

EGG TURNING BEHAVIOR OF BIRDS IN RESPONSE TO COLOR-MARKED EGGS

BY LARRY C. HOLCOMB

Howell (1942) reported that the incubating Robin (*Turdus migratorius*) rises from the nest and sits on the rim while turning eggs. The eggs may not be shifted for 45 minutes or may be shifted three times in 10 minutes. The time was so brief in shifting them that it seemed unlikely that all were rotated at any one time. Putnam (1949) reported that egg turning took place 12 times within 65 minutes of observation in the Cedar Waxwing (*Bombycilla cedrorum*) and that this frequency was common. Prescott (1965) found that the female Scarlet Tanager (*Piranga olivacea*) stands up in the nest every 1.3 hours to inspect and turn her eggs with two to six pushing motions. Mumford (1964) reported egg turning and probing into the nest by incubating Acadian Flycatchers (*Empidonax virescens*).

When observing Traill's Flycatcher (*Empidonax traillii*) from a blind for a total of 38 hours, I saw the female standing up in the nest to adjust eggs with her beak on the average of 4.9 times per hour. These eggs had been marked.

One would expect that incubating birds turn each egg in their clutch of eggs at random. If the eggs are turned at random and are turned several times each day one should be able to discover by experimentation if the incubating parent recognizes any foreign color on the eggs and makes an attempt to keep this color down.

PROCEDURES

These studies were carried out in Toledo, Ohio in 1964 and 1965 with the Red-winged Blackbird (*Agelaius phoeniceus*), Robin, Catbird (*Dumetella carolinensis*), Traill's Flycatcher, Cardinal (*Richmondia cardinalis*), American Goldfinch (*Spinus tristis*), Brown Thrasher (*Toxostoma rufum*), Field Sparrow (*Spizella pusilla*), Eastern Meadowlark (*Sturnella magna*), Indigo Bunting (*Passerina cyanea*), Blue Jay (*Cyanocitta cristata*) and Song Sparrow (*Melospiza melodia*).

In this study, eggs were marked with large letters as they were laid using bright red or orange fingernail polish (see plate 1). Each egg in every nest was marked. The nests were visited each day during laying and on the day after the clutch was complete, and eggs were moved so that the numbers on them all faced up or all down. On the day after the clutch was completed, a record was made of the number of eggs facing up or down and then on most occasions the eggs were moved so that the numbers all faced in the position opposite to the previous day.

My assumption, previous to these manipulations, was that an incubating bird turned each of her eggs a random number of times each day and that she selected the individual eggs at random. If

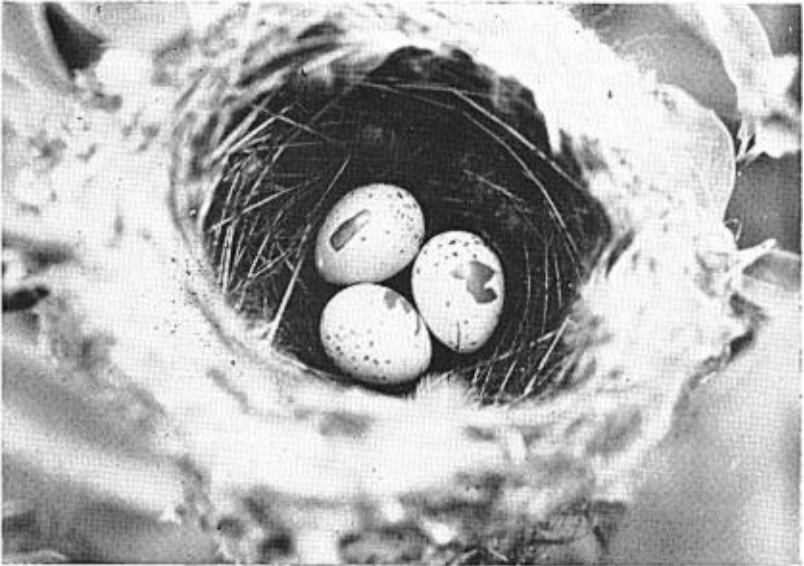
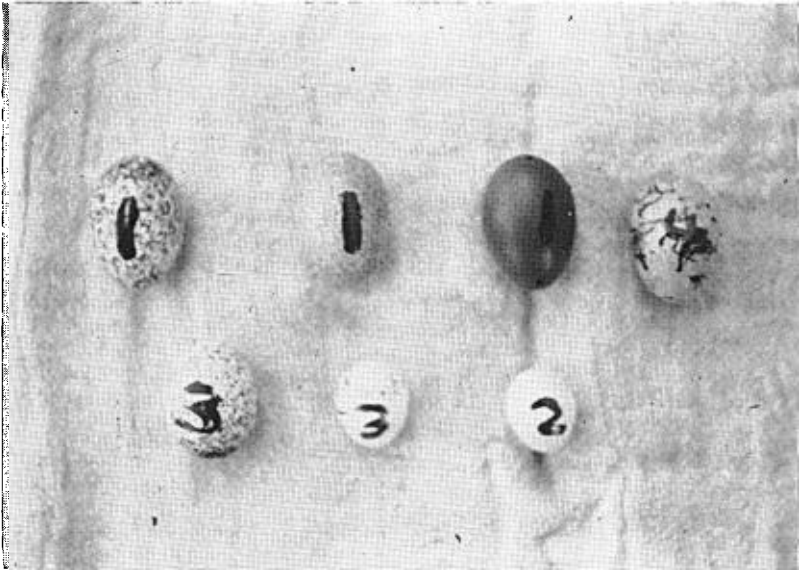


Plate 1. Upper photo shows color numbers on Cardinal, Brown Thrasher, Catbird, Red-winged Blackbird (upper row, 1. to r.) Cowbird, Yellow-throat and Indigo Bunting (lower row, 1. to r.) eggs. Lower photo shows Traill's Flycatcher eggs with numbers all facing up.

TABLE 1. EGG TURNING BEHAVIOR OF 12 SPECIES OF BIRDS IN RESPONSE TO COLOR-MARKED EGGS

Species	No. of Nests	Total No. of Visits	Total Eggs Found Down	Total Eggs Found Up	No. Times Eggs Placed Up By Observer	No. Times Eggs Placed Down By Observer	Per Cent Changed When Facing Up	Per Cent Changed When Facing Down	Mean No. Half-turns Per Egg Day
Redwing	33	205	458	273	110	95	63	40	.52
Robin	19	128	281	171	64	64	59	36	.47
Catbird	14	108	266	135	40	68	66	33	.45
Traill's Flycatcher	12	103	227	120	55	48	67	37	.53
Cardinal	11	88	147	75	47	41	60	28	.45
Goldfinch	7	42	144	80	22	20	61	33	.48
Brown Thrasher	6	41	87	54	20	21	61	38	.49
Field Sparrow	4	33	74	34	16	17	62	29	.44
Eastern Meadowlark	3	19	46	38	10	9	61	53	.57
Indigo Bunting	2	16	55	9	8	8	84	6	.45
Blue Jay	2	15	41	34	8	7	58	49	.53
Song Sparrow	1	10	25	21	6	4	57	47	.53

* — At least this many half-turns. They could have been turned dozens of times.

she did this, I could expect to find a mean of 50 percent of the numbers turned up and 50 percent down. If the number was on the lower half of the egg, it was considered down, *i.e.*, the number did not need to be touching the bottom of the nest to be considered down. In many instances the number on the lower half of the egg was visible if I peered into the nest at an angle.

Chi-square was used in analysis of two null hypotheses. The first null hypothesis was that eggs would be turned at random and that 50 percent of the eggs would have numbers facing up and 50 percent of the eggs would have numbers facing down. The second null hypothesis was that there would be no difference in the percent of eggs turned when the numbers were left up or down on the preceding day.

The percent of eggs turned when left with numbers facing up on the previous day was:

$$\frac{\text{No. of eggs facing down}}{\text{No. of eggs that had been left facing up the previous day}}$$

The percent of eggs turned when left with numbers facing down on the previous day was:

$$\frac{\text{No. of eggs facing up}}{\text{No. of eggs that had been left facing down the previous day}}$$

I had no way of knowing how many times the eggs may have been turned from one day to the next. The mean number of times given in Table I indicates only that the eggs were turned *at least* that often.

Eggs were also marked in nests where I did not do these experiments. The species were Yellow Warbler (*Dendroica petechia*), Kingbird (*Tyrannus tyrannus*), Yellow-shafted Flicker (*Colaptes auratus*), Common Grackle (*Quiscalus quiscula*), Cedar Waxwing, Mourning Dove (*Zenaidura macroura*), Rufous-sided Towhee (*Pipilo erythrophthalmus*), Bobwhite (*Colinus virginianus*) and Ring-necked Pheasant (*Phasianus colchicus*). Eggs were also marked in nests at Fremont, Nebraska in 1966. These included all of the species studied in Toledo except the Field Sparrow, Meadowlark, Song Sparrow, Cedar Waxwing, Bobwhite and Pheasant. Additional eggs marked in Nebraska (but not in Toledo) were those of the Rose-breasted Grosbeak (*Pheucticus ludovicianus*), Dickcissel (*Spiza americana*), Yellowthroat (*Geothlypis trichas*), Crow (*Corvus brachyrhynchos*), Warbling Vireo (*Vireo gilvus*), Orchard Oriole (*Icterus spurius*), and Black-billed Cuckoo (*Coccyzus erythrophthalmus*). There were 28 species in all that had their eggs color-marked but only 12 species in which I performed the experiments.

RESULTS

Table I gives the results of this study. In all of the 12 species, more of the eggs were facing number down than up and eggs were turned the opposite of the position they were left in the previous day more often if they had been left with the number facing up. The chi-square values for eggs of all species (except the Meadowlark, Blue Jay and Song Sparrow where few observations were made) would cause one to reject the first null hypothesis that the eggs are turned at random when they are numbered ($P < .005$). In other words, the incubating parents were apparently reacting to the foreign color marking on their eggs and had a tendency to turn the egg so that the foreign color was not visible.

The second null hypothesis to be tested was that the same percent of eggs would be turned if the eggs were all left with numbers up or down on the previous day. Chi-square values obtained in analysis would cause one to reject this hypothesis for all the species except the Meadowlark, Blue Jay and Song Sparrows ($P < .005$) except for the Brown Thrasher ($P < .025$). In other words, most of the species turned the numbered side down when it had been left up more often than they turned it up when it had been left down.

The eggs of each species were turned one-half turn on the average of *at least* once every two days (see last column, table I).

There were nest desertions in many of the species for several reasons; these included Cowbird (*Molothrus ater*) parasitism, adverse environmental conditions, or predation on some of the eggs. There was no case in any of the 28 species observed in which I had reason to believe that the markings on the eggs caused the bird to desert them.

DISCUSSION

Two basic relationships should be discussed: 1) Egg recognition by a parent bird and their reaction to foreign markings placed on their own egg, and 2) comparison of reactions to marked eggs and cowbird eggs in the species that were studied. These two are closely related.

(a.) *Egg Recognition*

Rensch (1925), in experiments with European passerines, found some species would accept their own species' eggs when they were painted red while others would not. When sets were exchanged between species, some were accepted and some were not. In those species that removed the parasitic egg of the cuckoos, Rensch found that the species' own eggs are not recognized but that an odd egg is. If a different colored clutch is substituted and a single egg from the individual's own clutch is included, their own egg is the one rejected. Thus, these birds did not recognize their own egg, but rather, the nonconformity of one egg.

McCabe and Hale (1960) reported that several redwing females deserted when their eggs were replaced by those of the Yellow-headed Blackbird (*Xanthocephalus xanthocephalus*).

Nice (1943) in summarizing the recognition of eggs by parents,

reported that gulls (Kirkman, 1937; Goethe, 1937; Tinbergen, 1936; Noble and Lehrman, 1940), terns (Marples, 1934; Tinbergen, 1936) and the Black-crowned Night Heron (Allen and Mangels 1940) have been shown not to recognize eggs of their own species, while murrens (Johnson, 1941; Dawson, 1921) are strongly attached to their eggs.

This study demonstrates that some species may recognize eggs of their own species and some do not. Some react to a solid-color foreign egg by deserting while others do not. Some species may accept the foreign color or foreign size in a different species' eggs. Even if the foreign color or foreign-sized eggs are incubated, there may be some different behavior toward them which is not obvious without special experimentation. The experiments described here indicate that 28 different species of birds did not desert their eggs due to the colored numbers placed on them. However, when 12 species were given a choice of leaving the foreign color where it was visible or not visible, nine of them turned the eggs so that it was not visible. I had too few observations on the three species which did not "hide" the foreign color to draw any definite conclusions.

(b.) *Recognition and Cowbird Parasitism*

Friedmann (1963) lists 17 species of birds on which he has a record as Cowbird victims 100 times or more. Some of these birds, such as the Song Sparrow and Field Sparrow, have eggs that closely resemble the parasite egg (spotted) but one is different in being of solid color, (the Indigo Bunting, whitish egg).

Friedmann listed the 12 species that I studied with regard to frequency of parasitism in the following manner: Song Sparrow, Indigo Bunting, Redwing, Traill's Flycatcher, and Field Sparrow were frequent hosts with over 100 records for each; Cardinal (70) and Goldfinch (over 50) were less frequent hosts; and Meadowlark (32), Brown Thrasher (31), Catbird (26), Robin (26) and Blue Jay (3) were infrequent hosts. The Goldfinch probably would be listed as a more frequent host if its breeding season overlapped more with that of the Cowbird. The Meadowlark, Brown Thrasher, Catbird, Robin and Blue Jay are larger birds and the Cowbird favors smaller species.

Two of the above species (Catbird and Robin) are known to eject Cowbird eggs quickly from the nest. The Cardinal and Field Sparrow frequently desert their nest and Redwings are known to desert when parasitism occurs. The Traill's Flycatcher, Catbird, Eastern Meadowlark, Redwing, Cardinal, Indigo Bunting, American Goldfinch and Song Sparrow have been known to bury Cowbird eggs beneath a new nest lining. Thus, excluding the Brown Thrasher and Blue Jay, we know that at least some individuals of these species react against a foreign egg in the nest.

Only six of the 12 species, Traill's Flycatcher, Brown Thrasher, Cardinal, Goldfinch, Field Sparrow, Song Sparrow and Indigo Bunting, have been known to produce several Cowbird fledglings. Even then, we cannot consider the Brown Thrasher or Goldfinch as important to Cowbird survival since they are parasitized infrequently.

If we evaluate the remaining four species in light of what Mayfield (1965) terms as "tolerance", arbitrarily defined as 20 or more percent of Cowbird eggs producing fledglings), the Song Sparrow is the only one which could definitely be called tolerant. I base this on Mayfield's evaluation of Field Sparrow and Song Sparrow and on the data summarized by Friedmann (*op. cit.*) and my own observations of Indigo Buntings and Traill's Flycatchers (to be published later).

My data are unfortunately scant for the Song Sparrow. This species should be studied further to find conclusively its reaction to foreign-colored eggs. There is a similarity of reaction to color-marked eggs in species which are frequently or not frequently parasitized. The frequently parasitized Indigo Bunting with white eggs was the only species which showed extreme reaction in keeping the red numbers from becoming visible (55 eggs found down and only nine up).

As mentioned previously, only two of the 12 species throw out Cowbird eggs regularly. Friedmann (*op. cit.*) believed that color was the decisive factor in Robins, since a Robin accepted a smaller, blue (small dark brown spots), Chipping Sparrow egg but threw out an egg the same size as her own but a different color. Nice (1941) had a Robin accept House Sparrow (*Passer domesticus*) eggs but usually they were thrown out.

Nickell (1965) reported several instances of Cowbird eggs thrown from the nest by the Catbird. Wilson and Bonaparte (1859-60) reported that two Brown Thrasher eggs were thrown out by a Catbird and Nuttall (1840) observed that foreign bird eggs were thrown out by the Catbirds.

Friedmann (*op. cit.*) conducted some experiments to see whether or not the reaction of the Catbird in throwing out foreign eggs was correlated with ability to distinguish its own eggs from those of other birds which differed in coloration and size. House Sparrow and Chipping Sparrow eggs were ejected. Robin and Mourning Dove eggs were rejected but another Catbird egg was accepted. A Catbird egg on which small specks and splotches were painted was rejected! Holcomb (1967) found that Mourning Dove eggs were removed when placed in a Catbird nest but one Robin accepted and incubated a Mourning Dove egg. These experiments show that Catbirds recognize a nonconforming egg in their nest but do not prove that they recognize eggs of their own species.

Although Robins and Catbirds have been shown to reject foreign colored eggs, they failed to do so in this study in which the foreign color consisted of contrasting marks on only one side of each egg. Even though a "disturbing" factor was present, the foreign color marks on their eggs were all of the same color and covered approximately the same portion of the egg shell. The foreign color seemed to be as "disturbing" to species which are frequently parasitized as to those which are infrequently parasitized.

SUMMARY

Eggs in 28 species were numbered with red or orange fingernail polish. Eggs were manipulated so that all the numbers faced up one day and faced down the next in 12 species. The frequency of those found up or down on the following day was recorded. Nine of the 12 species did not turn the eggs at random. Instead, Chi-square values were of a magnitude that indicate that the numbered side of the egg tended to be turned down. Furthermore, Chi-square values showed that the same nine species turned the numbers down when left up more often than they turned them up when left down. None of the 28 species deserted the eggs due to the marking technique.

The exact number of times eggs were turned cannot be stated, but they were turned half-way over *at least* once every two days.

Species that are frequently parasitized by cowbirds reacted to the colored eggs in the same manner as infrequently parasitized species. The colored numbers apparently acted as a "disturbing" factor to the incubating parent but these did not alter the original color enough to cause ejection or desertion. The Song Sparrow was the only "cowbird tolerant" species studied and too few data on egg-turning were available for good evaluation. This aspect of their behavior should be studied further. Indigo Buntings (white egg) reacted much more to the color markings perhaps because of the sharper contrast.

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