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Further Observations on the Timing of Skull Pneumatization in the Pine Siskin

Robert P. Yunick

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Robert P. Yunick
1527 Myron Street
Schenectady, NY 12309

During the 1975-1976 winter invasion of Pine Siskins *(Carduelis pinus)* in eastern New York, I assessed the timing of completion of the skull pneumatization process by determining the rate of decline of incompletely pneumatized birds of mixed ages (Yunick, R.P. 1977. Timing of completion of skull pneumatization in the Pine Siskin. *Bird-Banding* 48:67-71.). During a similar invasion in 1986-1987, I was able to augment these data; and through the use of rectrix shape as an age-determining method, I was able to perform this same pneumatization analysis on only immature birds, to compare to the 1975-1976 results, and to better define the period of completion of the pneumatization process. Some observations on rectrix shape and reliability as an ageing criterion were also made.

METHODS

Pine Siskins were captured at my yard feeder in Schenectady, New York, between 14 November 1986 and 8 February 1987. I examined each bird's moistened skull under an illuminated magnifier and classed it as either skull completely pneumatized (SCP) or skull incompletely pneumatized (SIP). Only data on first-time captures were used. These data were grouped by monthly thirds, combined with the 1975-1976 data, and used to determine the percentage of the population with incompletely pneumatized skulls, as done previously (Yunick 1977). Each monthly third was assigned a banding period (BP) number beginning with 1-10 November as BP1 and progressing consecutively to BP13 at 1-10 March.

Rectrix shape was used to determine age (Svensson, L. 1984. Identification Guide to European Passerines, 3rd Ed. Vitoria, Spain: Heraclio Fournier, SA.). Birds with pointed rectrices were grouped as hatching-year (HY) birds prior to 1 January, and second-year (SY) thereafter. Similarly, birds with rounded rectrix tips were after-hatching-year and after-second-year (AHY/ASY). The HY/SY group skull data were analyzed by monthly thirds, as above, to determine the decline of birds with incomplete pneumatization.

In May 1987, and February to June 1988, I took measurements on the width of the fifth rectrix of captured Pine Siskins at Schenectady, and at my Jenny Lake feeder near Corinth in Saratoga County, New York. These measurements were made with dividers to the nearest 0.1 mm, perpendicular to the rachis on the dorsal side, at about 10-15 mm from the feather tip. They were used to compare differences in pointed and rounded rectrix shape.

RESULTS AND DISCUSSION

Timing of Completion of Skull Pneumatization

Figure 1 shows the decline in the percentage of SIP birds during the November-February period using the combined 1975-1976 (N=770) and 1986-1987 (N=716) data. A regression analysis of these percentages predicts completion of pneumatization by all Pine Siskins at BP11.2. Since BP11 is the 11-20 February period, any fraction over 11.0 moves the completion date to the next higher period; i.e., BP12 in this case, or to 21-28 February. The 95% confidence limit on these percentages extends that completion date to as late as 1-10 March. The previous 1975-1976 analysis predicted either 21-28 February or 1-10 March, depending on data interpretation. The addition of the 1986-1987 data complemented and confirmed the earlier result of completion by 1-10 March.

Figure 2 represents the same analysis on only 1986-1987 birds with pointed rectrices (HY/SY). Regression analysis predicts the same completion date at BP12.0, or 21-28 February, which with the 95% confidence limit extends to 1-10 March, as in the mixed-age sample. This HY/SY sample shows

more data scatter than does the combined mixed-age sample (R=0.9042 vs. 0.9934); and the rates of decline vary slightly; i.e., 9.04 percentage points per monthly third for HY/SY birds vs. 10.16 for the mixed-age group.

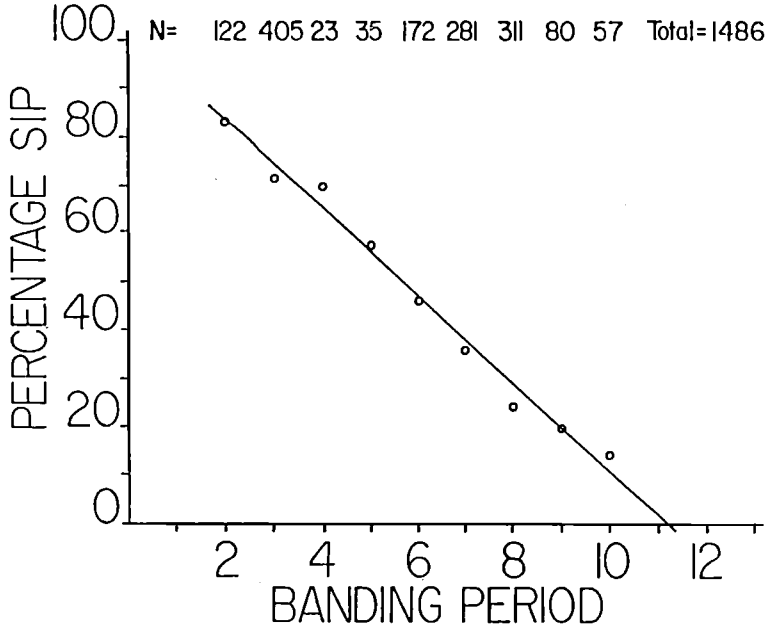

Figure 1. Distribution of Pine Siskins with incompletely pneumatized skulls based on a combined sampling of birds of mixed ages captured during the 1975-1976 and 1986-1987 invasions. Regression anaysis gave: Percentage SIP = 101.1 - 9.04(BP); r^2 = 0.9868, F-ratio = 523.32, p<0.00001. Percentage SIP = 0 at BP = 11.2.

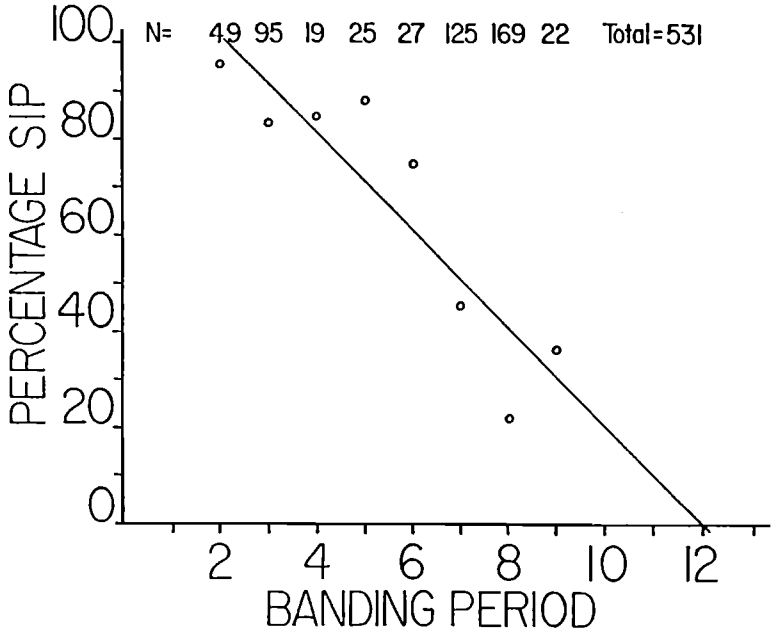

Figure 2. Distribution of Pine Siskins with incompletely pneumatized skulls based on only HY/SY birds captured during the 1986-1987 invation. Regression analysis gave: Percentage SIP = 121.9 - 10.16(BP); r^2 = 0.8175, F-ratio = 26.885, p = 0.00204. Percentage SIP = 0 at BP = 12.0.

I repeated both of these analyses using combined original capture data and recapture data and found no difference in outcome. In these analyses, recaptured birds were counted only once in any banding period, regardless of multiple captures of such birds in that period.

The earliest recorded capture of a HY bird with a completely pneumatized skull in 1975 was 16 November, and in 1986 was 15 November; in both cases, just as birds began to appear at my feeder. The regression line for the 1986-1987 data in Figure 2 predicts the first completion (line intersect at 100%) of pneumatization at 21-31 October, prior to the opportunity I had to capture and examine these birds. In a limited series of 12 siskins I captured near South Seaside Park, New Jersey, on 23 October 1986, one of the six birds with pointed rectrices had completed skull pneumatization, consistent with the predicted date of onset of completion. All six of the birds with rounded rectrices had done so.

My 1975-1976 data (Yunick 1977) on mixed-age birds predicted the first completion of pneumatization by 11 November. The 1986-1987 data on HY's only changes that to 21-31 October and is, in my opinion, based upon sounder premises and believed to be more accurate. It moves forward the date of last reliable ageing by skull examination from mid-November to late-October for birds with completely pneumatized skulls. The 1986-1987 data, or the 1986-1987 segregated HY/SY data, do not alter the earlier predicted final completion of the process by 1-10 March; rather, they confirm that conclusion at a higher statistical reliability (r increased to 0.9934 for the combined data). The predicted 1-10 March completion period is consistent with the last capture of a SIP bird on 5 March 1976. In 1987, Pine Siskins departed from my feeder in early February and I had no opportunity to again test this predicted time of completion on actual captures.

Change in Population Composition - Figure 3 illustrates the temporal distribution of HY/SY percentages among the 1986-1987 captures. Regression analysis of these data points from 11-20 November (BP2) to 21-31 January (BP9) suggests a decline in HY/SY birds among the birds captured (r=0.5946, p=0.1200). Using the extreme values of the regression line, the population declined from 81.4% HY in November to 64.0% SY by the end of January.

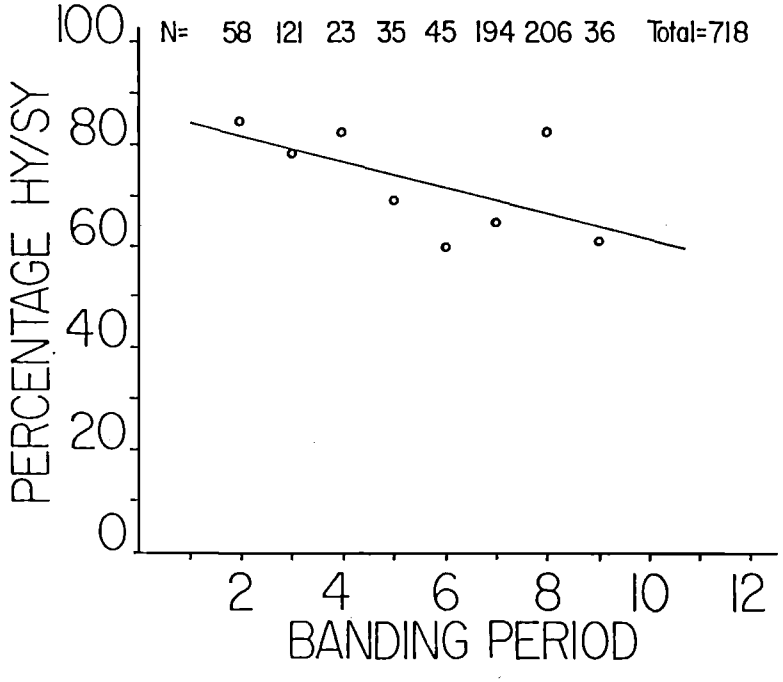

Figure 3. Distribution of HY/SY Pine Siskins in the 1986-1987 sampled population. Regression analysis gave: Percentage HY/SY = 86.43 - 2.49(BP); r^2 = 0.3536, F-ratio = 3.282, p = 0.1200.

Correlation of Rectrix Shape with Skull Condition - I compared rectrix shape to skull condition of the birds captured in 1986-1987. I captured 286 birds with incompletely pneumatized skulls and all (100.0%) had pointed rectrices. In this determination, tail shape was first noted, then skull condition determined. I captured 198 birds with rounded or semirounded rectrices and 197 (99.49%) had fully pneumatized skulls. The one November bird with round rectrices and incomplete pneumatization appeared to be a HY that had regrown a presumably accidentally lost tail, because complete rectrix renewal is not known for this species at the first prebasic molt. Alternately, it may have been an adult exhibiting a rare case of persistently incomplete pneumatization.

Variability in Rectrix Shape - As I examined more and more siskin rectrices, I noted some variability in rectrix shape. Pointed rectrices were noticeably pointed and gave the illusion of also being narrower, which tended to enhance the perception of pointedness. The rounding of the rounded rectrices varied from being bluntly rounded to semirounded. They appeared to be perceptibly wider, thus enhancing the roundness of the feather tip.

To test this perception that pointed rectrices seemed narrow and rounded ones seemed wide, I took width measurements of the fifth, right rectrix on 12 birds 10-17 May 1987 and combined these with 314 others taken 13 February-12 June 1988 to give 182 widths of pointed rectrices on SY birds, 110 rounded rectrices on ASY birds, and 34 pointed rectrices on newly fledged juveniles.

My perception on the difference in width of pointed and rounded rectrices in SY's and ASY's was confirmed statistically. Pointed rectrices averaged 7.06 mm (SD=0.303, range = 6.2-7.7) and were significantly different from round rectrices ($Z=16.95$, $p<0.0001$) which averaged 7.78 mm (SD=0.378, range = 7.0-8.8). While 0.72 mm may seem to be a trivial average difference, it is approximately 10% of the feather width, and when put into a holistic context involving the entire tail, helped separate the two rectrix shapes.

The rectrix width of the newly fledged juveniles averaged 7.24mm (SD=0.431, range 6.28-8.0) and was not significantly different from that of the pointed SY's ($Z=1.756$, $p=0.0792$), but was significantly different from the width of the rounded ASY's ($Z=6.62$, $p<0.001$). The observation that SY widths averaged less than that of newly fledged HY's appears attributable to wear. The HY rectrices were approximately one month or less old, while those of the SY's were nine to 12 months old at the time of measurement.

SUMMARY

Additional skull pneumatization data from a 1986-1987 invation of Pine Siskins in eastern New York confirmed and statistically enhanced the previously predicted date of completion of the pneumatization process in immature birds. These data helped to refine the predicted initiation date of this process; and suggest that completion occurs between 21-31 October and 1-10 March, consistent with observed dates of first completion and last incompletion of 23 October and 5 March, respectively, in captured individuals. Prior to late October, a pneumatized skull denotes an adult, while incomplete pneumatization from time of first fledging in April denotes a HY bird until 31 December, and a SY bird through early March.

Pointed rectrices averaged 0.72 mm narrower than, and were significantly different from, rounded rectrices. One hundred percent of 286 birds with incompletely pneumatized skulls had pointed rectrices, while 99.49% of 198 with rounded rectrices were pneumatized.

Between mid-November and late-January there was a 21.4% decline in HY/SY birds in the captured population from 81.4% HY at the start to 64.0% SY at the end.