

York involved an extra "conspecific" male in 3 of 4 instances (in 1 of these both males were hybrids), and in the 4th, involving 3 Blue-wings, the sex of the helper was apparently not determined. But in no case was overt aggression among the birds reported. Apparently, the resident males tolerated the helpers. In the Long Island cases, the males were adults, one of which bred in the same season as it "helped" another pair; the other may have bred, as it was later seen feeding young along with a female.

Our Blue-wing did not feed the young on most occasions when it was near the nest with food and perhaps should not be considered a nest helper. Other explanations seem possible. The Blue-wing may have lost its offspring, mate, or both to predators at a time when territorial and courtship drives were strong. Or, as Blue-wings are scarce in this area, it could have failed to find a mate and attempted to establish ownership of a space containing an acceptable female. As it frequently appeared to make advances to the Golden-wing female we favor the latter explanation or some variation of it.

Whatever the reasons advanced to explain the Blue-wing's behavior, the male Golden-wing's response might be expected. Lack of territorial response to heterospecifics is the rule in these birds (Gill and Murray 1972, Ficken and Ficken 1968). The Golden-wing male would be expected not to chase Blue-wings from his territory, and in the absence of a tendency to fight the Blue-wing, simply fled from the aggressor. The adoption of an inconspicuous habit may help avoid aggression, as reported by Murray and Gill (1976) for a case involving a Blue-wing and a Golden-wing in Michigan.

The interactions we watched appear to be new to the literature, but we see no clear interpretation of them. This situation may be indicative of stress upon individuals of the rarer form, especially when the other form is also not common (Murray 1974). Our Blue-wing's aggressiveness may be relevant to the reported replacement of Golden-wings by Blue-wings elsewhere. We believe Blue-wings to be increasing in abundance in southwestern Virginia, making this region worth watching as a possible developing zone of interaction between these two warblers.

We thank Frank B. Gill for reading a draft of this paper and for letting us see his and Murray's manuscript on these warblers.

LITERATURE CITED

- FICKEN, M. S., AND R. W. FICKEN. 1968. Territorial relationships of Blue-winged Warblers, Golden-winged Warblers, and their hybrids. *Wilson Bull.* 80: 442-451.
- GILL, F. B., AND B. G. MURRAY, JR. 1972. Discrimination behavior and hybridization between Blue-winged and Golden-winged Warblers. *Evolution* 26: 282-293.
- MEYERRIECKS, A. J., AND J. BAIRD. 1968. Agonistic interactions between Blue-winged and "Brewster's" Warblers. *Wilson Bull.* 80: 150-160.
- MURRAY, B. G., JR., AND F. B. GILL. 1976. Behavioral interactions of Blue-winged and Golden-winged Warblers. *Wilson Bull.* 88: 231-254.
- MURRAY, J. W. 1974. A check-list of the birds of Montgomery County, Virginia. *Raven* 45: 55-70.
- SHORT, L. L., JR. 1963. Hybridization in the wood warblers *Vermivora pinus* and *V. chrysoptera*. *Proc. 13th Intern. Ornithol. Congr.*: 147-160.
- . 1964. Extra helpers feeding young of Blue-winged and Golden-winged Warblers. *Auk* 81: 428-430.

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Adaptive significance of cowbird egg distribution.—From an examination of the distribution of the eggs of Brown-headed Cowbirds (*Molothrus ater*) among the hosts in a community, Preston (1948, *Ecology* 29: 115-116) reasoned that if female cowbirds distributed their eggs randomly among the available hosts' nests, then the probability that a nest will have 0, 1, 2, 3 . . . cowbird eggs is equal to each successive term in a Poisson series. The expected number of nests in each category could then be predicted by multiplying each respective frequency by the total number of nests in the sample. After examining five reports on host nests in this manner Preston found that the distribution of cowbird eggs among all the nests in each sample failed to fit the theoretical distribution nearly so closely as when he analyzed only the parasitized nests in each sample and just considered the distribution of cowbird eggs laid after the first one in each nest. He concluded from this analysis that the first cowbird egg is placed in a nest nonrandomly,

but all subsequent cowbird eggs are randomly distributed. The nonrandomness Preston observed was attributed to cowbird preference and/or avoidance of certain hosts' nests.

Mayfield (1965, *Condor* 67: 257-263) similarly analyzed additional host data and obtained results similar to Preston's, but he rejected Preston's interpretation and offered an alternative hypothesis to explain his results. Mayfield reasoned that a deficit probably exists in the number of observed one-egg nests, because some hosts abandon a nest the moment it is parasitized. He also reasoned that an individual cowbird might be more apt to lay in a nest where one cowbird egg had already been laid, as this would indicate the host is reluctant to abandon. Reasoning that abandoned nests are much less likely to be discovered, Mayfield felt that the data would be more realistic if the number of one-egg nests were increased by 10-15%. (The exact percentage, though chosen arbitrarily, was determined according to the difficulty of nests to be found and the tendency of species to abandon.) After increasing the number of one-egg nests, Mayfield obtained a remarkably close fit between the Poisson and the observed distributions of subsequent cowbird eggs. Thus, Mayfield concluded that the nonrandomness observed in the egg distributions was not due to cowbird behavior but due to sampling errors caused by early nest abandonment of some hosts.

Mayfield also suggested that exceptional data in his analysis that failed to fit the theoretical expectations for both the total cowbird egg and subsequent cowbird egg distributions might be due to such peculiarities as (1) exceptionally high rates of parasitism, (2) a relative shortage of host nests, and/or (3) any exercise of preferences for certain hosts' nests or avoidance of others. This reasoning suggests that cowbirds may have different strategies in different host communities.

The following is an analysis of cowbird egg distribution in a host community that exhibits some of the peculiarities mentioned above. I believe these factors may have significance in the interpretation of the results.

During 1974 and 1975 in the Flint Hills of northeastern Kansas, I studied brood parasitism by the Brown-headed Cowbird of three prairie, ground-nesting species, the Grasshopper Sparrow (*Ammodramus saviannarum*), the Dickcissel (*Spiza americana*), and the Eastern Meadowlark (*Sturnella magna*). The nests of the different host species were combined into one total for the analysis, as they are all ground nesters, and breeding territories overlap one another extensively. The three species had a combined incidence of parasitism of 70% with a mean of 2.7 cowbird eggs per parasitized nest. Only 26% of the parasitized nests contained but one cowbird egg, contrasting significantly with the data analyzed by Mayfield and Preston in which approximately 60% of the parasitized nests contained only one cowbird egg.

Comparisons of the observed egg distributions and those predicted from a Poisson, i.e. random, distribution are illustrated in Tables 1 and 2. The expected values were generated from calculations discussed by Preston (op. cit.) and Mayfield (op. cit.).

The cowbird eggs are not distributed randomly among the hosts' nests in this community (Table 1), suggesting some degree of preference or avoidance being exercised by female cowbirds, along with the likelihood that some nests are easier for female cowbirds to find than others. Table 2 shows that sub-

TABLE 1
DISTRIBUTION OF COWBIRD EGGS

	Cowbird eggs per nest						Nests	Eggs	P ¹
	0	1	2	3	4	≥ 5			
Observed	19	14	13	14	5	7	72	144	.01
Calculated	9.7	19.5	19.5	12.9	6.5	3.8			

¹ P is the approximate value of the significance probability for Chi-square Test of Goodness-of-Fit. Probability of 0.05 or larger is taken to indicate adequate fit. The 72 nests consist of 38 Eastern Meadowlark nests, 20 Dickcissel nests, and 14 Grasshopper Sparrow nests.

TABLE 2
DISTRIBUTION OF SUBSEQUENT COWBIRD EGGS

	Cowbird eggs per nest					Nests	Eggs	P
	0	1	2	3	≥ 4			
Observed	14	13	14	5	7	53	91	.30
Calculated	10	16.4	13.7	7.8	5.1			

sequent eggs are, indeed, distributed virtually randomly among host nests, though the probability value is not nearly so large as those obtained by Mayfield's analysis. As previously mentioned, Mayfield further increased the similarity of the observed and theoretical distributions by increasing the number of one-egg nests. This I did not do because I felt that such an adjustment introduces a bias as significant as the one that is removed. If one argues that a certain percentage of one-egg nests would have been found if the hosts had not abandoned, then one must also assume that if those nests had remained active, some would have contained one parasite egg, some two eggs, some three eggs, etc. The distribution of these nests should follow the distribution of the sample of nests that were found, rather than just affecting one class of nests, i.e. one-egg nests.

The significance of recognizing that additional cowbird eggs would have been laid in some of the undiscovered nests, had the hosts not abandoned, is as follows. If the abandoned one-egg nests had remained active, additional cowbird eggs would have been laid in a number of them. As the nests were abandoned, these additional eggs were either (1) laid in nests not previously parasitized (thus increasing the number of observed one-egg nests), or (2) laid in nests previously parasitized (thus increasing the number of multiple egg nests). Consequently adjustments made to account for the effects of nest abandonment should not be restricted to only one class of nests and should also involve the subtraction of some observed one-egg nests, as these resulted from previous nest abandonment.

Also, in the system I studied, several types of supportive evidence exist for Preston's (op. cit.) hypothesis that the initial cowbird egg to be laid in a nest may be done so with more deliberation than subsequent eggs. In a number of instances, as illustrated in Figures 1 and 2, a remarkable similarity was noted between the appearance of the host eggs and those of the initial cowbird egg to be laid in the nest. This resemblance was noted in each of the six nests that were found before the first cowbird egg was depicted. Subsequent eggs seldom exhibited the same similarity, except on rare occasions when the initial female apparently returned to lay a second egg. Three or more eggs from the same female were never seen. This interpretation assumes that an individual female cowbird lays eggs that are consistent in size and appearance, an assumption supported by Walkinshaw (1949, *Wilson Bull.* 61: 82-85).

This suggests that the initial egg may have been deliberately placed in a particular host nest, while subsequent eggs were laid less discriminately. This behavior pattern should be the result of female cowbirds avoiding nests in which they had laid the initial cowbird egg, especially if their egg closely resembles the host's eggs in appearance. This would reduce the possibility of mistaken egg ejections, i.e. a cowbird mistakenly removing one of her own eggs as she attempts to remove a host egg. The frequent occurrence of mistaken ejections in this system is discussed in more detail elsewhere (Elliott MS), but it appears to be largely due to the high incidence of multiple parasitism.

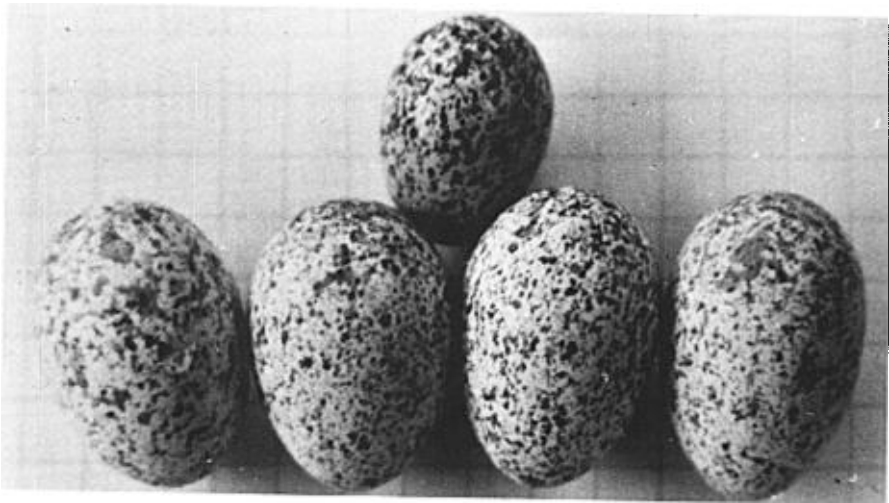


Fig. 1.—Illustrates the similarity in the markings of four Eastern Meadowlark eggs and cowbird egg laid in the same nest.

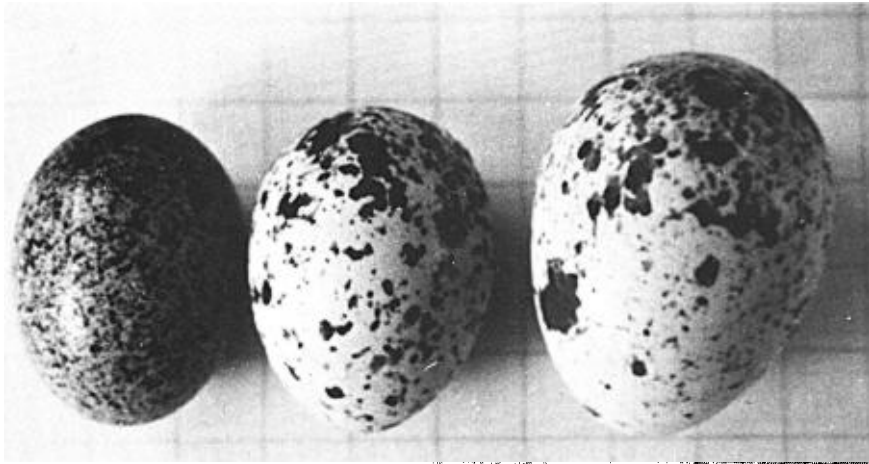


Fig. 2.—Illustrates the similarity in appearance of an Eastern Meadowlark egg (right) and the initial cowbird egg to be laid in the nest (middle). The cowbird egg on the left was laid the day after the cowbird egg in the middle. For discussion see text.

Finally, it should be pointed out that even though the hosts in this system are acceptors, evolution might still favor similarity in appearance between host and parasite eggs by reducing the frequency of nest abandonment by hosts. Possible disadvantages to increasing host-parasite egg similarities in this system are dealt with in more detail elsewhere (Elliott MS).

Analysis of cowbird egg distribution in a prairie community of hosts gives results similar to those obtained by Mayfield (op. cit.) and Preston (op. cit.). Evidence is also presented suggesting that, at least in this particular system, cowbird egg distribution is nonrandom. Possible advantages of this behavioral pattern may be related to minimizing mistaken ejections by female cowbirds.

I thank John Zimmerman, Steve Fretwell, Chris Smith, and Arthur Dayton for their advice and support during the course of this research. Additional thanks are due a number of fellow graduate students whose suggestions, ideas, and comments greatly improved this study. The Kansas State University Computer Center assisted in data analysis. Financial support for this research was provided by Kansas State University, the Bird Populations Institute, and the Frank M. Chapman Memorial Fund of the American Museum of Natural History.—PHILLIP F. ELLIOTT, *Division of Biology, Kansas State University, Manhattan, Kansas 66506. Present address: Department of Zoology, Iowa State University, Ames, Iowa 50010. Accepted 7 May 1976.*

Cannibalism in adult nesting Red-tailed Hawks.—Several accounts of cannibalism among nestlings in *buteos* have been recorded (Uttendörfer 1952, Ingram 1959, Matray 1974, Tubbs 1974). Baxter (1906) reported an adult Red-tailed Hawk (*Buteo jamaicensis*) feeding on an immature bird of the same species. Fitch et al. (1946) recorded remains of two *buteos* in the pellets of nesting Red-tailed Hawks, but cannibalism has seldom been recorded among adults. Clevenger and Roest (1974) reported seeing an adult Red-tailed Hawk carrying the partially eaten remains of another adult bird of the same species.

On 7 June 1975 one mile southeast of Francis Creek, Manitowoc County, Wisconsin, while banding nesting Red-tails, I found the remains of an adult and one live chick about 2 weeks old. Upon approaching the nest, which was 45 feet up in a white pine (*Pinus strobus*), I saw only one adult bird perched on a power pole one-quarter mile northeast of the nest tree. This bird began to call and circle above the nest as I approached and was the only bird seen the 30–45 minutes I was in the area.

When I reached the base of the tree, I found three rectrices from an adult Red-tail on the ground and several more among the branches of the tree while climbing to the nest. In the nest were four more rectrices plus the intact legs, pelvic girdle, and several vertebra of the adult bird. The one chick in the nest had a full crop and was in apparent good health. Prey remains in the nest consisted of Common Crow (*Corvus brachyrhynchos*) and rabbit (*Sylvilagus floridanus*).