

BEHAVIORAL ECOLOGY OF FLEDGLING BROWN-HEADED COWBIRDS AND THEIR HOSTS

PAUL W. WOODWARD

ABSTRACT.—Twenty-two fledgling Brown-headed Cowbirds (*Molothrus ater*) raised by nine host species were monitored between leaving the nest and independence. The objectives were (1) to record as much as possible about the fledgling period, especially those features that enable cowbirds to become independent, (2) to determine if fledglings behaved differently with different hosts, and (3) to determine if fledgling cowbirds possess adaptations for brood parasitism. Cowbirds usually left the nest when 10 or 11 days old, first fed themselves when 20 to 22 days old, and became independent when 25 to 39 days old. They went through three stages—inactive, active, and superactive—differentiated by how often they flew and by other behavior. General development was probably unmodified by hosts. Perching heights and home ranges of fledglings were modified in a host-specific manner. Cowbirds perched mainly at the hosts' foraging heights, and their home ranges corresponded to their hosts' territories; both are related to feeding efficiency. Cowbirds did not recognize hosts as individuals; they generally responded positively only to their host species. Hosts fed fledgling cowbirds more than they fed an equivalent weight of their own young. The loud, persistent calling of fledgling cowbirds may cause them to be fed more and is probably their main adaptation for brood parasitism.

Obligate brood parasitism in Brown-headed Cowbirds (*Molothrus ater*) is of interest to evolutionary biologists because of the adaptations that it has elicited in the cowbirds and the counteradaptations of their hosts. Friedmann (1929, 1963, 1966, 1971) and Friedmann et al. (1977) have summarized known records of cowbird parasitism and this species' life history. Rothstein (1974, 1975, 1976a, b) studied recognition of cowbird eggs by potential hosts. Robertson and Norman (1976) studied the response of host species to adult cowbirds near their nests. Little attention has been directed toward the period between the time when young cowbirds leave the nest until they become independent of their hosts, often referred to as the fledgling period. Eastzer et al. (1980) as part of their study watched a fledgling cowbird during the day it left the nest, Friedmann (1929) mentioned a few aspects of this period, and Nice (1939) reported on a hand-reared cowbird. Other scattered references occur in the literature, but I know of no detailed study of the fledgling period. With few exceptions, this critical period has been largely ignored in life history studies of North American passerines.

I investigated the fledgling period of these cowbirds, first in order to describe its events in detail, particularly the relation between hosts and their cowbird(s) and the behavioral and ecological features that enable fledglings to become independent. Second, I wished to determine if fledgling cowbirds raised by different hosts behaved differently. Lastly, I sought to

determine if cowbird fledglings possess adaptations for brood parasitism other than preadaptations they share with closely related, nonparasitic species as described by Hamilton and Orians (1965).

STUDY AREAS AND METHODS

This study was concentrated in four areas: (1) McKee-Beshers Wildlife Management Area and adjacent Chesapeake and Ohio National Park (Hughes Hollow), (2) Edward's Ferry, (3) Adventure, and (4) Reston. I watched other fledgling cowbirds at a bridge on Willard Rd., near River Rd., and Seneca. Reston is in Fairfax Co., Virginia; all other areas are in Montgomery Co., Maryland. Most observations were made from 27 May to 25 July 1975, but others were made in 1976. Twenty-two fledgling cowbirds raised by nine host species were followed for 348.9 h (Table 1).

To determine if fledgling cowbirds' behavior was modified by their hosts, I observed cowbirds with hosts that differed greatly in size (5 g to 40 g), habitat (open fields to forests), and feeding habits (ground foragers to canopy gleaners).

Each cowbird was banded with a U.S. Fish and Wildlife Service aluminum band. Owing to the small number of birds involved and the distances between study areas, color bands for individual recognition were not necessary. By banding on either the right or left leg, I could identify each individual. Unbanded fledglings

TABLE 1. Hosts, locations, home ranges and time spent observing fledgling Brown-headed Cowbirds.

Host	Location	No. of fledglings	Home range (ha)	Period of observation ^a	Total hours observed
Eastern Phoebe	Edward's Ferry	1	5.6	Days 1-23	51.8
	Willard Rd.	1	?	Day 1	6.3
	Reston	1	?	Days 1-3	4.0
Acadian Flycatcher	Hughes Hollow	1	0.3	Days 1-11	27.0
	Edward's Ferry	1	?	Day 1	6.5
Carolina Wren	Adventure	3 ^b	3.0	Days 1-26	82.0
	Hughes Hollow	1	0.6	ca. Days 7-15	9.0
	Reston	3 ^b	3.3	Days 1-19	36.9
Eastern Bluebird	Reston	1	2.2	Days 1-17	27.7
	Reston	1	?	Day 1	2.0
Blue-gray Gnatcatcher	Hughes Hollow	1	1.8	ca. Days 7-16	16.4
White-eyed Vireo	Edward's Ferry	1	?	ca. Days 5-7	6.0
Common Yellowthroat	Hughes Hollow	2 ^c	1.8	ca. Days 14-17	11.5
Northern Cardinal	Hughes Hollow	1	1.0	ca. Days 8-23	20.2
	Seneca	1	?	near independence	0.5
Song Sparrow	Hughes Hollow	2 ^d	0.5	Days 1-18	41.1
					348.9

^a Day 1 is the day of leaving the nest.

^b Two nest mates plus a fledgling from an adjacent territory. Observations of latter bird are incomplete.

^c Two fledglings in adjacent territories. Only observed in one territory.

^d Nest mates.

were identified by slight differences in plumage, size, behavior, and location.

I usually followed the birds daily from the time they left the nest until they became independent. Each day a fledgling was located by its loud, distinctive begging calls. Then I followed it (with binoculars) continuously for 2 to 4 h, remaining as close to it as possible without disturbing it or its hosts. I made no attempt to standardize the time of day for each individual.

I recorded all behaviors of the fledgling, especially feedings, movements, interactions, and perching heights, along with time. Distances and heights were estimated. Some vocalizations were recorded on a Uher 4000-L tape recorder at 7.5 ips using a Uher 514 microphone mounted on an 18-in plastic parabolic reflector. After the cowbirds became independent, I measured their fledgling home ranges either in the field or from a U.S. Geological Survey topographic map to an accuracy of 0.08 ha.

The rates of hosts feeding fledgling cowbirds are compared with hosts feeding an equivalent weight of their own young. I did not measure feeding rates for host fledglings, so it is necessary to use those of host nestlings during the last two or three days in the nest. Some justification for this approach is provided by a detailed study of feeding rates of nestling and fledgling Eastern Kingbirds (*Tyrannus tyrannus*; Morehouse and Brewer 1968), where nestling and fledgling feeding rates were similar.

It is necessary to compensate for differences

in body weight in order to compare cowbird vs. host-young feeding rates. I extracted these rates per nestling per hour for each host species from the literature. I could find no data for White-eyed Vireos (*Vireo griseus*), so they are not included. Then, from published accounts and my own records, I obtained weights of young of each species when they leave the nest. Finally, the feeding rate was multiplied by the number of host nestlings required to equal or to exceed slightly in weight one cowbird fledgling. I assumed that the types and sizes of food items that hosts fed cowbirds were the same or similar to what they would feed their own young. These differences in feeding rates were tested for statistical significance with a parametric paired *t*-test.

I performed a Spearman's rank correlation coefficient test to see if fledgling cowbirds' perching heights were correlated with the hosts' foraging heights.

RESULTS

GENERAL BEHAVIOR

Leaving the nest to independence. Although fledgling cowbirds vary in development, all share certain features that are important in reaching independence. Five general stages of development are recognizable: leaving the nest, inactive, active, superactive, and independence (Table 2). The stages of leaving the nest and independence are distinct and self-explanatory, but the other three form a continuum. They can be differentiated by frequency of flights and other behavior.

TABLE 2. Chronology of stages and important events in the development of Brown-headed Cowbirds. First number is age in days; number in parentheses is days out of nest.

Host and location	Leaving the nest	Event or stage						Independence
		Duration of inactive stage	Duration of active stage	First seen pecking	First seen coming down to ground	First seen walking and pecking ^a	Start of superactive stage	
Eastern Phoebe								
Route 28-2	11	—	—	—	—	—	—	—
Route 28-3	12 and 13	—	—	—	—	—	—	—
Willard Rd.	11	—	—	12 (2)	—	—	—	—
Edward's Ferry	11	11-12 (1-2)	13-22 (3-12)	13 (3)	20 (10)	17 (7) 22 (12)	23 (13)	34-36 (24-26)
Reston	13	13-14 (1-2)	—	—	—	—	15 (3)	—
Acadian Flycatcher								
Edward's Ferry	12	—	—	—	—	—	—	—
Hughes Hollow ^b	11	11-12 (1-2)	13-? (3-?)	13 (3)	—	—	—	—
Carolina Wren								
Adventure-RL	8	8-9 (1-2)	10-26 (3-18)	10 (3)	14 (7)	23 (16)	27 (19)	35-37 (27-29)
LL	9	9-11 (1-3)	12-31 (4-24)	12 (4)	15 (7)	16 (8)	32 (23)	36-39 (27-29)
Reston-RL	10	10-12 (1-3)	13-21 (4-12)	—	—	19 (10)	22 (13)	29-30 (20-21) ^c
LL	11	11-13 (1-3)	14-22 (4-12)	12 (2)	15 (5)	20 (10)	23 (13)	30-31 (20-21) ^c
Eastern Bluebird								
Reston	10	10-11 (1-2)	12-20 (3-11)	14 (5)	18 (9)	15 (6) 20 (11)	21 (12)	25-26 (16-17)
Reston	10 and 11	—	—	11 (1)	—	—	—	—
Blue-gray Gnatcatcher								
Hughes Hollow ^b	—	—	—	—	—	19 (9)	—	27-30 (17-20)
Northern Cardinal								
Hughes Hollow ^b	—	—	—	—	—	—	—	33-35 (27-29)
Song Sparrow								
Hughes Hollow-RL ^b	11	11-12 (1-2)	13-23 (3-13)	16 (6)	19 (9)	20 (10)	24 (14)	29-31 (19-21)
Un ^b	11	11-12 (1-2)	13-23 (3-13)	—	23 (13)	23 (13)	24 (14)	29-31 (19-21)

^a Number in roman type refers to walking and pecking in trees; italicized number refers to walking and pecking on the ground.

^b Age estimated.

^c Time of independence estimated.

Leaving the nest. Only one cowbird was seen leaving the nest. Without warning, a nestling cowbird flew ca. 3 m behind an Eastern Phoebe (*Sayornis phoebe*), which has just fed the cowbird, and landed on the ground. Seventeen minutes later, the cowbird flew another 3 m, again landing on the ground. Lack of food may have stimulated it to leave the nest. Until two hours before leaving the nest, the cowbird was being fed regularly by the phoebes, but then it was fed considerably less, probably because the adults were feeding another cowbird that had left the nest earlier. I found 10 other cowbirds within 30 min after they had each left their nests. Three were directly below the nest, one was slightly above the nest, and six were about the same height as the nest but 0.5 to 3 m from it. Heights above the ground after leaving the nest were from 0 to 5 m, with an average of 2 m. Nine fledglings perched in a tree or bush, and one was on the ground.

Time of leaving the nest varied. Five cowbirds left in the morning and six in the afternoon. The earliest was before 08:30 and the

latest was ca. 18:00. Ages at leaving the nest varied from 8 to 13 days ($\bar{x} = 10.9$, $n = 14$) with the norm being 10 or 11 days.

Shortly after leaving the nest, cowbirds tended to move higher in the vegetation, usually by short flights. For example, when one fledgling was first found, it was perching 1.5 m off the ground, about 7.5 m below its nest. During two hours of observation, it reached a height of 6 m by a series of short flights and by climbing through the trees.

Inactive stage. The inactive stage was an extension of the late nestling period. Generally, fledglings perched quietly except when adults came to them with food or when they had not been fed for a while, in which case they made chipping sounds. Their movements were mostly normal comfort and self-maintenance behaviors, although sometimes they flew short distances. They flew less than twice per hour. This stage usually lasted for the first two or three days out of the nest, and its duration did not vary with a fledgling's age.

Active stage. This stage lasted most of the

fledgling period (usually from 3 to 13 days out of the nest) and was best defined by hourly rates of flight. These varied daily and with different hosts but were mostly between two and nine per hour and increased with age. Flights were usually independent of the hosts' activities, although occasionally cowbirds flew after or toward an adult to be fed. Evidently the development of flying ability was stimulated by leaving the nest rather than by the fledglings' age. The cowbirds with Carolina Wrens (*Thryothorus ludovicianus*) at Adventure left the nest earlier (eight and nine days old) than other cowbirds in my study, probably because their nest cavity was too small to hold both comfortably. For the first two to three days out of the nest, these cowbirds could barely fly, but by the third and fourth days, they became active. At this age (11–13 days), a cowbird that had just left the nest would still be in the inactive stage.

As fledglings matured, they also moved on their perches more frequently. Fledglings did not move or fly constantly, but interspersed short periods of flying and/or moving on perches with periods of perching, preening, stretching, resting, or sleeping. They often chipped loudly and persistently.

All behaviors necessary for fledgling cowbirds to become independent are developed during the active stage. All, except flying, are associated with foraging and feeding.

"Pecking" was the first critical behavior to appear. I first saw it one to six days after the cowbirds left the nest. Pecking was initially exploratory. The fledglings might inspect an object, pick it up in their bill and then drop it or manipulate it before dropping it. Sometimes they pulled leaves through their bills or looked at and pecked their perches. Contrasting things, such as a dark spot on a leaf, or movement, such as a flying insect, often caught their attention. Fledglings were first seen feeding themselves when 20 to 22 days old. Occasionally they caught food items that were too large for efficient handling, in which case an adult might help by stunning the prey and forcing it down the fledgling's throat. Fledglings seemed to learn about food items through trial and error.

"Walking and pecking" came next in the development of self-feeding. Fledglings did this in trees when six to nine days out of the nest (15 to 19 days old).

"Coming down to the ground" occurred at 5 to 13 days out of the nest (14 to 23 days old). At first the birds spent only short periods on the ground, usually standing quietly, but sometimes being fed. As they matured, they spent more time there (Fig. 1). Of all the cowbirds

that survived to independence, only the one raised by Blue-gray Gnatcatchers (*Poliophtila caerulea*) was never seen on the ground.

Once on the ground, fledglings eventually walked and pecked there, assuming the foraging technique of adult cowbirds. This behavior was first seen 8 to 16 days out of the nest (16 to 23 days old) and increased with age, becoming common near the end of the fledgling period.

By the time cowbirds were 20 to 25 days old, all behaviors prerequisite for self-care had developed.

Superactive stage. The superactive stage usually began from 12 to 23 days out of the nest (21 to 32 days old) and 3 to 11 days before independence. It was characterized by fledglings almost constantly flying after their hosts and actively begging with quivering wings and loud calling. Flight rates were between 11 and 27 per hour.

When hosts were absent, the cowbirds foraged for themselves, but when hosts appeared, they stopped feeding and begged, often closely following a foraging adult.

The cowbird with phoebes at Reston became superactive when only three days out of the nest (16 days old); its foster parents stopped feeding it, probably because four phoebes were still in the nest. This cowbird disappeared by the following day.

Independence. Fledgling cowbirds became independent 16 to 28 days after leaving the nest (25 to 39 days old; $\bar{x} = 31.5$, $n = 10$). The final step in attaining independence occurred when the hosts stopped feeding the fledglings. The cowbird would fly after an adult, who would ignore it or aggressively dart at it, sometimes forcing the cowbird to the ground. I witnessed this aggression twice with Eastern Phoebes, once with Carolina Wrens, and once with Eastern Bluebirds (*Sialia sialis*).

Vocalizations. Fledgling cowbirds uttered distinctively loud calls. Friedmann (1929:272) described the call as a rather thin, strident "seer," while Nice (1939:233) named it a "yip." To me, their call sounded like "chip" or "chit." This note in various forms was the only call heard.

Occasional chips graded into periods of continuous chipping. In an unsystematic field sample, the number of chips in 15-s periods ranged from 1 to 27 with an average of 11.2 ($n = 137$). Three types of feedings were associated with this gradation. These were subjective categories because numerous types of feedings could be recognized.

In "inactive" feedings, the cowbird perched quietly when hosts came in with food. It might chip once or twice before or after being fed,

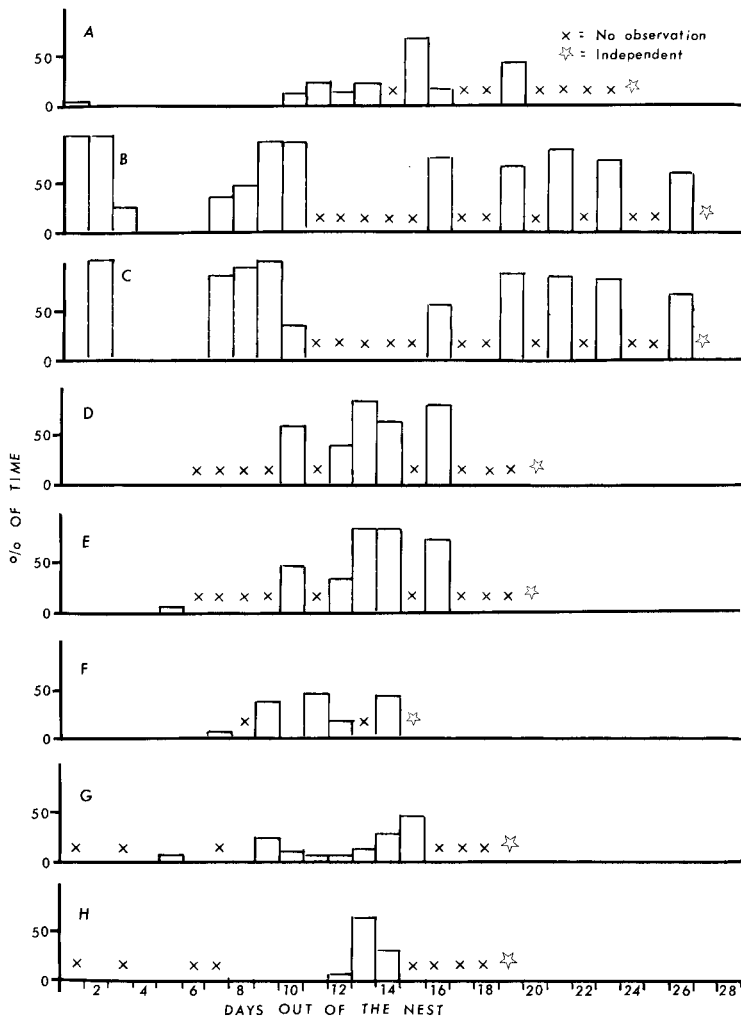


FIGURE 1. Percent of observation time fledgling Brown-headed Cowbirds spent on the ground. The number in parentheses is the percent of total time the bird spent on the ground. A, cowbird with Eastern Phoebes (9.1%); B, RL cowbird with Carolina Wrens at Adventure (56.0%); C, LL cowbird with Carolina Wrens at Adventure (53.6%); D, RL cowbird with Carolina Wrens at Reston (35.2%); E, LL cowbird with Carolina Wrens at Reston (35.4%); F, cowbird with Eastern Bluebirds (10.4%); G, RL cowbird with Song Sparrows (10.0%); and H, unbanded cowbird with Song Sparrows (13.2%).

but did not move. Inactive feedings often occurred when the cowbird was asleep or after a period of intensive feeding. In “moderate” feedings, the cowbird chipped before and after being fed, and moved only slightly. In “active or begging” feeding, the cowbird quivered its wings rapidly and chipped continuously (almost a trill), before and after being fed. It generally sat with the body parallel to the perch. Of 5,927 feedings I recorded, 5,193 (87.6%) were active, 599 (9.4%) moderate, and 175 (3.0%) inactive.

Figure 2 shows sonograms of typical calls with eight host species. Sonograms A and B show active feedings (begging); A shows continuous calling before a feeding, quiet when swallowing the prey, and calling afterwards; C through G show the single chip.

The frequency of the low point of 30 recorded chips ranged from 2.5 to 6.0 kHz (\bar{x} = 4.1) and the high point of the same notes ranged from 6.8 to 10.5 kHz (\bar{x} = 8.7). Each note lasted from 0.01 to 0.05 s (\bar{x} = 0.01, n = 77). When notes were closely spaced, the average time interval was 0.03 s (0.01 to 0.04, n = 107). In this limited sample, the number of chips in 1.3 s ranged from 1 to 22 with an average of 6.8. Notes were single, in groups, or in long series.

I was unable to determine the extent of variation in vocalizations within and among the fledglings. In the field, only the cowbird with Acadian Flycatchers (*Empidonax virescens*) at Edward's Ferry sounded different, which was confirmed by its sonogram. This call may have been abnormal because the bird appeared to be ill (it could not maintain its balance). How-

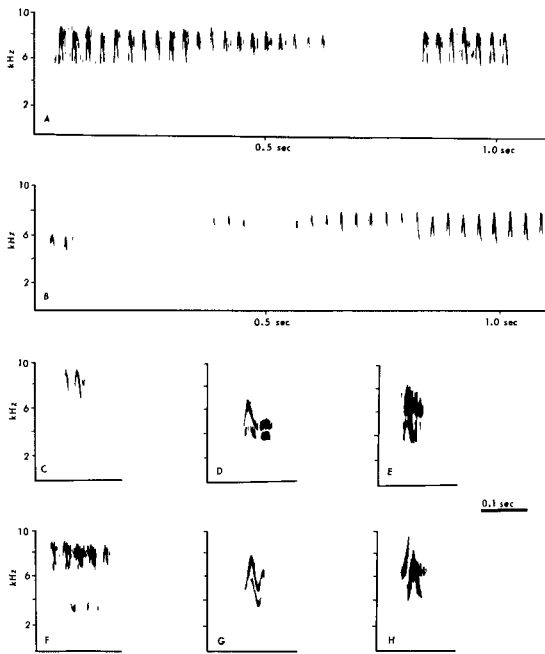


FIGURE 2. Calls of various fledgling Brown-headed Cowbirds with different hosts. A–B, begging (gap between tracings was when fledgling was swallowing food): A, with Blue-gray Gnatcatchers; B, with Common Yellowthroats. C–H, chip notes: C, with Eastern Phoebe; D, with Acadian Flycatchers; E, with Carolina Wrens; F, with White-eyed Vireos; G, with Northern Cardinals; and H, with Song Sparrows.

ever, the sonograms in Figure 2 suggest some structural differences in the calls of various cowbirds (see F and G), which could distinguish them as individuals.

Cowbirds called commonly throughout the fledgling period, even during the first few days after leaving the nest (Fig. 3).

BEHAVIORS MODIFIED BY HOSTS

Cowbirds were flexible in their recognition of host species, choice of perching heights, and size of home ranges.

Fledgling recognition of host species. My observations strongly suggest that fledgling cowbirds recognized their hosts as a species but not necessarily as individuals. Three times fledglings were fed and protected by a pair of host-conspecific birds that had not raised them as nestlings.

One case involved two cowbird nest-mates being raised by Carolina Wrens. Sometime between their 6th and 10th day out of the nest (15 to 20 days old), they joined a slightly younger fledgling cowbird, which was being raised by another pair of wrens in an adjacent territory. This second pair raised all three fledglings to independence.

In a similar situation, a cowbird being raised

by Common Yellowthroats (*Geothlypis trichas*) joined a nearby fledgling that I was monitoring near the end of its fledgling period. The new arrival spent increasing amounts of time in its adopted territory, and on the final two days of observation, the fledglings, who were about the same age, behaved as if they were nest-mates.

In a third case, again with Carolina Wrens, two cowbird nest-mates were in one territory and another cowbird, about the same age, was in an adjacent wren territory. From the 11th through the 18th day out of the nest (18 to 26 days old), they often switched territories together or singly and were fed by whichever pair of adults "owned" the territory where they happened to be. However, they reached independence in their original territories.

Friedmann (1929) reported that species other than those raising cowbirds occasionally fed begging fledgling cowbirds, but I never saw this. Fledgling cowbirds usually ignored individuals of other species while regularly begging at their hosts when hungry.

Seventy-five times during this study another bird that was neither of the same species as its host parent nor its nest-mate was within 3 m of the fledglings. In 65 cases (86.7%) the cowbird ignored the other bird, froze, became alert, or flew away. Six times the fledglings begged briefly at individuals of nonhost species. Typically, the cowbird would appear unaware of the nonhost's presence until motion in the vegetation attracted its attention. The cowbird would turn toward the motion, start to beg, and then stop, usually becoming motionless, after it saw the nearby bird. However, three times a fledgling with Song Sparrows (*Melospiza melodia*) definitely begged at an individual of a nonhost species.

This fledgling, on its ninth day out of the nest, flew after and vigorously begged at an immature cowbird, which side-stepped away and then flew away as the begging fledgling approached it by stepping along the perch. Four days later, as this fledgling was standing quietly on the ground, a female House Sparrow (*Passer domesticus*) foraged within 0.3 m of it, and the cowbird begged mildly at her. Thirteen minutes later, the female House Sparrow fed her fledgling within 1 m of the cowbird, and it again begged mildly. In both cases, the House Sparrow ignored the cowbird.

I found only one report of a fledgling cowbird begging at a species that did not raise it. Ficken (1967) reported that a cowbird raised by Eastern Phoebe begged at a Common Crow (*Corvus brachyrhynchos*), who eventually killed the fledgling. Friedmann (1929) recorded a large fledgling cowbird begging at a Chipping

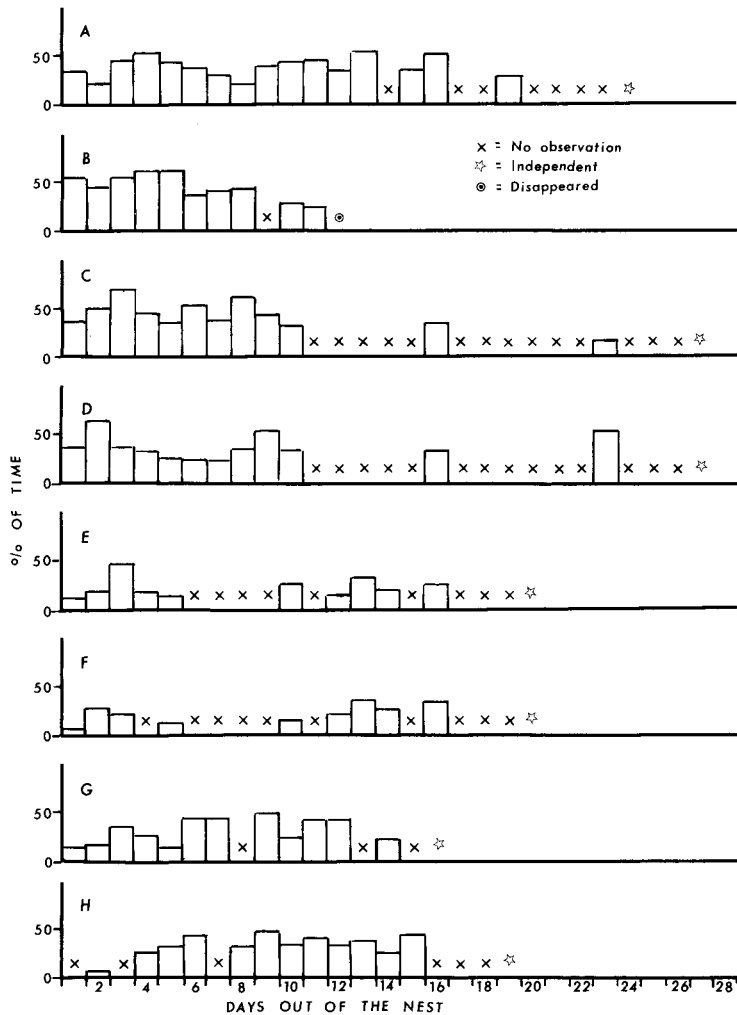


FIGURE 3. Percent of observation time fledgling Brown-headed Cowbirds spent calling. The number in parentheses is the average amount of time spent calling. A, cowbird with Eastern Phoebes (39.6%); B, cowbird with Acadian Flycatchers (46.7%); C, RL cowbird with Carolina Wrens at Adventure (44.4%); D, LL cowbird with Carolina Wrens at Adventure (37.4%); E, RL cowbird with Carolina Wrens at Reston (24.7%); F, LL cowbird with Carolina Wrens at Reston (23.6%); G, cowbird with Eastern Bluebirds (32.9%); H, RL cowbird with Song Sparrows (34.6%). There was only one observer for the cowbirds with Carolina Wrens in Reston, resulting in less detailed records.

Sparrow (*Spizella passerina*) with young of its own that had recently left the nest, but this fledgling might have been raised by another pair of Chipping Sparrows.

The last interaction between a fledgling cowbird and individuals of a nonhost species involved adult cowbirds. Near the end of the fledgling period, a cowbird fledgling flew into a field and landed ca. 2 m from a foraging adult male and female cowbird. When the fledgling flew within 0.5 m of the adults, the male chased it and forced it to the ground. The adults flew, landing 5 m away and continued foraging. The fledgling followed and landed 1.5 m from the adults and also began foraging. Shortly, all flew off. Two adult males and a female cowbird quickly reappeared to forage in the field. Seven

minutes later, the fledgling reappeared, landing near the adults. One of the males displaced it thrice before finally chasing it down into a mat of low vegetation. The adults and the fledgling then flew off in different directions.

Perching heights of fledglings. During most of their active stage (from 3 to 12 days out of the nest) fledgling cowbirds generally perched near the heights at which hosts were obtaining food. This was most apparent with Acadian Flycatchers, Carolina Wrens, Eastern Bluebirds, Blue-gray Gnatcatchers, and Song Sparrows, all of which often foraged clearly in my view.

Table 3 summarizes perching heights of fledglings, and Table 4 compares their commonest perching height with foraging behavior

TABLE 3. Perching heights of fledgling Brown-headed Cowbirds from 3 through 12 days out of the nest with various hosts. Numbers are percent of total time spent at each height; () indicates maximum canopy height.

Height interval (meters)	Carolina Wren RL-Adventure	Carolina Wren LL-Adventure	Carolina Wren RL-Res-ton	Carolina Wren LL-Res-ton	Song Sparrow RL	Song Sparrow Un	Eastern Bluebird	Northern Cardinal	White-eyed Vireo	Eastern Phoebe	Acadian Flycatcher	Blue-gray Gnatcatcher
21.1-24.0	()	()	()	()	()	()	()	()	()	()	()	()
18.1-21.0	()	()	()	()	()	()	()	()	()	()	()	()
15.1-18.0	()	()	()	()	()	()	()	()	()	()	()	()
12.1-15.0	()	()	()	()	()	()	()	()	()	()	()	()
9.1-12.0	()	()	()	()	()	()	()	()	()	()	()	()
6.1-9.0	()	()	()	()	()	()	()	()	()	()	()	()
3.1-6.0	()	()	()	()	()	()	()	()	()	()	()	()
0.0-3.0	()	()	()	()	()	()	()	()	()	()	()	()
Number of minutes of observation	1,303	1,315	475	440	1,020	690	1,143	652	360	1,755	1,382	685

* Highest percentage for each bird. Birds are arranged by increasing perch heights.

of host species, based on available literature and personal observation. The cowbirds' commonest perching heights were significantly correlated with the hosts' commonest foraging heights ($r_s = 0.958$, $df = 6$, $P < 0.001$).

Further support for this correlation comes from the cowbirds with Acadian Flycatchers and Song Sparrows, which were raised in the same floodplain forest ca. 90 m apart. Perching heights of the cowbirds reflected the differences in the foraging of the hosts in a predictable fashion (see Tables 3 and 4). The cowbird with flycatchers perched 30% of the time below 6 m, 3% between 6 and 12 m, and 67% above 12 m. Comparable figures for the banded cowbird with the sparrows were 67%, 33%, and 0%. Only the birds' behavior, not habitat features, could account for this significant difference ($\chi^2 = 1206$, $df = 2$, $P < 0.001$).

Neff's 1926 record of three cowbirds that left an Orchard Oriole's (*Icterus spurius*) nest also supports this correlation. Two of these fledglings were raised by the orioles and the other by a Rufous-sided Towhee (*Pipilo erythrophthalmus*). Neff reported (p. 334) that on the 10th to 14th day after leaving the nest, "I frequently saw the other two cowbirds from July 8-12 in the tree tops above the orchard diligently fed by their foster parents, the Orioles . . ." At the same time, the other cowbird was on or near the ground with the towhee.

Home ranges of fledgling Brown-headed Cowbirds. Home ranges of fledgling cowbirds varied from 0.3 to 5.6 ha (Table 1). With two exceptions, I saw hosts and fledglings in the same areas.

I did not attempt to measure territory size of the hosts before cowbirds left the nests, but the cowbirds' home ranges were apparently correlated in general with host territory size and the abundance of adjacent conspecifics. For example, with the Eastern Phoebe the nearest nest of a conspecific was 274 m distant and was the only other phoebe nesting pair within at least 1.6 km. The home range of their cowbird was 5.6 ha. On the other hand, conspecifics were evidently common near the areas where Acadian Flycatchers, Northern Cardinals (*Cardinalis cardinalis*), and Song Sparrows were raising cowbirds because territorial disputes were common. Home ranges of these cowbirds were much smaller than that of the cowbird with phoebes.

The cowbirds with Carolina Wrens at Res-ton and Adventure were exceptions to these generalizations. They moved into an adjacent wren territory and were fed by a different pair of wrens. Consequently, their home ranges were larger than the territory of the pairs that originally raised them as nestlings.

TABLE 4. Comparison of foraging heights of host species with the most common perching heights of fledgling Brown-headed Cowbirds. Birds are arranged by increasing foraging heights.

Species	Foraging heights	Source	Cowbird perching heights and comments
Carolina Wren	Primarily ground foragers.	Joan Fellers (pers. comm.); pers. observ.	Four perched below 3 m 69.8 to 89.0% of the time; did not perch above 9 m.
Northern Cardinal	From ground to 9.14 m, but most commonly below 3.05 m.	Crowell 1962	Perched from the ground to 21.5 m, but spent 65% of its time below 4.5 m.
Song Sparrow	In summer, cease to feed largely on ground and sometimes forage for insects among foliage as high as 6.13 m and 9.14 m.	Eaton 1914	One perched 47.9% of the time between 0.5 and 3 m and 32.8% between 6 and 12 m. The other one perched 45.1% of the time between 0.5 and 3 m and 34.6% between 10 and 15 m.
Eastern Bluebird	In spring, average foraging height is 2.02 ± 1.09 m. In summer, 3.76 ± 2.43 m.	Pinkowski 1977	Perched from ground to 21.5 m, but it spent 47.3% of its time below 1.5 m and 22% between 6 and 9 m.
Eastern Phoebe	Mainly below 6 m.	Bent 1942; pers. observ.	Perched 81.6% of the time between 6 and 15 m.
White-eyed Vireo	Range from 0.46 m to 14.33 m, with an average of 5.27 m.	Williamson 1971	Perched between 6 and 9 m during three days of observation.
Acadian Flycatcher	Mean foraging height is 6.4 m ($n = 93$, $SD = 12.9$, $SE = 1.3$). Maximum height is 15.24 m. Below canopy.	Williamson 1971	Ranged from ground to 24 m, but below forest canopy; 60.2% of the time between 12 and 18 m.
Blue-gray Gnatcatcher	Forage mostly in the top level of the tree foliage zone. Range from near the ground to almost 13.7 m. Most common foraging heights are 9.14 m and 10.67 m.	Root 1967	Perched from 0.5 to 21 m, but spent 63.5% of its time between 12 and 18 m, near or in the tree canopy.

HOST BEHAVIORS

Feeding rates and food items. Hourly feeding rates of each fledgling cowbird varied daily and from host to host, raising the question of how feeding rates for fledgling cowbirds compare with those of hosts feeding their own young. As shown in Table 5, the average feeding rate for cowbirds was always higher than that for the hosts' own young ($t_s = 6.37$, $df = 12$, $P < 0.001$). Luther (1974), in a study of Carolina Wrens feeding nestling cowbirds, also found this.

In three cases—Carolina Wrens at Adventure and Reston and Song Sparrows at Hughes Hollow—where two cowbirds were being raised by one host pair, the average feeding rates for each fledgling were almost equal, suggesting that their food requirements and the amount of time they stimulated the adults to feed them were equivalent.

Cowbirds were fed different items, according to their hosts. Eastern Phoebes fed rather large items, such as dragonflies (Odonata), adult and larval lepidopterans, flies (Diptera), crickets (Orthoptera), plant bugs (Hemiptera), and

mulberries (*Morus rubra*), while Carolina Wrens gave smaller items, mainly pillbugs (Oniscoidea) and harvestmen (Opiliones) in addition to some larval and adult lepidopterans. Eastern Bluebirds provided larval lepidopterans, moths, grasshoppers (Orthoptera), flies, and blueberries (*Vaccinium* sp.), while Common Yellowthroats gave larval lepidopterans and grasshoppers. At least with the latter two species, hosts fed the fledgling cowbirds the same food as their own young (Hofslund 1959, Pinkowski 1978).

Items fed to cowbirds by Acadian Flycatchers, Blue-gray Gnatcatchers, and Song Sparrows were too small to be identified. No food items were determined for White-eyed Vireos or Northern Cardinals because I had trouble observing the fledglings closely.

Recognition of fledglings by hosts. Despite an apparent lack of individual recognition, hosts raised cowbirds as if they were their own young. During my study, hosts always located, fed, and protected fledgling cowbirds without confusion, even when they also had young of their own.

Lack of individual recognition is suggested

TABLE 5. Comparison of fledgling Brown-headed Cowbird feeding rates with those for normal young of host.

Host	Fledging weight ^a (grams)	Average hourly feeding rate for fledgling cowbird $\pm \sigma$	Equivalent feeding rate for normal host young ^b	Source
Eastern Phoebe	17.8	21.93 \pm 7.81	5.35 (2)	Cuthbert 1962
Acadian Flycatcher	12.0	33.33 \pm 11.28	16.70 (3)	Mumford 1964
Carolina Wren	19.4	15.36 \pm 6.77 14.90 \pm 3.91 11.07 \pm 3.31 10.69 \pm 6.47 9.27 \pm 5.64	5.38 (2)	Nice and Thomas 1948
Eastern Bluebird	26.9	7.66 \pm 3.09	3.67 (1)	Woodward, unpubl.
Blue-gray Gnatcatcher	5.9	72.66 \pm 17.72	36.95 (5)	Root 1969
Common Yellowthroat	10.0	36.00 \pm 4.89	11.61 (3)	Stewart 1953
Northern Cardinal	25.8	7.98 \pm 2.76	3.67 (1)	Laskey 1944
Song Sparrow	17.8	16.62 \pm 7.23 15.93 \pm 12.27	10.42 (2)	Nice 1943

^a In this study, average fledging weight of Brown-headed Cowbirds was 26.95 g ($n = 19$).

^b Feeding rate per host nestling multiplied by number of host nestlings required to equal the weight of one cowbird nestling. () = number of host nestlings used to determine feeding rate equivalent to the cowbird's feeding rate.

Note: Differences tested by paired *t*-test ($t_s = 6.37$, $df = 12$, $P < 0.001$).

by the already discussed three cases of fledglings who were adopted by another conspecific pair and by the following example. At Edward's Ferry a nestling cowbird disappeared on the day when it should have left an Eastern Phoebe nest. Shortly thereafter, I placed another cowbird, about the same age as the missing one and also from a phoebe nest, in the nest. The cowbird left the nest immediately and finally climbed to a 1-m high perch. The phoebes showed little interest in feeding the fledgling, although they flew overhead whenever it fell as it moved about. Two hours later, they fed the cowbird after it had started begging persistently, and they raised it to independence.

Reactions of hosts to other species near cowbird fledglings. Eighty-seven times I found another bird or mammal within 3 m of a fledgling cowbird. In 64 (73.6%) of these cases, hosts did not respond, probably because they were not nearby. In the other 23 cases, the hosts attacked or scolded the intruder. They ignored mammals, but not birds, that were on the ground.

An Acadian Flycatcher chased an adult male cowbird that was 1.8 m from its fledgling cowbird and Carolina Wrens twice chased an adult female cowbird from their cowbird fledglings. These incidents show that hosts could distinguish between adult female and fledgling cowbirds, which resemble one another.

DISCUSSION

Fledgling Brown-headed Cowbirds face a variety of problems because they are raised by different-sized hosts with divergent life styles and in a wide variety of habitats. Cowbirds usually are not in contact with conspecifics un-

til they become independent. Under such circumstances, it is probably essential that species-specific aspects of their behavior not be modified by hosts if the cowbirds are to survive as adults. At the same time, other aspects should be modified to increase a fledgling's chances of survival when it is dependent on the host, and adaptations should evolve to make cowbirds more effective brood parasites.

Data about fledgling behavior are available for six of the host species—Acadian Flycatcher (Mumford 1964, Walkinshaw 1966), Eastern Bluebird (Thomas 1946), Blue-gray Gnatcatcher (Root 1969), Common Yellowthroat (Hofslund 1959), cardinal (Brackbill 1944), and Song Sparrow (Nice 1943, Smith 1978). Comparing Brown-headed Cowbird fledgling behavior with that of the host fledglings suggests a lack of any strong influences of the hosts' behavior on the cowbirds.

Development of fledgling cowbirds in many respects resembles that of the other species in general chronology—all begin feeding themselves when about three weeks old and become independent about one week later. In other respects, fledgling cowbirds resemble some host fledglings and in a few respects they do not resemble any host fledglings.

When they leave the nest, cowbirds can fly, although not well, as do young cardinals and Song Sparrows. Young Acadian Flycatchers, Eastern Bluebirds, and Blue-gray Gnatcatchers can fly fairly well, while Common Yellowthroats cannot fly when they leave the nest.

If two cowbirds leave the same nest, they separate until late in the fledgling period, although they are aware of one another's being fed. This is similar to yellowthroats and Song Sparrows, but differs from bluebirds and gnat-

catchers, where the brood remains together during the fledgling period.

Cowbirds are fairly conspicuous after they leave the nest, which sharply contrasts with fledgling yellowthroats and Song Sparrows, who hide in the vegetation for a week or so, but resembles bluebirds and gnatcatchers. Near the end of the fledgling period, at least bluebirds (pers. observ.), yellowthroats (Hofslund 1959), and Song Sparrows (pers. observ.) become superactive.

Several, if not most, passerines appear to beg loudly near the end of the fledgling period, whether or not adults are present, but not earlier. Cowbirds, however, beg loudly and persistently from the day they leave the nest until they become independent. Friedmann (1929: 276) stated, "In the great development of its food call, the cowbird approaches the Baltimore Oriole (*Icterus galbula*) and outstrips practically all of its numerous species of nest associates." My own experience has been similar. Only fledgling Northern Mockingbirds (*Mimus polyglottos*) and American Robins (*Turdus migratorius*) call nearly as loudly as cowbirds.

To test this impression, I searched Bent (1942–1968) for descriptions of young passerines' begging calls. He reported that the begging call of Golden-winged Warblers (*Vermivora chrysoptera*) and, by inference, Chipping Sparrows, resembles the calls of young cowbirds in form but the tone is gentler and weaker than the cowbird's (Bent 1953). Begging calls of most of the 70 or so other species for which I found data are either not as loud as the cowbird's, or more importantly, early in the fledgling period, are given only when adults are present. Eastzer et al. (1980) found that a fledgling cowbird on the first day out of a nest usually called 40–55 times per minute under experimental conditions that resulted in low feeding rates. A fledgling Red-winged Blackbird (*Agelaius phoeniceus*) called 15–25 times per minute and a fledgling Gray Catbird (*Dumetella carolinensis*) called 25–50 times per minute under the same experimental conditions that resulted in no feedings.

Of the hosts in my study, the begging calls of Eastern Phoebes (Bent 1942) and Blue-gray Gnatcatchers (Root 1969) are not as loud as the cowbird's. For the first week after leaving the nest, Eastern Bluebirds (Thomas 1946) and Song Sparrows (Nice 1943) call mainly when adults appear with food, but later beg when adults are not present. Hofslund (1959) reported that young yellowthroats are usually quiet between 11–20 days of age.

The development in fledglings of the adult cowbird foraging technique of walking and

pecking on the ground is unmodified by hosts, but other behaviors are flexible or modified in a host-specific manner. These latter behaviors increase young cowbirds' chance of survival while they depend on their hosts. Cowbirds are flexible in their ability to respond to whatever host happens to be raising them, which is essential since cowbirds can be raised by so many species. Surprisingly, however, thrice cowbirds switched from hosts who raised them to a conspecific pair in an adjacent territory.

Such parental switching could be advantageous to cowbirds, particularly in areas where cowbird parasitism is high and many foster parents are available. Thus, they would be somewhat insured against death of their hosts or reduced feeding rates, but such a habit would have drawbacks. First, nonhost adults probably would be unable to feed the cowbird because hosts protect fledglings and chase other birds away. Second, a fledgling cowbird would be most likely to be fed by an adult raising a cowbird itself or, as shown by Skutch (1961), by individuals of other species with their own young. If a cowbird begged at all adults and started following them, it might become separated from its original host and risk ultimately having no one to feed it. Third, begging at an adult of a nonhost species can be dangerous, as shown by Ficken (1967), who saw a cowbird beg at a Common Crow, which killed it. On the whole, the safest behavior for a fledgling cowbird is probably to establish and maintain a bond with its host until it becomes independent.

Only two behaviors were modified in a host-specific manner: perching heights and home ranges. Cowbirds perched at approximately the same height as their hosts foraged and their home ranges corresponded to their host's territory. This can be explained simply: by perching near the foraging host, the cowbird was fed faster.

Hosts never appeared to make the cowbirds perch at any particular height because they fed the fledglings wherever they were; rather, the cowbirds responded to the host's behavior. For example, Carolina Wrens and Song Sparrows both fed cowbirds 7–8 m above the ground, but they fed them in different ways. Both hosts captured prey on or near the ground. The wrens worked their way up slowly to the cowbird by short flights, pauses, and hops. The Song Sparrows flew directly to the cowbird in one or two long fast flights. Therefore, in order for a cowbird with Carolina Wrens to be fed efficiently, it had to perch low, while one with Song Sparrows could perch high or low and still be fed efficiently.

Fledgling cowbirds can take advantage of a

wide variety of species because of the apparent nonspecific begging response of North American passerines and evident lack of individual recognition by hosts (e.g., Kinsey 1935, Emlen 1941, Walkinshaw 1966).

According to Hamilton and Orians (1965: 373), "There has probably not been, in the evolutionary history of birds, any selective premium on species distinctiveness in the begging response." A host will respond positively to a calling cowbird in its nest. By calling more, cowbirds have further enhanced this relationship.

Some passerines seemingly cannot distinguish between nestlings of their own species and those of other species (e.g., Shelley 1936, Nolan 1961). In those cases where individual recognition has been recorded, it did not appear until the young were at least seven days old (Nice 1937, Peek et al. 1972, Burt 1977); possibly this discriminatory ability is learned, as suggested by Burt (1977). In either case, hosts would accept cowbirds as their own.

The calling of fledgling cowbirds also functions in another way. In a series of experiments with Pied Flycatchers (*Ficedula hypoleuca*), von Haartman (1953) showed that adults feeding young responded to their calls rather than to the sight or number of nestlings (i.e., the more young called, the more they were fed). Logically it follows from these experiments that fledgling cowbirds could be fed more than host young by calling more. Such a mechanism has been suggested for European Common Cuckoos (*Cuculus canorus*), another brood parasite (Lack 1968) and, as already discussed, is true for Brown-headed Cowbirds. The calling of fledgling cowbirds also allows them to be fed first if any host young are present. In a situation where hosts are considerably smaller than the cowbirds, as with Blue-gray Gnatcatchers, this behavior should insure that cowbirds receive adequate nourishment.

The main adaptation for brood parasitism that I found in fledgling Brown-headed Cowbirds was their loud persistent begging throughout the fledgling period. This behavior allowed them to be fed more frequently than an equivalent weight of host species' young and to exploit effectively the feeding response of parents to their young. This begging adaptation has also been suggested by Gochfeld (1978) for the Shiny Cowbird (*Molothrus bonariensis*) of South America and the West Indies.

ACKNOWLEDGMENTS

Eugene Morton first suggested that I work with cowbirds, and I profited greatly from my discussions with him. Morton, Douglas Gill, and Douglass Morse read the original

manuscript and offered valuable suggestions. Reviewers Richard Norman and Stephen Rothstein improved the final product. Margaret Donald found a parasitized Carolina Wren nest for me. Philip Cohen (U.S. Geological Survey) gave permission for me to work at the National Center in Reston. I am indebted to my wife, Joan, for help with the field work and for numerous discussions. This paper represents part of a master's thesis at the University of Maryland.

LITERATURE CITED

- BENT, A. C. 1942-1968. Life histories of North American . . . [birds]. U.S. Natl. Mus. Bulls. 179, 191, 195-197, 203, 211, 237.
- BRACKBILL, H. 1944. The Cardinal's period of dependency. *Wilson Bull.* 56:173-174.
- BURT, E. H., JR. 1977. Some factors in the timing of parent-chick recognition in swallows. *Anim. Behav.* 25:231-239.
- CUTHBERT, N. L. 1962. The Michigan Audubon Society phoebe study (part 2). *Jack-Pine Warbler* 40:68-83.
- CROWELL, K. L. 1962. Reduced interspecific competition among the birds of Bermuda. *Ecology* 43:75-88.
- EASTZER, D., P. R. CHU, AND A. P. KING. 1980. The young cowbird: average or optimal nestling? *Condor* 82:417-425.
- EATON, E. H. 1914. Birds of New York. N.Y. State Mus. Mem. 12, part 2.
- EMLEN, J. T., JR. 1941. An experimental analysis of the breeding cycle of the Tricolored Redwing. *Condor* 43:209-219.
- FICKEN, M. S. 1967. Interactions of a crow and a fledgling cowbird. *Auk* 84:601-602.
- FRIEDMANN, H. 1929. The cowbirds, a study in the biology of social parasitism. C. C Thomas, Springfield, IL.
- FRIEDMANN, H. 1963. Host relations of the parasitic cowbirds. U.S. Natl. Mus. Bull. 233.
- FRIEDMANN, H. 1966. Additional data on the host relations of the parasitic cowbirds. *Smithson. Misc. Collect.* 149:1-12.
- FRIEDMANN, H. 1971. Further information on the host relations of the parasitic cowbirds. *Auk* 88:239-255.
- FRIEDMANN, H., L. F. KIFF, AND S. I. ROTHSTEIN. 1977. A further contribution to knowledge of the host relations of the parasitic cowbirds. *Smithson. Contrib. Zool.* 235.
- GOCHFELD, M. 1978. Begging by nestling Shiny Cowbirds; adaptive or maladaptive? *Living Bird* 17:41-48.
- HAMILTON, W. J., III, AND G. H. ORIANIS. 1965. Evolution of brood parasitism in altricial birds. *Condor* 67:361-382.
- HOFSLUND, P. B. 1959. A life history of the yellowthroat, *Geothlypis trichas*. *Proc. Minn. Acad. Sci.* 27:144-174.
- KINSEY, E. C. 1935. Parental instincts in Black Phoebes. *Condor* 37:277-278.
- LACK, D. 1968. Ecological adaptations for breeding in birds. Methuen and Co., London.
- LASKEY, A. R. 1944. A study of the Cardinal in Tennessee. *Wilson Bull.* 56:27-44.
- LUTHER, D. H. 1974. Observations at a Carolina Wren nest from which Brown-headed Cowbirds fledged. *Wilson Bull.* 86:51-57.
- MOREHOUSE, E. L. AND R. BREWER. 1968. Feeding of nestling and fledgling Eastern Kingbirds. *Auk* 85:44-54.
- MUMFORD, R. E. 1964. The breeding biology of the Acadian Flycatcher. *Misc. Publ. Mus. Zool., Univ. Mich.* 125:1-50.
- NEFF, J. A. 1926. Misplaced foster devotion. *Bird Lore* 28:334-335.

- NICE, M. M. 1937. Studies in the life history of the Song Sparrow, I. Trans. Linn. Soc., N.Y. 4.
- NICE, M. M. 1939. Observations on the behavior of a young cowbird. Wilson Bull. 51:233-239.
- NICE, M. M. 1943. Studies in the life history of the Song Sparrow, II. Trans. Linn. Soc. N.Y. 6.
- NICE, M. M., AND R. H. THOMAS. 1948. A nesting of Carolina Wrens. Wilson Bull. 60:139-158.
- NOLAN, V. 1961. A method of netting birds at open nests in trees. Auk 78:643-645.
- PEEK, F., W. E. FRANKS, AND D. CASE. 1972. Recognition of nest, eggs, nest site, and young in female Red-winged Blackbirds. Wilson Bull. 84:243-249.
- PINKOWSKI, B. C. 1977. Foraging behavior of the Eastern Bluebird. Wilson Bull. 89:404-414.
- PINKOWSKI, B. C. 1978. Feeding of nestling and fledgling Eastern Bluebirds. Wilson Bull. 90:84-98.
- ROBERTSON, R. J., AND R. F. NORMAN. 1976. Behavioral defenses to brood parasitism by potential hosts of the Brown-headed Cowbird. Condor 78:166-173.
- ROOT, R. B. 1967. The niche exploitation pattern of the Blue-gray Gnatcatcher. Ecol. Monogr. 37:317-350.
- ROOT, R. B. 1969. The behavior and reproductive success of the Blue-gray Gnatcatcher. Condor 71:16-31.
- ROTHSTEIN, S. I. 1974. Mechanisms of avian egg recognition: possible learned and innate factors. Auk 91:796-807.
- ROTHSTEIN, S. I. 1975. An experimental and teleonomic investigation of avian brood parasitism. Condor 77:250-271.
- ROTHSTEIN, S. I. 1976a. Cowbird parasitism of the Cedar Waxwing and its evolutionary implications. Auk 91:498-509.
- ROTHSTEIN, S. I. 1976b. Experiments on defenses Cedar Waxwings use against cowbird parasitism. Auk 93:675-691.
- SKUTCH, A. F. 1961. Helpers among birds. Condor 63:198-226.
- SHELLEY, L. O. 1936. A Tree Swallow rears a Cliff Swallow. Bird-Banding 7:49.
- SMITH, J. N. M. 1978. Division of labour by Song Sparrows feeding fledged young. Can. J. Zool. 56:187-191.
- STEWART, R. E. 1953. A life history of the yellow-throat. Wilson Bull. 65:99-115.
- THOMAS, R. H. 1946. A study of Eastern Bluebirds in Arkansas. Wilson Bull. 58:143-183.
- VON HAARTMAN, L. 1953. Was reizt den Trauerfliegenschnapper (*Muscicapa hypoleuca*) zu futtern? Vogelwarte 16:157-164.
- WALKINSHAW, L. H. 1966. Studies of the Acadian Flycatcher in Michigan. Bird-Banding 37:227-256.
- WILLIAMSON, P. 1971. Feeding ecology of the Red-eyed Vireo *Vireo olivaceus* and associated foliage-gleaning birds. Ecology 41:129-152.

4117 Virginia Street, Fairfax, Virginia 22032. Received 7 November 1979. Final acceptance 22 February 1983.

Condor 85:163

© The Cooper Ornithological Society 1983

RECENT PUBLICATIONS

Marine Birds and Mammals of Puget Sound.—Tony Angell and Kenneth C. Balcomb III. 1982. Washington Sea Grant, Seattle, WA. 160 p. Paper cover. \$14.50. Puget Sound is known for its scenery and biological richness, yet human activities have degraded that environment and threatened its wildlife over the past century. Both sides are exposed in this fine book on the habitats of the region and the natural history of their marine birds and mammals. Its well-written text (by both authors) is lavishly illustrated with Angell's beautiful pen-and-ink drawings, and the combination has been handsomely designed. Each family or subfamily is introduced with a page or two about the general appearance and habits of its members, a blend of scientific information and the authors' observations. For each species, a one-column account (plus map of locality records) summarizes status, distribution, food, and critical habitat in the region. Additional data are given in more maps, charts, and a table in the appendix. The whole package describes with feeling these members of a marine community—and the dangers they face. While the book is aimed for those who live around Puget Sound, its theme has no boundary, and its illustrations will be admired by those who appreciate fine bird art. References, index.

A Bird-finding Guide to Ontario.—Clive E. Goodwin. 1982. University of Toronto Press. 248 p. Paper cover. \$12.50 Canadian. Source: University of Toronto Press, Toronto, Ontario, M5S 1A6, or 33 E. Tupper St., Buffalo, NY 14203. Ontario, a third larger than Texas, ranging from deciduous forest to tundra coast, contains small areas

and corridors whose avifaunas are well known, amidst vast areas of remote and inaccessible land and water. More than two hundred of the most popular and productive places to watch birds are discussed in a telegraphic, but readable style. Twelve simplified regional and local maps are designed to orient travelers who are equipped with a Provincial map. Lacks a comprehensive map for orientation. Includes systematic list of birds, and an index.—J. Tate.

Birding in Seattle and King County: Site guide and annotated list.—Eugene S. Hunn. 1982. Seattle Audubon Society. 170 p. Paper cover. \$7.50. Source: Seattle Audubon Society, 619 Joshua Green Bldg., Seattle, WA 98101. Companion to a field guide and slightly larger than one, this is a handbook for bird-finding in Seattle and its surrounding county. It first sketches the types of habitat that are embraced, from the city itself to montane forests. There follows a detailed guide to birding sites, illustrated with excellent maps. An annotated checklist (307 species), including charts of seasonal occurrence, summarizes information on the distribution of the birds and gives tips on identifying difficult species. Short but useful chapters offer preliminary lists of mammals, herps, and trees, and descriptions of special birding projects in the area. Uniquely for works of this kind, the book closes with a list of key habitat preservation issues throughout King County. The message: progress, if you will, from identifying and listing birds, to learning more about them and becoming active in conserving prize habitats. References.