

RATE OF RECTRIX REGROWTH IN THE DARK-EYED JUNCO

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As part of a study to determine the extent of changes in tail patterns of the Dark-eyed Junco (*Junco hyemalis*), it was possible to determine the rate of regrowth of replaced rectrices. Data were gathered on first-year juncos during July through early October for the years 1971 through 1974. These birds were captured on their natal grounds at Jenny Lake near Corinth, Saratoga County, in the Adirondack Mountains of New York.

At the time of capture, the outer three right rectrices of newly or recently fledged juncos were plucked, and on subsequent recaptures regrowth was measured. Regrowth was considered as a percent of total tail length for the longest of the three outer right regrowing rectrices. The results are plotted in Figure 1, and show

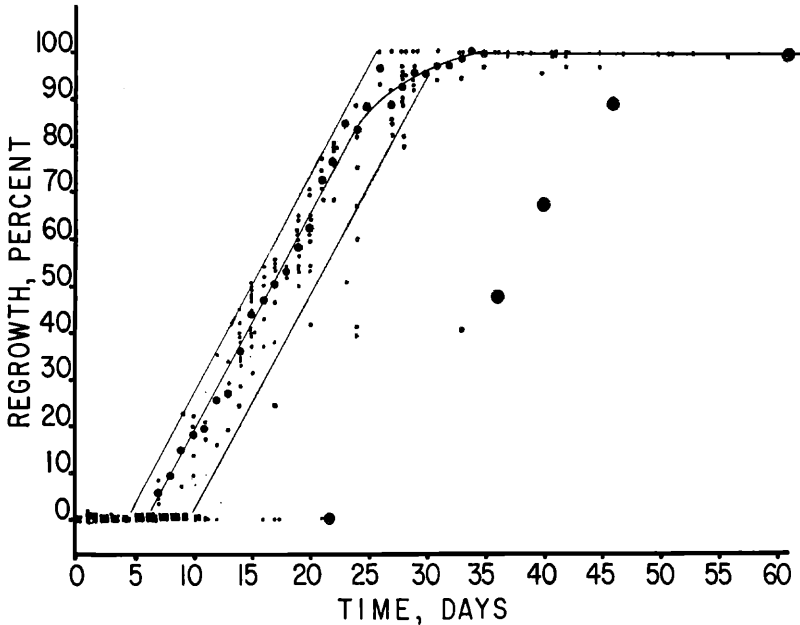


FIGURE 1. Regrowth of the rectrices of first-year Dark-eyed Juncos. Fine dots represent a datum point from one bird. Medium dots represent the mean values of regrowth for each day between days 7 and 35, excluding those points outside of the data band. The line between days 7 and 25, based on these means fits the equation: Regrowth Percentage = $-29.36 + 4.71$ (Time in Days). Beyond day 25, the curve was fitted by eye. The five heavy dots represent data for one bird identified as Sibling Two in the text. See the text for details. The line to the left of the regression line represents the quickest regrowth based on individual data points, and the line to the right encompasses 95 percent of those individual data points between zero and 100.

that regrowth took several days to begin. Once started, it proceeded at a linear rate until it was about 85-90 percent completed. At this time it appeared to slow down in some individuals.

The growth band in Figure 1 incorporates 95 percent of the individual data points above zero and less than 100 percent regrowth for the period of seven to 31 days following rectrix removal. Extrapolation of this growth band gives a minimum zero intercept of four days and a maximum zero intercept of nine days. The line within the band, which was fitted by the method of least squares, gives an average zero intercept of six days. Complete regrowth occurred in as few as 26 days after removal. Due to a departure from linearity at 85-90 percent regrowth, complete regrowth averaged 35 days. During the linear period of regrowth from day 7 to 25, the average rate of regrowth was 4.71 percent per day. Based on a sample of 151 first-year juncos of mixed sexes having an average tail length of 66.6 mm (range, 62-73; SD, 2.55), this rate of growth corresponds to 3.14 mm per day.

The average growth plot agrees with the growth observed on five individuals captured at one-day intervals. Two of the five that were captured on their 19th and 20th days showed increases of three mm, one bird caught on its 14th and 15th days showed an increase of four mm, another one caught on its 16th and 17th days showed an increase of four mm, and the fifth one caught on its 29th and 20th days showed an increase of two mm.

Some birds showed deviations from these averages. Ten percent of the zero regrowth points occur to the right of the regrowth band, and 10 percent of the regrowth points between zero and 90 percent also lie to the right of the growth band. These deviate points are the result of delays in initiation of regrowth rather than differences in growth rate. The majority of these deviate points were derived from very newly fledged birds that were captured between 1 and 12 July. These birds were among the least developed at the time of rectrix removal of all the birds in the sample.

Physical condition of the birds and their ability to gather food may contribute to delayed regrowth. As most persons who have worked in natal colonies or with natal populations at feeders well know, some small percentage of individuals in these populations may become ill or lack the ability to compete adequately for food. This lack of competitive fitness would hamper food intake and thereby lessen the energy available for feather regrowth. Alternately, even healthy individuals may be affected by their state of incomplete development. At the time of fledging, many fledglings are still completing their plumage growth. To impose the energy requirements of additional regrowth on top of their existing burden may be more than they can handle. In two or three weeks when they are further developed and their plumage growth requirements have been met, they would be more ably equipped to handle regrowth. Once these delayed birds initiated regrowth, it appeared to occur at essentially the same rate as for birds within the growth band. Details on some of these individuals are as follows.

One brood of three siblings caught on 1 July 1974 was especially interesting. Sibling One provided the slightly delayed growth points of zero at 12 days and 42.0 percent at 20 days. Siblings Two and Three showed zero regrowth at 21 days. Sibling Two was caught on the 2nd, 9th and 17th days; and Sibling Three was caught on the 1st, 4th, 5th, 8th, 16th and 17th days with no sign of regrowth, thus ruling out the possibility of having regrown the plumage and having lost it again by the 21st day. Sibling Two was caught also on the 36th, 40th, 46th and 61st days between which times regrowth was in progress. Its data points are represented separately in Figure 1. The points at 36 and 40 days indicate a growth rate of 4.9 percent per day or 3.12 mm per day (tail, 64 mm). Extrapolation to zero growth gave an initiation point of 26 days. This is the longest time required for any bird in this sample. Sibling Three provided the delayed growth point of 40.6 percent at 33 days.

In four cases the rates of two successive regrowths were compared. In each case the birds were caught over a sufficiently long period of time to allow completion of the first regrowth, its subsequent removal, and measurement of the second regrowth. In two cases, the second regrowth was more rapid, and in two other cases, it was essentially the same as for the first regrowth.

The two birds that displayed more rapid second regrowth were Siblings One and Two referred to above. Sibling One, which had regrown 42.0 percent by the 20th day of the first regrowth period, and which had this regrowth removed on the 40th day, regrew 53.1 percent by the 20th day of the second regrowth period. Sibling Two, which showed no regrowth at 21 days of the first regrowth period, and which had completed regrowth and had it removed on the 61st day, regrew 4.6 percent by the 7th day of the second period. This latter point falls on the average regrowth line.

In the two cases where the rate of second regrowth was equivalent to the rate of first regrowth, one bird had regrown 53.7 percent by the 19th day of the first period and 52.2 percent by the 18th day of the second period. The other bird showed 38.6 and 100.0 percent regrowth, respectively, on the 14th and 33rd days of the first period, and 56.9 and 91.7 percent, respectively, on the 20th and 31st days of the second period.

The average linear rate of rectrix regrowth of 4.71 percent or 3.14 mm per day was compared to that of some other species reported in the literature. Holcomb (1968) measured the growth of the outer left rectrix of American Goldfinch (*Spinus tristis*) nestlings for days 5 through 13 (0.5 to 14 mm growth). From day 5 to 9, the rate of growth increased from 0.5 to 2.0 mm per day, and then remained essentially constant at 2.0 to 2.5 mm per day for days 9 to 13. The weighted average of growth during this linear period of days 9 to 13 was 4.88 percent or 2.24 mm per day based on a mean length of 47 mm. Banks (1959) reported that the growth of primaries in White-crowned Sparrow (*Zonotrichia leucophrys*) nestlings averaged 3.4 to 3.9 mm per day (range 2.0-5.0) for days 2 through 6 of growth that began at age of four days.

Rectrix growth at age 6 through 9 days averaged 3.0 mm per day. Morton et al. (1969) reported that adult White-crowned Sparrows required 25 days to replace the rectrices, all of which grew concurrently. Based on tail lengths given in Roberts (1955) of 2.84-3.18 inches (72.2-80.8 mm), the regrowth rate was 4.0 percent or 2.9 to 3.2 mm per day.

Saunders (1956) noted that a Black-capped Chickadee (*Parus atricapillus*) which lost its tail in December required 21 days to regrow it. However, it is not precisely known that it lost it on the same day that it was first seen tailless at his feeder. If the time span is correct, it would equate to a regrowth rate over the entire replacement period of 2.9 mm per day or 4.8 percent per day, based on my sample of tail measurements (mean, 62.7mm; range, 58-70 mm; sample, 81). Prescott (1970) found that a first-year Song Sparrow (*Melospiza melodia*) whose tail was accidentally removed in late December regrew 10 mm or 14.3 percent by the 13th day and 40 mm or 57.0 percent by the 22nd day. This corresponds to an average rate of 3.33 mm or 4.8 percent per day in that interval. In another example of replacement of a lost tail, Henney and Nichols (1958) found that a Mourning Dove (*Zenaidura macroura*) required 48 days in March-April to regrow its tail. Based on Roberts' (1955) measurements of 5.7 to 6.7 inches for a Mourning Dove tail, the rate of regrowth over the total replacement period was 3.0 to 3.5 mm per day. During normal molting of the Mourning Dove, Swank (1955) found that panned doves regrew lost primaries at the rate of five mm per day.

An extensive investigation of molt in the House Sparrow (*Passer domesticus*) by Zeidler (1966) showed the following results in Table 1.

TABLE 1.
House Sparrow flight feather regrowth rate

Feather	Total regrowth period, days	Rate of total regrowth in mm-% per day	Range of linear growth	Range of linear growth, % of total	Linear rate, mm-% per day
8th Prim.	23	2.61-4.36	Days 3-17	11.7-86.7	3.22-5.36
2nd Sec.	19	2.52-5.25	Days 3-14	12.5-85.4	3.18-6.63
2nd Rect.	22	2.50-4.55	Days 3-14	10.9-76.4	3.27-5.95

The rate of growth over the linear portion of the growth range for House Sparrow flight feathers agreed quite favorably (3.2 to 3.3 mm per day) with rectrix regrowth for the Dark-eyed Junco (3.1 mm per day). In general, Zeidler's primary and secondary growth curves departed from linearity at about the same upper limit, 85-90 percent, as did these data for the junco rectrix regrowth, but his rectrix curve was not as extensively linear. In

addition, all of his plots were non-linear at the start, contrary to these data on the junco. Artificial removal of the junco rectrices, as opposed to natural molting of the House Sparrow plumage, may account for this difference.

SUMMARY

First-year Dark-eyed Juncos whose outer three rectrices were removed and regrown during July to October required four to nine days for measureable rectrix regrowth to appear and 26 to 35 days for regrowth to be complete. Growth occurred linearly from zero to 85-90 percent at the rate of 4.7 percent or 3.1 mm per day. A small portion of birds (10 percent) whose rectrices were removed on the day of, or very shortly after, fledging showed delays of up to 26 days for regrowth to appear. The growth rate, once growth began, in these delayed birds was essentially comparable to that of birds longer removed from the nest.

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