# Timing of completion of skull pneumatization of the Black-capped Chickadee and the Red-breasted Nuthatch

*Robert P. Yunick*

## Introduction

The invasion flight of Black-capped Chickadees *(Parus atricapillus)* during the autumn/winter 1977-78 provided an opportunity to determine the onset and termination of completion of skull pneumatization by regression analysis. This analysis was augmented with data from individuals from several other winter invasions as well. Lesser numbers of Red-breasted Nuthatches *(Sitta canadensis)* were captured through several autumn/winter periods and, while their number was insufficient to allow regression analysis, they were sufficient to allow determination of the timing of this process based on changes noted in recaptured birds.

## Methods

At the time of their capture and banding, the heads of these chickadees and nuthatches were moistened with water to mat the feathers to allow examination of the skull through the skin using a 10 X illuminated viewer. Prior to 1977, record was made of whether the skull was completely or incompletely pneumatized. During 1977-79, pneumatization patterns were recorded for each individual.

All birds were captured and banded at a feeding station located in the Adirondack Mountains at Jenny Lake near Corinth, Saratoga County, New York. Birds were captured at intervals of one to three weeks from September through April while these birds were on their winter territory. Using a method employed previously (Yunick, 1977, 1979), the percentage of chickadees with incomplete pneumatization was plotted against intervals of monthly thirds, and subjected to regression analysis. The samples referred to here included new bandings and repeat and return captures. A bird that was captured repeatedly entered the calculations as many times as the number of monthly thirds in which it was captured, but only once for any particular monthly third.

## Results

**Black-capped Chickadee** — The capture data for the period prior to and during the 1977-78 invasion are summarized in Table 1. Using the values for banding periods (BP) 1 through 7, a regression analysis gave the linear equation: Immature Percentage = 77.0 − 11.4(BP) with S.D. = ± 4.0, index of fit = 0.9694. The data points and the curve ± 2 S.D.'s are plotted in Figure 1. Alternately, because of the apparent curvature of the values for banding periods 3 through 8, those values were analyzed separately to give an hyperbolic equation: Immature Percentage = −27.1 + 214.0(BP) with an index of fit = 0.9985.

Using the average immature percentage of 69.0 percent determined from the captures during the period of August through mid-October as the upper limit on the immature content in the sampled population prior to the advent of completion of pneumatization, and applying the 95-percent confidence lines in Figure 1, the estimating equation predicts that the first immatures will complete pneumatization as early as 1-10 October. The last of them are estimated to complete the

**Table 1. Skull condition of Black-capped Chickadees at time of capture, 1977**

| Banding Period | Period Designation[1] | Number captured SCP[2] | SIP[3] | Sample Size | Percent SIP |
|---|---|---|---|---|---|
| 11—20 Oct.[4] | 1 | 9 | 20 | 20 | 69.0 |
| 1—10 Nov. | 3 | 5 | 4 | 9 | 44.4 |
| 11—20 Nov. | 4 | 17 | 6 | 23 | 26.1 |
| 21—30 Nov. | 5 | 28 | 5 | 33 | 15.2 |
| 1—10 Dec. | 6 | 19 | 2 | 21 | 9.5 |
| 11—20 Dec. | 7 | 37 | 1 | 38 | 2.6 |
| 21—31 Dec. | 8 | 42 | 0 | 42 | 0.0 |

[1] Each banding period (BP) was numbered consecutively from the middle third of October for the purpose of regression analysis.
[2] SCP = skull completely pneumatized.
[3] SIP = skull incompletely pneumatized.
[4] The data presented for this period are the collective total captures for the period of August to mid-October. In this case, each bird was counted only once during this period regardless of the number of times it was captured.

process by 21-31 December. The alternate hyperbolic estimating equation predicts a slightly later initiation of completion of 21-31 October and final completion of 1-10 January.

These predicted results were compared with observations made on individual birds and to the changes that were observed on repeat captures. The earliest documented completion in an individual occurred between 26 October and 1 November 1975. At that time, an immature that had been banded on 8 August was still not completely pneumatized on 26 October, but had completed the process by 1 November. The greatest number of individual completions, and the greatest occurrence of skull patterns in the final stages of completion occurred in the middle and end of November, in agreement with the large percentage drop shown for November dates in Figure 1.

The latest dates of completion among most individuals were in close agreement with that predicted in Figure 1. In the 1977-78 invasion, that is represented in Figure 1, the latest confirmed completion occurred in an individual caught originally on 24 November. This bird was recaptured on 3 and 18 December with its skull

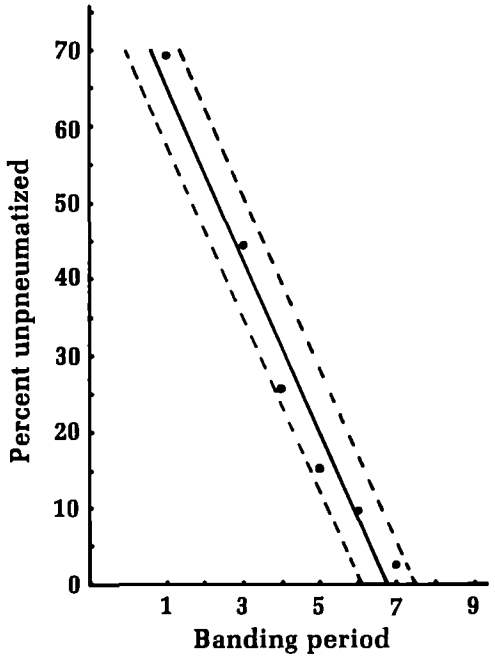


*Figure 1. Estimated timing of completion of pneumatization of the Black-capped Chickadee for autumn/winter 1977-78 using data for banding periods 1-7 from Table 1. The solid line fits the equation: Immature Percentage = 77.0 − 11.4(BP). S.D. = ±4.0. The dashed line represents the equation ±2 S.D.'s.*

still incompletely pneumatized. When recaptured on 31 December, its skull was totally pneumatized. The latest cases of incompletion were noted on birds captured 2 January 1977, 6 January 1979, and 2 February 1980. In the first two cases, a small window remained that appeared to be about seven to ten days away from completion. Continued examination of approximately 200 skulls during January through April in 1978 and 1979 showed not a single case of incomplete pneumatization beyond early January.

The 1980 capture appears to represent an extremely late case of completion. Judging from its condition on 2 February, this bird appeared as though it would complete pneumatization in mid-February. The bird's capture history points to it most likely being a second-brood fledgling which was very tardy in completing the process. At its original capture on 24 August 1979, it had already lost the yellow mouth color possessed by fledglings fresh out of the nest. This color change from yellow to white requires almost three weeks to complete. The presence of a white mouth and juvenile plumage on 24 August indicated that it had fledged no later than early August, thereby ruling out the possibility of an extraordinarily late brood.

This bird was captured 8 times following its banding. It showed progressively more pneumatization with time, but at a schedule well behind others of its kind. On 2 February 1980, it had an elliptical window measuring 2½ × 5 mm, generally centered on its skull. From its estimated dates of fledging to completion of pneumatization, this individual required nearly 28 weeks to complete the process.

Based on these results, it appears that banders may rely on skull examination to accurately differentiate adults from immatures until the end of September depending on geographical location and seasonal variation in the species' local breeding cycle. From early October until early February, only immatures may be safely recognized by incompleteness of pneumatization. After that date, skull examination loses importance as a means to determine age.

The dates determined here for the onset of completion of pneumatization are in general agreement with some reported dates for closely related species, although some variation exists between species. Winkler (1979) in Switzerland found that the Coal Tit *(Parus ater)* completes pneumatization at the age of 4-5 months at the end of September; the Willow Tit *(P. montanus)* first

reached stage 5 of completion, out of 7 stages described, by 17 October; and the Great Tit *(P. major)* and the Blue Tit *(P. caerulens)* first reached stage 6 out of 7 in early October. Verheyen (1953) in Belgium reported completion in the Blue Tit in late October—early November (based on the examination of 8 skulls), and similar timing for the Great Tit (based on the examination of 18 skulls, 13 of which were immatures, between 2 June and 4 November). Completion occurred at about 6 months.

At Jenny Lake 2 broods of Black-capped Chickadees are sometimes raised, however — perhaps not by all breeding pairs. The last of the winter residents abandon their winter territory in early or mid-April to establish breeding territories. The first brood is fledged typically in late June (about 15-20) and appears at the feeders at that time and in early July in limited number. Their numbers increase in late July when the parents are more concerned with feeding their second brood. This latter brood fledges in early August at which time there is a flocking to the feeders by the young. Bull (1974) gives fledging dates of 4 June—3 August; however, his date of 15 August for a second brood nestling date would extend the fledging period beyond what he cites for a confirmed date.

Thus, while there is a difference in timing among Jenny Lake broods of about 8 weeks, there is a greater span of 14 weeks between the first and last completion of the pneumatization process. However, referring again to Bull, the span between his extreme nestling dates is 12-13 weeks which approximates the 14-week span of extreme dates determined here. The first completions occur at an age of about 15-16 weeks with the majority occuring at about 20-21 weeks, and the longest normally requiring about 22-23 weeks to complete. One extreme case required nearly 28 weeks.

**Red-breasted Nuthatch** — While the number of captures of this species was not sufficient to allow regression analysis, a comparison of changes in skull patterns through the autumn/winter seasons, and the comparison of changes in recaptured individuals was made. It appears that initiation of completion in this species predates that of the Black-capped Chickadee. This high proportion of birds with completely pneumatized skulls at and beyond mid-November suggests that the process is complete in late November or early December. This is confirmed by the date of capture of the last individual with incomplete pneumatization. Except for two individuals mentioned below, this date during the 1977-79 period was 12 November. Over the longer 1970-79 period, the latest date was 17 November 1973. Based on the extent of pneumatization of the bird captured on 12 November 1977, and on the observation that it had completed pneumatization by the time of its next capture on 3 December, I estimated the completion to have occurred between 26 and 30 November. Thus, using the extreme dates of initiation just prior to 11 September and completion by 26-30 November, the span between these dates is about 12 weeks compared to 14 weeks for the Black-capped Chickadee. This compares favorably with the span of fledging dates given by Bull (1974) as 10-11 weeks.

There is at least one other difference between the pneumatization processes of these two species. So far, based on the examination of nearly 400 pneumatized skulls of Black-capped Chickadees, including those of new, repeat, and return captures, there has not been a single case of persistent or out-of-season incompletion of the process during the period September 1977 to November 1979. While this does not rule out the possibility of persistent incompletion, it indicates that its extent of occurrence does not have a significant impact on the reliability of skull examination as an age-determining method. However, from among observations of almost 60 pneumatized skulls of the Red-breasted Nuthatch in the same time period, two individuals have shown peristent incompletion.

One bird, which was banded 5 January 1974, was found to have a single 2- to 3-mm window in the back left quadrant of its skull 5 years later on 3 February 1979. The second was a bird which, when it was banded on 11 February 1978, had a small, unsymmetrical, "v"-shaped window centered on its skull. A year later, on 20 January 1979, this same bird was recaptured with a small elliptical window measuring 3 x 4 mm.

Winkler (1979) commented that completion of pneumatization in the Nuthatch *(Sitta europea)* in Europe takes a long time, i.e., beyond 6 months. He found that, up to the end of October, no young had yet progressed to stage 5 of the 7 he described. This schedule is very different from that found in the Red-breasted Nuthatch, but more nearly like that of the larger White-breasted Nuthatch *(Sitta carolinensis)*. At Jenny Lake, both of these nuthatches appear as newly-fledged juveniles in late June. Bull (1974) gives nestling dates for the Red-breasted Nuthatch of 6 June—18 August and of 3-22 June for the White-breasted Nuthatch.

The Red-breasted Nuthatch completes the process at the earliest in about 12-13 weeks, but more commonly in about 16 weeks, slightly earlier than the Black-capped Chickadee. While the majority of White-breasted Nuthatches showed the final stages of pneumatization in December at close to 6 months of age, one individual showed a much earlier completion estimated at late October—early November. The bird was banded on 18 August 1979 and recaptured on 30 September with incomplete pneumatization. On 21 October it was still unpneumatized but only about a week away from completion at an estimated age of 18-19 weeks. The latest completion recorded during this same 1977-79 period from among 29 White-breasted Nuthatches occurred in mid-January based on the nearly complete condition of a bird last captured on 6 January 1979.

Based on these results, it appears that most but not all Red-breasted Nuthatches may be aged by skull examination into early September. Beyond mid-September, to late November, the recognition of immatures is slightly suspect. Beyond December, birds with incomplete pneumatization are no longer only immatures, and must be recorded as after-hatching-year birds just as those with completely pneumatized skulls.

## Conclusions

The Black-capped Chickadee initiates completion of skull pneumatization in early October at an age of about 16 weeks. Completion continues until mid-January over a span of about 14 weeks with the majority of it occurring in November. Most individuals are 20-21 weeks old when they complete the process, with some as old as 22-23 weeks, and one extreme case of nearly 28 weeks. There appears to be no significant amount of retarded or persistent incompletion of the pneumatization process in this species. Skull examination may be used reliably through September to separate adults and immatures. During the period October through December, only immatures with incomplete pneumatization may be recognized.

The Red-breasted Nuthatch initiates completion of the pneumatization process in mid-September. However, it appears to complete the process more quickly—by middle or late November. In contrast, a small sample of White-breasted Nuthatches showed completion as early as late October to early November with the majority of completions taking place in December. The latest was estimated to be complete in mid-January.

A small number of Red-breasted Nuthatches showed persistently incomplete pneumatization beyond the estimated time of completion. In one case it was observed a year after banding when it was at least 20 months old, and in the other case it was observed 5 years after banding when the bird was at least over 5½ years old.

## Literature cited


Bull, J. 1974. Birds of New York State. Garden City, Doubleday/Natural History Press.

Verheyen, R. 1953. Contribution a L'etude de la structure pneumatique du crane chez les oiseaux. *Bull. Inst. R. Sci. Nat. Belge*, 29:1-24.

Winkler, R. 1979. Fur pneumatisation des Schaedeldachs der Voegel. *Orn. Beob.*, 76:49-118.

Yunick, R.P. 1977. Timing of completion of skull pneumatization in the Pine Siskin. *Bird-Banding*, 48:67-71.

_____ 1979. Timing of completion of skull pneumatization of the Purple finch and the Common Redpoll. *N. Am. Bird Bander*, 4:53-55.



*1527 Myron St., Schenectady, NY 12309.*