AGE AND SEX DETERMINATION OF NESTLING COMMON GRACKLES

By Paul B. Hamel

In the absence of information on a cloacal protuberance or incubation patch, adult Common Grackles (*Quiscalus quiscula*) can be sexed with wing and tail measurements (Wood, 1969). Some evidence exists that culmen, tarsus, and weight measurements can also be used to determine sex (Snyder, 1937). In all of these measurements the males are larger than the females although some overlap occurs. Nestlings of the Red-winged Blackbird (*Agelaius phoeniceus*), another sexually dimorphic icterid, can be sexed (Nero, 1960) and aged (Holcomb and Twiest, 1971) with external measurements. The present study was conducted to develop a scheme to age young birds, to determine criteria for sexing nestling grackles of known age, and to complement and evaluate an earlier sexing scheme by Willson et al. (1971). No effort was made to determine growth rates. A preliminary study of young grackles in 1968 indicated pronounced size differences among nestlings late in nest life and that a color phase phenomenon might be associated with these size differences.

MATERIALS AND METHODS

The work was carried out from April to June in 1970 and 1971. The primary study area was a wet second-growth aspen (*Populus tremuloides*) forest of 20 acres on the Rose Lake Wildlife Research Center, Shiawassee Co., Michigan. Preliminary data were gathered in 1968 at Manhattan Marsh, a 1.3 acre buttonbush (*Cephalanthus occidentalis*) swamp, near East Grand Rapids, Kent Co., Mich.

Eggs were individually marked with nail polish in the Rose Lake colony in 1971. Young birds were individually marked on the tarsus or toes using a black felt-tip marker during their early nest life. The felt-tip marker is preferable to nail polish for marking young because it is easier to apply, lasts just as long, and dries quicker than nail polish. Birds were banded with U. S. Fish and Wildlife Service aluminum bands after the 8th or 9th day in the nest and color-banded with plastic leg bands on the 11th or 12th day. When the birds are banded or color-banded at an earlier age, there is a high incidence of lost or maimed nestlings resulting from attempts by the parent birds to dispose of the bands.

Young were weighed in the field using a Pesola scale (100 x 1 g divisions) obtained from Bleitz Wildlife Foundation, Hollywood, California. Wing chord, tail, tarsus, culmen, and the innermost primary on the right wing were measured to the nearest 0.5 mm with a ruler. Wing chord was measured from the bend of the wrist to the tip of the manus in very young birds and to the tip of the longest primary in older nestlings, the tail from the base of the central rectrices to the tip of the longest central rectrix, the tarsus from the center of the tibiotarsal joint to the last undivided tarsal scute on its distal end, the culmen from the tip to the posterior end of the cornified area, and the innermost primary from its base to the tip.

In addition, the proportion of this primary's length split from the sheath (per cent split) was recorded.

The three color phases refer to the color of the pin feathers of the crown and upper breast viewed in good light. These phases are regions along a color continuum rather than discrete sets. "Charcoal" birds are very dark, almost black in coloration and appear rather glossy. "Light gray" individuals are much paler, gray or tan gray, and appear dull rather than glossy. Two of the 70 nestlings collected in 1970 had blurred vertical breast streaks in addition to being "light gray." Two of 34 nestlings handled in 1968 were also light gray with streaks. "Intermediate" birds are an intermediate gray color and not glossy.

Seventy nestlings collected for sex determination contributed significantly to a near-100% mortality at the Rose Lake colony in 1970. The birds were taken in either the 9th, 10th, 11th, or 12th day of nest life. Sex was determined by gonadal examination and the same measurements were taken on these specimens as on the living nestlings. The sex ratio of this sample was not significantly different from 1:1 (34:30; 6 unknown sex). All of the specimens were deposited in the Michigan State University Museum as spirit or skeletal material.

Measurements of the nestlings were used to derive equations for age determination. Computations were carried out on the CDC 3600 computer at the Michigan State University Computer Center, using 'LS', a least-squares routine in the university's statistical package, and double-precision arithmetic.

RESULTS AND DISCUSSION

Aging the Nestlings

Growth of all the structures measured is non-linear (Eyer, 1954) except the percent split of the innermost primary. This measure increases in approximately linear fashion after the tip of the feather first erupts on about day 5 (called "fringing" by Holcomb and Twiest, 1971). All data points except percent split were therefore transformed to the respective common logarithmic values before computation. The tail measurement was not used nor were young less than four days old included because of insufficient data.

Four equations were generated from different combinations of the variables for young 4-13 days old; each explained more than 99.95% of the variation in the data. The following equation yielded minimum standard error of estimated age:

$$A = -6.0144 + 12.9709(\log W) + 0.0301(S) - 4.9715(\log M)$$

standard error = 0.8311 days; $F = 397.1087$, df(3, 178); $P < 0.0005$.

A = age in days; W = wing chord in mm; S = percent split; M = weight.

The equation is used by measuring the wing chord, percent split of innermost primary, and weight. The wing chord and weight measurements are converted to logarithms, the values entered into

TABLE 1. Summary of data used in derivation of aging and sexing schemes. Numbers are mean ± SD and range.

Age, in days	No. of nestlings	No. of nests[1]	Wing chord	Per cent of primary shaft split	Tarsus	Culmen	Weight
4	11	3	23.7±17.2 (15 - 31)	—— ——	19.7± 8.7 (13 - 23)	8.4±13.7 (7.5 - 11)	26.8±21.2 (10.5 - 35)
5	10	4	29.4±17.8 (17 - 37.5)	2± 7.7 (0 - 5)	20.7±10.8 (14 - 25)	10.4±3.2 (8.5 - 12)	32.6±29 (13 - 40)
6	16	4	36.7±32.9 (20 - 53)	4.1± 7.8 (0 - 5)	24.3±11 (17 - 28)	11.3± 5.7 (9 - 12)	39.1±35.5 (14 - 51)
7	3	1	44.3± 5.9 (41 - 49)	5±0 (5)	26.3± 4.1 (23 - 28)	11.5± .7 (11 - 12)	51.8± 4.1 (48.5 - 54)
8	13	4	49.8±26.7 (34 - 60)	10.6±32.7 (0 - 33)	28.2± 6.5 (24 - 30)	12.8± 3.9 (10 - 14)	53.4±35.9 (35 - 72)
9	46	13	60.6±52.1 (44.5 - 75)	24.1±75.3 (5 - 54)	30.9±16.9 (24 - 36)	13.7± 7.2 (11 - 16)	57.1±77.2 (28 - 76.5)
10	40	11	67.7±48.5 (47 - 79)	37.4±68.9 (20.6 - 66.6)	32.1±13.3 (26 - 36)	14.0±6.1 (11.5 - 16)	59.2±71.2 (29 - 77)
11	25	7	74.4±46.4 (51 - 88)	46.9±62.6 (22 - 72)	32.6±14.8 (25 - 37)	14.8± 6.0 (12 - 17)	60.0±61.9 (25 - 80)
12	15	5	76.4±34.1 (55.5 - 89)	60.3±45.5 (34.9 - 74)	32.4±10 (26 - 36.5)	14.7± 4.6 (13 - 17)	56.5±32.8 (40 - 66)
13	3	3	82.3±11.3 (77 - 91.5)	70.9±10.6 (65 - 79.3)	31.7± 2.9 (30 - 34)	15± 1.2 (14.5 - 16)	62.3± 8.2 (58.5 - 69)

[1]Not the total number of nests as several were sampled more than once.

the equation, and the age is computed. For example, if a nestling weighs 53.0 g (log 53 = 1.7242), has a 56.0 mm wing chord (log 56 = 1.7481), and its innermost primary is 22% split, its age = $-6.0144 + 12.9709(1.7481) + 0.0301(22) - 4.9715(1.7242) = 8.8$ days.

All clutch sizes from one to five are represented in the data set, which is summarized in Table 1. When the average estimated age of all nestlings in a single nest was taken as an estimate of their age, the standard error of estimated age was reduced to 0.7 days.

Most estimates of age determined by this equation will thus be within ± 1 day of actual age. Common Grackles hatch asynchronously, as many as 36 hours elapsing between the hatching of the first and the last eggs in a clutch. The assumption made in this study that all young in a nest are the same age is, therefore, not accurate. However, an individual approaching a nestful of young grackles for the first time with the objective of banding them cannot safely make another assumption that one or two particular young are much older than the others. Such an assumption would be even more hazardous when the sex of the nestlings was also to be determined (cf. Willson, 1966).

If it is impossible to weigh the birds, a second equation, which allows computation of the age based solely on wing chord, is as follows:

$$A = -12.3748 + 12.2477(\log W)$$

standard error = 1.0470 days; F = 682.8293, df(1, 180); $P < 0.0005$.

Sexing the Nestlings

Differences in measurements and color phase were examined as possible predictors of sex for each of the ages (9-12 days) represented in the 1970 sample of 70 nestlings. No significant differences between the male and female means were noted for any measurement at any age. Variations in wing chord, innermost primary length, tail length, and weight of the specimens were so large that these characteristics were eliminated from any other consideration, leaving culmen and tarsus measurements as the most reliable characters to use for sexing the young. Variations in even these two characters were very large among 9- and 10-day old birds so only culmen and tarsus data for 11- and 12-day old nestlings were used for the following analysis. Figure 1 presents the data on these 28 nestlings. The ages (11 and 12 days) are pooled because essentially no difference in culmen and tarsus existed between these two ages.

From these data criteria for sexing the 11- and 12-day old nestlings were determined as follows: the lower limit of the male distribution for both tarsus and culmen was set above the measurement of the largest female, and the upper limit of the female distribution was set below the measurement of the smallest male (Table 2). The largest female measurements for tarsus and culmen were greater than the smallest male measurements. Individual nestlings whose measurements lie between those of the largest female and those of the smallest male cannot be identified. The criteria were not established based upon confidence intervals around the mean values of males

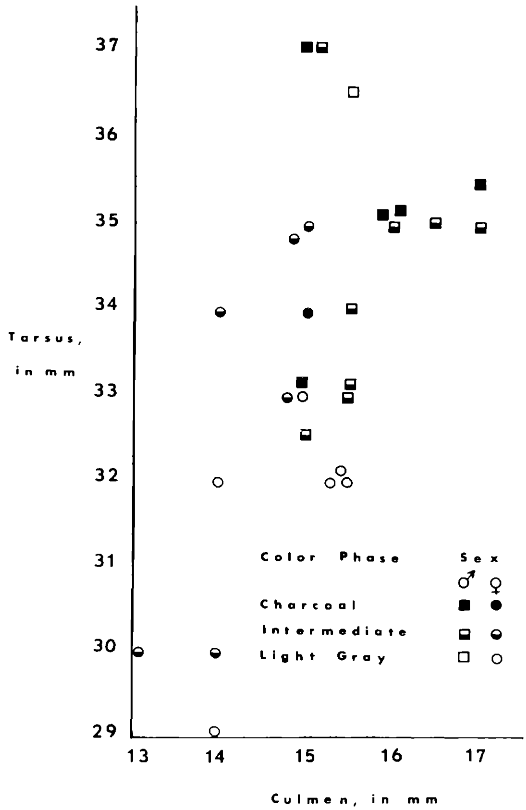

FIGURE 1. Tarsus and culmen measurements and color phase of 11- and 12-day old nestling Common Grackles. One "Intermediate" female (tarsus = 25 mm, culmen = 12 mm) has been omitted from the graph to conserve space. The remaining 27 11- and 12-day old nestlings from the Rose Lake sample in 1970 are included.

and females. In sexing animals externally using differences in length of various features, mean values are less importantt han the overlap in the ranges of male and female values. Each individual is only one point in a distribution and cannot be identified if the ranges of both sex classes overlap its measurement, even though the classes have significantly different means. Conversely, an individual can be sexed if its measurement lies in an area of non-overlap, irrespective of differences in mean values.

Application of the sexing criteria to the 28 nestlings in the original sample allowed identification of 18 (64%) into known sex categories. The proportion of unidentifiable young in the sample is not a very high number considering that about 20 % of the adults are intermediate in measurements and thus unidentifiable (Wood, 1969). The broad overlap of the measurements of the two sexes for both

TABLE 2. Criteria for sexing nestling grackles 11- and 12-days old.

Criterion	Component classes		Sample differentiated
1. Tarsus[1]	$> 35 = ♂$		4 ♂
measurement	$32 < X \leq 35 = U$[2]		10 ♂, 6 ♀
alone	$\leq 32 = ♀$		8 ♀
		identified	12 - 43%
		unknown	16 - 57%
2. Culmen	$\geq 16 = ♂$		6 ♂
measurement	$15 \leq X < 16 = U$		8 ♂, 8 ♀
alone	$< 15 = ♀$		6 ♀
		identified	12 - 43%
		unknown	16 - 57%
3. Combination of Tarsus and Culmen measurements			
Tarsus > 35 and/or Culmen $\geq 16 = ♂$			9 ♂
Tarsus intermediate AND Culmen intermediate = U			5 ♂, 5 ♀
Tarsus ≤ 32 and/or Culmen $< 15 = ♀$			9 ♀
		identified	18 - 64%
		unknown	10 - 36%
4. Tarsus length	$\geq 33 = ♂$		13 ♂, 6 ♀
Illinois	$31 \leq X < 33 = U$		1 ♂, 4 ♀
(Willson et al., 1971)	$< 31 = ♀$		4 ♀
		identified	17 - 61%
		unknown	5 - 18%
		MISIDENTIFIED	6 - 21%

[1]All measurements expressed in millimeters
[2]U = unknown sex

tarsus and culmen necessitated that the sexing criteria presented here include a wider range of intermediacy than Willson et al. (1971) allowed, based upon their data from Illinois birds.

Data from this study permit comparison of length of tarsus criteria used in the two sexing schemes. The tarsus criterion of Willson et al. (1971) is included in Table 2. The sample of nestlings used was the sample collected at Rose Lake in 1970. Because these birds were younger than the 13-day old birds for which the criteria were designed it might be expected that slowly maturing males would be misidentified as females. However, the scheme incorrectly identifies six females as males, more than are correctly identified as females, and no males are misidentified. It is not clear how the sex of the Illinois nestlings was determined. Therefore, caution should be exercised in applying the criteria of Willson et al. (1971) in sexing young grackles.

Contingency analysis based upon sex and color phase of nestlings using the G-test is shown in Table 3. Color phase does not appear to have any direct relation to size (Fig. 1), but it is significantly related to sex (Table 3). The probability of obtaining at random the distribution in Table 3 is < 0.05. This character is not an accurate one for sexing the young, however, since all three color phases occur in both sexes. It is not known if this color phasing is related to the iridescence of the adult plumage but the possibility seems worthy of further study.

TABLE 3. Color phase distribution in nestling grackles.

Sex	Color Phase Charcoal	Intermediate	Light Gray[1]	Total
Male	6 (5)[2]	19 (8)	3 (1)	28 (14)
Female	3 (1)	15 (7)	11 (6)	29 (14)
Total[3], [4]	9 (6)	34 (15)	14 (7)	57 (28)

[1]With pronounced streaking of the breast in two of 61 individuals.
[2]Numbers in parentheses indicate 11- and 12-day old nestlings.
[3]Data from Rose Lake, 1970; $P < 0.005$ of obtaining the total distribution at random.
[4]$P < 0.05$ of obtaining the distribution of 11- and 12-day old nestlings at random.

The criteria for sexing nestling grackles presented here are not statistically significant and they are based upon limited sample sizes. They must therefore be used with caution. Tables for field use including these sexing criteria and conversions of wing chord, per cent split of innermost primary, and weight measurements into values for the equations presented above are available on request from the author.

SUMMARY

Based upon data collected in central Michigan in 1970-71, a scheme for age and sex determination of nestling Common Grackles is presented. Two equations relating age in days with various combinations of external morphological characters were derived using regression techniques. The scheme for sexing 11- and 12-day old nestlings involves a combination of tarsus and culmen measurements. Broad overlap in size exists between male and female grackle nestlings as is the case with adults. A previously unrecorded color phase series among the nestlings is discussed.

ACKNOWLEDGMENTS

This study was supported in part by a grant from the Josselyn Van Tyne Memorial Fund of the American Ornithologists' Union.

LITERATURE CITED

EYER, L. E. 1954. A life history study of the Bronzed Grackle *Quiscalus quiscula versicolor* Vieillot. Unpubl. Ph.D. dissertation, Michigan State Univ., 158 p.

HOLCOMB, L., AND G. TWIEST. 1971. Growth and calculation of age for Red-winged Blackbird nestlings. *Bird-Banding*, **42**: 1-17.

NERO, R. W. 1960. Identification, Redwinged Blackbird. *In* U. S. Bureau of Sport Fisheries and Wildlife. 1961, "Bird-Banding Manual", mimeo, 88 p.

SYNDER, L. L. 1937. Some measurements and observations from Bronzed Grackles. *Can. Field-Nat.*, **51**: 37-39.

WILLSON, M. F. 1966. Breeding ecology in the Yellow-headed Blackbird. *Ecol. Monogr.*, **36**: 51-77.

WILLSON, M. F., R. D. ST. JOHN, R. J. LEDERER, AND S. J. MUZOS. 1971. Clutch size in grackles. *Bird-Banding*, **42**: 28-35.

WOOD, M. 1969. A bird-bander's guide to determination of age and sex of selected species. University Park, Penn., Penn. State Univ.

Dept. of Park & Recreation Resources, Michigan State University, East Lansing, Mich. (Present address: Dept. Recreation and Park Administration, Clemson University, Clemson, S. C. 29631).

Received 30 March 1973, accepted 4 September 1973.