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Mycoplasmal conjunctivitis in house finches (*Carpodacus mexicanus*) is more severe in left eyes than right

Andrew K. Davis[a]

Department of Environmental Studies, Emory University, Atlanta, GA USA 30322
[a]*Current Address: Odum School of Ecology, The University of Georgia, 140 E. Green St., Athens, GA 30602, USA*
Email: akdavis@uga.edu

ABSTRACT

One of the most well-studied avian diseases is the annual outbreak of *Mycoplasma gallisepticum* (MG) infections in house finches (*Carpodacus mexicanus*) in North America. This is a bacterial disease that causes conjunctivitis in one or both eyes of the host. While studying this disease in a New York finch population, researchers observed that there was a tendency for the conjunctivitis to be more prominent in the left eye of infected birds, although the small sample size of that study made it difficult to draw conclusions regarding this unusual observation. Here, this idea is tested further using a larger data set from a 4-year trapping study of house finches in Atlanta, Georgia, USA, a location with a high prevalence of MG infections. The severity of conjunctivitis in each eye of infected birds was scored on a 0–3 scale, and these data were statistically examined to identify possible side-biases in severity. Out of 254 house finches with conjunctivitis, the eye scores of all left eyes were significantly higher than right eye scores. There was no evidence for differential effects of conjunctivitis in left-bias or right-biased infections, and the left-biased pattern was similar in both sexes and in adult and young birds. These results confirm the anecdotal observation from the New York population and suggest that this is a universal phenomenon in the house finch–MG system. The significance of the finding is unknown, although the possibility exists that house finches display a degree of 'handedness' that causes their left sides to be exposed more frequently to potential fomites (*i.e.* bird feeders).

Keywords: *house finches,* Carpodacus mexicanus, Mycoplasma gallisepticum*, conjunctivitis, eye score, side-bias*

1. INTRODUCTION

House finches in North America are prone to seasonal outbreaks of infections with the bacterium *Mycoplasma gallisepticum* (MG), a disease that can cause considerable mortality (Hochachka and Dhondt, 2000) and that is highly visible, even to the layperson, since it causes conjunctivitis in one or both eyes of infected birds (Figure 1; Dhondt *et al.*, 2005). The clinical signs of infection (conjunctivitis) typically progress in severity as the infection progresses (Sydenstricker *et al.*, 2006), so that in severe cases, birds can be rendered blind by the conjunctival swelling, especially if it occurs in both eyes.

From a scientific perspective, the easily-observable clinical signs of infection has allowed for a wide-range of scientific investigations into the dynamics of this disease, including how it affects host plumage brightness (Brawner *et al.*, 2000), its mode of transmission (Hartup and Kollias, 1999; Sydenstricker *et al.*, 2005; Dhondt *et al.*, 2007), how it affects host behaviour (Hawley *et al.*, 2007) and host physiology (Davis *et al.*, 2004; Lindström *et al.*, 2005). Interestingly, in one of these investigations where population-level patterns were examined, Hartup *et al.* (2000) made an unusual observation regarding the severity of conjunctivitis in infected birds: of 16 birds with unilateral conjunctivitis, 13 (81%) of these were limited to the birds' left eyes. This observation, discovered in birds from New York, was considered an oddity, and never addressed again in subsequent investigations. During the course of trapping house finches for a 4-year population survey of MG infections in Georgia, the author had the opportunity to examine this idea further in a much larger data set that included a greater number of infected birds ($n = 254$), since MG tends to be more prevalent in the south-eastern United States (Altizer *et al.*, 2004a). Here, the results of this investigation are described.

2. METHODS

House finches were trapped on at least two days each week between August 2001 and July 2005 at three

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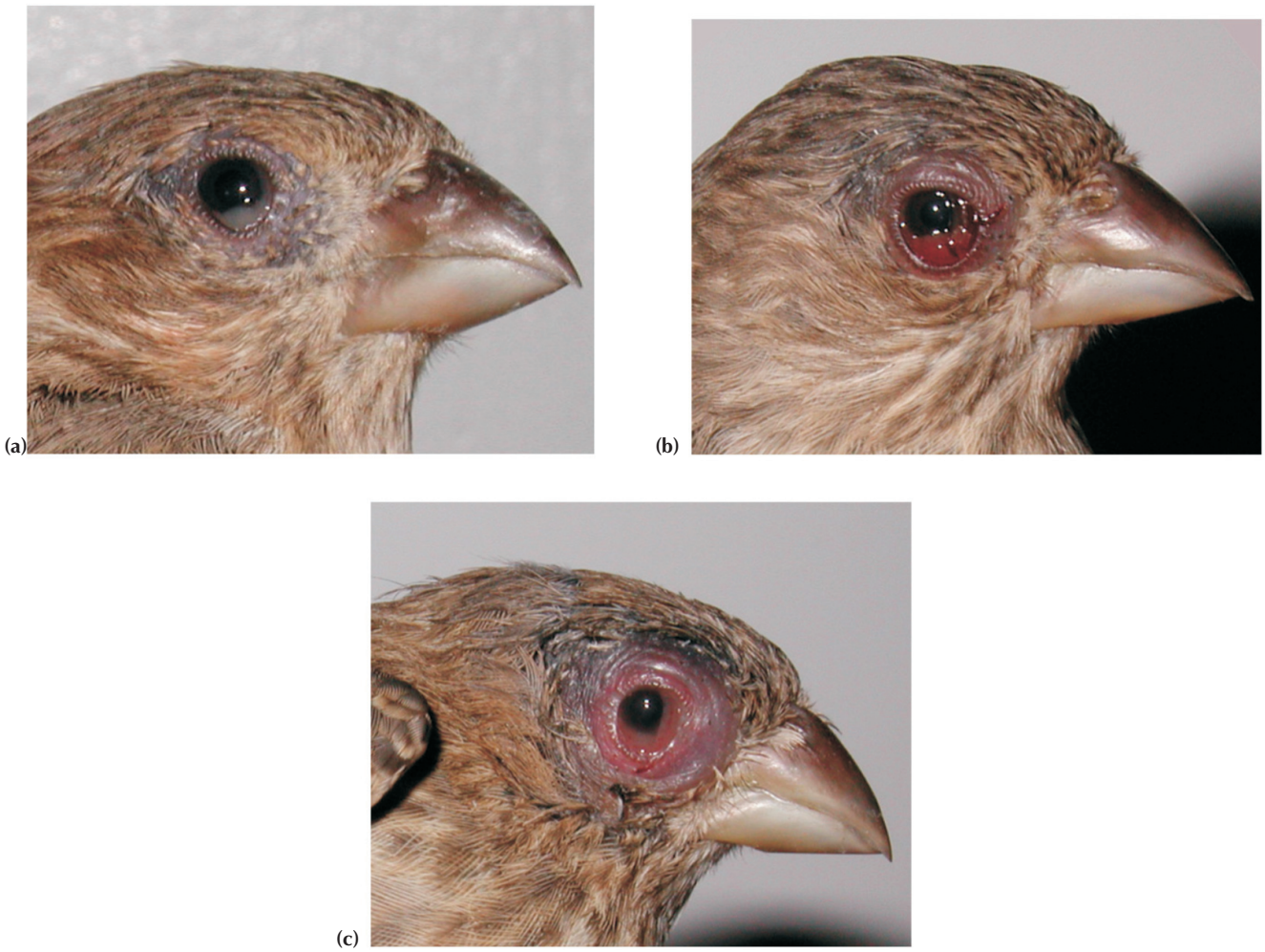

Figure 1 Photographs of house finches with increasing severity of conjunctivitis. With the eye scoring system used in the current study, the eye scores of these birds would be 1, 2 and 3, from (**a**)–(**c**), respectively. All photographs were taken by the author.

sites in Atlanta, Georgia, USA, as part of a long-term population study of MG infection dynamics (Altizer *et al.*, 2004b; Davis *et al.*, 2004). Birds were trapped using either mist-nets strung in front of feeders, or using walk-in cage traps (Davis, 2005). Upon capture, all house finches were banded with a US Fish and Wildlife Service leg band, aged, sexed, weighed and measured (wing length), and examined for clinical signs of infection with MG (*i.e.* conjunctivitis). Prior work has shown that the presence of conjunctivitis is nearly always (*i.e.* in 95% of cases) associated with infections with MG (Hartup *et al.*, 2001). For the birds with conjunctivitis, the severity of conjunctivitis within each eye was scored on a 0–3 scale, following previous investigations (Altizer *et al.*, 2004b; Sydenstricker *et al.*, 2006). In this system: 0 = no visible inflammation; 1 = pink conjunctival discoloration and slight periorbital edema; 2 = pink conjunctival discoloration, some mucus and fluid discharge, slight to moderate periorbital edema; and 3 = conjunctiva red and swollen to the point of blindness, feather loss around eye, and heavy fluid discharge (see Figure 1). Over the 4-year trapping period, a total of 254 house finches with conjunctivitis were captured (out of 1,900 birds trapped).

To determine if side biases in conjunctivitis severity exist, the eye scores of all infected birds were examined using a paired *t*-test. I was also interested in knowing if birds with a left-side bias differ from those with a right-side bias in their infections. For this, the difference between the right and left scores was calculated for each bird to provide an index of conjunctivitis side-bias. Thus, all infected birds were classified as either having a left-biased infection, right-biased infection, or no bias, although this last category was not considered here.

Secondly, I compared the body mass of birds between left and right-biased infections using ANCOVA, where side, age and sex were fixed factors and wing length was a covariate. This test essentially examined whether the side-bias leads to differential impacts of infection, since infections lead

Table 1 Summary of house finches captured in Atlanta, Georgia, USA with conjunctivitis from August 2001 to July 2005. Degree of conjunctivitis severity was scored in both eyes on a 0–3 scale (0 = no conjunctivitis, 3 = severe conjunctivitis). Left column shows the difference between the right-left eye scores (*i.e.* the degree of side-bias in conjunctivitis severity)

R–L eye score difference	No. of birds	%	
−3	12	4.7	Total left bias = 43.7%
−2	36	14.2	
−1	63	24.8	
0	80	31.5	
1	39	15.4	Total right bias = 24.8%
2	18	7.1	
3	6	2.4	
Total	254	100	

to reductions in (size corrected) body mass (Altizer *et al.*, 2004b). Age and sex were included in the model as these have been shown to influence infection dynamics (Altizer *et al.*, 2004b).

Finally, I examined whether the overall characteristics of birds differed in either side category. For this I compared the proportions of male and female birds in left and right side category, as well as the proportion of young (hatch year) and adult (after-hatch year) birds in both categories using Chi-square tests. For all tests that included age and sex, only those birds that were of known age and sex were considered. Analyses were conducted using Statistica 6.0 software (Statistica, 2003), and all tests were considered significant if $P < 0.05$.

3. RESULTS

There was a clear left-bias in the severity of clinical signs in house finches with a paired *t*-test showing a significant difference, with left eye scores being higher on average than right (average left score = 1.35, average right score = 1.04; $t = 3.64$, $P = 0.0003$). Furthermore, when the birds were grouped according to the difference between their right-left scores (Table 1), the total number of birds in all left-bias groups was larger (111 birds–43.7% of the total) than the right-bias groups (63 birds–24.8%).

There was no difference in weights of birds in the left-bias or right-bias categories, as this variable was not significant in the ANCOVA examining variation in body mass ($F_{1,104} = 0.017$, $P = 0.897$). The other variables in the model were also not significant, except for the expected trend for mass to vary with wing size ($F_{1,104} = 3.77$, $P = 0.055$).

Finally, out of 110 known-age and sex birds with conjunctivitis, 36 out of 54 adult birds (67%) had a left-side bias, and 36 out of 56 (64%) young birds had a left-side bias, and these proportions were not significantly different ($\chi^2 = 0.069$, df = 1, $P = 0.793$). Forty out of 60 males (67%) had a left-side bias while 32 out of 50 (64%) females had a left-side bias, and these were also statistically similar ($\chi^2 = 0.086$, df = 1, $P = 0.770$).

4. DISCUSSION

The data shown here demonstrate that there is a strong tendency for mycoplasmal conjunctivitis to be more severe in the left eyes of house finches than the right. This finding was consistent with the incidental observation by Hartup *et al.* (2000), where the majority of birds with mycoplasmal conjunctivitis in New York had greater clinical severity in their left eye. The larger sample size of the current study verifies this finding and suggests that this may be a common phenomenon in the house finch–MG host–pathogen system. This discovery is most certainly unusual, and also appears to be a unique phenomenon within avian and other wildlife diseases, as a literature search on the subject revealed no prior cases of side-bias in disease severity within any animal species.

Interestingly, house finches are also prone to another disease where the same idea can be tested–avian poxvirus (*e.g.* Zahn and Rothstein, 1999). Like MG, this disease also causes visible clinical signs (wart-like nodules or lesions that appear on the legs, toes, and other parts of the body) and these are readily seen during health surveys (Hartup *et al.*, 2004). In the 4-year survey of Atlanta house finches, 66 birds with visible pox lesions were observed. Of these, lesions were recorded on the left side (leg, wing or head) of 21 birds (31.8%), and on the right side of 22 birds (33.3%). Thus, there appears to be no clear side-bias in poxvirus lesions in house finches.

The left-side bias in conjunctivitis severity could be explained if house finches show a degree of 'handedness', or 'footedness', which has been shown in some species of passerines (Izawa *et al.*, 2005). In this case, since bird feeders are thought to be a major source of transmission of MG as fomites (Dhondt *et al.*, 2007), then perhaps a larger number of house finches are 'left-handed' than right, and, that these individuals may perch at bird feeders in such a way so as to touch their left eyes to the feeders more often than their right. However, this idea assumes that the severity of conjunctivitis reflects the level of exposure to the MG bacterium, which is not known. It is also just as possible that the expression of disease (conjunctivitis) in one eye of the other reflects a physiological process that has nothing to do with the birds' behaviour. In any case, this discovery warrants additional research to elucidate the causative mechanism, and also highlights the many gaps that yet remain in our understanding of not just this host-pathogen system, but all avian diseases.

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