

MOLTING OF NORTHERN YELLOW-THROAT IN SOUTHERN MICHIGAN

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DURING the summer of 1938, detailed studies were made of the molts of the Northern Yellow-throat, *Geothlypis trichas brachidactyla*, in southern Michigan. Observations of the post-natal molt were made each day on nestlings found near Geddes Pond, one mile east of Ann Arbor. Studies of the post-juvenal and post-nuptial molts were from fresh specimens collected at Portage Lake in Jackson County.

NATAL DOWN

The neossoptiles or down feathers are usually found in five different regions or tracts on the newly-hatched Yellow-throat. In the following table, these tracts are listed together with the length of each, as well as the approximate length of the downs or neossoptiles composing each tract. Measurements were taken from one newly-hatched nestling.

<i>Tract</i>	<i>Length of tract</i>	<i>Length of downs</i>
Coronal	4.0 mm.	5.0 mm.
Occipital	5.2 mm.	3.6 mm.
Spinal	5.5 mm.	7.5 mm.
Humeral	3.0 mm.	8.0 mm.
Femoral	2.5 mm.	5.0 mm.

Figure 1 shows the approximate location of these down tracts. While this figure presents the usual arrangement of the neossoptiles, variations do occur. On July 4, one of the nests studied contained one newly-hatched young and three eggs. This young bird was peculiar in that there were no neossoptiles in the femoral tracts. Unfortunately, the nest had been destroyed before my visit on the following day so that I was unable to find out if this peculiarity held true with the other occupants of the nest. While visiting another nest on July 7, which contained three newly-hatched young, I found that neossoptiles were adhering to the barely protruding tips of some of the tertiaries of two of the young birds. These feathers are present for only a short time, since they are pushed out by the underlying juvenal feathers.

POST-NATAL MOLT

The following description of the post-natal molt is derived from observations of five nestlings (from two nests) made at the end of each succeeding day.

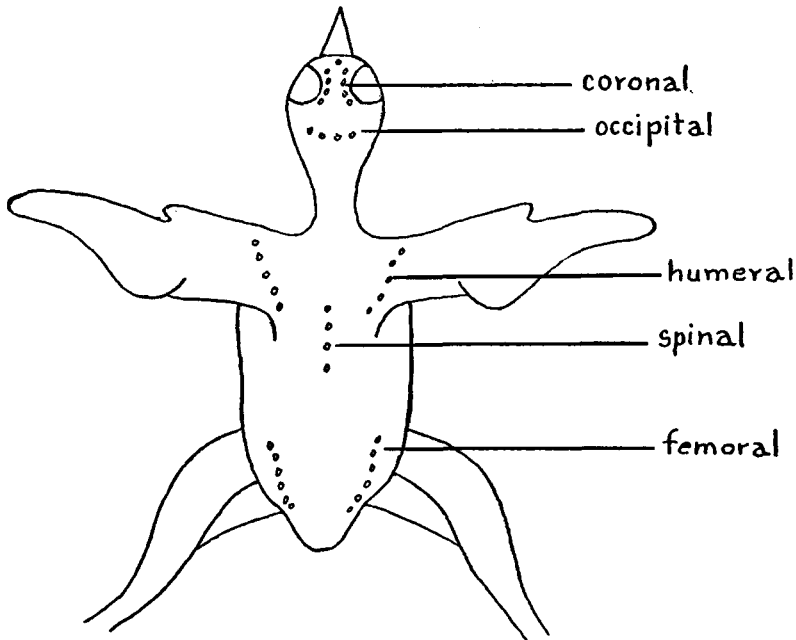


FIGURE 1. Diagram of areas of neossophtiles on the newly-hatched Yellow-throat.

First day.—Natal down present, as described previously. The first two or three primaries are the only feathers of the juvenal plumage that extend through the skin, although many others are visible.

Second day.—All of the primaries have protruded through the skin and the other feathers show up prominently beneath the skin. The ventral tract appears yellow in color and all the others bluish-gray.

Third day.—The feathers of the following areas have just pushed through the skin: humeral tract, and the greater primary coverts, secondaries, and greater secondary coverts of the alar tract.

Fourth day.—Feathers have newly protruded through the skin in the following regions: interscapular, cervical and dorsal regions of the spinal tract; axillary, sternal and abdominal regions of ventral tract; alula and middle secondary coverts; and the femoral tract.

Fifth day.—The feathers in these tracts have just thrust through the skin: coronal and auricular regions of capital tract; pelvic region of spinal tract; cervical region of ventral tract; crural tract; and the marginal coverts, alula coverts, carpalmetacarpal coverts and middle primary coverts of the alar tract. All feathers are ensheathed.

Sixth day.—The feathers in the following regions are now through the skin: frontal, superciliary, occipital, malar and sub-malar regions

of capital tract; and the upper tail-coverts and anal circlet of caudal tract. Feathers that have broken or are starting to break through their sheaths are: interscapular and dorsal regions of spinal tract; sternal, axillary and abdominal regions of ventral tract; humeral tract; femoral tract; and crural tract.

Seventh day.—Feathers that have now extended through the skin are those in: post-auricular and interramal regions of capital tract; and the rectrices and under tail-coverts of caudal tract. New feathers that have broken through or are starting to break through their sheaths are: occipital and malar regions of capital tract; cervical and pelvic regions of spinal tract; upper tail-coverts and anal circlet of caudal tract; cervical region of ventral tract; primaries, greater primary coverts, secondaries, greater secondary coverts, middle secondary coverts, alula, marginal and carpometacarpal coverts of alar tract.

Eighth day.—The loral feathers of the capital tract have protruded through the skin. New feathers broken through their sheaths are: frontal, superciliary, coronal, auricular, and sub-malar regions of capital tract; under tail-coverts of caudal tract; and alula coverts, middle primary coverts and under wing-coverts of alar tract. The feathers that have not yet broken through their sheaths are: loral, post-auricular and interramal regions of capital tract, and the rectrices.

POST-JUVENAL MOLT

In the preparation of an outline of this molt, the plumages of 18 immature birds, representing various stages of the molt, were carefully studied. These birds were collected between August 9 and August 29.

Two of the birds examined gave evidence of just finishing the post-natal molt and at the same time of starting the post-juvinal molt. In these birds, the rectrices, almost certainly juvenal, were partly ensheathed and had not attained their full length, while new feathers of the first-year plumage were found in the interscapular and dorsal regions of the spinal tract, in the humeral and femoral tracts, and in the sternal and axillary regions of the ventral tract. As the rectrices are the last feathers to appear in the post-natal molt, and since the other regions in which new feathers were found are among the first to start molting in the post-juvinal molt, the inference that the two molts have overlapped appears correct. Apparently, the juvenal plumage of some individuals is of very short duration.

The post-juvinal molt of the Yellow-throat has previously been described by Dwight ('The sequence of plumages and moults of the Passerine birds of New York.' *Annals N. Y. Acad. Sci.*, 13 (1): 73-360, 1900), by Chapman ('The Warblers of North America.' D.

Appleton and Company, New York, 1907), and by Forbush ('Birds of Massachusetts and other New England States.' Norwood Press, Norwood, Mass., 1929) as including only the contour feathers of the body and the coverts of the wings, and not the remiges or rectrices. This is at variance with what I have found, as will be shown in the following pages. Of the 18 immature birds studied, eight showed both the remiges and rectrices in some stage of molt, while the plumages of the remaining 10 birds represented earlier stages of post-juvinal molt.

The order of molt of the regions within the capital, spinal, caudal, ventral, and alar tracts is shown in Table 1. The molting sequence as indicated actually represents only the start of the molts of the various regions as the periods of molt in many cases overlap greatly. Procedure of molt within certain areas is described as follows:

Capital tract: Group No. 1 (Table 1) was divided into two sub-groups (a) and (b) because it was found that in some individuals the sub-malar and interramal regions started to molt before the frontal, coronal and occipital regions, while in others all of these regions seemed to start molting at about the same time.

Spinal tract: The procedure of molt was found to be variable for each region, and the molt of each is extended over a considerable period.

Anal circlet: The molt usually started with the anterior feathers.

Under tail-coverts: The single pair of feathers lying medially and just anterior to the row of under tail-coverts lags well behind the rest in molting. Within the row, the central feathers precede the outer in the order of molt.

Upper tail-coverts: The procedure was variable in different individuals.

Rectrices: In most of the specimens examined, all the rectrices appeared to have molted at about the same time. All the new feathers were nearly the same length; the outer feathers being slightly shorter than the central ones, as they are in the adult. However, in two cases the order of molt was found to be very irregular, new feathers of all sizes in singles or pairs alternating with the older, fully formed juvenal feathers which had not been shed.

Humeral tract: The molt starts at anterior and proceeds posteriorly.

Femoral tract: The medial rows of feathers precede the distal rows.

Cruval tract: The feathers are shed two or three at a time, the molt of the entire tract extending over a considerable period.

Ventral tract: The procedure of molt within each separate region is more or less irregular and the period of molt for each region is extended over a considerable length of time.

Alar tract: The molt of the regions of the alar tract as indicated in

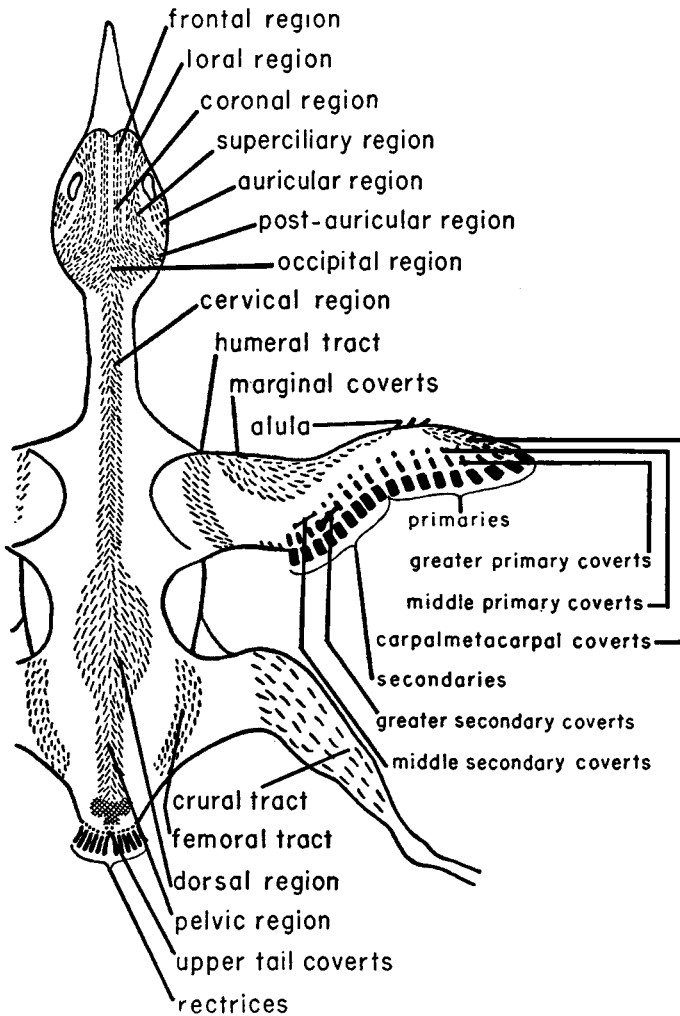


FIGURE 2. Dorsal view of feather tracts and regions on the Yellow-throat.

Table 1 probably represents the usual order of molt, but it is not infallible. These regions seem to vary somewhat more than the other feather tracts in their usual molting sequence. However, this variation was never found to be pronounced and, in all cases where it was observed, only the smaller wing-coverts were involved.

Middle secondary coverts: The molt starts at the proximal portion and proceeds distally in an even, rapid succession.

Greater secondary coverts: The molt starts at the distal portion and

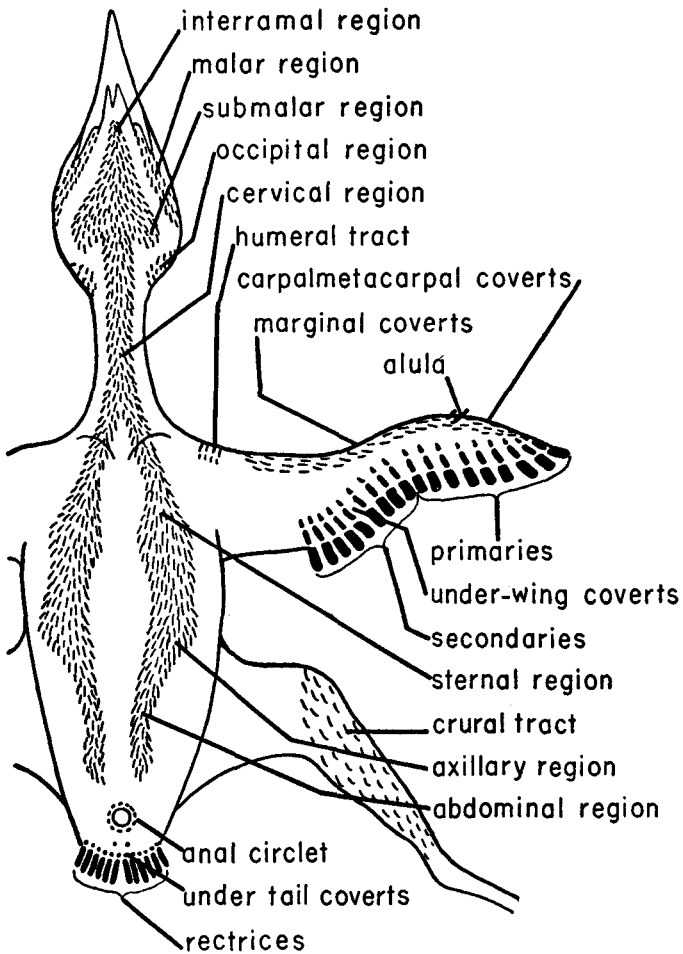


FIGURE 3. Ventral view of feather tracts and regions on the Yellow-throat.

proceeds proximally. This is just the opposite from what is found in the molt of the middle secondary coverts. The molts of the individual feathers occur in such rapid succession that the entire row of new feathers often appears to be in the same stage.

Primaries: These feathers molt one at a time starting with primary No. 1 (the most proximal) and proceeding to No. 9 (the most distal) in an even succession. However, the time interval between the molt of each successive primary is considerable, so that the molt for the entire row occurs over a comparatively long period. During this period the new feathers in all stages of development, as well as the older juvenal feathers, may be found at the same time.

TABLE I
MOLTING SEQUENCE OF REGIONS IN CAPITAL, SPINAL, CAUDAL,
VENTRAL AND ALAR TRACTS¹

<i>Post-juvencal molt</i>	<i>Post-nuptial molt</i>
<i>Capital Tract</i>	<i>Capital Tract</i>
1. (a) Sub-malar region Interramal region	1. (a) Sub-malar region Interramal region
(b) Frontal region Coronal region Occipital region	(b) Frontal region Coronal region Occipital region
2. Loral region	2. Loral region
3. Superciliary region Post-auricular region Malar region	3. Superciliary region Post-auricular region Malar region
4. Auricular region	4. Auricular region
<i>Spinal Tract</i>	<i>Spinal Tract</i>
1. Dorsal region	1. Dorsal region
2. Interscapular region	2. Interscapular region
3. Pelvic region	3. Pelvic region
4. Cervical region	4. Cervical region
<i>Caudal Tract</i>	<i>Caudal Tract</i>
1. Anal circling	1. Upper tail-coverts Under tail-coverts
2. Under tail-coverts	2. Rectrices
3. Upper tail-coverts	3. Anal circling
4. Rectrices	
<i>Ventral Tract</i>	<i>Ventral Tract</i>
1. Sternal region	1. Sternal region
2. Axillary region	Axillary region
3. Cervical region	2. Abdominal region
4. Abdominal region	3. Cervical region
<i>Alar Tract</i>	<i>Alar Tract</i> ²
1. Middle secondary coverts Carpal remex covert	1. Primaries Greater primary coverts
2. Greater secondary coverts	2. Marginal coverts Greater secondary coverts
3. Under marginal coverts Marginal coverts	3. Secondaries (including Tertiaries) Alula coverts Carpometacarpal coverts Under marginal coverts
4. Lesser secondary coverts Alula coverts Carpometacarpal coverts Middle primary coverts	4. Middle secondary coverts Alula Under primary coverts Under secondary coverts
5. Primaries Greater primary coverts Under primary coverts	
6. Secondaries Under secondary coverts	
7. Alula	

¹ The regions within any numbered group may be said to start to molt about the same time as no invariable sequence was found for their order of molting.

² In the post-nuptial molt, the order of molt of the carpal remex covert, lesser secondary coverts, and middle primary coverts was not determined.

Greater primary coverts: These coverts differ from all other coverts in that they molt one at a time with a considerable time interval between. Their molt is directly correlated with the molt of the primaries which they cover; that is, the molt of greater primary covert No. 9 occurs at nearly the same time as the molt of primary No. 9, and the molt of greater primary covert No. 8 occurs at nearly the same time as the molt of primary No. 8.

Secondaries: The first secondary to molt is always No. 7 (feathers numbered from the distal to the proximal end of the row). The molt of this feather is usually coincident with the molt of primary No. 5. Like the primaries, the secondaries molt one by one with a considerable time interval between. However, the order of molt of this region is quite different. This may be best shown by the following:

1	2	3	4	5	6	7	8	9
4	5	6	7	9	8	1	2	3

Here, the top series of digits represents the individual feathers of the region, numbered from distal to proximal end of the row, and the lower series represents the order of molt for each of these feathers. The three tertiaries are counted in as secondaries 7, 8 and 9.

POST-NUPTIAL MOLT

A general outline of this molt was made from the study of the plumages of nine adults (seven males and two females) collected between August 9 and September 4. Each was molting and represented a certain stage in the post-nuptial molt. Inasmuch as the adult birds during this period were much more wary and secretive than usual, they were exceedingly difficult to procure as specimens. As a consequence, the outline for this molt is probably neither as complete nor as accurate as the outline for the post-juvenal molt.

The period of the post-nuptial molt for the Yellow-throat in this region is approximately 30 days, extending from about August 5 to September 4. This period represents the composite period of the post-nuptial molt for all of the Yellow-throats in this region, but not the period of molt for the individual bird, which is much shorter. This is evident from the fact that I collected an adult female on August 14 that had not started to molt and an adult male on August 22 which was just beginning its molt.

On the relatively few specimens which were available for the study of this molt, I could find no significant difference, from that found in the post-juvenal molt, in the manner of molt within the various

TABLE 2
ORDER OF MOLT FOR ALL FEATHER TRACTS AND REGIONS¹

<i>Post-juvinal molt</i>	<i>Post-nuptial molt</i>
1. Dorsal region Sternal region Axillary region	1. Dorsal region Interscapular region Pelvic region Humeral tract Sternal region Axillary region Abdominal region
2. Interscapular region Pelvic region Humeral tract	2. Cervical region (spinal tract) Femoral tract Primaries Greater primary coverts Marginal coverts Greater secondary coverts
3. Interramal region Submalar region Femoral tract	3. Frontal region Coronal region Occipital region Interramal region Submalar region Crural tract Upper tail-coverts Under tail-coverts Rectrices Secondaries Alula coverts Carpometacarpal coverts Under marginal coverts
4. Frontal region Coronal region Occipital region Loral region Anal circlet Crural tract Cervical region (ventral tract) Abdominal region Middle secondary coverts Greater secondary coverts	4. Loral region Superciliary region Malar region Auricular region Post-auricular region Anal circlet Cervical region (ventral tract) Middle secondary coverts Under wing-coverts Alula
5. Cervical region (spinal tract) Under tail-coverts Under marginal coverts Marginal coverts	
6. Superciliary region Post-auricular region Malar region Upper tail-coverts Lesser secondary coverts Alula coverts Carpometacarpal coverts Middle primary coverts	
7. Auricular region Rectrices Primaries Greater primary coverts Under primary coverts	
8. Secondaries Under secondary coverts	
9. Alula	

¹ This table was prepared to show the various regions and tracts which were found starting to molt at approximately the same time, as well as to show the general order of molt. All regions and tracts included in one numbered group molt at about the same time. However, since the periods of molt for most of these regions and tracts overlap each other greatly, several of these groups may be found molting at the same time in any one bird.

regions. However, the order of molt for the various regions was in some cases quite different (Tables 1 and 2).

A comparison of the molting sequences as found in the post-juvinal and post-nuptial molts (Tables 1 and 2) shows that the order of molt in both the capital tract and the spinal tract is nearly the same, while the order of molt in the caudal, ventral and alar tracts is quite different. In the case of the caudal tract, the anal circlet is the first to molt in the post-juvinal molt and the last in the post-nuptial molt. In the ventral tract, the cervical region precedes the abdominal region in the post-juvinal molt, whereas the cervical region follows the abdominal region in the post-nuptial molt. It is in the alar tract, however, that one finds the most marked differences. Here, the middle secondary coverts are among the first to molt in the post-juvinal molt while they are among the last in the post-nuptial. The primaries and greater primary coverts are the very first regions to molt post-nuptially and among the last regions in the post-juvinal molt. There are also other minor differences which will be readily noted in comparing the lists in the two tables. There is a marked similarity in the order of molt of the alula which is found in the last group in both.

SUMMARY

The natal down feathers were usually present in five different tracts on the newly-hatched Yellow-throat. The post-natal molt starts at the end of the first day when the juvinal feathers begin to make their appearance. The juvinal feathers of the various regions and tracts protrude through the skin and finally break through their sheaths in an orderly sequence. By the end of the eighth day all of the juvinal feathers have broken through their sheaths except the rectrices and part of those feathers in the capital tract. The period for the post-juvinal molt begins with the appearance of the first-year feathers and sometimes overlaps the period of the post-natal molt. The post-juvinal molt, which involves all of the feathers, is also quite orderly, although it is different from the other molts in the sequence of the loss or appearance of the feathers of certain tracts and regions. The entire adult plumage is renewed in the post-nuptial molt which takes place in August and early September. The principal differences in the order of molt between the post-juvinal and post-nuptial molts are in the alar tract, although many other minor differences were noted.

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