Physical Characteristics and Arrival Times of Indigo Buntings in Eastern Missouri

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Introduction

Indigo Buntings (*Passerina cyanea*) show a relatively great range in plumage patterns and extent of blue in the plumage. One is tempted to presume that species showing such a great variational range in external characteristics are also the ones that can be more successfully aged by these characteristics. Male Indigo Buntings in their first nuptial plumage (= SY, second calendar-year males) have long been known to have brown greater primary wing coverts, while those in later nuptial plumages (= ASY, after-second-year males) have blue on each of these coverts (Dwight 1900). The apparent dependability of this criterion has gained support from recapture results as well as maturational changes observed in captivity (Taber and Johnston 1968, Carey and Nolan 1975, 1979, Payne 1982). The specific distinction is in the color of the outer vane of the greater primary wing coverts - blue in all of these coverts in ASY males, and all or some brown in SY males. However, use of other criteria for age classes in either male or female Indigo Buntings remains disputed or unknown. The study reported here, at a Missouri site through four years (1983-1986), provides data consistent with the validity of the above criteria for SY versus ASY nuptial males. It additionally demonstrates statistically significant subgroup differences within the male population. In most cases it remains unknown whether a particular male is a returned local resident or transient migrant belonging to another population.

Methods

Birds were mist-netted and banded (FWS standard bands) during four consecutive springs (1983-1986) at a site 5 km NNW of Foley, Lincoln County, Missouri (39° 08'N, 90° 46'W), on the western bluffs of the Mississippi River Valley. The numbers of nets employed, days of netting, and numbers of captures and recaptures progressively increased during these four years (Table 1). It should be understood nevertheless, that the temporal and qualitative differences in the netting activity each year, negate the significance of possible year-to-year comparisons based solely upon quantitative netting effort (Table 1). The capture or netting periods during the first two years were too brief and early to obtain a balanced representation of both sexes and all subclasses of the population. Netting during the third year was discontinuous. I report here results from the fourth year (1986). During this year, netting, banding and study were continuous from April 2 to June 1.

Table 1. Summary of netting efforts and capture/recapture results for each year and the same population of Indigo Buntings.

Years:	1983	1984	1985	1986
Netting Efforts:				
Dates:	IV 30►V 7	V 1►4	IV 25►V 16, 27►VI 1	IV 2►VI 1
Calendar days:	8	14	25	61
Net sites:	16	26	46	64
*Mean net-hours/day:	224	270	393	623
*Total net hours:	1,792	3,793	9,816	38,010
Indigo Buntings:				
Capture periods:	V 2►7	V 2►14	IV 28►30, V 5►15, 27►31	IV 24►V 31
First captures/bandings:				
Males:	5	64	24	88
Females:	2	22	22	86
Totals:	7	86	46	174
Recaptures (within year/season):				
Males:	0	2	6	18
Females:	0	0	3	16
Totals:	0	2	9	34

*Between 06:00 and 20:00 Central Standard Time.

The timing of this study was based upon results from the previous years, and especially those provided by cloacal lavages (Quay 1984). The objective this year was to obtain continuous monitoring of the population of Indigo Buntings from the time of arrival or first capture, through the first peak in breeding activity and the insemination of females. Cloacal lavages from the population in 1985 showed that the peak phase (phase #3) of sperm release occurred in the largest percentage (about 50%) of the males from May 4 to 15, and that by the last week in May essentially all of the netted and lavaged females had been inseminated. This was directly demonstrated by sperm and sperm ball remnants in cloacal lavages from females (Quay 1986).

Indigo Buntings were sexed on the basis of plumage characteristics and weighed to the nearest 0.1 g on a digital electronic balance (Sartorius "Type 1003"). Wing chord and tail lengths were measured to the nearest 0.5 mm. Cloacal lavages (Quay 1984) were taken from nearly all of the birds prior to banding and release shortly after capture. The percentage of the general body plumage that was blue was estimated and the occurrence of blue and brown in greater primary and secondary wing coverts recorded for all males. An index system (0 to +++++) was used to score in combination approximate relative intensity and areal extent of a bluish tinge in the plumage of females.

A few individuals of each sex had plumage patterns suggesting the possibility of a low level of intrusion of Lazuli Bunting (*Passerina amoena*) characteristics (Emlen et al. 1975). These were discounted in the analyses. Thus, whether individualistic or representative of *P. amoena* genetics, occasional white feathers or patches on flanks or bellies of males were not included in the percentages relating to blue or non-blue plumage.

Results and Discussion

Captures and Recaptures

Analysis of capture/recapture data is provided in Table 2. Sex ratios of captures and of recaptures were not significantly different from 1:1. This is in accord with Blake's (1969) results from North Carolina. However, in some published reports a preponderance of males sometimes has been suggested in some samples of Indigo Buntings (Johnston 1970). The dates of spring samplings from the latter, for example, indicate that later arriving females (see below) were likely to have been underrepresented or missed in the samplings.

Table 2. Analysis of capture/recapture data from the population of Indigo Buntings in spring 1986.

	Males	Females	Totals
Individuals: Recaptured from previous years:			
First captured/banded in:			
1983	1		1
1984	1		1
1985	4	2	6
First banded/captured this year:	88*	86	174
Total individual Indigo Buntings	94	88	182
Within-year (1986) recaptures:			
2nd captures:	14	13	27
3rd captures:	2	3	5
4th captures:	2		5
5th captures:	1		1
Totals:	18**	16	34***
Total captures in 1986:	112	104	216

* = 74 AY/males and 14 ASY/males.
** = 14 SY/males and 4 ASY/males.
*** Recapture rate within-year (1986) = 18.7 per 100 individuals, or 15.7 per 100 captures.

Males recaptured from 93 bandings in prior springs (Table 1) were represented by (numbers and estimated ages): two third-year (= TY, birds first captured and banded the previous spring in first nuptial plumage; therefore they were in their second calendar year, and now (1986) in their third), two after-third-year (ATY), one after-fourth-year (A4Y) and one after-fifth-year (A5Y) bird(s). Ages of two females recaptured from bandings in the prior spring could be characterized only as after-second-year (ASY).

Plumage Characteristics

Results concerning plumage characteristics of males are at least consistent with the criterion of color of greater primary wing coverts for distinguishing ASY from second-year (SY) birds (Table 3). However, the relative distributions and amounts of blue and brown elsewhere in the plumage were highly variable and not apparently diagnostic for age (Table 3). General plumage and greater secondary wing covert coloration of one ATY recapture were not distinguishable from those of SY males.

Two females recaptured from bandings in prior springs had advanced in the extent and intensity of a bluish tinge in the plumage, from indices of 0−+ and + to ++. This probably represents the change from SY to TY ages, but data are inadequate to prove this. Numbers of females per index value of extent and degree of plumage blue tinge were: 3/0, 6/0−+, 20/+, 32/++, 27/+++, 2/++++ and 1/+++++.

Table 3. Relative distribution and amount of blue in plumage of male Indigo Buntings. Number (%) of individuals by age.

Greater primary wing converts	All have blue (= ASY)			Brown or mixed (= SY)			
Greater secondary : wing coverts	Blue*	Mixed	(% of ASYs)	Blue*	Mixed	Brown	(% of SYs)
General plumage, Approx. % blue:							
100	15**		(65%)				
99		2***					
98		2	(30%)	1	1	1	(3.9%)
95		1			7		(9.2%)
90		2		1	2		(3.9%)
85					4		(5.3%)
80					4		(5.3%)
75					6		(7.9%)
70†					13		(17.1%)
65				1	6		(9.2%)
60					9		(11.9%)
55					7		(9.2%)
50					3		(3.9%)
45		1‡	(5%)		3	1	(5.3%)
40					3	1	(5.3%)
35					1		(1.3%)
30					1		(1.3%)
Totals:‡		23	(100%)	3	70	3	(100%)

* Blue on part (usually outer vane) of each greater primary wing covert.
** Includes 2 TY, 1 ATY and 1 A5Y recaptured birds.
*** Includes 1 A4Y recaptured bird.
† This is the median and mode %blue of the SY age class.
‡ Is an ATY recaptured bird.
‡ These totals are less than might be expected from Table 2, since birds with incomplete data were omitted.

Wing Chord and Tail Lengths

Mean wing chord and tail length measurements were significantly different between subgroups of males distinguished on the basis of plumage characteristics (Table 4). Moreover, these subgroups were not simple reflections of SY and ASY differences. Both maximally blue ASY and the SY males averaged smaller than ASY males of submaximally blue plumage (Table 4). Weights were much more variable than the relatively fixed wing and tail measurements, and were therefore not demonstrative of statistically significant differences. The ASY male plumage subgroup differences in mean measurements (Table 4) have no obvious explanation at this time. Tentative explanations could be based within genetic, developmental or physiological mechanisms, either individually or in some combination. These mechanisms could involve differences in nutrition, metabolism and hormonal status, particularly in relation to date of hatching and the subsequent environmental and physiological circumstances. Furthermore, understanding these differences within the male population is likely to be facilitated by improved information concerning molts and plumage maturation in this interesting species (Rohwer 1986).

In contrast to the males, the female Indigo Buntings showed no statistically significant subgroup differences in wing chord or tail length. Subgroupings arbitrarily defined on the basis of differences in blue tinge in the plumage were homogeneous in wing and tail measurements.

Table 4. Wing chord and tail lengths in male Indigo Buntings in relation to plumage characteristics.*

Greater primary wing coverts:	All have blue (= ASY)					Brown or mixed (= SY)
Greater secondary wing coverts:	All have blue		Mixed brown/blue			Mixed brown/blue
General plumage % blue:	100%	◄P►**	90-99%	40-99%	◄P►**	40-99%
***n =	14		6	8		66
Wing chord length:	66.39 ± 0.17	<0.001	68.33 ± 0.44	67.94 ± 0.44	<0.005	66.09 ± 0.19
Tail length:	52.07 ± 0.37	n.s.†	53.00 ± 0.22	52.81 ± 0.21	<0.001	50.45 ± 0.20

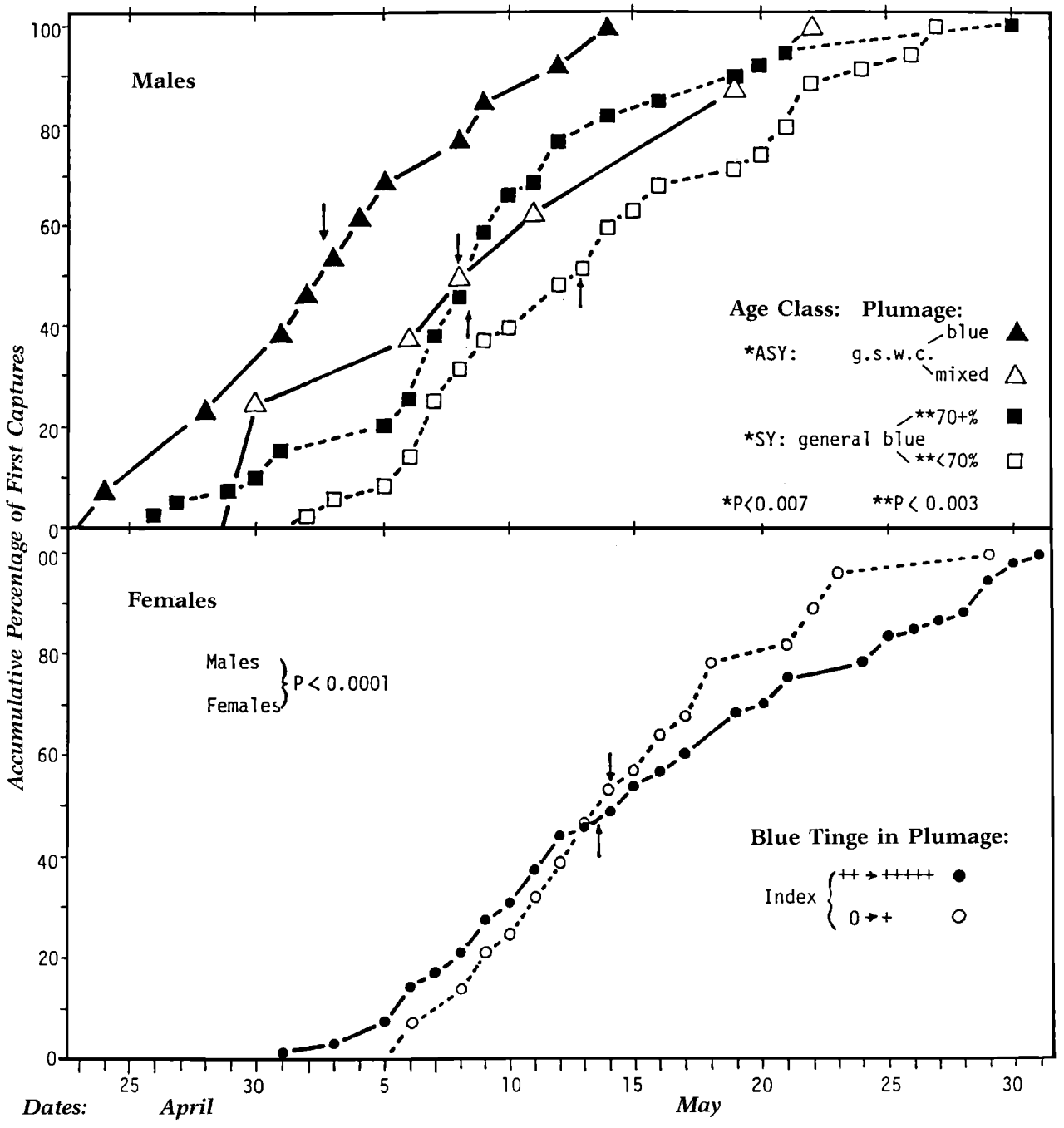
* Means ± standard errors are given.
** P = probability based on the Student-Fisher *t*; groups to either side are compared.
*** n = sample size.
† n.s. = difference not statistically significant.

Dates of First Captures

Dates of first captures in 1986 are probably representative of relative first arrival dates, especially because of the number and density of the net sites and the continuity of netting activity. Nevertheless, it is recognized that: (1) an interval of varying length intervenes between actual arrival within the study area and the first detected capture (many birds escape before detection or "capture" in a particular net), and (2) some secondary wandering may occur in the general area before arrival and capture in the study area.

A highly significant difference occurred between males and females in first capture dates ($P < 0.0001$, Figure 1), in agreement with earlier observations on spring migration chronology of sexes of this species (Johnston and Downer 1968). The male population, however, was not homogeneous in this characteristic; nor were their age subclasses. The upper panel of Figure 1 illustrates that although first captures of ASY males averaged earlier than those of SY males ($P < 0.007$), ASY males with relatively less blue and SY males with relatively greater blue were essentially equivalent in their first capture dates. Furthermore, *within* the SY male age subclass there was a significant difference ($P < 0.003$) in mean first capture date between arbitrarily defined more blue and less blue subgroups (Figure 1). Although a similar difference within the ASY male subclass is suggested by the graphs in the upper panel of Figure 1, the sample sizes of the ASY subgroups defined by blue plumage are inadequate for demonstrating or judging statistical significance for the observed difference. In summary, my results suggest not only a first arrival difference relating to male age, but also to degree of blue coloration. On the other hand among the females there were no differences in arrival times of arbitrarily defined subgroups based upon plumage coloration (Figure 1, lower panel). Therefore, median apparent arrival dates for males as compared with females at a particular site can be expected to depend in part upon relative representation of age and pigmentation subclasses and their subgroups within the male population.

Figure 1. Plots of first capture dates of male (upper panel) and female (lower panel) Indigo Buntings in the study area during spring 1986. No Indigo Buntings were captured from April 2 to 23. Median values for each of the population subgroups are indicated by vertical arrows. Probability (P) values are based upon two-tailed Mann-Whitney U tests corrected for ties (Siegel 1956, Hollander and Wolfe 1973). Although the plots for the two plumage subgroups of ASY males seem different, this difference is statistically not significant in these data (g.s.w.c. = greater secondary wing coverts). Sample sizes of groups: males: ASY g.s.w.c. blue = 13, ASY g.s.w.c. mixed = 8, SY 70+% blue = 39, SY < 70% blue = 35; females: blue ++ ► +++++ = 62, blue 0 ► + = 28.



Conclusions

Results from this study of a population of spring Indigo Buntings are consistent with, or confirmatory of, two previously reported relationships: (1) a difference between SY and ASY males of this species on the basis of color of greater primary wing coverts, and (2) a mean earlier apparent arrival (first capture) of males as compared with females. New findings include: (1) small but significant differences in wing chord and tail length between SY males and the comparably less blue subgroup of ASY males, (2) a small but significant difference in wing chord length between coloration subgroups of ASY males, and (3) spring arrival (first capture) times of males are related to age (SY versus ASY) and to extent of blue coloration. These new findings are not immediately or directly applicable to the further identification of subclasses according to age. But they do suggest that genetic and further behavioral and physiological field studies of population subgroups based upon external characteristics are likely to provide important new information concerning the biology of this species.

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