

THE SPRING MOLT IN ZONOTRICHIA¹

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During the winter of 1921-22, I began experimental work with wild birds which were trapped, banded, and then liberated. For purposes which will be announced in a later paper, two rectrices or tail feathers were plucked from each individual. From this, it became apparent that Gambel Sparrows (*Zonotrichia gambelii*) caught in late February and throughout March had, most of them, lost the middle or deck pair of rectrices and were growing a new pair. So uniformly had this occurred that fortuitous loss of all such feathers seemed improbable.

From this time on, a more or less detailed record was kept of the molt condition of each bird trapped. Succeeding years have added to the data secured and, beginning with 1923, Golden-crowned Sparrows (*Zonotrichia coronata*), trapped in numbers, were also carefully inspected. Of the large number of birds handled, many individuals returned to the trap for reinspection: the very thing, of course, that counts most in this sort of work.

Through the kindness of Director J. D. Figgins, I have been privileged to examine 15 specimens of *Zonotrichia leucophrys* from the collection of the Colorado Museum of Natural History, and a similar courtesy from Mr. C. D. Bunker, Assistant Curator of the Museum of the University of Kansas, has yielded 55 specimens of *Zonotrichia querula*. All these were taken in spring. Seventeen spring-taken specimens of *Zonotrichia albicollis* in the Daggett and Willett collections of the Los Angeles Museum, and in my own collection, were also examined.

Study of museum specimens and of live birds has been supplemented by minute examination of freshly killed birds, both by plucking them and by inversion of the skin, in order to determine the progress of the molt within each of the feather tracts and the relative progress of the different tracts. Growing feathers have conspicuous black butts from the time the bud begins to form until the feather is complete, and these are apparent on the inside of the skin. Notebook sketches of these in situ have been of distinct assistance. The feathers of certain of the tracts of some of the molting birds have been carefully mounted for study on paper sheets, in the order of their attachment to the skin. (For description of method see *The Condor*, xxvii, 1925, pp. 121-123.)

Obviously no one bird gives the whole story of a molt which covers perhaps two months of time. Each bird examined is merely a still picture of one instant in the period. Only by piecing together cross-sections, so to speak, of the molt condition of many birds, can conclusions be drawn as to sequences. The difficulty of determining sequences may be appreciated when we realize that the period of growth of the smaller feathers may not exceed two weeks, and of the down feathers a much shorter time. I hasten to say that for the smaller feathers the period of growth has not been determined by me. Up to the moment a feather begins renewal and from the moment a feather has matured, it carries no molt record, unless abrasion of the older feathers suffices to distinguish old from new. But even then the relative time at which renewal occurred is missing.

Fact is, no prepared-in-advance series of museum specimens is at all adequate for the minute analysis necessary if molt studies are to hold the place they should in phylogenetic coordination. Nor can the whole story be derived from handling trapped

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birds alive. The ABC's must come from freshly-killed, carefully-sexed birds subjected to the most minute examination of the feathers and of the inverted skin. So far as the age of the bird under examination is concerned, this can and should now be ascertained through the banding method. Late spring *Zonotrichiae* carry no age recognition marks, but a bird that has carried a band for a year or two, or that was banded in an immature plumage the previous autumn, leaves no doubt in the matter of age.

Critical study, then, of the material thus available, indicates that first year birds of all the western species of the genus *Zonotrichia* undergo, in early spring, a rather complete molt of the body or contour feathers, and along with them the down and the whole epidermis. This first prenuptial molt includes most, perhaps all, of the coverts of the wing, above and below, which are proximal to the carpal joint, and probably all the coverts of the tail, above and below. It also involves the three tertiary remiges of the wing and, as well, the deck or middle pair of tail feathers. Data so far obtained indicate that the dorsal saddle and rump have no organized molt in spring.

Perhaps this statement should be limited to the two far western forms, *coronata* and *gambelii*, since freshly killed specimens of the other forms have not been examined; but, since such dried museum specimens of *querula* and *leucophrys* as I have examined exhibit much the same evidence of spring molt as do museum specimens of *coronata* and *gambelii*, including the renewal of the deck rectrices, the inference that the molt is similarly extensive seems warranted. With two exceptions, every late spring specimen of *leucophrys* and *querula* examined had renewed its deck rectrices. None of the 17 specimens of *albicollis*, taken in late spring, had renewed its deck rectrices or had new or molting tertiaries.

This apparent aberrance on the part of *albicollis* corresponds, in so far as the observation goes, with the description of its spring molt given by Dwight in his classic on "The Sequence of Plumages and Moults of the Passerine Birds of New York" (*Annals N. Y. Acad. Sci.*, XIII, 1900, pp. 196-197).

As to *Z. leucophrys*, Dwight (*op. cit.*, p. 195) records a prenuptial molt in first year birds limited mainly to the head, with slight evidence of such molt in adults. It would seem remarkable if the eastern portion of the population of this species fell short of its western representative in completeness of spring molt. Four specimens (the only ones from eastern North America examined by me) taken between May 6 and May 20 in the province of Ontario, Canada, have all received their deck rectrices, tertiaries, and body plumage by a recent molt, as evidenced by the unabraded condition of the feathers.

That there is a similarly complete prenuptial molt in birds older than a year, I have been unable satisfactorily to determine for the reason that no late spring birds known to be two or more years old have been dissected. But I have reason to believe that such a molt does occur.

In individuals, the progress of molt seems to vary. One tract or another may be relatively further along in different birds, but, in general, I believe, the examples here cited give a fair appraisal of the relative progressions. The time of molt is more erratic. On any day, in March and April, one may take birds of the same species which appear to be a month apart in progress of molt. Individuals with feathers still growing may be caught even in early May when all but a few members of the flocks of *Z. coronata* and *Z. gambelii* have departed from southern California, but most of the last to go have completed their molt before they depart.

By mid-February, scattered follicles begin to darken. One specimen of *Z.*

gambelii taken February 16 had 5 dark buds on the crown, 17 on the cervix, 11 on the throat, 3 on one side of the breast, 4 in one humeral tract and 1 in the other, and 1 in the dorsal saddle. Another, taken the same day, had 4 buds on the crown, 6 on mid-cervix, 3 on one side of the breast, and a double row the length of the right costal branch of the ventral tract. I fancy most of these early buds are replacements induced by accidental loss of feathers in preening, slightly in advance of the time that they would have been cast in the normal processes of molt. With approach of molt season, feathers seem to be less tightly held in their follicles and are consequently more easily dislodged.

The earliest concentration of darkened buds appears normally to be in the cervix, quickly followed by a similar concentration about the fork at the anterior end of the ventral tracts. Deck rectrices are often a half inch or more long before any black feathers appear on the surface of the crown.

At the time molt becomes well organized in the three axial rows of the cervix (J.E.L. coll. no. 9319, *Z. coronata*, March 21, 1926) similar concentrations, with more rows involved, mark an axial line the length of each branch of the ventral tract. It is of interest at this point to note that this axial line does not continue on down the abdomen but ends just laterad of the costal notch after traversing the costal branch. In the ventral pterylae the abdominal rows of feathers are continuous with the lateral pectoral rows which are mediad of the axial ones. When later these lateral pectoral rows become involved in molt, continuous rows of buds extend from neck to vent.

In this March specimen of *coronata*, the humeral tracts were heavy with buds, particularly anteriorly, and a few were present toward (but not at) the anterior end of the femoral tracts. Buds of the plumulaceous feathers dotted the apteria and the crura, and similar dark buds were scattered over the crown, nape, and throat.

Externally, this specimen showed the middle tertiary grown, the outer one half grown, and the inner, two-thirds grown. One must not confuse the order of molt here; it is: middle, outer, inner, and this seems to be normal for *Zonotrichiae*. Since the outer tertiary, when grown, is twice the length of the inner, a half grown outer tertiary started to grow before a two-thirds grown inner tertiary did, if their rate of growth is equal.

The first upper coverts of the forearm (4 tertiary, 7 secondary) were half through with molt, which appears to proceed alternately for the tertiary coverts, and from the proximal end for the secondary coverts. Bilateral symmetry is not maintained in the molt of these covert series. In no. 9319 the molt on the right wing was in advance of that on the left. Molt was also beginning at the proximal end of the first and second sets of under coverts of the forearm.

New pattern feathers dominated on the cervix, and bursting sheaths were thick on the crown. Pins were abundant in the ventral tracts. Under and upper tail coverts had begun an irregular molt.

The new deck rectrices are usually well along or fully grown by late March. By the time the deck pair is grown, the crown of first year birds has lost most of the brown feathers of the lateral stripes.

A specimen of *Z. gambelii* taken the same day (March 21: J.E.L. coll. no. 9314) appeared to be somewhat farther advanced, with the black buds of cervix, breast, pectorales, and abdomen well organized in rows on either side of the axial ones. Crown, throat, and nape had molt well organized, too, but the rows were less completely involved. Three buds appeared anteriorly in each side of the dorsal saddle.

By mid-April, molt has involved the lateral rows of the dorsal and ventral tracts, and it is still incomplete on the crown, nape, and throat. The inside of the skin at this stage shows a rather complete series of dark buds about the head. The posterior portions of the humeral and femoral tracts are still in molt growth, while scattered buds occasionally dot the dorsal saddle and rump.

Recapitulating briefly, organized molt in western *Zonotrichiae* first appears in late February or early March at about the middle of the cervix, and soon involves axial rows of the cervix and of the gular and pectoral portions of the ventral tracts. Whole lineal rows become involved simultaneously and progress is from the middle toward each edge in each tract series. Thus the outer rows are the last to molt. On the crown, throat, and cervix, however, molt seems to be more or less uniformly distributed, or with only faint axial initiation. The forehead is the last to finish, along with the eyelids. The anterior portions of the humeral and of the femoral tracts are slightly ahead of the posterior portions, and the humeral tracts take slight precedence over the femoral tracts. The proximal first coverts, upper and under, and the proximal second under coverts of the forearm, and the proximal axillars and their coverts molt slightly in advance of the distal portions of the respective series. The reverse is true of the second upper coverts of the forearm. The two under covert series and the axillars all molt at about the same time, with their molt slightly behind that of the upper series.

The tertiaries are shed in the order of middle, outer, inner, and the middle one is often nearly grown before the other two are cast. The tertiaries are usually in molt when the deck rectrices are pretty well along. From a day to a week, rarely a longer period, usually elapses between the loss of the two deck rectrices. Once in a while one of them is not molted. Whether in the latter case the one molted is the one usually carried on top, I have not determined. But repeated observations indicate that either one may be on top in different individuals. That is, some are left-tailed, others right-tailed. But whether they may reverse this position from time to time is not determined. Very rarely one or both of the subdecks are found renewing with the decks, but this is so rare as to suggest fortuitous loss of all four.

Commenting further on the molt of the tertiaries and of the deck rectrices, which seems to occur somewhat independently of the body tracts as to time sequence, one may wonder whether these should be regarded as true remiges and rectrices, or as coverts. Both tertiaries and deck rectrices are molted in the spring of the year along with the greater coverts of both wing and tail, but without involving the true remiges or rectrices.

In the process of renewal, and contrary to the accepted belief, the old feathers are often carried securely held on the tips of pins until the latter have emerged as much as 5 mm. from the follicle. I have seen most of the feathers of a crown thus pushed out and still clinging, giving the bird a crested appearance. But this mode of renewal obtains on the body tracts as well. Did the bird not preen itself, and did it avoid contact with stems and branches, I dare say all the feathers would thus cling to the pin tips.

I have not detected regular spring molt in any of the following tract series: Primary and secondary remiges, alula, upper and under primary coverts, outer five pairs of rectrices, dorsal saddle, and rump. It is significant that when wings and tail are folded, as they are much of the time that the bird is not flying, all of the above series are covered. The tertiaries cover the primaries and secondaries, the greater secondary coverts cover the alula and primary coverts, the under secondary

coverts cover the under primary coverts, the wing covers the dorsal saddle and rump, and the deck rectrices cover the remaining pairs of tail feathers. It appears, therefore, that only the tracts of the body directly exposed to abrasion and sunlight are renewed in the spring molt. One can but marvel at this subtle adjustment.

When the spring molt is completed these western representatives of the *Zonotrichiae* are resplendent in a new plumage with very little difference if any between the sexes. No one who has noticed the frayed ragamuffins of late February and March and the stunning beauties of late April can doubt that the exposed contour plumage has been entirely renewed.

I cannot agree with Stone (Proc. Phila. Acad. Sci., 1896, p. 110) that spring molt has no bearing on the systematic relationships of species. Every detectable character in a bird must have its phylogenetic value. Each character adds to the story in its own way, but some probably carry the story farther back than do others. In the genus *Zonotrichia* we find a whole group of species whose pattern of plumage, about the head at least, has undergone widely divergent modifications. And yet, this whole group is still perfectly tied together by a similar and somewhat unique habit of spring molt. Is there any other one character among the species of this genus which provides better evidence of genetic relationships than does this rare character of spring molt?

Altadena, California, March 27, 1926.