A LIFE-HISTORY STUDY
OF THE BRONZED GRACKLE,
QUISCALUS QUISCULA VERSICOLOR
VIEILLOT

Thesis for the Degree of Ph. D.
MICHIGAN STATE COLLEGE
Lester E. Eyer
1954

This is to certify that the

thesis entitled
A Life-History Study of the Bronzed Grackle,

Quiscalus _quiscula_ _versicolor_ _Vieillot_.

presented by

Lester E. Eyer

has been accepted towards fulfillment
of the requirements for

Ph. D. degree in Zoology

George J. Wallace
Major professor

Date February 26, 1954.

O-169

A LIFE-HISTORY STUDY OF THE BRONZED GRACKLE,
Quiscalus quiscula versicolor Vieillot

By

Lester Emery Eyer

AN ABSTRACT

Submitted to the School of Graduate Studies of Michigan
State College of Agriculture and Applied Science
in partial fulfillment of the requirements
for the degree of

DOCTOR OF PHILOSOPHY

Department of Zoology

1954

Approved George J. Wallace

Lester Emery Eyer

The life history of the bronzed grackle, Quiscalus quiscula versicolor, was the subject of intensive study in the vicinity of East Lansing, Michigan, during 1951 and 1952. Emphasis was placed on the nesting cycle, particularly of those birds breeding in marshes and swamps. Other phases of the study included: (1) post-nesting activities of family groups, (2) the development of hand-reared birds kept in captivity for a year, (3) food habits, based on the analysis of 20 stomachs and supplemented by a review of the literature, and (4) roosting and flocking of grackles in mixed flocks of starlings and cowbirds in willow-thicket and maple-tree roosts. As a secondary objective the literature was reviewed for: (1) the complicated history of the taxonomy and nomenclature of the genus Quiscalus, and (2) the distribution and migration of the species quiscula, supplemented by unpublished return records of 52 grackles banded in the vicinity of East Lansing.

The nesting cycle. Male grackles arrive in southern Michigan about mid-March. Courtship begins when the females arrive from 6 to 10 days later. In selecting a mate two to four males compete for a single female by: (1) performing intimidation displays, e.g., bill-pointing and a challenge song accompanied by a roughed-feather display, and (2) accompanying the female on short flights away from the nesting

area. The dominant male becomes the mate after a week or so of competition. No definite territorialism is evident.

In early April the female, accompanied by her mate, begins hunting for a nesting site in the marsh. About mid-April the female starts the nest, while the male guards. Nest building is usually completed in two weeks.

A survey of nesting sites in a 12-square-mile area revealed: (1) that about half of the population nested in marshes and swamps and half in coniferous trees, (2) that the average size of the marsh colonies was 6 pairs, while that of the coniferous-tree colonies was 9.5 pairs, and (3) that the population was 12.3 grackles per square mile.

Incubation, carried on by the female only, begins nearly three days after the nest is complete and lasts for an average of 12.7 days. Both male and female feed the young, but only the female broods.

Out of 33 active nests the survival rate was 1.2 young per nest. Two important mortality factors were bad weather (23 per cent of eggs deserted) and predation (20 per cent by natural enemies, 6 per cent by the investigator).

Hand-reared birds. The young male began to "sing" following the postjuvenal molt, but the females did not start singing until December. The song of a mature bird was not attained by the captive young. Although the females begged and postured before the male, copulation was not observed.

In May one female showed signs of nest building--she picked up bits of string, grass and other material available within the cage.

Roosting. Before nesting both male and female grackles roosted in a willow thicket with starlings, cowbirds, and red-wings. (The roosting population, however, was predominantly starlings.)But as soon as incubation was started, the females roosted on the nests while the males continued to use the same willow-thicket roost.

A LIFE-HISTORY STUDY OF THE BRONZED GRACKLE,
Quiscalus quiscula versicolor Vieillot

By

Lester Emery Eyer

Submitted to the School of Graduate Studies of Michigan
State College of Agriculture and Applied Science
in partial fulfillment of the requirements
for the degree of

DOCTOR OF PHILOSOPHY

Department of Zoology

Year 1954

4-21-59

TABLE OF CONTENTS

Lists
Tables
Plates

LITERATURE CITED

LIST OF FIGURES

INTRODUCTION

Many of the rare birds of North America have been investigated quite thoroughly by students of ornithology, while some of the common birds have been neglected in this respect. The grackles are in the latter group. Although it is true that earlier ornithologists have examined the feeding and roosting habits as well as the taxonomy of the grackles, only limited studies of the life history of this species have been published.

Purpose

The primary purpose of this investigation was to learn more about the life history of the bronzed grackle, Quiscalus quiscula versicolor Vieillot, in Michigan and to assemble facts, both new and old, about its habits. In this study life history is understood to mean the annual cycle of events in the life of the bird. Steps in the nesting cycle such as mating, nest building, incubation, growth and development of the young, as well as feeding, roosting, flocking, and migration comprise the bird's life history.

A secondary aim was to assemble and summarize from the literature pertinent data concerning the taxonomy and distribution of the grackles. The writer felt a need for in-

cluding such background information about the grackles in order to give a more complete picture of this species.

Scope

The organization of the material has been governed by the chronological order of events. The background information of taxonomy and distribution is placed first. Then the life-history study is presented in the following order: migration, nesting cycle, post-nesting activities, hand-reared birds, food and feeding habits, and roosting and flocking.

Field investigations were conducted for two spring and summer seasons in East Lansing and the vicinity, Ingham County, Michigan. The nesting cycle was studied at a small marsh from the last week of March to the middle of June in 1951 and from the second week of March until the first week of June in 1952. However, additional measurements of growth were obtained at two other similar places during the 1952 season. In connection with the nesting cycle, a survey of the nesting population was made by locating nesting areas and counting mated pairs in a 12-square-mile area. Hand-reared young were kept from May 15, 1952 to August, 1953. Roosting observations were made at a willow thicket near a small lake during the 1952 spring and summer seasons. As part of the food-habits study, stomachs of nestlings, juvenals, and adults were examined in 1951.

Material and Methods

At the marsh where the main portion of this investigation was conducted, a 12-foot observation tower was constructed to afford a vantage point above the bush level for observing activities of the birds over the entire area (Plate 1, Fig. A). A blind was affixed to the top of the tower.

Measurements of growth in weight and in the length of the bill, wing, and tarsus were taken. For weighing a spring-balance, single-platform, dietetic scale sensitive to one gram was used in the field. Measurements of the bill, wing, and tarsus were taken as follows: <u>bill</u>, by placing one point of the dividers at the tip of the upper mandible and the other along the midline of the culmen at the posterior edge of the horny part of the bill; <u>wing</u>, by placing it on a ruler and measuring from the bend (carpal joint) to the tip of the fleshy part in very young birds or to the tip of the longest primary pin feather in older nestlings; <u>tarsus</u>, by placing one point of the divider at the tibio-tarsal joint and the other at the apex of a wedge-shaped crease in the skin at the junction of the tarsus with the toes.

Light intensities were measured with a Weston exposure meter, model 715, by holding it directed toward the zenith.

All photographs were by the author.

Acknowledgments

Many people have assisted the investigator in various ways during this study and such service is here gratefully acknowledged. The writer wishes to express his sincere thanks to Dr. George J. Wallace, whose constant interest and advice in the study and guidance in the preparation of the manuscript have been of great material help. Grateful acknowledgment is also due to Dr. Don W. Hayne for advice on statistical treatment, to Dr. Walter F. Morofsky for aid in the identification of insects, to Dr. William B. Drew for the identification of some plant specimens, to Professor J. W. Stack for suggestions in the use of the banding records of Michigan State College, and to Mr. C. C. Ludwig for permission to use his banding records. Sincere thanks are due Dr. Peter I. Tack for permission to carry out a portion of the study on the college farms of Michigan State College.

The writer wishes to express his sincere appreciation for his wife's constant interest and cooperation in this study, and for her help in the proof-reading and the typing of the manuscript.

TAXONOMY AND NOMENCLATURE

Taxonomic Relationships

The genus Quiscalus belongs to the family Icteridae. This strictly New World family is widely distributed in North, Central, and South America and the adjacent islands. It is a fairly large family having 35 genera (Hellmayr, 1937) and 88 species (Mayr, 1946). Quiscalus is confined to North America north of the Rio Grande valley and the adjacent islands.

There are three genera of icterids in North America north of Mexico which are commonly called blackbirds and often have been called grackles in the past. In addition to having names which are similar, they are all the more confusing to the casual observer because of similar color characteristics. All are black with iridescent colors of metallic hues on the head. Euphagus, which contains the smallest species, is the genus to which the robin-size Brewer's blackbird, E. cyanocephalus, and the rusty blackbird, E. carolinus, belong. The tail of these species is short and rounded, never V-shaped. The female is only a little smaller than the male and duller in color. Quiscalus contains medium-sized forms, the purple grackles, with long graduated tails. They are 11 to 13 inches in length. Males depress the central tail feathers to form a V-shaped tail while in flight

during the breeding season. As in Euphagus the female is nearly the same size as the male and somewhat duller in appearance. Cassidix, the boat-tailed grackles, contains the largest forms, that is, the males are much larger, averaging 16 to 17 inches, while the females are about the size of a male purple grackle (13 inches). The tail is long and graduated and, in the case of the male, is V-shaped during the breeding season.

As currently defined (1953) in the Nineteenth and Twenty-third Supplements of the American Ornithologists' Union (A.O.U.) Check-list, the genus Quiscalus is represented by a single species, quiscula, which is divided into three subspecies as follows:

Florida grackle, Quiscalus quiscula quiscula (Linnaeus)
Purple grackle, Quiscalus quiscula stonei Chapman
Bronzed grackle, Quiscalus quiscula versicolor Vieillot.

There is a very close similarity in the appearance of these three forms of the "purple grackle." A brief description of each will aid in distinguishing them.

The Florida grackle, Q. q. quiscula, is the smallest form. It inhabits the southeastern part of the United States mostly along the Atlantic and Gulf coasts. The head color of the adult male varies from a purplish bronze to a violet. Head color, however, is not considered to be a reliable characteristic for separating the three subspecies (Ridgway, 1902:214). The most useful color characteristic

is that of the back, scapulars, and sides of the breast, which in the Florida grackle is a dark olive-green or dull bottle green color with concealed iridescent bars of other metallic hues.

The slightly larger purple grackle, Q. q. stonei, is a highly variable form, occupying the area north of the range of quiscula, from the Atlantic Coast to the eastern slope of the Appalachian Mountains. The color of the back, scapulars, and sides varies from a bronzy purple to an olive-green or even a bottle green. Concealed iridescent bars on the back distinguish it from versicolor and the larger size separates it from quiscula.

The bronzed grackle, Q. q. versicolor, is the most widely distributed form (Fig. 1), breeding over the greater part of North America between the Rocky Mountains and the Appalachians and north to the tundra. It is about the same size as stonei, the purple grackle, but differs in color from both quiscula and stonei. It has a uniform bronze color over the back, scapulars, and sides. The lack of iridescent color bars to interfere with the bronze color is the most helpful distinguishing characteristic.

A fourth subspecies, named Q. q. ridgwayi by Oberholser (1919:269), inhabits a zone of intergradation between stonei and versicolor. This subspecies has not been recognized by the A.O.U. Check-list Committee to date (1953). According to Chapman (1936:415) it possesses color characteristics of

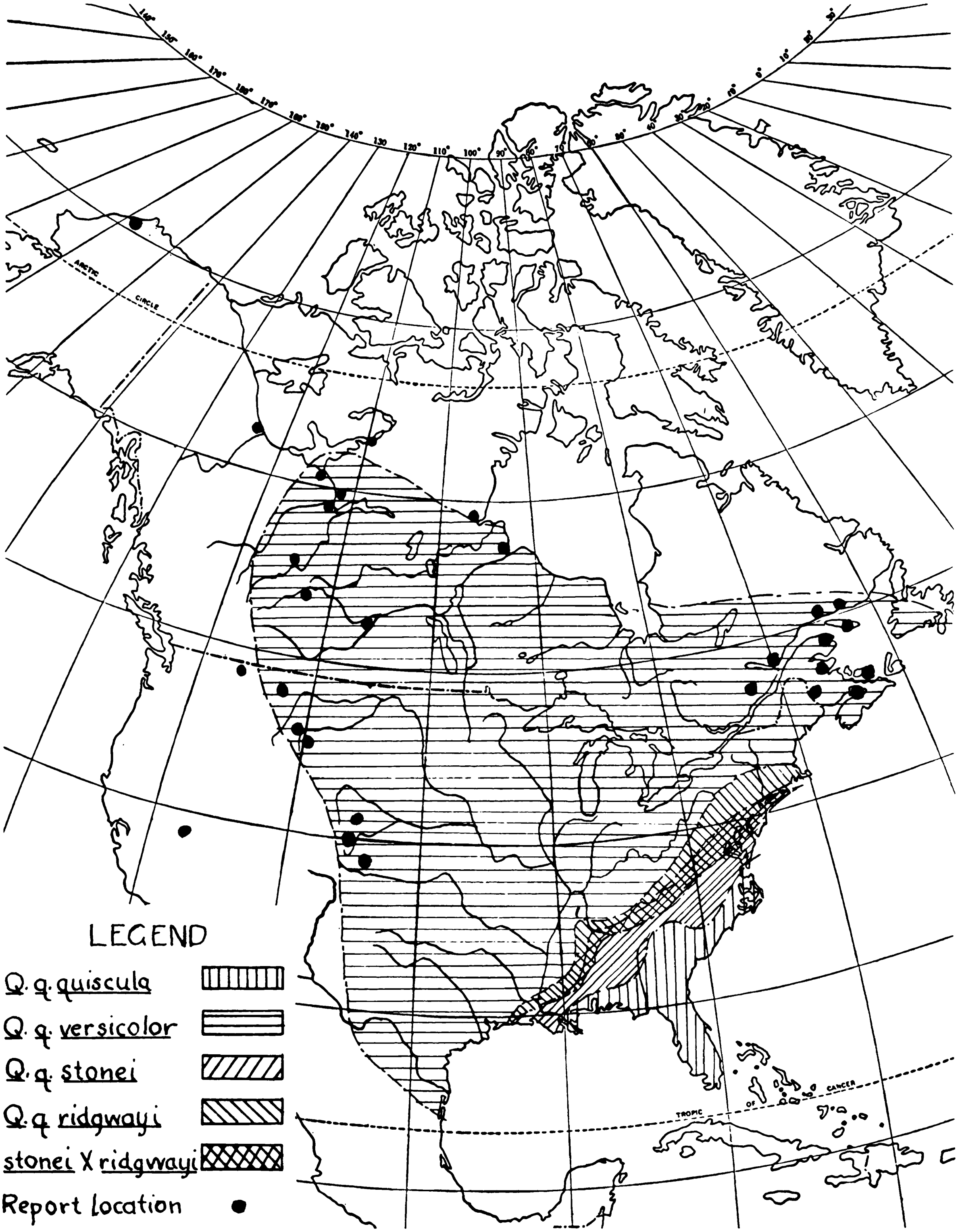


Fig. 1. Breeding range of the purple grackles, Quiscalus quiscula.

both forms. The back and rump are a rich bronze color without iridescent bars, much as in *versicolor*. The wings have the color of *stonei* but lack iridescent bars on the scapulars. The sides are a rich bronze with a few iridescent bars. This subspecies, then, has the bronze color of *versicolor* and the wing color and iridescent bars of *stonei*.

Nomenclatural History of *Quiscalus quiscula versicolor*

The nomenclatural history of the three subspecies of *quiscula* is interesting but confusing. Since a comprehensive review is beyond the scope of this work, the following account merely sketches the history of how the bronzed grackle received its name, *Quiscalus quiscula versicolor* Vieillot.

The Europeans who first came to America often applied the names of birds familiar to them in the Old World to similar birds over here. Mark Catesby (1731) was no exception (Allen, 1951:465). He described and painted a grackle while he was in South Carolina. It must have reminded him of a blackbird-like crow in Europe, a member of the family Corvidae, for he called it "The Purple Jack-Daw, *Monedula purpurea*." Perhaps this similarity to the jackdaw, which in reality is a crow, was the source of the name "crow blackbird," another name by which the grackle was known.

When Linnaeus classified North American birds, he used some of Catesby's descriptions in his classification. For

example, he used the description of *Monedula purpurea* for his *Gracula quiscula*. Thus, he was the author of the species name *quiscula* which is currently in use. The name grackle is probably the anglicized word derived from this genus name *Gracula* (Trotter, 1909:352-353). According to Trotter (1909) the name "purple grackle" was used by Wilson, this being its source in the current vernacular of ornithology.

Vieillot collected and described a grackle from the United States and called it *Quiscalus versicolor*. According to Wilson (1876:333) Vieillot chose the name *Quiscalus* to apply to the American bird in order to avoid confusion with a bird inhabiting India that was already called *Gracula*. By his very choice of this name for the genus he shows there was a question in his mind as to what kind of a bird it was. (*Quiscalus* is derived from two Latin words, namely *quis*, which means who, which, what, and *qualis*, which means of what sort.) The name *versicolor* means varied in color. Vieillot's *Quiscalus* is in current use instead of Catesby's *Monedula* or Linnaeus' *Gracula* because both of the latter are preoccupied. The subspecies name *versicolor* is also currently used.

The authorship of *Quiscalus quiscula versicolor* is therefore established. Vieillot supplied *Quiscalus versicolor* and Linnaeus supplied the species name *quiscula*. However, these names were applied to the purple grackles of the

eastern states, of which there was only one recognized form. Ridgway (1869:134) was the first to separate the bronzed grackle from the eastern and southeastern purple grackles. He described it and named it *Quiscalus aeneus* and designated Mount Carmel, Wabash County, Illinois, as the type locality.

The question as to whether the bronzed grackle should be regarded as a species or merely a subspecies soon arose. Six years after Ridgway had listed it as a full species Baird, Brewer and Ridgway (1875:219) listed it as a subspecies of *quiscula*. Stejneger (1885:43) in a foot-note referred to the bronzed grackle as *Quiscalus quiscula aeneus*. The A.O.U. Check-list (1886) listed the bronzed grackle as *Quiscalus quiscula aeneus*.

The bronzed grackle was known as *Q. q. aeneus* for 60 years. During that time, however, the taxonomic status of the species *quiscula* was examined carefully by several ornithologists. Wetmore (1939:230) who had examined Vieillot's type specimen housed in the Museum d'Histoire Naturelle in Paris, said he believed it was a bronzed grackle and not a purple grackle as had been supposed for so many years. He made the following statement about it:

> . . . there is no question as to its identification as indicated, and there seems to be no doubt that it is the basis of Vieillot's description. . . . The name of the Bronzed Grackle, therefore, becomes *Quiscalus versicolor* Vieillot, if it is considered a distinct species, or *Quiscalus versicolor versicolor*, if the belief is held that it is conspecific with the eastern and southern grackles of this group.

In viewing the taxonomic status of the genus Quiscalus Wetmore believed that there were two species, one the bronzed grackle with no subspecies, and the other the purple grackle with the hybrid (ridgwayi) occurring where the ranges of these two species overlap.

In 1944 the A.O.U. Check-list Committee followed Wetmore's suggestion and listed the bronzed grackle in the Nineteenth Supplement (1944:460) as Quiscalus versicolor Vieillot, thus giving it specific rank.

The bronzed grackle did not have the status of full species for long. Some who agreed with the Check-list Committee's decision about this changed their minds later. Sutton (1945) was one who did just that. He had this to say about it:

> . . . But I now believe I was wrong, and I believe the Committee's decision--whatever the basis therefore--is wrong, for when two or more anatomically very similar forms have the same color-pattern, call-notes, courtship behavior, nesting habits, roosting habits, molts, foods, etc., and interbreed indiscriminately wherever they occur together, they certainly must be called the same species, if the term is to have a truly biological meaning. . . . It is interesting, and desirable, to consider the possibility that the Bronzed Grackle may have budded off and become a full separate species; but so long as the bird itself recognizes no essential difference between itself and other forms of its genus with which it comes in contact during the breeding season, ornithologists may well accept its own obviously satisfactory decision in the matter and name it accordingly.

Three years after this statement was made the A.O.U. Check-list Committee made the following change in the Twenty-third Supplement (1948:442): "Quiscalus versicolor Vieillot,

the Bronzed Grackle, again listed as *Quiscalus quiscula versicolor* Vieillot."

DISTRIBUTION

Historical Background

The exact place of origin of grackles is not known because there is not enough direct evidence to trace their geological history. However, on the basis of present distribution most ornithologists believe that they are of neotropical origin. Bond (1948) claimed that grackles probably originated in southern North America and spread to Central America and more recently to northern South America.

Chapman (1935a, 1935b, 1936, 1939, and 1940) has advanced a theory to explain the present distribution of Quiscalus quiscula in North America. According to his view two groups of this species were isolated one from the other during the last glacial period, but following the retreat of the ice the two groups united again. He explained that as the ice advanced southward into northern United States, the grackles, as well as other animals, were forced to retreat. Those located east of the Appalachian Mountains withdrew to the Florida region, while those west of the Appalachians took refuge in Texas and northeastern Mexico. The two groups of grackles, presumably morphologically alike, at first were isolated from each other for a long period--long enough to allow two morphologically different forms to

evolve. Those confined to the southeastern area became the subspecies quiscula and those restricted to the southwestern area became the subspecies versicolor.

During their period of isolation the two groups of grackles were subjected to different types of climate (Huntington, 1952:163): quiscula in the Florida region to a humid climate with moderate temperature changes, and versicolor in the Texas-Mexico region to a drier climate with more extreme temperature changes. Huntington believed that the fact that versicolor was subjected to such changing conditions has contributed to its broadly adaptive nature and to its migratory habit. By contrast, quiscula appears to have been less aggressive in occupying new territory and has not developed the migratory habit to the same extent as versicolor.

Following the retreat of the ice, Chapman (1935a:22) explained that the grackles extended their range northward (Fig. 2). Versicolor, on the one hand, spread rapidly and extensively from the southwest to the east and north over much of North America, and quiscula, on the other hand, extended its range from the southeast retreat westward and northward along the coasts.

The subspecies stonei, according to Chapman (1936:405-407), was an off-shoot of quiscula. He accounted for the speciation of stonei in this way:

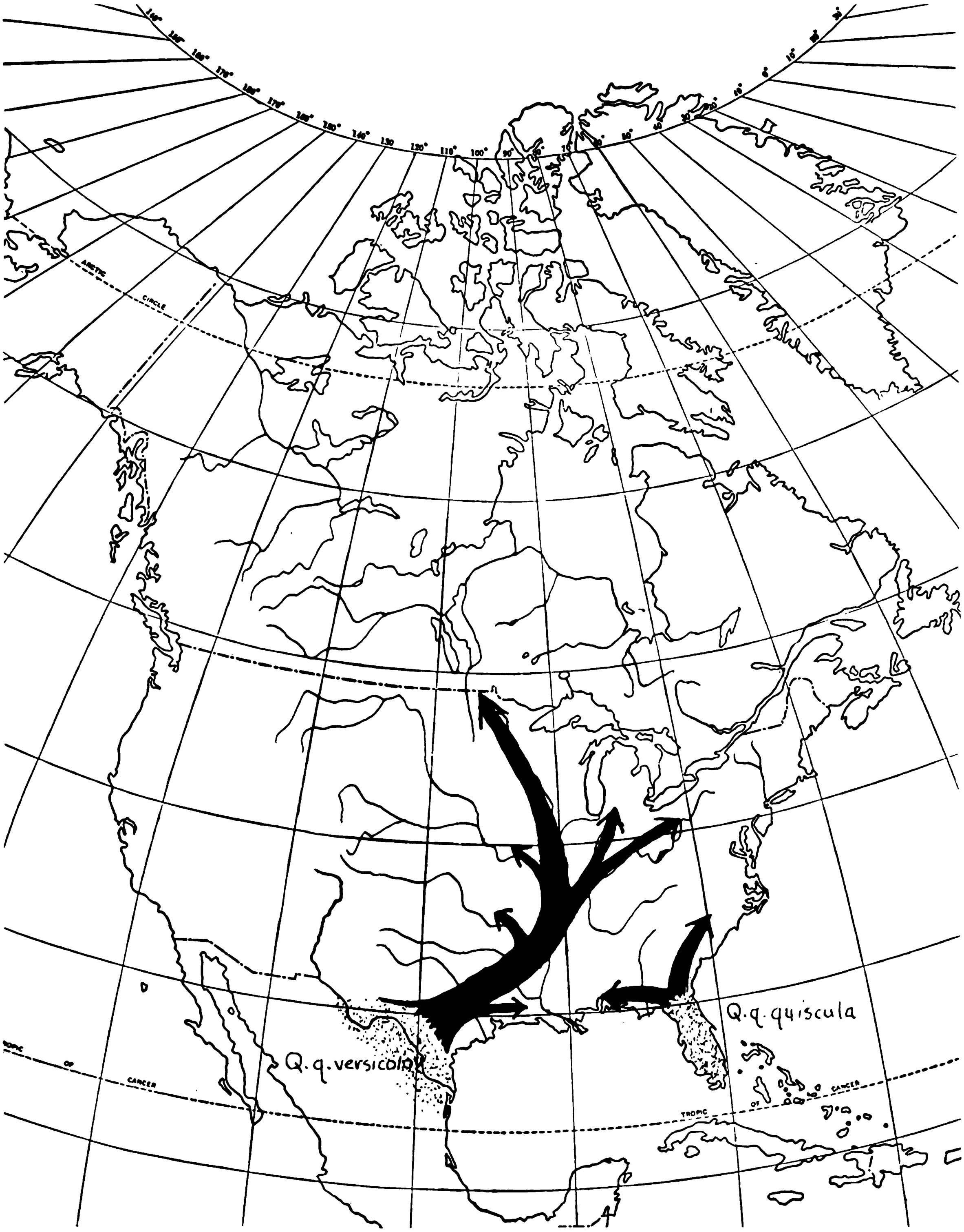


Fig. 2. Post-glacial dispersion of the Florida grackle, <u>Quiscalus quiscula quiscula</u> and the bronzed grackle, <u>Quiscalus quiscula versicolor</u>.

> . . . the changed population conditions incident to expansion of range have permitted these mutational characters to find expression in stonei, which we may provisionally consider as neither the product of its environment nor of hybridization, but of heritable, individual variation or mutation.

Huntington (1952:162) did not agree with Chapman's explanation of the speciation of stonei. He was convinced that stonei ". . . is the product of both its environment, through selection, and hybridization."

The subspecies ridgwayi was the product of hybridization between stonei and versicolor according to Chapman's view. Huntington considered ridgwayi, as well as stonei, to be intermediate forms resulting from hybridization between two end products, viz., quiscula and versicolor.

Breeding Range of Quiscalus q. versicolor

The bronzed grackle has extended its breeding range over a large portion of North America (Fig. 1). Its present range extends northward from the Rio Grande valley along the eastern slopes of the Rocky Mountains where it is found up to an altitude of 5,000 feet (Drew, 1885:16), north to Great Slave Lake, southeast across the forested part of Canada to southern Labrador, south to central New England, west to central New York, southwest along the western slopes of the Appalachians to southwestern Louisiana, and southwest along the Gulf Coast to the Rio Grande valley. Vagrants of versicolor have been observed beyond the normal range in the

west and north. Alcorn (1940) reported finding a dead bronzed grackle at Fallon, Nevada, which is over 600 miles west of the breeding range. Weydemeyer (1932, 1934) observed one or two bronzed grackles on different occasions in northwestern Montana west of the Continental Divide. Another interesting straggler was a male bronzed grackle taken at Wainwright, Alaska. Bailey (1948:291), who has this specimen in the Colorado Museum of Natural History, believes this is the only Alaskan record. Macoun (1903:411-412) reported grackles to be stragglers as far north as Hudson Bay.

Ecological distribution. The vastness of the breeding range of versicolor becomes more apparent when one realizes the fact that several major biotic communities are included. The major biotic communities occupied, including their successional stages and ecotones, are as follows: the Desert Scrub Subclimax of the Rio Grande valley, the Grassland Climax of the Great Plains, the Deciduous Forest Climax of the Mississippi basin, the Deciduous Forest-Grassland Ecotone of the prairie region, the Coniferous Forest-Grassland Ecotone of southern Canada in the west, and the Coniferous-Deciduous Forests Ecotone of southern Canada and northern United States in the east. Stragglers are found in the Tundra-Coniferous Forest Ecotone of northern Canada. In some of the southern states, where there are islands of the Oak-Pine Subclimax, bronzed grackles are also found.

The distribution and the abundance of the bronzed grackle varies from one part of the range to another. For example, it is more evenly distributed and more abundant in the Coniferous and Deciduous Forest Biomes than in the Grassland Biome. The bulk of the population is found in the deciduous forests of the Mississippi basin, the Great Lakes and the St. Lawrence valley, in which part of the range it is quite evenly distributed. Here too, where agriculture and cities have changed the original forest conditions, it frequently nests near farm dwellings, and in cemeteries and in parks. Its numbers decrease farther north in the western part of the Coniferous Forest Community and it is still less common in the central and eastern part of the same Community. Within this northern part of the range versicolor is found more frequently in swamps and along the borders of lakes and streams. In the Grassland Community grackles are largely limited to the vicinity of water and the dwelling places of man. They frequent the river valleys, sloughs and marshes, irrigation ponds and canals, as well as ranch dwellings and towns.

Distribution in Michigan. The bronzed grackle is common throughout most of the Lower Peninsula of Michigan, fairly common in the Upper Peninsula, and fairly common to common on some of the islands of the Great Lakes, but relative abundance may vary from one locality to another.

This is due to the gregarious nature of the bird during the nesting season and later during flocking.

Concerning the distribution of this species on the islands of the Great Lakes, Ford (1932), who visited 20 islands in northern Lake Michigan, the Straits of Mackinac and Lake Huron at the mouth of the St. Mary's River in July, 1931, observed grackles on only one island. He did not state which island that was. White (1893:225) reported bronzed grackles to be abundant during migration in September on Mackinac Island. Wood (1911:99), on the authority of the [lighthouse] keepers at Charity Islands, Lake Huron, reported this species to be a common spring migrant. Van Tyne (1923) noted that bronzed grackles were "fairly common" during the months of June, July, and August on the Les Cheneaux Islands of northern Lake Huron. The same writer (1948:108) stated, "Bronzed Grackles were common at St. James, Beaver Island, in 1937." He did not report any from Squaw, Trout, Gull or Hat Islands, but learned from Arthur E. Staebler and Leslie D. Case, Sr. that bronzed grackles were near the main settlement of South Manitou Island in June, though none were reported from North Manitou, South Fox, or North Fox Islands. The present writer visited Beaver, Garden, Gull, Hat and Shoe Islands on July 1 and 2, 1952, and found grackles on Beaver Island at St. James, but did not observe any on the other islands. The bronzed grackle has been reported from Isle Royale both in the spring and in the fall

(Wood, 1951:440-442). It has, therefore, been established that bronzed grackles occur on the following islands of the Great Lakes: Beaver, Charity, Les Cheneaux, Mackinac, Isle Royale, and South Manitou.

Winter Range of Quiscalus q. versicolor

Bronzed grackles spend the winter months, from late November until mid-February, in one of three parts of the winter range: (1) the lower Mississippi valley; (2) northeastern Mexico and a small part of Texas; (3) the southern states east of the Appalachians (Fig. 3).

The Mississippi valley from southern Illinois south to middle Louisiana and Mississippi is the portion of the winter range where most of them stay. However, grackles are observed nearly every winter in the more northern parts of the range. Here they are reported to be few in numbers in the eastern half of Kansas and Nebraska, the southern part of Minnesota, Wisconsin and the Lower Peninsula of Michigan, the Great Lakes area in Ontario and the southern New England States.

Cooke (1888:175) pointed out an interesting fact about the winter range of the bronzed grackle. He noted its complete absence over most of Texas. It seems to pass over that state and spend the winter in northern Mexico. The limits of this range have not been reported.

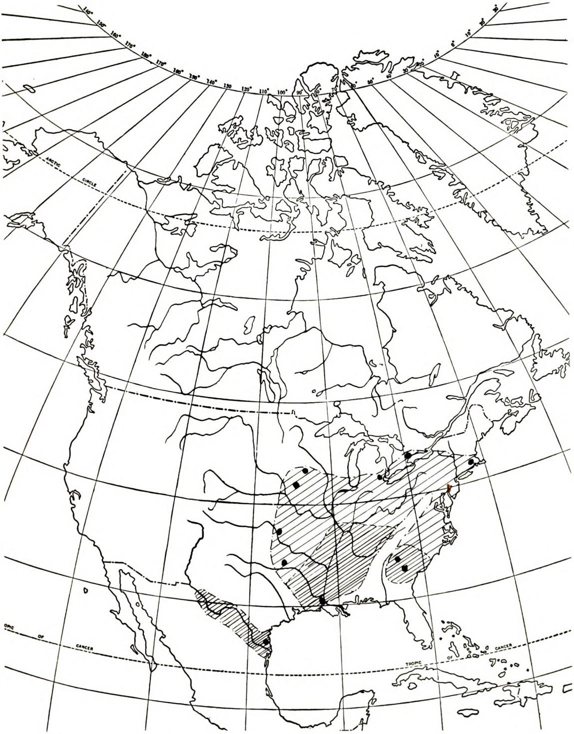


Fig. 3. Winter range of the bronzed grackle, Quiscalus quiscula versicolor. Dots show approximate locality where this species has been reported. Coarse cross-hatching depicts part of range where they are occasionally found in the winter. Fine cross-hatching represents the location of the bulk of the winter population.

A few of the bronzed grackles that nest in the northeastern part of North America spend the winter in southeastern United States. They have been observed during the winter months in southern South Carolina, Georgia, and Alabama.

MIGRATION

Spring

Bronzed grackles spend the months of December and January on the winter range located in southern United States and northeastern Mexico. They are most abundant along the Mississippi River and its tributaries. Here they roost in large flocks at night and range over the countryside in search of food during the day. There is little evidence of population change during these winter months.

At the first signs of spring in early February the number of grackles begins to increase in the southern parts of the United States. This general increase can be traced northward week by week as winter gives way to spring. Fig. 4 shows the approximate position of the vanguards of spring migrants, drawn from reports made by observers for the past 60 to 70 years.

The first migrants that leave the winter range in northeastern Mexico arrive in Texas about the end of January or in early February (Attwater, 1892:238). In the lower Mississippi valley, however, the first migrants do not leave until the first or second week of February.

As spring opens northward, migration is accelerated up the Mississippi valley but proceeds more slowly across the

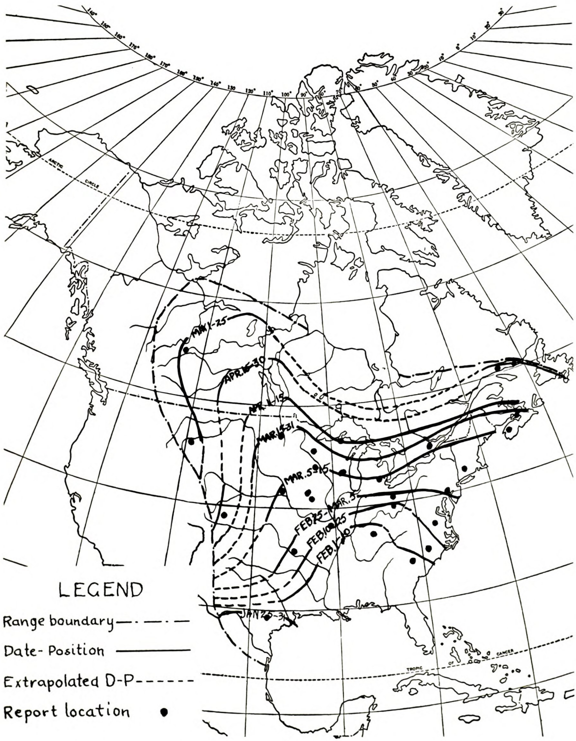


Fig. 4. Spring migration of the bronzed grackle.

Great Plains and the foothills of the Rocky Mountains. Cooke (1888) noted that grackles in the Mississippi valley were at latitude 44° 45' by March 25 but only at latitude 41° over the Great Plains at about the same date. This difference appears on the map (Fig. 4) as a downward swing of the date-position lines over the Great Plains. A possible explanation of this apparent lag of northward progress is that grackles tend to follow river valleys during migration (McCann, 1931:175; Perkins, 1932:90). Presumably those that spread over the Great Plains begin their migration in the lower Mississippi valley. Assuming that they do, then those which move northwestward along the tributaries of the Mississippi will not be at the same latitude on a given date as those which have continued northward up the Mississippi.

The Mississippi River valley is the main thoroughfare between the Rocky Mountains and the Appalachian Mountains for migrating bronzed grackles. Tributaries of this river, such as the Ohio and Wabash Rivers, are followed, in part, by those birds going to the Great Lakes region. Grackles that breed in northern and northwestern Canada probably enter that country from the upper Mississippi system. Cooke (1915:445) pointed this out when he examined the migration route used by birds in the valley of the Mackenzie. His line of reasoning is clearly set forth in the following quotation:

> It is evident that the westernmost breeding birds, those that summer in the Mackenzie Valley, must have reached

> their breeding grounds from the southeast by way of the Mississippi Valley.
>
> The cause of the choice of this route is easily found in the conditions of moisture and woodland. All these species are either lovers of damp forests or of moist meadows and marshy lakes. Their favorite surroundings extend in the United States not farther west than eastern Kansas and western Minnesota. On arriving at Manitoba, the dry plains that have been a barrier on their left for the last thousand miles, become better watered and interspersed with groves and soon these groves unite to form almost continuous well-watered forest--a genuine birds' paradise. Attracted by the early season and abundant food supply, the birds turn northwestward and settle for the summer in the valley of the Mackenzie.

Cooke listed the bronzed grackle among 18 species that use this route, but added that this would be difficult to prove, since it also ranges over the Great Plains as well.

According to Wood (1906:156) bronzed grackles, among other early hardy migrants, do not come to Michigan at a stated time each year, ". . . but are governed in their migration to a certain extent by favorable weather and food conditions." At Ann Arbor arrival dates have been recorded as early as February 20 (Wood, 1951:440-442). Throughout the course of many years, the average arrival date is around the middle of March. The present writer found the arrival date at East Lansing to be March 15 in 1951 and March 12 in 1952. At Alma, which is located 50 miles north of East Lansing, the arrival date was March 14 in 1953.

The first arrivals of grackles consisted of small flocks (8 to 9) of males at East Lansing. There were no females

until a week later. Petersen and Young (1950:466) found the same to be true at Madison, Wisconsin, during three seasons. While it is the general rule for males to arrive first, the writer observed an exception to this. Two females were among a flock of nine first noted arrivals at Alma on March 14 in 1953.

The duration of spring migration of grackles can be determined by noting the relative abundance of these birds at a given place throughout the migration season. This also applies to fall migration. Two writers have reported observations of this type in two localities over a period of years. Jones (1895:121, 236) reported changes in the population during spring and fall for a five-year period at Grinnell, Iowa. This locality is about 90 air-line miles west of the Mississippi River. Trautman (1940:141) described in more detail the changes in the grackle population throughout the entire year at Buckeye Lake, Ohio. Fig. 5 depicts the average abundance as described by the authors in such terms as "light," "heavy," and "same intensity" (Jones) or as "fairly abundant," "maximum abundance," and "few" (Trautman). It will be noticed that spring migration at Grinnell began about one week later than at Buckeye Lake and also that the maximum abundance at Grinell was about two weeks later. There is no appreciable difference in the fall migration pattern.

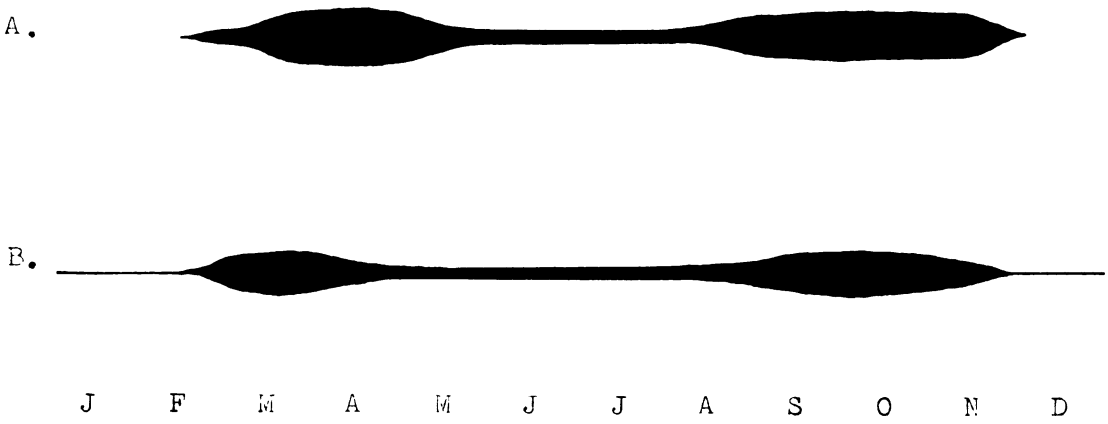


Fig. 5. Comparison of effects of migration on relative abundance of bronzed grackles throughout a year at two locations. A. The average for a five-year period at Grinnell, Iowa (Jones, 1895). The blackened portion is based on the reported abundance. B. The average for a few years at Buckeye Lake, Ohio (Trautman, 1940).

Fall

After a two-month period required for rearing their young, bronzed grackles move about in small family groups. During this post-nesting time they pass through a molt. Toward the end of the molting period flocking begins. This activity marks the beginning of a general but gradual movement to distant places.

Fall migration becomes evident when the local populations commence to show an increase in numbers (Fig. 5). By mid-August grackles on the northern breeding grounds in Canada begin to move southward. The effect of this influx be-

came evident at Grinnell in late August and early September, while the average beginning of fall migration at Buckeye Lake was only slightly later. The duration of migration was about the same for both places, ending by middle or late November.

While there is a scarcity of late departure reports in the literature, there are enough to delineate the southward movement of the rear guard of migrants in a general way. The average departure time in southern Canada and northern United States is mid-October. In the central states it averages from the last week of October to the first week of November. By late November all of the migrating grackles have reached their winter range.

How do grackles distribute themselves after they reach the winter range? According to Perkins (1932:90), who reported on the recoveries of 53 bronzed grackles banded at 12 stations in Indiana, grackles are at first (November) fairly close to the Mississippi, but become widely distributed during the remainder of the winter. He noted that all of the grackle recoveries west of the Mississippi were extremely close to it.

Where do Michigan grackles go for the winter? The writer has compiled the recoveries of 52 bronzed grackles, 22 of which are from the unpublished bird-banding records at Michigan State College, and 30 from the banding files of Mr. C. C. Ludwig, who banded grackles at Lansing and at Lake Odessa, which is located about 35 miles west of Lansing.

The locality of each recovery is plotted on the map in Fig. 6 and the data are summarized by states and seasons in Table I. These data reveal six interesting points about the migration and the wintering grounds of Michigan grackles.

(1) Almost all of the recoveries were from states located in a southwesterly direction from East Lansing. The states from which recoveries were reported include Alabama, Arkansas, Illinois, Indiana, Kentucky, Louisiana, Mississippi, Ohio, Tennessee, and Texas. This list compares quite closely with Perkins' report on Indiana recoveries. The exceptions are as follows: one Indiana grackle was recovered in Iowa and none were recovered in Ohio or Texas.

(2) Michigan grackles reported north of Tennessee (with two exceptions) were either spring migrants, i.e., recovered during March and April, or fall migrants, i.e., recovered before November 30. One grackle apparently wintered in southwestern Ohio and a second was recovered during the summer in north-central Ohio.

(3) Seven of the 10 grackles found west of the Mississippi River were located within a few miles of the river, while the other three were located near the Red River, a tributary of the Mississippi. This also is in agreement with what Perkins reported in 1938.

(4) Most of the recoveries (28 of the 52) were from Mississippi and Tennessee. Perkins listed 25 of 53 recoveries from Mississippi and Tennessee.

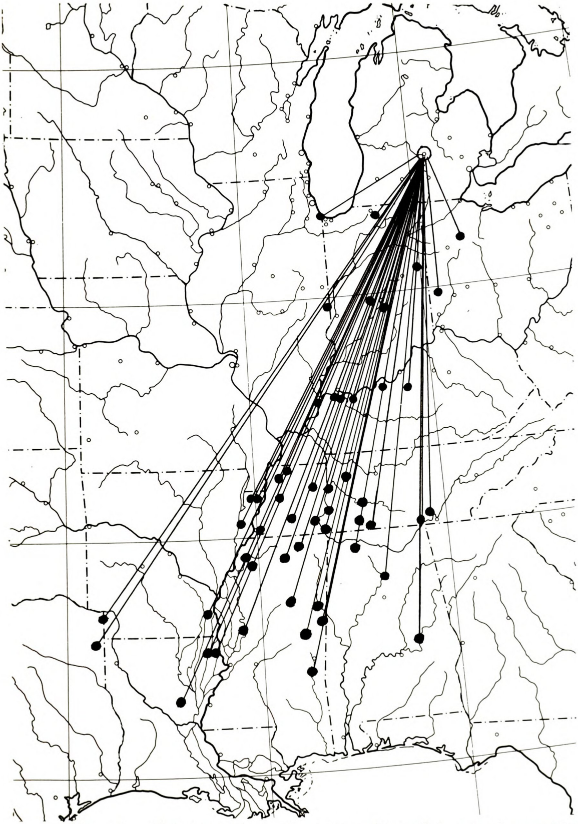


Fig. 6. The location of recoveries of bronzed grackles banded at East Lansing, Lansing, and Lake Odessa, Michigan.

(5) The distance traveled by grackles from Michigan to the points of recovery varied from 125 to 850 air-line miles. The most distant reports were from Texas and Louisiana.

(6) One grackle was recovered in Mississippi on May 23, nearly a month after migration ceased in Michigan. Perhaps that bird had been injured and was unable to fly north with the others. It was reported killed.

THE NESTING CYCLE

Introduction

The study of the nesting cycle was begun March 29, 1951, at a small (seven acre) marsh, composed predominantly of meadowsweet (Spiraea alba) and reed-canary grass (Phalaris arundinacea), located just beyond the southwestern boundary of the city limits of East Lansing (T4N R2W S24 Ingham County). Since this marsh is located near the Trowbridge railroad signal tower, it will be referred to as Trowbridge Marsh. Because observations were begun nearly two weeks after the first grackles arrived, their activities on arrival were necessarily omitted the first year. Later (April 9 to June 1), however, observations were made almost daily. A total of 14 pairs nested here that season. Egg laying, incubation, and hatching were carefully followed and growth of the young was measured. Observations on parental care were made from a blind. A map (Fig. 7) shows the vegetation zones and the locations of the grackle nests. Nests were collected and examined after the young had fledged.

Investigation of the nesting cycle was resumed on March 10, 1952. Daily checks were made on the campus of Michigan State College and at Trowbridge Marsh for early arrivals of bronzed grackles. The arrival, courtship, and the early

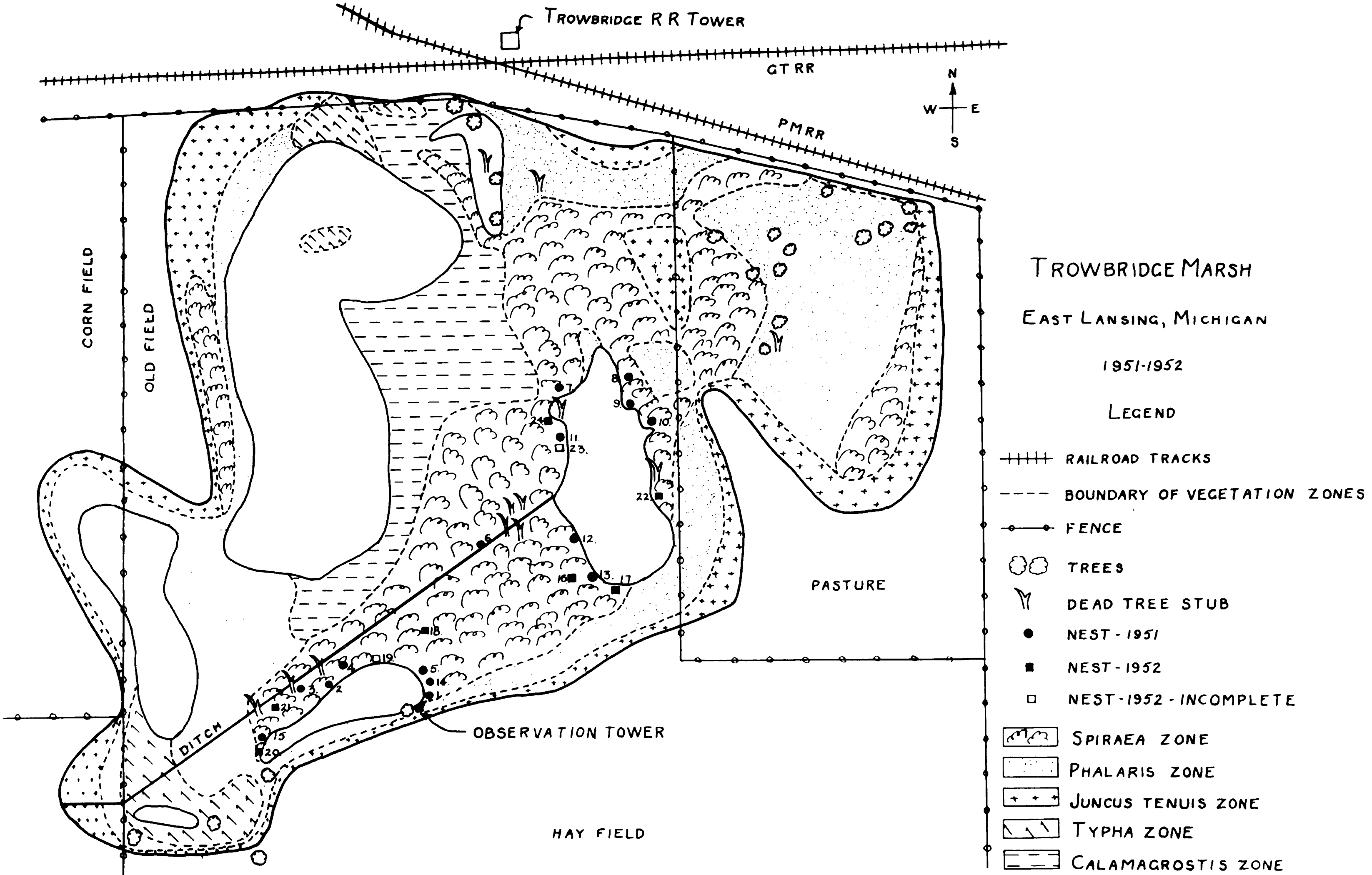


Fig. 7. Trowbridge Marsh showing vegetation zones and surrounding habitat.

phases of nest building were followed at a colony nesting in spruces and pines located on the campus. Observations at this place were made from the ground only. Nests were not measured or examined since the birds had chosen to nest near a dormitory for women. The location of this nesting area will be referred to as Williams Dorm. At the marsh the entire nesting cycle was studied from March 10 until June 3. Measurements of growth were not taken at the marsh that season.

During the 1952 nesting season measurements of growth of nestling grackles were taken at two other localities. One colony was nesting in a meadowsweet area, which was about one acre in extent and was crossed by a road. Water, 35 to 45 centimeters deep, was present throughout the nesting season. This bushy area, located along Forest Road near the southeast boundary of the city limits of Lansing (T4N R2W S26 Ingham County), will be referred to as the Forest Road colony. The period of observations was from May 3 to May 30. The nest history was followed for all nests but one. This one contained eggs which were being incubated at the time of the last observation. The other colony was situated among black willows (<u>Salix nigra</u>) which were screened on all sides by a willow thicket. This nesting site was on the northeastern edge of an extensive swamp (about 80 acres). The willows were in water 30 to 35 centimeters deep. This colony, located near Collins Road, six-tenths of a mile south of Forest

Road (T4N R2W S25 Ingham County), will be referred to as the Collins Road colony. The period of observations, including measurements, was from May 9 to May 30.

In connection with a study of the population density of bronzed grackles in the East Lansing area during the nesting season, a systematic search for nests was conducted over a 1½-square-mile area. Nearly all of the nesting sites were spotted from an automobile. All of the places which could not be examined in this manner, such as woodlots, bottomland woods along the river, and the more distant areas from the road, were investigated on foot. This study covered the period from April 25 to May 15.

General Ecological Considerations

Physiography. The topographic features of Michigan were formed, for the most part, by the retreating ice of the last (Wisconsin) glacial epoch. A mantle of glacial till of varying thickness was laid over this glaciated surface by the retreating ice. As the ice melted and retreated, such surface features as moraines, till plains, kames, and eskers were formed during the close of the glacial epoch. Due to poor drainage extensive areas of melt water accumulated, forming lakes, some of which subsequently drained and left flat lake-bottom land, another important topographic feature in Michigan.

At East Lansing and the area to the south of it, where this study of the nesting cycle was conducted, the topography is level to gently rolling. A moraine extends in an east-west direction along the south limits of Lansing and East Lansing. It may be identified as a complex system of low hills or ridges with many poorly drained hollows among them. Some of these hollows contain water the year around, creating small marshes or willow thickets, e.g., Trowbridge Marsh and the nesting area near Forest Road. To the north and south of this moraine there is a gently rolling to level till plain. The Red Cedar River flows westward along the northern boundary of this area to Lansing where it is confluent with Grand River.

Climate and weather. Seeley (1917:35), who made a study of the climate in Michigan based on 50 years of weather data, described the climate as follows:

> On the whole the climate of Michigan is not extreme in temperature, either in summer or winter, the rainfall is sufficient for most crops, the cloudiness is greater in the winter and less in the summer than in regions remote from the Great Lakes; the humidity is rather high throughout the year, especially on the lake shores; the prevailing winds are westerly, often high on the lakes but decreasing as they pass inland. Severe local phenomena such as hail, tornadoes, torrential rains, etc., occur infrequently.

At East Lansing the first signs of spring appear as early as late February or early March in protected places which are exposed to the sun. However, spring does not become established until mid-March within the city and not un-

til later in the open countryside. This is the season of high winds, cloudiness, and temperatures hovering around freezing. At night the temperature is usually below 32° F. and during the day may rise to 50° or 60° F. These conditions remain about the same during the early part of the nesting season, that is, until the second or third week of April. By this time the temperature at night is only occasionally below freezing, and during the day it may be as high as 80° F. The month of May and early June are definitely warmer, ranging from 40° to 55° F. at night and 60° to 85° F. during the day. A summary of weather conditions for the months when the nesting cycle was studied at East Lansing is given in Table II.

Biotic community. Michigan lies within two biotic communities, viz., the Deciduous Forest in the southern half of the Lower Peninsula and the Coniferous-Deciduous Forest Ecotone in the remaining portion of the state. The original forests have been modified to a great extent by clearing and draining the land for agricultural purposes, especially in the lower half of the Lower Peninsula, and by lumbering and later by forest fires in the upper half of the Lower Peninsula and the Upper Peninsula.

The original deciduous forest of the East Lansing area was composed of three main types or associations. On higher and drier ridges there was an Oak-Hickory Association composed of Quercus rubra, Q. alba, and Hicoria ovata. The remainder of the area was a Beech-Maple Association except

in the very low and wet places. It was composed of *Fagus mericana* and *Acer saccharum* with consocies of *Tilia americana* and *Fraxinus americana*. Along the Red Cedar River and its tributaries, where there were flood plains, a bottomland forest consisting of *Ulmus americana*, *Acer rubrum*, *A. saccharinum* and *Celtis occidentalis* existed.

At present the original deciduous forest has been reduced to small patches of woodlots, shade trees both in the city and around farm dwellings, and bottomland woods along he river. About half of the area under study was urban or suburban, while the other half was farm land of which about 10 per cent was wooded.

General habitat of Trowbridge Marsh. Trowbridge Marsh, a poorly drained hollow in a moraine, was probably a small lake at one time (Fig. 7). It has been partly filled, chiefly by the products of vegetation and, to a lesser degree, by lluvial deposits from the drainage slopes bordering it. During the course of time a considerable deposit of peat accumulated in this marsh. At present most of the area is covered with water during the period from October to May. The water level, however, lowers during the dry season, so that n normal years water stands in three of the five depressions, or, in exceptionally dry years, remains in only one.

Man, too, has played a part in bringing about the present condition of the marsh. Two railroads were built along he north margin of it. In dry seasons fires that were

arted by sparks from locomotives burned the dried peat on
e north and west sides of the marsh, forming the depres-
ons now present in those places. At one time the marsh
s drained by a ditch dug along a northeast-southwest line.
parently the water level was lowered enough to permit elms
d willows to grow there, but subsequent flooding killed
e trees and they have since been reduced to stubs. At the
me of this study a few black willows grew along the mar-
h and in the drier portions of the marsh. Drainage by the
tch was no longer effective. A pasture bordered the east
de of the marsh, where cattle were allowed to graze in
te spring and in summer. They were also allowed to enter
e marsh proper during the nesting season of the second
ar. To the south and west of the marsh there were culti-
ted fields. A cornfield adjacent to the west side of the
rsh was a feeding ground for blackbirds.

Viewed from a tower, the marsh was easily divisible into
fferent vegetation zones according to the most conspicuous
nts. Closer inspection of these zones revealed the pres-
ce of at least one or two types of plants which were abun-
nt enough to produce the appearance peculiar to it. This
the basis for determining the name of all but one of the
es appearing on the map (Fig. 7). One vegetation zone was
ed on the basis of the common occurrence of an inconspic-
s bog-rush (*Juncus tenuis*). Five vegetation zones were
ntified as follows: (1) *Juncus tenuis* zone, (2) *Phalaris*

ne, (3) *Spiraea* zone, (4) *Typha* zone and (5) *Calamagros-*
s zone.

Of all the vegetation zones studied in this marsh the
ncus tenuis zone had the most complex mixture of plants.
was a zone of transition, lying between the moisture-
ving plants of the marsh and the plants of the drier old
eld (Plate 1, Fig. B). This zone proved to be an important
urce of nesting materials; such plants as (*Juncus tenuis*)
d (*Asclepias incarnata*) were used. The plants commonly
und in this zone are recorded in List I.

There was a nearly pure stand of reed-canary grass in
e *Phalaris* zone (Plate 1, Fig. B). This grass was an
portant material used in the coarser structure of the nest
grackles.

The *Spiraea* zone, named because of the abundance of
adowsweet, was the most conspicuous zone (Plate 2, Fig. A).
the early part of the breeding season the *Spiraea* bushes
ew in varying conditions of moisture--from dry places to
ter 40 to 50 centimeters deep. A second shrub, a willow
lix gracilis), was present, but not abundant. Among the
raea bushes in the wetter places there was reed-canary
ss, which was about two-thirds the height of the bushes.
s combination of *Spiraea* bush and reed-canary grass was
grackles' favorite choice for nesting sites.

The *Typha* zone, composed of common cattail (*Typha lati-*
ia), was found in nearly pure stands. It was invaded

ong the margins by some of the grasses and arrowhead (*Sag-*
aria sp.). This vegetation zone was used by the red-wings
nesting sites but not by the grackles.

The *Calamagrostis* zone was a grassy area composed chief-
of reed-bent grass (*Calamagrostis neglecta*). It was a
t area in spring but was one of the first areas to become
y later in the season. Plants found in this zone are re-
rded in List I.

A considerable portion of the marsh was bordered by an
ld field community. Some of the weed stalks used by the
rackles in their nests came from this zone.

The variety of vegetation zones at Trowbridge Marsh
fforded many niches for nesting sites. The writer noted
sts of several species during the course of this study,
t no special effort was made to survey the nesting popula-
ion. Cornell (1950), however, included a survey of this
his investigation of the vertebrate population of the
rsh. The combined list of birds observed nesting in the
rsh proper or in the adjoining fields is recorded in Table
II.

In addition to breeding, birds resident to the East
nsing area used the marsh for feeding, resting and/or for
osting, while others merely flew over it. Early in the
sting season transient birds also used the marsh in the
me way. A complete list of resident and transient birds
ich were observed at the marsh during the course of this
udy is recorded in Table III.

Not all birds were accepted in this marsh community ithout protest from the grackles as well as from the red-ings and kingbirds. Birds which were harassed and chased hile they rested on a perch or flew over were as follows: nerican bittern (only while it was flying low over the bush ops), Cooper's hawk, red-shouldered hawk, osprey, sora only when it was within 10 feet of a nest), and American row (if it flew at an altitude of about 50 feet or less ver the marsh). Kingbirds aided grackles and red-wings in hasing the Cooper's hawk, which, the writer believes, raided he grackles' nests several times during the two seasons. ed-wings and grackles were the only birds that chased the thers mentioned in this list.

Mammals observed there by the writer or by Cornell comrise List II. Dogs also frequented the marsh, being attracted there by the pheasants, especially in the early part of he season when the pheasants were still using the marsh for a roost and shelter.

Reptiles were not common. Only one species of snake was observed, a small garter snake, *Thamnophis s. sirtalis*. Three species of turtles were found: a snapping turtle, *Chelydra serpentina*, two painted turtles, *Chrysemys picta marginata*, and one Blanding's turtle, *Emys blandingii*.

Two kinds of fish were found in the marsh: western mudminnow, *Umbra limi*, and brook stickleback, *Eucalia inconstans*.

Mating

In two seasons of study of the mating of bronzed grackes, little more than a foundation was laid for a more thorugh study. There are several reasons for this: (1) a late tart the first season (the study was not begun until after he females had arrived); (2) wide-range habits of the grackes--their activities are not confined to a limited territory ithin the colony; and (3) unmarked birds (an attempt was ade to trap them at Trowbridge Marsh the second year, but ithout success, and banded young did not return to the arsh).

In spite of these shortcomings and difficulties the riter was able to establish, in a general way, some features f the method of pair formation, courtship, and also the notes nd displays used at this time. By observing their activities rom day to day, especially during the morning hours from sunise until 10:30, the observer was able to distinguish certai ndividuals by their voice characteristics, attachment to ertain trees and bushes, or by the actions of males toward emales.

Arrival at the breeding grounds. As stated earlier, ales arrive at the breeding grounds first. On March 15, 952, two resident males were observed at Williams Dorm. his number had increased to five by March 21, the date of he arrival of the first females. All of the males associ-

ed with this colony (12 to 14) had arrived by March 27.
n exact count of the males would be almost impossible be-
use of their constant moving about and the obstruction of
e view by trees.) Not all of the males arrived at the
me time; some arrived after the first females. Probably
e arrival of the males is spread out over a period of two
eks.

This same year two females were first seen at Williams
rm on March 21, six days after the arrival of the first
es. The number of females gradually increased to 12 by
rch 31; this was the total female population of this col-
.

Territory. Bronzed grackles do not have a strong tend-
y toward territorialism; if any, it is the territory of
pe D" (Nice, 1941), i.e., restricted to a small area (10
50 feet) around the nest. During the first few weeks of
season males spend most of their time competing with other
es for a female. Such activity is not limited to the ter-
ory established by the male, as is the case with many other
ls; nor is it restricted to the nesting area of the colony,
it may occur within a radius of a half mile or more.
r the pairs are formed, the males guard their mates against
attentions of other males on and off territory--like
er's blackbird (Williams, 1952:13). From the time of the
blishment of the nest the male stands guard on one or more

ches located from 10 to 50 feet from the nest. Should an- er male grackle alight on one of his perches close to the t (15 to 20 feet), he will cause the intruder to leave by of two ways: (1) by flying to a point beside the intruder performing his display and song, or, (2) by perching be- e him and pointing his bill toward the sky and side-step- g rigidly toward him. If after these performances the in- der has not left, the defending male may fly to another ch, only to return after a few moments to repeat the in- idating acts. This usually is effective and the intruder ves quietly. Fights or chases were not observed to take ce under such circumstances. This act of guarding, how- er, usually takes place when the female is present or on e nest. At this stage of the nesting cycle he is guarding e female and not necessarily the territory. Later in the eeding period, when there are young in the nest, the male mains on guard some of the time while the female is away, t it is not uncommon to find both of them away for periods long as 15 minutes. Territorialism, then, appears to be mited to an indefinite area around the nest and around the male wherever she may be.

Kind of mating relationship. Monogamy is the most com- n kind of mating relationship among birds. A monogamous tuation usually exists where the sex ratio is nearly even. yder (1937), after sexing 204 bronzed grackles which he

dered to be a fair sampling, found the ratio to be 48.5
ent males to 51.5 per cent females. Inasmuch as six or
of the males had been removed from this sample before
ceived it, the actual ratio would have been nearly 50:50.
At Trowbridge Marsh and at Williams Dorm the sex ratio
ound to be nearly even, and from observations it appeared
monogamy prevailed among these birds. It is true that
g the early stages of pair formation, when two to four
are courting a single female, it is difficult to ascer-
whether a monogamous state is going to prevail. Later,
er, after pair formation is completed and nesting is
way, monogamy is evident.

Song display. As far as the human ear is concerned, it
esticnable as to whether the vocal sounds made by grack-
hould be called a song. How would one define a bird's
Mrs. Nice (1943:144) uses Nicholson's (1929:41) defini-
with the addition of the word "sometimes" as follows:

> Bird song is properly a sustained, more or less uninter-
> upted repetition of one or more notes conforming recog-
> isably to a constant specific type and [sometimes] used
> y the male as an expression of independent sovereignty.

rding to this modified definition, the grackle's utter-
would be classed as a song. Their song has been des-
d by several authors. Audubon (1827-1830:7) used such
tives as "squeaky" and "creaky" to describe the call, a
ication of the song. Forbush (1927:455) said the

. . . song of a flock has been compared to creaking of
swinging signs, rusty hinges of iron gates and creaking
of un-oiled wheelbarrow or cart wheels.

rs. Nice (1931:171) the song sounded like a "whicher-
." Saunders (1951:234) had this to say about the grack-
song, although he did not specify that it was the song
he bronzed grackle:

> It consists of one or two short notes followed by a more prolonged squawk. The quality is harsh and squawky or squeaky, with a peculiar metallic sound. . . . It suggests a rusty hinge or machinery badly in need of oiling.

The present writer also observed that the song consist-
f two parts: (1) a brief double syllable corresponding
he "wicher" part described by Nice, and (2) a longer part
h is the squeaky portion of the song. He further noted
the male's song varied among individuals in both qual-
and intensity. This became apparent when three or four
s, which were perched near each other, sang and displayed
he same time. Moreover, while the song was basically
same for all purposes, each individual male varied his
according to the use he made of it; for example, a
le call to a mate was weaker than the courtship song.

The display which always accompanies the song is so
ed that it begins ahead of the song and ends after it.
eneral, the display movements consist of raising the
hers around the neck and spreading the wings and tail,
ing the bird appear larger. The following description is
ed on a single courtship song display observed on March 21

at Williams Dorm. It may be broken down into five stages: (1) display movements began by a fanning of the tail feathers; (2) before the tail was completely expanded the wings moved slightly upward and outward; they were relaxed and looked somewhat drooped; (3) simultaneously with the wing movements, the feathers about the neck and shoulders were raised and the neck was arched; (4) the first part of the song was uttered with the outward movement of the wings and a ruffling of the neck feathers; (5) as the wings and neck feathers returned to the original position, the second part of the song was produced and completed before the display movements were finished. The frequency of the song of this male during courtship was 10 to 12 times per minute.

The female's song display is given in the same manner and is about as well performed as that of the male. It is used in response to the courtship display of a male but more often as a call or a response to a call from her mate. According to Nice (1943:132),

> Where song serves as a means of self expression, or as an expression of a social bond, and particularly where it serves as a bond between the pair, it may be equally (or fairly equally) developed in both sexes.

he female's song or call sounds much like that of the male t is enough different to be distinguishable in most cases. , too, is made up of two parts. The first part is the same that of a male, that is, a double syllable "wicher." The cond part often ends at a lower pitch than that of the le. Sometimes the quality is more of a buzz than a squeak.

er pitch [illegible] the [illegible] quality [illegible] the [illegible] [illegible]. The display [illegible] song is given in the [illegible] of that of the male, r, it is not quite [illegible], since it is usually [illegible] call, and also, since the [illegible] the physical appear- e.g., shorter tail and less iridescence.

ses of the song display. By modifying the song dis- he male uses it for several apparent purposes.

) *Challenge*. In the presence of one or more other he sings and displays in competition. This is evidenced more exaggerated puffing of the feathers and extending e wings, along with an increased frequency of song and ay. A female may or may not be present.

2) *Courting*. The song display of a male courting a e prior to copulation is the most exaggerated. It may erformed on a perch or on the ground. Puffing, arching neck, strutting, and performing the song display very dly are characteristic.

(3) *Call*. A mated pair uses the song display in its est form to call to each other. For example, when a male rns to his perch near the nest, he calls to his mate, and latter responds with a similar call.

Courtship flight of male. One of the most characteris- marks of a male grackle in the spring is his display ght. In its extreme form it is a slow even flight made

e by a deeply keeled tail and rapidly fluttering He uses this flight around the nesting area, flying from perch to perch, or following his mate while she structing the nest. It is slower than the cruising of the female and is, therefore, modified for faster by the use of a less fluttery type of wing beat and a ly less "V-ed" tail. Except on the longer flights, s to and from the roost, the tail is keeled most of ime during the breeding season, even when the bird is perch or on the ground. With the tail in such a form ird looks longer. As the breeding season advances, males ally change the display flight to a more normal flight the tail keeled less prominently and less frequently. imes they may be seen leaving a perch with the tail un- d and then suddenly depressing the central tail feathers rm a "V." Once when a male was returning to the nest food, he was seen to be flying with his tail flat, but V" it as he neared the perch close to the nest. This observed as late in the season as May 31.

Formation of pairs. Competition for females begins as as the first females arrive. Two to four males may be flying with or perched near a female much of the time l nest building and less frequently throughout the egg- ing period. In such a group there is constant rivalry ng the males, as indicated by intimidation displays-- challenge song and bill-pointing. The latter emphasizes

or height of the bird rather than large size. It is
ished by the bird's assuming a rather rigid pose with
ck extended and the bill pointed skyward. Compression
body and neck feathers causes the bird to appear slim-
d taller. It is usually a very effective means of in-
ting the other bird, especially if the latter is near
rmer's mate. "Bill-pointing" is not carried out as a
project among males, as it is among boat-tailed grack-
assidix mexicanus major, which stand on the ground or
in a group, all pointing their bills upward at the same
(McIllheny, 1937:276)
Group courting on most any suitable perch and in flight
conspicuous activity which is characteristic around a
ng area in the early part of the breeding season. At
ams Dorm, where there were Norway spruces 20 to 24 meters
and a few Austrian pines 12 to 15 meters tall, it was a
on sight to see such courting activity most of the time.
arch 25, at which time there were only two females and
2 males present, a typical courting scene was noted in
il between 10:00 and 10:30 A.M. Four males and one female
perched on the ridge of the roof of the dorm. All of
males were singing and displaying with much gusto. The
ale responded, now and then, with the call song, but, in
eral, she was not too concerned. The songs of the indi-
ual males ranged from an immature one to the typical song
en by what was considered to be a mature voice. The dis-

all was stimulated, but more so in the case of the
n the immature voice. He puffed out his feathers
d extended his wings farther than the others. One
ot the immature-voiced one) flew to another point on
of ridge; the others followed and perched about 10
apart. One "bill-pointed," but was ignored by the
. He repeated it with the same lack of response from
hers. In the meantime the female flew to a pipe at
ge of the roof. Then she hopped down to the eaves,
up a twig from the eaves, played with it in her bill
en dropped it. She flew up over the roof and away with
ur males in pursuit. There was much chatter among the
as they flew. One was observed to strike at another
d-air as they flew from sight. Four or five other males
were present in the area during this activity showed
terest. In this group courtship display was used to
idate the other males, not the female. The flight was
f following the female, not chasing her. It appeared
an elimination contest.

Later in the same day, what appeared to be an elimina-
of one of the males from a courting group, at least tem-
rily, was observed at Williams Dorm. At 5:51 P.M. a
le grackle followed by three males flew toward the south-
out of view. There was much commotion and fighting
g the males as they flew, similar to what was observed
ier in the day. Nine minutes later a female followed by

es returned from the south. Had one of the three ecome discouraged and dropped out of the contest? se one cannot be sure that it was the same female, he was not marked, but it sounded and looked like the oup that had departed only a few minutes before. roup courtship flights were occasionally observed at ost located at Coolidge Road one and one-half miles est of Williams Dorm. Antagonism among the males at ime appeared to be less intense than earlier in the day, soon disappeared after they joined the flock near the

Such group courtship flights and perch activities as were observed as late as April 14, 1952 at the dorm, pril 28, 1951 and April 23, 1952 at Trowbridge Marsh. Thus, pair formation among bronzed grackles at East ng appears to be the result of an elimination contest two to four males for a single female. Intimidation ng and display and, to a lesser extent, by bill-pointing e on the perch, and by the use of noises of checking and tering along with body contact while in flight appear to he means by which the more dominant males eliminate the rdinate. It is assumed that the dominant male wins the . Further investigation on this point needs to be carried with marked birds in order to establish the relationships certainty.

w long do pairs remain mated? Normally bronzed grack-
se only one brood and remain mated during that time.
beginning of each season they arrive unmated and, due
method of pair formation, the chances of reunion of
evious year's mates are slight. The family unit re-
intact for two to three weeks after the young fledge,
the young are dependent on their parents for food.

The Nest

esting site. Female grackles began hunting for a nest-
te at Trowbridge Marsh on April 4, 1952, two weeks af-
e first females had arrived. At this stage of the
g cycle pairs and often groups of two pairs were ob-
flying about the marsh from tree stub to bush, and
leaving the marsh completely for periods varying from
minutes to two or three hours. The length of time
away from the marsh was governed somewhat by weather
tions. (The relationship of weather to nest-building
ities will be discussed later.) Upon their return to
arsh most of their time was spent, as before, flying
one part of the marsh to another, but always in view
e the bush tops. Search for a nesting site began when
female, or perhaps the pair, would suddenly fly down and
ppear among the bushes for three or four minutes. Upon
pearing above the bushes they would fly to other parts
he marsh and search in the same manner.

rching continued until the female seemed to be at-
again and again to a certain bush. Even though con-
on had not begun, the female, and in some cases the
ould drive other birds from the bush. The female
the intruder, but the male used guarding tactics.
of a nesting site was not always permanent. Some-
female deserted the first spot for a more secluded
The latest date in 1952 when a female was observed
ing for a nesting site was April 17.

ll of the 24 nests started or completed at this marsh
the two years were placed in the very similar situa-
outlined below:

) All except one were placed in meadowsweet bushes--
s in a willow bush (<u>Salix</u> <u>gracilis</u>). A nest located
e former is shown in Plate 2, Fig. B.

2) A clump of last year's reed-canary grass was in all
wo of the bushes--two had none.

3) The heights of the nests above the water ranged from
69 centimeters.

4) Over half of the nests were placed fairly close to
water (within 3 meters).

(5) The water depth was from 45 to 60 centimeters at each
.

her details concerning the location of the nests at Trow-
ge Marsh are shown in Fig. 7 and Table VI.

Three requirements entered into the selection of nesting sites at this marsh, viz., concealment, spacing, and seclusion.

For concealment the nesting bird relied upon a screen of many branches of *Spiraea* bushes plus a few leafy culms of last year's *Phalaris*, as new foliage did not appear on the bushes until near the end of nest-building time. Concealment was furthered by the use of stems and leaves of this same species of grass in the outside structure of the nest. However, because the stiff, straight branches did not afford good cover from above, the nests were not very well concealed from aerial predators.

The spacing of the nests appeared to be influenced by he size of the area and the density of the nesting popula- ion. At Trowbridge Marsh, where there was a relatively wide rea suitable for nesting sites, the grackles spaced their ests quite far apart--13.1 meters in 1951, when 15 nesting airs were present, and 26.3 meters the following year, when here were only six nesting pairs. By comparison, at the orest Road colony, where the area among *Spiraea* bushes with itable nesting sites was much smaller, the eight nests were aced at an average of 7.69 meters apart. In this colony e female attempted to build her nest considerably closer-- ree meters from another nest that already had eggs. It was serted before it was completed. After the young had fledged om the neighboring nest, the deserted nest was reoccupied,

nd eggs were laid in it. Apparently, in this case, f tolerance was greater than three meters.

sion was attained by placing the nests in bushes water. More than half of the nests were situated rs or less from open water (Fig. 7). Since the usually deeper there than it was farther into the they were more secluded from wading animals. is gave the birds a greater sense of security.

building. Nests under construction in 1951 were ed in the first and second stages; however, the fourth stages were followed. In 1952 the progress struction of five nests was observed from the earles to completion.

nests were constructed entirely by the female, while guarded her. For a period of a week after the sef the nesting site, the female had only a passive in nest building. This interest varied, but was during the early and late parts of the day. Interhown by their actions of picking up nesting material ng with it. Occasionally one would carry material sting site, play with it or go through some movegestive of building, and then drop it. Actual con- did not begin until a week or 10 days after the e chosen.

s sometimes symbolically displayed nest construction esence of their mates. A few instances of males with

material were observed. One picked up bits of grass e ground, while his mate was getting nesting material y. He merely played with it in his bill and dropped nother male wove the leaves of a stalk of *Phalaris* the branches of a meadowsweet bush, while his mate was feet away inspecting her nesting site before building .

While the female is occupied with nest building, the guards her almost constantly. He perches near the bush his mate is fashioning a nest. He follows her in dis- flight to the point where she collects nesting material. d another male approach her, he "bill-points" and struts e the intruder; the latter usually leaves. At other of the day, when she is not engaged in nest building, ontinues to follow her and guard her.

Female grackles began collecting nesting material at reak, that is, about 20 minutes after arriving from the t. After a period of 10 to 20 minutes of nest building, of them left the marsh to feed, and then returned again bout 15 minutes. From this time until 10:00 A.M. they very active, after which time they became less active were around the marsh area less frequently. The period inattentiveness was sometimes broken by a few females after 0 P.M. However, very little building occurred in the late ernoon.

When nest-building activity was high in the morning, males were very busy collecting material, taking it to the te, and constructing the nest. An example of the degree of tivity of one female thus busily engaged from 9:16 to 9:30 M. will serve to illustrate this. She was constructing st 1, which was very close to the observation tower late 3, Fig. A). She was getting all of the material in e _Juncus_ _tenuis_ and _Phalaris_ zones immediately to the east the tower (Plate 1, Fig. B). The nest was at the third age of construction, i.e., the plastering stage (described page 63). During the course of 14 minutes she made six und trips between the nest and the edge of the marsh, av- aging 57 seconds for the time of the flight and for col- cting the material. The shortest time was 40 seconds, and e longest was 75. The time spent at the nest also averaged seconds; the shortest time there was 30 seconds, and the gest was 80. A 60-second rest period was taken after ving the nest bush at the end of the third trip. While female was at the nest, her mate called most of the time m the top of a willow bush located about 15 feet north of nest. He accompanied her on nearly every trip, following with his courtship flight in its extreme form. He was ays on guard and courted her while she was gathering nest- material.

The building of the nest may be divided into four parts rding to the stage of construction as follows: (1) plat- or suspension pocket; (2) outside; (3) plaster cup; and, lining.

(1) *Platform or suspension pocket stage*. A suspension ework was necessarily constructed first because all of nests were suspended to several small, upright branches he *Spiraea* bushes and often also to the larger stalks of *aris*. This was usually constructed in one of two ways: by weaving a few strands of milkweed fibers (*Asclepias rnata*) from branch to branch to form a rather taut, web- e platform upon which the coarse material for the bottom the nest was laid; or, (b) by forming a rather loose pocket posed of milkweed fibers attached to the branches at the t-rim level, thus roughly outlining the shape of the en- e nest, and placing a pad of coarse material in the bottom the pocket to form a platform. Milkweed fibers were used such supporting or suspension strands in all of the nests. is a tough, durable, and flexible material, hence, a very itable fiber for anchoring strategic points of the nest ructure. This stage, if not started too early in the sea- n, was usually completed the first day of nest building. e range of dates for this stage was from April 17 to 25.

(2) *Outside*. Coarse grasses, weedstalks, string, leaves, ssue paper, rags, or most any material of that type was used form the outer part of the nest. Such material was added

to the platform. Then the sides were built up by weav-
t around the upright branches of the bush and among the
ension strands of milkweed. Nesting material for this
e of construction was obtained from the surrounding
ds, the *Juncus tenuis* and *Phalaris* zones. On the average
to three days were required for this stage of construc-
. The extremes were one and four days. In 1951 the dates
he completion of the outside of the nest ranged from April
o 28; in 1952, from April 20 to 27.

(3) *Plaster cup stage.* Plastering often began before
second stage was completed. Wet, decayed vegetation with
mud was first added to the inside bottom of the nest.
material was usually felt-like and adherent enough so
a neatly shaped cup-like interior was built up from the
tom. The thickness of the walls of the cup was quite ir-
ular, due to the surface to which it adhered, but, in gen-
l, it was thickest on the bottom and thinnest at the rim.
upper rim of the cup was usually about an inch below the
er edge of the coarse outer material and was the last to
plastered. The material for this stage of nest building
obtained from the ground in the wet parts of the marsh,
efly from the *Phalaris* zone. One to two days were re-
red. The range of dates of the completion of this stage
1951 was from April 25 to 30; in 1952, from April 22 to 28.

(4) *Lining stage.* The first strands of lining were worked
o the rim of the plaster cup while it was still wet. When

aster material dried, they were firmly anchored to it.
tenuis comprised the bulk of the lining. This tough,
leafless and unbranched plant was interwoven with the
ed pieces downward in a neat and regular fashion. Two
r days were used for this fourth stage. In 1951 the
anged from April 27 to May 2; in 1952, from April 24

st building at this marsh began as early as April 12
ed as late as May 2 during the two seasons of study.
nt of time for constructing a single nest was from
nine days, on the average. The extremes were 6 and

ther in relation to nest building. It was pointed out
hat the interest displayed by female grackles for
esting sites and constructing nests varied according
me of day and also according to weather conditions.
ffected their activities in two ways: (1) a momen-
rdation or acceleration; (2) a long range effect
onged or retarded activity, or effected a change
ind of activity to another.

weather phenomena as high wind, precipitation,
, or sunshine had a noticeable effect on their
om day to day. There was virtually no activity when
high wind (15 m. p. h. or more) combined with
y precipitation. They were less active or more

ratic in their actions when there was a high wind and oudiness. On the other hand activity was higher on warmer ys with less wind.

The length of the nest-site-searching period and the inning of nest building seem to be governed by the gen- trend of the temperature. From April 1 to 11 in both s of this study the average daily temperature ranged be- n 34° and 57° F. During this time female grackles were hing for nesting sites. In 1951 the upward trend of emperature began about April 20 (Fig. 8). This marked nd of the nest-site-searching period and the beginning nest-building period. The average temperature climbed he 40° F. range upward into the high 60's during the period of nest construction. In 1952 the upward trend temperature began nearly a week earlier (Fig. 9). t in nest building also began as early as April 12, ys sooner than in 1951, but did not begin in earnest ril 17, only three days earlier than in the previous his slow start may be accounted for by the fact that rd trend in temperature leveled off in the low 60's, result, the nest-building period was prolonged to pril 12 to 30).

structure. Six nests were removed from Trowbridge analysis. The average dimensions were as follows:

	Diameter		Depth	
	Cm.	In.	Cm.	In.
Outside	16.48	6 1/2	13.45	5 3/8
Inside	9.98	3 7/8	7.60	3

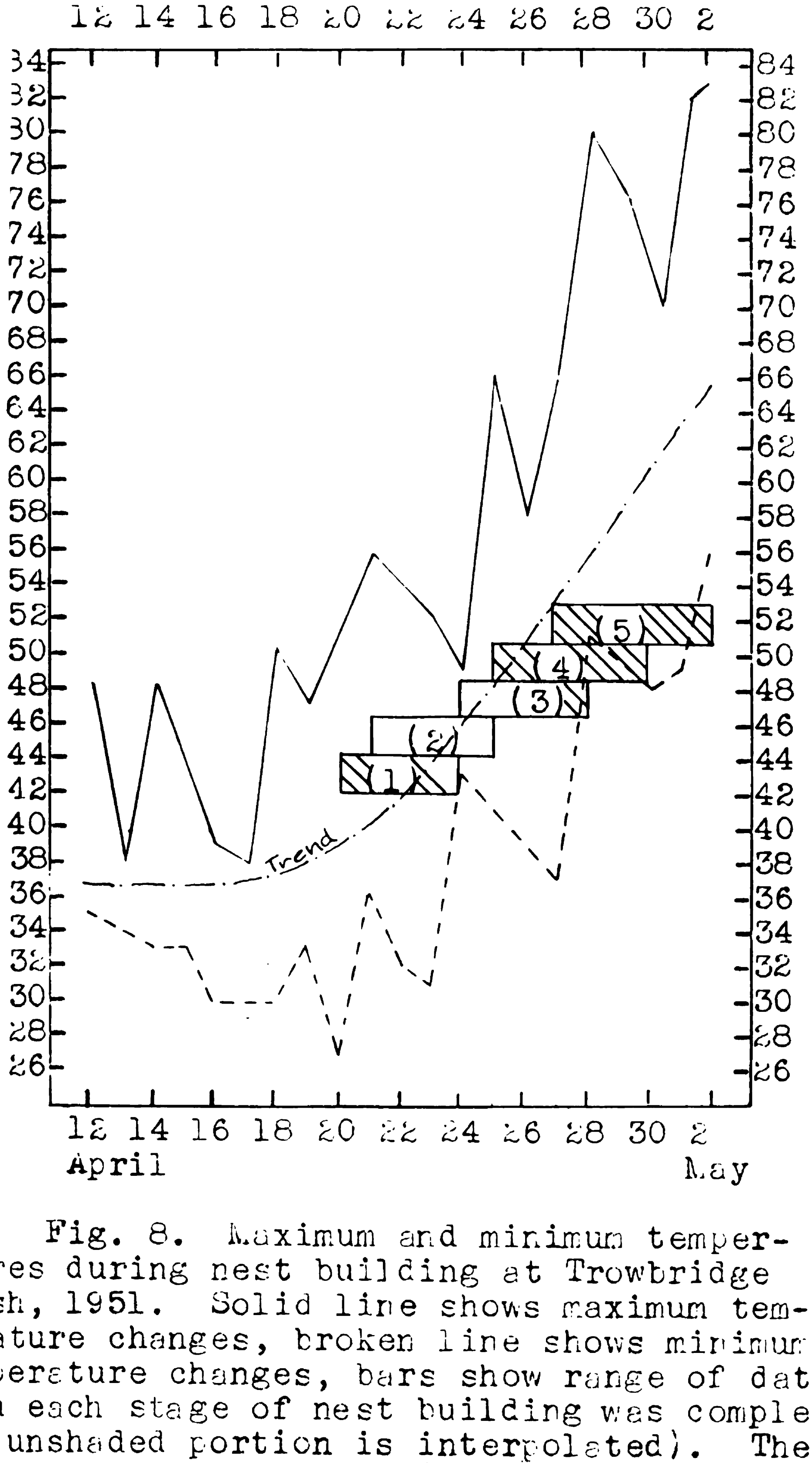


Fig. 8. Maximum and minimum temper-
es during nest building at Trowbridge
h, 1951. Solid line shows maximum tem-
ture changes, broken line shows minimum
erature changes, bars show range of dates
each stage of nest building was complet-
unshaded portion is interpolated). The
es are as follows: (1) nest started;
platform; (3) plaster cup; (4) outside;
lining. Trend drawn in by eye. (Weather
from Station Meteorological Summary for
ing, Michigan, U.S.Department of Com-
e, Weather Bureau.)

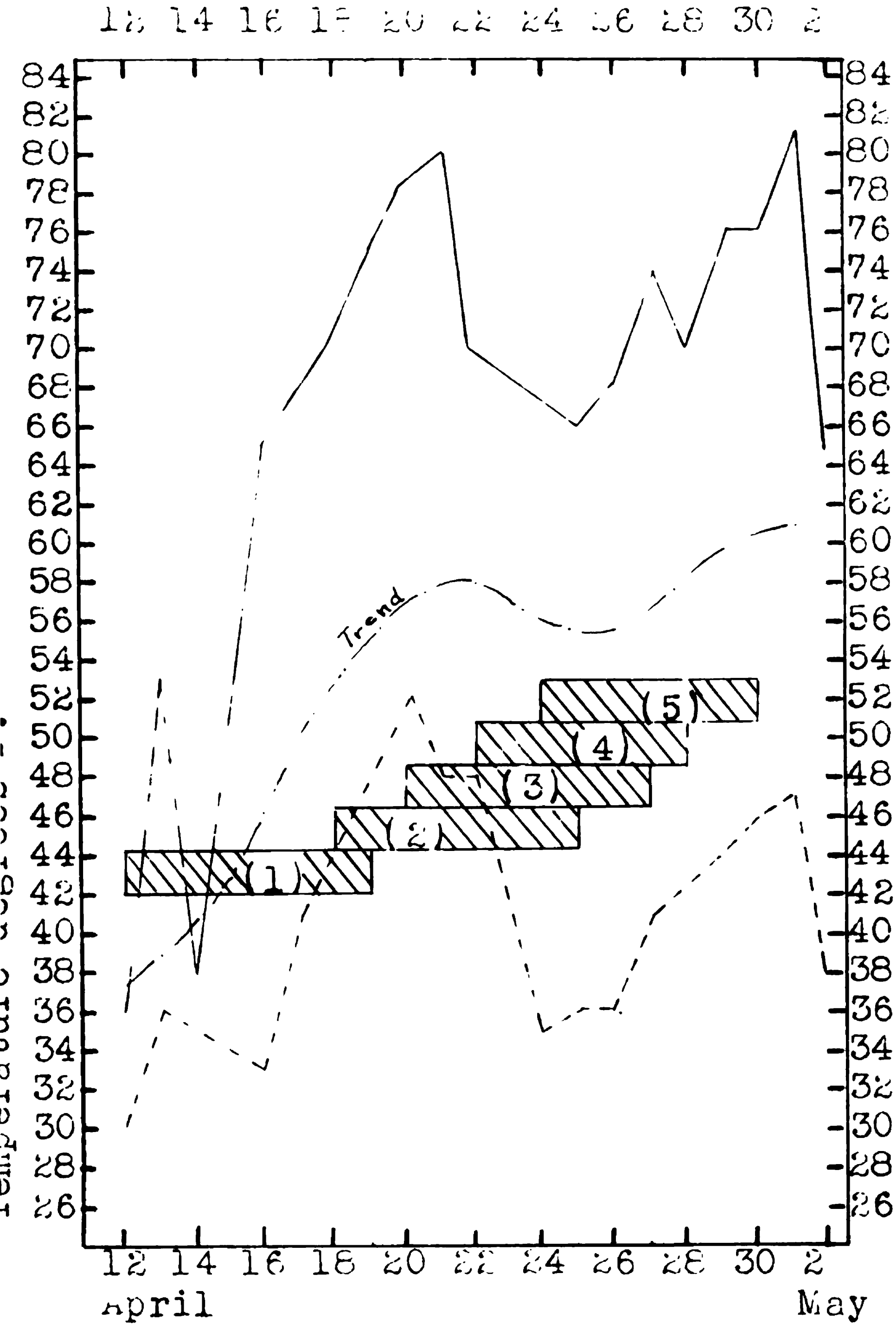


Fig. 9. Maximum and minimum temperatures during nest building at Trowbridge Marsh, 1952. Solid line shows maximum temperature changes, broken line shows range of dates when each stage of nest building was completed. The stages are as follows: (1) nest started; (2) platform; (3) plaster cup; (4) outside; (5) lining. Trend drawn in by eye. (Weather data from Station Meteorological Summary for Lansing, Michigan, U.S.Department of Commerce, Weather Bureau.)

erage dry weight of the six nests was 122.56 grams.
tails of nest size and composition are given in Tables
V.

fter weighing and measuring, each nest was carefully
tled into three parts, viz., the outside, the lining,
e plaster cup. Plate 3, Fig. B shows in cross-sectional
ese three parts of a nest.

n general, the nests appeared bulky due to the size and
ture of the outside structure. The walls were from
4.5 centimeters (1 to 1 3/4 in.) thick and were made
rse material. The outside comprised 24.6 per cent of
ight of the nest, but it amounted to considerably more
k. All of the milkweed fiber used for the platform
ter wall of the nest was included in the weight of the
e material.

he lining, which was 42.8 per cent Juncus tenuis stems
e fruiting heads, was securely anchored about the rim
nest where these plant stems had adhered to the plaster
The lining of one nest, which had been deserted with
it, was taken apart, and the length of each piece of
l was measured. The measurement of Juncus tenuis
51.19 meters (167.3 ft.). On the basis of the number
ting heads present this represented parts of 240 plants
species. This was more than five times the length of
terials, such as fine grass stems, leaves, and roots
n the lining. The average weight of the lining was
ams or 5.9 per cent of the weight of the nest.

The plaster cup was firm in structure. The thickness of the bottom averaged 1.71 centimeters (3/4 in.), while that of the rim was 0.66 of a centimeter (1/4 in.). The outer surface of the cup, which was in contact with the outside structure of the nest, was irregular, but the inner surface was smooth and symmetrical. The plaster cup of one nest, soaked in water in order to determine its composition, was found to be composed of small fragments of roots, stems, and leaves of grasses, sedges, and bur-reed (*Sparganium eurycarpum*) which were quite soggy when wet. Intermixed with these bits of plant material was a much smaller amount of organic mud containing fibrous plant material, small fragments of stems, leaves, and roots, and a few small seeds. A favorite spot for collecting this material was at the bases of *Phalaris* growing along the outer part of the marsh. The plaster cup was the heaviest portion of the nest, even when dry, comprising nearly 69.3 per cent of the total weight.

As hertofore stated, support for the nests at Trowbridge Marsh was furnished by the many upright stems of *Spiraea* bushes and, in many cases, by stems of *Phalaris*. The six nests examined were supported by 13 *Spiraea* stems, on the average; the number ranged from 8 to 18. There were eight *Phalaris* stems, on the average, the number ranging from 0 to 19.

<u>Durability of the nest</u>. The nest endures the wear of rearing a brood quite well. The parts of the nest that receive the most wear are the rim and the lining. By the time the young fledge, the coarse material forming the rim or upper edge of the nest becomes pressed down to the level of the plaster cup. Much of the lining becomes broken into small fragments, wasting away into debris, which accumulates in the plaster cup. But it does stay intact around the rim where it is cemented to the plaster cup.

By October all of the nests are soft because the mud of the plaster cup has been washed out by rain. About half of the nests are still in good shape, while the other half are either badly deformed and hanging by a few strands of milkweed fiber or they are completely down. Nests which had been constructed in 1951 were examined on March 15, 1952. Winter weather had destroyed most of them so completely that they were not found even though the markers were still there. The combination of wind and pressure of snow had torn all but two from their original positions. Traces of grass marked the place of two others. One of the two, which were at about the original level, was a mere mass of weeds and grass, while the other was still well formed.

Apparently grackles do not re-use their nests. Since they raise but one brood, there is no further need for a nest during the nesting season. Nests which have passed through a winter at East Lansing are usually not usable the

next season. One nest was built on a mass of material which might have been a nest of the previous year.

Survey of nesting population at East Lansing. A systematic search for nesting areas of grackles was conducted from April 1 to May 15, 1952, in a 12-square-mile area in the vicinity of East Lansing (Fig. 10). The purpose of this survey was to determine the location and situation of nesting sites and to count as accurately as possible the number of breeding pairs.

The area chosen for this survey consisted of three general types of habitat.

(1) *Urban or suburban*, with its city streets, parks, cemeteries, residential districts, and the campus of Michigan State College.

(2) *Country*, consisting of small "city farms," general farms with woodlots and trees around dwelling places, marshes, and swamps.

(3) *Bottomland woods*, some of which were within the limits of the city and some in the country, but all in the flood plains of the Red Cedar River and a small tributary of it.

Locating the nesting areas was greatly facilitated in two ways: (1) the fact that courting grackles were easily spotted at a distance by virtue of their size, noisiness, and attachment to certain places; (2) many roads that crossed the area studied made it possible to inspect much of the

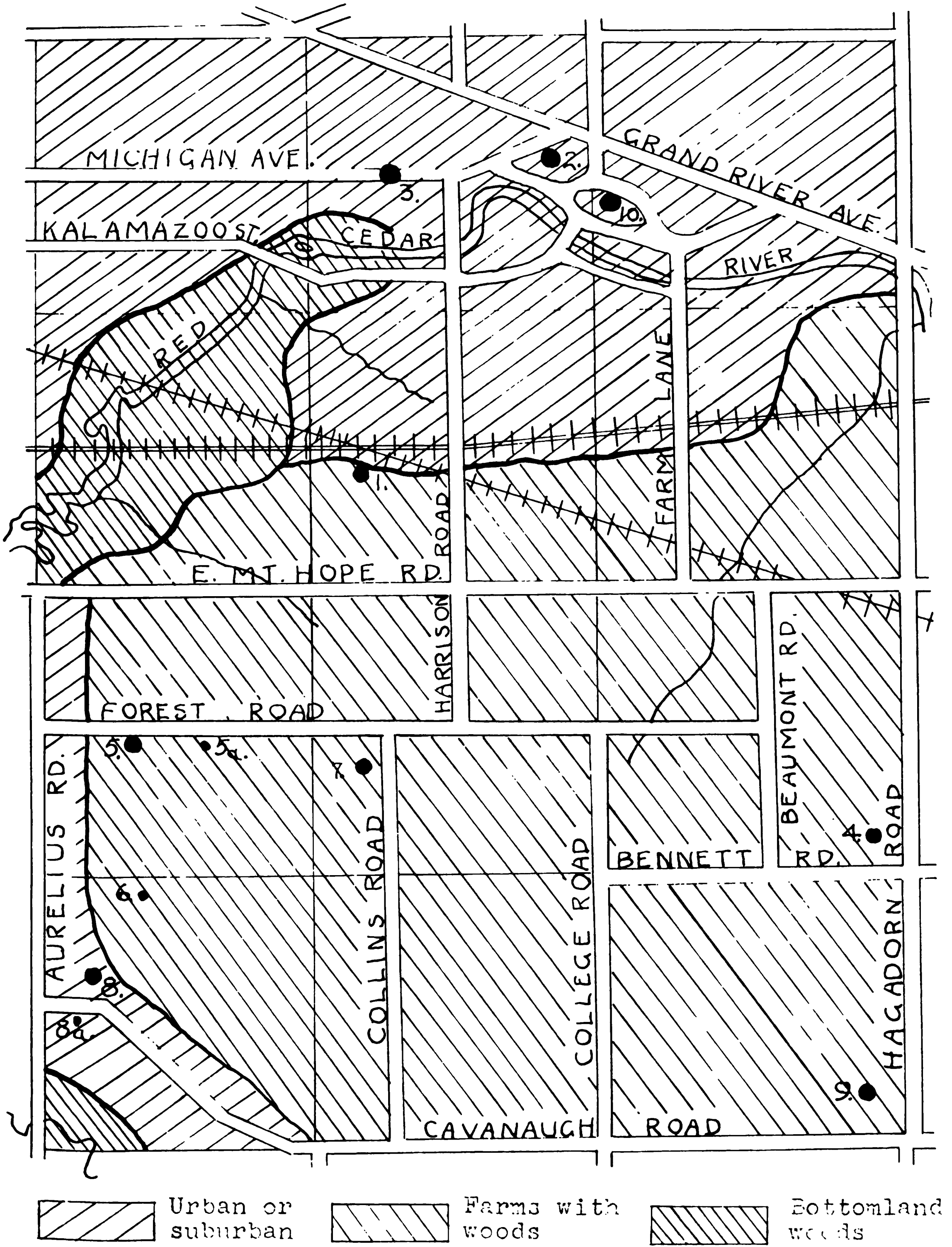


Fig. 10. Nesting population of bronzed grackles in the vicinity of East Lansing, 1952. Number of colonies in order of discovery. (1) Trowbridge Marsh colony; (2) Williams Dorm colony; (3) Michigan Avenue colony; (4) Bennett Farm colony; (5) Forest Road colony (5a a single nest); (6) a single nest; (7) Collins Road colony; (8) and (8a) Cavanaugh Road colony; (9) two nests; (10) Music Building colony.

area from an automobile or a bicycle. All but two of the colonies were spotted in this way. (The term colony is used here to mean a nesting area.) However, each woodlot and all distant places which were screened from view from the road were traversed by hiking.

The total number of nests, including those either in the process of being constructed or already occupied by a female, was 74. In other words, there were 74 pairs of nesting birds. It was impossible to get an accurate count of the number of birds present in the nesting area unless it was a small colony in an open area. Assuming a 50:50 sex ratio, the total nesting population was 148. The writer feels that this figure may be a little low (five or so), since there may have been a few young females which were not nesting yet. The population density was about 12.3 grackles per square mile, or expressed in another way, it was approximately one grackle per 51.9 acres (possibly one per 50 acres). The largest colonies consisted of 12 to 13 pairs, all of which were located within an area of about one acre. In two cases single nests were found almost a quarter of a mile from the main colony. In one place (Colony 6 of Fig. 10) a single pair was located over a quarter of a mile form the nearest colony.

A brief description of each nesting area will depict the locations sought by grackles in this part of Michigan. The nesting areas were numbered in the order of their discovery (Fig. 10 and Table II).

Area 1. Trowbridge Marsh has been described in detail (Plates [illegible]). [illegible] found in that area

Area 2. Williams Dorm colony, located on the campus of Michigan State College, was described earlier (page [illegible]). Twelve nests were situated in Norway spruce and Austrian pine. About half of them were suspended in forks at about one meter from the ends of branches, and the other half were resting on branches.

Area 3. Michigan Avenue colony was located on a parkway separating the traffic of that street. Seven nests were found in a spreading Austrian pine at levels ranging from 7 to 12 meters high (Plate 4, Fig. A).

Area 4. Bennett Farm colony was situated in a windbreak of Norway spruces located near a farmhouse (Plate 4, Fig. B). These trees were about 40 years old and were from 17 to 23 meters tall. Growth in the tops, where all 13 nests were placed was very dense. None of the nests were below 15 meters above the ground.

Area 5. Forest Road colony with a total of eight active nests was located in a small <u>Spiraea alba</u> area without <u>Phalaris</u> (Plate 5, Fig. A). A ninth nest was found about one-fourth of a mile away in a small willow swamp. At the <u>Spiraea</u> area the nest bushes were growing in water from 30 to 50 centimeters deep. This place was divided by Forest Road into two parts. Seven nests were located on the south side of the road where there was open water and where, also, the water was deepest. A single nest located at 5a, as previously mentioned, was situated in the crotch of a black willow 60 centimeters above shallow water (Plate 5, Fig. B).

Area 6. This was a small willow swamp with buttonbush (<u>Cephalanthus occidentalis</u>) growing in water over one meter deep. One pair of grackles was seen at this place on two different occasions. Because of their actions and apparent attachment to the area, it was assumed that they were nesting there.

Area 7. Collins Road colony was located in a willow swamp where four nests were placed in the crotches of black willow trees at a height of 65 centimeters above the water level (Plate 6, Fig. A). The water depth was 30 to 40 centimeters. All of the nests were within reach of an average-sized dog.

Area 8. Cavanaugh Road colony with a total of 14 nests was located in a small willow swamp with a border of sandbar willow (Salix interior) surrounding an open water area in which was an island of black willow and buttonbush. The water was over a meter deep except on one side where it was 60 to 70 centimeters deep. One nest was found in the sandbar willow thicket, suspended among several upright branches of this shrub (Plate 6, Fig. B). On the island 10 nests were situated in black willow trees and two in buttonbush. Nest 8a (Fig. 10) was located in a sandbar willow thicket about two tenths of a mile from the rest of this colony.

Area 9. Two nests were found in a small, rather open willow swamp. They were situated in crotches of black willows 1 to 1.5 meters above the water. The latter was 30 to 50 centimeters deep.

Area 10. The Music Building colony was located on the campus in Norway spruce and Austrian pine. Six nests were situated in a manner similar to those of the Williams Dorm colony.

This survey of the nesting population of grackles in the vicinity of East Lansing revealed several facts about their numbers, distribution, and choice of nesting areas and sites. There were ten colonies in all with an average of 7.4 pairs in each; six were located in marshes and swamps with an average of six pairs per colony, and four in coniferous trees with an average of 9.5 pairs per colony. The nesting colonies were in three general types of vegetation: (1) four colonies were in coniferous trees (one in a windbreak near a farmstead and three in the city); (2) two were in Spiraea alba marshes; and (3) four were in willow swamps. On the average, the distance between a colony and the one nearest to it was 0.6 of a mile; the shortest distance was about 0.2 of a mile and the greatest, about one mile. The height of the nests varied

rding to the kind of support. It averaged 10.5 meters
niferous trees, 1.5 meters in black willows, 0.8 meters
llow shrubs, 0.63 meters in buttonbush and 0.55 meters
adowsweet bushes. From this variety of nesting areas
ites it becomes evident that the bronzed grackle is a
adaptable nest builder and that, for the most part,
efers to nest in small groups.

iterature. In general, the bronzed grackle builds its
rom about three to five weeks after the first migrants
the breeding grounds. In the southern states it prob-
uilds at about the same time as the purple grackle does,
is during the month of April in Alabama (Golsan and
.914:227) and in late April to early May in Mississippi
rd, 1905:275-276). In the central and northern states
ilding begins at about the same time or a week later
it extends from mid-April to mid-May (Wilson, 1906:5;
, 1932:318-321; Trautman, 1940:390; Petersen and Young,
). In Montana and in Alberta, Canada, nest building
one month later, i.e., from mid-May to mid-June
1903:412; Cameron, 1907:401).
s species is a highly adaptable nest builder, as was
from the survey of the East Lansing area. This trait
nore evident in other parts of its breeding range.
ifferent general types of habitat and as many dif-
pes of nest situations were mentioned by 50 authors
iterature. These locations have been summarized in

e VIII. The number of times that each type of habitat upport for the nests was mentioned by the authors gives neral idea as to its frequency of use by the birds.

Nearly all of the writers who mentioned the use of conif- s trees noted that grackles preferred them for nesting s. In connection with the use of hollows and cavities, author pointed out the crudeness of the nest when it was ed in old woodpecker holes--they often used just a crude ng or none at all (Gibbs, 1903). Apparently grackles will e advantage of unused hollows or cavities in tree stubs ther they are in an old orchard or in a flooded bottom- d. The crevices in the sides of the osprey's nest are etimes sought. Roberts (1932:439) related an observation H. F. Kendall who saw several bronzed grackles nesting in osprey's nest at a height of 18 meters (60 ft.). The use several man-made structures has also been reported (Table .

The bronzed grackle uses the material at hand for its t and for that reason the composition varies from one type habitat to another. This versatility is manifested in e variety of materials used. Weed stalks, sticks, string, er, rags, eelgrass, wood-shavings, corn husks, feathers, rsehair, and mud are some of the materials found in nests cated in New England (Capen, 1886:56-57) and in the Midwest abrielson, 1922:302). Compared with the nest of the Florida

grackles, there is very little difference in choice
nd the general structure of the nest (Bendire,

Egg-laying, Incubation, and Hatching

ying. On the average, the first eggs were laid
ter the lining of the nest was completed. The
re one and four days. Eggs were deposited in the
ng hours from 6:00 to 8:00. The single exception
16, where the first egg was still warm at 7:30 P.M.
warm eggs the second day at 10:00 A.M. Either
was an erratic layer or she began incubating with
gg. All females deposited one egg per day on con-
ys, except the female of Nest 8, which apparently
y between the second and last eggs. The total num-
laid was 4.5 per nest and ranged from three to six.
of egg-laying at Trowbridge Marsh was from April
in 1951 and from April 25 to May 7 in 1952.

g. The background color of the eggs was of two
) a dark shade of a tarnished or rusty color, (2)
de of either an aqua or a pale blue color. Each
only one of these two background colors. Gentry
described the eggs of the purple grackle, "*Quis-*
reus (Bartram) Licht," as follows:

> und (color) is also subject to changes, specimens
> een with a deep rusty-brown color, and others with

> one of light greenish-white. It is a rare occurrence to meet with the two forms in the same nest-full, the latter being the predominant hue. Eggs with the brown background have in addition to the black and dark-brown streaks and dashes which cover the other type, chiefly about the larger extremity, a number of confluent, cloudy blotches of deeper shades of the same color. These markings are singularly grotesque in their pattern, and often bear strong resemblances to letters, figures and other characters.

eed (1904:243) said of the nesting habits and eggs of the ree subspecies of *quiscula*: ". . . The nesting habits and ggs of the subspecies of this Grackle [the purple grackle] o not differ in any particular." This is supported by the act that the color characteristics of the eggs of the bronzed rackles at Trowbridge Marsh agree with Gentry's description f the purple grackle eggs.

The length and width of 20 eggs from five sets at rowbridge Marsh were measured. These measurements, compared ith average figures reported by Capen (1886:56), who measured pecimens in New England, and Reed (1904:243), who gave the verage size of the eggs of purple grackles (the locality s not given) are as follows:

	Average Length		Average Width	
	Millimeters	Inches	Millimeters	Inches
Trowbridge Marsh	28.85	1.12	21.95	0.83
Capen	31.75	1.25	22.86	0.90
Reed	27.94	1.10	20.32	0.80

e length of eggs at Trowbridge Marsh varied from 27 millieters (1.06 in.) to 30 millimeters (1.18 in.), and the width, om 20 millimeters (0.79 in.) to 22 millimeters (0.87 in.).

Incubation. The female does all of the incubating, ich she commences in the late afternoon or early evening rior to the laying of the last egg. This differs from the oat-tailed grackle, which begins incubation at the laying f the second egg (McIlhenny, 1937:282). Only a few instances ere found where incubation had been started before 5:00 P.M. ost of the eggs were still cold at that time. However, in- ubation certainly begins at least 12 hours before the last gg is deposited, since hatching of a set requires two days.

The female soon establishes a routine way of entering nd leaving the nest. She usually alights on a bush top lo- ated 15 to 20 feet away, and, after a brief hesitation, escends out of view and hops from branch to branch along an rregular course to the nest. She nearly always enters the est from one direction and leaves it in another. Usually he approaches silently, but sometimes makes a low "check" r "churr" just as she enters the nest. Very often she makes imilar sounds when departing.

On the nest the female is alert and uneasy much of the ime. Uneasiness seems to be more pronounced on windy days. Probably the movements of the blind were responsible for ome of this action.) The female exercises in three ways: 1) by shuffling her feet as though turning the eggs, (2) y backing up on the edge of the nest in order to reach be- ow her breast with her bill to turn the eggs or to clean the est, (3) by turning from one position to another. These

do not occur at regular intervals; sometimes the etween them is only a minute, at other times it minutes, but generally it is about 10 minutes. a shuffling movement precedes the departure from Turning in the nest gives the bird a chance to little, which probably relieves fatigue. Some early always turn in the same direction, while others in either direction.

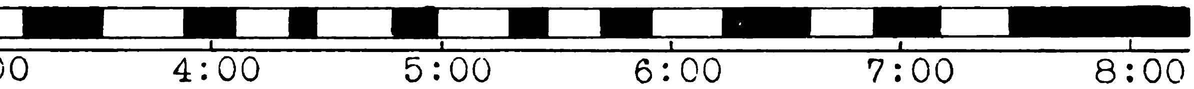
ale spends about a fourth to nearly half of his perch 20 to 40 feet from the nest. The female may the nest while he is present, but she usually is. attentive from about 8:30 A.M. until noon and again to 7:00 P.M. as compared with the earlier and later he day. During an observation period of one and a on the morning of the sixth day of incubation, the est 6 was present 41 per cent of the time. On the day, during a five-hour morning observation period, esent only 17.6 per cent of the time. On the tenth an afternoon watch of six hours this same male was 2.4 per cent of the time, 10 per cent of which was e female's absence. While he is on the perch, he eries of three to five calls to the female. After al of quiet for two minutes or more he repeats his which the female may answer with one call from the main function appears to be guarding, because, when es alight on the same perch in his presence, they rt.

g the morning hours the male visited the nest on
e of once every two hours; in the afternoon his
e less frequent. As early as the sixth day of in-
e was observed feeding the female while she was on
When the male came close to the nest, the female
egged with fluttering wings like a young bird. Once,
elfth day of incubation (very close to hatching
female uttered a warning "churr" as the male came
he nest.

g incubation the reaction of female grackles to in-
aried from one individual to another, but, generally,
em flushed when the investigator was about 15 to 20
. (The closest was four feet.) After the female
ed, she usually flew to a perch and objected by
' or "chucking." If the male was present, he joined
jection and perhaps added a few "churrs." Occasion-
male would fly over the intruder and object more
y.

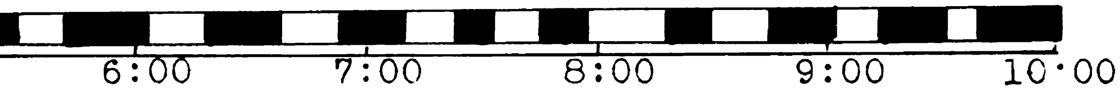
length of periods of attentiveness during incubation
mewhat according to the time of day and to individ-
rences. The females of Nests 6 and 17 were observed
ular (Fig. 11 and Table X). The female of Nest 6
about 16 minutes per period on the nest both in the
nd afternoon, and remained on the nest a little long-
beginning and end of each day, when the temperatures
ow as 12° C. The inattentive period ranged from 10

Female 6
Tenth day of incubation
May 14, 1951



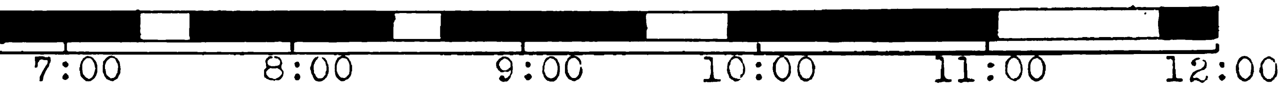
est: 169 min. Time off nest: 191 min. P.M.

Female 6
Eleventh day of incubation
May 15, 1951



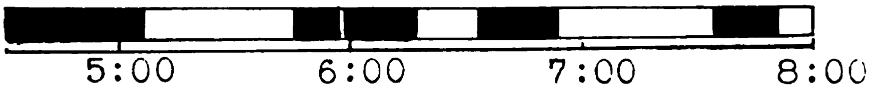
est: 160 min. Time off nest: 135 min. A.M.

Female 17
Seventh day of incubation
May 9, 1952



est: 249 min. Time off nest: 111 min. A.M.

Female 17
Tenth day of incubation
May 12, 1952



Time on nest: 96 min. A.M.
Time off nest: 210 min.

g. 11. A record of attentive and inattentive periods males incubating. Shaded portions of the bars rep- off the nest.

utes. The female of Nest 17 remained on the nest
longer intervals, averaging between 45 and 50 minutes.
rature was between 3°and 10°C. when this female was
Other factors, which will be discussed later, may
ed her to remain on the nest for periods longer than

ccurate check on the length of the incubation period
ts at Trowbridge Marsh showed an average of 12.7
days for two nests and 13 days for eight others.
n of the incubation period was computed from the
the last egg to the hatching of the last young.
ections of 33 nests with eggs were made nearly every
owbridge Marsh, Forest Road, and Collins Road colo-
ght of these 33 nests were deserted, a ninth had its
en, and the female of a tenth nest was killed. Nests
involved 23 per cent of all the eggs laid in these
while the other two nests involved only three per
number of factors--some known, some unknown--caused
. Known factors included weather and interferences
vestigator. Other possible causes included the in-
ysiological make-up of the bird and also some complex
lationships that were not observed. An account of
sts, which were either deserted or destroyed, fol-

out one of the eight females which deserted were
to about the same amount of interference by daily

ns of their nests. The female of Nest 17 had an
unt of disturbance because a blind near her was
own by cattle and set up again several times.
objection of incubating females to the intrusion
vestigator was not as vigorous as it was later when
e in the nest. There was no correlation between the
objecting by the females and their tendency to de-
terference was, no doubt, a contributing factor to
uragement of some that lacked zeal for incubating.
vorable weather, that is, a period of two or three
old, wet weather preceded the desertion of five nests
idge Marsh in 1951 (Nests 1, 5, 7, 9, and 15), two
he same marsh in 1952 (Nests 16 and 17), and one at
ad in 1952 (Nest 8). Figs. 12 and 13 give a graphic
f the correlation between desertion and weather.
re was practically no cover above these nests, the
ere greatly exposed. The urge to incubate under pro-
verse weather conditions probably waned in all
and those already lacking in zeal in this respect
lost interest completely. Desertion in all cases
after at least five days of incubation. None of them
ain in the same nesting area.
female of Nest 17 had other disturbing factors in
to weather. Interference by placing a blind near the
already been pointed out. There was also a third
ich is not clearly understood. On the morning of

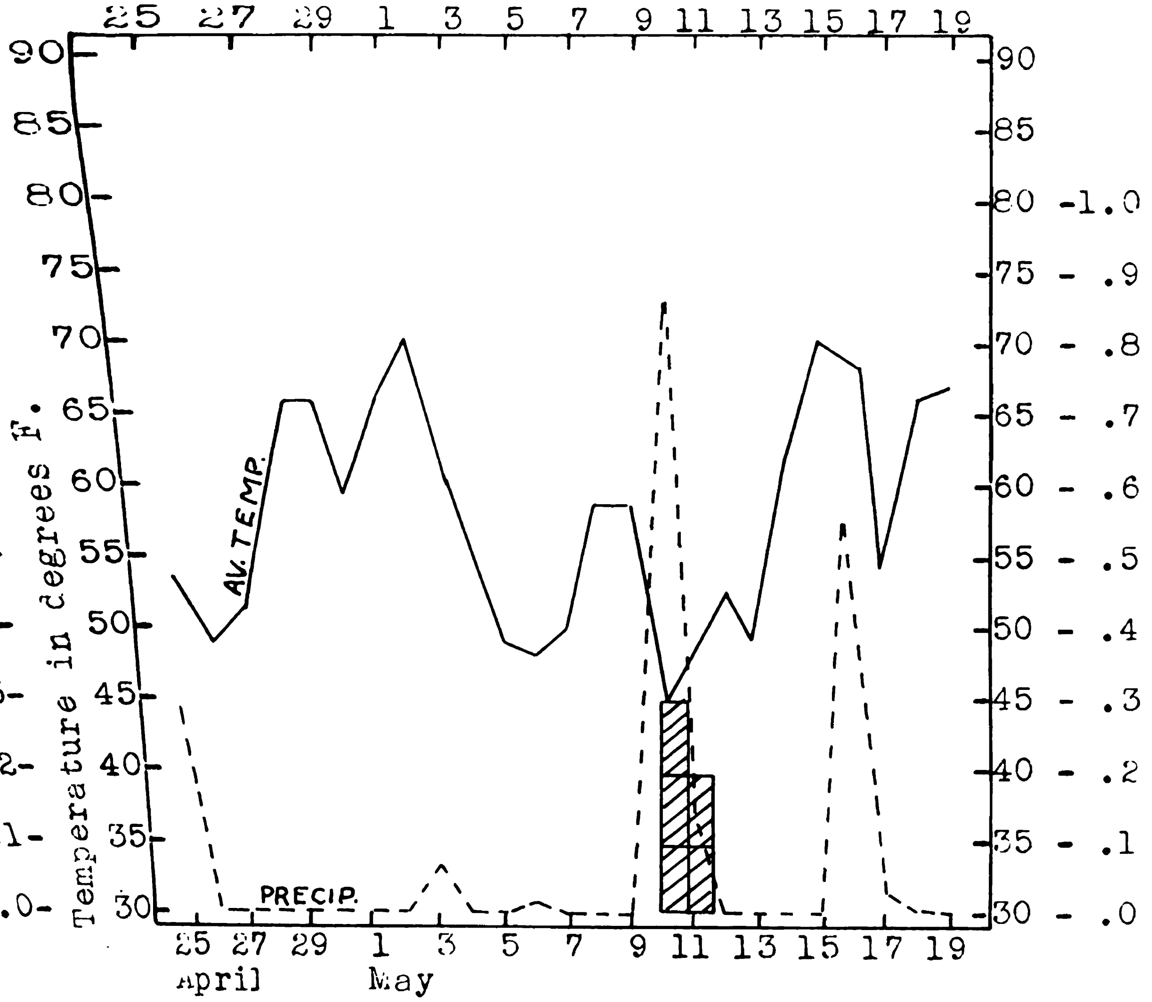


Fig. 12. The correlation of nest desertion with tem-
rature and precipitation at Trowbridge Marsh colony, 1951.
ach bar one unit high represents one nest with eggs. (Data
rom Station Meteorological Summary for Lansing, Michigan,
.S.Department of Commerce, Weather Bureau.)

the day when this female deserted, it was noticed that the male was not around as much as he had been on other mornings. When he arrived, he was accompanied by another female. Both females responded to his call as he approached the nest, so he was assumed to be the mate of the female of Nest 17. The writer strongly suspects that the second female may have been the one of Nest 16, which deserted three days previously. This problem of sharing her mate may have been a factor contributing to her desertion.

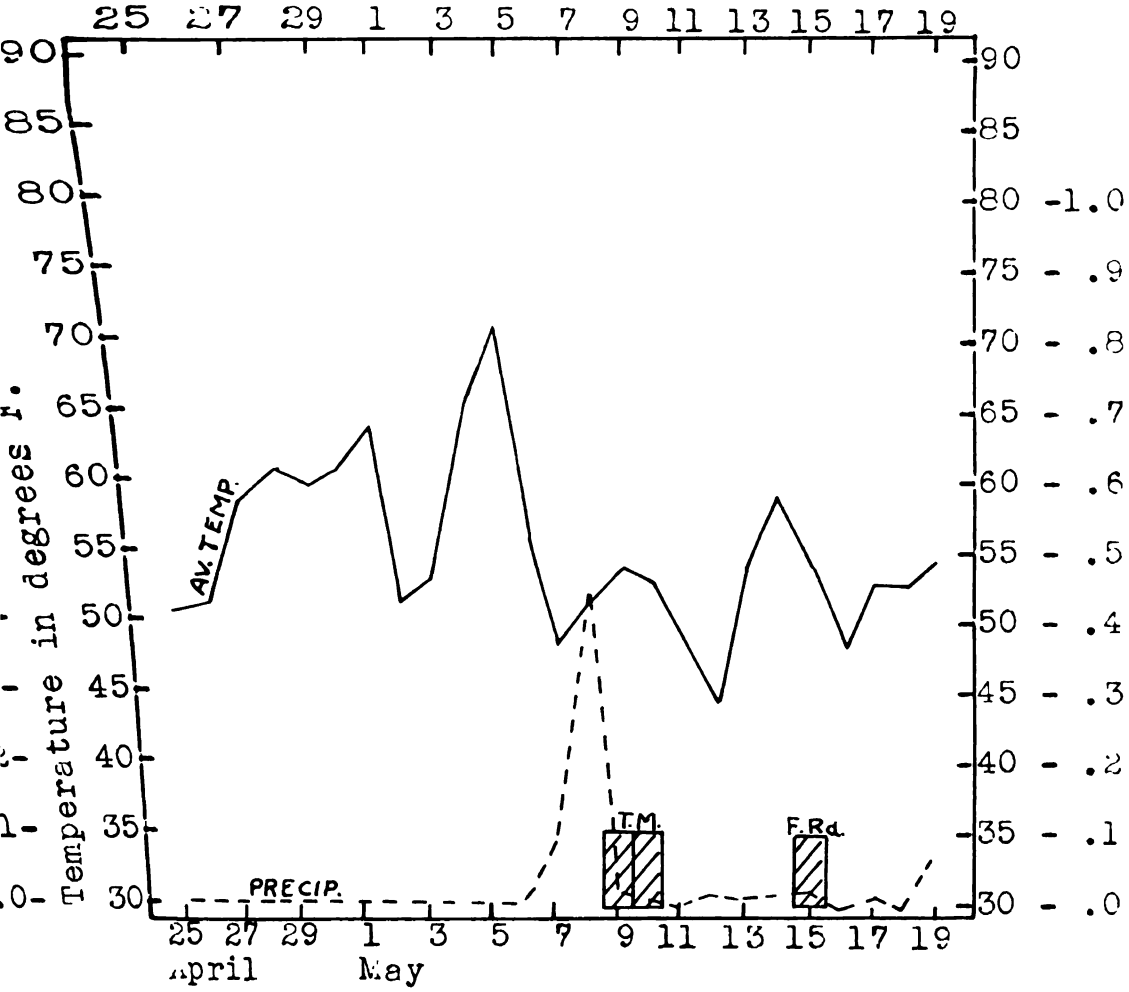


Fig. 13. The correlation of nest desertion with tem-
rature and precipitation at Trowbridge Marsh and Forest
ad colonies, 1952. Each bar one unit high represents one
st with eggs. (Data from Station Meteorological Summary
r Lansing, Michigan, U.S.Department of Commerce, Weather
ureau.)

The eggs of Nest 2 were broken. It is not known whether they were broken by her, by some other grackle, or, perhaps, by some other animal. Her nest was more exposed than any of the others at Trowbridge Marsh, since it had been placed on a *Spiraea* bush which had been pressed over on its side. The stems of this bush formed a ramp leading from the water to the nest, so that entry by a water bird, such as a coot or rail, would have been easy. Another possibility is a crow, since

some were seen at times over the marsh, and were always chased by the grackles.

The female of Nest 20 was caught in a trap and killed by dogs before the trap was inspected.

At least six of the eight desertions, therefore, correlate with prolonged cold, wet weather, which is understood to be the primary external factor causing desertion. The lack of or loss of a mate in addition to adverse weather may have been the cause of two other desertions.

None of the nests examined in this study contained a cowbird's egg, although one red-wing's nest at Trowbridge Marsh contained one. Friedmann (1929:215-216; 1931:61) reported several cases where bronzed grackles' nests have been parasitized by the cowbird.

Hatching. Hatching appeared to occur at any time of the day. One young was observed in the process of hatching at 10:27 A.M. Several hours later, at 5:05 P.M., a second young, with the capital down still wet, was present in the same nest. Another young with wet down was observed at Collins Road colony at 5:15 P.M.

Growth and Development of Young

The growth of young grackles was checked by weighing, and by measuring the length of the bill, wing, and tarsus nearly every day at three nesting areas. The ideal way of

making this kind of a study would be to obtain such data at the exact time of hatching, again at frequent intervals during the first two days, and then daily measurements until the young are ready to leave the nest. As the investigator was not able to do this, it was hoped that by having a fairly large sampling from three nesting areas, a reasonably accurate picture of the growth of young grackles in this region might be obtained.

Weighing and measuring was done in the late afternoon in nearly every case. During this study 410 weighings and sets of measurements were made on 77 different nestlings. The day of hatching of 29 nestlings was definitely known; it could be estimated for the remaining 48. The data on the 29 young were used to compute the amount and rate of growth.

Since measurements were not made at the exact time of hatching, seven young, which were known to be less than eight hours old, were used to represent the at-hatching age. It was believed that none of these had been fed, because they were all about the same weight (five and six grams). All of the young in the day-of-hatching class (zero day) were hatched within a 24-hour period. Some were newly hatched, others had been fed several times; therefore, the weights and measurements varied considerably (Fig. 14, page 101).

At hatching. Weight 5.5 grams, bill 6.4 mm., wing 9.0 mm., tarsus 5.6 mm. (Average of seven young less than eight hours old).

The skin of a newly-hatched chick is bright yellowish-orange color on the ventral side, which shades into a darker blue-black on the dorsal surface, especially on the top of the head and in the pelvic region. The margins of the bill are yellow; the lining of the mouth is bright reddish-orange.

The newly-hatched chick is nearly naked except for down which is 10 to 12 millimeters long and covers the capital, spinal (except for the cervical region), humeral, and femoral tracts. The ventral tract is naked. On the alar tract a few long tufts of down (14 to 15 mm.) are located along the line where the first greater coverts of the secondaries will appear later. At this age none of the future juvenal feathers are evident even as darkened areas under the skin.

The eyes are completely closed. The eye slit is 2.5 millimeters long.

A newly-hatched chick, just out of the shell, utters a faint "peep", raises its head feebly and opens its mouth in response to almost any sound or vibration near the nest. This is also true of the older ones in the day-of-hatching age class.

<u>Day of hatching</u>. Weight 6.5 grams, bill 6.2 mm., wing 9.6 mm., tarsus 6.2 mm. (Average of 29 young hatched within a 24-hour period.)

The larger members of this age class, which were assumed to be older, appeared to be a little stronger. In the hand

they were very limp and made clutching movements with their toes. The skin color, down, and reactions were the same as that of the previous age group.

One day. Weight 9.9 grams (7 to 13), bill 6.8 mm., wing 11.3 mm., tarsus 7.5 mm. (Average of 30)

The down persists in the places described previously (Plate 7, Fig. A). The only indication of juvenal feathers is the appearance of a dark heavy line under the skin of the wings where the future primaries and secondaries are developing.

The eyes are still completely closed, the eye slits are 2.5 millimeters long. The voice and reactions are the same but stronger.

Two days. Weight 14.0 grams (8 to 19), bill 7.6 mm., wing 13.7 mm., tarsus 9.6 mm. (Average of 28)

This wide variation in weight can be accounted for by the fact that in nests where there were five or more young, not infrequently the youngest was so crowded and covered by the older nestlings that it did not receive as much food, and, after two to five days of virtual starvation, died.

Dark points and dots under the skin mark the location of pin feathers found on the spinal (from the lower cervical region to the tail), humeral, femoral, ventral, and alar tracts. There is no indication of them on the capital tract or on the upper cervical region of the spinal tract. Most of the prim-

ary pin feathers project through the skin about one millimeter. Only the first two or three pin feathers of the secondaries have pushed out of the skin. The remainder are merely pimples of flesh. The pin feathers of the alula keep pace with those of the primaries.

The voice is a faint "peep." The eyes are still closed but the slits have increased to three millimeters. The young responds to sounds and vibrations among the bushes, as before, by holding its head up with neck stretched and mouth open. It makes clutching movements with the feet but does not hold on to anything.

Three days. Weight 19.6 grams (10 to 29), bill 8.8 mm., wing 17.4 mm., tarsus 12.3 mm. (Average of 31)

Pin feathers appear as rows of dots through the skin on the spinal (interscapular region to tail), humeral, femoral, crural, and ventral tracts. There are none on the capital tract. A row of dots under the skin on the caudal tract marks the location of the upper tail coverts. On the alar tract the longest primary and secondary pin feathers protrude about two millimeters.

The eyes may be seen through a slit which is 3.25 millimeters in length. In response to the sound of the writer's approach the young pop up their vibrating heads and "peep" with open mouths.

Four days. Weight 27.3 grams (16 to 38), bill 10.0 mm., wing 23.0 mm., tarsus 15.0 mm. (Average of 15)

The skin is looser and much darker than that of the newly hatched chick. Only the apteria of the sides and chin have the bright color of the younger chick. Plumage development has advanced (Plate 7, Fig. B). As pin feathers grow out in areas of natal down, tufts of the down are carried out on the ends of them. All tracts but the capital have tiny pin feathers. On the spinal tract pin feathers are longest in the interscapular region. Feather development is most advanced on the alar tract. The primary pin feathers are out from 3.5 to 6.0 millimeters; those of primaries number 1, 2, and 3 are the longest. The greater covert pin feathers are out 1.5 to 3.0 millimeters and the lesser coverts appear under the skin.

The eyes are open a little and can be seen through a slit 3.5 millimeters long. The voice is a loud, coarse "peep" that is used for begging for food. For the first time the young clutches the nest lining when it is lifted out of the nest.

Five days. Weight 34.5 grams (22 to 44), bill 10.7 mm., wing 29.4 mm., tarsus 18.3 mm. (Average of 21)

The capital tract becomes darker as pin feathers develop under the skin. The first pin feathers appear on the capital tract in the occipital region as a few pimple-like projections.

Along the spinal tract the pin feathers are now one millimeter in length in the interscapular region. Elsewhere along this tract they are about 0.5 millimeters. Pin feather development has advanced in the same proportion along the humeral, femoral, crural, ventral, and caudal tracts. The under tail covert pin feathers have not yet appeared. Along the alar tract the primary quills have pushed out noticeably. The first primary is about 11 millimeters and the ninth is about 7 millimeters. The secondaries and greater coverts have advanced proportionately. A few lesser coverts now project about one millimeter beyond the skin.

The eye opens a little wider but the opening is still a slit about 3.75 millimeters long. The voice is a loud and excited "peeping", audible at a distance of 10 to 15 meters. They still react to sounds and vibrations about the nest as before. When one is held in the hand, it clutches and hangs on to a finger.

Six days. Weight 42.8 grams (27 to 57), bill 11.5 mm., wing 36.0 mm., tarsus 20.6 mm. (Average of 18)

There is a general increase in the length of the pin feathers along all of the tracts. A few now project from the occipital region of the capital tract. The caudal pin feathers of the rectrices have appeared as have those of the ventral tail coverts. The primary quills are from 9 to 15 millimeters long. None of the feather tips have broken from the sheaths yet.

The eyes are still seen through a broad slit nearly four millimeters in length. The voice and general reactions are the same as those of the five-day-old chicks.

Seven days. Weight 52.8 grams (37 to 68), bill 12.5 mm., wing 46.1 mm., tarsus 24.5 mm. (Average of 15)

At this age, feathers are just beginning to break out of the ends of the quills along many of the tracts (Plate 8, Fig. A). Natal down is still present in all of the original places, but is now on the tips of quills or adhering to feather tips. It is most noticeable on the capital tract where the pin feathers are merely small points projecting from the skin. Pin feathers are from four to six millimeters in length along the spinal and femoral tracts. The quills of the rectrices are nearly one millimeter in length. The wing feathers, which are the most advanced, have the feathers breaking out of the primary sheaths as long as 1.5 millimeters. The rate of growth of the first three primary quills has been faster than those toward the ninth. The primaries are 15 to 23 millimeters long.

The eyes are nearly wide open, and for the first time the young show signs of fear. They may cringe momentarily and then suddenly begin begging with up-stretched, vibrating necks, as fright is overcome by hunger. They also cringe when the parents act excited. The voice is a course begging "peep."

Eight days. Weight 57.[illegible] grams (35 to 72), bill 1[illegible] mm., wing 51.8 mm., tarsus 26.1 mm. (average of 17)

At this age the young bird is beginning to appear feathered out. The black feather tips project from the sheaths on all of the tracts. The capital tract now has pin feathers from one to three millimeters long with the feather tips projecting about 0.5 of a millimeter. The quills of the rectrices are six to seven millimeters with feather tips out one millimeter. On the alar tract, primary Number 1 is [illegible] to 17 millimeters long and the feather projects from the quill two to four millimeters.

The eyes are now wide open (eye slit, 5.5 mm.). The young cringe at first, but after a brief period of adjustment they will stick their heads up and beg. The voice is changing from the coarse "peep" to a screechy "peep", which is also used for begging for food. Young at this age are definitely more active in the nest. They crawl around from one side of the nest to the other and occasionally flap their wings. They raise their bodies up to defecate.

Nine days. Weight 58.8 grams (45 to 74), bill 14.7 mm., wing 60.5 mm., tarsus 28.2 mm. (average of 12)

The down is most conspicuous on the capital tract and to a lesser degree on the humeral and alar tracts. The feathers are out of the sheaths a little more, but the bird still does not have the appearance of being completely feath-

ered out. The primaries are about 37 millimeters with the feathers projecting 5 to 10 millimeters from the sheaths. The pin feathers of the rectrices are eight millimeters and the feather tips are out one millimeter. As the sheaths open, bits of them flake off so that scales accumulate in the nest.

The young still respond to a parent bird's approach by shooting their open mouths upward and vibrating their stiffened necks vigorously. One was heard to give the "location" call note a few times at this age. This is a single, double, or triple note, which sounds much like the adult's "check,' but has the quality of a "chirp." When an older member of a nest utters this note, the younger ones immediately respond to it as described for the nine-day-old young.

<u>Ten days</u>. Weight 67.8 grams (51 to 75), bill 14.7 mm., wing 63.9 mm., tarsus 29.2 mm. (Average of nine young)

Tufts of down are still prominent on the capital tract. The primaries are from 40 to 45 millimeters long and the feathers project 10 to 20 millimeters beyond the end of the sheaths. The breast and neck are fairly well covered with gray-brown feathers. The rectrices are about 10 millimeters long with the feather tips projecting three to five millimeters.

The "location" note is used for begging for food most of the time. When the nestling is actually receiving food, the note becomes a buzzy, begging sound. Sometimes the

young stand up while begging, instead of stretching their necks upward; however, most of the time they still beg in the manner previously described. When the young are very active, they move about much in the nest and on the rim of it. One may stand up straight and stretch its wings outward or downward to aid in maintaining its balance (Plate 9, Fig. A). The young are able to perch on one's finger or stand on their tarsi on the rim of the nest and flutter their wings. At times when they are less active, they merely stretch a wing or preen the feathers of their wings, breasts, or backs. When at rest, they are very often so situated that all are facing the side of the nest from which they receive food (Plate 9, Fig. B). On hot days they move apart, some on the rim and some in the cup of the nest. They pant like an adult bird to reduce the body temperature. When an intruder approaches the nest, the young cringe, ruffle their feathers and "churr" like an adult.

Eleven days. Weight 73.5 grams (65 to 84), bill 15.3 mm., wing 70.3 mm., tarsus 29.7 mm. (Average of four)

The feathers have pushed out of their sheaths so that the young now look like birds (Plate 8, Figs. B and C). The primaries are only a little longer, 45 to 48 millimeters, and the feathers are out of their sheaths a little farther, 15 to 25 millimeters. The rectrices are 15 to 20 millimeters and the feathers are out 5 to 10 millimeters.

The activities of the young, which include perching on the rim of the nest, standing and fluttering the wings or stretching them, preening, and actively moving about in the nests, are about the same as those of the 10-day-old nestling except that there is more of it. When one approaches the nest, the young cringe and ruffle their feathers. If one is lifted from the nest, it may utter a loud "churr" of objection and then jump out. Several attempts were made to place them back into the nest after they had jumped, but they would not remain. Occasionally one would jump and fall into the water. It would swim to a branch of a bush for safety. One was so exhausted from trying to swim to safety that it would have drowned, had it not been rescued.

Twelve days. Weight 79.0 grams (74 to 84), bill 16.0 mm., wing 75.0 mm., tarsus 31.0 mm. (Average of two)

The young are completely covered by feathers except for the area around the eyes. Tufts of down on the ends of the capital feathers and a few of the feathers of the humeral and alar tracts is characteristic. At this stage of development the juvenal plumage is a soft brownish-gray color on the under parts and a dark gray to a black on the upper parts. The tail is short, varying from 15 to 30 millimeters in length with feathers projecting from 10 to 20 millimeters out of their sheaths.

Many young leave the nest at this age.

Nest leaving. Normally young grackles leave the nest when they are 12 to 14 days old, but if disturbed they may flush at 11 days.

Nest 25 with four young was closely observed for several days prior to nest leaving. During the last three days the parents became more sensitive and excitable than they had been previously. One of the young, which was a day older than the other three, flushed from the nest on May 31 when it was 11 days old. The other three merely cringed and "churred." The next day at 10:55 A.M. the female coaxed the other three young from the nest in the following manner. After feeding the young, the female moved about among the bushes near the nest uttering a soft "chuck." The young responded with the "location" note and scrambled over each other in an attempt to go toward her. While she continued coaxing, one of the young fluttered its wings as it jumped to a branch near the nest. In a few moments all three were out of the nest and perched three to four meters from it, giving the "location" note in rhythm.

Growth. Young bronzed grackles grow rapidly during 12 days of nestling left. This is reflected in the rapid increase in both weight and wing length (Fig. 14). A newly hatched chick, for example, will gain 15 times its weight by the time it is ready to leave the nest; its wing will lengthen nearly as much. Change in the length of the tarsus and bill

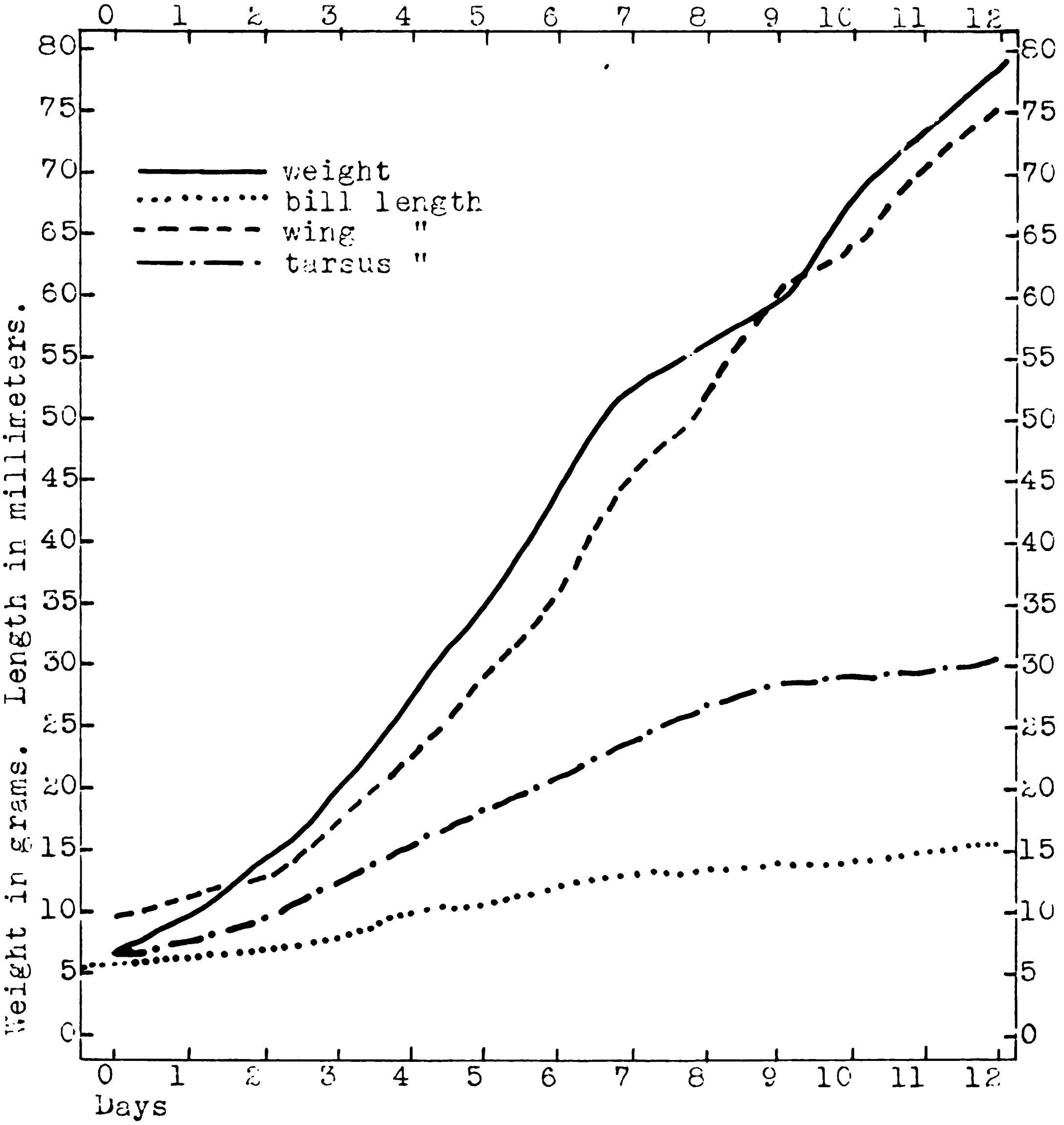


Fig. 14. Daily amount of growth of nestling bronzed grackles. (Trowbridge Marsh, 1951; Collins Road and Forest Road, 1952.)

is not as pronounced, the former increasing six times and the latter about three times during the period.

The rate of growth (in weight) is not constant but shows a definite retardation between the seventh and tenth days.

This is also the period when the bird is feathering out. Although changes in the length of the wing do not show the overall rate of feather production, it does, nevertheless, give some indication of it, since increase in the length of the primaries was included in the measurements of the wing. It will be noticed that the rate of increase in the length of the wing was greater than that of weight between the ninth and tenth days. This indicates that the rate of growth is retarded at a time when feather production is high.

How do fledglings 12 days old compare with adults in weight and in length of the wing, bill, and tarsus? The writer collected 15 grackles (4 adult and 11 juvenal) of both sexes during the month of August in 1951 (the molting season). The juvenal birds were so near the size of the adults that they are all classed as "adults." Following is a comparison of the average weights and measurements of fledglings and "adult" grackles:

	Weight	Wing	Bill	Tarsus
Fledglings (Av. of 2)	79.0 g.	75.0 mm.	16.0 mm.	31.0 mm.
"Adults" (Av. of 15)	114.0 g.	132.0 mm.	27.6 mm.	29.0 mm.

From this comparison it can be seen that the tarsus is fully developed by the time the young are ready to leave the nest. Among the "adult" birds collected, which included eight males and seven females, the tarsus of the males averaged a little larger (29.5 mm.) than did those of the females

(28.0 mm.). Since the measurements of the two fledglings were large, they probably were males. Aside from the tarsus, the other measurements and the weight show that the fledgling is about half grown.

Nesting Success and Mortality Factors

The rate of reproduction was lower and mortality was higher among grackles nesting in marshes and a swamp at East Lansing than among those at Madison, Wisconsin, where Petersen and Young (1950:471) examined two areas over a three-year period. Table XII shows a comparison of nesting success between these two localities. The lower rate of reproduction at East Lansing is reflected in three ways:

(1) by a lower per cent of successful nests, i.e., nests that fledged at least one young (35 per cent compared to 55 per cent at Madison);

(2) by a lower per cent of eggs that hatched (63 compared to 73 per cent);

(3) by a lower number of fledglings surviving per active nest, i.e., nests with at least one egg, (1.1 compared to 1.2 per nest at Madison). Table XIII shows the nesting success of the four colonies observed at East Lansing.

There were several factors which were the cause of nest failures at East Lansing (Table XIV), viz., weather, predation, infertility, broken eggs, desertion of young, young dying in the nest, and banded young removed by the parent bird.

Desertion of 23 per cent of the eggs laid was attributed to bad weather, as was pointed out previously (page 84). Two of the nesting localities, viz., Trowbridge Marsh and Forest Road, where desertion was high, were unprotected from wind and precipitation. Desertion due to bad weather did not occur at the Collins Road colony where the nests were sheltered.

Predation of two types destroyed 26 per cent of the 145 eggs laid (all were nestlings). Twenty per cent of these were taken by unknown predators and six per cent were removed by the investigator for stomach analysis. One of the predators at Trowbridge Marsh was believed to be a Cooper's hawk--it was observed flying low over the marsh several times during the two years of study. On one occasion when the nestlings were between five and eight days old a Cooper's hawk swooped down near the site of a grackle's nest, but failed to take one. Kingbirds and grackles chased it out of the area. On another occasion, when the young of Nest 21 were 9 to 10 days old, all of the young disappeared at one time. The female of that nest had had some of her tail feathers removed. This may have been the result of another attack by the hawk. (Under similar circumstances the female of Nest 25 was seen to cover her young when a Cooper's hawk passed over.)

At the Collins Road colony, where predation was high, the situation was different. There the nests were situated close to the water level (65 cm.) in crotches of black willow.

This group of trees with the nests was surrounded by a dense screen of sandbar willow shrubs (Plate [illegible], Fig. A). However, because the area immediately below the trees was open, the nests were accessible to avian predators and to animals that could wade or swim in the shallow water. One of the nests, which was partly torn down, could have been destroyed by a dog or a fox. (This swamp was a portion of a much larger one that afforded good cover.) Five young disappeared from one nest at a regular interval of one per day. Since the nest was not disturbed and only one young was taken at a time, it appeared to be the work of an aerial predator, or possibly that of a snake.

Among other mortality factors were infertility (six per cent) and broken or destroyed eggs (nine per cent), a total of 15 per cent. While this figure is high, it is lower than that reported by Petersen and Young (1950:475) who found an average of 25 per cent.

One nest with young was deserted. This may have been due to a combination of weather and interference by the investigator.

Death of young in the nest accounted for three per cent of the failures. No attempt was made to determine whether death was due to a disease or some organic malfunction. It became apparent in some cases, however, that the young destined to die were losing out in the competition for food and probably starved. This was the case in the only nest with

six young. Although the last one hatched was normal size at hatching (six grams) it was small compared with the first four hatched (14 and 18 grams) and died on the fourth day. In another case, where the first-hatched in a nest of four young died on the first day, death was not due to competition.

Even though several nests contained five young, no more than four fledged from any one nest. Either they died or disappeared by some other means. In three nests one was found dead. It is possible that three or four more of those listed under predation by an unknown predator might have died and were removed from the nest by the parents. The one that dies is not necessarily the last one hatched, although it often is.

Out of 43 nestlings which were banded nine were believed to have been removed from the nest by the parent bird. All nine disappeared from the nest within 24 hours after they were banded. Those that disappeared varied in age from four to seven days, most of them being five days. Apparently the female, which is the one that cleans the nest, tries to remove the leg band. If the young have developed the power to clutch the bottom of the nest, they may escape with only a broken leg. (Three were found with broken legs at the age of seven, eight, and nine days.) Younger nestlings are probably carried away and dropped in the same manner that fecal sacs are disposed of. The writer did not observe any removals or find any banded young which had been removed.

Parental Care

Both parents play an important part in caring for the young. Up to the time of hatching, the male's role has been one of guarding his mate and, to a lesser extent, the nesting site. After the young hatch, he continues guarding and, in addition, he shares in the tasks of feeding and nest sanitation (removal of fecal sacs) throughout the period of rearing the young. The female spends a greater per cent of her time at the nest, since she does all of the brooding, as well as part of the feeding. They are devoted parents and take good care of their young.

Brooding. For the first day or two after the first egg hatches, the female follows a brooding rhythm similar to that followed during incubation. She is more attentive during the cooler parts of the day and on cold days than she is during the warmer parts of the day. If a sudden change in the weather occurs, such as a thunderstorm or rain, the female, when absent from the nest, returns and promptly covers the young. At the first sprinkle of rain preceding a thunderstorm, the female of Nest 6 was seen to return with food for the two- and three-day-old young. Under this circumstance the brooding instinct was greater than that of feeding because instead of feeding them she immediately covered them and held the food for a few minutes before swallowing it. The female

of Nest 25 was just as careful about covering her four young, which were 10 and 11 days old, during rain, even though they were well protected by feathers.

While brooding, the female is alert and sensitive to sounds and movements about her and to the movements of the young beneath her. She is aware of the male's presence on his favorite perch near by. The mates call to each other frequently, as they did during the period of incubation. She responds to the squirming bodies under her by changing her position or by covering a hungry little head that has popped out. When the temperature is high, she backs up and rests partly on the edge of the nest, thus allowing air to circulate over the young and, at the same time, sheltering them from the direct rays of the sun. When it is cold she fluffs her feathers and settles down low in the nest so that only her bill and tail show.

As the young grow older and the demands for feeding them and cleaning the nest become greater, the female spends less and less of her time brooding. From eight hours of observation at Nests 6 and 25 during the first four days of nestling life, it was found that the female spent 50 per cent of her time on the nest and 50 per cent off. By contrast it was learned from 31 hours of observation at Nest 25, during the period from eight days until nest leaving, that the female spent only nine per cent of her time at the nest, six of which was for brooding, and three per cent for cleaning the nest.

This per cent of brooding time occurred during two rainy periods and at the beginning and end of night brooding. Female of Nest 25 brooded the young at night until they all left the nest.

Feeding. The parents share in feeding the young (Tables XV and XVI). In 34 hours of observation the average number of feeding visits made by the female was 3.3 per hour (extremes 0 and 9); the male averaged 2.3 visits per hour (extremes 0 and 5). During the first five days after hatching, when the female spent much of her time brooding, she made 1.1 trips per hour, while at the same time, the male made 3.5 visits per hour. Later, when the young were eight days old or older, the female increased hers to 4.1 times per hour, but the male decreased his to 2.5 per hour. The combined efforts of both parents ranged from four to seven visits per hour throughout the life of the nestlings.

The feeding frequencies of the parents of Nest 25 are depicted graphically by Figs. 15, 16, 17, and 18. The first three graphs are based on seven observations made on three consecutive days (when the young were 8, 9, and 10 days old, respectively) and represent a little over 23 hours of observation. Combining these observations, an average feeding frequency of the male, female, and both was drawn in Fig. 18 to show the approximate picture of feeding throughout an entire day.

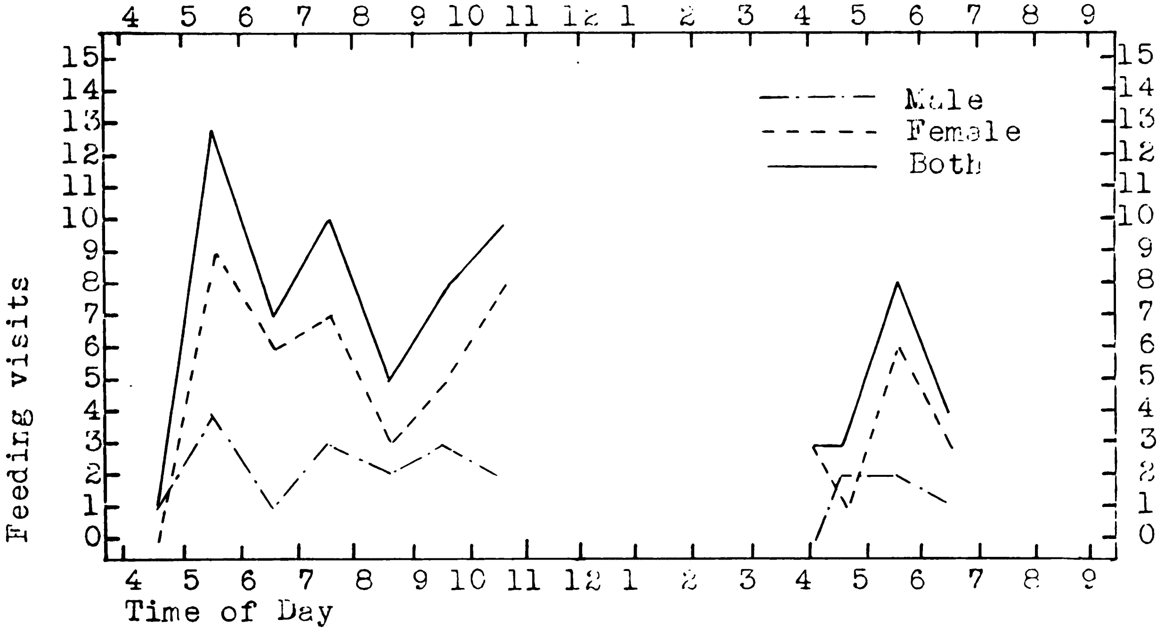


Fig. 15. Feeding frequency of bronzed grackles at Nest 25 with four nestlings eight and nine days old. (Morning observation was from 4:25 to 10:40, and the afternoon observation was from 3:15 to 6:50, May 29, 1952.)

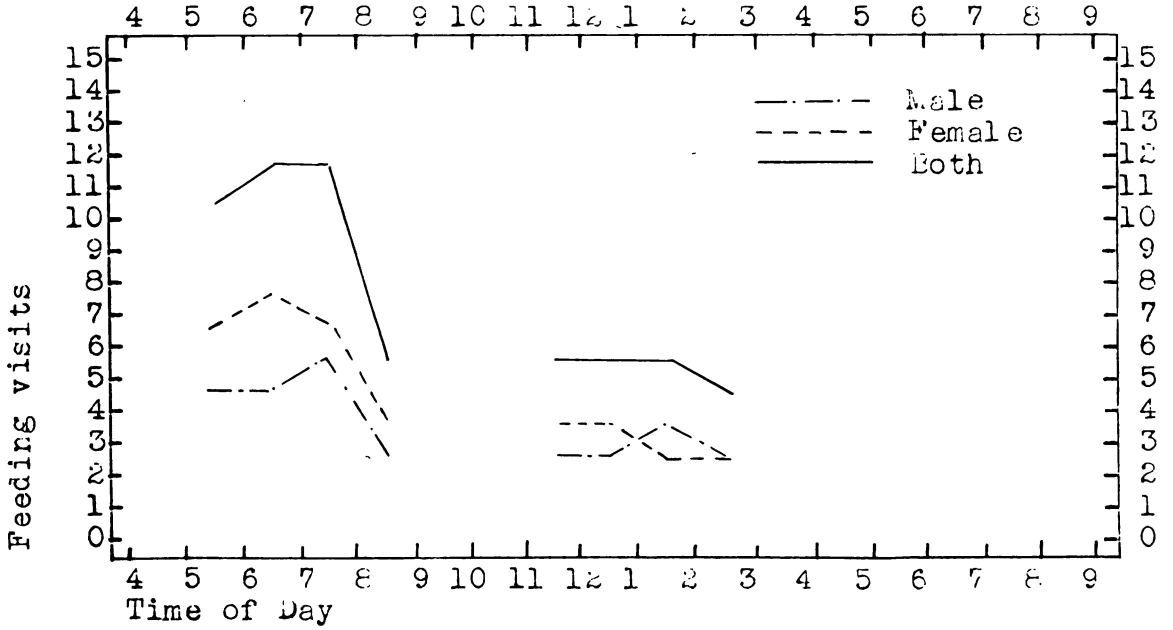


Fig. 16. Feeding frequency of bronzed grackles at Nest 25 with four nestlings nine and ten days old. (Morning observation was from 5:20 to 8:40, and the afternoon observation was from 11:00 to 3:00, May 30, 1952.)

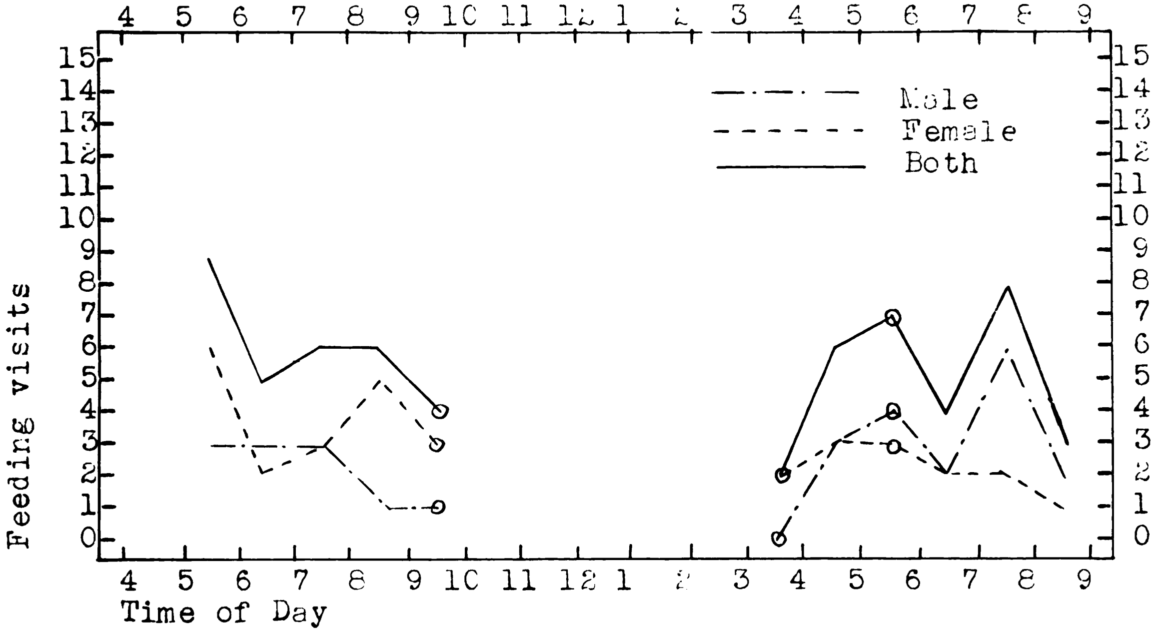


Fig. 17. Feeding frequency of bronzed grackles at Nest 25 with three nestlings and one fledgling near by. Ages were 10 and 11 days. Morning observation was from 5:15 to 9:25, afternoon observation was from 3:40 to 5:15 and 6:15 to 8:30, May 31, 1952. (Circled points are estimated.)

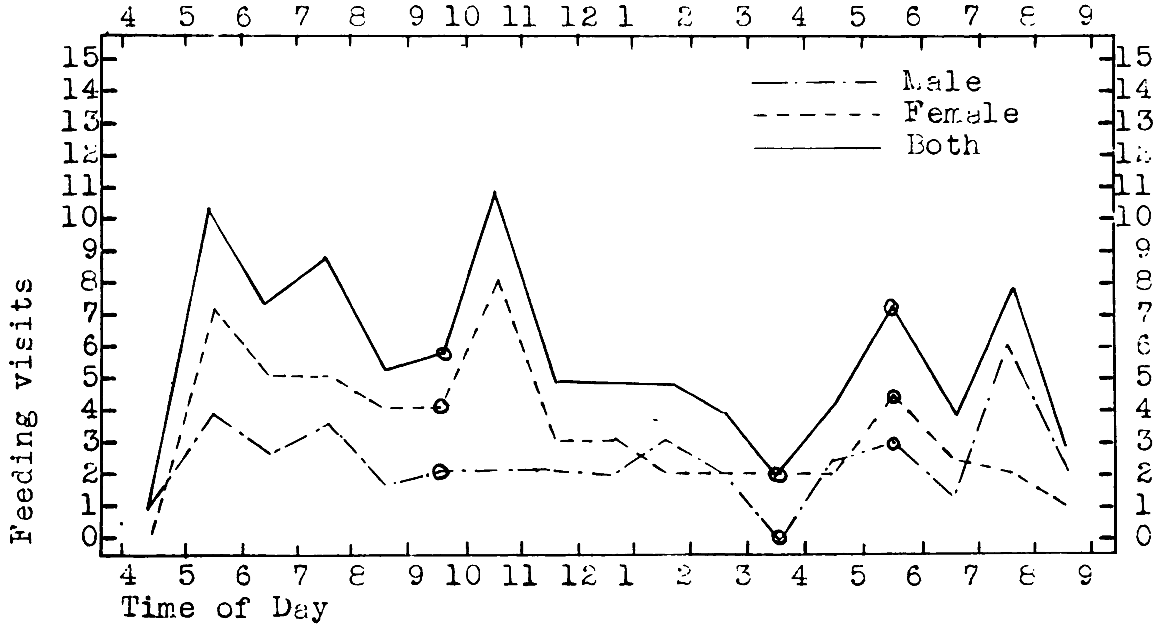


Fig. 18. Average feeding frequency of bronzed grackles at Nest 25 with four young during the last three days before leaving the nest. It represents the average of the total feedings by both male and female as shown in Figs. 15, 16, and 17, a total of 25 hours of observations made May 29, 30, and 31, 1952. (Circled points are estimated.)

Feeding by both the male and the female follows a pattern of attentive and inattentive periods. Throughout the day there are five periods when they visit the nest more frequently (8 to 11 times by both), the greatest amount being in the first half of the day. Very soon after the male arrives from the roost, he begins the feeding of the young for the day. Between the hours of 4:40 and 5:00 A.M. both parents are highly attentive. After a period of about an hour of less frequent visits, they again become more attentive between 7:00 and 8:00 A.M. A third period of attentiveness, which equals the earlier ones, occurs between 10:00 and 11:00 A.M. From that time until 5:00 P.M. the feeding frequency is at a moderate rate with the lowest period occurring between 3:00 and 4:00 P.M. As night approaches, they become more attentive again. A fourth peak of activity occurs between 5:00 and 6:00 P.M., and the last peak (mostly by the male) is between 7:00 and 8:00 P.M. Since the female begins brooding between 7:30 and 8:00, it is the male that completes the feeding for the day. The last feeding usually occurs between 8:00 and 8:15 P.M., just prior to the male's departure for the roost.

The impulse to bring food to the nest began early in the case of the male of Nest 6. It has already been pointed out that he fed the female at the nest as early as the sixth day of incubation. This may be regarded as "courtship feeding"; however, such an act was never observed between a male and

female away from the nest. On May 17 at 8:30 A.M. there were two young, which had hatched during the night (the down was dry), and two eggs present in Nest 6. During the next two hours the male came to the nest three times with food, and the female begged for it and was fed by him. The young were not fed during the two hours.

The method of feeding is direct, that is, food is carried in the bill and placed in the throat of the nestling (Plate 10, Fig. A). The number of young fed at a time varies according to the quantity of food. If two large grubs are brought to the nest, only two birds are fed. Usually the male has a larger amount of food per trip than the female so that he usually feeds three or four young to her two or three. Food is apportioned according to the intensity of begging on the part of the young and according to whether they can swallow it or not. If they do not swallow it, after it is placed in their throats, it is removed and placed in the throat of another. By this method each nestling receives food from three to five times per hour.

If the female is brooding, both parents occasionally feed the young at the same time. Cooperative feeding was observed at Nest 25 on several occasions. The male, on returning with food, usually went first to a high perch in a dead tree located only a few feet from the nesting site (Plate 10, Fig. B) and generally announced his arrival with a "check" or a call note. The female could see him from her position

on the nest. On three different occasions she was observed giving a signal to the male, which began with a begging "whiney" note followed by four or five pointing and bowing movements. The male responded by arriving immediately, usually in silence or with a "check" note. Upon his arrival she perched on the edge of the nest facing him and begged with fluttering wings and a "whiney" note. He usually gave her some of the food; then both proceeded with the feeding of the young.

<u>Nest sanitation</u>. The nest is kept free from excreta and other things foreign to it by both parents. The male's part in the sanitation of the nest is mostly that of removing fecal sacs. The female not only removes fecal sacs but also cleans the nest below the young (Plate 11, Figs. A and B).

Several times, usually in the morning following the first or second peak of feeding activity, the female of Nest 25 was observed to be half buried below the young for nearly a minute at a time, picking and eating droppings from the previous night. These morning cleaning periods were from three to eight minutes in length. As indicated heretofore, it is believed that young which are banded before they are capable of clutching the nest lining securely are sometimes removed by the female in an attempt to discard the band. Older nestlings, as has been pointed out, clutch the nest lining tight enough so that they are not removed, but in a few cases may receive a broken leg as a result.

On the average, one fecal sac is removed by a parent on every second visit to the nest. After each feeding the parent bird looks for and often pauses for a fecal sac. If two or more appear at one time, the parent may eat one or all. The maximum number observed removed at one time was three, and all three were eaten. Both parents eat about as many as they carry away. The male removed a few more than the female throughout 34 hours of observation. Those which are carried away are dropped in about the same place by the same parent. For example, the male of Nest 25 was seen to carry them about 25 meters away and drop them. Two or three disposal spots were found at Trowbridge Marsh during the first year of study. The female was not observed to drop those which she carried away, although she could have either dropped them or eaten them.

Defense. Defense of the nesting site, and the mate by the male is by vocal objection, by guarding, or by direct attack. One of the reasons why he makes fewer feeding visits to the nest, especially in the last few days before nest leaving is that much of his time is occupied by sentinel duty. The male of Nest 25 perched much of the time in the upper part of a dead tree located near the nest (Plate 10, Fig. B). But he also used another dead tree near the railroad tracks located 50 to 75 meters north of the nest, or a willow tree at the south edge of the marsh. If the writer stepped from the

blind when the male was on any of these sentinel perches he would immediately come to the nesting site and object by "churrs" and "checks." When other birds, such as hawks or crows come to the marsh, all the red-wings and grackles give warning notes. That of the red-wing is a kind of whistle but that of the grackle sounds like "kē-u-u," which is buzzy and slurred downward.

Guarding the female has already been described. It is the same during the nestling stage as it is during the incubation period.

Direct attack is used only as an extreme measure of defense. Avian enemies are chased by the male grackles and sometimes attacked in flight. Such attacks are not fatal. When the young are nearly ready to fledge, the parent birds are extra sensitive to the presence of an intruder. Occasionally a male or female made an attack flight toward the investigator, but at no time did they actually strike.

The female's method of defense is the same as that of the male except that she does not guard or act as a sentinel. When there are young in the nest, her greatest concern seems to be to cover them, as shown by the protective action of the female of Nest 25. One afternoon, when the young were 9 and 10 days old, the grackles and red-wings made warning sounds that usually indicated the presence of an avian enemy. The female of Nest 25 immediately arrived and covered the young by drawing well down into the nest and spreading her wings

slightly. The effectiveness of such protection is questionable. It may have been under just such circumstances that the female of Nest 21 (page 104) lost some of her tail feathers. The only trace of the young, which were 9 and 10 days old, was some feathers in the nest. If this was the case, covering the young was not an effective means of protection.

POST-NESTING ACTIVITIES

Young grackles depend upon their parents entirely or in part for their food during the first five or six weeks after they leave the nest. The dependent stage is three to four weeks in length and the semi-dependent stage is one or two weeks longer.

For the first two days after nest leaving the young remain within 15 to 20 meters of the nest. Because the flight feathers of the wing are only a little over half grown and the tail is less than one-fourth developed, locomotion is a combination of jumping and climbing, aided by fluttering the wings to maintain balance. Three to four days after leaving the nest they are able to fly unsteadily for a distance of 30 to 50 meters. When they have attained this degree of ability to fly, the family leaves the nesting area. Small family groups of two adults with young may be seen feeding on lawns and flying about throughout the first half of summer. At East Lansing they were seen as late as the middle of August. They fly to roost together as soon as the young are capable of sustained flight. According to Jones (1897) the old males escorted the most forward young to the roost as soon as they were able to fly, or, if the whole brood developed at the same time, then they were escorted by both parents. In this region young grackles were seen at the roost during the last week of June in 1952.

For the first two or three days, at least, after the young leave the nest, the frequency of feeding them continues in about the same rhythm as was followed while they were still in the nest. (Since observations of the family activities were not continued after they left the nesting area, the feeding frequency was not obtained.) As soon as the young leave the nest, they give the double-noted "location" call, which was described previously. On the day when most of them fledge, the marsh fairly pulsates with the incessant calling of the young. Red-wing fledglings, when present, add their bit to the chorus, too.

Care of the young now consists of feeding and protecting them. The young continue to be fed by the parents long after they leave the marsh. On July 31, 1951 a male was seen feeding a full grown young, while the latter begged with wing fluttering. On August 4, 1953 an adult female was followed by two young on a lawn in search of food. They gave a buzzy double note (a modification of the "location" call note) as they searched for food and followed the parent. As the female fed them, they begged in the usual manner. However, by this age they were able to catch insects, turn over leaves, etc., while their parent was hunting food for them. They had nearly reached the stage of independence.

HAND-REARED YOUNG

Three young grackles were reared in a cage from May 15, 1952 to August 10, 1953. Two of the young were fledglings, which flushed from the nest at the time they were taken. They were estimated to be 11 days old. Later they proved to be females. A third young was estimated to be eight days old at the time it was taken. Its adult plumage later was that of a male. At first they were housed in a small cage which was one by one by one-half meters. In mid-September they were transferred to a larger cage measuring one by one by one meters. The following spring, in mid-May, two of them were placed in a large out-door cage measuring two by two by one and a half meters. (The third grackle, a female, had been killed by the others earlier in the spring.) This cage was enclosed with one-inch chicken fencing and was without a floor. The development of plumage, voice, and feeding habits, and of motor actions and responses was observed.

Growth

Even though these three young grackles were in an unnatural environment, their growth and development revealed some information regarding the probable developmental changes of young in the natural state.

Measurements such as those made of nestlings were also made of the hand-reared birds. The writer endeavored to feed the young regularly at 45-minute intervals but often was not able to feed them for intervals as long as an hour and a half. Growth in weight fluctuated from day to day according to the number of times they were fed in a day. Fig. 19 gives a graphic picture of the amount of growth in weight and in the length of the bill, wing, and tarsus. It will be noted that growth in the length of the bill, under conditions of captivity, did not amount to much for the eleven days following "nest leaving." After the two females were full grown (30 to 40 days old) the bill measured 27 millimeters. The tarsus grew to the maximum length of 31 millimeters. Apparently the tarsus does not grow much more than about two millimeters after the young have reached the fledgling age, since it averages nearly 30 millimeters just before they fledge. Because the wing feathers grow at least a few millimeters each day, they are a fairly reliable criterion of age.

Although measurements were not made after 11 days of captivity, it became apparent that the youngest one was destined to be a larger bird. Before its juvenal plumage was completely developed, its feet, legs and bill appeared larger than those of the two females. Later, when all three were in adult plumage, it was obvious that the youngest was a male.

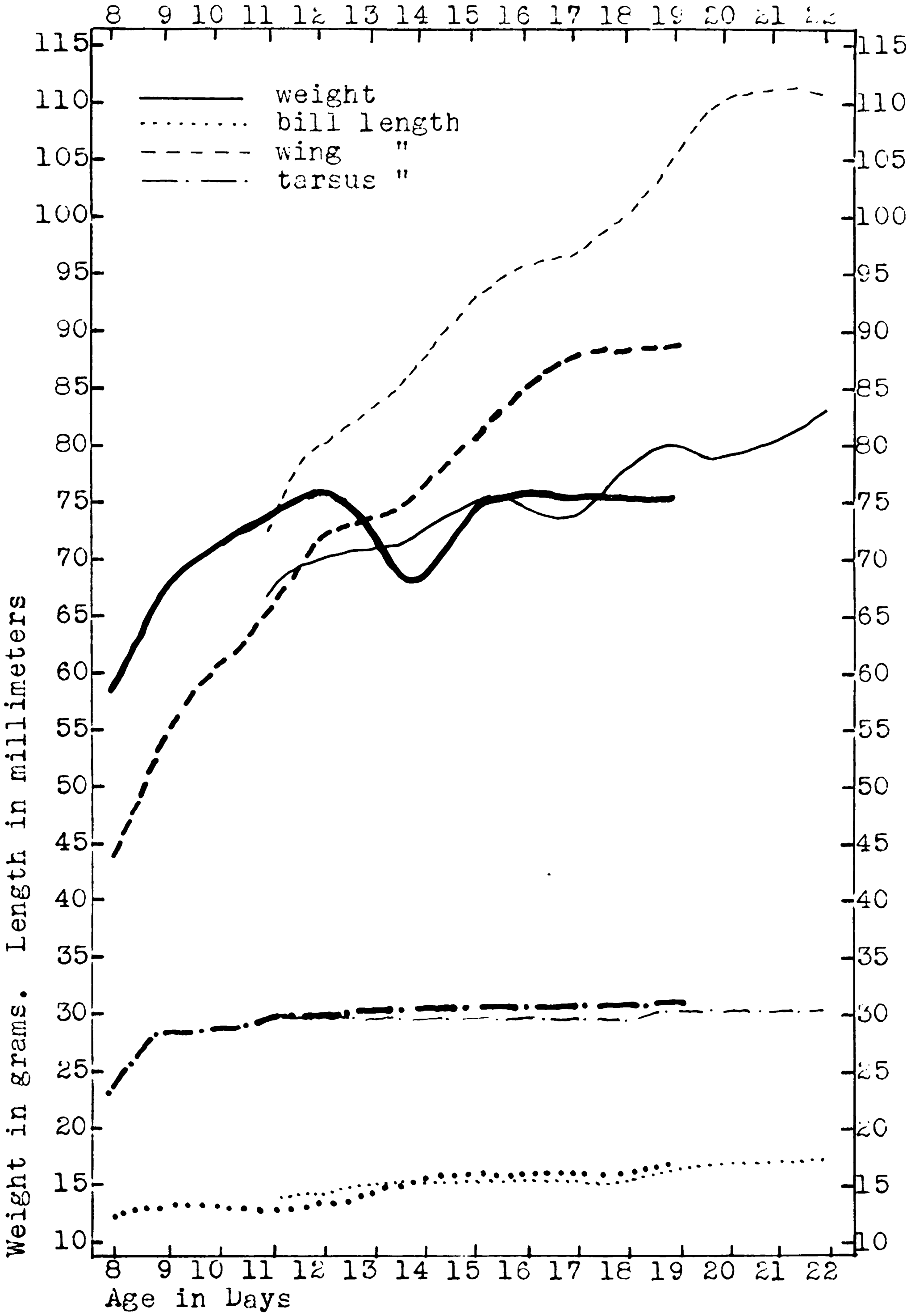


Fig. 19. Daily amount of growth of young bronzed grackles kept in captivity. Light lines represent average of two females, while heavy lines show measurements for one male.

Plumage

Juvenal plumage is acquired by a complete postnatal molt (Dwight, 1900:168). As the juvenal plumage feathers grow out, the down feathers are carrried away from the body and worn off by the seventeenth day. Juvenal plumage begins with the appearance of the pin feathers of the primaries at the age of two days and is complete when the rectrices have attained full size (25 to 30 days after hatching). The auricular region is the last to have pin feathers and these develop into feathers by the nineteenth day.

Dwight (1900:167) described the juvenal plumage of the purple grackle, which he said was indistinguishable from that of the bronzed grackle, as follows:

> . . . Whole plumage dull clover-brown, the body feathers often faintly edged with paler brown. Tail darker with purplish tints. Bill and feet sepia-brown, black when older.

mparing the juvenal plumage of males and females he noted at "In juvenal dress the female is perhaps paler below an is the male and usually indistinctly streaked." All ee of the hand-reared birds in this study showed a faint eaking on the breast feathers. It was first observed on sixteenth day for the females and on the seventeenth day the male.

The postjuvenal molt, which began about the first week uly and ended in late July, was complete. Upon examin- ten specimens of juvenal grackles collected in the field

it was found that molting began in late July and ended in mid-August. According to Dwight it takes place in early August. The first winter plumage, which is acquired with the postjuvenal molt, is identical to the adult's plumage. The metallic hues about the head and neck and the bronze color of the back are the same as described in the section dealing with taxonomy and nomenclature. The first nuptial plumage, according to Dwight (1900:163), is ". . . acquired by wear which produces no noticeable effect as is regularly the case with iridescent plumages." The postnuptial molt began July 12, 1953, when the first wing feathers appeared in the cage. At the time the second female died (August 8) and four days later when the male was released, this molt was not yet completed.

Feeding

For the first three months all three young were fed a ixture of cooked cornmeal and chopped, boiled egg (includ-ng the shell) with a drop of multi-vitamins added. Forceps re used to place the food in the open mouths. The tongue shaped like an arrowhead with the posterior part of the ngue forming the two barbs. As soon as food is placed be-d these barbs, the swallowing reflex causes the tongue retract, thus pushing the barbs against the food. Sev-l successive contractions of the tongue are used to push food to a point where it can be swallowed.

Hunger caused the young to beg. At first the male, which was three days younger than the females, begged by extending the neck upward, and vibrating the head vigorously while he uttered a "screechy" peep with his mouth wide open. The females opened their bills, uttered a raspy begging sound and fluttered their wings. They did not stretch their necks or vibrate their heads. The male changed to this type of begging a few days later. When they were 18 days old, they begged as described but added a few bows. Bowing was a gesture revealing eagerness to have the food placed in their mouths. One was seen wiping food from its bill on the fourteenth day. They were entirely dependent for feeding until near the end of June (nearly two months old), at which time they began picking at the food and taking it from the forceps or fingers.

In addition to their regular fare other types of food were offered to the birds in order to see what they would eat. They were given a variety of insects, grubs, and worms, which they ate. The grubs had to be killed first before they would take them. They did not eat strawberries or cherries when these fruits were in season, although adults relish them.

After the young were in their winter plumage, they were able to eat dried grains. The palatal ridge (described on page 134) was used for cracking large kernels or seeds.

Voice

The male was not heard to give the "location" call note at any time. His begging "chirps" were modification of it, but this did not sound quite like the notes uttered rhythmically by the females during the first few days of captivity. A few days after the winter plumage was fully developed (July 15) the male attempted to sing for the first time. The "song" consisted of a series of unmusical "gurgles" and "gargles." The females did not attempt to sing until later. Their vocal sounds were limited to "checks" and "churrs" of the adult type. Late in December all three began singing. The song consisted of three syllables. The first two were an abrupt "check-check" followed by a prolonged buzzy note. This was accompanied by a puffing movement of the feathers typical of an adult song or call. The voice of the male and of one female was of the same pitch and quality. The buzzy note of the other female's song was shortened and pitched lower. Early in January this same female uttered the "whiney" note and postured a few times. As spring approached, begging on the part of the females was more common. The full adult song was never attained by either the male or the females during this study.

Sleeping

On the night of the first day in captivity 11-day-old fledglings (females) were seen to sleep in two ways: one

tucked its head under the bend of its wing as it sat on the floor of the cage; the other merely drew its head back with the bill pointed upward at a 45-degree angle. As soon as they used a perch, all three tucked their heads under their wings.

Nest-Building Urge

On May 27, about 10 days after the male and female were placed in the outdoor cage, the female showed signs of wanting to build a nest. Although she picked up pieces of string, sticks, and other materials, she did not attempt to form a nest. Instead she flew from the ground to the perch or to an upper corner of the cage with a piece of material, became discouraged and dropped it. This female was seen posturing before the singing male, but copulation was never observed. From this it appears as though the female, at least, is ready to attempt a nest the first year.

FOOD AND FEEDING HABITS

The most outstanding published work concerning the food of grackles is that of Beal (1900), which was based on the analysis of the stomach contents of 2,346 purple grackles (including the bronzed grackle). Included with these were 450 nestlings. These birds were collected at all seasons of the year and from all parts of their range. More recently Hamilton (1951) published a study of the food of nestling bronzed grackles, which was based on the stomach analyses of 130 specimens.

Because so much has been contributed by others to our knowledge of food and feeding habits of this species, the writer made only a cursory examination of this phase of the life cycle. The aim here is to present some facts already published by others and to report the results of the personal findings.

Food

The adaptability of this species in feeding is as great as in nesting. The list of foods that it eats is long and varied. Beal (1900:60) found that the year-around diet included, on the average, 30.3 per cent animal food and 69.7 per cent plant food. The ratio of the amount of animal and plant food varied with availability. For example, during

the fall, winter, and early spring, when insects were not numerous, the diet of the grackle consisted largely of grains and seeds, and during the summer season, particularly during the breeding season, their food was mainly animal matter. Seasonal variation of animal and plant food is more clearly shown by the quantity of their favorite foods eaten, viz., insects and corn. During the winter (February) Beal found less than three per cent insects in their diet and 32 per cent corn. In early spring (March) he found 10 per cent insects and this increased to 62 per cent by May. The amount of corn eaten during that period decreased steadily to about 7.7 per cent in May. During summer the insect intake was 62 per cent and that of corn remained about the same (7.7 per cent) until August when it was increased to 14 per cent. This late summer increase is probably due to eating corn "in the milk." As cold weather approached, the number of insects available for food decreased and, at the same time, wastes of harvested corn were plentiful; consequently, the number of insects eaten decreased to 10 per cent (October), while corn increased to 50 per cent (September). Animal and vegetable foods of grackles reported by Beal are given in List III.

Food of nestlings. Beal examined the stomach contents of 456 nestlings, ranging in age from one day to near the fledgling stage. The overall proportion of animal food was

74 per cent and of plant food, 26 per cent. However, birds less than one week old had nearly all animal material, 95 per cent of which was insects. Most of these insects were soft-bodied forms, such as beetle larvae. Older nestlings received about the same diet of insects as that of adults, which included adult forms of beetles as well as the grubs. List IV shows the stomach contents of nestlings as reported by Beal.

Hamilton (1951), in examining the stomachs of 130 nestling bronzed grackles in New York State, found the contents to be composed of 89.1 per cent animal material, and 6.4 per cent plant material, the remainder being inorganic matter. (List IV)

Spiders were found more frequently in the stomachs of small nestlings than in older ones. A few millipedes were also found. Earthworms were broken into fragments and fed to young. Digestion of them was complete--there were no setae present in the droppings. A few sowbugs and snail shells were present.

The remains of small vertebrates included red-backed salamanders, Plethodon cinereus, tadpoles of Rana clamitans, and alewife, Pomolobus pseudo-harengus. One six-day-old nestling had a newborn field mouse, Microtus pennsylvanicus, in its stomach. Fragments of what was probably a masked shrew, Sorex cinereus, were also found.

Plant food was found by Hamilton to be present in 23 per cent of the nestlings' stomachs. Green grass was in several (nine per cent) of the gizzards. Other vegetable material included some waste grain and a few fruit seeds.

Stomach analysis of East Lansing grackles. Seven nestlings and 14 juvenals and adults were collected in the East Lansing area. The nestlings, ranging in age from the day of hatching to eight days old, were taken from the Trowbridge Marsh colony in 1951. The older specimens were collected in a blueberry swamp four miles east of East Lansing during August, 1952.

The contents of each gizzard were sorted into vegetable, animal, and mineral materials, and the per cent of the total volume was determined for each. In the case of the nestlings the stomach contents were nearly 100 per cent animal remains. There was a trace of mineral matter in three. No plant material was found. Stomachs of the juvenal and adult birds contained 40 per cent animal remains (extremes, 15 and 50), 53 per cent plant material (extremes, 45 and 55), and two per cent mineral matter (extremes, trace to five).

The food of the nestlings consisted almost entirely of insects, but a few spiders and small crustaceans (crayfish) were also included. There was no trace of plant material such as seeds, fragments of leaves or stems. Mineral matter was found in the two older nestlings.

Because the juvenal and adult grackles were collected in a blueberry swamp at the time when there was an abundance of berries, the per cent of vegetable matter was higher than that of the animal matter. Even though the grackles ate many berries, they also fed around the margins of pools in the swamp, where they found insects and small toads. List V includes the animal, vegetable, and mineral materials found in the gizzards.

Feeding Habits

The adaptability of grackles is also expressed in their feeding habits. The structure and use of the bill combine to a certain degree some of the features of both insect- and seed-eating birds. This, in addition to a natural resourcefulness, has caused the northern grackles to enter into a large number of feeding niches from which they get a variety of foods. According to Beecher (1951:428) the grackles of the genus Quiscalus probably head the list, in so far as adaptations for food in the blackbirds are concerned.

Structure and use of the bill. The nearly omnivorous diet of this species requires a bill which is capable of catching and devouring insects, as well as picking up hard seeds and nuts and cracking them into pieces small enough to be swallowed. Certain structural features of the bill aid in securing both types of food. In his account of the mus-

cular and skeletal adaptations of the skull for getting food, Beecher (1951:412) pointed out the fact that birds are capable of moving the upper mandible up or down with respect to the commissure. He described the kinetics of the upper mandible as follows:

> . . . the upper mandible may be moved up and down on its articulation with the cranial part of the skull--the naso-frontal hinge--and that this movement of the bill is communicated by an articulated series of rod-like elements to a quadrate bone on either side of the skull.

In use the upper mandible is protracted (moved upward) when the lower mandible is depressed, and is retracted (moved downward) when the lower mandible is raised. This is an effective means of increasing the gape and ". . . preserving the axis of the bill. . ." (Beecher, 1951:412). If the upper mandible were not movable, then Beecher notes that

> The axis of the bill would change with the degree of gape . . . , and this would be hardest on insectivorous species required to snatch their prey quickly. It is precisely these forms that have the highest degree of skull movement.

By comparing the cowbird, Molothrus, the red-wing, Agelaius, and the rusty blackbird, Euphagus, Beecher found a correlation between the amount of movement of the upper mandible and the diet. The movability of the upper mandible was greatest in Euphagus, which eats more insects (53 per cent) than seeds (47 per cent), and less movable in Molothrus, which eats more seeds (77.7 per cent) than insects (22.3 per cent). The bronzed grackle has a bill more like that of Agelaius, that is, more slender and a more movable upper

mandible than that of *Molothrus*. Its diet, as has already been pointed out, consists of 30.3 per cent animal material and 69.7 per cent of plant material (Beal, 1900), slightly more insectivorous than that of *Molothrus*.

Besides having a bill fairly well adapted to catching insects it has another special structure which aids in the cracking of hard seeds and nutshells. Wetmore (1919:190, 191) clearly described this structure as follows:

> The curious keel-like, angular projection found on the palate in the North American Grackles of the genus *Quiscalus* [is] recognized as one of the prominent characters distinguishing that group of Blackbirds . . . the palatal keel is developed as a compressed projection from the roof of the mouth slightly behind the center of the commissure. Viewed from the side it is truncated in front, forming an angular projection that has a tendency to become toothed at the tip. The anterior margin is sharp and the posterior portion is thicker and stronger. The entire ridge is developed as a fold in the horny sheathing of the palate, and the surface of the premaxilla underneath is smooth and flat and with no indication of a bony ridge to support the keel.

According to Wetmore this ridge first appears when the young are ready to leave the nest and is fully grown by the time the juvenal stage is reached. The writer observed this to be true of the hand-reared birds in this study.

The palatal ridge is used to crack kernels of corn and to score the shells of acorns in such a way that the shells are cracked off, thus exposing the nut meat (Wetmore, 1919; Schorger, 1941). In this way the more slender bill of the grackle can do what the thicker bill of *Molothrus* and the seed-eating finches are able to do.

Gaping is another method of using the bill in search of food. Beecher (1951) described the manner in which the eastern meadowlark, *Sturnella magna*, gapes. This description may well fit such a food-searching method used by grackles. Of this he said ". . . These birds drive the closed bill into the ground and open it powerfully against the resistance of the earth." European starlings, *Sturnus vulgaris*, bore holes in lawns for grubs in the same manner.

During part of the study made by the writer two bronzed grackles were kept in captivity in a large cage which was open at the bottom. This cage was placed on a lawn that was infested with white grubs. Starlings foraged there every morning, leaving the lawn punctured with holes formed in the manner described by Beecher. The writer noted similar freshly made holes in the ground within the confines of the grackles' cage, which were not present before. (Starlings could not enter the cage, since it was covered with a one-inch mesh chicken wire.) Even though these grackles were not observed forming the holes, it is believed that they made them by gaping, since the holes were so similar in shape and depth to those formed by starlings in the same lawn.

Use of the feet. As compared with the use of the bill, grackles use their feet much less during feeding. They seldom use them to uncover food by scratching. The bill is used to turn over leaves and rubbish. The feet are employed

when a large piece of food is held while being torn apart with the bill. The manner of using the feet and bill for killing crayfish was described by Roberts (1932:320) as follows:

> Of crawfish it is especially fond. Dragging them, squirming and struggling, from under the stones and roots, it carries them ashore and onto a convenient hard surface, where they are pounded and mauled until they cease struggling. The next move is to open a large hole in the back just behind the carapace, through which the meat is extracted until nothing but the empty shell remains. The dead crawfish was held firmly on the ground with one foot while the white meat was picked out bit by bit and piled in a heap near by until there was a good, sizable billful, which was gathered up and conveyed to the waiting nestling.

Wading. The writer has seen grackles wading in water along the margin of a river in search of snails, crayfish, and insects. They did not hesitate to submerge their heads in order to grab one of the animals.

Flying gull-like for food. Several authors have seen grackles fly above the water and swoop down to pick up floating bits of food or catch a small fish near the surface of the water (Townsend, 1912:294, 1918; Cottam, 1943; Cahalane, 1944). Their actions were as skillful as a gull.

Dunking food. Not infrequently bronzed grackles, both in the wild state and in captivity, have been seen taking large pieces of food to water where it was dunked and then eaten. In a little park on the campus, where peafowl were fed stale bread, grackles were observed taking a large piece

of it to the river near by and dunking it. Grackles in captivity dunked pieces of grain. It appeared to be the response to an innate drive.

<u>Attacking other birds</u>. Throughout the literature there are references to the predation of grackles on other birds, mostly on nestlings and smaller species. Too often the authors of some of these reports allowed emotion to hold sway, thus presenting a dark picture of the ravages of the grackle. There are, however, enough authentic records to show that there is a tendency for some individuals to attack and kill other birds. Townsend (1912:293) said ". . . I have seen one [a grackle] hold down a struggling English Sparrow with its foot while it deliberately pecked out its brains." Eaton (1914:250) reported having seen grackles attack a robin fledgling and kill it. He believed the nests of robins, least flycatchers, yellow warblers, chipping sparrows, song sparrows, purple finches, cedar waxwings, cuckoos, and other useful birds have been robbed by grackles. Nice (1937:14) included the bronzed grackle among the enemies of the song sparrow. Foster (1927), while operating a game farm in Pennsylvania, observed purple grackles attacking young pheasants and removing just the heads. Weber (1912) shot a male grackle that had just robbed a red-wing's nest of a young--the nestling was still in the grackle's bill.

During the two years of field observation in this study, the writer did not see a grackle attack and kill another

rd. There were two instances, however, which pointed ward that trait. Once a robin scolded and chased a male ackle from its nesting tree, suggesting that perhaps the ackle was attempting to rob the nest, but it was not ac- ally seen doing it. Another example, although an unnatur- one, occurred when one of the females of the hand-reared rds was attacked and killed by the male. The skull of the emale had been opened and the brains removed. (The male d an injured foot, and it looked as though it had been ighting.)

Because of the resourcefulness and aggressiveness of he grackle, it is conceivable that it would take eggs or oung of other birds for food. It is properly listed as an nemy in this respect. However, the extent of its destruc- iveness to other species is not known, and it may have been verestimated due to the emotional element, which is likely to interfere with accuracy of observation.

ROOSTING AND FLOCKING

The gregarious nature of grackles was observed during the nesting period, but this trait became even more apparent when its roosting and flocking habits were studied. The roost, with its swirling mass of bird life creating a commotion that can sometimes be heard for half a mile, attracted the attention of several early workers. Brewster (1890:363) studied a robins' roost that was also used by about 1,000 grackles and in his report included many interesting facts about the roosting habits of grackles. The most thorough study of a grackles' roost which has been published to date (1953) is that of Dr. Lynds Jones (1897) made at Oberlin, Ohio. This study covered the entire season from the arrival of the grackles in the spring until they departed in the fall.

Spring Roosting

Early spring. At first, during the early part of the migration period, grackles were observed flying to roost with flocks of starlings, red-wings, and cowbirds. The choice of a location for roosting varied from night to night. Trowbridge Marsh, for example, was used by 500 to 1,000 blackbirds, including grackles, on four or five occasions during the spring of 1952. This marsh was used only when the weather was good; during wet and windy weather the birds

resorted to more protected thickets and swamps. As the number of migrants decreased, there was less shifting from one roost locality to another.

By the end of March resident grackles, both males and females, of the Williams Dorm colony regularly roosted about a mile and a half away in a thicket of sandbar willow situated along the margin of a small lake near the city. They did not roost in the trees near the nests, as did those observed by Jones (1897:43) at Oberlin. However, the writer later observed that both male and female grackles nesting at the Bennett Farm colony, located in a windbreak of spruces, did roost among the same trees.

Late spring. After incubation was begun at the Williams Dorm and Trowbridge Marsh colonies, the female grackles roosted at the nest, while the males continued to roost at the same willow thicket that was used earlier. Males and females which were unsuccessful with nesting attempts continued to use that roost throughout the nesting season.

The roost. The willow thicket, which was situated along the eastern end of a small lake, was from one to two acres in extent. It was a dense growth of sandbar willow shrubs (Salix interior) standing from three to four meters high and growing in water nearly a meter deep. Near the thicket were a few aspen (Populus grandidentata and P. tremuloides) that were used as perches. Still more removed and

beyond the expanse of a small field were large trees, some of which were oaks (*Quercus alba* and *Q. rubra*) that served as gathering points for incoming flocks at night.

Going to the roost. The close of the day of activities at the nesting area (6:35 P.M. on March 25) was marked by a change in the behavior of the grackles just prior to their departure for the roost. The sound of the courtship song, prevalent most of the time, was suddenly stopped, and in its stead loud "checks" were uttered by all. Small groups of three to five moved to the tops of the taller trees where they remained for a few minutes, "checking," before departing in the direction of the roost. Those which left the Williams Dorm colony (more than a mile from the roost) flew along a direct line at a height slightly above the level of the tree tops. The flight speed of a pair of grackles was clocked by an automobile speedometer as they were flying on their way to the roost; it was found to be 23 miles per hour.

Arrival at the roost. The roost was shared by starlings, red-wings, cowbirds, and grackles. Starlings outnumbered the other species. Early in the spring they comprised about half of the roosting population. The grackles were in the minority, forming from 5 to 10 per cent of the roosting flock. The number of red-wings, which equaled that of the cowbirds during migration, decreased as spring advanced, and at the same time the number of starlings increased, so that

by mid-April there were about 75 per cent starlings, 20 per cent cowbirds, and about 5 per cent grackles.

Bronzed grackles usually arrived at the roost in small groups of four or five, seldom more than a dozen. Sometimes they arrived in mixed flocks. The time of arrival for all of the blackbirds began about a half an hour before sunset, at which time the light intensity was about 100 foot-candles.

In general, the actions of all the blackbirds were similar. The behavior from the time of arrival until they were settled for the night might be conveniently divided into five activity periods as follows: (1) arrival at the large trees, (2) flying down to the smaller trees and/or to the thicket, (3) a noisy period of shifting about among the bushes; (4) a quieting down period, (5) only voices of individual birds, and finally (6) all quiet.

(1) Upon arrival small flocks of blackbirds gathered in the tops of the larger trees where they produced a lively chatter. Suddenly the chatter would stop and after a brief pause, the entire flock would leave the tree with an explosive whir of wings. After a brief circling flight, which seldom was beyond view of the roost, they would return to the large trees. The period of using the tall trees as a perch usually ended soon after sunset when the light intensity was about 10 foot-candles (Fig. 20).

(2) Some of the blackbirds (including grackles) began flying down to the small trees near the willow thicket or

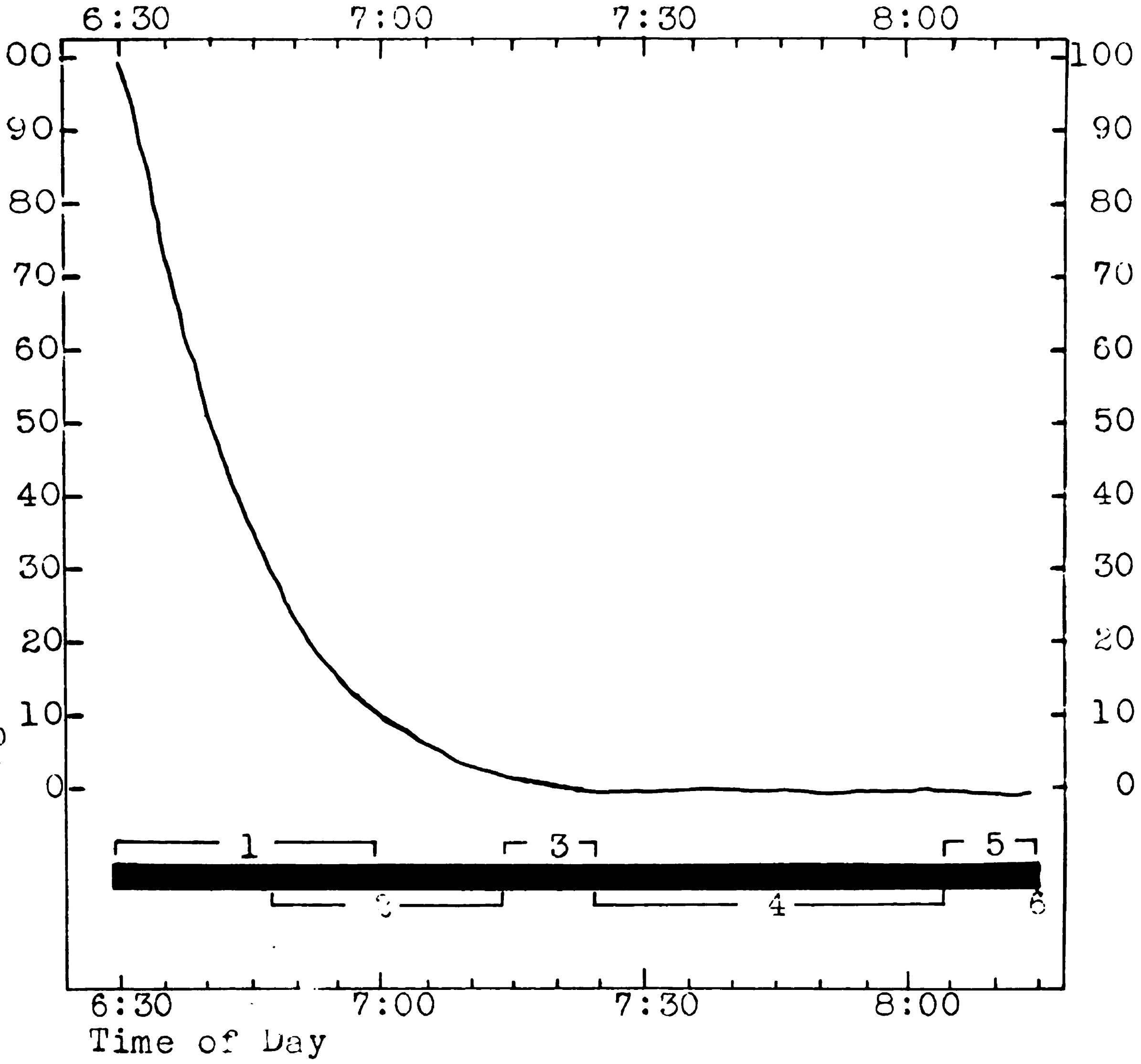


Fig. 20. Correlation of activities of blackbirds
bar) going to roost with time of day and light inten-
ity (curve), March, 1952. Numbers represent the fol-
owing activities: (1) arriving at trees near roost
nd circling flights back to trees, (2) flying down to
ushes of roost and circling flights back to roost, (3)
sound in roost a babble, also some shifting about, (4)
oisy but quieting, (5) only individual voices of birds,
6) all quiet.

tly to the bushes before the first period of activity
. They began entering the roost when the light inten-
dropped to about 30 foot-candles. For a period of about
an hour the blackbirds entered the thicket. Late arriv-
lew directly to the bushes.

(3) The next period of activity began when all of the roosting birds had left the trees and were shifting about within the bushes. The sound of 3,000 to 5,000 birds gathered in the relatively small area of the roost was a babble of voices. There was a sudden cessation of this sound prior to the taking off of the flock for a low circle flight. Such flights did not take place after the light intensity had fallen to 0.2 of a foot-candle.

(4) The babble gradually decreased as they settled into their places among the bushes. At this time they were situated at various levels from one to two meters above the water. Grackles segregated themselves from starlings. This period of chatter continued until about 8:00 P.M.--over an hour after sunset.

(5) For another half an hour individual voices could be heard. Finally only an occasional individual starling or red-wing was heard.

(6) Then all was quiet.

Of the six evening observations made during this study of spring roosting, three were made when the sky was clear, and three when the sky was overcast. It was found that the blackbirds began arriving at the roost about 20 minutes earlier on cloudy evenings. In spite of an earlier arrival they were not all quiet until about the same time as on clear nights--they merely required a longer period of settling down.

Departure from the roost. Four early morning observations were made, two when the weather was fair and two when there was a light rain with an overcast sky. Correlation of the morning activities at the roost with light intensity and time of day is shown in Fig. 21.

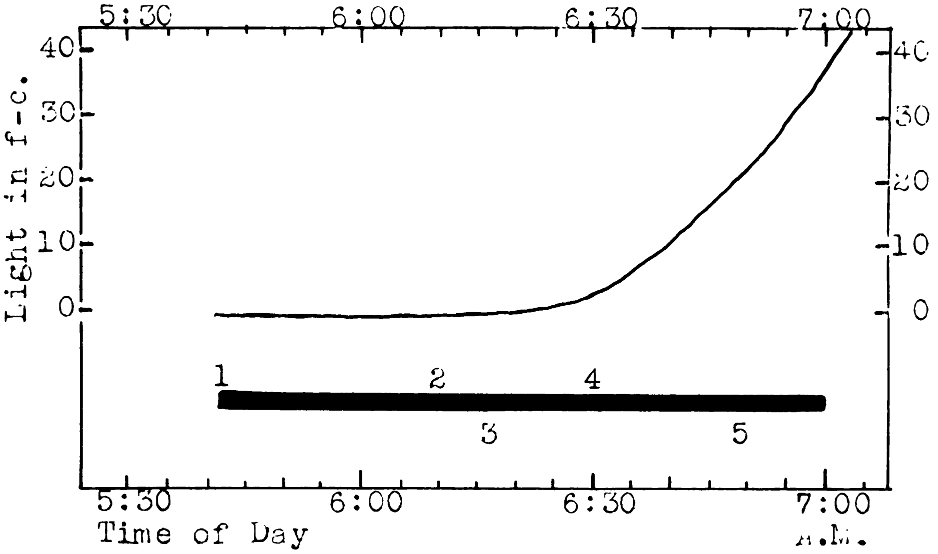


Fig. 21. Correlation of activities of blackbirds leaving the roost (bar) with time of day and light intensity (curve), April 1952. Numbers represent the following activities: (1) first grackle sounds, (2) noisy to a babble, (3) first blackbirds departed, (4) bulk of flock left, (5) stragglers left in small groups or individually.

The first bird sounds in the morning were those of the robin and the red-wing which began before 5:30 on a clear morning and later on a cloudy morning. As the light of dawn increased in intensity, the bird sounds increased also. By the time the light intensity was 0.1 of a foot-candle the sound had increased to a babble. The first few birds departed when the light reading was 0.5 of a foot-candle on a clear

morning and 1.2 on a cloudy morning. Large flocks did not leave until later when the light intensity was two to five foot-candles. Following the several large flocks (200 or more) were small groups of less than a dozen, which departed when the light intensity was much higher, from 10 to 30 foot-candles. All of the roosting birds had gone by 6:40 on a clear morning and by 7:05 on a cloudy morning. By comparison, Nice (1935) found at Columbus, Ohio, that the first flights of grackles left on a clear morning (mid-September to October 17) when the light intensity was about 8.5 foot-candles and on a cloudy morning when the light intensity was 13.5 foot-candles.

When a flock was about to leave the roost, the vocal sounds were suddenly stilled. After a brief pause of quiet, the bushes fairly exploded as a black mass of birds swirled upward and moved in a clockwise direction. As the great flock of a thousand or more turned, smaller flocks flew from it in nearly all directions of the compass.

Summer Roosting

<u>Willow-thicket roost</u>. The willow thicket near East Lansing was checked twice during the summer and was found to be used by starlings, grackles, and a few cowbirds. The percentage of cowbirds using the roost was smaller than it was in the spring. The total number of birds roosting there was about 50 per cent smaller. The behavior upon entering

the roost was no different from that in the spring.

A maple-tree roost. A large roost of about 5,000 birds (starlings, cowbirds, and grackles) was observed on a few evenings in late July of 1952. This roost was located in shade trees, most of which were sugar maple (Acer saccharum) in a residential district of Alma, Michigan. The number of each species was roughly 85 per cent starlings, 5 to 10 per cent cowbirds, and 2 to 5 per cent grackles. The number of grackles increased somewhat toward the end of July.

This roost had been used nearly every year for 15 years. (It was used again during the summer months of 1953 also.) In 1952 blackbirds began using it on June 26. Jones (1897: 43) reported that grackles began using the maple-tree roost at Oberlin on May 16.

Flocking

During early summer grackles were observed going to the maple-tree roost either as individuals or as small family groups. On June 27 young grackles could be identified among those in the roost not only by their duller plumage but also by the double "check" note which they uttered. Throughout the month of July there was an increase in the number of grackles at this roost, as the young of the year and the females accompanying them began using the roost for the first time.

Flocking, that is, the banding together of more than a family group, did not occur during the molting season. The grackles continued to go to the roost in small numbers or as a disorganized flock of 8 to 10 individuals.

Flocking was first observed during the last week of August, when bands of 25 to 30 entered the roost at one time. By mid-September the flocks had about doubled in size. Compared to the size of the companies observed by Jones (1897:49) at Oberlin (500 to 1,000) as early as July these flocks were very small. Brewster (1890:368) also mentioned large flocks entering the roost. The largest single group observed in this study was composed of 500 to 700 grackles.

SUMMARY

During 1951 and 1952 the writer studied the life history of the bronzed grackle, *Quiscalus quiscula versicolor*, in southern Michigan. The primary objective of the research was to investigate the nesting cycle of marsh- and swamp-breeding colonies. Other phases of the life history included in this study were: (1) post-nesting activities, (2) the growth and development of hand-reared young kept in captivity for a year, (3) the food and feeding habits of grackles based on the analysis of 20 stomachs and supplemented by a review of the literature, and (4) the roosting and flocking habits of grackles associated with starlings, red-wings, and cowbirds at willow-thicket and maple-tree roosts. A second aim was to assemble and summarize from the literature pertinent data concerning: (1) the complex and confusing problems of the taxonomy and nomenclature of the genus *Quiscalus*, and (2) the distribution of *Quiscalus* and the migration of *Q. q. versicolor* supplemented with unpublished return records of 52 bronzed grackles banded in the East Lansing vicinity.

Investigation of the nesting cycle was centered primarily on a breeding colony of bronzed grackles located in a small marsh near East Lansing. The predominant vegetation of that marsh was meadowsweet (*Spiraea alba*) and reed-canary

grass (*Phalaris arundinacea*). Other important habitat components were dead tree stubs, water where the bushes grew, organic mud, and a zone of plants bordering the marsh. A small bog rush (*Juncus tenuis*) and swamp milkweed (*Asclepias incarnata*) included in this zone were important constituents of nest structures.

During the second year additional information about the growth of the young was obtained from a second marsh of the same type and from a willow swamp.

Taxonomy and nomenclature. The nomenclatural history of *Quiscalus quiscula* is long and complicated. The bronzed grackle was first recognized as a separate species by Ridgway in 1869. Stejneger later (1885) referred to it as a subspecies of *Quiscalus quiscula* and shortly thereafter (1886) it appeared in the first A.O.U. Check-list as *Quiscalus quiscula aeneus* Ridgway. After further study of the relationships of the three forms of this species it was again listed as a separate species in the Nineteenth Supplement of the A.O.U. Check-list in 1944. However, four years later the A.O.U. Check-list Committee reversed its decision and once more reduced the bronzed grackle to subspecific status. Currently (1953) three subspecies of *Quiscalus quiscula* are recognized as follows:

Florida grackle, *Quiscalus quiscula quiscula* (Linnaeus)
Purple grackle, *Quiscalus quiscula stonei* Chapman
Bronzed grackle, *Quiscalus quiscula versicolor* Vieillot

Distribution and migration. Versicolor is the most widely distributed of the three subspecies. Its breeding range extends from the Rio Grande valley in northern Mexico north along the eastern slopes of the Rocky Mountains to Great Slave Lake in Canada, east to southern Hudson Bay and southern Labrador, south through New England, southwest along the western slopes of the Appalachians to Louisiana, west to northern Mexico. It is more abundant in the forest biomes of its range than in the grasslands. The bronzed grackle is common in both the Lower and Upper Peninsulas of Michigan and is found on several islands in the Great Lakes.

The winter range of this form includes the Rio Grande valley, the lower Mississippi valley west of the Appalachians, and Georgia and the Carolinas east of the Appalachian range. Small numbers winter over as far north as the lower parts of both Wisconsin and Michigan and the State of New York.

Spring migration of bronzed grackles begins in early February in the Rio Grande valley and in mid-February in the lower Mississippi valley and the southeastern states. Northward progress of spring migrants is more rapid along the Mississippi valley and slowest over the Great Plains region. The first migrants to reach Michigan arrive by early March. Those of the northernmost part of the breeding range reach the nesting grounds in May. Male grackles arrive at the breeding grounds in Michigan from one week to 10 days in advance of the females.

Fall migration begins in the northern part of the breeding range in August. The last migrants leave Michigan in late October or early November. On the basis of banding recoveries grackles from East Lansing and vicinity were found to go as far south as Alabama, Louisiana and Texas. Most of them go to Tennessee and Mississippi.

The nesting cycle. At East Lansing courtship begins as soon as the first females arrive in the latter half of March. In selecting a mate usually two to four males compete for a single female, until, finally, one dominates. The courting males follow the female on short flights from the nesting area. For the purpose of intimidation they display and sing, as well as "bill-point" before each other. The period of selecting a mate lasts from one to two weeks. Unpaired males occasionally continue competing for a mated female for as long as five weeks after the first females arrive. Monogamy was the most common kind of mating relationship observed.

The bronzed grackle does not show definite territorialism, or, if any, it may be a kind which Nice (1941) called "Type D," that is, one which is restricted to a small area around the nest.

The grackle's song is given by both sexes and is accompanied by plumage display. The male, in addition to utilizing it for courtship and intimidation, also uses it for

calling his mate. The female sometimes uses it in response to a male's courtship display, but more often, for calling her mate or replying to a call from him.

Courting males also have a flight display. This kind of flight is a slow even glide, effected by (1) depressing the central tail feathers, and (2) using a fluttering wing beat.

The female begins to hunt for a nesting site during the first two weeks of April. Her mate or two or more courting males follow her as she searches.

In 1952 a survey of nesting sites in a 12-square-mile area revealed that 36 pairs had located their nests in small marshes or swamps and 38 pairs in coniferous trees. On the average, the distance between a colony and the one nearest to it was 0.6 of a mile, and the greatest was one mile. The heights of the nests varied from 23 to 30 centimeters in the marshes and swamps, and from 7 to 23 meters in coniferous trees.

This survey also revealed some facts about the density of the nesting population: (1) the average number of pairs per colony was 7.4, the marsh and swamp colonies averaging 6 pairs, and the coniferous tree colonies averaging 9.5 pairs, and (2) the population density was 12.3 grackles per square mile or approximately one grackle per 51.9 acres.

Nest construction began during the first or second week of April. The time of the beginning and the duration of the

period of nest building was correlated with the average weather conditions.

The nest is constructed entirely by the female. The male sometimes symbolically displays nest building, but his major role is one of guarding the female. Normally there are four stages in the construction of a nest: (1) platform or suspension pocket, (2) outside structure, (3) plaster cup, (4) lining.

Nest building begins with the fastening of a few strands of milkweed fibers among several upright branches of the bush and grass to form either a platform or a loosely suspended pocket. To this support are added coarse stems and leaves of weeds and grass, string, paper, and other materials. Next, the inside of this bulky mass is plastered with wet organic mud, beginning at the bottom and working up to the rim. A lining of fine plant stems, mostly <u>Juncus tenuis</u>, covers the plaster cup. A few strands of the lining are anchored in the rim of the plaster cup while it is still wet, and more is added downward so that the bottom of the nest is the last to be covered.

On the average, the first egg is laid 2.8 days after the lining is complete. Usually one egg is laid per day--in the morning between 6:00 and 8:00. The clutch size ranges from three to six, the average being 4.5.

In most cases incubation begins on the afternoon before the last egg is laid. The female alone does the incubating, being more attentive during the cooler parts of the day (20

to 30 minutes on the nest at a time) and less attentive during the afternoon (5 to 10 minutes). The periods of inattentiveness vary from 15 to 30 minutes, depending upon the time of day and the weather conditions. The average length of the incubation period is 12.7 days.

During incubation the male spends 25 to 50 per cent of his time guarding, while perched 20 to 40 feet from the nest. He often continues guarding when the female is away from the nest. The male also visits the nest, and sometimes feeds the incubating female. Newly hatched young weigh 5.5 grams; the wing length is 9.1 millimeters; the eyes are closed, and natal down 10 to 20 millimeters long is present on the capital, spinal, humeral, femoral, and alar tracts. Two days after hatching, pin feathers of the primaries project one millimeter through the skin, and by seven days they begin to break out of their sheaths. The eyes can be seen through small slits on the fourth day and are nearly wide open on the seventh day, at which time the nestling shows the first signs of fear. When the young are ready to fledge, they are covered with feathers except for an area around the eyes; the tail is from 15 to 30 millimeters long; the weight is 79 grams; and the wing length is 75 millimeters. They fledge at the age of 13 to 14 days.

Of the 33 nests with eggs, only 1.2 young fledged per nest. Twenty-three per cent of the eggs were deserted during incubation because of weather; 26 per cent (as nestlings)

were destroyed by predators. A Cooper's hawk was believed to be one of the predators. Six per cent were taken by the investigator. Out of the 43 young that were banded, nine were probably removed from the nest by the parent bird in an attempt to dispose of the band.

The female does all of the brooding. At first she follows a rhythm similar to that established during incubation. After that she broods less each day, but continues it at night until the young have left the nest.

Both parents feed the young. During the first five days the male makes about 3.5 feeding visits to the nest per hour, as compared with 1.1 trips of the female. When the nestlings demand more food and require less brooding, the female increases the number of trips to four per hour, while the male decreases his number to 2.5 trips per hour. The male makes the first and last feeding trip each day, while the female broods.

Nest sanitation consists of the removal of fecal sacs by both parents, and the cleaning of the nest beneath the young by the female.

Post-nesting activities. During a three- to four-week period following nest leaving, young grackles are dependent upon their parents for food and are semidependent for another week or longer. Family groups remain together during this period of dependency.

Hand-reared birds. Three nestling grackles, a male 8 days old and two females 11 days old, were kept in captivity for 13 months. They attained full size at the age of about 35 days. The larger features of the male became evident before its juvenal plumage was completely developed. In all three young the breast feathers of this plumage were indistinctly streaked. The postjuvenal molt lasted through the first three weeks of July. The male attempted to "sing" soon after acquiring the winter plumage in late July. The females did not sing until late December. At that time the male's song was about the same as that of the females. The latter postured and begged before the male, but copulation was never observed. One of the females showed signs of nest building during late May.

Food. An analysis of the stomach contents of seven nestling grackles revealed that they had received nearly all animal material, which included spiders, small crustacea, and insects. The food of adults collected at a blueberry swamp included about 40 per cent animal material and 58 per cent vegetable material. From the literature the stomach analyses of nestling grackles conducted by Beal (1900) and Hamilton (1951) were compared. These studies revealed a higher per cent of animal than plant food: 74 per cent animal and 26 per cent plant food (Beal); 89.1 per cent animal and 6.4 per cent plant (Hamilton).

Roosting and flocking. As soon as grackles arrive in the spring, they roost in flocks mixed with starlings, red-wings, and cowbirds. At that time they use marshes and thickets for roosts. The females roost on the nest from the beginning of incubation until the young leave the nest. During that time males continue to roost in the marsh or thicket which they used in early spring.

A willow-thicket roost was used by 3,000 to 5,000 blackbirds, mostly starlings with fewer cowbirds, red-wings and only 5 to 10 per cent grackles. A maple-tree roost was observed in central Michigan where about 5,000 starlings, cowbirds and grackles began roosting on June 26; only two to five per cent of these were grackles.

Late in August grackles begin to gather in flocks which increase in numbers as fall approaches. The largest flock of this species observed at one time (October 2, 1952) numbered 500 to 700.

LIST I

PLANTS COMMONLY FOUND IN THE VEGETATION ZONES AT TROWBRIDGE MARSH

The *Juncus tenuis* Zone

Glyceria striata
Poa pratensis
Scirpus atrovirens
Scirpus lineatus
Scirpus cyperinus
Scirpus atrocinctus
Carex vulpinoidea
Carex scoparia
Carex lupulina
Juncus tenuis

Juncus effusus
Rumex verticillatus
Ranunculus parviflorus
Penthorum sedoides
Asclepias incarnata
Verbena hastata
Scutellaria epilobiifolia
Lycopus rubellus
Eupatorium perfoliatum
Solidago sp.

The *Phalaris* Zone

Phalaris arundinacea

The *Spiraea* Zone

Spiraea alba

Salix gracilis
Phalaris arundinacea

The *Typha* Zone

Typha latifolia

The *Calamagrostis* Zone

Calamagrostis neglecta
Carex scoparia

Carex aquatilis
Scirpus atrocinctus
Scirpus cyperinus

LIST II

VERTEBRATES OTHER THAN BIRDS OBSERVED AT TROWBRIDGE MARSH BY THE AUTHOR AND BY CORNELL* (1950)

Mammals

Masked shrew, Sorex cinereus*
Raccoon, Procyon lotor*
Thirteen-striped ground squirrel,
  Citellus tridecemlineatus
Meadow vole, Microtus pennsylvanicus
Muskrat, Ondatra zibethica
Meadow jumping mouse, Zapus hudsonius*
Cottontail, Sylvilagus floridanus

Reptiles

Garter snake, Thamnophis sirtalis
Snapping turtle, Chelydra serpentina
Painted turtle, Chrysemys picta marginata
Blanding's turtle, Emys blandingii

Fish

Western mudminnow, Umbra limi
Brook stickleback, Eucalia inconstans

LIST III

STOMACH CONTENTS OF 2,346 ADULT GRACKLES
(Beal, 1900)

	Per cent of Total Diet
Animal Food	
Insects	25.4
Predaceous beetles . . .	5.6
May beetles	4.9
Snout beetles	2.0
Other beetles	1.0
Caterpillars	2.3
Grasshoppers	7.3
Other insects	2.3
Spiders and "Myriapods" . .	1.5
Crustaceans and Molluscs .	3.1
Vertebrates	0.3
Total	30.3
Vegetable Food	
Grain	46.5
Corn	37.2
Oats	2.9
Wheat	4.8
Others	1.6
Fruit	
Domestic	2.9
Wild	2.1
Weed seeds	4.2
Mast, etc.	14.0
Total	69.7

LIST IV

STOMACH CONTENTS OF NESTLING GRACKLES
(Beal, 1900; Hamilton, 1951)

	Beal			Hamilton		
Animal	74.4	per	cent	39.1	per	cent
Insects	60.0	"	"	48.2	"	"
Scarabaeid beetle grubs	19.0	"	"	x		
Carabid beetles	10.0	"	"	x		
Elaterid beetles	----			x	20.8	
Weevils	3.0	"	"	----		
Other families of beetles	1.0	"	"	x		
Grasshoppers and crickets	21.0	"	"	[8.0]	"	"
Hemiptera	----			[19.0]	"	"
Caterpillars	6.0	"	"	----		
Ants	----	"	"	x		
Earthworms	----			10.9	"	"
Mollusks	----			5.2	"	"
Millipedes	x			0.8	"	"
Sowbugs	----			3.4	"	"
Spiders	x			5.4	"	"
Fish	----			6.6	"	"
Amphibians	----			8.3	"	"
Mammals	----			0.3	"	"
Vegetable	25.6	"	"	6.4	"	"
Grain	15.0	"	"	1.4	"	"
Fruit	7.0	"	"	1.8	"	"
Green grass	----			3.2	"	"
Grit	----			4.3	"	"

LIST V

STOMACH CONTENTS OF 14 JUVENAL AND ADULT GRACKLES FROM EAST LANSING VICINITY

- Animal
  - Insects
    - Beetles: Dytiscids, Hydrophilids, and Platystomids
    - Hemiptera: Pentatomids
    - Homoptera: Cicadellids and Cercopids
    - Lepidoptera larvae
  - Spiders
  - Vertebrates: Small vertebrae, possibly of immature toad; down feathers.
  - Vegetable
    - Seeds: Blueberries (Vaccinium sp.)
    - Fruit pulp: Blueberries
    - Moss
  - Grit
    - Quartz, feldspar, and cinder

TABLE I

RECOVERIES OF BRONZED GRACKLES BANDED AT EAST LANSING, LANSING, AND LAKE ODESSA, MICHIGAN

	Spring	Summer	Fall	Winter	Total
Alabama	-	-	1	3	4
Arkansas	1	-	-	4	5
Illinois	2	-	1	-	3
Indiana	1	-	3	-	4
Kentucky	4	-	1	-	5
Louisiana	-	-	-	3	3
Mississippi	3	1	-	6	10
Tennessee	4	-	2	11	17
Texas	-	-	-	2	2

Data from banding files of Michigan State College and of C.C.Ludwig.

TABLE II

AVERAGE WEATHER CONDITIONS AT EAST LANSING, MICHIGAN FOR THE MONTHS OF MARCH THROUGH JUNE, 1951 AND 1952*

	Temperature (Degrees F.)			Precipitation (Inches)		Wind (M.P.H.)		Sunshine (Per cent)
	Max.	Min.	Av.	Total water	Snow	Av.	Max.	
1951								
March	41.6	26.2	33.9	1.67	4.3	18.0	52	36
April	53.3	35.5	44.4	2.93	1.0	14.4	38	40
May	70.7	47.4	59.1	3.08	0.0	11.2	30	62
June	76.3	55.2	65.8	3.26	0.0	8.1	35	59
1952								
March	38.5	24.9	31.7	2.22	9.8	13.7	43	43
April	57.4	36.8	47.1	3.32	11.5	13.2	36	57
May	66.9	45.3	56.1	4.98	0.0	11.4	34	59
June	80.7	59.2	70.0	1.46	0.0	10.2	41	69

*Data from U.S.Department of Commerce, Weather Bureau Station Meteorological Summary.

TABLE III

BIRDS SEEN AT TROWBRIDGE MARSH FROM MID-MARCH TO MID-JUNE, 1950, '51 AND '52
(Asterisks mark those seen by Cornell [1950] and not by the writer)

Common Name	Genus	Species	Transient			Resident					
			Feeding	Resting	Flew over	Breed., Field	Breed., Marsh	Feeding	Nesting	Roosting	Flew over
Pied-billed grebe	Podilymbus	podiceps					x	x	x		
Great blue heron	Ardea	herodias									x
Green heron	Butorides	virescens						x	x	x	
American bittern	Botaurus	lentiginosus						x	x	x	
Least bittern	Ixobrychus	exilis					x*	x	x	x	
Mallard	Anas	platyrhynchos						x	x		
Black duck	Anas	rubripes					x*				
Blue-winged teal	Anas	discors						x	x		
Cooper's hawk	Accipiter	cooperii						x			
Red-shouldered hawk	Buteo	lineatus			x						
Osprey	Pandion	haliaetus		x							
Ring-necked pheasant	Phasianus	colchicus								x	
Virginia rail	Rallus	limicola					x*	x	x		
Sora	Porzana	carolina					x	x	x	x	
American coot	Fulica	americana					x	x	x	x	
Killdeer	Charadrius	vociferus				x					
Wilson's snipe	Capella	gallinago	x	x							
Rock dove	Columba	livia									x
Mourning dove	Zenaidura	macroura					x	x	x		x
Nighthawk	Chordeiles	minor									x
Chimney swift	Chaetura	pelagica									x
Belted kingfisher	Megaceryle	alcyon						x			
Flicker	Colaptes	auratus						x			

TABLE III "continued"

Common Name	Genus	Species	Transient Feeding	Transient Resting	Transient Flew over	Resident Breed., Field	Resident Breed., Marsh	Resident Feeding	Resident Resting	Resident Roosting	Resident Flew over
Downy woodpecker	Dendrocopus	pubescens						x			
E. kingbird	Tyrannus	tyrannus					x	x	x		
Alder flycatcher	Empidonax	trailli					x*	x			
Horned lark	Eremophila	alpestris				x					
Tree swallow	Iridoprocne	bicolor					x*	x	x		
Barn swallow	Hirundo	rustica						x			x
Purple martin	Progne	subis						x			x
Eastern crow	Corvus	brachyrhynchos									x
Long-billed marsh wren	Telmatodytes	palustrus					x*				
Short-billed marsh wren	Cistothorus	platensis						x	x		
Robin	Turdus	migratorius						x			x
Bluebird	Sialia	sialis									x
Starling	Sturnus	vulgaris					x			x	
Yellow warbler	Dendroica	petechia					x	x	x		
Yellow-throat	Geothlypis	trichas	x	x							
English sparrow	Passer	domesticus					x	x	x	x	
Bobolink	Dolichonyx	oryzivorus				x					
Eastern meadowlark	Sturnella	magna				x			x		
Red-wing	Agelaius	phoeniceus					x	x	x	x	
Bronzed grackle	Quiscalus	quiscula versicolor					x	x	x	x	
Cowbird	Molothrus	ater					x	x	x	x	
Cardinal	Richmondena	cardinalis							x		x
Goldfinch	Spinus	tristis						x	x		x
Savannah sparrow	Passerculus	sandwichensis				x		x			
Swamp sparrow	Melospiza	georgiana	x	x							
Song sparrow	Melospiza	melodia					x	x	x		

TABLE IV

NEST SIZE BASED ON SIX NESTS OF BRONZED GRACKLES FROM TROWBRIDGE MARSH

	Average	Maximum	Minimum
Dimensions of whole nest			
Outside diameter	16.48 cm. 6 1/2 in.	18.0 cm.	15.0 cm.
Outside depth	13.45 cm. 5 3/8 in.	16.7 cm.	10.0 cm.
Inside diameter	9.98 cm. 3 7/8 in.	11.2 cm.	9.4 cm.
Inside depth	7.60 cm. 3 in.	8.5 cm.	6.0 cm.
Plaster cup			
Inside diameter	11.40 cm. 4 1/2 in.	12.2 cm.	10.5 cm.
Inside depth	7.08 cm. 2 7/8 in.	8.7 cm.	5.5 cm.
Thickness of bottom	1.71 cm. 1/4 in.	2.5 cm.	1.1 cm.
Thickness of side	0.84 cm. 3/8 in.	0.9 cm.	0.7 cm.
Thickness of rim	0.60 cm. 1/4 in.	0.8 cm.	0.4 cm.
Per cent of nest weight			
Outer coarse material	24.6	33.0	18.0
Plaster cup	69.3	74.0	61.0
Lining	5.9	7.0	4.0

TABLE V

NEST COMPOSITION BASED ON SIX NESTS OF
BRONZED GRACKLES FROM TROWBRIDGE MARSH

	Average weight in grams	Per cent of nest weight
Outside		
Milkweed fiber	11.21	6.2
Grass stems and leaves	14.23	7.9
Weed stems and leaves	8.38	4.6
Leaves of trees	trace	trace
Roots of grass and weeds	trace	trace
Sedge	0.35	0.1
Juncus	0.16	trace
String and rag	0.51	0.2
Paper	0.38	0.2
Debris, crumbled bits of leaves, etc.	8.76	4.9
Total	44.03	24.6
Cup	124.04	69.3
Lining		
Juncus tenuis	4.59	2.5
Milkweed fiber	0.05	trace
Fine grass stems and leaves	1.53	0.8
Fine grass roots	0.28	0.1
Sedge	4.25	2.3
Total	10.70	5.9
Total average dry weight	178.77	99.8

TABLE VI

LOCATION OF NESTS OF BRONZED GRACKLES AT TROWBRIDGE MARSH, 1951 AND 1952

	1951	1952
Height above water (Meters)		
Average	0.60	0.43
Maximum	0.69	0.66
Minimum	0.23	0.33
Distance from nearest grackle's nest		
Average	13.10	26.30
Maximum	27.40	30.40
Minimum	9.10	18.20
Distance from open water		
Average	5.18	3.58
Maximum	33.50	10.00
Minimum	0.61	0.61

TABLE VII

LOCATION OF NESTS OF BRONZED GRACKLES IN A 12-SQUARE-MILE AREA AT EAST LANSING, 1952

Habitat					Situation								
Colony number	No. in colony	Urban or sub-urban	Country	Marsh or swamp	*Picea abies*	*Pinus nigra*	*Salix nigra*	*Salix interior*	*Salix gracilis*	*Spiraea alba*	*Cephalanthus occidentalis*	Average dist. from nearest grackle's nest in meters	Average height in meters
1	6	x		x					1	5		24.12	0.43
2	12	x			9	3						10.18	9.09
3	7	x				7						5.51	9.00
4	13		x		13							3.65	15.84
5	8		x	x						8		7.69	0.68
5a	1		x	x			1					396.24	0.60
6	1		x	x								618.82	?
7	4		x	x			4					12.19	0.69
8	13	x		x			10	1			2	12.40	1.32
8a	1	x		x				1				160.93	1.01
9	2		x	x			2					18.28	1.52
10	6	x			4	2						10.50	9.58

TABLE VIII

LOCATION OF NESTING SITES OF BRONZED GRACKLES THROUGHOUT THE BREEDING RANGE

(Figure is number of times noted by 50 authors)

Habitat		Support	
Shade trees in city	8	Coniferous trees	20
Cemeteries and parks	4	Deciduous trees	22
Farm and estate dwellings	6	Bushes	9
Old apple orchards	2	Vines	3
Cut-over land	1	Cattails	2
Lake margin	4	Bulrush	2
Pond	2	Grass	1
Marsh and slough	7	Old woodpecker holes	7
Swamp	4	Hollows in dead tree stubs	8
Stream borders	8	Knotholes in trees	7
Bottomland woods	1	Man-made structures	7
Island	2	Osprey's nest	7

TABLE IX

TYPES OF SUPPORT FOR NESTS OF BRONZED GRACKLES FROM REPORTS BY 50 AUTHORS

Trees	Bushes	Vines	Herbs	Others
White pine	Willow	Grape	Cattail	Osprey nest
Norway pine	Alder		Grass	Bridge
Norway spruce	Chokecherry		Bulrush	R.R.bridge
Hemlock	Huisache			Cornice
Cedar				Eaves trough
Willow				Beams of hay barn
Cottonwood				Hollow dead trees
Lombardy poplar				Woodpecker holes
Paper birch				Dead tree stub
Oak				Knothole in trees
Elm				
Sycamore				
Plum				
Box elder				
Maple				

TABLE X

A SUMMARY OF ATTENTIVE AND INATTENTIVE PERIODS OF TWO FEMALES DURING INCUBATION

	Female 6	Female 6	Female 17	Female 17
Day of incubation	10	11	7	10
Length of observation	May 14, 1951 6 hrs. 2:15-8:15 P.M.	May 15, 1951 5 hrs. 5:00-10:00 A.M.	May 9, 1952 6 hrs. 6:00-12:00 A.M.	May 12, 1952 3 1/2 hrs. 4:30-8:00 A.M.
Attentive periods				
Average	16.9 min.	16.0 min.	49.8 min.	45.7 min.
Extremes	8 - 43 min.	9 - 21 min.	15 - 69 min.	10 - 35 min.
Per cent of whole time	46.9	54.3	69.2	46.0
Inattentive periods				
Average	19.1 min.	13.5 min.	22.2 min.	22.8 min.
Extremes	15 - 25 min.	8 - 21 min.	14 - 43 min.	3 - 42 min.
Per cent of whole time	53.1	45.7	30.8	54.0

TABLE XI

A SUMMARY OF EGG-LAYING AND INCUBATION AT EAST LANSING, MICHIGAN, DURING 1951 AND 1952

	Active Nests	Number Eggs	Clutch Size	No. Days of Incubation
Trowbridge Marsh 1951	15	66	4.5*	12.75
Trowbridge Marsh 1952	6	25	4.4*	12.66
Forest Rd. 1952	8	36	4.5	-----
Collins Rd. 1952	4	18	4.5	-----
Total	33	145	---	-----
Average	--	---	4.5	12.70

*Two nests in which the eggs were destroyed before the clutch was laid were not included in the computation of clutch size.

TABLE XII

NESTING SUCCESS OF THE BRONZED GRACKLE AT EAST LANSING, MICHIGAN, AND MADISON, WISCONSIN

	E. Lansing	Madison
Active nests	33	62
Per cent successful	35	55
Number of eggs	145	288
Number hatching	91	209
Per cent hatching	63	73
Number of fledglings	36	135
Per cent of eggs	25	47
Per cent of young	40	65
No. per successful nest	3.1	4.3
No. per active nest	1.1	2.2

TABLE XIII

NESTING SUCCESS OF THE BRONZED GRACKLE

	T. M.* 1951	T. M. 1952	F. Rd. 1952	C. Rd. 1952	Totals
Active nests	15	6	8	4	33
Per cent successful	47	17	50	25	35
Number of eggs	66	25	36	18	145
Number hatching	36	14	27	14	91
Per cent hatching	55	56	75	78	63
Number of fledglings	18	4	11	3	36
Per cent of eggs	27	16	31	12	25
Per cent of young	50	29	41	21	40
No. per successful nest	2.6	4.0	2.8	3.0	3.1
No. per active nest	1.2	0.7	1.4	0.8	1.1

*T. M. is Trowbridge Marsh colony; F. Rd. is Forest Road colony; C. Rd. is Collins Road colony.

TABLE XIV

CAUSES OF FAILURES IN NESTS OF BRONZED GRACKLES

	Trowbridge Marsh '51	Trowbridge Marsh '52	Forest Road '52	Collins Road '52	Totals
Eggs not hatching	30 (45)*	11 (44)	9 (25)	4 (22)	54 (37)
Infertile	4 (6)	0 (0)	1 (3)	3 (17)	8 (6)
Destroyed	4 (6)	3 (12)	5 (14)	11 (6)	13 (9)
Desertion	22 (33)	8 (32)	3 (8)	0 (0)	33 (23)
Young not fledging	18 (27)	10 (40)	16 (44)	11 (17)	55 (38)
Predation	14 (21)	10 (40)	2 (6)	11 (17)	37 (26)
Investigator	7 (10)	0 (0)	1 (3)	0 (0)	8 (6)
Unknown	7 (10)	10 (40)	1 (3)	11 (17)	29 (20)
Desertion	0 (0)	0 (0)	4 (11)	0 (0)	4 (3)
Died in nest	1 (2)	0 (0)	4 (11)	0 (0)	5 (3)
Banding	3 (5)	0 (0)	6 (17)	0 (0)	9 (6)

*Per cents in parentheses are based on total eggs laid.

TABLE XV

FEEDING ACTIVITY OF THE BRONZED GRACKLE DURING THE FIRST HALF OF THE NESTLING'S LIFE

	Nest 25			Nest 25			Nest 6		
Age of nestling	2 and 3 days			3 and 4 days			4 and 5 days		
Period of observation	(May 23, 1952) 1 hour (7:00-8:00 P.M.)			(May 24, 1952) 2 hours, 25 minutes (5:00-7:25 A.M.)			(May 22, 1951) 1 hour, 30 minutes (4:40-6:10 A.M.)		
Number of nestlings	4			4			4		
	Male	Female	Both	Male	Female	Both	Male	Female	Both
Total feeding visits	3	1	4	8	8	16	6	1	7
Av. no. per hour	3	1	4	3.5	2.6	6.2	4	0.7	4.7
Extremes	-	-	-	2-6	1-5	1-6	2-4	1	1-4
Intervals	3	1	4	8	6	14	5	1	6
Av. length (Min.)	16.3	7	11	15.2	6	11.2	14.6	24.6	16.2
Extremes	11-13	-	7-13	6-34	1-12	1-34	8-22	24.6	8-24.6

TABLE XVI

FEEDING ACTIVITY OF THE BRONZED GRACKLE DURING THE SECOND HALF OF THE NESTLING'S LIFE

	Nest 25			Nest 25			Nest 25		
Age of nestling	8 and 9 days			9 and 10 days			10 and 11 days		
Period of observation	(May 29, 1952) 9 hours, 50 minutes (4:25-10:40 A.M.) (3:15-6:50 P.M.)			(May 30, 1952) 8 hours, 20 minutes (5:20-8:40 A.M.) (11:00-3:00 P.M.)			(May 31, 1952) 6 hours, 25 minutes (5:15-9:25 A.M.) (3:00-5:15 P.M.) (6:00-8:30 P.M.)		
Number of nestlings	4			4			4		
	Male	Female	Both	Male	Female	Both	Male	Female	Both
Total feeding visits	21	50	71	24	32	56	25	29	54
Av. no. per hour	1.8	4.6	6.5	3.1	4.3	7.4	2.7	3.3	6.0
Extremes	1-4	0-9	0-9	2-5	2-8	2-8	0-4	1-7	0-7
Intervals	23	52	75	25	32	57	25	29	54
Av. length (Min.)	23.3	7.6	12.4	19.9	12.5	15.4	17.0	12.4	14.5
Extremes	7-50	2-32	2-50	8-39	1-33	1-39	3-72	5-72	3-31

PLATE 1

Fig. A. Trowbridge Marsh. View from marsh toward observation tower. Field in background. April 28, 1951.

Fig. B. Trowbridge Marsh. View from observation tower along south margin toward northeast showing: (1) *Phalaris* zone; (2) *Juncus tenuis* zone; (3) Old field zone.

PLATE 1

Fig. A

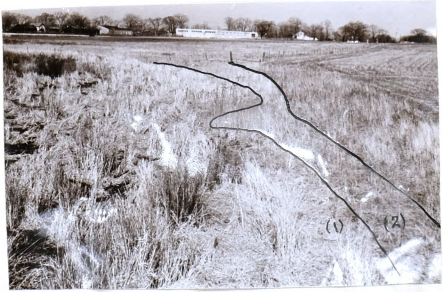


Fig. B

PLATE 2

Fig. A. Trowbridge Marsh. View from observation tower toward north showing _Spiraea alba_ zone, open water beyond, and Trowbridge R.R. tower at upper right. April 28, 1951.

Fig. B. Trowbridge Marsh. Nest 17 in a _Spiraea alba_ bush. Note open water in foreground. April 21, 1951.

PLATE 2

Fig. A

Fig. B

PLATE 3

Fig. A. Trowbridge Marsh. View from southwest part of marsh. Arrow shows location of Nest 1. Observation tower appears beyond black willow tree. April 28, 1951.

Fig. B. Cross-sectional view of Nest 17 from Trowbridge Marsh. Ink lines outline plaster cup, (1) outside, (2) plaster cup, (3) lining.

PLATE 3

Fig. A

Fig. B

PLATE 4

Fig. A. Michigan Avenue, East Lansing. Austrian pine, the location of nesting Area 3, where seven nests were situated. April 15, 1952.

Fig. B. Bennett Farm near East Lansing. Norway spruce windbreak in which 13 pairs nested. Farmhouse is beyond trees. April 30, 1952.

PLATE 4

Fig. A

Fig. B

PLATE 5

Fig. A. Forest Road colony. View from south toward open water with Spiraea alba bushes in background. Note truck on Forest Road, which divides this bush marsh. May 28, 1952.

Fig. B. Bronzed grackle's nest with four eggs. Nest was located at Area 5a in a black willow with a tangle of grapevine. May 7, 1952.

PLATE 5

Fig. A

Fig. B

PLATE 6

Fig. A. Collins Road colony, nesting Area 7. A willow swamp with a thicket of sandbar willow and black willow trees, where four pairs of grackles nested. May 28, 1952.

Fig. B. Bronzed grackle's nest among stems of sandbar willow at Cavanaugh colony, nesting Area 8. May 2, 1952.

PLATE 6

Fig. A

Fig. B

PLATE 7

Fig. A. Young bronzed grackle. The first day. May 16, 1952.

Fig. B. Young bronzed grackle. The fourth day. May 15, 1952.

PLATE 7

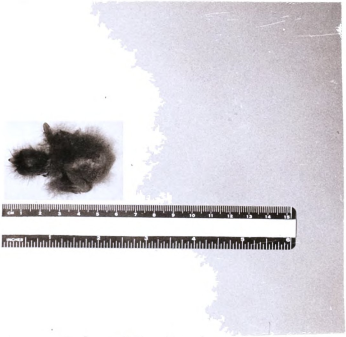


Fig. A

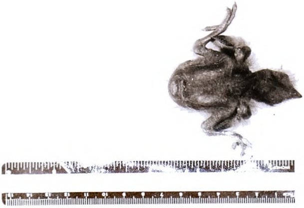


Fig. B

PLATE 8

Fig. A. Young bronzed grackle. The seventh day. May 15, 1952.

Fig. B. Young bronzed grackles. The eleventh day. May 15, 1952.

Fig. C. Young bronzed grackle. The eleventh day. May 25, 1952.

PLATE 8

Fig. A

Fig. B

Fig. C

PLATE 9

Fig. A. Three young bronzed grackles, age 10 days, in Nest 25 at Trowbridge Marsh. One is sitting in the cup of the nest, one is perched on the rim of it, and the third one in the background is stretching a wing downward. May 31, 1952.

Fig. B. Three young bronzed grackles, age 10 days, in Nest 25 at Trowbridge Marsh. All are facing the side of the nest from which they are fed. May 31, 1952.

PLATE 9

Fig. A

Fig. B

PLATE 10

Fig. A. Male grackle with food at Nest 25 at Trowbridge Marsh about to feed nine-day-old nestlings. May 30, 1952.

Fig. B. Dead tree near Nest 25. The three birds in the tree are: (uppermost) male grackle of Nest 25, (center) male red-wing, and (bottom) female of Nest 25. May 30, 1952.

PLATE 10

Fig. A

Fig. B

PLATE 11

Fig. A. Female bronzed grackle with a fecal sac about to leave Nest 25 at Trowbridge Marsh. May 30, 1952.

Fig. B. Female bronzed grackle with head below nine-day-old nestlings cleaning Nest 25. May 30, 1952.

PLATE 11

Fig. A

Fig. B

LITERATURE CITED

Alcorn, J.R.
1940. New and noteworthy records of birds of the state of Nevada. Condor, 42:170.

Attwater, H.P.
1892. List of birds observed in the vicinity of San Antonio, Bexar County, Texas. Auk, 9:229-238.

A.O.U. Check-list of North American Birds.
1944. Fourth ed., nineteenth supp. Auk, 61:441-464.

——— 1948. Fourth ed., twenty-third supp. Auk, 65:438-443.

Audubon, John James.
1827-1830. The birds of America from original drawings. (The Macmillan Co., N.Y., 1937), 500 plates.

Bailey, Alfred M.
1948. Birds of Arctic Alaska. The Colorado Museum of Natural History, Popular Series 8:1-317.

Baird, S.F., T.M. Brewer and Robert Ridgway.
1875. A history of North American birds. (Little Brown and Co., Boston), 2:1-590.

Beal, F.E.L.
1900. Food of the bobolink, blackbirds and grackles. U.S.D.A. Bull. 13, 8:1-77.

Beecher, William J.
1951. Adaptations for food-getting in the American blackbirds. Auk, 68:411-440.

Bendire, Charles E.
1895. Life histories of North American birds from the parrots to the grackles. Smithsonian Contribution to Knowledge 985, 32:1-1530.

Bond, James.
1948. Origin of the bird fauna of the West Indies. Wilson Bull., 60(4):207-229.

Brewster, William.
1890. Summer robin roosts. Auk, 7:360-373.

Cahalane, Victor H.
1944. The grackle as a fisher. Auk, 61:296.

Cameron, E.S.
1907. The birds of Custer and Dawson Counties, Montana. Auk, 24:389-406.

Capen, Elwin A.
1886. Oology of New England: a description of the eggs, nests, and breeding habits of the birds known to breed in New England. (Alfred Mudge and Sons, printers, Boston), 1-116.

Catesby, Mark.
1731-1743. The natural history of Carolina, Florida and the Bahama Islands. (In Allen, Elsa Guerdrum. 1951. The history of American ornithology before Audubon. Trans. of the Amer. Philosophical Society, New Series, 41[3]:387-591).

Chapman, Frank M.
1935a. Further remarks on the relationships of the grackles of the subgenus <u>Quiscalus</u>. Auk, 52:21-29.

——— 1935b. <u>Quiscalus</u> <u>quiscula</u> in Louisiana. Auk, 52:418-420.

——— 1936. Further remarks on <u>Quiscalus</u> with a report on additional specimens from Louisiana. Auk, 53:405-417.

——— 1931. <u>Quiscalus</u> in Mississippi. Auk, 56:28-31.

——— 1940. Further studies on the genus <u>Quiscalus</u>. Auk, 57:225-233.

Cooke, Wells W.
1888. Report on bird migration in the Mississippi valley in the years 1884 and 1885. U.S.D.A., Div. of Econ. Ornith., Bull., 2:1-313.

——— 1915. Bird migration in the Mackenzie valley. Auk, 32:442-459.

Cornell, Robert.
1950. A study of vertebrates in a seven-acre marsh in East Lansing, Michigan. An unpublished manuscript, Dept. of Zool., Michigan State College.

Cottam, Clarence.
1943. Unusual feeding habit of grackles and crows. Auk, 60:594-595.

Drew, Frank M.
1885. On the vertical range of birds in Colorado. Auk, 2:11-18.

Dwight, Jonathan.
1900. The sequence of plumages and moults of the passerine birds of New York. Annals of N.Y. Acad. of Sci., 13:73-350

Eaton, E.H.
1914. Birds of New York. New York State Museum Memoir 12. (The University of the State of New York), 1-719.

Forbush, Edward Howe.
1927. Birds of Massachusetts and other New England states. (Norwood Press. J.S. Cushing Co.--Berwick and Smith Co., Norwood, Mass.), 2:1-461.

Ford, Edward R.
1932. Summer birds associations on Great Lakes islands. Auk, 49:235-236.

Foster, Frank B.
1927. Grackles killing young pheasants. Auk, 44:106.

Friedmann, Herbert.
1929. The cowbirds. (Charles C. Thomas, Publisher. Springfield, Ill.), 1-421.

——— 1931. Additions to the list of birds known to be parasitized by the cowbirds. Auk, 48:52-65.

Gabrielson, Ira N.
1922. Short notes on the life histories of various species of birds. Wilson Bull., 34(4):193-210.

Gentry, Thomas G.
1882. Nests and eggs of birds in the United States. (J.A. Wagenseller. Phila.), 1-300.

Gibbs, Morris.
1903. The grackles change in nesting habit. Bull. Mich. Ornith. Club, 4(2):57-58.

Golsan, Lewis and Ernest G. Holt.
1914. Birds of Autauga and Montgomery Counties, Alabama. Auk, 31:212-235.

Hamilton, W.J., Jr.
1951. The food of nestling bronzed grackles, *Quiscalus quiscula versicolor* in Central New York. Auk, 68:213-217.

Hellmayr, Charles E.
1937. Catalogue of birds of the Americas and the adjacent islands. Zoological Series, Field Museum of Natural History, Publ. 381, Part X Icteridae:1-228.

Huntington, Charles E.
1952. Hybridization in the purple grackle, *Quiscalus quiscula*. Systematic Zoology, 1(4):149-170.

Jones, Lynds.
1895. Bird migration at Grinnell, Iowa. Auk, 12:117-134.

——— 1895. Bird migration at Grinnell, Iowa. Auk, 12:231-244.

——— 1897. The Oberlin summer grackle roost. Wilson Bull., 9:39-56.

McAtee, W.L.
1911. Economic ornithology in recent entomological publications. Auk, 28:282-287.

McCann, Horace D.
1931. Recoveries of purple grackles banded at Paoli, Pennsylvania, 1923-1931. Bird-Banding, 2(4):174-178.

Macoun, John.
1903. Catalogue of Canadian birds. Geological Survey of Canada, Part II:219-413.

Mayr, Ernst.
1946. The number of species of birds. Auk, 63:64-67.

McIlhenny, E.A.
1937. Life history of the boat-tailed grackle in Louisiana. Auk, 54:274-295.

Nice, Margaret M.
1931. The birds of Oklahoma. Publication of the Univ. of Okla., 3(1):1-224.

——— 1935. Some observations on the behavior of starlings and grackles in relation to light. Auk, 52:91-92.

——— 1937. Studies in the life history of the song sparrow, I. Trans. Linn. Soc. N.Y., 4:1-247.

Nice, Margaret M.
1941. The role of territory in bird life. Am. Mid. Nat., 26(3):441-487.

——1943. Studies in the life history of the song sparrow, II. Trans. Linn. Soc. N. Y., 6:1-328.

Oberholser, Harry C.
1919. Fourth annual list of proposed changes on the A.O.U. check-list of North American birds. Auk, 36:266-273.

Perkins, Samuel E., III.
1932. Indiana bronzed grackle migration. Bird-Banding, 3(3):85-94.

Petersen, Arnold and Howard Young.
1950. A nesting study of the bronzed grackle. Auk, 67:466-476.

Reed, Chester A.
1904. North American birds eggs. (Doubleday, Page and Co., N. Y.), 1-356.

Ridgway, Robert.
1869. Notices of certain obscurely known species of American birds. Proc. Acad. Nat. Sci. Phila., 21:125-135.

——1902. Birds of North and Middle America. U.S. National Museum, Bull. 50, Part II:1-833.

Roberts, Thomas S.
1932. The birds of Minnesota, Part II:1-821.

Saunders, Aretas A.
1951. A guide to the bird songs. (Doubleday and Co., Inc., Garden City, N. Y.), 1-307.

Schorger, A.W.
1941. The bronzed grackle's method of opening acorns. Wilson Bull., 53(4):238-240.

Seeley, Dewey Alsdorf.
1917. The climate of Michigan and its relation to agriculture. (Michigan State Board of Agriculture), 1-33.

Snyder, L.L.
1937. Some measurements and observations from bronzed grackles. Can. Field Nat., 51:37-39.

Stockard, Charles R.
1905. Nesting habits of the birds in Mississippi. Auk, 22:273-285.

Stejneger, Leonhard.
1885. Foot-note. Auk, 2:43.

Sutton, George Miksch.
1945. The bronzed grackle as a species. Auk, 62:170.

Townsend, Charles W.
1912. Bird genealogy. Auk, 21:285-295.

Trautman, Milton B.
1940. The birds of Buckeye Lake, Ohio. Univ. of Mich. Mus. Zool. Misc. Publ. 44:1-466.

Trotter, Spencer.
1909. An inquiry into the history of the current English names of North American land birds. Auk, 26:346-362.

Van Tyne, Josselyn.
1923. Summer birds of the Les Cheneaux Islands. Wilson Bull., 35(1):21-26.

———1948. Island life: a study of the land vertebrates of the islands of eastern Lake Michigan. Cranbrook Inst. of Sci., Bloomfield Hills, Bull. 27:1-179.

Weber, J.A.
1912. A case of cannibalism among blackbirds. Auk, 29: 394-395.

Wetmore, Alexander.
1919. Notes on the birds of Tennessee. Proc. U.S. Nat. Mus., 86:175-243.

Weydemeyer, Winton.
1932. The bronzed grackle in Lincoln County, Montana. Auk, 49:228.

———1934. Further occurrence of the bronzed grackle in northwestern Montana. Auk, 51:384.

White, Stewart Edward.
1893. Birds observed on Mackinac Island, Michigan during the summers of 1889, 1890 and 1891. Auk, 10:221-230.

Williams, Laidlaw.
1952. Breeding behavior of the Brewer blackbird. Condor, 54:3-47.

Wilson, Alexander and Prince Charles Lucian Bonaparte.
1876. American ornithology: or, the natural history of the birds of the United States. (Chatto and Windus, Piccadilly, London), 1-408.

Wilson, Burtis H.
1906. The birds of Scott County, Iowa. Wilson Bull., 18(1):1-11

Wood, Norman A.
1911. The results of the Mershon expedition to the Charity Islands, Lake Huron. Birds. Wilson Bull., 23(2): 73-112.

———1951. The birds of Michigan. Univ. of Mich. Mus. of Zool., Misc. Publ. 75:1-559.