BREEDING BIOLOGY OF MOCKINGBIRDS

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IN a life-history study of the Mockingbird (*Mimus polyglottos*) in Nashville, Tennessee, I have examined more than 250 nests and have banded more than 900 nestlings in my home area (southwest Nashville) in 29 years (1929–1957). In the earlier years of the study, this section was particularly adapted to the needs of the species and to field observations. Houses were widely separated, and acreage grounds were well landscaped in lawns and dense shrub plantings. Large tracts of unoccupied land contained scattered trees and clumps of native shrubs and vines. One could search freely for birds and nests. In later years the encroaching city engulfed the vacant land. Subdivisions of small lots and closely built houses replaced pastures and woods. Bird populations and field work were drastically affected.

My records are not uniform in coverage of nests examined. Those about my home could be watched closely. In some instances, those more distant may furnish only a description of the nest site or the number of nestlings banded. Therefore, the various types of data are compiled for a designated variable number of nestings.

NEST SITES

The 247 nest sites listed indicate a decided preference for small evergreens (shrubs or saplings) for the entire season; 133 nests (53.8 per cent of the total) were built in a variety of evergreens, including cedar, spruce, arborvitae, pine, boxwood, and a few others. The favorite was the common native cedar (*Juniperus virginiana*) with 82 nests, 33 per cent of the total.

As nest building starts before deciduous shrubs are in leaf, evergreen vines and saplings are almost always used for early nests. Later nests may be built in deciduous trees and shrubs and higher above ground; 22 per cent were in a variety of trees, mainly sapling hackberry (22 nests); elm (12 nests); locust (5 nests); hawthorne (5 nests); and lesser numbers in pear, sugar maple, ash, and osage orange.

Vines, including rose, coral honeysuckle, Japanese honeysuckle, and euonymus, were used for 28 nests (11 per cent). Shrubs, especially Amur River privet, which is usually evergreen here, were used for 27 nests (11 per cent).

A few nests were in unusual places: under the eaves of a wellhouse, a leafless grape vine, a leafless shrub at a wire fence, and a ledge of a grape arbor. Very unusual was one built on a protruding tree root on a creek bank below ground level at my home. It was disturbed by a predator on

24 April as young were hatching. Most unusual was one built in one section of a two-compartment nest box on a fence post in Murfreesboro, about 48 km (30 miles) south of Nashville. A trumpet vine covered the vacant side of the box. A set of four eggs was being incubated when I saw it on 16 June 1940, from which four young fledged.

A Mockingbird and a Brown Thrasher (*Toxostoma rufum*) used the same pear tree for nesting in 1941 in Warner Parks. On 16 June, I banded the brood of five Mockingbirds, ready to leave the nest, and a brood of two Brown Thrashers, which remained a few days longer.

At one nest in a dense clump of twigs of a young hackberry tree, the fledglings perished in their attempt to leave. Two dead young hung among the twigs on 10 July 1941.

Height of Nests above Ground

Height from the ground is listed for 189 nests, varying from 50 cm to six meters: 143 nests (76 per cent) were built one to two meters above ground; 35 (18 per cent) were two to five meters up; 10 nests (5 per cent) were under one meter above ground. Beginning in May when deciduous foliage has become dense, the percentage for higher nests increases progressively into June and July. J. M. Shaver (pers. comm.) observed a successful midseason nest 16 meters above ground in a tree on Peabody College Campus.

Materials Used in Nest Construction

All nests were constructed in a similar pattern with a heavy outer layer of twigs usually loosely laid. Inside is a compact layer of a variety of material such as dry leaves, plant stems, bits of fiber, paper, sheep wool, moss, hair, cloth, or any materials that pack readily and are available nearby.

The lining is of brown rootlets. Any other type of lining is very rare here.

Nest-Building Behavior

In early spring many nests may be started or almost completed that are not used. Carrying nest material and placing it in possible nest sites on his territory is part of the courtship behavior of the male. This behavior continues until one of the passing females remains to pair with the territory holder. She decides on the nest site. She may accept one of his chosen sites or may select one 30 meters or more from them. She then assists in building.

If both survive, the pair remain together for subsequent nests of the season and may remain together for several years.

Usually a new nest is built for each brood, but in 1938 a resident pair used the same nest for the second and fourth broods. Gage cites an unbanded pair in Clemson, South Carolina, that repaired a nest that was used in 1953 for nesting in 1954.

EGG LAYING

Egg laying may begin in March if temperatures in February and March are above normal. During the 29 years of this study (1929–1957), the peak of egg laying occurred in April. Of 235 nests, five clutches were laid in March (2 per cent); 95 clutches (40 per cent) were laid in April; 54 clutches (23 per cent) were laid in May; 56 clutches (24 per cent) were laid in June; and 25 clutches (11 per cent) were laid in July.

In 1938 there were more March nests found than in any other year in Nashville. In February a high of 23°C (74°F) was reported with a mean temperature of 4.5°C (8.1°F) above normal for the month; in March, the average was again 4.5°C above normal. On 3 April the temperature dropped to 0.5°C (31°F), but despite a killing frost, the mean monthly temperature was 1.4°C (2.6°F) above normal. (All data from U.S. Meteorological Monthly Summary.)

First egg of the 1938 season was reported 14 March by H. S. Vaughn. On 16 March H. C. Monk found a bird on a nest. Her first egg was apparently laid on that day as the brood left the nest on 13 April. At an inaccessible nest observed by him, young were off the nest on 11 April, indicating that egg laying may have started earlier than the March 14th record. At a subbanding station A. A. McMurray banded a brood of three on 3 April.

Next earliest laying dates occurred on 25 March 1921 (Monk); 25 and 28 March 1932 (Laskey).

Usually egg laying terminates in July, but there are a few records of young leaving nests in late August, which indicates that some clutches must have been laid in early August. My latest record is a set of three found 2 August 1944; the brood of two young was banded 20 August when they appeared to be eight days old. A brood of three left the nest 24 August 1947 at another subbanding station (V. C. Dismukes). Monk observed broods leaving the nest 25 August in 1932, 1950, 1951. D. Oxford reported four young leaving the nest on 26 August 1952.

NUMBER OF EGGS IN CLUTCH

The number of eggs in a complete clutch is known for 182 nests. There were 114 sets of four eggs (63 per cent of the total) with the largest number (55 sets) laid in April: sets of three eggs, 42 in number (23 per cent), also reached a peak in April with 20 sets laid that month. There were 26 nests with five-egg clutches (14 per cent) with 17 sets laid in May.

Although five-egg clutches were found in 11 of the 29 years, I usually found only one such set in a season, but there were two in 1940, with three each in 1942 and 1946; in 1941, there was an unusually large number, 11 clutches. It is difficult to arrive at a plausible explanation for this unusually large number of five-egg sets except weather conditions. For that year, I have records for the number of eggs in

32 nests: 34 per cent of this number contained five eggs. Temperatures for February and March averaged 2.6°C (5°F) below normal for both months. The chilly days of late March were followed by a sudden change to warm weather from 1 to 20 April. On all but two days, temperatures ranged from 1.5°C (3°F) to 7.7°C (14°F) above normal (average 4°C). This warmth caused an accelerated growth of vegetation. May and June temperatures averaged above normal.

In the previous year (1940) a pair nesting in Warner Parks had a five-egg set in late April from which three young fledged 14–15 May. I collected the nest for a parasite study. They built a second nest in the same fork in the small cedar tree one meter from the ground, and had another five-egg set from which five young fledged 23 June.

At another nest that was destroyed by a predator when young were hatching 24 April, a new nest was started 26 April. The first egg of a clutch of five was laid 2 May.

Although a number of authors give clutch size for the Mockingbird as three to six or four to six eggs, I have found only four instances cited for clutches exceeding five eggs. Bailey (1928) cites one set of six from New Mexico; Nice (1931) lists one six-egg and one seven-egg set for Oklahoma. Todd (1940) cites one set of six eggs (by Bayard Christy) in Pennsylvania from which five young fledged, leaving one dead in the nest. Alexander Wilson (1810) says of the Mockingbird "the eggs are 4, sometimes 5."

INCUBATION PERIOD AND NEST OCCUPANCY

Incubation is by the female and begins with the laying of the last egg of a clutch. The male usually sings from a high perch, eight to 25 meters from the nest, which he watches and guards during the first incubation period of the season. He will sometimes accompany the female when she leaves the nest. She forages her own food.

In 18 nests length of incubation period or nest occupancy or both were obtained for a complete clutch of eggs or a completely successful nest.

Hatching of the clutch is spread over several hours to a day, sometimes starting on the 11th day after laying of the last egg. The period from the laying of the last egg to the hatching of all eggs was 12 to 12.5 days.

Nestling periods varied from 10.5 to 12.5 days, usually 12 days.

The combined periods from the start of incubation to leaving the nest varied; 22.5 days (one nest, 4 eggs); 23 days (one nest, 4 eggs); 24 days (one nest, 4 eggs); 25 days (7 nests, 3–4 eggs); 26 days (one nest, 5 eggs in which all hatched, but one died at 5 days in tilted nest).

CARE OF YOUNG

Nestlings are fed by both parents. Some males are more energetic than others in providing food and more zealous in guarding the nest. Two color-banded males that occupied adjacent territories in two seasons had contrasting habits. "B" was a zealous singer, day and night, but his mate assumed the greater share of food gathering for the young. He was not pugnacious in nest defense. "Y" sang very little after the hatching of

TABLE 1
SUMMARY OF 180 MOCKINGBIRD NESTS
1929–1957

Month	*No. of nests*	*No. of eggs*	*No. hatched*	*Predation*		*Unhatched eggs*	*Nestlings or young disappeared*	*Nestlings banded or fledged*	*Percentage of success*
				Clutches	*Eggs*				
March	5	18	11	2	7	4		7	39
April	80	304	220	27	98	19	17	170	56
May	47	200	118	20	85	4	14	97	48.5
June	35	131	66	9	32	9	7	83	63
July	13	47	38	1	4	1	8	34	72
Total	180	700	453	59	226	37	46	391	56

Percentage of success is based on number of eggs laid. Some nests not followed after banding of young. Therefore nesting success may have been lowered somewhat in the final days of nest life.

the young, but zealously hunted food for them and pugnaciously guarded the nest. He repeatedly attacked me by following for over 100 meters, striking my back. He recognized me as the one going to his nest. More than once, he singled me out for an attack as I stood with others in the vicinity of his nest.

A pair may make several nesting attempts in a season. Due to predation, two successful nests are the usual number. However, "Abe" and his mate of 1938 fledged four successful broods, 13 young from four sets of four eggs. Gage (1961) reports four successful broods for an unbanded pair in 1956 and 1957.

In 1939 "Abe" had two mates simultaneously in April. Their nests were 80 meters apart. Abe sang from a tree midway between them and followed me as I visited each nest. The eggs of his old mate hatched 4 May; on 28 April the extra mate laid her first egg of the clutch of four. But on the day they were to hatch, the nest was still intact, but empty, and the female had disappeared.

In the eight complete and one partial nesting season Abe and his four successive mates had 49 fledglings.

One of his fledglings, hatched 19 July 1938, sang a muted song on 22 August when 34 days old. On 20 August, the female had fed one of the brood, which were partly independent on 17 August.

NESTLING SURVIVAL

There were 904 nestlings banded in 26 years (1932–1957) that apparently fledged. I have some data for 55 (6 per cent) of these birds. Most of these data are from nestlings banded at my home or at subbanding stations where trapping and observations could be carried on systematically.

Eight birds died or were killed near the nest site within a month after fledging.

Eleven were trapped near the nest site from one to four months after banding. None of these were retrapped after October. By that time winter territories are defended by the older residents, and young birds move elsewhere.

Five birds of more advanced age were killed or found dead in Nashville at the following ages: five years, one month; two years, 10 months; two years; one year, 10 months; one year, eight months. The older two were found within one-half km of their hatching place. The oldest had been rescued from a dog by me on the day it left the nest 14 May 1937. It was hand raised to independence but not tamed. It was not noted again until 17 October 1940, when trapped at my home and released. On 15 June 1942 it was reported by U.S. Fish and Wildlife Service as killed by a cat.

Two young, banded from different nests, were captured alive and released about a kilometer from their nests. One was trapped at my home in September when one year and two months of age. The other, at age eight months, came down a residence chimney in January.

Five were reported as recoveries at 32 to 320 km (20 to 200 miles) from Nashville. One was found dead at Greenbrier, Tennessee, in August, age three years and three months; one at Camden, Tennessee, in November, about 128 km (80 miles) southwest, age seven months; one at Rising Fawn, Georgia, about 175 km (110 miles) southeast in March, age nine months; one at Cumming, Georgia, about 320 km (200 miles) southeast in April, age one year and 10 months; one at Fulton, Mississippi, 256 km (160 miles) southwest in January, age one year and eight months. One immature bird, banded by Ana Cochran in Nashville, was recovered at Corinth, Mississippi, 205 km (128 miles) southwest in May, age one year. No Mockingbirds banded as adults have been reported outside of the Nashville area.

BEHAVIOR OF POSTNESTING POPULATION

From August into October there is considerable activity and movement among Mockingbird populations. Resident adults are molting or busy with fledglings in the early weeks and are not aggressive in territory defense. Independent young are flying about and hunting good feeding places, preparatory to establishing winter territory. The influx to the banding station results in trapping more of the species (mostly first-year birds) than at any other time of the year. These young birds call, sing, pursue each other, and occasionally indulge in premature courting or mating displays and in carrying nest material. On warm days an adult pair may participate in a brief, mild courtship display.

The jerky wing-raising display (called "wing-flashing") is observed frequently at this time as the birds move about on the ground. In summer it is seen mainly among fledglings and immature birds. Young birds just off the nest sometimes raise wings as they move across open spaces from the nest site. More often the display is seen as they encounter an unfamiliar situation or object or are exposed to a situation new to them. The approach is slow and halting. The wings are slowly raised in the characteristic manner, horizontally or upward, sometimes alternately as the bird peers at a certain spot or object. Frequently a peck gesture is then aimed

toward the object, followed by a quick retreat. This action may be repeated two or three times; then the independent immature bird may grasp the object in its bill. If it is food, it will be eaten without further wing raising.

Once I observed the display as an immature bird alighted on a pedestal bird bath that contained only a small amount of water. Perching on the rim, the bird bent down but failed to touch water. It raised wings two or three times as it peered into the nearly empty bowl that was rimmed above the water by dark algae. Finally it bent low enough to drink, then wing raising ceased.

The procedure seems to be a reaction in the inexperienced youngster to uncertainties: whether or not danger is involved, whether the next action should be to run (or fly if flight has been attained) or to attack. When no hostile response follows the testing period, the bird apparently feels that there is no danger; the instinct to flee is no longer present and wing raising ceases.

Among older birds the gesture may be seen occasionally in any season, but it is not habitual during the peak of the breeding season when food gathering for the young is of paramount importance. It seems to be a stereotyped mannerism used when they are leisurely hunting food for themselves. The adult performance lacks the uncertainty shown by the youngsters. The gesture is jerky, but the wings are more quickly raised between short, unhesitant runs over a grassy area.

Only once have I seen a known adult in the wing-raising display similar to that of the very young. On 11 August 1946 in late afternoon a color-banded female over six years old, which habitually fed on small fruits at my home, came to a spot where elderberries had been placed in a small space on the ground between a large shrub and an overturned wire mesh trap. She approached warily, jerkily raised her wings as she peered at the fruit. She stood still some seconds, then stretched slowly until she was able to grasp a berry, then moved cautiously into the small enclosure beside the fruit to eat.

After the fall molt is completed, older residents again assert territory rights by vocal sounds, lengthy songs, and pursuits. By the end of October newcomers are not allowed to tarry and must move on to some unoccupied area. Recoveries of my banded nestlings indicate that they may move only one-half km or may travel 320 km (200 miles).

In September the pair bond may be severed and the females leave the nesting territory. There is considerable individual variation in this behavior as illustrated by three color-banded pairs at my home. The "Y" pair separated in autumn; the female left for an unknown area, but returned in March to rejoin her mate. The "B" pair separated each autumn.

The female occupied and defended territory adjacent to his until the following mating season when they occupied the territories together. They were mates for the third season until his disappearance. One September they participated in a boundary dance, each on its own side of the boundary.

The nine-year-old resident "Abe" retained each of his successive mates throughout the year. If a mate disappeared in winter, he remained alone until the following mating season. His last mate (for five years) survived him. She joined a neighborhood male for nesting, but returned alone to the former winter territory. She sang, danced, and fought with the male that occupied the adjoining territory whenever he approached the boundary.

Males usually remain on fall and winter territory for spring singing, courting, and mating, but may nest in an enlarged area at a site selected by the female. Females that have held winter territory alone move in spring to join a neighboring singing male or to wander. A number of females may stop briefly on a male's territory before pairing is consummated.

AN EXPERIMENTAL MOCKINGBIRD

A nestling male Mockingbird, hand raised as nearly normally as possible from nine days of age (1 August 1939), was kept as an experimental bird until his death on 21 November 1954, age 15 years, 4 months. The major reason for keeping him was to find out if imitation of the songs of other birds is an inherited or a learned trait. His fine repertoire of imitations was gradually acquired as he heard calls and songs of nearby species, which he incorporated into his own songs.

He provided numerous opportunities for observations on wing-raising behavior in response to new experiences and unfamiliar objects.

His behavior through the year corresponded to the normal cycle of his species. In winter he defended his "territory" by flying to a certain window, where he was met by the outdoor territory holder. Both gave the loud *chuck* calls and "danced" up and down the window pane for as long as an hour at one session. He displayed in courting behavior but directed it to me. He placed nest material on a ledge.

For 12 years he was very active and healthy. One night he fell from his perch and lay sprawled on the floor of his cage as if he had a stroke. After a week of inactivity when he had to be force fed, he apparently recovered fully. But the following week, he again fell from his perch in the night. Although he ate well, he never fully regained his former vigorous activity. He avoided all perches and remained in his cage although the door was constantly open. His fine singing and courtship behavior persisted into his last summer, but mating behavior ended with his illness at 12 years of age. The oldest Mockingbird recorded in a wild population

is a color-banded individual of 12 years at the Michener home in California (Michener, 1951).

Immediately after death, the bird's body was examined by Katherine A. Goodpasture, and tissues were fixed for microscopic study. Histological sections were examined by Ernest W. Goodpasture, Professor of Pathology, Vanderbilt School of Medicine, who submitted a detailed report. In conclusion, he condensed his diagnosis to the following: "Progressive atrophic cirrhosis of the liver; Monckeberg sclerosis of arteries; pulmonary anthracosis." Other comments in the report state that the significance of atelectasis and pulmonary edema in the lungs was not evident and that the cirrhosis of the liver was of unknown etiology.

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SUMMARY

More than 250 Mockingbird nests were examined, and more than 900 nestlings were banded at Nashville, Tennessee, in 29 years (1929–1957).

As all nests could not be followed closely, various data are compiled for a designated variable number of nests.

Of 247 nests, small evergreen trees and shrubs were preferred for 133 nests (53.8 per cent). *Juniperus virginiana* was used most frequently for 82 nests (33 per cent of the total). Other sites are listed.

Height above ground is known for 189 nests, varying from 0.5 to six meters: 143 nests (76 per cent) were at one to two meters; 35 nests (18 per cent), two to five meters; 10 nests (5 per cent) were under one meter; one on a creek bank was below ground level.

All nests were constructed of a heavy layer of twigs, rather loosely laid, then a compact layer of a variety of material that packs readily and is available nearby, lined with brown rootlets.

Nest-building activity is a part of courtship behavior of the male. When paired the female assists with the building.

Egg laying may start in March and reaches a peak in April. Of 235 clutches, 40 per cent were laid in April, 23 per cent in May, 24 per cent in June, 11 per cent in July, and a few in August.

In 182 complete sets of eggs, 63 per cent contained four eggs, 23 per cent contained three eggs, and 14 per cent contained five eggs.

In 180 nests where data are known from egg laying to banding or fledging of young, 700 eggs were laid. Of these 453 hatched, 391 nestlings (56 per cent of the total number of eggs) were banded and presumably fledged.

Incubation period or nest occupancy of young or both are known for 18 nests. Incubation period (from the laying of the last egg to the hatching of the clutch) was 12 to 12.5 days. Nestling periods varied from 10.5 to 12.5, usually 12 days. Combined periods varied from 22.5 to 26 days with 25-day periods predominating.

Incubation and brooding are by the female, care of young by the pair. Several nesting attempts may be made in a season, but seldom are more than two successful. One resident color-banded pair had four successful nests in 1938.

Some data were secured on survival for 55 of the 904 banded nestlings (6 per cent) that were trapped or found dead after fledging, some within the month, the oldest five years. Five were recovered 32 to 320 km (20 to 200 miles) from Nashville.

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