AGE DETERMINATION AND MOLT IN THE BOAT-TAILED GRACKLE

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The success of behavioral, gonadal, systematic, and other studies of birds may depend on proper segregation of individuals into age classes (Pitelka, 1945; Davis, 1957). This study concerns criteria of age in the Boat-tailed Grackle (*Cassidix mexicanus prosopidicola*) derived from examination of specimens from central Texas. Special attention is given to criteria by which first-year and adult birds can be distinguished, in order to compare the annual reproductive cycles of these two age groups (Selander and Hauser, MS). The investigation is also designed to serve as groundwork for the author's comparative studies of behavior and phylogeny in the grackles.

The present study is based on 328 males and 165 females collected over a 16-month period in 1956 and 1957, within a ten-mile radius of Austin, Travis County, Texas. Specimens were processed as follows: The left testis or ovary was removed and placed in Bouin's fixative in preparation for histologic studies; body weight was recorded (within two hours after death); extent of molt, if any, was recorded in detail for each feather tract and its regions; types and numbers of juvenal feathers retained through the postjuvenal molt by first-year individuals were noted; extent of skull ossification was determined; iris color was recorded; relative amount of body fat was noted; and measurements of wing, tail, bill, tarsus, and middle toe were taken. Approximately 10 per cent of the specimens were prepared as study skins or skeletons and deposited in the Texas Natural History Collection.

Age determination of males presents relatively few problems. First-year males are duller and less glossy or iridescent than adult males and generally can be recognized at a glance (fig. 2). The duller color, in combination with a shorter and narrower tail, is generally so conspicuous that first-year birds are recognizable in the field. Care must be exercised in individual cases, however, because some first-year males are nearly as iridescent and dark as adults, particularly after the prenuptial molt, and have adult-like tails.

Age determination of females is a much more difficult problem and cannot be accomplished with certainty on the basis of plumage color alone. In worn plumage, color is of little value in age determination. In studying the race *C. m. monsoni,* Phillips (1950) had only limited success in aging female museum specimens, and he stressed the need in taxonomic studies for females of known age.

The need to establish criteria by which first-year and adult females can be identified with confidence and to test the validity of plumage color as an age criterion in males has necessitated a detailed investigation of molt. Characters other than color that were examined for use in determining age are feather shape and degree of wear, retention of juvenal feathers through the postjuvenal molt, iris coloration, degree of skull ossification or double layering, and size. Using a combination of characters, it has been possible to age all specimens collected. Some characters are of value not only in *Cassidix* but in related genera of icterids as well.

MOLTS AND PLUMAGES

The plumages of *Cassidix m. major* were described in part by Ridgway (1902) and McIlhenny (1937), but the present findings for *C. m. prosopidicola* necessitate some further comment on this subject. Other than a few notes by McIlhenny (*op. cit.*) and Dwight (1900), apparently nothing has been reported concerning molt in this genus.

Pterylography of the wing.—In the following accounts of molts and plumages, the nomenclature of feather tracts and their regions employed by Pitelka (1945) in his

study of jays of the genus *Aphelocoma* has been adopted in so far as possible. Because there are major differences in pterylography of the alar tract between corvids and icterids, the following notes are provided as background for discussions of molt and retention of wing feathers by first-year birds.

In *Cassidix,* there are 9 primaries and 9 secondaries. A small feather representing either a vestigial tenth primary or a tenth primary covert is found distal to and in line with the ninth primary; this feather is approximately the same size as the ninth upper

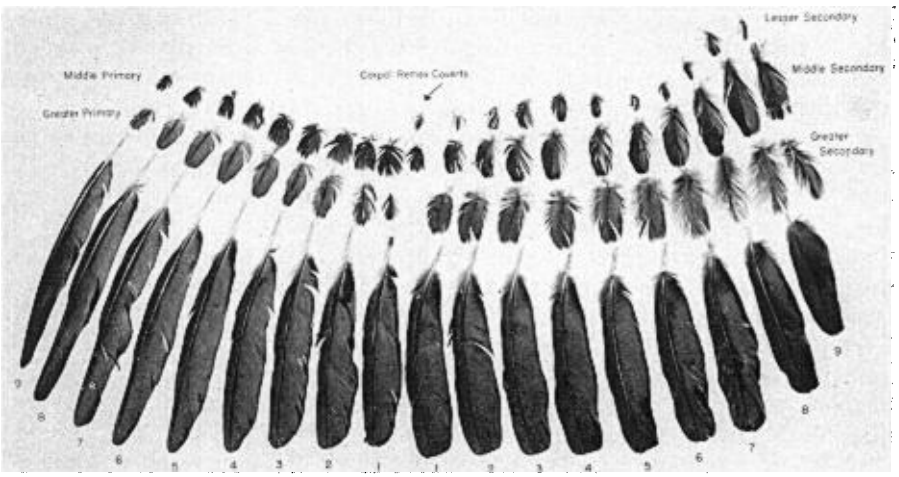

Fig. 1. Remiges and under coverts from right wing of adult male *Cassidix mexicanus,* arranged to show principal series.

greater primary covert. It molts with or immediately after the ninth primary and its coverts, not with the adjacent marginal coverts with which it might be confused.

On the under side of the wing (see fig. 1), the primaries have complete series of 9 under greater primary coverts and 9 under middle primary coverts. The latter are darker, wider, and shorter than the former. The first under greater primary covert is small, being one-half the size of the second. Under lesser primary coverts are not represented. There are series of 10 under greater secondary coverts, under middle secondary coverts, and under lesser secondary coverts. The under middle and lesser secondary coverts are darker than the greater, and the under lesser secondary coverts show considerable individual variation in size. At the distal ends of the series of under middle and lesser secondary coverts there occur an extra middle and lesser covert representing the coverts of the carpal remex.

Viewed ventrally the under greater primary and secondary coverts are slightly concave in shape, as are the primaries and secondaries; in contrast the coverts of the under middle primary and under middle and lesser secondary series are slightly convex.

In the wing dorsally, there are 9 upper greater primary coverts; the ninth is small and lanceolate, being approximately one-half as long and less than one-fourth as wide as the adjacent eighth covert. Only 8 very small upper middle primary coverts are present; the first is absent and its position is occupied by the carpal remex. There are 10 upper greater secondary coverts and 8 upper middle secondary coverts; a ninth upper middle secondary covert is absent. The carpal remex has a small covert which is in line with but smaller than the adjacent covert of the upper middle secondary series. As in *Aphelocoma* (Pitelka, 1945:232), there is a small covert lying between the covert of the carpal remex and the base of the innermost of the three feathers of the alula. Neither

primaries nor secondaries have upper lesser coverts.

Along the posterior, distal margin of the humeral region there is a series of 8 vestigial tertiaries. Proximally, this series grades into the humeral tract proper, and the distalmost feather of the series is inserted only 3 mm. proximal to the tenth upper middle secondary covert.

The pterylography of the wing is essentially similar in the related genera, *Quiscalus, Holoquiscalus, Euphagus, Molothrus, Tangavius,* and *Agelaius.* In *Quiscalus, Molothrus* and *Agelaius,* as in *Cassidix,* first-year birds frequently retain juvenal under wing coverts and some tertiaries through the postjuvenal molt. Whether this occurs in the other genera remains to be determined. Dwight (1900:159) and subsequent authors were in error in reporting that the postjuvenal molt of *Molothrus* and *Quiscalus* is complete. In *Molothrus* not uncommonly all under coverts and some long marginals on the leading edge of the patagial membrane are retained.

Juvenal plumage.—In this plumage, both sexes are buffy brown ventrally and the breast, abdomen, and flanks are irregularly streaked and blotched with dark brown or black (figs. 2 and 3). Dorsally, the birds are darker brown; the flight feathers are dull brownish black. McIlhenny (1937:275) reported that in *C. m. major* the juvenal plumages of males and females are identical, but juveniles of *C. m. prosopidicola* may easily be sexed on the basis of color differences alone. In juvenal males, the ventral dark streaking or blotching is darker and the individual streaks are much wider and, hence, more conspicuous than in juvenal females. Elsewhere in the plumage the brown color is darker (more blackish). A week after hatching, males are larger than females, and by the time of fledging the size difference is very conspicuous.

It seems probable that McIlhenny (1937:275) confused the terminal stages of development of the juvenal plumage with the onset of the postjuvenal molt. With reference to the supposed inception of the postjuvenal molt, he stated that "within a few days after leaving the nest, the young males begin to show a few dark feathers around the eye . . . ," and he claimed that feathers around the eye and on the anterior part of the crown "are the first to show the change from nestling [juvenal] to the first-year . . . plumage." In *C. m. prosopidicola,* at least, and probably within the species generally, the situation is different. The feathers around the eye in juvenal males which are darker than those of adjacent regions are late-developing feathers of the juvenal plumage. In nestlings, the eye region is naked or nearly so, and the appearance of feathers in the superciliary, ocular, loral, and anterior auricular regions is delayed until most other parts of the juvenal plumage are well grown. A similar condition is recorded for *Molothrus ater* (Friedmann, 1929:278) and is found also in *Holoquiscalus niger* (Selander, MS). These late-developing feathers are replaced in the postjuvenal molt but not until well along in the molt. They are dull brownish black and not easily confused with the more or less glossy black feathers of the first-year plumage which subsequently replace them.

Development of the juvenal under wing coverts also is delayed. At the time of fledging and for a period of several days thereafter, the juvenal under wing coverts are still growing. Generally they are darker and glossier than other contour feathers of the juvenal wing and, on this account, may be rather conspicuous. In some birds, there are a few dark feathers among the brown wing coverts, particularly near the bend of the wing. Usually some tertiaries and some late-developing feathers of the humeral tract, and, less frequently, the interscapular region are conspicuously darker than the other feathers, being about intermediate between other juvenal feathers and those of the first-year plumage. It is apparent that in late stages of development of the juvenal plum-

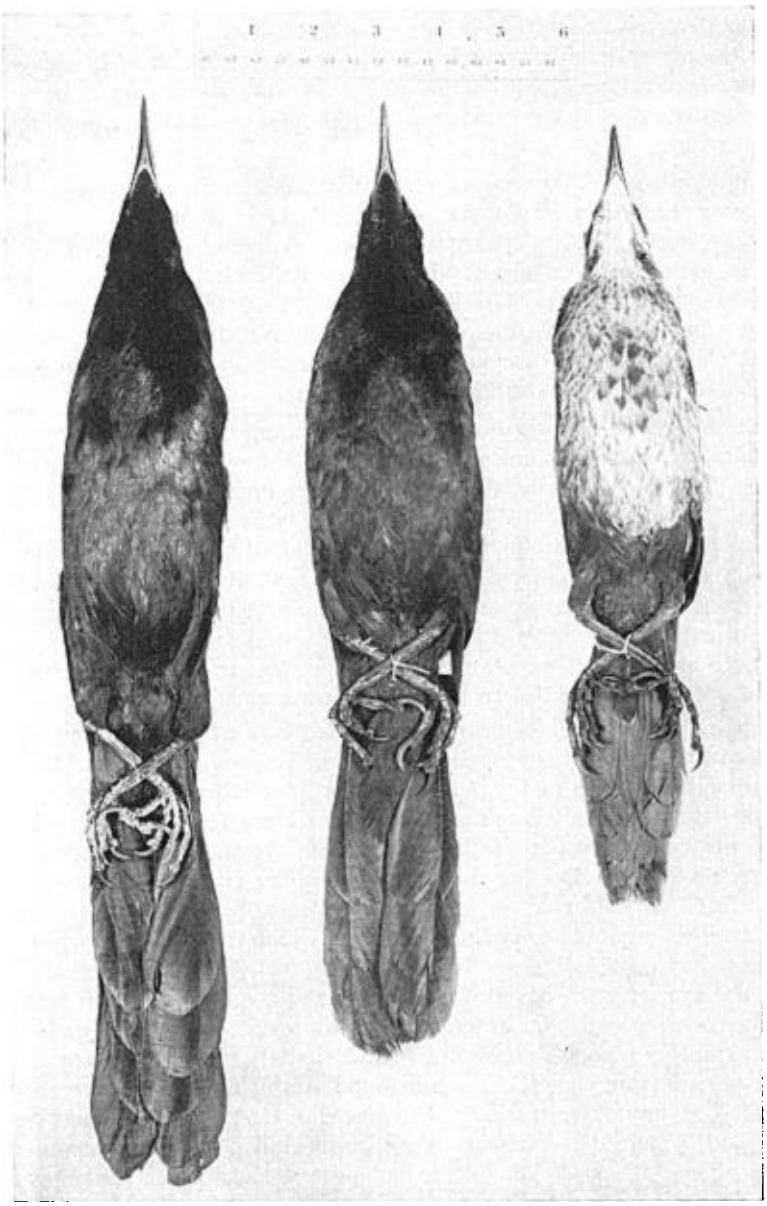

Fig. 2 Male specimens of *Cassidix m. prosopidicola* in ventral view. From left to right: adult, first-year, and juvenile.

age the color of incoming feathers depends, to some extent at least, on the degree of physiological maturity attained by the bird at that time. The presence of dark or semi-glossy feathers in juvenal males should not be mistaken for early inception of the post-juvenal molt. In the postjuvenal molt, most of the above mentioned late-developing feathers are replaced; the marginals and the head, interscapular, and humeral regions are completely replaced, but some tertiaries and under wing coverts usually are retained (see beyond).

Late appearance and precocious color development in juvenal marginals and late development of under wing coverts occurs also in *Aphelocoma* (Pitelka, 1945:234–235).

Postjuvenal and postnuptial molts.—In *Cassidix mexicanus,* the postjuvenal molt usually is incomplete, some or all juvenal *under* greater primary and secondary coverts and some juvenal feathers at the posterior margin of the humeral tract being retained.

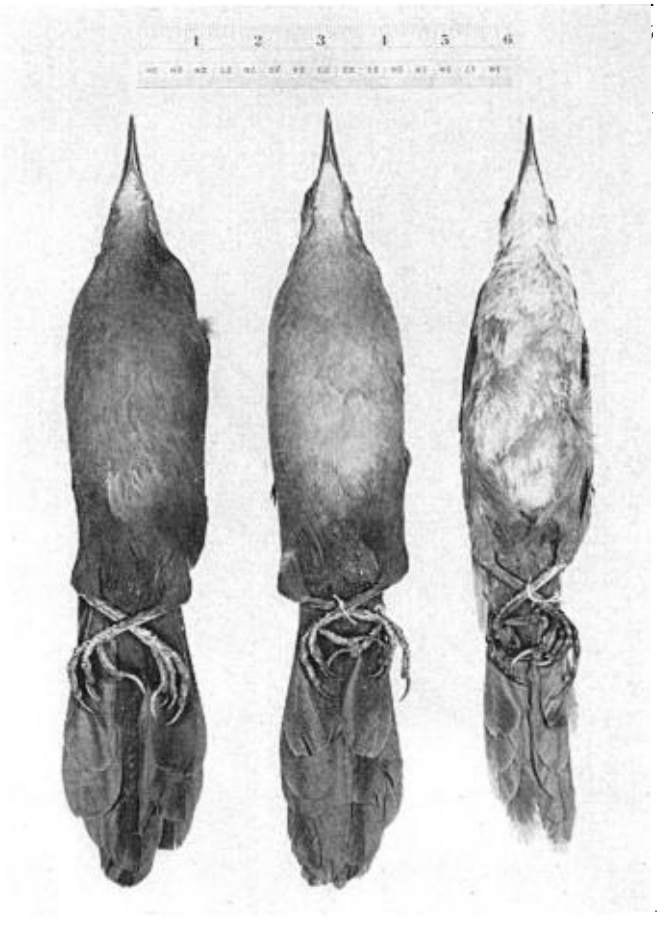

Fig. 3. Female specimens of *Cassidix m. prosopidicola* in ventral view. From left to right: adult, first-year, and juvenile.

With rare exception all other juvenal feathers, including rectrices, remiges, alula, and upper wing coverts are replaced. Aside from this feature, the postjuvenal molt is similar to the postnuptial molt and it is convenient to discuss the two together.

Inception of molt.—Both the postjuvenal molt and the postnuptial molt begin with the approximately simultaneous loss of primary 1 and its upper greater primary covert and the appearance of new glossy black marginal feathers immediately posterior to the bend of the wing. Shortly thereafter and at about the time primary 1 is one-third grown, the entire series of upper greater secondary coverts and the carpal remex are dropped, followed shortly by the series of upper middle primary coverts. Upper middle secondary

Table 1

Stages of Fall Molt in *Cassidix mexicanus*

Stage number	1	2	3	4	5	6	7	8
Primaries	1–2 dropped or growing but short	1–3 almost fully grown; 4 partly so	1–4 fully grown; 5 well grown; 6 dropped	7 dropped or partly grown; 6 partly grown; 8–9 old	8 partly grown; 9 old or dropped	9 one-fourth grown; 8 well grown	9 ⅘ or more grown, or ensheathed basally	Growth complete
Secondaries		Old or 1 and/or 8 dropped	1 fully grown; 2 three-quarters grown; 3 dropped; 4–7 old; 8 three-quarters grown; 9 dropped	3–6 old; 7 dropped	5–6 old; 3 and 4 well grown	6 old or partly grown; 5 well grown	6 ¾ or more grown, or ensheathed basally	Growth complete
Upper greater secondary coverts	Old or all dropped or breaking sheaths	One-half grown	Fully grown but ensheathed basally	Growth complete				
Alula				Old	Old or dropped	½ to ¾ grown	Growth complete	
Rectrices			Old	Dropped	One-fourth or less grown	One-half to three-quarters grown	1–3 ensheathed basally or 1–1 ⅘ grown	Fully grown except 1–1
Capital tract, dorsally		Old	Some new feathers evident	Feathers mostly old	Coronal and occipital regions one-half grown	Coronal and occipital regions refeathered; frontal reg. ¾ grown	Growth complete or few feathers growing in frontal region	
Capital tract, laterally		Old	Some new feathers evident	Feathers old or one-fourth grown	One-half grown	Three-quarters grown	All feathers at least four-fifths grown	Few feathers not fully grown
Spinal tract		Old or a few new feathers evident	One-half grown centrally	One-half grown throughout	Interscapular and cervical regions one-half grown; pelvic and dorsal regions three-quarters grown	All feathers new and at least three-quarters grown	Pelvic and dorsal reg. refeathered or few feathers growing in pelvic reg.; feathers of interscapular and cervical reg. ⅘ grown	Growth complete
Tail coverts		Old	Less than one-fourth grown	One-half to three-quarters grown	Growth complete			
Ventral tract		Old or some new feathers evident on breast	One-fourth replaced	One-half replaced centrally; old elsewhere	Old to three-quarters grown	Three-quarters to fully grown in most areas	Interramal region ¾ or more refeathered	Interramal reg. not fully refeathered

coverts are not replaced at this time, and upper greater primary coverts continue to molt one at a time with their corresponding primaries. By the time primary 3 is growing, molt has spread from the marginals at the bend of the wing to the more distal and proximal marginals dorsally and ventrally. Molt in the dorsal region of the spinal tract and sternal region of the ventral tract begins at about the time primary 5 is developing. Molt on the head is invariably initiated at a locus in the occipital region when primary 7 is developing and later spreads forward to other regions of the head dorsally.

The rectrices are lost as a unit at about the time primary 9 is dropped and after the tail coverts have been renewed. Thus the birds are tailless or bobtailed for about two weeks in the latter part of the molt period. Simultaneous molt of the rectrices in *C. m. major* was reported by McIlhenny (1937:276, 292).

Molt categories.—A total of 125 males and 79 females in fall molt was examined; this includes 41 males in postnuptial molt and 84 males in postjuvenal molt. Following detailed examination of each specimen, a series of 8 arbitrary stages of molt progress was established to permit comparisons of timing of molt in different sex and age groups in the two years (1956 and 1957) in which molt was studied. The stages (table 1) correspond in a general way to those defined for the postnuptial molt in *Aphelocoma coerulescens* by Pitelka (1945). However, some major differences will be apparent, mainly because *Aphelocoma* has 10 primaries, whereas *Cassidix* has only 9. By assigning specimens to intermediate categories, the total number of available categories was increased to 15. Each molting bird was assigned to a category and the resulting scores were plotted against time of collection in figure 4. A summary of information on timing of molt appears in table 2.

Technically, molt is not completed until the individual has passed through stage 8 and has replaced all feathers. However, for purposes of determining duration of periods of molt in individuals and in the population, birds in stage 8 are considered to have completed the molt. The amount of feather growth occurring after the time of completed growth of primary 9 and secondary 6 is relatively insignificant.

Preliminary plottings showed an absence of significant difference in timing of molt in 1956 and 1957, notwithstanding the fact that, at least for a sizable part of the adult and first-year population, the breeding season was shorter in 1956 than in 1957. In 1956 only a single brood was raised and both males and females were freed from duties connected with breeding at an earlier date than in 1957 (Selander and Hauser, MS). In figure 4, data for the two years are combined.

Molt in males.—From July 9 to October 17, all adult males collected were in molt. From figure 4, it can be estimated that the period of postnuptial molt in individual males lasts from 15 to 16 weeks or 105 to 110 days. The first adult male to complete the postnuptial molt was collected on October 17; but on the average adults complete their molt somewhat later, in the first week of November.

The data suggest that males undergoing their first postnuptial molt begin a few days earlier than older birds. Three year-old males taken between July 7 and 17 were in stages 1½ or 2, whereas three older adults collected in the same period were in stages 1 or 1½. Because the age of specimens in later stages of postnuptial molt was not determined, this problem cannot be pursued further, but it may be noted that Pitelka (1945, 1958) has demonstrated early postnuptial molt in year-old jays of the genera *Aphelocoma* and *Cyanocitta*.

Postjuvenal molt is characterized by irregularities and by great individual variation in timing, as reflected by the wide spread of categories represented by specimens taken on any one date.

Juveniles may begin molting on the average several days before adults. Three molt-

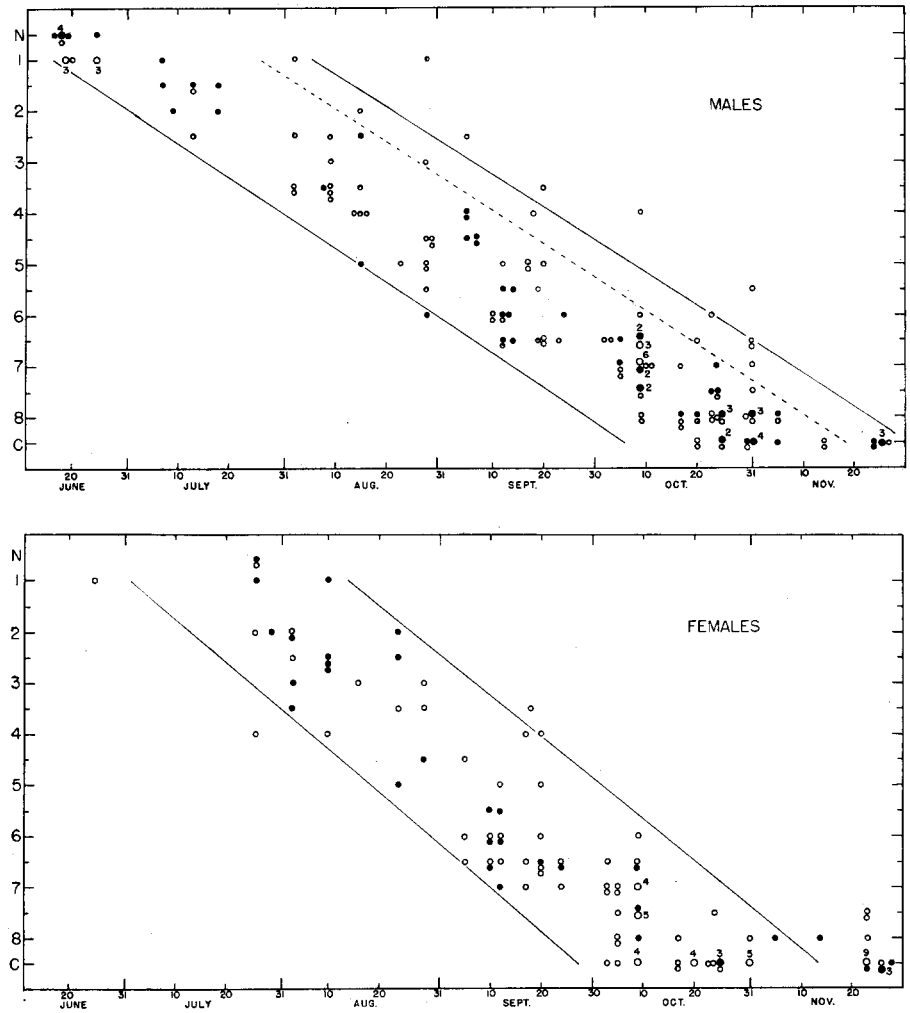

Fig. 4. Timing of molt in adult and first-year birds. Dots indicate adults, circles first-year individuals, large symbols represent two or more birds. N = no molt evident, C = molt completed, numbers from 1 to 8 refer to stages of molt. Dotted line shows separation of first-year males assigned to group A (early molting) and group B (late molting). See text for further explanation.

ing juveniles were taken on June 19 and one on June 20; one other juvenile collected on June 18 was not yet in molt. Seven adults taken in the period June 17–25 had not commenced to molt, and the first evidence of molt in adults was not seen until July 7; however, the individual taken on the latter date probably started molting about July 1. Although juveniles may begin molting slightly earlier than adults, they do not finish any earlier on the average.

It would appear that there are two fairly distinct periods of molt initiation in juvenal males. The great majority (group A in table 2) begin molting between June 19 and July 17, approximately the same time adult males are molting. The average date of inception in this group was June 29, which is about 11 days earlier than the average

Table 2

Comparison of Fall Molt in *Cassidix mexicanus*

	Males		Females	
	Postnuptial	Postjuvenal	Postnuptial	Postjuvenal
Start of molt	June 17-July 24	[1]June 19-July 17 [2]July 28-Aug. 8	July 3-Aug. 10	July 2-Aug. 10
End of molt	Sept. 28-Nov. 8	Oct. 6-Nov. 28	Sept. 26-Nov. 10	Sept. 24-Nov. 16
Period of molt in the individual	105–110 days		80–90 days	
Average date of inception	July 9	[1]June 29 [2]August 3	July 20	July 20
Latest date for specimen not yet in molt	June 25	June 19	July 26	July 26
Earliest date for specimen with completed molt	October 17	October 9	October 3	October 9

[1] Group A } see figure 4.
[2] Group B }

date for adults. Average date of inception for birds classed in group B was August 3. Birds of group B may be late-hatched individuals, perhaps products of second nestings.

Of special interest are those few juveniles whose molt progress is exceptionally far behind that of the main group of birds of their age class. The most notable of these, shown in figure 4, are: August 2, 1956, stage 1; August 28, 1956, stage 1; October 9, 1957, stage 4; and October 31, 1957, stage 5½. These birds were well below average in weight for the month in which each was taken. The bird in stage 5½ taken on October 31 weighed only 173 grams, 13 grams less than the next lightest first-year bird collected in October (table 10). In the field, it was apparent that this individual was in poor physical condition; its flight was weak and it was unable to keep up with the flock with which it was traveling. Molt was proceeding in the wing and tail and, to some extent, on the head, but molt of the sternal region apparently had stopped, despite the fact that a large medial area of juvenal feathers remained. That postjuvenal molt may in rare instances be suspended well short of completion is also demonstrated by a first-year bird collected on November 25, 1956. In this bird, there was no evidence of molt in progress. It had, however, failed to replace not only the juvenal under greater primary and secondary coverts and some tertiaries, as is usual in first-year birds, but also secondaries 3–6, rectrices 1–1, and many feathers in the interramal, loral, superciliary, ocular, and malar regions. Unlike the other abnormal individual collected on October 31, the bird was in excellent physical condition and weighed 213 grams; it was, in fact, the heaviest of five first-year birds collected in November.

Molt in females.—Molt in females requires 85 to 90 days, or about 15 days less than in males. As in the male, juvenal females, as a group, are more variable in timing than adult females, but over 90 per cent of juvenal females fall within limits determined by the span of molting adult females, and average dates of inception of postjuvenal and postnuptial molts are the same, July 20.

There are no records of suspension of postjuvenal molt in females comparable to that occasionally found in males, but in rare cases juvenal females fail to molt one juvenal primary or the central pair of rectrices.

Retained juvenal feathers in first-year birds.—Unlike the situation reported in *Aphelocoma* by Pitelka (1945), the postjuvenal molt in *Cassidix* is not invariably incomplete. In a sample of 26 males and 42 females taken from November to January and judged as first-year primarily on the basis of skull ossification, it was determined that approximately 8 per cent of juvenal males and 12 per cent of juvenal females had a complete postjuvenal molt. Percentages of first-year specimens of the two sexes that retained juvenal feathers and mean numbers of juvenal under greater primary coverts

Table 3

Retention of Juvenal Feathers by *Cassidix mexicanus* in First Year

Sex	Number	Per cent retaining some or all under greater primary coverts	Mean number of under greater primary coverts retained[1]
Male	77	90	4.3
Female	55	84	4.0
		Per cent retaining some or all under greater secondary coverts	Per cent retaining some tertiaries
Male	77	65	78
Female	55	74	85

[1] Individuals retaining no under greater primary coverts included in calculations; excluding these, mean number of primary coverts retained is 4.7 in both sexes.

retained are presented in table 3. It will be noted that a greater percentage of birds (90 per cent of males, 84 per cent of females) retain under greater primary coverts than retain either under greater secondary coverts or tertiaries.

Retained juvenal feathers are easily distinguished from new feathers, especially when replacement in a row of coverts or tertiaries is incomplete and adjacent old (juvenal) and new feathers can readily be compared. Compared to new feathers, juvenal feathers are browner (less blackish), slightly smaller, and have margins which are more frayed. These distinctions are normally apparent up until the time of the first postnuptial molt (second fall molt) and, thus, are of great value in age determination. Retained under greater primary coverts and tertiaries may be seen and sometimes counted in dry study skins, but it is difficult to examine the under greater secondary coverts without damaging the specimen by opening the wings. The present counts were made on freshly-killed, unskinned birds.

With rare exception, in cases in which partial replacement of the under greater primary coverts occurs, it is the proximal coverts that are retained. Thus, for example, covert series 1–2; 1–5; and so on are usually retained in these cases, but occasionally different series may be retained; for example, 1, 3–4, 6–7; 2–4; 1–2, 4–7; and so on. Those individuals that molt all under greater primary coverts invariably replace all under greater secondary coverts as well, and, in general, those retaining only one to three under greater primary coverts also tend strongly to replace all under greater secondary coverts. Usually it is the distal under greater secondary coverts that are retained when molt of this series is incomplete; thus, covert series 1–2; 1–6; and so forth are commonly retained, but there is a range of variation comparable to that in the under greater primary coverts.

From one to six tertiaries may be retained; these are the medial ones and are hidden by new distal and proximal tertiaries and by the new feathers of the posterior part of the humeral tract proper.

Asymmetry of replacement of coverts or tertiaries in the two wings occurs in not more than 5 per cent of specimens examined.

As mentioned previously, retention of juvenal feathers other than under greater wing coverts and tertiaries is rare. In the course of this study, one bird (male, December 19, 1956) was collected which had failed to replace rectrix 1 on one side. One male (March 14, 1957) had retained three long coverts of the leading edge of the patagial membrane; another (October 23, 1957) retained about six of these as well as under lesser secondary coverts 1–6. An abnormal adult male which had retained under greater primary covert number 7 in one wing was taken on December 19, 1956.

Since the foregoing was written, evidence has been obtained which strongly suggests that the number of juvenal birds having abnormal postjuvenal molt was greater in 1958 than in 1957. Two of six first-year males and one of three first-year females collected on February 20 and 23, 1958, showed plumage abnormalities. One male had retained juvenal primaries 1 and 2 and their upper greater coverts, secondaries 1 to 6, and about 90 per cent of the under middle primary and secondary coverts, in addition to all under greater coverts and some tertiaries. The plumage of this bird was very dull in color and the abdomen was streaked with brown. Another male had retained juvenal primaries 1 to 4 and their upper greater coverts and secondaries 1 to 6; the under middle coverts were new and plumage color was normal, however. Both birds and four normal-plumaged first-year males taken on February 20 and 23 were in early prenuptial molt. Their weights (180 and 290 grams) were normal (table 10). The abnormal first-year female had retained secondaries 2 to 6 in the right wing and 1 to 6 in the left, along with several under middle wing coverts. The weight of this bird (125 grams) was well above average. In color, the specimen was rather gray ventrally, but it was not abnormally so.

The apparent higher percentage of young birds retaining unusual types and numbers of juvenal feathers in the fall molt of 1957 probably is related to the fact that some second broods were raised in the summer of 1957 whereas none was attempted in the summer of 1956. Birds which fledged from late nestings would be relatively immature at the time of the postjuvenal molt and might on this account fail to replace some juvenal primaries, secondaries, and other feathers that are normally lost early in the molt. Evidence that the above mentioned abnormally-plumaged birds are somewhat younger than others collected in February is provided by the unusually large size of unpillared areas in their skulls. The two males had unossified patches measuring 8 and 10 mm. in diameter, whereas, as noted elsewhere, in February this diameter is normally only about 4 mm.

Prenuptial molt.—First-year males, but apparently not adult males or adult and first-year females, have a partial prenuptial molt in March and early April. This molt is sporadic and proceeds slowly, involving only a few feathers at a time. Molt centers in the head region and most frequently involves replacement of feathers of the interramal, auricular, superciliary, ocular, malar, and submalar regions of the capital tract. Often there also is some molt in the frontal, coronal, occipital, and loral regions; and in some birds there is scattered replacement in the cervical region ventrally and in the sternal and axillary regions. Less frequently some feathers of the cervical region dorsally and the interscapular region are replaced, and rarely a few feathers in the pelvic region are molted. Replacement in the auricular, superciliary, and malar regions may be complete, although generally it is not; but molt in other regions is rarely if ever complete.

Birds are highly variable individually with respect to extent of the prenuptial molt. Some individuals replace not more than a dozen feathers, while others may molt the majority of feathers of the head and anterior cervical region.

First evidence of prenuptial molt in 1957 was recorded on March 8, when a specimen was collected which showed molt in the interramal, superciliary, ocular, and auricular regions. A male, taken on March 25, had finished molting, as had another collected on April 2. Eight other males, taken between March 19 and 27, and a male collected on April 8 were molting. Six birds taken after the 15th of April had finished molting. In 1958, prenuptial molt was recorded as early as February 20, as noted elsewhere.

New feathers acquired in the prenuptial molt approach and sometimes equal those of adults in intensity of purple color and in glossiness. The effect of the prenuptial molt is to intensify the coloration of the head and anterior part of the neck, particularly the region surrounding the eye. The fact that first-year males renew feathers of the head and neck is probably adaptively related to the circumstance that these regions are prominently displayed in sexual and agonistic behavior occurring during the breeding season. By the time the prenuptial molt is finished the iris has reached full adult color. The bright yellow iris contrasts sharply with the dark glossy purple of the head and is conspicuous in sexual display.

McIlhenny (1937) made no mention of a prenuptial molt in *C. m. major,* but Lowery (1955:465) noted its occurrence in that race. A partial prenuptial molt, "chiefly confined to the neck but also affecting the head and breast," occurs in first-year male Red-eyed Cowbirds, *Tangavius aeneus* (Friedmann, 1929:337). Adult males of *T. a. aeneus* have "an irregular but always small amount of molt on the anterior parts of the body" (Friedmann, *op. cit.*:338). No prenuptial molt is reported in *Molothrus ater.*

Timing of molt.—Molt in males began at the time testes were regressing from breeding condition (Selander and Hauser, MS), but on the basis of our data it seems unlikely that there is a direct causal relationship between either this gonadal change or the accompanying supression of sexual behavior and inception of the fall molt. Similar findings are reported for the Rook (*Corvus frugilegus*) by Marshall and Coombs (1957), and Mewaldt (1958) has recently shown that molt usually begins in Clark's Nutcracker (*Nucifraga columbiana*) while the gonads are still in breeding condition. In *Cassidix,* this view is supported by the fact that juvenal birds whose gonads had not experienced cyclic development to breeding condition and regression molted very nearly in the same period as did adults. Moreover, even in older birds there was no precise relation between regression and molt inception. Although testes regressed about one month earlier in first-year males than in adults, the difference in timing of molt inception was at best 12 days. In the Redwing (*Agelaius phoeniceus*), Wright and Wright (1944:55) reported that "even though the year-old's testes regressed sooner than those of the adults . . . it does not appear that the molt starts any earlier than in the early molting adults." Lack of any mutually exclusive relationship between testicular activity and molt in *Cassidix* is indicated by the fact that fall molt is still in progress when autumnal recrudescence of testes occurs in October and by the fact that the prenuptial molt of first-year males coincides with the period of maximum rate of enlargement of the testes in March.

In *Agelaius,* Wright and Wright (*loc. cit.*) found a significant correlation in adult males between degree of advancement of the postnuptial molt and size of the regressing testes, evidence which suggests that "the physiological factors which bring about the regression of the testes may also bring about the molt . . . ." Possibly thyroid activity is involved in timing of molt and regression of testes, as pointed out to me by John Davis. In the House Sparrow (*Passer domesticus*), Davis and Davis (1954:342) found that the thyroids are active prior to molt, and they have presented evidence suggesting that "it is possible that the thyrotropic and gonadotropic functions of the pituitary are antagonistic." That thyroid activity influences molt in chickens is well known (Sturkie, 1954:

363). Assuming that pre-molt thyroid activity also depresses testicular development, it may be possible to account for the fact that the testes of some juvenal birds, which are slightly enlarged in June and the first part of July, "regress" to a completely inactive condition by August (Selander and Hauser, MS).

The delay of the postnuptial and postjuvenal molts until the young are well grown and fledged, seen in the Boat-tailed Grackle and in many other species of temperate birds, is probably an adaptation permitting maximum use of available food by the rapidly growing nestlings and reproductively active adult and first-year birds in the breeding season and by the molting population in the late summer and early fall. Various aspects of the problem of timing of events of the avian annual cycle in relation to food supplies are discussed by Lack (1954) and Pitelka (1958). Little can be added from the present study because quantitative data on food abundance are not available, except to note that both in 1956 and 1957 fall molt coincided with population highs of adult field crickets (*Gryllus* sp.) in the Austin region.

First-year and adult plumages.—The first-year and adult plumages of females are closely similar, but there are some average differences other than the usual presence of retained juvenal under wing coverts and tertiaries in first-year birds. Most of these have been noted by Phillips (1950:78). First-year females are often paler ventrally and on the sides of the head; the buff or cinnamon brown ventral color is grayer with less admixture of brown. As a result, the buff superciliary stripe is lighter and more conspicuous and the dark submalar stripe is more apparent. Ventral coloration is highly variable in both age groups, but it is especially so in first-year females, in which it ranges from dusky brown with dark shaft streaks to a rich cinnamon brown. Overlap between the age groups is too great for the character to be of much practical value in age determination, but by and large darker females are adult and paler ones are first-year. In figure 3, one of the paler first-year female specimens available is shown with the darkest adult collected. In worn plumage, the brown color of the under parts may remain more conspicuous on the breast of adult than first-year birds.

Dorsally, feathers of first-year females sometimes have narrow brown margins which are generally lacking in adults. The dorsal feathers are somewhat less iridescent than those of adults, but there is much overlap in this regard.

The rectrices, remiges, and upper wing coverts of first-year females average slightly browner and less iridescent. Also, they tend to wear and fade with greater rapidity and may be frayed and light brown in color by late spring, when those of adult females are only slightly faded. These feathers in first-year females are narrower than those of adults, and the rectrices are more rounded or less truncate terminally. This again is an average difference: mean maximum width of the outer rectrix in 10 adult females was 22.8 mm. (range, 21.0–23.6), and in 10 first-year females, 21.1 mm. (19.0–23.1).

Most of the differences mentioned above become increasingly less apparent as a result of plumage wear and fading with the advancing season. Even so, with experience it should be possible to correctly determine the age of between 65 and 75 per cent of female museum specimens using these characters alone.

Differences in first-year and adult male plumages require little further comment. The adult plumage is everywhere more iridescent, and the metallic colors are more bluish or purplish, less greenish. Following prenuptial molt, the color and iridescence of the head and neck of some first-year males may approach that of adults, but the other areas of the body which are conspicuously browner and duller, particularly the posterior under parts, makes identification a relatively simple matter.

As in females, the rectrices, remiges, and wing coverts of first-year males are duller,

paler, and narrower than in adults. The degree of overlap between males of different age groups is much less than in females. The rectrices of adult males are markedly broader and less rounded terminally than in first-year males, but, as mentioned previously, there is some overlap in this character.

Adult males are remarkably alike in color, whereas first-year males are highly variable both in color and degree of iridescence. Some "retarded" first-year males have coloration more or less intermediate between normal first-year color and that of the juvenal plumage. This is particularly evident on the abdomen, where markings similar to those of the juvenal plumage are frequently present. Viewed under good lighting conditions, even the most "advanced" first-year males are less iridescent than adults, so that 100 per cent separation of specimens is possible on the basis of color alone.

Albinism.—In view of the high frequency of albinism in some icterids (Nero, 1954), this character is surprisingly rare in *Cassidix* (Sprunt, 1958:37). Only random, partial albinism, involving absence of pigment in one or a few wing coverts, contour feathers of the body, or rectrices was recorded. This occurred in about three per cent of the specimens examined.

IRIS COLOR

Males.—Without exception, the irides of adult males are bright, intense yellow. In juveniles, the irides are dull brown; this changes over a period of several months to the adult color (table 4). The transition involves a gradual loss of brown pigment and a progressive intensification of yellow pigment. In May (1 record) the juvenal iris was

Table 4

Iris Color in First-year Birds

Month	Males		Females	
	Subadult color	Adult color	Subadult color	Adult color
August-Sept.	26	....	23	....
October	33	....	47	....
November	5	....	13	....
December	3	2	2	1
January	3	3	1	1
February	10	10	9	2
March	3	9	2	2
April	....	8	....	1
May-July	....	13	....	1
Totals	83	45	97	8

"dark brown;" in June (8 records) it was "dull yellowish brown;" and in July (2 records) it was "pale brownish yellow." There was a wide range of variation in iris color in first-year birds in August, September, and October. The average condition was "pale yellow," with extremes described as "pale whitish or grayish yellow" and "flat yellow of moderate intensity." Intensity of yellow continued to increase through November, and by December some individuals had irides that were adult in color. By January and February, 50 per cent of first-year males had adult iris color and in several other individuals the color was only slightly less intense than in adults; by March, 75 per cent were adult in color. None of 8 first-year males, taken in April, or 13 specimens, collected in May, June, and July, had subadult color.

Iris color is variable geographically in *Cassidix mexicanus* and should be carefully investigated. In adult male *C. m. major* in Louisiana, according to Lowery (1938:6),

"the region of the pupil is brown, but the periphery of the iris is yellow." In adult females of *C. m. major*, the iris is brown. According to McIlhenny (1937:275), while adult males are engaged in "battle or courtship" the iris changes from hazel to brilliant gold, as the pupil contracts. However, in *C. m. prosopidicola* there apparently is no color change during display. The pupil may be contracted, however, and the yellow iris expanded and rendered very conspicuous.

Females.—In adult females, the yellow of the iris is less intense or paler than in adult males, resembling that of first-year males taken in late November. Color changes from the juvenal brown to the adult yellow are similar to those described for males, and rates of development of adult color (table 4) would seem to be about equal in the two sexes, or, perhaps, slightly slower in females.

SKULL OSSIFICATION

Males.—In the vast majority of males, the cranium shows some unpillared or unossified areas throughout the first year of life. Occasionally, however, the skull may ossify completely as early as February, as shown in table 5. There is considerable indi-

Table 5

Cranial Condition in First-year Birds

	Males		Females	
Month	Incompletely ossified	Completely ossified	Incompletely ossified	Completely ossified
August-October	91	....	65	....
November	5	....	13	....
December	5	....	3	....
January	6	....	2	....
February	16	1	11	....
March	10	2	5	1
April	6	2	1	....
May	6	....	....	....
June	3	....	1	....
July	4	....	....	....
Totals	152	5	101	1

vidual variation in size of unpillared areas in birds taken in any one month, reflecting age differences and individual variation in speed of ossification. Thus, one individual taken in October had smaller unpillared areas than were present in some individuals taken in May. By February, the diameter of unpillared patches (generally two on either side of the cranium) normally is reduced to about 4 mm. These patches may be partially pillared and are likely to be overlooked if the cranium is not carefully examined in transmitted light. In June and July, the patches have diameters of 1 or 2 mm.

In 159 adult males examined, only four (2.5 per cent) did not have the cranium completely ossified. Presumably these birds were adults which had undergone only one postnuptial molt. The first of these was taken on August 28, 1956; it had a single unpillared area about 4 mm. in diameter on either side of the cranium. In December, 1956, three adult males having very small unpillared patches were collected. In the latter birds, it is probable that ossification was suspended and would not have gone to completion. The birds were normal adults in all other characters.

Females.—Data are less complete for females, but they indicate a rate of ossification comparable to that of males. Complete ossification in a first-year female was first

recorded on March 8, 1957. In 54 adult females examined, only two (3.7 per cent), a bird taken on August 23, 1956, and one collected on September 24, 1956, had an incompletely ossified cranium.

Pattern and variability in rate of ossification are similar to those of males.

SIZE VARIATION

Measurements are given in tables 6 and 7.

Sexual differences.—In the Icteridae, males are larger than females, and there is a wide range of variation in degree of sexual dimorphism in size (table 8). The trend is

Table 6

Measurements of Males

Dimension	Age group	Number	Period	Mean	Range	Standard deviation
Wing length	Adult	137	Oct.-July	184.3 ±0.4	173–200	4.7
	First-year	81	Oct.-July	174.5 ±0.5	165–188	4.2
Tail length	Adult	119	Oct.-July	203.8 ±0.9	178–232	9.6
	First-year	75	Oct.-July	178.9 ±0.8	165–200	6.8
Bill length	Adult	26	Aug.-Nov.	30.54	26.7–34.0	
		47	Dec.-March	30.83	28.0–33.2	
		38	April-May	31.95	29.0–34.8	
		20	June-July	32.47	29.8–37.0	
		131	Aug.-July	31.34±0.14	26.7–37.0	1.59
	First-year	26	Aug.-Sept.	27.36	22.4–31.9	
		15	Oct.-Nov.	28.91	26.6–30.5	
		35	Dec.-March	29.49	27.5–32.5	
		13	April-May	29.51	28.2–33.3	
		7	June-July	30.93	29.2–34.8	
		96	Aug.-July	28.93±0.19	22.4–34.8	1.82
Bill depth	Adult	132	Aug.-July	12.64±0.04	11.3–14.1	0.49
	First-year	97	Aug.-July	12.29±0.05	10.5–13.5	0.53
Bill width	Adult	132	Aug.-July	9.87±0.04	8.4–11.2	0.52
	First-year	98	Aug.-July	9.60±0.06	8.0–11.0	0.61
Tarsus	Adult	133	Aug.-July	46.38±0.14	41.8–50.0	1.66
	First-year	98	Aug.-July	45.89±0.18	41.3–50.0	1.80
Middle toe	Adult	134	Aug.-July	33.66±0.12	30.1–37.9	1.39
	First-year	97	Aug.-July	33.22±0.16	30.0–37.3	1.60

for increased dimorphism in species having polygamous or promiscuous mating relationships. The degree of sexual size difference in *Cassidix mexicanus prosopidicola* equals that of the promiscuous oropendolas *Zarhynchus* and *Gymnostinops*. *Quiscalus* is markedly less dimorphic than *Cassidix*. The average percentage difference for four dimensions falls between those of two species of *Holoquiscalus*, a "genus" which is lumped with *Quiscalus* by some authors, but which is, on the basis of structure (Ridgway, 1902:222-224) and behavior (Selander, MS), actually as close to *Cassidix*. It is significant that the degree of size difference in *Cassidix nicaraguensis* is intermediate between that of *Holoquiscalus* and *Cassidix mexicanus*, because *C. nicaraguensis* is in certain other respects intermediate between the more northern species of *Cassidix* and *Holoquiscalus* (Ridgway, 1902). It is obvious that the current classification of the typical grackles in

three separate genera does not adequately reflect the relationships between them and is in need of revision.

Age differences.—The wing averages 5.3 per cent longer in adult than in first-year males; in females the difference is only 2.2 per cent. Age difference in tail length is more marked; 12.2 per cent in males and 8.4 per cent in females.

Wing-to-tail ratios, expressed as wing length as a percentage of tail length, are shown in table 9. The ratio has some value as an age criterion. On the basis of this ratio alone it is possible to distinguish approximately 50 per cent of first-year females from all adult females; about 40 per cent of first-year males are distinguishable from all adult male specimens.

In adult males, there is an increase in bill length in the summer (April through July), amounting to about 1.5 mm. as compared to specimens taken between October and

Table 7

Measurements of Females

Dimension	Age group	Number	Period	Mean	Range	Standard deviation
Wing length	Adult	26	Oct.-June	143.4 ±0.2	135–150	3.5
	First-year	62	Oct.-June	140.2 ±0.1	135–147	2.7
Tail length	Adult	25	Oct.-June	144.5 ±1.2	132–154	5.9
	First-year	51	Oct.-June	132.4 ±0.7	122–145	5.2
Bill length	Adult	32	Aug.-March	24.22±0.18	22.2–25.9	0.99
	First-year	11	Aug.-Sept.	22.54	21.3–23.7	
		11	Oct.-Nov.	23.04	21.6–23.8	
		16	Dec.-March	23.66	21.4–25.9	
		1	June	24.1		
		38	Aug.-March	23.15±0.17	21.3–25.9	1.07
Bill depth	Adult	31	Aug.-March	10.38±0.06	9.9–12.3	0.32
	First-year	38	Aug.-March	10.18±0.06	9.6–11.3	0.12
Bill width	Adult	32	Aug.-March	7.99±0.12	7.1–8.9	0.46
	First-year	38	Aug.-March	7.97±0.09	7.2–9.4	0.54
Tarsus	Adult	31	Aug.-March	38.50±0.24	35.7–40.8	1.31
	First-year	38	Aug.-March	38.11±0.25	35.1–40.5	1.56
Middle toe	Adult	31	Aug.-March	28.05±0.22	25.8–30.1	1.20
	First-year	38	Aug.-March	27.75±0.20	25.4–30.4	1.22

March (table 6). Presumably a comparable increase occurs also in females, but insufficient data are available for the summer months (table 7). This increase is probably related to a seasonal change in diet; grackles eat greater amounts of insects in summer than in winter (Beal, 1900). Davis (1954:148) has demonstrated similar summer increase in bill length in the Brewer Blackbird (*Euphagus cyanocephalus*) and some other passerines. He suggested that the most likely cause "is the reduced amount of wear put on the constantly growing bill tip by a diet rich in insects." It may be noted the degree of seasonal variation in *Cassidix* is great enough to warrant consideration in studies of geographic variation in bill length.

In first-year birds, there is a gradual increase in bill length through the first year of life, but on the average the bill is nearly fully grown by December. Period for period bill length averages slightly less in first-year birds than in adults.

Seasonal variation in body weight.—Data on body weight are presented in table 10 and figure 5. In all months, first-year birds average less in weight than adults.

In August, average weight of adult males was less than at any other time of the year.

Table 8

Sexual Dimorphism in Size and Mating Relationship in Various Icterids

(Percentage Difference Between Sexes)

Species and race	Wing	Tail	Bill length	Tarsus	Mean	Mating relationship of species
Cassidix mexicanus prosopidicola	22.2	29.1	20.7	17.0	22.3	Promiscuous[1]
C. m. major	22.1	26.8	18.8	17.5	21.3	Promiscuous[2]
C. m. mexicanus	20.2	27.4	18.7	15.7	20.5	Promiscuous[3]
Cassidix palustris	22.4	27.2	14.0	17.3	20.2	Unknown; promiscuous?
C. nicaraguensis	18.0	25.9	14.9	14.7	18.4	Unknown; promiscuous?
Holoquiscalus niger niger	15.7	14.8	13.4	10.0	13.5	Monogamous and probably polygynous[4]
H. lugubris guadeloupensis	12.5	11.9	10.9	8.6	11.0	Unknown
Quiscalus quiscula quiscula	11.1	17.4	13.6	6.3	12.1	Monogamous (and polygamous?)[4]
Euphagus cyanocephalus	8.5	10.0	11.1	5.6	8.8	Mainly monogamous; polygyny common[5]
Euphagus carolinus	5.7	9.3	2.7	0.0	4.4	Monogamous
Dives dives	11.2	8.5	8.5	4.6	8.2	Monogamous[3]
Scaphidura orizivora	21.7	23.0	12.6	8.6	16.5	Probably promiscuous[3]
Tangavius aeneus aeneus	11.5	7.7	10.8	9.4	9.9	Unknown
Molothrus ater ater	8.5	11.2	11.1	4.9	8.9	Monogamous?[8]
Agelaius phoeniceus phoeniceus	18.2	19.1	18.2	14.2	17.4	Mainly polygynous; occasionally monogamous[6]
Icterus spurius	6.4	3.8	3.7	0.0	3.5	Monogamous
Icterus galbula	8.4	9.6	4.4	3.4	6.4	Monogamous
Amblycercus holosericeus	9.6	7.1	3.2	7.0	6.7	Monogamous[3]
Zarhynchus wagleri wagleri	28.6	22.8	24.7	17.2	23.3	Promiscuous[7]
Gymnostinops montezuma	24.8	22.8	23.5	20.0	22.8	Promiscuous[3]

[1] Selander and Hauser (MS); measurements for *Cassidix mexicanus* from present study and Lowery (1938); other measurements from Ridgway (1902).
[2] McIlhenny (1937).
[3] Skutch (1954).
[4] Selander (MS).
[5] Williams (1952).
[6] Nero (1956).
[7] Chapman (1928).
[8] Bent (1958); Friedmann (1929).

This is due in part to the fact that at least one "new" adult in first postnuptial molt is included in the sample. This bird weighed only 175 grams and apparently was not quite fully grown, although it was at least 13 months old. First-year males averaged 12 grams less than adults in August, at which time some first-year birds were still in a phase of rapid growth.

In September, there was an increase in average weight in both age groups of males. Food was plentiful and the birds accumulated fat as they were molting. The apparent slight drop in weight in October may be due to sampling error; but because it is shown in both age groups, there is reason to suspect that it is real and reflects the strain of physiological demands imposed by the molt, which was drawing to a close, and by autumnal sexual activity, which reached a maximum in mid-October (Selander and Hauser, MS). Food was less readily available in October than in September.

Weight of males remained relatively constant from November through March, but the data suggest a gradual loss in both age groups through December, January, and February. In this period, food was relatively scarce, temperatures were low, and rain was frequent. Long flights were made in search of foraging grounds.

The initiation of testicular development in February was not accompanied by a

Table 9

Wing to Tail Ratios in *Cassidix mexicanus*

(Wing Length as Percentage of Tail Length)

Age and sex	Number	Mean	Range	Per cent in which wing length equals or exceeds tail length
Adult male	118	90	80–98	0.0
First-year male	74	98	91–103	28.0
Adult female	24	101	95–107	58.3
First-year female	50	94	89–101	8.0

significant change in body weight. However, in March weight of adults apparently was increasing and it reached a maximum in April, coincident with the attainment of maximum testis volume. Body weight and testis volume of first-year males peaked a month later in May. In both adult and first-year males, testis regression was accompanied by a significant decrease in body weight. Regression occurred approximately one month earlier in first-year males (Selander and Hauser, MS).

In February and March, weight of adult females remained near the December-January level, but that of first-year birds fell off slightly.

Almost no data are available for females in the breeding season. A first-year female taken on June 25 weighed 110 grams.

Table 10

Monthly Body Weights, 1956–1957

Age group and month	Males				Females			
	Number	Mean	Range	Standard deviation	Number	Mean	Range	Standard deviation
First-year								
August	25	184.9±2.4	159–203	12.1	6	113.7	106–120	
September	16	196.3±3.7	172–230	14.7	18	114.6±1.2	105–120	5.0
October	42	191.4±1.5	171–212	9.6	51	113.9±1.0	99–138	7.1
November	5	203.8	189–213		13	117.5±2.0	102–129	7.2
December	5	199.8	192–208		5	119.0	113–123	
January	5	198.8	192–212					
February	13	193.2±3.4	169–210	12.1	12	114.0±2.4	99–126	8.4
March	12	189.8±2.6	175–209	9.0				
April	7	194.0	185–209					
May	6	203.5	191–217					
June	3	183.0	173–188					
July	4	187.5	177–194					
Adult								
August	4	197.0	175–209		15	116.4±2.3	102–131	8.8
September	9	211.3	195–223		10	120.7±1.3	114–129	4.2
October	23	205.9±2.6	187–240	12.7	5	115.8	110–124	
November	7	213.3	200–236		6	119.8	105–132	
December	12	212.7±4.8	185–237	16.9	6	123.2	117–129	
January	16	208.5±3.5	181–235	14.0				
February	11	206.0±3.3	187–217	10.9	6	121.6	117–126	
March	9	211.9	197–243					
April	17	227.1±3.1	205–250	12.8				
May	21	219.7±2.8	199–244	12.9				
June	17	225.6±3.5	204–253	14.6				
July	3	202.0	195–207					

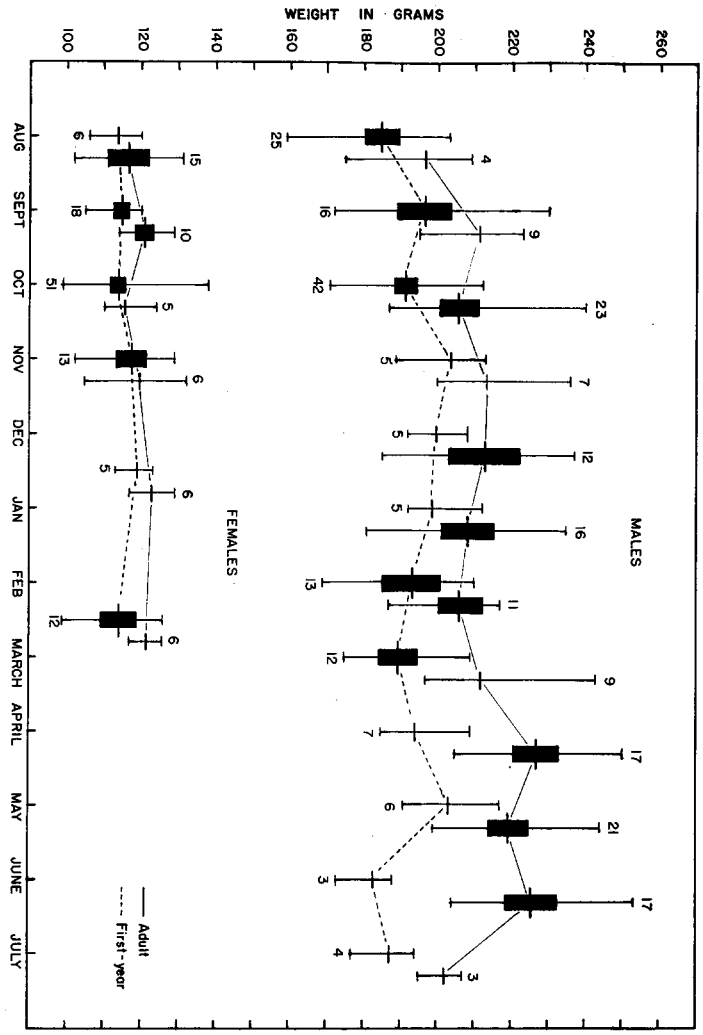

Fig. 5. Seasonal variation in body weight in different sex and age groups of *Cassidix m. prosopidicola*, showing sample size, mean, twice standard error of mean on either side of mean, and range.

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SUMMARY

Age determination and molts and plumages in *Cassidix mexicanus* have been studied, based on 493 specimens of *C. m. prosopidicola* from the Austin region, Travis County,

Texas. Using a combination of criteria it was possible to determine the age of all specimens examined.

The pterylography of the under wing and the sequence of molts and plumages are described.

The postjuvenal molt in *Cassidix mexicanus* and in at least some related genera of blackbirds is usually incomplete, some or all juvenal under greater primary and secondary coverts and some juvenal tertiaries being retained. In *Cassidix mexicanus* the postjuvenal molt is complete in eight per cent of the males and 12 per cent of the females.

The period of the postjuvenal and postnuptial molts in males lasts from 105 to 110 days; in females the molt period is 80 to 90 days. Juveniles undergoing postjuvenal molt and males undergoing first postnuptial molt may begin molting a few days earlier than older birds. Postjuvenal molt is characterized by irregularities and great individual variation in timing, especially in males. In rare cases, the postjuvenal molt is suspended well short of completion. The proportion of juveniles having abnormal postjuvenal molt was apparently greater in 1957 than in 1956.

There is no evidence of a direct relationship between testis regression and the inception of the fall molt.

In the vast majority of birds, the cranium remains incompletely ossified or pillared throughout the first year of life, but occasionally it may be completely ossified by February. In some individuals, ossification is suspended. Iris color changes from brown in juveniles to bright yellow over a period of months. Some individuals have adult iris color by December; in others the color may be subadult as late as March.

In the Boat-tailed Grackle, sexual dimorphism in size approaches an extreme among icterids illustrated also by the oropendolas *Zarhynchus* and *Gymnostinops*, that is, among members of the family in which mating is polygamous or promiscuous. In the Icteridae, there is a trend of increase in size dimorphism between sexes in those species showing such mating relationships.

In adult males, there is an increase in bill length in the summer, a phenomenon probably related to seasonal changes in diet. In first-year birds, bill length gradually increases through the first year of life.

Weight of adult males began increasing in March, a month after testicular development was initiated, and it reached a maximum coincident with attainment of full testis volume in April. Body weight and testis volume peaked a month later in first-year males. In both age groups, testis regression was accompanied by a loss of weight.

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