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THE PREVALENCE AND EFFECTS OF AVIAN POX ON BODY CONDITION AND PLUMAGE COLORATION IN NORTHERN POPULATIONS OF HOUSE FINCHES (*Carpodacus mexicanus*)

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Abstract

Models of sexual selection emphasize that variations in sexual ornamentation have important fitness consequences. For example, males in good condition are thought to be more capable of producing ornamentation than males in poor condition or those compromised due to disease. Consequently, these males are unable to allocate sufficient energy to sexual displays and thus may not be chosen by females. One ornamental trait likely to be affected by poor condition or disease is carotenoid-based plumage coloration. We investigated whether plumage coloration in male House Finches (*Carpodacus mexicanus*) is affected by the presence of avian pox, a viral infection characterized by wart-like lesions. We quantified the hue, intensity, and tone of male plumage coloration. In addition, we compared body mass, tail length, length of the longest primary, bill length, and fat measures of symptomatic versus asymptomatic birds. A total of 175 birds were captured at four sites in northern Utah and 20% of those captured had pox-like symptoms. The body mass of symptomatic birds was significantly lower than asymptomatic birds. Symptomatic birds were also caught more frequently at an urban residential setting than at rural areas. Results further indicated that symptomatic males were more likely to have a dull yellow plumage rather than the bright red color typical of asymptomatic males.

Introduction

Variation in secondary sexual characteristics can have important fitness consequences. Several studies have demonstrated that females select males with elaborate secondary sexual characteristics more than males not displaying such intricate ornamentation (Hill et al. 1999, Kose and Moller 1999, Moller 1988). For example, in male Barn Swallows (*Hirundo rustica*) the length of the tail increases the probability of obtaining a mate (Moller 1988).

The House Finch (*Carpodacus mexicanus*) is sexually dichromatic in plumage (Hill 1993). Females typically are gray-brown while males vary from pale yellow to bright red. The plumage coloration of males is found on the crown, eyebrow stripe, throat, breast, and rump (Hill 1993). Variation in male plumage coloration is found in most populations and has been shown to affect fitness. Hill et al. (1999) demonstrated that males with bright red coloration were more likely to pair with females relative to pale yellow males. Furthermore, variation in coloration may also affect foraging proficiency, parental care and social dominance (Belthoff et al. 1994, Hill 1991).

Variation in male House Finch plumage coloration may be affected by disease and parasitic infections(Hill 1993, Hill et al. 1999). Carotenoids must be obtained from the

environment for the production of red pigments found in males. In captive and wild studies, males produce a dull colored plumage when fed a diet deficient in carotenoids (Hill 1992, Zahn and Rothstein 1999). However, variation in male plumage coloration may also reflect an individual's ability to alter and physiologically process carotenoids (Thompson et al. 1997). For example, several recent studies have examined the effect of parasitic infections on male plumage coloration. These studies suggest that the presence of infections, such as the pathogen *Mycoplasma gallisepticum*, mite infestations, coccidial infections, and avian pox, are negatively correlated with plumage coloration in male House Finches (Brawner et al. 2000, Nolan et al. 1998, Thompson et al. 1997, Zahn and Rothstein 1999). Pathogens and parasites are thought to interfere with the physiological mechanisms involved in the processing of carotenoids such as the absorption, transport, and metabolism of ingested pigments (Brawner et al. 2000, Thompson et al. 1997).

The objectives of this study were to 1) determine the prevalence of avian pox, a disease frequently found in House Finches and 2) examine the effects of pox infections on body condition and male plumage coloration.

Methods

Species and Disease

The historical distribution of House Finches occurred from the Pacific coast to eastern Colorado and from the U.S.-Canadian border into southern Mexico (Hill 1993). However, in the 1940s, a small population was introduced to the eastern U.S. This eastern population has since grown exponentially and has expanded its range west. Currently, House Finches cover most of the United States and southern Canada and can be found in a wide range of habitats, including urban areas, grasslands, open coniferous forests, oak savannas, and deserts. House Finches are gregarious birds and generally travel in flocks between food sources in winter. Flock sizes can range from a few to hundreds of birds. They are semi-colonial but socially monogamous, with female mate choice playing an important role in pair formation (Hill 1993). Pair formation occurs between January and March while the birds are still assembled in winter flocks.

Avian pox is a virus characterized by wart-like nodules on featherless surfaces such as the legs, feet, eyelids and mandibles (Hansen 1999). The resulting tumors may cause difficulties in breathing and feeding, loss of toes, occluded vision, and increased susceptibility to secondary infections. Consequently, pox infections are occasionally lethal. Birds that recover from a pox infection are immune to the disease. Pox infections have been reported in many groups of birds such as raptors, galliforms, and passerines (Hansen 1999). The first reported case of House Finches infected with avian pox occurred in 1961 in Hawaii. The disease spread to Californian populations by 1972 and has subsequently spread throughout several western states (Power and Hunman 1976, Warner 1969). There are no published accounts of avian pox disease in eastern populations of House Finches.

AVIAN POX IN HOUSE FINCHES

Avian pox is transmitted by mosquitoes, air-borne particles, and through contaminated surfaces such as shared feeders and perches (Hansen 1999, Karstad 1971). Birds can be infected year-round but disease outbreaks are more common when environmental conditions favor vector populations in summer and early fall. Because avian pox can also survive on contaminated surfaces, transmission can occur during anytime of the year so long as environmental factors permit virus survival outside of the host (Hansen 1999).

Study Sites

Four sites in Weber County, Utah were monitored. Three of the sites were in Ogden, UT and included the campus of Weber State University (WSU), a residential setting 5 blocks west of campus, and a site at the Ogden Nature Center. The remaining site was at a rural setting in Hooper, UT.

Field Methods

House Finches were captured weekly from November 2000 until April 2001 at feeders using mist nets. All birds captured were banded with a uniquely numbered U.S. Fish and Wildlife Service leg band, sexed according to plumage characteristics, and examined for evidence of pox lesions.

Because viral infections may affect the growth of feathers during the pre-basic molt (Thompson et al. 1997), we assessed the effects of pox on feather growth by measuring the length of the longest primary and the length of longest tail feather. Bill length was also measured to assess the effects of avian pox on this characteristic. Physical condition was assessed by body mass and fat scores. Birds were weighed to the nearest 0.1 gram on a portable electronic balance. Fat scores were characterized by visually estimating the deposition of fat in the furcular hollow, wing pits, and on the abdomen. Fat scores were assigned 0 if no fat was present in the furcular hollow, 1 if there was <5% fat in the furcular hollow, 2 if there was 5-33% fat present, 3 if the furcular hollow was about half full, and 4 if the furcular hollow was full and fat was thick in the wing pits and on the abdomen.

Plumage coloration was scored by using the *Methuen Handbook of Colour* which quantifies colors according to hue, intensity, and tone (Komerup and Wanscher 1983). Hue is the element of a color that determines its name, intensity is the brightness of a color and tone quantifies the amount of black present. These three variables are expressed

numerically for each color sample represented. The three numbers were combined to arrive at a single score for each Cor. Plumage coloration of each male was scored by comparing five pigmented regions (crown, eyebrow stripe, throat, breast, and rump) to charted values. Plumage scores from all five pigmented regions were added together for a total plumage score and averaged to arrive at an average score. The average plumage score of each male captured was then broken down into two color categories: red/red-orange and orange-yellow/yellow. If the average score was from 16-20, the bird was assigned to the red/red-orange category and if the

average score was from 12-16, the bird was assigned to the orange-yellow/yellow category. Because male House Finches vary in color from pale yellow to bright red, pigmented males could not score below 12.

Data Analyses

All statistical analyses were performed using SPSS software (SPSS 1999). Data were first analyzed to determine if differences existed between sexes in the variables measured. When no differences were detected, then data from both sexes were pooled for analysis. If evidence existed for sexual dimorphism then subsequent analyses were performed separately for each sex.

Analysis of variance (ANOVA) was used to detect differences in body mass, tail length, length of longest primary, bill length and fat scores between symptomatic birds and uninfected birds. To determine if there was a difference in disease prevalence between the sexes and among the four sites, a goodness of fit G-test with William's corrections was performed (Sokal and Rohlf 1981). Bonferroni corrections for multiple comparisons were used in follow up tests (Sokal and Rohlf 1981). Values reported are means (±SE).

Results

A total of 175 birds were captured: 104 males and 71 females. Of this total, 35 (20%) were symptomatic for avian pox (Fig. 1). Pox-like symptoms included missing toes, lesions on the toes, bill, near the eye and at the bend of the wing (Hansen 1999). Males and females were equally likely to show pox-like symptoms (23% of males and 16% of females; $G = 1.53$, df= 1, $P = >0.05$). House Finches captured at the residential site were more likely to have pox-like symptoms than those captured at either the Ogden Nature Center or the Hooper site ($G = 11.05$, df= 3, $P = <0.01$; Fig. 2).

Sexes differed in the length of the longest primary and the length of the longest tail feather (Table 1). The average length of the longest primary in males was 78.45 (± 0.23) mm, whereas the average in females was 75.61 (± 0.26) mm. The average tail feather length was 60.59 (± 0.32) mm in males and 58.55 (± 0.42) mm in females. Hence, males and females were analyzed separately when comparing these variables in symptomatic and asymptomatic birds. There were no significant differences between the sexes with respect to fat scores, body mass, and length of the bill (Table 1).

Symptomatic birds had a significantly lower body mass than asymptomatic birds (Table 2). The average body mass of symptomatic birds was 20.75 (± 0.31) grams, whereas the average body mass of asymptomatic birds was 21.36 (± 0.13) grams. However, there were no significant differences between symptomatic and uninfected birds with respect to the length of the longest primary, tail length, bill length, and fat scores (Table 2).

The percentage of red/red-orange males in the entire population was 55%, with 45% of the remaining males classified as orange-yellow/yellow. Symptomatic birds were found to have

an increased yellowed plumage than asymptomatic birds. The total plumage score of symptomatic birds was 74.63 (± 2.15) and 79.67 (± 0.98) for asymptomatic birds. The average plumage score of symptomatic birds was 14.93 (± 0.43) and 15.94 (± 0.20) for asymptomatic birds. The differences in male plumage coloration between symptomatic and asymptomatic birds were statistically significant (Table 2.).

Discussion

This is the first study to document the prevalence and effects of avian pox in northern Utah House Finches. We found 20% of all House Finches captured had pox-like symptoms. These results are consistent with other
western House Finch populations. For example, 20% of 78 post-1960 museum specimens collected in southern California had symptoms associated with avian pox (Zahn and Rothstein 1999).

There was a significant difference in the number of symptomatic birds captured at each site. The locality of each site provides a possible explanation. The Hooper site is a rural setting, whereas the other sites are more urban. Residential sites are likely to contain more bird feeders than rural sites. Bird feeders are believed to facilitate transmission of diseases such as avian pox (Hansen 1999). Thus, symptomatic birds may be more prevalent among urban sites because of the ease of transmission offered by bird feeders. Similar to these findings, McClure (1989) found that diseased birds in Ventura County, California were caught more frequently at urban sites where bird feeders were abundant than at rural sites with a lower density of bird feeders.

We found that symptomatic birds weighed significantly less than uninfected birds. Although significant, the difference in body mass was only a 2% difference between symptomatic and asymptomatic birds. Nolan et al. (1998) demonstrated that, following an outbreak of *Mycoplasma gallisepticum,* male and female House Finches in Alabama weighed significantly less than before the outbreak occurred. In this study, there were no significant differences between symptomatic and uninfected birds with respect to the length of the longest primary, tail length, bill length, or fat scores. However, all of these variables, with the exception of fat scores, are affected by parasitic infections in other studies. For example, Thompson et al. (1997) found that the wing length of House Finches infected with mites in California was significantly reduced relative to uninfected House Finches. Similarly, Nolan et al. (1998) found that wing length and bill length decreased significantly when a House Finch population in Alabama became exposed to *Mycoplasma gallisepticum.* Although we did not record any significant differences between symptomatic and uninfected birds in these variables, a general trend does exist. The average wing length and bill length of symptomatic birds is slightly shorter than that of uninfected birds.

This study demonstrates that avian pox is correlated with the reduced expression of male plumage coloration and may signal physical condition. Studies examining effects of parasitic infections on ornamental traits have found that infected birds are unable to display the decorative sexual traits their healthy counterparts exhibit (Brawner et al. 2000, Nolan et al. 1998, Thompson

et al. 1997, Zahn and Rothstein 1999). We found a large proportion of the male population to have the yellow or dull plumage coloration (45%). This is in direct contrast to locations where pox has not been reported, where 95.3% of males have the bright red coloration (W. Wehtje unpublished data *cited in* Zahn and Rothstein 1999).

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