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# The Potential Effects of Eggshell Porosity on Brown-Headed Cowbird and Dickcissel Incubation Periods

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# The Potential Effects of Eggshell Porosity on Brown-Headed Cowbird and Dickcissel Incubation Periods

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**Abstract**

The Brown-headed Cowbird (*Molothrus ater*) is a brood parasite that lays its eggs in nests of other species; the eggs are incubated and the offspring are then raised by the host. Grassland-nesting Dickcissels (*Spiza americana*) are commonly parasitized by Cowbirds. Cowbird eggs have been reported to hatch sooner than equivalently-sized host eggs, giving their hatchlings a competitive advantage over host offspring. Our study focused on the hypothesis that the apparent accelerated development of Cowbirds is caused by greater eggshell porosity which allows for increased availability of oxygen during incubation. The mean pore area of Cowbird eggshells (2.043 ± 0.674 $\mu m^2/mm^2$; $\bar{x}$± SD) was 5 times greater than Dickcissel eggshells (0.383 ± 1.095 $\mu m^2/mm^2$; $t = 5.772$, $df = 31.598$, $p < 0.001$). However, the mean number of pores per eggshell did not differ significantly between Cowbirds (0.263 ± 0.122 pores/$mm^2$) and Dickcissels (0.229 ± 0.130 pores/$mm^2$; $t = 0.846$, $df = 38$, $p = 0.403$). The data support our hypothesis that Cowbirds have greater eggshell porosity than their host, which could lead to a shorter incubation period.

## Introduction

Brood parasitism is an adaptation of Brown-headed Cowbirds (*Molothrus ater*) in which they lay their eggs in nests of other bird species. The host species provides total parental care for the parasite (Cowbird) offspring. The Brown-headed Cowbird has been reported to have a shorter incubation period than many of its host species (Hauber 2003).

Hatching earlier than its host allows the Cowbird nestling an opportunity to eject host eggs and "dominate intrabrood hierarchies [by diverting] parental care away from brood nestmates" (Payne 1977, as cited by Briskie and Sealy 1990). The mechanism by which Cowbird eggs hatch earlier than their host nestmates remains unresolved.

We tested the hypothesis that the accelerated rate of development in Cowbirds is due to specific characteristic of the eggshell. One eggshell characteristic which influences incubation time is shell porosity. Greater porosity in eggshells allows a greater exchange of metabolic gases and positively affects (shortens) the rate of embryological development (Paganelli 1980, Vleck and Bucher 1998, as cited by Zimmerman and Hipfner 2007).

We tested this hypothesis by comparing the pore size and pore number between eggs of Cowbirds and a common host species, the Dickcissel (*Spiza americana*), a grassland nesting songbird. Cowbirds have a 10-11 day incubation period, whereas Dickcissels have a slightly longer incubation period (12-day) (Hauber, 2003). We predicted that Cowbirds have greater eggshell porosity than their Dickcissel hosts which could account for a shorter incubation period.

http://schmoker.org/BirdPics/Photos/Blackbirds/BHCO_1.jpg

http://www.wiu.edu/biology/personnel/peer/pictures.html

http://www.carolinabirdclub.org/gallery/images/Dickcissel%20116%20Womble.jpg

Figure 1: An adult female Brown-headed Cowbird (left), two Cowbird eggs and one Dickcissel egg within a Dickcissel nest (middle), and an adult female Dickcissel (right)

## Materials and Methods

20 Brown-headed cowbird eggs and 20 Dickcissel eggs were collected from nests in McDonough County, IL, Konza Prairie, Kansas, and Scott County, Iowa from 2006-2009 and stored in a freezer. Each egg was divided into 3 regions—apex, equator, and base– in order to have a representative sample of egg fragments. The regions were treated with hot 5% NaOH for ca.15 minutes to remove the inner membrane and outer cuticle. Eggshell fragments were dried and then examined with a compound microscope (400x total magnification). Pores were counted and pore diameters were measured from 54 fragments per egg (3.07$mm^2$/ fragment). Pore number data for each species were normally distributed and analyzed using an Independent Samples t-test (Zar 1999). Pore area data were natural log transformed and were also analyzed using an Independent Samples t-test (SPSS 2005). Analyses of mean pore number and pore area per egg were performed with square-root transformed data (SPSS 2005).

## Results

**Table 1: Statistical Comparison of Mean Pore Area per $mm^2$ and Mean Pore Number per $mm^2$ Between Cowbirds and Dickcissels**

| | Cowbird (n=20) | Dickcissel (n=20) | t-test results |
|---|---|---|---|
| Mean Pore Area ($\bar{x}$ ± SD) ($\mu m^2/mm^2$) | 2.043± 0.674 | 0.383± 1.095 | $t = 5.772$, $df = 31.598$, $p < 0.001$ |
| Mean Pore Number ($\bar{x}$ ± SD) (pores/$mm^2$) | 0.263± 0.122 | 0.229± 0.130 | $t = 0.846$, $df = 38$, $p = 0.403$ |

•Cowbirds had a significantly larger pore area per $mm^2$ than Dickcissels (Table 1).

•No significant difference between Cowbirds and Dickcissels in the mean number of pores per $mm^2$ (Table 1).

**Table 2: Statistical Comparison of Total Mean Pore Area per Egg and Mean Pore Number per Egg Between Cowbirds and Dickcissels**

| | Cowbird (n=13) | Dickcissel (n=18) | t-test results |
|---|---|---|---|
| Mean Pore Area ($\bar{x}$ ± SD) ($\mu m^2$/ egg) | 85.490± 25.680 | 34.384± 20.070 | $t = 6.224$, $df = 29$, $p < 0.001$ |
| Mean Pore Number ($\bar{x}$ ± SD) (pores/egg) | 15.443± 4.804 | 11.548± 5.126 | $t = 2.142$, $df = 29$, $p = 0.041$ |

•Significant y greater pore area and pore number per egg in Cowbirds compared to Dickcissels (Table 2).

## Conclusions

Brown-headed Cowbird eggshells had a greater overall porosity than those of their Dickcissel host. The Cowbird had significantly greater mean pore area than the Dickcissel when considering the total egg as well as the eggshell fragments. However, there was a significantly greater mean pore number in Cowbirds only when comparing the total egg. A greater porosity may be one of the mechanisms allowing Cowbirds to hatch earlier than their host species, because it allows more exchange of metabolic gases and could positively contribute to a shorter rate of embryological development (Paganelli 1980, Vleck and Bucher 1998, as cited by Zimmerman and Hipfner 2007). Since Cowbirds have been found to have a 10-11 day incubation period, and Dickcissels have been found to have a 12 day incubation period (Hauber 2003), the greater porosity from our results correlates to the shorter incubation period. These results support our hypothesis that an accelerated incubation period is due to eggshell porosity.

In our future studies we will investigate the effects of shell thickness on overall porosity, as it has been utilized in other studies of hatching asynchrony (Zimmerman and Hipfner 2007). We will also compare the eggshell porosity of Brown-headed Cowbirds with the eggshells of Red-winged Blackbirds (*Agelaius phoeniceus*), another host species that is a member of the same family as Cowbirds, Icteridae. If the Brown-headed Cowbird egg shell porosity is found to be significantly greater than that of the Red-winged Blackbird, it would support the hypothesis that greater porosity is a mechanism that allows Cowbirds to hatch earlier than their host species. Since the two species are in the same family, and Red-winged Blackbirds are non-parasitic, greater porosity may be considered an adaptation specific to the parasitic Cowbird.

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