THE MOULT OF THE NORTH AMERICAN *TETRAONIDÆ* (QUAILS, PARTRIDGES AND GROUSE).

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Plates IV and V.

(*Concluded from page 51.*)

Dendragapus obscurus (*Say*). DUSKY GROUSE.
" " **fuliginosus** *Ridgw.* SOOTY GROUSE.
" " **richardsonii** (*Dougl.*). RICHARDSON'S GROUSE.

The material examined, although not very extensive, shows the same sequence of plumages and moults as among the Quails.

Natal Down. — Above rich buff mottled with black and spotted with black on the forehead and sides of the head. Below dull buffy white. Two specimens of *obscurus* (Amer. Mus. Nos. 63989 and 63990, Utah, June 15) are mere chicks; but much of the juvenal plumage has grown on the upper surface and the first and second primaries are just in sight, the others being far more advanced, while the tail is also visible.

Juvenal Plumage, acquired by a complete postnatal moult. Above grayish brown with buff or whitish shaft-streaks and irregular barring or mottling of black, buff and gray; the crown reddish tinged. Below chiefly white with a thick sprinkling of black spots except on the chin. Two specimens of *fuliginosus*, about half grown (Amer. Mus. Nos. 45275 and 45276, July 12 and 13, British Columbia), illustrate this plumage and the early appearance of the postjuvenal moult, the first and second primaries still growing while the seventh to the tenth have been already renewed.

First Winter Plumage, acquired by a complete postjuvenal moult, excepting the two distal primaries of each wing. A dress practically adult is assumed at this stage.

First Nuptial Plumage. — There is no material showing prenuptial moult, but it must be very restricted, judging by breeding

birds. Later plumages are repetitions of the winter and summer dress.

Dendragapus canadensis (*Linn.*). CANADA GROUSE.

Natal Down. — Above rusty buff with dusky mottling. Black spots at nostrils, on forehead, on lores and behind the eye. A rufous patch bordered with black on the occiput. Below pale straw yellow.

Juvenal Plumage, acquired by a complete postnatal moult. Very similar to the adult female dress but browner above, rustier on the crown, neck and throat, whiter on chin, and with the pattern of the flank feathers quite different. A bird in my collection (J. Dwight, Jr., No. 1367, ♂, Nova Scotia, August 9) shows new black, white-tipped body feathers laterally on the breast, the first of the winter dress. Of the remiges belonging to the juvenal plumage, the first and second are nearly matured, the third is worn and with the buff edging of this stage, the fourth is a mere pin point, the others up to the eighth secondary (the eighteenth remex) are new and the remainder old. The rectrices of the first winter are partly grown. The sexes are alike in this plumage.

First Winter Plumage, acquired by a complete postjuvenal moult. Young birds become practically indistinguishable from adults, the black areas, however, are less solidly black and the white edgings broader. October birds examined show no further signs of moult. It is of interest to note that the black feathers of the chin and sides of the head are basally white, those nearest the white markings, as the throat crescent and head spots, having the largest areas of white. Furthermore one web of the feathers situated at the side of the white areas may be white and the other black, — a point that is of more significance, as will be seen, in *Lagopus*. The amount of white in both genera is apparently greater in the younger birds.

First Nuptial Plumage. — I can throw no light on the subject of a prenuptial moult. August birds in my collection are much worn about the chin, the area most involved when moult occurs in allied species.

Second or Adult Winter Plumage, acquired by a complete post-

nuptial moult, nearly completed except on the neck and throat as early as mid-August. Two males (J. Dwight, Jr., No. 1365, Nova Scotia, Aug. 9, and No. 1393, Nova Scotia, Aug. 13) have already lost the old distal primaries, the new ones being still somewhat pulpy and little of the worn body plumage remains.

Later plumages are repetitions of those already described.

Dendragapus franklinii (*Dougl.*). FRANKLIN'S GROUSE.

I have seen no material which throws any light on the moult of this species.

Bonasa umbellus (*Linn.*). RUFFED GROUSE.
" " **togata** (*Linn.*). CANADIAN RUFFED GROUSE.
" " **umbelloides** (*Dougl.*). GRAY RUFFED GROUSE.
" " **sabini** (*Dougl.*). OREGON RUFFED GROUSE.

The material examined indicates precisely similar moults in all the races of this species. The renewal of the remiges by the postjuvenal moult begins when the birds are only about one half grown, a striking characteristic of all the Tetraonidæ, and I have been able to trace all the interesting stages of plumage in the young bird by a series of *Bonasa* that includes all sizes from the chick to the full grown bird. The moult of *Bonasa* is typical of the whole family of Grouse and Quails.

Natal Down. — Above chestnut, paler on the crown, mottled on the body; a dull black postocular line. Below pale buff or primrose yellow, brightest on the chin, and a faintly brownish collar. A downy chick of *umbellus* (Amer. Mus. No. 25344, New York, May 27) has eight primaries and nine secondaries with their coverts barely breaking from their sheaths; the first and second primaries and the inner secondaries are not yet visible.

Two chicks of *umbellus* (Amer. Mus. No. 51447, New York, May 30, and L. B. Bishop, No. 2889, Connecticut, June 3) are slightly more advanced. Another of *umbellus* (L. B. Bishop, No. 2946, Connecticut, June 29) shows the distal pair of primaries, the rest of the wings better grown and new body feathers coming in at the sides of the breast and on the back at the root

of the neck. A chick of *togata* (J. Dwight, Jr., No. 5964, ♀, Quebec, July 1) has the remiges well developed except the two distal and a few proximal. The tail is beginning to show as the rectrices push out the tufts of down surmounting them; the wing-coverts are well grown; and the sides of the breast are covered with new feathers which have also begun to appear in the anterior dorsal and lumbar regions and on the throat and crown. No. 5968, ♂, of the same brood, three days older, shows a little more tail and more feathers on the crown. No. 5978, ♀, of the same brood, eight days older, shows a couple of inches of tail and has already begun the postjuvenal moult of the primaries, the eighth, ninth and tenth having fallen out. The chin, throat, forehead, superciliary stripes and mid-abdomen are still downy.

Juvenal Plumage, acquired by a complete postnatal moult. It is at its full development when the birds are less than three quarters grown, the loss of the remiges by the postjuvenal moult beginning very early. This plumage is similar to that of the adult female, but is browner with paler and less distinct barring, the chin white instead of buff, the rectrices more distinctly barred, and the remiges with wider and more mottled outer webs. There are no neck tufts, males and females being practically indistinguishable at this stage. A specimen of *togata* (J. Dwight, Jr., No. 4166, ♂, Quebec, July 24) is not much more advanced than No. 5978, but is double the size and has very little down left on the chin. Two other males (J. Dwight, Jr., Nos 1363 and 1364, Nova Scotia, August 7,) have renewed the primaries from the tenth outward as far as the fifth, and the body feathers also of the first winter plumage are appearing on the breast laterally and on the back. Several other specimens in the American Museum are at about the same stage (Amer. Mus. No. 57877, Manitoba, August 6, and No. 55575, Wisconsin, August 24).

First Winter Plumage, acquired by a complete postjuvenal moult, except the two distal primaries. The full adult dress is assumed, males becoming distinguishable from females by the more prominent black neck tufts now acquired for the first time. A specimen of *togata* (J. Dwight, Jr., No. 224, ♀, New Hampshire, Sept. 10) has assumed this plumage except for the head and throat, and the third and fourth primaries, while buff-

spotted under wing-coverts have replaced the gray ones of the juvenal stage. Numerous October specimens examined have lost all traces of moult except in some of them on the border line between the breast and throat. The 'ruff' of young males is not so deep a black as that of adults and the barring of the lower parts is less extensive and somewhat paler, but plumage characters cannot be absolutely depended upon to distinguish young from old.

First Nuptial Plumage, acquired by a limited prenuptial moult confined to the head and chin. A specimen of *sabini* (Amer. Mus. No. 47282, British Columbia, June 2) shows numerous pin feathers on the chin, throat, sides of head and forehead. Another *sabini* (Amer. Mus. No. 47279, ♂, British Columbia, May 20) also shows a few pin feathers. A few other spring and summer birds of other races have been obtained too early or too late (*i. e.*, March or June) to show positive signs of moult.

Later plumages are repetitions of the winter and summer dress.

Lagopus lagopus (*Linn.*). WILLOW PTARMIGAN.
" " **alleni** *Stejn.* ALLEN'S PTARMIGAN.

The series of Ptarmigans in the American Museum of Natural History and in the U. S. National Museum, together with specimens from Alaska kindly loaned me by Dr. Louis B. Bishop, and a few in my own collection, illustrates most effectively all the plumages and moults of these Arctic birds. The study of this material, amounting to nearly two hundred specimens, now enables me to explain the parti-colored plumages of these birds, a matter that has long baffled investigation and given rise to a belief that the individual feathers themselves change color without being moulted. It has also been believed by some that Ptarmigans moult continuously and in a hap-hazard way during the whole year. All of these ideas have arisen from a misconception of the facts, which show that the feathers supposed to be changing color or pattern are of that particular color and pattern at the time they first expand, that the continuous moult resolves itself into definite periods, and that the feather growth is systematic, differing in no respect from that of the rest of the Grouse. The

one essential difference between the moults of the Ptarmigans and those of the Grouse is found in the extra moult in the autumn by which the brown feathers regularly assumed at the usual periods of moult in both young birds and old are replaced by white ones.

As for the prenuptial moult, it may or may not be more extensive than among the Grouse, the extent of renewal varying apparently with the latitude. Birds living in lands of eternal snow appear to assume very few dark feathers, chiefly about the head, as the brief Arctic summer sets in. Those of lower latitudes undergo a more extensive moult, which, however, never includes the remiges nor the rectrices. Besides this, as females seem to assume more dark feathers than do males, we are led to the conclusion that the Ptarmigans are a remarkable instance of protective coloration, and that their plumage is modified to suit their environment. We know them best in their winter dress, snow white with black rectrices hidden by white coverts, and can understand how readily they harmonize with a snowy landscape, being thus protected from their enemies. With the melting of the snow they don a dusky dress mottled with buff, which is confined chiefly to the upper parts. A little later the annual moult takes place, including practically the whole plumage, and a reddish brown dress is assumed upon the back, head and breast, the remainder of the body and the wings becoming white. An extra moult shortly after removes the brown feathers. If white were assumed everywhere at the time of the annual or postnuptial moult, which begins as early as July, it would not be protective; but why the postnuptial moult should not be postponed until white would be protective, is a theoretical matter that need not concern us. The salient fact is the occurrence of a moult similar to one characteristic of a number of the Ducks and observed, although not understood, many years ago. A description of it as noticed in the Mallard may be instructively read in this connection.[1] Further details of this moult among certain Ducks have been published by Mr. Witmer Stone[2] and Mr. F. M. Chapman.[3]

[1] Waterton, Loudon's Mag. Nat. Hist., VIII, 1835, p. 544.

[2] Proc. Acad. Nat. Sci. Phila., 1899, pp. 467–472.

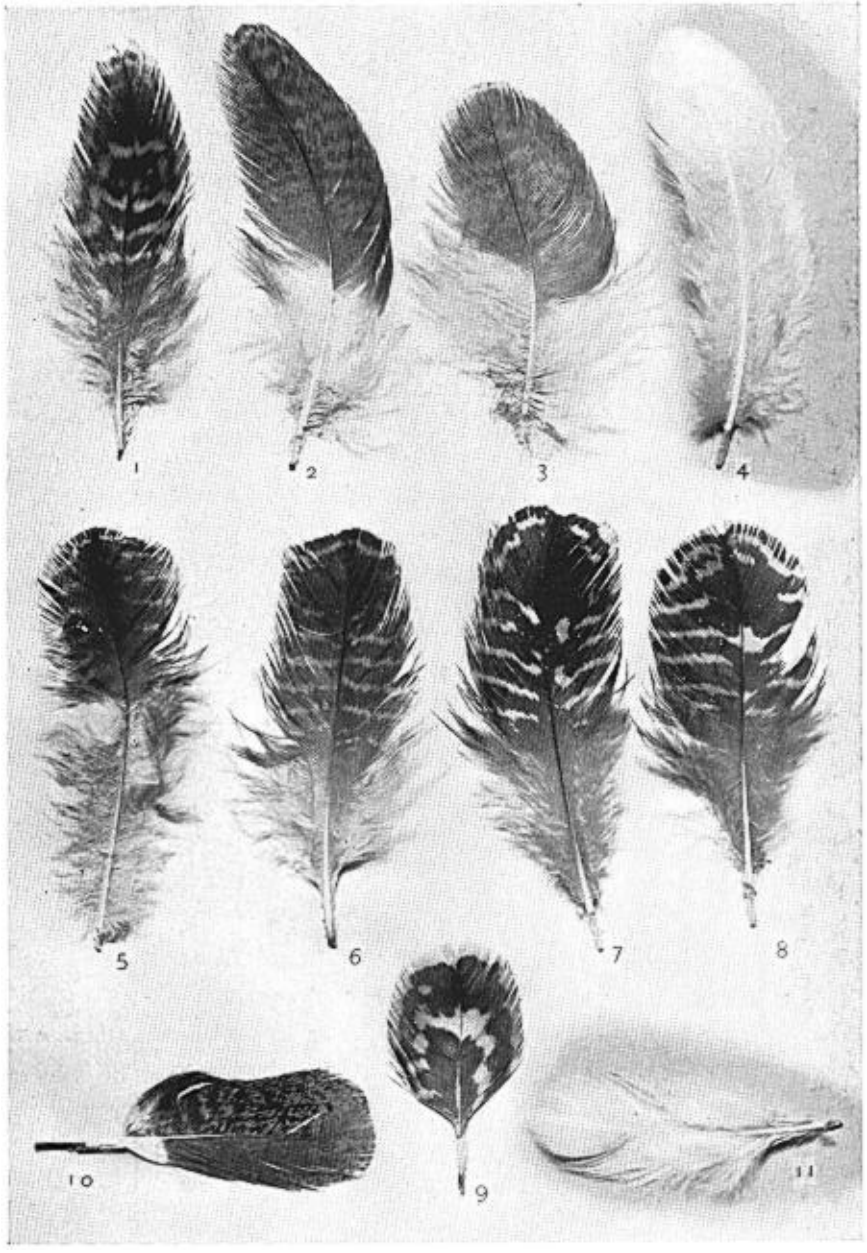
[3] Bull. Amer. Mus. Nat. Hist., XII, 1899, pp. 231–240.

This extra moult so quickly succeeds the one preceding it that new brown and new white feathers may be found almost side by side. If, however, we bear in mind how feather growth radiates more or less symmetrically from definite points, we can distinguish two moults rather than two stages of one, and if we could trace the history of each individual feather, we would doubtless find it subject to the same laws which govern the development of plumage in all species of birds. The difficulty arises of designating the intermediate stage of plumage by a name. It exactly corresponds to the 'autumnal' or 'winter' plumage of most birds, but part of it is soon renewed by the extra moult. It seems to me it might best be called the *preliminary winter plumage*, which, when the brown feathers have been replaced, becomes the *supplementary winter plumage*. One thing is evident — the brown or dusky stage does not properly belong to the nuptial or summer plumage, for its appearance is synchronous with the postnuptial renewal which begins among the remiges. Young birds also pass through a preliminary winter plumage following the juvenal, assuming by the postjuvenal moult a dress that is scarcely different from the corresponding stage of adult plumage, although the brown feathers acquired are fewer and more scattered. As in the adult, this plumage is also followed by a wholly white supplementary winter dress.

The plumages of the Ptarmigans are puzzling not only on account of the plumage intermediate between summer and winter dress, but also on account of the rapidity with which the moults follow each other, one beginning before the previous one is completed, and apparently overlapping it at some points. Moreover, the incompleteness of the partial moults with the irregular retention of feathers peculiar to them adds to the confusion of ideas resulting from seeing together an assemblage of feathers belonging to several different stages of plumage. As for the rapidity with which one moult treads upon the heels of another, it can only be said that the mode of life of the Ptarmigans requires it and the activity of a feather papilla is no greater than the necessity. As a matter of fact, some papillæ produce approximately one feather in May, another in July and a third in September, but there are many which produce but two feathers

during this period and others only one, while all of them are dormant during the long winters. The 'generations' of feathers are most frequent where the blood supply is richest. Problems of plumage solve themselves as soon as we can say when and where each feather grows, and a comprehension of the idea of sequence is the key to the whole matter.

Before taking up the series of plumages and moults in their natural order of development in the Ptarmigans, I wish to call attention to Plate IV which shows the four constant types of feathers found upon *Lagopus lagopus*. It is the mingling of the four that has proved a stumbling block to many observers. Fig. 1 represents one type, the juvenal plumage; Figs. 2, 3, and 10 a second type, the preliminary winter plumage; Figs. 4 and 11 a third type, the supplementary winter plumage; and Figs. 5–9 a fourth type, the nuptial plumage. That feathers of all of these types grow at definite times is amply shown by many of the series of birds examined and is illustrated by Figs. 9, 10 and 11 which show new feathers still clasped by their sheaths; but it must be remembered, there is some tendency for one type to run into another. My object is to indicate when and where these types grow and how they are modified in color and pattern by age, sex, individuals, and particularly by position. If observers would pay attention to a few of these matters first we would hear very little afterwards about color change without moult. The parti-colored feathers are principally on the line of demarkation between light and dark areas, and the same style of feathers will always be found upon corresponding areas of birds taken at the same stage of development. The feathers of the second type, for instance, always show an amount of white basally which varies with the position they occupy in the feather tracts. The white, too, is most extensive upon the webs nearest white areas, just as it is in *Dendragapus*, or any other species with contrasting colors. This may be seen by examination of the feathers of the mesial borders of the sternal bands of the ventral feather tract where dark parti-colored feathers largely tipped or variegated with white are regularly produced at the postnatal, postnuptial and prenuptial moults. The triangular wedge of ventral feather tract extending between the sternal bands produces only white feathers at the



PTARMIGAN FEATHERS.

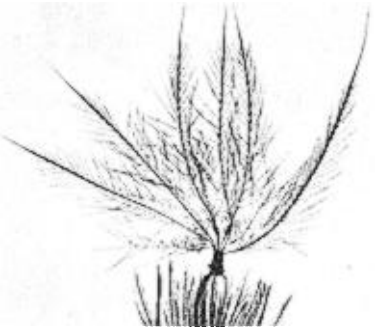


FIG 1. DOWN FEATHER OF PTARMIGAN.

FIG. 2. DOWN FEATHER OF QUAIL.

postjuvenal and postnuptial moults, such feathers appearing upon the sternal bands at a later period, namely, at the supplementary postjuvenal and supplementary postnuptial moults. There is no theory about any of these matters, — the facts are patent only they have not been understood. Nor is it an easy matter to understand them without following them in detail, but this is just what I propose to do, and I am glad to say the series I have examined forms a complete chain of plumages in which even the intermediate links of moult are not missing. It is only by tracing the development of the successive 'generations' of feathers peculiar to each feather tract and studying their relation to each other, that we may arrive at the true explanation of the apparently hopeless confusion of variously colored feathers found upon the Ptarmigans during the summer months. Instead of confusion we find each tract and each feather governed by the usual laws of feather growth, and the only confusion discoverable is that existing in the minds of those who have not grasped the facts. What these facts are I have already endeavored to sum up, but they will become still clearer if the reader will follow me through the pages which follow. As with the other Grouse and Quail the sequence of plumages and moults is illustrated by specimens studied in the natural order in which the plumages have developed. We will begin with *Lagopus lagopus.*

Natal Down. — Downy chicks are mottled above with rusty brown and dull black, the crown is chestnut and a dark line runs behind the eye; below they are a pale buff yellow. This down, shown in Plate V, from a photomicrograph by Dr. Edward Leaming, varies little upon different parts of the body or in different species of the Tetraonidæ. Fig. 1 represents it attached to the apex of a juvenal feather of *Lagopus lagopus* and Fig. 2 shows it similarly attached to a juvenal feather of *Colinus virginianus*, the former plucked from the humeral tract, the latter from the chin where the down is shorter. It is found not only at the apices of the body feathers but at those of the flight-feathers and of the rectrices, being practically continuous with the barbs of the succeeding feathers, the tips often breaking away with the confining band which gathers them into a bundle.

A downy chick (Amer. Mus. No. 26178, Labrador, July 1,

"five days old"), is just beginning to show the sprouting juvenal remiges, the outer ones being least developed. Another chick (Amer. Mus. No. 26179, Labrador, June 29, "twelve days old") has the wing-quills and coverts well out of their sheaths, and some of the brown rectrices are beginning to show, together with a few dusky, white-tipped feathers of the humeral tracts. Still another (Amer. Mus. No. 26177, Labrador, July 22) is slightly more advanced, new juvenal feathers expanding on the sides of the breast, anteriorly on the back, on the rump, and on the lumbar tracts, while eight primaries are partly grown, the first and second or distal pair of each wing not yet showing. Several specimens in the U. S. National Museum are well advanced into the next plumage and need not be particularly described.

Juvenal Plumage. — This dress is acquired by a complete postnatal moult beginning shortly after the chick leaves the egg and practically ends before the bird is more than half grown, the natal down persisting longest on the chin, throat, sides of neck and abdomen. This plumage is of the first type as shown by Plate I, Fig. 1, dusky above and variously barred, mottled and edged with rich ochraceous buff, many of the feathers being narrowly tipped with white, while a richer buff prevails below; the dusky markings are reduced to irregular bars, and to mere spots upon the chin and upper throat, where the buff is very pale and the feathers white basally as well as terminally. The abdomen (including the wedge of the ventral feather tract extending to the neck), the flanks, the crissum, the tibiæ, tarsi and toes become dull yellowish white, the flanks, crissum and upper part of the tibiæ being obscurely barred and having a rusty tinge. It should be noted that the feathers adjacent to the mesial borders of the sternal bands approach type two, being dusky, often finely mottled and showing basally and terminally large areas of white. Similar feathers also grow at the postnuptial moult scattered irregularly, chiefly along the external border of these bands, but the two kinds may be distinguished by the greater wear showing upon the earlier developed feathers. The juvenal remiges are grayish brown somewhat mottled with buff, except the two distal primaries which are white, sometimes speckled with dull black terminally. The late development of the first and second primary, usually long after the

third is grown, suggests the idea of classing them as part of the winter plumage. As, however, they belong to the series which develops before the postjuvenal moult begins, it seems best to class them with the juvenal dress, as I have consistently done in describing the other Grouse and Quails. The juvenal rectrices are deep brown barred with reddish brown and narrowly tipped with white. Males and females are practically indistinguishable in juvenal dress.

The early appearance of the postjuvenal moult when the birds are hardly half grown is not peculiar to the Ptarmigans, but the appearance of new white primaries at both ends of a brown series is confusing unless the origin of these feathers is thoroughly understood. Several birds illustrate this stage. One of them (Am. Mus. No. 26176, Labrador, July 22), hardly half grown and still downy about the head, has replaced the ninth and tenth juvenal primaries by white ones just breaking from their sheaths; the ninth is a mere pin point, while the white first and second are nearly grown and still pulpy, the brown third primary showing traces of its immaturity by the persistent scaly sheath at its base. Except about the head and throat the juvenal plumage of the body has been mostly acquired. Another bird, the date of capture lacking (Am. Mus. No. 45191, Labrador) is more advanced, the tenth primary being well grown and only the third to the sixth of the brown ones remain. The juvenal tail is still retained. Still another bird two thirds grown (Am. Mus. No. 26175) retains only the third and fourth of the brown juvenal primaries although juvenal feathers are still expanding on the back, head and throat.

First Winter Plumage (*preliminary*), acquired by a postnuptial moult which is generally very incomplete in birds of the far North, but more extensive in those of lower latitudes. A mere sprinkling of reddish brown finely vermiculated or mottled feathers of the type shown by Plate 1, Figs. 2, 3 and 10, may be acquired or the renewal may be complete, the abdomen, flanks, legs and feet, however, always assuming at this moult pure white feathers of the type shown by Figs. 4 and 11. The remiges except the two distal primaries, which are not moulted, and most of the wing-coverts are replaced by white ones. A few proximal remiges that correspond to tertiaries, and a couple of rows of

median coverts are not moulted until later, the postjuvenal moult overlapping in a measure the limited one succeeding it. The black tail tipped with white is acquired at the postnuptial moult, the median pair of rectrices being latest in development, the rest of the series all being renewed at nearly the same time. There are fourteen black rectrices. The two central feathers usually reckoned as rectrices appear to be in the row of coverts which they certainly follow in their moult, developing white and being renewed, when they are renewed, at a later period than are the black rectrices. The rectrices are moulted once in the year, the coverts often twice and a few of them three times.

Males and females in this intermediate plumage are not usually distinguishable, although the latter may be duller and with more tendency to barring, especially on the breast. A female scarcely full grown (Amer. Mus. No. 26173, Labrador, August 27) has assumed much of the preliminary plumage and is already beginning to show a few white feathers of the supplementary stage. Some body feathers of the juvenal stage are retained, including a few parti-colored ones on the inner margin of the sternal bands; the third primary is brown and also one feather of the alula. The tail is perhaps one quarter grown. New white feathers are growing systematically upon the abdomen, legs and toes, the points of first development for the toes being each joint. Two other birds (L. B. Bishop, No. 4503, ♀, and No. 4506, ♂, Yukon Delta, Alaska, August 28) are at about the same stage, but have assumed a few reddish feathers, chiefly on the breast. The first and second primaries have lost almost all traces of immaturity, the third has not been replaced and is brown, the fourth is only one half grown, and the fifth merely shows the remains of its sheath. At about the eighteenth remex partly grown feathers will be found, and the rest of the series is not yet renewed, but an exact count is extremely difficult in all dried and distorted wings. Worn parti-colored feathers occur on the sternal bands adjacent to the ventral wedge, which is beginning to be clothed with pure white feathers replacing yellowish ones, but these variegated feathers will be renewed when the moult just beginning at the anterior part of the sternal bands reaches them, as will the external barred buff feathers that sweep backward over the flanks. The advance of the

two moults practically side by side, apparently in three parallel bands, on the breast and abdomen may be traced in a number of specimens which illustrate it. A female (Amer. Mus. No. 26169, Labrador, September 5) has assumed wings almost wholly white; the third primary is a mere pin point, its brown juvenal covert still retained, and the inward course of the moult has reached the eighteenth remex. The new white one is just visible, the seventeenth half grown, and the inner members are as yet unmoulted. The median coverts and a few dusky lesser coverts are still retained. New white feathers are growing among the axillaries and upon the flanks and abdomen at the places where they regularly develop. Four other birds (L. B. Bishop, No. 4504, ♀, No. 4505, ♂, No. 4507, ♂, and No. 4509, ♂, Alaska, August 28) are at about the same stage or slightly more advanced. The third primary of each is now white and one half grown while they still retain a brown feather of the alula and some brown ones of the carpo-metacarpal border. In two others (L. B. Bishop, No. 4502, ♂, and No. 4508, ♂, Alaska, August 28) the white of the sternal bands is more prominent and the tails a little longer.

A female (L. B. Bishop, No. 4597, Alaska, Sept. 11) is still further along, white feathers beginning to appear about the chin and throat. Another bird (L. B. Bishop, No. 4657, Alaska, Sept. 19) has become almost wholly white on the abdomen except a few feathers of the flanks, and new white feathers of the supplementary winter dress are growing at the usual initial points of development on the breast, throat, chin, head and back. Three more (L. B. Bishop, No. 4655, ♂, No. 4656, ♀, and 4658, ♀, Alaska, Sept. 19) differ little from the last although the white middle pair of tail-coverts is now in sight taking the place of the juvenal feathers. A specimen evidently *alleni* (Amer. Mus. No. 45195, wrongly labelled "Nova Scotia, summer") illustrates the full development of the preliminary winter plumage, the wings being absolutely white although the inner remiges show signs of recent growth. The upper parts and breast are almost wholly of the reddish second type of feather, the abdomen wholly white, as are the flanks, legs and toes.

First Winter Plumage (*supplementary*), acquired by a partial supplementary postjuvenal moult, which beginning at the usual

points removes the brown feathers of the preliminary dress, together with such barred feathers as may have been skipped by the incomplete postjuvenal moult. As a result of the last two moults birds become wholly white except for the black rectrices, males and females being indistinguishable. Numerous winter specimens illustrate this plumage. In some cases brown feathers may persist throughout the long Arctic winter, which furnishes a period of rest from November to May, much needed perhaps after the active feather production of the short summer. A few specimens show this (U. S. Nat. Mus. No. 19887, ♀, Great Slave Lake, April 4; No. 93060, ♀, Alaska, April 1, and No. 94409, ♂, Labrador, March 21); the last is an unusual case with much brown. As old and young in full white plumage are indistinguishable except that adult males appear to have the crown feathers basally black, it can only be said that this dress is worn without change until April, as shown by several specimens (U. S. Nat. Mus. No. 50060, ♀, Nulato, Alaska, April 12; No. 31660, Ft. Anderson, Canada, March 17; No. 98033, Bergen, Norway, March 15; Amer. Mus. No. 26889, Norway, "end of March"), and others with no indication of prenuptial moult up to that date.

First Nuptial Plumage. — At the beginning of the brief summer which follows the long winter a partial prenuptial moult takes place, the extent of which appears to depend upon latitude, sex, and probably age. Part of the white body feathers are replaced by dusky or reddish ones, males assuming chiefly those of the type shown by Plate I, Figs. 5 and 6, the color being dull black barred or mottled with buff; females, those of the same type but more boldly barred with a richer buff, as shown by Figs. 7, 8 and 9. Females may now be distinguished with certainty from males for the first time by plumage characters, the barring being coarser and extending to the head, throat and breast, the feathers of which in the male are reddish brown, chiefly with narrow dusky terminal bands, and often tipped, on the chin especially, with white. It should be observed that parti-colored feathers basally or terminally white may be assumed at this moult on the internal borders of the sternal bands just as in juvenal dress, the abdominal wedge, flanks, legs and feet, retaining as a rule the white feathers of the winter plumage. The

white remiges and their coverts are always retained and often much of the rest of the wing plumage, the median rows of coverts being the ones renewed if any are. The tail-coverts may be renewed, but the fourteen black rectrices remain. More than fifty specimens, chiefly in the U. S. Nat. Mus., illustrate the acquisition of this plumage, by growth of new feathers, during April, May and June, some still sprouting in July even when those of the next stage have begun to appear. It is not easy to tell old birds from young. The early appearance of new feathers is shown by the following specimens: U. S. Nat. Mus. No. 98034, ♂, Norway, March 15; No. 93059, ♂, Alaska, April 11; No. 73217, ♂, May 1, Alaska; No. 93146, ♂, Alaska, May 21; No. 46082, ♀, Alaska, May 9, and others too numerous to mention. There are many June birds and of these may be mentioned two specimens (Amer. Mus. No. 26174, ♂, Labrador, June 2, and No. 26170, ♀, Labrador, June 8) which from their plumage appear to be year old birds and are still acquiring new feathers at a number of points although fairly clothed above with the nuptial dress, which has extended to the inner members of the remiges and the median coverts.

Second or Adult Winter Plumage (preliminary). — Even before the nuptial dress is fully acquired the postnuptial moult sets in, beginning a little prior to the postjuvenal and resulting in an intermediate plumage partly white and partly reddish brown which may hardly be told from that of young birds at the same season. It should be observed that the moult of the remiges now includes the two distal primaries which are retained in young birds. Adults, however, seem to be somewhat grayer with finer mottling or vermiculation upon feathers of the type shown by Plate I, Figs. 2, 3 and 10, those of the throat being of a deeper red-brown with less barring than those of young birds. Practically young and old, both males and females, are all indistinguishable except by inconstant differences when clothed by the preliminary winter dress, but their age and sex may usually be told by the left over tell-tale feathers of an earlier plumage. Several Labrador birds (Amer. Mus. No. 26167, ♂, July 15, No. 26168, ♂, July 22, No. 26171, ♀, July 14, and No. 26172, ♀, July 15) show the postnuptial moult beginning early in July, as

they have already assumed several new, partly grown inner primaries and a very few of the reddish brown body feathers. An Alaskan specimen (L. B. Bishop, No. 4501, ♀, August 28) has renewed eight of the ten primaries, the two outer ones being worn and dirty white by comparison, and part of the other remiges and the wing-coverts except the median rows. New reddish mottled feathers have grown, scattered on the back rump and among the upper tail-coverts; and reddish feathers basally white, varying with their location, have largely replaced the nuptial ones on the chin, throat, breast and sides. The growth of white feathers is well under way on the abdomen, flanks, legs and feet, and the later strips of supplemental white on the sternal bands have even begun to appear producing shortly, as in the young bird, the effect of a central band of white with two lateral bands. The outer feathers of the sternal bands are the last to be renewed, a condition found on a female (L. B. Bishop, No. 4598, Alaska, Sept. 11) with the first and second primaries not fully grown, and the rectrices not yet reaching beyond the coverts. The abdomen, flanks, legs and feet are white, as well as most of the sternal bands, and the white is extending to the breast, white feathers just expanding being found at the customary points on various areas. The head and throat are chiefly reddish mixed with barred nuptial feathers, which also persist to some extent upon the back where white feathers of the supplementary stage are beginning to show. A similar male (Amer. Mus. No. 26162, Labrador, Sept. 26) shows a greater number of white feathers of the supplementary winter dress, and the primaries are full grown. Two specimens of *alleni* (Amer. Mus. No. 25857, ♂, and No. 25858, ♀, Newfoundland, Sept. 15) also illustrate the preliminary winter plumage, having acquired a larger number of the reddish feathers than will be found on more northern birds, of which I have examined a large number from Labrador and Alaska. These birds, taken in various stages of plumage during July, August and September, illustrate the serial growth of feathers and the final acquisition of the pure white winter dress.

Second or Adult Winter Plumage (*supplementary*), acquired by a partial supplementary postnuptial moult, the beginnings of which

have been shown by the specimens described. Adults become wholly white, the females indistinguishable from young birds, but males apparently assume crown feathers which are basally black, gray prevailing in young birds. An Alaska specimen (Amer. Mus. No. 26180, ♂, October), indicates that the white dress may be acquired before November in that latitude; and this bird as well as others (*e. g.*, Amer. Mus. No. 26165, ♂, Labrador, December 20) show that basally black crown feathers grow in the autumn and are not white ones recolored in the spring.

Second or Adult Nuptial Plumage.—This is acquired, as in the young bird, by a partial prenuptial moult, doubtless extremely limited in high latitudes. The colors of adults are somewhat richer with a tendency to less barring and finer mottlings, at least in males. Two males (Amer. Mus. No. 49902, Great Slave Lake, Canada, June, and No. 26890, Archangel, Russia, May 5) illustrate new growth of feathers radiating from the usual points, the late renewal of the forehead and lores being excellently shown. The growth is confined wholly to the head, the rest of the bird being pure white. Numerous other specimens examined need not be here described, although illustrating the varying extent of the prenuptial renewal.

Later plumages and moults are but repetitions of those already fully explained in all details.

The wear of feathers in the Ptarmigans throws some light upon questions of plumage but they do not appear to suffer much from it and the rapid succession of the summer moult prevents marked abrasion or fading in most cases. As for the moult of the claws described by several observers, I need not discuss it in the present connection.

That the plumages are complicated and difficult to understand I am ready to admit, but I fail to find the slightest reason for supposing them to be produced otherwise than by moult. I may not have systematized the plumages or the moults in the best manner, but at least I have tried to bring out the facts in a way that I hope may clear up the misty ideas that have prevailed in spite of the plumages of the Ptarmigans having been the theme of so many writers.

Lagopus rupestris (*Gmel.*). ROCK PTARMIGAN.
" " **reinhardi** (*Brehm*). REINHARDT'S PTARMIGAN.
" " **nelsoni** *Stejn.* NELSON'S PTARMIGAN.
" " **atkhensis** (*Turner*). TURNER'S PTARMIGAN.
" " **townsendi** *Elliot.* TOWNSEND'S PTARMIGAN.

The series of Rock Ptarmigans and near allies, though smaller and less complete than that of *lagopus*, shows conclusively that there is an analogous sequence of moults and plumages. The dusky buff-barred juvenal and nuptial stages of plumage are followed by an intermediate stage when mottled dusky gray feathers are assumed more or less abundantly on the upper parts of the head and the breast, while coincidently the wings, abdomen, flanks, legs and feet assume a white plumage which is retained for a twelvemonth. The dusky gray plumage, however, is scarcely donned before a supplementary moult begins, radiating from the usual points of departure on the sternal bands, and from the numerous other points on the back and head where other moults regularly begin. This supplementary moult advances down the middle of each sternal band or a little to its inner side, beginning on the sides of the breast and radiating laterally, so that the mesial borders of these feather tracts lose their parti-colored feathers earlier than do the borders beneath the wing. There is usually only a sprinkling of feathers of the intermediate stage on these tracts, together with *two sorts* of feathers that originated at the previous postnatal or postnuptial moults, according to the bird's age, all of which are now replaced by the growth of new white ones, as presently are all dusky feathers elsewhere. A pure white winter plumage with black tail results from *two* moults just as in *lagopus*. No evidence of color changing without moult is to be found. At the beginning of the short Arctic summer a prenuptial moult of varying extent takes place, apparently birds of localities where the snow is ever present undergoing a very limited renewal of grayish dusky feathers. I have discussed the corresponding changes of plumage so minutely under *lagopus*, that I need not repeat here except for clearness. The remarks apply to *rupestris* except when otherwise specified.

Natal Down. — It is difficult to distinguish the chicks from those of *lagopus*, but they are usually paler and grayer.

Juvenal Plumage, acquired by a complete postnatal moult. Much duskier, and more barred, with less rusty tinge than the same stage of *lagopus*. Two birds, apparently *reinhardi* (Amer. Mus. Nos. 64133 and 64134, Greenland, July 28), about one third grown, still retain natal down on the chin, throat, mid-abdomen, legs and feet, but have already acquired four partly developed white proximal primaries of the winter dress. The first and second juvenal primaries are white, partly grown, the rest dusky. The juvenal brownish tail is not fully grown.

First Winter Plumage (*preliminary*), acquired by a fairly complete postjuvenal moult excepting the first and second primaries. The wings (except the median coverts and inner remiges) become white together with the abdominal wedge of the ventral tract and all posterior to it including the flanks, legs and feet; while the head, throat, breast, sides and back become more or less dusky according to the extent of the renewal in different individuals and probably according to the latitude. These feathers are of the type shown by Plate I, Figs. 2, 3 and 10, but dusky instead of reddish as in *lagopus*. The black rectrices are acquired at the postjuvenal moult.

A number of specimens show the later stages of this plumage with the quickly ensuing change into the wholly white dress. It will suffice to cite a few. One (Amer. Mus. No. 67883, Sitka, Alaska, Sept. 15) has completed the postjuvenal moult of the wing except the third primary which is only half grown. The dusky preliminary dress prevails above and on the head and throat, with white feathers of the supplementary dress appearing on the throat, chin, back, tail-coverts and sternal bands, the last largely renewed by the supplementary moult which has not yet reached some parti-colored juvenal feathers at one border and both juvenal and preliminary winter ones at the other. The white of the mid-breast, abdomen, flanks, legs and feet is part of the preliminary dress. Another (Amer. Mus. No. 64130, ♂, Greenland, August 26) is more advanced, showing many white feathers of the supplementary stage. Other specimens (Amer. Mus. Nos. 66878, 66881, ♀, and 66882, ♀, Alaska, Sept. 15) are

simply a little further advanced with the lower parts almost entirely white and numerous patches of white on the head and back, the third primary by its immaturity marking them as young birds.

First Winter Plumage (*supplementary*), acquired as already indicated by a limited supplementary postjuvenal moult which removes all dusky retained juvenal and preliminary winter feathers. Both sexes become white with black tails and indistinguishable from *lagopus* except in some young males which have traces of the black lores peculiar to adults.

First Nuptial Plumage, acquired by a partial prenuptial moult, the extent of which seems to vary with latitude, sex and individual. Birds dwelling where snow prevails the whole year acquire but few dark feathers, as indicated by a couple of males (L. B. Bishop, No. 4182 and No. 4183, White Pass, British Columbia, June 11), the latter wholly in worn white winter dress save for a few partly grown dusky feathers on the crown, the former with a few on the crown and a similar small patch on the throat. It is not possible to say how far this moult will extend, but the lateness of the date precludes extensive renewal before the postnuptial moult begins. Other birds assume a grayish finely vermiculated or mottled dress, retaining only the white remiges and their coverts, the black rectrices, the white legs and feet and a variable number of white wing-coverts and white feathers of the mid-abdomen. Females would seem to undergo a more extensive renewal than males, being coarsely mottled and barred with buff and black, and now distinguishable for the first time from males by their plumage.

Second or Adult Winter Plumage (*preliminary*), acquired by a postnuptial moult, probably less complete in higher latitudes. The early beginning of this moult is shown by three worn females of *reinhardi* (Amer. Mus. Nos. 64128 and 64129, July 28, and No. 67820, July 25, Greenland) which have acquired a few new primaries and some dusky body feathers. Males and females are practically alike in this preliminary dress, and differ little from young birds.

Second or Adult Winter Plumage (*supplementary*), acquired by a partial supplementary postnuptial moult, birds becoming wholly white with black tails. Males, however, assume jet black lores

which distinguish them from young birds and from females. The coming of this dress is illustrated by several September birds (Amer. Mus. No. 67877, ♂, and No. 67880, ♀, Alaska, September 15) which have recently acquired new first and second primaries at the end of the postnuptial moult and are assuming many new white feathers about the head and on the back, by the supplementary moult.

Second or Adult Nuptial Plumage, acquired by a prenuptial moult, limited to the body plumage, as in the young bird.

Later plumages and moults are similar to those already described and occur in definite sequence.

Lagopus evermanni *Elliot.* EVERMANN'S PTARMIGAN.
" **welchi** *Brewst.* WELCH'S PTARMIGAN.
" **leucurus** *Swains. & Rich.* WHITE-TAILED PTARMIGAN.

I have seen too few specimens of these species to enable me to trace their sequence of plumages and moults, but those I have examined indicate the same changes as in *lagopus* or *rupestris*. *L. leucurus* becomes absolutely white in winter, the tail being white at all seasons except in the gray juvenal stage.

Tympanuchus americanus (*Reich.*). PRAIRIE HEN.
" " **attwateri** (*Bendire*). ATTWATER'S PRAIRIE HEN.
" **cupido** (*Linn.*). HEATH HEN.
" **pallidicinctus** *Ridgw.* LESSER PRAIRIE HEN.

The usual sequence of moults and plumages prevails in this genus, the species of which need not be discussed separately.

Natal Down. — The bright tints of the lower parts of the chicks is characteristic, no other members of the Tetraonidæ approaching so nearly a canary yellow. Above they are mottled with rusty brown and dull black, spots of black also occurring on the nostrils, crown and behind the eyes. A chick of *americanus* (L. B. Bishop, No. 1968, North Dakota, June 12) shows the remiges and coverts partly grown, but the first and second primaries are not yet visible; elsewhere down prevails except a few juvenal feathers appearing in the humeral tracts. A chick of

attwateri (Amer. Mus. No. 59539, Texas, April 25) is similar but even younger.

Juvenal Plumage, acquired by a complete postnatal moult, which is overlapped by the postjuvenal moult before the birds are one half grown. This is illustrated by a young *americanus* (L. B. Bishop, No. 2070, North Dakota, July 5), which still retains natal down upon the head, throat, under surface of the wings, abdomen and legs. The first and second primaries are mere pin points, the third to eighth grown, the ninth a pin point and the tenth just expanding, the new ninth and tenth of course being part of the first winter plumage. The barred juvenal body plumage has been assumed elsewhere. Both males and females resemble adult females at this stage, being dusky above lined with white and barred with buff, the lower parts being dull white barred with dull black and buff, but neck tufts are lacking.

First Winter Plumage, acquired by a complete postjuvenal moult excepting the two distal primaries. Young and old become practically indistinguishable. A specimen of *cupido* (J. Dwight, Jr., No. 4370, ♀, Martha's Vineyard, Mass., Sept. 29) is almost wholly in this dress, new feathers however still expanding upon the chin and throat while the third primary is only half grown. The rest of the remiges except some inner members of the series show few signs of immaturity.

First Nuptial Plumage, acquired by a partial prenuptial moult, confined to the chin and head. A specimen of *attwateri* (Amer. Mus. No. 59538, Texas, April 25) shows a few new feathers growing among the old on the sides of the head.

Second or Adult Winter Plumage, acquired by a complete postnuptial moult.

Later plumages are repetitions of summer and winter dress.

Pediœcetes phasianellus (*Linn.*). SHARP-TAILED GROUSE.
" " **columbianus** (*Ord*). COLUMBIAN SHARP-TAILED GROUSE.
" " **campestris** *Ridgw.* PRAIRIE SHARP-TAILED GROUSE.

The material is limited, but it shows that the birds of this genus evidently moult like the other Grouse.

Natal Down.—Not seen.

Juvenal Plumage, acquired by a complete postnatal moult. Similar to adult female but grayer and the throat white instead of buff.

First Winter Plumage, acquired by a complete postjuvenal moult excepting the two distal primaries. Several specimens have doffed most of their juvenal dress, the last of it persisting about the chin and neck. One bird (Amer. Mus. No. 47297, British Columbia, August 25) retains only the third and fourth primaries and some inner secondaries; the first and second of the series as usual only partly grown.

First Nuptial Plumage, assumed probably by a limited prenuptial moult, but not shown by the series examined.

Second or Adult Winter Plumage, acquired by a complete postnuptial moult. Several British Columbia specimens, taken in August, show actual moult at various stages.

Later plumages and moults are repetitions of earlier ones.

Centrocercus urophasianus (*Bonap*). SAGE GROUSE.

The specimens examined were all taken in Wyoming in August, September and October and show the same stages of plumage as in the other Grouse. A young bird (Am. Mus. No. 64006, Wyoming, Aug. 15) is partly in juvenal dress, the first and second primaries not grown and the others already renewed by those of the winter dress except the third and fourth. An adult male (Amer. Mus. No. 64012, Wyoming, Aug. 25) has assumed new primaries excepting the distal two which are old and worn, the body plumage is partly renewed. An adult ♀ (Am. Mus. No. 64005, Wyoming, Aug. 15) has the four distal primaries old, the others new. The usual sequence of plumages and of moults undoubtedly takes place.

In conclusion I would say that as the subject of moult is to many a sealed book, I have gone into details and repetitions that may appear tedious, chiefly for the purpose of emphasizing the fact that moult is systematic no matter how varied the resulting plumage may be. Once let this idea be grasped and the most complex problems of plumage may be readily solved without recourse to theoretical explanations.

EXPLANATION OF PLATE IV.

All of these feathers are from the humeral tracts of specimens of *Lagopus lagopus.*

Fig. 1. Juvenal Plumage (Amer. Mus. No. 26169, ♀, Sept. 5).
" 2. Preliminary first Winter Plumage (from same specimen as Fig. 1).
" 3. Preliminary first Winter Plumage (Amer. Mus. No. 45195, no data).
" 4 and 11. Supplementary first Winter Plumage (Amer. Mus. No. 26889, ♀, March, and Amer. Mus. No. 26162, ♂, Sept. 26).
" 5. First Nuptial Plumage (Amer. Mus. No. 26168, ♂, July 22).
" 6. " " " (" " " 26174, ♂, June 8).
" 7 and 8. First Nuptial Plumage (Amer. Mus. No. 26172, ♀, July 15).
" 9. First Nuptial Plumage (Amer. Mus. No. 26170, ♀, June 8).
" 10. Preliminary second Winter Plumage (from same specimen as Fig. 6).

EXPLANATION OF PLATE V (PHOTOMICROGRAPHS).

Fig. 1. Neossoptile of Natal Down attached to tip of Juvenal Plumage feather (Amer. Mus. No. 26179, June 29, "12 days old") from humeral tract of *Lagopus lagopus.* (×20.)
" 2. Neossoptile of Natal Down (J. Dwight, Jr., No. 2044, ♀, October 5) from chin of *Colinus virginianus.* (×20.)

FURTHER NOTES ON LACÉPÈDE'S 'TABLEAUX.'

BY CHARLES W. RICHMOND.

IN PRESENTING some notes on the date of publication of the above paper in 'The Auk' (Oct. 1899, 325), I stated that Lacépède's bird genera, as well as several credited to Cuvier, should be properly quoted as "Lacépède, in Daudin, Traité," etc., instead of "Mém. de l'Inst. III, 1801," assuming that a certain preliminary paper (in quarto), containing these genera and supposed to have been published in 1799, could not be found. In this I was mistaken, for before the appearance of the October 'Auk' I received a letter from Mr. Sherborn announcing the discovery of a copy of this rare tract, which has recently formed the basis of a second communication to 'Natural Science' (Sherborn, Nat. Sci., Dec., 1899, 406–409).

The full title of this tract, quoting from Mr. Sherborn's account, is