THE CONDOR

VOLUME 64 MARCH-APRIL, 1962 NUMBER 2

AUTUMNAL BREEDING OF BOAT-TAILED GRACKLES IN FLORIDA

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Many species of birds that are resident in temperate latitudes experience a short period of sexual activity in the fall associated with partial recrudescence of the gonads from the preparatory or regenerative phase (Marshall, 1952, 1959). Normally this is followed by a long period of gonadal and sexual inactivity in the winter; but, exceptionally, and for reasons not fully understood, autumnal recrudescence of the gonads leads to full gametogenesis and a second breeding effort within a one-year period. Autumnal breeding in birds has been reviewed at length by Marshall (1952), and an important example of this phenomenon is provided by Orians (1960), who studied colonies of the Tricolored Blackbird (*Agelaius tricolor*) in the Sacramento Valley of California where breeding occurred in October and November of 1959.

The present report deals with another colonially nesting icterid, the Boat-tailed Grackle (*Cassidix major*), at Orlando, central Florida, where autumnal nesting occurred in 1956, 1959, and 1960. Autumnal breeding has not previously been reported in any species of grackle.

ACKNOWLEDGMENTS

This investigation was supported by the National Science Foundation (Grant 15882) and the American Museum of Natural History, at which institution the senior author was a research fellow in 1960. The assistance of Dean Amadon in arranging for field work by the senior author in December of 1960 is gratefully acknowledged. We are also indebted to Mr. John Bull for information on nesting in southern Florida.

THE "NORMAL" ANNUAL CYCLE

Before presenting information on autumnal breeding in *Cassidix*, it will be instructive to review the "normal" annual cycle in which breeding occurs only in the spring and early summer. We do not have exhaustive information for *C. major* in Florida, but reasonably complete data are available for the very closely-related Great-tailed Grackle (*Cassidix mexicanus*) at Austin, south-central Texas. This form has until recently (Selander and Giller, 1961) been regarded as only racially distinct from *C. major*, and it is likely that there are no important differences between the species with regard to phenology of their annual cycles.

Cassidix major.—Referring to Florida as a whole, Howell (1932:433) reported nesting by *C. major* from March to the first part of July, mainly, however, in April and May. Actually, there is some regional variation in periods of nesting in the state, as indicated by data from extensive collections of eggs made by Nicholson from 1908 to 1960, which are summarized as follows:

Region	Dates of egg collections	
	Earliest	Latest
Duval County, northeastern Florida	April 19	May 2
Kissimmee Prairie, central Florida	February 27	May 27
East-central Florida	March 10	May 9
Southern Florida	February 26[1]	June 13

[1] Record by John Bull of nest building in 1961; eggs probably not laid before March 1; definite egg records by Nicholson on March 25, 1937.

In central Florida, the major breeding effort occurs in March and April. The earliest record of eggs for Florida is February 27, 1923, when two fresh eggs were found by Nicholson near Lake Kissimmee, Osceola County; and, at Royal Palm, Everglades National Park, in southern Florida, John Bull (letter, March 9, 1961) noted that nest building began on February 26 in 1961. In south-central Florida, birds under observation by Selander at Sebring and other localities in the spring of 1961 did not commence nesting until March 2. And in northern Florida, breeding occurs in the latter part of April and in May; at Mayport Yacht Basin, Duval County, and at Saint Marys, Camden County, extreme southeastern Georgia, breeding had not begun on March 11, 1961, when Selander visited these areas.

In central Florida, Nicholson's records indicate that the annual molt in *Cassidix* occurs from mid-July through October.

In Louisiana, *C. major* breeds from late March through June, and the annual molt is in progress from July to October (McIlhenny, 1937). At the western limit of the range of the species in southeastern Texas, some early nest building begins in the last week of March, but the main breeding effort occurs in April and May. By June 15 it is unusual to find eggs still being incubated; and the breeding season has ended and winter flocks are forming by July 1. Molt occurs from July to October (Selander, MS).

Cassidix mexicanus.—The sequence and timing of events in the annual cycle of *C. mexicanus* in south-central Texas are generally similar to those of *C. major* in Florida. Seasonal variation in testis volume in the Austin region is shown in figure 1, in which the cycles of adult and first-year males are treated separately. Since a full discussion of the gonadal and behavioral cycles of this species will be presented elsewhere (Selander, MS), it will suffice here to limit our remarks to a few major points.

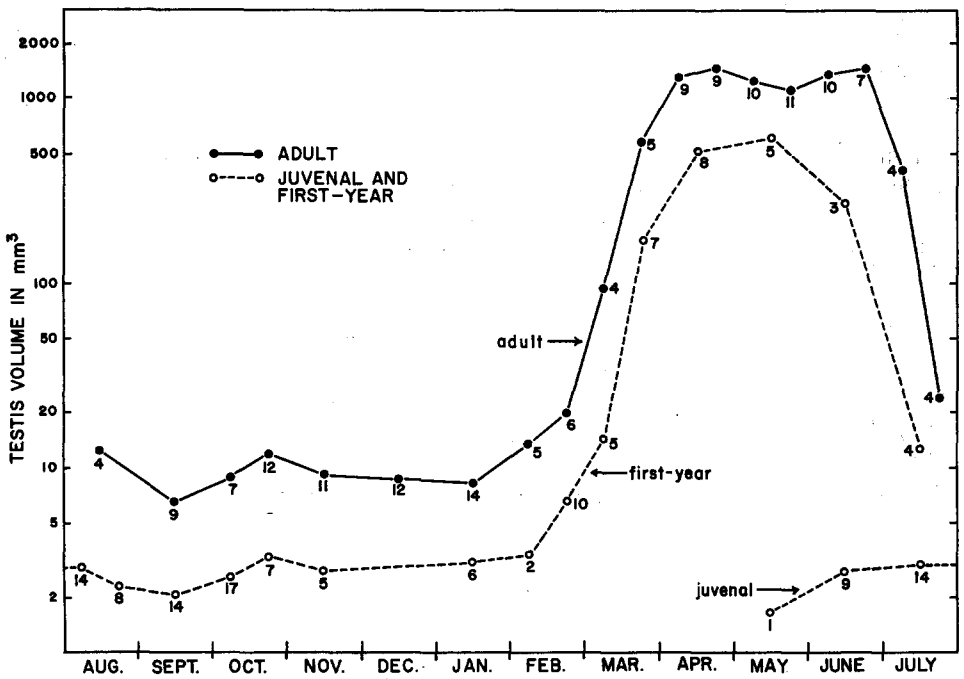

Fig. 1. Male gonadal cycle of the Great-tailed Grackle (*Cassidix mexicanus*) in the Austin region, Texas, as indicated by volume of left testis. Numbers below points indicate sample sizes.

Vernal recrudescence of the testes of adult males begins in the first part of February, and maximum testis volume is attained in April. Except for a minor depression in volume occurring in May, full volume and spermatogenic activity are maintained through June. Females are nesting in this three-month period, April through June. Testicular regression in adults occurs in July, with minimum volume being achieved in September. With rare exception, testes collected in September are in the classical regenerative (formerly called "resting") histologic condition, with a single row of spermatogonia and a few primary spermatocytes in the seminiferous tubules.

As shown in figure 1, spring development of the testes begins two or three weeks later in first-year males than in adults, and the period of maximum development is shorter, with regression beginning in June.

Postnuptial and postjuvenal molts occur from July through October and the first half of November (Selander, 1958:362). In August and September, flocks composed of individuals in heavy molt roam about the city of Austin and adjacent agricultural fields; the winter pattern of communal roosting is established and little if any sexual or territorial behavior is manifest. Males rarely sing or display, and attempts to elicit sexual responses from males by presenting them with female dummies are unsuccessful.

A slight but significant increase in mean testis volume occurs in both adult and first-year males in October. At this time the testes of many adult but relatively few first-year males advance to a histologic stage in which two or three rows of spermatogonia and primary spermatocytes are present in the seminiferous tubules. There is also a significant increase in the number of Leydig cells in the interstitium. This is the height of development, and a decrease in mean testis volume is apparent in November, together with a return of many of the testes to the histologic stage seen in September. By December, the majority of testes have returned to this stage.

The ovaries of females show slight increase in mean diameter of follicles in October, as compared to September, and there is a reduction in mean diameter in November and December.

The degree of manifestation of territorial and sexual activity in the period of autumnal recrudescence of the gonads in October varies from year to year depending upon the prevailing weather conditions. By way of illustration, we may cite two examples. In 1956, temperatures were unseasonally high through October, with mean weekly temperatures of 70° to 80° F. (cf. table 2). Considerable numbers of adult males were singing during much of the day, and some males established themselves at traditional breeding colony sites in the city. Strong sexual responses to female dummies were obtained. Some females visited the old breeding sites, but nest building was not observed and the females made no overt responses to the songs and solicitation displays and vocalizations of the males.

In November, temperatures dropped sharply, with weekly averages of 50° to 60° F. At the same time, the incipient reproductive behavior ceased, but an occasional male sang weakly on warm days in December and January.

In 1957, temperatures were unseasonally low from mid-September through October, and there was an unusual amount of rain, particularly in October. Typical winter flocking behavior was seen until October 19, which was a clear, moderately warm day following several days of heavy rain and sustained low temperatures. On October 19, several adult males stationed themselves at an old breeding colony site in Austin and sang with considerable vigor; they gave full solicitation displays to females for the first time since the previous June. The next day, October 20, was overcast and chilly. Most of the males that had established territories failed to appear at the breeding colony site, having apparently returned to the foraging flocks. Heavy rain fell on October 21 and 22, all but

completely suppressing sexual activity in the grackles. October 23 was mild and dry, and a few adult males sang strongly, but several days of cold and rainy weather followed, with a record low temperature of 32° F. being recorded on the 28th. When mild weather returned in the first week of November, the period of autumnal recrudescence of gonads was apparently at an end. A few birds sang weakly, but a few days later there was practically no sexual or territorial behavior evident in the grackles of the Austin region.

In summary, the level of gonadal and sexual activity seen in October in the Austin region is approximately equivalent to that shown in February, a month and a half before breeding occurs in the spring. Only a small part of the total population shows conspicuous territorial or sexual behavior in the fall, most birds remaining in winter flocks. As in February, cold, rainy weather has a powerful depressing effect on the incipient reproductive activity shown in October. In the species *Cassidix mexicanus* there are no records of autumnal gonadal activity leading to nest building or other advanced reproductive behavior.

AUTUMNAL BREEDING IN FLORIDA

Autumnal breeding occurs in small groups of *Cassidix major* inhabiting several parks and park-like areas surrounding small lakes in the city of Orlando, Orange County. The birds are permanent residents in the city, and our observations indicate that the size of the groups centering their activities around the lakes remains more or less constant throughout the year and from year to year. The total population inhabiting Orlando is probably on the order of 50 individuals. In December, 1960, we found 10 females, two adult males, and one first-year male at Lake Eola; at Lake Ivanhoe there were approximately 20 females, three adult males, and at least three first-year males. Only a single female was seen at Lake Lucerne, but it is probable that other grackles were in this area.

Evidence of autumnal reproduction in Florida was first obtained by Nicholson on October 19, 1956, at Lake Eola in City Park, where two females were seen pulling long grass from the ground and carrying it into clumps of ornamental bamboo. Seventy-five days later, on January 2, 1957, Nicholson again visited Lake Eola and saw a female feed a begging juvenal male perched in a cabbage palm several hundred yards from the aforementioned clump of bamboo. The young bird was well grown and was perhaps in an early stage of postjuvenal molt, as Nicholson's notes refer to its "mottled" appearance. The age of this juvenile cannot be precisely determined, but it seems likely that the bird had fledged two or three weeks prior to the date of Nicholson's observation, in which case it can be calculated that it had hatched from an egg laid sometime between November 7 and 14. This calculation is based on an incubation period of 14 days for *C. major*, as determined by McIlhenny (1937:282), and a nestling period of 21 days (Skutch, 1945:26, for *C. mexicanus*).

Autumnal breeding was not recorded in 1957 or 1958, but it should be noted that an extensive search for nests or young was not made in those years. In 1959, however, from five to seven short-tailed fledglings were seen on December 26 at Lake Lucerne; the birds were barely able to fly and had undoubtedly fledged only a few days before. On December 28, the number of juveniles at Lake Lucerne had increased to from 10 to 12, and they were still being fed by females as they perched in rushes on a small island about 20 feet from the shore of the lake. Visiting the lake a third time, on January 15, 1960, Nicholson found six to eight juveniles on the island. They were foraging for themselves and apparently were independent; only a single older female was present.

Assuming that the juveniles at Lake Lucerne had fledged on December 23, it is calculated that the eggs from which they hatched were laid on or about November 19.

Autumnal breeding occurred again in Orlando in 1960. At Lake Eola, Nicholson

found newly built nests in two clumps of bamboo on November 20; one clump (A) held a single nest, and the other (B) held three nests. A previous examination of the bamboo clumps in October had failed to reveal nests, and a park attendant reported that grackles were first seen building in these clumps on or about November 13. Additional nests were constructed between November 20 and 23, for, on the latter date, Nicholson found three nests in clump A and six in clump B. The additional nests were well along in construction and several females "scolded" when Nicholson approached the nesting sites. Since females were not flushed from the nests, it was believed that none of the nests held eggs. It would appear that eggs were never deposited in these nests, since four of them that we examined on December 12 were empty and three of the four were unfinished, lacking the characteristic inner lining of grass or other fine plant fibers. Further evidence that the nests were abandoned was the fact that the females in the area did not protest as we approached the clumps of bamboo and climbed up to examine the nests.

Although the nine nests in the bamboo clumps were unproductive, some successful autumnal nesting did occur at Lake Eola in 1960. Six juveniles that had been out of the nest perhaps a week were seen at Lake Eola on December 14, 1960; in two the rectrices were still conspicuously ensheathed, and none of the young birds was capable of sustained flight. The nests from which they had fledged were not located but were presumed to be in rushes on a small island approximately 40 yards from shore. It is calculated that eggs from which the juveniles hatched were laid in the first week of November, at least one week prior to the beginning of the abortive nesting effort in the clumps of bamboo.

Successful breeding also occurred at two other park areas in Orlando in the fall of 1960. On a small island at Lake Lucerne, one short-tailed juvenile was being fed and "guarded" by a female on December 12. And at Lake Ivanhoe, four, and possibly five, recently fledged juveniles were found. On December 12, one was being attended by a female in a legustrum bush at the edge of the lake; and four others, two of which were attended by a single female, were seen on December 14 in willows and cypress trees on a boggy finger of land jutting into the lake. Like the young birds seen at Lake Eola, these juveniles were hatched from eggs laid in the first week of November.

In summary, at least 11 juveniles were fledged in December, 1960, from three colonies in Orlando. It is entirely possible that other juveniles were overlooked, for our search was not exhaustive.

Data added since completion of the manuscript.—Autumnal breeding of Boat-tailed Grackles was again recorded by Nicholson in 1961. At least one male was holding territory in a clump of canes on a small island near shore at Lake Lucerne on November 19, 1961. Begging calls of young, probably nestlings, were heard from the island on December 7, 8, and 9, when at least one female was seen carrying food to the island. Approximately 10 females were believed to be attending nests on the island.

Females spent considerable periods of time on an island in Lake Eola early in December, 1961, and on December 20 a fledged juvenile with a half-grown tail was being fed and "guarded" by a female on the shore 200 feet from the island.

Age of fall breeding females.—On December 13 and 14, 1960, we were able to trap three females at Lake Ivanhoe. They were in unworn plumage and had without question undergone normal fall molt a few months previously. Using age criteria established by Selander (1958), it was determined that two of the females were adult (in this case at least one and one-half years old), and the third was a first-year bird, that is, it had fledged in the summer of 1960. Each adult had a brood patch that was somewhat less edematous than that possessed by incubating birds and was in the process of being refeathered, with about a dozen small, ensheathed feathers on it (table 1). The first-year female lacked a brood patch. This evidence, together with our observations of females

TABLE 1

GONADAL CONDITION IN *Cassidix major* IN CENTRAL FLORIDA

Locality	Number, sex, and age	Diameter of largest ovarian follicle (mm.)	Brood patch	Date
Lake Ivanhoe, Orlando	♀ adult	1.2[1]	+	Dec. 13, 1960
Lake Ivanhoe, Orlando	♀ adult	1.0[1]	+	Dec. 14, 1960
Lake Ivanhoe, Orlando	♀ first-year	None visible	—	Dec. 14, 1960
Kissimmee Prairie	5 ♀ ♀ adult	< 0.5	—	Dec. 13, 1960
Kissimmee Prairie	♀ first-year	None visible	—	Dec. 13, 1960
Kissimmee Prairie	2 ♀ ♀ adult	< 0.5	—	Feb. 19, 1961
		Length of testis (mm.)		
Kissimmee Prairie	6 ♂ ♂ adult	3.27 (2.7–4.3)		Dec. 13, 1960
Kissimmee Prairie	3 ♂ ♂ first-year	2.47 (2.4–2.5)		Dec. 13, 1960
Kissimmee Prairie	8 ♂ ♂ adult	5.60 (4.1–7.1)		Feb. 19, 1961
Kissimmee Prairie	♂ first-year	3.5		Feb. 19, 1961
Kissimmee Prairie	♂ adult	16.0[2]		March 5, 1961
Kissimmee Prairie	5 ♂ ♂ first-year	4.46 (2.8–7.2)		March 5, 1961

[1] Oviduct partly enlarged; other females showed no enlargement of oviduct.
[2] Full breeding size.

that were feeding young (all of which were dark ventrally and, thus, were probably adult rather than first-year; see Selander, 1958) strongly suggests that first-year females are not involved in the autumnal breeding effort. First-year males also were presumably not involved, since they normally do not breed even in the spring of their first year. Similar findings are reported for Tricolored Blackbirds by Orians (1960).

Molt cycle.—Although brood patches are refeathered following the autumnal incubation period, none of the adult or first-year individuals seen in Orlando in December, 1960, was molting. Nicholson has not noted molting grackles in Florida except in late summer and early fall at the time of the postjuvenal and annual postnuptial molts following vernal breeding. We therefore suspect that birds that breed in the fall do not have a second postnuptial molt in the winter or spring. However, the postjuvenal molt of individuals hatched in the fall apparently occurs a few weeks after fledging, that is, in late December and January.

Survival of young.—We have not determined clutch size in fall nests; but, if it is the same as in the spring (3 or 4 eggs), the percentage of fledging success from eggs laid is very low. Even in successful fall nests it appears that usually only a single juvenile is fledged. Similarly, nesting success was poor among Tricolored Blackbirds breeding in the fall in California in 1959 (Orians, 1960); as in *Cassidix major*, many nests of the Tricolored Blackbird were deserted in some stage of construction, and even more were abandoned after eggs had been laid in them. Eggs were hatched in no more than one-fourth of the nests in which they were laid, and in most cases only one nestling was fledged per nest (Orians, 1960:382). Starvation is suggested by Orians (1960:383) as the most probable cause of the high nestling mortality.

Juveniles of *Cassidix major* seen in December, 1960, appeared to be in good physical condition, but two showed evidence of minor abnormalities in formation of the proximal parts of the vanes of the rectrices, a condition which might be attributable to dietary deficiencies, particularly a shortage of protein.

A bird identified as one of the young hatched in the fall of 1960 was seen at Lake Eola on March 10, 1961, by Selander. The bird, a male, was in first-year plumage, but it had retained conspicuous patches of feathers of the juvenal plumage on the chin and supra- and post-orbital regions. Also, the rectrices were missing; but, since the bird was not collected, we could not determine whether these feathers had failed to develop in the

TABLE 2

MONTHLY CLIMATOLOGICAL DATA FOR ORLANDO, FLORIDA, AND AUSTIN, TEXAS[1]

Month	Orlando[2] Mean temp. (°F.)	Orlando[2] Precipitation (inches)	Austin[3] Mean temp. (°F.)	Austin[3] Precipitation (inches)
January	61.1	1.95	50.6	1.87
February	63.0	2.22	54.6	2.24
March	66.7	3.57	60.3	1.97
April	71.8	3.48	68.1	3.52
May	77.3	3.17	75.2	3.84
June	81.2	6.33	81.9	2.22
July	82.0	9.05	84.5	1.50
August	82.4	7.08	84.7	2.03
September	80.7	7.79	78.8	3.31
October	74.3	4.76	69.9	1.77
November	66.9	1.54	59.1	2.12
December	61.5	1.78	53.3	2.35

[1] Source: Local Climatological Data sheets issued by the Weather Bureau, U. S. Department of Commerce.
[2] Data for period 1943–1960.
[3] Data for period 1942–1956.

postjuvenal molt or had been adventitiously lost sometime after the molt. The relatively inferior muscular coordination and the general demeanor of the bird provided convincing evidence that it was only a few months old. Once it was seen to follow a female in the manner of a young bird that had only recently become independent of parental care.

It is of considerable interest that this young male made several efforts to sing, producing peculiar soft, squeaking notes that only remotely resembled the normal song of *C. major* but which were not unlike notes produced by a three-month-old juvenal male of *C. mexicanus* that was stimulated to "sing" in the laboratory by injections of testosterone proprionate (Selander, MS). First-year males of *C. major* fledged in the vernal period of nesting are capable of producing perfect versions of the song by March of the following year. The young male seen on March 10 also readily mounted and attempted to copulate with a female dummy placed on the ground in feminine solicitation posture. This behavior, together with the efforts to sing, strongly suggests that the testes of the bird were active in the production of testosterone. Indeed, it is highly probable that the bird had responded gonadally to the same set of environmental factors that brings older birds into reproductive condition in the spring.

ABSENCE OF AUTUMNAL BREEDING IN "NON-URBAN" POPULATIONS

In so far as we have been able to determine, autumnal breeding is limited to birds inhabiting the parks surrounding lakes in the residential districts of Orlando. Grackles living in agricultural and prairie land in central Florida breed in the spring but apparently make no reproductive effort in the fall. On December 13, 1960, we collected nine males and six females in the Kissimmee area, 18 miles south of Orlando. None of these birds showed unusual gonadal enlargement, brood patches, or other evidence of reproductive activity (table 1). No juveniles were seen in this area. Several males were singing in trees on the grounds of a small zoo at the edge of Kissimmee, but we found no nests there; nor did we find evidence of fall breeding at several nesting sites used annually in the spring by large breeding colonies of these grackles. Most of the grackles in the Kissimmee area were foraging in loose flocks in agricultural fields; and hundreds were seen flying to a roost in cypress trees on a large island in Lake Kissimmee in the late afternoon. Except for the fact that a few males were singing, the behavior of grackles in the Kissimmee area did not differ from that of individuals of *C. mexicanus* wintering

in the Austin region, Texas. The more frequent singing of males of *C. major* in Florida is attributable to the average higher winter temperatures of that region (table 2), for, as noted previously, unusually warm winter days will induce sporadic singing in males of *C. mexicanus* in Austin.

VERNAL BREEDING IN ORLANDO AND THE KISSIMMEE PRAIRIE

Nicholson's records, dating from 1940, indicate that grackles breed each year in the spring in Orlando. The vernal reproductive effort of the birds in Orlando in 1961, as in other years, coincided with that of populations of the Kissimmee Prairie. In the Kissimmee Prairie, gonadal development began in February, as indicated by a sample obtained on February 19, 1961 (table 1). By March 5 at least some adult males were in full breeding condition, but the testes of first-year males were only beginning to show recrudescence from the winter condition. In Orlando on March 10, 1961, five or more females were sitting on nests in a royal palm tree at Lake Eola, and one adult male was in attendance at this small nesting colony. On the same small island of rushes at Lake Lucerne in which a female was seen feeding a recently fledged juvenile in December, 1960, 10 females were building nests or incubating eggs on March 10, 1961, and three adult males held territories on the island.

DISCUSSION

We have established that Boat-tailed Grackles, inhabiting parks in Orlando, breed in March and April and, at least in some years, again in the fall, beginning in the first part of November, although some nest building may be in progress in the latter part of October. Until banded birds are followed through the year, we will not know whether one individual breeds twice in the same year, but this is likely. In any event, as a population, the birds in Orlando have both vernal and autumnal breeding periods.

As mentioned previously, the small groups of grackles living in the city parks surrounding lakes in Orlando are permanent residents. They forage on extensive areas of lawn that are watered and remain green throughout the year. The tree and shrub vegetation of the parks is a combination of native and exotic elements, including bamboo, live oaks, royal palms, cabbage palmetto, cypress trees, and legustrum and other cultivated shrubs. Vegetation along the margins of the lakes and on small islands includes rushes and willows. The parks are visited by large numbers of people at all seasons of the year; and the natural supply of insects and seeds utilized by the grackles, which is probably maintained at a relatively high level throughout the winter by horticultural practices, is greatly augmented by food, mainly bread and seeds, supplied by human visitors to the parks. On December 14, 1960, the location of several juvenal grackles was determined by following females that were carrying bread obtained from a woman who spent several hours feeding the birds in City Park. This extra supply of food is great enough to support large numbers of gulls, ducks, and feral Rock Doves (*Columba livia*) that are found daily in the park throughout the winter.

It is apparent that the most obvious differences in the environments of grackles in the Orlando parks and of birds in other areas in Florida are the aspects of the vegetation and the level of the food supply in fall and winter, to which we attach great significance in determining whether or not autumnal breeding occurs. In the Kissimmee area, for example, the grass is brown, many trees and shrubs lack leaves, and the food supply is, from all indications, not abundant in the fall and winter. But in Orlando the birds live in areas in which horticultural practices tend to maintain the habitat in an essentially constant favorable condition. Fall and winter temperatures in central Florida (table 2) are not low enough to inhibit breeding, and, hence, conditions in Orlando remain favor-

able for breeding throughout the year. The situation is in its basic ecologic aspect essentially similar to that described by Orians (1960) for Tricolored Blackbirds in California, in which autumnal breeding is believed to be a man-induced phenomenon postdating widespread irrigation in the valleys that provides nesting and feeding sites at this time of the year.

Recent work on tropical species living in equatorial regions in which environmental conditions are favorable for breeding at all times of the year indicates that birds have the capability of experiencing two gonadal and breeding cycles a year (Miller, 1959*a*, 1961). In species of higher latitudes, the lengthy refractory period which follows gonadal regression from the vernal breeding condition is to be viewed as an adaptive mechanism preventing response to potentially accelerating environmental conditions in the late summer and early fall, when attempted reproduction would be unsuccessful (Miller, 1959*b*, 1959*c*; Marshall, 1961). It is likely that the appearance of incipient reproductive behavior and minor gonadal development in October marks the end of a refractory period in *C. mexicanus* in Texas. And for purposes of discussion, we will assume that *C. major* has a regeneration phase of approximately the same length as the other species, during which the birds are refractory to photoperiod and other environmental stimuli that would otherwise induce gonadal recrudescence. According to the interpretation of Marshall (1959, 1961), the onset of autumnal sexual activity marks the time of spontaneous progression from the regeneration phase to the acceleration phase, at which time the neuroendocrine machinery is again (or for the first time in the case of yearling birds) susceptible to antagonistic sets of accelerating and inhibiting environmental factors. The birds are now potentially able to achieve gametogenesis and to breed, but external inhibitors will normally halt the process in autumn and prevent wastage of reproductive potential in winter. In the case of our grackles, the effects of accelerating factors seemingly dominate for a few weeks in October and gonadal development begins; but, except in the special environment of the Orlando parks, inhibiting factors have assumed the upper hand by the end of the month. These factors probably include decreasing temperature, vegetation changes, decrease in food supply, and, perhaps, decreasing photoperiod. The various external factors regulating avian reproductive cycles are discussed in detail by Marshall (1961).

It is interesting to note that in Orlando the grackles apparently come into breeding condition in the first part of November, a month after the time (early October) that the presumed refractory period ends in *C. mexicanus* in the Austin region. Because the timing of events in the annual cycle of *C. major* in central Florida is approximately three weeks ahead of that of *C. mexicanus* in central Texas, there is reason to expect a termination of the refractory period of the birds in Florida early in September. If the vernal curve of testicular growth in adult males is projected to the fall period of recrudescence, it appears that the birds would achieve full spermatogenesis early in November. Fall recrudescence occurs when day-lengths are approximately the same as in the period of vernal gonadal development and when the photoperiod is decreasing at a rate approximately equivalent to that at which it is increasing in the spring. Temperatures during autumn are slightly higher than they are during spring (table 2).

Precipitation is about equal in the spring and in the fall in Orlando and also in Austin (table 2). Orians (1960) has suggested that fall breeding of Tricolored Blackbirds in 1959 was triggered by a heavy rainfall on September 18, 15 days before nesting began at the two colonies studied. In the case of the Orlando grackles, however, an examination of weather data for the period from 1956 to 1960 reveals no evidence of a similar triggering effect. September of 1960 was a month of unusually heavy rain (11.21 inches, with 4.39 inches falling on the 11th), but rainfall was normal in September in other

years in which autumnal breeding occurred (6.27 inches in 1956 and 8.33 inches in 1959; compare with data in table 2). Precipitation for October was above average in 1956 (8.24 inches) and 1959 (5.97 inches) but was below average in 1960 (3.17 inches).

It is probably no accident that both icterids, the Tricolored Blackbird and the Boat-tailed Grackle, in which autumnal breeding has been recorded are highly social, colonially nesting species. Indeed, a case could be made for the hypothesis that autumnal breeding is more likely to develop in colonial forms either because they are by the nature of their ecology adaptively adjusted to respond more readily to temporarily favorable conditions (as suggested by Orians, personal communication) or because intraspecific behavioral interactions are more frequent and have a more profound influence in regulating their gonadal and behavioral cycles than in the case of relatively non-social species which establish large territories and experience a lesser number of such interactions. Perhaps both factors are operative, but, in any event, in *Cassidix*, as also in other highly social icterids, there are obvious inter-relations among daily and hourly cycles of activity (such as roosting, feeding, bathing, and preening) of individuals, one of which is social facilitation, or "that phenomenon observed when the performance of an activity by an individual stimulates the immediate performance of the same activity by its neighbors" (Crook, 1961:135). Anyone who has observed the "contagious" and synchronized foraging and nest building activities of female grackles at a breeding colony will probably agree with Lehrman (1959:490) that "it can hardly be doubted that the activities of colonial birds have some mutual influence on their breeding cycles." With regard to autumnal breeding, we suggest that social facilitation and other types of social stimulation may be critical factors in bringing groups of individuals into reproductive condition. For example, let us suppose that, as a result of the influence of external accelerating factors such as abundant food and warm temperature, a female grackle in a foraging flock begins pulling grass or otherwise manipulating nest material; the stimulus provided by the sight of the act might be sufficient to induce other individuals in the same "mood" to manipulate material, which would in turn stimulate the first female, and so on.

We follow Orians (1961) and F. A. Pitelka (in conversation) in believing that coloniality has its chief adaptive significance not in providing enhanced social stimulation but in furthering exploitation by the population of environmental resources, particularly food. But while the increased social stimulation is, as recently expressed by Orians (1961), "probably a minor secondary phenomenon in such species," it does seem likely that the response to favorable breeding conditions in the fall and winter, such as those created by human activities in the Orlando parks, is made more probable and/or accelerated by social interactions among individuals of colonial species.

SUMMARY

Boat-tailed Grackles (*Cassidix major*) nested successfully in small colonies in November of 1956, 1959, and 1960 in parks surrounding small lakes in the city of Orlando, Florida. At least one juvenile was fledged in December, 1956; from 10 to 12 were seen in December, 1959; and at least 11 young are known to have fledged in December, 1960. The population of grackles resident in Orlando, which is estimated at about 50 individuals, also nests annually in March and April and thus has two breeding seasons within a one-year period.

Autumnal breeding of grackles in Orlando is believed to represent a post-refractory-period response to favorable environmental conditions provided by horticultural practices which maintain the habitat in an essentially uniform condition throughout the year. Like the autumnal breeding of Tricolored Blackbirds studied in California by Orians, it would appear to be a strongly man-influenced phenomenon. Boat-tailed Grackles in-

habiting agricultural and prairie land near Orlando and in other parts of the range of the species have only a single, vernal reproductive period.

Apparently only adult females and males are involved in the autumnal breeding effort. Brood patches of females are refeathered following incubation but it is doubtful that a postnuptial molt follows autumnal breeding. Young fledged in the winter have a postjuvenal molt a few weeks after fledging.

Fledging success from autumnal nests is very poor, with successful nests producing usually only a single juvenile. Some nests are abandoned in late stages of construction before eggs are laid. A juvenal male that hatched in the fall of 1960 showed behavior indicative of gonadal activity in March of 1961.

The possibility that response to environmental conditions favorable for reproduction in the fall is more probable and/or is accelerated by social stimulation in highly social, colonial species is considered.

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