MOLT OF PRIMARIES OF ADULT ROCK PTARMIGAN IN CENTRAL ALASKA

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THE complex annual plumage changes of Rock Ptarmigan (*Lagopus mutus*) have attracted frequent study. Two investigations are outstanding in scope and thoroughness: Salomonsen's (1939) monumental work on descriptive aspects of plumages and feather replacement and A. Watson's study ("The annual cycle of Rock Ptarmigan." Ph.D. thesis, University of Aberdeen, 1956) of free-ranging ptarmigan in arctic Canada and Scotland. Careful examination of hundreds of museum skins enabled Salomonsen to postulate a number of relationships between molt and breeding cycles; many of these ideas were confirmed by Watson's extensive field research.

I was able to get information on summer plumage changes of live-trapped Rock Ptarmigan while studying population changes among these birds on breeding grounds in central Alaska. These observations, made in an area from which Salomonsen had little material and where Watson had few field observations, extend and clarify some aspects of molt discussed by those authors. This is especially true regarding year-to-year changes in molting schedules and the rates of molt of remiges.

I am grateful to the Alaska Department of Fish and Game for the opportunity to gather and analyze these data in connection with Federal Aid in Wildlife Restoration Projects W-6-R and W-13-R. My wife, Judith S. Weeden, Alan Courtright of the Alaska Department of Fish and Game, and George C. West, Laboratory of Zoophysiology, University of Alaska, reviewed and ably criticized the manuscript.

MATERIALS AND METHODS

Rock Ptarmigan were caught at Eagle Creek, 105 miles northeast of Fairbanks, Alaska, from May through August, 1961–65. According to the A.O.U. Check-List of North American birds, fifth edition (1957), Rock Ptarmigan in this area should be *L. m. nelsoni,* possibly with some characteristics of *rupestris.* I examined, banded, marked, and released 633 adults in the five-year period, including 254 males, 80 hens that did not raise chicks, and 299 hens with young. Of these, 13 cocks and 25 hens were caught two or more times in one molt period. These birds provided data on the rate of molting of primary feathers. Adults collected in September and October (29 males, 32 females) gave information on the time of complete replacement of primaries.

The last primary shed at the time a bird was examined, even if the feather follicle was empty, was used to indicate the stage of molt attained. This was determined by counting from P10 proximally until the first gap in the series was encountered.

Close observation of the progress of nesting allowed me to compare the molt with events in the breeding cycle. The age of chicks accompanying hens was determined by comparing feather development of chicks of unknown age with that of chicks

of known age. Westerskov's (1956) method of determining age in Willow Ptarmigan chicks (*Lagopus lagopus*) was of value in the present study.

MOLT IN MALES

Adult male Rock Ptarmigan (see Figure 1) dropped the innermost primary (P1) between 6 June and 20 June in all years. Males reached a peak of courtship, mating, and display activity in the last half of May. Their mates began incubating during a period of 10 days centering on 1 June except in 1964 when nesting was delayed. The shedding of P1 occurred when males were spending less and less time with the females or in territorial defense, and when many cocks left their territories for stream beds or ridge tops where they would pass the entire summer.

Six of seven adult males collected from 20 August to 8 September had the outermost primary (P10) of the new set only partly grown. One male shot on 6 September, and 22 taken from 14 September to 6 October, had completed the replacement of all primaries. By inference, therefore, primary replacement in the whole male population took from 5 June to approximately 10 September, or about 100 days. One male (specimen number 394, Alaska Department of Fish and Game) had not begun molting on 18 June 1965, and had a new, fully grown P10 on 18 September 1965. This bird had replaced all of the primaries in less than 90 days.

Other evidence about the rate of molt in individual males comes from records of birds caught twice in one summer (Table 1). The number of such records is small; however, the evidence does suggest that primaries are dropped in quicker succession early in the molt than later on. I conclude that adjacent primaries are dropped at intervals of from three to

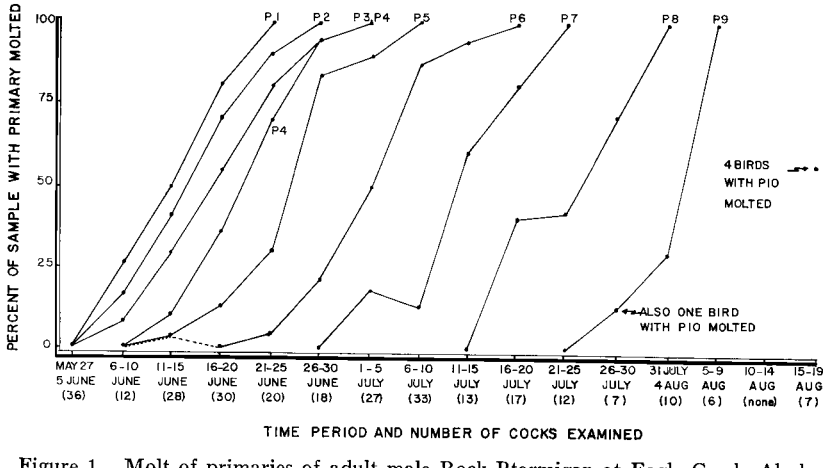

Figure 1. Molt of primaries of adult male Rock Ptarmigan at Eagle Creek, Alaska, 1961–65.

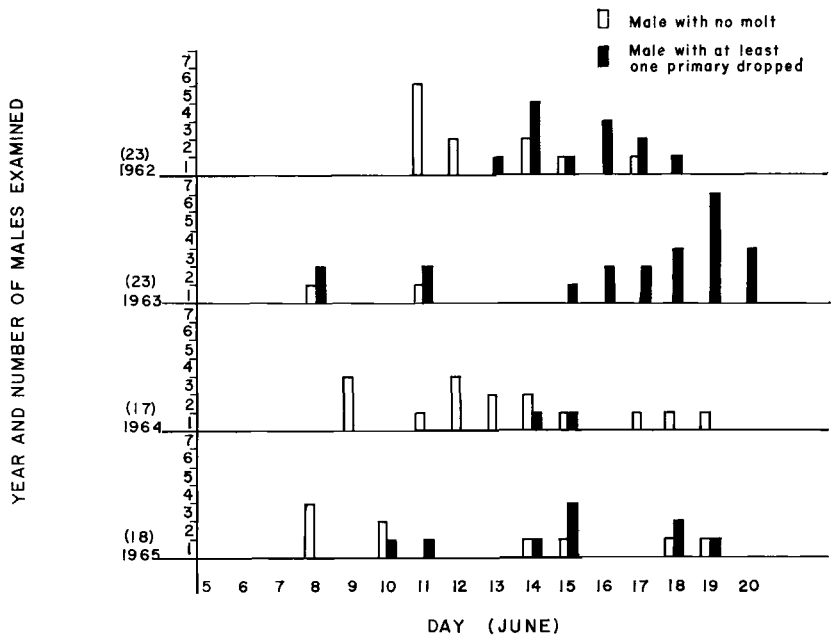

Figure 2. Annual variations in time of molt of adult male Rock Ptarmigan, Eagle Creek, Alaska, 1962–65.

five days at the beginning of the molt (until P4 is lost) and at intervals two or three times longer thereafter.

The spacing of molt curves (Figure 1) corroborates this impression. The first birds with P1, P2, and P3 molted all were found from 6 June to 10 June, and the first individuals with P4 and P5 shed were trapped in the period 11 to 15 June. The initiation of molt of succeeding feathers in the series come at longer intervals: P6 between 21–25 June (excluding one individual which dropped P6 between 11–15 June), P7 in the period 1–5 July, P8 between 16–20 July, and P9 between 26–30 July. (Few records for P10 are available for analysis.) This lengthening interval between curves in Figure 1 probably results from the slowing of the molt in individual males, as concluded from data on recaptured cocks.

The molt of primaries began earlier among males in 1963 than in 1962, 1964, or 1965 (Figure 2). In 1963, the last male that had not begun to drop its primaries was caught on 11 June; in the other years, the last cocks with no molted primaries were found on 17 June 1962, 19 June 1964, and 19 June 1965. The molt appeared to be late in 1964 in comparison with all other years, since only two cocks with molted primaries were caught before 20 June in that year. In all other years many birds caught before 20 June had begun to molt.

TABLE 1

RATE OF MOLT OF ADULT MALE ROCK PTARMIGAN CAUGHT TWICE IN ONE SUMMER

Specimen number[1]	*First record*		*Second record*		*Days/ primary shed*
	Date	*Primary last shed*	*Date*	*Primary last shed*	
1018	2 June	no molt	6 July	6	5.7
1178	8 June	no molt	30 June	5	4.4
1173	19 June	no molt	1 July	5	2.2
1104	9 June	no molt	19 July	6	6.7
1041	21 June	1	1 July	4	3.3
734	17 June	2	12 July	7	5.0
1187	23 June	4	27 August	10	10.0
1139	23 June	5	20 July	7	8.0
1079	19 July	6	29 July	7	10.0
767	25 June	6	15 July	7	20.0
1073	3 July	6	25 July	8	11.0
1087	21 July	7	1 August	8	11.0

[1] Of the collection of the Alaska Department of Fish and Game.

TABLE 2

RATE OF MOLT OF ADULT FEMALE ROCK PTARMIGAN CAUGHT TWO OR MORE TIMES IN ONE SUMMER

Specimen number[1]	*First record*		*Second record*		*Days/ primary shed*
	Date	*Primary last shed*	*Date*	*Primary last shed*	
762 (1964)	8 July	no molt	20 July	2	6.0
1048	30 June	no molt	6 July	2	3.0
1037	1 July	no molt	9 July	2	4.5
160	30 June	no molt	8 July	3	2.6
1195	28 June	no molt	7 July	4	3.0
205	26 June	no molt	7 July	4	2.7
473	2 July	no molt	19 July	4	4.2
1196	28 June	no molt	21 July	5	4.6
1200	1 July	no molt	24 July	5	4.8
762 (1963)	22 June	no molt	22 July	6	5.0
753	30 June	no molt	30 July	7	5.7
430	22 June	no molt	7 August	8	5.2
1208	3 July	1	18 August	8	6.6
782	2 July	2	20 July	6	4.5
1037	9 July	2	12 July	3 and 2	3.0
1069	7 July	3	28 July	6	7.0
470	2 July	4	5 August	8	8.5
388	11 July	4	30 July	7	6.3
809	11 July	4	20 July	6	4.5
818	18 July	4	27 July	6	4.5
1093	21 July	4	2 August	6	6.5
787	2 July	5	25 July	8	7.6
1255	22 July	5	30 July	6	8.0
1299	30 July	6	18 Sept.	10	12.2
1298	30 July	7	9 August	8	10.0
1294	30 July	7	9 August	8	10.0

[1] Of the collection of the Alaska Department of Fish and Game.

MOLT IN FEMALES

The timing of the molt of primary feathers among female tetraonids is influenced by the success of their nesting attempts. Therefore, I have treated molt data from successful and unsuccessful nesters separately.

Successful nesters.—Hens that nested successfully (hatching at least one young) at Eagle Creek began to lose P1 between 21 June and 10 July (Figure 3). Hatching peaks (dates on which half of the eggs had hatched) in this area occurred on 19 June in 1961 and 1963, on 23 June in 1962 and 1965, and on 1 July 1964.

Females, like males, molted more quickly early in the sequence than later (see Figure 3 and Table 2, a list of hens caught more than once in a molt period).

Hens with chicks molted earlier in 1963 than in other years, and were comparatively late to start molting in 1964 (Figure 4). The history of one hen (ADFG 762) caught twice in both 1963 and 1964 illustrates the year-to-year differences in molt. This bird's chicks hatched 21 June 1963 and 5 July 1964. On 22 July 1963 the female had lost P1 through P6, whereas on 20 July 1964 it had dropped only P1 and P2. In this individual, the delays in nesting and molt in 1964 seemed to be of the same magnitude.

Further data on the relationship between the molt stage of females and the age of their chicks are given in Table 3. Very few hens began to drop

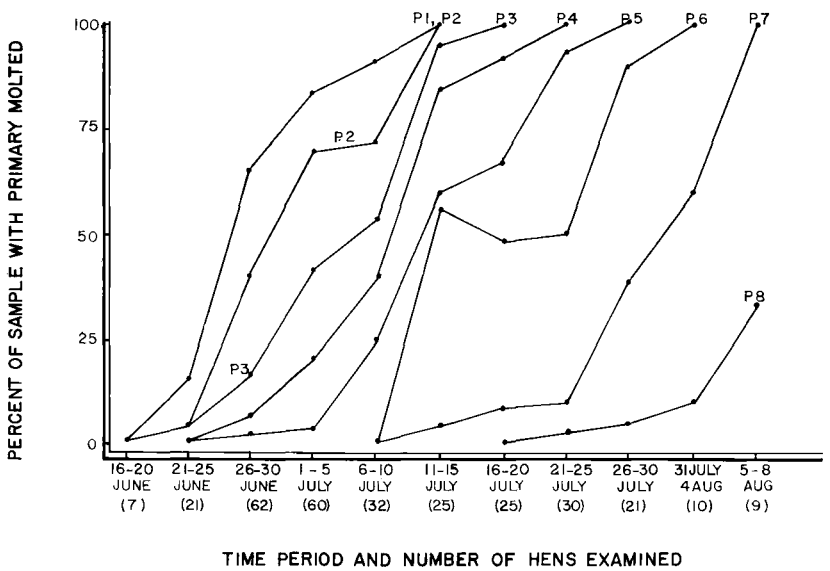

Figure 3. Molt of primaries of adult female Rock Ptarmigan with chicks at Eagle Creek, Alaska, 1961–65.

TABLE 3
WING MOLT OF ADULT FEMALE ROCK PTARMIGAN IN RELATION TO AGE OF THEIR CHICKS

Age of chicks (days)	*Number (and percentage) of hens achieving given molt stage*						
	No molt	*P1*	*P2*	*P3*	*P4*	*P5*	*P6*
1–3	28 (90)	1 (3)	1 (3)		1 (3)		
4–6	13 (48)	7 (26)	5 (19)	2 (7)			
7–9	3 (9)	11 (31)	10 (29)	6 (17)	4 (11)	1 (3)	
10–12	1 (3)	6 (21)	7 (24)	12 (41)	2 (7)	1 (3)	
13–15			6 (27)	4 (18)	7 (32)	4 (18)	1 (4)
16–18			2 (20)		2 (20)	4 (40)	2 (20)
19–21					4 (44)	4 (44)	1 (11)
22–24					2 (22)	4 (44)	3 (33)
25–27						5 (42)	7 (58)
28–30						4 (44)	5 (56)
31–33						2 (29)	5 (71)

their primaries until the chicks were at least four days old. Almost half of the hens did not drop P1 until the chicks were about seven days old. By the time the chicks were able to fly (at 10–12 days) nearly all hens had molted one or more primaries.

Unsuccessful nesters.—Hens whose nests were destroyed rarely renested. These birds apparently began to molt soon after nesting terminated. Dif-

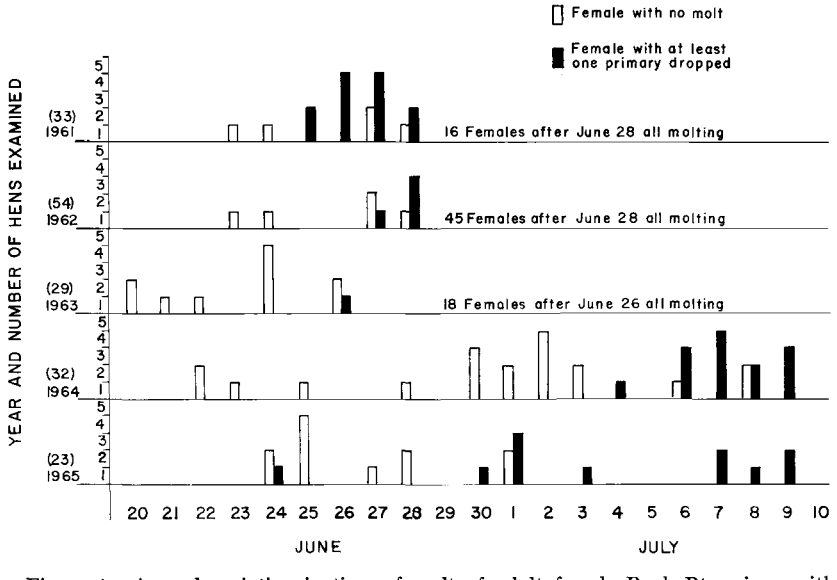

Figure 4. Annual variation in time of molt of adult female Rock Ptarmigan with chicks, Eagle Creek, Alaska, 1961–65.

TABLE 4
MOLT OF PRIMARIES OF 80 ADULT FEMALE ROCK PTARMIGAN THAT NESTED UNSUCCESSFULLY

Period	*Number of hens at stage of molt indicated*										
	No molt	*P1*	*P2*	*P3*	*P4*	*P5*	*P6*	*P7*	*P8*	*P9*	*P10*
16–20 June	7	1		1	3	2					
21–25 June				1	3	6					
26–30 June					3	5		1			
1– 5 July				2		2	4	1			
6–10 July			1			5	3	2			
11–15 July							2	3			
16–20 July							2	3			
21–25 July					1		1	1	3		
26–30 July								1	2		
31 July–4 August								1	2		
5–10 August									1	2	2

ferences in dates of nest destruction probably account for the variation in molt status of unsuccessful nesters at a given time (Table 4). As a whole, unsuccessful hens began to lose primaries somewhat later than cocks and earlier than females incubating successfully.

DISCUSSION

This study confirmed the findings of Salomonsen (1939: 418) and Watson (*op. cit.*) that male Rock Ptarmigan begin replacing primaries when territoriality is waning and their mates are incubating, that hens whose nests are destroyed begin molting soon after nest destruction, and that successfully nesting hens (the last adults to begin the molt) commence replacement of primaries shortly after their chicks hatch. Somewhat similar sequences have been demonstrated or suggested in other gallinaceous birds, including Willow Ptarmigan (Bergerud *et al.*, 1963: 701; Committee on grouse disease, 1911: 35–41), California Quail, *Lophortyx californicus* (Genelly, 1955: 281–282; Raitt, 1961: 301), Bobwhite, *Colinus virginianus* (Thompson and Kabat, 1950: 29), Ring-necked Pheasants, *Phasianus colchicus* (Kabat *et al.*, 1950: 8–9), and an Alberta population of Blue Grouse, *Dendragapus obscurus* (Boag, 1965: 107). In contrast, Bendell (1955: 355) found that all adult Blue Grouse on a Vancouver Island, British Columbia, study area began to lose primaries at the same time in late May, and Mackie and Buechner (1963: 259) thought that male and female Chukars (*Alectoris graeca*) started the molt simultaneously.

The actual difference in timing of the molt between cocks and successfully nesting hens at Eagle Creek amounted to 15–20 days. Because of the difficulty of distinguishing successful from unsuccessful nesters in autumn, I do not know whether this difference is maintained throughout

the molt period—that is, whether cocks complete the molt of primaries 15–20 days earlier than hens with chicks. There certainly is not a difference of two or three weeks in the completion of the entire autumn molt, including body feathers, in these two groups of Rock Ptarmigan.

The molt in both sexes of Rock Ptarmigan was delayed when the general phenology and nesting were severely retarded. In 1964, interior Alaska experienced one of the coldest, snowiest springs on record. On 25 May, when nesting normally has begun, five females collected at Eagle Creek had follicles less than 6 mm in diameter. Snow covered 70–90 per cent of the ground in nesting habitats. The first blossoms of *Anemone narcissiflora, A. parviflora, Cardamine purpurea, Dryas octopetala, Loiseleuria procumbens, Pedicularis lanata, Petasites frigidus, Ranunculus nivalis,* and *Silene acaulis,* all common in breeding habitats of Rock Ptarmigan, were found an average of 12 days later in 1964 than in 1963. Thompson and Kabat (1950: 29) found that molts of male and female Bobwhite were retarded in a year of late hatch. Raitt (1961: 302), however, thought that among California Quail only females were sensitive to delays in breeding schedules, as far as molts were concerned.

Höhn (1961: 102) suggested that reduction of gonadal hormone secretion, particularly prolactin, is involved in the main summer molt of birds. Prolactin, a molt-suppressant, is secreted during the period of incubation and brooding of young. Eggs (or, in some cases, chicks at an early stage of development) could serve as tactile or visual clues maintaining prolactin secretion. Among ptarmigan, the loss of eggs through nest destruction or hatching could trigger the molt by lessening prolactin production. This hypothesis would relate molt retardation in "late" years to delayed reproductive cycles, not (directly) to weather. Watson (*op. cit.*: 192) suggested several things that could cause a delay of molt among male Rock Ptarmigan, including food supply, behavior of hens, decreased testicular activity, and increased thyroid function.

Kabat *et al.* (1950: 6) found a strong correlation between age of chicks and stage of wing molt of parent female Ring-necked Pheasants. Thompson and Kabat (1950: 29) reported a similar relationship in Bobwhite, but cautioned that consort between hen and chicks did not prove parentage. At Eagle Creek, successfully nesting female Rock Ptarmigan generally dropped P1 a few days after their young hatched. However, there was no close relationship between the hens' stages of molt and their chicks' ages. Since only a small amount of exchange of chicks between broods occurred in the study population (determined from marked chicks), I do not think that errors from comparing hens with chicks other than their own explain the variation observed. One factor that could cause this kind of variability is weather at the time of hatching. If cold or rainy weather persisted for

several days after the chicks hatched, the female would continue to brood the chicks for a longer time than in fine weather. This could act as a continuing stimulant to prolactin production and thus would suppress molt.

The molt of primaries among Rock Ptarmigan in central Alaska is begun and almost completed during a time when food is most varied and most abundant and when ptarmigan have the smallest daily range. Movements of considerable size occur among ptarmigan in this region in September and October, culminating in emigration of nearly all females in the latter half of October (Weeden, 1964: 536). From mid-September to mid-October there is also a marked change from a varied diet of seeds, fruits, leaves, and animal matter to a diet composed almost entirely of buds and catkins of dwarf birch (*Betula nana, B. glandulosa*) and willow (*Salix* spp.) (data on file at the Alaska Department of Fish and Game, Fairbanks).

SUMMARY

The molt of primaries of adult male Rock Ptarmigan in central Alaska began in the period 5–20 June in 1961–65 and was completed 5–30 September. The molt began when territorial behavior was waning and when hens were incubating. Primaries were molted faster early in the molt period than later. A cold and snowy spring in 1964 delayed the molt and breeding schedule of Rock Ptarmigan by about 12 days in comparison with 1963.

Adult hens with chicks began molting 4–12 days after their chicks hatched, rarely earlier. Hatching peaks varied from 19 June to 1 July; molting began latest in the year of latest hatchings. The molt proceeded faster among hens early in the molt period than later, as was the case among males. There was no close correlation between molt progress of hens and the age of their chicks.

Hens that lost nests began shedding primaries soon after the nests were destroyed. As a group, unproductive hens molted later than cocks but earlier than hens that nested successfully.

LITERATURE CITED

BENDELL, J. F. 1955. Age, molt and weight characteristics of Blue Grouse. Condor, **57**: 354–361.

BERGERUD, A. T., S. S. PETERS, AND R. MCGRATH. 1963. Determining sex and age of Willow Ptarmigan in Newfoundland. J. Wildl. Mgmt., **27**: 700–711.

BOAG, D. A. 1965. Indicators of sex, age, and breeding phenology in Blue Grouse. J. Wildl. Mgmt., **29**: 103–108.

COMMITTEE OF INQUIRY ON GROUSE DISEASE. 1911. The grouse in health and disease. Vol. I. London, Smith, Elder and Co.

GENELLY, R. E. 1955. Annual cycle in a population of California Quail. Condor, **57**: 263–285.

HÖHN, E. O. 1961. Endocrine glands, thymus and pineal body. Pp. 87–114 *in* Biology and comparative physiology of birds, Vol. II (A. J. Marshall, ed.). New York, Academic Press.

KABAT, C., D. R. THOMPSON, AND F. M. KOZLIK. 1950. Changes in pheasant weights and wing molt in relation to reproduction with survival implications. Wisconsin Conserv. Dept., Tech. Wildl. Bull., **2:** 1–26.

MACKIE, R. J., AND H. K. BUECHNER. 1963. The reproductive cycle of the Chukar. J. Wildl. Mgmt., **27:** 246–260.

RAITT, R. J., JR. 1961. Plumage development and molts of California Quail. Condor, **63:** 294–303.

SALOMONSEN, F. 1939. Moults and sequence of plumages in the Rock Ptarmigan (*Lagopus mutus* [Montin]). Videns. Medd. Fra Dansk Naturhist. Foren. Vol. 103.

THOMPSON, D. R., AND C. KABAT. 1950. The wing molt of the Bob-white. Wilson Bull., **62:** 20–31.

WEEDEN, R. B. 1964. Spatial separation of sexes in Rock and Willow ptarmigan in winter. Auk, **81:** 534–541.

WESTERSKOV, K. 1956. Age determination and dating nesting events in the Willow Ptarmigan. J. Wildl. Mgmt., **20:** 274–279.

Alaska Department of Fish and Game, Fairbanks, Alaska.