more populous. The first dry year (1933), with its shortage of water and food, was very hard on the desert dwellers. The next year brought more of them into the citrus groves and orchards. Growers have told us of leaving field boxes out several days and on returning, finding quail's nests and sometimes eggs in them. Their natural nesting sites on the ground at the bases of trees and bushes were often destroyed by cultivation or flooded by irrigation. We ourselves have observed, and we also have been told of, many nests that were washed away. Some of the more thoughtful growers went to the pains of throwing up dikes around nests to protect them from irrigation water.

Our first two pictures (figs. 18 and 19) show one such nest which was protected by Mr. Carlos Stannard. This nest was photographed on May 27, 1934. It contained eight eggs, and the young were off in a few days. The male was covering the eggs and had become so used to the people that he had to be touched before he would leave.

At the end of the second dry year, quail had gathered in great numbers on irrigated places, where they found food, water and protection, but very precarious nesting places. Imagine our amazement when the Stannards called us early in June of 1935 to look at a quail's nest in a sour orange tree. This nest was in the center of the tree, four feet from the ground, and it held fourteen eggs. It was well constructed, of sticks and was better lined than ground nests we have seen. We believe it was built entirely by the quail, as it did not have a "built over" appearance and all the materials seemed fresh.

On the morning of June 21 there was much activity at the nest, and soon the parent birds were on the ground enticing the young to follow them. Later in the day it was discovered that three weaklings had been left and three eggs did not hatch. "One Swallow does not make a summer," but at least one female quail had broken a tradition to solve the problem of protecting her nest under new conditions.

Phoenix, Arizona, November 29, 1935.

AGE DETERMINATION IN THE AMERICAN CROW

WITH ONE ILLUSTRATION

By J. T. EMLEN, Jr.

In a series of bird specimens it is often convenient if not important that immatures be separated from adults. In certain species this is not easy, and many data in literature have lost much of their potential value to modern investigators through the failure or inability of ornithologists to make such distinctions.

In the course of certain recent ecological studies with eastern and western crows (*Corvus brachyrhynchos*), a proper interpretation of the data in hand required that specimens be grouped by age as well as by sex into four categories: adult male, adult female, immature male, and immature female. The well-known characters, diagnostic of age, that are associated with the degree of ossification of the skull and the presence of the bursa fabricii were found to be reliable only in summer and early fall when the fluffy juvenal contour feathers formed an equally accurate and much easier means of age identification. Similarly, the blue color of the iris and the clear horn color of the undersurface of the claws are distinctive only in very young individuals. As winter approaches, the young birds tend to accumulate larger quantities of fat around the gizzard and other viscera and generally weigh 20 to 30 grams more than adults of their respective sexes. With the approach of the breeding season the

first year birds do not show the pronounced growth of the gonads typical of older breeding birds. Through the breeding season the size of the gonads is, therefore, a good indicator of age classes.

Internal characters are, however, limited in their applicability. External characters such as those associated with the plumage, which serve equally well with prepared skins and fresh specimens, are of greatest practical value, and it is with these that the remainder of the present paper deals.

An examination of the contour feathers of a large series of birds was made without furnishing a solution to the problem. Dwight (Annals N. Y. Acad. Sci., 8, 1900, p. 154) was able to see a difference in color in the body plumages of first-winter and second-winter crows, and apparently used it in his studies of the molt of the American crow. The present writer found himself incapable of applying this character with any degree of certainty in a majority of cases. Many unmistakably adult specimens showed, to the writer's eye, the greenish gloss which Dwight described for the first-year birds. Attention was therefore directed to the flight feathers.

In the postjuvenal molt of the crow the juvenal body plumage is completely replaced, while the flight feathers are retained and carried over through the first winter and the following spring to the second fall molt. The postjuvenal molt of the American crow apparently closely resembles that of the European rook as described by Witherby (British Birds, 7, 1913, pp. 126-139), in omitting the remiges, the bastard wing, the primary coverts and most of the secondary coverts, as well as the rectrices. Any characters associated with the retained juvenal wing and tail feathers of the crow that serve to distinguish them from those which replace them in the second fall molt are useful as identification marks for first-year individuals. The following six peculiarities of these feathers were found to be useful in determining ages of specimens of the four races of North American crows (*C. b. brachyrhynchos, C. b. paulus, C. b. hesperis,* and *C. b. caurinus*).

1. In first-year birds the flight feathers, particularly the rectrices, exhibit more wear than do the corresponding feathers of adults. While this is obviously a variable and therefore not infallible character, the occurrence of heavily worn tail feathers can be linked with first-year birds in a high percentage of cases. It is therefore useful as a first step in dividing an unassorted series (fig. 21).

Wear of the juvenal flight feathers perhaps results partly from the rather severe treatment which they receive during the formative stages in the nest, but probably more particularly to an inferior construction which shows up in the brittleness of the barb tips. Fault bars are much more prevalent in the feathers of first-year birds.

2. The first-year flight feathers are less heavily pigmented, having a dull brownish cast in contrast to the glossy black of those of the adults. This is especially noticeable on the under surfaces of the wings and tail. The ventral ridge of the barbs is solidly pigmented in adult feathers, whereas in juvenal feathers it shows an almost translucent ridge capped by a narrow crest of pigmented keratin. Pigmentation in the barbules is also heavier in adult feathers.

3. The ventral aspect of the rhachis of the wing feathers, particularly that of the outer primaries and their greater coverts, is whitish nearly to the tip in first-year birds, while in adults the whitish or horn color is confined almost entirely to the furrow of the umbilical groove, and extends only part way along the rhachis.

The whitish color in the rhachis is due to the translucent quality of the keratin covering the white central pith. In the outer primary of adult birds this whitish color can be traced as a thin line between the two heavily pigmented ridges bordering the umbilical groove of the rhachis to within 15 to 20 mm. of the tip. In the first-

year birds the two pigmented ridges are finer and less heavily pigmented and can be traced on a whitish background to about the same point. Transverse sections at this point reveal a broad area of unpigmented keratin surrounding most of the ventral half of the rhachis in first year feathers. In adult feathers the keratin is pigmented from both sides almost, if not entirely, to the midventral line.

4. The shape of the rectrices, and to a less extent of the remiges, differs in the two age groups. In first-year birds the feathers are bluntly pointed or rounded in contrast to the more truncated feathers of adult birds (fig. 21). This character has been described for various species of birds and furnishes one of the best and most reliable means of age identification.

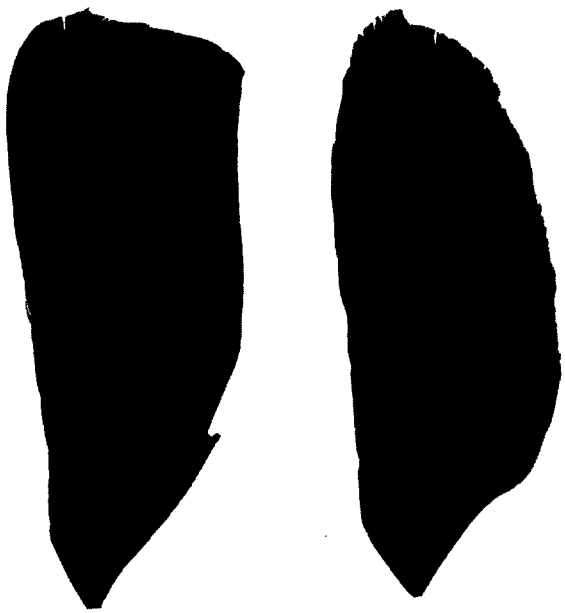

Fig. 21. Right outer tail feathers of adult (left) and immature (right) male crows taken on October 26, 1932, at Estes, New York. Compare the shapes of the two feathers and note the irregular wear of the barb tips of the immature bird's feather.

A May specimen of the western crow (*C. b. hesperis*) (no. 235191, U. S. Nat. Mus.) and a February specimen of the eastern crow (*C. b. brachyrhynchos*) (no. 57306, Phila. Acad. Nat. Sci.) possess all the characteristics of first-year birds with the exception of a few rectrices which are typically adult in nature. Since the occurrence in each case is asymmetrical it may be inferred that odd feathers lost accidentally in the first year were replaced by feathers of the adult type.

5. The shape of the tail of first-year birds is rather square, especially when the outer pair of rectrices is not considered. In adults the tail is more rounded. For example, typical adult and typical first-year specimens in the collection of the Museum of Vertebrate Zoology showed the following differences in length between the central rectrices and the next to the outermost rectrices.

	Minimum	Maximum	Average
10 adult males	7 mm.	17 mm.	12.0 mm.
7 adult females	8	23	12.5
13 immature males	2	8	4.5
18 immature females	4	8	6.7

6. The wing length of adult birds is generally, though not invariably, greater than that of first-year birds. Wings of adult males taken in mid-winter from New York state, Pennsylvania and Washington, D. C., averaged approximately 13 mm. longer than the wings of immature males from the same localities. Adult females, which are 6 to 8 mm. shorter in wing length than the adult males, have wings 12 to 16 mm. longer than the immature females from the same localities. Individual variation is, however, considerable in the crow, and several immature female specimens were actually larger than small adult males. Obviously wing measurements are of little value in themselves except as they may add weight to a tentative determination based on other characters.

Age determinations like subspecies determinations are often dependent on fine distinctions and should be based upon not one but many features. The six characters described in this paper should not be used individually, but they should supplement one another. By applying them in this manner a high percentage of conformity can be obtained, so that very few specimens had to be discounted as indeterminate.

Division of Zoology, University of California, Davis, California, January 23, 1936.

ABNORMALITIES IN BIRDS

WITH FOUR ILLUSTRATIONS

By HAROLD MICHENER and JOSEPHINE R. MICHENER

PART 1. TUMORS

Of the approximately 30,000 passerine birds we have banded over a ten-year period, about 150, a small fraction of one per cent of the total, have had tumors on the feet, legs and, more rarely, on the wings at the bases of the first primaries and on the top of the head just back of the beak. These tumors—large, rough, wart-like swellings—often cause great enlargements at one or both ends of the tarsus and in extreme cases along the whole length of the tarsus. Sometimes parts of toes or whole toes are lost, and the feet are left useless except as props. This disease seems to be mildly contagious among wild birds since it occurs in epidemics—the most severe of which extended over most of the year 1934 and a few months of 1935. As the swellings subside their exteriors become dry scabs which, when they come off, leave smooth, white skin. Later this acquires the appearance of normal skin. With the few birds in which we could follow the disease cycle from beginning to end its duration was from one to five months, with most of the cases indicating the longer period. There is not space for case histories.

We have found these tumors on Mockingbirds (*Mimus polyglottos*), California Thrashers (*Toxostoma redivivum*), Audubon Warblers (*Dendroica audubonii*), California Purple Finches (*Carpodacus purpureus californicus*), House Finches (*Carpodacus mexicanus frontalis*), Willow Goldfinches (*Spinus tristis salicamans*), Gambel Sparrows (*Zonotrichia leucophrys gambelii*), and song sparrows (*Melospiza melodia*) without any evidence that any one species is more susceptible than the others. Apparently the same disease was common in the aviaries of southern California