Kansas Ornithological Society
BULLETIN
PUBLISHED QUARTERLY
Vol. 33 December, 1982 No. 4

HOST BEHAVIORAL DEFENSES TO COWBIRD PARASITISM

Karen L. Folkers

The Brown-headed Cowbird (*Molothrus ater*) is a widespread brood parasite in North America. This cowbird has been known to lay its eggs in the nests of 216 species of birds (Friedmann *et al.* 1977). Parasitism can cause the mortality of at least one egg since cowbirds frequently remove a host egg (Friedmann 1963). Parasitism may also be detrimental to survival of host young due to nestling competition (Payne 1977). The reactions of hosts to cowbird eggs vary greatly, but have been used to classify hosts into two categories, rejectors and acceptors (Rothstein 1975a). Rejectors simply remove the cowbird egg from their nest. This prevents nestling competition, but allows the loss of a host egg. Acceptors are hosts which do not remove the cowbird egg from their nest. The acceptance may be due to many factors, but most likely the host may not be able to differentiate between their own and a cowbird's egg. Those that can recognize the alien egg may often be too small to remove it. These acceptors not only lose the egg that the cowbird removes, but also suffer from nestling competition.

Prevention of parasitism would be an asset. This might be accomplished through aggressive nest guarding. For nest guarding to effectively prevent parasitism several factors must be present. The host must recognize cowbirds as a threat and be able to discriminate between cowbirds and other species. Furthermore, host behavior must be threatening enough to prevent the cowbird's approach and persistent enough to prevent parasitism.

The purpose of this study was to compare the defense against Brown-headed Cowbirds employed by certain acceptor and rejector species. I observed responses of Red-winged Blackbirds (*Agelaius phoeniceus*), Yellow Warblers (*Dendroica petechia*), Gray Catbirds (*Dumetella carolinensis*), and Yellow-headed Blackbirds (*Xanthocephalus xanthocephalus*) to cowbird models. Of these species, both the Red-winged Blackbird and Yellow Warbler are commonly parasitized acceptors. The catbird is a known rejector. The Yellow-headed Blackbird is seldom parasitized, only 16 cases reported by Friedmann *et al.* (1977), but is an acceptor species (Rothstein 1975b). Due to the added detriment of nestling competition, I predicted that acceptors would behave more aggressively towards cowbirds than rejectors. It is possible also to compare the defenses of frequently parasitized species and seldom parasitized species, and I also predicted that heavily parasitized hosts would have been selected to react more strongly than species seldom parasitized.

Methods

This study was conducted in Dickinson Co., Iowa. One site was the restored prairie at Iowa Lakeside Laboratory. A second area was the Freda Haffner Kettlehole Preserve. All testing was done in June and July 1982.

Four study skins were mounted on poles approximately 1 m in height. I used study skins of a female Brown-headed Cowbird, a male Brown-headed Cowbird, an Eastern Kingbird (*Tyrannus tyrannus*), and a Vesper Sparrow (*Pooecetes gramineus*). These models were placed within 1 m of an active nest. The model was left in position for 5 min., during which time the reactions of the nesting pair were recorded. The model was then replaced by another model and the test repeated. All four models were presented consecutively in a random order.

The aggressiveness of the nesting pair toward each model was rated by the scoring scheme of Robertson and Norman (1976). The intensity of aggressive behavior was scored as (1) distant ($\geq$ 5 m) silent observation; (2) close (< 5 m) silent observation; (3) distant alarm calling; (4) close alarm calling; (5) fly-by investigation; (6) nest attentiveness; (7) hovering above model; (8) distraction, such as the broken wing display; (9) attacking the model; and (10) dual attack by the pair. Duration of response was scored as (1) response given briefly; (2) response given several times or for up to 1 min.; (3) response given for 1-3 min.; (4) response given from 3-5 min. The total response for each nesting pair was then computed by taking the intensity score times its duration score summed for all behaviors observed during the testing period. Testing for statistical significance followed methods outlined in Sokal and Rohlf (1981).

Results

Red-winged Blackbirds, with a high incidence of parasitism, reacted with significantly more aggressiveness to the female cowbird model than to any other model (Friedmann's method of randomized blocks, $X^2=9.07$, $P<0.05$; Table 1). The strongest reaction of Yellow Warblers was also to the female cowbird model. The difference in warbler responses was not statistically significant because of the few nests I was able to test. These results suggest that these two species recognize the female cowbird as a threat. Despite the conclusion by Robertson and Norman (1976) that the reaction to male and female cowbird models was not noticeably different, my tests indicate that acceptors reacted much more aggressively to female cowbirds than to males. This would be appropriate, since it is the female cowbird that searches for and parasitizes host nests (Norman and Robertson, 1975). Redwing response to the other models (Eastern Kingbird, Vesper Sparrow and male cowbird) were equally intense and not significantly different from each other (Table 1).

Table 1. Mean response of each host species to models (Number of nests tested). See text for manner of determining score.

Host Species	Incidence of Parasitism[1]	Vesper Sparrow	Eastern Kingbird	Male Cowbird	Female Cowbird
Yel-head. Blackbird	0 / 9	22 (2)	56 (2)	29 (2)	26 (2)
Gray Catbird	0 / 6	6 (2)	7 (2)	4 (2)	7 (2)
Red-wing Blackbird	10 /29	22 (9)	22 (10)	29 (10)	49 (9)
Yellow Warbler	4 / 9	11 (1)	29 (3)	15 (3)	51 (1)

[1]Incidence of parasitism observed at Iowa Lakeside Laboratory in 1982; parasitized nests/total nests found.

The catbird reacted less aggressively than the other hosts to any model. These lower level responses consisted basically of close silent observation. The response of catbirds to either cowbird model was no stronger than their response to other models.

The Yellow-headed Blackbird, seldom parasitized and highly colonial, reacted aggressively to all four models, significantly more so to the Eastern Kingbird (Kruskal-Wallis test, $H=4.62$, $P<0.05$; Table 1).

Colonial redwings (i.e., those in the Kettlehole) were more aggressive than those nesting more dispersed in upland areas. Mean response to any model by colonial Red-winged Blackbirds was 34, while non-colonial redwings scored 12 (Kruskal-Wallis test, $H=4.81$, $P<0.05$). Their mean response to both cowbird models also contrasted greatly (but could not be shown statistically different): 44 for colonial redwings versus 12 for non-colonial redwings.

Mean response to female cowbird models by parasitized redwings was 14 while non-parasitized redwings averaged 59. The difference between these scores is statistically significant ($P=0.05$, Wicoxon 2 sample test).

Discussion

The increased aggressiveness of Red-winged Blackbirds and Yellow Warblers to

female cowbirds is easily understood. First, these two species were often parasitized in northwest Iowa and subjected to the negative effects of cowbird parasitism. Second, both species are acceptors, which not only suffer egg loss but also increased nestling competition. These detrimental effects could cause selection for recognition of and defense against female Brown-headed Cowbirds.

The increased aggressive response of colonial Red-winged Blackbirds could be due in part to the increased surveillance possible in a colony. Also, since the marsh colony area is likely of higher quality, the birds there were forced to compete more and only the more aggressive or experienced redwings were able to secure and hold a territory. Less aggressive and/or inexperienced birds, then, were forced to settle in upland areas. The lower level of aggressiveness in parasitized redwings may be why these pairs could be parasitized. Perhaps these pairs were first time breeders and did not recognize cowbirds as a threat to their reproductive success.

The Gray Catbird, a rejector species, received low scores against all models. However, catbird nest guarding has been shown effective in reducing or preventing cowbird parasitism (Scott 1977, Slack 1976).

Yellow-headed Blackbirds reacted aggressively to all models (mean score = 33). This species is highly territorial in the breeding season. The extremely high response to the kingbird model (56), rather than to either cowbird model, may reflect territorial defense behavior against a "black bird". Yellow-headed Blackbirds may have viewed the kingbird model as a neighboring redwing. This explanation is supported by the fact that the male cowbird model (also a "black bird") evoked the next highest response (29).

Acknowledgements

Kevin Drees, Adam Leff, Dean Cox, Peter Taft, Wade Olson, Mark Maffett, Sondra Jacobson and Peter Lowther assisted in locating nests. Peter Lowther commented on early drafts of this paper.

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—Box 173, Armstrong, Iowa 50514.

THE CARDINAL IN WINTER

Robert E. Gorton, Jr.

Populations living in a seasonal environment respond to fluctuations in resource quality and abundance with changes in population size and resource utilization (Fretwell 1972). An adaptation to times of seasonal resource depletion and thermal stress in birds may involve a shift in the social system of a population from a territorial system to one of flocking and/or group foraging, thereby increasing foraging efficiency and making it easier to detect predators. Likewise, the costs of

territorial patrol and defence are eliminated. To consider the details of winter social organization, I undertook a study of the Northern Cardinal (*Cardinalis cardinalis*). The cardinal is a common bird of woodland edges and thickets in Kansas (Bull and Farrand 1977), with a winter social system described as "intermediate" between resident and flocked (Rohwer 1975). Its size (20-23 cm) (Bull and Farrand 1977) and conspicuous coloration facilitate accurate observations. In this study, I sought answers to the following questions: 1) How large are winter flocks, and what is their sex composition? 2) What effect does temperature and depth of snow cover have on flock size? 3) How does flock size and population size change over time? 4) Are there sex-specific perch heights in winter, i.e. some kind of ecological segregation of males and females? and 6) What is the nature of interactions between individuals in a flock?

Methods

This study was undertaken in the Wildcat Creet valley region near Manhattan, Riley County, Kansas. It consisted of 16 field trips of approximately 2 hrs. each between 24 December 1981 and 8 April 1982, following the same route each trip. The study period was divided into five 3-week periods so that each period contained at least one field visit.

A flock was defined as three or more individuals in proximity to one another and moving as a unit, and a pair was defined as two individuals in proximity to one another and moving as a unit. The sex and vertical position of each individual were recorded, with the latter divided into four categories: ground, >0-3 m, >3-5m, and > 5 m. Perch height (i.e. vertical position) was recorded each time a bird was observed, while census data were taken only on the initial pass through the study area to avoid counting the same bird twice. Weather was noted on each visit, with ground cover considered significant if the snow was at least 2.5 cm in depth. Interactions between individuals were recorded as they occurred.

Results

The average number of individuals censused increased from 13.7 birds/day between 24 December-14 January to 34 birds/day between 5-25 February. The population then declined to 16-16.5 birds/day between 26 February until the end of the study (Table 1). Similarly, mean flock size peaked between 5-25 February, dropping to 0 with the onset of territorial behavior. Numbers of flocks observed in a given time period generally decreased over the study period. Flock size, however, tended to increase over time until the onset of territorial establishment.

Table 1. Summary of data from field visits in each time period. Average flock size is given with 1 S.D.

	24 Dec.-14 Jan.	15 Jan.-4 Feb.	5-25 Feb.	26 Feb.-18 Mar.	19 Mar.-8 Apr.
Ave. No./day	13.7	18	34	16.5	16
Ave. flock size	4.2 ± 1.3	4.6 ± 1.3	6.7 ± 2.9	6.3 ± 4.3	0
Total No. flocking	63	42	47	25	0
%	57.2	75.0	69.1	75.8	
No. flocks observed	14	7	7	4	0
No. in pairs	36	14	20	8	14
%	29.1	25.0	29.4	24.2	87.5
No. alone	11	0	1	0	2.
%	10.0		1.5		12.5
Ave. male/female ratio	1.4	1.4	1.3	1.4	1.0
Ave. temp. (°C)	-4.5	-4.0	-2.5	+7.5	+4.0
Significant ground cover?	yes	no	yes	no	no

The percentage of birds found in pairs was rather constant until the end of March, while the percentage of individuals observed alone dropped to virtually

none through most of the winter, increasing again at the end of the study period, due to unmated males (Table 1). The percentage of individuals in flocks increased to an approximate plateau for nine weeks (15 January-18 March), until flocking disappeared. Sex ratios within flocks were virtually constant over the study period (1.3-1.4 males/females). As temperature increased, flock size increased, as did variance in flock size (Table 1). Degree of ground cover had no observable effect on flock size.

No significant differences in perch height choice were observed between males and females in any of the five time periods (Table 2) (r X c Chi-square test; Chapman and Schaufele 1970). However, both sexes tended to choose lower perch heights early and late in the study, and chose less discriminantly in February and March.

Table 2. Numbers of individuals observed at particular perch heights in each time period.

Time	Sex	Ground	0-3 m	3-5 m	5 m
24 Dec.-14 Jan.	Male	15	41	16	3
	Female	10	40	9	6
15 Jan.-4 Feb.	Male	3	24	1	4
	Female	1	23	2	3
5-25 Feb.	Male	1	14	4	17
	Female	0	19	6	9
26 Feb.-18 Mar.	Male	0	10	5	4
	Female	3	7	5	2
19 Mar.-8 Apr.	Male	0	7	1	1
	Female	0	7	0	0

Intraflock interactions usually consisted of males supplanting other males from a perch. Continued pursuits occurred, but were far less common. Of 11 such instances, only one occurred between two females. First territorial song was heard on 28 January, with the first clearly territorial interactions occurring on 13 February.

Discussion

Cardinals were observed primarily in flocks, less commonly in pairs, and occasionally alone. A given individual probably moves about within these three categories in a given winter. An interesting observation was that there were particular areas in which at least a pair of birds could always be found; sometimes more, but never less. Whether they were the same pair was unclear; individuals were not marked. One may speculate, however, that a pair might remain true to an area, joining a flock as the flock moves into this area, then remaining behind when the flock moves on. Alternatively, pairs may change within the area. In any case, some areas were constantly occupied throughout the winter.

Flocks tended to be of moderate size (4-6 individuals), with sex ratios slightly favoring males. Pairing probably occurs early in the winter in many cases (or perhaps in fall), since some pairs, even when in a flock, moved as a pair, with movement by one individual followed by movement in the same direction by another of the opposite sex.

Ground cover had no obvious effect on flock size, while temperature may have had some effect. Increasing temperature is weakly correlated with increasing flock size, although this may be a spurious correlation insofar as it was impossible to separate this correlation from increasing flock size with time. Population size increased through the winter, then decreased to a spring population size of 16-16.5 birds, approximately 48 percent of the maximum winter population. As winter progresses, foraging areas may become increasingly scarce and variable in

quality, pushing more and more individuals into smaller areas. The more difficult resources become to find, the more advantageious it may become to have more individuals looking for them. Thus, different environmental conditions induce different optimal flock sizes. As the weather grows milder, more insects become active and available as prey, and more buds become available as well. Territorial behavior disperses individuals again with the onset of the nesting cycle. The trend was for fewer flocks with more individuals per flock, for reasons described above. These flocks may occasionally coalesce.

No sex specific differences in perch or foraging heights and sites were observed. Cardinals of both sexes tended to forage on or near the ground and in shrubs and bushes. The tendency toward higher perches coincided with the onset of territorial advertisement.

Intraflock interactions usually involved males and seemed to involve dominance, taking the form of perch site usurpation. As pairs drop out of flocks, the dominant male may get first choice of territories with his attendant female. If birds of a flock tend to settle in the same area, familiarity of individuals and their dominance status may minimize agonistic interactions between occupants of adjacent territories. Pairs that never leave an area have the advantage of site occupation, and are free to join a flock temporarily for resource search and predator avoidance. Such areas may well be the optimal areas for later fledgling success, to the extent that it is correlated with resource abundance.

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Div. Biol., Kansas State Univ., Manhattan, KS 66506.

Red-breasted Nuthatch Nesting in Sedgwick County.—The Red-breasted Nuthatch (*Sitta canadensis*) is a winter resident throughout Sedgwick County. Nesting was suspected in 1981 when a pair was seen regularly at the feeders of Nathan and Geula McDonald in south Wichita from 2 April through 12 June. A search was made of the surrounding area, but no nest was discovered.

At the sunflower seed feeders of Forrest and Edith Long in east Wichita two individuals were seen throughout the winter months of 1982. In early March, Mr. Long erected a wren house in a 12 m white birch (*Betula alba*) growing approximately 3 m from his patio. The house consisted of an unseasoned pine log, with bark, approximately 30.5 cm long and 15.2 cm in diameter. A 10 cm cavity had been bored lengthwise into the log and a 15 x 15 cm cedar top was screwed over the opening. Approximately 10 cm down from the top a 2.2 cm opening was drilled as an entrance for the wrens. There was no perch below this opening.

In late March Mr. Long observed the two Red-breasted Nuthatches attempting to enter the wren house. They would not fit through the opening so a wood rasp was used to enlarge the opening to 3.2 cm. The house was then re-erected approximately 6 m high. In April, pine resin was seen around the entrance hole and Mr. Long observed the nuthatches hovering for an instant before diving through the opening. Believing the resin was oozing from the pine log and impeding the entrance of the birds, he removed this resin twice. Later he learned that nuthatches were bringing resin in their bills from nearly pine trees, and subsequent resin was left around the opening (Fig. 1).

On 23 May 1982 the adult Red-breasted Nuthatches were seen carrying insects into the nesting box. This is assumed to be the hatching date since daily observations revealed no insect carrying on earlier dates. On 4 June 1982, I spent several hours observing and photographing the nuthatches. With an extension ladder I climbed the white birch and removed the top of the nesting box. Inside

Figure 1. Adult at entrance to next box. Note the pine resin around the entrance hole which had been brought to the nest site by the adults.

Figure 2. Adult at entrance to nest box. At 16 days old the young came to nest entrance to accept food from parents.

were three young birds. The bottom of the cavity was lined with wood chips that had been removed from the inside walls. After replacing the top and while I was still next to the nest box an adult arrived, looked briefly at me and plunged into the entrance hole. On 8 June, the young birds were seen sticking their heads from the entrance to accept food from their parents (Fig. 2). On 13 June 1982 neither the young birds or the adults were seen. I assumed they fledged early that morning.

Two sunflower seed feeders, below the nesting box, provided food for the adults throughout the nesting period. The adults were often seen leaving the nest, stopping at a feeder for a few seeds, and then flying off to find insects for their young. They were never observed feeding seeds to the young. It is suspected that the abundance of pines in this area of Wichita, the white birch, and the pine bird house all contributed to the occurrence of Red-breasted Nuthatches nesting in Sedgwick County, Kansas.—*Robert J. Gress, Naturalist, Wichita Board of Park Commissioners, 11th Floor, City Hall, 455 North Main, Wichita, Kansas 67202.*