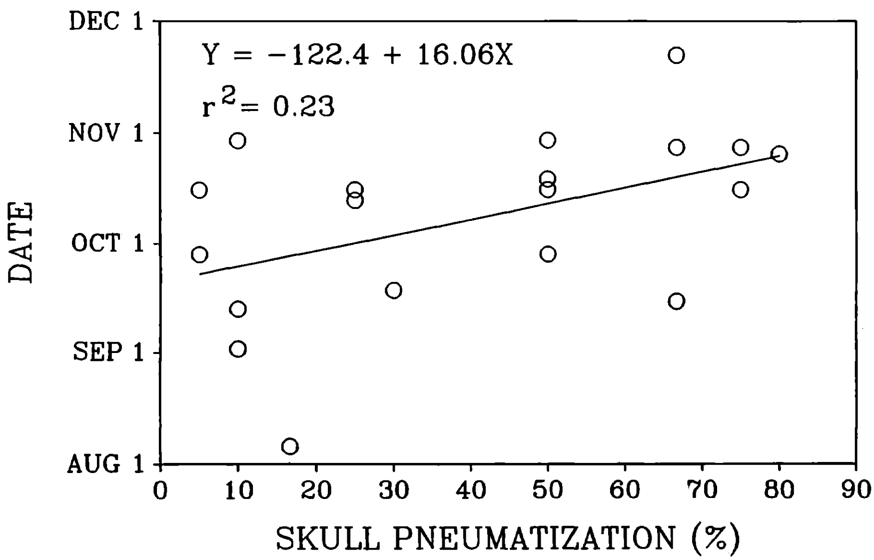

FIGURE 2. Plot of the percentage of skull pneumatization completed in individual specimens in relation to date of year (n = 20).

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FIGURE 1. Longitudinal variation in wing chord (mean ± SE) of males and females collected throughout the year north of 22°N latitude in Mexico and North America, and also in the Bahama Islands and Cuba in a) definitive plumage, b) supplemental and first alternate plumage and c) juvenal and first basic plumage. Means are reported for each two degrees of longitude, e.g., means reported for 83°W are means of all specimens of a given plumage and sex class collected west of 82°00′00″W and east of 84°00′00″W, regardless of time of year.

early November. Some SY birds, however, maintain small "windows" until well into second year. These results agree with Tipton and Tipton (1978) who stated that the skull pneumatization is not completed on the breeding ground in late summer and fall prior to fall migration, and that SY birds may "show small windows through [their] first spring." In addition, ASY birds rarely exhibit incompletely pneumatized skulls suggesting that some adult birds may never complete skull pneumatization (Table 4).

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KEY TO AGING AND SEXING

Painted Bunting, *Passerina ciris* Band size: 1
A.O.U. No. 601

Age

By skull pneumatization:

1a. Incompletely pneumatized 2
1b. Completely pneumatized 3
2a. January through May .... SY
2b. June through December .... HY
3a. January through October .... AHY
3b. November through December .... U

Sex

By reproductive structures:

1a. Cloacal protuberance present .... M
1b. Cloacal protuberance absent 2
2a. Brood patch present .... F
2b. Brood patch absent .... U

Aging and Sexing by Plumage and Winglength

1a. Primaries 8 and 9 edged brown or green. Body plumage may be either entirely drab brown or olive green or multicolored bright blue, green and red 2
1b. Primaries 8 and 9 and all rectrices edged dull red. Entire head and neck bright blue except chin, throat and eyering. Chin, throat, eyering, rump, and underside bright red. Upper back bright green 3
2a. Entire body drab brown to olive-green or olive-yellow, except head which may have small patches of bright blue feathers. Incoming body plumage, if any, is olive-green or olive-yellow. Some incoming feathers on head may be bright blue. (Individuals occasionally exhibit a diffuse reddish wash on the underside and/or dorsal surface of the body. Rarely a few small patches of bright red or yellow plumage may occur dorsally or ventrally.) 4
2b. Primaries 8 and 9 edged green. Body plumage may vary from olive-green dorsally

and olive-yellow ventrally (female-like) to bright green dorsally and bright red ventrally, with a blue head and red rump (male-like). All incoming body plumage, if any, is adult male-like. Most or all incoming rectrices and remiges, if any, are edged dull red .... SY-M

3a. January through July .... ASY-M
3b. August through December .... AHY-M
4a. All greater primary coverts are green 5
4b. Most or all greater primary coverts are dull brown 6
5a. January through July .... ASY-F
5b. August through December .... AHY-F
6a. Small patches of blue plumage on head .... SY-M
6b. No blue plumage on head 7
7a. All rectrices and primaries 7 through 9 edged green 8
7b. Remiges and rectrices uniformly dull brown and unworn. Body plumage may be either dull brown ventrally and dorsally, or olive-green above and olive-yellow below. No blue or red body plumage 16
8a. East of 94° longitude 9
8b. West of 94° longitude 11
9a. Wing chord greater than or equal to 68.0 mm 13
9b. Wing chord less than 68.0 mm 10
10a. Wing chord less than or equal to 64.0 mm 14
10b. Wing chord greater than 64.0 mm and less than 68.0 mm 15
11a. Wing chord greater than or equal to 70.0 mm 13
11b. Wing chord less than 70.0 mm 12
12a. Wing chord less than 67.0 mm 14
12b. Wing chord greater than 66.5 mm and less than 70.0 mm 15
13a. January through August .... SY-M
13b. September through December .... HY-M
14a. January through August .... SY-F
14b. September through December .... HY-F
15a. January through August .... SY-U
15b. September through December .... HY-U
16a. East of 94° longitude 17
16b. West of 94° longitude 19
17a. Wing chord greater than or equal to 69 mm .... HY-M
17b. Wing chord less than 69.0 mm 18
18a. Wing chord less than 63.0 mm .... HY-F
18b. Wing chord greater than 62.5 mm and less than 69.0 mm .... HY-U
19a. Wing chord greater than or equal to 71.0 mm .... HY-M
19b. Wing chord less than 71.0 mm 20
20a. Wing chord less than 64.0 mm .... HY-F
20b. Wing chord greater than 63.5 mm and less than 71.0 mm .... HY-U