

PLUMAGE CHANGES IN THE GOLDEN EAGLE

BY MALCOLM JOLLIE

Plates 18-22

THE appearance of the note by Spofford (1946) entitled 'Observations on two Golden Eagles' has been the stimulus for the presentation of this material which will attempt to answer his questions and indicate points needing further study.

Spofford was struck by the difference in his two specimens and said: "Inasmuch as the two eagles examined were as unlike as would seem possible within the limits of variation based on age and sex, it seems worth-while to append a brief description of each." He then proceeded to describe typical juvenal and adult plumages of the Golden Eagle (with the exception of the white epaulettes of the latter).

This plumage variability has puzzled taxonomists more, perhaps, than that of any other species of bird and, although we now associate the juvenal and adult birds as members of the same species and know that the plumage of the species is highly variable with age and individual, there is still need for an analysis of these variations. Such an analysis has been impossible because of lack of information regarding the manner of molt.

This paper is but a preliminary report in which I will describe as fully as possible, with the materials at hand, the process of molting as it occurs in this species and the individual and age variations which have made the study of this form so difficult.

The historical aspects of this problem need be treated only superficially. From the earliest observations, differentiation of the young and adults as separate species has resulted in hopeless confusion which has continued down to the present time among primitive peoples (Schäfer, 1939—central and western Asia). Therefore, comments will be restricted to more recent and better informed sources.

The first notes of interest are to be credited to Temminck (1820). Although he kept two birds in captivity over a period of years and made general observations on the pattern changes from the juvenal to the adult plumages, he did not record the manner of molting.

The unique character of the molt in this species was suggested by MacGillivray (1836). "They begin to moult early in the season, and the change of plumage is always very gradual. In some species new feathers are observed at all seasons, as is the case more especially with the eagles, which in this respect resemble the grous[e] and some other birds."

Naumann (1820–1847) in his 'Naturgeschichte der Vögel Deutschlands' gave considerable space to the "two species" of this bird. His descriptions, being based upon this erroneous assumption, are thus of slight value, yet he had observed the incomplete nature of the molt. His statement is as follows: "Wie beim Steinadler und andern grossen Raubvögeln geht auch hier der Federwechsel so langsam von Statten, dass sich beim Erlegen mancher Individuen Federn von dreierlei Kleidern finden, wobei dann die ältesten zur Unkenntlichkeit abgebleicht, ihre Enden verstossen und abgerieben sind, die jüngsten dagegen bei noch vollständigem natürlichen Umfange eine sehr dunkel und glänzende Färbung haben, gewaltig gegen jene abstechen und das Gewand noch bunter machen. Eben wegen der langwierigen Mauser möchte ein durchweg frisch hervorgekommenes Gefieder, noch in seiner völligen Neuheit befindlich, schwerlich vorkommen, dagegen die meisten Individuen theilweis zweierlei Kleider tragen."

Naumann described three plumages for each "species": a juvenal, an immature (molted two to four times) and an adult (a plumage achieved at an age of six to ten years?), but gave no account of molting from one plumage to another.

Brewer (1854) wrote that: "In a wild state, three years are required to complete the clouded barring, the principal mark of the adults, and which, even after that period, increase in darkness of color. When kept in confinement, the change is generally longer in taking place; and I have seen it incomplete at six years. It commences by an extension of the bar at the end of the tail, and by additional cloudings on the white parts, which increase yearly until perfected." In spite of his knowledge of pattern change Brewer did not describe the type of molt.

Booth (1881–1887) figured birds in three plumages; a juvenal, an immature and an adult. He commented that in his opinion maturity is reached about the fifth or sixth year.

The ideas of Naumann were much amplified by Severtzov who also can be credited with much additional information. Although his work represents the high point in the confusion concerning this species, it also represents the peak of detailed analysis. According to Severtzov, as translated from the French (Menzbier, 1894: based upon a monograph on the eagles by Severtzov), "the young bird begins to molt at the age of 14–15 months, in June and July. This molt, at first very slow, lasts until September or October. It is arrested in winter and continues during the following summer. The second dress is nearly complete at the age of thirty months (at the end of the second summer of molting). The first molt is entirely achieved by the third year

(beginning of the third summer of molting), but then, nearly without interruption, the older feathers of the second dress begin to drop, replaced by those of the third dress which is completed by the fifth year. The fourth dress is completed by the seventh year, the fifth by the ninth year, etc. . . . The ages corresponding to the diverse dresses may be determined from the individuals in molt, which always carry feathers of 3 ages: fresh, the previous year, and of the year before that, recognizable by their color and wear . . ." Further along he clarified his views as to the time required for a complete molt. "The common plumage is composed always of fresh feathers, of those of the year before, and of the year before that, . . . the mixed remiges and rectrices are of two years; fresh and of the year before, . . ."

Heinroth (1898), in discussing the molt of large predators, said: ". . . bin ich nicht im stande, die Mauserungsweise auf ein Schema zurückzuführen, man findet oft starke Unsymmetrieen der beiden Flügel sowie Ungleichheiten bei Vögeln derselben Art." He diagrammed the wing of a specimen of *Aquila clanga* and let the matter drop.

The classical works of ornithology by Gadow (1893) and Stresemann (1934) assume a complete annual molt. This general opinion has become quite fixed and generally accepted among ornithologists. This concept, along with a general understanding of the progressive pattern changes in this species, is found in Oberholser (1906), Forbush (1927), Engelmann (1928), Bent (1937), and Witherby, *et al* (1939).

Bent (1937), taken as representative of this group, assumed that the molt may extend from March until October (Forbush, 1927) but presented an unconvincing account. "The juvenal plumage is worn for one year without change except by wear and fading. From that time on progressive changes take place through annual complete molts, toward maturity . . . The fully adult plumage is not complete until the bird is four years old or more." He pointed out the progressive decrease in the amount of basal white of the plumage with age.

Perhaps the most impossible account is that of Cameron (1908) who wrote that "according to my observations the male eagle began to molt on April 13, . . . he had renewed his plumage by May 1. The female molted two months later, in the middle of June, and had finished molting by June 26, . . ." Such a discussion of molting is ridiculous to anyone familiar with the ways of even the barnyard fowl yet Cameron is not to be castigated for error. Errors have been the rule in the discussion of the plumage of this species.

Miller (1941) came close to the facts when he commented that "In the eagles and larger hawks the replacement of secondaries is comparatively irregular, as also in the *Cathartidae*. Apparently it is not uncommon for individuals to fail to molt all the secondaries in a single year."

Among the eastern Europeans, knowledge of the work of Severtzov has apparently been retained and I note Kozlova (1932) spoke of specimens as in the third and fifth dress. Kleinschmidt (1934) points out: "Das abgebildete Stück hat Federn von drei Alterskleidern, bis auf die Schafte abgenutzte, schwächer abgenutzte und neue ganzrandige."

A somewhat individual view (similar to that of Hartert, 1914) is expressed by Stegmann (1937) who said that molting from the first plumage begins at the end of the second summer and continues practically without pause through the whole year (and thereafter). At the end of summer and during the autumn molting is heaviest, and during the winter the feathers are freshest. He described five plumages from juvenal to adult.

Spofford (1946) cast doubt upon the published accounts of molt of this species and cited Severtzov's (1888) account as most satisfactory in explaining the partial molt and feather age variation he observed in his specimen. He stressed the need for observations on the molt of this species rather than the acceptance of unsatisfactory accounts in the literature. He is to be commended for observing the partial annual molt of this species, although this plumage character is so obvious that I have often wondered how so many diligent workers have overlooked it. (Many have probably suspected it.)

The incomplete nature of molt in this species was first recorded (to my knowledge) by MacGillivray (1836) and Naumann (1820-1847). In spite of early recognition, this fact had been "lost" until the account of Spofford (1946). The age at which the adult plumage is achieved has been variously stated but has never been based upon exact observations of an individual or upon the study of plumage sequence from skins. It is a sad commentary on modern, yet quite unscientific, ornithological writings that the ignorance of the past concerning this bird is constantly being perpetuated.

Recently, two papers (Spofford, 1942; Stabler, 1942) on the molt of several predators have been published. Papers on the molt of various species of hawks should produce information concerning the phylogeny of the group as suggested by Miller (1941) and, therefore, detailed observations on all species are solicited.

I first encountered this problem much in the same manner as Spofford. In March, 1941, I received a live, immature Golden Eagle from Jack C. Miles, a taxidermist, of Denver, Colorado. The eagle, "Miss Goldie," had been caught in a trap in northeastern Colorado. It died within two weeks of receipt and an examination of the bird indicated something like aspergillosis or tuberculosis. This is incidental to the topic at hand, but in preservation of this bird I noted that the wings were about one-half molted, about six of the inner primaries and a scattering of secondaries in each wing. The two outer tail feathers had been replaced but the others were "typical" juvenal feathers. In this manner I was introduced to the problem but assumed that the advent of disease might have put a stop to the normal molt.

After I became interested in the Golden Eagle, visits to museums to examine skins of this species focused attention on the matter of plumage variations and molting. It became apparent at once that only juvenal birds possessed a uniform, easily identifiable, plumage and that after the beginning of the first molt the specimens possessed both fresh and worn feathers. No matter in what season a bird was taken, it presented this mottled pattern (greatly variable as to the extremes of contrast) of feathers of different ages and, among subadults, of different patterns.

Although the period during which feathers were being replaced might be determined by a thorough study of the skins, the extent of each molt seemed impossible to determine satisfactorily. Attempts to employ pattern changes from the juvenal to the adult were blocked by lack of information regarding the molt. I attempted to separate one generation from the other by indications of difference in age (fading and wear). The newest feathers with a fresh sheen were easily identified but older feathers blended into the very oldest. It would seem logical that some feathers would be subject to more wear and fading than others and it was apparent that the softer plumes, when fresh, lacked the luster of the harder feathers (especially true of inner secondaries and the median and lesser wing-coverts).

One problem was to determine how much a feather could fade and wear in one year. Fading and wearing are especially noticeable among the lesser coverts of the wing. Observations indicated that in one year a feather could be bleached to a corn color and heavily worn along its margins. Thus lesser coverts in some (unmolted) juvenal birds matched the badly worn coverts of adult birds. It was quite clear from this point on that the extremes might be differentiated but that the intermediates must remain hypothetical until a sequence or, at least, a general pattern of the molt were known. Thus, unlike Spofford

(following Severtzov), I was unable to separate three generations of feathers; I was hard pressed to identify the newest generation with certainty.

In this study of birdskins, difficulties were legion and successes slight. The birdskins refused to allow a 'peeping Tom' to ascertain which feathers had been replaced and which had not. From a skin, only approximations concerning the order of secondaries could be drawn. These difficulties, I do not doubt, account for the general ignorance of the molt in this species. The solution to the problem seemed to lie in the study of the living bird.

For more than four years I have concentrated my observations on this eagle and tried to make these observations as complete as possible concerning not only behavior but also individual variations and molting. Field observations have been secondary, however, to the observation of captive birds.

To date I have 'owned' six eagles at one time or another. Only three of these birds have contributed to my knowledge of the molt and pattern changes of this species, and frequent mention will be made of them through the remainder of the account. The most important character has been 'Smoky' 'the good egg.'

Smoky's story began on April 19, 1943, when Miss Verna Mace (Mrs. Don Zander) took two eggs from a nest in Larimer County, Colorado. The eggs were warmed in the sun and 12 hours after having been left by their parent they were placed in an incubator along with a miscellaneous group of eggs being prepared for embryological study. On April 27, Smoky hatched and her nest mate expired in the shell. From that time on she has been weighed, measured, and closely observed up to the time of writing.

The other birds were Apache and George. Apache was taken from a nest at the age of six and a half weeks by Richard Garrett near Boulder, Colorado, on June 6, 1942. This bird was held until January 23, 1943, when she was lost while flying near Boulder. George was taken from a nest in a eucalyptus tree on April 23, 1944, by Arthur MacAdams in Alameda County, California. This bird was held until May 15, 1945, when he was killed and preserved.

The method of procedure in studying the molt of Smoky was to collect all feathers that were dropped on each feeding trip up Strawberry Canyon (while studying at the University of California, Berkeley). Trips were made every two or three days although, on occasion, the periods were longer. The feathers collected on such a visit were strung together and stored. It should be indicated that my collecting technique during the second molt was much improved—every feather

large enough to see was saved. This paper is somewhat premature; I had not expected to work over the material until Smoky had molted into an adult plumage. However, I am confident that sufficient material is now at hand to treat this subject adequately.

During the course of this study specimens have been examined from several collections. References will be made to specimens from these collections by number and the initials of the museum. Collections examined are as follows: American Museum of Natural History (AM), notes taken by Charles Sibley; California Academy of Science (CAS); Chicago Natural History Museum (CM); Colorado Museum of Natural History (CMNH); University of Arizona—Department of Zoology Collection (UA); University of Colorado Museum (UCM); Stanford University Collection (SUC); and Museum of Vertebrate Zoology (MVZ) at the University of California.

At this point I would like to acknowledge the assistance I have received during the course of my studies of this species. I wish to thank the following for their efforts in my behalf: Mrs. Don Zander, Richard Garrett, Charles Sibley, Mrs. Jean Luce, Henry Weston, Arthur MacAdams, and Dr. Alden H. Miller.

No completely satisfactory description of the downs of the chick and their replacement has been presented but, as that is another topic, it must be reserved for another paper and only general remarks can be made here.

At hatching, the eaglet (weight about 100 grams) is thinly covered with a fluffy down (after drying) of light steel gray color with slightly darker tips. Seemingly, it is somewhat darker along the back, mid-line of wings, and especially the nape of the neck. The ear is rimmed with short, thick, conspicuously white down. Around the eye and on the edge of the eyelid the down is conspicuously dark. A few pink spots of skin are exposed along the vertebrae between the shoulders and also on the manus. The down on the ventral surface is incomplete medially, especially around the navel (umbilicus) and along the posterior aspect of the tarsus from the heel to toes. The down tracts of the chick are made up largely of prepennae with some 'preplumulae' in the apteria, especially posteriorly and ventrally.

At the age of six days the preplumule down has appeared everywhere. The teleoptiles are evident on the wings at eight days and all over the body somewhat later. The primaries were first detected at the age of eleven days, and at thirteen days they were about one-quarter inch in length. The covering of down improved as the preplumulae took over the function of covering the youngster. From about fifteen days on, this down was the prominent cover until over-

grown by the teleoptiles. The teleoptiles completely cover the down at about eight weeks and the young bird reaches full feather growth at the age of fifteen weeks.

At the age of eight weeks (approximately) the preplumulae begin to be molted (groin region) and are replaced by the plumules of the juvenal bird. This may be spoken of as the first true molt; finished by October of the year. The first molt of the teleoptiles and plumules of Smoky began at an age of about eleven months.

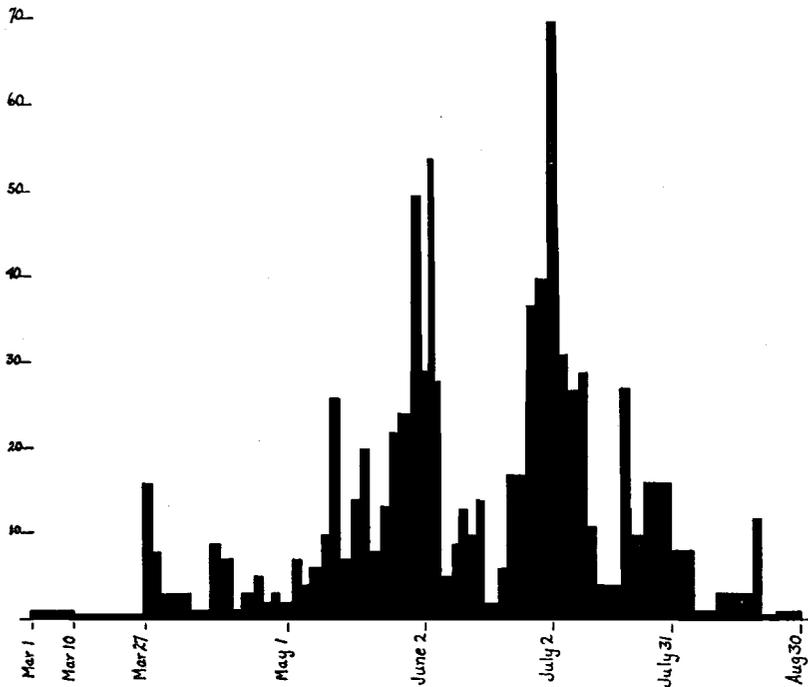
The complete molt of Smoky has been observed twice while only the beginning of the first molt was observed for George. In 1944, the first signs of molting were noted on March 11. A group of eight or ten feathers were growing in at the angle of the jaw on the left side. The molt was first substantiated by the dropping of down and feathers from the head and neck. At first the number of feathers dropped was small, gaining in numbers each week. By March 27 the first large wing-feather (primary No. 1 of the right wing) was dropped. Reference to Text-fig. 1 will indicate the number of feathers dropped each day throughout the molting period as averaged for the number of days in each collecting period.

A few notes describing this molt are in order. The first feathers to be dropped were from the nape area. On April 7 I noted the "head, neck, and chest fairly heavily molting. The head and neck are positively unsightly."

From the head and neck the molt progressed to the back and belly. The first under tail-covert was recovered on May 18. The plumage, from head to tail, from early in the molt period until its close, was "patchy." Although the anterior parts are the first to molt they continue molting to the last.

On June 3, I commented: "There is a large bare patch on the top of her head, but the head and neck are more than 50% molted. Her whole appearance is that of mid-molt and she is very patchy—light and dark. The angles of the wings and the underside are molting heavily and all the middle coverts of the wing are gone as well as patches here and there. Her back is heavily patched with new feathers and several large scapulars present the new color scheme, . . ." By July 13 the "upper part of the body appears 75% molted but 'patchiness' is not more or less marked than since starting her molt."

The completion of the molt was recorded on September 9. "Smoky appears to have completed her molt. I have not picked up any feathers for about the past two weeks." Further notes are recorded under September 16. "One tail feather and one flight (right wing No. 7) are still growing (three-quarters out). The body has become fairly



TEXT-FIGURE 1. Number of feathers molted each day during season of 1944 as averaged for each collecting period. Approximate total 1850.

solid in appearance but the partial character of the molt is obvious. Almost all the feathers of the neck, breast and back have molted but the belly and upper legs are patchy. Most of the lesser coverts of the wing are old ones and molting was heaviest at margin and angle." The under wing-coverts, tibiae and tarsi were untouched.

At this point it would be well to compare the results of this first molt with those recorded in the skins of museum specimens. For this purpose I have chosen a specimen in my own collection—a bird killed in the Chiricahua Mountains of southeastern Arizona. This bird was shot October 14, 1945, but, unfortunately, I could recover only the wings and feet, the rest having been burned. This bird was a typical immature finishing its first molt. The second specimen (62356 MVZ) was collected near Niles, Alameda County, California, and is dated October 20, ?. It appears to have finished molting.

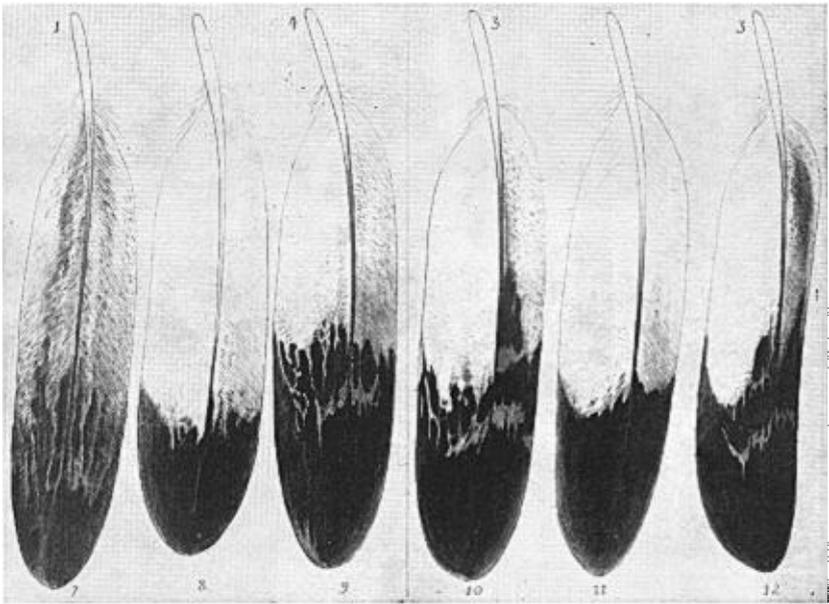
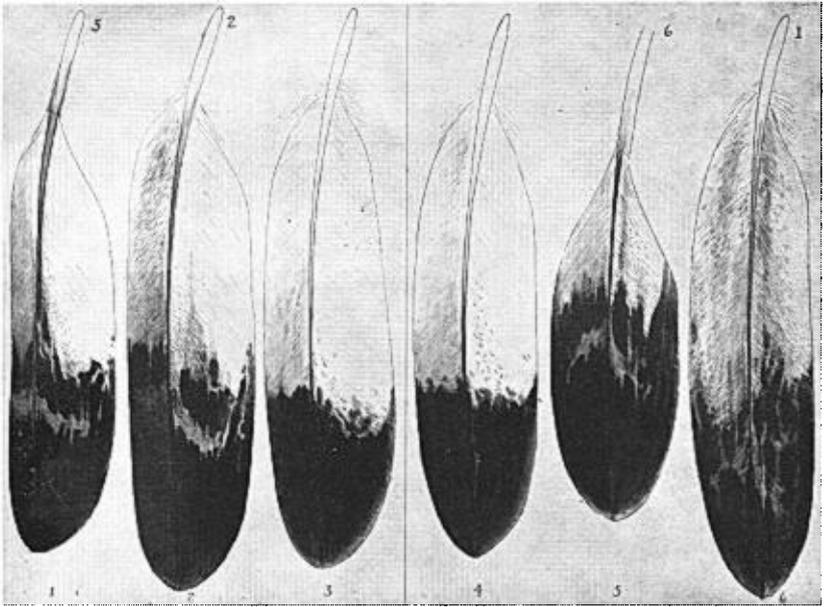
I have summarized the information regarding the wings of Smoky and these specimens in Text-figures 3, 4, and 5. It can be seen that the number of wing feathers molted by Smoky exceeds the number in

either of these specimens, but in general there is sufficient agreement to indicate the usual trend. As to the tail feathers involved in the molt, the number is highly variable. One specimen (in my possession) has dropped only the two outer feathers, another (22745 CMNH) both decks (central tail feathers), while the bird from Niles and Smoky dropped eight (Text-fig. 5). From my scant notes, 7 or 8 would seem to be normal for juvenals. The body of the bird from Niles is well molted; the head, neck, back and chest are fairly uniform. In general I believe the molt as observed in this captive bird is entirely normal but probably represents the result of optimum conditions which are not necessarily enjoyed by all wild birds.

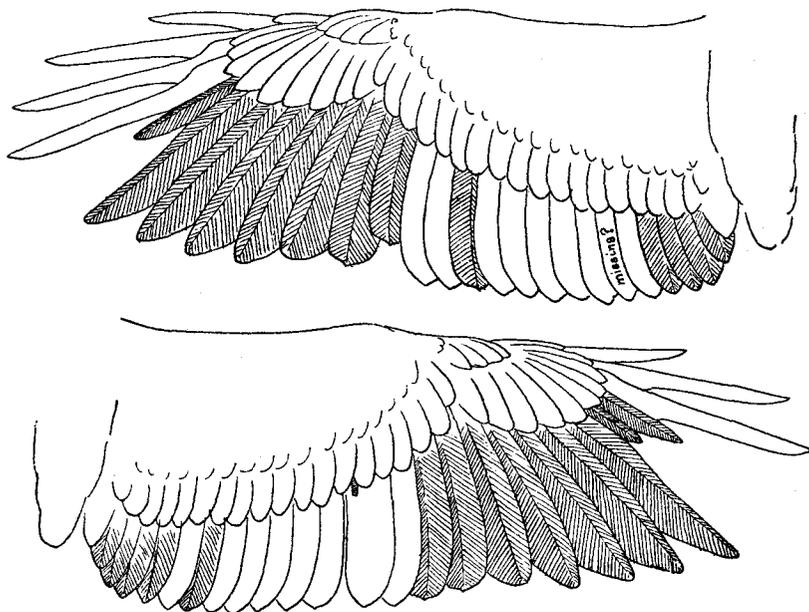
The molt in 1945 was first noticed on March 29 in both Smoky and George. In both birds the molt proceeded about evenly until the demise of George in May. A summary of the number of feathers dropped by Smoky can be seen in Text-fig. 6 while the complete story for the large feathers is told in Text-figs. 2 and 5. A study of the molted feathers indicated that again the molt started in the head region but shifted sooner to other areas. Among the areas not touched by the first molt were the under wing-coverts and these were 'completely' molted at this time. Belly, under tail-coverts, and tibial plumes appeared early among the feathers and in large numbers, with the appearance of tarsal feathers by mid-June (an especially large group on July 13). Meanwhile head, neck, back, breast and wing feathers were also dropped in quantity, up to the time of last collection on August 25. From information furnished by Henry Weston, the molt ceased about the end of the first week of September although, during the last of October and on December 20, two additional feathers were dropped. These last may have been due to accidents.

Unfortunately the difficulties of the material make it almost impossible for any complete statistical analysis, so I have dealt only in generalities. In my examination of Smoky at the completion of her second molt she presented a fairly uniform appearance and it would seem that most feathers have been molted at least once with a few old feathers at various points. The number of unmolted covert feathers in the wing is questionable, but some of the lesser coverts may have been skipped as the molt this season appears to be mainly marginal and next to the remiges. However, I doubt from their neat appearance whether many of them have been skipped. Rather I will assume that their normal color is lighter and more faded than the marginal feathers and larger coverts and such is the case.

This molt can be summed up as completing that started the previous season with a simultaneous second molt for most (percentage?) of the



GOLDEN EAGLE: (*Upper and Lower*) TAIL OF MVZ 62356—IMMATURE PLUMAGE. THE UPPER NUMBERS INDICATE REPLACEMENT ORDER; LOWER NUMBERS ARE FOR TEXT REFERENCE.



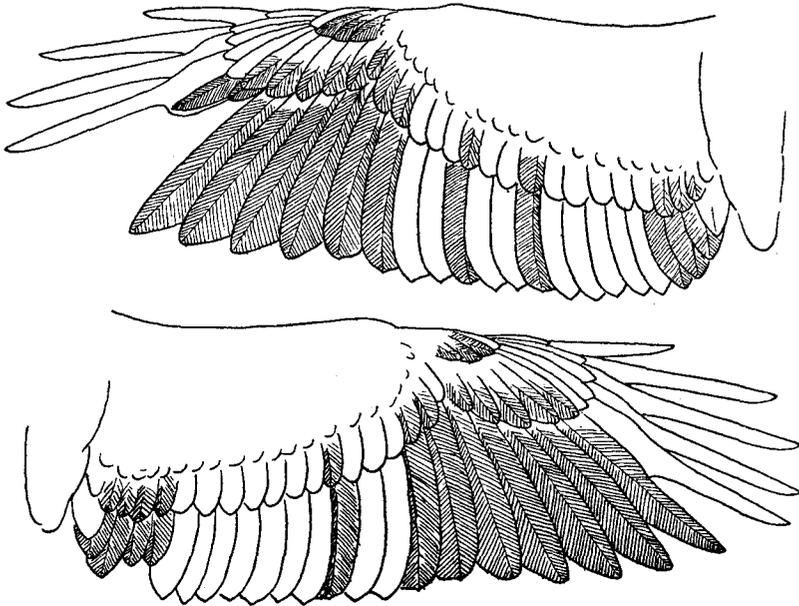
TEXT-FIGURE 3. Left and right wings (as in text-figure 2) of 62356 MVZ (Niles, California, October 20, ?).

head, neck, back, scapulars, and some remiges and rectrices, as is noted in Text-figures 3 and 6. This second molt period saw the replacement of seven tail feathers—four juvenal and three immature.

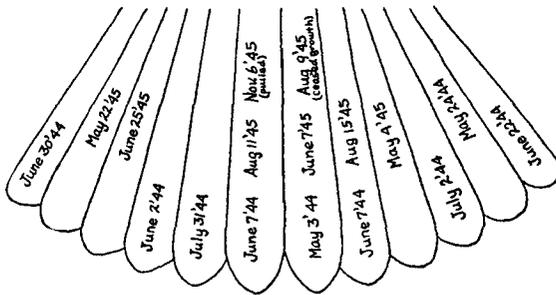
Comparison of Smoky, at the completion of her second molt, with skins indicates that the procedure was normal. Comparable specimens in this plumage are 91286 MVZ, 12511 and 18936 CAS, and 349 of the J. E. Law collection now housed at the Museum of Vertebrate Zoology.

Regarding the molting period of wild birds, the study of museum specimens has not been as productive as might be hoped. At the time of study, attention was focused more on pattern and only cursory attention given to signs of molt. To be detected in the skin the molt must be well under way with a fairly large number of feathers involved. My examination for signs of molting was directed more to the loss of wing and tail feathers. The loss of secondaries is exceedingly difficult to detect in the skin.

Of the 84 specimens examined personally, 23 were juvenals and showed no molt. Of the juvenals only seven were actively molting or had molted into a first immature stage. Of the remaining 61, 24 were taken during the period from November to February and showed no



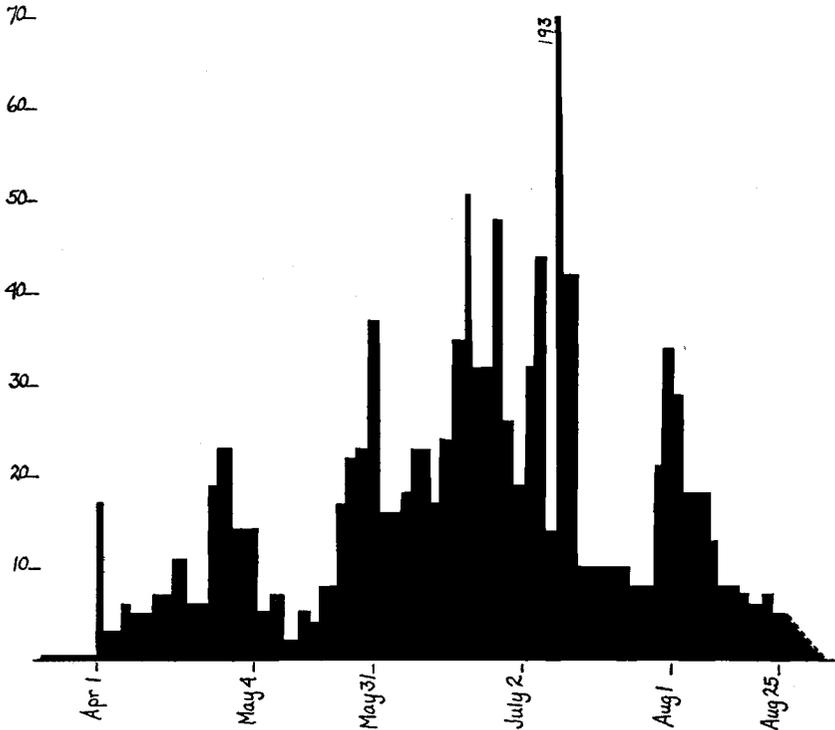
TEXT-FIGURE 4. Left and right wings (as in Text-figure 2) of bird taken in Chiricahua Mts., Arizona, October 14, 1945.



TEXT-FIGURE 5. Replacement dates of tail feathers of Smoky.

active molt except in several doubtful cases. Incomplete notes eliminate part of the remainder leaving only 21 specimens for which useful information is available. To this information I have added observations on three birds in the Denver zoo, and have summarized the facts in Table 1.

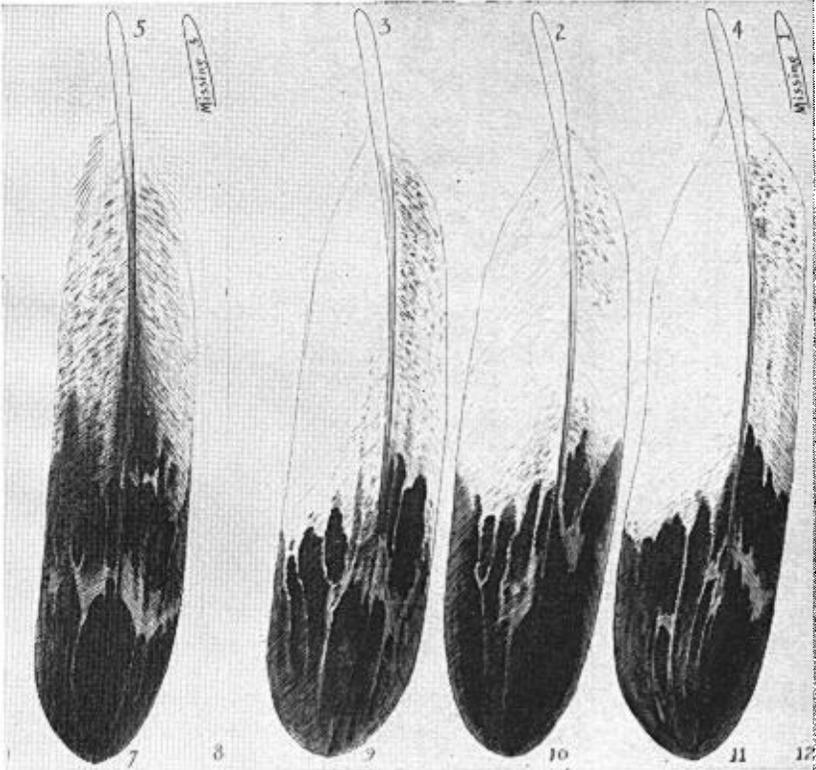
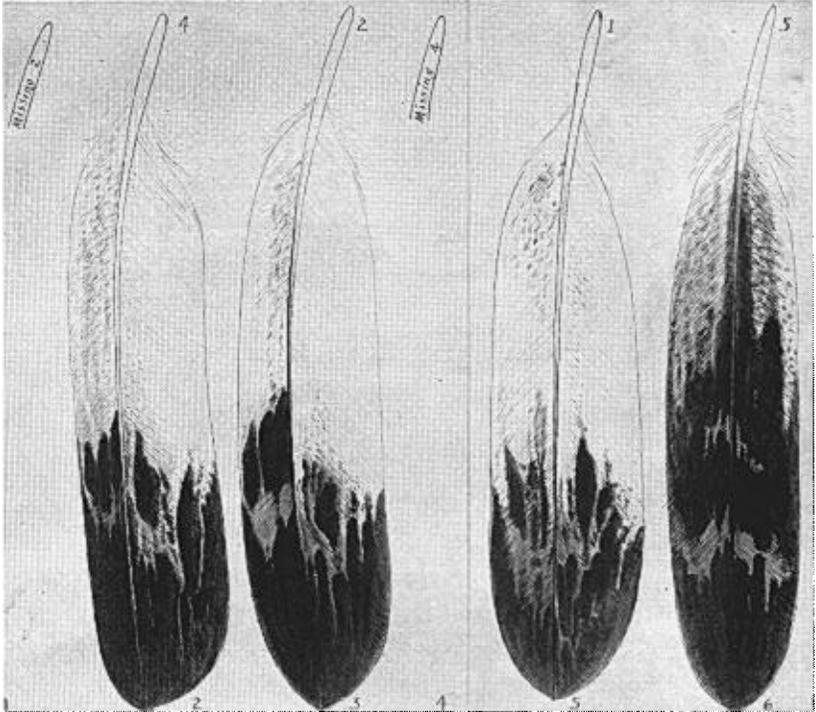
The molt of Smoky in captivity is corroborated by Table 1 and by observations in the field. It should be kept in mind that in the field only the more obvious losses can be detected. Most of my field observations have been made on adults and, therefore, certain facts must be



TEXT-FIGURE 6. Number of feathers molted each day during season of 1945 as averaged for each collection period. Approximate total 2600.

given consideration. Molting is dependent not only upon the physiologic well-being of the bird but also upon its hormonal condition. Breeding is well known as a deterrent to molting, and this fact was recognized by Severtzov (Menzbier, 1894). Severtzov concluded erroneously from the condition of the plumage as correlated with testicles in several specimens that the birds bred on alternate years, molting lightly during the breeding year and heavily during the year of rest. It is to be assumed from this that adults will commence somewhat later than immatures or non-breeding adults and perhaps continue molting somewhat later in the season (1568 UA; see Table 1).

From my field notes several exceptional instances can be cited of protracted molting through the winter months. For December 31, 1942, I have: "A second eagle appeared from Two-mile Canyon direction; came overhead, passed to the northwest and returned overhead low. Molting inner flight, fairly apparent (second or third in right wing)." On January 24, 1943, a pair was observed of which the female



GOLDEN EAGLE: (*Upper and Lower*) TAIL OF BIRD FROM COLOMBIA, CALIFORNIA, ILLUSTRATING IMMATURE TYPE OF TAIL. THE UPPER NUMBERS INDICATE REPLACEMENT ORDER; LOWER NUMBERS ARE FOR TEXT REFERENCE.

TABLE 1

<i>Specimen</i>	<i>Museum</i>	<i>Age</i>	<i>Date</i>	<i>Sex</i>	<i>Remarks</i>
JUVENAL TO IMMATURE:					
160281	CM	11 mo.	3/19	♀	Few new feathers in wing
160279	CM	11 mo.	3/26	♀	No sign
	Jollie	18 mo.	10/14	♀	Feathers of wing still growing
62356	MVZ	18 mo.	10/20	♂	Feathers of wing and tail growing
1722	UA	18 mo.	10/23	♂	Feathers of wing and tail growing
101185	CM	19 mo.	11/28	♀	Finished
91286	MVZ	20 mo.	12/20	♂	Finished
IMMATURE TO SUBADULT:					
	Jollie	22 mo.	2/29?	♀	No sign
12511	CAS	28 mo.	8/24	♂	Nearly finished. Wing and tail still growing
SUBADULT TO FIRST ADULT: FIRST ADULT TO ADULT:					
22436	CMNH	35 mo.	3/8	♀	Beginning; breast and belly?
	Denver Zoo	36 mo.	4/3	?	Started
	Denver Zoo	Ad.	4/3	?	Started
	Denver Zoo	Ad.	4/3	?	Started
349	Law (MVZ)	36 mo.	4/8	♀	Molting begun
7292	SUC	Ad.	4/19	♂	Not obvious
19075	CAS	39 mo.	7/11	♀	Molting heavily
12511	CAS	40 mo.	8/24	♂	Feathers of wing and tail growing
53801	MVZ	Ad.	"Fall"	♂	Molting heavily
53802	MVZ	Ad.	"Fall"	♀	Molting heavily
39146	CAS	Ad.	10/26	♂	Tail feathers still growing
1569	UA	Ad.	11/5	♂	Tail feathers still growing
12820	CAS	Ad.	11/13	♂	Finished
Black Mt.	SUC	Ad.	11/17	♀	Finished
562	Brooks (MVZ)	46 mo.	2/1	♂	One tail feather growing

showed a notch in the secondaries of the right wing and the tail was exceedingly irregular in outline as though several feathers were coming in. Another female observed on January 27, 1943, lacked the two first secondaries of one wing. During a relatively brief period of observation, the first two examples seemed gradually to achieve a more perfect appearance, especially the latter. It can not be stated definitely that these birds were undergoing molt but the evidence would suggest it. Although I have observed about 30 different pairs at all months of the year (observations made mainly in spring, early summer and fall) signs of molting were detected only in a few individuals.

On March 9, 1946, the female of a pair was noted to have a gap in the secondaries, at, or inside, the fifth secondary of the right wing. An adult bird observed on March 15, 1946, had two gaps in the tail, indicating recently molted feathers, and a first primary missing in the left wing. This bird, from the circumstances of the observations, may have been a non-breeding adult.

On April 9, 1944, I observed near his nest a male bird which appeared to be molting. My notes read, "the male has molted the sixth (?)"

primary in the left wing. The right wing is missing the first (?) primary and a secondary at the secondary center (fifth secondary) of molt." Three weeks later the wings seemed to be mended.

Secondaries have been found at nests during two seasons on June 6. In the latter case the male was observed at close range and was molting heavily. In contrast the female seemed immaculate.

A pair of eagles observed near Oakland were first noted to be molting on June 10, 1945 (several feathers recovered) although no sign of molt could be detected in wing or tail.

A juvenal eagle was observed on June 16, 1943, near Monarch Pass, Colorado. This bird lacked an inner primary and, perhaps, a secondary. The tail appeared to be complete.

A pair of eagles breeding east of Oakland showed gaps in the wings on July 2, 1944. "Both birds have apparently started molting. The female appears to have dropped both first primaries and the male may be missing a secondary. Obviously (?) not molting heavily yet." I recovered several contour feathers from the vicinity of the nest.

From my field observations I conclude that remiges or rectrices may be replaced at any season but, in general, conform to the molting season as described for Smoky and as shown for skins in Table 1.

The incomplete nature of the molt in the Golden Eagle which has led to the lengthy descriptions of Severtzov and the confusion of others seems to be a characteristic of the "Aquilid" group¹ (genera *Aquila*, *Hieraaëtus*, and *Uroaëtus*). Friedmann's (1930) account of *Aquila rapax* would suggest this and my own examination of adults of this species would confirm it. Heinroth (1898) commented on the irregularity of *Aquila clanga*. Whether a molt of this type occurs outside the group I cannot say. I would suspect that such a bird as a California Condor (see Miller, 1937) or any of the large Old-World vultures might need extra time. Examination of skins of the Condor reveal no indications of the molt. Severtzov (Menzbier, 1894) noted that the Lämmergeier has a complete molt of remiges and rectrices but said the body takes two seasons. The Bald Eagle, according to Crandall (1941), undergoes a complete annual molt, and examination of skins indicates that such is the case.

From a study of the molt both in captive and wild birds the following conclusions can be drawn.

1. A 'complete' change in plumage is achieved in two seasons. It would appear that, in general, the molt is incomplete the first season and is completed the second, along with a simultaneous remolting of some areas.

¹ Basis for designation of such a group not corresponding to any subfamily of the *Aquilidae* recognized at present will be presented in another paper.

2. There is a general anterior-posterior gradient of tract importance, beginning on the head and proceeding posteriorly to the other parts. The first molting period is characterized by near completion of the anterior dorsal areas while the posterior and ventral tracts are scarcely touched. During the second period these posterior and ventral tracts are replaced. The position of a tract in the gradient series shows correlation with its importance to the welfare of the bird. The primaries (and tail feathers?) are largely replaced each year while the less important secondaries are replaced much more slowly.
3. Each tract seems to have independent control, and more or less clearly attempts a complete annual molt. Success depends upon size, the overlooking of irregularities, and position in the gradient series. It would seem that the head, neck, back, throat, scapular tracts and alulae are largely replaced each year (along with the primaries and rectrices) while the under wing-coverts and the tarsi are molted only on alternate years.
4. Individual feathers at any point may be missed in the molt (especially in linear series) and are not picked up until the next round of molting. This is well shown by flight-feather 7 in Smoky's left wing. Irregularity increases with age; adults scarcely follow any pattern.
5. In linear series such as the remiges and rectrices there is some order to the molt. Order among the primaries is fairly rigid and proceeds from the inner one outward. Among the secondaries there is an inner, a median (at no. 5) and an outer molt center and replacement is fairly orderly but much more subject to irregularities than in the primaries. The greater coverts of the wing usually drop in the same order as the secondaries, while the median coverts drop irregularly and are largely replaced during alternate seasons. The tail feathers have lost all semblance to order and irregularities are the rule, although the molt seems to start most frequently with the central feathers.

Viewing the molt of this species in the light of what takes place in the Bald Eagle, there is no reason why a complete annual molt should not take place. Even when molting is heaviest the flight potential of the bird is but slightly reduced. A combination of extreme dependence on flight perfection and the time needed for the growth of new feathers must be tentatively accepted as the answer.

An appreciation of the changes in pattern that occur in the Golden Eagle will necessarily depend upon an understanding of both the individual variation that occurs in this species and of the mechanism that determines the age variations. As most authors have pointed out, the change in pattern, particularly of the rectrices, is one of increasing darkening and banding with the final elimination of the white bases of the juvenal feathers. As it is quite clear that the rectrices take longest to achieve an adult pattern, I will depend largely upon them in discussing these changes.

It should be made clear at once that I do not claim to offer a solution for the age identification of all specimens. However, I feel that most of the non-adult specimens can be identified with some surety. As I

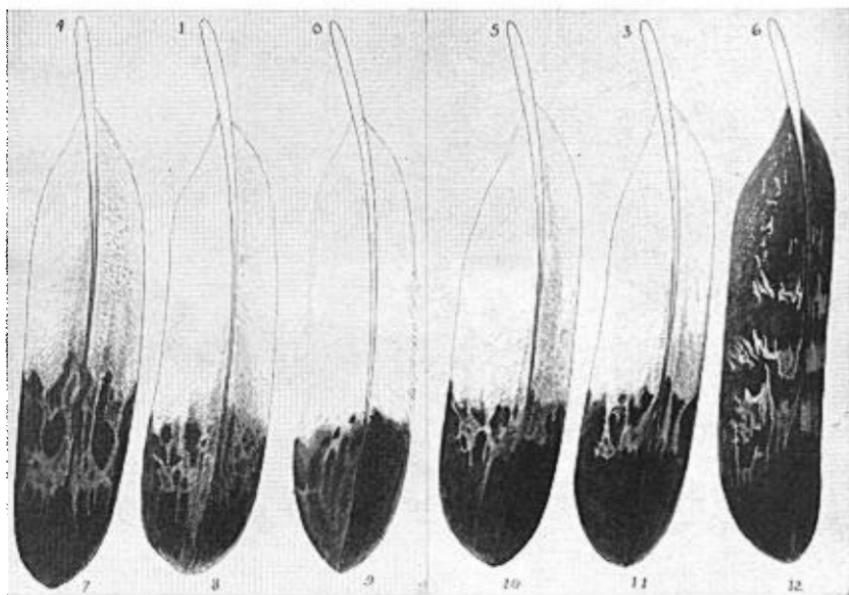
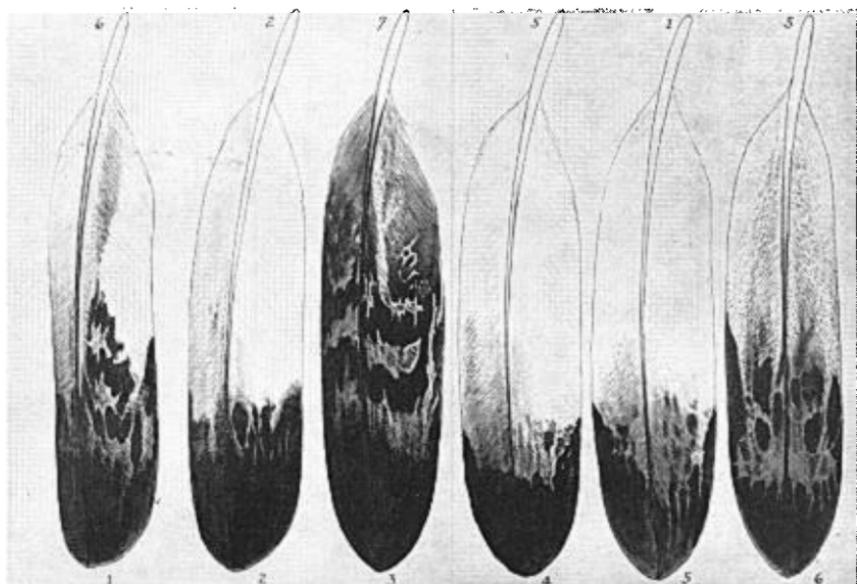
do not think a word description can possibly convey the images which I wish to offer, I have prepared a group of illustrations to go with the brief descriptions. In all, I recognize five age plumages of the Golden Eagle; a juvenal, immature, subadult, first adult, and adult.

The question of what determines the pattern of a feather presents a most interesting problem. In general, my remarks are all based upon a theory which has yet to be tested, although, it seems to me, a paper by Boss (1943) throws some light on this problem. Boss, studying Herring Gulls in which a pattern change somewhat similar to that in the Golden Eagle takes place, discovered that the adult plumage was determined by the presence in sufficient quantities of the male hormone.

As the gonads of both male and female gulls produce the male hormone, the development of the adult plumage was determined by a minimal level that was achieved in both sexes at three years of age without the appearance of sexual behavior. As breeding does not take place till after the assumption of the adult plumage, the males do not achieve this plumage earlier than the female. Other characteristics (bill color, etc.) would indicate that, as in adults, the gonads of the immature birds undergo seasonal periodic changes (most noticeable of course in the subadults). Thus there was superimposed on the gradual growth of the gonad, secondary seasonal changes in size or at least hormone productivity.

Some time prior to seeing this paper, I had expressed similar ideas concerning the cause of plumage changes in the Golden Eagle. These ideas were not well received on the grounds that no such case was known to exist. I attempted to secure pellets of male hormone in order to test its influence on the pattern of a young male (George) but unfortunately could obtain none. Although this is but a possibility it seems to me certain that some similar situation controls the pattern in this species.

Regarding the hawks in general, this theory finds little support. It has been noted by falconers that when a feather of a juvenile bird is pulled, either a juvenal or an adult feather (depending upon the date) replaces the lost plume. There are no instances of an intermediate type, but, as the smaller hawks, with which I am familiar, attain the adult plumage at the first molt, it seems probable that a juvenal type is produced until a threshold quantity of some hormone throws the switch to the adult type. In only one species, the Goshawk (Bond and Stabler, 1941), has there been any indication that pattern changes can be traced through a sub-adult stage achieved at the first molt. The subadult stage is only an average in the Goshawk, however, and does not constitute a really recognizable individual plumage.



GOLDEN EAGLE: (*Upper and Lower*) TAIL OF MVZ 91286, ILLUSTRATING SUBADULT STAGE. UPPER NUMBERS INDICATE REPLACEMENT ORDER; LOWER NUMBERS ARE FOR TEXT REFERENCE.

In the Golden Eagle, if the development of pattern is a gradual thing, not a step-like series, becoming increasingly darker with an increase in hormonal output of such an organ as the gonad, the pattern in a tail should indicate this. Unfortunately nothing is known about the seasonal gonadal changes in eagles, therefore no correlations are as yet possible.

In an effort to find out whether transitional types exist, I have pulled the tail feathers of two captives. On October 2, 1942, a juvenal central tail feather was pulled from Apache and was replaced by a feather of a weak immature pattern. A deck feather of a similar pattern is to be found on 22745 CMNH. This feather was closer to the normal second-plumage type than those produced by 80785 MVZ or feather 5 of Plate 20, upper figure.

On October 21, 1944, a juvenal central tail feather was pulled from George, and on February 3, 1945, another. The new feathers showed a transition toward an immature type.

I doubt that an eagle's rectrix follicle ever duplicates, in the broad sense, the same pattern; variations are always present. As a tail feather takes 75 days to grow, a considerable physiologic change can take place in that time.

From the evidence at hand I must reverse my former beliefs and say that there are transitional stages from the juvenal type toward the adult. No one will deny the extreme variations, almost continuous, that exist, but an understanding of them must be based upon a knowledge of the general transitional patterns of plumage changes that take place as the juvenal is converted to the adult.

The development of pattern in Smoky has been carefully observed and, in general, it would support the assumption that captive birds take longer to attain the adult plumage (Brewer, 1854), although some may reach maturity at the same age as wild individuals (Temminck, 1820). In consideration of the feathers produced by Smoky I can say that only the rectrices seem to approach the normal pattern.

A general understanding of pattern changes with age can be gained by an examination of feathers produced by a single follicle for each of the molts. Only three feathers in Smoky's tail have been molted during both seasons (*see* Text-fig. 5). In Plate 18, upper figure—a, b, c—I have illustrated the juvenal, immature and subadult feathers produced by the left central follicle. Feathers e and f are those produced by the right central follicle. Feather e (*see* Text-fig. 5) replaced the immature feather which dropped on June 7, 1945, but because of some irregularity of growth it was dropped on August 9, when but half-grown. The pattern is advanced over that of the juvenal feather

(see Plate 18, upper figure b) but does not approach that of c which replaced an immature dropped on August 11. The feather that replaced this partly grown plume, f, matches c in pattern. On November 6, 1945, I pulled c and it was replaced by the abnormally dark feather d which shows little or no pattern. The only other feather that had been replaced each molt is no. 2 (counting from the center) on the right side (g). The pattern of this feather is scarcely more than that of an immature, but the important point is that it is darker than any of the others and considerably darker than the feather it replaced (similar to b). Comparison of feathers e and c shows nicely the tendency for the pattern to darken as the molt progresses.

Using these pattern changes as a criterion for following the normal pattern changes of the wild bird, I will describe and discuss the various plumages which I have been able to distinguish in this species.

The first is the juvenal plumage. This is developed in the nest and worn for one year when it is partially replaced by 'immature' feathers. The tail of the juvenal bird is easily identified and well known to most ornithologists although, to my surprise, Spofford (1946) questions its validity.

In comparing juvenal feathers there is striking variation. In Plate 18 I have illustrated a group of juvenal tail feathers showing some of the differences. Feather c (Plate 18, lower figure) is the usual type. An extreme type is described by Baird, Brewer and Ridgway (1874) from the Boston Society of Natural History collection. "A young male from Massachusetts . . . has the tail plain black, the extreme base and tip white." The white tip is normal but usually wears off soon after the young leave the nest although indications of it may remain for some time. I have seen young in which only a glimpse of white could be seen, the rest being covered by the tail coverts. The most aberrant pattern I have seen is e (lower figure). This feather was taken from a young female in the Chalk Bluffs area of northeastern Colorado. The pattern of the other plumage was normal.

The juvenal plumage is blackish brown in tone, darker than that of the adult, somewhat lighter in the middle and lesser coverts. The bases of the feathers are clear white in sharp contrast to the dark tip which shows no marbling. There are no marblings of brown or gray at the base of the black terminal band of the rectrices although small spots or grayish lines may occur. The hackle color ranges from bright yellow to somber tan but is usually duller than the adult. The tarsi are dull tan as are also the margins of the feathers along the anterior border of the wing. White tarsi are not as uncommon as would be suggested by Eliot (1939) and others. As the North American sub-

species has been characterized by dark tarsi (Baird, *et al*, 1874), this point is of some interest. The tarsal color would seem to be a local variation. Of ten young eagles examined in northeastern Colorado, eight had almost pure white tarsi (two specimens 20674 CMNH and 130647 CM are from this area and have white tarsi). This type of tarsal coloration does not seem to be correlated with any particular part of the range but crops up here and there (*i. e.*, one specimen, 41993 CAS, from near Atlin, British Columbia). Light tarsi are associated with generally light colored plumage and golden hackles (approach *A. c. chrysaëtos*).

The juvenal feathers are characterized by more pointed tips than later feathers. This is especially true of the remiges and rectrices which are somewhat narrower in form than the replacing feathers. The tail feathers of the juvenal plumage are somewhat longer than those of older birds because of the apical point but the wing feathers of the older birds are somewhat longer. In general the new feathers are more generous than those that result from the "mass production" methods of the juvenal (*see* Plate 18, upper figure).

The next 'dress' which I will call the 'immature' plumage is produced by the first molt. It features the retention of a good percentage of juvenal feathers combined with new feathers. The 'immature' feathers are easily identified not only because they are wider and (if not worn) lack the point of the juvenals but, in addition, the pattern of the larger feathers shows a marbling of the white base. Variation in the style and amount of marbling are almost as extreme as the patterns of the juvenal feathers and all grades from a juvenal-like pattern to a heavily marked pattern can be found.

In the 'immature' plumage the hackles have gained the brightness of the adult and the leading edge of the wing is brightly marked with yellowish-edged feathers. The body feathers retain the juvenal pattern but the new dark feathers contrast sharply with the old feathers. The flights, secondaries, and scapulars approach the adult pattern but tend to retain some white at their bases and the marblings show a tendency for longitudinal streaking as well as transverse.

In Plate 19 I have illustrated the tail of an 'immature' bird. The approximate order of the molt is indicated on the figure. In Plate 20 the tail of a bird beginning its second molt is shown. Four feathers are missing from this tail but these were probably of the juvenal pattern. In contrasting the central tail feathers, the tendency for darkening of the pattern during the course of the molting season is well shown. In Plate 19 the decks were the first to drop while in Plate 20 they were among the last. A second point is that the pattern of the decks tends

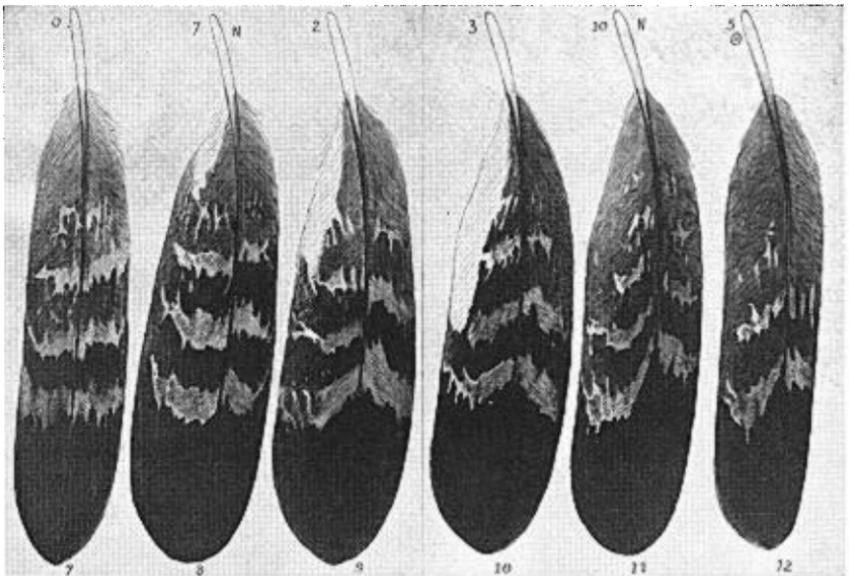
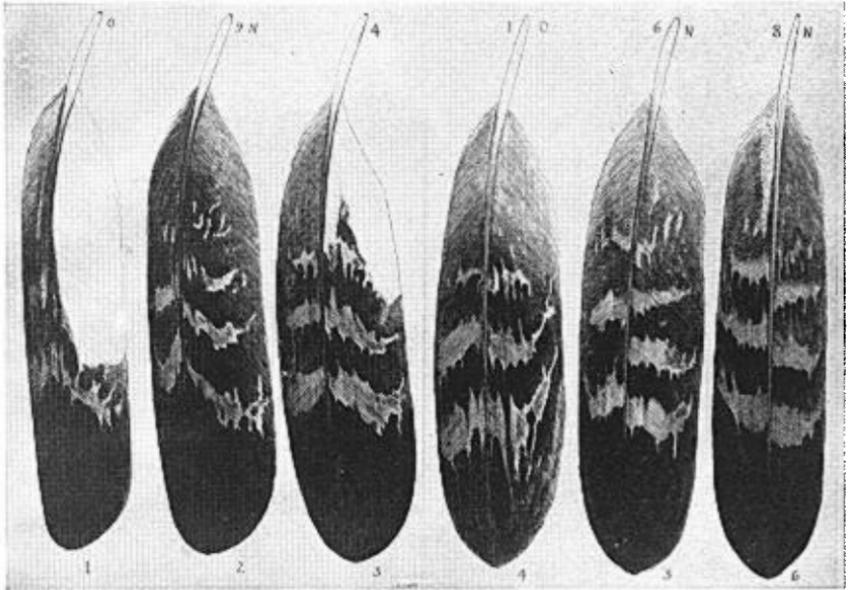
to be darker than that of the outer tail feathers. I have seen specimens (22745 CMNH) where the pattern of the decks did not show any real difference from that of the outer feathers but in the great majority the deck pattern is independent and tends to be darker. Among the outer feathers it is difficult to show any darkening of the pattern during the molting period although the oldest feather in Plate 20 has the lightest pattern and in the upper figure the no. 2 feather on the left side, which is just coming in, is the darkest. Individual variations would tend to obscure this pattern trend, but need not be taken as proof of its non-occurrence.

The plumage achieved by the second molt may be called the 'sub-adult' because I believe I have observed birds breeding in this plumage and because it introduces the first feathers of the adult pattern. Birds in this plumage retain only a few juvenal feathers and, essentially, appear adult except for the retention of these and immature feathers with their white bases. Reference to Text-figs. 2 and 5 will indicate the composition of wing and tail in Smoky at this time. In this plumage the entire tail has been molted once as have also the flights (occasional feathers may be missed) and three or four inner flights have molted a second time (up to the fifth primary in one case; 12511 CAS). A number of juvenal secondaries will be found in the wing of most individuals.

In Plate 21 I have illustrated the tail of a bird in this plumage. This particular tail is easily interpreted and makes a fine example. Feather 9 is a very worn juvenal feather missed in the first two molts while feathers 1, 3, and 12 differ from the rest in their striking patterns. Obviously 3 and 12 are feathers replacing 'immature' feathers while 1 represents a late, dark, 'immature' type. The appearance of fully adult feathers at the second molt was indicated in Smoky and has been substantiated by this specimen. Number 1 feather is doubtful, but its pattern is within the limits of the 'immature.' All 'immature' birds need not have adult pattern feathers as in some the tail is just replaced once with no feathers being molted a second time. In fact, one or two juvenal feathers may be retained in this plumage in exceptional cases. It is of interest to note that the juvenal feather in this figure shows indications of mottling. Marbling is quite unusual but such a pattern may be obscured by the heavy pigmentation of the usual juvenal feather.

The third molt produces the next plumage which is fully adult except for the retention of a few feathers of the 'immature' pattern in the wing and tail. This may be called the 'first adult.'

The tail of a (questionable) 'first adult' specimen is shown in Plate



GOLDEN EAGLE: (Upper and Lower) TAIL OF BIRD IN AUTHOR'S COLLECTION SHOWING FIRST ADULT PLUMAGE. THE UPPER NUMBERS INDICATE REPLACEMENT ORDER; LOWER NUMBERS ARE FOR TEXT REFERENCE.

22. Although the exact age of this specimen cannot be determined it will serve to indicate a possible pattern. Number 1 feather is an 'immature' while numbers 4 and 7 are feathers retained from the sub-adult tail. This accounts for only three of the feathers and, as it is improbable that nine were replaced, one or more of the others is probably old. Old-appearing feathers beside 4 and 7 are 3, 9, 10 and 12. This tail pattern is possible mathematically. Assuming eight feathers to a molt (probably an abnormally high number), twenty-four feathers could be replaced. Actually only eleven have been molted twice while one has been replaced once, making a total of twenty-three replacements.

The order of molt for this tail cannot be drawn from an examination. The small amount of white at the bases of some of these plumes is of interest. *White appears at the base of many 'adult' feathers produced at this time.* Many specimens that have retained juvenal feathers up to this molt produce very dark immature types in replacement as in Plate 21.

The final plumage is that of the adult and is assumed usually with the fourth molt (or fifth). It would seem to me that there is considerable individual variation in the achievement of the adult plumage. If variation does exist, age may be only poorly related to pattern, and if some birds retain white in the tail, they are no less adult than those that do not. If lack of white were essential to the 'adult' pattern some birds might conceivably never become 'adult.' Naumann (1820-1847) told of an individual held in captivity 20 years without eliminating the white from the base of the tail, and Severtzov (Menzbier, 1894) based one of his species on adults retaining white in the base of the tail at all ages. It may be that in the American subspecies, white is never retained after an age of about four years, but this is yet to be demonstrated.

Adult rectrices are as variable as other stages. Some have three or more bands of light gray while others have but two. Specimens 352748 and 448106 AM show no markings. The style of banding of the rectrices was described by Spofford (1946) as "goshawk style," but this seems to me to be a poor characterization. The goshawk pattern is common throughout the '*Aquilidae*' but does not apply to the Golden Eagle. The gray bands of the eagle feather are best described as irregular gray marblings.

In summary several facts stand out. There is no particular order to the molt of the tail, and the number of feathers dropped is variable, usually becoming less with age (adults usually showing about four). The pattern of a feather tends to darken according to the date of

replacement as would be expected in view of the gonadal theory, although the individual variations may obscure it. The pattern seems also to be controlled by the number of feathers produced by the follicle and these can be classed as 'juvenal,' 'immature' or 'adult.' The pattern of the deck feathers is somewhat darker than that of the outer feathers. Three age plumages can be recognized before the attainment of the 'adult,' and this is essentially achieved at an age of three and one-half years, in the 'first adult' plumage. (The age at which a completely adult plumage is achieved is individually variable.) The development of pattern is not just a simple "clouding" or "marbling" of the white base of the juvenal feathers but is rather a complete reorganization of pigmentation with each pattern. Variability is the only constant in the plumage of this species..

Another plumage character of interest is the occurrence of white scapular patches. Spofford (1946) described a male in which "there was a clear white 'epaulette' in the upper part of each scapular tract, which showed clearly only when viewed from in front as the eagle lowered its head to feed. . ." Naumann (1820-1847) figured one specimen and described a second seen in the vicinity of Köthen on the Elbe, which had shoulder patches nearly as large as those of *Aquila heliaca*. Severtzov (Menzbier, 1894) saw an adult in captivity for 20 years which had small white scapulars at the insertion of the humerus and described a young bird in the juvenal plumage with small epaulettes. Further on he stated that he had found "traces, more or less insignificant, on 8 of 70 examples. . ."

In my own experience I have never found white epaulettes on any of the over eighty specimens which I have examined, nor have I observed them in the field. It is my opinion, however, that single white feathers in the hind neck or shoulder region are quite common. An adult observed at the nest during the spring of 1947 in New Mexico showed small white patches at either shoulder in flight.

The question of the significance of this trait is easily answered. If we consider the 'Aquilid' group, we find white epaulettes cropping up among the various species. Engelmann (1928) noted this fact and commented on the occurrence of white feathers in the shoulder and back of the Golden Eagle and compared this with their occurrence in the Booted Eagle (*Hieraaëtus pennatus*) and in the Imperial Eagle (*Aquila heliaca*). To Engelmann's account I can add that such epaulettes are found in *Hieraaëtus fasciatus* (Dresser, 1871-1881, and Swann, 1933) while in *Aquila verreauxi* the entire back and rump are white as well as some of the scapulars. This character seems to be

common to most of the members of the group and is of phyletic significance.

A last variable which I will discuss is that of eye color. Again Spofford can be cited. He described the eyes as reddish, "somewhat similar to *Accipiter* (?)." The color of eyes has also been commented on by Severtzov (Menzbier, 1894). "The color of the iris varies also with age. That of the young of the year is of pure brown, rather dark; that of the adult, of the third plumage, of a reddish cinnamon, which brightens with age until it is a brownish orange." Rothschild and Hartert (1912) described a male (535120 AM) taken in Algeria. "Its iris was dull yellow, variegated with rufous brown; . . ." Engelmann (1928) commented that "Das prächtige Auge ist mittelgross, von stechendem Ausdruck, in der Jugend bräunlich, im zweiten Jahre braunrot und später oft brennend rotbraun. Der Mann hat meist leuchtendere Färbung. In Gefangenschaft aufgezogene Stücke erreichen diese Farbhöhe viel später oder überhaupt nicht, sine Tatsache die wir bei vielen Greifen wiederfinden."

Among the hawks in general, eye color seems quite variable and does not seem to be correlated with sex although it is with age. In one female Cooper's Hawk that I had, the eyes were a bright ruby red, just as in the adult Goshawk. Other Cooper's Hawks had eyes ranging from bright reddish orange to yellow. The same extremes are found in the Sharp-shinned Hawk. Eye color in Red-tailed Hawks is also variable. Most examples begin to assume a yellow eye at an age of four or five months and by the first winter are of the adult type. One female that I possessed retained the juvenile eye even when in the adult plumage.

In my own experience with the Golden Eagle I can confirm Engelmann's remarks. I have observed two males and two females closely at the nest and can say that the eyes of the males were in both cases a bright hazel to yellowish color while the females had dark brown eyes scarcely lighter than juvenile birds. It is my guess that eye color is a secondary sexual characteristic, reaching its peak during the breeding period and becoming browner during the summer and fall. In the future, eye color should be noted for every specimen.

The history of research concerning eagles has been rife with error. I do not feel that this paper is free from error nor do I feel it marks the 'last word.' I hope it will arouse some discussion which will be helpful in bringing to light new ideas and interesting specimens. In view of this paper's preliminary nature, I hope to be able to add to the ideas here and expand the coverage of the discussion to all the subspecies at a later date.

SUMMARY

I have attempted to treat the problems of molting and plumage changes of the American subspecies of the Golden Eagle. I have not attempted to define subspecific variations of pattern which I believe exist. I have shown that a complete molt is accomplished in two seasons although some tracts undergo a more than 'partial' annual molt. Plumage variations are extreme, but three classes of patterns are described; a 'juvenal,' 'immature', and 'adult.' These pattern classes are variable within limits and represent the first, second and third feathers produced by each follicle. Pattern type is controlled first by the number of feathers produced by the follicle and secondly by the date at which the feather is replaced as related to a hormonal theory of pattern determination. I have described four age plumages before the full adult stage is reached. An 'adult plumage' is achieved at the close of the third molt at an age of $3\frac{1}{2}$ years although another molt may be needed to rid the plumage entirely of immature feathers.

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NOTES ON MEXICAN BIRDS

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THESE notes relate chiefly to some of the birds collected by the senior author between August 8 and September 12, 1946, while he was a member of a party led by Mr. Charles M. Bogert and including Drs. A. P. Blair and John M. Moore and Señor Rodolfo Ruibal y Cuevas, all of whom were of valued assistance in the field.

The localities mentioned are as follows:

LAS DELICIAS, COAHUILA (about 26° 20' N. Lat., 103° W. Long.).—This desert hamlet lies in a valley almost entirely surrounded by rather barren mountains. It is about 35 miles northeast of San Pedro, Coahuila. Conspicuous plants are prickly pear and cholla cactus (*Opuntia*), *Yucca*, mesquite (*Prosopis*) and, in the canyons, desert willow (*Chilopsis*). Permanent springs in two of the canyons supply water for a pond, small irrigated fields and a few fig and mulberry trees at the village, which attract many birds. There are no cottonwoods. Flickers (*Colaptes*) and Golden-fronted Woodpeckers (*Centurus aurifrons*) were absent.

SALTILLO, COAHUILA.—A little work was done near this city in country similar to that about Las Delicias but somewhat better watered and with larger yuccas and mesquite. *Colaptes* and *Centurus* were common.