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VEGETATION AROUND PARASITIZED AND NON-PARASITIZED NESTS WITHIN DECIDUOUS FOREST

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Abstract.—We quantified the vegetation in 0.04-ha circles around 93 nests from 12 forest-dwelling neotropical migrants to determine whether the structure of the vegetation influenced the probability of parasitism. Forty-five nests were parasitized by Brown-headed Cowbirds (*Molothrus ater*) and 48 were not parasitized. Nests were located within deciduous woods in south-central Wisconsin. We compared 16 variables including percent cover at varying heights, densities of shrubs and trees, and number of dead trees (snags). For all species combined, nests parasitized by cowbirds were characterized by a more open sub-canopy (percent cover 3–10 m) and canopy (percent cover > 10 m) and more ground cover (percent cover 0–0.5 m). Associated with these differences were a higher density of small shrubs and saplings (0.5–1 m) and a lower density of tall shrubs (>5 m) and small trees (7–14.5 cm DBH). Proximity of the nest to a snag did not increase the risk of parasitism. We speculate that the differences in vegetative structure around parasitized and non-parasitized nests were due primarily to differences in the host species composition between the two groups and resulted from cowbird nest-searching strategies and densities of host nests. For Acadian Flycatchers (*Empidonax virescens*), the only species for which we had a sufficient sample size to make a within-species comparison, parasitized nests were associated with a more open canopy than non-parasitized nests. None of the other vegetative variables measured differed between the two groups. Our results suggest that species nesting within small forest openings may be particularly vulnerable to cowbird parasitism. However, for a variety of reasons, we do not recommend management at a micro-habitat scale. Instead, we recommend that managers minimize the risk of parasitism through landscape-level management where large areas of contiguous forest are maintained.

VEGETACIÓN EN LOS ALREDEDORES DE NIDOS PARASITADOS Y SIN PARASITAR EN UN BOSQUE DECIDUO

Sinopsis.—Cuantificamos la vegetación en círculos de 0.04 hectáreas en los alrededores de 93 nidos pertenecientes a 12 especies de migratorios neotropicales para determinar si la estructura de la vegetación podía influir en la probabilidad de los nidos ser parasitados. De los nidos estudiados 45 fueron parasitados por el tordo *Molothrus ater* y 48 no fueron parasitados. El trabajo se llevó a cabo en bosques deciduos de la parte surcentral de Wisconsin. Se compararon 16 variables incluyendo el porciento de covertura a varias alturas, densidad de árboles y arbustos, y el número de árboles muertos. Para todas las especies, los nidos parasitados se caracterizaron por un sub-docel (porciento de covertura de 3–10 m) y un docel (porciento de covertura > 10m) más abierto y mayor cubierta en el suelo (porciento de cobertura 0–0.5 m). Asociado a estas diferencias se encontró una mayor densidad de arbustos y renuevos (0.5–1 m) y una menor densidad de arbustos altos (>5 m) y arboles pequeños (7–14.5 cm DBH). La proximidad de un nido a un árbol muerto no incrementó la probabilidad de ser parasitado. Se infiere que las diferencias en la estructura de la vegetación en los alrededores de nidos parasitados y no-parasitados se debió principalmente a diferencias en la composición de especies huéspedes entre los dos grupos y fue el resultado de las estrategias de búsqueda por parte de los tordos y la densidad de nidos de especies

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hospederas. Para *Empidonax virens,* la única especie de la cual tenemos suficientes datos para hacer comparaciones, los nidos parasitados estuvieron asociados a un docel más abierto que la de los nidos no-parasitados. No se encontró diferencia entre las otras variables estudiadas en los dos grupos de aves. Nuestros resultados sugieren que las especies que anidan en pequeños claros del bosque son particularmente vulnerables al parasitismo reproductivo. Sin embargo, por una serie de razones, no recomendamos el manejo a escala de microhábitat. Recomendamos, que los manejadores minimicen el riezgo de parasitismo con medidas dirigidas, a reducir los bordes y a mantener áreas contiguas de grandes extensiones de bosques.

The Brown-headed Cowbird (*Molothrus ater*) parasitizes a wide variety of species within the eastern deciduous forest (Friedmann 1929, Friedmann et al. 1977). Many of these host species have declined in number during recent decades, and the declines have been attributed in part to poor reproductive success resulting from brood parasitism (Brittingham and Temple 1983, Mayfield 1977, Robinson et al. 1993, Robinson et al. 1995). In an earlier paper, we showed that the intensity of parasitism within deciduous forest is associated with the proximity of open habitat to the nest (Brittingham and Temple 1983). In this manuscript, we examine structural features of the vegetation, including the presence of dead trees (snags) near the nest, that may be associated with higher rates of brood parasitism.

The structure of the vegetation is often used by birds as a proximate factor in establishing territories (Hilden 1965). For many species, the structure and composition of the vegetation where a bird is found occurs in a predictable pattern, and certain features are identifiably different between areas where the bird is present and where it is absent (e.g., Ambuel and Temple 1983, James 1971). Similarly, within a particular habitat, the microhabitat around the nest site often differs in a predictable pattern from random points within the surrounding vegetation (e.g., Holway 1991). Although the cowbird does not build a nest and parasitizes a wide range of species, the probability that a nest is parasitized may still be associated with a particular microhabitat as a result of nest-searching strategies or host densities. If the frequency of parasitism varies with structural features of the vegetation, land managers may be able to predict where cowbird parasitism will most likely occur and which species will be particularly vulnerable, and to develop recommendations to reduce the probability of parasitism.

Robbins (1979) recommended that snags should not be left within the forest interior because they may be used by cowbirds for watching host nest-building activity. He suggested that the presence of a snag would, in effect, introduce edge conditions and increase the probability of a nearby nest being parasitized. However, removal of snags within the forest interior is a controversial management recommendation because of the value of these dead trees as both cavity trees and foraging sites for numerous forest birds (e.g., DeGraaf and Shigo 1985, Evans and Conner 1979). We tested the utility of Robbins' (1979) recommendation by determining whether the number of dead trees were higher near parasitized nests than non-parasitized nests and whether nests near a dead tree were more likely to be parasitized than nests farther away.

TABLE 1. Avian species and nests included in survey of vegetation, Baraboo, Wisconsin, 1979–1980.

Species	Number of nests located[a]		Number of nests included in survey of vegetation	
	Non-parasitized	Parasitized	Non-parasitized	Parasitized
Acadian Flycatcher (*Empidonax virescens*)	32	5	31	5
Least Flycatcher (*Empidonax minimus*)	4	1	4	1
Wood Thrush (*Hylocichla mustelina*)	3	12	1	9
Veery (*Catharus fuscescens*)	2	3	2	3
Red-eyed Vireo (*Vireo olivaceus*)	0	1	0	1
American Redstart (*Setophaga ruticilla*)	3	1	3	1
Hooded Warbler (*Wilsonia citrina*)	0	4	0	4
Mourning Warbler (*Oporornis philadelphia*)	0	1	0	1
Louisiana Waterthrush (*Seiurus motacilla*)	1	0	0	0
Ovenbird (*Seiurus aurocapillus*)	3	12	3	11
Scarlet Tanager (*Piranga olivacea*)	1	1	1	1
Indigo Bunting (*Passerina cyanea*)	2	8	2	7
Rose-breasted Grosbeak (*Pheucticus ludovicianus*)	4	1	1	1
Total	55	50	48	45

[a] Brittingham and Temple (1983).

STUDY AREA AND METHODS

During the summers of 1979 and 1980, we located 105 nests of forest songbirds that were potential hosts of the Brown-headed Cowbird (Brittingham and Temple 1983, Table 1). Our study site was approximately 1,000 ha of deciduous forest located in the Baraboo Hills, Sauk County, Wisconsin (Brittingham and Temple 1983). Fifty of the nests were parasitized and 55 were not parasitized.

We quantified the vegetation in a 0.04-ha circle around 93 of the nests (Table 1) using methods described by James and Shugart (1970) with some minor modifications (Ambuel and Temple 1983). We measured percent cover with an occular tube in four height classes (0–0.5 m, herbs and low shrubs; 0.5–3.0 m, shrubs and saplings; 3.0–10.0 m, sub-canopy; and >10 m, canopy) at 20 randomly selected points within each 0.04-ha circle and calculated the mean percent cover for each height class. We

tallied the number of shrub and sapling (DBH < 7 cm) stems along two arm-length transects (≈2-m wide) that bisected the 0.04-ha circle. Shrubs and saplings were recorded in four height classes (0.5–1 m, 1–3 m, 3–5 m, and >5 m). Trees within the 0.04-ha circle were tallied in five size classes based on diameter at breast height (DBH), (7–14.5 cm, 14.5–22 cm, 23–37 cm, 37–52 cm, and >52 cm). We also recorded the number of dead snags. A dead snag was defined as any standing dead tree regardless of species or height.

For each variable, we calculated the mean value for non-parasitized nests (n = 48) and for parasitized nests (n = 45), and we tested for differences between the two groups using a t-test. To test whether nests in close proximity to a dead snag were more likely to be parasitized, we divided the nests into two groups, those within 11.3 m (radius of the 0.04-ha circle) of a dead snag and those farther than 11.3 m from a dead snag. We calculated the percentage of nests parasitized in each group and used a chi-square test to test for differences between the two groups. For Acadian Flycatchers, the only species for which we had an adequate sample of both parasitized nest and non-parasitized nests (Table 1), we compared the vegetation between the two groups of nests in the manner described above.

RESULTS

Nests parasitized by Brown-headed Cowbirds were characterized by a more open sub-canopy (percent cover 3–10 m) and canopy (percent cover > 10m) and more ground cover (percent cover 0–0.5 m) than non-parasitized nests (Table 2). Associated with these differences were a significantly higher density of small shrubs and saplings (0.5–1 m) and a lower density of tall shrubs (>5m) and small trees (7–14.5 cm DBH) around parasitized nests (Table 2). The difference in the total number of shrubs and saplings was marginally significant (P = 0.06) and was higher around parasitized nests (Table 2). None of the other variables we measured differed significantly between parasitized and non-parasitized nests. Fifty-three nests were located within 11.3 m of a snag, and 40 nests were located farther than 11.3 m from a snag. The percentage of nests that were parasitized did not differ (X^2 = 0.32, df = 1, P > 0.5) between the two groups (50.9% versus 45.0%). In addition, the number of dead trees near the nest did not differ between parasitized and non-parasitized nests (Table 2). For Acadian Flycatchers, the canopy (percent cover > 10m) was more open around parasitized nests (n = 5, $\bar{x} \pm$ SE = 89.0 ± 5.3) than around non-parasitized nests (n = 31, $\bar{x} \pm$ SE = 96.3 ± 0.9). No other variables we measured differed between the two groups.

DISCUSSION

Levels of cowbird parasitism of forest songbirds vary regionally (Hoover and Brittingham 1993) and within a region vary at a landscape scale with rates being highest near openings, edges, or other locations such as livestock corals that provide ample feeding opportunities for cowbirds (e.g.,

TABLE 2. Structure of the vegetation in a 0.04-ha circle around non-parasitized nests and nests parasitized by Brown-headed Cowbirds in Baraboo, Wisconsin, 1979–1980.

Variable	Mean ± SE per nest			
	Non-parasitized $n = 48$	Parasitized $n = 45$	t	P
% Cover				
0–0.5 m	42.8 ± 2.8	52.9 ± 3.7	2.18	0.03
0.5–3 m	37.1 ± 3.3	37.9 ± 4.7	0.13	>0.8
3–10 m	58.4 ± 3.1	46.0 ± 3.2	2.76	0.007
>10 m	88.1 ± 3.0	76.1 ± 4.2	2.33	0.02
No. shrubs and saplings/0.04 ha				
0.5–1 m				
1–3 m	213.7 ± 22.4	303.0 ± 38.7	2.03	0.04
3–5 m	165.7 ± 27.0	207.9 ± 34.3	0.97	>0.3
>5 m	17.7 ± 2.5	16.2 ± 3.1	0.38	>0.7
Total no. shrubs and saplings	16.3 ± 2.0	9.4 ± 1.8	2.57	0.01
	413.4 ± 38.9	536.5 ± 52.7	1.90	0.06
No. of trees/0.04 ha				
7–14.5 cm (DBH)	9.0 ± 0.8	6.3 ± 0.6	2.57	0.01
14.5–22 cm (DBH)	6.6 ± 0.6	5.5 ± 0.5	1.35	>0.1
23–37 cm (DBH)	6.8 ± 0.5	8.0 ± 0.9	1.31	>0.1
37–52 cm (DBH)	3.2 ± 0.3	2.7 ± 0.3	1.21	>0.2
>52 cm (DBH)	1.0 ± 0.2	0.8 ± 0.2	0.68	>0.4
Total no. trees	26.6 ± 1.6	23.4 ± 1.5	1.46	>0.1
No. dead trees/0.04 ha	1.2 ± 0.2	1.6 ± 0.3	0.90	>0.3

Brittingham and Temple 1983, Gates and Gysel 1978, Robinson et al. 1995, Rothstein et al. 1980, Thompson et al. in press, Verner and Ritter 1983). Results from the current study suggest that parasitism rates also vary with the microhabitat surrounding the nest.

Differences in the structure of the vegetation in the vicinity of parasitized and non-parasitized nests may reflect the nest-searching strategies used by the cowbird or may result from the cowbird's response to local variation in host densities. Cowbirds locate nests to parasitize primarily by watching host nest-building activity (Friedmann 1929, Norman and Robertson 1975). A relatively open canopy and sub-canopy with a dense understory would enable cowbirds to attain an elevated perch with an unobstructed view of host nest-building activities below, thus improving their efficiency at finding nests. In open marsh habitat, cowbird parasitism is highest in marshes with a high density of trees around the perimeter presumably because the cowbirds use the trees as observation perches to watch the activity of the birds below and to locate nests (Freeman et al. 1990).

Cowbirds may also be attracted to small openings within the canopy because of locally high host densities. Ambuel and Temple (1983) surveying birds and vegetation on the same study site where we conducted our research found that densities of birds were greatest where small open-

ings within the canopy were associated with dense undergrowth particularly of shrubs. Other researchers (e.g., Johnson and Temple 1990) have speculated that cowbirds concentrate their nest-searching activities in local areas where host densities are high, and Thompson et al. (in press) found that, at least in some areas, cowbird abundance is correlated with host abundance. Therefore, the structural features that are associated with high levels of parasitism are also associated with both ease of observation and high host densities.

Differences in the structure of the vegetation between parasitized and non-parasitized nests could occur if, for any particular host species, cowbirds select nests associated with a more preferred microhabitat over nests associated with less preferred microhabitat. For one species, the Acadian Flycatcher, sample sizes were sufficient to compare parasitized and non-parasitized nests. As predicted, parasitized nests were associated with a more open canopy, but none of the other variables measured differed between the two groups lending weak support to this hypothesis. However, additional data including both parasitized and non-parasitized nests of a variety of species would be needed to adequately test this hypothesis. Secondly, differences in the structure of the vegetation between parasitized and non-parasitized nests could result from differences in the host species composition between the two groups (Table 1). Most species for which we had adequate sample sizes were either parasitized very rarely (e.g., Acadian Flycatcher) or were very heavily parasitized (e.g., Indigo Bunting, Wood Thrush) suggesting that one of the factors influencing host preference may be the microhabitat associated with the nest.

Our finding that dead trees near a nest did not increase the probability that the nest would be parasitized does not support Robbins' (1979) hypothesis. Our results also differ from those of Anderson and Storer (1976) who found that the number of Kirtland's Warbler (*Dendroica kirtlandii*) nests that were parasitized was higher when snags were present near the nest and decreased as the snag was located farther from the nest. They concluded that cowbirds were, in fact, using these snags as observation perches. We believe our results differ from those of Anderson and Storer (1976) because of structural differences between jack pine (*Pinus banksiana*) stands where Kirtland's Warblers nest and deciduous forest habitat. Jack pine stands are fairly open, and snags provide female cowbirds with an extensive view of nest building activities below. In deciduous woods, snags may be located above or below the forest canopy. Snags below the canopy will not provide a better observation perch than exposed branches of living trees, and the latter are plentiful. Dead snags above the canopy will provide the female with an unobstructed view of the canopy, but the female will not be able to observe the nest building activity of the songbirds below the canopy. Consequently, we concur with the recommendations of others who have suggested that snags be retained within the forest whenever possible because of their value as cavity trees and foraging sites (e.g., DeGraaf and Shigo 1985, Evans and Conner 1979).

In conclusion, our results suggest that within forest habitat, species that

nest in shrub cover within small openings may be particularly vulnerable to cowbird parasitism. Because these small openings also support high densities of birds (e.g., Ambuel and Temple 1983) and provide nesting habitat for a variety of neotropical migrants including Hooded Warblers and Kentucky Warblers (*Oporornis formosus*), elimination of these openings is not recommended. In addition, because most of these small openings are created by natural events such as wind thrown trees it would be extremely difficult to eliminate them. Therefore, instead of managing at a microhabitat scale, managers may be most successful at minimizing the risk of cowbird parasitism through landscape-level management where large areas of contiguous forest that include core areas of forest interior away from edges or openings are maintained (Robinson et al. 1993).

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