FALL REMEX AND RECTRIX MOLT IN THE CARDINAL

By Jan G. Reese

I collected information on the Cardinal (*Cardinalis cardinalis*) molt while trapping and banding fall migrating songbirds along the east side of central Chesapeake Bay over the past nine years. This paper gives the fall molt sequences, chronology, and time of most intense molt for individual remiges and rectrices of the Cardinal. Late and incomplete molts are presented and discussed.

METHODS

Cardinals were captured with 36 mm mesh mist nets or multicelled potter traps during September through December at St. Michaels, Talbot County, Maryland. Traps were operated daily (except during rain or high wind) during the fall of 1967–69 and 1973–74. In the same field, hedgerow, woods and marsh locations, 11-13 nets were set up each year. Nets were not baited and were opened chiefly during sunrise-early morning and late afternoon-sunset periods. Potter traps were used only at a feeding station after mid-December and baited with whole kernel corn. The condition of each remex and rectrix was recorded for each newly-banded Cardinal and those repeating more than 10 days since last captured. A feather was considered molting if it was in any stage of growth prior to being fully-formed. Birds lacking any fully-formed, symmetrical pairs of remiges and/or rectrices were regarded as molting. Molt was considered incomplete in Cardinals without molting feathers, but having both fully-formed old and new remiges and/or rectrices. For analyses, Cardinals of known age and sex were combined to make four (ad. ♂♂, ad. ♀♀, im. ♂♂, im. ♀♀) bivariate frequency distributions (daily total birds in sample and number with molt) of individual remiges and rectrices. Sequences, chronology, and period of most intense molt between males and females in either age group showed no differences, so data for sexes were combined in each age category. Age data were then grouped into five-day period classes, and histograms were constructed for each feather to simplify computation, obtain a more cohesive distribution, and facilitate comprehension. The bivariate histograms were converted to percentage values, i.e. ratio of total birds molting to total five-day period sample, to determine the period when the highest percentage of Cardinals were molting that particular feather. Cardinals lacking complete skull ossification, solid orange bill or blunt rectrices were classified as HY (hatching year). Cardinals with all three of these characteristics were considered AHY (after hatching year), but age could not be determined for a few individuals captured in late November and December.

RESULTS

My data indicate the fall remiges and rectrices molt sequences for both AHY and HY Maryland Cardinals are as follows:

Primaries	1 - 2, 3, 4, 5, 6, 7, 8, 9
Secondaries	9, 1 - 8, 2 - 7, 3, 4, 5 - 6
Rectrices	1, 2, 3, 4, 5, 6

Primary molt was initiated at approximately the same time as secondaries 1-8 were molting, and the rectrices started to molt about the time secondaries 2-7 molted. I found some minor variations to these sequences and timing among HY birds.

The AHY portion of the population commences molting as soon as the nesting season ends in mid to late August, and they have a tendency to accelerate the molt by initiating and terminating the remiges and rectrices molt sequences by almost concurrently molting sets of two feathers, i.e. primaries 1-2, 8-9, secondaries 9-1, 5-6 and rectrices 1-2, 5-6. Rectrix molt was accelerated when many AHY Cardinals were molting number 6 before number 1 was half grown. Thus, the remiges and rectrices molt of AHY Cardinals was more intense, showed a less defined sequence, and occurred over a shorter period of time than HY birds. HY Cardinals start molting anytime from mid-summer through late fall because young fledged in May can start the postjuvenal molt in July, but young fledged in July may not start until September.

Figure 1 gives the molt chronology for individual feathers of both age groups and the period when the highest percentage of the Cardinals captured were molting (in any stage of growth) each feather. Some HY birds were well into the molt sequences when trapping first began on 1 September. Therefore, the information on molt initiation for some feathers should be used with discretion until late summer trapping can be carried out. Disparity between AHY and HY periods with the highest percentage of captures molting indicates a slightly different chronology for each age group.

The latest date I found the initiation of remex molt was 14 September in AHY Cardinals and 11 September in HY birds. Molt of remiges and rectrices was first completed on 5 October in AHY Cardinals and 20 October in HY birds. Molt in AHY Cardinals decreased sharply about 25 October, and all AHY captures after 2 November had completed the molt. Molt tapered off in HY Cardinals between 10 and 25 November, but a few individuals exhibited molt as late as 10 December. Of 127 HY Cardinals captured in November and December, only 19.7% were molting remiges and rectrices, 33.9% had completed their molt, 41.7% had incomplete molt, and 4.7% had all their juvenal flight feathers.

Two AHY Cardinals were found molting certain feathers five to 15 days after other birds were last observed molting that particular feather. These two birds were captured on 2 November and both were completing their molt sequence—primaries 7-9, secondaries 4-6, and rectrices 5-6. Late molt was found in nine HY Cardinals (eight males) between 26 October and 10 December and is summarized in Table 1. There were some minor irregularities

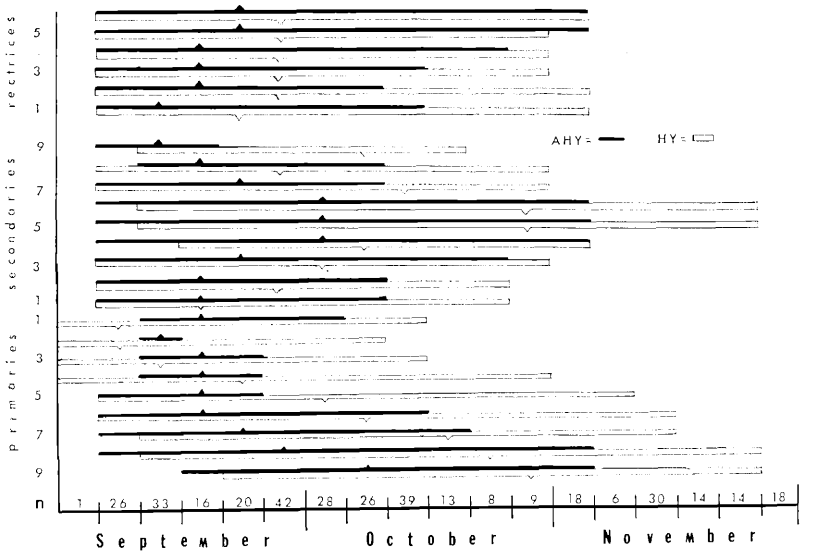

FIGURE 1. Cardinal remex and rectrix molt chronology and period when the highest percentage of birds captured were molting individual feathers. Analyses were derived from a sample of 100 adults (52 ♂♂) and 261 hatching-year (125 ♀♀) Cardinals. Triangular point indicates period when highest percentage of the birds were molting that feather. The period sample size is represented by n.

TABLE 1.

LATE molt in HY Cardinals.

Molting feather in sequence			Date	Days after molt last found in late feather
Primary	Secondary	Rectrix		
7	8[1]	2	26 Oct.	6
9	6	6	2 Nov.	5
5	9	old	8 Nov.	12
new	5	5	12 Nov.	24
new	new	4	15 Nov.	20
new	7	old	21 Nov.	26
8	5	old	24 Nov.	11
3	2	old	10 Dec.	58/50
new	new	6	10 Dec.	45

[1]Underline denotes feather in sequence that is late.

in the sequence of nearly all incidences of late molt. Asymmetrical late molts are not included in Table 1, and molt over 10 days late is excluded from the individual feather chronology.

No incomplete molt was found in any of the 114 AHY Cardinals captured, but 53 of 312 non-molting HY birds had both old and new fully-formed remiges and rectrices. One male with all new remiges and all old rectrices was captured on 15 October. This is the earliest detected incomplete molt, but may be premature because rectrices were commonly found molting until November. Incomplete molt was next observed on 8 November and was

TABLE 2.

Summary of incomplete molt combinations in November and December HY Cardinals.

Incomplete molt combinations			Cardinals in combination
Primaries	Secondaries	Rectrices	
new	new & old	old	28 (53)[1]
new	new	old	18 (34)
new	new	new & old	3 (6)
new	new & old	new & old	2 (4)
new	old	old	1 (2)
new & old	new & old	old	1 (2)
			53 Total

[1]Number in parentheses indicates percent of total.

found with increasing frequency thereafter. Of 114 Cardinals captured after 7 November, 18 of 64 (28%) in November and 35 of 50 (70%) in December had ceased the postjuvenal molt.

Table 2 lists the generalized incomplete molt combinations found in the remiges and rectrices of 53 HY Cardinals. Incomplete molt resulted most frequently with combinations of new primaries, new and old secondaries, and old rectrices. A total of 28 Cardinals with this combination ranged from one to eight feathers short of completing their secondary molt sequence. Secondaries failing to molt occurred with the following inclusive feathers and frequency:

Old secondaries	1-6	5-6	1-7	3-6	4-6	2-6	3-9	2-9	6	5	
Frequency	8	5	3	3	3	2	1	1	1	1	total 28

Three individuals in Table 2 have a combination of new remiges and old and new rectrices. These three individuals retained old rectrices 2-6, 3-6, and 6, respectively. Two Cardinals had a combination of new primaries and old and new secondaries and rectrices. One of these had old secondaries 5-6 and rectrix 6; the other, secondary 5 and rectrix 6. The single bird with new and old remiges and old rectrices had old primaries 5-9 and secondaries 1-8. This Cardinal was the only example of partial primary molt found during the study.

Retention of all the juvenal remiges and rectrices was found in three HY Cardinals between 8 and 30 September, but these birds may have been late initiating molt. After 3 November, I captured

six additional HY Cardinals with all juvenal remiges and rectrices. These six birds had juvenal body plumage, and their bills varied in color from black to mottled black-orange suggesting they fledged too late in the season to initiate the postjuvenal molt.

DISCUSSION

Data for the incomplete remiges and rectrices molt suggest it is imperative for HY Cardinals to complete the primary molt sequence once it is started. If molt is late in starting and environmental strain demands too much of the Cardinals' energy reserve, then the objective is best achieved by termination of the rectrix molt in the usual sequence (simultaneous remiges-rectrices) allowing a maximum effort toward primary replacement. This was evident in all incomplete molt combinations. Cardinals with partial molt were frequently captured after 7 November suggesting that environmental pressures initiated molt termination during mid to late October in Maryland. This period may be arbitrary if these Cardinals were migrants from more northerly locations.

Scott (1967) gives evidence that incomplete HY Cardinal molt involves only fledglings from late summer broods. Michener and Michener (1940) found young House Finches (*Carpodacus mexicanus*) underwent a complete postjuvenal molt if they hatched early in the nesting season, but fledglings from succeeding broods retained more and more juvenal remiges as the season advanced. Scott (1967) found incomplete postjuvenal molt in 68% of the fall and winter immature Cardinals captured at London, Ontario. I found 41.7% of the fall and winter HY Cardinals captured in Maryland had partial postjuvenal molt and 4.7% retained all juvenal remiges and rectrices. A larger percentage of HY Cardinals with incomplete postjuvenal molt at the more northerly Ontario location suggests climatic conditions of decreasing day length and lowering temperatures may be most important in premature termination of the postjuvenal molt. Numerous combined factors involving food supply, climatic conditions, and individual physiology could be instrumental in timing molt. A complete understanding of intraspecific variation in molt timing is not known, but King and Farner (1961), Payne (1972), and Ligon and White (1974) offer some noteworthy explanations with evidence supporting the above factors.

Studies of the Rufous-sided Towhee (*Pipilo erythrophthalmus*) (Davis, 1957) and Cardinal (Scott, 1967) have shown premature termination of the postjuvenal molt leaves a large percentage of immature birds with juvenal rectrices. These feathers are useful in aging immature birds during the first year, because juvenal rectrices are pale, worn, narrow and pointed in contrast to deeper colored, wider and blunt-tipped rectrices of the postjuvenal and latter plumages. The 21% more HY Cardinals retaining juvenal rectrices in Ontario than in Maryland indicates the usefulness of this method for aging Cardinals decreases with decreasing latitude.

SUMMARY

Cardinals molt the remiges and rectrices simultaneously, starting the primaries shortly after molting the first feather in the secondary sequence. Rectrices start molting about midway through the secondary molt sequence and are among the last feathers to be replaced. Sequences for primaries, secondaries, and rectrices are given and individual feather chronology is figured for adult and immature Cardinals captured in Maryland from September through December. AHY Cardinals accelerate remiges and rectrices molt by concurrently molting sets of feathers at the beginning and end of each sequence. AHY Cardinal remiges and rectrices molts were last started on 14 September, first completed on 5 October, and the last molt observed on 2 November. HY Cardinal remiges and rectrices molts were last started on 11 September, first completed on 20 October, and last observed on 10 December. HY Cardinals frequently failed to complete the postjuvenal molt, and some retained all the juvenal flight feathers through the first winter. Incomplete molt resulted most frequently with a combination of new primaries, new and old secondaries, and old rectrices. Rectrices molt was commonly eliminated from the usual simultaneous remiges-rectrices molt sequences of late season molting HY Cardinals to allow a maximum effort towards completing primary molt before terminating the partial postjuvenal molt. Unusually late molt was found in nine HY Cardinals and these results are discussed.

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