THE POSTJUVENAL WING AND TAIL MOLT OF THE RUFFED GROUSE (*BONASA UMBELLUS MONTICOLA*) IN OHIO[1]

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ABSTRACT

Because feather-replacement patterns influence the validity of aging criteria, 21 captive and 47 wild-trapped Ruffed Grouse from Ohio were studied to determine if their wing and tail molt is comparable to that of more northern races. The results indicate that juvenal primaries numbers 9 and 10 are retained during the first year, but that the progression of wing molt appears to be one to one and one-half weeks slower than that of New York birds. The tail molt occurs about four weeks later than that of New York grouse of comparable age. Differences were not detected in molt timing and pattern between wild and captive birds. Aging keys for chicks between 1 and 18 weeks are adjusted for the apparent slight geographical difference in wing molt rate. The peak hatching period in Ohio is May 15–28, approximately one and one-half weeks earlier than hatching dates reported for Wisconsin.

In 1957 the Ohio Division of Wildlife initiated a study to gather preliminary information on the age and sex composition of Ohio's Ruffed Grouse population. Analyses of wings and tails collected from fall-shot samples during the first three years resulted in age ratios that suggested low productivity and possibly a declining population (Hanson 1963, p. 35). However, information from drumming counts, hunter questionnaires, and field observations did not substantiate such a trend.

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The consensus among biologists was that the low age ratios probably reflected an inadequate aging technique, rather than a true representation of population structure. Subsequently, a two-phased investigation of the aging and sexing criteria used was begun in 1963. This paper reports on the first phase, a study of wing- and tail-molt pattern and rate in Ohio Ruffed Grouse.

The main objective of phase one was to determine if grouse at this latitude (southern Ohio) retain juvenal primaries 9 and 10 throughout their first year. Aging criteria are mainly based upon characteristics of these outer two primaries. Therefore, if regional differences in molt physiology exist, and some portion of the immature population drops these remiges during their first fall or winter and acquires adult primaries, this would bias the age ratios against immatures.

Dwight (1900) and Petrides (1942) concluded, from examining museum skins, that the Ruffed Grouse does not drop juvenal primaries 9 and 10 during the post-juvenal molt, but retains these outer feathers until the postnuptial molt of their second summer. Wright and Hiatt (1943) drew the same conclusion by comparing the outer primaries with bursa depth on hunter-shot birds. The only published investigation based on continual observations of molt sequence and rate of live known-age specimens is apparently that of Bump, *et al.* (1947) in New York. Their findings support those of earlier workers. Thompson and Taber (1948, p. 17) recognized that minor variations due to genetic, latitudinal, or climatic factors would affect the use of molt progression as an age indicator for chicks (ages 1–17 weeks) of gallinaceous species. All future references to Ohio grouse refer to birds inhabiting areas south of 40°N latitude.

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TECHNIQUES

The rate and pattern of the wing and tail molt of southern Ohio grouse were observed in both captive and wild birds. To obtain captive specimens, eggs were collected from local wild nests and hatched in incubators at the Waterloo Wildlife Experiment Station, New Marshfield, Ohio. Fourteen grouse were successfully raised to maturity in brooder houses at the Experiment Station during 1962–64. From the 11 reared in 1963–64, the presence or absence of each primary, its length in millimeters, and the condition of the calamus (blood quill or hard) were recorded weekly. Because the birds were not examined daily, the exact age at which a particular primary began growth was not always known. A comparison of successive measurements of length showed that the early growth of primaries was approximately 5 mm per day. Using this rate, the day primary growth began was estimated by extrapolation. Particular attention was given to the outer two juvenal primaries. After numbers 9 and 10 had matured, the birds were examined approximately every two weeks to determine if these primaries were being retained. Primaries are numbered 1 through 10 beginning with the inner-most and proceeding distally. Data on rectrix development and body weight were also collected. Another cohort, consisting of seven birds, was raised in 1966. Although these grouse were not raised primarily for molt study, periodic examination of their feather development served as a check on those studied in 1963–64.

The diet for all years consisted of mealworms (*Tenebrio* sp.), fresh lettuce, and Purina Game Bird Starter during the first six to eight weeks. Thereafter the birds were fed other commercial game bird preparations (Grower and Developer

pellets) and scratch grain (corn 60 percent, wheat 20 percent, kafir corn and buckwheat 10 percent). Fresh lettuce was supplied twice weekly.

A basic concern of studies involving captive wild animals is whether phenomena observed under artificial conditions occur similarly in nature. Consequently, for comparative purposes, data on wild birds were collected concurrently. To observe the postjuvenal wing molt of non-captive grouse, chicks from wild broods were live-trapped, examined, marked, and released during the summer and fall of 1963. Captures were made using cloverleaf traps (Chambers and English 1958). It was anticipated that a number of these birds could be retrapped periodically from summer to February, 1964, to gain a record of the wing-molt progression of individuals. Additional observations on wing and tail molt were obtained from immatures live-trapped during the summer of 1966.

Plumage and molt nomenclature used in this paper follows that of Dwight (1900). For subspecific consideration of the Ruffed Grouse, the reader is referred to Todd (1940) and to Aldrich and Friedmann (1943).

RESULTS AND DISCUSSION

Success in raising Ruffed Grouse in captivity was disappointing. The rearing facilities and methods employed were similar to those used for pheasants (Seibert and Donohoe 1965, pp. 5–6). In 1963, of the 31 chicks that hatched, nine (29 percent) survived and reached full size. In 1966, seven (35 percent) of the 20 chicks survived. This relatively high chick mortality may have resulted from failure to maintain sufficiently high brooder-house temperatures during cool nights in late May and early June. Fay (1963), in Michigan, experienced a survival rate of 78 percent for chicks started using methods and facilities that appeared basically similar to ours.

Unless otherwise noted, the findings presented below pertain only to grouse reared and/or examined in 1963–64.

Wing Molt of Wild Grouse

Data on molt and growth of live-trapped grouse were obtained from one to seven immature birds weekly throughout the summer, with the exception of July 15–21, August 5–11, 19–25, and September 2–8, when none was captured. This sample provided information from 34 different immatures from 15 broods.

Recovery of previously marked birds during the fall and winter by trapping and hunting was low. Only two immatures banded as chicks were recovered. Eight additional unmarked immatures (aged by dissecting out and measuring the bursa of Fabricius) were obtained by various means between September 6 and November 8.

Due to the inability to recover marked immatures as anticipated, it is not possible to prove that, under wild conditions, the outer two juvenal primaries are retained by Ohio grouse throughout their first year. However, in nine of the ten wild birds mentioned above, a comparison of bursa depth with primaries 9 and 10 showed that the outer remiges were not dropped during the postjuvenal molt. All ten specimens had a bursa depth greater than 9 mm, and nine had *obvious* juvenal outer primaries.

Other observations were made on wild-trapped immatures suggesting retention of the outer primaries. Between August 27 and October 2, 1963, eleven birds which were live-trapped had lost juvenal primary 8. The adult feather was $\frac{1}{3}$ to $\frac{4}{5}$ grown in seven of these birds. In all instances, however, primaries 9 and 10 were present and were obviously completely grown juvenal feathers. A similar condition was found in five immatures live-trapped in mid- to late August, 1966. When primary 9 was plucked from these birds, it was found to be firmly embedded in the follicle and gave no indication of being loose prior to dropout. Thus no immatures were found in the process of molting primaries 9 and 10, as

might be expected in such samples if these feathers were normally dropped during the postjuvenal molt.

Wild-trapped adults (one and one-half years old or older) were found in the process of molting the outer two primaries between August 15 and September 24, an event observed occasionally in birds taken in October.

One additional finding is noteworthy. Of 2,010 wings received from grouse hunters from 1962 through 1965, only two showed primaries undergoing molt after November 1. This sample was well distributed over the fall and winter period and is firm evidence that the outer primaries are normally retained throughout the winter by Ohio grouse under natural conditions.

Wing Molt of Captive Grouse

The nine known-age grouse chicks hatched and reared in captivity during 1963 molted juvenal primaries 1 through 8, but retained juvenal primaries 9 and 10 their first year. The four birds kept captive for over 16 months dropped these outer two primaries between August 10 and September 1 of their second year. Tables 1 and 2 give the rate and chronology of molt for these pen-reared Ohio grouse.

TABLE 1

Postjuvenal wing-molt progression of juvenal primaries of nine pen-reared Ohio Ruffed Grouse. Numeral preceding each abbreviation refers to the number of birds having the condition indicated. Inc=feather incomplete, c=feather complete, dr=feather dropped in all birds.

Age (days)	Age (nearest week)	Juvenal Primary Number									
		1	2	3	4	5	6	7	8	9	10
Hatched 5/20/63											
5	1	9 inc	9 inc	9 inc	9 inc	9 inc	9 inc	9 inc			
11	2	9 inc	9 inc	9 inc	9 inc	9 inc	9 inc	9 inc			
18	3	9 c	9 c	5 inc**	9 inc	9 inc	9 inc	9 inc	7 inc		
27	4	1 c*	6 c	9 c	8 c	7 c	9 inc	9 inc	9 inc		
32	5	dr	3 c	6 c	9 c	9 c	—	—	9 inc	9 inc	
40	6		dr	dr	5 c	9 c	9 c	—	9 inc	9 inc	9 inc
46	7				1 c	7 c	9 c	2 inc	9 inc	9 inc	9 inc
54	8				dr	dr	4 c	9 c	3 inc	9 inc	9 inc
61	9						dr	9 c	9 c	9 inc	9 inc
68	10							2 c	9 c	7 inc	9 inc
73	11							dr	9 c	7 c	5 c
81	12								9 c	9 c	9 c
88	13								1 c	9 c	9 c
95	14								dr	9 c	9 c
	15–68±									9 c	9 c

*Number 1 dropped in other eight birds.

**Number 3 completely grown in other four birds.

The pattern (chronology) of the postjuvenal wing molt in this sample agrees with that found for the New York birds studied by Bump, *et al.* (1947). However, a difference may exist between Ohio and New York populations in the rate of the postjuvenal wing molt and the timing of the tail molt. For wing molt, a slight rate difference is implied in Table 3, which shows the age when adult primaries began growth in the two samples. For Ohio, the mean age and expected variability of this event is given. It is assumed that the New York data on initiation of growth also represent some measure of central tendency. As shown, primaries 1 through 8 commenced growth an average of seven days later than those of New York birds of comparable age. Periodic inspection of the 1966 pen-reared sample

TABLE 2

Postjuvenal wing-molt progression of adult primaries of nine pen-reared Ohio Ruffed Grouse. Numeral preceding each abbreviation refers to the number of birds having the condition indicated. Inc=feather incomplete; c=feather complete.

Age (days)	Age (nearest week)	Adult Primary Number 1	2	3	4	5	6	7	8	9	10
Hatched 5/20/63											
5	1										
11	2										
18	3										
27	4	8 inc	2 inc**								
32	5	9 inc	6 inc	2 inc							
40	6	9 inc	9 inc	9 inc	3 inc						
46	7	4 inc*	7 inc	9 inc	8 inc	1 inc					
54	8	9 c	3 inc	8 inc	9 inc	9 inc	1 inc				
61	9	9 c	9 c	9 c	9 inc	9 inc	9 inc				
68	10	9 c	9 c	9 c	3 inc	9 inc	9 inc	4 inc			
73	11	9 c	9 c	9 c	9 c	6 inc	9 inc	9 inc			Juvenal prima-
81	12	9 c	9 c	9 c	9 c	9 c	9 inc	9 inc			ries retained
88	13	9 c	9 c	9 c	9 c	9 c	6 inc	9 inc	4 inc		
95	14	9 c	9 c	9 c	9 c	9 c	1 inc	9 inc	9 inc		
102	15	9 c	9 c	9 c	9 c	9 c	9 c	8 inc	9 inc		
109	16	9 c	9 c	9 c	9 c	9 c	9 c	1 inc	9 inc		
117	17	9 c	9 c	9 c	9 c	9 c	9 c	9 c	9 inc		
124	18	9 c	9 c	9 c	9 c	9 c	9 c	9 c	9 inc		
130	19	9 c	9 c	9 c	9 c	9 c	9 c	9 c	8 c		

*Number 1 is a completely grown adult feather in other five birds.
**Number 2 is a completely grown juvenal feather or is missing in other seven birds.

supported this finding. A further examination of the available information indicates that the postjuvenal wing-molt rate is approximately one to one and one-half weeks slower in Ohio grouse. For instance, Bump, *et al.* (1947, p. 86) report adult primaries numbers 1 and 2 complete at six weeks. In the Ohio sample, these primaries completed growth at approximately seven and eight weeks, respectively. The growth of the more distal adult primaries shows a similar pattern. In Ohio, primaries numbers 5, 6, 7, and 8 completed growth during the 11th, 13th, 15th, and 18th weeks, respectively (Table 2), whereas in New York these same primaries matured at 10, 11, 13, and 17 weeks (Bump, *et al.* 1947, p. 90).

TABLE 3

Comparison of postjuvenal molt between Ohio and New York grouse. Given is the age in days when adult primaries commenced growth.

	Primary Number 1	2	3	4	5	6	7	8	9	10
New York*	14	20	27	35	42	49	61	74	Juvenal not replaced	
Ohio** $\bar{X}$	23	27	34	40	47	56	68	85	Juvenal	
SD	1.4	2.7	2.4	2.2	2.1	2.8	1.9	2.4	not replaced	

*From Taber (1963, p. 123).
**1963 pen-reared sample (N=9).

Tail Molt

Evidence regarding differences in rate of molt is supported by observations on the rectrix (tail) molt of both pen-reared and wild-trapped birds. Bump, *et al* (1947, pp. 88–89) reported the juvenal tail completely grown at six weeks and dropped between weeks nine and ten. In Ohio samples, the juvenal rectrices completed growth at eight weeks. These feathers were dropped, in all captive specimens, between August 15 and 22, at 13–14 weeks of age. All of five immatures, age 11–12 weeks and live-trapped on August 14, had complete juvenal tails, whereas, of three birds age 14–15 weeks captured on August 27, one had its juvenal tail, one was tailless, and one had an adult tail 30–40 mm long. In 1966, of eight immatures age 13–15 weeks and live-trapped between August 12 and 23, all either had juvenal tails or were tailless. Again, data obtained from the captive birds in 1966 agree with these 1963 observations. Aging of the above-mentioned wild chicks was based on molt-progression data obtained from the known-age captive birds.

The adult rectrices, which begin growth almost immediately after the juvenals are dropped, were complete in seven of the nine pen-reared immatures by October 5 and in all of four immatures live-trapped between September 27 and October 2. Three captive adult grouse began growing new rectrices (first postnuptial molt) the last week in August and completed this growth between September 18 and 27. Four of six wild adults trapped between August 29 and September 24 were growing new rectrices.

From information gained in this study, it appears that the endysis of adult rectrices takes place almost concurrently in both immature and adult grouse, and that the onset of this event, in immatures at least, occurs about four weeks later than in New York birds of comparable age. Conclusions regarding differences in molt rate, as reported above, must be viewed with some caution, considering the relatively small size of the sample from Ohio, the lack of comparative information on variability, and the possible differences in rearing and study techniques between the two states.

Comparison of Molt Between Wild and Captive Grouse

Woehler (1953) suggested that stresses of captivity retarded feather development in captive Ring-necked Pheasants (*Phasianus colchichus*), whereas Westerskov (1957, pp. 33–34) found no difference in the molt rate between semi-wild and captive ringnecks. Examination of data collected in 1963 and 1966 in Ohio revealed no clearcut differences in the wing-molt progression of captive and wild grouse. For example, six of seven immatures from three different broods, wild-trapped on July 11–12, 1963, had adult primaries 1 and 2 complete, adult primaries 3 through 5 incomplete, juvenal primaries 6 through 8 complete, and juvenal primaries 9 and 10 incomplete. Wing observations made July 13 on the nine pen-reared specimens (eight weeks old) showed the same feather development. As previously noted, observations showed that the timing of the tail molt of wild and captive birds coincided.

The data are insufficient to enable a satisfactory comparison of body weights between pen-reared and wild birds. The weights of the captive chicks for weeks 2–9 averaged approximately 0.5 to 3.5 ounces lighter than those reared by Bump, *et al.* (1947, p. 94) and by Fay (1963, p. 647). Neither the reason for nor the importance of this difference can be ascertained. However, the birds I reared appeared to be in good condition throughout the period of study.

Although limited, the data collected suggest that progression and rate of molt in the captive sample were comparable to those of the wild birds examined. Zwickel and Lance (1966, p. 715) have reported similar findings for Blue Grouse (*Dendragapus obscurus*).

Age Determination by Wing-Molt Stage

The principal value of the postjuvenal molt of gallinaceous birds to wildlife biologists is its usefulness in aging and in back-dating events related to nesting phenology.

According to Bump, *et al.* (1947, p. 285), the majority of hens in a given locality begin nesting within a few days of each other. This indicates that precise knowledge on incubation periods and hatching dates in relation to weekly weather conditions may be valuable in understanding local changes in grouse population. Maximum accuracy in the age determination of grouse broods is therefore desirable. Due to apparent differences in the molt rate between Ohio and New York populations, maximum accuracy cannot be obtained using previously published aging keys (see Hale, *et al.* 1954). The key provided in Table 4 is based on the "average" wing condition I observed for chicks at a given age and should permit correct aging, to the nearest week, of young Ruffed Grouse (1–18 weeks) in Ohio.

To estimate the peak hatching period for grouse in southern Ohio, one specimen was selected from each of 25 broods live-trapped in 1963 and 1966 and aged, using Table 4. Hatching dates for these birds were then determined by extrapolation.

TABLE 4

Key for aging immature Ohio grouse between 1 and 18 weeks by primary molt, based on nine captive grouse reared in 1963

Primary:	Condition	Approximate age in days
Juvenal:	#1 to #7 are blood quills,	
:	#4 less than 32 mm long	5
Juvenal:	#1 to #7 are blood quills,	
:	#4 more than 33 mm long	11
Juvenal:	#1 and #2 complete,	
:	#8 present	18
Juvenal:	#1 dropped,	
:	#2 to #5 complete	27
Juvenal:	#2 dropped,	
:	#3 to #6 complete,	
:	#9 present	32
Juvenal:	#3 dropped,	
:	#6 complete,	
:	#10 present	40
Juvenal:	#4 dropped,	
:	#5 to #7 complete,	
:	#9 over 50 mm long	46
Juvenal:	#5 dropped,	
:	#6 to #8 complete	54
Juvenal:	#6 dropped,	
Adult :	#1 to #3 complete	61
Juvenal:	Primary #7 dropped,	
Adult :	#4 complete,	
:	#5 and #6 incomplete	68
Juvenal:	#8 to #10 complete	
Adult :	#7 less than 45 mm long	73
Adult :	#1 to #5 complete,	
:	#7 over 45 mm long	81
Juvenal:	#8 dropped	88
Adult :	#1 to #6 complete,	
:	#7 over 103 mm	
	(slightly shorter than #9)	95
Adult :	#1 to #6 complete,	
:	#7 as long or longer than #9	102
Adult :	#1 to #7 complete,	
:	#8 is a blood quill and reaches to a point over half-way to the	
	end of #9	109
Adult :	#8 incomplete but is as long as #9	117
Adult :	#8 with soft calamus but longer than #9	124

This indicated that 80 percent of them hatched during the two-week period of May 15–28. The earliest hatching date found was during the week of May 1–7 (two broods); the latest was during the week of June 19–25 (one brood). Eggs of four clutches obtained from local wild nests hatched in the Waterloo Experiment Station incubator between May 19 and May 21. Hale and Wendt (1951) reported that 61 percent of the Wisconsin broods sampled hatched between May 27 and June 9.

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