MOLT, AGE DETERMINATION, AND ANNUAL CYCLE IN THE CUBAN BOBWHITE

GEORGE E. WATSON

As a preliminary to a study of the variation of characters within the Cuban population of the Bobwhite (*Colinus virginianus cubanensis*) it was necessary to establish the sequence of molts and plumages and the annual cycle in order to age individual specimens. Some of the findings were interesting enough of themselves to warrant publication.

Studies of the molts of U.S. populations of Bobwhite have been carried out by Dwight (1900), Stoddard (1931), Leopold (1939), Petrides and Nestler (1943), and Thompson and Kabat (1950). Dwight and Stoddard found a complete adult molt during the fall and a partial molt of the head and throat in the late spring. The others have dealt mainly with the value of the method of primary feather replacement as an indication of age of birds up to one year old. Differences in timing of both molts and the extent of the spring molt were found between the U.S. and Cuban populations during the present study.

The pterylosis of the Bobwhite has never been adequately studied. Clark (1899) gives a small plate showing the main feather tracts, but the discussion is superficial. Brewer (1961) mentions a dorsal apterium in the species. Since no clipped alcoholic specimens of Cuban Bobwhite were available, no pterylosis study of the population was attempted.

MATERIALS

One hundred thirty Cuban Bobwhite study skins were assembled from the following museums: United States National Museum, American Museum of Natural History, Chicago Museum of Natural History, Museum of Comparative Zoology, and Yale Peabody Museum. Specimens were available from every month. Of this number, one was still mostly in the juvenal plumage, 70 were birds of the year, and the rest were adults; 44 were females and the rest males (see Table 1). Breeding data were available only for 11 Peabody Museum specimens collected in 1955. In addition, specimens of Florida and Mexican Bobwhite and Black-throated Bobwhite, *Colinus nigrogularis*, were examined for comparison.

METHODS

For study of the molt, the birds were separated into the following age groups on the basis of plumage and molt characteristics; juvenal, first year, and adult. Birds in each of these age classes were then arranged by month. Each specimen was carefully examined for molt. The feathers were lifted

TABLE 1

OCCURRENCE AND NATURE OF MOLT BY MONTH IN CUBAN BOBWHITE SPECIMENS

	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Totals
First-year ♂♂		XX 0		XXX	00	---	--0 000 0	000 000 000 00	-00 000 00	-00 000	0	0	45
Adult ♂♂	X	XX	X	XXX XXX	-00	000 000	--0 000	-0	000 0	000 000 0	0	-0	41
First-year ♀♀		XXX X (juv.)		XX	X00	-00	-	--0	-00 000 0	-0	-		26
Adult ♀♀		0X	X	XX	X	XX	000	00	-00			00	18

– indicates specimen shows no molt; 0 = body molt only; X = body, wings, and tail in molt.

using a pointed probe or narrow forceps in order to disclose pinfeathers or the bases of vanes still in sheaths.

Nomenclature of molts and plumages in this study follows that of Humphrey and Parkes (1959). Each molt is named for the plumage it renews. In the Bobwhite, which has two molts a year, the sequence is as follows (Dwight's terms are included in parentheses where they differ):

Plumage	Molt
Natal	(Postnatal)
Juvenal	First Prebasic (postjuvenal)
First Basic (first winter)	First Prealternate (first prenuptial)
First Alternate (first nuptial)	Second Prebasic (first postnuptial)
Second Basic (second winter, adult)	
Second Alternate (second nuptial, adult)	

Since the material studied consisted of birds undergoing the first prebasic or later molts, natal down and juvenal plumage are mentioned only when retained on these specimens. The descriptions of molts and plumages apply to both males and females since no appreciable difference in sequence or molting pattern was found due to sex. Slight timing differences, however, are suggested by the data.

Numbering of the remiges follows the American system (e.g., Petrides and Nestler, 1943). Counts were made centrifugally from the short axial sec-

ondary as a point of reference in order to avoid missing any molting remiges. The 10 primaries are numbered distad and the nine secondaries mediad, with the five shorter innermost remiges termed tertials. Since no detailed pterylosis study was made, areas of apparent plumage are designated rather than feather tracts.

AGING

The light-colored juvenal plumage is distinct enough to be instantly recognizable (Dwight, 1900; Stoddard, 1931; Petrides and Nestler, 1943). The first basic plumage, however, is not at once separable from the perfected plumage. Since the outer two pointed juvenal primaries are retained until the second prebasic molt, birds still showing them are less than one year old (Dwight, 1900; Stoddard, 1931). The juvenal primary coverts, which, with the exception of the outer two are white tipped, are likewise retained and have been considered far more reliable for aging quail in which primaries may be broken (Van Rossem, 1925; Leopold, 1939; Petrides and Nestler, 1943). Adult Primaries 9 and 10 are rounded; adult primary coverts lack whitish tips and are wider than the juvenal coverts. These aging characters are apparently also valid for the Cuban Bobwhite population.

A further clue is the retention of a few of the juvenal flank feathers in fall individuals which have not yet completed the first prebasic molt. The problematic specimen, however, is the year-old bird undergoing its second prebasic molt. The outer primaries are the last to be molted and regrowth is slow so that a bird may still show the juvenal first and second primaries and yet be in almost complete second basic body plumage. Birds which have just completed the first prebasic molt, however, are in full fresh plumage with the outer two primaries at approximately the same stage of wear as the other primaries. In birds more than a year old, the primaries have undergone extreme foxing and wear near the tips, especially in males which drag the wing tips on the ground during courtship strutting (Stoddard, 1931). Worn primaries appear almost buff distally rather than uniform greyish brown throughout.

FIRST PREBASIC MOLT

The juvenal plumage, with the exception of the outer two primaries and the primary coverts, is completely replaced during the late summer and fall following hatching. The first sign of this molt is the replacement of the innermost primary (1) which begins at about the same time as the initiation of growth by the outer two juvenal primaries (9 and 10). Primary replacement proceeds distad in regular order and only one or possibly two new basic primaries are in growth at any given time. The outer two juvenal primaries, which complete growth with first basic Primary 5, are not replaced in this

molt but are retained until the second prebasic molt. The juvenal primary coverts are also retained.

Replacement of the secondaries begins with No. 3 and proceeds mediad and finally distad, Nos. 2 and 1 being shed last and replaced about the same time as Primary 8. The tertials are replaced before the inner secondaries; the juvenal alula is shed with Primaries 7 and 8.

Body molt begins at the sides of the upper breast while Primaries 3 and 4 are being replaced and when the bird is about half adult weight. Feather replacement spreads over the rest of the breast, upper back, and to the sides and flanks. These areas may show numerous first basic feathers while the head and nape still have remnants of the natal down. At the height of molt, active feather growth takes place in all tracts simultaneously. The belly, crown, cheeks, and throat are the last portions of the body to complete the first basic feathering.

All the rectrices are shed almost simultaneously after the completion of growth by the outer two juvenal primaries and at about the time of the completion of growth by basic Primary 6. They are quickly replaced. The fresh upper and under tail coverts are fully grown before the rectrices are shed and extend up to 25 mm beyond the tips of the growing tail stub. Apparently, the Bobwhite is the only North American galliform for which such a mode of tail replacement in the first prebasic molt has been described (Petrides and Nestler, 1943). Two adult male British Black Grouse (*Lyrurus tetrix*), examined in the Berwyn Mountains of North Wales on 29 August 1960, also had shed and were regrowing all the rectrices simultaneously (see also Witherby et al., 1940). In the adult Bobwhite, however, the tail molt is the same as that described for most of the other Galliformes with a centrifugal loss and replacement. In first prebasic molt, the Chachalaca (*Ortalis vetula*) has a centripetal first prebasic tail molt, and subsequently centrifugal (Petrides, 1942). Timing of the molt of various portions of the plumage is shown in Fig. 1.

All earlier authors imply that the system of regrowth of the juvenal and first basic primaries in U.S. quail is invariable; the outer two juvenal primaries are retained while the rest of the remiges are replaced during the first prebasic molt. Thompson and Kabat (1950), however, found that a sizable proportion (exact ratio not given but probably near 30 per cent) of first-year birds trapped in Wisconsin during the winter of 1947–1948 had an arrested primary molt which stopped at No. 7, but that only one out of 87 had an arrested molt in 1946–47. One specimen in each of the two-year samples was found to have the primary molt extended to No. 9. That these were young birds was verified by the retained juvenal primary coverts. Three adults in their two-year sample also showed arrested primary molt. The authors suggest

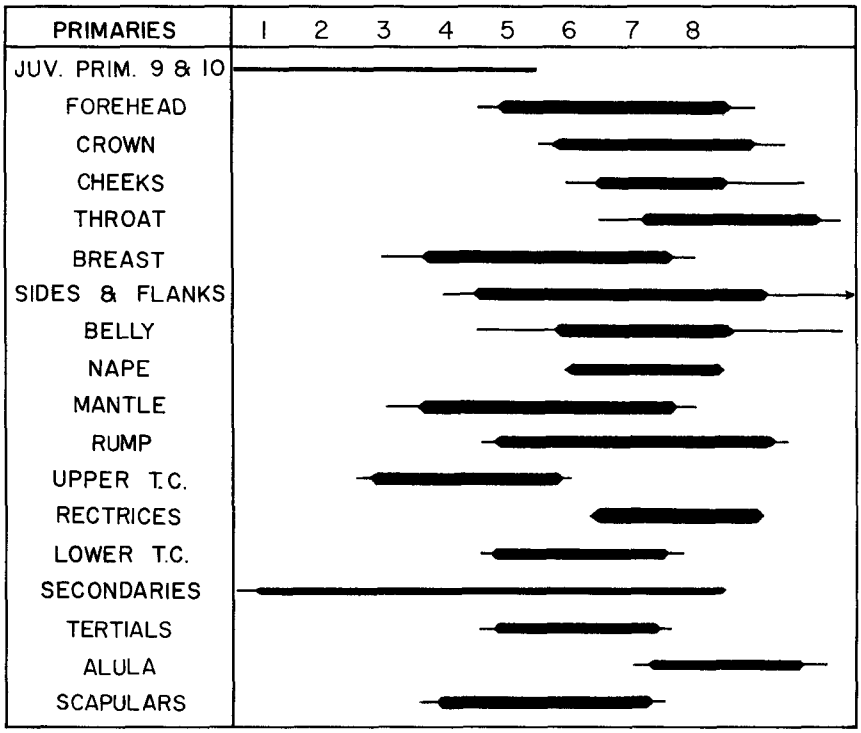

FIG. 1. The relation of first prebasic molt in various parts of the feather coat to the primary schedule in Cuban Bobwhite.

that the onset of cold weather stopped the molt in late-hatching individuals and that temperature acting on the thyroid may thereby control the initiation and extent of molt. Arrested molt in adult primaries and secondaries has also been described in the Blue Grouse (*Dendragapus obscurus*) in British Columbia (Bendell, 1955), and in the Chukar Partridge (*Alectoris chukar*) in New England (Watson, MS).

There is only one possible case of arrested second prebasic molt in a male Cuban Bobwhite and none in first-year birds. On the other hand, three male and five female Cuban specimens in the present first-year series of 45 and 26 retain only one pair of outer juvenal primaries. In two of these cases, one male and one female, only one ninth primary has been dropped (in one case the right, in the other the left). In all eight specimens, all the juvenal primary coverts are retained, indicating that the specimens are, in fact, in first basic plumage rather than undergoing second prebasic molt. In addition, most are spring birds. It seems highly improbable that bilateral loss of Primary 9

could occur fortuitously without loss of No. 10. It appears, therefore, that occasionally the wing molt of Cuban Bobwhites may be extended to include another primary. The possibility that this extension may be correlated with higher winter temperatures in Cuba suggests itself. Three of these specimens were collected in 1900, two in 1906, one in 1913, and two in 1948. The latter three of these years show higher than average November and December mean temperatures but the correlations are at best slight. Based on data supplied by the United States Weather Bureau, the mean monthly temperatures (in °F) for the 20-year period 1931–1950 at Havana, Cuba are November: 74.8 and December: 72.8. The mean temperatures during November and December of the autumn preceding the years with extended molt birds were 1889: 74.6, 71.3; 1905: 76.3, 73.1; 1912: 75.0, 74.8; and 1948: 77.9, 74.0. Both monthly means were below average in 1899, but both were above for the other three years. This evidence is hardly proof, but a few data on primary molt in wild and domestic Turkeys suggest that in that species, too, southern forms may have a more extensive primary molt. The northern race of the wild Turkey (*Meleagris gallopavo silvestris*) has the normal galliform pattern with the outer two juvenal primaries retained, but in the Florida race (*M. g. osceola*) and in the domestic Turkey, Petrides (1942) and Leopold (1943) found that only the outer juvenal primary is retained while Primary 9 is dropped during the first prebasic molt. The domestic Turkey is regarded as descended from the southernmost populations of the species (Latham, 1956). The same molt pattern is also found in the Ocellated Turkey (*Agriocharis ocellata*) in Yucatan (Petrides, 1945, and confirmed by a series in the Peabody Museum). Smith (1961) found an extended primary molt in the Chukar Partridge in Utah.

The time of start of the first prebasic molt is probably determined by date of hatching (Petrides and Nestler, 1943), and its course and duration perhaps by such additional environmental factors as temperature, humidity, and food supply. An early maturing individual collected on 22 September 1917 is in fresh first basic with no traces of juvenal plumage except Primaries 9 and 10 and the primary coverts. Other fall specimens have not yet reached this stage in November and some even in December. The first prebasic molt is complete by early January when all male first-year specimens examined show no evidence of feather replacement.

SECOND PREBASIC MOLT

Three males and one female (12 August 1955, 18 November 1911, 4 December 1913, and 26 September 1930) are definitely identifiable as undergoing the second prebasic molt. In the first male, Primary 3 is half grown, in the second, Primary 9 is three-quarters grown, and in the third, it is half grown,

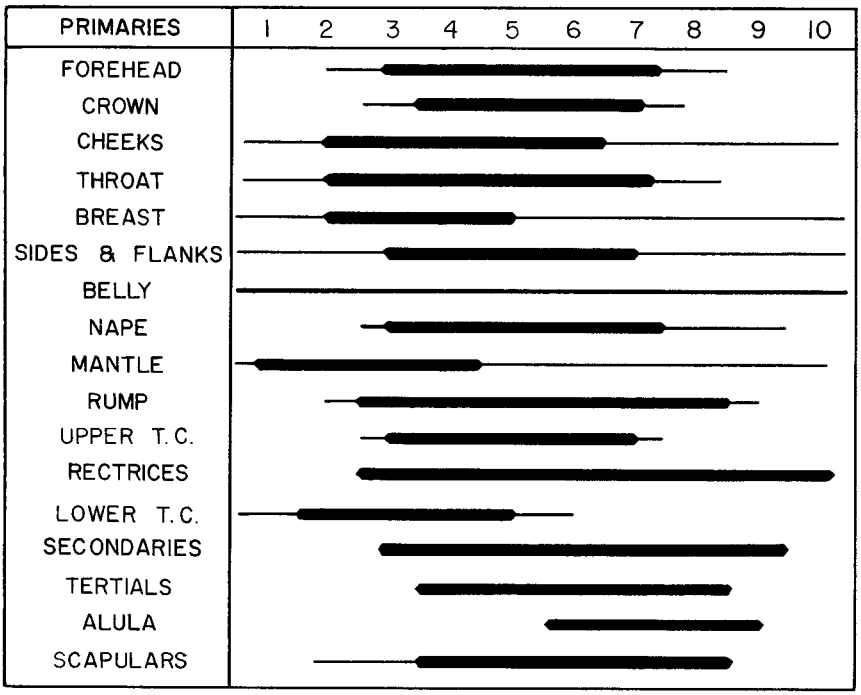

FIG. 2. The relation of adult prebasic molt in various parts of the feather coat to the primary schedule in Cuban Bobwhites.

while in both the latter the juvenal outer primary is still retained. The throat, upper breast, and back are also in molt in these two specimens. The female has just begun the molt; Primary 3 is just appearing.

ADULT PREBASIC MOLT

The first indication of the prebasic molt in the adult male is the replacement of the innermost primary. The rest of the primaries are replaced in regular succession progressing distad so that when the outer one is fully regrown, the molt is just about complete. Whereas, in the first and second prebasic molts, usually only one or two primaries grow at a time, as many as four may be simultaneously in growth in adults. Figure 2 shows the approximate correlation of the molt in the other tracts with this primary schedule. During the period of molt of Primaries 4–7 nearly all tracts show heavy regrowth of pinfeathers. Molting of the secondaries begins with No. 3 and usually progresses mediad, with Nos. 2 and 1 completing the sequence after No. 10. Miller (1941) attributes such a sequence to feather crowding in the

wrist region of short-winged birds. The order of the inner secondary molt may vary both individually and from wing to wing on the same individual.

Body feather replacement begins on the breast, head, and mantle and in general progresses posteriorly from a molt center in a tract. In the adult, the head and neck are molted early, while these areas are retarded until the end of the prebasic molt in first fall birds. The under tail coverts are replaced early in the molt and the upper tail coverts soon thereafter. These coverts may possibly act as substitutes or braces for regrowing rectrices during flight. The tail is molted late, and instead of all the rectrices being dropped simultaneously as in the first prebasic molt, the central pair is shed first and molt proceeds centrifugally, the outer pair (Nos. 6–6) being complete at the time the outermost primary is dropped. This growth is not entirely regular and individuals may show asymmetric tail growth.

In some individuals, the prebasic molt may be completed in December, but molting specimens are common in January, February, and March. It is therefore difficult to define precisely the end of the prebasic molt and the start of the prealternate molt in this population. In the individual, perhaps, there is a well-defined period of cessation of molt as was apparently found by Dwight and Stoddard in U. S. quail. A good criterion for distinguishing the two molts in adults is the state of wear in the primaries and rectrices. A bird with fully grown fresh remiges and rectrices which is renewing the forehead, chin, and center of the throat is probably in the prealternate molt since these are among the early portions of the plumage to complete the prebasic molt (mostly with Primary 7). In first-year birds, since the head and throat are among the last regions to assume the first basic feathering, this method of distinguishing the two molts cannot be used.

FIRST PREALTERNATE MOLT

The first prealternate molt is probably of varying intensity throughout the population; some individuals may molt far more extensively than others. First-year males collected in January and a few collected in February are not molting, but some early February birds show molt on the chin and throat, and later examples on the upper breast and sides of the neck. In early March birds, in addition, pinfeathers are present among the ear coverts, superciliaries, nape, and mantle, while later in the month, areas in molt include the crown, forehead, back, sides of breast, flanks, and belly. No spring-collected specimens are molting any wing or tail feathers. A few specimens collected in April show little or no feather replacement and may have completed the prealternate molt, but some May, June, and July examples are still molting.

ADULT PREALTERNATE MOLT

The adult prealternate molt usually involves the chin, throat, head, breast, upper back, nape, and, in some individuals at least, feathers of the lower back, flanks, and sides of the belly. The molt may start as early as January; all April, May, June, and one July specimen in the series show evidence of molt.

Direct evidence for a prealternate molt in first-year as well as in adult birds is lacking and its occurrence must be inferred. Even using a 12-power lens, I cannot distinguish on morphological grounds alternate from basic feathers on the breast, flanks, and mantle, the three areas where such a molt has not previously been found in Bobwhites. Moreover, first basic feathers in these areas are no different from perfected feathers of later molts. Dwight (1900) and Stoddard (1931) do not mention characters for distinguishing feather generations. Individual feather color and pattern characteristics are useless in such a highly polymorphic population; such characters as buff feather tips are apparently due to individual differences.

Three possible interpretations may, therefore, be made of specimens molting during the spring: (1) They may be late individuals still undergoing the first prebasic molt. (2) An interruption in the regular sequence of the prebasic molt may have taken place so that the birds molts partly; stops in the late fall, and then resumes molting in the spring. (3) This may be a prealternate molt, more extensive than the one that Dwight and Stoddard described for U.S. populations of the species.

The available evidence on the matter is as follows:

1. A large proportion (82 per cent) of specimens from February through May are molting.
2. Some specimens (especially male birds-of-the-year) from January, February, and March are not molting.
3. There is no molt of the remiges or rectrices during the spring.
4. Portions of the body are in molt which have already undergone a fall prebasic molt in other individuals and which are fully covered with fresh feathers in January and February specimens. During the fall molt, regrowth in these same areas is correlated with regrowth of specific remiges.

This evidence, plus the fact that both Dwight and Stoddard claim on the basis of their studies of living captive birds that a prealternate molt follows a midwinter cessation of molting, suggests that the third conclusion may be true: that this is a prealternate molt, more extensive than that described for U.S. Bobwhites.

Dwight and Stoddard found only a limited prealternate molt about the head and throat of U. S. Bobwhites. Dwight points out, however, that spring speci-

mens were scarce in the collections he examined due to a curtailed spring season. In Pennsylvania, for instance, spring hunting of Bobwhites has been restricted since 1838 (Latham and Studholme, 1952). Stoddard (1931:8) found birds with the appearance of "being in molt at the wrong season." This he attributed to accidental loss of loose feathers. He might possibly have been examining birds undergoing a more extensive prealternate molt than he had expected on the basis of Dwight's work. The extension of the prealternate body molt of the Cuban quail, however, may also indicate that a marked physiological adjustment, genetically determined, has taken place in the Cuban population not found in the Florida or other more northern populations. This may be an adaptation to increased wear and heavy summer rain in the southern part of the species range. The extreme wear of the unmolted remiges and rectrices of summer specimens supports this conclusion. The molt of the Mexican and other southern populations of Bobwhites should also be investigated to ascertain whether they, too, show a more extensive prealternate molt. Cursory examination of four specimens of *Colinus virginianus thayeri* collected in Chivela, Oaxaca, from 27 March to 6 April 1927, does suggest that such may be the case. The head, throat, nape, mantle, breast, and rump show feather replacement in progress in both adult and first-year birds. This is especially interesting since some quail specimens from Cuba closely approach *C. v. thayeri* in color and pattern and a Mexican origin is postulated for some of the birds introduced into Cuba (Gundlach, 1893).

The extended primary molt in some individual Cuban quail, and in some southern Turkeys mentioned above, seems to parallel the extended prealternate molt. Geographic variation in molt is also known in other species. Salomonsen (1939) found that various populations of the Rock Ptarmigan (*Lagopus mutus*) differed in the extent of the three molts per year depending on climatic conditions. Pitelka (1945) demonstrated geographic variation in extent of the first prebasic molt in jays of the genus *Aphelocoma*. Lynes (1930) found marked geographic differences in the presence or absence of the prealternate molt within various species of *Cisticola*. In equatorial Africa only one yearly molt takes place, but temperate zone populations undergo a prealternate molt. In intermediate populations, an increasing percentage of individuals show prealternate molt the farther they are from the Equator. The same is true in *Prinia subflava* in the Congo (Chapin, 1953), and in three African members of the genus *Ploceus* (Moreau, 1960) in which the prealternate molt is acquired mostly by savanna-inhabiting forms.

FEMALE MOLTS

Specimens of females are far fewer in the sample than males but the evidence indicates that the order of feather replacement and sequence of the

plumages is the same as in the male of the corresponding age. Although the prealternate molt may not be quite as extensive as in the male, it is certainly more than previously described by Dwight (1900), who found that U.S. female quail also had a less extensive prealternate molt than U.S. males. The female tends to molt slightly later than the male (see Table 1).

TIMING OF MOLTS

Although the data are meager, it appears that both molts occur slightly later and the prealternate molt may be more prolonged in Cuba than in the Florida Bobwhite populations studied by Stoddard. The dates he gives for molts are prebasic, August to November; and prealternate, February to May (most March and April). In Cuba, specimens collected in all years grouped together, nearly all adult males were in primary or tail molt from August to December and in body molt from January to July. Therefore, individuals in the population may molt in any month of the year. In a given year, although it is possible that the periods of molt are far more restricted, the evidence suggests that the molts in Cuban quail are more prolonged. Of 13 adult males collected from August to early December, only one December specimen is not in prebasic molt. Of 28 January-to-July specimens, four (two February, one March, and one July) are not in prealternate molt. Among the males in first basic plumage, both December specimens are still finishing head (first prebasic) molt, all three January specimens are not molting, and two of the seven February specimens have not yet begun the prealternate molt. Otherwise the molt timing is the same as in the adult males with the prealternate molt extending into July. The smaller female sample suggests that they too have more prolonged molts than Florida females. It is possible that lower January mean temperatures in northern Florida (54.5 F in Tallahassee) where Stoddard's birds were captured has tended to retard the start of the prealternate molt. January mean temperature in Havana is 72.4 F. Retaining a full feather coat during the coldest month of the year is probably of adaptive significance to the northern Florida quail. It is perhaps also significant that first-year Cuban quail similarly tend to retain full plumage in January. If there is a refractive period in the natural molt of an individual papilla (Assenmacher, 1958), then such a lag in initiation of first prealternate molt may be otherwise explainable. The head is always the site of start of the prealternate molt; but it is the last area to complete the first prebasic molt in yearling birds. The head feather papillae then may need a month's refractive period before growth is reinstituted. Prebasic molt is complete on the head of adult birds relatively much earlier.

WEAR

Newly molted body plumage in the fall is fresh and bright in both sexes. The tips of the body feathers tend to become worn or broken with time, however, and some spring specimens no longer show broad gray edges to the mantle feathers. Faint white or buff edging on breast or crown feathers usually disappears in the late spring. Color changes on the breast and flanks are minimal although the intense black of the male's upper breast and head is usually dulled by midsummer. The wings and tail show the greatest evidence of wear and color change with time. The secondaries and especially the outer primaries change from grayish brown to nearly buff at the tips by summer and are very frayed, often with broken tips. Such breakage, especially noticeable in males which have finished spring display posturing, obscures the pointed tips of the juvenal primaries, and necessitates the use of the primary coverts as an aging character. The rectrices become broken or worn so severely that they may lack barbs and not extend beyond the new incoming tail coverts in the early fall.

BREEDING SEASON

Direct evidence of breeding season timing from adult specimens is meager. In 1955, males were collected on 12 August and 10 September which had enlarged testes and had probably recently bred. The first is a first-year bird. A female collected on 10 September was in the process of laying. All November-collected birds had regressed gonads.

A juvenal female just beginning first prebasic molt and weighing 90 grams was also collected on 10 September, while two males showed nearly completed first prebasic molt on 28 September. Because of the range in developmental rates found by both Stoddard (1931) and Petrides and Nestler (1943), these young birds can only be aged within two or three weeks as two and four months, respectively. Several other family groups with young chicks were observed all through September in Pinar del Rio. This evidence would give a minimal breeding season during 1955, lasting from early June to late September and based on a very small sample. Breeding information is not recorded on any of the other specimens from earlier years. Bond (1936), however, states that "in early spring the birds pair, the nesting season lasting from April until July."

Stoddard (1931) and Bent (1932) give a six-month range from April to October for the breeding season of U.S. quail, but this includes records from several years. The most important nesting months are May through August. Late breeding records are attributed by Stoddard (1931) and Latham and Studholme (1952) to second attempts at nesting following destruction of the first brood. Therefore, the height of the quail breeding season may tend to be

slightly later in Cuba than in the southern U.S. but it covers approximately the same range of time.

MOLT AND THE BREEDING SEASON

Molting is a complex physiological event in the life of a bird, probably temporally related to other cyclic events such as breeding, but not necessarily directly influenced by the gonads. Evidence available from various species of birds, mostly domestic chickens, implies that although gonadal hormones may help to determine timing of molt through temporary inhibition, the thyroid hormone directly initiates molt (see review by Assenmacher, 1958). Mewaldt (1958) found that some Clark's Nutcrackers (*Nucifraga columbiana*) started molting before the eggs were laid. In California Quail (*Lophortyx californicus*), Genelly (1955) found that the inception of female molt occurred well after hatching of young. In the Cuban Bobwhite collected in 1955, some body feathers were in sheaths on a laying female (10 September) and two males with enlarged gonads (12 August, 10 September) had already begun molting. In Bobwhite, therefore, prebasic molt may start, at least late in the season, before breeding activity has ceased. These may be second nesting attempts, and it is possible that early breeders may not molt until well after the chicks are hatched. This situation is in agreement with recent findings of independent hormonal control of breeding and molt in the yearly cycle and suggests that different thresholds for thyroid initiation and gonadal inhibition of molt exist in early and late breeding birds.

SUMMARY

One hundred thirty specimens of Cuban Bobwhites were examined for molt. First-year birds may be separated on the basis of the outer two pointed juvenal primaries and white-tipped primary coverts retained until the second prebasic molt. The Cuban Bobwhite undergoes two molts a year, a complete prebasic and a partial prealternate. The sequence and timing of these molts is described, and differences between the sequence of molt of various portions of the plumage in first-year and adult birds are pointed out. The prealternate molt in the Cuban population is far more extensive than that described for the Eastern U.S. populations, and it is suggested that this is a southern adaptation shared with some Mexican populations. The breeding season and its relation to the molting cycle is discussed. It is concluded that the two are not directly under the same hormonal control in this species.

ACKNOWLEDGMENTS

For loan of material under their care, I am grateful to Drs. Herbert Friedmann, Dean Amadon, and Emmet R. Blake, and to Mr. James C. Greenway. I have profited from many stimulating discussions of molts and plumages with Dr. Philip S. Humphrey, and Dr. S. Dillon Ripley has continually offered advice and encouragement. Part of this research was carried out while I was a National Science Foundation predoctoral fellow.

LITERATURE CITED

ASSENMACHER, I.
1958 La mue des oiseaux et son determinisme endocrinien. *Alauda*, 24:241–289.
BENDELL, J. F.
1955 Age, molt, and weight characteristics of Blue Grouse. *Condor*, 57:354–361.
BENT, A. C.
1932 Life histories of North American gallinaceous birds. *U.S. Nat. Mus. Bull.*, 162:9–40.
BOND, J.
1936 Birds of the West Indies. Philadelphia, Academy of Natural Sciences.
BREWER, L. S.
1961 Dorsal apterium present in Bobwhite. *Wilson Bull.*, 73:279.
CHAPIN, J. P.
1953 The birds of the Belgian Congo, Part 3. *Bull. Amer. Mus. Nat. Hist.*, 75A: 404–410.
CLARK, H. L.
1899 The feather tracts of North American grouse and quail. *Proc. U.S. Nat. Mus.*, 21:641–653.
DWIGHT, J.
1900 The moult of the North American Tetraonidae (quails, partridges, and grouse). *Auk*, 17:34–51, 143–166.
GENELLY, R. E.
1955 Annual cycle in a population of California Quail. *Condor*, 57:263–285.
GUNDLACH, J.
1893 Ornithologica Cubana, ó catalogo descriptivo de todos las especies de aves, tando indigenas como de paso anual o accidental, observados en 53 anos. Habana, La Moderna.
HUMPHREY, P. S., AND K. C. PARKES
1959 An approach to the study of molts and plumages. *Auk*, 76:1–31.
LATHAM, R. M.
1956 Complete book of the wild Turkey. Harrisburg, Stackpole.
LATHAM, R. M., AND C. R. STUDHOLME
1952 The Bobwhite Quail in Pennsylvania. Pennsylvania Game News, special issue no. 4.
LEOPOLD, A. S.
1939 Age determination in quail. *J. Wildl. Mgmt.*, 3:261–265.
LEOPOLD, A. S.
1943 The molts of young wild and domestic Turkeys. *Condor*, 46:133–145.
LYNES, H.
1930 Review of the genus *Cisticola*. *Ibis*, 72, Supp.
MEWALDT, L. R.
1958 Pterylography and natural and experimentally induced molt in Clark's Nutcracker. *Condor*, 60:165–187.
MILLER, A. H.
1941 The significance of molt centers among the secondary remiges in the Falconiformes. *Condor*, 43:113–115.
MOREAU, R. E.
443–471.
1960 Conspectus and classification of the ploceine weaver-birds. *Ibis*, 102:293–321,

PETRIDES, G. A.
1942 Age determination in American gallinaceous game birds. Trans. Seventh N. Amer. Wildlife Conf.: 308–328.
1945 First winter plumages in the Galliformes. *Auk*, 62:223–227.
PETRIDES, G. A., AND R. B. NESTLER
1943 Age determination in juvenal Bobwhite. *Amer. Midl. Nat.*, 30:774–782.
PITELKA, F. A.
1945 Pterylography, molt, and age determination of American jays of the genus *Aphelocoma*. *Condor*, 47:229–261.
SALOMONSEN, F.
1939 Moults and sequence of plumages in the Rock Ptarmigan (*Lagopus mutus* (Montin)). *Vidensk. medd. fra Dansk naturh. Foren.*, 103:1–491.
SMITH, R. H.
1961 Age classification of the Chukar Partridge. *J. Wildl. Mgmt.*, 25:84–86.
STODDARD, H. L.
1931 The Bobwhite quail, its habits, preservation and increase. New York, Scribners.
THOMPSON, D. R., AND C. KABAT
1950 The wing molt of the Bob-white. *Wilson Bull.*, 62:20–31.
VAN ROSSEM, A. J.
1925 Flight feathers as age indicators in *Dendragapus*. *Ibis*, 67:417–422.
WITHERBY, H. F., F. R. C. JOURDAIN, N. F. TICEHURST, AND B. W. TUCKER
1940 The handbook of British birds. vol. 5:215.

PEABODY MUSEUM OF NATURAL HISTORY AND DEPARTMENT OF ZOOLOGY, YALE UNIVERSITY, NEW HAVEN, CONNECTICUT, 16 DECEMBER 1961 (ORIGINALLY SUBMITTED 17 JANUARY 1961)