

NOTES ON THE INDIGO BUNTING

BY CHARLES H. BLAKE

In the vicinity of my banding station, three miles northwest of Hillsborough, N. C., the Indigo Bunting is a regular but scarce breeder and a common migrant. The comparison of the calculated longevity and the observed number of returns makes it clear that most of the birds handled are transmigrants. Birds banded long enough to afford returns number 590 but only 25 of these have actually provided returns.

SURVIVAL RATE OF ADULTS

By a method equivalent to that which I have described (Blake 1967, p. 5) I find a weighted annual survival of 0.585. Two birds have shown a survival of essentially six years from the date of banding. At first glance it seems that we might take the six-year survival as $2/25$ of 0.08 and calculate an annual rate. This might be admissible if the sample of returning birds were very large and we agreed that the annual rate is constant throughout life. The second point is one that, at present, can be neither proved nor disproved. It simply appears to be true. Now, our six-year survival rate of 0.08 means an annual rate of 0.656 which is 12 percent higher than 0.585. Calculation from the rate of 0.585 shows that approximately one bird in 25 should live six years. The moral of this is that, when we have only a small sample, a small variation in the number of long-lived birds makes a large difference in the survival rate deduced from the age of the longest-lived birds.

SPRING MIGRATION

The spring bandings offer one solution for a point which arises later. The sex ratio may be considered 1:1. For the spring bandings for 1957 to 1967 there are 133 males to 134 females.

TABLE 1. SPRING ARRIVALS BY PERCENTAGES OF TOTALS FOR EACH COLUMN

Periods	Females	Yearling Males	Adult Males
11-20 April	—	1	3
21-30 April	7	14	31
1-10 May	21	51	51
11-20 May	48	33	9
21-31 May	24	—	6
Total Numbers	134	66	67

I have no explanation for the near equality in numbers of yearling and older males. As yet I cannot accept the hypothesis that a considerable fraction of yearling males are indistinguishable

in plumage from older males. Such an hypothesis would require the replacement, not only of all primaries, but of secondaries, and perhaps tertiaries, at the first spring molt. As will be shown later, out of 37 yearlings for which actual counts of replaced primaries are on record only one bird had replaced seven and I have no record of replaced secondaries. The hypothesis would seem to require two distinct regimes of replacement.

From Table 1 we can approximate the median dates of banding as: females 14 May, yearling males 7 May, and adult males 3 May.

FALL MIGRATION

The data on this migration are rather unsatisfactory. It is clear that some movement begins early in August. There is some evidence that this movement is wandering by young birds. Beginning in the last 10 days of August there is a sudden increase in the number of captures. The fall movement reaches its peak in the last 10 days of September followed by an immediate and very great decrease in numbers. The table shows percentages for 241 fall takes by periods.

TABLE 2. FALL MIGRATION

Periods	Percent	Periods	Percent
1-10 Aug	2	21-30 Sept	40
11-20 "	4	1-10 Oct	7
21-31 "	11	11-20 "	2
1-10 Sept	13	21-31 "	1
11-20 "	20		

PROPORTION OF SUMMER RESIDENTS

I stated above that only 25 birds have shown returns. Allowance must be made for mortality between the first and second summers in residence. Dividing 25 by 0.585 we obtain 41.7 as the estimate of the real number of residents banded. This is 7.2 percent of the 590 birds available for returns. Two breeding pairs per season is a fair estimate, based on field observations, of the situation within a reasonable distance of my station.

We can now make another estimate of the number of birds that should survive six years after banding. The number of birds banded long enough to provide any six year-olds is 248. Of these 18.0 can be considered residents. The six-year survival rate is the sixth power of 0.585 or 0.043. We estimate 0.76 birds will be alive six years after banding. Again we find that one bird too many has actually survived that long.

SEX RATIO OF THE RETURNING BIRDS

It has already appeared that there are equal numbers of males and females in the spring. The 25 returning birds are 14 females

and 11 males. Is the ratio of 1.27 females to one male actually different from a 1:1 ratio?

Croxtton (1953, p. 252) presents a method for determining the probability that a proportion of one sex equal to or greater than the observed proportion will occur in a sample drawn from a population of known (or assumed) sex ratio. A sample of 25 is close to the dividing line, in size, between the use of the Bernoulli distribution and the Gaussian distribution. In either case there are very close to three chances in 10 of drawing a sample containing at least 14 females from our observed population. If the method is carried one step further to find the probability of drawing a sample with 15 or more females and subtract this from our previously determined probability we find, with a Gaussian distribution, a little better than one chance in 10 of drawing a sample containing just 14 females. The Bernoulli distribution gives close to one chance in 7. In either case we conclude that there is no sexual difference in the tendency of an individual of this species to return, in the breeding season, to an area to which the individual has previously formed some attachment.

The account by Taber and Johnston (Bent 1968, pp. 100, 101, 106) gives what, at first sight, seem extraordinary statements of sex ratios showing a vast preponderance of males. On 20 Apr. 1909 there were hundreds of males and only three females at Dry Tortugas. My earliest female banding date is 27 April, so there may well have been almost no females in that latitude on that date. The situation at Gainesville, Fla., between 18 October and 6 November 1963, when banding showed about three males to one female and a general statement of four males to one female in winter in Jamaica do not suggest to me any ready explanation. At all events, I do not consider that we have any proof of an excess of males in the total population of the species.

REPLACED PRIMARIES IN YEARLING MALES

I have already discussed this point (Blake, 1965) but more than twice as many examples permit a closer examination. The new mean and standard deviation are 5.06 ± 0.68 . I have stated an extra significant figure because it was retained in calculating the numbers that would have been observed were the distribution strictly Gaussian. Inspection of Table III indicates some skewness of the observed distribution. Unless replacement of eight primaries should prove to be part of a different regimen of replacement, it would not be expected in more than about one bird out of 300.

The designation of the molt to which the first replacement of primaries belongs may prove to be a semantic rather than a biological problem. The replacement does not occur in close temporal relation to the post juvenal molt. I have not seen a clear statement of the sequence of events in the spring in the wild. Two distinct possibilities may be noticed. First, the primary replacement is complete, or almost so, before the first prenuptial body molt begins. In this case I would regard the primary molt as a final and separated episode of the post-juvenal molt. Second, the primary molt begins

TABLE 3. REPLACED PRIMARIES

No. replaced	Observed birds	Calculated birds
4	7	6.3
5	22	21.7
6	7	8.4
7	1	0.4

with, or more probably later than, the beginning of first prenuptial body molt. Then the primary molt would have to be considered part of the prenuptial molt.

In this connection some comments on the molt of the Cardinal may be significant. This species replaces all wing quills at the post-juvinal molt. At the postnuptial molt the replacement of primaries and body plumage begin at essentially the same time. This is the usual situation, at least in passerines which molt before fall migration. On the other hand the post-juvinal body molt begins well before the dropping of the first primary. It may be half finished by the beginning of primary molt. It is conceivable that the post-juvinal primary molt of the Indigo Bunting may be still more laggard. The failure to replace some inner primaries may result in even more postponement.

MOLT

Taber and Johnston (in Bent 1968, p. 89 *et seq.*) show that the prenuptial body molt in Central America is chiefly confined to the period January to March but with some evidence that the extreme span is December to May. This information is derived largely from the appearance of blue in the body plumage of males. There is no indication of when the first winter outer primaries are replaced. My own observations validate the rare occurrence of body molt as late as mid-May. I have three records of molting spring birds, one in April and two in May. This is one percent of total spring captures. Since many more birds are taken in May than in April, it is not surprising there have been more observations in May than in April.

The same authors give the period of post-nuptial molt as August to late fall, perhaps mostly September and October. This I can neither confirm nor deny. My observations of numbers molting in fall are roughly proportionate to the number of captures in each ten-day period. One contrast between spring and fall may be noticed. Molting birds in spring make up one percent of the captures but in fall the ratio reaches 15 percent.

I do have some indication that the post-juvinal molt is somewhat earlier than the postnuptial. In fact I have taken one young bird in molt on 19 June and the post-juvinal body molt may be largely over by 10 September.

WEIGHTS

The weights shown in Table IV do not evidence a remarkable accumulation of fat in most cases. We may conclude that the base weight, that is, weight without readily disposable fat, is a little less than 12.5 gms. The large number of birds weighing 13 to 15 gms. suggests that the Indigo Bunting in this region goes "off passage" before it has fully utilized its fuel load. It is possible that the accumulation of fat may be strongly related to date of capture in the fall. The two heaviest birds, 16.3 and 18.9 gms., were taken on 23 Oct., and 9 Oct., respectively. The heaviest bird probably was nearly 34 percent fat by weight. I tried loading one bird of about average weight to find the maximum gross weight at take-off. My result was 17.6 gms. Evidently I did not find the absolute maximum.

TABLE 4. WEIGHTS

	No. Weights	Extremes gms.	Means gms.	Percent < 13 gms	Percent 13-15 gms.	Percent > 15 gms.
Apr., May	19	12.1, 15.4	13.9	21	68	11
Sept., Oct.	34	12.6, 18.9	14.4	3	73	24

Odum *et al.* (1961) determined by extraction the fat present in fall migrant Indigo Buntings killed at a TV tower in extreme northern Florida. Their fat-free wet weight is essentially what I have called base weight. By calculation from their figures I find it to average 12.9 gms. Their maximum percentage of fat (35.2) would indicate a gross weight of 19.9 gm. Using a base weight of 12.9 gms. my heaviest bird would contain 31.8 percent of fat as compared with 33.9 percent using my estimated base weight.

An aerodynamic comment is appropriate here. An airplane or other similar device supported by airfoils can in established, level flight carry a total weight greater than that which will permit take-off from the ground. A bird may do what is usually forbidden to aircraft, that is, launch itself from a height and acquire considerable speed by losing altitude.

COMPARISON OF BLUE GROSBEAK AND INDIGO BUNTING

When I began to band both these species in some numbers I was struck by the fact that size and beak shape seemed to be the only real differences between them. This immediately suggested the possibility that they were congeners. The recent publication (Bent, 1968) of the pertinent life histories is a great aid to the detailed comparison of these two and also comparison with the Lazuli Bunting (*Passerina amoena*).

It is obvious that the only real difference in coloration of the two former species is the brown wing bars in both sexes of the Blue Grosbeak. It is, perhaps, more noteworthy that the light blue-gray and black beaks of the males are quite exactly the same al-

though the Blue Grosbeak has a stouter, more abruptly conical beak. This difference is paralleled in the Cardinal and the Pyrrhuloxia. In both cases there seems to be an adaptation to the more indurated seeds of warmer and of drier climates.

The molts and plumages of the males are quite similar. Replaced outer primaries appear to be always present in the male Indigo Bunting but infrequent in the Blue Grosbeak. The main difference is that the nuptial plumages, after the first, in males of the Blue Grosbeak are acquired by wear rather than a prenuptial molt as in the Indigo Bunting.

My observations on molt and plumage succession have led me to conclude that it is highly labile, differing often, in some degree, between individuals and especially between closely related species. The difference in winter plumage of fully adult males of the two species here compared is essentially the same as that between males of the Summer and Scarlet Tanagers.

To my ear the songs of the two species are very similar and this seems to be borne out by the descriptions in Bent.

There are some striking similarities in nest placement and nest materials. Both species tend to use membranous materials, such as dead leaves, snake skin, and paper. Such materials are not emphasized in the descriptions of the nests of the Lazuli Bunting. They may be less available in its range.

The clutch size is quite similar in the Blue Grosbeak and the Indigo Bunting. There is a slight difference in egg color, those of the former being less often lightly brown-dotted than those of the latter.

A final point should be made concerning the pigmentation of the three species, *caerulea*, *cyanea*, and *amoena*, as contrasted with that of *ciris* and *versicolor*. It is quite certain that the former group have no carotenoids in their feathers, but only melanin and "blue structure." This fact is emphasized by the *amoena* described by Erickson (in Bent, 1968, p. 124) in which the rusty breast band was actually blue. The simple addition of "blue structure" to the normally rusty feathers would have produced this result without any loss of the original melanin. On the other hand *ciris* and *versicolor*, quite aside from melanin and "blue structure", must have carotenoids over the entire underparts and most of the upperparts. Part of the head plumage may lack carotenoids.

In conclusion I suggest that *caerulea*, *cyanea*, and *amoena* form, at least, a subgenus and that *ciris* and *versicolor* form another genus or subgenus. I am not in a position to offer any opinion as to the placement of the tropical American species now placed in *Passerina* and such genera as *Cyanocompsa*.

CONCLUSIONS

The annual survival rate of adults is 0.585.

The sex ratio for spring migrants and for returning birds is 1:1.

Only 7.2 percent of the banded birds are summer residents.

The number of replaced primaries of yearling males is $5.06 \pm$

0.68, with a nearly Gaussian distribution.

Although the maximum possible weight is over 19 gms., the majority of birds weigh less than 15 gms. at my location.

It is proposed to sink *Guiraca* in *Passerina*.

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TRAPPING COMMON PUFFIN FLEDGLINGS

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INTRODUCTION

Several techniques for capturing adult Common Puffins (*Fratercula arctica*) have been described and reviewed by Lockley (1953) and Lockley and Russell (1953), but none for the young. During recent studies of puffins at Great Island, Ferryland, Newfoundland, a method for trapping fledglings on their nocturnal journey from their burrows to the sea was devised. This paper reports trap materials, method of construction, and capture results.

In 1967 puffin chicks were banded and measured at their burrow prior to fledging (Nettleship, 1968), however, several difficulties were encountered. In addition to the great amount of time that was required to locate occupied burrows, we were frequently hampered in our banding attempt by the inaccessibility of the chick within the nest chamber because of the burrow length, shape, and structure. Most puffin burrows tend to extend beyond an outstretched arm and often curve at sharp angles, which renders locating and capturing the chick difficult, sometimes impossible (e.g. this study; Bent, 1919; Lockley, 1953; and Myrberget, 1962). In high density nesting areas, tunnels from different burrows often interconnect,